A COMPLETE COMPILATION OF

THE TECHNICAL AND MAINTENANCE ARTICLES

FOR CITROËN DS, ID AND D-SPECIAL MODELS

Published in the 1974-2011 issues of Citroën Club of North America (Formerly Citroën Car Club of Ohio) Newsletters. Also known as the "Citroënthusiast."

Originally compiled by Ken Betsh, edited by Don James, re-edited by Mark L. Bardenwerper, Sr.

The late Phil Devingt's 1966 Chapron Decapotable and Mark Bardenwerper's 1968 ID19 in 2004. Phil's car was demolished later in a fire. The ID19 has a new owner and is still going strong.

Foreword

by Mark Bardenwerper

These articles were distributed in a 10 disk set of floppy disks containing articles published up to 1999. Nowadays, our computers don't even include floppy drives. They were quirky, fragile and only held 1.44 megabytes of information. I still find it incredible that Ken and Don were able to squeeze this monstrous amount of information onto those little square pieces of plastic! Those floppies laid in the back of my desk for a very long time.

After finishing my first book, I began to think about how I could go about bringing this information to a new audience. The first thing I realized was the immensity of the job, but I knew that if I got started on it and did not try to keep track of the time consumed, I would eventually get it done. It took nearly three years, on and off task.

It wasn't until I was nearly finished with the "files from the floppies," when Ken told me that he had continued his work and created an addendum containing all of the remaining articles up to 2011, the year of the demise of Citroen Club of North America. Of course, I could not leave them out.

Ken Betsh and I have had several conversations about liability. There is concern that the information might be misused, or owners might not be as careful about blocking their cars up as they should. Citroen D's have several issues making them potentially more dangerous to work around. They primarily have to do with the hydraulics. These cars are entirely sprung from fluid and air kept under great pressure. An absence or change in the pressure will turn the car into dead weight. If you happen to be under a D when the hydraulics empty, you will be killed as it falls on you unless the car is adequately supported with stands. Several owners have had this happen and we do not want you to become a statistic. I do hope that we have included enough warnings where applicable.

Furthermore, the hydraulic system is under incredible pressure. Spray from a ruptured line can blind or penetrate skin like a toxic scalpel. Take every precaution when working around piping under pressure and use aircraft-like precision in your repairs and restorations.

I have gone to great lengths to make sure that the spirit of the original writers' work is preserved, while at the same time honing some of the text to make for better readability. You will find that Ken added remarks now and then. I did not alter these, as he and Don were and still are unrefuted authorities on nearly aspect of D ownership and restoration. I have added some as well. Mine are in parentheses with my initials in brackets. There is also still plenty of room for differing opinions. I hope these will be taken in the proper vein.

So much has changed in car restoration and in technology in general. Keep in mind that we made some effort to update resources, but they too change. For instance, Don James, one of the original editors, closed his Citroën parts business many years ago.

I also took the liberty of adding a few articles of my own. Some of them are newly written, but most of them were done over the course of the years of my D ownership. I sold my 1968 ID 19 in 2009 and now drive a 1983 GSA. These cars are but the latest of a long line of European cars I have owned. The first I remember working on was when I was around 8 or 9. It was a 1951 Mercedes Benz 170VA. Next came a 300SL Gullwing, then a BMW Isetta. That makes for almost 60 years of experience, much of that time spent as a professional tech. In 1993, I retired for a while and earned a bachelor's degree in technology education. That was when I started to get the writing bug. It was also when I got my ID19, a barn find that had sat for over 20 years.

Please regard this book as you would any bit of historical evidence and take what you will with that primarily in mind. These articles were published over a long period of time, the first concerning cars barely broken in. Later ones addressed problems with cars that had sometimes passed through several hands. The cars we now are working on are here solely due to the efforts of these early owners. It is a testimony to them that they were really designed to last several years, yet are still here for our enjoyment and caretaking. These people solved problems with materials and parts available. In the pre-internet days, parts were not readily obtained and owners were joined only through the mail and by telephone. Often they were entirely isolated. The Citroën Club was often their sole source of knowledge. This book is a tribute to them and our cars.

Preface

by Ken Betsh

This project started (and hopefully was completed) with two major goals: (1) to include all D-model technical information from every newsletter published by the Citroën Club of North America since its founding in 1974 up through the end of 1996 and (2) to organize the material in an easy-to-find manner with all articles on a particular subject next to each other.

We started with a complete set since joining the Club in early 1985. Don James loaned most of the earlier issues and Denis Foley added a few more. Our total count is 128 issues. We may have missed a few very early issues but these seldom contained the type of material sought for this book.

Work done earlier in preparing the indexes that have appeared several times in the newsletters eased the sorting process. Those indexes didn't use the author's title for his article. Instead, a descriptive title was created starting with the area of the car (body, engine and etc.), the specific part of the car (frame, head and etc.) and the problem and/or repair. Multiple such entries were made for articles covering multiple topics. After considering alternatives, the most effective way to organize the book was to use these created titles and to arrange them in alphabetical order. Articles covering multiple topics have been divided into separate articles. Multiple articles by the same person on the same topic have been combined into a single article. Articles on a single specific subject by different contributors have been kept separate, but next to each other with the earliest first.

While we have had no intentions to rewrite the original articles, the opening paragraph(s) of many have been condensed and restructured so that the user of this book can quickly decide if a particular article will tell him what he wants to know. We sincerely hope these changes do not offend the contributors.

The cooperation of Don James and his willingness to serve as editor of this book has been most important–we couldn't have really done it without him. He served as editor of the newsletter for many years and contributed many articles. Some of his editorial comments in this book date back to the time the article first appeared. He has reviewed the entire contents of this book and many of his comments are new. Don has disagreed with the views of a few contributors and would have preferred the articles deleted. We felt it best to include the articles along with his reasons for disagreement. How often have we decided what to do by first ruling out those things we should not do?

The photographs and drawings originally published with these articles had been scanned in the JPG format. Ability to look at and/or print these illustrations will depend on the user's computer. The JPG format is the commonly used photo format to send pictures by email. Unfortunately, a few of the original drawings and photographs have been lost and it has been necessary to copy them from a newsletter or create replacements. A few crude or hard-to-read sketches have been touched up. Every effort has been made to assure their accuracy.

Under each article title is a line with the writer's name, the state he lives in and a date. Club members wishing to contact a writer will find his home state useful since the Club's annual membership directory is divided that way. Sad to say, many writers are now deceased and we've lost track of others. The writers of a few early articles were never identified. A few articles were written by vendors or others who never were Club members.

DISCLAIMER

The articles found here are to be used primarily for historic purposes. They often contain content that is obsolete or advise the use of chemicals and materials now found to be personally or environmentally harmful.

Use caution when using any information found here. The authors will not be held liable for their use or misuse.

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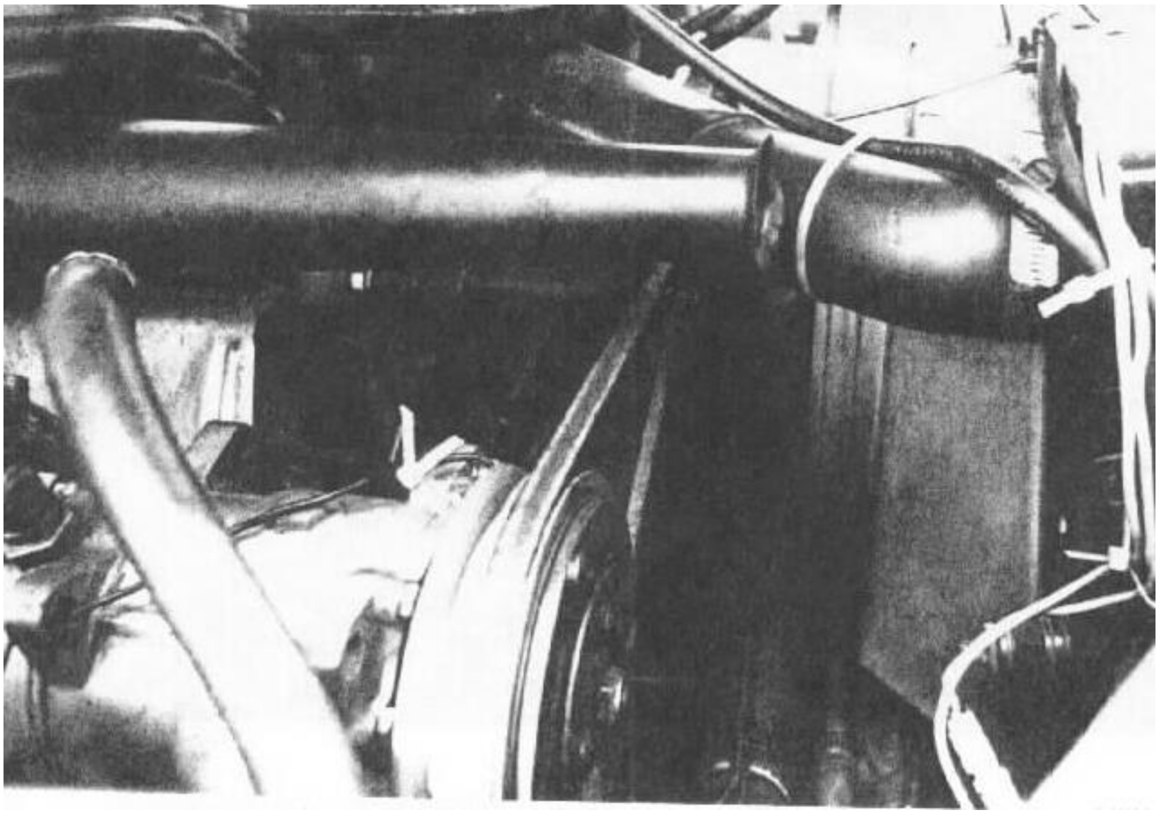
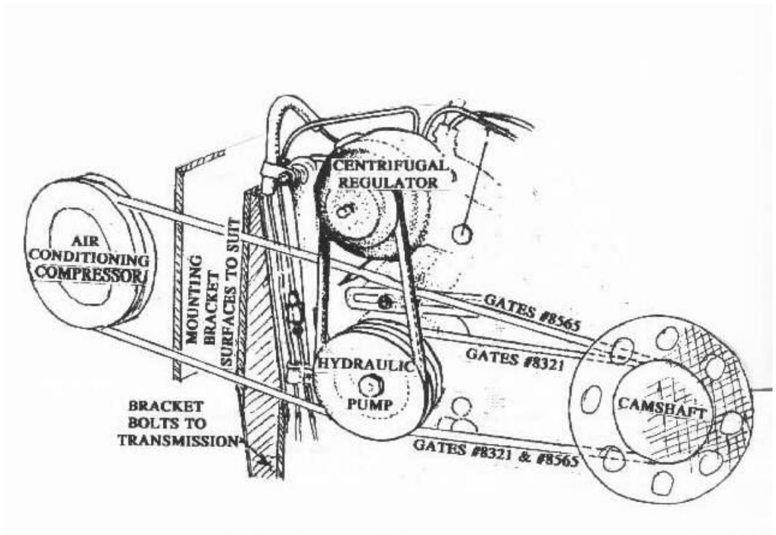
Chapter 1–Air conditioning

Belt driven directly from large camshaft pulley
Dave Burnham, NY (May 1984, p.11)



This picture shows an alternate way of driving the air conditioning compressor on your D-model. The belt goes around the large pulley and is lifted above the clutch release mechanism by adjustable roller that is attached to the lug where the centrifugal regulator mounts. The belt is back tensioned by having the back side of the belt running on the roller.

Belt driven directly from small camshaft pulley
Ed Noriega, WA (Feb. 1984, p.6)



This article is intended for air-conditioned D-model owners who find driving the compressor off the water pump pulley causes premature water pump bearing wear/failure, and the belt slips on the water pump pulley because the pulley speed is too fast for the compressor load.

My '71 DS21 originally had the compressor driven off the water pump pulley. When the A/C (air conditioning) was on and the engine running fast it would pull or drag on the belt because the water pump sheave speed was too fast for the load. It would cause a whine/squeal and smoke, such that it had to be turned off. To avoid that the compressor mounting and belts were rearranged so that the compressor would be driven directly from one of the smaller cam (engine) shaft pulley sheaves, as follows:

The outer belt for the hydraulic pump was removed, vacating that sheave, and the inner belt for the pump was replaced with a thicker one 7/16" x 32.1" (Gates #8321). This left a vacated sheave on the camshaft pulley that could be used to drive the A/C compressor. So a large 7/16" x 56.5" belt (Gates #8565) was used, running from the engine pulley sheave through the bottom groove of the vacated hydraulic pump sheave, then around it and upwards to the A/C compressor pulley sheave.

From the top of the A/C pulley it runs straight back, high over the vacated hydraulic pump sheave to the engine pulley, completing that circuit. The third and outer sheave of the hydraulic pump pulley used to drive the centrifugal regulator was left unchanged, however this belt has to be removed to allow access to put in the other belts. With this arrangement the A/C is driven at a slower speed with plenty of power and no slippage, and it can be tightened up without damage to any of the other accessories. The hydraulic pump however is now driven by only one 7/16" thick belt which is still thicker and stronger than either of the 3/8" thick belts it had originally, however the thickness of this belt can be increased up to 1/2".

The A/C compressor is mounted on an offset bracket/weldment bolted to the engine flywheel/casting on the exhaust side. It is attached to this bracket with threaded rod stock lengths with adjusting nuts on both sides. In this position there is enough room for air to circulate past the A/C compressor to the exhaust header and also it puts the compressor farther out and away from the heat.

Editor: This system will make your compressor turn much slower. This may affect your low-speed cooling in traffic. But, using this setup will allow you to use a much larger displacement compressor. This will make the system much more efficient. A larger compressor will restore good low-speed operation. The original article included additional illustrations that do not seem necessary to convey the idea and technique.

Duct cracks repaired with fiberglass cloth
Don James, OH (Aug. 1985, p.16)

Vacuum-formed plastic of the under-dash air conditioning units used on the D-models tends to crack easily. It can be repaired easily by using fiberglass cloth on the back side. Better still, reinforce the back side before it cracks. Just sand the plastic on the back side to get it clean and rough so that the fiberglass will hold.

Finned tube added to condenser
Ken Butler, NM (Apr. 1989, p.11)

My '70 DS21 Pallas is equipped with an air conditioner condenser system that can be added easily, uses the original equipment, and disposes of the heat outside of the vehicle. The later model Citroëns with the condensers in the fenders and fans to pull air through holes in the bumpers are a big improvement over the older types with the small condenser in the air tunnel, but it is too big a conversion for most of us.

Approximately 12 feet of 1/2" copper tubing with 1" diameter fins is added. A hose carries the hot freon gas from the compressor down under the left side of the car to the finned tube. The finned tube is clamped up under the frame where the aluminum covers are fastened. It runs back to the forward edge of the rear fender and zig zags over to the right hand side. Going forward in the same, it is coupled by hose to the original condenser inlet. This was designed by the Los Angeles Citroën dealer for cars in the Arizona desert area and sure helps cooling.

Overheating ’72 may be due to belt slippage
Don James, OH (Nov. 1985, p. 4)

Q. I have a '72 Citroën DS21 Pallas with 119,000 miles, a one owner car. When the A/C is turned on, the heat register goes into the high range and the light comes on. I have drained, flushed and installed a new Citroën radiator cap, put in new anti-freeze and added Freon. Can anybody give suggestions to alleviate the condition? -Lee Hill

A. Since you have a '72, the condensers should be located in the bumper area of your car, so there is no way the A/C can make your engine overheat. It is a sure bet that your belts are slipping, and this is causing your water pump to stop turning. Check for a plugged expansion valve or an overcharge of refrigerant. Water can form ice and plug the expansion valve, as can little bits of rubber hose flaking off.

Relay disables compressor during rapid acceleration
Ken Butler, NM (Apr. 1989, p.11)

A useful addition to an air conditioned car is a relay, J.C. Whitney catalog #54-1394. Just four wires connected readily under the hood, it senses rapid acceleration, as in passing, and stops the compressor until the car returns to a steady speed. This makes available several more horsepower to facilitate safe passing. Cooling is not affected since the compressor is only off for a short time.

Editor: Relay not listed in 1996 Whitney catalog. (Perhaps a microswitch could be used. [MB])

Chapter 2–Body and trim

Catalytic primer may prevent hairline fiberglass fractures
Lugert, Jerry, NV (Jan. 1991, p.12)

The fiber top on the DS sometimes develops many hairline fractures that show through the paint. When I repainted I used an expensive catalytic primer that may prevent this. The idea is that all the molecules tend to virtually become one, like fiberglass, rather than permitting cracks to show through as with most primers. So far, so good.

Cleaning car includes rust preventative steps
Charles Fowler (Jun. 1976, p.1)

Before you start, be sure to have necessary materials–bucket, sponge, chamois, polish and cloths. At your local discount or auto store purchase a can of spray silicone, spray undercoat and small bottle of Armorall.

Start on the inside. That way, if time or energy runs out, what you have accomplished will give you a sense of satisfaction while you drive. Pull up gray plastic tabs at rear of the rugs and remove them for cleaning (rugs). Vacuum the headliner, seats, door sills and floor. Use sponge and chamois to clean all glass on the inside. If you have vinyl seats, you may want a special cleaner for them. Armorall will make the dash (padded and painted), vinyl trim, seats, tires and exterior paint look like new.

Now that the inside looks nice, comes the important part of cleaning–RUST! This is the demon enemy of Citroëns and the best way to prevent it is to remove the dirt that holds the moisture and keep bare metal covered. Raise car to full height and remove the rear fenders. Boy, look at all that silt. Hose, wire brush and putty knife away all the dirt in the front and rear wheel wells, frame rails under doors, and the inside of the rear fenders. While waiting for things to dry, open the doors and insure drain holes in the bottom are open. Use wire brush and spray undercoat to clean and cover any bare spots or evidence of rust. The undercoat will dribble, so concrete driveway owners be warned. Pay particular attention to the rear bumper brackets and top front inside of rear fenders. Open front doors and clean debris from the rubber flaps at front bottom edge.

Use the can of spray silicone to shoot everything that looks like rubber. Open hood, doors and trunk lid. There is an amazing amount of it and this stuff really prolongs the life of rubber. Noticed the engine compartment, have you? Yes, there is lots of rubber there too, but it is best to wipe the grease from boots, hoses and spark plug wires before spraying. I bet you forgot the boots on the rear suspension cylinders.

Now it is cleaned, rustproofed and rejuvenated and you're too tired to polish the exterior. Oh well, there is always next weekend.

Color names and AC numbers for all models
(May 1990, p.26)

Metallic = (M)

Color	**Couleur**	**Ref**	**Models, Years**
Wormwood	Absinthe	AC 512	ID 62
Amber	Ambre Dore	AC 308	DS 61
Purple	Aubergine	AC 406	DS 56
Beige	Beige Agate	AC 091	DS 69
	Beige Albatros	AC 087	DS 71-72; ID 70-73
	Beige Antillais	AC 309	DS 62; ID 62
	Beige Tholonet (M)	AC 085	DS 73-75; ID 74-75
	Beige Vanneau	AC 083	DS 73-75; ID 74-75
White	Blanc Albâtre	AC 096	DS 68; ID 68
	Blanc Carrare	AC 144	DS 62-67; Cabrio 64-69
	Blanc Cygne	AC 093	DS 69; ID 69; Cabrio 69
	Blanc Meije	AC 088	DS 71-75; ID 70,72-75, Cabrio 70
	Blanc Paros	AC 102	DS 62-65; ID 62-66
	Blanc Stellaire	AC 097	DS 68; ID 68
Blue	Bleu Andalou	AC 623	DS 68
	Bleu Antarctique	AC 617	Cabrio 64-70
	Bleu Camargue	AC 635	DS 72; ID 72-73
	Bleu Crépuscule	AC 618	Cabrio 64-70
	Bleu d'Orient	AC 616	DS 65-66,72; ID 65-67,72-73
	Bleu Danube	AC 630	DS 69; ID 69
	Bleu de Provence	AC 612	DS 63; ID 63-64
	Bleu Delphinium	AC 603	DS 59-60
	Bleu Delta	AC 640	ID 74-75
	Bleu Lagune	AC 639	DS 73-75; ID 74-75
	Bleu Monte-Carlo	AC 605	DS 60-61,66; ID 60-61,67
	Bleu Nuage	AC 604	DS 59; ID 59
	Bleu Nuit	AC 601	ID 59-60
	Bleu Pacifique	AC 607	DS 61-62; ID 61-62
	Bleu Platiné (M)	AC 632	DS 69-70
	Bleu Royal	AC 619	Cabrio 64-70
	Bleu Turquoise	AC 138	ID 57-58
Dark Red	Bordeaux	AC 421	DS 66-67,69-70; ID 67-70
Bronze	Bronze (M)	AC 320	DS 71
Brown	Brun Aurochs	AC 412	DS 63; ID 63
	Brun Écorce	AC 401	DS 68; ID 68
	Brun Isard	AC 414	DS 64-65; ID 64-65
	Brun Palissandre	AC 409	DS 62
	Brun Sardoine	AC 420	ID 66
	Brun Scarabée (M)	AC 427	DS 73-75; ID 73-75
	Ecaille Blonde	AC 306	DS 59-60; ID 59-60

Grey	Champagne	AC 134	DS 56-60
	Gris Anthracite	AC 101	DS 62-65; ID 62-65
	Gris Ardoise	AC 105	DS 63
	Gris Argent	AC 114	Cabrio 64-70
	Gris Brumaire	AC 095	DS 69; ID 69
	Gris Ciel Lourd	AC 120	ID 66
	Gris Cyclone	AC 119	DS 66; ID 66-67
	Gris d'Anjou	AC 086	DS 71; ID 70
	Gris d'Été	AC 106	DS 64-65; ID 64-65
	Gris Impérial (M)	AC 112	Cabrio 64-70
	Gris Kandahar	AC 133	DS 66-68; ID 67-68
	Gris Mirage	AC 142	ID 58-59
	Gris Mouette	AC 146	DS 61
	Gris Nacre (M)	AC 113	Cabrio 64-70
	Gris Nacré	AC 095	DS 68-70,72-75; ID 74-75
	Gris Nocturne	AC 099	DS 67
	Gris Palladium (M)	AC 108	DS 65-66
	Gris Palladium (M)	AC 108b	DS 67-68
	Gris Palombe	AC 145	ID 60
	Gris Rosé	AC 136	DS 56-60
	Gris Sable	AC 104	DS 63; ID 63
	Gris Sahara	AC 111	Cabrio 64-70
	Gris Typhon	AC 147	DS 61; ID 61
Ivory	Ivoire Borely	AC 084	DS 73-75; ID 73-75
Yellow	Jaune Panama	AC 307	DS 60
	Jonquille	AC 305	DS 58-60
Chestnut	Marron Glacé	AC 143	DS 59-61; ID 59-61
Black	Noir	AC 200	DS 56-74; ID 57-68,74-75
Red	Capucine	AC 303	ID 57-58
	Rouge Carmin	AC 411	DS 63-65
	Rouge Corail	AC 418	Cabrio 64-70
	Rouge Cornaline	AC 419	DS 66,68
	Rouge Corrida	AC 417	Cabrio 64-70
	Rouge Corsaire	AC 403	DS 67
	Rouge de Rio	AC 424	DS 71
	Rouge de Grenade	AC 426	DS 72
	Rouge Estérel	AC 408	DS 60-62
	Rouge Masséna	AC 423	DS 72; ID 72-73
	Rouge Rubis	AC 416	Cabrio 64-70
Sand	Sable Métallis (M)	AC 318	DS 69-70,72
	Sable Noir	AC 110	Cabrio 64-70
Green	Vert Argent	AC 527	DS 72-75; ID 73-75
	Vert Charmille	AC 522	DS 68-72; ID 68,70,72
	Vert Cru	AC 505	DS 56
	Vert Foret	AC 519	Cabrio 64-70
	Vert Hédéra	AC 518	DS 65; ID 65-66

Vert Ilcinee....................AC 623...........DS 67
Vert Jura........................AC 509...........DS 66; ID 67
Vert Mélèze...................AC 507...........DS 60-61; ID 60-61
Vert Muscinée...............AC 524...........DS 69; ID 69
Vert Olive......................AC 510...........DS 62; ID 62-63
Vert Tilleul....................AC 516...........DS 64; ID 64

Convertible conversion kit from English company
Hugh J. Meyers, MD (May 1989, p.4)

Dee-Ess Conversions (Malvern) Ltd is a shop in England manufacturing kits to make D-series convertibles and performing conversions. An ad in the September issue of Thoroughbred & Classic Cars doesn't list prices or an address but states to call Linda Williams (0295) 711606. I know no other details of what they do or the quality of the work.

Editor: According to Andrew Brodie, this company has "ceased trading."

Convertible rear clip fabricated from sheet metal
Fay Butler (Jan. 1993, p.14)

Basically, I shape metal in a method that I call "pure metal shaping." The panels stay unstrained and very predictable, enabling me to generate the shape, usually working from the center out and in a way that the end result requires none of the classic "pick and file" to smooth out. The panels are directly off of the power hammer with no material removed from them.

In making the rear body, I started with a paper template that gives me the specific size blank to cut and also locates where all the turned edges and highlight lines are to go. After the panel is stretched on the power hammer in the proper area, then I have the basic sheet to start folding it up to make the panel. At this point the paper should lay on the shaped sheet the same as the original part, just that the edges are not turned. To turn an edge I locate the line where the turned edge will start and run the panel through the Pulmax machine (machine with deep narrow throat) with a set of dies that just give me a thinned out line. Then by hand I turn up the edge; it will want to fold on the line because it is thinner there, therefore slightly weaker. Once it is folded up, I run the panel back through the Pulmax machine with another set of tools that detail the edge, usually to a 90 degrees. From that edge out I use a foot-operated mechanical shrinker/stretcher machine to gather up the excess material to give the detailed edge the right "take off." If the edge has a multi-turned edge (that is, more than one) then I start with the inside one first and work out. Sometimes, if the excess material outside the turned edges is not enough material, I will get more by thinning it out on the power hammer.

The "highlight" lines along the side of the body and the top edge of the outside panel were put in with a rubber top die and steel bottom die that looks like a slightly curved 3" section of a 1" diameter pipe cut in half. The rubber pushes the metal over the pipe in a defined line, not stretching the steel.

The rear deck lid area was made in four pieces with seams going into each corner. I fit each piece to the lid then welded them together to have a complete top body section that the lid fit into. Then the sides (which were one piece except for the little "ear" at the bottom rear that had to be another piece because it was curved in profile) were welded to the top area with one long butt weld seam. All welds were TIG and some were done without the use of filler rod, and all were done without grinding them. They were placed so as to be able to get a power or air hammer to them in a flat area to planish out.

Editor: Planish-to toughen, smooth, or polish (metal) by hammering or rolling. The original newsletter article included eight photographs of work in progress. The body on initial fit, fit excellently and only required minor tuning. Fay Butler has an educational video tape on the "Principles of Metal Shaping" which may still be available from MotorSports Tool in Macclenny, FL. Fay also runs seminars in his shop in Wheelwright, Massachusetts for people interested in learning his trade. (Fay Butler is still going strong. See http://www.faybutler.com/ [MB])

Dashboard transfer from ’71 to ’69 requires major rework
Rod Burwell (2010 #3, p.35)

In trying to install a complete 1971 dashboard into a 1969 body, major cutting, fabricating and welding are required. The substructures are not the same. Exchange of the wiring harness is also required

Door latch lubrication on late outer handles prevents failure
Don James, OH (Jan. 1985, p.23)

The '72 D-models have a small spring in the latch that breaks from wear and corrosion, and it is a job to replace. Routine oiling of the latch prevents this common problem. I use a Valvoline transmission oil bottle with a pointed spout to "squeeze" in the oil. Just pull back the rubber by the window and try to hit the latch mechanism.

Door water protection covers made from plastic bags
Don James, OH (Aug. 1985, p.16)

Those of you who have lost or damaged the plastic covers over the stamped holes in the inner door panels can make new ones very quickly and easily. Hold up a plastic garbage bag while a helper scribes the outline of the hole with a magic marker. Then cut it out with scissors. A double garbage bag will make both right and left pieces. Glue them on with contact cement. Plastic will stretch, and it is easy to get a neat tight job. Remember, these covers are important as there is water flowing down the insides of your door. If they are not replaced, the inside door panel trim may warp from the dampness.

Fender flap for steering arm replacement
Don James, OH (Apr. 1988, p.14)

Replacement flaps for the openings in the front fenders that allow the steering relays to swing partially into the fenders can be easily made from rubber stock. Many D-models have a lot of dirt, mud, and even road salt in the engine compartment coming from the wheel wells because of torn or missing rubber parts. When you replace the front fenders, you can see how the rubber strips work and pull them with your fingers to get them into position.

Use a hand grinder to grind off the heads of pop-rivets so the old rubber flap can be removed. The front fender has been removed from the car. A blunt nail can be used to poke out the old rivets.

Use the old rubber flap as a pattern for cutting the new rubber and marking the hole locations. Heavy shears can be used to cut rubber stock.

Use an oversize drill bit to make the holes. Rubber tends to close up any holes put in it. Drill into a piece of scrap wood.

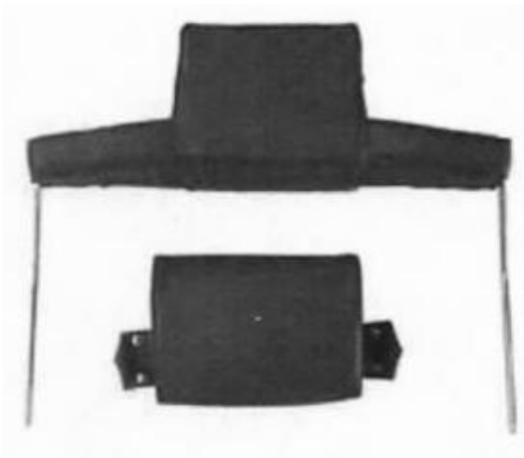
Use 1/8" diameter pop-rivets to install the new rubber flap. The metal straps have been cleaned and reused. Dip the rivets in thick oil to prevent rusting. Add extra rivets if needed.

This project takes about 45 minutes. Some folks may think this is a worthless detail, but attention to detail is what keeps your car from becoming a big pile of very unreliable junk. Keeping road water from the engine will keep things neat and clean, and make working on and servicing your car a more pleasurable experience.

Fender removal easier with silicone spray on mounting horns
Don James, OH (Feb. 1984, p.6)

After removing your fenders, be sure to spray the mounting "horns" with silicone spray lubricant. This keeps the rubber from sticking and prevents any difficulty removing them next time. Use an anti-seize compound on all fender mounting screws, lug nuts, manifold bolts and etc. Lacking this, oil on the threads is better than nothing.

Headrests may fit into concealed tubes
Nebo Djurdjevic (2008 #2, p. 24)

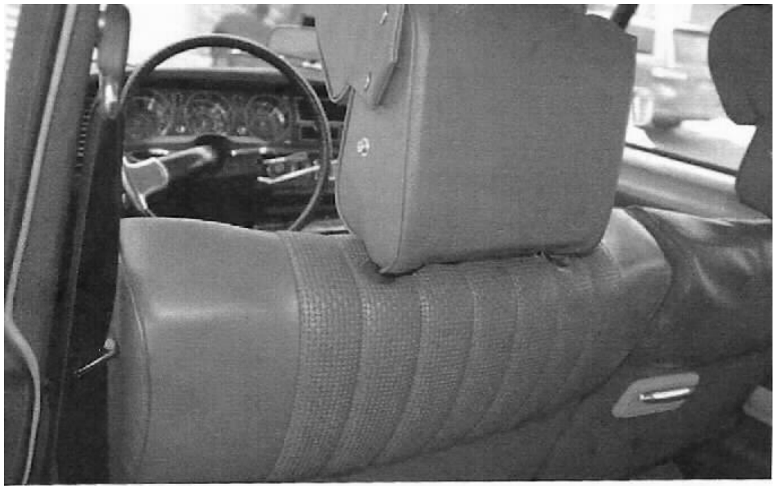


Headrest styles; wide mount (left) and narrow.

I have been planning for a while to get headrests installed on my '71 D Special and the first thing was to determine if I needed wide headrests (old style) that attach at the side of the seat backrest or narrow ones that can be inserted right into the backrest.

I examined the top of the backrest by pressing it with my hands and detected two pipes built right into the frame at a distance that appeared to be correct. I had a pair of CX headrests, but I noticed that the distance between the rods on them is narrower than on those for the DS. I found that Western Hemispheres in California had the correct type of headrests as well as plastic bushings that can be inserted in the seat as guides and a grommet for proper finishing at the top of the backrest.

I placed a small Philips screwdriver right above the pipe and made a little hole in the backrest cover. I inserted the plastic bushing through the cover and straight into the pipe in the seat frame. I put a little bit of glue on the seat cover just under the plastic bushing top in order to get them attached and prevent any potential tearing of the seat cover.



The final step was to simply insert the headrest.

Hood and fender fit
Rod Burwell (May 1983, p.5)

A few people drop their hood and it closes with a clack, as it did when the car left the factory. They are envied by many, who have to twist and jump on the front corner of the hood to get it to latch. The saddest of all are the ones that must price a new hood after the one on their car has blown open. There are so many adjustments that even the do-it-yourselfers don't know where to start. The front of the fenders can be moved back and forth, and also in and out. The hood can be moved back and forth and up and down. It will also move side to side.

The fenders are the place to start. Set the fenders so that the gap between the front door and fender is even. If the front end has been hit, you may have to straighten it to get the fender attaching bracket in the wheel-well to "line-up". This is a good time to get the fender to fit flush with the front door. The rubber sockets on the fenders that slide onto the taper pins that project from the door frame can be adjusted by loosening the bolt at the bottom of the socket.

Next, measure the hood at the front edge, add 3/8", and set the gap between the fenders to that measurement. Center the bolts in the slotted holes in the bumper.

Now, gently lower the hood. Probably one or both of the hinges will need to be moved to get the edges of the hood to fall into the slots in the fender. Where the hinge attaches to the frame of the car, it will adjust in or out. Where the hood itself attaches to the hinge, the holes are slotted back and forth.

Many people have loosened the two bolts and found the hood would not move. There is a bracket attached to the edge of the aluminum, close to the corner, with two phillips-head screws. This bracket is attached to the hinge with a single 8 mm bolt, which must be loosened to move the hood.

With the hood centered between the fenders, the gap should be constant along the edge of the hood, providing the hood has not been flattened. Many people are still unhappy however, because the curve on the edge of the hood is greater than the fender (the front and rear of the hood is flush with the fenders, but the hood is above the fender at the center). The hood looks perfect, but it has been hit at some time in the past, and the tubes that are part of the steel frame that supports the aluminum skin, have been bent. Someone should make a jig to straighten these bent tubes on the car. A lot of cars need it.

Now, with the hood fitting, the final job is to adjust the hood latches, including the most important of all–the safety latch. The pull cable to release the hood latch should be tight but should not have moved the sliding plate more than 1/16". The distance between the latch sockets in the fenders can be measured, and used to set the pins in the hood. The fore and aft location can be set by eye or with tape on the fender. In some cases the hood bracket for the pins has been bent and will have to be straightened to get the pin to fit the socket.

The latch pins can be screwed in or out to get the front of the hood flush with the fender. These pins can be removed entirely while you are making the above adjustments to hood alignment to make the job easier.

The safety latch is mounted on the left front hood latch. It can be moved up and down and back and forth. Often the arm that hooks on a bar welded to the hood frame is bent. It can easily be bent back with pliers. The "notch" in the arm should fully engage the bar, but if it is too far forward, the bar will bend the arm when the hood is closed.

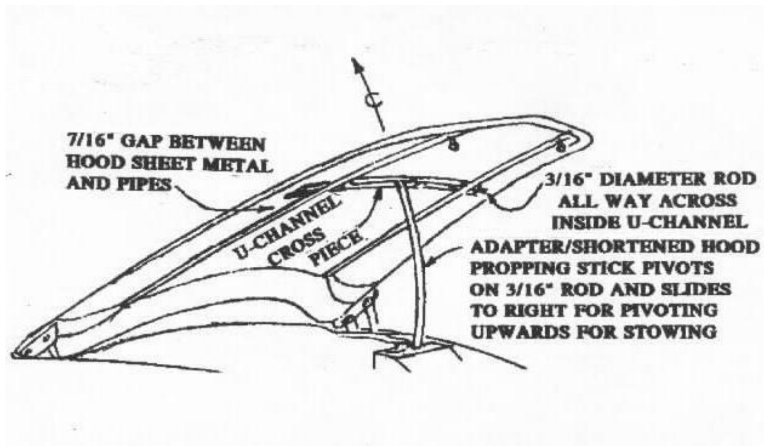
Caution: be sure that the release cables are attached BEFORE you close the hood. Be very sure that the safety latch and hood latches are working and holding properly before driving the car.

Hood dropping invites trouble
Don James, OH (Jan. 1984, p.4)

Do not drop the hood to close it. These cars are not "Detroit Iron". Dropping the hood will bend it in time, and there is always the danger that it did not latch. Lay the hood down gently and press each corner firmly. You will feel it latch. We have again heard of a hood being wrapped over a windshield. This is one of the most common problems to have happen on both D-model and SM cars. The safety latch will not hold at speed.

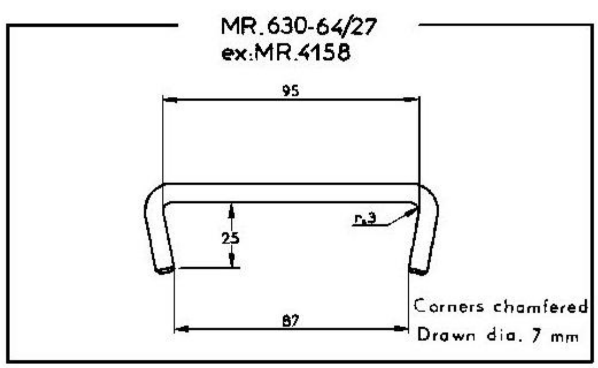
Solution: be sure the hood is latched.

Hood prop modified to support center
Ed Noriega, WA (Sep. 1984, p.18-abridged)



I have a solution to the problem of the D-model hood sagging on the left when propped open on the right side. The fabrication of an added U-channel and shortening of the original propping stick allows the hood to be supported in the center. A simple detent plate added to the top of the radiator holds the propping stick when the hood is raised. An added 3/16" diameter steel rod allows the propping stick to slide back to its original right side for stowing. All parts and materials needed for this project can be found in any good hardware store.

Editor: Mr. Noriega's original newsletter article included lengthy step-by-step instructions and drawings for a modification we feel no one would now want to make. The risk of damage to irreplaceable hood parts and negative effect on resale value is too great. Best solution for getting the hood out of the way when working indoors is a well-placed "sky-hook" suspended from the roof or ceiling. A tail from the hook aids in getting it into position to use or pulling it away when finished. Some owners have a simple short C-shaped rod that fits into holes in one of the hood hinges to hold the hood almost vertically. (The C-shaped rod is in fact a factory-designated tool, MR 630-64/27. Drawing shown below. [MB])



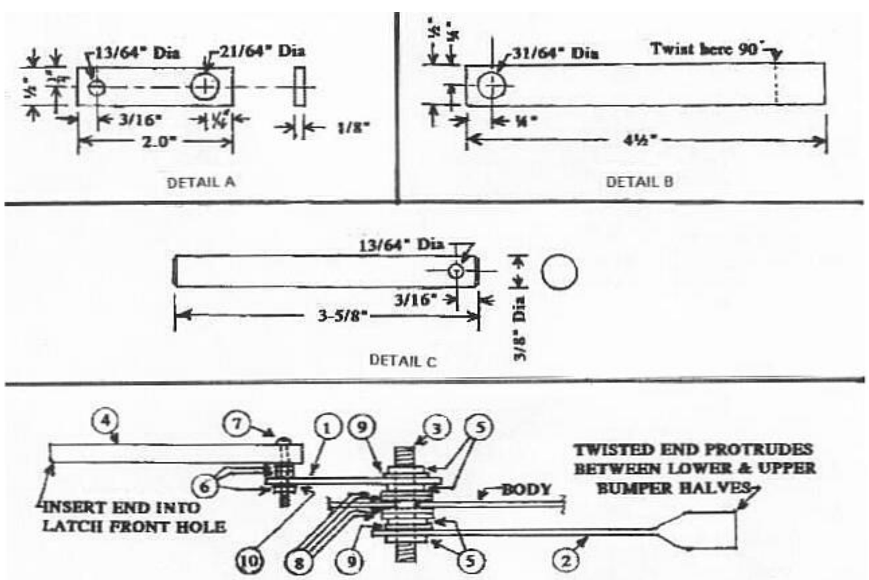
Hood release modification permits opening from front of car
Dave Root, FL (Dec. 1988, p.10-abridged)

For some time I have contemplated a shortcut for the effort required to get the hood open while standing in front of the car. What I've finally come up with meets these requirements and is a real joy to operate–a mechanism simple to make, easy to operate, more or less invisible from the exterior and readily removable if and when necessary. It is simply a bell-crank mechanism operating a rod that fits into the hole on the front of the hood latch–one unit for each side. The lower part of the bell-crank goes in the space between the upper and lower members of the bumper and is the part you push on to release the latch.

Anyone with an electric drill and a little ingenuity can make a set of these external hood opening devices (access to a small drill press is a great help). I estimate the time to make and install a set on a later D-model ('66 to '72) would be less than one hour.

Materials Required

- 2-1/8" x 1/2" x 2" long steel (item #1 in assembly drawing, below)
- 2-1/8" x 1/2" x 4 1/2" long steel (item #2)
- 2-5/16"-18 x 1-3/4" long threaded rod (item #3)
- 2-3/8" dia. x 3-5/8" long steel (item #4)
- 8-5/16"-18 hex nuts (item #5)
- 6-10-24 hex nuts (item #6)
- 2-10-24 x 1" long round head machine screws (item #7)
- 8-5/16" flat washers (smaller OD, if available, item #8)
- 4-5/16" lock washers (item #9)
- 2-3/16" lock washers (item #10)



Front hood release lever details and assembly

Procedure

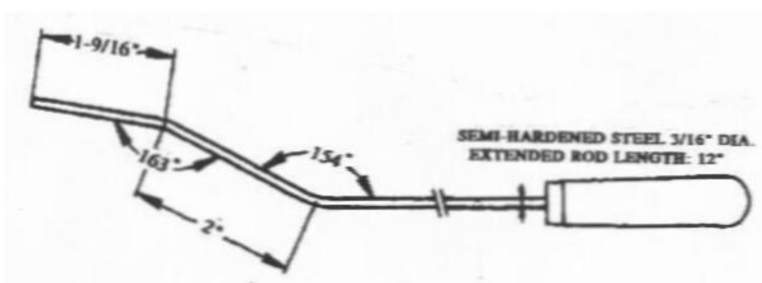
1. Modify the 2" long pieces as shown in detail A, above. Drill 13/64" hole 1/4" from one end.
2. Modify the 4-1/2” long pieces as shown in detail B, above. Drill 21/64” hole 3/8” from one end. Bend 1/2” of other end 90 degrees in a vice.
3. Modify the 3/8" diameter steel rod as shown in detail C, above. Drill a 13/64" hole through the 3/8" diameter steel, 3/8" from one end.
4. You are now ready for the drilling on the car. Open the hood the hard way for the last time. Lay a straight edge along the inside edge of the ear that has the bolt through it to fasten the fender in place. Along the edge of the straight edge, scratch a line in the area painted black. On that line, 3/8" in from the chrome upper part of the bumper make a center punch mark. Do this on both sides of the car. At these marks drill through with a 21/64" drill. Remove the burr from the underside of these holes with a long chisel or file.
5. Put a nut on one end of the 5/16"-18 pieces of threaded rod. Slide on the 1/8" x 1/2" x 4 1/2" piece, then a lock washer, then another nut. Tighten the nut very tightly. We'll call this the lever subassembly.
6. Put the 10-24 x 1" round head machine screw through the hole in the end of the 3/8" diameter steel pieces. Then put two nuts on locked together at point that will allow the screw to turn freely in the 3/8" pieces. Next, slide on the 1/8" x 1/2" x 2" piece followed by a look washer and nut. Holding the two nuts, tighten the last nut. We'll call this the plunger subassembly.
7. Put the lever subassemblies up through the holes you drilled just behind the bumper. Put two flat washers on each side (unless you found washers with very small outside diameters you will have to cut them off with a hacksaw or chisel. This is so they will fit down flat in the spot on the black area back of the bumper where they go). Next put on a hex nut just tight enough so the lever will move with some resistance (this is so it will not flop around in flight). Position the levers in the straight-ahead position.
8. Now for final assembly. Grab the plunger assembly and with the 3/8" diameter on top, stick it in the hole in the front of the hood latch, then slip the 1/8" x 1/2" x 2" long piece over the protruding 5/16"-18 piece. Follow this with a lock washer and nut. Hold the bottom nut with an open-end wrench (1/2") and tighten down the top nut very firmly. Repeat for the other side.
9. Now for the final fun step. See that the levers work the latches freely and that the spring returns them to the locked position. Now, let the hood fall and latch. Then, if you are ready for this, push the levers outward and your hood is unlatched.


Front hood release installation

Hood released with 6mm rod or screwdriver when cable fails
Neal Newman (Sep. 1984, p.22)

Here's a tip for those of you who may have had (or will have) a stuck hood release. If a cable breaks, or a fender-bender stuffs your hood latches in a tiny bit and slackens the cables, the latch cannot be released in the normal fashion. The folks at Citroën have provided for this, however, by making a hole in the front of the latch housing. Simply take a big screwdriver or pinch bar and gently pry up the corner of the hood (about 1/2" or less). Look in with a flashlight and you will see a hole in the upper part of the latch housing. Carefully insert a rod of about 6 mm or a long thin screwdriver, and push the latch back to release. It may take quite a push if there is tension on the hood. As far as I know, this works on all later D-models.

Hood released with tool when cable breaks or is disconnected
Don James, OH (Aug. 1985, p.31)



Very often we hear of someone that closes the hood on his D-model after forgetting to rehook the release cables. There is no need to mangle the hood. Construct the tool as shown above. A 12" length of 3/16" diameter steel rod should work fine. A handle, such as on a file, will prove very practical.

Next time you open your hood, you will see that all "four-headlight" D-models have a round hole at the forward end of the latch mechanism. This is what you must hit with this tool. Just slip it under the small crack where the hood meets the front bumper and when you hit the hole, push in.

If your cables are still attached, but you can not release the hood because they have stretched or because the cable-end is not adjusted properly, you can grasp the cable through the opening in the inside of the front fender. This opening allows the relay arm to swing into the fender well. The opening to this is supposed to be covered by a rubber mudflap that you can reach through and grasp the cable or it's housing. You should be able to put enough of a kink in it that with the help of an assistant pulling the release inside the car, you should be able to open the hood catch easily.

Hood to fender alignment retained with added marker hole
Bob James, OH (Feb. 1984, p.6)

The most onerous chore in replacement of a D-model fender is the hood to fender alignment. Next time before removal, examine this alignment and adjust to perfection by loosening the 14 mm bolt at front of fender under the hood. Now tighten the bolt and drill a 1/8" hole near the bolt and through both the corner of the fender and the chassis. This hole can be used for alignment during future fender replacements. Similar alignment holes can be used if you ever remove the hood.

Leather cleaner and rejuvenator that works: “Leatherique”
Don James, OH (Nov. 1982, p.8 and Feb. 1995, p.9)

About three years ago I bought an old parts car mainly for a brown leather interior to replace the bad cloth interior of my '72 S-Special. It had been sitting in a field for a number of years and the leather was in very bad shape, as far as looks go. But there were no cuts or tears except a large hole cut in the storage pocket of the driver's side door panel. A fellow club member was able to supply a leather door panel with a good pocket.

I next ordered a product called Leatherique from an ad in a car restoration magazine that was supposed to make old leather look like new. I sent them a sample of the color that I wanted, and in a few days a can of the "stuff" arrived.

I tried it first on the old torn panel. I followed the instructions and painted it on. It was terrible. It was the worst looking stuff that I had ever seen. I tossed the panel into the corner of the garage and forgot about it. Later, when a fellow club member came over to see my car, we were in my garage talking when he noticed the door panel. He wanted to know why I put the hole in a "new" leather door panel. I did a real double take when he showed me the panel. It was perfect. It seems when the "stuff" gets dry it looks totally different. There is no warning on the can that it will look terrible at first. They do an excellent job of custom color matching. I have done all of my seats, and they still look good after three years of driving the car to work at a machine shop.

It cleans up with water, sort of like latex paint. You can change the color of the leather, too, if you like. They also sell a rejuvenator oil that will soften hard leather. It is the only stuff I have ever seen that works–not just wishful thinking like Lexol. You must remove the old finish before you use it, so that it can soak in. Be sure to remove excess rejuvenator oil or your new finish will not stick. They also sell a leather crack filler. A friend who used it cautions not to use too much. It gets very hard and it's very difficult to sand off the excess.

Leather cleaner and rejuvenator that works: "Leatherique"
George Pasvlisko, Jr. (Mar. 1995, p.16 and Jan. 1996, p.13)

Think of your leather as a once living natural product that it is and treat it accordingly. Leather consists of porous, protein-strong fibers that must be kept clean and enriched to stay strong and flexible, just like our own skin. Therefore, we do not recommend the use of silicone sealers for leather or lacquer-based dyes as they seal the pores and prevent conditioners from doing their job. They cause leather to dry, crack and age more quickly. We do not wrap our bodies in plastic wrap to keep clean. Think of how harmful that effect would be and how much we benefit from soap, water, moisturizer and good sun block. Rejuvenator Oil and Prestine Clean work because they do not contain any lanolin, petroleum products, waxes or artificial soils that only sit on the surface of the leather for a "slick" look and feel. The natural wholesome ingredients penetrate and work from within. Once Rejuvenator is in the pores of the leather, it continues to work for many months. Application of Rejuvenator would be required seasonally, with Prestine Clean wipe downs monthly or as often as you clean your interior, depending on the use and storage of your motor car. Daily drivers require more care than a garaged vehicle.

Step 1-Liberally apply Rejuvenator Oil to your interior seats, dash, door panels, and rubber seals, which all will benefit from the natural conditioner. Roll up your car windows, park your car in the warm sun for several hours and allow the oil to steam in. The oil has a capillary action that forces proteins into the leather as dirt is forced out. You will notice the oil itself is not heavy as you apply it, but the seats may become sticky or tacky as the dirt, air pollution and perspiration from the drivers and passengers are forced out of the leather.

Step 2-We suggest leaving the bottle of Prestine Clean in the sun to warm also while your car is receiving its facial. Then pour some of the warmed cleaner into a bowl for easy access and clean the interior with a terry washcloth or a soft brush liberally dipped in the cleaner. Don't forget your vinyl and rubber door seals, which will be like new from the thorough cleaning.

Step 3-Lightly buff your interior with a dry terry cloth and enjoy the luxurious feel and smell of completely clean, conditioned leather.

Leather restoration and refinishing
Charles Fowler, Dec. Feb. 1990, p.3)

Regarding leather care, I would not use saddle soap as it could stain light colored leather and is suitable more for burnished material found in equestrian areas. Lexol is a good readily available product. For very hardened leather, the best rejuvenator oil I've found is Leatherique.

License plate pan in fiberglass from Western Hemispheres
Chris Dubuque, WA (Feb. 1995, p.10)

The front license plate pan for four-headlight D-models has not been readily available for quite a few years now. The pan is a stamped sheet metal affair that seems ultra-vulnerable to the ravages of advancing miles. These ravages include flying rocks and debris, the car settling down onto an object as the suspension settles, or the straps and arms from a tow truck. Once the pan is damaged, it is very difficult to repair with good results. Part of the reason is that the little fins for the horn grilles are virtually impossible to get straight once bent!

Fortunately, Western Hemispheres is now stocking a European-made reproduction made from fiberglass (P/N DX 578 230A). Now before you scoff at a fiberglass reproduction, you must see the quality of this particular part! The mold was apparently taken from a original part, and so the shape is perfect. The reproduction pan has many layers of glass weave so the part is quite rigid and strong–maybe stronger than the thin gage sheet metal original. Also, the horn grille fins are reinforced on the inside, which makes them very strong, resistant to damage and yet look exactly original from the outside.

One of the more clever aspects of the reproduction parts are how the manufacturer handled the threaded nuts that are welded onto the original part to accept the mounting screws. The fiberglass pan cleverly has metal inserts mounted in the fiberglass which are threaded M5 x 0.8 to accept the mounting screws in the same fashion as the original pan.

Painting can be pain(ting) when doing it yourself outdoors
Dave Root, FL

Part One (Mar. 1993, p.15)
The only thing I like less than doing bodywork and car painting is paying someone else to do it! After altering somewhat the shape of the hood of my '70 Pallas by not realizing it was in first gear as the pressure rose, a bit of cosmetic surgery was overdue. Also, there were some more minor dents and scratches that warranted repainting the car from the windows down.

In a Citroën catalog, I had seen a "D" sedan with a light pinkish orange color that my mind's eye began to see as an asset to the appearance of my car. I thought a striking-looking car like a "D" deserved an exotic color like this.

I determined to try to ease the strain and pain of painting by doing the bumping, filling, sanding, masking, and spraying by stretching out the whole process over a long period of time to reduce the feelings of urgency and tediousness of the process.

From experience, I have found that when having a certain color in mind, that it is a process of trial and error to reach the desired goal. Small color chips are a start, but often are misleading when the color thus depicted is spread on a whole car. The first quart I had someone mix from seeing a chip was close, but after spraying a quart on the door edges and one side of the car, it didn't seem to be quite the color I had envisioned.

Besides, my efforts became plagued with troubles: I was working outside, which in itself can cause problems. First, a piece of newspaper I had used for masking but had not taped down properly was lifted by a wind gust that deposited it in the fresh paint on the rear deck! I quickly pulled it free, but it left newsprint on the back of the car. I could have let it go by adding an additional sign–"If you can read this, you're following too closely"–but instead, I removed the printing successfully with masking tape.

Evidently, this wasn't all the frustration I needed because, since I was out of practice, I began getting "curtains" (a series of connected runs). I had enough "curtains" to start an interior decorating business. Instead, I removed them by again using masking tape–and old painter's trick (and I am an old painter, but with amateur status).

At this point I decided to order a quart of a slightly darker shade of paint that I hoped would be closer to what I imagined it should be. How will this all come out? I don't know yet, as I am in the middle of procrastination–something I am becoming a "pro" at during a paint job in effort to take out some of the pain. I am waiting for a current cold spell to pass before proceeding ahead slowly. Hopefully, good results from my efforts will be seen by those who come to our Sebring Spring meet. Some paint jobs look better if you stand back a little, but I hope that with mine one won't have to stand back as much as 50 feet to make it look good! In car painting, I have learned that the best policy is to expect the worst but hope for the best. If I have been successful in removing the "PAIN" from "PAIN-TING", I hope that what is left is a "TING" of beauty.

Part Two (Apr. 1993, p.14)
I can report that the "pain-ting" is done and that the somewhat pleasing (I think) light coral color will remain for some time, for better or worse.

How did I come up with such a color? I never saw a Citroën with that color, but spotted a picture of one with it on page 64 of the book, "Les Prestigieuses Citroën", by Fabien Sabates. Also it appeared in an early ID19 Citroën catalog. In addition, it is the color of the house of Calvin O'Neill (former Citroën dealer in Haines City, Florida), and the hue of my wife's bathrobe. It is enough color to attract the eye, but soft enough not to be too shocking. Anyway, I am stuck on it, as were some dozen or so insects who were attracted to it when it was wet. As "curiosity killed the cat," so these bugs lost their lives. Anyway, they came off easily. I gave them the "brush off," telling them to "bug off." Or it could be said that I am stuck with the color as I will not have the inclination to go through the agony of panting again for some time. But at least I "stuck to it" and got the job done, finally. And it is somewhat presentable, after some lessons I learned and extra work I put myself to. I will relate these for the somewhat doubtful benefit it might be to humanity.

After putting off final "P" Day ("P" for painting) as long as possible, I was "hot to trot" or "passionate to paint" and there was no turning back. I had a whole side of the car to repaint which was already standing upright. I took the hood off and stood it upright for easier access. The painting of the side of the car went rather well. Encouraged, I put one full wet coat on the hood and it looked about perfect. But since the directions say "two full wet coats" I started on the second coat bravely. But after it was done, I saw the dreaded phenomena: runs, so called "curtains" were starting. I quickly laid the hood down flat, but too late! I removed some of the runs with masking tape, but this left some rather uneven places. Because of the addition of hardener in the acrylic enamel, in a few days I could sand the runs and uneven places dry with 220 paper, then wet with 1200 (very fine) paper. To give gloss I used polishing compound (not rubbing compound). There was some overspray in places which I removed with 1200 paper and polishing compound.

Because I find masking tedious, boring, and time-consuming, I elected to roll the windows down rather than mask them. Later I spent three times as much time removing overspray as I would have spent in masking! But I learned a great way to clean windows which could be of general help: I dampened a cloth with lacquer thinner, rubbed it all over the glass and chrome, then rubbed this immediately with newspaper. The windows came out sparkling clean! This procedure also works wonders on chrome and stainless trim. I also used this process on a kitchen window my wife was having trouble getting clean, thereby proving I had some value in the house as well as the garage.

After much suffering and work, I have a car that looks good at least from a distance, and not too bad close up even, provided one is not hypercritical, allowing I am a human being and a non-professional car painter. When I paint I always learn lessons, but forget them by the time I get up gumption to paint a car again.

Reading the above could have several results. If you are a confirmed "Let a professional do it" type, you are more convinced than ever to keep it that way. If you are a proficient car painter, you may readily see what I did wrong and feel some justified pride in what you can do. Or if you are a do-it-yourselfer like I am, you can understand, sympathize, and empathize with what I have gone through.

We Citroënthusiasts can be in different categories yet all share the desire to keep our Citroëns looking good and running better–and can have fun doing it and talking about it.

Editor: Dave sold his coral-colored car and the new owner had it repainted a beautiful black.

Pan under engine easier to install with brake ducts attached
Ken Betsh (2009 #4, p.13)

Replacing the nearly flat pan under the D-model transmission and front brakes is a lot easier if it is removed with the two sheet-metal brake air ducts still attached to it. Each air duct extends forward several inches from the pan and is held by two easy-to-reach sheet-metal screws at the front edge of the brake air duct inlet opening in the valence under the front bumper. Removing and replacing the pan with the ducts still attached adds very little extra effort compared to the frustration of lining up many more screw holes the other way.

Replacing rear trailing arm mounting area
Doug Pengelly (2005 #1, p.25)

Right side rust damage seen with wheel and suspension removed

After having driven my DS for many years, I began to notice that it was behaving funny, funnier than usual, that is. It would sway laterally at the back end. When changing lanes over street-car tracks, it would seem to hesitate leaving it's lane and then all of a sudden jump over. The second clue came when I noticed that the rear tire sidewalls were rubbing against the fender skirts. Upon closer examination it became clear that the rear wheels weren't too parallel. Taking the fenders off and jacking the car up, I soon discovered why. The suspension arm bearings go through a box section and the part with the suspension stops was rusted and sheared off, leaving the arm loose enough to move slightly. In effect, the rear suspension was being held up by the anti-roll bar. On closer inspection, I realized that if the trunk-lid leaked, water ran down to the lowest point and pooled where the box section for the arm bearings was.

Same area after the rusty part has been removed

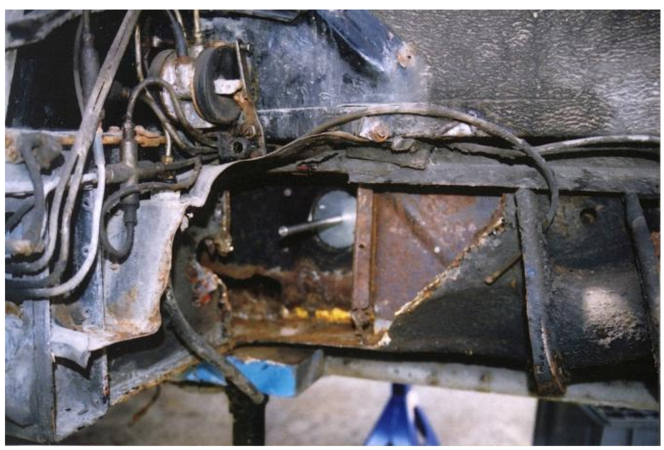
Later on people told me that when this happens, they usually scrap the car. This never entered my mind as I was busy thinking about how I would fix it. I had the Chassen book "How Citroen" and it had templates to make the repair pieces and a brief instruction on how to do it. Never one to do things the easy way, I set out to fix the car. I had also been planning on repairing the main frame rails and front footwells, so I figured that now was the time.

I did not have room in the garage to get around, so I raised the car in the driveway and set it on jackstands, with the rear ones on either side of the cross box behind the gas tank and the front ones at the point where the front suspension arms mount in their bearings. I leveled the box sections and was able to get the doors to shut properly (which they hadn't done in a while).

SAFETY NOTE: Never trust the hydraulic suspension or a jack to hold your car up when you are under it. Always use jack stands or supports to secure the car. The car is heavy and you will go "squish."

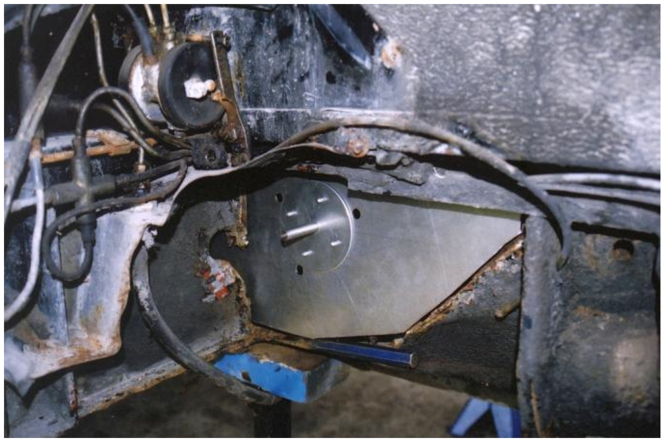
To gain access, I removed the back seat, rear heater and the anti-roll bar. The suspension arms are held on by three studs on the outside and a big castellated nut inside the trunk (for which the Citroen Autoclub Canada has a special tool). The arms were nice and snug, but I got them out by putting a bottle jack sideways inside the trunk between the arms. I pressed it apart while hitting the outside with a big hammer to separate the outer box from the arm.

Since lining the arms up is important, I took Bob DeBruyn's advice and did one side at a time. I did the worse side first so that I would have a better reference to line up to. I also removed the rear suspension cylinders and spheres to inspect their mounts.



Left rear area with alignment tool in place to center outer plate

Once the arm was off I was able to get an idea of how rusty things were. I cut out the outer box wall and cleaned up and cut back until I had good metal. Using nice thick 1/8" plate steel, Bob made up plates for the rear box according to the Chassen book, and drilled a precise hole to snugly fit the outer arm bearing. He also made an alignment tool to get the inner and outer centered properly. It consisted of a rod with a pointy end to line up with the far arm, going through two discs snugly fitting the inner and outer holes of the box section to line them up relative to the other side. I added extra reinforcing metal inside the box and then welded the plate in place. I also fabricated new suspension stops since they are part of the outer section.



Left rear area with outer plate in place ready to be welded

Before closing the box I was sure to paint the insides to prevent new rust. I brushed on two coats of Tremclad red iron oxide primer. For the areas near where I was welding, I sprayed a weld through primer, which doesn't burn away (as much). Even though I was using a mig wire welder as opposed to a torch, the metal gets nice and hot and bits of undercoating have a habit of burning nicely. Unlike the guys on TV, I use a welding mask, making it hard to see the little flames. I kept a bucket of water at hand so as not to set the whole damn car on fire.

Same area with inside reinforcing metal welded in place

After completing one side, I reinstalled the arm and did the other side. Fortunately the mounts for the suspension cylinders were pretty solid, and did not need repair.

Rear window defroster repair procedure

Citroën Technical Bulletin 111–Dated 8/6/69 (May 1993, p.24)

1. Replacement of the flat eye terminals: Tin the section of the terminal which is to be soldered. Tin solder it at the place provided (using a soldering iron).
2. Repairing a break in resistance wire less than 0.5 mm (0.020") in length: The repair can be made with a soldering iron. There are no special precautions. Place a bead of tin solder at the rupture. The solder adheres to the wire only and assures the junction.

3. Repairing a break in resistance wire more than 0.5 mm (0.020") long: Cut a piece of #28 copper wire 10 mm (3/8") longer than the broken section of the resistance wire. Flatten this wire along its entire length to a width of O.6 to 0.7mm (0.024" to 0.028"). To insure that it rests rectilinear, it is preferable that this wire be flattened between two plates, using a vise rather than a hammer. Carefully tin the copper wire. Position it so that it overlaps the resistance wire of the windshield 5 mm (3/16") at each end. Tin solder the resistance wire and the wire attached at each end. After soldering, glue the wire onto the glass using a transparent adhesive commonly available in local hardware or department stores. Make the wire adhere to the glass by pressing on it lightly, using a screwdriver, for example. Allow it to dry 24 hours. Remove the excess glue using a scraper or an eraser, but avoid scratching the glass.

Remark: For these operations use a small soldering iron (approximately 30 Watts) and soldering wire with a flux core (Permatex makes a solderless window grid repair kit. It is Permatex Part No. 09117. [MB])

Rear windows shatters after leaving defroster on all day
Ken Butler, NM (Jul. 1984, p.20)

My J.C. Whitney rear window defroster worked great until the day I forgot to shut it off and left it on all day in the shop parking lot. Lesson learned! Put a timer or wire it to the ignition switch so that it will operate only when the car is running.

Editor: A photograph in the original newsletter article shows a shattered rear window of a D-model sedan.

Roof leaks stopped with sealer around roof bolts near front
Barton Milligan, Bahamas (May 1994, p.7)

After suffering from water leaks over the driver's seat and suffering even more from the comments about the water leaks over the passenger seat for over twenty years, I finally took time to locate the cause of the problem. Upon removing the roof once again to install a new seal and put on a new headliner, I looked carefully for signs of where the water had been coming in and concluded that the roof seal had not been leaking! However, there was rust around the holes for the bolts that hold the roof on.

Now I'm sure that many others have also noticed that a D-model roof leaks when the car is moving and not when it is stationary. The reason is that rainwater is swept back along the trim above the door and then enters the car up around the bolts. The motive force could be capillary action or a differential in air pressure between inside and outside created by the motion of the car. In any event the cure is a little sealer around the heads of the two bolts over each front door opening. The bolts placed further back have not seemed to be a problem for me but there's no reason not to seal them too.

I have been reading Citroën newsletters for two decades and have seen numerous suggested remedies for roof leaks and have tried quite a few. However, my new discovery is the only one that has worked for me.

Roof resealed with Penetrol and silicone
Charles Fowler, Dec. (Jul. 1983, p.5)

Several members have questioned how to cure a leaking roof on a D-model. Here is what worked for me:

Materials Required:
- 1 qt. Penetrol
- 1" paint brush
- Tube of clear silicone windshield caulk
- 11 mm open and box wrenches.

Penetrol is a paint additive sold in better hardware and paint stores. If you can't find it in a quart size, buy the gallon and I'll tell you how to use the rest later. Silicon sealer can be bought in tubes for caulking guns, but it is expensive and the stuff always dries out so a 6 to 8 oz. tube is enough.

Using a wide screwdriver, without sharp edges, pry the rubber roof molding away from the roof all the way around. Now start over, holding the rubber away from roof with screwdriver while dipping the Penetrol behind it with the brush. This is easier with a helper. While you are at it, coat the space between the rubber molding and the chrome also. Wipe off excess with a rag and repeat operation with the silicone. A helper is handy here as you must insert the finest continuous bead that you can achieve. Silicone excess is difficult to remove and after drying, looks like scum on the paint, but it can be peeled off tediously. If there is a gap between the rubber and chrome molding, apply a fine bead along there, also. Smooth with a finger dipped in Penetrol.

Now look under the roof lip overhang on the outside (above the window glass) and you will find five 11mm bolts on each side. These pass through the roof and attach to 11mm nuts in the lip that passes around the roof on the inside of the car. There are also three blind bolts fastened to nuts above the windshield inside and one more behind each roof turn signal. D-Special owners won't have much trouble tightening all of these, but Pallas model owners will probably have to remove the inside roof trim. These nuts must be tightened snugly as they are the major cause of leaks.

Mix 10% Penetrol with oil base black gloss Rustoleum. Use this to paint the cowl at bottom of windshield, door jambs and posts, engine compartment frame horns, etc. This stuff soaks in, dries shiny, and doesn't peel.

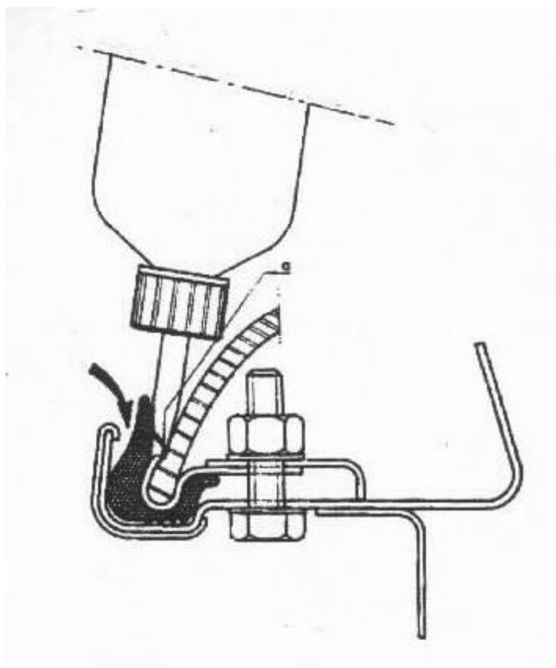
Roof resealed with caulking and Whitney #18GK4337B strips
Ken Butler, NM (Feb. 1987, p.8)

A permanent fix for that leaky roof: Remove all bolts holding the roof in place and all chrome trim. Remove roof and wire brush the inside with an electric drill motor until clean of all glue.

Cut a short nap rug to fit the roof. Cement it in place with contact cement applied to both surfaces–the inside of the roof and the back of the carpet. Wire brush the groove into which the roof is bolted to remove all mastic, rust, etc. Using GE Silicone Rubber Caulking, apply a generous bead in the body groove into which the edge of the roof fits, and apply a bead to the edge of the roof itself. Stick rubber weatherstripping (J.C. Whitney long) to the roof. Place the roof in its groove and bolt it down, starting at the center front and progressing to the rear, alternating sides. Promptly remove all excess caulking with a wood stick. You now have a permanent headliner that will stay up there, and if you have not been too skimpy with the silicone, you now have a totally watertight roof.

Roof resealed with varnish

Citroën Technical Bulletins #67 and #77–Dec. 18, 1968 (Mar. 1992, p.16)



A poor sealing against water from the roof can become apparent by: (1) a roof lining stained by water or (2) appearance of water through the hole located in the roof frame over the right front door entrance.

Service:

- Obtain sealing varnish (the type sold in plastic tubes).
- Remove the ribbon of mastic placed at the front of the roof.
- With the help of a screwdriver, pull back the lip of the rubber roof seal so as to permit easy passage of the spout of the plastic tube (see above).
- Simultaneously apply at "a" a slender continuous string of varnish around the entire circumference of the roof.
- Do the same operation at "b".
- Allow the varnish to dry at least 5 minutes then replace the ribbon of mastic at the front of the roof.

- The car can be used four hours after application of the varnish.

Notes:

- On painted roofs (station wagons or older D-models) avoid excessive use of the varnish in order to prevent its attacking the paint.
- This operation must be done on cars that are perfectly dry.
- When applying the varnish, in order to prevent damage to the paint of the roof, proceed as follows:
- On the roof, apply evenly with the edge of the rubber seal, a band of infrared type adhesive tape (smooth paper backing).
- Lay in the varnish as indicated in the paragraph "Service", them separate the adhesive band which also will remove the excess varnish without leaving any marks on the paint.

Rust and corrosion retarded with oil-soaked batts
Chuck Alexander (Oct. 1979, p.2)

To help retard rust and corrosion from forming on the hydraulic pipes in the front and rear left wheel well areas, pack fiberglass insulation batts (unfaced) soaked with a heavy oil around the pipes before putting the gravel shields back on. The tighter the packing the longer the oil will stay in the batts.

Editor: Protecting the pipes is a good idea, but not this way.

Side bump strips reattached with double adhesive tape
Paul Fontaine, IL (May 1990, p.11)

Several of my door bump strips became detached of late. A local body shop suggested a 3M product called Scotch Mount, 7/8" x 20 yards, #06831, available from automotive paint stores.

The material is a double coated acrylic foam tape with an orange backing that is peeled off after attaching it to the bump strip. Both surfaces must be chemically clean and dry for good adhesion. I took the added precaution of adding a fail-safe self-tapping screw on each end of the bumper strip.

Be sure to get the tape with the orange backing as there is a variety with green backing. This tape is not cheap, however the knowledge that the bump strips on your Pallas are firmly anchored is well worth the price of the tape.

The first time I used only one thickness, but it did not account for the inequities of the strip and the door sheet metal. I found that two layers was a better cushion and compensated for the various inequalities of the surface.

Station wagon rear fender held by hidden bolt
Ken Betsh (2009 #4, p.13)

Just like the sedan, a single bolt locks each rear fender of a D-model station wagon in place. Instead of being in plain sight as on the sedan fender, on the wagon it's hidden behind a reflector located below the lowest of three rear lights in a vertical row. Removing the reflector requires removing two small screws, plus moving the reflector up to free a retainer clip.

Tail gate wrinkle accident pulled out by local body shop
Ken Betsh, PA (Apr. 1993, p.16)

A recent rear-ender to our '72 D-wagon left the lower tail gate and bumper bent beyond salvage and the rear of the wagon floor where the tail gate is attached was pushed forward about an inch in the center to about two inches on the right. The other party's insurance company recommended the body shop of the local Oldsmobile agency who did an amazing job of pulling it back into position. I made a deal for the use of the tail gate and bumper that I removed from a similar wagon stripped many years ago.

Knowing the force required to pull out the damage required a lot of restraint to the body of the wagon and knowing the shop had no experience working with Citroëns, I advised them to tie their restraints at the base of the swinging arms supporting the rear wheels. What I failed to say was that next to the right side base there is a short rubber hose connecting two metal pipes in the gasoline filler line. I became aware of damage to this hose the first time I attempted to refill the tank; a considerable amount leaked out from under the front edge of the rear fender.

Trim strip clips held with screws instead of pins
Ken Betsh (May 1997, p.22)

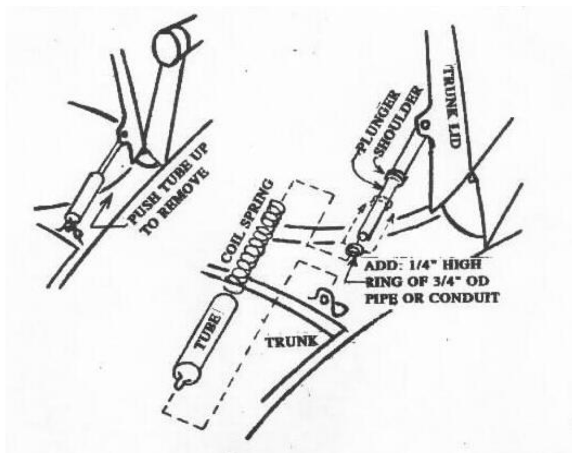
Remounting those thin stainless steel strips along the top and bottom edges of Pallas doors and fenders can be difficult if some of the red plastic retainers are lost or damaged. Care is needed in removing them prior to doing body work and repainting. There's a small plastic pin in the center that expands the inside end. If at all possible drive this pin partially out from the inside when removing the retainers.

If the plastic piece won't stay in, remove the center pin and attach to the body panel with a 4-40 machine screw, washer and nut. If short of the plastic pieces or they just won't hold the strip tight, particularly at the ends of the strips, fabricate an alternative by cutting a piece of metal about 5/16 by one-half inch and drilling a 1/8 inch hole in the center. Insert a 4-40 screw with an internal tooth lock washer in this hole and slide the assembly into the end of the strip to a point where it lines up with the mounting holes in the body panel. I find that as I tighten a nut on the screw, the head of the screw now hidden by the strip will be held from turning by the lock washer. I try to find stainless steel mounting hardware.

Trim strip clips replaced with Volkswagen part
Jack Shotton (Feb. 1997, p.8)

The stainless steel trim pieces at the door-bottoms of the Pallas are held on by nylon clips. These clips can be replaced by asking your automotive paint store for UFO part no. 5065R. The same clips are used by VW. (Volkswagen part number is 131-853-585C. There are other suppliers. [MB])

Trunk lid opens higher with added spacer
Ed Noreiga, WA (Jul. 1984, p.19)



For a D-model trunk lid that does not open as high as before the question may be what to do. After years of use the coil springs that push a plunger up to open the lid lose some of their push. When I removed the coil springs/plunger/tube for cleaning and repainting I discovered that the lid opened up higher as I pushed the tube upward for removing. The spring fits in the tube. In the closed position the plunger seats all the way to the bottom of the tube and the coil spring is compressed by a shoulder midway on the plunger. However, the spring is not compressed all the way but lacks about 1/4" before it is completely compressed in the tube. The way to get the coil spring to push the plunger out farther is to install some sort of spacer around the plunger between the shoulder and coil spring. However, putting a plug, washers or spacing material at the bottom of the tube will not do because that will prevent the plunger from seating in the tube, thereby keeping the lid from closing. The spacer must fit around the plunger end take up all the slack to compress the coil spring completely. This slack amounts to 1/4" therefore the spacer must be a 1/4" tall ring (annulus) of 3/4" OD pipe or conduit, as shown in Fig. 36. This ¬" translates itself to about two inches higher opening at the edge of the lid, which may or may not make a difference to some people depending on their height. Anyway for those who want to try it, here's how.

Editor: Many people tell us this either doesn't work or adequately solve the problem. An easier and more effective solution may be a new spring.

Window seals made from garage door seal
Charles Fowler, Dec. (Nov. 1982, p.4)

I wonder if other members have the same problem as I have when working on their car. I think it is called ineptitude. I read and hear of all these ingenious solutions to many of our problems, but when I try to execute them–disaster!

I must not appear as stupid as I feel because Don James always sends me his latest modification and rebuilt parts without instructions. "You see, Don, it's not for me, but there is this little old lady in town that needs instructions to install your latest geewhizit".

My latest fiasco came after reading another club's newsletter article on how to replace the outside seal for the roll up windows. Well, mine were starting to deteriorate and this fellow says all you have to do is buy some garage door seal, glue it over the old car seals and presto, instant concours. The trouble starts when you shop for the seal. Most of it sold is heavy, double-lipped, spongy stuff and completely unsuitable. I bought some on sale to put on my garage door, anyway and wouldn't you know it, the stuff on the door was just what I needed, but of course ancient.

After much searching, I finally found just the ticket; cheap, single lip and of course, white. But the price was only $8.50 for thirty feet of it. Because it was rolled up, the lip which laid against the window was distorted when laid flat. Not to worry, I stretched the stuff for several days and the pressure of the window straightened it. I cut off the lip of the old seal and glued the garage door seal on with Goodyear Pliobond (I never had much luck with rubber glue). Next I installed the clips and painted everything black. Holy hydraulics, no kind of paint dried on this stuff! I tried tire black, leather paint, enamel and several kinds of acid. Finally discovered that vinyl top paint worked perfectly. I cut the ends just like the originals. Installation wasn't difficult (which puzzled me) and I now had shiny new window seals.

Winter driving care suggestions
Ed Hodge (Mar. 1977, p.3)

I'm sure people driving Citroëns know what a wonderful car they have, so these winter months they should take care of them. Let the wet snow drop off from under the fenders before driving it into the garage; drive in with a cold engine. The floor of the garage will be drier with less steam and heat from the engine on the walls. Also, roll down the windows of your Citroën and let the floor mat dry out. Put an electric heater fan on the floor of the garage with the rear car door open on the wall side of the garage. Run your Citroën through the car wash, especially after each snow. It's a good idea to place a 3-1/2 feet x 5 feet painters plastic on the floor so the wet from your shoes will not go into the floor mat.

While your breath makes the windshield steam, so the whole inside of your car could be steaming, also. All the dampness in the car, plus the hot heater, is pushing the dampness into the body–thus rust!

Twice a year one should take off the inside plate that's behind each rear fender and wash them clean. Grease all moving parts and paint with Derusto–also the panels along the frame behind the doors. I've thought of using an electric roof and gutter cable heat tape inside along the inside panel between doors and frame. It could be plugged in once in a while to dry out, deice next to the frame, especially after icy wet days. (I sure hope none of you are still driving your cars in the snow! [MB])

Chapter 3–Brakes

Air requiring bleeding may come from pump or spheres
Don James, OH (Jan. 1984, p.10)

Q. I have been having constant problems with air in the brakes of my '67 DS. I have had all of the spheres rebuilt and a new shaft seal put in my hydraulic pump. Could the air be coming from the brake control valve?

A. No. The older cars that use brake fluid are a much bigger problem with air than the newer ones. There are only two places air can get into the system. Most common is the induction track to the pump. The pick-up tube, hose, pump cover and shaft seal. Inspect carefully for very small holes and cracks. Replace the hose with clear vinyl tube from a hardware store. Keep your hydraulic tank as full as possible, but don't overfill. The only other possibility is a low vapor pressure fluid in the system such as traces of alcohol or a bad sphere. Just because the spheres are rebuilt does not mean that one could not be defective.

Also, when bleeding your brakes, have patience and bleed slowly. Don't churn up a lot of bubbles in your hydraulic tank. Very small fine bubbles may take 30 minutes to condense and float to the surface. Shut the car off before you give it that final bleed. If you suspect alcohol in the system (smell the hydraulic tank), drain the fluid and refill with fresh. This should solve or improve your problem. Air in your brakes can cause delayed action, a buzz, squeal, or groan from your front brakes. It can also cause a chatter or shudder exactly like that caused by bad rear motor mounts.

Bleeding can't be done without weight on rear
Don James, OH (Sep. 1983, p.5 & Aug, 1985, p.16)

Q: I have my '70 DS21 up on jack stands and have removed and checked all of the spheres and accumulators for pressure. I have opened the bleed screw on the pressure regulator after replacing the spheres to bleed the air out of the system. Next, I attempted to bleed the rear brakes, but I could get no fluid from the bleed screws on either brake. I removed and cleaned the bleed screws and still nothing. What's wrong with my rear brakes?

A: All D-models have proportional braking. The more weight that is carried in the rear of the car, the harder the rear brakes will work. If the car is on stands or a lift so that the wheels are hanging, the brakes won't work at all. The car must be sitting on all four wheels to bleed the brakes properly.

Run the rear up on car ramps to be able to get safely under the car. If your car is not rusty, you can place the height control lever in the highest position. This high position will block open the height corrector and you will have maximum pressure in the cylinder. Fluid for the proportional braking system is taken from the rear suspension cylinders and a line takes it up to the brake control valve. (I placed a pair of blocks under the car that were short enough to just fit when the car was at normal height. Then I removed the rear fenders and bled the brakes while that car was standing on its weight. The blocks prevented the car from falling precipitously. Remember, NEVER get under a car that is not supported by blocks or stands. NEVER! [MB])

Bleeding late U.S. specification brakes
Betsh, Ken (2002 #3, p.11)

I've never had a mileage schedule for bleeding the front brakes. It always must be done after working on the front brake assemblies or after replacing either front sphere or the accumulator (main or brake), after they leak nitrogen. Sometime though, you might encounter or for some known or unknown cause, a delay in braking when pressing the pedal. This may be accompanied by a short rattle-like sound of hydraulic fluid movement.

To see the flow, I've always bled the brakes with a clear plastic tube long enough to reach the reservoir and allow the fluid to be recycled, even if the fluid from the brake lines contains air or nitrogen bubbles. These bubbles will safely dissipate in the hydraulic fluid tank.

Location of the bleed points depends on the car. Those with Citromatic will have the right-side bleed point on the centrifugal regulator and the left-side at the brake-actuated two-speed idle control at the base of the carburetor. Even some manual shift cars, such as my '71 DS, came from the factory with this two-speed idle control.

The factory has always recommended brake bleeding be done after the system pressure has been released by opening and closing the main bleed screw on the pressure regulator. Their procedure is to press the brake pedal and then start the engine so that the initial buildup of pressure goes to the brakes. It's never been clear to me if this is to keep the initial pressure low or if is a means to minimize leakage of nitrogen from spheres that are no longer in original condition (or both). I try to follow this while my ideal and faithful assistant (my wife) starts the car with her foot on the brake. I watch the return hose and when the fluid flow is full and bubble-free, I tighten the screw and, at the same time, signal my wife to both stop the engine and take her foot off the brake pedal.

This procedure has worked for me on all D-models except the '72 versions, both an earlier Pallas I owned in the late '70s and my wife's wagon, owned since late 1980. I understand the U.S. (probably also Canadian) versions of the '72s had some sort of limit valve in the brake lines so that in event of a line rupture, one could not pump the system dry if he/she kept the pedal pressed. I've never been able to find anything in the service or parts manuals about how or where this was done, even though other details of American-only cars are listed (See, Failure due to sphere rupture or leak detectors. [MB])

The point of this is that when one attempts to bleed the front brakes of a '72 as described above, instead of a steady flow of fluid, only a short spurt flows and it is necessary to pump the brakes to produce a flow.

In working on this front brake system, I note the pistons are both hydraulically actuated and, after use, retracted. There are no return springs. This might explain how a sticking piston could cause drag after use, even though I've never had this problem.

All the DSs and the later IDs, with their differing power brake systems, have fully independent front and rear circuits using dual "master cylinder" pedal controls. Bleeding of the rear is completely independent of the front. Just to be on the safe side, I never work on the front and rear at the same time or without ample time to field test the results after working on either.

Bleeding rear brakes can’t be done with car on jack stands
Tom Rivel, Quaker City Club Newsletter (Jan, 1986, p.34)

The D-models have proportional braking. The more weight that is carried on the rear wheels, the harder the rear brakes will work. Therefore, you must have your car sitting on all four wheels to bleed the brakes. While this is not news to most owners, not all are mechanical experts. This thought occurred to me when I got a letter from a club member who had his D-model up on jack-stands and couldn't understand why he couldn't bleed the rear brakes.

Editor: When the rear wheels hang free with the manual height control in any position except all the way up, the automatic height control valve positions itself to release all pressure to the spheres in an attempt to lower the car. With no pressure to the spheres, there is no pressure available to operate the rear brakes.

Caliper rebuilding
Betsh, Ken (2002 #3, p.11)

As far as I'm concerned, the greatest thing Citroën ever did to the D-models to improve reliability and reduce maintenance was to replace brake fluid (the standard moisture-retaining, vegetable-based type) in the hydraulic suspension system with a mineral-based fluid (what most of us call "green" fluid, even if an alternative fluid with a different color is used). The number of times I've cleaned brake pistons, replaced o-rings, and bled the system in driving a '67 ID with brake fluid about 132K miles (and bought brand-new) was several times greater than in driving three later D-models with "green" fluid well over a half-million total miles. So much more of the following comes from my recollections of 25 to 35 years ago as from more recent experience. Both the front disk and rear drum components for the two fluids were exactly the same EXCEPT for the o-rings (for a while some cross-compatible "white-coded" o-rings were available for the rear).

The biggest problem I had with the '67 (the car using brake fluid) was in finding a brake pad that was not wearing proportionally, or not at all, indicating the piston operating it was frozen (stuck). Presumably, it became frozen in the fully engaged position and once this resulted in enough wear of the pad to not contact the disk, it never again functioned. This failure won't be recognized in driving since one of the safety features of the car is that a brake or tire failure on one side up front produces absolutely no sideways pulling effect. Prior to freezing, these pistons may have taken extra force to engage and this could explain brake delay, although I believe compressing undesired air (more likely nitrogen from leaking spheres) in the brake system to be the most likely cause of delay.

While a brake piston will obviously extend further without a brake pad in place, it will reach the disk before it comes free. The method I have used to remove a brake piston makes it necessary to unbolt the particular brake assembly so that, with the hydraulic pipes still attached, it can be moved forward enough for the piston to clear the disk. I've done this on the right side without removing the radiator (but with the front duct removed). Each brake assembly is held in place with four bolts, two large ones into the front of the transmission (gear box) casing and two smaller ones on top through rubber bushings into a bracket on a cross bar. I used a scissors jack with a wooden block under the appropriate side of the transmission to take the load off the bolts to be removed.

Before trying to drive out the piston using the car's hydraulic pressure, I reconnected the hydraulic pipes so that only the stuck side would be energized. This meant removing the short pipe connecting the two sides in series and moving either the bleed screw or feed pipe as required. With this method and using an assistant operating the brakes so I could watch the progress, I was always able to free a stuck piston. Actually once it started to move, modest additional pressure brought it out and dropped it into a pan that also collected the residual fluid (which was discarded). With the '67, I'd find corrosion on the sides of the piston, the lining of the hole into which it fitted and both the main o-rings and the fiber "dust" rings. Sometimes I had to use very fine crocus cloth to clean the outside leading edge of the piston, the part exposed all the time to the weather.

The two times I've removed pistons from a car with "green" fluid car (once being when the car was being dismantled), the pistons came out quickly and were "squeaky" clean inside. Even wear on the o-rings after 160K miles was so minor they could have been reused (note, only the front is being discussed, the rear can be a different story).

Once one piston was removed, I repeated the process for the other one, which often came out much easier, then completely disconnected the assembly. I always removed one side at a time. Getting the pistons back in required accurate alignment to get them started. Lacking any fixtures for this, I laid the assembly on the floor so that the opening in the side in which I was about to insert a piston faced upward. I inserted both the o-ring and the "dust" ring (never knew what to really call it) into place after applying a bit of the proper fluid to both rings. I sat the piston on top of the opening and then took a 2-to-3 foot length of 2x4 and laid it across the piston with equal lengths on each side. I then pressed down with hands on each end (sometimes very hard) trying very hard to keep the ends of the 2x4 equal distance from the floor. Of course, the pipe connections at this point were open, so once the piston started in, it travelled the rest of the way without a lot of additional force.

The right-side brake caliper (either side could be done first) was reassembled to maintain support the transmission, then bled before beginning work on the other side. I found the toughest part of reassembly often was getting the hydraulic pipes correctly started in their holes. A lot of care was required to avoid cross-threading. The tougher steel pipe fittings could ruin the starting threads in the aluminum brake housings. Before reassembly, I'd always check the pipe seals. If reused, I always remove any straggling pieces and sometimes reverse them end-for-end. I always followed the advice of an excellent well-known Citroën mechanic to tighten these pipe fittings "good-and-tight" and then back them off about 30 to 45 degrees so they didn't freeze in place. After all, it's the seal that does the sealing job, not the metal-on-metal fit. My exception to this was the bleed screws. I got them as tight as possible with a short end-wrench.

I don't ever recall removing the left-side brake assembly without first removing the radiator.

Caliper rebuilding
Carl Boyer and Dean Van Amburg, UT (Oct. 1991, p.22)

Front brake hang up on LHS-2 (brake fluid) cars subject to periods of disuse is extremely common. This is a result of a build-up of corrosion slats between the brake pistons and their caliper bores. If the brakes are once applied in this condition, then the pads will be unable to force the pistons back in their bores due to the friction between the piston and bore. This corrosion is almost inevitable due to the exposure of the calipers to mad spray and salt through the cooling ducts from the bottom of the car.

Exacerbating the problem is a felt wipe placed in a groove in the caliper bores just on the disc side of the piston o-ring seals. This felt wiper is meant to keep road grit from following the piston back into the caliper and fouling the o-ring. It also wicks up brake fluid that inevitably weeps past the piston seals. The hygroscopic properties of brake fluid combined with road salt and moisture flushing behind the pad, along with the heat of braking and the galvanic action of dissimilar metals of the piston and calipers...you can see why problems develop. Aren't you LHM owners out there feeling smug about the self-lubricating and anti-corrosion properties of green fluid now?

Presented here are two suggestions for two possible courses of action. Which you choose depends on the time available, your mechanical capabilities, and your nerve and determination to see the job done thoroughly. Remember, you are working on the braking system of the car and the consequences of your actions affect not only you and your valued property (your Citroën), but others' safety as well. Don't undertake any repairs until you are sure of what you are doing. Read the repair manuals, newsletter articles on the subject, and articles on the theory of the system involved before you start.

OPTION 1-THE JOB DONE RIGHT
The best long-term solution is to remove the calipers from the car and thoroughly clean and remove corrosion from the caliper bores. Removal and reinstallation procedures are outlined in most manuals–usually the factory manuals are the best guide. I will concentrate on what I have learned through experience working on LHS-2 brakes and what is not covered in the manuals.

The toughest part of the job is getting the pistons out of their bores. The safest way is to fabricate a brake line (standard 3/16" available from any auto parts store) and modify one end with J.B.M.'s French Connection tool. Attach the American end to the master cylinder of a "helper" vehicle with a conventional foot-pressurized brake system. Note that this solution is geared to brake fluid or LHS-2 cars so there is no incompatibility in using a helper car with the same type of fluid. I have not heard of this problem with LHM cars, but should you need to remove a stuck piston from such a car, this would not work. Some imagination applied to the second option before removing the caliper from the car, and you would have the job 90% done.

Strip the transfer line from your caliper and install a bleed screw in one union of one side of the caliper. Remove any line seal first. Install the new "French Connection" into the other union in the caliper half. Your line should be long enough to get well away from the helper car and use enough old rags to contain brake fluid lost when the piston pops out. Bleed the air bubbles out of your caliper half, then use the brakes of your helper car to pump the piston out in stages. Watch the reservoir on your helper car master cylinder; it will need frequent topping up. Repeat this process with each caliper half. When you are done be sure to normalize the brake system in your helper car according to its manufacturer's recommendations. Your braking "help" has fooled the car into behaving as though one of its split systems has failed. You must correct this before driving off in the helper car or it may only have half its braking capability. (I have never heard of this happening, but on some cars, you have to reset the brake warning light switch in the proportioning valve by opening a bleed screw on the other half of the system and depressing the brake pedal until the brake warning light just goes out. [MB])

Using either compressed air or a high pressure source such as another Cit or an ABS-equipped car is just too dangerous, not to say messy, when the stuck piston lets go. Once the piston is out, key or label them to keep them paired with their respective bores. I don't know that this is absolutely necessary, but I'd rather not find out too late that it was. (It’s not. [MB]) It's generally not a bad idea to keep things paired up anyway. Any pistons corroded or pitted in the area swept by the seal will have to be replaced. Fortunately, this area is bathed in fluid, so it usually is OK. But if the pads were worn and piston surfaces were exposed and corroded past the seal, and subsequently pressed back in the new pads, problems will develop down the road.

The calipers can be split in halves simply by unbolting to allow better access to remove the felt wipers and o-ring seals. Remove the corrosion you will find in the grooves in the caliper, but be especially careful of the edges of the o-ring channel or sealing problems will result. You can be less concerned with the felt wiper groove.

Install new seals and wipers if available. If not available, the o-rings may be reused if not damaged, and you can fabricate felt wipers out of flat felt stock or a felt oil seal from a bearing supply with the same cross-section. You can adjust it to the right bore size by cutting out a section. J.M.B. has offered in the past a specialized square-section o-ring to replace this wiper, but if you use felt, saturate it in silicone brake fluid (DOT-5) before installing. This will exclude water, and thus corrosion in the future, and the fluid will not degrade the adjacent o-ring seal. (Better to use a second o-ring with a slit in it to prevent corrosion and allow it to simply wipe. [MB])

Reassemble the caliper halves and tighten the capscrews to 32-40 ft-lbs. Install the calipers and tighten the rubber-bushed cross-member fixing screws to 29-32 ft-lbs., but do not tighten the large caliper to gear case bolts yet. Install the front brake pads and wear indicator leads. Install and bleed all brake lines. Then, while a helper applies the brakes, firmly tighten the gearbox-caliper fixing screws to 95-100 ft-lbs. Release the brakes.

OPTION 2-THE QUICK FIX

Perhaps this title is a little misleading because it never "fixes" the underlying problem. This should be considered standard preventive maintenance procedure on any LHS-2 car currently working well to prevent the problem Mr. Pellow experienced. This will require the patient help of anyone able-bodied enough to press the brake pedal only on command, but it does not take long if the brakes are already free. Frozen pistons will take time and care.

Supplies you will need include an aerosol can of brake cleaner, a large set of water pump pliers, a very stout, long screwdriver–preferably with a square shank, a small hand pump can for oil–not contaminated with oil (either a new one or one degreased thoroughly and designated for this job), a small bottle (one-half pint will do) of castor oil from your local pharmacy, and the crank extension bar from your tool kit.

Place the car in a level, well-lit spot, although you can do all of this with the parking brake applied. Remove the spare tire and radiator snout with cross-brace. Loosen the spring clip securing the front brake pads. Use the water pump pliers on the boss drilled for the clip and the backing plate for the adjacent front brake pad to force the piston back into the caliper a bit. If it is so frozen that this will not budge, try the screwdriver between the brake disc and the edge of the pad braking plate, prying carefully both above and below the friction material, to work a little space so the pad can be removed with the help of the pliers.

DO NOT omit this next step or you will have BIG problems! Grasp the hand crank extension rod and insert the thinner hex-shaped end between the brake piston and the brake disc in the place where the pad once was, midway up and down in the void, with the tip of the rod all the way in, touching the hub of the brake disc. Now have your helper gently, but firmly, apply the brakes. The piston should extend much further out until it pins the shank of the rod against the disc. If the rod is not in this void, the piston would pop clear out and reinstallation is, to say the least, awkward. I saw this happen once on a car with the pad in place. The pad was so worn that the pad and rotor were wearing metal-to-metal until the piston popped out and a massive leak resulted. That is why your wire embedded brake pad warning light should be checked to insure it is functioning properly (Cars with no warning device should be routinely inspected. [MB])

Release the brake pressure. Now that more of the piston is exposed than would normally be the case, use your pump can of castor oil to flood the exposed surface of the piston. Lever the piston equally back in as far as you can. It should go all the way back flush with the inner caliper face, but it doesn't have to on the first try. Be careful not to pry too aggressively against the outer edge of the brake disc when working the rearmost edge of the piston back into the caliper. If the first repair option sounded too involved, it pales to insignificance when compared to the task of replacing a cracked, chipped, or broken brake disc.

Re-center the rod in the pad opening and reapply the brakes. Repeat the lubing and levering several times, and the piston should work more freely. After exercising that piston to your satisfaction, lever it back and clean the rotor surface of any castor oil with the aerosol brake cleaner. Reinstall the pad. Move to your next pad and start the procedure again.

When all the four pistons have been exercised and pads reinstalled, replace the spring clips, wear indicator leads, and radiator snoot. Now the car should roll freely after the brake is released. A delay, but ultimately free release without lots of forward progress to induce it is indicative of air trapped in the brake lines.

Caliper rebuilding
Chris Dubuque, WA (Jun, 1993, p.8)

Sticking front brake calipers on D-models are not a common problem, but can happen now that the cars are at least 20 years old. As with most hydraulic parts, front brake calipers tend to stick primarily on brake fluid (LHS2) cars, but occasionally can also be a problem on green fluid (LHM) cars. The only cure for sluggish or frozen brake pistons in the front brake calipers is to remove the caliper from the car and rebuild the caliper. It is not acceptable to attempt to loosen the piston by working it back and forth with the caliper in the car. This method, although it may free the piston temporarily, will not cure the corrosion and/or dirt that jammed the piston in the first place.

CALIPER REMOVAL
Removing the calipers from the car may not be a very pleasant job, but it is not all that difficult. Start by removing the radiator. After disconnecting the appropriate hydraulic tubes, the two large main caliper bolts can be removed along with the two smaller 14 mm bolts holding the caliper to the front cross bar.

HINT: The transmission is supported by the motor mounts in the calipers and therefore, when removing the two 14 mm bolts, the whole transmission will want to drop. An easy way to hold the transmission up prior to removing the bolts is to insert the crank handle into the front of the transmission.

CALIPER DISASSEMBLY
With the caliper(s) removed, they can be given a preliminary cleaning. At this stage, I recommend spray engine degreaser, lots of brushing and then a rinse with a garden hose. Don't worry about getting water in the hydraulic ports since the caliper will ultimately be fully disassembled and cleaned.

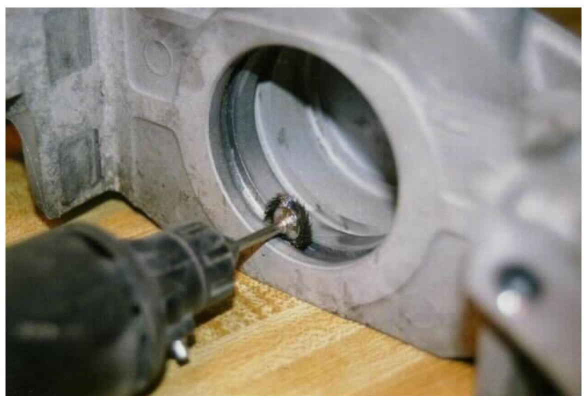
With the calipers a bit cleaner, you should now disassemble the caliper halves. Be sure to remove the rubber motor mounts in the inboard half of each caliper. These rubber mounts should be inspected and replaced if necessary.

Getting the frozen piston(s) out of each caliper half is the only real trick. The safest and surest way is to rig up a grease Zerk fitting to an old Citroën hydraulic tube end. A grease gun can then be used to "pump" the piston(s) out. Most greases are not compatible with the rubber used in brake fluid cars, so any rubber that has come in contact with grease should be discarded–don't worry, you will likely have to replace it anyway. The grease gun method is far safer and more likely to work than using compressed air. Compressed air is usually about 100 psi. This pressure only generates about 440 pounds of force to push the piston out–about the same as two big men hanging from the stuck piston. This is usually not enough to free a frozen piston. A grease gun can generate many thousand psi. For example, if 4000 psi is required push out the stuck piston, this pressure is equivalent to about 17,600 pounds of force. This is like hanging five or so whole cars from that poor old frozen piston. Under these forces, the piston will always come out. More importantly, since air is highly compressible, the piston can come flying out with a vengeance when it finally lets go. I have a friend with a scar on his forehead where a brake piston flew out while using compressed air. He is fortunate it just grazed his head.

Once the piston(s) are removed, the seal and felt wiper can be removed with a pick. It is possible that the felt wiper will be a disaster and will require scraping out.

CLEANING COMPONENTS

Thoroughly cleaning the caliper halves is the next step. The groove for the felt wiper may have significant corrosion and old felt goop stuck in it that is difficult to clean. I believe that the best method to clean the caliper halves (including the felt wiper grooves) is to have them glass-beaded. Some feel it is inappropriate to glass bead seal grooves in aluminum parts, but I personally feel that it is no problem in this case. An alternative to glass-beading is to simply use solvents or degreasers. In this case, the corrosion in the felt wiper groove may need to be cleaned with a wire brush in a Dremel tool as shown below.



INSPECT PISTONS

Inspect the pistons to ensure that the chrome plating is intact. Some slight wear on the piston is fine, but the chrome must not be broken through in any place. The picture below shows a piston that is worn, but still very serviceable. Replacement pistons were made of aluminum with a hard anodized surface. Again, some wear is OK, but the hard anodizing must not be broken through.

The chrome plated steel pistons are much more satisfactory than the aluminum ones. New pistons are difficult to find and expensive. Fortunately, used pistons can be obtained fairly easily and are usually in usable condition. Invariably they will come from a retired LHM car.

REASSEMBLY

It is usually best to replace the o-rings. Original Citroën o-rings seem to be fairly easy to find, but aftermarket ones are available at significantly lower prices. Always replace the felt wiper. The felt wiper is not available any longer through Citroën, but Western Hemispheres has had them remanufactured. The last picture shows all parts ready to be assembled (notice the new felt wiper, the new o-ring, and the new motor mount rubber). In LHM cars, the felt wiper should be soaked in LHM. In brake fluid (LHS2) cars, the felt wiper should be covered with brake fluid compatible grease (ask for this special grease at good auto parts stores, or order from Western Hemispheres under part number SP-1230). Do not use regular grease! I suppose that soaking it in brake fluid will be OK, but the special grease is better. The pistons should be able to be pressed in by hand. Complete reassembly by torquing all bolts to the torques specified in the manuals. It is best to replace all the seals in the hydraulic tube connections. These seals are available through the usual Citroën parts sources. (Many rebuilders use a second rubber seal instead of the felt one, putting a small slit in it to prevent pressure buildup. [MB])

Caliper rebuilding, LHM-type shows minimal wear
Ken Betsh, PA (Jun. 1994, p.8)

As part of my effort to eliminate brake frequent chatter (or shudder) when coming to a stop, I recently replaced one well worn brake disc (see separate story) and replaced the o-rings and felts in both sides of both front brakes. As far as I know, it was the first time this was done on my car with about 232,000 miles. While the opposing pads were wearing about the same, I noted that after the car was parked for a few minutes, one pad would be loose as expected and the other would feel tight as though it might not be fully released.

The very obvious thing one sees after dismantling the brakes after all this mileage is the very little wear on the o-rings–one would think they'd last a million miles. The felts were a little dirty but with some cleaning could be reused. The pistons were as shiny as new inside and the minor surface corrosion near the outside end cleaned readily. Since I had the new parts (at a cost over $100), I used them. Afterwards, the only difference was that all the pads were loose when checked a few minutes after being used. The pads are retracted only by suction after the brakes are used and apparently any difference in drag upon the opposing pistons means that the one that moves easier does all the moving.

It is necessary to remove the hydraulic brake carriers from their mounted positions in order to clear the disks so that the pistons can be removed. Since the carriers carry the weight of the transmission and front of the engine, only one carrier can be removed at a time and even then some additional support is needed. I use a hydraulic jack and wooden block under the transmission with just enough lift to keep things in place. I managed to get both off and back on without removing the radiator. It did help to remove the bottom two radiator mounting bolts so that I could lift it slightly to have room to reach tools into the bolts and nuts holding the brake carriers.

The easiest brake piston to remove on a mechanical-shift car is on the right-side carrier (because the bleed screw is directly on the carrier). After the mounting bolts and the hydraulic feed pipe clamps on the transmission case are removed, one can pull the carrier forward without disconnecting any lines.

Place the carrier in or over a pan and gently apply brake pressure (at the pedal) until you hear a piston drop into the pan. Chances are one will completely come out and the other won't move. Depending on which did come out, you must now move either the feed pipe or the bleed screw so that all pressure goes to just the side with the piston still in place. Again apply brake pressure until it drops out. If there isn't enough brake pressure to get the second piston out, start the car with caution. If the transmission and radiator positions aren't close to normal, the radiator fan will bind on the shroud that surrounds it. A lack of reserve brake pressure on DS's may cause you to wonder if the brake accumulator is still functioning.

Getting the pistons back in the carrier is not too easy. I coat the o-ring surface with fluid. The piston will go in as far as the o-ring without much force but only if exactly lined up. Beyond this point takes some force. I place the carrier with piston up on the floor and lay a short piece of wood across the piston upon which I can press from both sides–standing on if necessary.

Replace any disconnected hydraulic lines with extreme care to prevent cross-threading. The tough steel fittings and soft aluminum carrier body makes this easy to do. If the fitting is in the correct position it should start to screw in with little effort. Don't fasten any pipe clamps until the fittings are back in place. My rule on tightening the fittings is to get them good and tight and then loosen them about 1/16 turn (30 degrees). After all, it's the seal and not the threads that keep them from leaking and what is just a tight fitting now may be a frozen fitting the next time it needs to be removed.

Naturally, it will be necessary to bleed the brakes after this operation. Since about a half-pint of fluid from each carrier will be lost in the pan–and this is the fluid that has been next to the pistons for who knows how long, I do my bleeding with a long tube back to the reservoir so that no more fluid is lost. I bled both sides after doing just one side since I wanted to use the car before working on the other side.

Most DS's have a pipe on the left side up to a hydraulic piston on the carburetor where the bleed screw is located (why so many mechanical-shift cars had this to allow two speed idle has never been explained to me).

There's no slack in this line and it will have to be disconnected in order to remove the carrier. At this point a spare bleed screw comes in handy since the one on the carburetor piston has different threads. You might find a metric machine screw that will fit well enough for the piston push-out operation. Before either will go into the place the pipe was removed, the pipe seal will also have to be removed.

In my case the left side disk and seals were replaced first and the car was driven before any work was done on the other side. This stopped almost all my chatter and shudder problems. I could feel no other effects from this one-side-only repair. I was thwarted in changing the other disk (see separate story) and could only change the seals. This didn't change the very minor chatter or shudder that remained and I'm convinced this is due to the one remaining worn disk. One conviction I've had for many years and this reinforced: the pioneer effort by Citroën to replace conventional brake fluid with a superior mineral fluid was a great step forward.

Cam adjusting tool prevents rounded hex head adjusters on rear brakes
Paul Fontaine (Sep. 1983, p.3)

I've made a tool for releasing the brake shoe adjusting cam that gets so rusted on those rear brakes. It's a wrench that fits over the cam after removing the brake drum and shoes. It has the leverage to work the cam back and forth so that penetrating oil can get in. This saves rounding the hex-head adjusting bolt on the brake backing plate. (Sadly, no picture. [MB])

Chatter may be due to radiator overflow
Don James, OH (May 1985, p.10)

Front brakes may chatter when they get wet. Be sure that your overflow and drain tube on your D-model's radiator is attached properly and not aimed at or near the brakes. This is a common problem on many cars.

Disk replaced with hardest pre-'71 type
Ken Betsh, PA (May 1994, p.11)

For some time I've wanted to rebuild the front brakes on my 71 DS and the recent need to remove the left axle to replace a boot, plus the fact I now have a lot more spare time, said now is the time. The reason was to eliminate the chatter frequently heard just as I was coming to a stop. This chatter would not be heard the first time the brakes were used in the morning or when stopping very gently. Replacing a well-worn disk with one showing no wear at all and replacing the seals (o-rings and felts) on just the left side almost completely eliminated the problem. I was defeated in trying to change the right-side disk. I did get the seals changed on the right side.

I've been very concerned with the wear of the front brake disks and suspected these thinner and scored parts were causing the chatter. The amount of wear was quite obvious when the thickness of the outer edge of the rotor where the pads didn't touch was noted. This outer lip caused a false operation of the worn-pad indicator light on the dashboard. Long before the pad was worn to the point where the imbedded wire touched the disk, this outer lip cut into the insulation of the wire outside the edge of the pad.

Three things were removed or moved aside to remove a disk:

(1) the driveshaft held by six nuts on lugs screwed into a flange on the shaft of the transmission–the easy part

(2) the hydraulic brake carrier held by two large bolts into the transmission case and two bolts and nuts through rubber bushings to a bracket attached to a cross member that supported the radiator and

(3) the separate parking brake carrier bolted to the side of the engine with two large bolts.

Getting these parking brake bolts loose on the left side was very difficult and impossible on the right side. They could only be reached from under the car (my air conditioning compressor blocked top-side access on the right side). These bolts required a 19 mm or 3/4" wrench and my ultimate weapon was a 1/2" drive socket and an 18" long swivel joint handle.

With my foot pushing on the handle from under the front of the car I was able to break both left side bolts loose. The right side was another story. The heads of the these bolts lined up with the vehicle frame with insufficient clearance for my socket and handle (which only measured 2-3/8"). I tried my 17-19 mm box wrench with a short piece of pipe as an extension but no luck.

Once the left-side parking brake carrier bolts were removed (which was rather easy after the initial tension was broken), it was possible without removing the operating cable to push it sufficiently clear of the disk to remove the outer pad and then remove the disk. I did adjust the inner pad for maximum clearance during the removal. Incidentally, the manual called for a thin 14 mm wrench for adjusting the parking brake pads. Perhaps due to the wear on my pads, my regular open-end wrench was useable even after the much thicker replacement disk was installed.

I did my final parking brake pad adjustments before attaching the driveshaft on that side with two nuts holding the disk firmly in place, with the brake lever released and the transmission out of gear. This allowed me to turn the disks while under the car to find any “high” spot. I adjusted all four pads to very lightly touch at that point in each case. When completed, my parking brake lever moved about half its travel length when the brake was applied.

My replacement left-side disk came from my old ‘67 ID. It was retired and stripped in 1977 with about 132,000 miles when a rear suspension bracket tore loose from rust damage. There was no noticeable wear of the disk. After almost 16 years of storage in a damp location, my local auto machine shop resurfaced the disk mostly to remove some surface rust. When he compared that disk with the one I removed from the ‘71, he said the difference was not in the miles (233,000 on the '71) but in the type of steel use‘. Apparently the type of steel that gave shorter stopping distances for a given pressure wore faster. While he had no knowledge of Citroën, he said that several other foreign makers had done the same thing, resulting in disks that wore faster. By the way, he did not need any special tools or adapters to handle the Citroën disks.

In reassembling the disks and driveshafts, I learned something overlooked before. The flange of the driveshaft that fit over the studs attached to the transmission was thicker for the older style driveshaft (the one using round boots). The studs used with the older style were, according to the parts book, 60 mm long (#DS373-68) vs. 51 mm (#DX373-268A) for the newer style. When I changed the type of driveshafts I should have changed the studs. I had wondered why the nuts became fully tight without many turns and the end of the studs did not protrude thru the nuts when they were tightened. I drove the car for many years that way and none ever came loose.

Early style caliper rebuilding and adjusting
Don James, OH (May 1984, p.22)

How many of us have seen an old ID or DS19 sitting in a field someplace and thought that it would be a great car to restore; until we saw those rusty front brakes. One look and you just know the car will never roll again. These brakes are very complicated compared to the newer cars, but work wonderfully well when adjusted properly and cleaned of all that rust. The problem is how to get it apart? It’s like a Chinese puzzle.

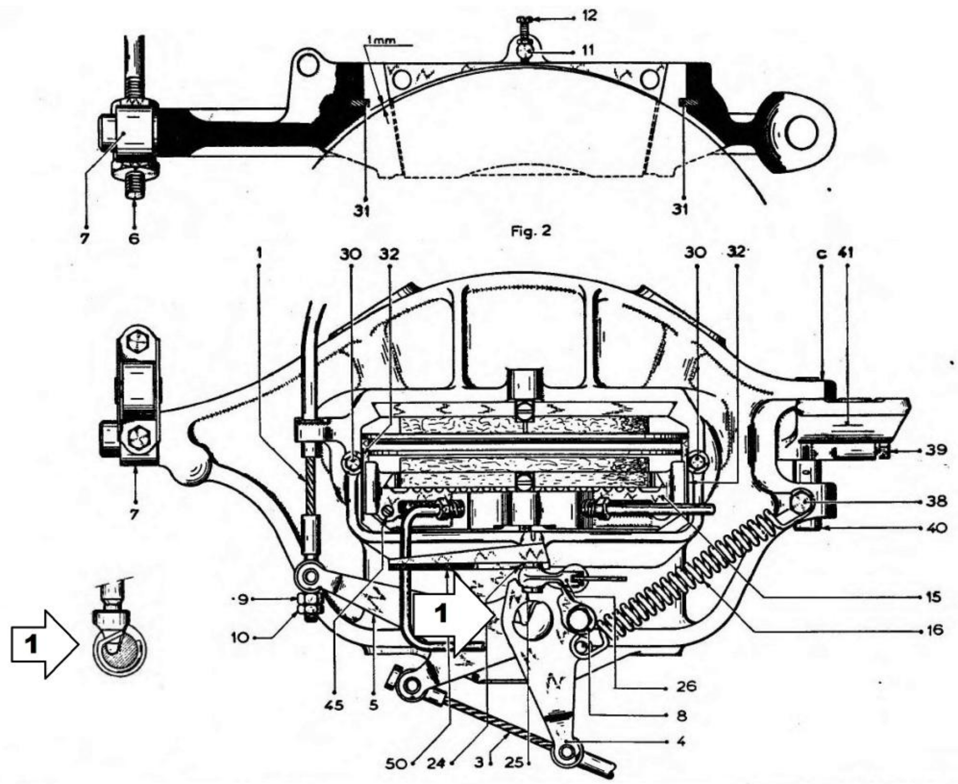
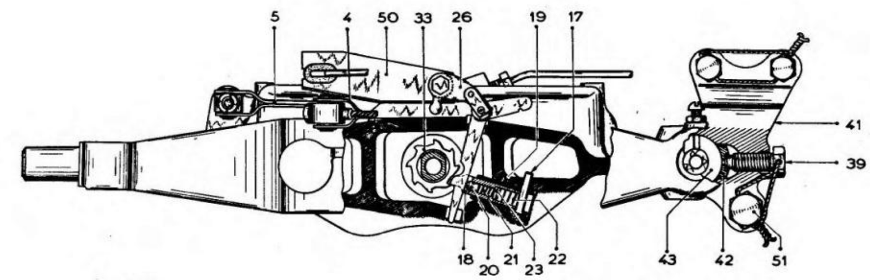
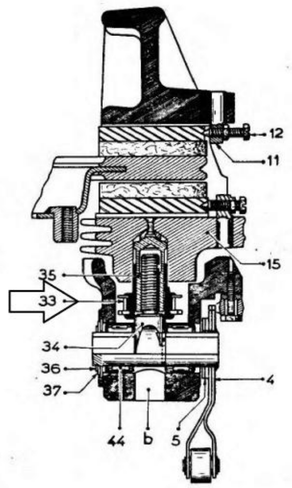


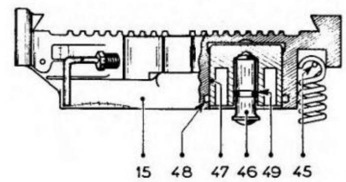
Fig. 2

To remove the brake caliper you must remove the radiator and, by blocking up the transmission, remove the front engine support. Next you must get the pads out. This means you must remove the battery tray and anything else that is in your way. Unscrew the jam-nut and set screw (#12, above) that retains the pads. This retaining screw goes through a pin (#11, above) that must be removed before you can get the pad out. You may need heat and plenty of penetrating oil. Open the bleed screw and you may be able to get the pads out. If not, you may be able to remove the entire caliper at this point if not frozen to the disc.

To understand how the brakes work, please look at these drawings. The large aluminum casting is the yoke. It can float back and forth on the pin (#43, below) that is mounted to the engine block. There is a carrier inside the yoke that holds one of the pads. This carrier holds two pistons and floats inside the yoke. The pistons act on only one side of the disc, but because the yoke is free to float, equal pressure is applied as in any floating caliper system.



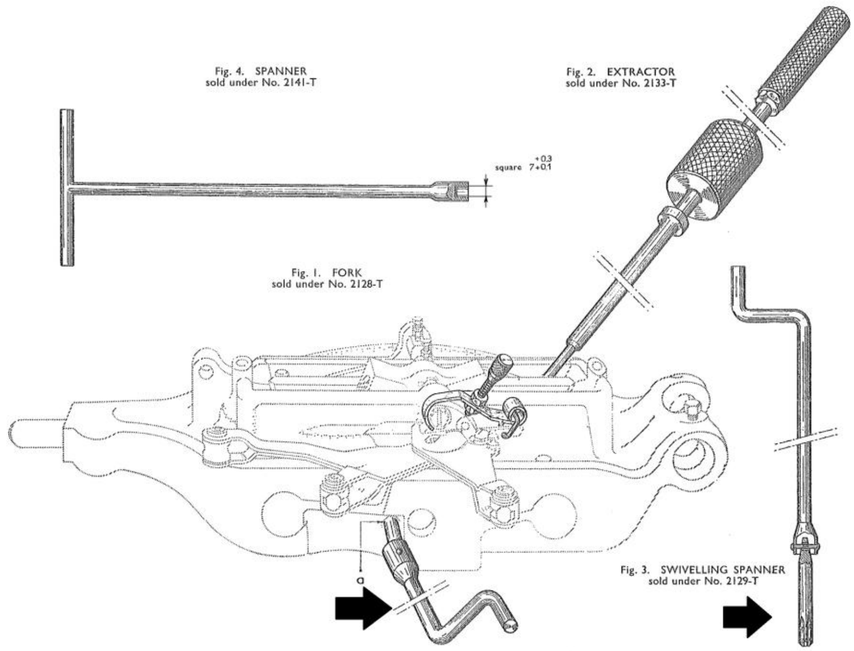




The problem is the mechanism for the parking brake must work the carrier mechanically to apply pressure to the disc. This is done with a rotating cam mechanism on the parking brake lever shaft (arrow 1, top figure) working a pushrod against the carrier. Again there is a problem because as the pads wear, the parking brake adjustment would continuously change. This was solved by the use of a “nut and screw” arrangement that increases the length of the pushrod with a ratchet to turn the nut every time the parking brake is set. The ratchet mechanism is shown at the white arrow and #33 at the bottom of the second figure.

In order to back off the carrier to release the pads, the ratchet must be disengaged by pushing down on the pawl–or releasing the spring pushing it into engagement (#22, second figure)–and a special tool (plain black arrow) is placed through a hole in the yoke to engage the gear teeth (not shown) that are around the outside of the ratchet. These gear teeth may be moved, if you have the caliper off of the car, with a sharp tool. It is important to note that these teeth have been known to break off of the gear and this might give problems.

When the ratchet mechanism has been retracted, the carrier can be moved to one side, and the “half-moon” keys can be removed after you remove the screws (#30, top view). These keys are shown at (#31 in the top figure, side view). If the “half-moon” keys are rusted into the yoke, a small hole can be drilled at the location shown by the black arrow #8 (top figure). Use a pin punch through the hole to remove the key. In getting the caliper apart, you may need to use heat, and plenty of penetrant. Take your time and go slow. Soak parts overnight if needed.



Special tools required

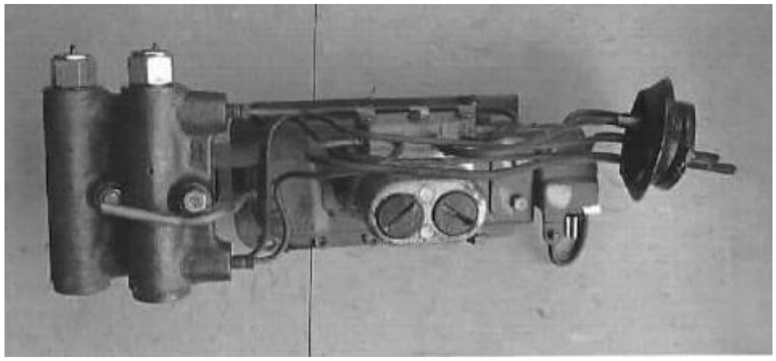
Once you have the brake apart, replace the o-rings on the pistons with new ones made from EPDM material. This MUST be used for use in brake fluid. The o-rings that you can get at the hardware store will NOT work! -222 is the size. Be sure to use Never-Seez compound on all parts when you reassemble the brake, but keep it away from the rubber parts.

One other problem is the parking brake cables. These may be frozen. If penetrant does not free them when applied to the outside of the cable sheath, use a torch to heat the sheath, while pulling and bending the cable. Hold one end in a vise.

Red Dellinger reports that there is another problem area with these brakes that can make them shudder and chatter. This is caused by a worn bushing at #7 (top figure). This is the adjustable stay that holds the front of the caliper. Replace the worn rubber and all is well.

If you do manage to get these brakes apart, you will find that the engineering that went into them, and the fine machine work are cause for great pride and respect. Not many cars have been made that were given so much attention to their braking system. These brakes were obviously expensive, and certainly not cost effective, but many other items on the D-models are designed in the same manner. This type of engineering tends to make the cars time consuming to service as well as expensive to build. Makes you wonder how they stayed in business. I am sure it would be an education to see how they manufactured and assembled these cars. The French seem to be able to work magic!

Failure due to sphere rupture or leak detectors
Burnham, Dave (2008 #4, p.5)



Brake valve assembly with leak detectors (to left)

Sudden brake failure on a DS or SM is very rare. On cars made before 1972, brake failure mostly resulted from a total loss of fluid or an obstruction in the brake system. If there was total loss of fluid, there would have been many warnings before the loss of the brakes. The system design on all the hydraulic cars is such that sub hydraulic systems would fail one by one well before the brakes. On a DS the steering goes first (hydraulic steering assist) then the shifting (hydraulic shift cars), then the suspension, and the last to fail would be the brakes. By the time the big red light comes on and other sub systems fail, it would have gotten your attention and the car would have been safely parked.

In a couple of odd cases we had cars that had sphere bladders deteriorate (suspension, main and or brake accumulator spheres). Small rubber chunks of the bladders then floated through the system and lodged in the brake valve making really odd braking situations, while the rest of the car worked hydraulically. Cleaning the system, cleaning or replacing the brake valve and replacing the bad sphere and hydraulic fluid fixed the problem.

One other possible way brake failure can occur on the USA and some Canadian DS and SM cars 1972 and later is from the leak detectors that were installed into the braking system for our market. I am not sure why these valves were installed but probably for some USA DOT regulation. These units which are installed in series between the brake valve. They sense if there is a hydraulic leak. If a leak is detected, it completely shuts off the fluid to the brakes. Personally, I would rather have the car pissing out all its fluid attempting to stop rather than have the leak detecting brake valve shut off all supply to the brakes just to keep fluid in the system as you press harder and harder on the brakes and nothing happens. The steering and suspension all work perfectly on the car except the brakes do nothing at all. And the minimal parking brake will barely slow the car down!

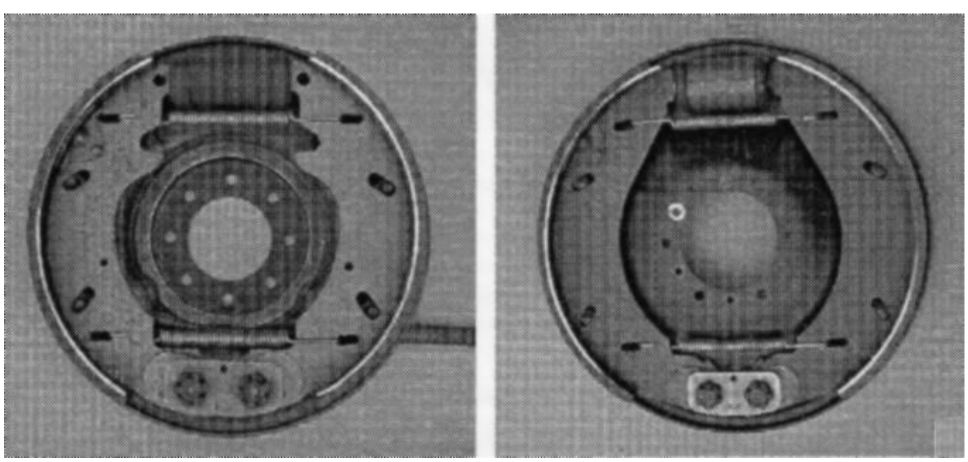
You can experience this in a safe way when you bleed the brakes on 1972 and later cars. If you press too hard on the button, the fluid flow to the brakes shuts off. When bleeding these cars' brakes, you have to press lightly on the brake pedal so as to not activate the leak detector or pump the brakes like a "regular" car.

Floating shoes and plated cylinders assure full braking
Roger Williams (2005 #2, p.14)

For reasons unclear to anyone, Citroën chose to anchor the bottom of the brake shoes and provide adjustment via an eccentric bush in conjunction with the snail cam at the top end. If the brakes are properly adjusted, which requires a special tool, they are very good. Unfortunately most people do not have the special tool and make do with a variety of odds and ends, notably bent coat hangers, etc, which do not always achieve the results that Citroën intended. The shoes should be just touching all the way around when adjusted. They are then backed off a small amount on the snail cams and the drum fitted and the snail cams turned out until the shoes just start to touch the drum. The requirements of the above are that the curvature on the brake shoes is identical to that on the drum, and if this is so, there is only one position in which the shoes can be anchored to touch along the length of the lining as described above. An alternative is to use a scrap brake drum and cut a segment out and adjust as above. Unfortunately this requires the drum to be perfectly round and exactly the same diameter as the drum that is being used on the car. It would be a miracle if these conditions were met!

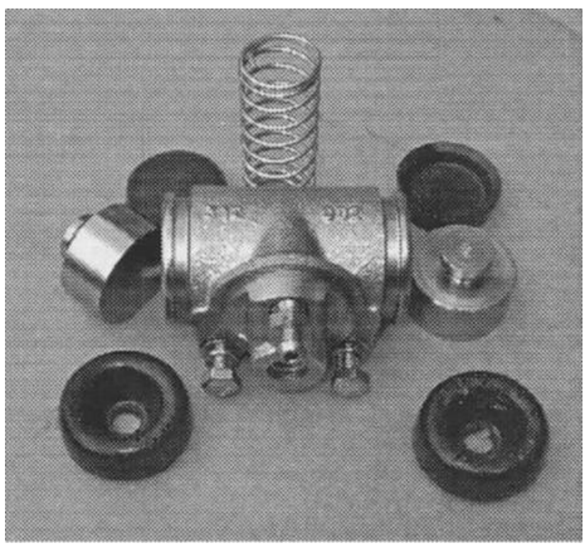
Most people just adjust their brakes using the snail cam and this results in all the load being taken on the edges of the linings nearest to the slave cylinders. The linings wear down rapidly and quite often cause sufficient heat to distort the brake drum. Pretty soon they get worn down to the rivets, if you are old fashioned enough to still use the rivet type, which scores the drum and then requires skimming. Another point to note, and again I can find no one who can explain it, is why did Citroën only provide half a length of lining on the trailing shoes? Maybe because with their system of fixing the bottom of the shoes, the 'missing' section of lining would not have done anything anyway!

Conventional drum brakes use a system where the bottom of the shoes slide in a slot. They are free to go up or down and thus centralize themselves when the slave cylinder pushes the top of the shoe towards the drum. The advantage of this system is that they can be adjusted by using the snail cam only, and the wear is more or less even around the whole of the brake shoe. Additionally, the full length of the shoes can be lined, so that more lining can be utilized when braking.



If the bronze and eccentric steel bushes are removed from the bottom of the shoe/brake back plate, and replaced with the plate shown, which is clamped using the nuts that held the eccentric steel bush, a conventional type drum brake system is achieved. Furthermore, if you ever wish to return to the original system, all you have to do is replace the discarded bushes. A series of these kits, comprising a pair of shoes lined full length and skimmed to the drum diameter together with the bottom plates and a set of new springs, have been tested over the last year and show a 40% improvement over a well-adjusted original system.

Now, let's tackle brake slave and master cylinders. Over the last few years, the drum brake has been largely superseded by the disc brake, except on small cars with small diameter rear brakes and small slave cylinders. This is making it increasingly difficult to source original equipment brake slave cylinders, as the manufacturers gradually phase out production of the larger diameter slave cylinders. It is therefore becoming important to keep your brake slave cylinders in good condition. This is not easy if the cars are laid up during the winter months, the time when the pistons stick in the bore and cause the surfaces to become pitted and leak fluid past the seals. A solution is to nickel-plate the whole slave cylinder unit: i.e., the body, pistons, spring, bleed screw, etc. Although this adds an initial cost when changing a slave cylinder, it is a more long-term solution, especially when you bear in mind that new slave cylinders of good quality are not so easy to obtain any more. The same can be said of the master cylinder, which can be similarly treated.



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Front brake bleeding procedure
Dave Root (Jun 1997, p.14)

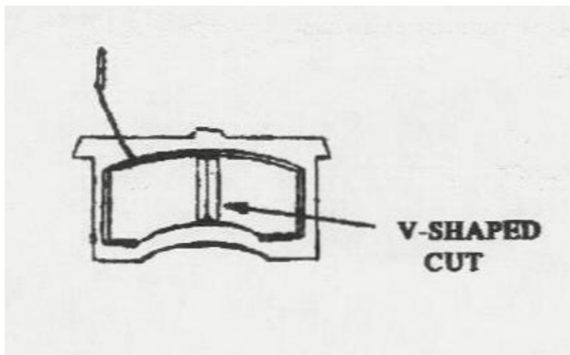
Your D brakes may need bleeding if any work is done on the brakes or if perhaps you have let the fluid level get low. The need for bleeding will be evidenced if your brakes take abnormal pressure to apply or if there is a delay after you push the pedal before the car stops.

Get two pieces of Tygon (plastic) transparent tubing of the proper size and fasten a piece of proper length to each bleed screw of the front brakes and run them into the top of the reservoir. (The bleed screw of the left front brake is sometimes near the carburetor.)

Open the bleed screws using a 9mm wrench. Leaving the hood open, start the engine and press the brake pedal and hold until the fluid you see passing into the reservoir is free of bubbles.

Shut off the engine and close the bleed screws. Remove the tubing. (I keep it in the spare tire wheel.)

Groans and goans eliminated with V-shaped pad slots
Charles Fowler (Jul, 1983, p.5)



After replacing the front brake pads in my D wagon, it developed an irritating, shuddering moan as it was braked to a stop. The pads were a hard composition, made in Canada, and quickly acquired a shiny glaze. My first attempted fix involved beveling the leading and trailing edges of the pad and placing a light coat of grease between the backing plate and piston. No luck.

I finally cut a narrow groove through the pad's short length which eliminated the problem. Make the cut slightly V-shaped and almost to the backing plate. You can use a cut off blade in a circular saw but beware of the asbestos dust. Use a mask or arrange a shop vacuum to prevent inhalation.

Parking brake adjustment
Don James, OH (Jan, 1985, p.18)

Worst cause of parking brake wear comes from adjusting for pad wear with the cable wear adjustment. Parking brakes should only be adjusted at the caliper. This is done from under the car. It is easy to see if someone has mis-adjusted your parking brakes from beneath the car. Be sure that all four caliper arms are firmly against their stops when the brakes are off (released). Release the jam-nut and adjust each screw for individual pad wear, only with the arms against the stops.

Wearing out the parking brake pads by mistake can happen if they are accidentally left on while driving. Best way to prevent this is to be sure that you set the brake firmly every time you use it. That way you will always feel the drag should you drive with it still on.

Parking brake springs installed with Whitney valve spring tool
Ken Butler, NM (May 1989, p.18)

J.C. Whitney valve spring compressor, #14JA2556T, is the perfect tool for installing those ornery parking brake springs (no longer available. They looked like lawnmower valve spring compressors, but were sturdier, for car valves. They have gone the way of the flathead. I used a pair of hose clamps, a laborious task to install, but did make quick work once installed. [MB])

Pistons and castings modified for added rubber LHS seals
Ken Butler, NM (Apr. 1995, p.19)

This alteration eliminates the usual corrosion present on brake fluid vehicles such as my '68 ID. The external lip of the seal locks into the altered felt groove while the internal lip of the seal locks into a groove ground into front end of the piston.

Only Kelsey Hayes #09443501 marked on rim of seals (EIS #C 1026) will fit properly. I found that Kelsey Hayes was using more than one mold to produce these seals that are sold under the EIS trademark at brake parts outlets. Only those seals marked on the rim of the seal, molded in the rubber, Kelsey Hayes #09443501 can be adapted to this application. For this reason, get the seals on hand before cutting any metal. A spare set would be good insurance for replacement if needed.

Do not attempt to cut the groove in the piston by any other means than grinding with a narrow wheel, 1/32", or you may peel off the thick, chrome plated surface of the piston, destroying it. Patience is a virtue in the operation. Do not crowd the wheel into the piston. Let it cut without stressing the plating in any way. Details in regard to machining dimensions and method of machining will be furnished to interested members.

The alternative is to change to silicone brake fluid or continue to fight stuck pistons and dragging brakes with excessive wear on pads and discs. I managed this on a small Atlas bench lathe, but it will be much easier with a larger machine.

Editor: Silicone grease such as NAPA #7651346 is a big help when installing LHS-2 (brake fluid) parts. Two other photographs with the 0original article have been omitted as unnecessary. One showed the pair of casting halves. The other showed the complete brake assembly ready to be reinstalled on the car. (A simpler and more effective modification would be to replace the felt ring with an additional sealing o-ring with a small slit in it. [MB])

Pistons unstuck with grease gun
John Hege (May 1991, p.9)

I've gone through that ordeal of sticking calipers myself and with customers' cars. While there is no quick way to rebuild calipers, I have an easier way to remove frozen pistons. I have a grease fitting brazed to a brake line which I attach to the caliper, enabling me to jack out the piston with a traditional grease gun. Lacking a torch I suppose you can connect it with plumbing fittings and a compression coupling. There is no need for a "helper" car, no brake fluid on the floor and the grease gun produces enough pressure to remove pistons that would be hopelessly stuck otherwise. It's even easier to clean out the grease in a Citroën caliper because it has no internal passages.

Pistons unstuck with grease gun
Don James, OH (May, 1992, p.22)

Removal of brake or clutch pistons can be difficult if not impossible when you can't get hold of the piston. Any hard tool would scratch it and cause it to be ruined. Try attaching a line to the cylinder with a compression fitting and then force grease into the line by attaching a standard grease fitting and using your grease gun. The grease gun can easily put 10,000 psi of pressure and will free almost anything. The grease will ruin the seals on any brake fluid components, so be sure to change them.

Pistons unstuck with hypo syringe
(Feb. 1979, p.2)

To lubricate sticking brake pistons more easily, apply the lubricant with a small plastic hypo syringe of the kind used to apply solvent to acrylic sheeting. Look in your discount or hardware store in the acrylic sheet and plastics section.

Rear brake adjustment
Betsh, Ken (2001 #5, p.10)

The hex-head external adjustments for the rear brakes tend to "freeze" in place and resist turning with normal 14mm wrenches. The ones toward the front of the car can be especially hard to adjust due to limited clearance. Instead of rounding off a stuck hex head with a 12-point hex wrench, I use the simple flat 6-point 14mm stamped-steel wrench that came with the car tool kit and, if necessary, hit the end of it with a hammer. (Not good for the tool, but for me it has little other use.) Before doing this I squirt some penetrating oil under the hex heads.

I've heard advice that one should keep the adjustments very close to the dragging point so that the pistons need travel a minimum, thus increasing the life of the o-rings. Others have said a large clearance is desirable to maintain clearance after heating from use and, for a unexplained reason, to reduce squealing. I've gone with the minimum clearance way and have never felt there was any dragging when warm. My experience has been that any unusual sound from the rear brakes indicates leaking fluid. In the cars with mineral fluid, the o-rings last at least 100,000 miles. Thanks to this fluid, there is no internal piston rust to add wear to the o-rings.

At least twice a year I remove the brake drums to check that the mounting points near the bottom end of each shoe haven't frozen. To do this I just temporarily remove the heavy spring pulling the two shoes towards each other and make sure the shoes can wobble around the bottom pivot points. If not, I dismantle and clean these pivots and reassemble with some "never seize" compound between the eccentric spacer and the large mating hole in the shoe. Unless I want to go through a tedious resetting process, I take note of the position of this eccentric spacer before disassembly so it can be put back in the same position.

My method for adjusting the eccentric spacers anchoring the rear brake shoes requires a lot of patient trials since I lack both the special measuring tool shown in the factory service manual and a modified spare drum seen at a Citroën service shop. I start by setting the eccentric spacers for maximum clearance. I then replace the drum and adjust the external hex-head adjustments just before there is any drag at any point as I turn the drum. Now I remove the drum and rotate the eccentric spacer about 60 degrees and replace the drum. Usually there still isn't any drag at any position of the drum but, if so, I check the hex-head adjustment to be sure the drag is not due to this. Then I continue to rotate the eccentric spacers in smaller steps until the drag point is found and then back off just a slight amount. While this doesn't sound very professional, I generally get long life with fairly uniform wear of the linings. (One can also clamp a hex wrench to the hub so the turned end just touches the face of the shoe at it’s farthest point. Spin the hub and make necessary adjustments to make the shoe contact all the way around. Test fit the drum, reclamp the hex wrench outward and readjust until the drum just fits, then readjust inward very slightly. Make final check for proper circumference and assemble. I prefer a slightly larger gap to prevent piston sticking caused by insufficient travel. [MB])

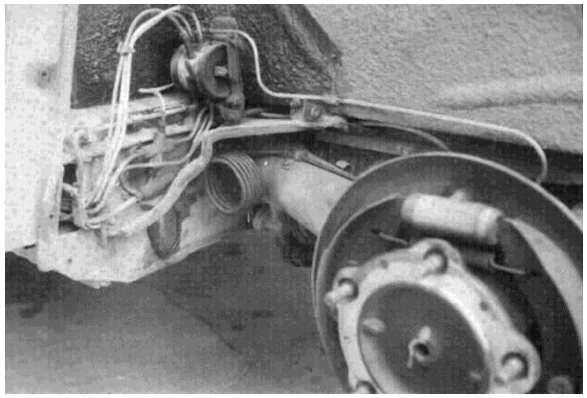
With well over 200,000 miles on my two D-models, I've only had the rear drums turned down once. Even then I'm not sure it was really necessary. This was done satisfactorily at a nearby automotive machine shop where no one ever heard of Citroën.

Rear brake bleeding procedure
Dave Root (Jun 1997, p.14)

It is important that the rear wheels are on the floor and that the full weight of the car is on them. Unless you have an assistant available, prop the brake pedal ON with a wood prop made the right length (or a suitable weight on the pedal).

Attach a piece of tubing to the bleed screws, running it into a glass jar. With the engine running, open one bleed screw and run out enough fluid to make sure the bubbles are out and close the bleed screw. Repeat at the other wheel and remove the tubing.

Rear pivoting pipes replaced with coiled tubing
Ken Butler, NM (Jun. 1989, p.13)



Here is a permanent fix for the leaking rear brake swivel pipes. It consists of six turns of American 3/16" steel brake tubing wrapped around a spray paint can. Leave enough tubing straight on each end to reach the brake drum fitting. Remember to install the Citroën nut in the right direction on each end. A 3/16" copper tube compression sleeve can be carefully silver-soldered at the proper distance from the end–in the absence of a French connection tool.

Clamp both ends, one to the frame and the other to the suspension leg in such a manner that the center of the coil lines up with the center hole in the chassis pivot. This provides a coil that moves radially with the axle movement, up and down. These coils have served me trouble-free for 10 years.

Coat the finished units with rust-proofing grease! Note the rubber hose under the clamp protecting the steel brake line from damage. All hydraulic lines should be insulated from direct contact with clamps.

Editor: Swivel pipes were used in cars with brake-fluid (LHS) hydraulic systems. Later LHM (mineral-fluid) cars use hoses that seem quite durable. After-market hoses compatible with brake fluid (but not mineral fluid) are available.

Spongy D-Special brakes caused by failing accumulator
Garrett Rea (May 1995, p.7)

One of the biggest hydraulic problems that I experienced with my D-Special started a couple of years ago when a van ran a stop sign and forced me to bring the car to a quick halt (it is now a four-way stop there). After the skid, air horn, bird and obscenities to the idiot who almost killed himself I noticed that the pedal felt a little spongy, but I just passed it off as it was not too severe.

A few days later there was a huge puddle of fluid under the driver's rear corner of the car. I figured then that I had a failure of some part of the rear brakes, as this would explain the soft pedal and the new puddle. Removal of the rear fender showed no problems, but the frame was wet, so the next check was the line that crosses in the trunk. It was then that I opened the trunk and saw that I had two unrelated problems: the leak was the new and now empty gallon can of

Texaco in the trunk. The can had been punctured when a box crushed it during the emergency maneuvers the Sunday before. I went ahead and bled the brakes on the car, and all was OK for a couple weeks.

It was then that the real problems started while in Columbus one weekend. Press the pedal and either there were no brakes or the rear of the car would dive and the rear wheels would lock. Bleeding the brakes would make the car OK for a while, but in a mile or two the problems would start again. This was during winter and as I really did not need a car as Athens is a town where you can walk to everything, I let the car sit in front of my parents' house until spring.

Spring break came and so did a lift to my parents' to look at the car. I went out to the car and started it up–now I had brakes, as in the period of time the problem had come to light: "air" was obviously getting into the system and an earlier look at the car the weekend of the major failure had shown that the pump, fluid level, and suction hose were OK. I had mentioned the problem to others to see if they had any ideas. Terry Tekushan had a conversation with Bob Hoffman of Citroën Auto Sales fame and mentioned the problem with my car. Mr. Hoffman had seen this before and told Terry the cause of the problem: a slow leak in the main accumulator. And sure enough, in the spring when I fired the car up, I let it run with the bleed screw open for a while, and once closed with the car up, the pump cut in and out almost constantly. No problem, just go down to the shop, put the car on the rack and throw another main accumulator on it.

It is problems like this that bring out good learning experiences. I learned the solution to an odd hydraulic problem and my parents learned that a DS makes a good snow fence.

Troubleshooting check list
Reprinted from Citroën factory booklet "Citroën Hydraulic System, Possible Incidents With Suggested Causes and Remedies."

Submitted by Jerry Seville (Aug. 1985, p.24)

INCIDENT	POSSIBLE CAUSES	REMEDIES
11) Poor or ineffective braking.	Hydraulic fluid pressure low.	Trace causes, rectify.
	Pressure supply pipe(s) obstructed.	Clear obstruction.
	Brake control unit passages obstructed.	Clear obstruction.
	Brake linings contaminated or worn.	Clean or change linings.
	Slide valve(s) sticking in brake control unit.	Free off.
	Stop light switch incorrectly adjusted or faulty.	Re-adjust or change.
12) Harsh or fierce braking.	Automatic wear take-up mechanism not functioning.	Check for cause and rectify.
	Rear brake shoes clearance to drum excessive.	Adjust clearance.
	Front brake units fitted wrong.	Align brake pads to discs.
	Rear fixing bolts of front brake unit loose.	Tighten fixing bolts.

	Front anchorage nuts of front brake unit loose.	Tighten nuts.
	Front brake unit silent bloc bushes worn.	Change silent bloc bushes.
	Excessive end play in front brake moving carrier.	Adjust by re-shimming.
	Rear engine mounting nuts loose.	Tighten mounting nuts.
	Pistons sticking in front brake.	Free off pistons.
13) Brake squeal.	Dust in rear brake drums and/or bearings.	Blow out dust.
	Leading edges of brake linings not square.	Square off.
	Brake drums scored.	Skim or change.

Other parts of the Citroën factory booklet in which the above appears are in this book under the following chapters: 8 – Citromatic, 18 – Hydraulics, 25 – Steering and 27 - Suspension

Chapter 4–Breakdowns

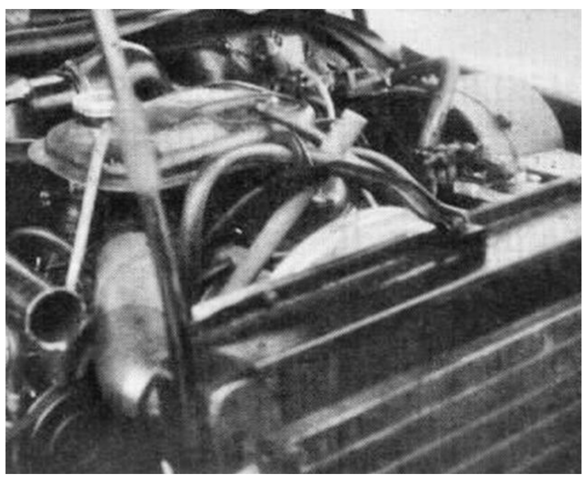
Alternator light stays on after engine starts
Dave Root, FL (Jun, 1890, p.3)

If the alternator warning light doesn't go off after engine starts, the problem may only be due to loose or blown fuse.

Engine dies due to broken points spring
Don James, OH (Jun. 1982, p.3)

One day on my way home from work, my car stopped rather suddenly. A quick check showed no spark. Opening the distributer I found that the spring on the points had broken. I found a twig on the ground and wedged it against the broken spring. The car would not rev very high, but it got me home and it only took five minutes to fix.

Hydraulic pump belt tension restored with broom handle
Dave Root, FL (Jan. 1990, p.4 & Feb. 1990, p.16-abridged)



About halfway on a fifteen mile trip, my Citromatic clutch disengaged and suddenly I had a racing engine, but no visible means of locomotion. Fortunately, I remembered that you could engage the clutch on a Citromatic by pushing on the little lever under the dash, so we kept moving. I should have stopped to see what was causing the problem, but it was raining and I was moving. I pressed ahead until I reached my destination. With the engine still running, I looked under the hood and saw what I expected–the centrifugal regulator was not running and, surprise, neither was the hydraulic pump! The anchor or hinge bolt had fallen out, loosening the belts. About this time I was losing suspension and all other hydraulic functions were, of course, soon to cease.

It was not feasible to repair the trouble at the time and under those circumstances. I spotted an old broom handle and pushed it in under the pump in such a way that it was wedged by the top radiator bracket and kept in place by the main hydraulic return line. This held the pump up enough to put sufficient tension on the belts. When I started the engine, the car rose triumphantly to the occasion, floating and flying me home!

The chance of this happening to anyone else is probably about a million to one. However, for those of you who like to keep your Citroën emergency tool kit up to snuff, the length to cut from a used or new wood broom handle is 18".

Hydraulic warning light on road requires attention
Don James, OH (Jun 1987, p.12)

What do you do when you are driving down the road when suddenly, the red hydraulic warning light comes on? First, and most important is to stop the car immediately! Do not continue to drive on–find out what is wrong. This is important because loss of hydraulic pressure will cause the total loss of brakes and extremely heavy steering. Cars with Citromatic transmissions will not shift, nor will the clutch disengage.

After the hood is open, look to see if there is any fluid in the hydraulic tank. If there is, check to see if the hydraulic pulp is turning. This seems very elementary, but it is a very common problem and is usually missed on first inspection. Coolant dripping on the hydraulic pump belts from a missing drain tube on the water pump can cause the belts to slip. Also, cars with air conditioning have a habit of stripping the splines or shearing the rivets on the driving pulley.

If there is no fluid in the hydraulic tank, there may be a large amount of fluid near the point of the car where the leak occurred. If the entire engine compartment seems to be covered with fluid, the first place to check is the rubber return line from the pressure regulator. If you have not relocated the pressure regulator, you will find it on the side of the engine block, beneath the fuel pump on your D-model. It is right on top of the engine in an SM or GS-and easier to get to! This rubber return line is the bypass line that takes fluid from the regulator back to the hydraulic tank when the regulator cuts out and the pump is not doing any work. It is a common point of failure.

If there is no fluid in the tank, and there is no way to determine where the leak is because everything is covered with fluid, the only way to find the leak may be to pour more fluid in the tank, open the bleed screw on the pressure regulator with the engine running, and then, while watching for the suspected leak, close the bleed screw. Be sure to wear eye protection while looking for a leak with the system under pressure. When you find the leak, do not touch it or try to stop it with your finger. To do so would risk an injection of fluid through your skin.

Once you find the leak, it is a sure bet that you will feel better. A competent garage can help you solve your problem, using ordinary American brake lines and fittings. A leak in a sphere usually indicates that a sphere has gone flat. That's another good reason to carry a spare sphere!

Slow leaks from the power steering or hydraulic pump may not require immediate attention, but they serve as good indicators that the seals in the units need replacement. Leaking height correctors are a sign that the metal strap on the diaphragms has rusted away. The diaphragm is no longer sealed tightly on the ends of the corrector, and the leakage may have caused corrosion of the aluminum.

Knock or clacking noise due to loose camshaft pulley
Bob James, OH (Jan. 1982, p.7)

A knock or clacking noise in my '65 ID was traced to a loose nut on the camshaft pulley that drives the water pump and etc. It might be a good idea to put some Loctite on this nut or at least check it for tightness.

Pressure switch failure causes major oil leak
Don James, OH (Jun. 1982, p.3)

The oil pressure sending unit has been known to leak suddenly when the diaphragm ruptures. This loss of oil will cause the contacts to fail, so the light on the dash may not work. Plenty of D-model engines have been ruined this way. If you don't carry a spare with you, at least carry a spare metric bolt to screw in should it fail–thread size 10 mm x 1.5 pitch.

Resistor failure stops engine–quick fix
Allen Gravelle, Ontario (Jul. 1986, p.17)

On a quick Sunday trip to Quebec in search of beer, my DS began to sputter cough and generally run bad. We made the beer store got our provisions and left for home. Two miles from the border the Citroën started coughing again, then heaved and died. I jumped out opened the hood and began checking the electrics. I could hear electrical arcing but was not able to see it. Suddenly Cheryl, watching from the right fender side, yelled, "Al, I see it, it's sparking on top of that white thing attached to the coil." I slid over to her side and sure enough, there it was for all to see. The externally mounted bakelite ballast resistor was shorting out. I taped the leads together and we resumed our trip. We arrived in time to watch the fourth quarter (our team won). The resistor was replaced with a new one from Canadian Tire.

Editor: It's more likely the faulty resistor was intermittently opening the circuit.

Use of manual clutch release during centrifugal regulator failure
Don James, OH (Nov. 1986. p.18)

If the Citromatic centrifugal regulator bearing seizes and the regulator stops turning, your clutch will not engage and your car will coast to a stop. Anytime your car won't move, check the regulator for turning. The car can be driven by cutting off the belt, and then using the manual clutch engagement lever under the dash to engage the clutch. This is a bit jerky, but it will get you home. Manual clutch engagement is used when you are crank-starting the car to engage the clutch on Citromatic cars. Check your owner’s manual about this.

Use of manual clutch release during centrifugal regulator failure
John Mazmanian (Feb. 1989, p.11–abridged)

We were cruising south on I-75 in Florida when all of a sudden the engine started to race–no gears in engagement. A visual inspection after stopping revealed plenty of fluid and no broken belts. There was a funny smell emanating from the engine compartment. I closed the hood, jumped back in, moved the selector to first–nothing. While still in first gear, I tried the clutch release trick under the dash, and lo and behold, the car moved off. Another emergency stop was made after smoke started to billow out of the engine compartment. This time I saw the centrifugal regulator bearing had seized causing the drive belt to burn. I removed the belt and was still able to drive as long I used the re-engagement control lever under the dash. A call and slight detour to Ralph Cudworth completely and quickly solved the problem. He had prepared a new front assembly with a new bearing before we arrived and had it installed in no time.

Editor: For more info about changing this bearing, see: "Citromatic– Centrifugal regulator front bearing replacement." You don't need to remove the regulator from the car.

Chapter 5–Carburetors

Air hose plugged with plastic cork
(Feb. 1979, p.3)

If you have de-polluted your D-model and can't figure out what to put in the front metal nipple on the carburetor air hose, try a plastic champagne cork pushed in all the way. (American spec cars built after 1967 had air pumps and associated plumbing. This equipment has been more often than not removed. [MB])

Air volume screw cleaning cures rough idle
(Feb. 1979, p.2)

Periodic cleaning of the air volume control screw on Solex carburetors on D-Specials will help prevent stalling, rough idling, and poor gas mileage. They get very dirty from the oily crankcase fumes that are vented to the air intake of the carburetor and from dirt from outside air. Back out the screw completely (located at the upper left of the carburetor) by hand, taking care not to loose the spring. Clean the screw and spray carburetor cleaner in the screw's orifice on the carburetor. Put the screw all the way in by finger tip and then back it out about three turns and start the car. After the engine has reached operating temperature, attach a tachometer (or have someone watch the car's tachometer) and unscrew the air volume control screw until maximum idle is reached.

Carburetor operation, general description
Kevin Cameron; Cycle World Magazine (Mar. 1993, p.10)

Descriptions of how carburetors work tell us that fuel spraying from the needle jet is atomized by the airflow and...wait. Stop right there. How is it atomized, and why? What makes the atomizing finer or coarser? Let's look into it. Long ago, a fellow named Hochschwender photographed droplets suspended in a rising stream of air. They weren't "teardrops" at all, but were squashed spheres, flattened by air pressure on the side facing the flow. As drops were made bigger, or the air velocity higher, they became flatter until their centers caved in under the pressure of the air streaming against them. Then they popped, reformed into a ring, then burst into a necklace of much smaller droplets.

Why should this be? The grand old man of fluid mechanics, Ludwig Prandtl (1875-1953) outlined the matter. Liquids are held together by molecular forces of attraction. Inside the liquid, these forces are largely "invisible" because they act in all directions, but at the surface, they act like a skin under some slight but measurable tension–the so-called surface tension. In the absence of other forces, surface tension pulls the droplet into spherical shape. Just like the rubber skin on a water balloon, surface tension produces pressure inside the droplet. This is proportional to surface tension and inversely proportional to droplet size. Opposed to this is the pressure of the air hitting the drop, which tends to flatten it. This is called the dynamic pressure, and is proportional to the density of the air and the square of its velocity. As the flow slows in hitting the droplet, its kinetic energy is converted into pressure energy.

Fuel shoots from a carburetor's needle jet, straight out into the intake stream, which is speeding past at hundreds of feet per second. The fuel droplets are heavier than the air, so they can't instantly accelerate to airflow speed, but lag behind. This difference in speed subjects them to dynamic pressure, which flattens them in good old Hochschwender style, bursts their centers, and explodes them into halos of tiny droplets. If the airflow velocity is high enough and these smaller droplets have not yet accelerated up to speed, they too, may in turn be flattened and burst into yet-tinier droplets. In short, Hochschwender and Prandtl proposed that for a given air velocity, there was a corresponding droplet size to which fluid would inevitably be broken down by this process. To estimate what this size might be, Prandtl suggested that a droplet would break when the dynamic pressure of the air equaled the droplet's internal pressure (created by its surface tension).

This gives us part of the reason why smaller carburetors are easier to tune than bigger ones; they produce higher venturi velocity which physically reduces the fuel droplets down to smaller sizes. These smaller droplets evaporate promptly to make an easily ignitable mixture that engines thrive on. Engines are often designed to give mean intake-duct velocities near 350 feet per second. Using this velocity, Prandtl's formula gives a droplet size of about 100 microns, or .004 inch. This is not bad for a rough calculation, for in fact droplet sizes from carburetors range between 50 and 200 microns. Why so big? Remember that this calculation is for the case in which the droplet is hit, that is, with full stream velocity.

In reality, by the time mid-sized droplets have been formed from the break-up of big ones, the air will have accelerated them quite a bit, so the relative droplet-to-air velocity will have fallen. The droplets are coming up to speed in the airflow. That permits some bigger ones to escape unbroken.

Now consider a limiting case. The air-blast fuel-injection system used on Orbital Engine Company's automotive two-stroke engines works as follows: There is a pre-chamber, connected to the engine's combustion chamber by a small orifice. Fuel is injected into the pre-chamber, forming large-ish droplets in the 50-100 micron size range. Next, a tiny valve opens, admitting a burst of air to the pre-chamber at 60 psi. This drives the coarse fuel/air mixture out through the orifice, where the flow reaches the speed of sound, and into the main combustion chamber. Naturally, the air, being lighter than fuel, accelerates quickly through the orifice, leaving the fuel lagging. This produces a very great speed difference between the droplets and the air accelerating past them, and the result is extremely fine atomization–down to a mean droplet size of 10 microns, or .0004 inch. When we try this number in Prandtl's formula, we get a corresponding velocity of 980 feet per second–satisfyingly close to the speed of sound.

There are endless racing and hot-rodding epics in which the hero struggles to get big, hi-po carburetors to work on his modified engine, but just cannot combine all necessary aspects of performance–acceleration, top speed, throttle response, freedom from detonation.

Yet it all makes sense. Tiny fuel droplets from small, high-velocity carburetors evaporate fast and ride happily with the air to their hot destiny in the cylinders. Big droplets from monster mixers prefer to resist and misbehave every way they can: wetting the walls, refusing to turn corners, failing to evaporate fully, even splattering against sparkplug insulators where heat bakes them to conductive carbon film that shorts out the spark.

The engine misfires-"shoots ducks," in the old hot-rod lingo–and doesn't clear until high rpm brings the intake air speed up enough for good mixture to resume. Sudden throttle movements leave these liquid sluggos loitering in the intake pipes while the now-lean air/fuel charge hastens to the cylinders.

The unhappy result is a "momentary interruption of service," with detonation–the spice of the tuner's life–a likely possibility.

Choke cable repair
Jerry Lugert, NV (Jan. 1991, p.11)

The inner cable of the manual choke on my '70 DS became too short due to breaking where it attaches to the carburetor upper butterfly. It became time to cannibalize again from my ever reliable stash of spares. The first step is to disconnect the speedometer where the cable halves join near the alternator. This permits you to withdraw the section of the dashboard holding the speedometer and other gauges to gain access to the choke cable. The choke knob and exterior chrome bevel unscrew from dash and cable is then raised up into access hole provided by the removed gauges. Then the entire cable mechanism can be pulled into the interior from rubber insulated hole in firewall (after unfastening it from the carburetor).

Place the cable in a bench vice or on a work table and begin the process of determining which combination of the two cables you now have will make the best whole cable. I had to use the inner core of one and the outer of the other. In so doing, it meant further "dis" followed by reassembly. Run some sort of solvent/lubricant down the housing and begin to work the inner cable free. Ultimately the inner core is pulled out from the choke-handle end, but not until proper releasing takes place. This releasing consists of sliding the small ball retainer collar to one side, being careful not to lose the ball in the process.

Another ball will then be seen "living" under the one you just removed. This one is likely not to fall out as easily. A little prompting with solvent followed by tapping may be necessary. Once this "inner ball" drops out (hopefully in your hand), the entire inner cable can be withdrawn from its housing. The inserting of this cable in another housing did not go as smooth for me as I would have liked. After much lubrication and many attempts, I finally managed to get it past the housing joints that provided resistance. I concluded the inner cable must be very straight. The making straight process (with pliers or whatever) requires great care so as not to snap the tempered steel. Once the cable is inserted and all that protrudes is the integral shaft/knob-handle, the entire process gets interesting.

This is where this rather lengthy explanation should save you much time–time I used learning what I did. I carefully inserted the first small steel ball into the single receiving hole. It was then necessary to pull the handle/knob out about three-quarters of an inch more and insert the second small steel ball and immediately slide the outer collar over this hole BEFORE trying to move the cable. Now it should be possible to press the cable all the way into its housing without losing the steel balls. These balls serve as catches so the inner cable does not get accidentally withdrawn in the process of using the choke. The small collar over the steel balls gets somewhat distorted during the R & R, so I wrap a little tape around the shaft to prevent the collar from accidentally sliding off the steel ball.

Now everything is replaced in reverse order of removal with a little soap around the firewall insulating rubber. This may all seem like a lot of bother, but try starting your Citroën in below zero weather without a choke!

Cleaning and adjustment procedure
Don James, OH (Mar. 1985, p.11)

After removing the entire carburetor, use a spray can of carburetor cleaner to blow through all the holes. There are two large slot headed plugs on each barrel of the Weber carburetor. These are located on the outside, but you must remove the carburetor to get to the one on the valve-cover side. These plugs cover the chamber where the small idle and low speed holes are drilled into the bore of the carburetor. There are three holes in each barrel. Clean these out. Gum and varnish is "clear" in color, so don't be fooled because you can see light. The Weber carburetor is very easy to clean because of this screw in plug, but you can imagine the crazy way the engine would run with just one piece of dirt or rust floating in this chamber and floating from hole to hole.

The key to adjusting the carburetor is to get the throttle plates closed. The idle speed is not set with these plates like on an American car. Internal passages allow air and gas to mix and go around the throttle plates. If the throttle plates are open too far, only air will be drawn around them and not enough idle mixture through the idle passages. The throttle plate must only be open a certain amount. If they are open too far, adjustment of the idle mixture screws will do nothing. They will have no affect because there is no fuel being drawn through the idle passages, and the car is running, using the low speed jets or even the mid-range jets to run. I have even seen carburetors that were so out of adjustment that fuel was being drawn out of the main jet when the engine was at an idle. Wear eye protection while looking down the throat of the carburetor if the engine is running. There are many good books on carburetors on the market too.

Downstream jet requires periodic cleaning
Ariel Robinson, VA (Jul. 1984, p.20)

Everyone I've talked to in the region hasn't been aware of the existence of the "downstream jet" in their D-models. It is a simple orifice screwed into the intake manifold, below the carburetor, on the rear side. A 10 mm wrench will unscrew it after you disconnect a smallish rubber hose leading to a tee connector in the crankcase breathing system. Take this jet out and clean the carbon deposits out of it until you can clear the small hole in it. You should be able to blow through it. A very small jeweler's screwdriver, small drill bit or paper clip can be used to restore the orifice. Do not enlarge the hole. If this "down-stream" jet is clogged it is impossible to obtain a correct idle mixture and a correct running mixture. This jet lets air into the manifold in calibrated amounts at all times. It will improve fuel mileage and make it possible to adjust the slow (idle) running mixture if other factors are correct. This jet is listed in the owners manual as an item for periodic maintenance.

Editor: Only the later models, perhaps starting in 1966, '67 or '68 had this jet. On such cars there is a three-way union along the hose that vents the crankcase fumes to the carburetor air intake hose from which a small hose connects to this jet.

Fire prevented by epoxy on fuel inlet
Jack E. Davis (Feb. 1992, p.22)

One of the weak points of the Weber carburetors on D-models is that the gasoline input tube can become loose to the point of falling out. If it does while driving and the engine is hot, you have the potential of a fire. What we have here is a brass tube pressed into pot metal. I suppose over time the pot metal expands and the tube is no longer tight. To fix the problem I remove the tube, clean it with emery cloth, and then coat it with steel epoxy glue and press it back in place. Maybe there is something better, but this has worked well for me. This isn't something you should think about doing later–DO IT NOW! (A far more elegant and trustworthy method of repairing this problem is by making or finding a threaded brass nipple and carefully tapping out the inlet hole on the carburetor cover to accept it. See the next article. [MB])

Fire prevented by wire and clamp on fuel line
From "Chevrons", Lance Hellman, Ed. (Nov. 1977, p.3)

Many Citroëns do not have a clamp on the carburetor. The problem is that the hose loosens with age and the small amount of pressure the fuel pump exerts may make the hose disconnect from the carburetor. This results in gas sprayed all over the engine and wiring and usually a roaring gas-fed fire. A small "radiator hose" clamp should be installed. Sometimes the tube the hose slips over has itself pulled out of the carburetor; if this tube appears loose, it should be gently tapped to reseat it. I usually install a clamp AND a piece of wire to prevent either possibility. I've bought two Citroëns that had gas fires caused by disconnected gas lines. In one, the burned remains of the gas hose, complete with metal tube, were laying beneath the engine.

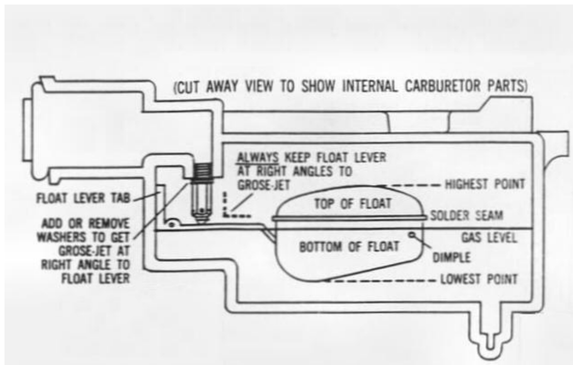
Fire prevented by wire and clamp on fuel line
Don James, OH (Nov. 1984, p.2)

The second big engine killer (the first being an oil pressure switch leak or rupture) is a fire fed by a loose fuel hose at the carburetor. The brass hose barb (tube) to which the fuel line is attached to the carburetor can come loose. Because this brass tube itself can pull out of the carburetor, a simple hose clamp to this tube is not the solution. Be sure you use a hose clamp and SAFETY WIRE it to the carburetor body.

Float valve alternative is ball-shaped
Charles Fowler (Nov. 1982, p.6)

Gross-Jet is a needle and seat replacement for your Weber carburetor. Advantages are less friction and better fuel level control. This type of valve opens faster and gives a more positive shut-off. It is all metal and gives perfect fuel level control without any binding. Keeps level constant even when cornering hard. Saves gas. Not as susceptible to dirt. Smoother idle. Less susceptible to flooding from vibration. To compare the difference (according to their advertisement), the new all metal Grose-Jet rolls into place. Two balls do the trick. The old steel and plastic tip needle and seat scrapes into place.

Float valve alternative is ball-shaped
Andrew Hathaway, NJ (Mar. 1990, p.18)



After installing a Weber two-barrel carburetor on my '72 D-Special in place of the original Solex, I found that there was too much gas going through the engine. It both smelled bad, had the odd bit of black smoke, and used more gas than it should have. I was wondering what to do about it when I got my Winter 1990 Vol.8 #1 copy of Citroën Quarterly with a very good article by James O'Gara in which he lists a number of things to do vis-a-vis carburetor care.

One of the things was to get a ball bearing type of fuel admission system installed in the Weber called a Grose-Jet. The number of the part is W501-.084 for $4.50 plus $3.50 shipping (1990 prices). The company is D&G Valve Manufacturing Co., 8 Mount Vernon Street, Stoneham, MA 02180.

I had to bend the brass rod that holds the float a bit to get the old valve out and the new one in. I didn't want to take the chance that I would break anything by trying to tap the rod out. Do this very carefully. Use a deep socket to remove and install the valves. I found that the clearance was the same for both valves and didn't have to adjust it. The factory setting is 3 mm for the adjustment. Just having the exhaust smell better and a smoother engine makes the car better.

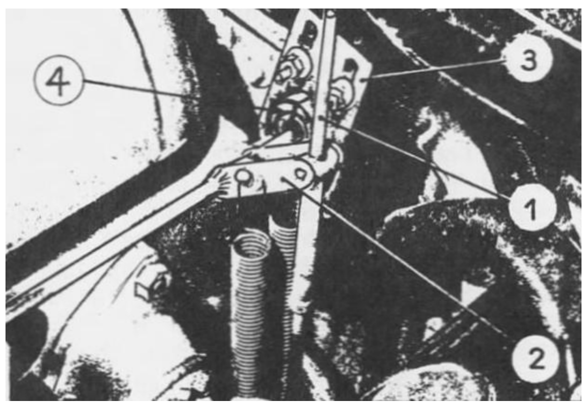
Editor: This article does not include these warnings included in Grose-Jet's instructions reproduced in original newsletter: Don't use shellac or pipe dope. Always replace gas line filter. If there isn't a filter in the line, install one. Don't smoke. Have a fire extinguisher handy. Have a heavy asbestos (?) blanket handy to smother a fire in the carburetor. (I have yet to see a carburetor that I could not easily remove the float pivot pin. Do not under any circumstances bend the float tang. The carburetor that this person used may have simply had a bad needle and seat. I have tried to find current information for Grose-Jet and I doubt they exist anymore. Their phone number does not work. You may be able to find new old stock. [MB])

Float valve failure due to exposure to diesel fuel
Randall Jones (Apr. 1997, p.8)

Shortly after refilling my DS while on a trip, it lost power and died. I looked in the rearview mirror to see a huge cloud of white smoke. After some thought about a reason, I realized I had accidentally filled the tank with diesel fuel. After draining the tank and refilling with gasoline, Wendy and I were able to drive on to our destination for that day.

The next morning it started and died. I opened the hood and got a strong smell of raw gas. After removing the top of the carburetor, I found the float had sunk. The soldered seam around the center had several pinholes in it. I believe the diesel fuel had destroyed the paint and coating that had been put on at the factory. (I have my doubts that this was the cause, if in fact this was what was wrong to start with. It is possible that the needle tip was damaged. Floats are never painted. [MB])

Gas pedal linkage bushing repair
Don James, OH (Jul. 1986, p.25)



The rear end of the carburetor control relay shaft rests in a rubber "bushing" that is fused to a bracket mounted on the firewall. After many years this bushing disintegrates, letting the shaft flop around loosely. This produces a delay in throttle response to the gas pedal due to the slack in the linkage at that point. One way to correct that problem when an original replacement bushing/bracket cannot be obtained, is to use a short piece of heater hose.

Cut a piece of hose about one inch long and slit it lengthwise, then slip it around the shaft and push it in between it and the bracket/hole. The hose will hold the shaft tightly in the center and allow quick throttle response. The fused rubber bushing and its support are not hard to get to.

Parts:
1. vertical accelerator control rod
2. trunnion lever
3. flexible bearing bracket
4. rubber insert/hose

(Others have used a proper sized nylon grommet. [MB])

Idle adjustment problem due to jet blocked by emission
Citroën Technical Information #80-December 18, 1968 (Mar. 1999, p.3)

The jet for passage of the gases into the intake manifold can become obstructed by carbon after a period of motor operation. The adjustment of the motor idling can become impossible with a blocked jet. It is advisable to systematically clean the jet every 6,000 miles.

Clean the jet by placing it in a commercial cleaning bath or a bath composed of 50% fuel and 50% trichlorethylene. Dry the jet with compressed air before remounting. (Trichlorethylene is rather dangerous; I would strongly advise against using it. You might use acetone; fingernail polish remover. [MB])

Idle and low speed irregularity due to lost jet
Ken Betsh, PA (Apr. 1991, p.15)

I first noticed what seemed to be engine missing while driving about 35 MPH in village traffic. Also, the engine idled so slow, as to almost stall. However, when out of town and able to "put the pedal to the metal," I had all the original get up and go. From this I was sure I had an ignition or carburetor problem and not a valve or other basic engine problem. A slight readjustment restored normal smooth idling. All the spark plug and ignition coil wires were tight and my dwell meter told me the condition of the points had not changed. After waiting an hour for the engine to cool, I changed the plugs (Citroën has always warned us to only change plugs when the engine is cold).

Alas, none of this or refilling the gas tank was of any help.

With a little more driving I became convinced the trouble was with the carburetor. As soon as I press the pedal down beyond a certain point the engine ran smoothly. However, the car was soon up to 50 MPH on level roads. Upon removing the top of the carburetor with the idea of checking the float valve and level (which were OK according to the brief manual I carry with me) I noted the idle air jet for the primary barrel–which is on the side towards the engine–was missing. Since my manual says the jet for the secondary barrel is exactly the same and because it can be easily reached with the carburetor fully assembled, I transferred it to the primary side. Now I found control of the idling speed almost impossible but the car would run smoothly at 30 MPH. There was no doubt I found the cause of my trouble.

My real problem was that this occurred while at Rendezvous some 350 miles from home. It's now a rainy Sunday morning and most of the parts sellers are not around. No one had a spare carburetor or the part I needed. It didn't help to think about the two spare carburetors I had at home and my wife and I had just started an extended Canada vacation trip. While I was out testing the jet swap, someone said to Polly: "There's always chewing gum". She found some, I applied it to the opening and was now able to set the idling. After a test run to get some lunch and armed with several names of people to contact along our way, we were off to Portland, Maine and the 8 PM overnight ferry to Yarmouth, Nova Scotia. We didn't want to loose the $222 paid for passage of the car, ourselves, plus a cabin for the eleven-hour voyage.

Everything was fine until a comfort stop. In the short time the car stood still without any air flow over our fix, engine heat caused the gum to run down and create an opening. First the engine would race while at idle and then it would stall. At the next stop I pushed a wad a paper in the opening.

We had no further problem and ignored it until we were in Halifax two days later. A contact there loaned me the jet out of a carburetor attached to an engine in his garage pulled some time ago from a 68 DS. I said I would mail him a jet from one of my spare carburetors as soon I got home. I removed what I thought was all of the gum and paper, installed the jet and drove away thinking my worries were over. Within minutes things became worse than ever.

The only way to keep the car from stalling was to tighten the idle screw almost to its maximum. I was certain the jet pushed a speck of gum or paper into a position to block the internal passage and I was now setting the idling by opening the throttle plate into its active range. Setting the idling to a repeatable speed this way is just about impossible. Using the choke to control the engine made matters worse–probably because the fuel ratio was already too rich due to the plugged air passage.

Fortunately, the owner of the old engine agreed to sell me the entire carburetor from which the jet had been borrowed. If anything on a car deserves a "if it ain't broke, don't fix it" statement, it's a carburetor.

Nevertheless, I felt I should look inside (the bowl area) of the replacement before I use it. I'll never regret this because there was a heavy layer of hardened deposits at the bottom of the bowl. I cleaned it as best as I could, made sure both idle jets were in as tight as possible and installed it.

The old "lump in the throat" feeling came when everything was back together and it was time to turn the key. To my great joy, the car started and after a minor idle adjustment the car ran better than ever. We had no more carburetor troubles during the remaining trip.

Idle troubles may be due to dirt in carburetor bowl
Ken Betsh (2000 #3, p.13)

Most of the time when I have idle trouble with my D-models and it's not due to a spark plug/ignition problem, I end up cleaning all the idle jets, the idle adjustments and the bowl of the carburetor. When cleaning the jets solves the problem and I don't remove the top of the carburetor to clean the bowl, the trouble usually returns. I'll then find quite a few minute dirt particles at the bottom of the bowl. While the inlet jets in the bowl are perhaps 1/8 inch above the bottom, I can see that in certain movements of the car, these dirt particles might get sloshed around and drawn into the jets and then cling to narrow passages. I'm careful while removing the top of the carburetor since one end of the gasket may cling to the top and the other end to the bottom. Pulling the top away quickly can cause it to tear and become unusable.

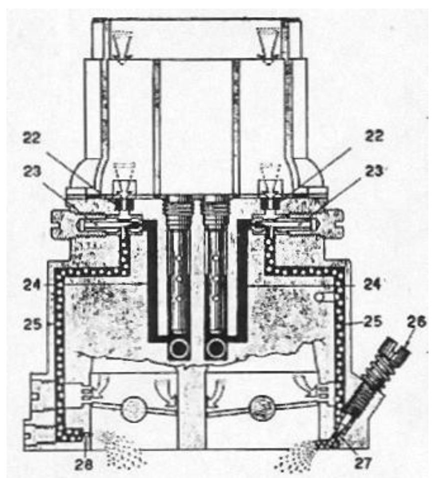
Information available in Glenn book
Ken Butler, NM (Feb. 1987, p.8)

Information on many carburetors used on Citroëns may be available from your public library. Ask for Glenn's "Foreign Carburetor and Electrical Systems", Chilton Book Company 629.287, Library of Congress No. 65-12892. (Now hard to find. Covers up to 1968. [MB])

Plugged passageway cleared
Ken Betsh, PA (Mar. 1996, p.13)

This is a follow-up to the problems when a replacement carburetor idle jet pushed a small piece of a temporary plug held with chewing gum further inside (see previous article).

The day was saved when my rescuer sold me the entire old carburetor from which he had loaned me the jet. This article tells how I repaired the old carburetor.

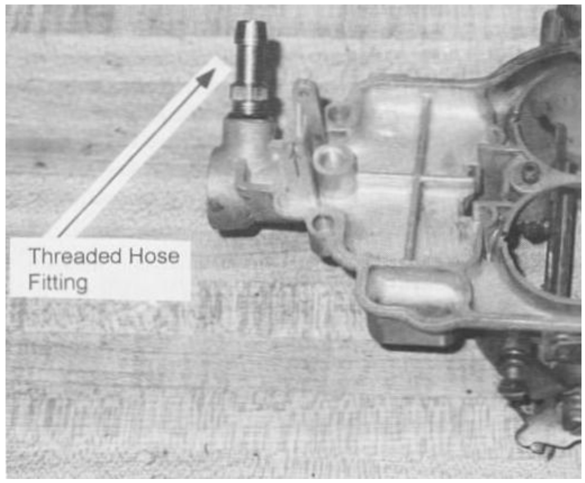


The passageway behind the jet turns 90 degrees to drop vertically to an internal jet at the base of the bowl (this passageway is marked #24 in the above figure). This vertical passage way is formed all the way to the top of the lower half of the carburetor and then plugged at the top and covered by the main gasket. I removed the soft metal plug by first drilling a very small hole through its center. Then I screwed in a small screw that when pulled brought out the plug. As expected, there was material blocking the passageway that I could now remove. I found a very small piece of coreless solder just fit the hole for the plug and stayed in place when spread with a strike from a center punch.

While working on it, I noticed the base had considerable warp at the four corners with mounting holes. I had a local machine shop resurface the base to be flat. I then had to file the four mounting holes to allow the carburetor to drop over the manifold mounting studs. It's obvious the metal used to mold the carburetor body is soft enough to deform around the mounting points under the pressure of overly-tightened mounting nuts.

The carburetor has now been is use for about 10,000 miles and mileage is as good as its ever been on this car.

Pressed-in inlet nipple replaced with threaded part
Chris Dubuque (Mar. 1999, p.10)



A prudent safety step when working on a D-model carburetor is to replace the pressed in nipple in the top cover for the gasoline input hose with a threaded fitting. Shown above is a 5/16" barbed hose nipple with 1/8" pipe thread on the threaded end. (For a time, a fellow from Australia was making these with a metric thread of M9x1.0. This slightly smaller, non-tapered size left more metal in the casting, making for a stronger fit. You might think about making your own using the 5/16 fitting, but grinding it slightly first so the die fits. [MB])

Rebuilding procedure includes throttle shaft bushing
Chris Dubuque (Mar. 1999, p.10)

Most DS sedans and wagons built after 1966 use a progressive twin throat carburetor made by Weber of Italy. Over the years, there were many slightly different versions of this carburetor to accommodate requirements, such as manual versus Citromatic transmissions, emission control changes, etc. However, the basic carburetor remained very similar for a full 10-year span of DS production.

The carburetor model designation is Weber 28X36. The specific model is given by a series of letters and numbers which are stamped on the mounting flange of the carburetor or printed on a metal tag fixed to a top cover screw.

Typical model designations found on US-model carburetors are DLED3, DLED4, or DMD 1.

The Weber 28X36 carburetor is a pillar of simplicity and reliability. However, age and high mileage take their toll. Here are some thoughts I have accumulated on rebuilding these carburetors.

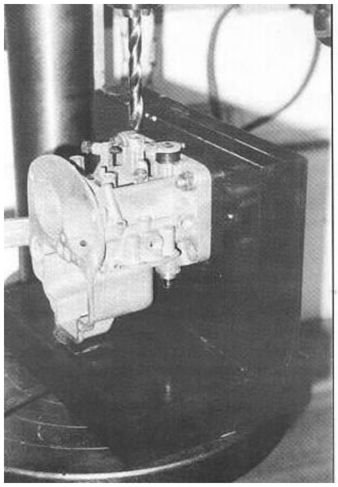
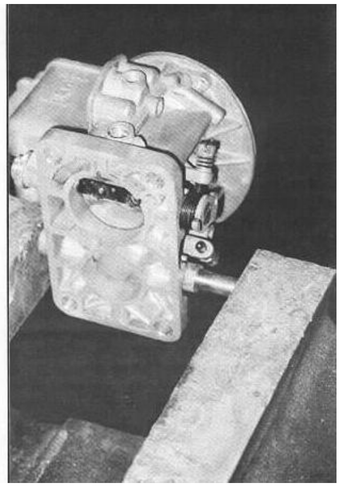
In my experience, one of the biggest problem getting these carburetors to function properly is due to mis-assembly and sloppy assembly. Typical scenarios include inadvertently mixing up a part that is intended for the primary barrel by installing it into the secondary barrel (or vice versa). As a general rule, when you have two similar looking jets, the one with the smaller number printed on it is intended for the primary barrel. However, it is not always possible to rely on this technique since some jets are labeled with alpha characters, such as "AC. 1" or "AB."

Another example is severely incorrect jetting due to past owners' tampering. So review the repair manuals carefully when putting a carburetor back together. One point to note is that the jet sizes for US model (smog) carburetors are not published in any of the repair manuals (all of the manuals are intended for European models). While it may be difficult to know exactly what jet sizes belong in your specific carburetor, at least check to see that they are in the "ball park" with the carburetor jetting which is published in the repair manuals.

The carburetor is mounted to the intake manifold with a thermal-insulating block made of a fibrous material, similar to brake or clutch lining. This fiber block is somewhat soft, causing the bottom of the carburetor to become severely warped with repeated tightening of the carburetor mounting bolts. It is common to see the bottom of the carburetor warped nearly 2 millimeters! Due to this warpage, it is imperative that the fibrous block and the carburetor are kept as a matched set. Of course, the best solution is to machine the bottom surface of the carburetor flat and install a new fibrous block. If you are patient, the bottom surface of the carburetor can be filed and then sanded until it is perfectly flat. New fiber blocks are available and sold under part number 5427584.

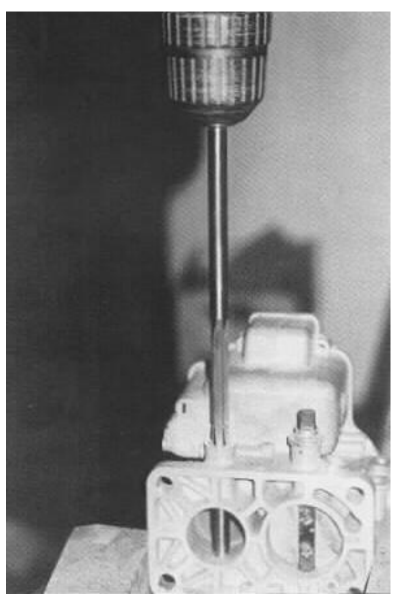
Unless the carburetor has extremely low mileage, the throttle shaft bore in the primary barrel will be extremely worn, allowing the throttle shaft to wobble in the bore. This creates a vacuum leak, which will adversely affect idle and the ability to pass emission tests. Unfortunately, repairing the throttle shaft bore is not particularly easy. It is recommended that one leave this task to a specialist, as it is a bit tricky to do it oneself.

But due to a streak of stubbornness, I decided to attempt to bush the shafts myself. After a bit of practice, I was able to successfully repair the throttle shaft bores by installing fabricated bronze bushings.

First, I drilled the worn hole in the carburetor body to a larger size. To ensure the hole drilled perfectly straight, built a jig to hold the carburetor body very solidly and very accurately in a drill press (above, left). I only drill partially through each side so the bushings would not migrate inward and jam the throttle butterfly.

Next, I carefully pressed in the bronze bushings. The outside diameter of the bushing was a few thousandths of an inch larger than the hole in the carburetor to ensure a snug fit (above, right). After the bushing was trimmed flush with the carburetor body I reamed the bushings to the correct size for the throttle shaft (below). We have found that it was necessary to have a tiny bit of "slop" to ensure that the throttle shaft did not bind in the carburetor body due to thermal expansion of the metal parts as the engine warmed up.



The only parts that really need to be replaced with new items at rebuild were the gaskets, the fibrous block and the float cut-off valve (needle and seat). All of these parts were available in the US from the usual parts sources. The remaining parts were reused after cleaning and inspection

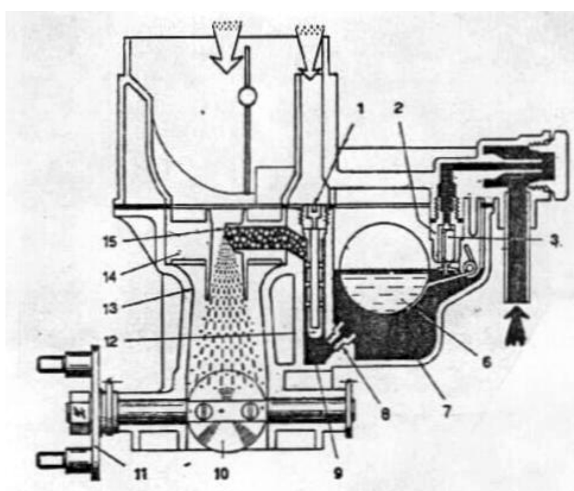
(Some people are using copper or brass shim stock to make thin shims instead or reboring. [MB])

Rebuilding service available from Western Hemispheres
(Feb. 1994, p.17)

Western Hemispheres, Santa Cruz, CA, has initiated a carburetor rebuilding program for the DS21 Weber 28/36. The carburetors have been thoroughly rebuilt using some original and some reproduction parts. The throttle shafts have been re-bushed with custom made bronze bushings and the carburetors come supplied with a new fiber mounting block, gas hose, clamps, and other mounting hardware. Chris Middleton (who works on Citroëns in the Seattle area) has used many of these rebuilt carburetors and reports good results.

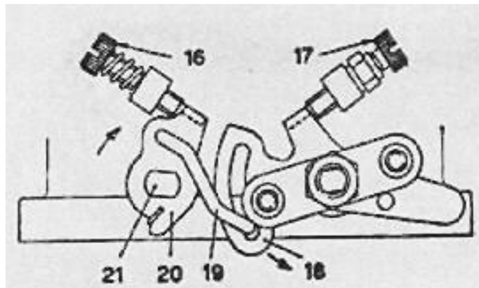
Weber 28/36 DDE/DLE operation
Ken Betsh (May 1991, p.24)

The function of the carburetor is to supply the engine with a mixture of gasoline with air in the proper proportion for all operating engine speeds and loads. For optimum economy this proportion by weight should be one part gasoline and 16 to 17 parts air. For maximum power this ratio should drop to one part and 12 to 13 parts. This amount of air is insufficient to allow complete vaporization of the gasoline at the temperatures within the carburetor. A breakup of the liquid gasoline into the smallest possible droplets uniformly distributed in the air is all that can be achieved. The carburetor must be a precise and complex device to meet these requirements.



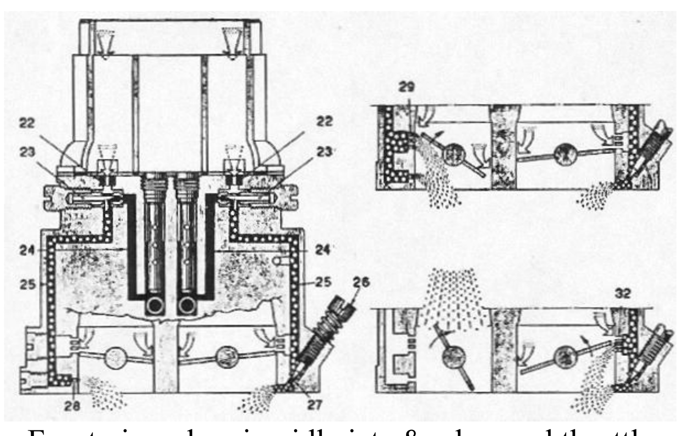
Right-side view showing float (6) & main jet (8)

The first requirement is a small reserve supply of gasoline stored in an area called the bowl (7) maintained at an exact level. This level is maintained by a float (6) that controls a valve consisting of a pin (3) attached by a wire to the float and a seat (2) screwed to the inside of the carburetor cover. Adjustable (by bending) tabs on the float control the rate at which the separate fuel pump fills the bowl and the height of the gasoline in the bowl when the valve cuts off the supply. Air above the gasoline in the bowl is maintained at atmospheric pressure by on opening in the gasket to the area supplying the two air correction jets (1). Gasoline in the bowl flows into two sump areas (9) via two main jets (8)–one for each of the two barrels. Gasoline in each sump area surrounds the lower part of the emulsion tube (12) and enters the passage (24) feeding the idle jet (23) for that barrel.



Partial rear view showing pedal linkage

A pause to review some basic details may be in order for those not familiar with the Weber 28/36 Carburetors used on the Citroën D-21 series automobiles. The accelerator pedal is more-or-less directly coupled via a bracket (11) to open and close the throttle plate (10) near the bottom of the smaller barrel. A slotted linkage (18,19 ties opening of the smaller or primary barrel to the opening of the larger or secondary barrel on a delayed basis. That is, the accelerator pedal must be pushed sufficiently to open the throttle plate of the primary barrel about half-way before the throttle plate for the secondary barrel starts to open. This allows the gasoline/air mixing in the primary barrel to be slanted toward economy and that in the secondary barrel toward performance. The outputs of the two barrels mix together in the manifold upon which the carburetor is mounted. Each barrel feeds all four cylinders. The viewing definitions with the illustrations apply to the carburetor as mounted in the car. The smaller, primary barrel is on the side of the carburetor closest to the engine.



Front view showing idle jets & advanced throttle

At idle, both throttle plates are essentially closed and the workings of the engine and its valves result in a suction that draws mixed fuel and air through idle circuits in both barrels. Liquid gasoline that would have been about halfway up the supply passages (24) is sucked up to the idle jets (23) through minute openings (.045 to .075 mm) and combined with air at atmospheric pressure entering via idling air jets (22). This is pulled down passages (25) where it is diluted by additional air entering dual-purpose openings (29, 32). The resultant mixtures reach the engine via a fixed opening (28) on the primary side and an adjustable opening (27) on the secondary side. Neither throttle plate is perfectly closed, however, and some additional air is added to the mixtures.

The closed position of the primary throttle plate is factory set by a stop screw (17). This is item marked in most shop manuals, in so many words, as "Factory set-do not adjust". The 1972 manual specifies a setting so the gap between the throttle plate and the walls of the barrel is only 0.05 mm or about 0.002" (2 mils).

The closed position of the secondary throttle plate is adjusted by a stop screw (16) conveniently located near a needle valve screw (26) that determines the mixture opening (27). These are adjusted together to set the idle speed and richness. As the needle valve screw (26) closes the mixture opening, the throttle plate stop screw (16) must be opened to keep the engine from stalling. This produces a leaner mixture since the air passing by the very slightly opened throttle plate contains little, if any, gasoline. The adjustment procedure is actually rather simple since a mixture that is too rich also slows the idle speed.

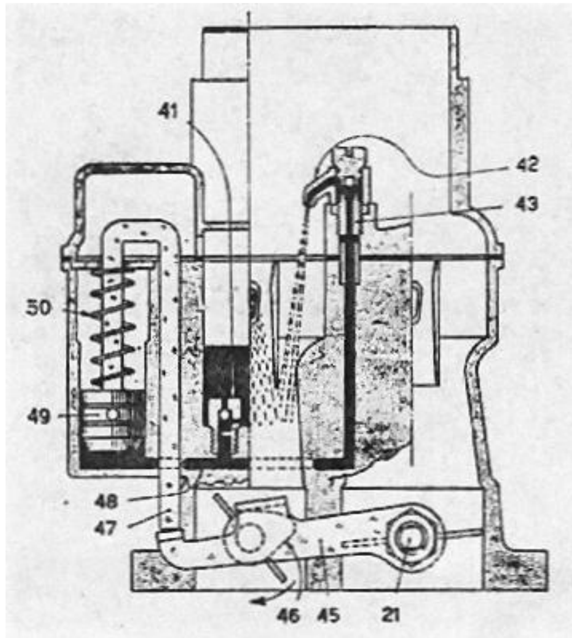
As one presses slightly on the accelerator pedal to increase idle speed or maintain a steady speed up to 25 to 35 MPH on level roads, the primary throttle plate moves so that one, two or all three auxiliary idle passage openings (29) that were above the throttle plate are now below it and able to supply fuel/air mixture to the engine. The air that did enter these openings (29) now passes the increased opening of the throttle plate.

The throttle plate of the secondary barrel remains during this slow driving phase. To be more precise, it remains in the idle condition and the same fuel/air mixture provided during idle still enters the engine.

As the throttle plate opens further to achieve faster driving speeds, the main jet system utilizing the principle of a venturi tube starts to function and the reduced suction below the throttle plate reduces and then stops the idle system. In a venturi tube the cross-sectional area is smoothly reduced and then expanded. At the narrow spot the velocity of the liquid or gas flowing through the tube must increase and, following the laws of physics, the pressure decreases. The greater the flow rate, the greater the pressure reduction. This principle is widely used to measure flow rates.

In the carburetor, the narrow part of each barrel (13) creates a pressure reduction that is transferred to fuel nozzles (15) by inserts (14) supporting the nozzles in a smaller secondary venturi tube. This pressure reduction or suction pulls gasoline via the sump (9) above the level determined by the float in the bowl. The amount pulled varies with the rate of air flow in each barrel or, in effect, the speed of the engine and is limited by the size of the openings in the primary and secondary main jets (8).

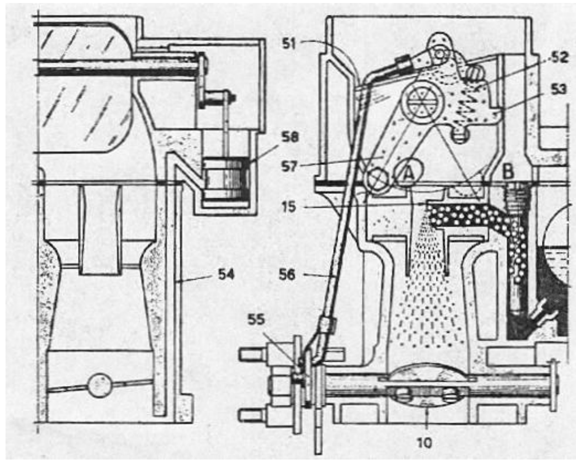
Gasoline entering the air stream at the nozzles (15) is premixed with air pulled through the air correction jets (1) and the openings in the emulsion tubes (12). The emulsion tube arrangement, sometimes called an air bleed, provides a compensation for what otherwise would be an increased richness of the mixture as the volume of air through the carburetor is increased.



Front view showing accelerator pump

Despite all the compensation taken to maintain a proper gasoline to air ratio at all speeds, a problem would still exist at the moment the accelerator pedal is quickly pressed down–such as when a driver wishes to pull out into traffic or to pass another car. While there is an instant increase in the available air, a little time is needed to get the heavier fuel moving in the necessary quantity. To prevent a hesitation or what seems like a momentary stall, a piston (49) closes a check valve (41) and pushes a measured quantity of gasoline out a separate nozzle (42). This nozzle is located between the barrels but positioned to spray the fuel into the center of the primary barrel. The piston operates via a spring (50) and linkage (45, 47) from a cam (46) on the shaft of the primary throttle plate.

The linkage (45) is loosely pivoted from the secondary throttle plate shaft (21). That is, rotation of that shaft does not activate the linkage. The same check valve (41) allows the system to refill with gasoline from the bowl and keeps the system from functioning when the accelerator pedal is pushed down slowly.



Front and right-side views showing choke detail

The cable from the dashboard choke control is attached to the lower end of a lever (57) that allows a damper (51) at the carburetor air intake to close. This restricts air to all functions except air correction jets (1). This augments the weak suction the engine produces at cranking speeds–which is considerably less than idling speed–and increases the gasoline/air ratio to compensate for cold temperatures (the illustration shows lever 57 in the choke-fully-on position; when the choke knob is pushed in, the lower end of lever 57 is in the dotted position near the letter B).

The damper (51) shaft is tied to the operating lever (57) via a spring-loaded (52) cam so that an override dashpot (58) can partially reopen the damper when the engine starts-even though the choke knob is fully pulled out (the illustration does not show a small opening between the upper side of the dashpot and the carburetor air intake area above the damper). An air pressure difference pulls the dashpot down. A rod (56) tied to the choke linkage opens the primary throttle plate slightly to restore the effects of increased engine friction and a possible too-rich fuel mixture on the idle speed.

In preparing an earlier article, I realized I knew less about the workings of this vital component of our favorite automobile than any other part. A search of my extensive collection of the newsletters of several clubs and organizations produced almost no useful information. About the only useful thing, besides my Citroën repair manuals, in my "archives" was a photocopy of an article from a French publication called, "Moteur". I was impressed with the illustrations and have used them in this article. With the aid of a technical and standard French-English dictionary, I decided the text was aimed at explaining this particular Weber carburetor to one who understands carburetors in general and only used it as an outline for this article. I've added material from an old Motor Services' Automotive Encyclopedia (published by Goodheart-Willcox Co., Inc.), comments of friends and my own observations.

There doesn't appear to be very many differences between the DDE and DLE series. All I've noticed have been some jet size changes and a means of attaching a air dashpot to the rear of the DLE series to slow the closing of the throttle plates. The dashpot appeared on cars with an exhaust air pump and I assume it was part of the pollution control package. The French article ignores the advanced idle arrangement on the secondary barrel found on all D-models with hydraulic shift (and many stick-shift '70s and '71s).

Weber made several more extensive changes on the carburetors used on the '72 D-models. The most noticeable are a choke damper that only covers the primary barrel and a gasoline/air ratio idle adjustment on the primary barrel.

Worn throttle bushing causes irregular idling
Jerry Lugert, NV (Jan. 1991, p.11)

The Weber carburetor eventually gets excessive wear due to throttle linkage pressure on the lower butterfly shaft. Excess air enters here and requires an experienced shop/machinist to place a teflon-filled bushing. Such repairs seem hard to find, yet will save about $300 for a replacement carburetor.

Further, the base of the carburetor warps due to the poorly designed bolt pattern for mounting the carburetor. The base requires good filing or other resurfacing. These corrections are most significant for Citromatics that will not shift well at fast idle. A worn carburetor will only idle fast when hot. It’s amazing what a reconditioned, properly jetted carburetor will do for these machines.

Worn throttle bushing causes irregular idling
Ken Betsh, PA (Apr. 1991, p.15)

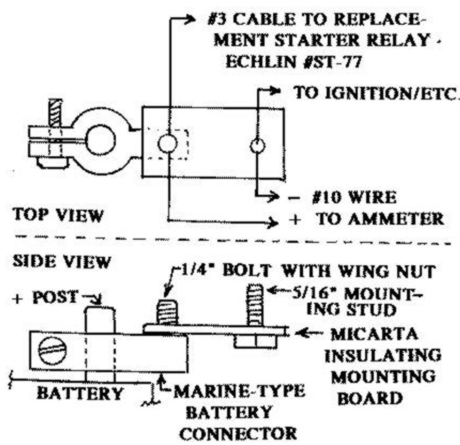
A frequent old-age Weber carburetor problem is due to wear of the holes for the shaft of the main barrel throttle plate. The normal symptom is that a well-adjusted carburetor will often let the engine die at idle when warmed up. Resetting the idle only leads to very fast idle at other times.

After Dave Burnham drilled out the worn holes for the throttle plate shaft and installed new bushings, I found everything adjusted as expected. It's now been is use for about 10,000 miles and mileage is as good as its ever been on this car.

Chapter 6–Charging system

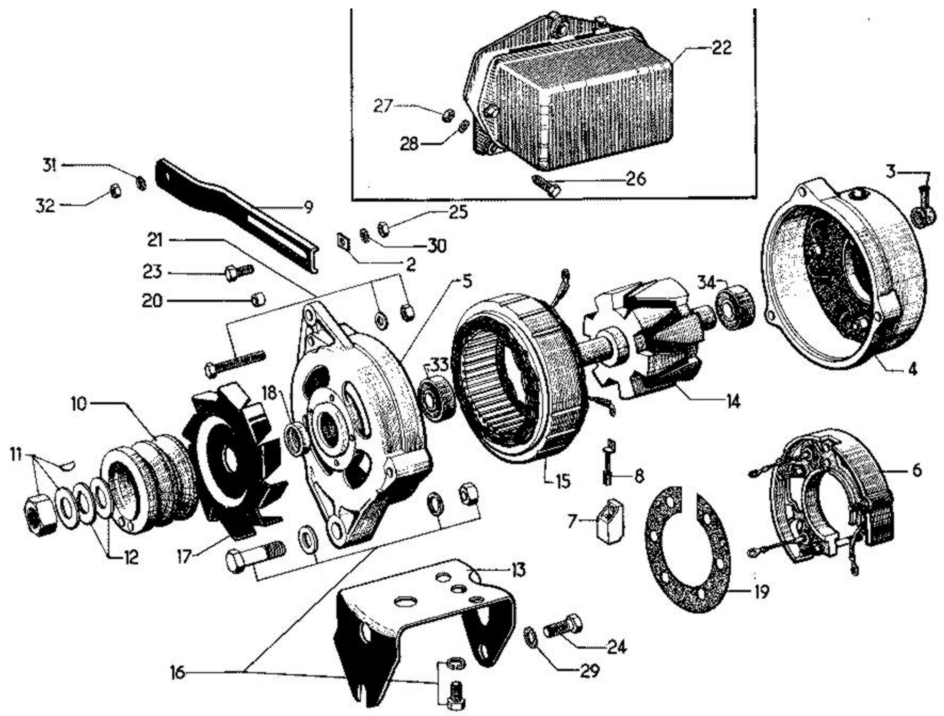
Ammeter connection uses battery post extension
Paul Fontaine, IL (May 1990, p.11)

Not satisfied with the idiot light for the charging circuit, I installed an ammeter (amp meter). It can be purchased at your local hot rod store (in my case it was Strum). Fig. 90 shows an extension for the positive terminal of the battery made out of a piece of Micarta plastic. With a marine type battery terminal on the battery post, the plastic adapter was drilled to fit the post and the other end was drilled for a 1/4" bolt. Two lengths of #10 or #12 electrical wire run up to the dash connections on the amp meter. The meter was mounted upside down on the panel that supports the steering column. I took the idiot light out of the circuit as the resistor that is wired into the circuit suffices to energize the field of the alternator. Now I can tell if my charging circuit is functioning correctly.



I'm using a GM-type replacement voltage regulator. The wiring circuit is the same as the schematic in the CCC (California) Newsletter #362, September, 1990, with the exception of replacing the charge light indicator with a 10 Watt 10 Ohm fixed resistor from Radio Shack.

Assembly drawing/part numbers
Citroën (Feb. 1989, p.1, 16)



1. DX 532-030 A....................................Alternator, Complete: Paris-Rhone #A 13 R 110
2. DX 391-88 ....Plate
3. DX 511-73 ....Protector
4. DX 532-03 ....Bearing plate
5. HY 532-07 A......................................Bearing plate
6. DX 532-6 ....Support for diodes, complete
7. HY 532-11 ....Brush holder
8. HY 532-19 B......................................Set of brushes
9. DX 532-32 A......................................Tensioner
10. 1 D 5 414 775 A................................Pulley
11. DX 532-37 ....Set of securing parts
12. DX 532-37 A......................................Set of washers for pulley
13. 2 D 5 411 239 R................................Securing stand
14. HY 532-58 ....Rotor
15. 1 D 5 411 238 E................................Stator
16. DX 532-68 ....Set of securing parts
17. HY 532-80 ....Fan
18. DX 532-81 A......................................Distance brush

19. DX 532-83 ....Deflector
20. DX 532-90 ....Distance piece
21. HY 532-94 A......................................Set of 3 rods
22. HY 535-1 A..Regulator
23. ZD 9372 000 W ....Screw
24. ZD 9382 500 U ....Screw
25. ZD 9524 100 U ....Nut
26. ZD 9453 430 W ....Screw
27. ZD 9525 900 W ....Nut
28. ZD 9233 400 U ....Washer
29. ZD 9260 600 U ....Washer
30. ZD 9290 400 U ....Washer
31. ZD 9290 700 U ....Washer
32. ZD 9526 200 W ....Nut
33. ZC 9620 103 U...................................Ball bearing
34. ZC 9620 316 U...................................Ball bearing

Bad fuse may cause warning light while driving
Dave Root, FL (Jun. 1980, p.3)

When this happens you suspect the regulator or alternator but it is usually merely a blown fuse on the bulkhead (driver's side fuse nearest the center of the car) or simply that the fuse and/or fuseholder needs cleaning to restore contact. The same problem may also be the result of a bad ground connection from the regulator.

Delcotron replacement procedure
Dave Root, FL (Dec. 1983, p.4, Feb. 1989, p.14)

If or when the French alternator or regulator on your D-model goes bad, consider putting in a GM Delco-Remy Delcotron alternator with a built in regulator. These are plentiful as they have been used on all GM cars from 1970 on. They can easily be repaired or replaced inexpensively if ever necessary to do so.

Since the official alternator for the D-model is now around $281 and the regulator costs about $67, a guaranteed Delcotron from a used parts emporium for $25 did seem, at least, to have a cost advantage. And a rebuilt Delcotron, if preferred, can be bought for $55 or less, plus core charge. Also, the Delcotron is said to be the most reliable alternator made.

1. Buy a used, rebuilt, or new Delcotron Alternator depending on how much you want to spend. Be sure to get one that has a double pulley with the land fairly narrow between the two grooves so as to match the pulley on the car.
2. A slight alteration of the Delcotron is needed to make it fit. This can be done with a hand hacksaw as aluminum cuts readily. The mounting ear is 2" long and you need to make it 3/4", measured from the pulley end.
3. Remove the steel bracket from the old alternator and slot out the right-hand mounting hole to make it like the left hand end. This will let you screw the mounting bolt most of

the way in before the alternator is in place which makes it much easier. (The bracket cannot come loose with the right hand mounting bolt tightened.) Next, with a round file make the hole near the bend in the bracket into a slot that will be approximately 1/8" longer than it is wide. This is to match the mounting hole in the Delcotron, and you can use the same bolt that was holding the old alternator to the bracket.

4. Now, with the Delcotron bolted to the bracket, make a simple right angle bracket to fasten to the end bell of the alternator using the existing 5/16"-18 tapped hole. After this bracket is bolted to the end bell, weld or bolt it to the steel mounting bracket, depending on what facilities you have available.
5. Put the alternator in place.
6. Buy a "pigtail" for the Delcotron alternator from an auto parts store. It costs about $2 and is a special plug with a large red wire and a small white wire coming out of it.
7. Attach the red wire to a wire that is hot-with-the-ignition-on. The white wire goes to the ground wire coming from the yellow idiot light on the dash. (Originally connected to the voltage regulator.) If the white wire is not attached to the ground wire of some light, the alternator won't charge.
8. Attach the heavy hot-all-the-time wire that was attached to your old alternator to the large main terminal of the Delcotron.
9. You will need to make an extension for the arm that holds the belt tension on the alternator. For this, use a piece of 1/8" x 1" steel cut 3-1/2" long. Drill a 5/16" hole, 1/2" from each end. Just bolt it to the old arm and use a short 5/16" bolt for the alternator end.
10. Remove the rest of the wires from the old regulator and tape the ends, then the old regulator may be removed.
11. As the original belts are apt to cause the "pigtail" connector to come too close to the distributor, use two new Gates 7390 belts or equivalent.

While considering options, it is well to note that your original Paris Rhone can be repaired, but it could run quite high, if that is a factor in your thinking. If the regulator is at fault, it is usually not practical to try to repair it as the repair, even if successful, usually does not last. If authenticity is an issue, the Delcotron looks a lot like the original, and few people would notice the difference unless you pointed it out. A point in favor of the Delcotron is its good reputation for reliability, and, should repair be necessary, it can be done nearby where parts would be readily available.

Editor: The above is basically Dave's second and more detailed article with step numbers from the first article added.

Delcotron replacement warning light potential problem
Don James, OH (Nov. 1985, p.4)

Q. I removed the Paris Rhone alternator and replaced it with a Delcotron alternator using information on how to do it in a newsletter that I receive. It works fine, and I have no trouble with it except that the indicator light stays lit, but dim. I would like to know if something I did was wrong, or does it stay lit always? It did not stay lit with the French alternator.– Joe Laureiro

A. I am sure that your indicator light should not remain lit. You did not say if you changed the voltage regulator along with the alternator. The regulator and alternator are matched and must be replaced together. Some systems use a 24 volt bulb in the indicator light for resistance.

Your wires could be connected in a different way, or the system may work differently than original (this is the reason that it is best to stick with the original if you can). Write the author of the article that you saw. He should be able to help. (Use a more up-to date Delco alternator with an internal regulator. [MB])

Diagnosing charging system troubles
Don James, OH (Nov. 1986, p.13)

First thing with battery charging troubles is to determine if the problem is in the voltage regulator or in the alternator itself. The alternator can be quickly checked by using a jumper wire (a wire with alligator clips used for testing). Run the jumper wire from the "EXC" connection on your alternator to the positive terminal of the battery while the engine is running. You may pull the spade connector that is currently on the "EXC" terminal off while making this test, and tape it so that it doesn't short by accident on something (EXC stands for “excitation”).

A volt meter should be attached to the battery or use the type that plugs into a cigarette lighter to register battery voltage (these meters are inexpensive and can be purchased for $12-$20). With the engine running, your meter should show a reading of 13 volts or more, and this reading should increase as the engine is revved off of idle. Do not drive the car with jumper wire. Test for two minutes only. The jumper wire is a bypass of the voltage regulator and extended operation of the car will over charge the battery.

If you get a voltage reading across the battery of only 12 volts or less, you do indeed have a problem with the alternator or the connections to it. If the alternator is fine, no loose belts, etc., and you suspect the regulator, first clean all connections to the regulator so that they are shining brightly. Resistance here can cause problems. Regulators may be opened and the contacts cleaned with sandpaper followed by a removal of grit with thin cardboard or coarse paper. Adjustments can be made to the regulator to compensate for contact wear, but you MUST know what you are doing and have an amp meter in addition to a voltmeter.

I do not recommend changing to GM or Ford alternators if it can be helped. Those that have tried it have had problems getting the light to work properly on the dash. Also it is better to keep the car original if possible to save parts problems. The original alternators work fine, and are not a source of problems. The American alternators are much larger and make working on the car a bit difficult. Special brackets must be fabricated to mount them. They will give more "juice" available for running heavy loads continuously or extra cooling fans.

TIP: If the alternator does not charge your battery at all, check all the fuses to be sure they are good and making contact correctly. One of the fuses carries the alternator excitation current.

Diode short runs down battery
Dave Root, FL (Nov. 1982, p.5)

Did you ever have a dead battery in your Citroën with no apparent reason? After a three week trip to Ohio, I was anxious to drive the Citroën. But in response to my attempt to start it, it made no sound. I charged the battery back up and all was well for awhile, but the same thing happened several more times. I had the alternator checked and it was charging. I noticed that when I disconnected the terminals from the battery the regulator would click. This proved to be a bad diode in the alternator, which was causing the battery to discharge through it! The replacement of one diode was the answer.

In this case, the alternator was charging all right even though one diode was leaking current through it–causing the battery to run down mysteriously.

When an alternator will not charge, it is usually caused by a bad diode and these can be replaced at a reasonable cost. You can remove the alternator yourself and it is not too big a job to disassemble it. Once that is done it is easy for someone to check the diodes for you. They can be purchased through an electronics supply house. Many people throw alternators away not realizing that, in most cases. The replacement of a diode will solve the problem.

If you have never removed your Citroën alternator and want to do it, here are a few tips that might help. Removing the battery is quite simple and gives you better access to the alternator. There is a ground wire coming out of the negative terminal that needs to be cut to help you swing the ground terminal and battery frame (that holds the regulator) out of the way. You can put spade terminal connectors on this ground wire to make it easier to disconnect. There is no room to get a socket and ratchet on the bolts that hold the alternator bracket in place. A 9/16" box ratchet wrench works faster than a regular open end or box wrench. (The head is 14 mm but 9/16" is near enough in size to work OK). The front bolt doesn't need to come out many turns as the alternator bracket is slotted for easy removal (or it can be slotted). The rear bolt, which is about 1-1/4" long, needs to be taken all the way out, as a slot would not be practical for the back ear of the bracket. Since 1-1/4" of thread is by no means needed to hold this bolt in place, you can remove 1/2" or more of the thread by turning it in a lathe or grinding it off with a bench grinder. Then you have a pilot to help start the screw in its tapped hole down in this restricted space when you re-install the alternator. It is best to tag the wires you take off the alternator as it will make it easier to locate them when putting it back in.

Disassembly, tests off-car to identify problems
Don James, OH (Nov. 1986, p.19)

Before you throw a lot of money away on a new alternator, better check the one you have for a repairable problem. Sometimes they are easily fixed. If your alternator is making noise because of bad bearings, new bearings are standard sizes and available at any bearing supply house. Bearings go bad because of over-tightened belts.

You can easily test any alternator while it is off of the car. Hook wires from a 12 volt battery to the alternator in the following manner: positive from the battery to EXC; negative from the battery to the aluminum housing or bracket (ground). Next hook the test leads from a voltmeter to the housing (ground) and to the BAT + connection on the alternator. Spinning by hand should give you voltage and you should feel some resistance to turning.

Getting the alternator open is easy. The pulley must be held in a vice while loosening the large nut on the end of the shaft. An old "V" belt can be used in the pulley groove and pinched in a bench vise to prevent the shaft from turning. Pull off the pulley from the shaft (use a gear puller if needed). When removing the pulley and fan, watch for spacers, washers, and shims. Be sure you lay them out in the correct order and facing the proper way for assembly later. Remove the key from the shaft. You do not need to remove the pulley from the shaft if you do not plan to replace the front bearing.

It is important that the alternator casing separate from the iron lamination at the front cover. Remove the three bolts that tie the end covers together. Use penetrant and rap with a hammer around the edge of the front cover. If stubborn, use heat on the aluminum front cover until it separates. Place a scratch line or match mark on covers and iron before separation.

This picture shows what the front cover and the rotating field will look like. The bearing from the rear cover will stay on the end of the shaft. A multimeter or a simple circuit tester that is powered by a small battery can be used to check that the wire in the rotating field (armature) is not broken. Check this by testing for continuity between the copper slip rings, as shown.

Next check for any "short" by checking for continuity between the copper slip ring and the metal shaft or bearing. There should be no continuity here. If the rotating field fails any of these tests, find a rotating field from another alternator or buy a new alternator. Other cars use the same rotating field, and there is nothing special about the one used on the Citroën. If you can find one of the same brand and shaft diameter and length, it will probably solve your problem. Also the alternator shaft may be pressed apart and new wire wound on, but this may be more trouble than finding another alternator.

Stuck brushes on the slip rings are a frequent cause of problems. Broken wires in the rotating field are also a problem–the wire wound too tight.

If the brushes are worn out, new ones can be purchased at any electric motor shop. Don't worry if you can't find exactly the right size. The carbon brush cuts and files easily and can be fit to your purpose. Brushes do not often wear out.

Here, the diodes are being checked with a battery-powered multimeter (most any battery-powered circuit tester could be used). Simply remove the wires from their studs by removing the nuts. Current should only pass one way thru the diode. Two types of diodes are used. One passes current in one direction, and the next in the other direction. Check for continuity between the diode terminal (which must not have anything attached to it) and the aluminum heat sink that the diode is pressed into. You should get continuity in one direction; but if the test wires are reversed, no continuity should be seen. If you find one of the diodes that does not pass the test, new ones can be purchased from an auto parts store. You may also salvage them from other alternators and they are worth saving. Just be sure your replacement passes current in the same direction as the one you removed. All diodes can be pressed into their heat-sink plate. Age makes no difference. A diode is either good or bad.

While working on this half, check for continuity and shorts in the stator windings. Check the brushes and holders to be sure they are not sticking.

To get the two halves of the housing back together, the brushes must be held back in their holders to avoid hitting the slip rings. The above picture shows a wire temporarily inserted in two small holes to retain the brushes. Wire nails can also be used to hold the brushes compressed against their springs. When the unit is assembled, pull out the wires and the brushes will snap out against the slip rings. These holes can be used in an emergency to squirt WD-40 or LPS #1 to free stuck brushes. Use only an electric contact type of lubricant, never oil to do this. Rap on the housing with a hammer to free stuck brushes. [I do not recommend using oil here, ever. (MB)]

Also note that both mounting holes in the mounting bracket have been cut into a slot so that complete removal of the alternator mounting bolts is not needed. The black device with a black wire on the back of the alternator a radio noise suppressor.

Fan can cut cable and wires not properly positioned
Don James, OH (Aug. 1985, p.31)

Particular care should be taken in routing the speedometer cable and the wires to the backup light switch past the battery on D-models. The fan on the alternator comes very close to these wires and can saw through the insulation and cause a short. This short can be hard to find at best, and at worst can cause an engine fire.

Hiding a Ford regulator in alternator equipped Citroen D's and SM's
Mark L. Bardenwerper, Sr. (Jan. 2007)

Many of us have replaced the Ducellier voltage regulators on our alternator equipped Citroen D and SM models with electronic Ford regulators. The original voltage regulators have long ago passed their life expectancy and new ones are very difficult to find. Lights flicker and change intensity with shortened bulb life. Our batteries risk damage from overcharging. In 1985, John Titus wrote the definitive article on this subject in the Hollywood, California Citroen Club newsletter. In it he described how to install an electronic Ford voltage regulator such as NAPA part #MPEVR440SB to stabilize system voltage. Figure 1, from that article, shows the electrical circuit for the original system. Figure 2 shows the Ford regulator in place. This system works well. However, it uses a different method of controlling the charge indicator light. Instead of using a relay to disconnect the ground for the charge indicator lamp, it uses a current differential. This can cause charge light flicker.

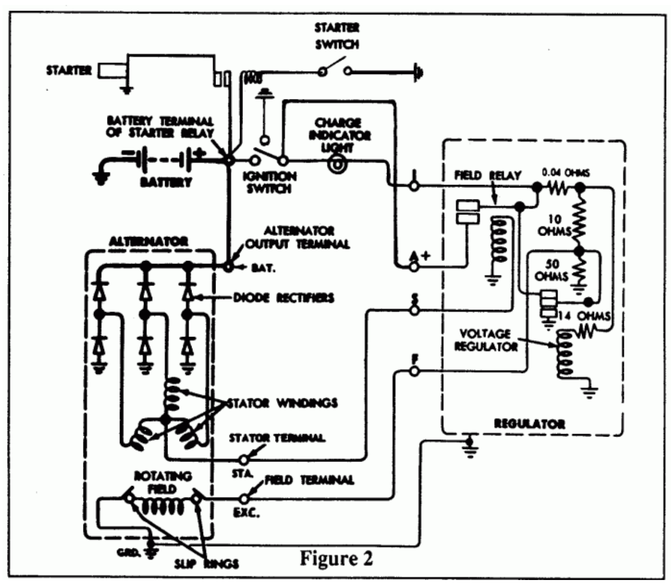


Figure 2

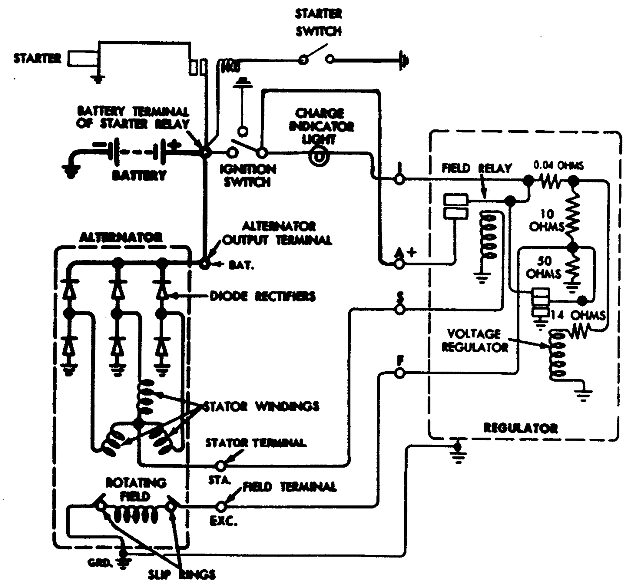
This drawing from a John Titus article shows the original circuitry used on alternator equipped D's. SM's should be similar. Besides controlling the charge indicator, the starter switch ground is attached to the L terminal of the regulator. When the engine is running, the points open, turning off the charge light and disabling the starter.

This same relay also disables the starter after the engine is running on some cars. The starter inhibitor feature must be bypassed in order to use the Ford regulator unless an extra relay is installed. To restore this function, Citroen owner and electronics expert Don Bennett has successfully added a relay and a resistor. I decided to go this one better and use the existing relay, which is already voltage matched to the system. This would not only make it unnecessary to modify the starter wiring, but it would also retain the original charge light function. I also didn't want to see an ugly, squat, silver Ford regulator where the tall black original once was. With a little measuring, I decided that it might be possible to hide the Ford voltage regulator inside the existing regulator and retain all of the original functions, with no further modifications.

I had the original Ducellier voltage regulator in my parts bin from my car. A used replacement was working no better. I first removed the cover of the old Citroen regulator, noting that when the three terminals faced me, the left-hand relay was the cutout relay and the right-hand one was the actual voltage regulator. I removed the right hand relay, which was held in place by a long machine screw and a few solder joints. Underneath were 2 wire wound resistors. These I simply cut off. I discovered that, with the regulator relay removed, the "EXC" terminal lost its support. I fixed this by applying some epoxy to steady it.

I was now ready to disassemble the Ford regulator. It was way too large to fit inside the Ducellier box unless stripped to the essential circuit board. I drilled out the rivets that attached the cover, then one that held the output transistor to the base. I then desoldered the electronics board from the terminal lugs. This had to be done carefully to avoid damaging the very fragile transistor and the printed circuit contacts. The board then was free from the base. I found that it just fit under the Ducellier cover if I turned it 90 degrees and tilted it so the solder points pointing to the right and the power transistor was at the left rear.

As purchased from the auto parts store, the replacement regulator was far too large to fit inside the Ducellier regulator can. The circuit board was a perfect fit, but all of its metal surroundings had to be removed.



Another figure from John Tutus' article with the Ford regulator grafted in. Note the starter switch ground has been moved. This disables the starter inhibitor circuit. This change is not needed on all cars.

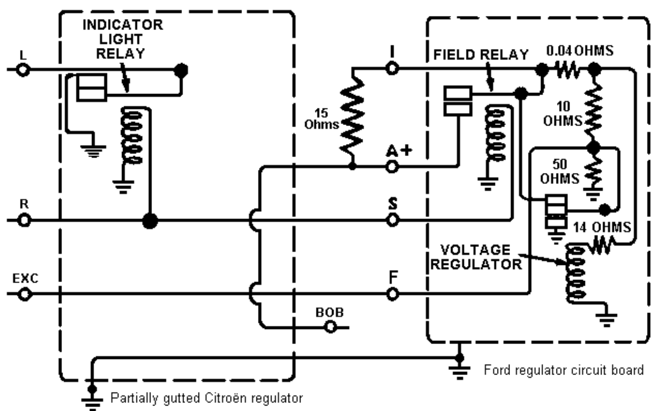
A few more details had to be worked out. First, the Ford regulator used the original base as a heat sink for the power transistor. Without a way for the heat from this transistor to dissipate, it would rapidly die. The solution was to pop rivet a copper strip to attach the transistor to the base of the old regulator, copper being an excellent conductor of heat. Luckily there was a rivet filling a hole that grounded the cutout relay exactly where it needed to be. I drilled it out and used a small bolt to attach the copper strip and the ground wire. Now the heat could travel down the copper strip through the regulator base. I added another tab of copper strip underneath for good measure. The thin strip attached to the heat sink bent readily to allow access to the bottom of the circuit board.

I then soldered all of the jumpers in place, leaving them long enough to allow me to press the board down to the proper angle for final attachment. First I tried a cardboard square, which you will see in my pictures. However, this proved not to be durable, though I tried various types of glue. The final solution there was to use a square of thin styrene plastic cut from the bottom of a small discarded box. High temperature silicone glue worked the best. It has not lost its grip since I fitted it. Again, I did not make this final attachment until all of the wiring was done.

My first attempt at getting the regulator to work failed. The charge light on the dash stayed on and the alternator would not charge the battery. I had originally thought that the Ford regulator didn't need anything attached to the terminals that ran the charge light. I was wrong about this. The Ford voltage regulator actually uses the indicator light current to close a relay that supplies the full field current to the alternator (which is why the Ford regulator can be wired directly to the battery rather than to the ignition switch). Bypassing the indicator light terminal on the Ford regulator prevented the alternator from receiving field current from the regulator.

In John Titus' article, he stated that the Ford voltage regulator, if mounted on a Citroen, needed to see a voltage coming from the charge light circuit to operate, but a backup circuit could be installed so that, should the light bulb fail, the charging system would still operate. Because I was not using the Ford regulator to operate the charge indicator light, I needed to add another jumper from the original “BOB” terminal to the “A+” on the board and a 15 ohm resistor from “BOB” to the “I” solder point. This time, it worked.

The regulator in my car is visually indistinguishable from the original, except for the screws that replace the rivets that hold the cover on. I have driven the car several hundred miles with and without lights and wipers and have not had any trouble. I did bring my old regulator along on my first few trips, particularly when I drove it all the way from Wisconsin to Detroit, Michigan for the 2006 Citroen Club of North America Fall Meet. Now it is in my spare parts bin and my battery charges a nice smooth 14.5 volts with no more flickering lights!

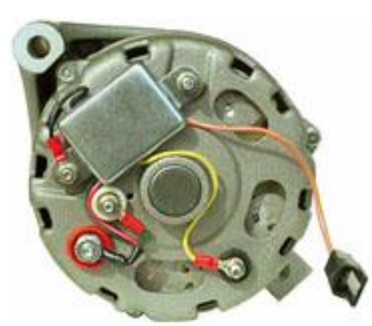


Circuitry for Ford regulator grafted to original Ducellier base, retaining the original cutout relay. The wiring and 15 ohm resistor fit under the board. In practice, the Ford board is turned so the circuitry points down. Solder connections at BOB and all others are all made internally on the appropriate rivet heads. This diagram shows the power transistor figuratively as a set of points.

Nearly completed regulator conversion. The original terminal closest to you is epoxied in place underneath to keep it from turning. The cardboard was later replaced with a piece of thin styrene plastic sheet. Cover just fits over, with original rivets replaced by 2 sheet metal screws. The original cork gasket needed to be trimmed a little, but still seals the box just fine. Note the resistor has a shrink tube over it to protect it from short circuit. This may not be necessary, and could possibly prevent it from dissipating heat. I will leave this off if I make another.

The terminal coming off the back is the BOB terminal. Note the copper strip, pop riveted to the transistor heat sink. You can just see the screw that holds it to the base, with the relay ground. Solder joints are made at the shiny tops of rivets on the old regulator, which are insulated, yet provide electrical path to the terminals. Note extra black ground wire soldered to the relay and the board. I didn't trust the rivet, even though I wiped some dielectric grease on it to prevent corrosion. All external connections are identical to the originals in function. Once the cover is on, it is impossible to see the update.

Just after finishing this article, I came upon a product that could make this entire process much easier. Several web sites are selling a device that is designed to mount on the rear of a Ford alternator to convert it to one wire operation. That is, it is a miniaturized voltage regulator! I found at least 2 sites that sell them. One is AMK Products (amkproducts.com), the other, Falcon Parts (falconparts.com). I haven't done any more research, but this little box should fit inside the Citroen regulator with room to spare. They cost $30-35.00.



Tiny self-contained regulator will fit easily inside the Ducellier regulator with little fuss. Here is how it looks when mounted on the back of an older Ford alternator.

Many thanks to John Titus and Don Bennett for their technical advice, Tony Jackson for help with composition and imaging.

Indicator light feeble blinking above idle speed is normal
Citroën Technical Information #94–Apr. 23, 1969 (Mar. 1999, p.11)

When the motor turns at a speed slightly higher than idling, certain cars equipped with an alternator produce a "feeble blinking" of the indicators or the bulbs on the dashboard. It disappears when the motor runs at a higher speed. This phenomenon is due to the principle of the regulation system and should not be deemed reason for repair. (This can also be caused by poor ground at the voltage regulator or a poor continuity through the fuses or wiring connectors causing excessive voltage drop. [MB])

Substituting a Ford voltage regulator
Feb. 1979, p.2, Apr. 1979, p.4, Jul. 1981, p.3)

This is a procedure to replace the Paris-Rhone or Ducellier alternator voltage regulator with one from '63 thru '68 model Fords that had an alternator. The same voltage regulator fit all the models.

Remove the original unit and use one of the holes in the mounting plate of the battery holder for one of the two holes in the Ford unit. Another hole will have to be drilled for the second one. You want to have the four tab-connectors pointing straight up. You must attach new female spade connectors to the three wires that were connected to the one side of the French unit. The battery (+) wire should already have a female spade connector on it (usually pink).

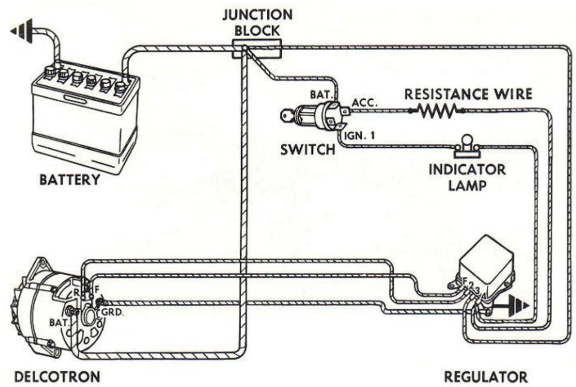
The connector marked "I" on the Ford unit is for the indicator lamp wire ("L" or red on the Citroën scheme). The Ford tab marked "A+" is for the above mentioned battery (+) wire. The "S" tab corresponds to the "R" or white lead in the Citroën scheme, and the "F" or field tab corresponds to the "EXC" or yellow lead. Make sure the black ground wire from the battery is grounded under one of the screw heads that secure the Ford unit to the battery holder.

Upon starting the car, you may notice that the yellow discharge light stays lit for awhile. Gunning the engine to about 2,500 RPM should extinguish the light and it should not come back on even at a slow idle of around 750-800 RPM. If the yellow light stays on all the time, reinvestigate the wiring.

Substituting a GM type Etron #D-635
Paul Fontaine, IL (May 1990, p.11)

Some years ago I switched from the Citroën regulator to the GM type per a diagram in a CCC (California) Newsletter. The system worked very well until one day the battery was dead.

Checking for the ground that discharged the battery, I found that the relay that disconnects the battery when the engine is shut off stuck on and discharged the battery. I picked up a new one from my local parts store–an E-Tron-635 for approximately $18. This type is mechanical and was standard on all GM cars with alternator and exterior regulator, '72 to '84. The wiring circuit is the same as the schematic in CCC (California) Newsletter #362, September 1990 with the exception of replacing the charge light indicator with a 10 Watt 10 Ohm fixed resistor from Radio Shack (next article).



(Lacking the above mentioned article, this diagram may be of use. This diagram is of a typical early 60's GM charging system. [MB])

Troubleshooting charging system problems
Ken Betsh (2000 #1, p.4 & 2000 #4, p.15)

Fig. 211 - Alternator Schematic Diagram

Fig. 212 - Alternator Wiring Diagram

When the alternator warning light did not go off after my D-model started after the first overnight stop on a recent trip to Florida, past experience had me thinking that all I need to do was change a fuse. A quick check showed no blown or loose fuses. My next thought was that perhaps the warning light was a false alarm. I used my combination dwell meter/voltmeter (I always carry it in the car) to measure the voltage at the battery terminals with the engine running and found it less than 12 volts. Since I had a fairly new battery, it was obvious that the alternator was not charging the battery. Had it been charging, the voltage would have been at least 13 volts. The warning light was staying on for a definite reason.

I then used the voltmeter to determine if I had battery voltage at both the alternator output and the field terminals of the alternator (the "large terminal" and "EXC" points in the accompanying wiring diagram). I did this with the engine off and the ignition switch on. This told me that the ignition switch and associated fuse had not failed and that the voltage regulator might be OK. It looked as though the alternator itself was at fault.

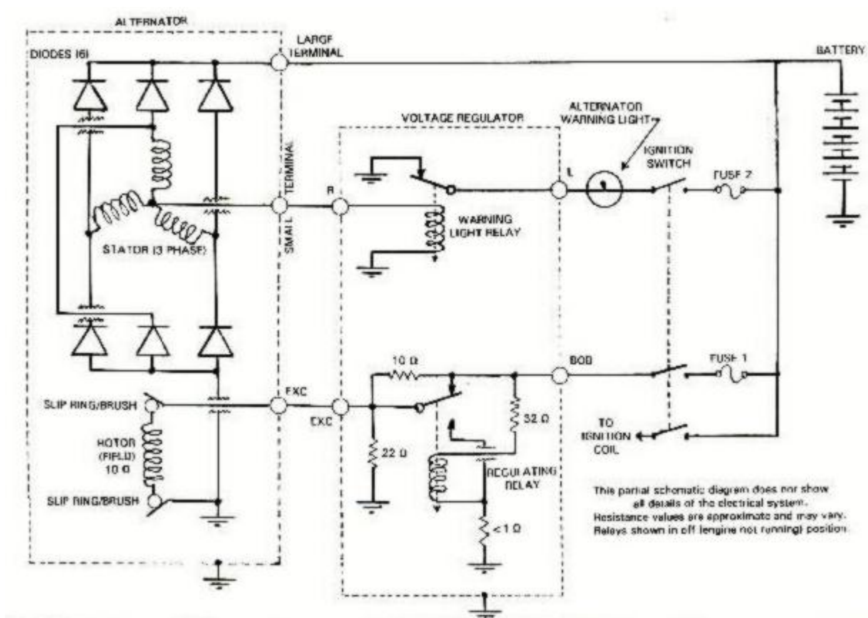
While the bad news was that I might have a defective alternator while about 140 miles from home, the good news was that I had a spare with me. However, I didn't want to take time needed for an exchange only to discover the trouble was elsewhere. I wanted to make some kind of a test that would prove that it was defective.

Our host that night was also a retired engineer and had a multimeter with resistance (ohms) measuring ranges. We quickly found the field circuit (EXC terminal to ground) of the spare alternator had a resistance of much less than a hundred ohms, but at that same point the alternator on the car was open-circuited. Now I could proceed to swap alternators with an expectation we could continue our trip.

Two hours later the spare alternator was firmly in place. I turned the key and was delighted when the yellow warning light went out after the engine started. A check of battery voltage showed almost 14 volts–it was being charged. We completed our trip without further alternator, or any other, problems.

If I didn't have the use of a multimeter, I would have unplugged the wire normally on the EXC terminal of the alternator and temporarily connected a 12-volt trouble lamp I also carry in the car between the battery (+12 V terminal) and the EXC terminal of the alternator. If it didn't glow (not full brightness), I would know the alternator field circuit was open. This test could have been made without the engine running and with the ignition turned off.

Alternator Repair - After returning home, I took the alternator to a highly respected local shop specializing in alternator, generator and starter repairs. They found the rotor open and sent it to a specialty shop that was able to repair it, but also could have rewound it if necessary. The local shop replaced the bearings and the well-worn brushes and even repainted the alternator case for a total cost of just under $100. Exact replacement brushes were not available and slight larger ones had to be filed to fit.



Alternator Internals - The accompanying alternator schematic diagram shows that the alternator generates a 3-phase alternating current (AC) that is converted to DC (direct current) by six diodes (devices that allow current to flow in only one direction) in a full-wave rectification arrangement. Because the diodes prevent the stator from discharging the battery when not in operation, the alternator output is directly connected to the battery.

The AC is generated in fixed windings (the stator) within a moving electro-magnet. This electro-magnet is called the field and also called the rotor because it must be rotating. Energy to operate the field comes from the battery and is connected by two fixed contactors, called brushes, touching two slip-rings on the rotor. One brush is internally connected to the alternator case (which is grounded) and the other is connected to the EXC terminal.

The amount of current produced in the stator varies both with the rotation speed of the rotor and the amount of current flowing in the rotor. Maximum rotor current, and thus maximum alternator output current, occurs when full battery voltage is applied to the EXC terminal. To control the output current and thereby control the charge of the battery, the voltage to the rotor must be regulated. Also, the voltage to the rotor must be turned off when the engine is not running to avoid discharging the battery.

Voltage Regulator Internals - The small metal box hanging on the bracket that secures the D-model battery is called the voltage regulator even though it also contains an independent circuit to operate the alternator warning light on the dashboard. Each function is controlled by a separate precision relay in the voltage regulator box. These relays are essentially electrically-operated switches.

The schematic diagram above shows the relay switch contacts of the voltage regulator in the non-energized condition--the condition that exists when the ignition switch is first turned on but the engine has not been started. Note the lower relay, the actual voltage-regulating relay applies full battery voltage to the EXC terminal of the alternator.

While current from the battery flows through the 32-ohm resistor, the relay coil, and the small less-than-1-ohm resistor, the current that exists without the battery being charged by the alternator is not enough to move the relay switch contacts. No current flows in the warning light relay when the alternator is at rest and the switch contacts on this relay provide a ground connection for the warning light so that it glows.

Note that by the use of separate fuses and multiple sections of the ignition switch, a single failure results in a warning light that either does not work when it should, or stays on when it should go off--either being a positive indication that something is wrong. The schematic diagram in Fig. 211 has been reduced to bare fundamentals. The separate wiring diagram in Fig. 212 shows that other lights, gauges and accessories are wired to these fuses and the ignition switch.

Once the engine has been started and the alternator produces current so as to relieve the battery and allow it to start recharging, the voltage across the battery and fed to the BOB terminal of the voltage regulator starts to rise enough to open what was the closed contacts of the regulating relay switch. This places the 10-ohm resistor in series with the rotor, thus lowering the rotor current and, as a result, the alternator output current. If the voltage across the battery still rises above that needed for full charge, the regulating relay pulls the 'arm" of the relay switch contact down to the lower contact. This allows the less-than-1-ohm resistor to shunt almost all the current that would normally go to the rotor and thus reduce the alternator output to almost zero. But now the increased voltage drop across this small resistor slightly reduces the voltage across the relay coil tending to open the relay switch contacts. In reality, the moving contact is in a state of flux so that it vibrates very fast and the voltage at the EXC is an average of what exists in the "off" state, the "on" state, and the "in between" state. The 22-ohm resistor helps to smooth the operation. While I can't say for sure, the less-than-1-ohm resistor probably helps to provide a temperature correction factor. The voltage across a fully charged battery at 32EF (0EC) should be about 0.3 volts higher than at 68EF (+20EC). Citroën specifications call for the fully charged voltage at 68EF to be between 13.5 and 14.5 volts. My measurements of several cars, several regulators and several batteries is that it is usually in the 13.7 to 14.1-volt range. Don't trust the normal dwellmeter/voltmeter to be exact in this measurement.

I've never measured the output at the small alternator terminal feeding the R terminal of the voltage regulator, nor have I seen any specifications for it. The circuit diagram would lead me to expect one half of the alternator output voltage and the diodes would block the battery voltage when the alternator is not operating. I presume that at about the point when the alternator is producing a useful output, the voltage to the warning light relay coil pulls the moving contact away from the grounded contact and thus turns off the warning light.

Both relays have mechanical adjustments that are factory adjusted and sealed. I've never attempted to make any readjustments. If you are curious to the point of opening the voltage regulator, both relays look alike and the one that controls the warning light is nearest the L terminal.

The values of the resistors are not marked and come from my measurements on three Ducellier regulators. One of the three regulators had been removed from one of my D-models because it allowed the battery to greatly overcharge to the point of boiling it dry on a long trip. I found the less-than-1 ohm resistor burned out (open circuited). It actually is a short length of resistance wire in a loop. The other resistors are wound on forms over an inch in length and mounted on the bottom of the voltage regulator. While the relay contacts are sealed inside the regulator, the crimp connections to these resistors are exposed to the under-the-hood environment.

Trouble-Shooting - The wiring diagram (Fig. 212) should help in trouble-shooting a battery-charging problem. Keep in mind that when the engine is not running, the EXC terminal of the voltage regulator is internally connected directly to the BOB terminal and the L terminal is internally connected to ground. If either the BOB connection on the voltage regulator or the EXC connection on the alternator are disconected with the ignition switch on, they must not be allowed to short to ground. This would cause fuse #1 to blow.

Both diagrams in this article apply to the '70 through '72 D-models--those that use the big "can-opener" size ignition key. Earlier models used a two-section ignition switch that accepted the door key. While the older switches were known for failures, I've never had a problem with the later type. The '67 and earlier D-models used DC generators with a totally different type of voltage regulator.

I've had unusual problems with both the fuses and the fuseholder. Because of the high current rating of these fuses, they can get rather hot before they blow. While a short circuit will blow a fuse almost instantaneously, a current 20% over the limit may take several minutes to blow. I've seen fuses with the solder melted at the end and fuse clips that have lost their spring tension. It's almost necessary to measure voltage at both ends of the fuse holder to be certain both are OK.

The wiring diagram (Fig. 212) shows the starter relay and starter switch circuit that are only on the '70-'72 models with Citromatic. On these models, one moves the shift lever to a start position rather than turning the ignition switch beyond the normal "run" position. The Citromatic starter circuit is wired to the L terminal of the voltage regulator so that once the engine is running and the alternator warning light has gone off, moving the shift lever to the start position will not engage the starter.

I've seen one Citromatic model with an alternator with an apparent intermittent internal current leakage path through or around a diode sufficient to operate the warning light relay without the engine running. Whenever the owner turned the key to start the car and the alternator warning light did not come on, he knew he would have to open the hood and push the plunger on the starting relay to get the car started.

The late models with manual shift use a starter with a built-in solenoid that eliminates the need for a separate starter relay. These models have an ignition switch with an attached starter switch and this switch is in the "hot" side of the battery.

Precautions - Section 530 of Citroën Manual 583, Volume 1, lists many precautions in checking the alternator. One that I feel is very important to the welfare of the diodes is: DO NOT OPERATE THE ALTERNATOR WITHOUT IT BEING CONNECTED TO A BATTERY. I would term trying to operate with a completely dried-up battery just as dangerous as with no battery at all.

Specifications - On D-models with a heated rear window, the alternator should produce 33 Amperes at 14 Volts at an engine speed of 1710 RPM. Earlier models met this specification at an engine speed of 1960 RPM.

Replacement Alternatives - I find the Citroën alternator to be extremely reliable and strongly recommend repair rather than replacement with a different kind. In over a half-million miles of driving D-models with alternators, the only trouble I've had with them, other than the failure described here, was a noisy bearing. The car in which the rotor failed had been driven over 280,000 miles without touching the alternator.

Modern-day replacement alternators can solve or cause another problems. For quite some time, semi-conductors (such as transistors) have replaced the relays in voltage regulators and in most cases the voltage regulating circuit is now built into the alternator. The compatibility of the voltage regulator is guaranteed since they're in the same package. From what I hear and read, the problem can be in the means to operate the warning light--a problem of greatest concern in the Citromatic models. I can't offer any advice from experience since replacement original-type voltage regulators installed years ago on my two high-mileage cars continue to work.

For many years after American cars began to use alternators, they used separate voltage regulators that worked just like the ones on the D-models. Not every manufacturer connects one side of the field to ground within the alternator, but I know Ford did so. Therefore, if I were to attempt to replace the voltage regulator with an available less expensive type, I'd look for something made for Fords. Fortunately, the current Whitney catalog lists a solid-state (semi-conductor) electronic voltage regulator for '65-'86 Ford, Lincoln and Mercury for about $10. I'd try to mount it without removing the old regulator and leave the L and R connections on the old regulator--assuming the warning light function was still OK. I'd just move the BOB and EXC connections to the replacement regulator.

Credits and References - Additional information about alternators written by Chris Dubuque (from which I borrowed the alternator and voltage regulator outline drawings), Paul Fontaine, Dave Root, and Don James appear in this D-Book. John Titus wrote about using an electronic regulator for a 1970 Mustang in a Citroën Car Club (California) 1990 Newsletter. Last, but not least, are the specifications and test procedures in Section 530 of Citroën Manual 583, Volume 1, mentioned above.

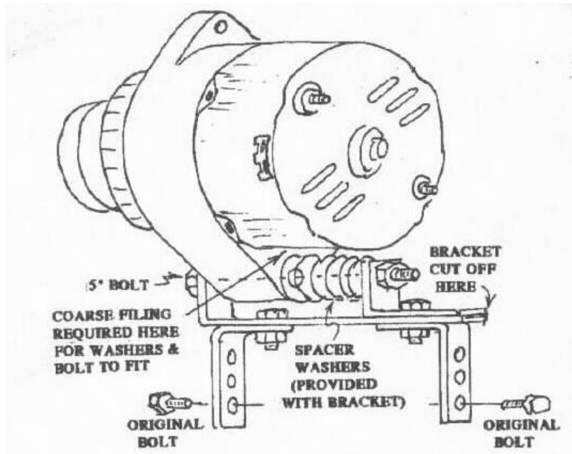
Follow-up - The two diagrams accompanying this republished article (Fig. 211 and Fig. 212) have a few minor corrections. The circuit breaker mounted on the battery hold-down bracket on most late U.S. models is just for an auxiliary electric radiator cooling fan and is not, as shown originally, in line with the connection of the battery to the fuse panel and ignition switch. The headlights and the horns are wired through their switches directly to the battery without any protective fuses or circuit breakers. I've heard stories of burned-up wiring harnesses and now I can see how it could happen. Perhaps my error was due to some wishful thinking.

Current to the auxiliary radiator fan is controlled by a relay mounted next to the circuit breaker. Current to operate this relay goes through the thermostat switch on the relay to the +12-volt connection to the ignition coil resistor. A short on this wire would not blow either Fuse 1 or Fuse 2 but quite likely stop the car. The limitation of this arrangement is that if your radiator overheats the fan automatically goes on but then stops if you turn off the ignition switch to stop the engine. In Article 10.2 of this D-Book, Russ Spears describes how to rewire the relay to allow the fan to run without the ignition switch being turned on.

In simplifying the alternator schematic diagram, I didn't note that almost all the electrical accessories are connected to either Fuse 1 or Fuse 2, some ahead and some after the ignition switch. A failure of one of these accessories or the wiring to it could cause a fuse to blow and thus disable the alternator or the alternator warning light. Connections to these accessories are shown in the wiring diagram in the second diagram.

Most of us have at one time or another parked our D-models and later found we left the turn signal on--something that would not have happened if it were wired through the ignition switch. Apparently this is true on the European models. My original wiring diagram, taken from the Citroën factory manual, showed it that way. The factory apparently wired the flasher relay connection ahead of the ignition switch on the U.S. models so that the 4-way flashers, which uses the same flasher relay, would operate without the ignition switch turned on. At that time the European models did not have 4-way flashers.

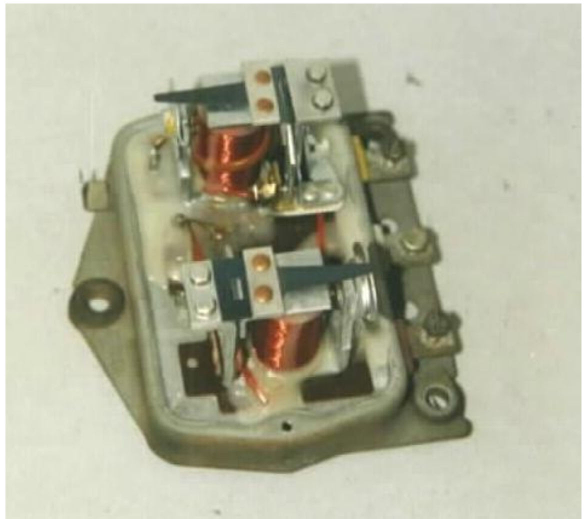
Universal mounting bracket made to fit
Ed Noriega, WA (Mar. 1984, p.18)



This article is intended for those D-model owners contemplating converting from generator to alternator or who presently have an unstable alternator mount. The original generator mounting bracket on my '71 DS21 had been cut, bent, and brazed every which way to accommodate an alternator. However it was weakened in the process and because the alternator was somewhat cantilevered it was subjected to a twisting force that bent the mount 3 degrees or so off line, enough to cause the belts to jump off frequently. Well, that bracket had to go and instead an adjustable universal alternator mounting bracket from J. C. Whitney & Co. (Part Number 74-7332A, $17.98) (Dated information: Google for Universal Alternator Bracket. [MB]) was adapted for this application. The bracket is made of sturdy 3/8" thick stock and has plenty of pieces with many holes on every piece to allow for many arrangements and configurations.

In this case some filing between some holes was required to make them into slots and drilling of a new hole was required for assembly that would fit was done with ordinary hand tools. The same bolts that were used for/on the original generator mount were used to attach the universal mounting bracket to the engine on the original tapped holes. A pivot bolt 1/2" x 5" was required to attach the alternator to the universal bracket. However, some filing was also required of some of the alternator body casting protuberances, for clearance of the pivot bolt from the bracket, and for the belt tensioning bracket to line up and slide over an adjustable range. The original belt tensioning bracket had to have a leg, or link added to it, and the whole thing then had to be offset with washers to make it line up with the alternator's body/geometry. With these changes the alternator is now rock solid and right in line with the two sheaves of the large pulley wheel on the engine.

Voltage regulator causes headlight brightness pulsing
Don James, OH (Aug. 1985, p.15)



Note: Illustration with original article showed a generator regulator

Quite often enthusiasts complain of having headlights that pulse bright and dim. Cars that have a mechanical regulator are the only ones that have this problem.

Mechanical voltage regulators operate on a simple principle. A small part of the generator's (or alternator's) output energizes an electro-magnetic bobbin (coil of wire). When the output of the generator reaches 13-14 volts, the magnetism is enough to pull down a spring-loaded contact arm. When the arm is pulled down, the contacts open, and this cuts the excitation current to the generator or alternator (exciter is the electromagnetic field in the generator).

When the magnetic field in the generator or alternator is cut from it's power supply the lower magnetism lowers the output of the generator, thus the strength of the magnetic bobbin in the regulator, and the contact points close again and the cycle starts all over again.

This is all supposed to happen so fast that you cannot see the pulsing in your headlights. What happens is that resistance builds up at corroded terminals, connections, and even the contact points themselves. Contact points can get pitted and wear, thus causing a change in the adjustment of the regulator. There can also be resistance in the generator or alternator connections or inside at the brushes. Resistance in the ignition switch contacts can also cause problems and is easily checked with a jumper wire.

If you think your problem is caused by too great a differential of cut-in and cut-out voltages, start by cleaning the contacts in the regulator as shown. Contacts are very hard and are made of a very wear resistant material, so the use of one of your wife's nail board files may speed the job. Be sure to finish with a points file or run cardboard through the points to remove all traces of abrasive particles.

Adjustment of the regulator is easy if you watch the pulsing and then observe the regulator's action with the cover off. Problem is usually caused by points breaking contact too soon. Be sure you check all of the simple things first before you attempt to adjust the regulator, and be sure when you adjust, that you place a meter on the battery terminals to watch the charging voltage.

Pulsing lights can also be caused by a bad or weak battery. The main thing to remember is that the pulsing shows that the battery is fully charged and that the regulator is working. The easiest thing to do is to just live with the pulsing, as no harm will come to the system, and you will probably find the pulsing to be less in warm weather.

Wiring diagram includes voltage regulator
Chris Dubuque, WA (Jun. 1993, p.12)

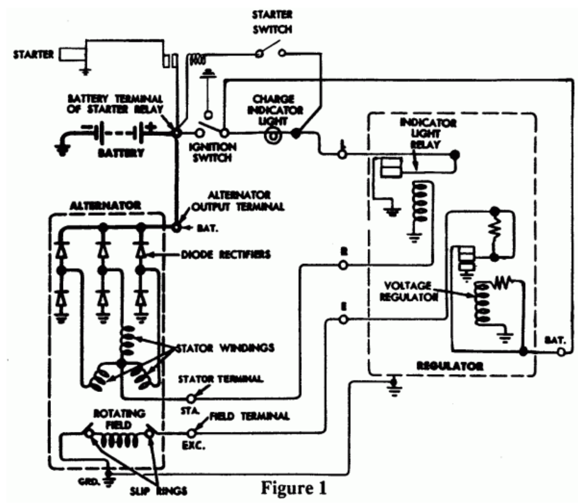


Figure 1

Cars with starter inhibitor has ground for starter switch running through the “L” terminal of the regulator to prevent starter operation while the engine is running. When the alternator is providing current to “R”, the related coil pulls the indicator light relay points open, extinguishing the charging system light and denying the starter relay a ground.

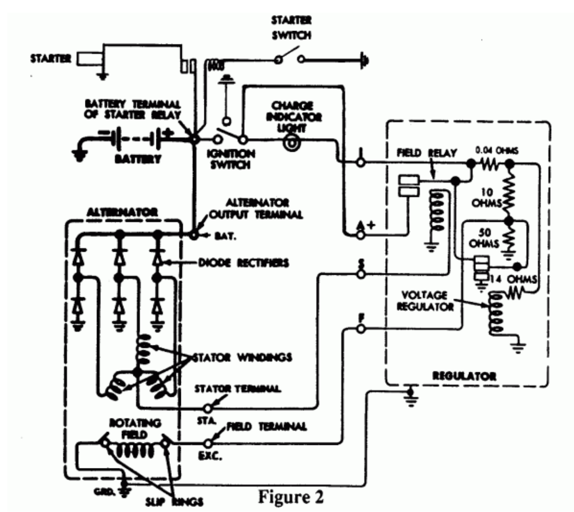


Figure 2

Cars without starter inhibitor lack the starter switch ground wire connection at the voltage regulator.

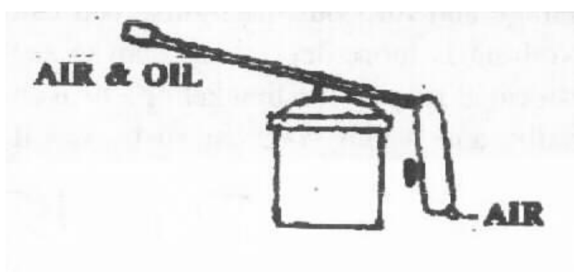
(These are not the original diagrams. There was only one and it was very poorly reproduced. The ones provided from John Titus are more descriptive. [MB])

Chapter 7–Chassis and frame

Frame and door oiling vital to preserve car
Don James, OH (Sept. 1983, p.6, Dec. 1983, p.12, Apr. 1985, p.17)

How many readers have taken the time to oil the frame and doors of their car recently? If you haven't sprayed these areas (or if you are operating your car with bad spheres) you are killing your car. Rust tends to snowball because it will soak up water just like oil. Dry out your car for a few days and shoot it with oil before it is too late. Oil is much better than paint for stopping rust, because it is self-healing. If you scratch a painted piece of metal, it will rust at the scratch. An oiled piece of metal will heal over when scratched, oil penetrates and it "creeps". Oil will run off a clean piece of metal, but a rusty piece of metal will soak it up like a sponge. Even if do not wish to repair a rusty frame, you can get a lot more life from the car if you spray or even pour oil into the frame. Much of my advice comes from the study of cars that have rusted.

Spray inside the frame with Penetrol or regular motor oil. It should be a fresh, tacky oil. Mix STP with the oil to get it tacky. If you spray, thin the oil with kerosene. Be careful of fire. Trichlorethylene works better and won't burn. A good hardware store can sell you a quart of it. The oil will drip for about two days, but it will creep all over your frame.



This is a drawing of an oil sprayer with a fitting for connecting to an air compressor that I prefer for spraying the frame and inside the doors of a D-model. I have, however, used the method of just pouring oil into the frame thru the holes in the rear seat's "peg pockets" and found that it worked very well. The small holes that the pegs of the lower back seat cushion fit into can be enlarged with an electric drill. Oil would run out at both ends of the car, showing me good coverage. I used a Valvoline transmission oil bottle with a pointed spout to "squeeze" in the oil. The bottle can also be used to squeeze oil into the doors.

There are holes and small rubber plugs all over the bottom of the car useful for oiling. Plugging the holes in the bottom of a D-model frame to limit the escape of oil poured in to prevent rust may not be a good idea. Doors and frame must have drain holes for ventilation and drainage of condensation. The frame must have good ventilation while driving to dry out any water and prevent rust. This is why Citroëns seem to rust so fast if they are allowed to sit. They are close to the ground, and are not ventilated if not run. Some holes have plugs, and some do not. Better find out which.

There is a small rubber plug just above the rear suspension cylinder mount on each side. Remove this plug and spray oil inside. Once you see where it is, you can drill a hole into this box section from the trunk so that you may oil in the future without even removing the rear wheels and fenders. I understand the SM is built the same way. The inside of this box section will be rusting from condensation, and you cannot see it. The trunk floor is also very important to the strength of this area of the car. If rusty, you will find yourself with a dislocated suspension cylinder, sooner or later. Do not place your car's suspension in the highest position if it is rusty. Also, the suspension "stops" can be drilled with a small hole and filled with oil from an oilcan. A small sheet metal screw will plug the hole. The same can be done for the rear bumper mount.

While you are at it, you should look for loose undercoating and use a putty knife to remove it. Prime the bare metal and touch up with more undercoating. Loose undercoat will cause your car to rust faster than if it had no undercoat. The loose undercoat traps water behind it and holds it there. The fenders and bottom of your car need this coating because of the sandblasting they get from the road. Paint alone just won't hold up. Seal all of your old undercoat by spraying with Penetrol. This helps keep water from getting through the porous undercoating. Oil does wash off. It must be done often to maintain its protection.

Spray inside the doors at least twice a year. Your windows will work much smoother too. Keep door drain holes open. There is water flowing through your doors from the window slots every time it rains. That is why you must keep drain holes open, and oil them often. Drill small holes to spray oil through. The gas pedal should be oiled and the triangle box below the pedals, too.

Paul Fontaine estimates that of about half of the five quarts of tractor transmission oil poured into each side of the frame of his '72 D-wagon leaked out at the rear of the chassis and a large hole in the front (off center of the chassis by 12" or so). He suspects two or three quarts would be sufficient if he (temporarily) put plastic plugs in 3 or 4 holes in the bottom. Several short welds leaked at the center of the chassis.

Important Points

1. Rusting action is much faster in early winter and spring.
2. Oil only when car is dry.
3. Oil applied to the bottom of the car does little good as it is easily washed off in areas around the wheels.
4. Oil can be thinned easily by heating the oil with a propane torch.

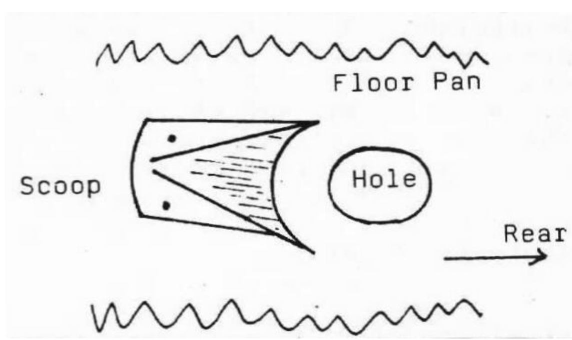
5. Don't heat the oil in a pressure tight container.

Excuses For Not Oiling Your Car

1. I don't drive my car in the winter. a: Your car will rust from ground moisture and condensation.
2. My car has been Zuff coated and will never rust. a: These rustproofing treatments are very good, but are never applied to the proper places such as the suspension stops. These coatings must be applied when the car is new and the interior metal structure is clean. They won't stick to dirt and rust, and only serve to cover it up. Oil on top can not hurt. Fighting rust is a constant battle.
3. My car comes from down south and has only a small spot of rust on the fender. a: Citroën D-models do not show rust easily. If you can see any rust, it is a sure bet there is ten times the rust in a place that you can not see.
4. I have heard of something better than oil and I plan to use it next year. It will stop rust. a: Great, if it stays wet and is self healing. Many types of oil are used by enthusiasts. Chain saw bar lube, chain oil, STP mixed with penetrating oil, even wax toilet seals that have been melted and dissolved in oil. If it soaks in and is "self healing" it should work fine. Anything is better than doing nothing.
5. Oiling sounds too messy to me, and I want a clean car. a: A little caution and a few newspapers will catch any drips that come from the body. The bottom of your engine and transmission is very oily and you can see that this area does not rust. Use fresh oil, not used motor oil. Used oil is much dirtier and will have acids in it.

D-models are especially prone to rust because of their unique construction. It is said that if you park your car in a windowless garage and turn out the lights, you can hear them rust. Nothing is more depressing than to see a Citroën with a dislocated suspension bracket or a broken frame. Don't standby and watch your car rust. Oil it now!

Frame protected with air scoops to create vacuum
Eric Locker (Feb. 1988, p.11)



I've made little air scoops and riveted them next to some of the holes in the bottom of the chassis, facing to the rear. These holes are generally closed off with rubber plugs, which have been removed of course. These scoops will create a vacuum when there is an air flow, sucking out the air from the inside of the chassis boxes, drying them out (I hope). I put three in the back, and I will put two in front, behind the wheels. In the back there are three, because I put one in the middle of the cross member.

I had to drill a 1/2" hole for this. The original holes are just above the exhaust pipes and closed off with a plate that I did not feel like removing. I made the scoops from some copper pipe I had lying around; they turned out to be about 1" high and 1.5" long.

I also ran some tests and discovered that the strongest vacuum was created when the lip of the scoop was about 0.75" away from the edge of the hole. I suppose that a different size scoop would require another distance.

Frame protected with cathodic “rustbuster”
Eric Locker (Feb. 1988, p.10)

The first thing I did to protect a recently-purchased essentially rust-free DS was to buy a "RustBuster" from J.C. Whitney (made by the Rust Evader Corp. of Altoona, PA). This is a cathodic rust protection unit. It keeps the chassis and body of the car charged negatively and that, according to theory, supplies the electrons and/or negative ions which combine with the prevalent oxygen in place of the steel ions, and thus prevent rust. Cathodic rust protection is used on ships and on steel structures under water/ground, where it seems to work. They use very heavy currents in contrast to this unit, which uses only about 80 mA.

The "RustBuster" consists of a little black box (3.75" x 3" x 1.75") and two or four (depending on whether one buys the regular or the heavy duty unit) little white boxes (2" x 2"). It comes with connecting wires, terminals, etc. The black box is the command module. It has colored wires coming out from the sides, one red LED, two green LEDs, and a switch. The white boxes are anodes (positive). They also have wires coming out from their sides and self-adhesive bottoms.

The command module has to be connected to the positive terminal of the battery (or to any permanently hot terminal in the car) and to the ground (body, chassis, etc.). The other wires are to be connected to the anodes which are stuck to the chassis at strategic places. It is very simple since everything is color coded.

The red light indicates that the unit is ON. The green lights pulsate every few seconds. Every time they blink, the anodes are charged positively, imparting the negative charge to the chassis. This charge slowly fades and is renewed at the following blink. It is very pretty to watch, and one feels sure that rust is on the retreat. The manufacturer claims that it is perfect.

In my very limited experience, it does seem to work. I had cleaned the outside of the chassis with one of those rotary paint removers, and it started to rain. (The car sits outside, covered, in the driveway.) When I returned to it after a couple of days, the metal was still clean. But, will it really keep the whole car rust free in the long run? Ask me in twenty years.

According to the manufacturer, the command module may be mounted under the hood. I don't know if I would trust it to stand up to the heat–and one would not see it blink. So far all my connections are temporary. If the car is not driven, the car battery should be on a trickle charger. I tried to run the unit straight from the charger, but it didn't like it. Parts of the body which are connected with rubber bushings (fenders, bumpers) need to be grounded with their own wires.

Finally on this subject, I suppose one could keep the car negatively charged by making some kind of anodes, mounting them on the chassis with a thin, dielectric separator (like in a capacitor), and connecting them (the anodes) to the positive terminal of the battery. It may discharge the battery faster, but it should work.

Editor: Every few years an "Electronic Rust Control" device to control automobile corrosion appears in aftermarket advertising, beating the drum with promises of protection from rust on cars, pickups and recreational vehicles. The ads claim that the same technology that protects ocean-going vessels, underground pipelines, and offshore oil rigs against rust and corrosion is now available to you for your vehicle. The ads claim that this amazing electronic system is the best rust insurance you can buy, the cost is a small price to pay for the complete protection you get, the advertised product is better than spray rustproofing and easy installation.

Sounds great, doesn't it? Where do you line up to buy one? Well, hold on there, and let's take a closer look. This "Electronic Rust Control System" is a battery operated, "cathodic protection" device. It is an "impressed current" device that is supposed to work like this: a positive voltage is applied to one or more anodes (terminals) located at various points on the car. A negative voltage applied to the body of the car is then supposed to prevent corrosion. It should be understood that "cathodic protection" is a valid technique when the metal to be protected is immersed in a continuous, conductive aqueous medium such as seawater (for ships) or water-soaked soil (for pipelines).

However, these voltage devices are an unlikely source of protection from automotive corrosion because the concept behind them is fundamentally flawed. In theory, corrosion can be effectively stopped by applying a negative voltage to a metallic area, with respect to that of the electrolyte "water" directly in contact with that area. The voltage drop across the metal-electrolyte interface impedes the conversion of metal atoms to ionic corrosion products. Tests have shown that "impressed current" devices for cars, even when carefully implemented, cannot provide practical corrosion protection (R. Baboian, Materials Performance, July 1987). The thin, discontinuous and highly resistive nature of water adhering to a car make it impossible to keep the protective current flowing for a distance of more than a few inches from the anode and precludes protection of significant areas of the vehicle with only a few anodes.

The device would work only if the car were kept immersed in electrolyte to complete the electrochemical circuit. In the absence of complete immersion, a network of anodes spaced by no more than two inches would be required to keep the protective current flowing over the entire area. Such a network would be prohibitively expensive and would be subject to corrosion itself.

By comparison, the benefits of cathodic protection can be and are being provided to the automotive consumer through the use of galvanized steel which provides protective voltages right at the spots where they are needed. Gravel chips through the paint and zinc layers expose dissimilar metals (zinc and steel) forming, in essence, a local battery which maintains a protective voltage drop between the steel and the electrolyte at that point. The thicker the zinc layer, the longer this battery can provide cathodic protection. Under some conditions, reaction products from the zinc provide a barrier layer impeding further rusting.

Finally, here's an excerpt from the Summer, 1988, issue of "Watch" newsletter of the General Motors Corrosion Technology Center: "This subject has come up several times at National Association of Corrosion Engineers (NACE) committee meetings. It was clearly stated that the devices being sold were not cathodic protection and could not protect the automobile from rust. In fact, Texas Instruments in a joint research program with the auto industry, demonstrated that to provide any form of successful cathodic protection of the inner steel panels of an automobile would require the spacing of electrodes at approximately 3" to 4" in all directions, which certainly is not practical. Moreover, in this concentration of electrodes, a serious side effect occurs, namely the cathodic delamination of the paint on the outside of the panels. In fact, the net result is increased corrosion, not corrosion protection. NACE sponsored an information session at Corrosion '87 and publicly refuted all claims of electronic cathodic protection of automobiles. For the record, cathodic protection occurs when electrons flow from a cathode (electrode) through an electrolyte (salt solution) to the anode (car body). It does not occur from electrons flowing through the metal."

Frame protected with Penetrol and linseed oil
Paul J. Fontaine, IL (Feb. 1987, p.9)

Three years ago I poured approximately two quarts of a mixture of Penetrol/boiled linseed oil/raw linseed oil into each side of the frame of my '72IDF. The four drain holes were plugged with golf tees temporarily until the mix had set up. While employed in the Texas oil patch prior to WWII, we sprayed our oil field cars with boiled linseed oil after removing the cheap black lacquer and passivating the raw steel with phosphoric acid. This method was highly effective over the then current asphalt-type undercoating. Life of a fender in the salt air of the Texas Gulf coast was less than a year. Returning to Corpus Christi in 1946, my oilfield car was the only one with the body still intact and only a few spots of rust visible.

The previous owner of my ID cut 4" diameter holes in the inner side rails for the magnet ends of a pair of stereo speakers (not recommended as the large holes will compromise the structural integrity of the frame). These holes gave me a good opportunity when I got the car to check the condition of the interior of the frame rails. The insides were free of any signs of corrosion; the original paint was in good condition.

A few weeks ago the speaker on the left side developed a frog in its throat. After both speakers were removed, the inside of the frame was inspected for corrosion. Much to my relief, no visible rust was apparent. The anti-rust mix had congealed to a waxy finish. Checking the coating with a sharp instrument, it adhered tenaciously to the sheet metal with some creeping up the sides. The lower front corner is prone to rust as well as the rear area near the gas tank wall. I suggest treating the frame after several days of dry weather to assure the dry condition of the frame and when the ambient temperature is above 60° F to assure good coverage of the mixture.

Frame protected with Penetrol, STP, chain lube mix
Terry Tekushan, OH (Apr. 1987, p.8)

The way to inhibit rust on most cars is to pour or spray oil into the box sections. However, my '71 ID19 does not have any enclosed box sections anymore, leaving large expanses of frame exposed to road grime and salt. Don James says my car is the rustiest Citroën he has seen anyone actually drive on a regular basis. Since I drive my "parts" car through the winter and wanted to keep a bad rust situation from getting worse, I used Denis Foley's recommendations to come up with this concoction:

- 1 part bar and chain lube
- 1 part motor honey (STP oil treatment should work, too)
- 1 to 2 parts Penetrol

This mixture is better suited for brushing on, unless you have high compressor pressure and a general purpose sprayer. On my car, this stuff has continued to protect the metal even after two months of daily winter downtown Cleveland rush hour abuse.

Apply it after the car has been bone dry for a couple of days to areas that will be exposed to road spray. Include these easily forgotten places:

- Front fender arches including the area inside the fender where marker lights are
- Door bottoms and seams
- External frame and trunk seams especially where covers contact the frame
- Rear bumper brackets, suspension stops and brackets
- Rear fender saddles (corners)
- Behind and around taillight and license plate assemblies and brackets
- All hydraulic lines, exposed or not.

There are undoubtedly other areas that I have not noted, but just look carefully for areas which could surprise you with rust one day. I hope you will give this a try, even if your car sits most of the time–it still can rust. It is disheartening to see a car needlessly debilitated by rust. Even the life of a rusty car will be greatly extended with this treatment.

Frame protected with petroleum jelly, linseed oil and bee's wax mix
Pgh Citwrench (Jun. 1987, p.13)

Through the years there have been numerous articles on rust prevention. The theme song always is "if you don't do something to your Citroën and you drive it in the winter snow and salt, you will have a big problem before very long." I have a recipe for a rust preventative that is very effective if you can keep the compound on the area in question. This recipe will not completely stop rust that is already there, but there are things that can help.

I'd like to say that this is an old family recipe, and in a way it is. It was developed at a Fortune 500 R&D center about 20 years ago, and literally hundreds of people have used it for a wide variety of applications. It has two main virtues–it works and it is fairly inexpensive. Its drawbacks are that it's messy to apply and it takes time.

The compound is a mixture of the following. One pound of petroleum jelly (buy generic, not Vaseline, its too expensive), one pint of raw linseed oil, and one toilet base wax ring (the type that doesn't have the plastic base is cheaper).

Regardless of what you finally do with this mixture, you have to mix it in these proportions and put it in a pot and heat to about 200° F. When the mixture is liquid, you can now do one of three things. (1) You can use it in the hot state and spray it onto the area you want to protect, or (2) you can paint it on with a brush, or (3) in the ratio of 1:1, you can combine the hot mix with kerosene, stir well and allow to cool. This mixture can be sprayed or painted on cold.

When this mixture is applied to metal the base of the compound, or layer next to the metal is always going to remain slightly soft. The bees wax in the wax toilet set helps form a hard skim coat on the surface of the compound that will tend to protect the entire surface. This coat will be very successful on all areas of a car except in the wheel well areas where the wax coating is worn away by the water action from the wheels; and every two or three years you may have to go back and redo these areas. The skin coat is further enhanced if you just happen to drive the car very soon after application on a very dusty road. The dust will collect on the wax and slightly embed itself. This seems to improve the wear ability of the surface. You can touch the surface in a day or so and not get any on your finger. The thickness of the skim coat increases with time for up to a month or so. Then it appears to level off for several years. I have one car that I have had for nine years and the skin coat is still on top of a soft underneath layer. You can still be very rough with it and scuff off the top skin coat and there will still be a thin coat left.

You may be concerned with clean up. While applying this wax mixture to a car you are sure to get some where you don't want it, or later on you may need to repair an area and want the wax off. Where the wax has been on for a while, you can use lacquer thinner and it will wash off easily. On a car body, where I have gotten some on the paint or the bumpers during the application process, I use a strong solution of warm water and Spic and Span soap.

If you have an older car and rust is already a problem, you can use the cold mix with the kerosene and spray it on the affected area. The kerosene has a tendency to wet the surface and to form a capillary action to carry some of the wax on into the cracks and into the affected area. The problem is that the kerosene dries out very fast and leaves only a very thin coat of the wax. Those who really want to preserve the car, then go back and spray hot wax over the area treated by the cold compound.

Now to talk about how to apply it hot. Temperature is important. The air temperature should be above 70° F, while the mixture temperature should be between 150 and 190° F. A paintbrush is very good on areas that you can reach; but for a car, it doesn't work very well. Now this brings with it some problems. You have to be very organized and get the wax onto the surface while it is hot. When the temperature falls below 150° F you must quit and reheat the wax, since it is important to have the wax firmly seated on the surface and the temperature helps you do that.

The equipment to use can be varied. Some people may have an air compressor and a spray system that will really put the wax where they need it. I use a two gallon galvanized steel garden spray can. I altered this can by replacing the top seal with an o-ring instead of the rubber seal supplied. I replaced the hose with some 1/4" ID Tygon plastic tubing that is capable of handling the temperature. I replaced the valve with a standard 1/4" thumb valve and put 3" of 1/4" copper tube on both sides of the valve, such that the tubing can be slid onto the copper tube and held with simple hose clamps. I used the brass spray head supplied. I had a four foot 110 volt heating tape that I wrapped around the bottom half of the can to help get it hot at the start and to help hold it hot during application. Use an old 6-quart steam cooker pot. This lets me put three portions of the recipe in it at a time. I use our electric cook stove to heat the compound. Many times I have to put this pot in a sink of cold water to cool it back to 195° F. This is the temperature I use to put it in the spray can. I use a 4" diameter food strainer to insure that there are no dirt particles when filling the spray can.

The trick is to have the can warm when you add the wax. You also must have put compressed air through the spray hose to insure that it is empty of cold wax. As soon as you get the wax into the tank, close it and pump it up and then run about a cup of hot wax back into the pot. This will heat up the spray line, valve, and spray head. Now you are ready to go spray. If for some reason you take a long time, you must run the spray into a can or something to get the cold wax out of the spray tube. After you clean cold wax out of it once or twice you will get the hang of it.

When I rustproof a car, I wash it underneath as best as I can. Then I drive the car two or three days when it is warm, to insure that it is dried out. When ready to apply the hot mix I park the car on top of a 12 ft x 20 ft plastic tarp–4 or 5 mil thickness is best. I start my application underneath at the center of the car, and work my way out. I spray everything with hot wax. You have to spray the insides of some frame members on the right side of the car while you are working on the left side. It's just easier that way. I literally cover every square inch under and behind bumpers of the car. Then I remove the door panels and spray inside the doors. On a DS Citroën, I take out the back seat and remove the gas tank plate and spray the gas tank and the fill tube area and fill tube tunnel. I open the trunk and take off the cover to the rear torsion bar and spray that area. To simplify this whole thing, I think in terms that go like this. The only area you don't spray is the area you want to rust.

As you spray certain areas a lot of the wax will run off and fall back on the plastic cover. I have a 12" metal bowl that I move along under the car with me to help catch some of this run off. I also will make some effort to scrape up some of the wax from the plastic and reheat it. The problem is that this wax has a tendency to pick up dirt and so you must strain it as you put it back in the spray can or spend a lot of time cleaning out the dirt from the spray head.

The cost of this is difficult to give because of the different way people buy things. I buy the petroleum jelly at discount drug stores in the one pound jars, raw linseed oil in gallon cans, and the toilet base rings by the dozen at a discount hardware store. For a CX station wagon I would have 20 portions of the materials on hand to start the job.

There is only one thing that will keep you going at a messy job like this, and that is the knowledge that it really works. When you finish, you will promise to never do it again, and that will last until you are faced with another new car that the salt is getting ready to eat.

In 15 years of using this on five cars in the Pittsburgh area, where we have at least four months of driving in the salt covered streets, I have had very good luck and have kept my cars on the go with very little body work. Where I had problems was in areas where I had failed to get the compound on or had failed to go back and redo it in areas that had been disturbed for one reason or another.

Frame protected with STP and automatic transmission fluid mixture
Tom Henceroth (Apr. 1977, p.4)

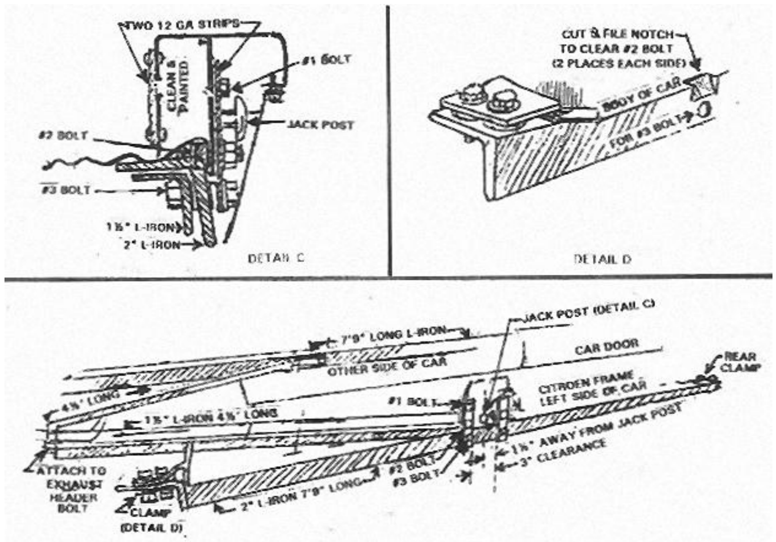
I suggest having the underside of your car steamed at least twice a year, spring and autumn. After all the moisture dries, get a large can of wheel bearing grease and smear a good coat all over the underside, packing it into all nooks and crannies. Be sure not to plug any of the drainage holes. If you cannot reach into some of the inner areas, get a pump-type oil can with a fairly long spout, and squirt in a mixture of STP and transmission fluid.

One quart of STP to two quarts of automatic transmission fluid. The transmission fluid will not damage the rubber parts and will penetrate into all the little valleys, while the STP is sticky and will cling to the surfaces well.

Around trim pieces, a few drops of 3-in-1 or other light oil will run down behind them and protect these areas. The procedure is a little messy–but have you ever seen rust damage on an oil can?

I recommend using one of the 'mop and shine' floor waxes for the interior vinyl and crinkle-paint dashes, after a good cleaning, of course. For the exterior, I suggest only a high quality wax be used, as the cheaper ones have a high silicon and oil content that actually attracts dust after you've applied it. Remember, too, do not use a dry cloth, as it increases the likelihood of scratching the surface.

Frame repair with added L-iron bars
Ed Hodge (Jun, 1976, p.3)



Inside of body frame, pull up the side gray rubber mats all the way (they can be rubber cemented down again). If there is a lot of rust, scrape and chip out and break away all rust, even if large chunks, but don't worry if you leave large holes. Scrape out behind frame with a coat hanger wire bent into a hook. Use 18 gauge metal to cover holes and pop-rivet in place.

Inside the doors, push in on inside door panels around base of window crank to expose and push out the pin holding the crank. Pop the panels off the doors with a screwdriver–they'll pop back in.

Take off the aluminum side panels on outside under doors. Loosen the screws with Liquid Wrench. Chisel and hammer from side to side to loosen, then you will see the inside and main frame.

Block each side of the car with hardwood logs several inches in diameter with flat parallel ends. (I used to use pieces of 4 or 6x4. [MB])

Scrape and chip rusty areas. Break off loose chunks. Go well into the front frame. If you make a hole in it, get heavy 10 gauge metal and pop-rivet (3/16") holes up after treatment and painting.

Fabricate and attach strips to strengthen the jack post. Cut two 12 gauge steel strips (two for each side) to mount vertically 1-1/2" away from the jack post. Drill each for three 1/4" mounting bolts. Attach upper two bolts through holes drilled in frame member (third bolt will go through hole in L-iron added in next step).

Add L-iron under the edge of the frame. Cut a 7 ft-9" length of 2" x 2" L-iron for each side. Notch cut and file notches as required to clear the 1/4" bolts added in the above step to strengthen the jack post. Position the L-iron along the 1/2" ridge of bottom of body front to back, clamping front first with two 5/16" hard steel bolts. Use a jack or anything about 12" high to hold the back end of L-iron up in place. Use C-clamps. Make rear clamps last, clamping to the 1/2" lip edge of each end of the body. At the locations of the strips added in the above step to strengthen the jack post, drill a 1/4" hole. Bolt the body and L-iron together.

Add an L-iron brace from each side to a common center point. Cut a 4.5-foot length of 1.5" x 1.5" L-iron and mount between the bottom-front jack post strength bolt and the body bolt near the center of the car to which the exhaust header is attached.

Editor: I consider this a crazy idea. It's only included because it was once published in the newsletter (before my time) and the drawings and details Mr. Hodge included.

Frame repair with thin low-carbon or galvanized steel
Don James, OH (Jan. 1993, p.8)

Q: My '72 D-Special needs a new floor and side rails and I am wondering what options are open to me. I have considered several approaches from simply having the damaged frame sections restored with new sheet metal to improving on the original sub-frame with a stronger, lighter and more corrosion-resistant alternative (perhaps aluminum). – Michael Usubiaga

A: You face the same problem that many enthusiasts do. My own thoughts on frame repair are to stick with the original thickness sheet metal. Never go thicker, because you want the "new material" to draw down to the old, not the other way around. Thicker material can cause a lot of distortion in the frame.

On the material to use, I would recommend low carbon steel or galvanized steel only. The use of aluminum or stainless will cause faster corrosion of the original material in the area it is attached. We have published the "sacrificial anode" chart in this newsletter before, and it explains the problems with dissimilar materials. The galvanized can only be used if you are going to rivet the new material, since it is difficult to weld.

Most professional restorations will go with welding, as it is much quicker, but riveting has the advantage of allowing painting of the parts before assembly, and does not require a lot of equipment–just a lot of time. Also, there is no heat involved.

You should not need any specific dimensions as long as your car is not "bent" now. Just measure and cut to fit. If your car is "bent" or broken, you may wish to consider carefully if it is worth repairing. Dimensions for the frame are given in the factory "body manual."

The cost of having the new frame pieces made is very reasonable and any sheet metal or heating shop should be able to make them from your cardboard patterns. It is very important to make a pattern of each and every piece you plan to fit. Check fits, make bends, and correct mistakes first. Get some books at your local library on sheet metal work. Any sheet metal man will find repairs to the D-models easy, but an "automotive frame welder" will tell you that you have a junk car because he is not able to understand how to repair it. It is closer to aircraft repair.

Remember that most of the work is in cleaning up and cutting out the old metal. Making the patterns and putting on the new metal goes pretty fast. Preparation is everything. There are more bad frame repairs around than good ones, and an improperly done repair car ruin the car making future repairs impossible or impractical.

Most importantly, find the cause of the rusty metal. Fix roof or trunk leaks. Be sure to provide drain holes should water enter again. Give it a way out. Try to eliminate foam-rubber or absorbent materials, or try to figure a way to insulate them from the metal. Cover with rust preventative primer and then paint. As a last step, spray all internal frame and body parts with fresh oil (I like chainsaw bar lubricant because it is sticky). (John Chassin's 1977 book, Why Citroën, has a complete description of the process of making and installing chassis parts. [MB])

Frame stress less using high driving position to change tire
Tom Rivel (May 1984, p.9)

A tire can be changed by using only the highest driving position, something that you may want to think about if your car lacks a certain amount of structural rigidity (that's a euphemism for "suffers from frame rust"). When the car is put in the high position, it is only the pressure of the suspension bottoming (topping?) on the frame at the rear which causes the pressure to rise until the regulator cuts out. There is no valve in the height corrector for this position. This means that a lot of force is being applied at that point and can cause the rear suspension cylinder to tear away if the frame is weak at that point.

Editor: The much greater pressure is also hard on the spheres.

Frame repair panels produced in Europe
Andrew Brodie, UK (Feb. 1993, p.7)

Frame repairs are now a lot easier in Europe because accurate fully detailed repair panels have been in production for some time. Using them it is possible to restore the frame in such a manner as to be "as it left the factory." Our UK company sells D-model as well as other replacement panels.

Rust prevention steps
Eric Locker (880210)

After seeing my '67 D-wagon, the car I have been driving for the last 20 years, fall victim of rust despite counter efforts, I'm not about to let that happen to a replacement (from Florence Burwell) with no rust to speak of on the chassis and only minor damage to the body. This is a progress report on what I did so far and what I plan to do in the future.

First, I bought and installed a cathodic rust protection unit. Secondly, I am painting any rust spots with Rust-Mort (SEM Products, Belmont CA). This is a thin liquid containing phosphoric acid; it turns rust black and into supposedly rustproof compound. This liquid is available in professional auto paint stores. There is also a thicker, milky liquid called Rust-Seal that puts a plastic coating on the metal. I have had this stuff peel off, so I don't know how efficient it would be.

Third, any exposed metal is being sprayed with Cold Galvanizing Compound, available in auto paint stores, hardware stores, etc.

Fourth, I am covering all the seams inside and out with Brushable Seam Sealer (Tremco, Cleveland OH), again, sold in auto parts stores.

Fifth, every surface I am working on is being painted with Rustoleum on top of the Cold Galvanize and the seam sealer.

Sixth, I sprayed the inside of all the boxes on the chassis with Rust-Mort. When this was dry, I sprayed with LPS 2 (Holt Lloyd Corp., Tucker GA). This stuff is supposed to penetrate and also leave an oily residue. Since enough has been written about spraying the chassis, I shall not go on.

Seventh, I added frame ventilation air scoops (described separately).

Eighth, it goes without saying that I'll re-undercoat the car once all the other things are done.

Rust repair of frame rail, fuel tank well and trunk
Don James, OH (Sep. 1983, p.6)

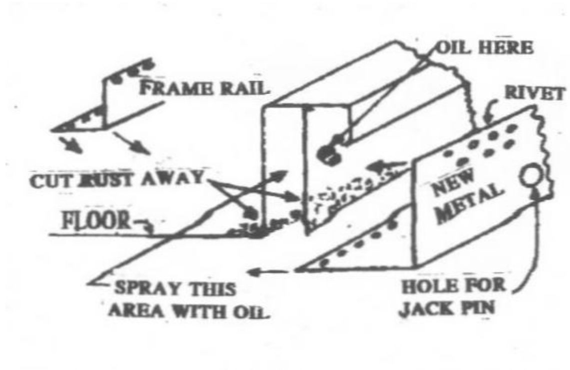
The main places to check for rust are the bottom and sides of the main frame rail, gas tank box and trunk. The easiest way to fix this is to pop-rivet new sheet metal in. The hard part is cutting away the rusted metal and this is a matter of finding the right tool for the job. A sheet metal "nibbler" will work fine in most places. Tin snips will work in others. If you use an abrasive cutting disc, you can cut sheet metal with it very nicely. A torch can be used as a last resort, but be careful of fire.

After you have removed all of the rusty metal you should wire brush, scrape, sandblast as much as you can to get the metal clean.

Next, use metal-prep on all exposed bare metal surfaces and wash it off. Let it dry and you are ready to prime. Damp-proof red rust-preventative primer should go on first. A primer with zinc in it is also good. You can mix in Penetrol with the primer to paint rusty areas that can't be cleaned properly. Penetrol can be obtained at most large hardware store paint departments. It is a clear, thin liquid similar to varnish. It is sold as an additive to increase the adhesion of paint, but it is also excellent for stopping rust. It takes about 24 hours to dry and it is thin, but this allows it to soak into the rust and set-up. It is expensive, but you will only need a gallon for your whole frame.

After you prime the metal, you should paint it with one or two coats of "black" rust preventative paint. If you can't get a brush into some of the internal frame areas, spray it in there.

Sit down and make a drawing of the sheet metal parts you will need. If you can't draw, cut a piece of thin cardboard as a pattern for the part you need and bend it to all of the corners or angles. This system will work for almost any part of a D-model frame because there aren't many compound curves. Even suspension cylinder brackets can be made up. Just make what you want out of cardboard first so you can see how it will fit.



This drawing shows typical rust damage in the side-rail area under the doors and how two new sheet metal pieces can be cut and bent for restoration. Take the cardboard parts or drawings to a sheet metal shop to have it bent. Light parts can be made at a heating shop and they can sometimes make things out of double thickness of galvanized. Look in the yellow pages and call around for a shop that can break and shear at least 6 feet for your frame rails.

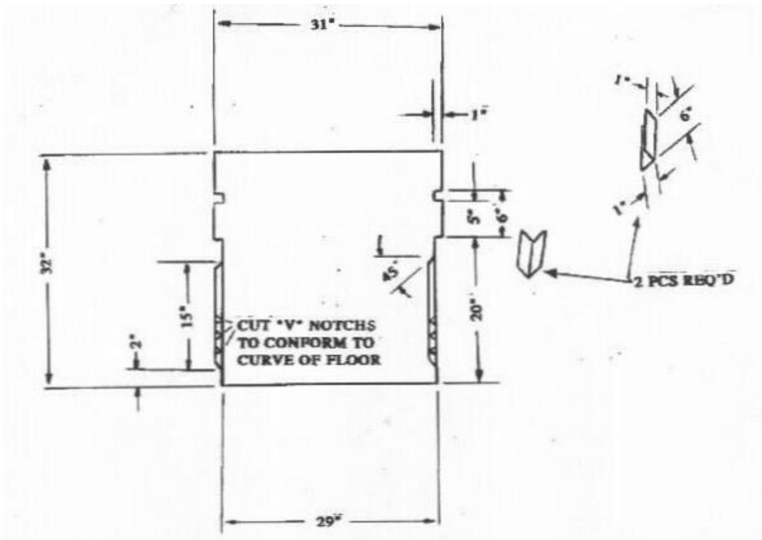
Remember, Citroëns are made out of thin sheet metal, so don't let anybody switch you to heavy material, as it just makes it harder to work with. Take them a sample of original material and tell them to stay within .005" of its thickness. Don't use stainless steel to fix rusty frames. It is very hard to work with. The rest of your car will still rust.

Now you have the tough part done. Spray the area that you are going to apply the new sheet metal to with "spray undercoating". Also spray the back side of the new metal with primer, paint, and undercoat. Put the new metal against the car and you are ready to rivet. You can draw the new metal down tight with sheet metal screws if it doesn't conform just right. Drill the holes for the rivets four at a time. If you drill all of the rivet holes first, they won't line up after you put in a few rivets. The undercoat may squeeze out of the "sandwich" as you go, but this just means you have a good seal. Let the undercoat dry before you rivet. This makes it neater to work with.

To prevent it from happening again, try to determine how water got inside your frame. A wet floor mat will rust a hole into the frame and then the water will rust out the bottom of the box section. Then it rusts fast because with no bottom, the wheels splash water right up inside.

The gas tank filler tube runs down at an angle to the box. This brings water with it. Calk or a piece of sealant around this filler tube will stop water getting in. Water leakage into the trunk will rust out the trunk floor and the jute backing of the trunk liner will hold water against the sides of the trunk walls. Water also gets in by condensation. You should keep the car parked on concrete if possible.

Trunk floor replacement sheet metal pattern
Don James, OH (Nov. 1985, p.38)



This drawing shows the dimensions is for a trunk floor repair panel on D-models. This piece was to go on the outside of the trunk floor. I cut the "V" notches myself with tin snips. Notches allow floor pan to bend. Extra angles fit near the front. Pieces were cut from cardboard first to check fit.

Many enthusiasts would like to fix the rust on their cars, if they only knew how. Spot welding and pop-riveting are the most accepted methods. Many furnace shops and heating installers have the equipment to form parts to restore your DS, and it is not expensive. Any sheetmetal shop can bend the parts and cut them faster than you can. Sheetmetal shops can cut and bend this easily from a drawing like this. This piece cost me $5 to have made of galvanized steel at a local shop. Don't use galvanized if you plan to weld.

Zinc chromate primer best protection over rust
Ed Hodge (Nov. 1976, p.2

Put aside a little time with your Citroën because it is special.

1. Keep it clean and drive with care;
2. Change oil four times a year;
3. Never-I mean NEVER-let rust appear;
4. Take off those side frame panels (one side at a time), scrape and wash with Metal Treet and paint every year before it's too late;
5. Repair, or have someone who will do it, all rusted places under the frame. Paint with Pratt & Lambert Effecto Zinc Chromate Primer L25.

6. Take all inside arm rest panels off the inside of the doors with a large screwdriver-the handle washer will push in and show a small pin; hammer it out with a small nail-do this first;
7. Get rid of all rust inside the doors and on the bottom side, too, and paint with Effecto;
8. Lift up those gray mats-even the side ones. They must be de-rusted and reglued down later.

Pratt & Lambert Effecto Zinc Chromate Primer L25 enamel has a mustard color, is quick drying and very tough. It is used for sea-going ships and marine machinery to be painted white, gray or whatever. It is a low-odor interior and exterior marine primer that fights rusts. Even if there is just a little rust left, it will dissolve it. Cost is minimal. One word of caution–please use a fan nearby while painting.

Editor: Sale of zinc chromate paint is now forbidden for health and environmental reasons. (Rustoleum or some alternative in the proper color and sheen is a good alternative and not toxic. [MB])

Chapter 8–Citromatic

Alternative neutral may prevent an accident
Dave Root (Mar. 1990, p.13, abridged)

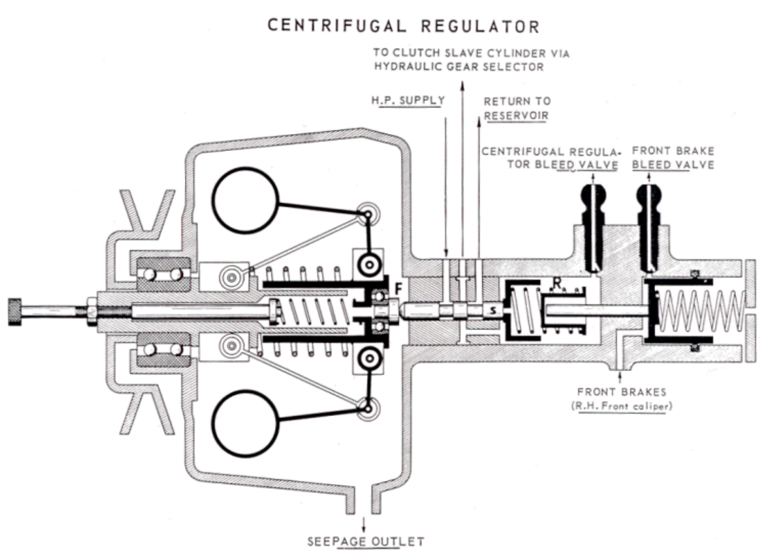
I had just started up our '70 white Pallas and was revving it up to help it "get up" a little sooner–as I had done hundreds of times before. But this time, I suddenly became conscious of rapid forward motion. It and I were approaching my old South Bend lathe with alarming velocity! Next there was a loud crash accompanied by a "tinkle, tinkle."

With the thought of possibly helping someone with a Citromatic D-model to avoid having a similar experience to mine and to avoid my doing it again, I have thought of a few precautions. Since first, neutral, and second are all in a straight line parallel with your line of vision, it is sometimes possible to have the car in first when you think the lever is in neutral. Therefore, it seems a better procedure would be to, quickly after starting it, put the lever in the neutral that is between first and reverse. Now you can better see that it is not in first. Also, it might be well to practice having the brake on while you are revving it up. Better still, don't rev it up to speed the raising process–be more patient (like I'm not) and let it just "get up" when it's ready.

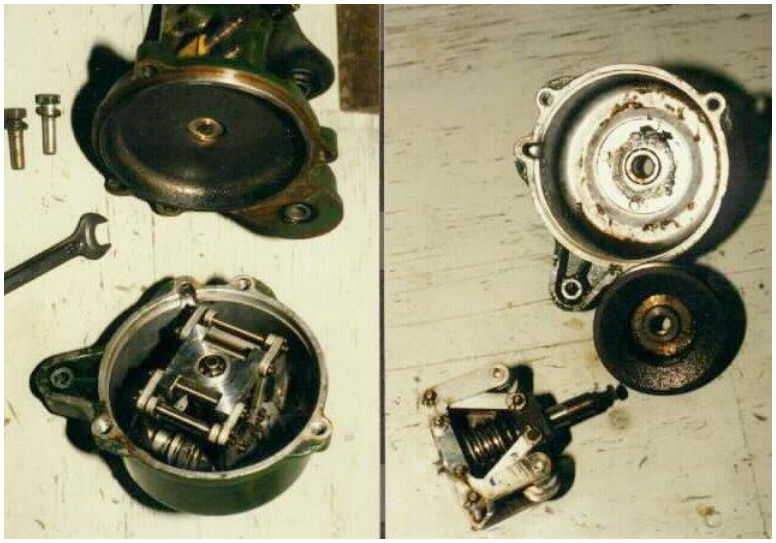
Backup light switch defect causes reverse gear lockup
Don James, OH (Mar. 1986, p.31)

If your Citromatic equipped D-model will not go into reverse, be sure to check for problems with the backup light switch. There is a small metal slug that can fall out of the switch and jam the shift rod. This could cause a shifting problem on standard shift models, too.

Centrifugal regulator cross section drawing
Eric Locker (Jan. 1990, p.3)



Centrifugal regulator front bearing replacement
Citroën Manual (Sep. 1986, p.15)


Centrifugal regulator, disassembled

DISMANTLING:

1. Remove the drive pulley and the rotating assembly
2. Remove the four rivets (below) and remove the plate holding the bearing.
3. Remove the front bearing.

FITTING:

4. Push the front bearing right home into its housing.

5. Fit the retaining plate and fit four new rivets. Note: For this later operation, stainless steel "pop" rivets may be used (1/8" OD, 1/4" length).
6. Fit the rotating assembly. Screw up the drive pulley and make sure that it can turn freely.

Editor: These instructions fail to mention the pulley unscrews from the shaft. It's only necessary to remove the front cover of the regulator from the car, not the entire regulator. (Pulley threads are right hand. Bearing is a double row sealed 5201-RS2. Lightly oil all pivots. [MB])

Centrifugal regulator front bearing replacement
Don James, OH (Nov. 1986, p.18)

Problems with the bearing in the front cover of the centrifugal regulator found on D-models equipped with Citromatic gear change are inevitable unless this bearing has been changed. I am aware of many people that have taken trips and had them spoiled by trouble with this bearing. The original bearings were of open construction, and this was a real mistake on Citroën's part. Replacement bearings using a sealed construction are not easy to get and are available only on special order. This bearing is lightly loaded if you do not keep your belts too tight, as the regulator must simply spin as an engine RPM sensor. Failure of the bearing is caused by lack of lubrication.

Repair is easy if you need to replace it. The front cover of the regulator can be removed without removal of the entire regulator from the car. Three bolts hold the cover, and the cover will come off along with the pulley and the short stub-shaft. Be sure you loosen the belt before you remove this front cover.

The pulley unscrews from the shaft. Hold the pulley in a vice, and use a large wrench to grab the aluminum block that is the body for the governor weights. The threads are "right handed" so you should have no trouble in unscrewing the pulley. They do not seem to be extremely tight. Drill out the rivets and replace with pop-rivets or with small machine screws after tapping the holes. (The original pictures were used in the preceding article. [MB])

Clashing indicates inadequate clutch release
Don James, OH (May 1992, p.22)

Owners should also be aware that if their Citromatic car grinds or clashes gears, the clutch is not releasing properly. A car that is equipped with Citromatic is no different than any standard transmission car and if you grind the gears in a stick-shift car, you are not pushing in the clutch.

A Citromatic car that grinds is no reason to tear apart the Citromatic valve or make judgments about the transmission. Check the simple things first, such as jacking up the front wheels and watching the clutch release lever as someone puts the car in gear. If the lever is moving properly, as a manual transmission would, then the grinding can only be caused by a clutch mechanism that is not releasing completely.

Be sure the button under the dash is not pushed, if you notice the lever does not move at all. This button is used for starting the car with the crank, but can also be used to allow the carburetor bores to be opened up when starting the car on a hot day (the clutch prevents the carburetor from opening up on later type Citromatics). The button can also be used to "bump start" the car should the engine stall and you still have hydraulic pressure and some momentum.

Should the bearing in the centrifugal regulator lock up or the belt break, you can still operate the car a bit jerkily by using the button under the dash. Pushing the button down toward the firewall engages the clutch.

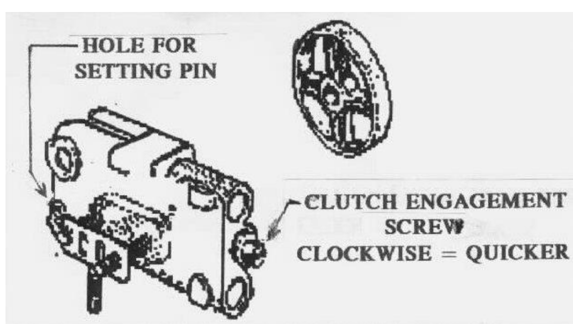
Clutch cylinder spring failure causes troubles
Andrew Brodie, Great Britain (Nov. 1984, p.8)

Just a note for your newsletter as an addition to the excellent article on the hydraulic clutch DS (previous issue), concerning a problem we have found in Europe on cars made after September, 1972 (on cars that use the later clutch slave cylinder), for diaphragm clutches.

The slave cylinder in these cars contains a spring, DX314-287. Over 60,000 miles of town driving we have found regularly this spring is broken. This causes all manner of problems, slow and irregular disengagement, failure to select gears, etc. It is often characterized by a leaking clutch slave.

Replacement and cleaning out the clutch slave cylinder and removing shards of spring usually cleans up the leak without new seals. This spring is no longer available, so I don't know what to suggest except trying to find a close replacement or trying to set up the car to run without it in place (which does seem possible).

Clutch re-engagement control valve function and adjustment
Don James, OH (May 1993, p.15)



The clutch re-engagement control valve determines the speed that the clutch will engage after a gear change. A collar on the screw prevents rotation beyond 360 degrees, but this collar can be removed if needed. Too much slippage after a gear change can shorten clutch life on Citromatic equipped cars.

This control also senses throttle position and allows more slippage if the driver is giving a lot of "throttle."

Another job done by the control valve is to prevent the opening of the throttle unless the car is ‘in gear" (clutch is engaged). For this reason it is impossible to "rev up" a car with Citromatic while standing still. This can make clearing flooded engines difficult and sometimes hot starting difficult. A trick to open the throttle plates fully is to push the lever underneath the steering wheel to manually engage the clutch while in neutral. This lever is used for hand crank starting the car.

The above picture shows the clutch re-engagement control valve. Fluid leakage from the hole for the setting pin is caused by clogged or restricted drain hose, improper slope to the hose or a clogged vent on the hydraulic tank. This valve drains by gravity.

Clutch re-engagement control valve function and adjustment
Andrew Brodie, Great Britain (Feb. 1994, p.16)

The Citromatic clutch re-engagement control is the last adjustment to make. I cannot emphasize too much that everything else has to be set up just as the workshop manual states. About right or "sounds good" simply will not do. Time and time again cars come into our workshop with the ignition timing and idle speeds etc. wrong and the car drives badly. The system is very reliable and stable if set up correctly and will last most of the life of the clutch without resetting! Mostly we find the ignition timing is wrong.

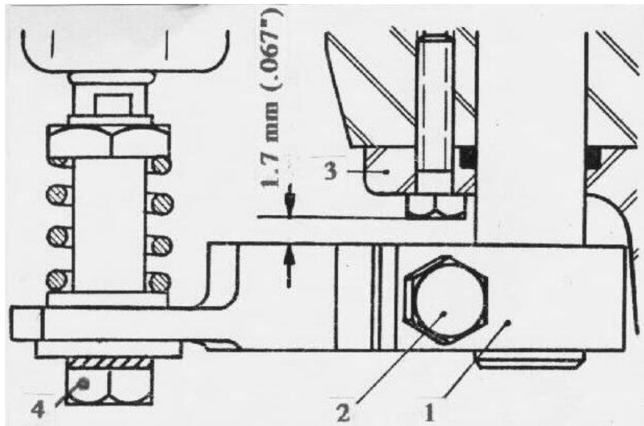
Get a photocopy of the workshop manual. Check that the distributor centrifugal advance works at least approximately. Get that idle timing correct. You can afford a basic strobe timing light. Remember that the idle/low speed power of the engine is critical. I will leave you to read up the manual for the rest with the reminder to set up the car, test drive, and then check it all again. Get it correct and it will all stay correct for up to 15,000 miles.

Now, the re-engagement. This is fairly easy. The key knowledge is that there are 18 turns available on the adjusting screw. So turn the adjuster clockwise... (tighten) gently until you get to the end of the thread, counting the turns. Write this down. Now unwind back to where you were.

You can now proceed with confidence within a limit of about 8 turns either way from the center of the thread. Go ahead, undo it about 4 turns and try it. If the engine speeds up and the clutch is slipping during changes then tighten away until you feel happy with the smoothness of the clutch take-up between gears 2-3-4. Feel free to go too tight. You know where you were and can go back to that setting. The actual adjustment is rather sensitive, which is why there is supposed to be a collar on the adjuster to stop the owner going too far. When you get it about right, you will see what I mean, as at this position, a half turn or so will make a perceptible change.

I believe the reason that the collar is fitted is also to allow some adjustment for driving style. The re-engagement control has a built in adjustment for altering the re-engagement speed as the throttle opening is varied. That is, it reengages faster with wider throttle openings to prevent excess clutch slip with increased power. However, some people drive very gently and others like a snappy change.

Clutch-lock adjustment procedure
John Yosuke Otsubo, CA (Jan. 1986, p.20)



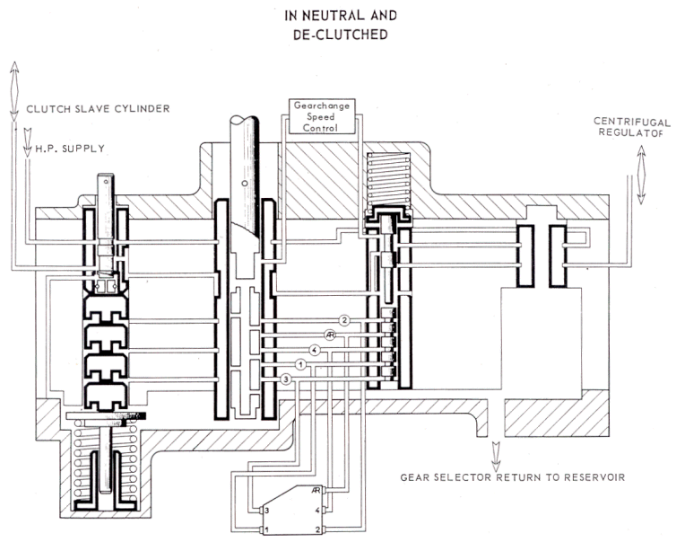
Adjusting the clutch lock clearance is not so hard to do.

1. Take out the spare tire
2. take out the air duct to the radiator
3. take off bolt #4 (above)
4. loosen bolt #2
5. move #1 back and forth to meet a clearance of 1.7 mm minimum.

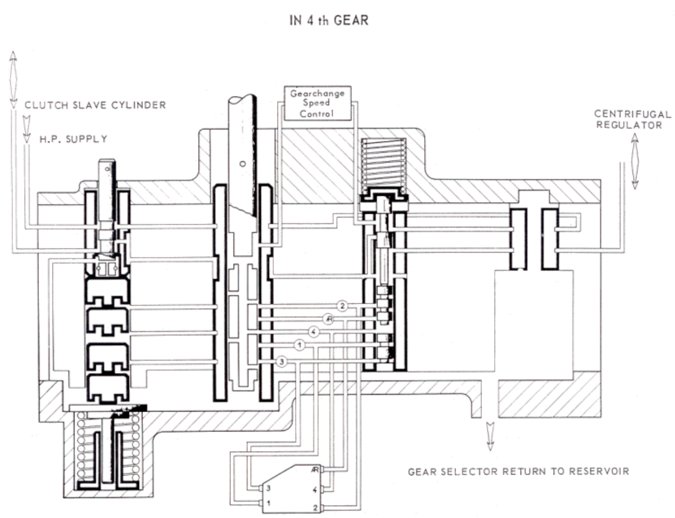
First gear not synchronized on early models
Don James, OH (May 1992, p.23)

The old cars that used the three-main bearing engine had a rather primitive transmission. It is very strong but has no synchronizer on first gear and those transmissions that were fitted with Citromatic did not have all of the safety features of the more modern versions. Always be sure the car is at a dead stop before you engage first or reverse gear. If you don't, the result can be broken and damaged teeth.

Gear selector cross-section drawing
(Feb. 1990, p.12)

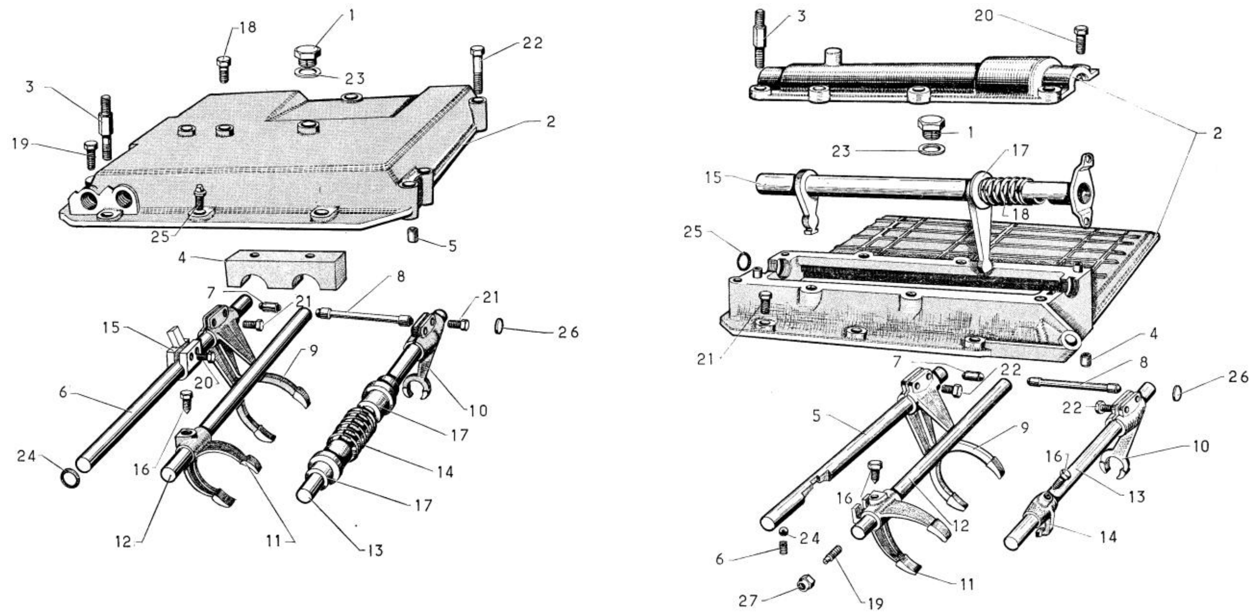


Citromatic shift block in neutral with clutch disengaged



Citromatic shift block in 4th gear with clutch engaged

Gearbox same as manual except cover
Don James, OH (Sep. 1984, p.11)



Difference between the standard shift gearbox and Citromatic

The only difference between the standard shift gearbox cover (left) and the Citromatic gearbox cover (right) is the thickness and the mechanism to move the shifter forks. The gearbox is the same!

Gearbox shift piston seal replacement
Don Dellinger (2000 #3 p.12)

Should it be necessary to replace the gearbox shift piston seals, this repair should be taken with great caution as this entails major adjustments to all pistons and cylinders after their removal. A bad adjustment will destroy the synchronizers and shift forks, and necessitate another gearbox or major overhaul of yours. An experienced person who is familiar with this system should only do this operation.

CAUTION - This also applies to changing gearbox covers. For instance, if you decide to change your old LHS fluid car to LHM, you cannot just exchange one for the other. The gearbox shift pistons must be adjusted for the gearbox you are installing it on, or risk destruction of the gearbox.

Leaks-Certain bolts loosen allowing fluid to slowly leak away. And if you delay too long, you will eventually hear that whine and grind of gears and bearings that run dry from lack of lubricant. All Citroën transmissions, except cars with BorgWarner automatics, have to be checked at the check plug on the side of the transmission. Most all use 80 or 90 W EP oil and should be checked on level ground. The correct oil level is at the bottom of the threads of the check plug. The reason for the loss of lube oil is the bolts that hold the output housing. The top cover and the front cover can work loose; sometimes the bolts even fall out.

On the D and SM, it is necessary to remove the pan with the brake ducts so you can see what you are doing. This means raising the car on a lift or over a pit or jacking the front up and blocking it for safety. The pans are usually filthy and have screws missing. This is also a good time to retrieve the tools you lost down there from working above. Now you should see the brake rotors and the output housings pretty well.

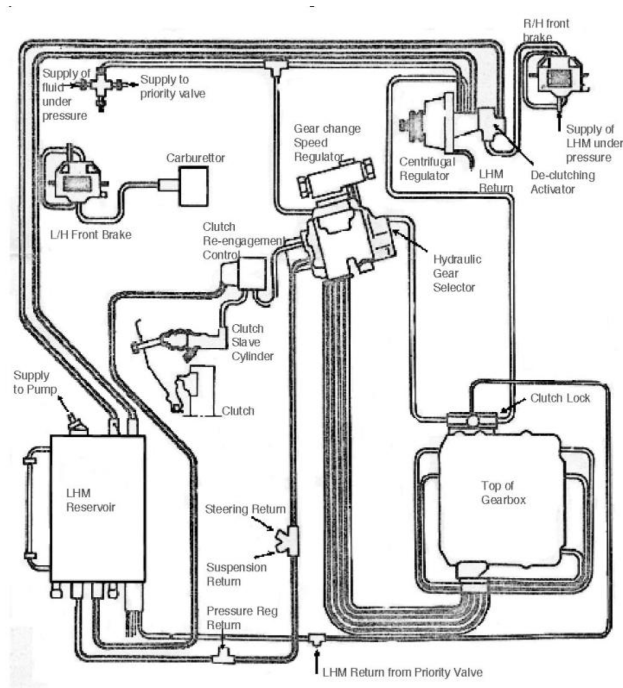
Depending on the year, you will need various wrenches: 12 and 14 mm for early cars and 11 and 14 for later cars. Tighten all you can get access to-some you can only promise to do (and should) should you have to do the clutch at a later date. Of course, this is only a stopgap repair. When the transmission is pulled in the future, all seals and gaskets should be replaced.

Sometimes, when checking the fluid level on D series cars with hydraulic gear change, you may see fluid excessively running out of the check plug hole when you take the plug out. This may be caused by one or more of the shift pistons in the gearbox cover leaking into the transmission as the pistons move in and out with the gear change. The oil will also seem very thin to touch - LHM and 80 EP. This has happened to me on driving a brand new car back to PA from NJ in 1972. Each time I shifted to third gear that seal on the piston would really leak. Thanks to the spare liter of LHM and the tool kit I was able to drain the excess back into the 1 liter can from the drain on the bottom of the transmission and pour it into the reservoir to get back to where I came from-about 20 miles. By shifting from 2nd right through to 4th gear, it eliminated the leak and I returned to the new car pickup, trading that car for another.

As you have the splash pan and brake ducts off, now is a good time to inspect all the return lines-rubber and plastic. Old age sets in and they crack where they are clamped, where the bulge is in the line or on the unit it is attached to. Also check the tightness of the connections on the high pressure side (steel lines), making sure the lines are not rubbing against each other or anything else that could cause them to wear through. Now is the time to clean the splash pan and brake ducts and replace all missing screws on the brake ducts themselves.

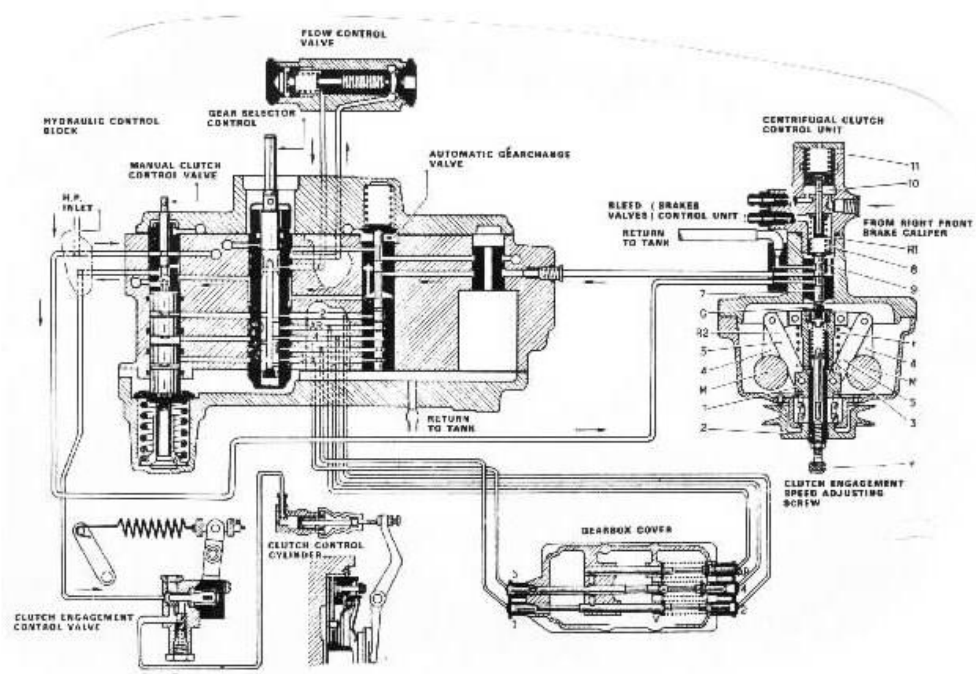
Reassemble the pan with the brake ducts attached to the splash pan. Check from the top to see that no steel lines are rubbing against the pans or each other. Good Luck!

Hydraulic circuit diagram
Eric Locker (Jan. 1990, p.1)



Citromatic Hydraulic Circuit Drawing

Hydraulic components diagram
Citroën (Sep. 1984, p.1)



Citromatic hydraulic components and piping

New centrifugal regulator cures transmission clunk and internal leak
Barton Milligan, Bahamas (Jun. 1995, p.9)

Many owners of Citromatic have experienced a clunking noise when shifting into second gear. There seem to be almost as many explanations of this phenomenon as there are Citromatics. I offer the following experience for what it may or may not be worth. A lot of checking showed that the internal leak that was causing my pressure regulator to cycle every ten seconds was somewhere downstream of the system branch leading to the "brain valve." Fortunately, before I could find time even to think about dismantling that marvel, I noticed there is a line to the centrifugal regulator from the "brain valve."

Indeed, removing the return line from center of the centrifugal regulator showed a constant flow. Well, the point of all this is that when I replaced the centrifugal regulator, the second gear clunk virtually disappeared (the pressure regulator now cycles every twenty seconds). I'd certainly like to hear whether people think this is just a coincidence or not.

Operation and adjustment introduction
Don James, OH (Sep. 1984, p.12)

The series of articles by Don (Red) Dellinger to follow will help you put your Citromatic back in adjustment, no matter how screwed up some previous owner has made it. Follow the instructions step by step. Please remember one thing–check the simple things first. If your Citromatic sounds like it has marbles in it, bleed the centrifugal regulator at the bleed screws provided at the top. The Citromatic will not work correctly if there is air in the brakes, so bleed at the carburetor, too.

If the gears grind, check to be sure that the clutch release lever is moving forward far enough. If it is and the gears still grind, there is obviously something wrong with the clutch and pressure plate–not the Citromatic! The gears would grind, even with a standard shift. As with most of the problems that owners have with their Citroëns, 99% of the problems that develop come from simple, and avoidable causes.

The single biggest problem with Citroëns is caused by mechanics working on the cars when they do not understand how they work! They never fail to put the entire car out of adjustment and cause more damage than years of normal wear could cause.

An automatic transmission that gets the same fuel mileage as a standard shift has been the dream of many auto makers for years. The trick is to eliminate the clutch, but retain a direct drive with no slippage. This was invented years ago by Citroën. The transmission was not a fully automatic, but could have been if they had wanted it.

It is what we now call an automatic stickshift or semiautomatic transmission. Citroën called it "Citromatic" and it is more wondrous than their famous hydro-pneumatic suspension.

Operation and adjustment: Part 1–Principles and advantages
Donald (Red) Dellinger, PA (Sep. 1984, p.12)

Many people get confused about Citromatic equipped cars especially if they have never had any previous experience with this type of shift. Most owners who have driven them for years do not understand the workings of this hydraulic marvel. When I think of it, it must be as close and effortless as you can get to a fully automatic transmission without the undesirable aspects of the fully automatic transmission such as loss of power, loss of control, flexibility, economy, etc.

The Citromatic is quick, positive, safe, economical and effortless IF all units are working and are adjusted properly. No four speed shifts faster or more accurately than a DS with Citromatic. No declutching manually, no wait for synchronization, no foot slipping from clutch pedal, no clutch slip (riding clutch), no left leg cramps in traffic, quick shift from 4th to 3rd are just a few of this transmission's good points. One of the transmission's great points is ease of shifting even in hard cornering when extra power is needed. In a normal 4-speed equipped car you must remove one hand from the steering wheel, declutch with the left foot, move gear lever with right hand, release accelerator, etc. Valuable time is lost in these motions! The control of the car may be lost by split second timing in an emergency cornering situation. Citromatic is instantaneous and when adjusted properly the shifting is precise.

Most people are not patient enough to take time to understand Citromatic. Most mechanics do not understand it, therefore cannot adjust it properly. Most Citromatic clutches are so improperly adjusted that they have overheated and warped, which causes clutch chatter and gives erratic operation. Once all of the components of the Citromatic are adjusted properly the only slippage the driver will get is if the car is started off in a gear higher than it should be (2nd or 3rd when it should be in 1st). Have you ever observed the shift pattern closely? Typical Citroën engineering! The transmission must be in neutral to start for safety (the shift block can only be in neutral or the starter will not turn). 1st and reverse are directly across from each other. This is for ease of parking (minimum movement of the lever).

A properly adjusted DS will idle into a parallel spot just by touching the brake pedal and shifting from 1st to reverse to 1st again. By the way, the brake pedal on a DS is to be operated by the right foot only–no left foot on brake and right foot on accelerator like an American auto–this will defeat all adjustments. The champignon or mushroom foot brake rubber sphere is designed for a minimum travel its entire life and is lower than the accelerator pedal for a special reason–quick reaction time from the accelerator to the brake with the right foot, your foot only has to pivot on the heel to depress the brake and pivot to the right for the accelerator. If this is not so in any Citroën D-model the accelerator linkage needs adjustment. This is all leading to proper driving of the DS Citromatic.

When all the adjustments are carried out properly to the driver's satisfaction, from this time on, normal maintenance should be a clutch adjustment every 10,000 miles (5,000 miles if the car is used primarily for stop and go driving). Exception: when any of the components in this circuit are replaced, then adjustment of that component is necessary.

The transmission, differential, clutch pressure plate, clutch disc and release bearing are identical to the manual shift cars except for the internal shift rods and forks and the operation of the clutch. Instead of a mechanical clutch cable and rod there is a clutch slave cylinder and fitted to the transmission top covers are five servos or pistons (one each for 1st, 2nd, 3rd, 4th and reverse). Lines leading from the hydraulic gear selector (shift block) to the transmission connect to these servos and are tied together in one bundle. Like any hydraulic clutch slave cylinder, it has one function–to engage or release pressure on the clutch release fork to operate the clutch mechanism. This lengthy description is necessary because the manually shifted car clutch free travel is also adjusted here by feel of distance or clearance, which can be checked quickly with finger and thumb, but NOT the Citromatic.

The Citromatic clutch is adjusted so that at 750-800 rpm the clutch components are just about ready to contact each other–disc, pressure plate and flywheel. Putting it more simply, the clutch release or throw-out bearing is depressing the fingers on the pressure plate to the point where the clutch is just about to engage slightly but is still disengaged. For comparison on a manual shift car, the point reached when you are in 1st gear and have eased out on the clutch pedal to where another 1/8" would cause the car to start to creep away on the level. Manual shift and Citromatic clutches are adjusted differently. The manual clutch is adjusted without the engine running and the clutch pedal out (clutch engaged position) by pressing with your right thumb against the adjusting bracket (clutch fork) toward the radiator. There should be approximately 6 mm clearance or play. Turning the adjusting screw clockwise reduces the clearance, counter-clockwise increases it. That's it for the manual shift car owners, but for you poor buggers with Citromatic, let me continue as we are going to the meat and potatoes of it.

Operation and adjustment: Part 2–Clutch adjustment
Donald (Red) Dellinger, PA (Sep. 1984, p.13)

Start engine and bring to normal temperature. If the front of your car has been wrecked and the crank extension will not fit through the air duct without binding, you must either remove the duct or make a tool from 1/4" or 5/16" rod (obtained from a hardware store) and weld about 2" 14 mm or 9/16" allen key to the 3 foot long rod. We use an old army surplus rifle cleaning rod that has a "T" handle that revolves. This must take the place of the crank extension piece. It is inserted in the front of the transmission and must be pushed in approximately 1". This makes contact with the transmission main or clutch shaft that passes through the clutch disc and is supported by the pilot bearing in the flywheel.

Now, back to the adjustment procedure. With the engine at normal operating temperature, turn the large air screw (brass) located at the front bottom left of the carburetor clockwise until seated and slightly tight. This should slow the engine speed. Check and adjust engine idle and mixture screws to obtain a smooth idle of 750-800 rpm (check with tach).

Since the clutch disc is connected to the transmission main shaft and our crank dog is pushed in, this is the speed the engine will be idling at when you stop for any reason in driving–so at this speed we want the clutch disengaged (primary idle).

Since the clutch disk is connected to the transmission main shaft and our crank dog is pushed in with the crank or our home-made tool, by changing the adjustment we can adjust the DS clutch properly. Turn the adjustment bolt counter-clockwise with the engine running (WARNING: watch fingers in moving pieces–belts, fan, etc.) until the tool (or crank extension) starts to rotate. This will mean that the clutch is starting to engage. Then turn the adjustment bolt clockwise until the tool just stops turning (clutch just disengaged) then continue to turn the bolt one full turn clockwise. You are now finished with the clutch adjustment.

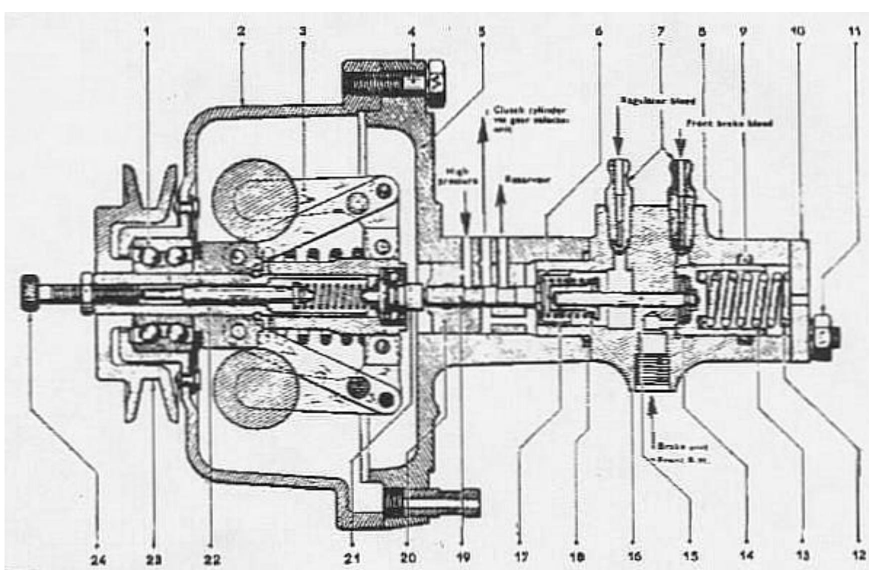
Note: If the shaft will not stop turning even after turning in the adjustment bolt all the way, then the pressure plate is broken and a new clutch is necessary. This is a fairly common occurrence even with manual shift on high mileage cars. If you try to adjust any other components of the system and you have a faulty pressure plate or clutch you will not be successful at all.

Operation and adjustment: Part 3–Engine idle
Donald (Red) Dellinger, PA (Sep. 1984, p.14)

The next step (providing the clutch adjustment was successful and the clutch/pressure plate mechanism is working properly) is to adjust the engine idle. I prefer 1000 rpm secondary idle. To adjust, unscrew the large brass screw you previously screwed in back out (counter-clockwise) to obtain 1000 rpm. Now, step on the foot brake and the engine speed should drop to 750-800 rpm (primary idle). When you let go of the brake the engine idle should rise to 1000 rpm (secondary idle). You are now finished adjusting idle.

Note: Remember, 1000 rpm minus 750 rpm equals 250 rpm (for future reference).

Operation and adjustment: Part 4–Centrifugal regulator
Donald (Red) Dellinger, PA (Sep. 1984, p.15)



1-front bearing; 2-bearing end plate; 3-governor mechanism; 4- assembling screws; 5-regulator; 6-dashpot; 7-bleed screws; 8-clutch disengagement corrector body; 9-seal; 10-rear plate; 11-nuts; 12-spring; 13-piston; 14-circlips; 15-rod; 16-spring; 17-cup; 18-seat; 19-slide valve; 20-support; 21-pad; 22-sleeve; 23-pulley; 24-adjusting screw.

The next unit we will adjust will be the centrifugal regulator, located above the high pressure pump and driven by a small belt from the pump. This belt must not be over tightened or the result will be premature bearing failure in the centrifugal regulator. The centrifugal regulator has one purpose only. That is to start discharging fluid from the clutch slave cylinder between 800 to 1000 rpm of the engine (a very slight amount). When the engine speed increases from primary to secondary idle speed, just enough fluid is released from the clutch slave cylinder to make the clutch start to engage. When the clutch starts to engage just slightly, the car starts to "creep" or move slightly in first or in reverse. Therefore, the operation of the regulator is as follows. When in first or reverse gear and your foot is on the brake pedal, the engine is at primary idle and the regulator has clutch disengaged and the car stays still.

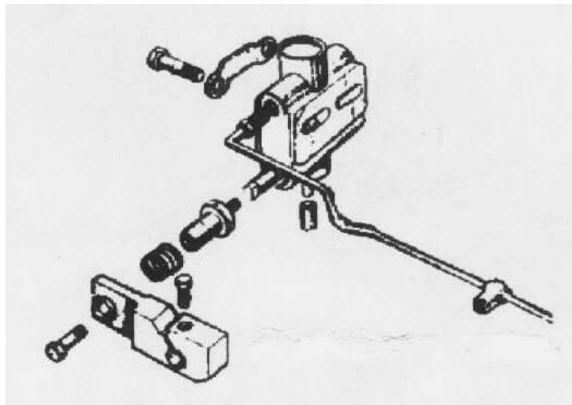
When you remove your foot from the brake pedal the engine speeds up (approximately 250 rpm) to secondary idle which in turn causes the weights in the regulator to signal the clutch to start to engage and the car begins to creep. It is only normal to have your foot on the brake when stopped at stoplights or signals or for backing up. This is why it is important to use the right foot only for braking–so that the accelerator is released and the primary and secondary idles work properly.

If the car will not creep when the foot brake is released in first gear, it will need adjustment. Shut off engine. The adjustment is an 8 mm headed bolt that goes through the center of the centrifugal regulator pulley and is locked in place with an 8 mm nut. Unlock the nut and turn the bolt out (counter-clockwise) one turn. Lock the nut, then start engine and check creep again.

Continue this adjustment (counter-clockwise to increase creep/clockwise to decrease creep) until the car is set to creep at a speed you are comfortable with (if the car stalls on selection of first gear, turn the adjustment screw until you achieve the desired creep). This is a fine adjustment and should be adjusted in increments of one turn or less at a time.

If the car stalls every time on starting out or coming to a stop, usually the seals on the piston inside the regulator are swelled and hard, causing the piston to stick in the bore. This is a simple unit and consists of a set of centrifugal weights and springs acting on a sliding piston controlled by the adjusting screw. Its only purpose is to activate between the difference in speed of primary and secondary idle to release a minute amount of fluid from the clutch slave cylinder.

Operation and adjustment: Part 5–Guarantee control
Donald (Red) Dellinger, PA (Sep. 1984, p.15)

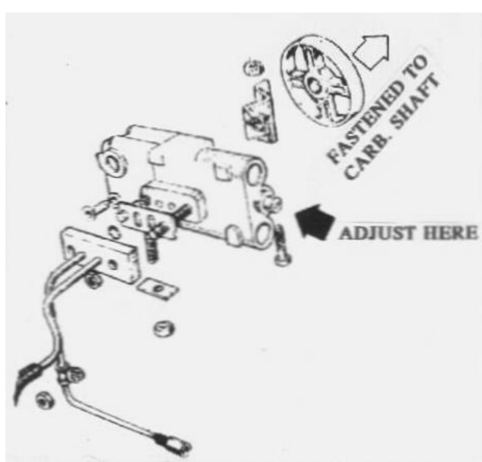


This figure shows the Citromatic guarantee control. This safety device is located on the right side of the transmission. Its function is to ensure (guarantee) that the transmission's gears 1 and 2 are engaged before the clutch can engage, by stopping fluid return from the clutch slave cylinder unless the gears are fully engaged.

Adjustment procedure is as follows. The hydraulic pressure must be up, the engine off and gear selector must be in neutral. Loosen the two 11 mm headed bolts that hold the control to the transmission. Pull the unit toward the front of gearbox until it stops. Push backwards slowly until the unit snaps rearwards (this is the neutral position) and retighten the bolts.

Generally, this unit never gives any trouble and almost never gets out of adjustment. Adjust only if it is removed for repairs.

Operation and adjustment: Part 6–Clutch re-engagement control
Donald (Red) Dellinger, PA (Sep. 1984, p.16)



This control is attached to the intake manifold in front of the carburetor and is activated by the carburetor primary throttle shaft. Its function is to control how quickly fluid is discharged from the clutch slave cylinder between gear changes. It therefore determines how fast the clutch reengages while shifting.

There are two adjustments. The first one is on the side of the unit facing toward the driver's side of the car. There is a straight slotted screw protruding approximately 8 mm, sometimes with a knob fixed by a small screw. The knob has a small raised post allowing it to be turned only 350 degrees, but by unscrewing the small screw it can be turned without stopping against the small peg. If the speed of the clutch re-engagement between gears is too slow, turn the screw in (clockwise) until you are satisfied with the clutch re-engagement speed. If the re-engagement of the clutch is too fast, unscrew it (counter-clockwise) until it suits you. This screw will not unscrew and fall out and sometimes must be adjusted several turns depending on the condition of the clutch (such as when a new clutch is installed).

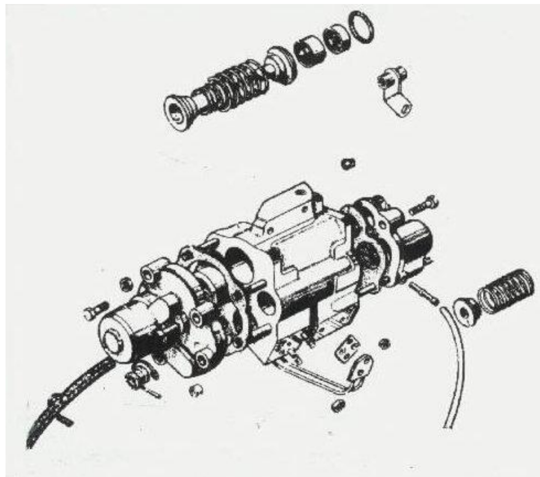
After getting the adjustment set, you can reinstall the small knob with the setscrew. Install the knob straight up, which will give you approximately 175 degrees of fine adjustment in either direction. The adjuster has a very fine thread, so the adjustment is not too sensitive.

A second adjustment is sometimes necessary. Someone may have removed the carburetor and did not fasten the unit on the idle position. As a result, the shaft adjustment in relation to the carburetor idle may have been moved. There is a small hole (usually plugged with a plastic plug) just above and to the rear of the shaft centerline (towards the front of car). This is an adjustment/alignment hole. Normally with the throttle closed a 2.5 mm (.100") wire should pass through the hole in the housing and go into the line-up hole in the internal shaft, locking the unit and the throttle shaft tight. If it does it is alright.

If not, proceed as follows. Grip the control unit shaft with thin vice-grip pliers near the body of the control. While holding shaft from turning, loosen the 8 mm bolt in the clamp between the control and the carburetor shaft, push 2.5 mm (.100") wire in hole in housing and turn the shaft against the spring tension until the wire falls into the hole in the shaft and locks the unit from turning. Release pliers, align shaft coupling and tighten the 8mm bolt. After realignment of the control, repeat the first adjustment if necessary (it usually is).

After adjusting the unit, you should road test it. Drive the car at approximately 55 mph in 4th gear on a level road. Move the gear change control to 3rd gear without releasing the accelerator pedal. The shift should be smooth and almost unnoticeable. If not, stop and fine adjust by the knob (or screw if yours no longer has knob on it). Road test and readjust to suit your driving style. Total time involved is about 1/2 hour.

Operation and adjustment: Part 7–Shift block
Donald (Red) Dellinger, PA (Sep. 1984, p.17)



There is only one adjustment on the shift block itself and it very seldom, if ever, needs readjustment unless the shift block is removed from the car. Adjustment procedure is as follows. With left hand, reach under and to the rear of the shift block. There you will find a rubber plug with the largest part about 11 mm in diameter. After removing this dust cover you will have access to a 3.94 mm hole. When 1st gear is selected with the control lever a pin 3.94 mm diameter x 50 mm length will slide into the lineup hole approximately 30 mm and lock 1st gear position in the shift box. If not, a mirror will allow you to see the hole. The best method to line up the hole (if it is not already) is to have someone move the control lever to the left/right/in/or out slightly in order to line the hole up in the shift block so that the pin can be inserted.

Once you have the pin inserted into the shift block properly, then you must adjust the shift control lever to the corresponding 1st gear position. To do this you must first remove a dust cover from the metal cowl to the rear of the shift block (under the hood). This plug is about 1-3/4" in diameter and is made of rubber. It exposes two 8 mm bolts that tighten a clamp between the control lever mechanism and the shift block. To adjust, loosen the lower 8 mm bolt and align the shift control lever to the 1st speed detent (it pops into place), then tighten the lock bolt. Remove the alignment pin and reinstall the dust cover (plugs). You are finished.

This unit is faithful and almost never gives trouble but is often accused as being the cause of trouble. One exception is when it becomes gummed up and stiff (especially in cold weather). Then it must be flushed out or removed and cleaned. A hissing noise from the shift block can be caused by misadjustment or a sticking piston that can be remedied by adjustment or removal and cleaning. Seriously, this unit is like all Citroën hydraulic units and is well engineered and needs little attention. Should service be required, never take it apart in place. It is easily removed from the car to be repaired on the bench.

Editor: Before you look for any trouble in this unit, be sure that you check the belt on the centrifugal regulator. The car will not move if the regulator is not turning. Do not overtighten the belt. Should the belt break, the car can be driven by using the manual engagement control that is located under the steering column.

Starting car with transmission stuck in gear
Don James, OH (Aug. 1988, p.20)

To start an engine that is in gear, put vice grips on the clutch release lever that sticks out of the bell-housing, just forward of the hydraulic pump. Push the vice grips toward the nose of the car to release the clutch, while a helper starts the car.

Take care while doing this, and DON'T LOSE YOUR GRIP! The car may lurch and run you over!

After the engine is running for a minute you should have built up enough pressure to operate the clutch and gears and the car should go into neutral. Other than this, you can only get to neutral by removing the air duct to the radiator and operating the transmission rods manually. It may be that your car is stuck in two gears at the same time, but if you work the clutch fork manually as stated above, you can eliminate the transmission problems.

Starting car with transmission stuck in gear
Brad Nauss, PA (Jan 1995, p.9)

A "new customer-to-be" called about a Citroën he was looking at to purchase. He was hesitant because, whenever the car's starter was engaged, the car would begin to attempt to back up. Curiously, the car's shift lever was now in neutral. Since I heard of this problem before, I asked him if the car was sitting where it would have been backed in. "YES." The car is a Citromatic? "YES." Could the person who parked the car perhaps not have known that you NEVER park a Citromatic transmission car in gear? "YES." When I told him that I thought I knew what the problem was, there was a long silence. "How serious is it, doctor?" was the next question.

The likely scenario was that when the car was parked, it was left with the shift control lever in reverse. This left the transmission gears engaged in reverse. Eventually, the hydraulic pressure reserve dropped off. The transmission could have popped back into neutral, but occasionally mechanical pressure against the drivetrain would prevent this due to the gears being pressed tightly together.

The repair seemed relatively simple, but great caution had to be used. This could be done only with the correct equipment and by someone who fully understood the workings of a Citroën hydraulic system. The hydraulic system had to be re-pressurized, but how?

I chose to remove the belts from the hydraulic pump and made an arrangement to turn the hydraulic pump by hand. Eventually, enough pressure was made to return the transmission to the neutral position. (A sturdy electric drill with a pulley chucked in it has been used successfully. [MB])

I might also have jacked one side of the car off the ground far enough to allow the front wheel is clear the ground or any other object. This would require great caution, because if the suspension were to raise the car, the wheel might contact the ground. Blocking the car off the ground with wood or jack-stands with wood planks under the frame of the car would prevent this. Also, chocking the front and rear wheels on the side still on the ground would make absolutely sure that the car could not move. Nothing could come near the raised wheel.

Only then could the parking brake be released and the engine started and left at a slow idle. Placing the shift lever into neutral position, the raised wheel would continue to rotate. Within a few minutes, the hydraulic pressure would rise sufficiently to move the transmission into neutral.

Fortunately the transmission suffered no damage. I drove the car slowly and cautiously for the first few minutes to assure myself that there were no other problems. I knew that this was usually the case.

Troubleshooting check list
Reprinted from Citroën Factory booklet, "Citroën Hydraulic System-Possible Incidents With Suggested Causes and Remedies"

Submitted by Jerry Seville, PA (Aug. 1985, p.26)

Before attempting any adjustment, make sure that the engagement speeds are correct. The engagement should be set to give:

idling speed at 550 rpm;
clutch drag at 725 rpm +/- 25;
accelerated idling at 900 rpm +/- 25.

For further details of clutch engagement see Booklet F. 141.

INCIDENT	POSSIBLE CAUSES	REMEDIES
17) Clutch engages too fiercely at small throttle openings or when changing gear.	Incorrect setting of initial clutch clearance.	Adjust to 1mm.
	Clutch re-engagement control spring incorrectly adjusted.	Increase spring tension.
	Foreign matter under the large ball valve in reengagement control.	Clean.
	Clutch re-engagement control faulty.	Change re-engagement control.
	Centrifugal regulator (later cars) faulty.	Change.
	Clutch control piston (early cars) sticking in its bore in hydraulic gear selector.	Free off or replace gear selector.
	Clutch thrust race sticking on its guide.	Free off.

	De-clutching piston sticking in its bore.	Free off.
Clutch engages too slowly.	Clutch re-engagement control spring incorrectly adjusted.	Reduce spring tension.
	Centrifugal regulator faulty.	Replace.
	De-clutching piston sticking in its bore.	Free off.
Clutch will not disengage at all.	Clutch disc stuck.	Free off.
	Incorrect setting of clutch free play.	Adjust.
	Clutch disc linings broken.	Fit new clutch disc.
	Clutch toggles incorrectly adjusted or broken.	Adjust or replace.
	Clutch thrust race (throwout bearing) damaged or sticking.	Replace.
	Clutch lock lever in "locked" position.	Release.
	De-clutching piston stuck in its cylinder.	Free off.
	Feed pipe to de-clutching cylinder obstructed.	Clear.
	Clutch re-engagement control obstructed.	Clear.
	Centrifugal regulator faulty.	Change.
	Clutch operating mechanical linkage broken or bent.	Fit new parts.
Clutch drags with engine idling in first gear.	Incorrect adjustment on hydraulic gear selector, on centrifugal regulator or idling speed too high.	Adjust to specified speeds.
	Throttle sticking.	Free off.
	Clutch thrust race sticking or damaged.	Free off or change.
	Low pressure pump output too high.	Change low pressure pump.
	Hydraulic gear selector faulty.	Change.
	Centrifugal regulator faulty.	Change.
Clutch fails to engage at 700-750 rpm.	Excessive initial clutch clearance or incorrect adjustment on hydraulic gear selector or on centrifugal regulator.	Adjust.
	Inadequate output from low pressure pump (early cars).	Change pump.
	Non-return valve defective.	Change.
	Clutch thrust race sticking.	Free.
	Hydraulic gear selector faulty.	Change.
	Centrifugal regulator fault.	Change.
Clutch slipping.	Clutch disc linings worn.	Fit new clutch disc.

	Incorrect clutch free play.	Adjust.
	Clutch pressure plate springs weak.	Replace.
	De-clutching piston sticking in its bore.	Free off.
	Low pressure pump output inadequate.	Change pump.
	Air in low pressure pump circuit.	Bleed.
	Centrifugal regulator faulty.	Change.
	Hydraulic gear selector faulty.	Change.
Clutch judder.	Clutch drag (engagement) speed and/or idling speed and/or accelerated idling speed set incorrectly.	Adjust to specified speeds.
	Engine mountings loose or damaged.	Tighten or change.
	Clutch disc lining contaminated.	Fit new clutch disc.
	Grease or oil on clutch pressure plate and/or flywheel.	Clean off.
	Pressure plate distorted.	True up or replace.
	Clutch toggles set incorrectly.	Re-adjust.
	Hydraulic gear selector faulty.	Change.
	Centrifugal regulator faulty.	Change.
Inability to engage any gear.	Clutch lock lever in "locked" position.	Release.
	Absence of/or insufficient high pressure.	See Incident 1, found in Chapter 18 - Hydraulics, "Troubleshooting."
	Mal-alignment of hydraulic gear selector with mechanical gate.	Align, using special pin.
	Mechanical friction in gear-box cover preventing interlock mechanism from freeing.	Correct.
	Gear change speed regulator obstructed.	Change.
	Internal air lock in hydraulic gear selector.	Operate gear lever in all gears and clutch lock lever until air lock is dispersed.
	Internal pressure leak in hydraulic gear selector.	Change hydraulic gear selector.
	Mechanical selector sticking or jamming.	Correct.
	Obstruction in high pressure pipe.	Clear.
	Gearbox cover piston sticking in its bore.	Free off.
	Selector fork or shaft distorted.	Change.

Crashing gears.	Gear-change speed regulator mal-adjusted.	Adjust.
	Synchromesh gears faulty.	Change.
	Hydraulic gear selector faulty.	Change.
Delay between gears when changing.	Excessive initial clutch free play clearance.	Re-adjust.
	Clutch drag speed set incorrectly.	Re-adjust.
	Clutch re-engagement speed set incorrectly.	Re-adjust.
	Accelerated idling speed set incorrectly.	Rectify.
	Mechanical resistance in clutch mechanism.	Rectify.
	Hydraulic gear selector faulty.	Change.
	Centrifugal regulator faulty.	Change.

For further details, see Citroën Booklet F. 141, "Clutch Engagement and Gear Change." 3 - Brakes, 18 – Hydraulics, 25 – Steering and 27 - Suspension

Chapter 9–Clocks

Clock stopped–fixed with WD-40 spray
Don James, OH (Feb. 1987, p.9)

Q. The clock of my '69 Pallas runs for about two days and then stops, requiring a great deal of manipulation with the set button to get it started again. I do not think this problem is related to the cleanliness of the internal mechanism. This problem has occurred since purchasing the car new in 1969.–Matt Bergeson

A. I drilled a small hole in the side of the clock and sprayed some WD-40 into the mechanism when I had the same problem. (Not recommended. Take apart as in previous article and lube with tiny amounts of correct oil only in on shafts and gears. [MB])

Pendulum clearance adjustment restores operation
Charles Fowler (Apr. 1989, p.10)

I have repaired several D-model clocks using the same method which may be of some aid to other owners. All D-model clocks that I have seen are internally similar.

The clock is press fit into the dash. Use a small sharp screwdriver to pry it out, being careful not to mar the paint. Remove the bare ground wire from the spring clip, the round connector (light), and the flat connector (B+). Cover the workplace with a cloth or paper towel. Lay the clock on its face and carefully uncrimp the two sides and bottom, which will free the glass and faceplate. Use a small pair of needle-nose pliers to remove the set knob from the front. Be sure to grasp the small part near the glass to avoid cracking the knob. Remove the ground post and other tiny securing screw from the back. The clock can now be removed from the case for inspection.

Locate the pendulum and note how it swings to and fro over the copper colored disc which is actually a coil of wire. If the pendulum sticks during its movement, turn the clock upside down and find the bottom part of the pendulum, which is a piece of sheet metal. The idea is to insert a jeweler's screwdriver or small knife and gently pry the sheet metal part of the pendulum away from the copper disc. You must obtain just enough clearance so that it doesn't bind without losing the magnetic attraction. Put several drops of WD40 on the shaft end pivots. I know this drives watch repairmen crazy, but think of all the sperm whales you will be saving.

Reassemble in reverse sequence. When crimping the face bezel back on, use a large screwdriver to press down rather than pliers. Note the tapped hole in the case that allows access to the fast/slow adjustment. You may want to attach the clock to a battery charger for a length of time to check its accuracy.

(WD 40 is not a recommended oil. Use only light oil specifically for the purpose. No, not sperm whale oil. [MB])

Chapter 10–Clutch

Cable pin substitute in an emergency
Paul Fontaine (Jan. 1989, p.19)

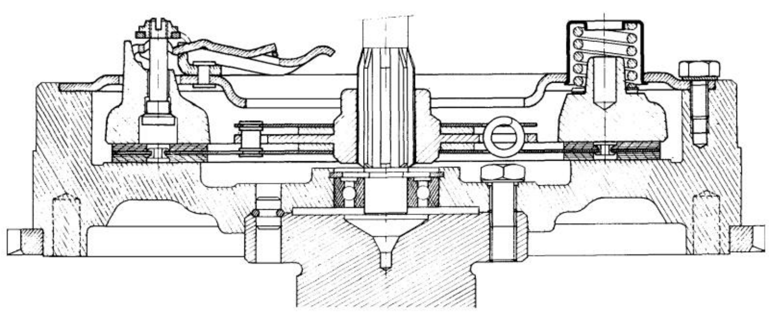
Last summer the clutch on my 21F quit. I knew it was the cable or attachments. So I drove the 12 miles home using the old technique of shifting sans clutch. I found that the pin at the end of the cable had sheared. A "safety clip" for use with farm equipment was a nice fit and pushed it into the toggle. Now, I carry a spare.

Clutch disk centering tool use
(Oct. 1979, p.2)

Anyone planning a clutch job will be needing a clutch centering tool or a cut off, splined drive shaft from an old car to make sure the new clutch assembly is centered before tightening down. J.C. Whitney sells such a metric alignment tool (part # 15-0000T). It contains four different sized adapters, but the 15 mm size is the one needed for D-model Citroens. One could also have a 15 mm adapter machined to use on any American alignment tool. (This tool is not available anymore. Look for KD Tools 2420D clutch aligning tool set. [MB])

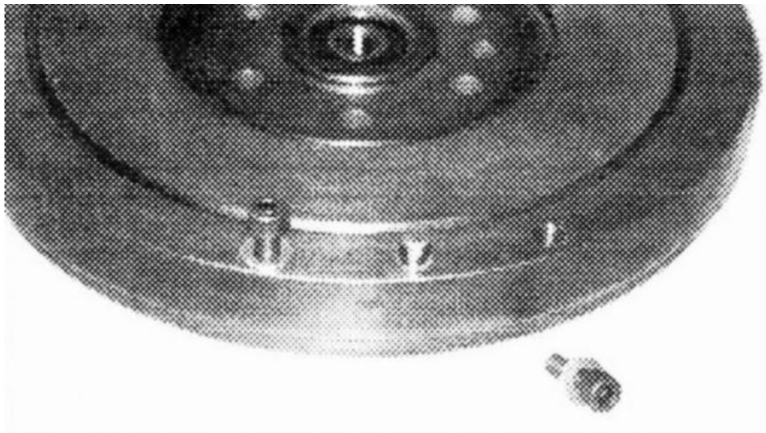
Diaphragm-type pressure plate needs flywheel modifications
Chris Dubuque (2000 #4, p.14)

Replacement pressure plates for the clutch is an item currently difficult to find. Undoubtedly, someone will make a production run of them someday (I hear that the European DS clubs are negotiating with Valeo right now). (All necessary parts are available now. [MB]) But for the mean time, an alternative must be found. This was true earlier with the throw-out bearing and now rebuilt units are available from most of the usual Citroën parts sources.

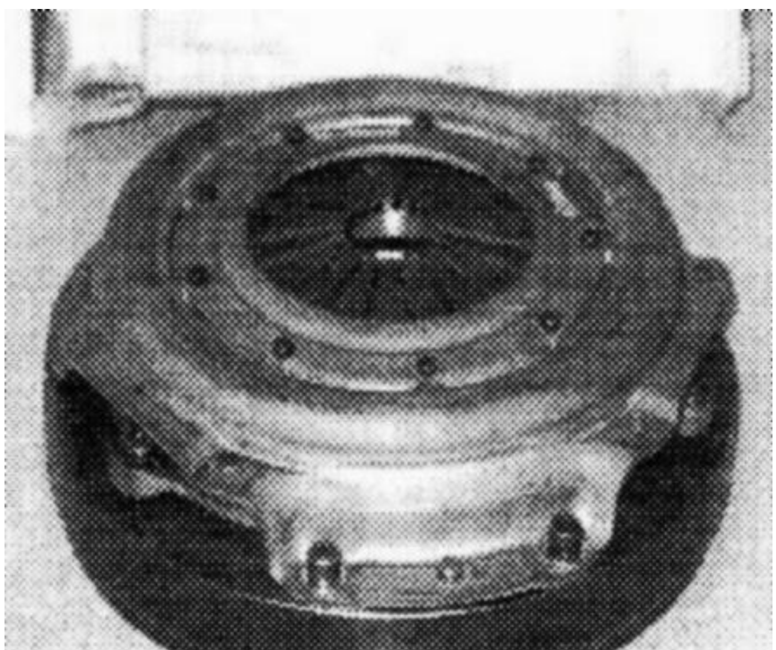


Original finger-type flywheel must have the outer shoulder machined down

A DS owner in our area recently contacted us concerning a slipping clutch on his '71 DS21 wagon. He was faced with the decision of reusing a "used" original-style pressure plate, or performing some sort of a modification (he chose the latter). We just completed a successful clutch conversion on his car, involving a diaphragm-style pressure plate. This much improved pressure plate was used on the very late-model DSs that were equipped with fuel injection. As of this writing, these pressure plates are still available.



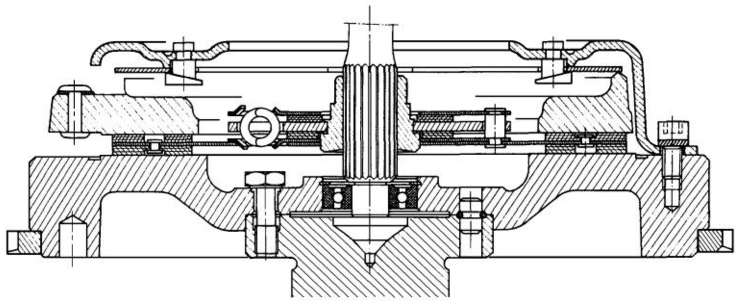
We modified his existing flywheel to accept the newer-style pressure plate. The modifications consisted of machining the flywheel to a near "flat" configuration and drilling/tapping mounting bolt holes for the new pressure plate (see above). This is a very similar modification to the one we recently performed on a Traction Avant (see Citroënthusaist issue 1999-6). (Not included here. [MB]) An alternative to modifying the standard flywheel would be to obtain a DS flywheel designed for the diaphragm-style pressure plate (maybe not be all that easy to find). (Also now available, which then would require the use of a newer starter motor as well. [MB])



Complete assembly

I do not plan to provide a step-by-step procedure since that can be a bit boring to read, but if you plan to make this modification, the following items are important:

1) While the flywheel looks nearly flat after the modification, in reality there should be a small difference in height between the pressure plate mounting surface and the clutch driving face. Here is a good sketch. The friction area is .35mm higher.



2) The throw-out bearing and throw-out bearing clip is different for the diaphragm-style clutch.
3) The stamped sheet metal actuating arm for the throw-out bearing and the bell crank for the clutch cable appears different based on a review of the DS parts book. But we encountered no difficulties using the standard parts.
4) The clutch disk itself is the same as a standard DS21.
5) We have not tried this modification on a car equipped with a Citromatic transmission. However, we are confident enough to try it if one comes along needing a clutch job.

Must remove pressure plate keepers during installation
Ralph Cudworth (Jan. 1986, p.5)

Those doing a clutch job on their car are reminded to remove the "keepers" that hold the pressure plate compressed. They are there to make installing the clutch easier, but must be removed before you install the transmission.

Pivot screw held in place with added wire
Ken Butler, NM (Feb. 1987, p.8)

Any time the radiator is removed on stick-shift D-models, there will access to the following. Remove the pivot bolt and washer from the clutch bell crank (that part that attaches the cable to the clutch operating rod). Drill a small hole, 1/16" through the head of the bolt, from flat-to-flat. After reinstalling the bolt and washer, lace some soft iron wire through the hole and tie it to the inboard clutch spring mount. This will eliminate the possibility of this assembly becoming loose with a resulting loss of clutch action.

Chapter 11–Cooling

Auxiliary electric fan cools overheated radiator
Betsh, Ken (2002 #5, p.10)

While about 400 miles from home attending a club event, I found my D-model temperature gauge almost up to the red portion and staying there. The first time was on the way to the final rendezvous point where I had an hour or so for it to cool down and find it was low on water. For years I've carried a small approved gas container filled with water and this gave me a chance to use it. I never ran out of gasoline since I bought it!

We had to add water about three times on the way home. I found I could cool the radiator to make it fully safe to remove the cap in about five minutes by mechanically closing the relay that operates the auxiliary electric engine fan. This relay has a green slip-on plastic cover and is mounted on the side of the battery hold-down bracket. I removed the cover and used a small wad of paper towels to hold the armature of the relay down. This fan is controlled by a thermostat on the right side of the radiator but apparently the water temperature had not risen to the point of operating. Even if it did come on, the thermostat circuit is wired through the ignition switch so the fan would stop as soon as the engine is stopped. But the relay is directly wired to the battery so my method allowed the fan to run without the engine.

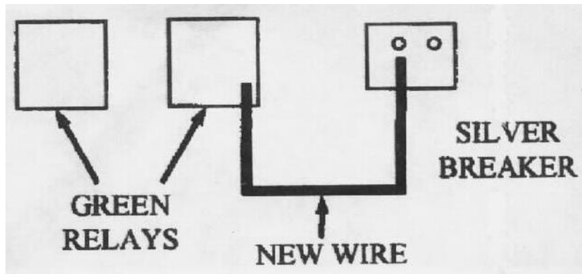
The leak in this case was found to be in the radiator near the top center. A local radiator shop fixed it by closing off the horizontal tube having the leak.

Auxiliary electric fan runs with added switch
Dave Paulin (Dec. 1976, p.4)

Some D-models sold in the northern parts of the country were equipped with the “heavy duty” heating system which usually included an electric cooling fan positioned in front of the main, belt-driven engine fan. The electric fan is supposed to come on when the engine temperature reaches a certain high level and triggers a heat switch on the radiator block. However, that's not always the way they work. Some go on whenever the ignition is turned on, at any temperature. Some don't go on until the engine block is near the melting point. A simple solution is to install a panel toggle switch on or below the dash. The wiring under the hood can be intercepted anywhere along its length.

Now you have control over the electric fan and can switch it on and off at will or as the driving conditions and temperature dictates. (The thermostatic switch is often faulty. Replace with one that comes on at 212 Deg F. [MB]).

Auxiliary electric fan runs without ignition switch
Russ Spears, MD (Apr. 1994, p.13)



Aiding the engine cool down faster after stopping is a good idea. This can be done by rewiring the electrical fan to run with the ignition off until it is shutdown by the thermostatic switch. This is done on other makes of cars.

On our '72 DS21 it turned out to be a simple operation. On the "out" side of the battery carrier are two relays and a circuit breaker. I found by testing that the thermostat switch is connected to the second from front relay at the inside right pole. Remove this wire and replace it with a new one and fasten the other end to the output side of the circuit breaker nearby.

Auxiliary fan switch replaced with water heater thermostat
Don James, OH (Aug. 1985, p.14)

Ever have the temperature switch in your radiator that turns on the fan go bad? They are expensive and hard to get. An ordinary household hot water heater thermostat strapped to the upper hose going into your radiator will work and at a fraction of the cost of the original switch.

Engine block drain of later cars is on right side
Ken Betsh (2000 #6, p.9)

While changing a water pump only requires draining the radiator and not the engine block, sooner or later the need arises to find the plug to remove to drain the block. The shop and parts books don't identify it by name and even the owner's manual supplied with the '72 models leads you astray; it says to look for it by the oil dip-stick. What the owner's manual says is true for the old long-stroke engines in earlier D-models.

Actually, on the post-'66 engines, it's on the right side, between the rear of the starter motor and the rear engine mount support. A 21 mm socket gets it loose.

I admit I don't drain the block and replace the anti-freeze every year. I do drain the radiator every fall and put in a half-gallon of new anti-freeze in each car and fill with water from our reverse-osmosis water filter. Tap water can be bad news in some parts of the country.

Hose between water pump and intake manifold failure
Betsh, Ken (2002 #5, p.10)

Most of the few times I've had a road breakdown from engine overheating and coolant loss has been due to the failure of the short, specially-formed, small diameter hose between the back of the water pump and the intake manifold under the carburetor. The center portion lies very close to the engine block and eventually a leak develops here. For some time prior to failing, it will become very soft. This is a good warning to replace it or at least carry a spare. As a wild guess, I'd say this part has a lifetime of 100K to 150K miles.

Lower radiator hose cut from Gates 20601
Ken Butler, NM (Feb. 1987, p.8)

Replacement for lower radiator hose for '68 to '70 D-models and possibly more: cut a section from Gates #20601 hose.

Overheating due to stuck-closed thermostat
Betsh, Ken (2001 #5, p.10)

When our D-wagon boiled over this past summer while my wife was almost home from a local shopping trip, I started to worry about complex problems and overlooked the simple. All my past failure experiences with thermostats have been that they fail to close when cold. My first check after getting the car home and cooled down was the oil dipstick. While just a small amount of water in the oil will make it look milky, it looked normal. Because a leaky head gasket could cause a loss of water/coolant or the overheating from another cause could warp the aluminum head and cause a compression loss, I did a compression check. This showed no problem. So, I swapped the top radiator hose with a spare having no thermostat and, after filling with water, everything was fine, yet another tribute to the ruggedness of the D model.

After a few weeks without any overheating I decided that the trouble must have just resulted from letting the water level get too low. I refilled the system with new anti-freeze and reinstalled the original top hose with a thermostat. Even before starting a test-ride, the red overheating warning light came on, even though the temperature gauge was just entering the red zone. Now with a different thermostat, all is again well.

I never found any advice as to the desired cold water level in the D-models with the separate expansion tank. I've always just added enough to cover the bottom of the tank when cold.

Overheating eased with thermostat modification
Dave Root, FL (Jun. 1980, p.3)

In very hot weather this is a pretty common problem on a Citroen. It helps if you turn the heater control to 'hot'. Also it helps to remove the valve from the thermostat. (Do not remove the thermostat entirely as the water will circulate too fast to cool properly, thus defeating your purpose.) Sometimes I have had to drain the cooling system and put in fresh, cool water to help it cool down. So in summer, drain the anti-freeze out at home in order to save it since it is not convenient to do so on a trip.

Editor: Never put in straight water–some form of corrosion resistance, such as in anti-freeze, is a must. (antifreeze also raises the boiling point, further protecting the car. [MB])

Radiator can blow hose if pressure rating is too high
Don James, OH (Jan, 1983, p.4)

Problems with cooling, system leaks and hoses may be caused by a replacement radiator pressure cap rated at too high a pressure. Older D-model cars had a 2 pound cap and later models had a 4 pound cap. Hoses are not re-enforced on these cars and can fail easily if run under too much pressure. Tractions are run with no pressure. Remember, if you spring a coolant leak in the radiator, hoses or water pump, you will be able to drive much farther before you add water if you loosen the pressure cap so the system does not develop pressure.

Radiator cleaned with muriatic acid
Don James, OH (Nov. 1982, p.9 & Sep. 1985, p.13)

Modern radiators are not built heavy enough to be rodded out. This is only done on large trucks. A radiator shop will simply use acid to clean your radiator and charge you $20 for it.

1. Remove the radiator and flush it completely with clean water. Antifreeze or oil will stop the cutting action of the acid, so remove all traces.
2. Find suitable way to plug all openings to the radiator. Corks or even a kid's toy balloon will work fine.
3. Fill the radiator carefully with muriatic acid (available at hardware stores for cleaning concrete.) It is very inexpensive. Pour in an entire gallon and top off with warm water. Wear gloves and eye protection. When radiator is full, agitate, but do not cap tightly as the fumes must escape.
4. After 20 or 30 minutes drain the acid and flush completely with water. Mix a small amount of baking soda with water and slosh it through to neutralize any traces of remaining acid. Flush completely again.

Use as much acid as you need for the amount of time you are willing to spend and the degree of rust on the parts. Dilution with water will slow the cutting action of the acid, but will not stop it. Heat will speed the cutting action.

This method works well for small steel parts as well as copper or brass, but do not use acid on any aluminum parts or radiators. Do not attempt to do this without removing the radiator from the car. Be sure to oil any steel parts after they have been neutralized with baking soda.

Please observe precautions found under “Chapter 23–Safety & Health, “Muriatic acid precautions.”

(I would not recommend this anymore. The muriatic acid will ruin any concrete it gets on. The radiators on most of our cars are now too old to withstand this. I used to work in a radiator shop and they actually could be rodded, though when they reach a certain age, they become too frail. A good radiator shop can make a new radiator for you if you supply an old one for the tanks and straps. [MB])

Radiator rubber mounts can be held with silicone adhesive
Don James, OH (Jun. 1988 p.10)

Rubber mounts that go under the radiator can get separated from the metal cups that hold them. For easier installation of the radiator, try a bit of silicone adhesive to glue the rubber to the cup.

Radiator with added tubes stops overheating
Don James, OH (May 1985, p.8)

Many Club members are solving their overheating problems by having their radiators recored with more rows of tubes. This seems like a good idea. It is expensive and will cost about $150-$200 to have this job done. It is probably money well spent if it prevents a ruined engine.

Be sure to check the easy things first. Be sure the air duct going to the radiator is in good shape and attached properly with no broken zippers. Be sure that your pressure cap is only a 4-pound type, and that it is working correctly and holding pressure. You can't hold pressure with a leaking water pump either, so be sure it is in good shape. You must hold pressure on a hot day or steam can form in the head. A blown or leaking head gasket can do the same thing. If the car has ever been overheated badly, suspect the head gasket. They do blow when the aluminum head warps. This goes for SMs too. Check your coolant level often.

Radiator with less tubes used on some D-models
Ken Nelson (Jan. 1984, p.5)

If a radiator has been boiled out and flushed, but over-heating continues, here is the problem and cure. On some 69-70 IDs, D-20s, and D-Specials, Citroen shorted us on the radiator cooling capacity. They cheapened the radiator by using only two rows of tubes instead of the usual three rows. If you have got a persistent serious overheating problem, let enough water out of the radiator to uncover the tube tops and count the rows, front to rear.

Two row units will have an empty shelf at the rear from one side to the other. On a 90 degree day, my '70 D-Special with 80,000 miles would just start boiling at 60 mph, and I'd vapor-lock the carburetor if I slowed down to normal in-town speeds. When I fortunately found an old, uncleaned 3-row radiator through a friend, installing it immediately dropped the temp into the middle of the 'white zone' in 90-degree weather and 60 mph speeds. So, pass the word around; save those old 3-row radiators. There are lots of cars that'll start needing them, because when an engine has 10-14 years on it, the block collects enough crud in it, and the holes in the head gasket close up enough to make the 2-row radiator inadequate.

Seven pound radiator cap replacement
Ken Butler, NM (Feb. 1988, p.9)

Suggested replacement radiator cap for D-models: Stant BR 28, 7 lbs pressure, $2.99 (1988 prices) at Checker Auto.

Water pump bearings replacement
Dave Root, FL (Jun. 1990, p.18)

There are two schools of thought on why D-model water pump bearings fail. (1) Some think that the thrust imposed by the tension of alternator and air conditioner belts causes it. (2) Others feel that the seal leaks enough water into the bearing producing rust and ultimately scale, the particles of which wedge between the balls and the bearing races causing the bearings to seize up. I tend to go more for the latter school of thought since, with my somewhat limited knowledge and experience, I have found failed bearings were always rusted and locked with scale. Further proof of the presence of moisture has been that the soft steel bearing spacers have been blistered with rust scale. Also, I believe the ball bearings used are designed to withstand a lot more thrust than can be imposed by belt tension.

Citroen engineers apparently did not expect their water pump seals to leak, so they prescribed shielded ball bearings in the pumps. These steel shields will not keep out water or small particles of grit. Most people who rebuild pumps replace the ball bearings with sealed bearings. These have soft seals running on the inner race hub on both sides. Some rebuilders remove the inner seals and provide a grease fitting so that the area between the bearings can be pumped full of grease. I could do this but, knowing me, it might be dangerous. Since you can't see the bearings with the pump assembled, it would be easy to pump too much grease in and "blow" the seals. I have elected to go with the sealed bearings leaving both seals in place as I believe these will last at least as long as I will! The seals should keep out any water that might leak by the pump seal, keep small dirt particles out, and keep the grease in.

Of the people who have rebuilt pumps, those who think the bearings are not strong enough bore out the housings and put in an extra bearing; others just go with the same number of sealed bearings. Some tap a hole where a grease fitting can be used, some do not. Opinions differ-all have merit-and the choice is yours if you need a rebuilt pump. Good sources for these are J.B.M. Industries and (Brad Nauss); there maybe others.

If you have the time, inclination, access to an arbor press, and a source for standard metric bearings, you can renew the bearings in the pump yourself. Get sealed bearings in the following sizes:

Rear (rotor end): 32 mm OD x 12 mm ID x 10 mm thick
Front (pulley end): 37 mm OD x 12 mm ID x 12 mm thick

With the mounting surface mounted on the arbor press or blocking, be sure the rotor will clear obstacles when it gets past the mounting surface. It is quite flimsy and can easily be destroyed if an edge catches on something. (I learned this the hard way once.) Since the bearing inside diameter and the pulley bore are both a press fit on the shaft, quite a lot of pressure is required to remove it. After it is out, you will need snap-ring pliers to remove the snap-ring that holds the bearings in place. As the outside diameter of the bearings are a slide fit in the housing, they should come out easily, perhaps with a little urging of a long, thin punch or rod put in from the other end. When putting the shaft in, first put the bearings in the housing, reinstalling the bearing spacer and snap ring. Then push the shaft through the bearings on the press leaving the pulley off. Last, press the pulley on the shaft until its hub touches the bearing.

The following are a few suggestions for removing and installing the pump. I've heard this can be done without removing the radiator, but it's far easier with the radiator out of the way. After removing the hose and nuts from the studs, the top two studs must be removed. This is so you can pull the pump forward a bit so it can be rotated counterclockwise on the axis of the long stud on the left, looking from the front of the car. You then slide the pump forward and off, and you don't have to remove the stud on the left side. The tapping of the holes through the top flange of the head is a typical example of Citroen engineer over-kill. These serve no other purpose other than to make it hard for the poor guy who has to remove them after 20 or so years of corrosion. The threads are not needed because nuts go on the end of those two studs anyway. So, I drill those tapped holes through with a 21/64" drill–the top two only. This makes for much easier installation of those two studs, since they will then slide in from the front or back. A water pump rotor than wiggles or wobbles (with belts not too tight) has developing bearing problems. After returning from a long Rendezvous trip, still with "D-jitters", I tried to wiggle the water pump shaft in my D-model, and it wiggled. So I took the pump out. Then I put in my "trusty" spare pump that I had carried along for the last trip for 4600 miles. It lasted just 10 miles when the bearings seized and the belts squealed. I took the pump off and apart-also the original one that I found to have good bearings after all. It had a slight endplay problem causing the slight wiggle.

Water pump life extended
Rod Burwell (2010 #3, p.28)

A water pump can fail if the drain with its plastic hose gets plugged. Cleaning the drain hole with a drill bit can extend the pump life greatly. Lack of a drain hose can cause premature clutch failure. Without the hose, water getting past the rotating seal within the pump can drip down through the hole for the clutch lever and allow the throw-out bearing to seize. When this happens, there’s additional wear on the fingers on the clutch pressure plate. Once one finger wears off, the clutch no longer disengages.

One way to keep water from getting by the rotating seal within a water pump, resulting in a seized bearing, is to fill the space within the pump with grease by adding a grease fitting on the top of the pump.

Water pump removal without removing radiator
Ken Betsh (2000 #6, p.9)

While all advice for this project says the radiator must be removed, I just again replaced a water pump without removing the radiator. First I removed the four screws holding the fan. Even with auxiliary electric fan, there's enough clearance after unbolting the fan to pass the belts after loosening the alternator.

The pump is held by five studs. The top two screw through the casting behind the pump and are used to fasten brackets. Nuts on back of these two studs must be removed. The other three studs "dead end" into this casting. After removing the five nuts on the front side of these studs holding the water pump, the gasket cement may still hold the pump in place. Striking a wooden block held to the side of the pump eventually will loosen the pump. However, the radiator only allows moving the pump forward less than an inch, not enough to get it off the car.

With the pump slid forward, an untapped area of the upper four studs is exposed and it's easy to reach in with a vice-grips and loosen the studs. With just the bottom stud remaining in place, the old pump comes out with almost no effort. The removed studs are of various lengths, so a note must be made of where each goes.

In mounting the replacement pump, I make sure not be leave any gasket cement on the studs. And of course, I always use a new gasket. Fortunately, they're still available from the Citroën parts sources.

Water pump replacement procedure
Chuck Daley, IL (Jan. 1983, p.9)

REMOVAL

1. Remove the spare tire, radiator cooling air duct and battery (if on the left side)
2. Drain the radiator
3. Loosen the hose clamps on the upper and lower radiator hoses and remove the radiator
4. Remove the fan
5. Remove the alternator and air pump drive belts
6. Remove the nut on the engine drive pulley. A way to remove the nut is to use a 26 mm wrench or a 10" Crescent wrench, block the wrench with a piece of 2 x 4 and use the hand crank to turn over the engine. Slide the drive pulley forward on its shaft
7. Remove the hose from the water pump. Be careful; this hose is a 2" diameter hose and you'll have to get a Citroen replacement if it is not reusable
8. Remove the nuts and brackets from the water pump. Write down what goes where so you can get it back together correctly. Slide the pump forward and off its mounting studs
9. Remove the gasket and clean the mounting surface (now is a good time to replace the hydraulic pump drive belts. You'll never have such easy access to them until the next time you replace the water pump)

INSTALLATION

1. Remove the heater hose from the water pipe between the pump and lower radiator. Remove the water pipe (it passes under the alternator). Clean the corrosion out of the pipe and rubber hose
2. Install the hose on the water pump. Don't tighten the clamp firmly (it's easier to get the hose on now than when the pump is mounted)

3. Make a new gasket and apply gasket cement to both sides of the gasket (New ones are easily procured. I would not use cement. Smear only a thin layer Permatex gasket sealant on each metal surface. Make doubly certain you put it on in the correct direction. It is assymetrical and will surely leak. [MB])

4. Install the water pump on the mounting studs. You'll have to jockey it around a bit with the hose installed, but it should not present any difficulty

5. Install the nuts and brackets on the pump and tighten

6. Hook up the heater hose to the lower water pipe

7. Slide the engine drive pulley back on and use Blue Lock-tite on the nut. Tighten securely

8. Install the drive belts and adjust for proper tension. Don't make them too light

9. Adjust the position of the water pipe going to the lower radiator. Tighten the hose clamp on the water pump

10. Install the radiator, tighten the upper and lower hose clamps

11. Install the battery

12. Fill the radiator

13. Start up the engine and check for leaks

14. Run until hot. Purge air from engine and cooling system. Top off system

15. Install the radiator air-cooling duct and spare tire

Water pump replacement suggestions
Don James, OH (Jan. 1989, p.19)

Never try to install a water pump without removing the radiator. (It can be done as long as the studs come out cleanly. [MB]) Mounting studs can be removed by "double-nutting" or using a jam nut (see following article) to unscrew them. Be sure the old gasket is removed completely and the surface is clean and flat.

Use a very small amount of silicone sealant on the gasket to hold it in place. Tighten nuts as evenly as possible in gradual steps so pump pulls down evenly to prevent cracked castings. Do not over-tighten the belts. Be sure all belts are used and that they are a "matched set". Use no more tension than is needed to prevent slipping.

For a long pump life, be sure the drain tube is kept open to allow the shaft seal to drain. Never operate the car with the drain hose off, as water and coolant will make the belts slip and rust the clutch mechanism. The shaft seal will last a very long time if proper coolant mix is maintained. Never run the pump dry or on plain water.

Water pump studs removed with double nuts
Don James, OH (Feb. 1988, p.9)

Removal of studs such as those used to mount the water pump is easy if they are "double-nutted". This simply means that two nuts are placed on the same stud and then tightened against each other. This puts a "jam" on the nuts, and using one wrench to turn either one of them will remove it.

Chapter 12–Driveshafts

Boot replacement for triangular-shaped hubs ('71-'72)
Chris Dubuque, WA (Jun. 1994, p.14)

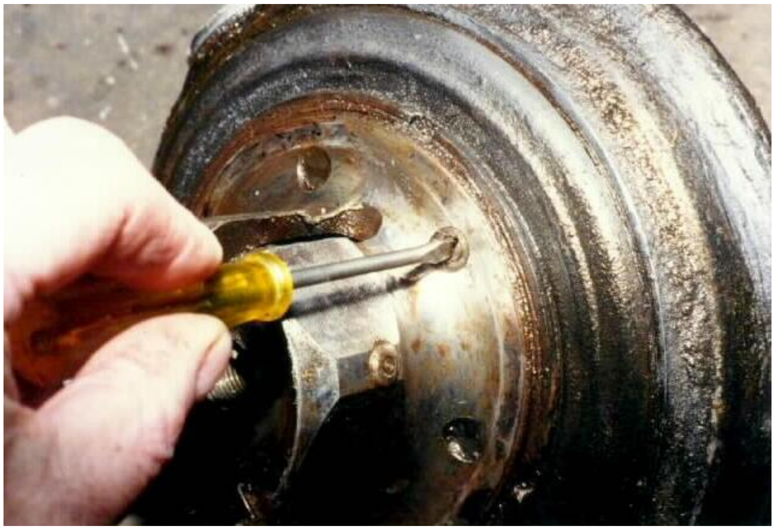
The rubber inner U-joint boot on late D-models (and SMs), no longer available from Citroën, fits on an unusually shaped triangular steel tri-axe universal joint. Due to the unusual shape, it is probably impossible to find a boot from another car that fits adequately. J.B.M. Industries has reproduced the boot which was originally sold under part number 5409965. I have tried the J.B.M. boot, and although it is not shaped exactly like the original, it fits every bit as well. When using either the original Citroën boot or the J.B.M. boot, it works best to use a narrow metal clamp such as the original Ligarex strap. Ligarex strap and the Ligarex installation tool are available through several of the usual parts outlets in the U.S. Nylon wire ties will only work if they are extremely heavy duty and are installed very tightly.

Boot replacement procedure, pre-'65 type
Don James, OH (Apr. 1992, p.14)

D-model drive shafts are very dependable and seldom give any trouble, but older D-models–the ones with the first type of drive shaft–can have wear on the inboard universals, while the outer joints are usually in perfect shape. The average enthusiast will not want to get involved with solving these problems, so this is more for casual information.

The drive shaft is held to the wheel bearing by a very elaborate and expensive bit of machine work. A large ring that requires an incredibly thin spanner wrench clamps the driveshaft flange with the round driving "dogs" or pins in engagement with the expanding collet arrangement that is used to retain the road wheel with one simple bolt. The large ring is threaded to the inside of the wheel bearing carrier and prevented from rotating by the use of a staked set screw.


Carefully grind away staked metal to expose the setscrew


Removing the set screw

Only the very old cars used a metal retainer on the outer driveshaft boots. This retainer is used because the boots are split beneath this retainer, with the metal covering the "crack". The split was needed to get the boots over the inboard universal. New replacement boots will stretch enough to expand over the universal if it is disassembled. The metal plates are replaced using small rivets.


Grind the metal boot retaining plate to remove it. Replace using small rivets

The driveshaft universals are of conventional design, but the bearing caps are held in place without a snap-ring. A groove that is machined inside the bore and around the outside of the bearing cap is injected with plastic through a communicating hole in the forging body. Fortunately the plastic will melt at a very low temperature if heated and will drip out like candle wax. A sharp rap sideways will knock the cap out. Special drive shaft universal presses are also available that will use force to shear the plastic, also.

Heat softens internal plastic retainer ring

As is evident here, the universals can be very worn, giving considerable play to the drive shafts. The inboard universals will frequently be found to have torn boots, and having no method for frequent greasing, causing extreme wear if left unattended.

When the bearing caps are removed, many small needle bearings will come out. They need to be cleaned and repacked with grease.

Heat melts out plastic retainer

Warning; grease holds needles but prevents the Locktite from holding the caps.

A good bearing cap can be cleaned and polished. New seals here were machined from solid Teflon bar stock. These seals also serve as spacers. The tricky part is packing the needles with grease to retain them while keeping the outside of the bearing cap clean and grease free. Retain the bearing cap with Locktite, and be sure to use primer.

Split boots are available for the old model drive shafts: they save time and are easy to install if you keep everything clean. Nylon ties hold the boot temporarily while the glue sets. Spray the boot with black vinyl paint if you want a black appearance.

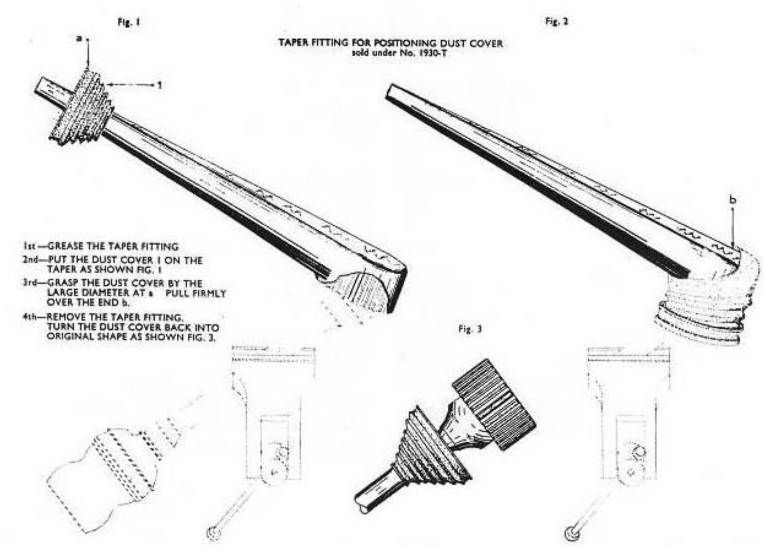
Boot replacement procedure, pre-’65 type
Chris Dubuque (Jan. 1998, p.8)

Recently I had the need to repair/rebuild a set of drive shafts from a '57 DS19 I am restoring. I remembered an old newsletter article concerning rebuilding DS19 driveshafts in one of the Club newsletters. I looked through my newsletter library and sure enough, in the 1992 No. 4 issue (previous article), I found an excellent article by Don James. He discussed a method to disassemble the U-joints using heat (from a torch) to melt the plastic (or glue?) the factory used to assemble the U-joints. I am glad to report that his method worked exactly as advertised. Disassembly per Don's instructions allowed the U-joints to be inspected and re-greased.

One thing that perplexed me quite a bit was how to install the inner driveshaft boots. The rubber boot has a hole in it that is about one inch in diameter–but the boot must be stretched over the inner U-joint, which is about 4-1/2 inches in diameter! In Don James' article, he discussed using "split" boots to replace the original as an alternative to having to stretch the boots. I have never liked split boots much, since they tend to separate and sling grease about the engine compartment. I decided to attempt to use original boots if I could figure out a way to install them.

In the DS19 repair manual, there is a ridiculous looking tool consisting of a tapered cone that is used to gradually stretch the boot up to the proper diameter (see the illustration from the original manual). I couldn't imagine that this would ever work–surely the boot would split. To make matters worse, any original DS 19 boot has probably been sitting on a shelf for 30 years! If nothing else, wouldn't the age of the rubber surely guarantee that the boot would rip before being stretched so severely?

Anyway, I thought I would give it a try since I had several new original boots (P/N D37288). I searched a bit to find something that I could modify into the shape of a cone similar to the Citroën tool (1930-T) shown below. Eventually, I found the perfect item–a 4-1/2 inch diameter wine bottle!



Using 2 inch wide packaging tape, I taped the bottle onto the end of the splines, taking care to wrap numerous turns of tape around the splines themselves so their sharp edges wouldn't cut the rubber boot. Using a slurry of WD 40 and engine oil, I discovered that if I turned the boot inside-out, it could be slid down the neck of the bottle without too much effort. Much to my surprise, the boot slid right over the splines and onto the axle! The next two pictures show the boot as it is being slid over the bottle the boot installed. I must admit, I never thought it would have worked!

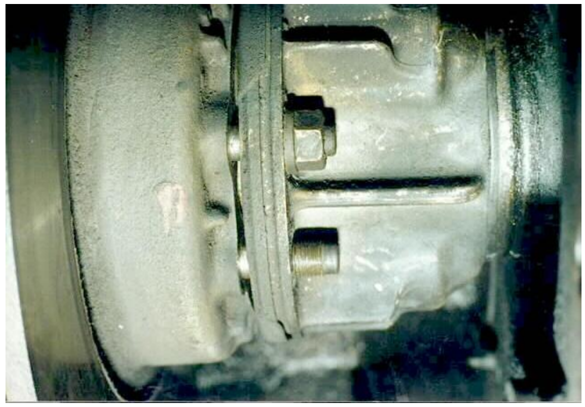
Electrical tape holds wine bottle, covers splines

Boot replacement procedure, round-hub type ('66-70)
Don James, OH (Jun. 1988, p.8-amended)

As the rubber of the boots on the inboard universal joints of the driveshafts gets older and cold or hot weather takes its toll, cracks and tears develop which allow dirt and water to enter the joint. The inboard joints are protected by their location so a small crack is not cause for you to postpone a trip, but repair of the boot should be made at the first opportunity. If grit or water get into the joint, they will rapidly wear the joint and cause failure. This article covers the replacement of this boot on D-models from the start of the shorter-stroke, five-main-bearing engine ('65DS/'66ID) until a change to a steel hub using a larger triangular-shaped boot (in or about the '70 model year). The two types may have been used interchangeably on cars sent to the USA. It is important to inspect these boots and determine which type you have. Both the boots and the replacement procedure are different. The later type, with a triangular-shaped boot, allows the triaxe to be disassembled by simply loosening the boot. The round-type (aluminum) requires use of a strong wheel, gear or bearing puller.

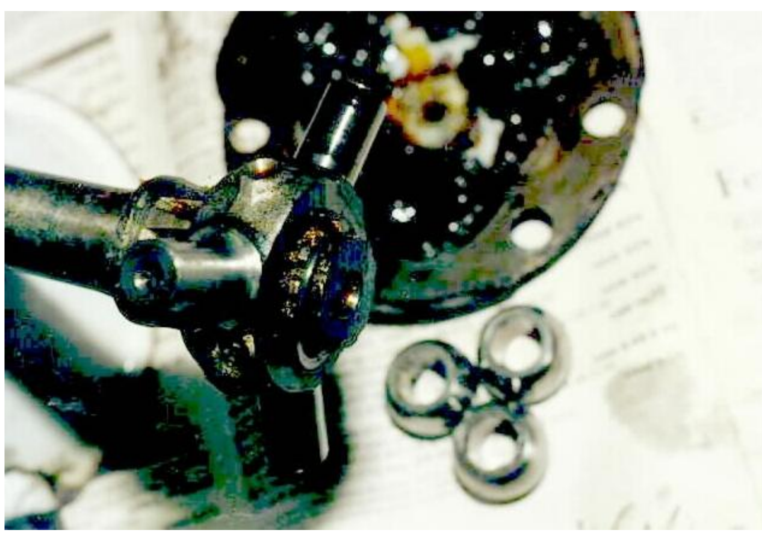
As at the start of most projects on the car, the area that is to be worked on should be cleaned first with engine degreaser at the coin-operated wash to remove grit and grime. It is recommended that the radiator and front fender(s) be removed first. The car must be supported at the front on jack stands with the wheels removed.

Six nuts with washers retain the casting of the inboard joint to the brake disc. Several long 1/2" drive extensions can be driven with a breaker bar if they are fed through the hole in the frame where the driveshaft passes through.


Side view of rotor and traixe show nuts and washers to be removed

The driveshaft is then pulled back from the brake disc after removal of the small flathead screws exposed on the face of the wheel bearing assembly when the wheel is removed. The hub is too large to clear the opening in the wheel bearing. Work on the driveshaft continues with it hanging from the wheel bearing. Removal of the tie-rod may help but shouldn't be necessary as long as the steering wheel can be turned. Use a brush to clean the housing casting and boot in a pan of solvent. (You will need a strong three-jaw puller later. If you cannot source one, you will have to take the shaft to a machine shop for disassembly. To completely remove the shaft from the car for work to continue at another location, the upper and lower ball joints and tie rod must be released from the steering hub and the entire assembly transported. [MB])

The end cover is pried off in a clean area. Remove old lubricant. Loosen the clamps that hold the old boot and slide the housing and old boot down the shaft so that the balls and triaxe can be removed.


Balls removed. Snap ring visible

A snap ring on the end of the splined shaft locates the triaxe on the splines of the shaft, but you will discover that the triaxe will be stuck fast. It is removed from the shaft using a good strong wheel or gear puller. A typical gear puller is not strong enough to pull it from the spline, as it is a shrink fit. Look for fine threads and a heavy-built puller. A bearing puller is ideal if you can get one. Warming the triaxe with a propane torch can help with removal. Do not overheat or you will damage the hardness of the metal. Once the triaxe is off, the housing can be slid off and the entire shaft brought out through the hole in the steering hub.

Clean all parts carefully and keep from grit and dust, blowing off all parts with air just before assembly. If you notice wear in the steel raceways inside the housing, you should switch the housings from right to left side. Direction of rotation is reversed, exposing a new wear surface. Check for wear by feeling for a "groove" in the center of the raceway.

Parts ready. Small puller, lower left was not used. Heavy puller partially visible, right.

Now is the time to install a new outer CV joint rubber protection cup and clamp if needed. You will not be able to do it later without repeating this entire procedure. Carefully reinsert the shaft through the steering hub in the correct direction. Parts must be installed in proper direction and order, starting with the housing. The new boot then can be slid over the splines, outer clamp first. The aluminum housing is then slid on, making certain of the orientation.

Lube the rubber and will stretch smoothly on. Slide it way down the shaft then put the housing onto the shaft, making certain proper orientation.

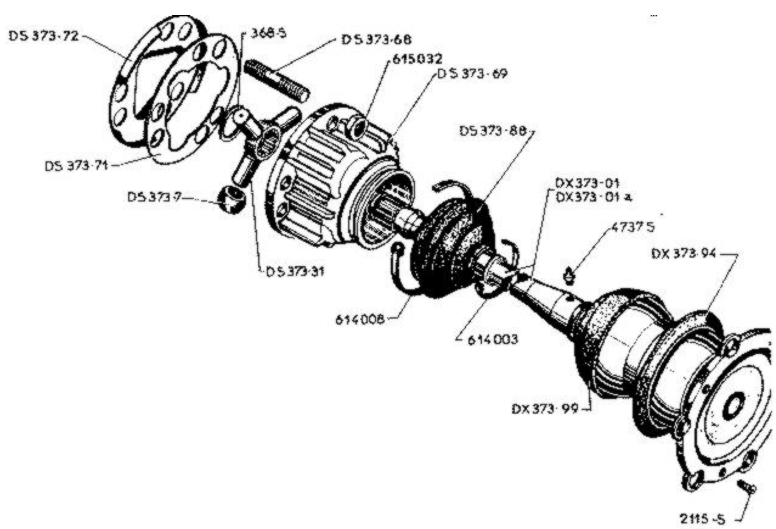
Triaxe being refitted

Fit the triaxe in the original direction. Heating it with a propane torch will probably make it drop right on, but have tools ready to tap it home if it is a bit tight. Do not heat it too much! Heat it only until it begins to change color. Turning it blue is too hot.

Once completely cooled, replace the snap ring, oil the bearings and three balls and install them. Slip the housing up to engage the triaxe balls into the steel raceways. Replace the endcover and hold temporarily with a few hand tightened short bolts and nuts. Fill the joint with special CV joint grease. DO NOT USE WHEEL BEARING GREASE as it is too thick and will not flow in cold weather.

Slide the boot to its proper location on the groove and fasten with CV boot clamps of proper size. Take care that the new boot does not chafe on anything when installed.

Boot replacement procedure, round-hub type ('66-70)
Ken Betsh, PA (May 1994, p.12)



As soon as I recently removed the front left fender of my '71DS for some rust control and prevention work I noted a huge amount of grease on the frame around the inner end of the left driveshaft. This was quickly traced to a break in the boot covering the tri-axial universal joint. While this car originally had the type of driveshaft using a triangular shaped boot, I had replaced the axle, wheel bearing and ball-joint assembly with that from my stripped '70 wagon a few years ago in the process of isolating a vibration problem. I never reinstalled the original assembly even after finding play in the right side tri-axe to be the problem.

PART 1-Genuine Citroën round-type replacement boots were no longer available. One point of this article is to describe the ease with which a U.S. made replacement part sold by Brad Nauss Automotive can be installed. While the dimension of the large end of the replacement boot was exactly right, the small shaft end was slightly undersized and required extra stretching to install.

The first step was to free the axle once the wheel was removed (my job was done with the fender removed for another reason–but this may not have been necessary). The inner end was held by 6 nuts, requiring a 17 mm socket to loosen. These nuts were extremely tight and a 6-point socket (as opposed to the standard 12-point type) was used to get them loose. Two small screws held the outer end in place until the 5 wheel lug nuts were installed. While this allowed me to pull the shaft away from the car several inches, the triaxe housing (#DS373-69) was too large to clear the opening in the wheel bearing assembly. It helped to turn the steering wheel to one extreme. My original steel inner housings were smaller, so they had slid completely free, making them easier to work with.

The next step was to pry off the sheet metal covering over the end of the housing (#DS373-72) and to loosen the clamps on the old boot. This allowed me to slide the housing up the shaft to expose the triaxe (#DS373-31). I noted that contact between the triaxe and the housing was via three bushings (#DS373-7) that were able to slide in the shafts of the triaxe. I used the axle grease fitting position and the numbers marked on the triaxe and the housing to keep track of relative positions so that I could reinstall everything in the same relative position. I made a sketch to help me remember and assigned shaft numbers so the three bushings, which readily slid off the ends of the shafts, could be returned to their original places. I doubted if this mattered but I didn't care to give myself something to wonder about in the future.

The triaxe was pressed onto a spline on the end of the driveshaft and did not readily come off even after removing the circle clip (#368S). I found a 3-lever steering wheel puller I bought a couple of years ago for $10 at Carlisle did a nice job in getting it off. (See previous article. [MB]) Now the housing and remains of the old boot could be removed. At this point I noticed the outer boot was about to fail and decided to replace it as well. The available replacement part for it was an exact fit. It went on easily once the grease fitting (#4737S) was temporarily removed.

Getting the new inner boot on took some effort (which Brad had alerted me). I greased the inside of small end and used a small screwdriver to aid in stretching it over the end of the shaft. The blade of this screwdriver fitted inside the grooves of the spline and helped in working the boot over this area. One push after that got it up to where it would be clamped. I delayed attaching clamps until everything else was back in place.

I was careful to slide the tri-axe housing in the correct direction over the shaft before reattaching the triaxe. I used a hammer and a 1-3/8" socket as a collar over the end of the shaft to drive the triaxe back on the spline to the point where the circle clip could be refitted. The three bushings were then replaced on the axles of the tri-axe and the housing were pulled up to its proper place. I had a lifetime supply of grease gun cartridges and used the contents of one to repack the tri-axe housing. (Use CV joint grease, not bearing grease. [MB]) I used the same type of clamps used by Citroën.

Brad sold me a new length of clamp strap for the large end of the boot (the removed piece wasn't long enough to tighten back in its original place). The old piece was obviously long enough for clamping both the shaft end and the outer boot.

PART 2-You can't imagine my chagrin some three weeks and 700 miles later to find it happened all over again. There was no doubt that the new grease on the frame was what I had used inside the boot. This time the break started under the clamp at the small end and ran lengthwise for about one inch.

Why did it fail? (1) Did the clamp cut it? (2) Was it damaged by the stretching of the small end to mount it? (3) Did the large amount of grease I put inside the boot cause excessive pressure at the small end when the triaxe slid to its most-outward position (which happens during a sharp turn and/or when the suspension was in a all-the-way up or down position). My guess was that the excessive grease was the reason.

This new problem was discovered on a Friday when it was too late to reach Brad to send another boot. This caused me to do what I should have done the first time. In searching my basement crawl space area full of old Citroën parts I found a right side driveshaft using the round boot and this boot seemed soft and pliable–not relatively hard like the one that originally failed. Then I remembered that this was from the '70 wagon (the one on my car on the right side came from my old '67 ID) and, yes, the boot had been replaced with a Citroën part at sometime during the ten years we drove the car. I didn't use it on my DS because the wheel bearing had become noisy. All I had to do was remove the boot from this right side driveshaft and install it on the left side driveshaft on my DS. In the process, I found it was in excellent condition and carefully noted how much grease was packed within it. After installing it, I only added an amount equal to what I lost in the transfer.

My next trip of 1500 miles with went off with no further problems.

Before writing this story, I talked with Brad to get his advice. He knew from experience that over packing the boot will cause pressure that will crack the boot. He quoted from repair manual #583: "Spread 200 g (7 oz) bearing grease on ball joints and triaxe–300 g (10.5 oz) on vehicles after 6/71."

I was then sure that the 7 oz. recommendation for the type of driveshaft I had was far less than the amount I used. Incidentally, the same manual specified 61-79 ft lbs on tightening the six nuts holding this type of driveshaft to the brake disc and transmission.

Life extended by swapping inner universal joints
Allison H. Grayson, ID (Jan. 1986, p.5)

Worn inboard universal joint races can get double life by switching them right for left and vice-versa. The direction of rotation is reversed. Watch for loose transmission shaft extensions or stub axles. These things can come loose from the housing!

Editor: Always use special CV joint grease--never use chassis grease.

Loose bolts cause damage
John Yosuke Otsubo, CA (Aug. 1987, p.18)

Make sure that the six bolts on each inboard universal joint housing are tight. Do this to avoid what happened to my '74 DS23 fully automatic.

1. Raise the front of the car and remove both front wheels
2. Use a 1/2" drive socket set with extensions and tighten the six bolts firmly by working through the opening in the frame through which the driveshaft passes. Use Locktite (available at auto parts stores) to secure
3. Inspect to make sure there is enough grease on the driveshaft universal. Use special CV joint grease; it is a free flowing grease

Here is the broken brake disk, damaged driveshaft end-plate and pieces from the considerably damaged transmission housing. I was very lucky that this happened to me on the street and not while I was on the freeway.

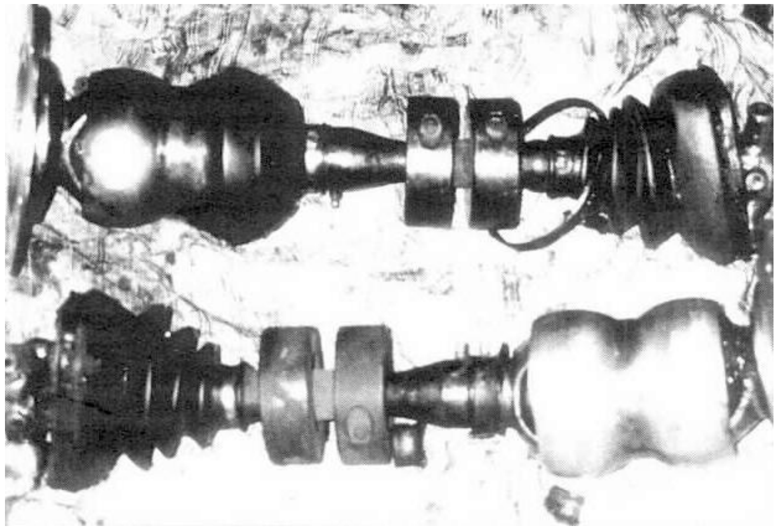
Editor: What first appear as bolts are removable studs with nuts. Problems develop when either the nuts alone or studs with nuts loosen. The factory manual calls for a tightening torque of 75-

100 ft-lbs for the steel tri-shaped housings and 85-110 ft-lbs for the earlier round aluminum type–meaning a lot of muscle. (Not hard if you use a 1/2’ drive impact gun. [MB])

Replacing outer dust covers
Hagino, Takashi (2001#1, p.11)

Recently I found the outer dust covers (both sides) on my axle shafts were completely destroyed, but I couldn't find out why they were damaged (above). From the parts book, "Models D, 1972 No. 611 Part 1", there were two types of dust covers - made of rubber and polyurethane. My DS23 Pallas is a '74 model so it had the polyurethane type. This was known also from the rest of the fragments; thicker and harder than that of rubber. It is my hobby to do work on my DS and I am always gaining more knowledge from it.

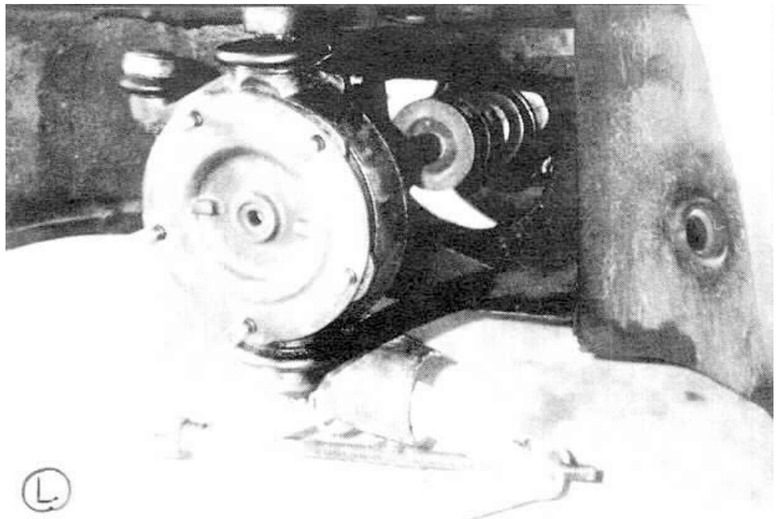
We can find in the Brooklands book, "Citroën DS & ID 1955-1975" that the "rubber boots help seal out dirt. Citroën makes replacement ones that zip up along one side and can be replaced in a few moments... " All right, I would try it.


Pair of axle shafts from Peter Wells

Fortunately, I had one pair of used drive shafts with hub bearing and tri-axe units from Mr. Peter Wells in the U.K. from when I had imported a used gearbox from him several years ago. My thanks to him, he shipped them in the same box as the gearbox. It was not easy to handle because of the weight. There was also plenty of old grease that needed many rags and old clothes!

For a long time I thought that the inside of the front wheels were ordinarily dirty by the splashed grease from the universal joints. But I found it is not usual that joint grease splashed so much. Choose a good grease -quality and quantity-for example, a moly grease. Multi-use grease is not suitable and using too much gives a worse result. Refitting the inner seal inside of wheels kept it clean after a long drive. (This extra grease was likely from frequent over-greasing if the shaft zerk fitting. [MB])

The car was jacked up at the four corners, then I released the suspension oil pressure. I always do this in my garage for saving the spheres and stoppers. I then took the tires off with the help of a garage jack to the lower suspension arms. I remove the collar band from the inner dust boot and freed the driveshaft from the tri-axe housing.



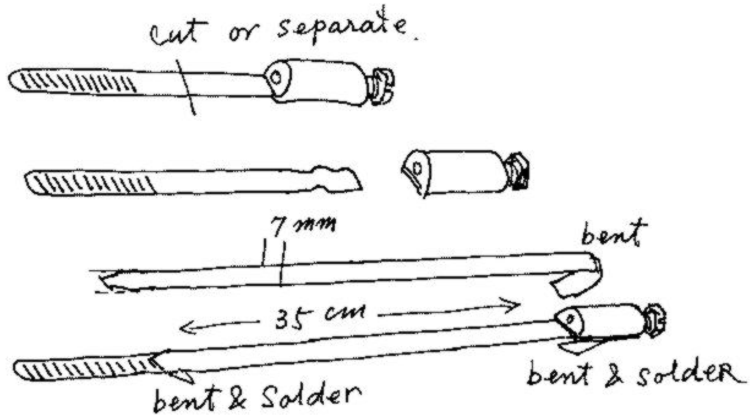
Removing the two retaining screws on the flange, I then withdrew the driveshaft through the pivot's big hole (see above). (Note that this is not possible on earlier cars with aluminum inner housings. [MB]) You must take off the balls from the tri-axe because this tri-axe could not clear so easily. To be drawn out from the hub bearing hole, the shaft needed to be inclined maximally. My biggest finding was that there was no inner seal!

I had withdrawn four drive-shafts from the big heavy pivots, but only one inner seal was found. I wonder what has happened in the world. Of course, my DS had none! Certainly the most difficult work was how to insert the inner seal to the inner groove of the pivot (see below).

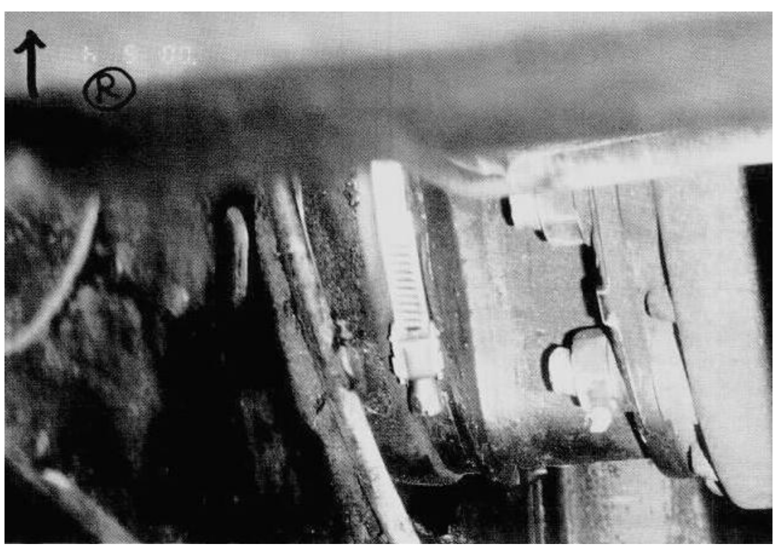
This inner seal may be made of urethane and has many teeth for keeping the grease in the yoke when you steer. The inside is thinner than the outside. Inserting time must be the last work of refitting the driveshaft into the big pivot's hole.

Before completely refitting the shaft, one inch before from the space between the pivot and outer double yoke, insert the seal to the groove by pushing with your fingers. Then slowly and carefully pressing the flange by using the wheel nuts equally to screw, careful not to push out any part of the seal, completely refitting the seal to the groove.

By steering the wheel joint to ensure the seal was perfect, there was not any grease leakage on the surface of the outer yoke. The two retaining screws were then refitted on the flange.



When you want to do easy and perfect work to band the inner dust boot to the tri-axe unit, make a special big-sized collar band using 7mm wide stainless steel sheet about 35cm long, and one large conventional hose screw band as shown in the picture above. Having a large diameter screwed band makes it possible to firmly fix the triangular type boot to the housing. And it is easily applied and can be used forever.



Axle shaft installed with extended hose clamp retaining the inner boot

Studs through brake disks longer for older round-hub driveshafts
Ken Betsh, PA (May 1994, p.11)

The flange of the driveshaft that fits over the studs attached to the transmission is thicker for the older style driveshaft (the one using round boots). The studs used with the older (aluminum [MB]) style are, according to the parts book, 60 mm long (#DS373-68) vs. 51 mm (#DX373-268A) for the newer style. I now know that when I replaced a newer type driveshaft (the kind that use triangular-shaped boots) with an older type, I should have changed the studs.

I had wondered why the nuts became fully tight without many turns and the end of the studs did not protrude through the nuts when they were tightened. I drove the car for many years that way and none ever came loose.

Vibration stops after lubricating CV joint with bad boot
Russ Spears, MD (Feb. 1994, p.14)

On the second day of a trip from Maryland to Florida, my DS started to pick up vibrations like an American car going over expansion joints. It got progressively worse until driving over 35-40 MPH was rightly impossible. Being a Sunday, no garages were open. Checking for obvious broken or loose parts, none were found. The next morning the car was fine, drove perfectly. It was put on the lift, inspected, and nothing was found that could cause such a problem. I had no more problem until about 50 miles from our Florida destination, when that damn vibration started once again.

As luck has it, we were located less than 50 miles from Ralph Cudworth's Cituations. I called Ralph and talked about the problem. He said, "Bring the Cit down after the Holiday." Friday morning I reluctantly started the car and headed for Cituations. As before, the car ran beautifully down to the garage and back. While there, Ralph checked the car and found nothing wrong or broken. After a test drive he said the Citroën rode and shifted very well and, “if it's not broken you can't fix it."

All was fine heading home until we reached North Carolina. The vibrations came again and we had to take a slow detour to Raleigh where Bill Hargrove runs the Import Car Center. At last, the Citroën was checked and inspected while the vibrations were occurring. It was found that the right inner CV joint had been running out of lube as the boot was damaged with age. When hot the joint was catching at each revolution. The boot was repacked and the DS had a temporary fix.

After returning home I repacked the CV joints and replaced all four front axle boots. During servicing I have always looked for tears and lube drips, but being that the tears were so minute, nothing was visible. The cracks were apparent only if you pushed the boot with your fingers.

It's not so big a job to remove the front axles. The unit can be pulled out through the hub without removing the tri-axe if you have the newer triangle (steel [MB]) type set up. Watch for the ring seal that is inside the hub. It can be pulled loose. After removing the circlip the tri-axe can be pulled off with a three-jaw puller, not without some difficult and exerting effort. If you want to reverse the drive unit housings to equalize wear, be sure to loosen the nuts while the wheels are still on the ground.

Chapter 13–Electrical

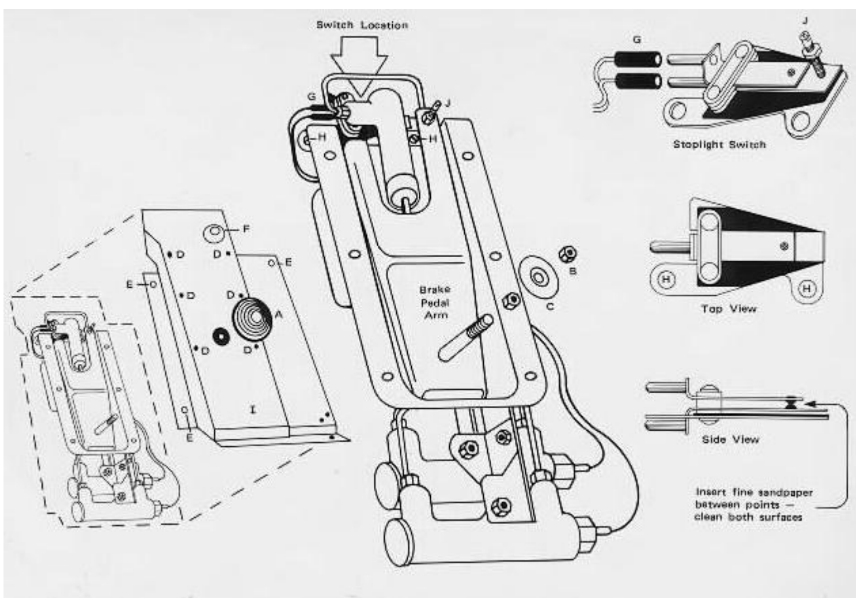
Backup lights alternative replacement
Ken Butler, NM (May 1989, p.18)

Backup lights from Checker Auto, sold as Stratolite #105, will replace the original British units.

Brake lights added to sedan rear turn lights
Vic Hedl, OH (Mar. 1984, p.5)

Replacement of the turn signal bulbs and sockets on the rear of my DS with a pair of dual-filament bulbs and sockets from the tail-lights of a parts car gives me an extra set of brake lights. I ran an extra wire down behind the back seat and spliced into the rear brake light wire. This is an easy modification that should make the car more noticeable and less likely to get "rear ended".

Brake light switch repair and replacement
Ken Hiner (Jan. 1986, p.28)



DS brake control showing stop-light switch details

After 14 years and 206,000 miles, the stop light switch in my DS21 had enough crud on the points, that the brake lights suddenly did not work at all. Adjusting the screw (Item J in Fig. 91) all the way out did allow the brake lights to come on dimly, but they flickered, indicating a bad connection somewhere.

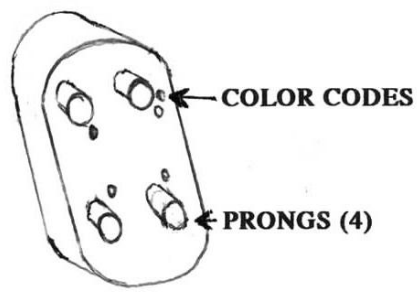
To gain access to the stop light switch for adjustment or cleaning, remove the rubber brake button (A) –it's a pressure fit and simply pulls off of its washer shaped mount (C). Next, remove the nut (B) and washer (C). Remove the piece of carpet glued to the brake assembly cover.

Once the carpet is out, the 6 bolts at (D) can be removed. Next, remove the slightly larger bolts at (E). After the two bolts holding the gas pedal mount are removed, the cover can be lifted out.

The stop light switch can be adjusted through the access hole (F) without removing the cover (I), however, in order to clean the points, the cover must be removed, then slip a folded piece of fine sandpaper between them (see side view of switch illustration). First, however to avoid any electrical pyrotechnics, disconnect both wire pull-off connectors at (G) which supply current to the switch.

If you want to remove the switch from the car, loosen and remove the two screws at (H). Since they're in a very cramped location, take some extra caution and partially loosen both screws, then wrap a piece of thin wire around each screw shaft just below the head. The screws can then be removed or replaced by holding the wire in one hand and using the screwdriver with the other.

Color codes are those of tips, not wire insulation
Don James, OH (May 1986, p.14)



Ignition switch (pre '70) prong color codes

Q. While removing the choke wire behind the dashboard of my '67 DS19A, the wires fell off the four prongs on the back of the ignition switch. When I put them back where I thought they might go, the car did not start up correctly. Could you tell me what goes where? There are also additional wires that are loose. This is the list of the additional wires: (1) one green wire with a maroon tip, (2) two green wires with a red tip and (3) two green wires with a red tip. Do you go by the color of the wire or the color of the tip?

Robert Perez

A. The drawing that you show of the back of the ignition switch (above) is the key to your problem. The paint dots on the back of the switch should match the color of the "tip" of the wire. Wires are only color coded so that the bands on the tip are marked. The color of the insulation on the wire means nothing. Colors of the bands on the tips of the wires can fade and change slightly with age, and also there may be a few places on the car where color match is not exact, but close.

It is impossible to tell you exactly which wire goes where if all of the wires in your dash are loose because every year and model of car seems to use a different layout. But they are all similar in the way they are used and should be in groups from the harness. You may need to use a circuit tester to find where each wire is connected.

Loose wires and wires that fall off all of the time are a frequent problem with these cars because of their age. The problem is easily corrected by slipping windshield washer or vacuum tubing on the connector to restore the tension.

Color codes protected with clear shrinkable tubing
Tom Freund, CA (Sep. 1986, p.12)

Coding of electrical connectors and wires can be a problem because most pressure sensitive tapes cannot take the engine compartment temperatures (especially the 2CV6) and unravel. My solution is clear shrinkable tubing either over paper with ink-written coding or over colored vinyl pressure-sensitive tape. Alfa FIT-221 polyolefin tubing in 1/8" and 3/8" initial diameters will cover most needs. It shrinks to half of its original diameter on heating (cigarette lighter) and is resistant to gasoline, grease and water. It will not support combustion and has an operating temperature of 275 Deg F. Incidentally, the initial diameter can be stretched by 15% or so without damage to the shrink property.

Connectors that fail can be cleaned and reused
Tom Freund, CA (Sep. 1986 p.12)

Strands of wire in or near the crimp of the electrical connectors will suffer appreciable corrosion over the years, resulting in high resistance. I cut off the connectors, uncurl the end ears, clean in acid (Lysol toilet bowl cleaner is excellent) with an old tooth brush, rinse with water, wrap the ears over bare wire ends and solder after putting on a label with its shrink tubing. Windshield washer rubber tubing 5/32" or 3/16" ID is suitable for the female connector.

Fuel gauge problem due to broken connector on tank
Steve Varso (Mar. 1991, p.21)

When having trouble with your gasoline gauge, don't look for trouble with the gauge itself. Start by removing the rear seat and the back cushion. Next, remove the gas tank cover (8 screws). Remove the "unit" in the tank (3 screws). Usually the brass flat connector to the lead wire is broken. A drop of solder and it is okay again.

Fuse failure cause found with buzzer
Don James, OH (Nov 1984, p.8)

Next time you have an intermittent short circuit, don't keep blowing the fuse while you are trying to find it. Use an old seat belt buzzer with alligator clips across the blown fuse. Unlike a meter or test lamp, you do not need to see an indicator. You can easily hear the buzzer while you jiggle the wires to find the short. When the buzzer stops, you have found the short, and the fuse can be put into place after you make sure it will not short again.

Fuse failure due to backup light switch affects alternator
Ken Betsh (Apr. 1998, p.13)

About a year ago I had an occasional blowing of the 30 ampere fuse in the circuit that provided field current to the alternator. Without field current the alternator obviously couldn't charge the battery and the yellow warning light would come on (it being protected by a different fuse). This always happened just after starting to back the car out of the garage. It seemed more likely to occur when the car had not been used for two or more days. As a result, it took longer to start. I rationalized that I had pulled more energy from the battery and the alternator had to deliver more battery recharging energy. The appearance of the blown fuse made me believe this was a moderately excessive current situation and not a hard short circuit. Also, the blown fuse would be warm, indicating it had passed a good amount of current before it blew.

I first suspected the alternator regulator–particularly the relay within it that controlled the alternator field current. I carefully cleaned the space between the relay contacts. I was very careful to not disturb these contacts to the point of changing the voltage to which the battery charged. This did not produce a cure.

After the fuse blew a few more times, I realized my back-up lights were not working. I thought I found the reason. My wiring diagrams showed me that the fuse protecting the alternator field also protected the backup light circuit, turn signal, radio and other items. Some of the things protected by this fuse were controlled by the ignition switch and some were "hot" all the time. When I recently had the front air duct off for another reason, I swapped the switch on the front of the transmission that controls the backup lights with a similar switch from the '70 D-wagon I stripped many years ago. Since that time I've had no more fuse failures. However, examination of the removed switch showed no visible cause for the trouble.

The load on this fuse was quite heavy. Separating these circuits with individual fuses would not be too easy. Examination of electrical harness assemblies from older cars showed the factory made many splices within the harness, hidden with the wrapped vinyl cover.

Finally, I discovered that the spring action of the clips holding the fuse was rather weak. Pinching the opposite sides of the clip together without a fuse in place and a thorough cleaning took care of the problem permanently.

Needless to say, this fuse is the first thing someone should check when an alternator ceases to function.

Fuse failure due to backup light switch affects alternator
Chris Dubuque (Jan. 1999, p.9)

The following is a follow-up to an article that Ken Betsh wrote in 1998 Citroënthusiast (above). Ken wrote of an experience he had in his DS where he discovered that a back-up light switch failure caused a fuse to blow when selecting reverse. The fuse affected the backup lights, the alternator and other equipment.

I had a similar experience. But instead of a hard failure within the back-up light switch, I discovered that the switch terminals were scraping the back of the aluminum air duct for the radiator. My car has a 5-speed transmission which might locate the back-up light switch a bit closer to the back of the air duct. When backing up, occasionally the engine/transmission would move sufficiently to allow the switch terminals to rub the aluminum shield, resulting in a blown fuse. I don't have to tell you that it took quite a few blown fuses before I was able to diagnose this problem. The proverbial light bulb going off was the discovery of electrical arcing marks on the back of the aluminum air duct!

The "fix" was to bend the switch terminals down slightly to point them away from the back of the air duct. (One could easily place a lower rated fuse than the main one inline with the backup light power wire. [MB])

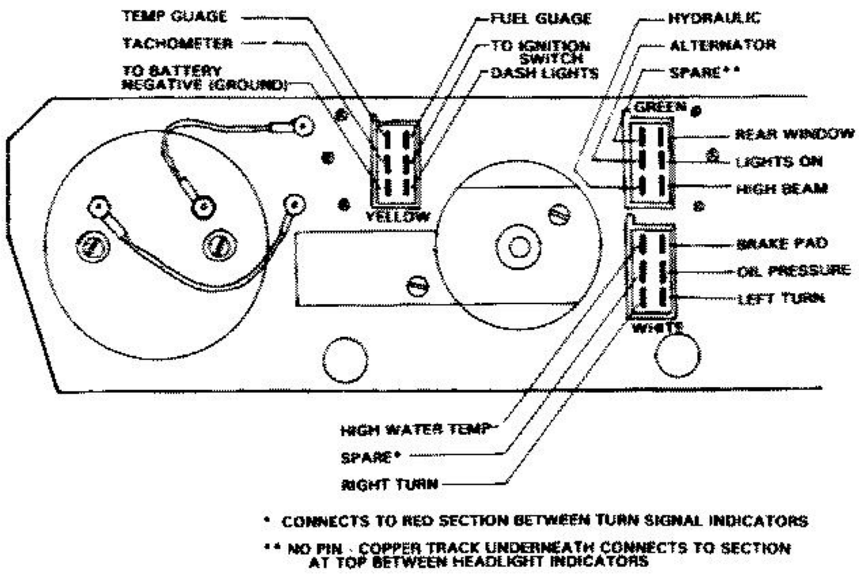
Interior light door switch controls buzzer/relay
Don James, OH (Nov. 1984, p.8)

If you can turn on the interior lights from the dashboard, but when the doors are opened the interior fails to light, check to be sure the door switches are working properly and are clean. Then look under the dash at the steering column for the key-in-the-ignition buzzer, or the wires to it. Connect the proper two wires (there are 3), and your problems are over. Seems this has happened to a lot of cars when the first owner got tired of hearing the buzzer, so he disconnects it, and does not realize that the buzzer is also a relay for the interior lights.

Light lenses held by stainless steel non-captive screws
Ed Noriega, WA (May 1984, p.9)

Stainless steel 6-32 slot head cap screws that are threaded the full length can be used to replace the chrome plated brass Phillips head screws that attach the various light lenses. Although the chrome screws have a smooth shank portion and a short threaded end, full length thread serves just as well. The stainless steel screws are almost as bright as chrome and harder, so will not get scratched or gouged and rounded-out like softer brass screws.

Parking brake switch connected to unused speedometer warning light
Betsh, Ken (2001 #1. p.8)



Instrument panel wiring diagram - 1970-76 models

When it comes to difficult adjustments on the D-model, the parking brake pads have to rate near the top of the list. While the right side can be adjusted from under the hood if there's no air conditioning compressor in the way, the left side requires getting under the car. The need to reach in a small space almost requires the car to be on a lift or over a deep pit. If these brakes are used correctly-that is, if they are fully released before moving the car-an adjustment is very seldom required. On the other hand, it's easy to apply these brakes loosely and then drive for a while before realizing they were not released. After doing this just a few times, one may find these brakes don't work well even when the lever is fully pulled or the pedal (on Citromatic cars) is pushed all the way down. After all these years, I finally have installed an automatic switch on the parking brake pedal to operate a previously unused warning light on the dashboard, a bright red segment between the two green turn-signal indicators. I believe this light was used on European-version D-models for a unique left-side/right-side minimum battery drain parking light.

The bulb for this indicator and the circuit path to a connector on the speedometer assembly already exists. This light is wired to one of the six flat-blade "pins" of the white connector. On my car (a '72 USA-model), there was no connection in the wire harness to this pin. However, a standard 1/4-inch push-on connector available in all parts stores will fit. I had to remove an insulating jacket over the connector I used in order to slide it onto the pin (after attaching a wire).

One side of this light is internally wired to "ground", the negative side of the battery. To make the light work, it is necessary to connect the proper pin on the white connector through an added switch to the positive side of the battery controlled by the ignition switch. This can be easily done by splicing a second wire into a wire going to the yellow connector. These two wires then go to a switch mounted on the parking brake lever or pedal.

In my case, my '72 manual-shift D-wagon came with the pedal-operated parking brake and had a switch attached that was originally wired to a seat-belt or key-in-lock buzzer circuit that the first owner disconnected. Unfortunately, the switch had the wrong "polarity". It would have turned the light on when the brake was released. I was able to adapt an old switch (no longer sold) from some scrapped electronic equipment. What is needed is a single pole, single throw, normally closed switch (or a double pole, double throw, with both normally-open and normally-closed contacts).

Removing the speedometer assembly to make the connections is rather simple once the speedometer cable is disconnected under the hood. This cable runs to the side of the transmission under the radiator. However, it can be disconnected at fittings immediately to the rear of the alternator. These fittings may be covered with a piece of black tubing that can be slid out of the way.

Once the switch is installed, the wires must be tied down so that they will not be disturbed when operating the brakes.

Rewiring solves nightmare problems
Dave Root, FL (May, 1991, p.23)

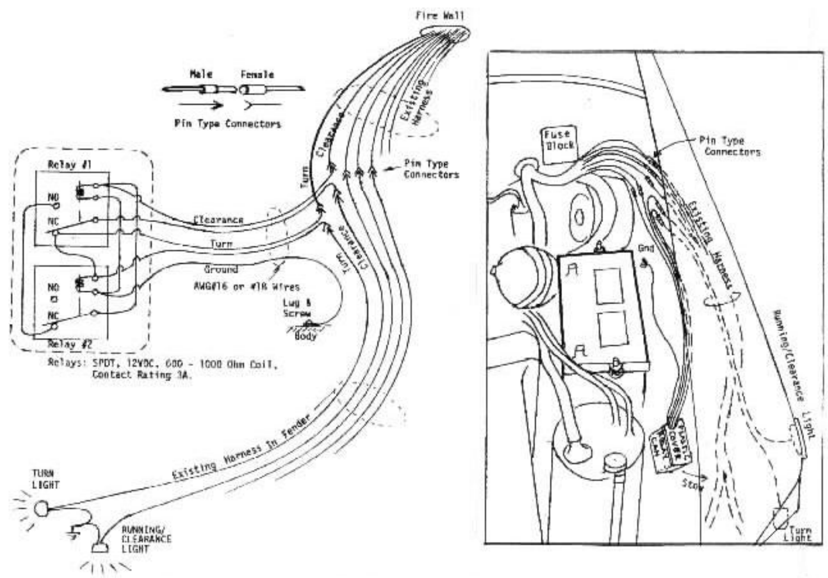
It began while we were headed home in our '70 Pallas on a rainy evening. When I flipped the wiper switch on, the wipers gave what was to be their final swipe for a while and quit as the yellow light came on the dash. I soon found that nothing that should work with the ignition on would work, except the ignition. The lights were working, and the engine was running so we came on home as we tried to see between the raindrops on the windshield.

But this was just the beginning of a series of electrical problems that came up, one at a time. The digital clock display had stopped coming on, but when you put the brakes on, the clock display would light up and the brakes lights would not! Then the taillights failed to come on with the headlights. Then, the warning lights would not come on when you turned on the ignition, but the engine would start. Then finally, the engine would not start due to no current to the coil. One of the problems was a poor connection in the six terminal quick connector coming off the ignition switch, but most were caused by grounded or open circuits going to the thing that was not working. In these cases I cut the old wires off and ran new ones. This was a tedious process, but is quicker than trying to find the location of the short or open circuit.

To make it easier to locate problems next time I made up a fuse block to lay under the dash cover near the steering column and when I ran a new wire, I ran it through a fuse.

Why D-model wiring has a tendency to self-destruct remains a mystery to me. Some factors may be the nature of the connectors, the quality of the insulation, and the fact that not many separate circuits are fused.

Side lights made to flash with turn signals
Ed Noriega, WA (Nov. 1986, p.9)



Schematic/hookup of side-light relay logic circuit (left) & installation (right)

Here is a relay logic circuit device to make the side marker lights blink in or out of sync with the turn signals, depending on whether the headlights are on or off. Because the front turn signals on the D-models are so low, they are visible only from the front and cannot be seen from the sides by other drivers in tight traffic, such as when you want to make a lane change.

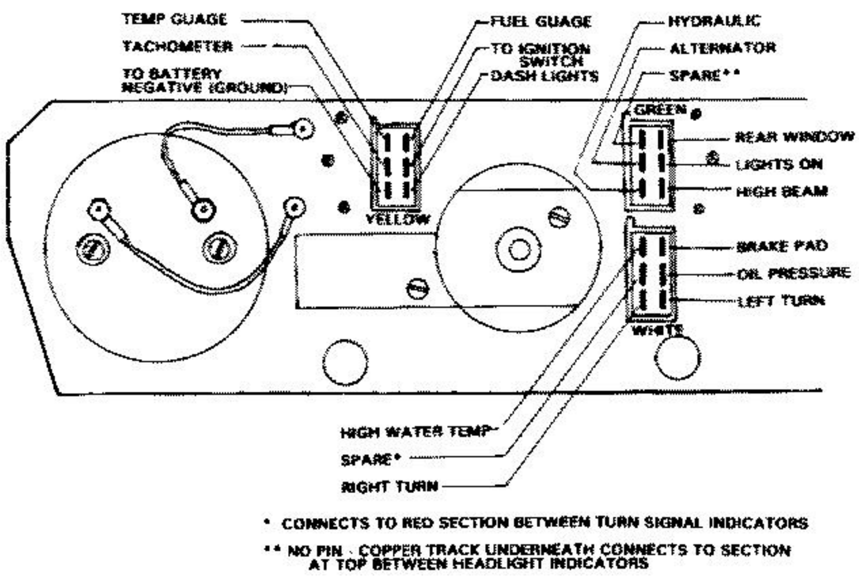
Nothing is changed in the original factory circuits, only the relay logic circuit is connected between the existing connections from the firewall harness. The marker lights will still light in their normal manner when the headlights are on. One of these devices is needed for each side of the car. I housed each device in a square 8-oz can with a plastic cover and stowed it in the fender.

The firewall harness leads to the turn and marker lights are separated and the connectors from the device's wire leads are connected in series with them. Each device requires two SPDT (single pole, double throw) 12VDC relays or two DPDT (double pole, double throw) 12VDC relays of which only one pole will be used in each. The relays should have coil resistances of from 600 to 1000 ohms, the higher resistance preferred but anything between will do and the contacts should be rated at no more than 3 amperes (otherwise the relays will be of too large a size). Also required is some AWG#16 or AWG#18 wire of whatever color is desired, male and female pin type connectors, and the small can mentioned. Some pin type wire connectors that will mate with the wire harness are, "JT&T Wire Products, Special Connectors for AWG #16-#14 wire", male pin type and female socket type, available at most auto parts stores. (Checked the current catalogue; I do not see these. Do not use bullet connectors. They are not a match for those found on Citroen D's. [MB])

Wire up the relays per the accompanying schematic, attach/solder the pin type connectors to the long wire leads–suit yourself on the length of these leads as they will connect to the wire harnesses from the firewall and the ground lead will attach somewhere to the body with a lug and screw. The device can will just stow away somewhere in the fender. Observe body polarity for the pin type connectors which are symbolized by arrow "tails" and "heads" to prevent accidental shorting to the body on contact. The "hot" leads have female connectors which are shown as arrow "tails" whereas male connectors are shown as arrow "heads". Finally, after the relays are wired up and their leads are arranged in a bundle that will exit from the can, wrap the relays in some foam material and stuff them in the can. Make a cutout slot in the can cover for the wire bundle, with its connectors attached, to come out.

After all has been done the marker lights on a side should; (1) light when the turn signals blink on that side while the headlights are off; (2) extinguish (blink-off) when the turn signals blink-on while the headlights are on and (3) remain lit when the headlights are on and the turn signals are off.

Speedometer electrical connection identified
Betsh, Ken (2001 #1, p.8)

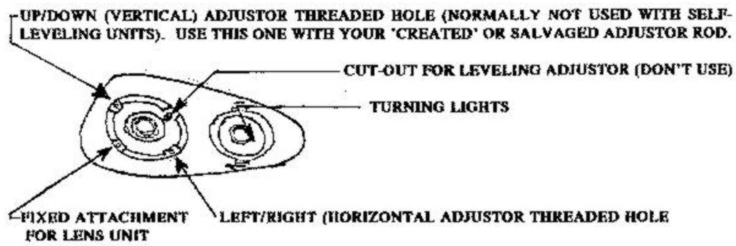


Instrument panel wiring diagram - 1970-76 models

All the connections to the speedometer assembly are identified here for use in trouble-shooting. Bear in mind that some of the indicator lights are internally wired to ground and require battery voltage to operate whereas others, such as the alternator, hydraulic pressure, oil pressure, water temperature and brake-pad wear indicators, are internally wired to the ignition switch and require grounding of the applicable wire to operate. There is no separate connection for the big red "stop" light. It is internally connected via diodes to the three indicator lights indicating a dangerous engine condition. Sensors for the fuel and water temperature gauges provide varying resistance to ground.

The rather dim light within the ignition switch on the '72 models is provided by a fiber-optic link to one of the panel lights on the speedometer assembly. If you swap the speedometer assembly with one from another car, it may not have the plastic piece to hold it in place.

Turning headlights installation
Rick Collin (Mar. 1984, p.12)



European headlight assembly (rear view)

I've installed European turning headlights and would recommend them to everybody who can beg or borrow to get them. One point with the European lights–it is unnecessary to install any of the self-leveling equipment on the outer light to get these lights to function well. My equipment (used) came with those parts missing, most notably the cables, cable ends, anti-roll bar attachments and one of the lever arms and threaded rods for the headlight leveling bar. Also, the bar itself was sawed in half on the diagonal to permit packaging in a smaller box (nice people, hmm?).

At any rate, I purchased a length of metric threaded rod of the appropriate size, cut it into the required lengths, filed a ball end on the part that pops into the headlight lens housing and into the location indicated for non-leveling units (moveable lights were not available on all models). On the plastic headlight nacelle, there were four possible locations for threaded rods. One location was for a fixed attachment, one for left-right adjustment with knobs, and one for up-down adjustment on fixed light cars. This location was not used when the leveling equipment was installed (the other corner had a cut-out which allowed the rod from the self-leveler to pass through the body of the nacelle).

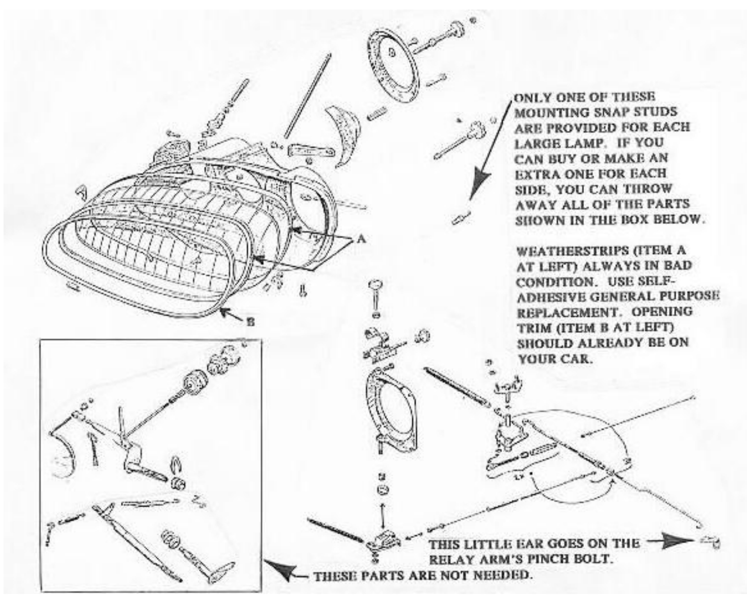
I found the units to be very easy to install. It required the acquisition of some miscellaneous metric nuts and bolts and some bending and finagling with the steering idler arm bell-lever to allow the rod which actuated the turning high-beams to bypass the AC compressor pulley and the refrigerant-dryer unit. I found that the turning units had a tendency to go out of adjustment–possibly temperature sensitive (expansion/contraction of the adjustor rod/ cables). I have yet to install an electrical relay to separate the function of the turning highs from the main high-beams.

When I say that these units are easy to install, I would like to explain that I live right smack in the middle of New York City, have to work on the street and have a limited supply of tools. In the case of the headlights, I removed and reinstalled each fender separately and carried each of them up five flights to my walk-up apartment to do the installation so as to avoid having to lay them down on the street. All told, including searching for nuts and bolts, I don't think it took me more than four hours. Unless you live in an industrial city, you may have trouble obtaining metric threaded rod. You should seal the space between the glass covers and the exterior of the fender/plastic trim with silicone to keep water from penetrating (rust/rust/rust!). Please, look very carefully at the installation of the U.S. style pods since the European style is similar–not identical. The glass covers are held against the rubber surround, inside the fender opening, by the 'V' end plastic gizmos that slip onto the ends of the various lengths of threaded rod).

If you don't get these gizmos with your units, you can salvage the U.S. units but you must line the inside of the 'V' with rubber (an old bicycle inner tube is good) to cushion the glass and please tighten evenly and securely. I would advise anyone without good mechanical aptitude to (1) get a Polaroid of the U.S. installation from several angles, (2) look at someone else's European installation if possible and (3) get help. It is easy, and will save a bundle over what a dealer may charge if you can find one who'll do it.

Turning headlights installation
Don James, OH (Aug. 1983, p.6 & Jul. 1984, p.10)

For those of you that are thinking of installing turning headlights with glass covers on your DS, it should be pointed out that they add more than their cost to the value of your car. Also, the lights are very easy to install. Their mechanism is so simple you will wonder why all cars do not have them. The larger outer lights are supposed to float up and down, but they can be anchored so that they do not move. The mechanism for the "up and down" is much more complicated and not very reliable. It also requires considerable dismantling of the front and rear suspensions to install the controlling parts. The turning mechanism is very simple.



Parts for the European headlight assembly

Many enthusiasts who have purchased these light sets for their cars are bewildered by all of the parts. The lights are very simple to install on the car, it just takes time–about a day. Most used light kits require several hours to clean and paint the parts.

(This article suggests replacing the leveling mechanism with a fixed, non-adjustable stud. You really should use an adjustable rod, the same parts as for the lateral adjuster. This second adjuster replaces the entire moveable assembly and provides needed adjustability. Also, the outer "weatherstrip" is really a specially profiled rubber gasket. To make you lights watertight, attractive and rattle-proof, you should buy new replacements. [MB])

Turn signal flasher replacement and relocation make louder sound
Ken Betsh (May 1995, p.10)

Should you need or want to replace the turn signal flasher in late D-models ('70 to '72), a "loud" type replacement flasher such as Ideal #577V, mounted under the dash is my recommendation. The small replacement units, typically one-inch diameter and one-inch long, make almost no clicking sound alone whereas the longer replacements, typically two-inches long, may make a quiet to a fairly loud clicking sound. The type that makes no sound alone is only suitable for cars have a separate alerting sound source such as a chime tone.

A two-prong replacement is sufficient for these D-models. The third prong is only needed for those cars using a single dash indicator lamp for both left and right turns. However, the three-prong type can be used–it is just that no connection is made to the third prong. One problem, since these replacements normally plug into a socket on most cars, there may be no indication on the flasher as to which prong is for which wire. In two-prong applications, the flasher is just an intermittent interrupter and it doesn't matter which way it is wired.

The Citroën flasher is in a rectangular package mounted on the top side of the horizontal shelf that forms the base of the dashboard. It's behind the tachometer. It mounts with a single bolt which isn't too difficult to reach once the speedometer assembly is removed. All those I've seen have an unused third prong and all three prongs are colored coded to match the insulators on the sockets that plug into the prongs. These prongs are the same size as on the replacement flashers (flashers on older D-models, however, have the familiar round Citroën connectors).

I found a hole in the shelf in my car near the original location of the flasher and found the leads were long enough to be pulled through the hole and reach the replacement flasher mounted below the shelf. This relocation has two advantages: (1) it's easier to change the next time and (2) it's clicking sound is easier to hear. Perhaps it's only us older Citroën owners who find ourselves forgetting to turn off the signal because we don't hear the clicks. Besides a slightly louder sound, the replacement flasher has a faster switching pace and this means more clicking sounds.

I mounted the replacement by cutting a piece of steel sheet metal into a four-inch long by one-inch wide rectangle and rolling it around a round rod slightly smaller than the diameter of the flasher. The metal I used had enough spring action to hold the flasher firmly but still allow it to be pushed in and removed. I made it cover about 3/4 of the circumference, which left a tab into which I drilled a single mounting hole. I inserted the flasher and installed it using a self-tapping screw already at the new location to secure a clamp for a heater control cable. Because of the insulators provided on the electrical connections, I felt no reason to disconnect the battery while making this replacement. The "hot" lead is through one of the three or four fuses under the hood on the left end of the fire-wall.

The original flashers may fail in several ways. I've taken one apart and found it has two moving reeds. Apparently the heavier one is just to make the clicking sound whereas the smaller one, the one that usually fails, operates the electrical contacts to turn the lights on and off. The first time I had a failure, the turn lights would just stay lit continuously. By just adding a small quiet flasher in series with the defective flasher, I retained the original clicking sound which, at a time when my hearing may have been better, seemed adequate.

As most owners probably know, this same flasher also provides the four-way flasher function. It's because the four-ways must work without the ignition switch turned on that the turn signals keep working after turning off the ignition. Be sure the replacement also works in this mode. Typically a worn flasher for turn signals will still work OK when it has the four-way load.

Neither the original nor replacement flashers will function for turn signals when either the front or rear signal bulb is disconnected or burned out. This is almost always the problem when the turn signal works OK for one direction but not the other. The best check when a turn signal doesn't flash correctly for either direction is to turn on the four-way and look at all four lamps at the front and rear.

Another possible cause of trouble is a front bulb installed or connected backwards so that the bright filament is in the parking lamp circuit and the dim filament is in the turn/four-way signal circuit. The pins on the correct bulbs are keyed so the bulb only locks in the correct way. But it can be forced the wrong way. Or, someone could have reversed the pin connections after removing and replacing a front fender. A front bulb that isn't grounded properly can lead to some strange interactions with the parking lights.

Incidently, the Ideal replacement flasher mentioned above is, according to the package it came in, supposed to make a 90 dB pulsating sound. Knowing a 1000 Hz continuous tone at this level can drive one mad, I expected it to make a sound like someone striking a pan with a large spoon. If this 90 dB rating is correct, the only explanation is the brief time of a click compared to the repetition rate or the frequency range of the click sound. As it turns out, the intensity of the clicking sound is "ideal".

For those who have never removed the speedometer assembly before, the first step is to disconnect the speedometer cable at a fitting in the cable aside the alternator. All the D-models I've worked on have about a one-foot long piece of black sleeving over the cable that covers this fitting. Once this fitting is loosened, the speedometer assembly can be pulled forward enough to reach behind it and remove the cable from the back of the assembly. Electrical connections for the tachometer, gas and temperature gauges and lights are via three color-coded connectors that are easily separated. The '72s also have a fiber light cable to illuminate the ignition switch that must be separated.

Turn signal flasher with loud clicks, J.C. Whitney #13-2596P
Dave Root, FL (Jan. 1989, p.8-condensed)

The turn signal warning lights on D-models are not sufficiently perceivable in the daytime for one to be properly warned always to turn off the turn signal. I sought first to solve this by connecting Radio Shack buzzers or beepers to each warning light circuit. These worked well as warning devices, but they also seemed to get on my wife's nerves.

Then the "perfect solution" came to me–a musical turn signal flasher. I found the same thing in the Whitney catalog and a local auto parts store as Parker Hannifin #510. I quickly installed one that played "Love Me Tender, Love Me True" ("Aura-Lee"). The first time she heard it, I thought I saw a faint smile. But after a shopping trip in her D-model, she said sharply, "Please take that thing off the turn signal. I got so sick of hearing that silly tune that I almost started turning without using the turn signal!" I must have foreseen this crisis because, fortunately, when I ordered the musical flasher, I also ordered the J.C. Whitney #13-2596P-Extra Loud Turn Signal Flasher. It just goes, unromantically, "cluck-cluck-cluck."

Turn signal reminder uses Radio Shack chime
Ken Butler, NM (May 1989, p.17)

Citroën turn signal switches leave a lot to be desired. They are non-canceling and so quiet they are often left on. After many attempts to use added lights or buzzers, I have added the following to both of my cars to provide a pleasant reminder to cancel them.

For '70-'72 D-models with the plastic-bodied turn signal switch, you will need one 12 volt Electronic Chime from Radio Shack, #273071 and one heavy duty three prong flasher unit from any auto supply shop.

To install, first remove the ground terminal from the car battery. Locate your existing flasher unit, which is usually at the back of the dash, near the ash tray. It will be a two prong unit, with the prongs parallel to each other. Replace the wires onto the three prong unit in the same pattern. Install a matching terminal. Connect this to the third or the horizontally-oriented terminal and feed the wire through the dash to the ignition switch area under the steering wheel dash cover.

NOTE: Current carrying-wires are terminated in female connectors, insulated with rubber sleeves. Male type connectors are not insulated and do not carry current until mated; this is to prevent short circuits.

The chime unit has three wires, red, white, and black. Locate an area to the left of the steering wheel that will accommodate the unit, then proceed to make the following connections. The lead from the flasher third terminal goes to the white or trigger lead. The black lead goes to ground at any convenient bolt or screw going into metal. The red wire provides power at all times. A convenient place to connect this is to locate the male plug coming from the light and horn switch; remove 1/2" of insulation from the red wire; twist the ends together, then tuck it back into the socket and replace the plug. Tape all exposed wires, then replace ground terminal on the battery. Operating the turn signal should now result in a musical two-tone chime, stopping when it is canceled. If not, recheck all connections.

For pre-'70 D-models using the metal frame type of turn signal, you will need one Radio Shack Chime #273-071 and two Radio Shack Diodes #276-1141, 3 Amp, 50 PIV. To install, again first remove the ground terminal from the car battery. This type of switch has three male terminals on its right side as viewed from the driver's seat. They are bolted through a plastic insulator with nuts on the end facing the rear. The diodes are marked with a white and black end. Twist the white end wires together with a short piece of wire and tape these bare ends. Loosen, but do not remove, the top and bottom nuts and loop the leads from the diodes marked black under these nuts and retighten them (the diodes are a one-way switch for electric current and prevent both right and left lights from working at the same time). To wire the chime unit, connect the short lead from the white ends of the diodes to the white lead of the chime unit. Connect the black lead from the chime under any convenient bolt or screw for ground. Remove 1/2" of insulation from the red lead and twist the bared end together. Locate the male connector from the headlight and horn switch. Tuck the bared red wire into the socket and replace the male lead. This will provide "always on" power to the unit.

Replace the ground strap on the battery, turn on the turn signal and you should be rewarded with a pleasant two-tone chime, reminiscent of a department store. If not, recheck your wiring and the diodes for error. A small 12-volt test light is a handy means of tracing a circuit. Ground one lead and trace power flow with the other end. The twisted ends of the diodes should show a flashing light synchronized with your turn lights. The juncture of the red lead to the horn and light switch should show a steady light with the turn signals off. Grounded connections are better if the paint is scraped off to bare the metal.

Turn signal reminder uses Radio Shack chime 273-068
Philippe Devingt, Ontario (Feb. 1996, p.9)

When I went to Radio Shack to purchase the 273-071 electronic chime used by Ken Butler in the preceding article, I was told it was discontinued. I found another, 273-068, which does an excellent job.

To install, remove the ground battery terminal from the car. Find the existing flasher unit, which is usually at the back of the dash. Change it for a three-prong unit. The chime comes with three screws, but you need only two, the + and –. Connect the + on the third prong of the flasher unit and the – to the ground somewhere on the body of the car. Replace the ground battery terminal. I promise you will never forget to turn off your flasher. You may need ear plugs for your wife. This is for cars '70 and later. I hope this will help some new member who is hard of hearing like me.

Turn signal switch lever repaired after break at base
Ken Betsh, PA (Mar. 1995, p.13)

In the some 450,000 miles of driving four '70-'72 D-models, my wife and I have had turn signal switch levers break off at least four times. This is the type with a center-off position and the lever is pulled to sound the horns (switches on earlier models were pulled to cancel the turn signal and the horns were operated by pushing in the headlight switch). For us, failure has occurred when trying to sound the air horn in a near-panic situation (someone pulling out directly in front of us) or when the air horn has stopped working for some reason (such as being accidentally disconnected under the hood).

The breaking point always is at the same place–inside the switch itself. The metal rod ends about 3/4" inside the plastic sheath normally extending outward from a 1/2" or so diameter plastic ball inside the switch. The breaking point is usually flush with the surface of the ball. Attempts to repair with one-drop cement have never been successful.

After dismantling the first broken switch to see the internal construction, I've devised this repair. Drill a 7/64" hole into the ball about 3/8" deep (not all the way through the ball) in line with where the metal lever was (a mold mark of this position should be visible). Use a 6-32 self-tapping machine screw (1/2" to 1" long, hex-head suggested) to thread this hole. Don't use a sheet-metal screw with much coarser threads. Now if a regular 6-32 machine screw 2" or more long can be found, insert it in place of the self- tapping screw. This will allow full use of the switch.

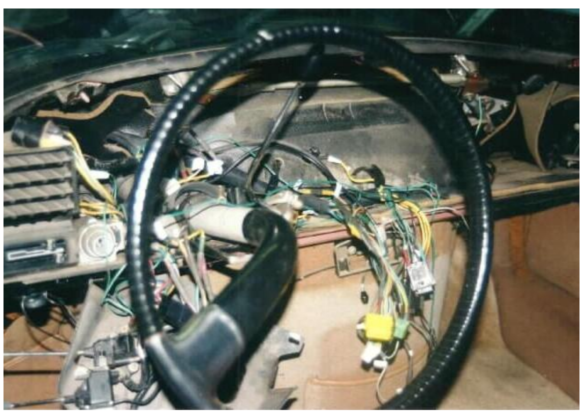
My next step was to modify the broken-off lever for reuse. The remaining plastic sheath at the broken end was removed and the part of the rod that was under the sheath was ground down as evenly as possible so that it could be threaded with a 6-32 die (I don't have a lathe at my disposal). Once threaded, it was installed in place of the added screw. Other than the operating end of the lever being about a 1/2" shorter, the switch will function as if nothing ever happened. I've been using this repair for several months.

One caution must be made. Three of the four broken switches I've examined used two vertical hard plastic (perhaps Delrin) pivot pins holding the plastic ball (into which the hole was drilled). The fourth switch uses metal pins which can cause a problem because these pins are held by internal sheet metal pieces connected to the hot side of the battery. The drill hits the inside ends of these pins which means the operating screw or lever will now have +12 volts on it if the witch has metal pins. You will know if the pins are metal by the sound and resistance while drilling. I used a double-insulated, ungrounded electric drill (no third pin on the power plug). There should be no shorting problem using a grounded electric drill if there are no other car to earth connections such as possibly through a battery charger. If you use this fix with a switch with metal pins, insulate the metal lever with tape or non-conductive tubing.

Wiring harness restoration uncovers damaged insulation
Chris Dubuque (Mar. 1997, p.9)

One of the systems on our D-models suffering the ravages of time is the wiring. After Chris Middleton and I have repaired about a dozen wiring harnesses, we find them to be all very unique. As an example, we recently rebuilt the harnesses on two otherwise identical 1969 DS21 Pallas Citromatic cars. The harnesses were astonishingly different! This makes locating a used harness of the same configuration virtually impossible, and underscores the need to develop techniques to rebuild them. The following paragraphs describe some of the techniques that have worked well and have resulted in reliable, safe, and highly original appearing wiring harnesses.

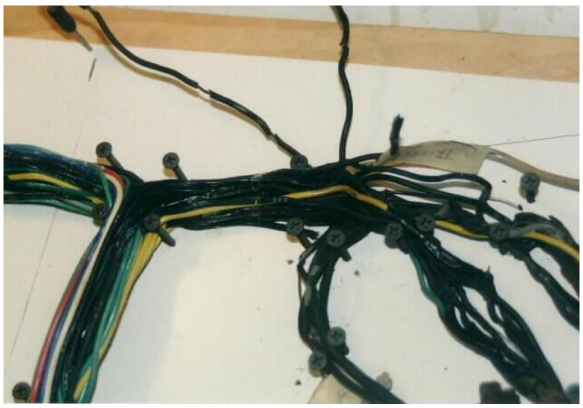
THE BASIS PROBLEMS–The most obvious area on the DS to reveal wiring damage is the harness branch which travels in the engine compartment from the left firewall, forward. This harness branch leads to the coil, fuses, heater, alternator, etc. It is quite common to see the wiring in this area have dry, brittle, and crumbling insulation. Also, corrosion can usually be found on the wire itself, leading to unwanted high resistance. It is foolish to ignore this type of wiring damage. Most of the wires in the area we have been discussing are unfused. Therefore poor, brittle, and missing insulation represents a significant fire hazard.



GET OUT THE TOOL BOX–When removing the wiring harness from the car, LABEL EVERYTHING! Do not expect to rely on the existing terminal color codes. Many of the color codes are almost the same shade of-something-and all are old and dirty. Also, whenever possible, I prefer to leave the switches and idiot lights hooked to the wiring harness. The picture above shows what your car will look like with the dashboard removed.

Whether building an entire harness from scratch or repairing the old one, I have found that it works well to fasten the old harness to a large sheet of plywood, covered with white paper. I use a combination of screws and nails to provide the "gates" to funnel each branch of the harness into a distinct path. I then carefully draw the harness on the white paper, noting such things as where the wrapping starts and stops, the number of wires, the colors, the type of terminal, and what the function of the wires are. Don't be impatient–the more notes the better.

The old cloth harness wrapping can now be removed. Unwrap the old wrapping as opposed to cutting it off or you'll inadvertently cut wires. During this process, you will find out how well you did with the screws and nails, as now bunches of wires will want to flop out of position. It doesn't take much flopping before you get hopelessly confused. The next picture shows a close up of some bad wires, which only became visible once the cloth wrapping had been removed. Also, this photo shows how the screws and nails "gate" the harness branches.

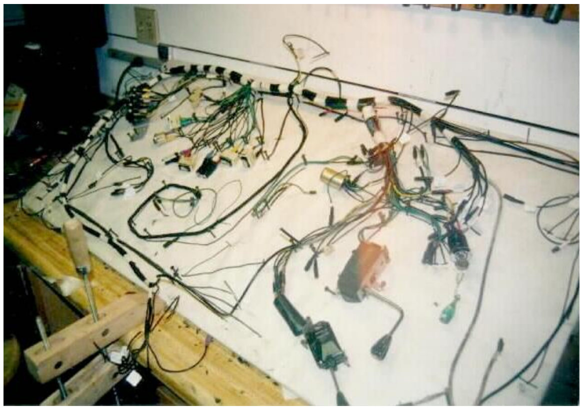


Remove ONE of the bad wires from the plywood. Duplicate the wire gauge exactly. Fatter wire is not always better, since that practice will make it exceedingly difficult to poke the completed harness through the holes in the firewall. As far as wire length is concerned, I cheat and add about 1/2 inch of length to most wires just in case. Install new terminals on the new wire to match the original termination.

Please note that Western Hemispheres in California stocks most of the terminals used in these harnesses, including new color code sleeves and fuse holders. The original terminals are somewhat unique and are of excellent quality, so buy them–don't use hardware store terminals.

Once the new wire is terminated, feed it back through the nails and screws on the plywood to its original location. Slowly, methodically, and carefully, repeat this process with every wire that needs replacing. But remember, ONE WIRE AT A TIME! There will be many wires that will be in perfectly good condition, so expend your energy doing a good job replacing only the bad ones.

REWRAPPING THE HARNESS–As a preliminary stage to rewrapping the harness, use regular masking tape to regroup and bundle the wires into the correct branches. The picture below shows the harness on our example car being rebundled with masking tape. Finally, wrap the harness with black cloth bicycle handlebar tape. You can do this right over the top of the masking tape–hey, that is what Citroën did! Cat-Eye brand bicycle handlebar tape is a dead ringer for the original wrapping. Don't use black vinyl electrical tape–it results in a non-original looking, sticky, gooey mess.



Since I have done these repairs for other people, I do a fairly rigorous functional test of the harness, but this step is not necessary if you are pretty sure you haven't made any mistakes. Below shows the completed harness, ready to be reinstalled in the car. Good luck. It is not really that bad of a job if you are slow and careful. It just takes time–plenty of it.

Wiring repairs made by soldering and use of heat shrink tubing
Richard Hollabaugh (2009 #1, p.10)

The tried and true method I've used for years for wiring repairs is to solder the wires together and then use heat shrink tubing to insulate and seal the connection from the elements. The usual method I've seen on Citroëns is to strip the wires, twist them together, and then put a loose piece of tape over the connection. This is guaranteed to fail and worse yet, cause additional problems when it does. Another common method is to use the crimp connectors and crimping tool commonly found in auto parts stores. This is a little better, but because the connection produced by manual crimping is not airtight, it will corrode and fail over time. The goal when connecting two wires together is to make a connection that is safe and will not fail for the life of the car.

Let's go over the tools and steps needed to make a good connection. You will need a soldering iron, rosin core solder, heat shrink tubing and a heat gun or hair dryer. All of these things can be found at Radio Shack or Home Depot-type stores, or you may already have them. Soldering irons come in different sizes. The smallest are for small electronic work and the largest for heavy gauge wire. The best one for automotive work is the 100 to 150 watt "soldering gun." Most wires and connectors on Citroens are heavy enough that a small electronic "pencil grip" soldering iron will not work. Some wires, like the battery-to-starter wire, will require the use of an oxyacetylene or propane torch.

The first step is to strip at least half an inch of insulation off each wire to be connected. Make sure that the copper is shiny and clean. If it's dark or corroded in any way, soldering will be difficult. If possible cut the wire back until you get clean copper. If it's not possible to cut the wire back, then use a piece of sandpaper to clean the copper strands as much as possible.

The second step is to place a piece of heat shrink tubing on one of the wires. The tubing should have a diameter just large enough to slip over the joined wires and be long enough to cover all of the connection, plus a quarter inch on each side. Shrink tubing shrinks about 50 per cent in diameter when heated. Keep the tubing at least a couple inches away from the heat of the soldering iron while you are soldering the connection.

The third step is to twist the wires together. Keep the connection tight, neat and straight. The fourth step is to solder the wires together. Safety glasses are recommended while soldering. Gloves are a good idea also. Use rosin core solder intended for electronic circuits. Do not use plumber’s solder, soldering paste, or acid core solder. The rosin in the solder will help the solder stick to the copper. This process is called, "tinning." Apply only as much solder and heat as is needed. If too much heat is used the wire insulation will melt. If you are just learning how to solder, use a couple of wire scraps to learn on and refine your skills. Look over your solder connection. All sides of the connection should have solder on them and the copper should wick the solder up into the strands. If you have too much solder on the connection, a slight tap on the work surface while the solder is liquid will remove the excess. When you are satisfied with the results, move on to the next step.

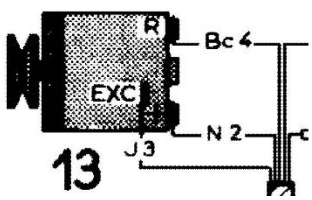
The fifth and last step is to slide the previously placed heat shrink tubing over the connection. Make sure all copper wire is covered. Use the heat gun or hair dryer to shrink the tubing. A slower way to shrink the tubing is to use the heat from the soldering iron, but it's a fine line between too much heat from the soldering iron and not enough. You can use the same procedure for connecting a wire to a connector. Heat shrink tubing is a great insulator and can be used to cover part of the connector and the wire. If the connection will be subject to repeated water spray, then place a dab of silicon sealant on the connection before you slide the heat shrink tubing over it. When the tubing shrinks it will push out any excess sealant.

That’s it! Now all your wiring connections will be trouble free for many years.

How to read early Citroen D wiring diagrams
Mark L. Bardenwerper, Sr. August, 2025

Most of the wiring diagrams in the Citroen manuals look impossible to decipher. There are tiny pictures of the car's electrical components scattered around the page. Little black lines emerge then duck into greyish "tubes" going who-knows-where. If you only see those diagrams, there is little wonder that you will be stymied. These diagrams are quite useless to most of us without the charts and legends. I will try to make sense of this for you.

I have chosen to examine the charging system, as it seems to be a very common source of trouble. Its main components are the alternator, the voltage regulator and the charge warning light. We'll begin with the alternator. For any component that you can't find, they provide a page called, "marking of parts" just following the diagram page. Each one has a number. In the one we are working with, the alternator, is assigned the number 13.



Alternator

Colour	code
White	Bc
Blue	Bl
Grey	Gr
Yellow	J
Brown	Mr
Mauve	Mv
Black	N
Red	R
Green	Ve
Violet	Vi

Color legend

Each wire has a code with letters and a number. Here we see three wires, Bc 4, N 2 and J 3. The letters denote the colors of the ends. Citroen used colored ends to differentiate their purpose. They were not concerned with the entire diagram, only at the particular component. That is how they were able to use such a limited number of colors to perform so many tasks. When you replace parts, they will tell you which wire connects where. Naturally they are in French. To the right is a list of the abbreviations and their colors, in English.

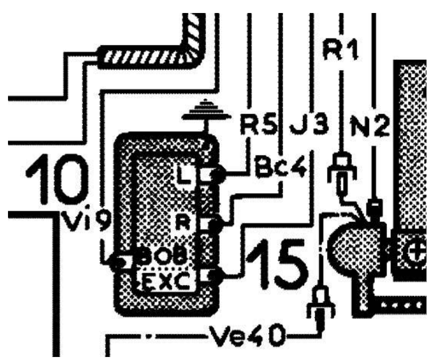
Each wire also has a number. This is where the Wiring Schedules come into play. They are on pages directly following the diagram. Every wire in the car is listed there. Wires with the same numbers are electrically connected. So here, we can look up the numbers 2, 3 and 4. Here is the portion the page with those numbers on it.

Front	2	Black	Starter relay (10) (not disconnectible)
		Black	To Alternator + terminal (13)
		Yellow	To R.H. fuse box (17) (fuse box n°2)
		White	To R.H. fuse box (17) (fuse n°1)
		Red	To ignition switch (30)
		Black	To switch for lighting and horns (39)
		Black	To relay (19) for R.H.. Q.I. headlamp (terminal 1)
		Black	To relay (20) for L.H. Q.I. headlamp (terminal 1)
Front	3	Yellow	Alternator (13) (terminal « EXC »)
		Yellow	To voltage regulator relay (9) (terminal « EXC »)
Front	4	White	Alternator (13) (terminal R)
		White	To voltage regulator relay (9) (terminal R)

Portion of wiring schedules

Starting with wire #2, the starter relay is at the top of the list, the source of DC power. It is connected to the + terminal at the alternator, the one we are concerned about. Wire 2 is very busy. It also feeds another six locations.

Wire 3 has only two points, at the alternator EXC terminal and at the EXC terminal at the voltage regulator. Again, realizing that we are working with DC current, the source is at the top of the list. Wire 4 also runs just between the alternator R terminal and voltage regulator terminal R.



Voltage regulator and portion of battery, with starter relay

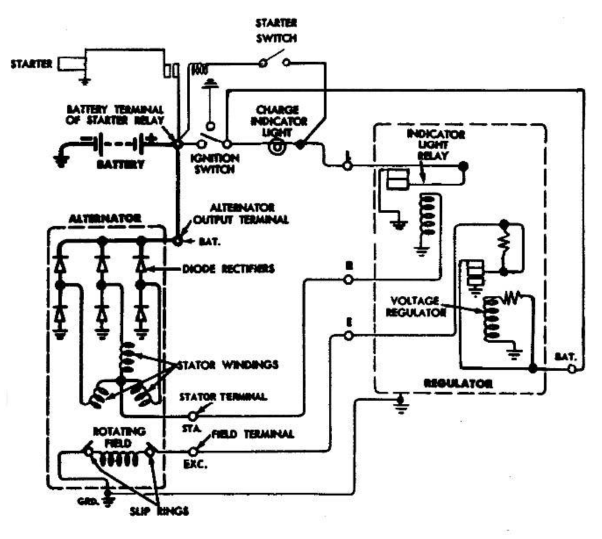
Now let’s have a look at the voltage regulator. The voltage regulator is component number 10 (confusingly termed, “relay for voltage regulator”). Here you see two of the wires are accounted for, but note again the change in the end colors. Remember, Citroen only wants you to concern yourself with the colors being used at the individual component. You see the regulator has two more connections Vi 9 and R5. Note also that we have found the originating end of wire number 2, over at component 15, the starter motor relay, which on these cars is mounted on the battery + terminal. Here are the entries in the wiring schedule for wires 5 and 9.

Front	5	Red	Voltage regulator relay (9) (terminal L)
		Red	To charge warning lamp (34)
Front	6	Yellow	R.H. fuse box (17) (fuse n°2)
		Black	To windscreen wiper motor (16) (automatic stop)
		Black	To accessories terminal (18)
		Green	To windscreen wiper switch (32)
Front	7	White	R.H. fuse box (17) (fuse n° 1)
		Black	To rear junction
		Red	To stop lamp switch (24)
		Black	To ignition switch (30)
		Black	To switch (35) for parking lamp
		Black	To clock (36)
Front	8	Red	Ignition switch (30)
		Violet	To ignition coil (25)
Front	9	Violet	Ignition switch (30)
		Violet	To charge warning lamp (34) and engine oil pressure warning lamp (33)
		Violet	To front heating switch (29)
		Violet	To thermometer (40)
		Violet	To fuel gauge (44)
			To brake pressure switch warning lamp (43)
		Violet	To direction indicator switch (46)
		Violet	To rear heating (- 59°F) switch (56)
		Violet	To fresh air blower motor switch (60)
		Violet	To voltage regulator relay (9) (terminal « BOB »)

Portion of wiring schedules

Wire 5 goes from the regulator "L" terminal to the charge warning lamp. Wire 9 starts at the ignition switch. Looking down the list of destinations, we find that it not only powers the charge warning lamp, but it also sends voltage to the BOB terminal on the voltage regulator.

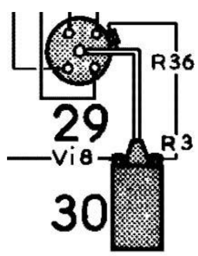
I know that the purpose of this article is about how to use the component layout wiring diagrams, but I thought you might get a better idea just how much information you can get from them without a lot of searching for other sources. Here's a diagram of the charging system of a typical Citroen D model.



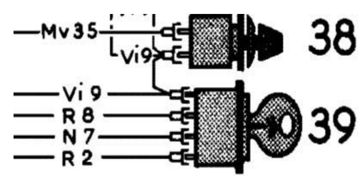
Typical Citroen D charging system diagram

Note that on some models, the voltage regulator not only controls the ground for charging warning lamp by opening it once the engine starts and the regulator sees voltage from the alternator, but it also disconnects the ground for the starter relay, preventing the starter motor from operating while the engine is running. When this is not present, the ground for the starter switch goes straight to the frame.

Let's try one more wire tracing project. Let's say that your car cranks but won't start. You discover that the coil + is not getting power with the ignition switch on. We must trace the path of the electricity from its source to the coil. You will find your issue somewhere along that path. We will start from the coil end with a picture of the coil in the diagram. But first, we consult the page, "marking of parts" to determine the component number, which is 30. We will later find that the ignition switch is 39.



Coil and distributor



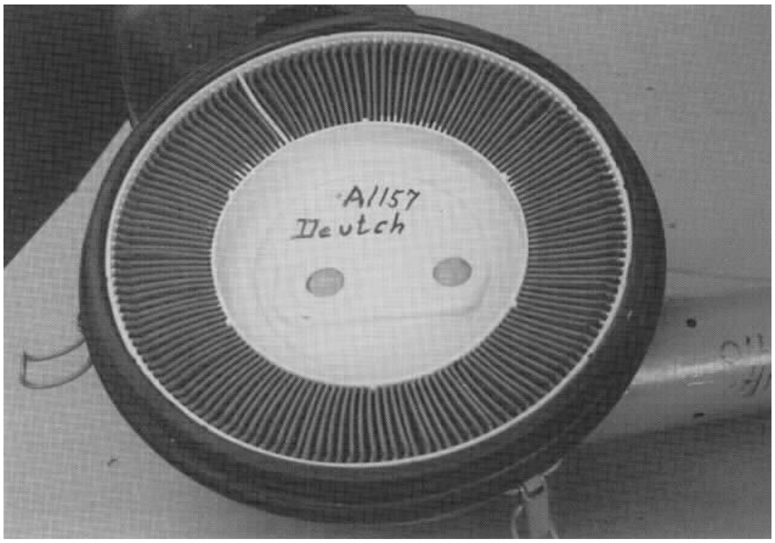
Ignition switch

We see R 36 going to the distributor and Vi 8 going elsewhere. Let's now go the Schedule of Wiring for more information. Wire 8 happens to be included in the second portion of the wiring schedule, above. We learn that it goes to only one place, the ignition switch. There you see your wire 8, but there are others. You are only concerned with the one that carries the current through the switch to the coil. To find out which one you need to concentrate on, we go back the Schedule and look up the other wire numbers one at a time. We see R2, N7 and Vi9. Hmm…we recall that we saw one of those numbers before…let's look again at wire 2 in our Schedule, above. Bingo! Wire 2, as we already know, begins at the starter relay and is constantly hot. And sure enough, it is listed as going to the ignition switch. There you are. You have traced the path. Your problem lies along it.

I hope this article will make you more comfortable with working with these diagrams. Find the one in your manuals that coincides with your car, make paper copies and keep them handy. The more you study, the more comfortable you will be with them and the faster you will solve an electrical problem when one crops up. I did not delve here into other processes of electrical diagnosis. We know that electricity may be invisible and we have tools to help with that. It's not "electrickery!"

Chapter 14–Engine

Air filter replaced with modified Walmart Deutch A1157
Ken Butler, NM (Apr. 1995, p.17)



Wal-Mart Model Deutch A1157 Air Filter

Walmart's Model Deutch A1157 air filter can be adapted to fit the post-'65 D-model. Trim the original metal filter with curved tin snips and leave a shoulder. Plug the central holes with duct tape on both sides. (Now, very hard to find. [MB])

Blocked crankcase vent causes oil cap buzz
Don James, OH (Nov. 1984, p.10)

As part of your next service, take some time to clean the screen in the crankcase vent cover. It's about 3" in diameter and on the lower left side of the block near the rear. Later D-models have a hose from the cover up to the air intake hose to the carburetor. One bolt removes it and you will not need a new gasket.

These babies get so clogged that I have seen the oil filler cap jump up and down with pressure from blow-by when the engine is cold. This makes a buzzing sound at idle. Placing your hand on the filler cap will confirm if you have this problem.

Bower, BCA bearing replacements for Citroën part numbers
Submitted by Dave Paulin (Dec. 1983, p.8)

This is an interchange chart for the bearings found on your Citroën. The Citroën factory number is shown on the left; the Bower/BCA number on the right.

Citroën	**Bower/BCA**	**Citroën**	**Bower/BCA**
P 136	14124A-14274	33505	209
M 179	307	33706	303

P 192	28158-28315	69500	203
209	7209	88006	309
2 305 E	5305 X3	88007	5306W
2 306 E	5306 W3	88021	14130-14274
2 307 E	5307 W3	88022	1755-1729X
2534	305	88038	2788-2720
2535	304	88039	1779-1729X
5647	202	88041	J 24 1248
6209	209	88046	366-363
6209 AC	209	88047	377-3720
6303	303	88048	438-432
6303 AC	303	88065	5307W
6305 AC	305	88066	13C CUP
6306 AC	306	88068	J32 1664
6307 AC	307	88069	5307W
6308 AC	308	88077	308
10380	203	88086	385X-383
10482	205	88090	206
10530	306	88091	207
10724	302	88094	28158-28315
16482	205	88095	527-522
32080	206	89442	30307
33503	307	89446	406
33504	308	89459	30205
Citroën	**Bower/BCA**	**Citroën**	**Bower/BCA**
89467	5305	502895	32209
2 89467	5305	506287	J24 1232
89471	J24 1248	506324	208
89475	204	506571	209 LO
89500	203	507539	MU 1307 TM
89699	MSN 1308 EL	508207	405
89951	302	508642	211 SL
89964	30207	508646	308 L
403227	32308	508669	MU 1306 UM
408400	30209	508670	307 SL
408451	30208	601473	6 CUP
420384	211	601478	6CE CUP
420395	212	620000	5207 W
420439	30307	620002	205 LO
420962	30206	620011	5207 W3
423075	309	620016	30209
423097	310	620032	30307
425722	207	620049	32206
431048	30210	620050	32207
490280	7207	620077	35

500367	MU 1306 UM	620080	5305 X3
500535	5305	620085	302 S
501249	5306 W	702360	304
501433	207 S		

Camshaft built up and reground by Cal Cams
Ken Butler, NM (Feb. 1987, p.8)

When rebuilding the engine, if you find the lobes of the camshaft are seriously worn and your credit line is not up to a new shaf, call Bob or Chico at (415) 562-3622, Cal Cams, 937 86th Avenue, Oakland, Calif 94621. They will weld to build up the lobes if necessary and grind the shaft to the original specifications. They have the master for Citroen cams. Should the shaft seal be too badly worn to retain oil and the area of the shaft badly scored, have this area reground to 28 mm diameter and install a Chicago Rawhide Mfg Co #10955 seal (28 x 46 x 8 mm) from your ball bearing supplier. The original seal is ZC9612-629U (29 x 46 x 10 mm). The CR unit fits in the distributor housing perfectly. (Original seal is now available [MB]).

Camshaft pulley checked by turning fan
Robert Kast (Jan. 1983, p.6)

Check the tightness of the camshaft pulley nut before starting on any trip and examine the rivets on the hub. This check for loose or torn out rivets can be done as follows: with a light to help you see, turn the cooling fan back and forth while watching the nut on the end of the large pulley. There is always some slack from the timing chain, but if you see the pulley move and the nut or the hub not turn with it, you have a problem. You may need a mirror to help you see. I spent $200 to get my DS towed last summer while on a trip. The splines in the hub of the pulley were stripped.

Editor: If the pulley is removed while working on the car, be sure that it is tight when you reinstall it. Loctite on the spline to prevent it from working loose will help.

Camshaft pulley loose rivets cause noise

Betsh, Ken (2002 #5, p.10)

Any D-model with air conditioning is a prime candidate to develop a problem with the camshaft pulley. The sheave part of the pulley is riveted to the hub and eventually the stress of the AC compressor either causes the rivets to fail or tear the holes into which they are attached. The first clue I had of impending failure was a rattle-like sound at idle that went away at higher engine speeds when not using the air conditioner. Since this noise also happens when the water pump bearings start to fail, I first attempted to wiggle the engine fan. While it wouldn't wiggle on its axis, I noticed it could be turned perhaps about 15 degrees. As this happened, I noticed the belts could move lengthwise more than an inch before meeting resistance.

My first thought was that the engine chain or the tensioner for it had failed. I pulled the distributor cap and noted that as I moved the engine belts, the distributor rotor stood still. The main engine pulley is called the camshaft pulley because that is what it's attached to. Since the distributor rotor is driven from the camshaft, this test told me that while the camshaft pulley was able to turn, the shaft to which it is attached was not turning. This meant the chain and tensioner were OK.

While repair of the pulley is possible, most advice is to replace it with a pulley taken from a parts car that didn't have AC. The same part is used on cars with and without Citromatic. Replacing this pulley is no easy job. The steering rack has to be removed.

Camshaft pulley loose rivets replaced with 1/4" x 20 screws and nuts
Don James, OH (Jun. 1988, p.22)

One common failure on D-models is the sheet metal pulley that is used to drive all of the accessories that need to be powered by the engine. One failure mode is for the rivets in the hub to work loose and allow the sheet metal to work back and forth. This wears the holes out and eventually the rivets shear. It is easy to spot this common ailment by firmly twisting the pulley back and forth while looking at the nut on the shaft to be sure it moves with the pulley, particularly at the limits of "play." This test is also useful for checking timing chain wear or play.

If the rivets are working loose, a fix is shown above. Drill out the rivets and then drill and tap for 1/4-20 screws. These will replace the loose rivets and grip tightly. It requires drilling out enough material so that it usually takes out any elongation in the rivet holes.

The other failure mode is when the large nut that retains the pulley to the end of the camshaft comes loose or was not tightened. This will strip the spline inside the pulley hub. The only fix is to replace the pulley.

Camshaft pulley loose rivets replaced with allen cap screws
Ken Butler, NM (Apr. 1989, p.11)

Drive to the camshaft pulley is through six 1/8" (or so) rivets that hold the sheet metal V-belt sheaves to the steel hub, splined onto the camshaft. This may be improved by drilling out the soft rivets one at a time, then tapping the hole for #10 Allen cap screws and installing check nuts on these and riveting over the projecting screws. Allen bolts are hardened and far stronger than soft rivets.

A permanent fix is obtained by having a plate of 1/16" steel turned by a shop to a 5" outside diameter with a 1.900" bored in the center. This is tack welded to the hub of the sheave in six places and to the sheet metal of the larger sheave in six places. Alternate the welds from one side to the other to keep the sheave running true.

Camshaft pulley substitute hub has four screws to reach spline grooves
Dave Root, FL (May 1993, p.18)

A clattering, scraping noise from under the hood reminded me of several bad experiences with water pumps. So, I stopped the engine and turned the water pump by hand finding that it was turning very free as was everything else including the camshaft pulley, which of course should not have been turning, since the camshaft was not.

After removing the radiator, power steering, etc. in order to get at the problem, I found that the nut that was holding the pulley in place was just slightly loose enough so that the "working" of the pulley hub on its shaft had evidently led to wear. This ultimately caused the splines of the hub to shear out completely. The hardened splined shaft had acted like a reamer and had ground out the bore of the pulley's soft steel hub.

Assuming a new pulley assembly or a used one with a good hub would be very expensive and time-consuming to locate, I elected to make a new hub on my lathe. I used the diameter of the camshaft as the bore of the hub. The outer small OD of the hub 1/8" was longer than the original to allow for tapping four 10-32 x 3/8" long set screws, tapped at an angle so that they could reach into the spline grooves of the camshaft. They were placed 90 degrees apart so that they could each reach the bottom of the groove of the splines on the camshaft.

I used 10-24 flat-head machine screws to fasten the hub onto the pulley rather than rivets, then peened the screws over to keep the nuts from loosening. To keep the set screws from ever loosening I used a steel collar to slip over the outer small hub with the same thickness as the length of the small outer hub. This was made to bear on the setscrews so they could not back out.

The big outer nut holding the pulley on had a lock-plate made of sheet metal with ears bent onto the flats of the hex to hold it tight. I tightened the nut with a hinge handle and long pipe for leverage to get it tight.

Editor: This is not a good idea, as the high load on the four setscrews can damage the spline on the end of the camshaft. Do not operate an air conditioner with this substitute.

Cylinder firing order
Ken Betsh, PA (960612)

If you are confused over details of your D-model engine other members thought everyone knew, this article is addressed to you. We'll conclude with firing order for the benefit of anyone faced with a car where all the spark plug wires are missing and must be replaced with unmarked and uncut wire.

The first thing to know is the four cylinders are numbered 1 thru 4 starting at the front of the car. If you forget or doubt this, you'll find the numbers cast into the engine valve cover near the spark plug holes. If you were to see the engine with the head removed, you'd note the center two pistons (cylinders #2 and #3) are in the same up/down position. The piston in cylinder #1 is in the same position as that in #4 but this pair is opposite that of the other pair. If the main shaft of the engine (called the crankshaft) is turned 180 degrees, the position of the four pistons would be reversed. The crank that can be inserted in the front of the transmission is directly connected through the clutch to the crankshaft. Turn it 360 degrees and the pistons move and return to their original position. But, the engine is not back to where it was.

The reason it is not really back to where it was is that it is a four-stroke engine. You must turn the crank two full turns to complete one engine cycle. During stroke #1 as the piston goes down from a top position, the inlet valve for that cylinder (toward the left side of the car) opens and the suction from the increasing volume pulls in air with vaporized gasoline. By the time the piston is all the way down this valve closes (and the outlet valve stays closed) so that on stroke #2 the trapped content is compressed as the piston moves to the top. The ratio of the enclosed volume when the piston was at the bottom to what it is at the top is called the compression ratio (8.75 for the DS21). When the piston is at the top the second time, the ignition system causes an arc at the spark plug to start the gasoline mixture to burn, or to be more precise, start a controlled explosion. The resulting pressure pushes the piston down for stroke #3. As the piston comes up again for stroke #4, the exhaust valve (toward the right side of the car) opens and the explosion byproducts are pushed by the piston into the exhaust system.

Now the full cycle can repeat. As one cylinder goes thru each of these strokes, each of the other three cylinders are in each of the other three strokes.

The engine valves and ignition are controlled by a separate shaft that only makes one revolution for every two revolutions of the main engine shaft (crankshaft). Because of eight cams ground into this second shaft to control the eight engine valves, it is called the camshaft. Heavy springs keep the valves closed except when pushrods riding the cams push rocker arms to make the valves open.

One electrical circuit generates the spark for all four cylinders and is directed to the proper spark plug by the distributor. The distributor is geared one-to-one to the camshaft–the rotor makes one full revolution for every two turns of the crank or crankshaft.

With the relative positions of the four pistons, it's obvious the four cylinders can not fire in direct sequence. You couldn't fire #3 immediately after #2 and couldn't go back to #1 just after #4. While there are two choices of sequence, Citroen chose 1-3-4-2. While moving the spark plug wires to change the sequence is easy, the design of the cams on the camshaft leave no option.

The coupling between the crankshaft and camshaft is via a chain at the back of the engine block with a unique means of taking up slack from wear and keeping the two shafts in an exact relative position. Both shafts turn clockwise when viewed from the front of the car in normal operation.

Incidentally, the pulley to which the water pump, alternator and hydraulic pump are belt driven is attached to an extension of the camshaft. If someone familiar with engines in conventional rear-wheel-driven cars wonders why this pulley is so big, it's because it turns at only half the speed of a pulley driven by the crankshaft in that other car.

The distributor rotor also turns clockwise. The gear coupling to the distributor shaft has some play could cause concern when adjusting the timing. Friction solves the problem. Because the rotor turns clockwise, it will be at the counter-clockwise extreme of the range the gear play allows it to be moved when not running. This is the reason the company tune-up procedure says to rotate the distributor housing counter-clockwise when adjusting the timing.

The device we call the distributor also contains the points to generate a series of four sparks for every revolution of the distributor. This is done with a four-sided cam on the shaft within the distributor. These points alternately open and short a condenser in series with the primary of the ignition coil. The big spark occurs at the instant they open. Incidentally, for long point life it is vital the condenser match the ignition coil.

The condenser for the '70-'72 cars (those with tachometers and a coil with a series resistor) is electrically different from that for the older D-models. The only matching of a condenser to the distributor is the mechanical mounting.

With the DS21 distributor mounted at the front of the engine block and using a cap with a flat top, the rotor is near the 11 o'clock position (looked at from the left side of the car) to fire #1 spark plug, 2 o'clock for #3, 5 o'clock for #4 and 8 o'clock for #2.

Ordinarily, the distributor can be removed and replaced without upsetting this sequence. The drive key has an offset that makes it almost impossible to make a mistake. However, if the distributor is disassembled, there is a right and wrong way to reattach the drive key and unfortunately, the shop manual doesn't tell which way is right. My only suggestion is mark down the relative position of the drive key offset and the keyway to position the rotor before taking anything apart.

The illusive hole to insert a timing pin behind the alternator allows you to position the engine at the point where the points should open. The pin falls into a slot in the flywheel, which is attached to the crankshaft. This could occur either when cylinder #1 or #4 should be firing. The camshaft pulley could be 180 degrees from showing any mark for an electronic timing light.

Cylinders counted from the front
Jack E. Davis, NM (Mar. 1997, p.17)

I sometimes think of my Citroën as the car with the bass-ackward engine. The D-model front-wheel-drive engine drivetrain setup starts at the front with the transmission, then the differential, and last, the engine. The flywheel is at the front of the engine–not at the rear as in most other cars.

My first attempt to get a '66 DS running after major engine work failed because I timed the ignition on the basis cylinder #1 is that farthest from the flywheel. While true in most all other cars, it's not the case in the D-model. It finally dawned on me that the #1 piston is nearest the flywheel, at the front. I removed the valve cover and found the valve timing didn't match up with my ignition timing. My confusion came from having the engine out of the vehicle, thinking I was working on a normal engine set up. All I had to do was change the plug wiring and the old Cit fired right up.

The engine had locked up while driving home from where I bought the car in Texas. Someone had installed a new oil filter incorrectly and the engine didn't receive sufficient oil pressure. This particular year model didn't have an oil pressure gauge or low oil pressure warning light. The crankshaft was damaged and had to be replaced.

(About now is when I would install a pressure gauge or connect an original-style light. [MB])

DS23 fuel injected engine in DS21 may be difficult
Don James, OH (920607)

Q. My son and I have stripped rust-free '65 DS21 Pallas to the lowest common denominator– anything that was not welded together was taken apart, stripped and painted. All hydraulic lines were replaced. Suspension parts are all LHM. Everything was going well, if five years of work can be called doing well.

Then I found a fuel injected DS23 motor and bought it. After a total rebuild, it started instantly. I knew all the parts were not attached because after three years I had forgotten where some things went. I am desperate to find someone with a fuel injected DS21 or DS23 who will give me or sell me some information. Can someone help me? --K. Reed Merrill

A. You have a splendid car, and it sounds like you have done a very complete restoration job on it. Changing to LHM fluid is always a good move if you are replacing all the hydraulics and rubber parts. Just be sure that you replace all of the rubber and don't miss anything or your system can become contaminated.

I do not think your choice of powerplants will be very easy for you. Parts for fuel-injected cars, as well as information about them is difficult if not impossible to find on this side of the pond. I should also imagine that you will have to do a bit of cutting on the frame's firewall in order to get enough room to install it. The DS23s are quite a bit noisier also, so you had better consider some sound-deadening material. It should be a real rocket if you can get it in there. But when it breaks, it will surely be more problems for you.

(Engine swaps are not a real challenge unless one tries to install a later engine into a very early car with a deeper footwell. DS21's all had 5 main bearing engines, so any 5 main bearing engine will fit without a lot of reworking. Fuel injection parts are much easier to get nowadays. Be warned that increased horsepower will require an update to your suspension spheres with stiffer damping.

Front wheel turns engine
Fred Nieuwenhuijs (Feb. 1996, p.9)

Instead of using the hand crank on my front-wheel drive Citroen, I jack up one front wheel, set gear in highest position and turn the wheel by hand. Totally harmless!

Head bolts hit with hammer may not snap off
Don "Red" Dellinger, PA (Jan. 1985, p.25)

D-model head bolts have a habit of seizing on their threads and snapping off when you remove them. This will happen most often on the bolts along the exhaust manifold side. The cause is the extra heat from the air injection system on pollution equipped cars. Cure is to smack the bolt heads real hard with a hammer before you remove them. Vibration will set them free.

Head gasket replacement cautions
Betsh, Ken (2003 #2, p.14)

Professional car mechanics will tell most do-it-yourself Citroën owners to not attempt to replace a head gasket if they've never done it before or don't have an "expert" looking over their shoulder. I've done it three times all alone. My first was on a 1960 ID with the old-style engine and once each on the two D-models that are now in my garage. In all three cases, the cars had "broken down" and couldn't be driven to the nearest gas station, let alone to a qualified Citroën service garage. It's been several years since I've last done it, but there are many details not easily forgotten.

The first concern was having all the necessary tools and replacement parts. I say this because one of my experiences was over 400 miles from home and I needed to borrow a torque wrench. That was a long time ago and I was lucky enough to be carrying an unused engine overhaul gasket kit that J. C. Whitney sold at a very reasonable price at that time (but no longer available).

Because the position of the top of the distributor was an obstacle in removing the head, I removed the entire distributor but not before turning the engine with the crank to where the points just opened (as determined by a voltmeter). This was to save time when later reinstalling it. After removing the distributor, I plugged its shaft hole with a small rag.

Then I disconnected the starter solenoid and verified the transmission was in neutral. Once the head was loosened, any intentional or accidental turning of the engine may have allowed some cylinder liners to lift with rising pistons. Breaking the bottom seals would have caused a major problem getting the liners back in place.

My next step was draining the radiator and removing the hoses to the water pump and removing the overflow water tank (except on the earlier car). I didn't, however, drain the water in the engine block. I removed heads with the intake manifold, the water pump and short interconnecting hose still in place. I always removed the carburetor for fear of damaging it while handling the head. While it was possible to lift off a head alone with the exhaust manifold in place (after disconnecting the exhaust "down" pipe), I've always worked with an assistant. The extra weight was just too much.

Getting the 16 head bolts loosened and removed can be a challenge. Even though they were originally tightened to the specified 44 foot-pounds, I've found they took a lot more torque to "break" them loose. While I've never had a bolt I couldn't loosen with a half-inch drive socket wrench and long handle, Red Dellinger said that he has found it necessary to hit the top of some bolts with a hammer to break the tension. I heard horror stories of the head of one of these bolts breaking off. Should this happen, I know I'd have to lift the head up off the broken bolt before trying to remove it.

Once all the bolts were removed, I was able to remove the head but only after lifting it up about a quarter-inch to clear a fixed center locating pin. First, I had to lift out the eight valve push rods. I marked them so they could be returned to their original positions.

Except for the time away from home, while I've had an engine head off, I took it to a machine shop where the valves could be reground. Most any shop can do this, but they may not have the proper replacement seals for the valve stems. If I had to guess a mileage for a valve job is needed or recommended, I'd say about 150,000 miles. I'm told a good sign that the valve stem seals are worn is oil in the exhaust upon starting that soon goes away.

While new head gaskets were installed dry (no added shellac or other sealant), I've found both the removed block and block top surfaces usually had hardened sealant residue which I removed.

I'm told aluminum heads such as on the D-models are susceptible to warping when overheated. However, I've never had the head surface reground in my three experiences nor wished I had.

Even if I was able to lift the head off the engine block alone, a helping, or at least a guiding hand, was almost essential in putting it back in place.

While there's a definite reassembly and tightening sequence to the head bolts, I initially replaced them and ran them up "finger-tight" in an undefined order, especially those holding the intake valve shaft assembly. The shop manuals start with the center bolt and progress alternately one-by-one to the front and rear ends. I first tightened to 22 foot-pounds torque and then repeated the sequence tightening to the specified 44 foot pounds. Along the way, the valve pushrods had to be reinstalled. Once this was done, I then readjusted the valves.

The final step in each case was to drain and replace the oil and oil filter before restarting the engine. Once done, in all three cases the engine (with the distributor properly set) quickly sprang to life and I had no head gasket leakage problems afterwards.

After driving the car for a few weeks, I slightly loosened the head bolts and retightened to 44 foot pounds, one by one. I also reset the valves.

Head gaskets available from Olson's Gaskets
Charles Fowler (Feb. 1990, p.3)

I just received a head gasket and intake/exhaust gasket made by Olson's Gaskets; 3059 Opdal Rd. Port Orchard, WA 983666, 206-871-1207. Service and quality is excellent. They will make a head gasket for D-models. They must have an old gasket or tracing.

Editor: This 1990 vendor information may no longer be valid. (It is, except the phone number is now 360-871-1207. info@olsonsgaskets.com. Head gaskets are now readily available. There is one gasket that would be a great candidate and that is the thick gasket between the head and air injection spacer on later smog equipped cars. [MB])

Hose between air cleaner and manifold
(Feb. 1994 p.17)

A reproduction foil hose for the air cleaner that ducts warm air from the exhaust manifold into the air cleaner is now available from Western Hemispheres. The hose accelerates engine warm-up in cold weather. Sold under part number DX171231A.

Editor: This 1994 vendor information may no longer be valid. (It is. Western Hemispheres part number is also still valid. [MB])

Idle troubles due to loose crankcase vent hose
Ken Betsh (2000 #3, p.13)

I recently found a new cause of idle troubles. The opening in the large hose between the air filter and carburetor for the crankcase vent tore loose. The resulting opening apparently changed the vacuum condition in the carburetor and as a result, slowed the idling.

Idle troubles may be located with leak-down test
Don James, OH (Mar. 1985, p.10)

I am still trying to adjust the idle on my '70 DS21. At idle, the engine "hunts" between 800 or 1200 RPM. Below 750 it just dies. This would indicate an air leak in the intake manifold. However, it is hard to imagine an engine that is 15 years old to suddenly develop a leaky intake manifold. I checked and changed all the vacuum hoses. Vacuum on the gage is very erratic. It varies from 17 to 21. A bad intake valve could also give this reaction. I guess I will have to give the engine an air "leak down test" and see if I can determine the cause. --Paul Fontaine

Editor: A leak down test is a good idea. It simply involves blowing air into the sparkplug hole with the engine at top dead center and both valves closed (firing position). Then listen for where the air is leaking from–exhaust pipe, exhaust valves, crankcase, piston rings.

I think you will find your valves are fine. A fifteen year old engine will probably have worn rings, even if no oil is burned. The ring end gaps open up as the engine wears, and air can be drawn into the cylinder by the vacuum on the intake stroke. This condition is developed over a period of time. Before worrying about the rings, check the easy things first. A restrictive exhaust can cause these problems. More likely a dirty or miss-adjusted carburetor is the cause of your problems.

Inner valve spring removal saves wear
Rod Burwell (Jan. 1983, p.8)

I removed the inner valve springs on my station wagon's engine. Removing the inner valve spring should save wear on lifters, cam, end rockers. I've driven the car for some time and find the engine will still rev over 5000 rpm. Most people never rev the D-model engine over the 5500 rpm red line. The engine does not pull well over about 4500 rpm.

From all my experience with the D-model engines, wear of the valve gear is the biggest problem. The lobes on the camshaft wear from the heavy spring pressure used to close the valves. I have found a place that regrinds the camshafts for me by welding up the worn lobes.

Editor: I don't think removing valve springs is a good idea and do not recommend it. There are two springs under each valve, one inside the other.

Motor mounts affect "feel" of the car
Don James, OH (Jan. 1985, p.25)

Bad motor mounts allow the engine to bounce up and down in the rear, which causes rapid failure of the exhaust system, clutch shudder, knocking or clunking noises as the ear hits the can, buzzing in the gear change lever on manual cars and brake shudder on hard stops. These mounts must control engine torque reaction as well as drive and braking torque. The only thing that can make as big a difference as new motor mounts in the way your car "feels" is replacing your spheres.

Mounts are removed as an entire assembly as shown in the drawing. Place a jack under the rear of the engine to support it while you work. A special distributor wrench with a bend in it makes a fine tool for removing the three bolts that are hidden by the exhaust manifold. If your car is Citromatic, you will need to remove the intake manifold.

Motor mounts should be changed in pairs, but it is easy to see why some enthusiasts only replace the exhaust side on Citromatic cars. The exhaust side is usually the worst because that is the direction of engine torque reaction and the heat from the manifold causes early failure. If only one mount is changed and the other is collapsed, all of the weight of the engine is on the new mount and could cause early failure (but it might be worth the risk on a car with Citromatic).

All motor mounts are bad if they have never been changed during the life of the car. There is only a question of degree. You would be flat too if you had an engine sitting on you for 12 years! The worst cases are when the ear from the block is hitting on the metal motor mount can. You can see this easily with a flashlight. Height of the mount is not real critical, but they must both be adjusted the same. The dimension shown in the drawing is with weight on the mount and this is a little hard to judge if the engine is still in the car. I have set mine at 96 mm with no weight on the mount and have had no problems.

Motor mounts affect engine vibration transmitted to car
Don James, OH (Sep. 1984, p.23)

Q. Motor mounts have been a frustration with my nice '72 D-model lately. New ones seem OK for three to six months, then they no longer isolate engine vibration, resulting in this vibration being transmitted to the body structure. When the car was new, this was never a problem. What has changed? --Frank Starr

A. You are not the first one to notice this problem. I don't know if the mounts have changed or if they are selling "old stock", but it is true that the factory mounts do not hold up. J.B.M. Industries has the cure. Our motor mount inserts are made to be installed in your old can. They solve the problem and cost half as much! Mounts should be installed in pairs for best results. These are very popular and not only solve the vibration, but brake and clutch chatter as well. Instructions on how to install them have been in a previous issue of the newsletter. Be sure that you replace the sheet metal disc when you install the new mounts. This is a heat shield for the mount on the exhaust side. It doesn't look like much but it is needed. Heat and pressure cause mount failure.

Motor mount removal
Betsh, Ken (2001 #3, p.13 & 2002 #1, p.9 - rewritten)

Shortly after raising the rear of the engine in my D-model the first time to replace the motor mounts, I found it necessary to replace the exhaust flex pipe. A crack developed at the joint where the front end of the flexible portion was welded to a short sleeve. The flexible portion had become rigid with age and raising the engine block placed a lot of stress on this joint. Because the arms connecting the motor mounts to the engine block needed to clear the center stud of the mounts, I raised the engine block several inches. The next time I did the job, to aid in removing the starter, the following method was used.

I lifted the engine block sufficiently to relieve the weight on the motor mounts and then removed them by unbolting the short arms attached to the top of the motor mounts from the side of the engine block. Three bolts threaded into the block.

The operation was done with the hydraulic suspension pressure fully released, the car in its all-the-way-down position. The engine was supported by placing a short wooden block crosswise on my garage floor so that the cast-in, front-to-back ridges on the engine bottom cover near the oil drain and oil filter cover rested on the block, but NOT on the drain or filter cover themselves.

To determine the desired height of the wood block to go under the oil pan, I started with the car all the way down, then slid a 2x4 flat-side under the car to this contact point and "eye-balled" how much more was needed to just clear this space. This was a real hands-and-knees operation and I did it without getting or reaching under the car. I then added about an inch more thickness. As I write this I don't remember how thick the block needed to be but I seem to recall a couple of pieces of 2x4 flat side with perhaps a piece of 1x4 did the job.

The next step was to remove the engine air filter assembly and the sheet-metal shield over the exhaust manifold. Needless to say, this had to be done with the engine cold. Before lifting the engine, I removed the two anchor bolts at the base of each motor mount. I did this on both sides even though I, was only removing the right-side motor mount. It helped in the disassembly if I first loosen the large nut holding the arm to the top of the center stub of the motor mount. This would not be necessary on the left side if only working on the right side.

After raising the car to the normal driving position, I used a three or four foot piece of 2x4 to push the spacer blocks into place. I then released the suspension pressure and watched as the car dropped, with the rear of the engine lifting a bit above the surrounding body. The wooden blocks pressed on the oil pan, the bottom of each motor mount lifted about a quarter to three-quarters of an inch above the base they normally set on.

With the suspension pressure released, it was now possible to temporarily remove the front spheres to provide greater access space. I covered the top of the resulting open suspension cylinder so dirt wouldn't fall in.

When removing and reinstalling a mount for reason, such as removing the starter, I found this to be the opportune time to adjust the final height of both mounts. Even if they were balanced when originally installed, which they should have been, it's likely the much greater heat on the right side from the exhaust may have caused the right-side mount to sag or compressed more than the other side. Any adjustment can be made by turning the lower nut on the stud, the one I didn't have to touch in order to remove the mount. Otherwise take care this nut doesn't move.

Motor mounts replacement procedure
Dave Root, FL (Dec. 1983, p.14 & Jan. 1990, p.8)

If the rubbers in the mounts collapse to the point that the bracket fastened to the engine is resting on the metal of the mount housing, you get vibration from the engine and maybe a clunk when you hit a big bump. Then it is time for some alarm, but first, try this:

ADJUSTING OLD MOUNTS

1. Loosen the top hex nut on the mount if you can. For this you need a 27 mm or 1-1/16" open end wrench. On the passenger side this should be easy especially if you remove the sphere. But on the driver's side where space is limited, especially with Citromatic, you can swing a wrench about 4" long (I made one out of a piece of 3/16" x 2" steel). This works if the nut is not too tight. If it is, you might want to take the mount out. If you can get the top nut loose on both sides, remove them. Unless your elbows, wrists, and fingers bend a different way then mine you will find that to get to the driver's side mount you will have to lie on top of the engine on your stomach and reach in toward the back of the mount with your left hand. You can feel the nut and get a wrench on it, but you can't see it if you have Citromatic.

2. If you got the nuts off, raise the car to high position and put jack stands under the jacking points just behind the front wheels. Then using a floor jack, raise the engine, but stop when you feel resistance.

3. Reach under the sheet metal shields and turn the bottom nuts up on the studs 4 or 5 turns (these nuts should turn freely by hand since there is now no weight on them).

4. Now let the engine back down, put the hex nuts back on the studs and tighten them. Start the engine (after the sphere is on and the car is backed off the stands). If you still have much vibration and/or if you, like me, like a challenge and/or are a glutton for punishment, proceed to remove the mounts.

REMOVING ENGINE MOUNTS

Before doing this you need new rubbers or rebuilt mounts, either of which you can get from J.B.M. The passenger side mount is much easier to remove than the driver's side one. It helps to slot the upper and back bottom holes of the bracket horizontally so that bolts may be started before putting the bracket in place, since it is hard to get your hands in to start them afterwards. The following suggested procedure is submitted for those who may have a need and feel brave enough to want to try it.

1. Drain the radiator.

2. Remove all 4 of the bolts that hold the mounts down (2 per side). You will need a 14 mm or 9/16" universal swivel socket, and 18" extension and a ratchet.

3. Raise the car to top height and put jack stands under jack points just back of the front wheels.

4. With hydraulic or screw jack, raise the engine just enough so that the weight is off the mounts (check by seeing that the mount bases will swivel easily by hand).

5. Release hydraulic pressure and remove passenger side sphere.

6. Remove the three mounting bracket bolts--they have 14 mm heads. Slide mount out. Optional–slot upper and back mounting holes as mentioned above for easier reassembly.

7. On the driver's side, lying on your back and looking up through the large opening around the axle, remove the following obstructions: fuel pump, oil pressure sender unit, oil dipstick and tube (use short 11/16" open end wrench for this). Take hose off of bottom of intake manifold and push it up out of the way. Now you can remove the front bracket mounting screw (11 mm). Sometimes in this step you can work better by shining your light and looking up through the opening that is just beside the crankcase and working with your left arm up through the large opening around the axle.

8. The top bracket mounting bolt (14 mm) and the rear bracket mounting bolt (11 mm) now need to be removed from above. I found the best way to do this was to lie cross-ways on the engine with your head over the driver's side of the engine. It is best to lay a rug over the engine and passenger side fender, unless you want to go through life with a permanent indentation in your chest in the shape of a D-model air cleaner. This also helps when you dismount–you just give a push and slide off over the fender–about the only fun part of the whole job! To reach down through the limited space, your left arm or hand cannot be fat or

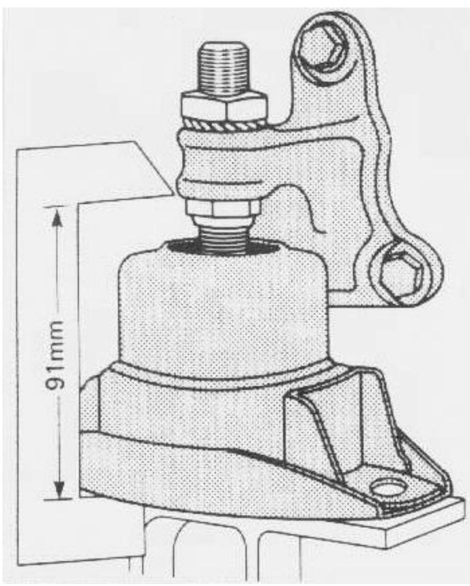
very muscular or you will get stuck. A wristwatch or long-sleeve wouldn't let you ever make it to the bolt head with your wrench and...don't expect to see the bolt heads, but you can feel them and get a wrench on them.

9. Now from the bottom again with all the bolts out, you can feed the mount down through the opening, turning it every which way. If you lose patience like I did, you can help the space problem by removing the two bolts that hold the parking brake caliper in place and sliding it up out of the way.

10. To rebuild your mounts, drill out the rivets or spot welds, pull out the old bottom rubber and put in the new one. When reassembling, small flat-head machine screws can be used. One in each end is enough as they are only needed for alignment until the mount is installed.

11. Reposition the brackets on studs making the distance from base of mount to bottom of bracket eye surface 3-5/8". Nuts need not be super tight.

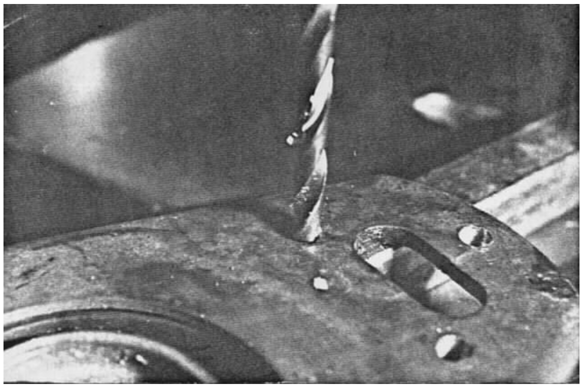
12. To reinstall the mounts, reverse the above procedure. Because of some discrepancy of my particular car, some vibration was still present after my last "operation," but I was able to correct it by raising the engine about 3/8" higher on the driver's side.



Editor: Dave's 1983 article just covered changing the right-side mount. One side should not be changed without changing the other. The above picture submitted by Ken Hiner shows the factory specified adjusted height WITH the weight of the engine on it. Start with a distance of 96mm with no weight on it.

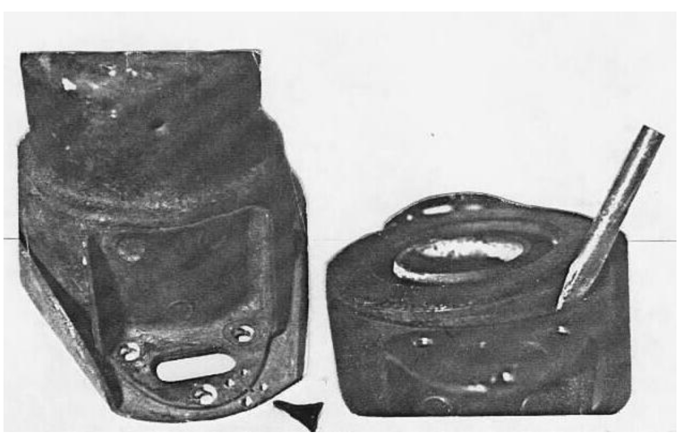
Motor mounts rubber core replacement
Don James, OH (Jan. 1982, p.8)

DISASSEMBLY AND PREPARATION



1. Drill out the spot welds where you see the dimples on the bottom of the mount as shown below. Use a 3/16" drill or any size to match the rivets that you will use to fasten the cans together again.

2. Chamfer the rivet holes with a larger size drill or a counter-sink.

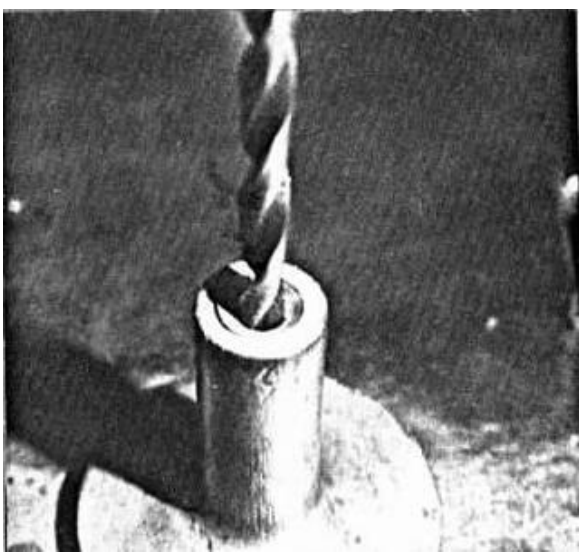


3. Use a prick-punch or other type of "match mark" tool on the halves of the can as shown, upper left, to aid in reassembly.

4. Separate the can halves. While normally easy with the spot welds drilled out, stubborn ones may need the aid of a chisel.

5. Pry the old rubber from the can. It may be necessary to roll a screwdriver around the inside of the can as shown, upper right, to loosen the old rubber.

6. Remove the center shaft from the old rubber by using a large drill as shown above to remove the portion of the shaft that is headed over. This will allow removal of the washer from the end of the shaft.



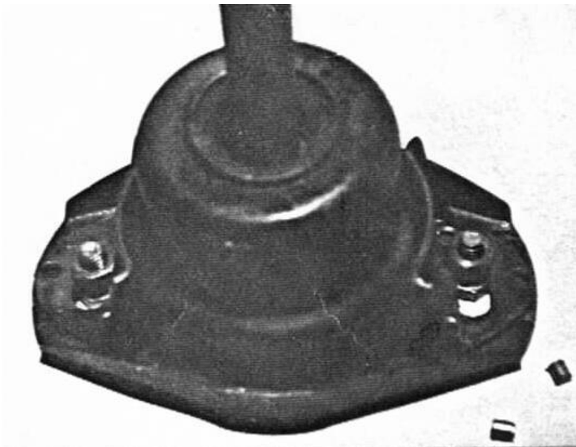
7. Drill the end of the shaft as above so it can be tapped for a retaining screw. The shaft is very tough. Use an oversize "tap drill" to prevent breakage of the tap. Drill 7/32" for a 1/4”-20 tap or use the same idea on any suitable size metric tap and screw.

8. Wire brush the shaft and the can to remove dirt and rust. Pound out any dents in the can. A separate piece of rubber in the upper part of the can is reused. Note its position if removed so that it is replaced right-side up.

REASSEMBLY

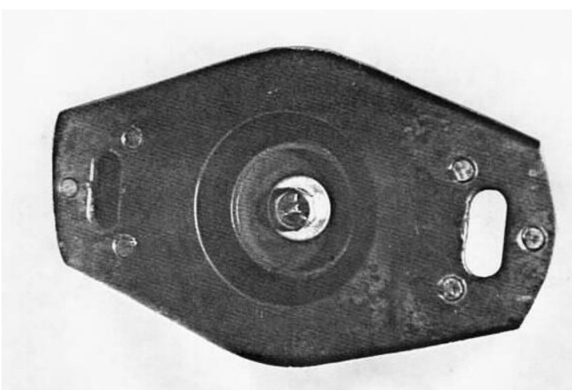
9. Reassemble center shaft to the new rubber. Put a drop of epoxy glue (Loctite Blue [MB]) on the threads of the small retaining screw placed in the newly-tapped hole so that it will not vibrate loose.

10. Insert the shaft and new rubber assembly in the upper can half. Baby powder in the can and on the new rubber will make it easy to push into the can. Do not use motor oil to lubricate any part of the motor mount. Be sure the separate reused rubber piece in the top of the can is in its original position. The new motor mount rubber must not protrude from the metal can by more than 1/8" before pulling down to rivet. Some mounts have a thicker top rubber that must be sawed thinner to 3/8".



11. Temporarily use some bolts and nuts to draw the halves of the cans together as shown above for riveting. If correctly reassembled, the holes in the two halves for rivets will line up.

12. Install three rivets at each end. You can place small pieces of steel in any extra holes. Small slugs of steel are available at hardware stores in the form of steel rods. Head them over on an anvil with a ball-peen hammer and a drift punch. The bottom of the reassembled motor mount should look like this:



Noise like bad rod bearings from bent valve causes extra work
Ken Nelson (May 1992, p.9)

My '70 DS wagon sat over a year in the driveway with the engine still in the car while I rebuilt the transmission. After reinstalling the gearbox, I cranked the engine over with the starter and instantly got a loud "clang-clang" from the engine. Nervously, I checked the installation over to make sure the alternator fan or something else was not hitting another part. Nothing looked amiss. Carefully hand cranking the engine to see if the noise was still there, I heard nothing except wheezing cylinders and felt nothing abnormal in its resistance to cranking. Gingerly, I blipped the starter solenoid to find the noise was gone. The engine finally caught, and sounded normal.

Six months later, we drove the car to Florida and stopped in Greenville, SC, on the return to visit my wife's brother for Thanksgiving. The car had run perfectly thus far. Thirty minutes after parking in my brother-in-law's driveway, I went to move the wagon so his wife could get her car out. The engine fired immediately and made horrible knocking noises that sounded very much like a bad connecting rod big end bearing. I was stunned. Breaking out in a cold sweat, I thought, "how could it sound like this after behaving perfectly normal when I shut it off"? At this point the car had traveled about 1000 miles since the gearbox installation.

Not believing my ears, I fired her up again to hear the same ominous clatter which was synchronized with engine RPM, but sounded slightly erratic in form. The noise sounded like it was coming from within the engine, a strong metallic "clang-clang-clink-clang" deep enough in tone to indicate something around the crankshaft. I've heard bad rod bearings before, and this sounded very close to it. Shutting down again, I just sat there in disbelief, unable to imagine how something this catastrophic-sounding could have happened as suddenly as if someone had thrown a switch. Engine bearings don't fail like this! The noise always starts small, giving increasing warning that they're getting worse.

I checked the oil immediately for signs of metal particles: nothing. I pulled each plug wire loose in turn while the engine was running to see if the sound changed–a bad bearing knock will most always change sound, decreasing when the appropriate cylinder stops firing. The noise didn't change. I listened to the engine from all sides, even making a stethoscope from a length of thin tubing and putting it to the engine and my ear.

In all my then 13 years of Citroen experience, doing all my own work, I could only conclude that the only way to find the noise and fix it was to pull the engine–at which point I nearly got sick. We were 900 miles from home, it was Tuesday of Thanksgiving week, and I had to be back for work the next Monday. And all I had with me was my large toolbox. What in blazes could it be? The thought of telling my wife we had a major problem was odious, as it gave her additional justification for pointing out the folly of my obsession with these cars.

Ashen-faced, I asked my brother-in-law if I could hole up in his garage for the remainder of the week while everyone else went to Grandma's for Thanksgiving. He graciously agreed and even left me a car for local parts gathering. Figuring I had 3.5 days to "fix it or forget it," I rented a towable engine hoist, picked up a roadkill muffler in case I decided to run the engine on the floor and proceeded to scatter Citroen parts all over the garage.

I pulled the engine and transmission out together, ran it on the floor–same noise, no new clues. I developed a genuine hate for Citromatic hydraulic pipes running everywhere, messing up access during the extraction (have since learned how to eliminate most of the clutter of Citromatic – another story later). I dropped the oilpan–spanking clean, no metal anywhere. I bought Plastigage, pulled all the rod and main bearing caps, checked clearances with this hair-like plastic thread. Everything was perfectly normal. Now I was getting really crazy! I re-torqued the caps, reinstalled the pan, ran engine on floor–same noise!

Retreating to the local White Castle burger joint whose minipucks kept me alive, I figured it the noise wasn't coming from the bottom, the only thing left to look at was the top. By this time, it was Friday noon, and I still was utterly baffled and running out of time. After pulling all the headbolts, breaking one off in the process, I found I was so stupefied with exhaustion, that I couldn't lift the head off complete with manifolds (completely forgot I had an engine hoist that easily could have picked it off). Instead, I pulled off the intake manifold to lighten the head and stared in disbelief at the No. 3 intake port, where two chunks of what remained of the end of the intake valve guide sat on top of the valve head. That's what caused the knock! Well, even more reason to take the head off.

Summoning enough energy to lift off the head, I found to my horror that this engine had the only composite, not copper jacketed, head gasket I had ever seen. And of course half of it was stuck to the head and half to the block!

One headbolt down, one valve guide down, one headgasket down and it's 4:00, Friday! So I did the only thing I could in my state of utter exhaustion and frustration. I sat down and cried. I realized then I had created my own catastrophe 1000 miles earlier when I first cranked the engine over after letting it sit for a year. The clanging noise I had heard first after installing the gearbox was the No. 3 intake valve sticking open due to surface rust on its shaft from lack of exercise. Airborne moisture coming in thru the air filter and the open exhaust pipe had condensed on the shaft during the frosty winter and the surface rust kept the valve from closing (it had been open all that time) when the engine cranked. Of course, the piston hit the valve head several times, popping it closed with a CLANG because the rocker arm had already retreated. After two to four clangs, the rust wore down to where the valve operated normally, but the piston hits had already bent the valve stem slightly.

Although the bend was not enough to prevent the valve from sealing well enough for the engine to sound and act normal, it was enough to put a slight side load on the guide end in the intake passage. A thousand miles of running had fatigue-cycled the guide so it broke off where it stuck out of the head metal, then floated up and down the valve stem until it split in several pieces. It must have picked the time I went to move the car to fall apart and rattle on the backside of the intake valve. Fortunately, no big pieces went through the engine. The odd thing was why this failure should sound so much like a connecting rod bearing failure–it had me completely snookered.

Finally finding the problem did little to help since the next panic was that it was 4:00 on a Friday and I needed three totally unavailable parts–or so I thought.

Necessity is definitely a mother, so I decided there had to be other engines with similar sized parts, so I called an auto parts place with machine shop service, raced across town with my ailing head (getting a ticket in the process) and cried "help!" While the parts guy, a counterman and a machinist studied the head and their parts stock, I visited a Mercedes and Toyota dealer and others looking for valve guides of the same inside and outside dimensions.

One Toyota guide I found looked within 0.002 inch of the right OD and did have the right I.D., but I was so tired I rejected it as being not close enough for a proper press fit. To my amazement, back at the shop the parts guy had found the same Toyota guide I rejected was indeed the right size, with a minor difference on its port end, but fit just fine. The machinist had already installed it, stuck the bent valve in his lathe to hammer the head straight and check shaft straightness, then ground all the intake valves and seats. The parts guy had made a new headbolt with a metric die, but all three people had no idea how to replace the head gasket. I thanked them profusely for their ingenuity, then had to pick my jaw up off the floor when they only charged me $12.50. If I told them to double, triple it, but they refused.

I left with a can of Brakleen degreaser and a can of Permatex Red high temperature liquid gasket sealer in hopes I could piece the head gasket back together. That evening I cleaned each gasket half on head and block with Brakleen, tweezers and a toothbrush to remove loose particles that might prevent the two surfaces from coming together tightly. After double checking both surfaces, I slathered them with several coats of Permatex. I carefully lowered the head onto the block using two head bolts as guides along with the single dowel pin.

It went together like a Chinese puzzle so I torqued the bolts and ran the engine on the floor again with the roadkill muffler to heat-cycle the gasket and re-torqued it to improve the seal and also checked the oil for water and vice-versa. Then I set the valve clearances and reinstalled the whole drivetrain in the car.

We were back on the road late Saturday. The temperature gauge ran a little hot in spite of being November, so I sweated bullets fearing the Frankenstein gasket would let go–but it held.

We made it home, I never did replace the gasket, and to this day I find it hard to believe this crazy idea worked. It just goes to show that when you're desperate, strange fixes can sometimes save the day.

MORAL-Never crank an engine over with the starter if the engine has been sitting for a long period of time. ALWAYS HAND-CRANK IT FIRST to avoid bending a valve.

Noise like knocking or slacking due to loose camshaft pulley
Bob James, OH (Oct. 1982, p.7)

A knock or slacking noise in my '65 ID19 was traced to a loose nut on the camshaft pulley that drives the water pump and other accessories. It might be a good idea to put some Loctite on the nut or at least check it for tightness.

Editor: See several articles under "Engine - Camshaft Pulley."

Oil checks made with car on level, wait after stopping engine
Ken Betsh, PA (May 1999, p.13)

First advice we old-timers have for new D-model owners is to only check the oil level when the car is really level; that is, it won't roll if out of gear with no brakes applied and is also level from side to side. You should also wait at least five minutes after the engine has been stopped.

Oil consumption blamed on low engine compression
D. Lowell Nissley, FL (Apr. 1991, p.7-condensed)

Using a 21 year old DS to pull a trailer from Florida to Pennsylvania started with a upbeat, optimistic frame of mind–and a dead battery. Four hundred miles later, I checked the oil just in case it might be down a bit. Wow, it was three quarts low! I walked 1/4 mile to an auto parts store and purchased a case of Castrol 20W50 oil. Two hundred miles later it became obvious that the engine was pumping oil into the air cleaner at the rate of one quart per hundred miles. The oil then ran down on the manifold where it smoked profusely.

I called reliable Ralph Cudworth at Cituations for advice. He suggested that the crankcase breather hose may have kinked allowing crankcase pressure to build up. As an emergency measure I removed the tired, flabby and rotted breather hose to allow the engine to breathe.

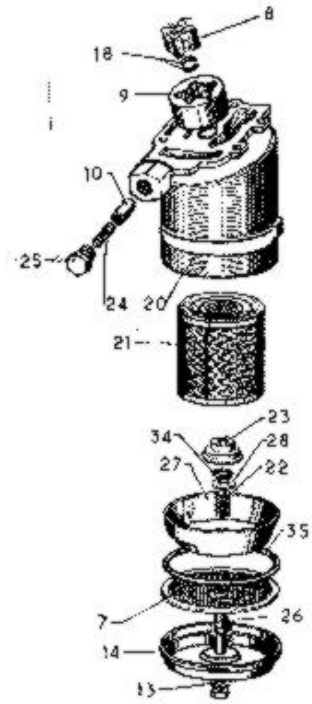
Two hundred miles later, oil no longer pumped into the air cleaner, but now sprayed against the firewall on the driver's side, efficiently smelling up the car interior with old oil smell. Also, the engine was running very poorly and was difficult to start once stopped. I removed the plugs and wondered how the thing ran at all. I've seldom seen plugs burned and fouled worse. I just happened to have a set of new plugs, purchased about five years ago. The car now started and ran fine except for the continued use of one quart of oil per hundred miles and so much oil in the carburetor by this time that it would not idle.

Two days later I stopped at Red Dellinger's for a physical–for the car. Unfortunately, #1 cylinder had only 115 pounds compression and the others 130 instead of 155. The solution is major surgery–either open engine surgery or a transplant. Meanwhile, a can of STP and local driving helps delay the operation to such a time as selective surgery can be done.

Oil filler cap repair
Russ Spears, MD (Jun. 1994, p.9)

The top of my oil filler cap came off leaving the lower part in the valve cover tower. After carefully fishing it out–yes, it did fall inside–I found that it does snap together. I unsnapped it, glued the thing together, and replaced it after drying.

Oil filter and pump cross-section drawing
Don James, OH (May, 1993, p.14)

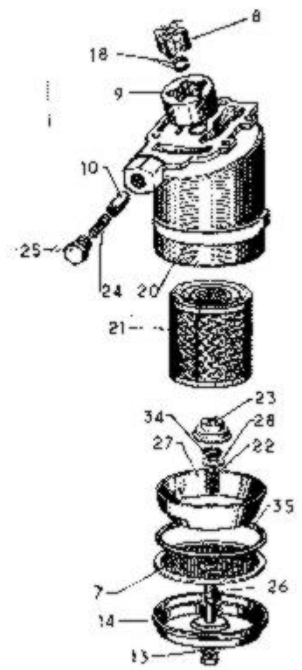


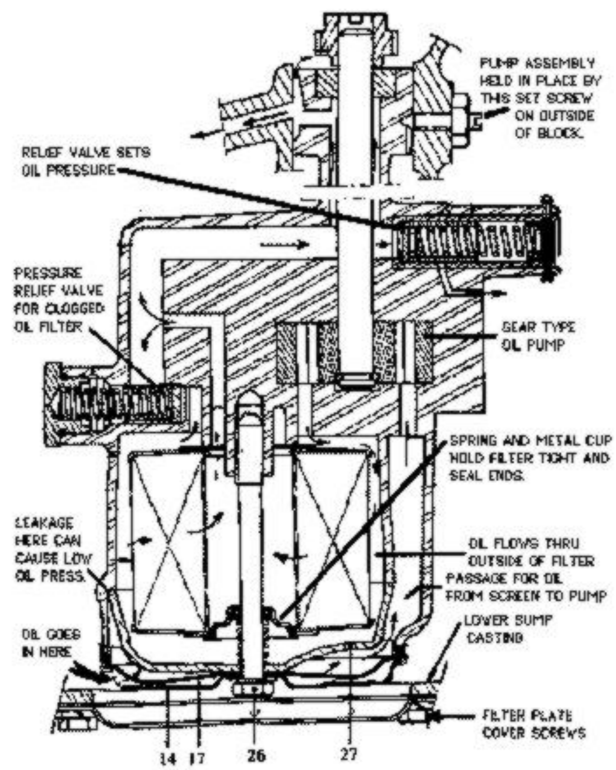
Oil enters the oil pump and filter housing through a sheet metal plate (#14, above), passes a coarse filter screen (#7), and then moves into a rectangular passage that goes outside of the filter housing to the pump gears. It is forced out of the pump into the filter chamber, passes through the filter element and exits from the center of the filter.

The danger here comes from the heavy steel stamping (#27) that serves as a cap for the filter housing. It is held by only one highly stressed central bolt (#26) that must retain the system oil pressure on the caps entire surface area. It is important that the central bolt be installed correctly and be tight. Otherwise, low oil pressure can result.

Oil filter assembly errors can ruin engine
Don James, OH (Nov. 1984, p.10 & Mar. 1986, p.31)

It is important that owners of D-models equipped with the 5-main bearing engine (since '65) are very careful when changing oil filters. It is one of the most important parts for the long life of your D-model engine. However, your oil filter may not be working. The problem comes from not understanding how the filter works. We've heard many stories about ruined engines when oil pressure is lost due to missing or loose parts in the oil filter system on D-models.

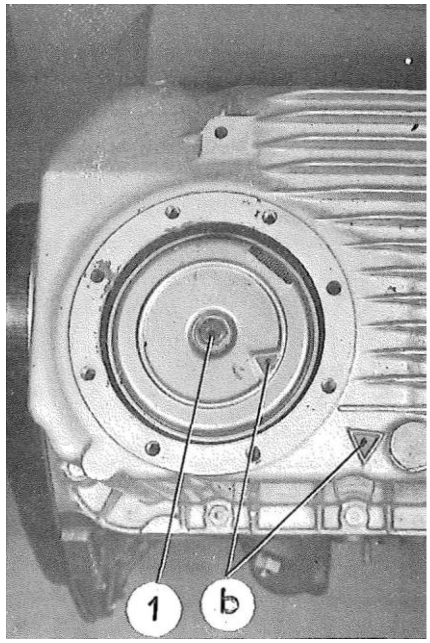




The oil is first sucked up an opening in a sheet metal plate (#14, above left), through a screen (#7), then up a channel along the side of the housing (#20), to the oil pump (#8 and #9) above. The oil pump puts the oil under pressure and forces it down into a chamber formed of housing (#20) and housing cap (#27). The heavy steel housing cap (or cup) must seal tightly to a small "step" or ledge inside the housing. It is only held in place by one bolt (#26) THAT MUST BE TIGHT. Otherwise, you will loose oil pressure. Figure the oil pressure in PSI times the square inch area of the cup, and you can understand the load on the cup and bolt assembly.

Now the part that causes filter trouble: The spring (#22) forces a washer (#28) and o-ring (#34) against the cup (#23). This spring and cup place tension on the oil filter (#21) and hold it tightly to the top of the housing, while at the same time sealing the bottom of the filter so that oil must flow from the outside to the inside of the filter, where it is then forced up into the top of the housing again, and on to the engine. Many owners have thrown away parts #22, 23, or 34. They do this because they do not know where the parts go, or what they are for. You can get away without the o-ring (#34), but you must have #23 and #22 for your filter to do any good. Oil will go around the filter if it is not held in place by the cup and spring. Another reason to be sure the long bolt is properly installed and TIGHT.

Another problem when changing filters is that the old rubber gasket may stick inside the top of the housing and not be removed with the old element. The rubber gasket can float sideways and possibly block the outlet holes.



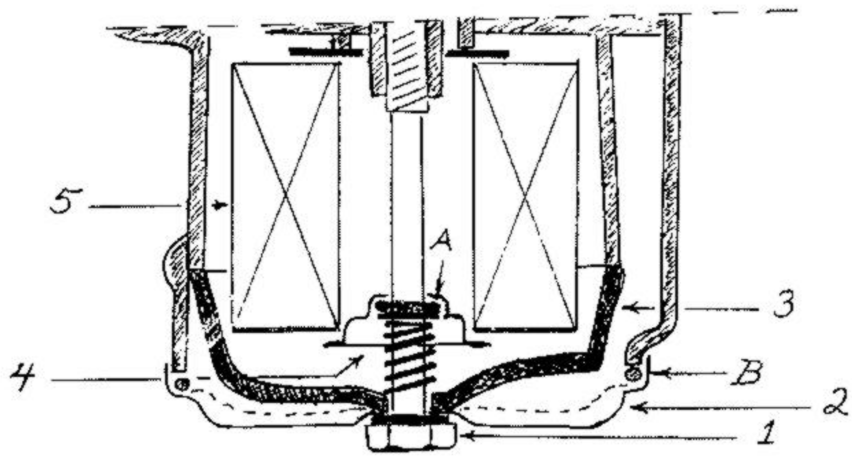
The sheet metal plate (#14) is well marked with a triangle that MUST line up with a triangle embossed in the oil pan of the engine next to the oil filter access. (I have added this picture, as it is vitally important and should not have been left out. Note the arrows (b). The one on the left corresponds to #14 in the other diagrams. These arrows point the SAME direction, not towards each other. This is VERY important! Bolt (1) is tightened ONLY to about 85 inch pounds, so be careful with it. [MB])

The gasket at the access cover plate (not shown) does not need to be changed with every filter change. Gaskets can last for years. Use Permatex or other gasket cement to "glue" the gasket to the cover plate. Smear grease on the "crankcase side" of the gasket to prevent it from sticking to the bottom of the case. Be sure to remove all traces of the old gasket when you install a new one. New gaskets can be cut from gasket paper that is available at any auto parts store.

Change your oil and filter often. The filter is very small for the size of the engine and, if not changed frequently, it will clog and the bypass valve (#10) will open. When this happens, your filter is doing no good. Be sure that your oil pressure warning light is working correctly and be sure to watch it closely after you change your filter. The lamp should go out within 20 seconds.

CAUTION: Over revving on cold mornings with thick oil can cause the pressure relief valve (not shown) to be forced back beyond its regular travel and stick in the open position causing loss of oil pressure.

Oil filter changing procedure
Lee, Peter (2001-2 Pg 11)



1. Drain the engine oil.
2. Remove 8 bolts securing access plate on bottom of oil pan. Remove plate and gasket.
3. Loosen and remove bolt #1, screen assembly #2, bowl #3, filter thrust cup #4, and filter element #5.
4. Wash screen in solvent and dry, replace seal "B."
5. Place components on bolt #1, in the following order, starting at the bolt head:
   copper washer
   #2 screen assembly
   #3 bowl
   spring
   steel washer
   seal "A"
   #4 filter thrust cup - Be very sure it is positioned as shown
   #5 filter cartridge
6. Screw bolt into pump, be sure it is straight. If slanted it could be missing its threaded hole and improper oil pressure may result.
7. Align two arrows, one on bottom of screen assembly and one on bottom of oil pan and tighten bolt #1 to 6 ft-lbs.
8. Replace gasket and reinstall access plate. Refill sump with 5 quarts of oil.
9. Oil pressure may be verified by observing #1 intake rocker arm visible through the oil filler hole of the rocker arm cover.

Oil filter O-rings need occasional replacement
Ken Betsh (2000 #4, p. 16)

Recently the oil-pressure warning light on our D-Wagon was flickering at low speed idle. While assuming the switch for it on the lower, left side of the engine block had degraded, I took the advice of my favorite Pennsylvania parts supplier when recently replacing the oil filter and replaced the two o-rings in the apparatus holding the filter. Voilà! (as the French would say), no more flickering. The old parts were so hard they broke into pieces when removed. However, this wasn't a full cure for the flickering light at idle, addressed in an article located in a carburetor chapter.

I have replaced the gasket perhaps every five years or so on the plate covering the filter and always put it back on in the same position as it was. The cover plate puts grooves into one side of the gasket, unlike an inner ridge, resulting from the otherwise flat surface, of the other side.

Oil is killing our cars
Keith Ansell, president, Foreign Parts Positively, Inc., www.foreignpartspositively.com / Tel: 360-882-3596

About a year ago I read about the reduction of zinc dithiophosphate (ZDDP) in the oils supplied with API approval that could affect sliding and high pressure (EP) friction in our cars. The reduction of these chemicals in supplied oil was based on the fact that zinc, manganese and/or phosphates reduce the effectiveness and eventually damage catalytic converters and introduce minute amounts of pollutants into our atmosphere.

A month or so ago I had a member of the Columbia Gorge MG Club bring a totally failed camshaft and lifters back to me that had only 900 miles on them! I immediately contacted the camshaft re-grinder and asked how this could happen. They were well aware of this problem as they were starting to have many failures of this type. In the past, the lack of a molybdenum disulfide camshaft assembly lubricant, at assembly, was about the only thing that could create this type of problem. My customer has assembled many engines and had lubricated the camshaft properly and followed correct break in procedures.

This got me on the phone to Delta Camshaft, one of our major suppliers. Then the bad news came out. It's today's "modern" API (American Petroleum Industry) approved oils that are killing our engines.

The next call was to another major camshaft supplier, both stock and performance, Crane. They now have an additive for whatever oil you are using during break-in so that the camshaft and lifters won't fail in an unreasonably short period of time. They also suggest using a diesel rated oil on flat tappet engines.

We then contacted Redline, a racing oil manufacturer that we use for the race cars. Their response was, "We are well aware of the problem and we still use the correct amounts of those additives in our products." They continued to tell me they are not producing API approved oils so they don't have to test and comply. Their oils were NOT the "new, improved and approved" ones that destroy flat tappet engines! "We just build the best lubricants possible." Sounds stupid, doesn't it, new, approved but inferior products, but it seems to be true for our cars.

To top this off, our representative from a major supplier of performance and street engine parts, EPWI, stopped by to "warn us" of the problem of the new oils on flat tappet engines. This was a call that the representative was making only because of this problem, to warn their engine builders! The reduction of the zinc, manganese and phosphates were causing very early destruction of cams and followers. They recommended that, for now at least, there must be a proper oil additive put in the first oil used on new engines, beyond the liberal use of molydisulfide assembly lube. The first oil was the time the additives were needed, but remained skeptical that the first change was all that was necessary. We should use diesel rated oils such as Delo or Rotella, usually available at auto stores and gas stations.

This problem is BIG! American Engine Rebuilder's Association (AERA) Bulletin #TB2333 (no longer available [MB]) directly addresses this problem. I had a short discussion with their engineer and he agreed with all that I had been finding.

Next phone call was to a retired engineer from Clevite, a major bearing and component manufacturer. First surprise was that he restored older British motor bikes. The second surprise was that he was "very" aware of this problem because many of the old bikes had rectangular tappets that couldn't rotate and were having a very large problem with the new oils. He has written an article for the British Bike community that verify all the "bad news" we have been finding.

Camp Cams put out Tech Bulletin 225, “Flat Tappet Camshafts.” http://www.compcams.com/Base/pdf/FlatTappetCamTechBulletin.pdf They have an assembly lube and an oil additive. The telling sentence in the bulletin was, "While this additive was originally developed specifically for break-in protection, subsequent testing has proven the durability benefits of its long term use. This special blend of additives promotes proper break-in and protects against premature cam and lifter failure by replacing some of the beneficial ingredients that the oil companies have been required to remove from the off the-shelf oil".

The next question is, “Now what do we do?”

Camshaft re-grinders, DeltaCam, recommended that we use oils rated for diesel engines. Delo from Standard Oil was named. It is about the same price as other quality petroleum based oils. They are not API formulated and have the zinc dithiophosphate we need in weights we are familiar with. Crane) recommended that we use their additive for at least the first 500 miles.

General Motors recommended adding EOS, their oil fortifier, to your oil. It's only about $12.00 for each oil change for an 8 ounce can. This problem seems to be something GM has known about for some time!

Redline Oil recommended their street formulated synthetics. They have what we need!

After over a week of contacts we verified that the major oil companies are aware of the problem. The major oil distributors Castrol, Redline, Valvoline and Industrial oils’ seem only aware of marketing programs and have no knowledge of formulation. The only major oil companies they were aware of doing anything to address this were Valvoline, who is offering an off road 20W-50 and Redline.

Castrol admitted to seeing a pattern emerging on older cars. The thought it might be advantageous to use a non-approved lubricant, such as oils that are Diesel rated, 4 Cycle Motorcycle oils and other specified diesel oils.

Last question: So what are we at Foreign Parts Positively going to do? After much research we are switching to Redline Street rated oils and stocking the Castrol products that are diesel rated. Castrol, owned by British Petroleum, is now just a brand name. This is a difficult decision as we have been a dealer and great believer in all Castrol Products for over 40 years. We have been using Castrol Syntech oil in new engines for about 3 years so the cost difference in changing to Redline is minimal. The actual cost in operation is also less as the additive package in Redline makes a l-year or up to 18,000 mile change recommended! Yes, it is a long change interval but with lowered sulfur levels and the elimination of lead and many other chemicals in the fuels there are less contaminants in our oil from the fuel, which is the major contributor to oil degradation. We will continue to offer the Castrol products but will now only stock the suggested diesel oils that they produce.

I have had the good fortune to have the ear of quite a few leaders in the industry including some wonderful input from Castrol. We have been very reluctant to "dump" Castrol, as it has been such a great supporter of our cars and industry over the years. Castrol hasn't really abandoned our cars, just shifted to a more mass marketing mode. Many Castrol products are not appropriate for our cars today, some still are.

Too many things are starting to show up on this subject and it has cost us money and time. Be aware that "new and improved", or even products we have been using for many years, are destroying our cars as it isn't the same stuff we were getting even a year ago.

For the cars that use engine oil in their gearboxes this may even pose a problem, as these additives that have been removed could be very critical in gear wear. We will be using oil specifically formulated for manual gearboxes with brass synchronizers. The only oils we are aware of that fit the criteria are from General Motors and Redline.

Now for the latest report:

Castrol GTX 20W-50 is still good for our cars after break-in. 10W-40, 10W-30 and other grades are NOT good. Absolute NOT GOOD for any oil (any brand) that is marked "Energy Conserving" in the API "donut" on the bottle, these oils are so low with ZDDP or other additives that they will destroy our cams. Virtually all diesel rated oils are acceptable.

Castrol HD 30 is a very good oil for break-in of new motors. This oil has one of the largest concentrations of ZDDP and moly to conserve our cams and tappets.

Only an unusual Castrol Syntec 20W-50 approaches the levels of protection we need when we look to the better synthetic lubricants. We are attempting to get this oil, but will be using Redline

10W-40 or 10W-30, as these are lighter weights for better performance, flow volume, less drag and have the additive package we need.

The trend today is to lighter weight oils to decrease drag, which increases mileage. Most of these seem to be the "Energy Conservation" oils that we cannot use.

Redline oil and others are suggesting a 3,000-mile break-in for new engines! Proper seating of rings with today's lubricants is taking that long to properly seal. Shifting to synthetics before that time will just burn a lot of oil and not run as well as hoped.

The energy conservation trend was lead by automakers first, to increase mileage numbers and secondly, because the ZDDP and other chemicals degrade the catalytic converter after extended miles, increasing pollution. We don't have catalytic converters and the mileage gains are not that significant for most of us.

For you science buffs, ZDDP is a single polar molecule that is attracted to iron based metals. The one polar end tends to "stand" the molecule up on the metal surface that it is bonded to by heat and friction. This forms a sacrificial layer to protect the base metal of the cam and tappet from contacting each other. Only at very high pressures on a flat tappet cam is this necessary because the oil is squeezed/wiped from the surface. This high pressure is also present on the gudgeon pin (wrist pin) in diesel engines, therefore the need for ZDDP in diesel engines.

Second part of the equation is molybdenum disulfide (moly). The moly bonds to the zinc, adding an additional, very slippery sacrificial layer to the metal. I found out that too much of the moly will create problems; lack of this material reduces the effectiveness of the ZDDP. The percentage, by weight is from .01 to .02%, not much, but necessary.

Latest conclusions: running our older, broken in engines on Castrol 20W-50 GTX is ok. Break in a new engine for 3,000 miles on HD 30 Castrol.

New engines (after break-in) and fairly low mileage engines will do best with the Redline 10W-40 or 10W-30 synthetic.

If you have any additional input let us know. We need to let every flat tappet engine owner, i.e.: every British car owner, know that things are changing and we must meet the challenge.

Oil is killing our cars - continued
Nebo Djurdjevic (2007 #3, p.16)

With three air-cooled Citroëns in my garage (two flat-four GS' and a flat-twin 2CV), I didn't sleep well after reading the article, "Oil is Killing our Cars," in the Spring 2007 Citroënthusiast. Just to recap in case you missed it, the article explained that the latest API specifications mandate a much lower content of anti-wear ZDDP additive compared to the oil formulations used at the time our classic cars were still in production. As a result, there is an increased number of incidents of premature wear and failure of camshafts and other major engine components. The ZDDP content is usually shown to contain zinc and phosphorus.

With the spring oil change routine around the comer, I commenced an in depth research trying to fully understand what is going on and find an adequate solution. One of the most useful sources of information can be found at Porsche 3S6 Registry web site https://porsche356registry.org/article/58. An excellent article by Charles Navarro from LN Engineering titled, "Modem Oils and an Air-Cooled Engine," explains the characteristics of air-cooled engines and the impact of the latest oil formulations with decreased content of zinc and phosphorus. The side bar which deals with the specific question, "What oil should I use in my 356?" was of great interest to me since the 356 has a flat-four, air-cooled engine. The article refers to another great piece on LN Engineering web page http://www.lnengineering.com/oil.html (Dead link. [MB]) that publishes a table with the test results showing the content of Zinc and Phosphorus found in various types of oils available in the USA and Canada. (This page seems to be unavailable, but I did find this http://lnengineering.com/resources/2014/02/28/oil-what-motor-oil-is-best-for-my-aircooled-porsche-or-any-high-performance-engine/ [MB])

The landscape was very grim - most of the oils I used and trusted in the past now have severely reduced content of zinc and phosphorus while keeping the same brand name. The articles mentioned above are very informative and I highly recommend them. However, if you are looking for the bottom line results, they boil down to securing the minimum content of 0.12% (1200ppm) for both zinc and phosphorus in your oil.

I looked at the specifications published by the major oil companies (e.g. Total, Castrol, Valvoline, Kendall, Redline) and found that some of them do not publish the content of zinc and phosphorus in their products. In order to make my research complete and get the specs for the current formulations, I contacted them either by phone or e-mail. For example, I spoke to a technical specialist from Redline and found that their current formulation for l5W-50 synthetic oil has 0.123% (1230ppm) of zinc and 0.11 % (1100ppm) of phosphorus. He also said that he would not recommend their l5W-40 formulation designed for diesel engines due to the much higher level of detergent than normally used in gasoline engines.

Looking at that "Citroën Prefere Total" sticker on the rear window of my cars and knowing that the factory recommended oil in the original user manuals for 2CV, GS and DS was Total GT 20W-40 or Total GTS 20W-5O, I was particularly interested in modem Total oils. Since the levels of zinc and phosphorus were not published in product sheets on Total's web site, I sent them an e-mail asking about mineral oil Total Quartz 5000 20W-50 and semi-synthetic oil Quartz 7000 15W-50. After a few days I received a response from Total Lubricants USA. They informed me that the Total/Elf oils (Total and Elf brands are owned by Total) use European formulations (ACEA specifications) that allow for higher level of zinc and phosphorus than American Petroleum Industry (API) specs, and they attached the requested data sheets. Quartz 5000 20W-50 has 0.109% (1090ppm) of zinc and 0.10% of phosphorus, while Quartz 7000 l5W-50 has 0.125% (1250ppm) of zinc and 0.118% (1180ppm) of phosphorus. Total's representative also advised that they have a network of retailers in the USA and Canada that carry Total/Elf products, and he provided the coordinates of a retailer in Toronto area. George Dyke visited the retailer a few days ago and I am sure that he will be kind enough to insert a note at the end about that experience. You can inquire about the retailers in your area by contacting:

CANADA: Andre Bolduc, Total Lubricants USA Inc., 1260 Crescent #201-12, Montreal, Qc, H3G 2A9, Canada

Tel: 418-681-0792/ 418-576-7712, Fax: 418-681-6647, email: andre.bolduc@total-us.com / www.elfoils.us

USA: Laurent Siret, Total Lubricants USA, 5 North Stiles Street, Linden, NJ 07036 Tel: 908-374-5063, Fax: 908-862-6885, email: laurent.siret@total-us.com

Postscript from George Dyke:
On May 17, I went over to Auto-Camping, the Toronto source for Total and ELF oils. They did not have Quartz 7000 or Quartz 5000 in stock. They said they would not be getting first shipments until late summer. However they did have Elf oils in stock. They recommended that we use Elf Excellium 5W50 for Citroën engines like the D and 2CV. Excellium 5W-50 cannot be used with catalytic converters. And they said that if your Citroën has a catalytic converter, like a late model CX, then go with Elf Excellium 10W-50. The Elf Excellium oils are old style products. While they meet the needs of older Citroëns and are the ideal "classic oil" to use, personally I would prefer the Quartz product because it uses the latest formulation and the zinc and potassium levels that we need.

What concerned me too is that, according to Citroën manuals, oil requirements are

SM - 20W-50
DS - 15W-40
GS - 20W-50
2CV - 20W-50
Traction Avant (4 & 6 cyl)

I am pleased to report that there are other oils that make the grade. Both Michael Stefanovic of CAC and CCNA member Richard Batchelor have been in touch with AMSOIL and here is what Ron Arner of AMSOIL Canada has to say:

AMSOIL has been a leader in the development of top of the line motor oils and other lubricants since 1972, when AMSOIL introduced the first API approved synthetic oil. It was warranted for 25,000 miles, or 40,000 km. AMSOIL introduced the concept of extended drain to the United States. AMSOIL purchases the highest quality additives available, to keep ahead of the competition.

Summary (AMSOIL):
AMSOIL 20W-50 (ARO) for your Citroëns, is high in both zinc and phosphorus. AMSOIL 20W-50 (ARO) contains over 1350 PPM of zinc, and over 1250 PPM of phosphorus. AMSOIL has a Technical Service Bulletin - MO-2006-l0-26, dealing with the subject "Flat Tappets and Camshaft Lubrication" and lower levels of zinc and phosphorus. It is available on AMSOIL's website, AMSOIL.com. And in that document are some interesting things:

The European Standard, ACEA,was introduced in 1996, so there would not be an ACEA spec for classic Citroëns.

The reduction of zinc and phosphorus, with ILSAC GF-4 applies generally to lower viscosity oils up to SAE30. However zinc and phosphorus are used for wear protection primarily because of low cost. There are other additives which are just as effective in wear prevention for these oils.

The standard for testing motor oils for wear prevention is the Four-Ball Wear Test (ASTM D-4172). Refer to page 2 of the Technical Service Bulletin for comparisons of oils. The smaller the wear scar, the better the protection. Three AMSOIL oils are tested: 0W-30, l0W-30, and 20W-50 (TRO) - modified for racing by the addition of friction modifiers. The wear scar for 20W-50 (TRO) is 0.43. The wear scar for 20W-50 (ARO) is 0.40.

So there are viable oil solutions for our Citroën's from both Total and AMSOIL. This is very good news indeed.

(The Amsoil site is now devoid of any such information. The sales information however, is very similar to that found on other synthetic oil makers' sites, such as Schaeffer http://www.schaefferoil.com/supreme-7000-racing-oil.html. [MB])

Oil leak due to missing lower timing chain cover screw
Ken Betsh, PA (Apr. 1993, p.15)

The need to add five quarts of oil during a 350 mile trip home was judged to be an external leak since the engine ran fine and there was no sign of oil in the exhaust. I found the cause after arriving home–the bottom screw holding the cover over the timing chain was missing. The missing screw provided an opening to an area fed by the oil pump–there was no leak when the engine was stopped. There has been no problem since it was replaced (it can be reached from under the car). My only guess as to how it came loose is that a body shop repairing some accident damage just prior to the trip may have loosened it to attach restraints to the chassis, and it finally fell out.

Oil leak due to oil warning light sender
Steve Varso (Mar. 1991, p.21)

Using or losing oil? Check the oil sending unit located directly under the fuel pump, easily seen and removed from under the car.

Editor: If a thread adapter, such as that made in the past by J.B.M. Industries, has been installed, an American sending unit from any parts house can be used as a replacement. Be sure it is rated at least at 50 pounds pressure.

Oil pressure gauge uses hole drilled in block
Jack E. Davis, NM (Jul. 1986, p.16 & Mar. 1990, p.17)

One of my pet peeves with my '66 ID21F has been the lack of an oil gauge or low oil pressure warning light as found on the later Citroëns. This caused me great anguish with another '66 I bought a few years earlier. Someone had not installed the oil filter properly which caused a loss of oil pressure and consequently, the engine locked up on me. This happened on the way home, about a day and a half from home. The factory service manual says that to check oil pressure, One can remove the oil line at the cylinder head and attach an oil pressure gauge. This seems a cumbersome way to check oil pressure. When I removed the engine for repairs, I made provisions for an oil gauge.

I needed to do some work on the transaxle of my '66 ID21F, which means removing the engine/transaxle assembly. While the engine was out I likewise made provisions for an oil pressure gauge fitting on this vehicle. I had failed to record the measurements when I did the first one, but this time I did some measuring and will pass it on to you, like show and tell. First, let me tell you what else I found. I also decided to rebuild the motor mounts with kits supplied from J.B.M. Industries.

After I had done the deed of drilling and tapping for the oil fitting, guess what I found behind the left motor mount? A plug that led directly to the oil gallery! I believe that I could have adapted a fitting at this plug, although it looks like a tight fit and might cause a problem if the motor shifted. Well, anyway I had already drilled into the block and had an opening leading into the oil gallery.

This is what I did. Remember, you should only try this if you are pretty handy with tools, and the engine is out of the vehicle. Also remember this is a '66 ID21F with a DX engine. I can't guarantee you can do this with other models. One inch below the bottom of the fuel pump and one and one-quarter inch to the rear is an accessible area and thick part of the block. You might feel better if the oil pan is removed as you can then feel the thickness of the area you are going to drill into. When you feel comfortable with the spot you are going to drill into, start with a 1/8" drill and don't drill any deeper than 7/16", otherwise you could drill through the block and then you are going to be "mucho mad" at Jack E. Davis, to say the least.

Next enlarge the hole to 1/4", again being careful not to go deeper than 7/16". Make sure you are drilling straight in and not at an angle. Now enlarge the hole to 5/16" and tap to 1/8" pipe tap. Clean out the loose metal. Now with a 1/16" drill, drill little by little upwards maybe 40 to 45 degrees into the main oil gallery. As you are drilling clean out the drilling frequently so none of the metal enters the oil gallery. If you do this with caution you shouldn't get any drillings into the gallery.

The pros and cons: Drilling and tapping at the area suggested will give you plenty of room for either an electric sending unit or a fitting for a manual oil gauge. If you screw up you may have ruined the block although you should be able to patch up the screw up with steel epoxy glue. I have lucked out twice.

Oil pressure switch replacement suggestions
Ken Betsh (2000 #4, p.16)

Despite horror stories in old newsletters about the oil-pressure switches rupturing and quickly draining the oil, I've only replaced switches a few times, in over 30 years and well over 500K miles, when they developed minor leaks. The first time, I spent more time getting the wire back on after replacing the switch, so I sought a better way the next time. I started by tying a string to this wire where it disconnected under the hood so that I could pull it back into position after changing the switch. I then loosened, but did not remove, the nut holding the wire lug on the old switch. This allowed it to turn freely as I unscrewed the old switch. Before starting to screw in the new switch, I loosely fasten the wire lug to it so that all I needed do was tighten the nut on the lug to complete the installation.

I assume everyone knows that if this warning light should come on while driving, you should IMMEDIATELY stop the engine and let the car coast to the edge of the road and examine for a loss of oil.

Oil pressure switch rework for CX may also work for a D-model
Richard Hollabaugh (2010 #3, p. 48)

D-Book editor's note: This article was originally published as a CX repair. It is included here because the same repair should be applicable to a D-model. On the D-model the oil sender is on the left side of the engine block below the fuel pump. If defective it will leak oil directly to the ground. A parts-store replacement sender for a D-model will ideally have a stud for a flat ring electrical connection.

The oil pressure sender on the Citroen CX eventually fails and leaks oil. If you are like me and don't want to spend the whole $18 plus shipping for a new one, this article is for you. I have a frugal (cheap) solution that almost anyone with some tools can do for as little as $5. We will be taking the original sender out and modifying it into an adapter for a very commonly available sender.

You will need a 7/8" wrench to remove the oil pressure sender, hacksaw, 5/16" drill bit, l/8" NPT tap, teflon thread tape, and oil pressure sender similar to a PS15. The PSl5 sender has a l/8" pipe thread for the oil passageway, and a flat spade connector that matches up to the CX wiring harness. It's commonly available off the shelf for $5 to $8 at just about any auto parts store.

To remove the original oil pressure sender use a 7/8" (22 mm) open-end wrench to unscrew it from the block. Save the copper washer for re-use.

Now we will turn the original leaking sender into an adapter to mount the PSl5 sender. Take the original sender and cut off the top just above the 6-sided nut section. Using a small screwdriver or pick, take out the innards. There will be a spring, electrical contact, and 2 rubber membranes. The inner-most membrane is crimped into the housing and is the part that cracked, causing the unit to leak.

The PSl5 sender uses a National Pipe Thread (NPT) l/8" connection. The pipe thread is an interference fit. The threaded section is tapered so when the male thread is screwed into the female thread, the threads tighten against each other to form a high pressure, leak-free connection.

Once the sender is cut open and cleaned out, you should see the small oil passageway that goes through the threaded mounting of the sender. The drill size for the l/8" NPT tap is 5/16 inch. Mount the sender in a vice and drill down about 3/8" with the 5/16" bit. A drill press will ensure that you drill straight. But a hand drill will work just fine if you are careful to make sure you drill a straight hole.

Carefully tap the hole with the 1/8" NPT tap. Make sure the tap goes in straight. Back the tap out to clean off the metal shavings every once in a while. Use some oil on the tap for lubrication. The metal of the original sender is quite soft and will tap easily. When the tap bottoms out in the drilled hole, you are done.

Clean the adapter well to make sure there are no metal shavings left. Wrap a couple turns of teflon tape around the new PS15 sender threads and screw it into the newly made adapter. As you screw the PS15 sender into the new adapter, you will feel it getting tighter and tighter as the threads come together.

Now mount the adapter/sender unit back on the engine and connect the wire. Don't forget the copper washer. Verify that it works by checking the oil pressure light on the dash and starting the engine. Check for oil leaks. Now, if the sender should ever fail again, you can easily replace it.

Oil pressure varies
Paul Fontaine (May 1988, p.20)

The crankshaft pressure gauge connected into the block through a J.B.M. conversion fitting shows oil pressure varies with RPM and ambient temperature. At 3000 RPM with straight SAE 30 oil in the summer, the gauge hovers around the 50 psi area, and falls off to 5 psi at idle. In the winter with straight 20/20W oil at 3000 RPM, the gauge reads 40 psi and 5 psi at idle. It is nice to know what the two hydraulic circuits are doing; the pressure gauges are much more comforting than the idiot lights.

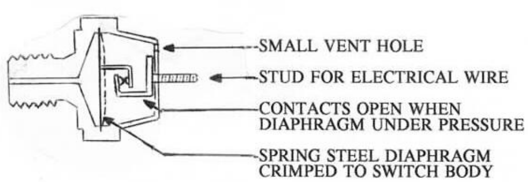
Oil should have additives removed from API-approved types
Keith Ansell (2007 #2, p.16) Nebo Djurdjevic (2007 #3, p.16)

Since engine oil is critical to any Citroën's health we are publishing these articles, "Oil is killing our cars." It touches on a number of interests and concerns to all, like those who have vintage

British sport cars, and particularly those cars that use engine oil in the tranny! I have been using Shell Rotella T diesel oil in my 2CV's, Tractions and DS for many years on the advice of Ivan Frank, who wrote technical documentation for Citroën USA in the 1950's and 1960's. He brought his technical expertise to Rendezvous about 10 years ago. Ivan said at the time that modern oils were not appropriate for older engines. (Judging by this article, he seems to have been right! - George Dyke)

Oil switch failure emergency fix
Don James, OH (Jun, 1982, p.3, May 1984, p.3, Nov. 1984, p.2)

In just one winter we heard of three engines ruined by a failure of the oil pressure switch on D-model cars. In cold weather, or if too thick of an oil is used, the diaphragm in the switch can suddenly blow out. When it does, the oil gets on the contacts of the switch and the driver has warning the engine has lost oil pressure.



The figure above gives an idea of the problem. The factory switch has a small vent hole located under a plastic cover cap. You can't see the vent hole unless you remove the cap.) This small vent hole will allow your engine oil to escape in a hurry, sometimes in a few miles. The result is a totally ruined engine! Sometimes the switch does not blow out, but just leaks oil. In this case you are lucky because all you have is a small leak. One Club member had the entire switch blow out as he was moving the car out of the garage. A stream of oil 1" in diameter came from beneath the engine.

Causes of the problem are age, cold weather, thick oil, or over revving the engine when cold. These switches seem to fail, either suddenly or with a slow leak, at about 60,000 miles. Not all switches fail. Some have over 160,000 miles without problems.

J.B.M. Industries once made kits to convert these switches to an American type oil switch that can be purchased in any auto parts store. The kit has the switch and an adapter that converts the very coarse metric thread on the block to a standard 1/8" pipe tap (this also makes installing an oil pressure gauge easy). The American switch does not have the vent hole, so if the diaphragm fails, you don't lose your oil, only the warning light will not light.

The oil pressure warning switch is located under the intake manifold on all late model five-main bearing D-models. It is just to the rear of the fuel pump. Follow the wire and you will find it. When you install the new switch, just screw the adapter to the new switch and screw the entire assembly into the block using the same copper sealing washer. Do not over-tighten. Attach the wire. Your oil pressure warning switch should light when you turn on the ignition, but the car is not running. If it doesn't, your wire is not connected or your switch has oil on the contacts.

If you're still driving with an original-type oil pressure switch, you may want to carry a spare, an adaptor or at least a short metric bolt to screw in should it fail-thread size 10 mm x 1.5 pitch.

Oil warning light flashes due to loose filter screw
F. J. "Mark" Heliger (May 1990, p.19)

At first the low oil pressure warning light came "on" while the engine was at "slow" idle at a traffic light. There was no light with the foot off the brake. When stopped after arriving home, the light came on again at idle with foot off the brake. A check of the oil level showed it full. Hmmmm, puzzling to say the least.

I worried about it a few days, and then phoned some experts for ideas. Don James had a quick reply, "Look for a loose oil filter securing bolt". He said that had been the cause of some engine being wrecked back there in his territory. Naw, very unlikely that the "sender" went bad. Seldom do.

I got the first warning at a stop light while heading for a car hoist I could use about four miles from home. A little further on, as I slowed without braking, again the light came on. Rev up, the light went out. Then it was with higher and higher revs. Then I tried shifting to second; light would go off and I would go at highest road speed and shift to neutral and shut down the engine and coast, start up again and repeat. Fortunately, at that point I was on a road with little traffic. Come to a light, shut down. Light change, start up. Needless to say I was very highly excited and very fearful. By then I felt sure it was the loose filter.

And that's what it was. I removed the bolt with my fingers. No doubt I was too cautious about over-tightening when I last changed the oil. In the future I shall use a torque wrench. The book calls for 6 to 7 ft-lbs.

Piston stuck to cylinder loosened with grease gun pressure
John Hege (May 1991, p.9)

I have used a grease gun to free up a frozen engine on an ID19 by fixing a grease fitting to a gutted spark plug. Messy, true, but it saved me a teardown on a car that otherwise wasn't worth the trouble or expense.

Piston stuck to cylinder loosened with grease gun pressure
Don James, OH (May 1992, p.22)

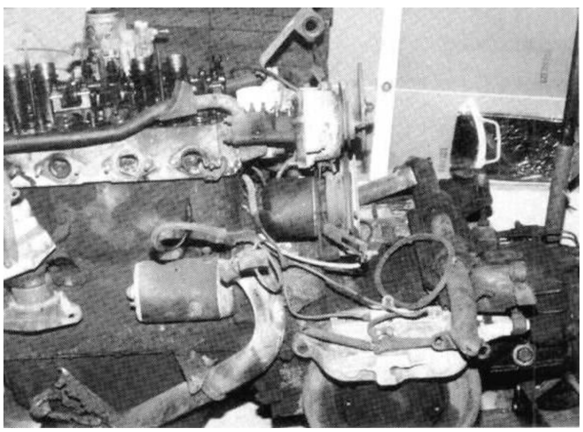
To free a stuck engine, use your grease gun to force grease through the sparkplug hole. The grease gun can easily put 10,000 psi of pressure and will free almost anything. But be gentle, you can develop a tremendous force and don't want to break the crank or rods. Fill the cylinder with oil first and be sure both valves are closed by running back the adjusters or removing the rocker shaft. This method will force oil right past the rings and help free the stuck piston, provided you know which one is stuck.

Piston stuck to cylinder pressed out after being in freezer
Rod Burwell (Sep. 1983, p.6)

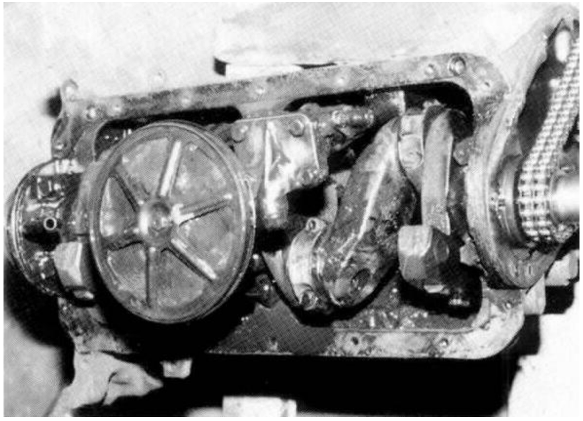
A D-model with only 12,000 miles on the clock, but that had been wrecked and not driven for many years, had a stuck engine. I was able to get the stuck piston loose from the liner by placing it in the freezer. I was then able to press the piston out. I think that if the liner is honed it can be saved.

This engine was very clean inside and looked like new. But, the camshaft had about .030" wear on several of the lobes and the lifters were shot.

Rebuilding a pre-'65 DS engine
Don James, OH (Mar. 1992, p.11)



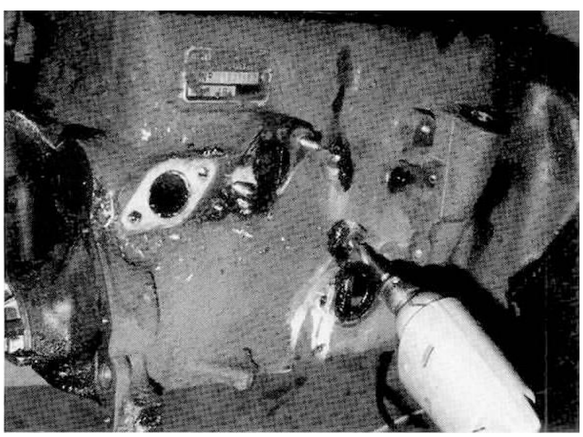
This article describes the rebuilding of a 1911 cc three-main bearing engine with Citromatic from a pre '65 Chapron convertible. The picture above shows the condition of the engine as received. The engine and the transmission suffered from exposure to the elements. Many brackets and mountings were broken from improper removal from the car. The exhaust manifold was broken and all the driven components such as water pump, hydraulic pump and centrifugal regulator were frozen.



The picture above shows the condition of the oil strainer and block after preliminary cleaning. Improper removal of the cylinder head without first draining the block caused the crankcase to fill with antifreeze creating a greasy goo.

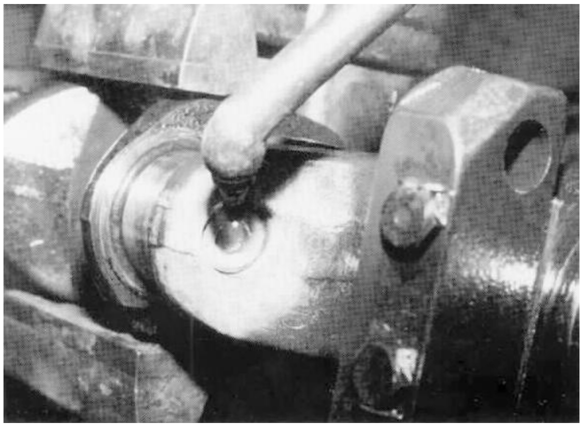
Rust and grease clogged all the passageways. Pistons on cylinders #3 and 4 were frozen in their liners. The liners were machined away to recover the connecting rods. The two pistons that were not frozen had piston rings that were cracked and broken in many places. This condition is also not unusual with this model engine. Replacements have a slightly thicker top ring and a split skirt for quiet operation. The original liners showed very little wear. The lifters could only be removed from the cylinder block by pressing them out from below.

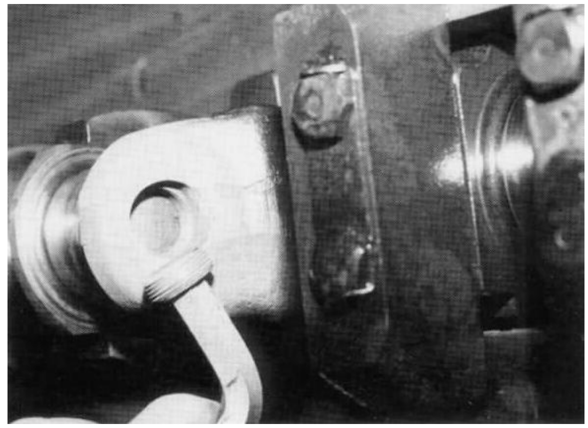
The cylinder block drain was clogged with rust and had to be drilled out, as shown below, to open it up. This is not unusual on this engine. Without the drain being open, there is no way to drain the block.



When the cylinders were reinstalled, the seats for the liners were cleaned and new gaskets were used. The new gaskets had an additional thickness (blue). This part of the gasket went face up between the adjoining cylinders.

Cylinder liners were held in place temporarily with short bolts and large washers. The cylinder liners extend into the crankcase. This "wet liner" method of construction is the reason for the extreme durability of Citroën engines.

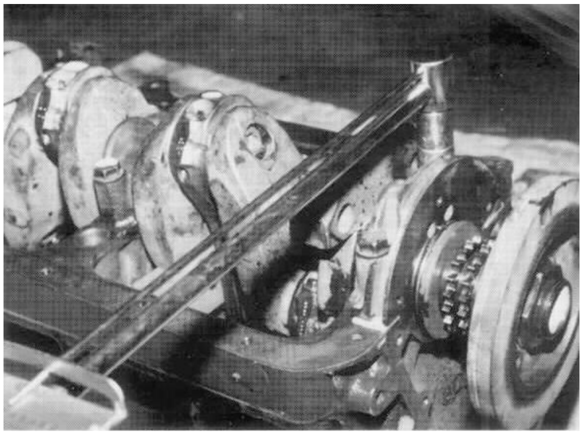




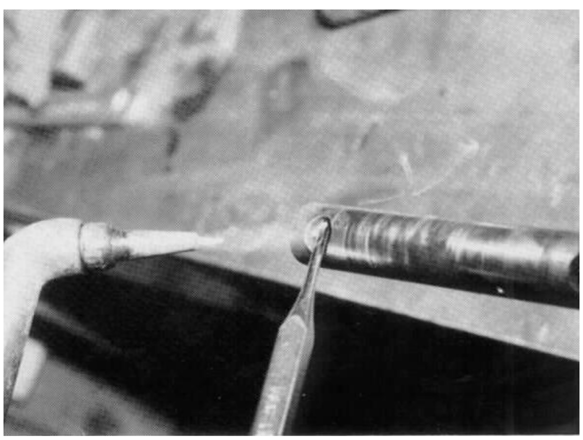
The block was now ready for new bearings and crankshaft. Cleaning the crankshaft oil-ways is a step that a lot of rebuilders miss. The shop manual states that these should always be cleaned... and for good reason. Removing the plug in each journal for cleaning required heating (above left) and a 12mm Allen wrench (above right). On removal of the plug, many rebuilders think they only see part of the steel crankshaft. What you see here is hard packed dirt! This had been removed from the oil by centrifugal force. This dirt packed all the oil passageways in the crankshaft and had to be dug and drilled out. A homemade tool was used to help remove this packed dirt.

The screen filter, shown above, on these three-main bearing engines are easily five times the size of that used on later engines. But it cannot be removed to clean it on a regular basis like later engines. Changing oil often is the real solution to keeping this engine clean.

The trick to installing the crankshaft correctly was to leave the bolts on the rear cap loose until the thrust washers were correctly installed and the sprocket and damper were run down tight with the large nut on the end of the crankshaft. Earlier engines lack this damper. With the proper shims finally selected and installed, the shaft turned freely. Lastly, the rear bearing cap was correctly torqued.



The cylinder head on this engine needed to be re-machined. The head was warped either by prior overheating or improper removal. On this engine, the intake valve rocker shaft was bent from improper removal of the cylinder head. Valve adjusters must be backed off before removing the head bolts or a bent rocker shaft will be the result. The replacement intake valve rocker shaft was found to be full of goo and had to be cleaned and polished before installing. End plugs on the shaft needed to be heated, as shown below, so they could be removed for cleaning the inside of the shaft. This required drilling out. A new plug was pressed into the hole, but I could have simply brazed it up. The exhaust rocker shafts were replaced as well.



The rocker shaft supports needed to be drilled out as they were also clogged. Dirt can plug them so solid that oil will not reach the rocker shafts, undoubtedly why these were so bad. Valves were lapped before they were installed.

Rebuilding notes
Don James, OH (May 1992, p.22)

When removing the head, rap the head bolts with a hammer, particularly on the exhaust side, since corrosion tends to make them snap off when you force them loose. Be sure to inspect cylinder block carefully for cracks in the surface where the head gasket sits. Drill out the block coolant drain hole, as this is usually clogged with rust and it is very difficult to drill when the engine is still in the car. Pistons and liners are matched and should not be switched. Lifters should always be removed and inspected when ever the head is off. Pits in the lifters should not be tolerated. Worn and pitted lifters eat camshafts!

A grease gun can be used to free a stuck engine before removing the head, provided you know which piston is stuck. Fill the cylinder with oil first and be sure both valves are closed by running back the adjusters or removing the rocker shaft. Force grease through the sparkplug hole (with a strong adapter fitting). Be gentle…you can develop a tremendous force. You don't want to break the crank or rods. This method will force oil right past the rings.

Rocker arm shaft hard chrome as expensive as new parts
Mike Marko (May 1985, p.16)

My friend, the machine shop owner, says I could buy two sets of rocker arm shafts (at Western Hemisphere's prices) for what it would cost to recondition and chrome mine. He also estimated that to bush the intake rockers would not be cost-effective over buying new ones.

Spark plug insert installation–vacuum cleaner keeps chips out
Terry Tekushan, OH (Jun. 1991, p.18)

My relaxed state was shattered when I removed the #2 spark plug from my recently acquired '72 DS21 and found an insert stuck to it. Apparently, a spark plug was cross-threaded or over-tightened, requiring the installation of an oversized insert into which a spark plug could then be installed. This would have been acceptable if the insert itself had not been stripped and covered with some sort of pipe-sealing compound.

"What to do now," I wondered. Fortunately, the solution was to be found with the machinist duo of Don and Bob James. I was able to get the old insert stuck back into the spark plug hole and I drove to Don's in Kent, Ohio sweating excessively the whole way. In the meantime, Bob James had machined and threaded a new insert and made a cutter for enlarging the hole. We would cut a larger hole, tap it, and install a new insert with high temperature Loctite. We trekked to Bob's home in Tallmadge to perform the surgery.

"How are we going to keep all those metal chips out of that cylinder?" I asked. Don, of course, had a clever solution. We procured an old Hoover "Constellation" canister vacuum cleaner, which has an exhaust port that can accept a hose for blowing dust out of enclosed spaces. We attached the end of the hose to the top of the carburetor with electrical tape and propped open the throttle. Having turned on the Hoover so that it was blowing into the carburetor, Don slowly turned the engine with the hand crank until the intake valve on that cylinder was open and the exhaust valve closed. The air was now pressurizing the combustion chamber and blowing out of the spark plug hole. All of the chips from cutting and tapping were blown clear of the cylinder.

The operation was a complete success! And one bit of advice for anyone attempting this at home: Put a clean bag in the canister vacuum cleaner or else you will cover the carburetor throat and jets with a silt-like layer of dust. I speak from experience (we didn't follow that advice). However, it was a price worth paying to keep all of the metal chips from accumulating in the cylinder.

Starting at -20ºF easier with pure synthetic motor oil
Doug Hart, Ontario (Feb. 1994, p.16)

We have two D-models we drive in winter, both without block heaters. On occasion we have overnight temperatures (skiing in Quebec) in the -30º C range or lower, which translates to about -22º F. We found that using pure synthetic (Quaker State) oil really solves the problem of winter starting, especially if the ignition is all in good order.

(Being from Wisconsin, where it also gets pretty cold, I have always used mineral 10W 30 oil rather than the 20W 50 favored in warmer climes. [MB])

Starting in winter harder with newer fuels
Ken Betsh (2000 #3, p.13)

I've noticed in the past few years that both of my Citroëns don't start as quickly in cold weather and require longer use of the choke. I attribute this to the changes the gasoline refiners have made to gasoline to reduce undesired vaporization in tanks. Our cars use circulating cooling water to preheat the vaporized gasoline going into the engine cylinders and this heat rises into the carburetor where the vaporization takes place. The first thing I look for when my cars remain sluggish in colder weather is a thermostat that has failed or at least doesn't close tight when cold. I have never driven the cars with the thermostat removed. I think a fast warmup is essential.

Temperature gauge and light error
Ken Betsh, PA (Mar. 1999, p.7)

Occasionally someone asks about inconsistencies of the two engine temperature indicators on the late D-models. Sometimes the gauge can get into the red area without the warning light coming on or the light does come on when the gauge is below the red area. The gauge and the light have two completely independent sensors. The gauge is connected to a sensor in the base of the water pump. This sensor is essentially a varistor–a resistor whose resistance varies with temperature. A sensor removed from a parts car measures about 2000 ohms at room temperature.

The sensor for the warning light is a thermal switch mounted high on the left side of the engine block between cylinders #3 and #4. It can be seen from above by looking between the head and intake manifold behind the carburetor. It has a single electrical connection; it works by grounding a wire to the lamp. Unlike the other two red warning lights, this one never gets checked when you start the car. Checking the bulb with the push switch on the dash doesn't check the wiring to the sensor. To check the light and wiring have an assistant watch the light, with the ignition switch on but engine not running while you momentarily short the end of the sensor to the manifold with a screwdriver. This should make the light flash.

When I first bought my current DS sedan (used), this light came on whenever the gauge went slightly above normal. I bought a new sensor and, before installing it, ran some comparative tests in a laboratory oven with the old part. While I didn't know the temperature specification for the sensor, I quickly found the old one operated at about 25 degrees (F) lower than the new one. The new sensor eliminated the problem. Incidently, like most thermal switches, there's an overlap.

The temperature must fall several degrees below the turn-on point before it turns off. This explains why once the light comes on, it takes a while for any corrective action to turn it off.

Turbo added after making DS23 modifications
Magnus Aellebent (Jan. 1984, p.6-condensed)

Translated and submitted by Ake Allerth, Sweden

My DS23 Pallas M seemed perfect, without compromises except for one "aber"…the engine. Limited by the French tax rate, it is too weak for the car's perfect performance. I decided to fit it with a "Turbo Fan". The DS engine's heavy swing mass, it's competitive large stroke, and large torque radius curve makes it suitable for a turbo fan. I think it will it stand the test because the DS engine uses forged, hardened crankshaft, the same bearings as in the CX diesel, sodium filled exhaust valves for cooler operation. The transmission should not cause any trouble because the same parts are used in the SM and the Merak.

A high pressure turbo from Eberspacher-Bosch was fitted. The exhaust pipe system was kept as it was, with the exception of the front pipe. The fuel system was modified to suit the higher pressure, i.e., more atmospheric pressure. The carburetor damper shaft was tightened with pinbearing packing pressed into the carburetor head. Because Weber uses non-homogen floats, I had to exchange or strengthen these somehow, or the floats would "implode" from the increase in pressure. I solved the problem by drilling holes in the float and filling with foam. Another problem was that the fuel pressure must be following load pressure to the bottom of the fuel pump membrane. The fuel pressure must increase analogous to the turbo load pressure. To do this I lead the load pressure to the bottom of the membrane. Water injection and intercooler was fitted to avoid ping.

The result was quite good. Top speed: 136.7 mph, acceleration 0-60 in less than 10 seconds. I won a highway race with a Porsche 911. However, a leaking gasket lead to a damaged crankshaft bearing.

I restored the engine and lowered the compression. A new turbo was fitted, two double barreled Dellorto turbo-carburetors, later exhaust pipe system and an electric fuel pump. Now the 0-60 mph acceleration is 7.5 seconds.

Editor: Carburetors on the car are placed in a pressurized "box" and this gives the effect of being run far below sea level. Throttle response with this system is good.

Valve adjustment done when exhaust valve is wide open
Jack E. Davis, NM (Jan. 1998, p.13)

I found in a French book a way to set valves on a DS. It's not new, but it may help a shade tree mechanic like me. I found it a lot easier than the English way.

Valve wide open	Set inlet rocker	Set exhaust rocker
Exhaust 1st cylinder	3	4

Exhaust 3rd cylinder	4	2
Exhaust 4th cylinder	2	1
Exhaust 2nd cylinder	1	3

Valve adjustment procedure
Betsh, Ken (2003 #2, p.14)

I've never set a mileage amount for resetting the engine valves, but do so when I notice an increasing clacking sound when the engine is hot. Over the years there have been both cold and hot specifications, but since burning myself has no appeal, I do it with engine cold, setting the intake valves for 0.006 inch and the exhaust for 0.008 inch. I set them for a snug fit of the appropriate feeler gauge with a check that the next larger size will not fit.

Even though I have a spare valve cover gasket, I remove the cover carefully since part may stick to the cover and another part stick to the engine head. This gasket hardens with age and can be accidently torn.

I adjust each pair of intake/exhaust valves with the associated cylinder at TDC (top dead center). If I know the distributor position and dwell are properly set (which I can quickly check with a dwell meter), I set the engine by turning it with the crank until the meter indicates the points have just opened. Before doing this I lift off the distributor cap for two reasons; (1) to determine the next cylinder to be fired (which will be the first one whose valves I adjust) and (2), since the ignition is on for the meter, to prevent a cylinder firing and possible engine starting. After doing the initial cylinder, I continue with the normal 1-3-4-2 firing order. After doing the four pairs of valves, I go through the cycle again just to double-check my adjustments.

After putting the valve cover back on, I go back and forth in tightening the two nuts securing the cover. Unless done evenly, I will find oil leaking under the gasket at one end or the other.

Valve adjustment simplified
Charles Fowler (Feb. 1984, p.5)

The simplest method I've ever witnessed for adjusting valves on a D-model was displayed by Bob Hoffman at Cleveland Citroen. With the plugs removed, turn the crank until a rocker arm is at full depression opening the valve completely. Continue turning the crank a full 360 degrees. You are now exactly opposite the cam and can adjust that valve's clearance. Using this method, you can work your way front to back, or the other way, ignoring power stroke, etc. Incidentally, Bob set both intake and exhaust valves at .006" on a cold engine and I've followed his example for 11 years. At 150,000 miles my D-model required no head work except cleaning.

(Factory setting is 006” intake, 008” exhaust. [MB])

Valves burned due to rusted air injection pipe
Charles Fowler (Sep. 1987, p.18)

I was astonished to discover that my '72 D-model had developed a burned valve. This seems to be rare in these engines, especially under 100K miles. After disassembling the head and while awaiting parts, I decided to eliminate the ugly air injection pipe. This is the pipe that fits under the air cleaner on the exhaust side. It had been capped in the usual fashion after removal of the air pump and anti-backfire valve. The underside was completely rotted away.

I recall some ancient automotive maxim against running unrestricted exhaust and always assumed this caused an increase in the operating temperature of the exhaust valves. This seems to fly in the face of the emission control principal of injecting air behind the exhaust valves by use of an air pump.

Owners of D-models should be warned to check those air injection pipes. The simple solution for me was to cut, file, and grind a blanking plate to fit over the inlet in the head.

Water leak into cylinder stopped with engine block sealer
Dave Root, FL (May 1992, p.13-condensed)

The day after my engine severely overheated on a typical 95º F Florida summer day using the air conditioning, I pulled the plugs to check compression. I was convinced I had burned an exhaust valve. I was surprised when plug #1 came out soaking wet! Three cylinders had normal compression, but on #1 it was 210 lbs! Obviously the combustion chamber was partly filled with water, but at least a valve was not leaking.

After consultation with a local auto parts store owner, I treated the cooling system with a product called "K W Heavy Duty Metallic Engine Block Sealer." Normally I am skeptical of such "quick fixes," but it seems to be working. No more water in #l cylinder, and the engine runs smoothly. Compression now checks about the same on all cylinders.

Before treating with sealer, I started the engine with #1 plug removed to blow out the water, then just followed the procedure outlined on the can. I will no doubt eventually have to have the head milled and put in a new head gasket, but I can enjoy it a while before having to do that.

Chapter 15–Exhaust

Flex pipe alternative
Ken Betsh (2011 #1, p.15)

Over my many years of Citroën D-model ownership, the most often replaced part, other than oil filters, spark plugs and ignition points, has been the flexible pipe between the exhaust manifold and the muffler. Records from when our Citroëns were our daily-drivers show replacements seldom lasted more than about two or three years. Invariably, an opening would develop where the spiral center part joined one or the other solid tubular end-piece. Apparently the spiral section gradually lost its ability to flex as the engine moved on its mounts with respect to the body-mounted muffler. I believe the original design used stainless steel for the spiral part, but suspect it was not used in the replacement parts.

After describing this situation with the French-born mechanic that does all the repairs on my car I don't do myself, he suggested adapting a different style of flexible exhaust coupling that he said was used on almost all other cars. He even had one on hand that matched the Citroën pipe size. It had greater flexibility than any Citroën flex-pipe I've installed and he said he never saw one lose that flexibility.

The photo above shows this flexible coupling on my D-wagon after I let him install it. Being shorter than the original part, he had to weld on a short length of stainless pipe to one end. The best part was that the cost of the parts and labor was not much more than just the previous flex- pipe, which took a lot of work for me to install.

That was three years ago and today it looks like and works just as it was installed. Now after my favorite Pennsylvania Citroën parts supplier reviewed this article just prior to publication, he tells me the only flex-pipe he now sells looks much like my alternative. It still fits between the exhaust down-pipe and muffler like the original, which means no welding is required.

For those replacing a flex-pipe (with either the new or original replacement type), my very helpful parts supplier urges the following:

(1) Always reinstall the original type front flex-pipe clamp, which is also a hanger. This supports the bottom of the down-pipe, and prevents tension being placed on the exhaust

manifold. Failing to have this support at the bottom does lead to cracked exhaust manifolds.

(2) Always use a flat-band-type clamp on the front of the muffler like that originally used by Citroën. This holds things in place well and does not crimp the metal on the muffler or flex-pipe. Then if you have to remove the flex-pipe, it is much easier. Using a USA-type "saddle"-type clamp with the round metal rod that tightens will usually crimp the metal and make it impossible to take apart again without damage.

In changing a flex-pipe I try to be as gentle on the muffler as possible, especially if it has quite a bit of age. It's mounted on rubber bushings that can be torn loose. Moving it very far on the end where the flex pipe attaches can put stress on the coupling to the twin exhaust pipes on the other end, resulting in a new exhaust leakage problem and possible need to replace the muffler.

In replacing a flex pipe, removing the old one is the hardest part. I recall one time, when the ends of the old one seemed to be frozen in place after removing the clamps, I cut it into two pieces at the leakage point (while still on the car) and used a chain wrench to break the rust bond by turning the separated ends. (Sounds like the ideal place for liberal application of heat. [MB])

Like most other do-it-yourself Citroën owners, I never trust the suspension system, even with the tire-changing prop, when working under the car. The only safe way, even with a car that's far from being a "rust bucket", is to place solid wooden blocks under four places where the bottom of the car is the strongest, behind the front wheels in line with the rear wheels and in front of the rear wheels in line with the front wheels. The kind of flex-pipe replacement done on my car probably could be done by any reputable muffler or general repair shop providing they follow these exact lifting instructions.

Flex pipe replacement
Betsh, Ken (2001 #3, p.13)

Changing an exhaust flex pipe is my most dreaded repair job, miserable at best in warm weather and with a risk of damaging a rusty but still viable muffler and/or tail pipes. Before starting, I raise the car to the "top" position and place emergency support blocks under both sides of the body "frame" (I never trust my life while partially under the car to just the hydraulic system even with the factory-supplied jack stand in place on one side).

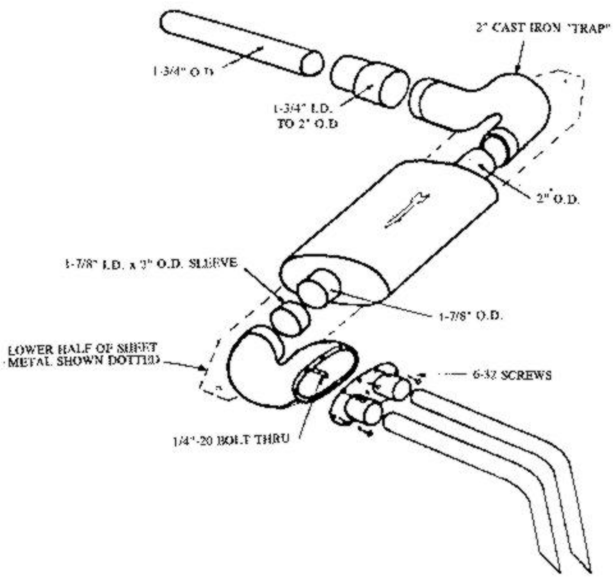
I start by loosening the clamps on both ends and using a strap wrench at the front end of the old flex pipe to try to turn it enough to break loose a "rust bond" that has usually formed.

Next I completely loosen all the tail pipe mounting straps and loosen the muffler at both ends - using boxes or blocks to hold them near their original position. I don't separate the tail pipes from the muffler, even though the fittings on the muffler where the tail pipes are attached are often where the first rust failure occurs. Then I work the old flex pipe loose without hammering on the front of the muffler.

(The muffler shops have a trick that can be used at home. First cut the pipe a very short distance from the entrance to the part to be saved, then heat the pipes until red and turn out with a water pump pliers. If you have an oxyacetylene torch, carefully use it to cut the piece to be removed lengthwise, starting inside of the muffler and working outward. Hold the torch at an extreme angle, taking care to melt only the inner piece, not the muffler inlet nipple, using brief spurts of oxygen to blow out the molten metal. Allow to cool briefly, then grab one of the cut lips of the remnant with a sturdy pliers and twist. The piece to be removed will bend into a spiral, allowing for easy extraction. If you do not have a torch, you might be wise to let and exhaust expert do it. [MB])

Muffler alternative uses P-traps at ends
Peter Bazeley, MA (May, 1984, p.10)

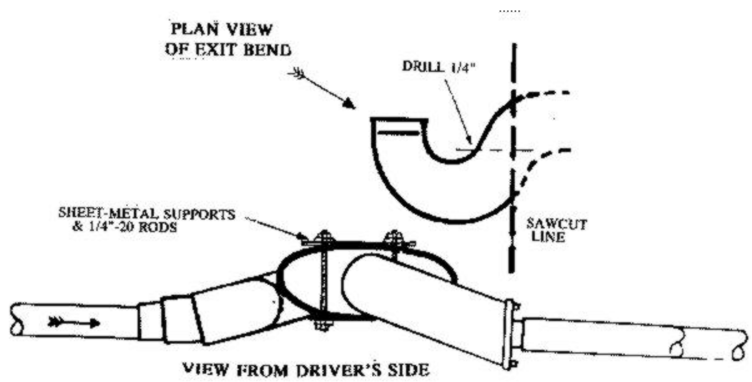
My objective was to have a cheap, serviceable exhaust system incorporating an inexpensive domestic muffler. The other components were chosen for longevity, so that they can be used over with each muffler replacement. The system is a money saver, if you don't count your labor, for a determined home mechanic with a small workshop. The payoff gets better with each exchange of the cheap muffler. The assembly is shown below.



The approximately $50 worth of components consist of:

1. Two "P" traps, 2 inch, cast iron, no-hub type, from a plumbing supply
2. Two 10-foot lengths of 1-1/2" E.M.T. (electricians metallic tubing) for tailpipes
3. Two pieces of sheet metal, 20-gauge, 4" x 42" from a heating/ventilating shop
4. Threaded 1/4”-20 rod plus nuts
5. Muffler: 3-1/2 x 7" x 15" or so long with 2" inlet and 1-7/8" outlet, from an auto parts store
6. Connector Pipe: 1-3/4" O.D. x 16" long
7. Adapter: 1-3/4" to 2" I.D.
8. Tube: a short stub of 2" O.D.
9. Clamps: 1-3/4" or 2"
10. Muffler paste.

One of the cast iron "P" traps was cut across the bend to get the optimum opening and the angle up into the muffler well under the front seats (see figure below). The 5" x 2-1/2" bulkhead was sawed from 3/16" steel plate and bored to take the two machined tube stubs, which were then welded in (for the tail pipes). This assembly was bolted against the cast iron "P" trap using a 1/4-20 bolt at center and a ring of 6-32 screws and a liberal amount of muffler cement.



The tailpipes were bent up by using a screws around the perimeter plus a stout length of two-by-four with a hole through which the pipe is passed and levering one against the other. The easier alternative, if you know an electrician, is to borrow a pipe bender. (Why not just go to an exhaust shop and have them bent for you? [MB]) Then the crimped edges of the Citroën hanger were flattened to fit the diameter of the new pipes. Foreign car 1-1/2" clamps are tough but not impossible to find–maybe TV antenna hardware? (Stock exhaust part, easy to source. [MB])

The cast iron P-trap bends were then force-fitted to the muffler, the 2" sleeve being necessary on the outlet, then the whole assembly was sandwiched between the two lengths of sheet metal, through-bolted at strategic points with the 1/4-20 threaded rod. Careful forming was necessary to seat it perfectly in the "well" then both ends drilled at 40-1/2" centers to mount on the Citroën hangers.

I have now installed four such set-ups. The first car has just had a new $25 muffler after nearly three years; the zinc/galvanized E.M.T. tailpipes still look good.

(All exhaust parts for the D are easy to buy on the Internet nowadays, except for the rear dual tailpipes with no resonator. They are too long to ship economically. Even they may be cut and sent in pieces, then reassembled by welding. [MB])

Muffler clamps for VW Beetle will fit
Don James, OH (May 1985, p.8)

Use VW muffler clamps to fasten the tailpipes to your DS muffler flanges. These VW clamps are available at any auto parts store and fit the old air cooled VW beetles.

Muffler for Saab and flex pipe for diesel VW Rabbit are used
Doug Hart, Ontario (Apr. 1993, p.9)

I have found a good alternative to unavailable Citroen exhaust systems here in Canada is to modify the stainless steel flex pipe for a diesel Rabbit and use a SAAB muffler. The flex pipe seems to be of very good quality and Speedy Muffler was quite willing to install and guarantee the system. This has worked very well on our two cars. Both are driven all year and are well oiled.

Pipes made from 1-1/4" TV antenna mast
(Feb. 1979, p.2)

The two thin exhaust pipes emanating from the rear of the muffler on our D-models can be replaced or rebuilt using 1-1/2" O.D. antenna masts easily found in a discount, hardware or TV store. It is usually sold in 4 and 10 foot lengths. The shorter lengths are easier to handle. They can be brazed to existing exhaust pipes as repair sections or, using two 4 foot sections to make one long pipe, can be used to replace the resonator and tail pipes altogether.

Stainless steel system available from England
Earl Conrad (May 1993, p.19)

Stainless steel exhaust systems for early DS models are available (in 1993) from: P.D. Gough & Associate; The Old Foundry; Common Lane; Watnall, Nottingham NG16 IHD England; Phone +44 (0)155 938 2241; FAX +44 (0)115 945 9162. http://www.pdgough.com. All parts are made from 304 18G Austenitic Stainless steel from original patterns. Stainless systems were also available from Coventry S Ltd. (Gilbert Compton) in New Carrollton, MD, but he seems to have disappeared.

Editor: Hypertronics, another English company, have recently advertised the availability of a complete DS stainless steel exhaust set. Peter Fyfe in Halifax, Nova Scotia, no longer makes stainless steel mufflers. (Hypertronics no longer in exists. P.D. Gough information has been updated. Nouvalari Engineering Ltd., www.nouvalari.com has stainless exhaust for D's as well as HY and SM. [MB])

System constructed with "cherry bomb" muffler
Paul Fontaine (Nov. 1983, p.5)

With this muffler system, your Citroën will sound like a true sports machine if you stand on the go pedal or will have a pleasing rumble in the normal mode of operation. You should increase your mileage by 2 to 3 mpg as the back pressure is reduced. Total cost for this modification was $37.00. However the cost will vary as to your source of the 90 degree ells. I buy mine in the flea markets for a buck each.

BILL OF MATERIAL

1-Universal tail pipe hanger,

1-Maremount Cherry Bomb #87502

1-60" piece of 2" I.D. Stainless Flex from J.C. Whitney, Chicago #24-05288

1-piece bar stock 1" x 3/16" x 9" with 5/16" holes on 8" centers—rear support

1-piece bar stock 1" x 3/16" x 6" with 5/16" holes on 5" centers—right hand side

1-piece bar stock 1" x 3/16" x 5-1/2" with 5/16" holes on 4-1/2" centers–left hand side

2-2-1/8" muffler clamps--modified as shown in Fig. 123, detail A,

7-2" muffler clamps–for flex tubing

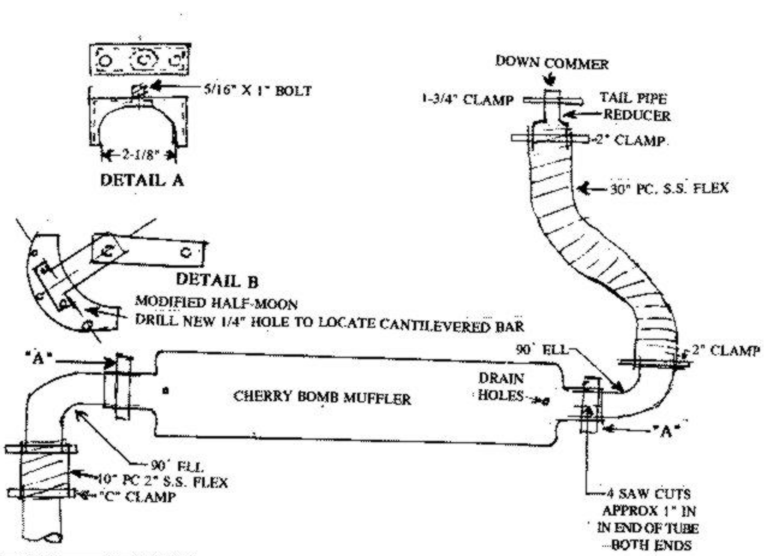
1-1-3/4" muffler clamp for reducer at down comer

1-1-13/16" x 2" O.D. tail pipe reducer (fits '66 to '72 Chevrolet exhaust system)

2-90 degree ells for old style overhead flush toilet 2" O.D. from plumbing supply or flea market

5-5/16" x 1" hex head bolts with lock washers, washers and nuts

2-1/4" x 1" hex head bolts with lock washers, washers and nuts.



Assembly of the Paul Fontaine's muffler system

PROCEDURE

1. Remove half moon muffler hangers and modify by removing one bolt and locating cantilevered bar so that it is 90 degrees to a line through the original outside mounting holes. Drill new hole for mounting in new position, for 1/4" bolt. Mount the 5-1/2" bar stock with holes on the left side (driver's side). Mount the 6" bar stock with holes on the right side.

2. Modify the 2-1/8" muffler clamps as shown in Fig. 122. A 5/16" hex head bolt will fit snug in the saddle preventing the head from rotating. This is the clamp that holds the muffler.

3. Install the half-moon hangers with the modified cantilevered/bar stock.

4. Drill an 1/8" hole in each end of the cherry bomb in line as this will locate the bottom of the muffler. These holes will drain condensation in cool weather.

5. Install the 2-1/8" modified muffler clamps on the muffler and insert the center mounting bolt in the ends of the bar stock. Take up the slack in the bolts to hold the muffler temporarily. The writer holds the muffler up in position with a plastic milk case and a 2 x 4.

6. Install the 90 degree ells in the muffler ends. Now adjust the muffler clamps so that the clamp is over the area previously notched to allow the tubing to shrink around the ells. Note the sketch on notching the ends of the muffler.

7. We assume that you have previously removed the original flex pipe, so that the 1-11/16" O.D. stub tube on the down commer is available. Clean the rust from the stub and dope it with Never-seize.

8. Install the tail pipe reducer, coat the inside with Never-seize.

9. Slip the 2" I.D. stainless steel flex over the 2" O.D. end of the reducer and bend an "S" curve and mark the flex for cutting, approximately 30".

10. Cut the flex with a hack saw and clean the raw edges, check to see if the flex will slide over the ells.

11. Install the flex, the extra material is the "S" will allow you to push the flex over the ell.

12. Cut two 10" sections of flex for the tailpipe connections.

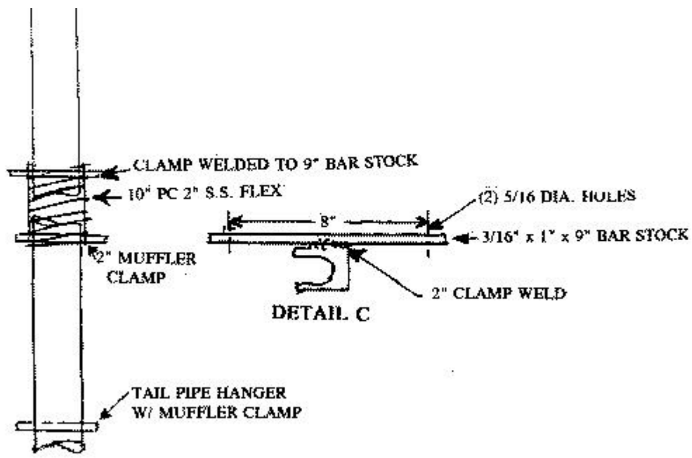
13. The tailpipe is a 2" O.D. tubing approximately 84" long. The writer scrounged a leg from a child's swing/teeter-totter set. This thin-wall tubing was the correct O.D. and 96" long. Saw off the rusty end and clean up the edges. He broke off a brace tube in the middle of this pipe, leaving the bolt holding the brace in place to plug its hole. If you can't scrounge a 2" tailpipe, you will be stuck with the ridiculous price of tail pipe from the local muffler shop.

14. Slip one of the 10" sections of flex over the ell on the exit end of the muffler and insert the tail pipe. Push the tailpipe into place and hold it up in place against the bottom of your Citroën. Mark the location of the original tailpipe hanger with the rubber bumpers/strap assembly. Cut the tailpipe at this point.

15. Attach a 2" muffler clamp to the 9" bar stock with the holes on 8" centers and weld the clamp as shown in Fig. 123, detail C. If you do not have an arc welder available, perhaps you can design your own solution to the clamping and hanging of the tailpipe. The writer used a Maremount clamp with the raised portion on one side making it ideal for arc welding.

16. Install the universal tail pipe hanger in the old bracket on the DS. Because the ID19 does not have a resonator, there is no convenient mounting bracket. Therefore, you will have to locate the tailpipe hanger where convenient.

17. Now that all the bits and pieces are in place, go over all the bolts and nuts and check that they are properly torqued. I always manage to miss a few causing a get out and get under operation on the side of the road.



For those interested in the theory of exhaust suppression or attenuation of sound, the muffler volume should be ten times the displacement of one cylinder. The 121 cubic inches of a DS21 engine is divided by 4 and multiplied by ten to give just about 300 cubic inches. The muffler I used is 4" diameter by 24" long or 301 cubic inches–the theoretical requirement for average attenuation of sound. The change in diameters at the end of the reducer from 1-11/16" to 2" sets up an interface of the exhaust gases. This causes harmonics in the wave front of the gases and sets up resonance. This condition is known as exhaust tuning and increases the scavenging of the gases. It would require a dynamometer to check out the improvement in horsepower. I know there is some improvement as my 71 D-Special increased the MPG by 10% with the above muffler system plus the removal of the DOT required garbage associated with induction system.

Chapter 16–Fuel

Cap that locks made from Gates #54
Ken Butler, NM (Jul. 1984, p.22)

Want a locking gas cap for a Citroën without taking out a bank loan? Purchase a Gates Rubber Co. #54. To make this fit, saw or file away about 1/16" of the turned down metal from the clockwise sides of the filler pipe. Cut only that part that is turned down back toward the fender. Cut and trial fit to the locking ears of the gas cap and you have a '57 Chevy cap that fits your Citroën. (I am not certain that our gas caps are supposed to be vented or non-vented. [MB])

Don't park with right side low when low on fuel
Dave Root, FL (Jun. 1980, p.3)

If you have less than 1/4 tank of gas, avoid parking on a slant with the driver's side low as the gas can't get to the outlet line in the tank. The pickup line is on the passenger's side. This can be puzzling, but if you've had it happen, you know how to avoid it.

Sometimes gas does not reach the carburetor for some other reason that cannot be immediately determined at the time it happens. To avoid getting stranded on this account, solder a short piece of 3/8" O.D. copper tubing to the lid of an empty one gallon tin can after piercing or drilling a hole in the lid large enough for the tubing to stick through. Lay the can down on its widest side with the lid in lowest position. Pierce a tiny hole near what is the top of the can when it is lying in this position. If need for it comes up, remove the can lid and fill with gas. After putting the lid back on, pull the neoprene tube running from the fuel pump to the carburetor off at the fuel pump. With your finger over the end of the 3/8" copper tubing, lay the can horizontally beside the battery with the end of the can resting on the fan shroud. Quickly stick the neoprene gas line running from the carburetor onto the copper tube so as to avoid spilling any more gas than necessary and you drive about ten miles this way before you have to refill the can. When doing this it is advisable to pull the line running from the tank off at the fuel pump and plug it with a wooden rod or pencil. This will prevent gas from running out if the pump should start working again.

Several times this 'auxiliary tank' has saved me time and a possible towing charge or saved me calling my wife who has towed me home so many times it is no longer a thrill to her.

Filter fits in 5/16 inch line, Purolator 805
Andrew Hathaway, NJ (Feb. 1995, p.9)

Considering how old the D-models cars are now, it's a good idea to be able to see if the gas tank is allowing any rust, etc. to get up into the pump and/or carburetor. At a local chain outlet I got Purolator Model 805 for a 5/16" fuel line. The kit includes hoses and clamps, and for my setup was just the right length, giving a little clearance at each end of the mounting between the pump and carburetor. Other setups require longer hose. I also picked up a 3-pack replacement kit, part #896A long. It includes instructions and two o-rings.

The instructions are easy to follow. I found that the unit installed very easily. Make sure that none of the wires going to the distributor rub on the clamps or the filter itself.

Gasoline without lead useable in Citroën
Don James, OH (Nov. 1985, p.26)

The answer to the question, "Can I run my DS on unleaded gas?" is yes, but it must be a high-test (premium), unleaded gas. The lack of lead will not hurt your car, but the detonation and spark knock can indeed ruin it in short order if it is run on gas that does not have enough octane. Lead tends to make soft carbon deposits in the combustion chamber and if these deposits are thick enough, they can glow red hot and cause dieseling or worse, detonation.

Unleaded gas will not harm your valves. Leaded gas contains such a small amount of lead that it could not possibly lubricate the valves in the "blast furnace" environment they are working in. Lead deposits on the valve stem probably cause more wear than lubrication to the guides, but the valve seats are banging away constantly. Today, most everyone agrees that propane powered engines last a very long time, and that propane, butane, and methane gas do not contain lead.

It seems the problem is that quite a few people believe that lead is going to "lubricate the valves" in some way. It is time to point out that it is the gas refining companies themselves that published reports saying that this was the benefit of the addition of lead in gasoline. The real reason for putting lead in gasoline was to get higher octane with less refining–i.e. cheaper. Very early cars did not have leaded gasoline, and their low compression was the only way they could burn low grade gas. Aviation gas was always lead free, but very expensive because of the extra amount of refining that was needed.

Note: The above was written when regular leaded gasoline was still available but all the refiners had changed their premium (high-test) grade to unleaded. (D’s run fine on regular no-lead gas, but as with any engine, the timing my be accurately set. [MB])

Line with many pin holes found after car dies on road
Dick Phenicie (Apr. 1977, p.2)

A Christmas journey to Baytown, Texas was cut short when our faithful Citroen died about 300 miles from our destination. No gas was getting to the carburetor. With the help of our CB and a 'good buddy', I was able to get a lift to a station where the owner drove me and emergency gas supplies back to the unconscious machine. By rigging up a gravity-feed system consisting of a gallon plastic jug hanging from the san visor and tubing to the carburetor, we were able to coast at a nice 55-60 mph to our son's. Mileage economy, incidentally, was phenomenal–33-34 mpg.

Close inspection revealed many little pin holes in the plastic gas line. Picture me blowing cigarette smoke into the tube while my grandson reported the smoke from a thousand Indian campfires under the car. Repairs were made fairly easily and we enjoyed a safe journey home.

Poor mileage and fuel odor due to bad fuel pump
Betsh, Ken (2001 #3, p.13)

After wondering for several months what was causing the oil warning light on my D-wagon to flash at idle (even after changing the oil filter o-rings) and what was the cause of poor gasoline mileage plus the source of the occasional smell of gasoline under the hood, it wasn't until I was certain that my oil level on the dip stick was going UP after several trips that I suspected raw gasoline was getting into the oil system. This could also explain why the oil became black soon after being changed. Since the fuel pump is the only place in the engine system where the two are isolated by a diaphragm, I swapped the fuel pump with a used spare and solved all these problems.

The changing process is fairly easy; it's held on two studs with nuts requiring a 13mm socket. It's also easy to drop the nuts into the underhood "never land" and then discover you have no spares since this 8mm size is hardly used elsewhere on the car. These studs also hold a very thick gasket/spacer holding a plunger pin between the pump and the engine block.

Pump may require priming when replaced
Ken Betsh, PA (Apr. 1999, p.14)

Fuel pumps seem to be one of the Citroën's most reliable engine accessory. In my almost 2/3 million miles of driving post '66s (with my wife's help), I've never had a pump problem. (Perhaps that's because I have always carried a spare.) A few years ago I had an intermittent miss problem that before being solved drove me to try everything–including swapping the fuel pump. But after changing it, the car wouldn't run at all until I primed the pump by pulling the hose at the carburetor and pouring some gasoline down the hose.

The year before, another club member and I tried to get a DS to run that he had found and considered buying. It had set for at least two years. The engine was stiff but not frozen. We removed the plugs and used jumper cables (the battery, of course, was dead) and ran the engine on the starter for a total of about 20 seconds. While running this way we turned on the ignition switch and found the oil light went out and the ignition dwell was within the acceptable range. We reinstalled the plugs (they didn't look too bad) and were disappointed that the engine made no attempt to start. However, now the engine turned slower and the voltage drop in the jumper cables was rather great (I think we only had about 8 or 9 volts). At this point our available time had run out and we had to quit. We never went back (the body of the car didn't appear to be in a desirable condition) and I still wonder if the problem was that the fuel pump needed priming. Of course, starting an engine in excellent condition on such a low battery voltage is a challenge.

Spit below half tank of gas due to rust and dirt in fuel
Steve Varso (Feb. 1992, p.22)

Are you having problems such as the engine sputters or dies? You check the ignition, then the gas gauge and everything seems okay. It might start with the "choke" out all the way, but it soon dies. The remedy is to drain the gas tank and clean the filter in the tank. It will be stuck in the drain plug.

Get a can of Gumout carburetor and choke cleaner and leave the filter to soak in it for a couple of days. Then blow out and replace. It will be good for a couple of years. A friend's '67 Pallas ran fine with a full tank of gas but when the tank got to half full or lower, it began to spit and finally just stopped running. Fill the tank and off it would go–no problem.

We drained the gas tank and found it was loaded with rust and dirt. The tank filter was all gummed up. I soaked it in carburetor cleaner for a couple of days and blew it out. We cleaned out the tank, replaced the filter, and now everything is okay.

Tank has two drains
Ken Betsh (2000 #4, p.13)

The fuel tank has two drains which I've used in rare occasions with the feeling I would find the source of this dirt and remove it. To do this I would wait until the tank is almost empty and pour the contents into a one-gallon glass jug for observation. Most of the time, the gas would be completely clear of any dirt. The much-larger right-side drain is also the filter. I've never found any dirt clinging to it. I suspect most, if not all, tanks with this much age have some dirt on the bottom that stays there and doesn't drain out and usually doesn't enter the hose to the engine. Perhaps the best bet is to not let the tank get so low that more than 15 gallons are needed to fill it.

I've never dismantled a tank to see the inside but understand there is a low fence, maybe an inch high or so, near the right end from front to rear so that the filter and feed-point to the engine are on the much smaller right side. One time I ran out of gas on an expressway and drifted to the shoulder where the right side of the car was lower than the left. While the car would not immediately restart, it did start about ten minutes later. It ran fine about 10 miles to the next exit where over 16 gallons was needed to fill it.

Tank removal hints
Ken Betsh (2009 #4 p.13)

Removing a large sealed panel under the back seat gives full access to the gas tank and its retainer fasteners. While the good news is that the bottom of the tank is protected by the one-piece, non-removable underbody of the car, the bad news is that this part of the body has ventilation holes that allows moisture and dirt to enter and produce rust damage in the small gap between it and the bottom of the tank. My first two tank removals were on cars being dismantled for parts and I was glad for this experience before removing a tank temporarily for rust restoration.

My first step toward removal was to completely drain the tank at two points on the bottom. I'm not sure of the internal construction of the tank but am certain that opening just one point will leave fuel in the tank. I always removed the left-end first (with a 12-mm wrench) and then the larger right-end drain (with a 21-mm wrench). The fuel-tank filter either comes out with the larger drain plug or is easily pulled out if it sticks to the end of the one-piece nylon tube that goes all the way to an elbow next to the fuel pump on the side of the engine. The end of this tube is cut on a diagonal and I learned through experience that its position should be noted so that, if replaced, it's returned to the same position, that is, the distance from the bottom of the tank.

There are three pipe or tube connections to the right end of the tank that, if not removed, prevent lifting the left end of the tank sufficiently to clean and treat any rust damage under the tank. I separated the large stub-pipe for the fuel inlet under the right-rear fender. Next, I unclamped and removed a plastic (perhaps nylon) vent tube from a stub-pipe at the end of the tank.

The real challenge is dealing with the barely flexible one-piece molded nylon fuel-output tube since there's no connection or splice point on the outside of the tank. There is a protective flexible cover over the tube next to the tank that I released and slid up the tube (towards the front of the car) after loosening a clamp reached via the bottom access cover behind the right-rear door. The tube must be pulled out of the tank which is made difficult by a right-angle bend molded into the end of the tube matching a right-angle turn in the larger metal tube within the tank into which the nylon tube is inserted. I was able to remove the tube and later reinsert it, by clamping it with vise-grip pliers set to grip it without crushing it. My only relief from fear in doing this was that, if I ruined it, I had a spare part previously removed from an earlier D-model.

The last detail in removing the tank was to disconnect the electrical connections on the top center for the dash-mounted fuel gauge. The tank sensor is a float-actuated variable resistance that can be removed without removing the tank.

Tank, well and line replacement and repair
Paul Fontaine (Jul. 1984, p.24)

My D-model frame was rusted out in two areas near the gas tank well. Removing the gas tank is reasonably straight forward if you follow the proper sequence.

(1) Drain the tank by removing the filter gadget.

(2) After the well cover is removed, remove the two clamps holding the plastic gas line on the frame.

(3) Pull the plastic gas line out of the tank from the outside of the frame.

(4) Remove the two tie-down clamps, rubber spacers and a small rubber tube connected to the tank on the right side.

(5) Remove the filler tube so that you can pull off the 1-1/2" I.D. rubber filler tube connecter to the tank.

(6) With a large screwdriver, pry up the left side of the tank and wiggle the tank filler tube out of its hole.

The tank was pitted with deep rust spots. Not wishing to trust the rust pits for another decade, I removed the tank from a '71 D-Special. This tank had minor rust spots. On installing it, the original rubber tubing that covered the plastic gas line where it went through the frame would not go through the frame as it had become stiff with age. A piece of 3/8" I.D. gas line hose slipped over the plastic line and pushed through the frame and also fit tight on the short piece of copper tubing that held the plastic line in the filter. I sprayed the plastic line with dry silicone lubricant before inserting it into the tank, as the copper was rather a tight fit.

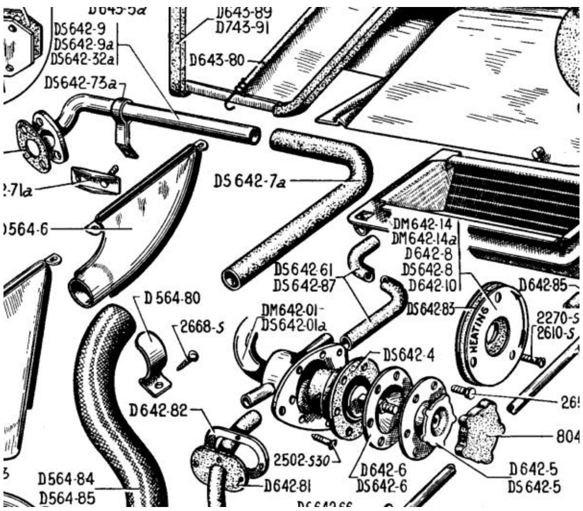
There was a fair collection of dirt underneath the gas tank around the hole where the drain and filter were located. There was also a collection of crud in the hollow box section adjacent to the pipe the gas filler tube ran through. A small section of 4" had rusted through at the bottom corner. I cleaned this out as much as possible with a hacksaw blade and air pressure from a blow gun. I sprayed Penetrol through the rusted hole in the frame and through the bottom hole after removing the plate. I installed 20 gauge galvanized 4" x 5" angle on the back wall and both sides to beef up the rusted areas in the gas tank well.

Editor: Rusted gas tank wells are a problem on the D-models. It is a good idea to stop the water from following the filler tube down into the gas tank well. More on this subject will soon be in the Citroën Quarterly. Gas tanks that are rusty inside can be removed after draining and coated with a quart of gas tank sealant by simply sloshing the sticky sealant around in the tank. This stuff works very well, and will seal even small leaks and pin holes.

Chapter 17–Heater

Auxiliary heater problem due to control valve constriction
Technical Information #20 dated Dec. 15, 1961 (Jun. 1993, p.6)

It is possible on the new DS19 that complaints may be received regarding inadequate heating during the cold weather. This may be due to a constriction in the heating system, particularly at the heater control valve. This prevents a full flow of hot water through the valve and consequent loss of heat.



To overcome this condition, proceed as follows:

- ∗ Drain radiator
- ∗ Disconnect rubber elbow hose (DS642-7) from the rear of the pipe (DS642-9); (see above image, extracted from parts book 466 [MB])
- ∗ Disconnect rubber hose from the rear of the auxiliary heater mounted alongside the left rear fender. On earlier models of the DS19 this hose leads directly to a metal tube on the suction side of the water pump
- ∗ Open heater control valve all the way. This valve is located on the passenger side of the firewall underneath the dashboard. This permits an open circuit to exist between the inlet side of the valve and the outlet side
- ∗ Alternately introduce water pressure into both ends of the circuit. Eventually the constricting matter will be dislodged
- ∗ When fully satisfied that all the material has been removed reconnect hoses and refill cooling system
- ∗ If the above procedure does not successfully remove the obstructing material it will be necessary to dismantle the heat control valve.

See operation No. DS642-3 in the 465 DS19 repair manual. (This article refers to an early version of the water control valve that had a diaphragm in it. After August, 1961, they were replaced by gate valves, a better design. [MB])

Broken heater valve base replacement
Dave Root, FL (Feb. 1990, p.13)

The heater valve on every D-model I have owned has allowed enough water to pass in the "closed" position to allow unwanted heated air to come through the heater in the summer. To combat this I would remove the hoses from the heater unit in the blower under the hood and fasten them together by means of a short piece of 1/2" copper pipe and hose clamps. Once in doing this I noticed the small plastic elbow fastened to the heater unit by means of a small flange was partially broken in two (that's why the water level had been going down slowly).

My solution was to get a 3/8" pipe floor flange and cut it to the shape of the broken plastic piece. I then drilled holes in it to match those in the plastic flange. With this in place, I used 3/8" galvanized pipe close nipples with a 90 degree elbow to a 3/8" brass gate valve. In the other end of the valve I used a 3/8" to 1/4" pipe reducer. Into that I put a 1/4" pipe nipple which was just the right size to fit the hose going into the heater. Now I just open the valve in the Fall and close it in the Spring.

Core unplugged with muriatic acid
Dave Paulin (Jan. 1982, p.6)

A poorly working heater in my car was fixed by pouring muriatic acid in the heater core. It seems the heater core was full of a brown goo that 30 minutes of soaking in the acid cured. I then flushed it with a garden hose and replaced it in the car. Plenty of heat now.

Please observe precautions found under “Chapter 23–Safety & Health, “Muriatic acid precautions.”

Increase heat by cleaning air screen
Don James, OH (Nov. 1984, p.11-condensed)

The first step to restore heater performance is to remove the fresh air intake duct and clean the screen where it fits into the housing. Bugs and bees can plug this duct and screen and prevent a full flow of air into the housing.

Mice are the worst problem. They love to make nests in these ducts, and if your car spends any time outside, it is a sure bet these ducts are plugged. Clean the screen every year. Be sure the ducts are properly attached.

Check the fan to be sure it rotates easily. The fan motor is a common problem with the heaters. It may run, but not develop the proper amount of power. It should sound a bit like a hair drier. See the next article if it needs attention.

Be sure all cold air vents inside the car are turned off. It is possible to get hot and cold air at the same time on your Citroën. Understand the controls!

Other tips: a winter thermostat will increase heat. The zipper on the radiator air duct can be opened and fastened with a snap so that some of the warm engine compartment air can be "recirculated". A rear seat heater available on some models increases heat output. It takes much longer to heat up because the additional coolant contained in it adds volume.

Increase heat by cleaning motor and core
Don James, OH (Dec. 1988, p.14)

Many enthusiasts complain of poor heat from their cars and this is not at all fair to the car, as the heating system is adequate for most winter conditions unless they are very extreme. The problem is that like most things on the D-model, the heater requires maintenance. Bugs, dirt, and rust can cause your heater to become very inefficient.

To get the heater working properly, the front fender must be removed from the car and the entire heater assembly removed and taken to the bench. Do not skip the fender removal. Fenders are easy to remove for a reason, and most operations on the car require it. Learn how. If something makes fender removal difficult, fix it.

Heater hoses can be joined together with a short piece of pipe, or simply plugged if you do not wish to have a loss of coolant. Coolant can be drained also. Don't forget to remove the cable to the heater control valve if one is fitted.

Start disassembly by removing the screws holding the two halves of the heater together as shown above (use care as the old plastic may be getting brittle). Clean the heater housing with strong soap and water. Take care when you withdraw the heater core as the halves separate. Flush bugs and dirt from the fins on the heater core.

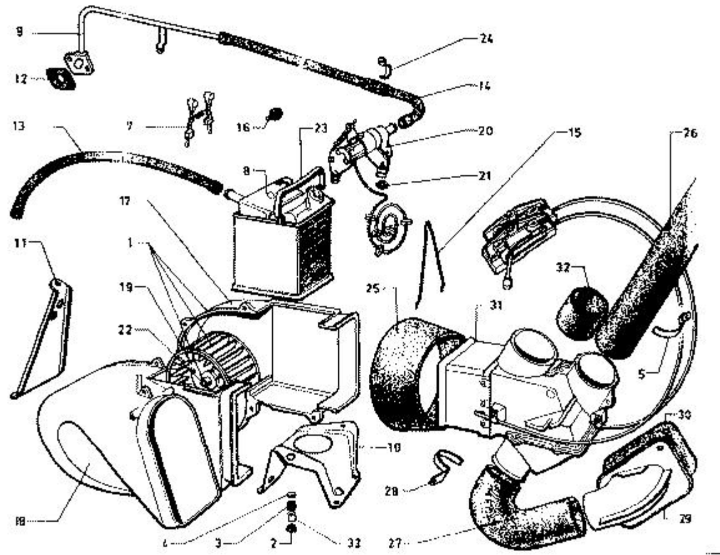
Remove the screws holding the electric blower motor and fan to the right side of the heater as shown above. Note how the rubber bushings fit. Take care with the wire as you withdraw it from the housing. Later cars have a more powerful permanent magnet motor with a nylon fan, while older cars have a metal fan and are much quieter because they have less power. Later cars sound like a vacuum cleaner motor when they are running properly. Stuck brushes are the usual cause of poor fan performance.

The above picture shows a permanent magnet motor of the latest type. It is of open construction, and dirt and corrosion are the enemy. Note the metal clip covering the brush spring (marked in the photo with *). Remove the clip and withdraw the spring. Pull the brush out, clean it then lubricate it with WD-40 (no [MB]) or LPS #1 or any lubricant that is good for electric motor use. (Get a bottle of “Zoom” at the hardware store. [MB]) The brush must slide freely. Lubricate the bearings of the motor. Test the motor on the battery to be sure it runs well with minimal sparking at the brushes.

The picture below shows the heater core by itself after the valve assembly has been removed. There are two sizes of heater cores used. Older cars have a larger core (and weaker motor), but may not have a valve fitted to the core. It is easy to see inside the cores that have the valve on top as seen here. Because coolant comes in on top and out on top, the core is the "low spot" and gets clogged very easily. The core seen here was almost completely blocked with white corrosion of the tubes. Water flow was only a trickle. Rinse the core with soap and water to remove any grease that would slow the acid.

Muriatic acid is very cheap. Pour it directly into the core at the opening. Use the acid straight from the bottle. Let the acid soak for 10 minutes. Repeat four times. The core should be freely flowing. Rinse with clear water for 15 minutes to remove all the acid. WARNING: Wear gloves and eye protection. Work outside. A violent reaction can be expected if the acid contacts aluminum (or concrete [MB]).

Here is an exploded view of the D-model heater assembly. It is from a Citroën parts manual and was on the front cover of the original newsletter carrying this article. The thin copper tubing, part of item 20, is positioned in the air flow from the heater core to automatically regulate the heat.



Valve leakage repair
Arnold Oshin NJ (Mar. 1998, p.18)

When fog started streaming into my '70 DS21 from the air intake vents, it seemed obvious some hot coolant with anti-freeze had somehow leaked. Looking under the hood, I noticed coolant leaking around the heater core. When gently pressing on the thermostat valve on top of the heater core, more coolant escaped into the air intake housing, and thus was able to enter the passenger compartment.

Apparently the thermostat valve had developed a leak and had to be repaired. The first task was to remove the valve and check the gasket sealing the valve to the heater core. This seemed OK, but since it was removed, the gasket should be replaced. Then upon more careful inspection, it was determined that there was a slight crack in the plastic body of the valve and that it would have to be repaired or replaced.

Since I have much "stuff' around, I decided to repair it. Using "Smooth-On" 2-part epoxy, I covered the entire valve with this very strong compound and let it dry for 12 hours. To replace the small gasket (3/4 in diameter, square section) I was advised that a suitable o-ring could be substituted. However, I finally found a knowledgeable person at a hydraulic supply warehouse that suggested the following gasket would work well. It is actually a piston seal for a hydraulic cylinder. Specifically it has a square cross-section, is the proper diameter, and one side of it has a double annular sealing groove. Here are the details: Progressive Hydraulics P/N 840400500, TEL (800) 447- 4409, price $2 each. (This is still a good phone number and the part number is as well. [MB])

With the new seal installed and the body repaired with epoxy and remounted on the heater core, it has been working just fine with no more inside windshield fogging.

Chapter 18–Hydraulics

Accumulator relocation return hose fails
Paul Fontaine (Jul. 1984, p.24)

After re-routing the hydraulic lines for the regulator, the low pressure return line rubber hose became intimately engaged with the fan on the alternator and subsequently released a spray of the system's vital fluid into the engine compartment. To prevent such occurrences in the future, I routed the return line through an 18" section of 3/8" copper tubing past the alternator fan to the front of the radiator and then under the air shroud tunnel to the relocated regulator on the right side.

Automatic transmission fluid shouldn't be used
Don James, OH (Jan. 1985, p. 26 & Nov. 1985, p.22-edited)

Dexron, an automatic transmission fluid (A.T.F.), should not be used in a good hydraulic system. It is too thick to give a proper ride, steering, or braking action! It is like STP–too thick to be of value as a hydraulic fluid for our cars. It is not a hydraulic fluid. Automatic transmissions run at a temperature far higher than that of your Citroën's hydraulic system. Touch one after a run and find out!

The friction characteristics of fluids such as Dexron are the reason that I rule them out in a Citroën hydraulic system. While they are mineral based and will not harm rubber parts, the additives to improve the friction of the bands and clutch plates in an automatic transmission do not lubricate the close fitting metal parts such as spool valves and pump pistons in a Citroën. Automatic transmissions use roller and needle bearings on all of their shafts and skidding or sliding is not wanted in these cases. No parts in an automatic transmission fit as closely as the hydraulic pistons and spool valves in your Citroën. A.T.F. will wear out the sliding metal parts and Teflon seals of your Citroën in a very short time.

Your owner's manual tells you can use Dexron Type A automatic transmission fluid, but only to get you to a dealer as soon as possible. The dealer is supposed to drain it out! If a car is old and leaky, Dexron might be the way to keep it on the road longer, but we are constantly hearing of enthusiasts that put Dexron in a good hydraulic system. It is cheap and it works, so they can see no problem. The long-term effects can be very bad for the next fellow that buys that car. Dexron is not even recommended in power steering on American cars anymore.

If you have Dexron in your car now, you probably can't switch back to LHM or Texaco Aircraft #15 if it has been in there for more than 30,000 miles. The thinner fluids will result in a lot of internal leakage. Your pump will cut in and out frequently to keep up with the leakage from the worn seals and your car may sink rapidly when parked. The Teflon seals can be replaced, but nothing can be done about the worn pump pistons and spool valves.

Now, I am sure that there will be a lot of enthusiasts that will say, "I have been using Dexron for years, and my car still runs!" This is true, but for years he has missed the pleasure of the ride and performance that the car was designed to give. If he tries to switch back now, he will find that his pump cycles very often, and if it kicks in more than once every 30 seconds or so, he has problems and had better find out where they are.

One thing that Citroën enthusiasts must get over is the attitude that "because it still runs, I got no problem!" It will cost them a lot at some point in the future!

If you put the wrong thing into your hydraulic tank and run the car, you can never get it all out without a complete disassembly and rebuild of every hydraulic component on the car! LHS-2 cars (USA-versions before mid-'69) can use regular automotive brake fluid or silicone fluid.

LHM cars (post mid-'69) can use LHM or Texaco Aircraft #15. There are many different types of aircraft hydraulic fluid. Some of them will dissolve plastic! Use only Texaco Aircraft Hydraulic #15! It is used in jet aircraft, for autopilots, and in guided missiles. This is to be used as a substitute for LHM only.

Seems people have gone crazy with what they have put in their hydraulic tank. One fellow with a nice LHM car went to an airport and got some aircraft hydraulic fluid. Whatever it was, it was blue in color and all of the o-rings in the pump dissolved! It ruined the hydraulic system. Remember, you must know what you are putting in your tank!

Do not put aircraft fluid in your LHS-2 car! Other people do not understand Citroëns. One fellow in Columbus was told that since the car was "hydraulic", he could safely put hydraulic jack oil in his car. He had a beautiful '64 DS19, which should have had brake fluid or LHS-2 in it. The car was ruined. He had the spheres rebuilt three times because he thought that this was cheaper than making new car payments! He finally gave up when everything on the car, including the brakes, started leaking.

If your car has only been run on LHM, stick with it, or switch to the Texaco #15 (cheap at airports from a 55 gallon drum). If your car has been loosened up from being run on Dexron A.T.F., you might try switching to a thicker hydraulic fluid such as the Lubriplate (see separate article). Specifications indicate this is a thicker fluid. Use a paint viscometer cup to test any fluid at different temperatures.

(Many users used Dexron for years with no ill effects. [MB])

Bleeding and priming the pump and regulator
Reprinted from Citroën factory booklet, "Citroën Hydraulic System, Possible Incidents with Suggested Causes and Remedies"

Submitted by Jerry Saville, PA (Sep. 1985, p.17)

When the high pressure pump, rubber feed pipe, reservoir filter unit, pressure regulator or main accumulator have been removed and refitted for any reason, it is necessary to bleed the system by running the engine with pressure regulator bleed screw slackened off by one turn until all traces of air bubbles disappear from the fluid being returned to the reservoir. To check this, remove the filler cap from the reservoir and observe through the aperture the fluid being returned to the reservoir. Tighten pressure regulator bleed screw and allow pressure to build up until pressure regulator cuts out. Release pressure regulator bleed screw and again observe until all traces of air have disappeared from fluid so released. Finally, tighten the pressure regulator bleed screw.

If difficulty is experienced in making the pressure pump function as indicated by the absence of any flow of fluid into the reservoir, it becomes necessary to prime the high pressure pump. This can be effected by removing the complete filter assembly from the reservoir, inverting it and filling it with hydraulic fluid with the engine running. When the fluid is obviously being drawn into the high pressure pump, top up the inverted filter and replace it as quickly as possible into the reservoir.

Bleeding needed frequently
Don James, OH (Mar. 1984, p.14)

Q. My pump is apparently sucking air because I have to bleed every few days. I've checked the filter in the reservoir and the intake hose, so its not getting in there, just be around the shaft bearings. Will this kill the pump? My ID19B is my daily driven vehicle."–Bob Shell

A. Air sucking into a hydraulic pump is not good, but will not "kill" it. I would advise you to check carefully the intake hose for very small cracks. Bending it will sometimes reveal them. The only other source of air leakage is the pump shaft seal. It is also possible for you to have nitrogen in your system from a leaking accumulator sphere, but this would go flat after a short time.

Castor oil and silicone added to brake fluid
Ralph Hope, Houston C.C.C. (Oct. 1979, p.2)

For brake fluid cars, be sure to drain the hydraulic system annually, regardless of the miles driven. Be sure to bleed the brakes more often and take out a substantial amount of fluid. I recommend adding an ounce of castor oil to every 44 oz. of fluid. Since, the brake fluid absorbs water much more easily than the green mineral fluid, I also recommend adding some liquid silicone to the reservoir which, because it is lighter than the fluid, will stay on top and help prevent water absorption into the brake fluid.

Editor: I strongly oppose such a recommendation. (While castor oil has been successfully used at about 15% in warm climates, silicone should not be used in the mix. It will not stay on top. It will mix in and cause problems. Castor oil will harden at low temperatures.[MB])

Chrysler Type 7176 and LHM substitute?
From "Motor", Submitted by Paul Fontaine (Nov. 1985, p.22)

There's yet another special automatic transmission fluid (A.T.F.) on the shelf. The new A.T.F., designated by Chrysler as Type 7176, is for use in all of their 1978-85 automatics with lock-up torque converters. It's already being used as the OE-fill for Chrysler lock ups. And Chrysler suggests (strongly) that if you're having problems with a Chrysler converter that bucks or shudders as it locks up, you should try refilling the transmission with the Type 7176 fluid.

Evidently, the new fluid's lower viscosity (when cold), along with its different friction characteristics, can smooth things out considerably while the converter locks.

Editor: The risks are too great–don't use it. (It's obsolete. [MB])

Clamps replaced with tie-wraps may leak when cold
Don James, OH (850814)

Plastic tie-wraps could be a troublesome substitute for those thin hose clamps usually found on Citroën boots or dust covers. They tend to allow leaks in cold weather.

Cleaning of parts
Don James, OH (Jan. 1986, p.3 & Apr. 1987, p.13-excerpt)

Alcohol will easily remove the black algae that builds up on the filter and all metal and rubber parts of a brake-fluid type hydraulic system (including one converted to silicone fluid). But, DO NOT USE RUBBING ALCOHOL as this contains water. The alcohol you use to clean must not contain water. Use "denatured" alcohol found in the paint department of most hardware stores.

For cleaning parts of a mineral-fluid (LHM "green" or alternatives), do not use any form of alcohol. Instead, use kerosene (gasoline is compatible but too hazardous).

Color mark indicate fluid compatibility
Bob Shell (Mar. 1984, p.14-condensed)

According to my rough translation of the official Citroën parts manuals, the assemblies, parts and joints marked in green are strictly reserved for circuits using mineral base fluid (LHM). The joints marked in white are common to the two circuits. The assemblies, parts and joints marked in red or unmarked are reserved for circuits using vegetable base fluid (LHS, LHS2). The switch-over from vegetable to mineral came with the 1966-67 model year change in Europe according to my parts book.

Editor: The switch-over was not until the middle of the 1969 model year for cars built for the USA market.

Dexron higher viscosity may cause problems
Charles Fowler (Jul. 1975, p.1)

I've tried Dexron Type A automatic transmission fluid and found it an acceptable and inexpensive substitute. However, it seems to have a higher viscosity than LHM and on a cold morning the brakes were sluggish and I have returned to the LHM. An automatic transmission additive should be used. The problem with these additives is that they attack the rubber seals, causing them to soften and swell. This could be troublesome on a Citroën and quite expensive to repair.

So if you want to experiment, please be sure to use a conditioner that recommends a companion product to stop leaks. Bob Hoffman at Citroën Auto Sales says to follow explicit instructions in your owner's manual for trouble-free service.

Editor: The moral of the story is to stay away from any kind of automatic transmission fluid (except an unavoidable short-term emergency use) and never add any unproven additive. The owner's manual does define LHM as "similar to automatic transmission oil." It also says: "Use only the green liquid sold in containers on which the green letters 'L.H.M.' appear" and "in case of emergency, it is permissible to use automatic transmission oil ref. Fluid A, Type A, such as the brands listed below: Esso AQ-ATF-2924A, Shell Donax T 6, Sunoco Trans-Matic B-10-107 and Citgo AQ-ATF-1562 A. In such cases, please visit your Citroën dealer as quickly as possible, to drain the reservoir and refill it with the liquid recommended."

(Modern A.T. F.'s are better than in the past, but LHM is still recommended. [MB])

Diagram of early DS19 system
Citroën (Dec. 1983, p.8)

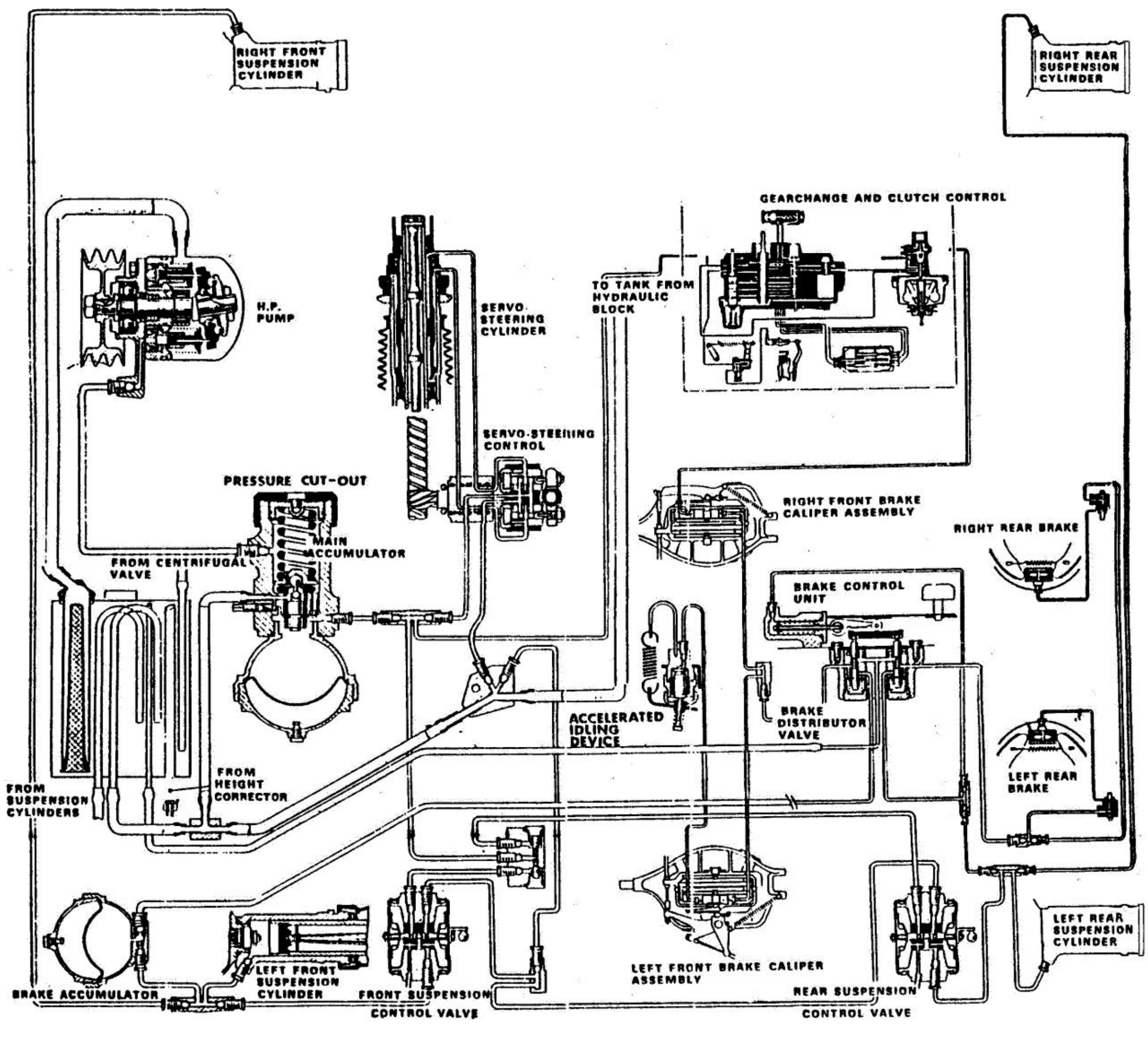
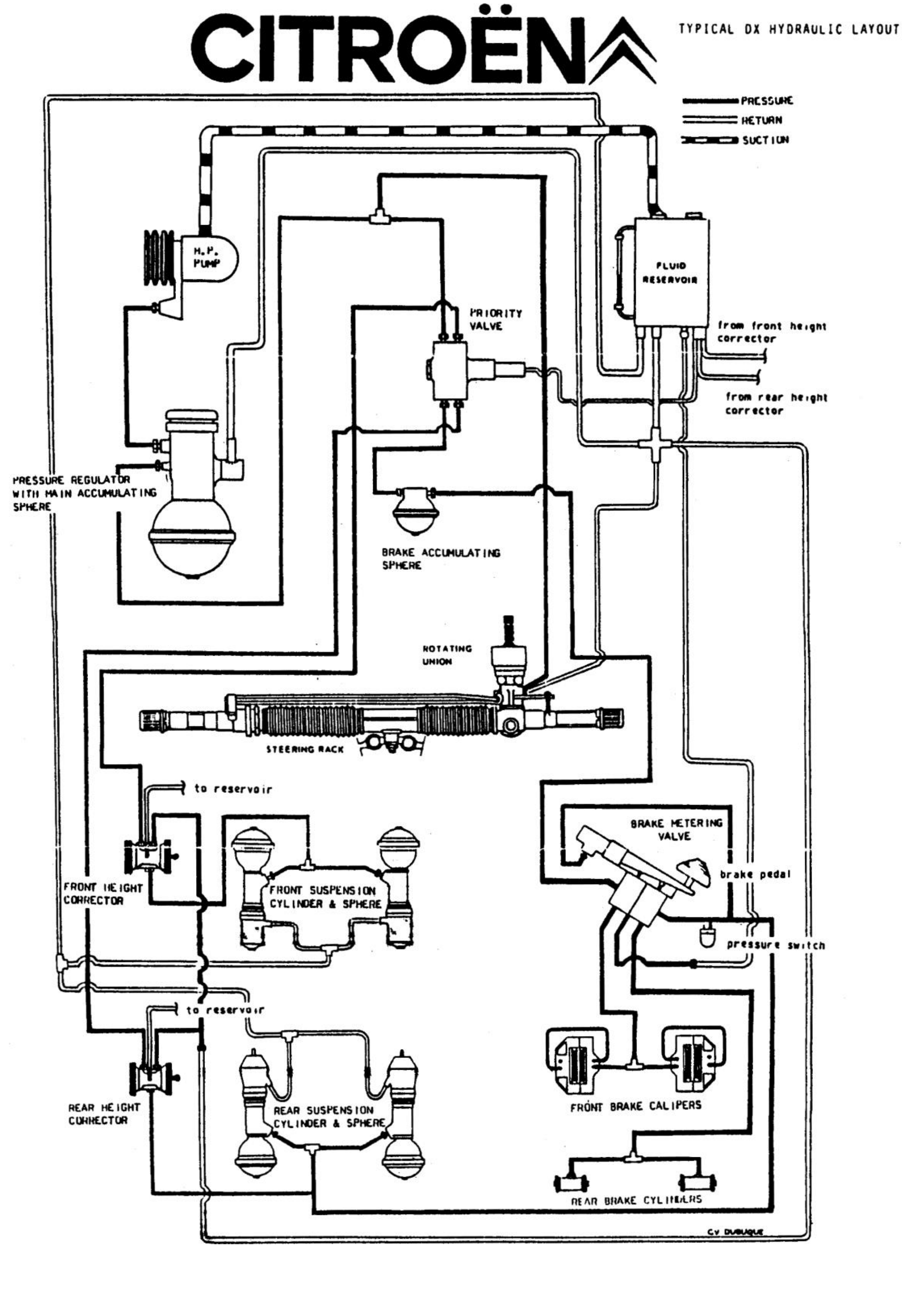
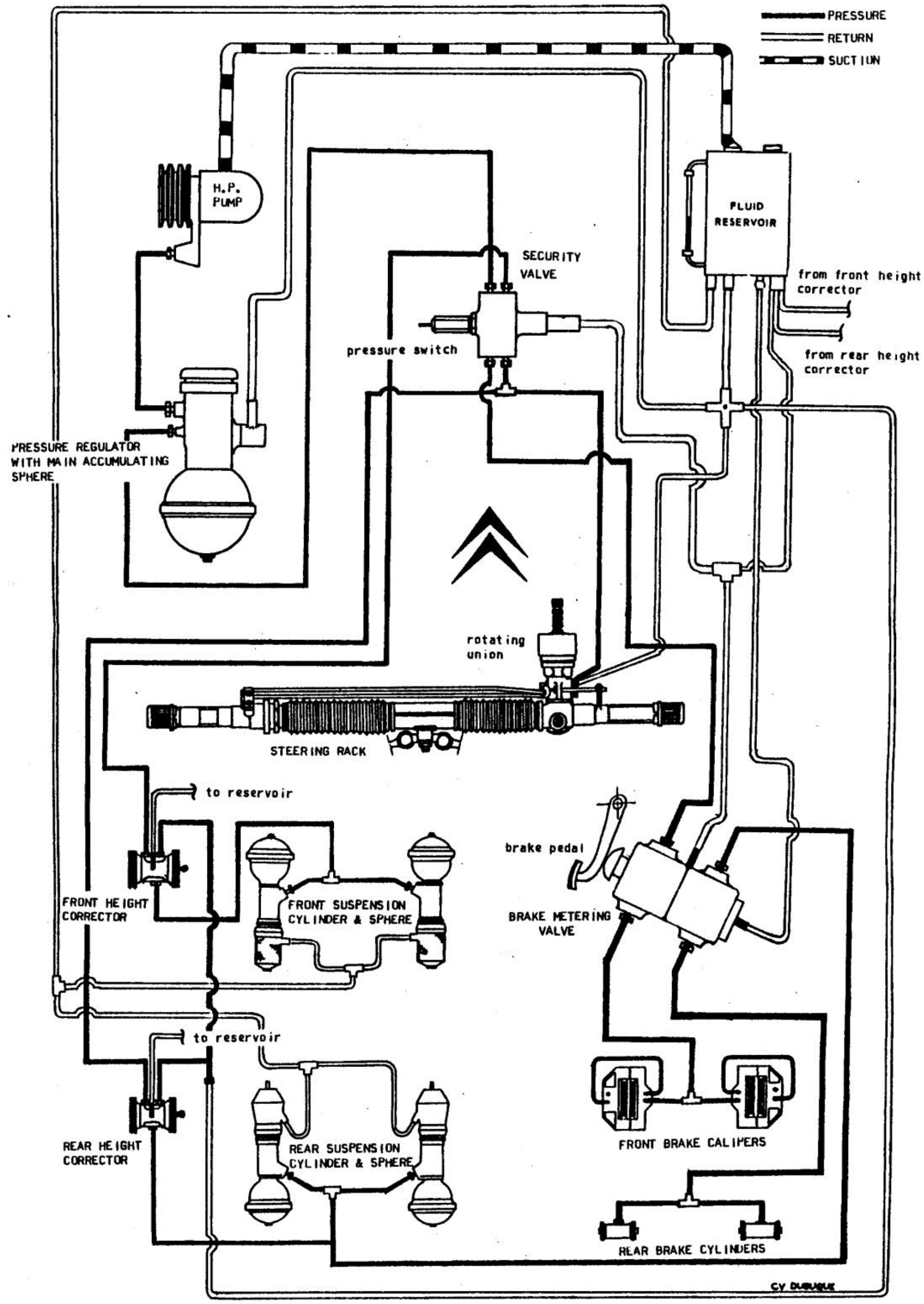


Diagram of typical DS system
Chris Dubuque, WA (Jan. 1986, p.30)



(I am including a second drawing by Chris Dubuque. This one is of the ID system. It is simpler and does not utilize the feedback brake system used on DS. The DS system can also include the Citromatic transmission system, where the ID never had it. [MB])



TYPICAL DV HYDRAULIC LAYOUT

Draining and flushing of the hydraulic system
Mark Bardenwerper, WI (Jan. 2003)

This article was adapted from a Citroen U.K. factory booklet. While published very early in the D production run, the information still holds for any of these cars, except as noted.

In the same way as the periodical draining of the engine and gearbox oils, the draining of the hydraulic fluid from the hydraulic system is a normal maintenance operation. The correct functioning and long life of all the hydraulic units depends upon this operation being carried out.

After the first 300 miles (500 Km) it is necessary to drain the engine oil. This first draining is a security measure. The lubricating power of the drained oil remains, but the “running in” of parts by movement releases metallic particles which can conveniently be removed with the engine oil. The hydraulic mechanisms are also “run-in”. Their operational conditions are no less severe than those of the engine. It is necessary to protect them with just as much care.

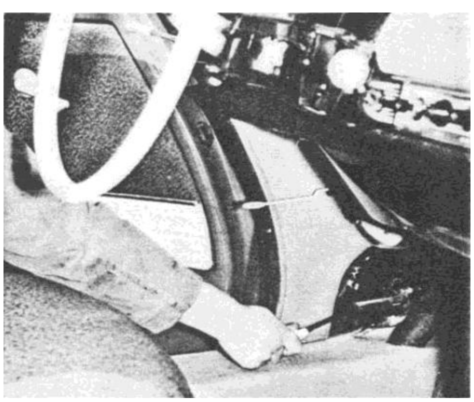
The efficiency of the filter is such that draining of the system at the first 300 miles (500 Km) service is not necessary. It is only required that the filter be cleaned and examined.

It is because of this efficiency, added to regular maintenance of the filter, that the frequency of draining can be 6 to 10 times less than that of the engine oil.

WHEN THE HYDRAULIC SYSTEM SHOULD BE DRAINED.

It is advisable to drain the hydraulic system on the DS, ID and BREAK (SAFARI) every 18,000 miles (30,000 Km) approximately. Nevertheless this figure is flexible: A vehicle driven only in towns or mountains or in dusty or humid countries or submitted to long periods of immobilisation necessitates greater frequency of draining than others which are frequently in use on the open road in a temperate climate.

Cleaning and periodical examination of the hydraulic filter, absolute cleanliness and careful fitting when working on the hydraulic system and units, will avoid premature draining of the system.



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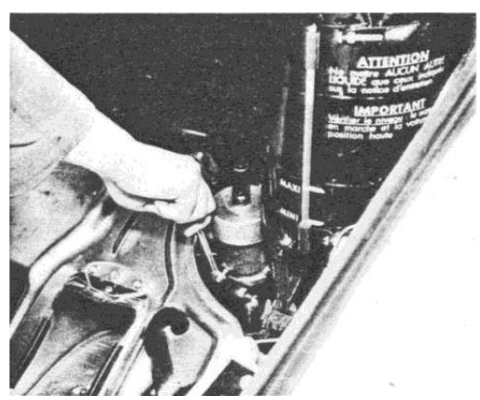

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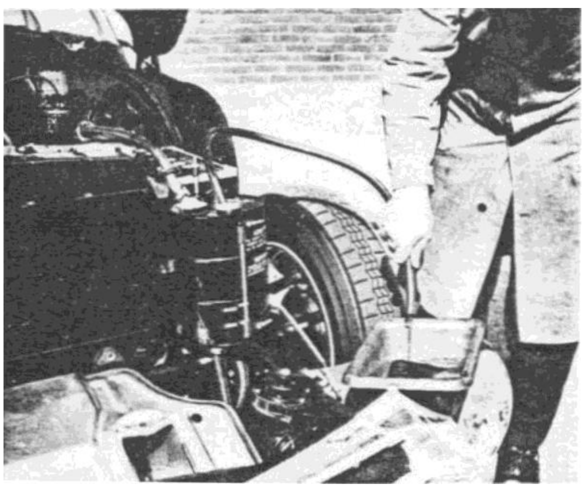
PROCEDURE FOR DRAINING THE HYDRAULIC SYSTEM

1. Complete draining: Complete draining of the system necessitates the removal of all the units. One can, however, obtain efficient draining without removing the units by following the method of operation given below.

Put the car in the low position by means of the manual height control (illustration No. 1).

Unscrew the pressure regulator bleed screw (illustration No. 2). (Note the position of the regulator on this early car. Later cars have the regulator mounted on the left side of the engine, unless it has been relocated. [MB])

Operate the hydraulic brake pedal until there is a complete exhaustion of pressure reserve from the brake accumulator (or from the brake accumulators on previous types). (On cars with power steering, turn the steering wheel fully one direction then the other to remove as much fluid from that system. On cars with Citromatic, operate the manual clutch control under the dash several times. [MB])



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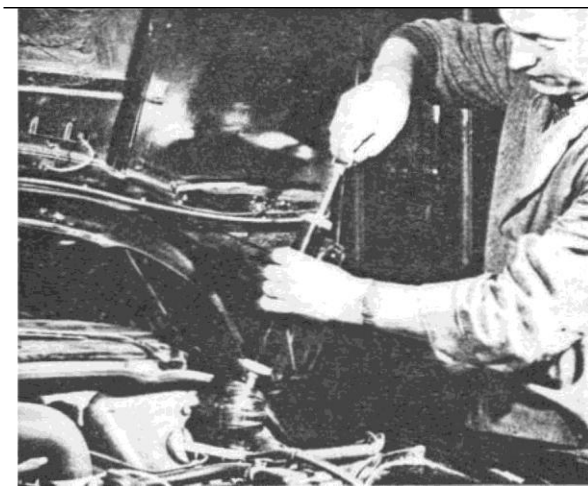

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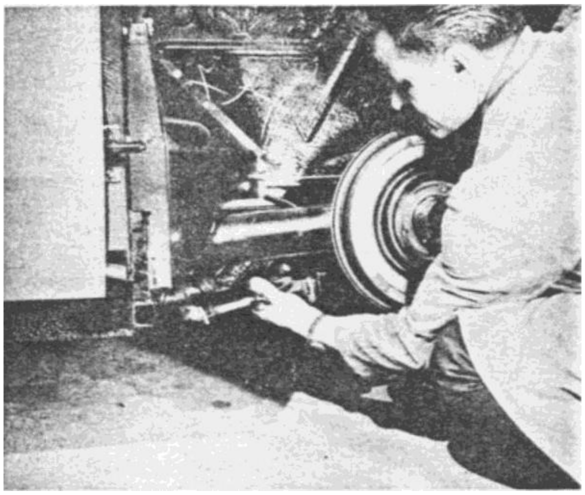
Drain the reservoir by siphoning (illustration No.3). (This was for very early cars. Later ones have a rubber standpipe that serves as a drain attached to the side of the reservoir, held by a spring clip and having a twist off plug. Detach the pipe from its clip, remove the plug and drain the reservoir by tilting standpipe into a pan set below the level of the base of the reservoir. [MB])

On the ID with supplementary suspension connection to the master cylinder, also drain the brake auxiliary reservoir (illustration No.4).



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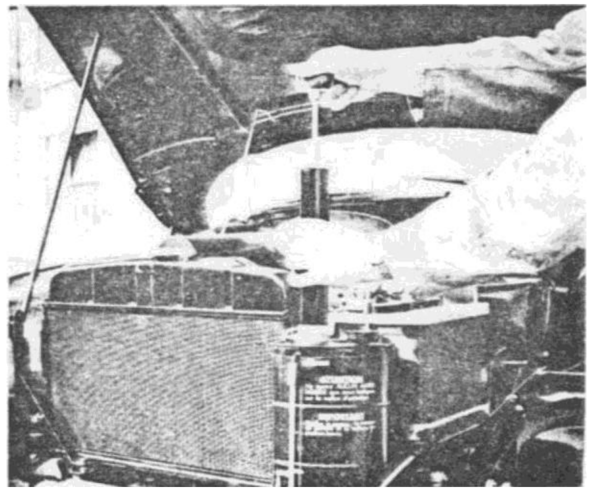

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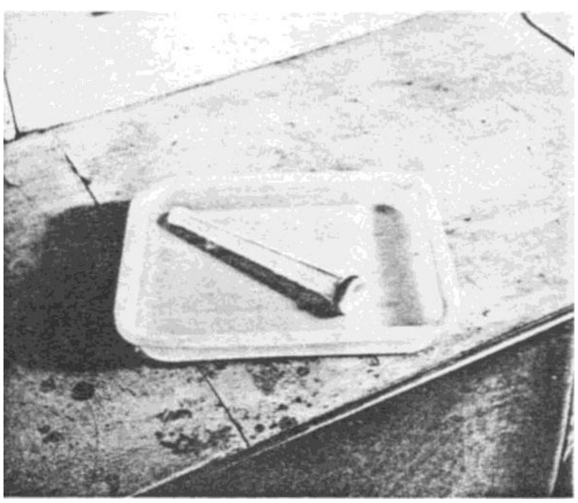
By hand, compress the rear suspension cylinder dust covers (illustration No.5) in order to expel from them the fluid contained, towards the main reservoir.

Complete the draining of the reservoir by means of a clean syringe (illustration No. 6). (On later cars, draining is automatic provided the standpipe is left in the drain position. [MB])

Remove the reservoir, plug up the openings, and pour in 1-3/4 pints (l litre) approximately of alcohol, screw on the cap and shake the reservoir vigorously in order to cleanse it. (It is permissible to just run some alcohol straight through the reservoir into the drain pan on later cars with standpipes unless it is really filthy. [MB])

Drain out the alcohol and refit the reservoir. (Omit this step, except as above on later cars with standpipe. [MB])



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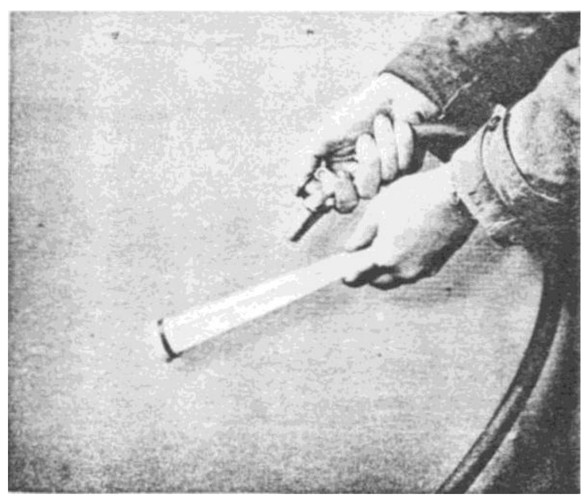

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Clean the filter by immersing it in clean alcohol (illustration No. 7).

Then blow with compressed air from outside (in the reverse direction to the flow of fluid) (illustration No.8), again rinse and very thoroughly check the filter.

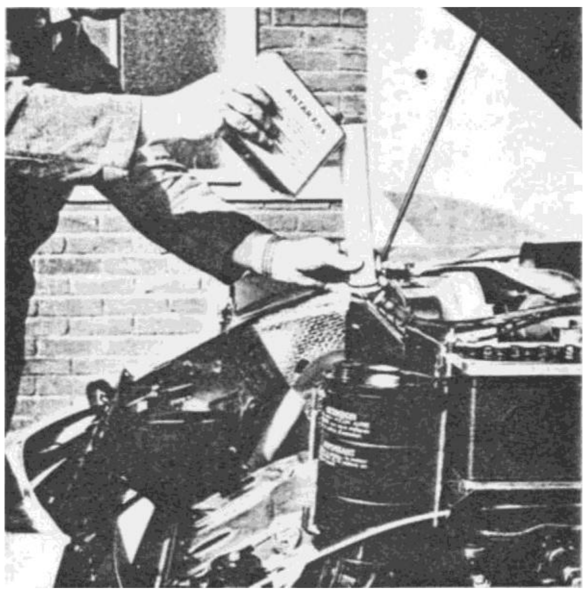
ALL FILTERS SHOWING DEFECTS IN THE MESH MUST BE RENEWED.

Pour 7 pints (4 litres) approximately of new fluid into the reservoir.

Start the engine and let it run for a few minutes in order to prime the high pressure pump.

Tighten the pressure regulator bleed screw.

Check that the level of the fluid in the reservoir is correct after having placed the manual height control in the required position for this operation (normal position or high position according to type-inscription shown on the reservoir).



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<u>Note:</u> If the high pressure pump does not prime itself: withdraw the filter tube from the reservoir, reverse it and pour fluid through the intake orifice (illustration No.9).

Replace the filter tube and run the engine, pressure regulator bleed screw unscrewed, until the pump is primed. (This is evidenced by peering into the filler opening of the reservoir and watching for a cascade of fluid returning from the pressure regulator via a down turned pipe. When no bubbles are evident, close the pressure regulator bleeder screw and allow pressure to build up until the regulator clicks then recheck for bubbles. Repeat as necessary. Twice should be sufficient. [MB])

2. <u>Partial Draining:</u> If the car is relatively new or if the draining of the system has recently been carried out it is unnecessary to carry out a complete draining. It is simply necessary to cleanse the height corrector section of the system.

Proceed in the following manner:

Put the car in the low position.

Unscrew the pressure regulator bleed screw.

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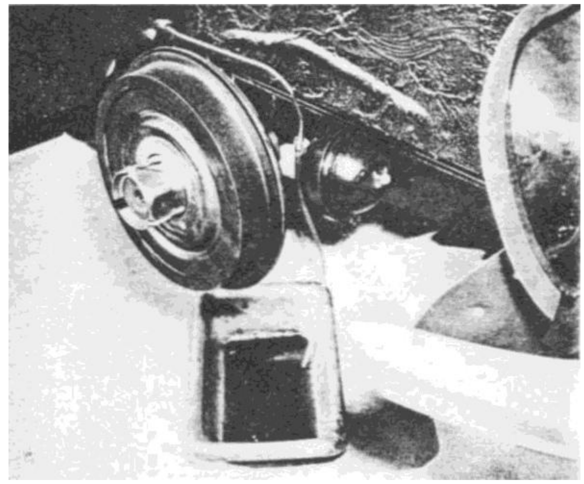

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With alcohol, clean the external part of the union, the area round the union and the joint of the suspension sphere and suspension cylinder (illustration No. 10).

Disconnect the pipe from the suspension cylinder.

Put the manual height control in the high position.

Tighten the pressure regulator bleed screw.

Start the engine (normal idling).

Let approximately 1/4 pint (one eighth of a litre) of fluid flow through the pipe in order to remove any impurities which may be inside (illustration No. 11).

Stop the engine.

Remove the suspension sphere and cleanse together with the suspension cylinder, as detailed in the suspension damper booklet.

WHEN TO FLUSH THE HYDRAULIC SYSTEM.

The hydraulic system must be flushed out in the case of severe gumming up of the slide valves or when contains unsuitable products such as mineral oil, for example. (They are referring to removal of any non-compatible fluid. In the event of contamination, time is of the essence to minimize damage. When severe or when long standing, positive results may be limited. [MB])

This operation is not necessary to suppress damper noise.

PROCEDURE FOR FLUSHING THE HYDRAULIC SYSTEM.

Drain the hydraulic system completely.

Refill with hexylene glycol (or Hydraurincage in the case of LHM cars; these fluids are not interchangeable [MB]) and run the car with this product for approximately 20 miles (30 Km). (1500-5000 km or 1000-3000 miles for Hydraurincage. [MB]) Again completely drain the system and refill with correct new hydraulic fluid.

In the case of unsuitable fluid in the system, flushing with hexylene glycol must be followed by complete dismantling of all the units in order to replace all the ring seals, sleeves, dust covers and rubber pipes which usually come in contact with the fluid.

The suspension spheres and accumulators must be replaced.

Note: Hexylene glycol is a product of:

S. I. D. A. 16, rue Monceau,
Paris - 8e - Tel. CARnot 04-80.

Or

SHELL CHEMICALS Ltd.
Villiers House,
London W.C.2.

(These suppliers are probably obsolete. Hexylene glycol is available from Sigma-Aldrich or almost any chemical company. It is rather expensive. I would suggest using a liter or a quart, then top off with brake fluid and run the mixture slightly longer. [MB])

Drier on reservoir keeps moisture out of fluid
Will Cummings (Apr. 1989, p.11)

To keep moisture from entering the brake fluid of my D-model hydraulic system, with its attendant internal rust, I drilled out the vent hole in the cap of the hydraulic reservoir, soldered on a copper tube, and ran a plastic hose from there to a plastic tube filled with Driedrite, a moisture absorbing agent. From there I ran the plastic hose to a small inner tube with the valve removed to accommodate the air moving in and out of the tank as the fluid level changes.

Filter should be cleaned every 6,000 miles
Technical Bulletin #45 dated 3/23/67 (Mar. 1992, p.18)

You are reminded that the cleanliness of the hydraulic system filter is essential to the proper functioning of the system, and consequently we ask you to see to it that D-model owners have this filter cleaned every 6,000 miles.

The first cleaning is at 600 miles during the first inspection. Use alcohol only on red/LHS-2/brake fluid cars. Use kerosene only on LHM/green fluid cars.

Fluid loss into Citromatic transmission housing
Don "Red" Dellinger, PA (Jan. 1992, p.5)

The gearbox oil needs to be changed on hydraulic shift (BVH) cars more frequently than on standard shift (BVM) cars because the shift piston seals could get bad (leak) and this would show as overfull; the hydraulic fluid would also go down.

I had this happen on a new car I was driving back from the distribution point in New Jersey in 1972. The hydraulic high pressure light came on and the fluid was gone...but no leak! I used the spare liter and that was not enough.

Hortense Moran (she and her husband, Dan, had a Citroën agency in Peapack, NJ) was following me at the time and gave me extra fluid, but it just disappeared. Then I noticed fluid coming from the speedometer housing on the gearbox. To make a long story short, I did some figuring and decided that I was using third gear most of the time and that had to be the piston leaking in the transmission cover. I drained four liters of oil from the gearbox and poured it into the hydraulic tank. I returned to the distribution point without using third gear for more than a few seconds at a time.

I also remember the first DS21 I picked up at the Brooklyn distribution point. After about three miles, I returned to complain about a singing ring and pinion noise in the transmission. I was told by the engineer, Mr. Lou Weiss, that this was normal. It must have been because they were all that way and still are after hundreds of thousands of miles.

Fluid, Texaco #15 for aircraft characteristics
Texaco Publication (Nov. 1985, p.22)

Manufactured from specially selected ingredients, Aircraft Hydraulic Oil 15 provides the user with the utmost in low temperature performance as well as the corrosion resistance, oxidation stability and anti-wear properties so necessary in today's hydraulic systems. This mineral oil product is widely used in many of today's aircraft hydraulic systems and shock absorbers. It is compatible with all seal materials normally found in such systems that are designed for use with petroleum oils, and is dyed red for ease of identification.

Aircraft Hydraulic Oil 15 meets the requirements of superseded U. S. Military Specification MIL-H-5606A and the Canadian and British equivalents 3-GP-25B Amend. 3 and DTD 585. NATO symbol H-515 applies. This oil is for use in hydraulic systems and other locations of aircraft, missiles as well as non-aircraft uses where an oil meeting MIL-H-5606A is required.

Typical Characteristics

Appearance	Red (dyed)
Gravity, API	32.3

Flash, COC, ºF	210
Pour, ºF	-75
Neutralization No.	0.03
Viscosity (cSt) @	
-65ºF	2070
-40ºC	450
40ºC	13.5
100ºC	5.0
SUS at 100ºF	74.3
SUS at 210ºF	43.0
Viscosity Index	372

Editor: The use of this fluid will not improve your ride if your spheres are low on nitrogen.

Fluid types, usage and markings
Dave Paulin (Mar. 1977, p.1)

Vegetable-based brake fluid was used in some 1969 and all prior U.S. models. All of the hydraulic hoses and spheres, for example, are painted black and the low pressure hoses will have a red stripe on them somewhere. The high-pressure line seals are red.

Newer cars using mineral LHM oil, the spheres and hydraulic reservoir canisters, for example, are green and the high-pressure line seals are also green. Any line seals or o-rings that are white are interchangeable and can be used in either system.

Editor: Very early D-models (which used brake fluid) may have no color

Height sinking quickly needs several checks
Don James, OH (Sep. 1983, p.5)

Q: My Citroën sinks very quickly. I have replaced the main accumulator sphere with a new one and replaced the hydraulic pump. Could the brake accumulator sphere be the problem?

A: Causes of sinking can be from several internal leaks are possible in different components. Steering, brakes and worn suspension cylinder seals are the most common problems. Pull off the rubber return lines from suspected components or disconnect them from your hydraulic tank. They should not leak fluid when the car is just sitting running and the suspected components are not being used. As an example: there is a low-pressure return line from your brake valve that allows the fluid to escape back to the tank when you release the brakes. This should not leak when the brakes are not actuated. Just pull off the rubber line and see if it leaks.

Rotating union and suspension cylinder seals will be worn if your car has more than 100,000 miles on it. A test for worn seals is to check your pump cycle time with the suspension at ride height and with the car in the lowest position. Any difference and you know the suspension seals are bad.

You can check for internal leakage from the pressure regulator by watching the stream of return fluid in the hydraulic tank. With the cap off of the tank, watch for a stream of fluid from the top of the tank when the pump cuts out (stops rattling). When the pump starts to work (starts rattling) the flow of fluid should stop. If still in doubt, remove the 3/16" line from the pressure regulator and plug the hole in the regulator. Open bleed screw first. Use an old fitting and line that has been pinched off for a plug. Start the car and close the bleed screw. The pump cycle time should be very long. If it is less than 10 minutes, replace the small steel check-ball in the pressure regulator. It is removed easily after removing the main accumulator sphere.

(Another common problem is faulty height correctors. [MB])

Hose from reservoir to pump PCV may harden and crack
Barton Milligan, Bahamas (Mar. 1984, p.9 & Jun. 1993, p.11)

Replacing the hose from the reservoir to the hydraulic pump with transparent plastic tubing cannot be recommended in green fluid cars. This tubing is heavily plasticized PVC (typically 55-60% by weight dioctylphthalate or DOP) and the plasticizer is rather quickly leached out by LHM or aircraft fluid. The DOP in the fluid won't hurt one's car, but the tubing becomes hard and then brittle. This can be demonstrated by placing a small piece of tubing in a jar of fluid for a couple of weeks. Fuel line, as recommended in the regulator relocation instructions, is fully satisfactory and is widely available in 1/2" I.D.

On the other hand, the plastic tubing is probably the material of choice for brake fluid cars, but anyone would be wise to do a compatibility test before trusting any particular piece of tubing to long term service. Just place a left over piece of tubing in a jar of fluid, cover tightly and check after a few weeks. If the tubing has hardened or swelled, another type should be found.

Leak and damage due to bad hose connector crimp
Allen Gravelle, Ontario (Nov. 1986, p.7-condensed)

A month after replacing the hydraulic regulator, a leak announced itself by spewed hydraulic fluid all over my garage floor. It appeared to be at the junction where the rubber return hose enters the aluminum casting on the pressure regulator. Fluid was pouring out of the bottom screw of the casting or so it appeared. After checking the hose and finding it OK, I replaced the pressure regulator again. Just as it looked like the problem was solved, this part failed in exactly the same fashion. A third regulator was fitted and the leak stopped. Some wetness along the bottom of the regulator was dismissed as residual fluid or whatever gumbo sticks to parts. Off I went to Toronto and the Raid 86 Barbecue.

Returning through the streets of Toronto, I thought I smelled burning LHM...not possible! A glance at the right side of my windshield had me asking myself if my window was that dirty? A mile later upon leaving the motorway, all hell broke loose. First, the suspension quit, allowing me to feel any stray toothpicks; then, the steering let me know what it might be like to steer an eighteen wheeler with manual steering (very, very scary)! The brakes lost some grip, but never gave up the ghost.

This time the return hose had exploded. I took it apart and found that the plastic connector I had used to join the rubber return hoses (this is a relocated regulator) was badly crimped. Fluid could not return to the reservoir. It backed up and blew the hose apart.

(When doing modifications make certain that your work is up to safe standards. When in doubt about your abilities, keep your car original. [MB])

Leak detection aid by noting pump cycling times
Don James, OH (Nov. 1984, p.8)

Trouble finding an internal hydraulic leak? Carefully time your hydraulic pump cycle time with the car at normal ride height, then again with the car lowered. If the pump runs less often with the car lowered, you have leakage in the suspension. Could be bad suspension cylinder seals.

The problem might be elsewhere if no change in cycle time. Disconnect the small high pressure line from the regulator (open the bleed screw first). Pinch off an old line to make a plug, put it into the regulator, start the car and close the bleed screw. Pump should go a long time before it cycles.

Since you have now disconnected the entire car from the system, the regulator should hold pressure for at least ten minutes without the high pressure pump kicking in again. If it does not, you have an internal leak in the regulator or a main accumulator that is very low on nitrogen and does not store enough fluid. If the regulator leaks, try replacing the check ball first. This check valve is visible after removing the accumulator sphere from the regulator and removing the screw that holds the small retaining plate (these check balls are available from J.B.M.).

If after these tests you still have a short cycle time, the regulator is defective or if the pump runs continually, the pump may be defective and not able to pump up enough pressure to achieve "cut out". To test, you will need a gauge to see what is happening as far as pressure goes. You can use an old piece of original hydraulic line and fitting, with a 3/16" compression fitting to adapt it to a 0 - 3000 psi gauge. Cut out pressures are different for older and newer cars, so consult your shop manual. Newer cars reach 2500 psi. Use this test gage in place of the plug or pinched off line you are using.

Remember: any internal leakage from the regulator must return to the tank by way of the return line. Clear vinyl return hose can be a temporary substitute so that you can see the fluid flow. When the pump is working, there should be no flow of fluid. Fluid should only flow when the regulator "cuts out." If not, you have a defective regulator.

If the pump works so hard that the belts slip and the regulator won't cut out, you have a dangerous situation. A chunk of rubber is blocking the spool valve in the regulator, and because there is no cut-out, your pressure is going sky-high. If the belts are made tight enough, something will blow! A sphere is like a grenade, and you do not want to be around when it blows. Remember to wear safety glasses when working with high-pressure hydraulics.

Never remove a line or open the system without opening the bleed screw on the side of the pressure regulator first. Be sure the height lever inside the car is at it's lowest position!

Where does the chunk of rubber come from? The sealing sleeves on the hydraulic line connections. If you are not careful, you can easily clip a piece of rubber from one with the end of the steel hydraulic line when you install it (such as when changing a regulator or pump). This is the reason that the manual says to always use a new sealing sleeve when you replace line fittings. The old ones can be reused if you take a little care. Be sure that you place the end of the rubber that gets "chewed" facing out. Be sure there are no strings of rubber hanging from it. New sealing sleeves can be made from proper sizes of vacuum line or windshield squirter tubing. This will work for both fluid types! Just cut it off to an equal length with a single edge razor blade (there are plenty of places on the car that you can find the proper size tubing to make seals in an emergency).

If your pressure reserve system checks out OK, but you still have an internal leak when the car is reconnected, you can check the steering easily. Place a shim or wide feeler gage behind the connection to the steering rack. This will block off the steering and you may then see if the cycle time is any better.

If your problem is not in the steering, you will have to check other components such as brake valve, Citromatic, etc. Look for leakage in the return lines. Just pull them off, one by one.

Leak detection aid by noting pump cycling times
Chris Dubuque (2000 #6, p.12)

I have put up with my D-Special sinking rapidly for long enough. For the last few years, my 1972 D-Special would sink to the stops within 10 minutes after shutting off the engine! In addition, the cycle time of the pump was pathetically short – about 10 seconds. I figured that this was very hard on the hydraulic pump and pressure regulator. In addition, my nerves were being taxed to the limit when I had to wait a fairly long time for the car to raise back up - even after just a few minute stop (e.g. a quick run to the grocery store).

My first plan was to start the car, let it raise, shut the engine off and then pull the hydraulic return hoses off the bottom of the fluid reservoir, one by one, until I found one that had an excessive fluid flow through it. My rationale was that flow through the return lines, when the engine was shut off, must be from an up-stream leaking hydraulic component. I could then trace the return hose back to the component and replace/repair that part. Unfortunately, this worked better in theory than in practice. First, all of the return lines had some amount of fluid "leaking" back into the reservoir. Second, some of the return hoses have multiple tributaries and branches up-stream making it difficult to isolate an individual component. Lastly, I had to decide what constituted "excessive" flow. One drop a second? Five drops a second? I realized I wasn't sure how to define "excessive" leakage.

Plan Two: I decided to give up on the return side of the component and concentrate up-stream on the high pressure side of all of the hydraulic components. What components could the fluid be leaking through? One good gander at the hydraulic schematic and I decided that I possibly had two problems; a large internal leak (causing the short pump cycle time) and a second leak in the height correctors and/or suspension cylinders (causing the car to sink rapidly). The short cycle time could be originating from just about any hydraulic component in the car. So much for Plan Two.

Plan Three: Good old trial and error. I began guessing at which parts might be at fault and then I just replaced it or rebuilt it. The following table outlines the steps I took, in the order I performed them and the results:

REPAIR	-- SINKING TIME--		PUMP CYCLE TIME
	FRONT	REAR	
Before	10 min	15 min	9 sec
Rebuild front suspension cylinders	10 min	15 min	9 sec
Replace brake metering valve (new)	10 min	15 min	17 sec
Replace front height corrector (used)	10 min	15 min	17 sec
Replace rear height corrector (used)	10 min	15 min	17 Sec
(At this point, I'm getting pretty discouraged!)			
Replace front height corrector (new)	Over 12 hrs	10 min	17 sec
(AHA! Progress!)			
Rebuild rear suspension cylinders	Over 12 hrs	4 hrs	125 sec

WOW, what progress! The pump cycle time went from 9 seconds to over 2 minutes and the car practically stays up overnight! I would like to get the back to stay up even longer, which I suspect I can do if I were to buy a new rear height corrector (I have never replaced the rear height corrector with a new one). Unfortunately, rebuilding height correctors does not fix internal leakage. Height correctors rely on extremely precise machining and lapping to achieve their low internal leakage rates. As the spool and its sleeve wear, there is no recourse other than replacement.

I'm not sure there is a moral to this story other than to say that it appears that numerous hydraulic components contributed to the rapid cycle time and sinking rate. I guess it was naive to think that after 20 years and one quarter of a million miles, just one component would be the cause. However, the biggest benefits came from the new height corrector in the front and steering rack rebuild. Also, I believe that the fact the steering rack rebuild had a significant effect on the sink rate at the rear of the car indicates rear height corrector and security valve internal leakage. Note that all testing was performed with spheres properly charged.

LHS doesn’t contain glycol
Bob Shell (Mar. 1984, p.14)

While in Washington DC on business at the patent office a few years back I looked up the French, German and Belgian Citroën fluid patents. All of them are essentially the same; the fluid is Castor Oil with an antifoaming agent (Ethyl Acetate) added. Shortly after reading up on this some friends of mine and I bought a 50 gallon drum of castor oil government surplus and added Ethyl Acetate (about 10% by volume) and ran our cars on it for some time. It is very different in color and scent from U.S. brake fluid, also does not eat up paint.

Editor: Fluid experiments like this that could lead to disaster are a bad idea. Don't try this. (This patent is likely for LHS-1. In 1964, synthetic-based LHS-2 replaced it. Since this was written, castor oil has been successfully used mixed at 15% with brake fluid. However, it thickens excessively in cold weather and should be completely drained and replaced with pure brake fluid until warm weather returns. The latest experiments have been mixing PAG automotive air conditioning lubricant and brake fluid. [MB])

Line failure repaired with brass compression union
Dave Root, FL (Sep. 1988, p.25-condensed)

A 1/4" brass compression union I happened to have on hand was used to repair a leak in the main hydraulic line on my SM with a DS engine. I had accidentally pushed it against the camshaft pulley. The pulley's edge was just rough enough to resemble a buzz saw cutting into a hollow log. Contrary to what I was led to believe for a number of years, these will hold pressure. I didn't even have to disconnect any tubing.

(By all means, this is not a permanent fix. [MB])

Lubriplate “Low Pour 70” works well
Allison H. Grayson, ID (Nov. 1985, p.20)

For the last year I have been using Lubriplate Low Pour 70 hydraulic oil, which conforms to MIL-H-5606B, like Texaco "BB" or Aircraft Hydraulic Oil #15. This has the famous Lubriplate anti-wear additives. My reservoir filter gets virtually no black filth on it. #15 was a real improvement in this area over LHM but the Low Pour 70 is even better.

Since some leeway exists within the limits in the MIL-spec, owners of Citromatic cars should be careful but I have had no problems in my manual shift car. The Lubriplate does seem to be slightly "thicker" than #15 but the only time the pistons have been sticky at all was in the first few seconds after starting the car at -15ºF, this after a night as low as -17ºF. The HP pump made a little tapping noise for just a moment. Since the black filth on the filter is mostly deteriorated rubber parts, dissolved gum in the fluid this should indicate less wear on them.

The metal parts of the Citroën hydraulic system are like other hydraulic systems. The problem with substitute mineral oils is with viscosity. The Citromatic timing and the suspension dampers (shock absorbers) are calibrated for the viscosity range of LHM. Thicker fluids foul up the Citromatic and make the car ride "hard". Thinner fluids increase wear of all moving components in addition to causing the Citromatic to "crash" the gears, slam the clutch and allow the suspension to bottom out more easily. Paraffinic-base oils tend to clog valves and tiny orifices, such as those in the Citromatic, the dampers, the height corrector dashpots and the steering. So we need either a napthenic-base or a very highly refined paraffinic-base oil in order to minimize waxy deposits.

Automatic transmission fluid like Dexron is bad about this. It does not bother an automatic since the operating temperature is around 20ºF. But the Citroën system's temperature varies from outside temperature, whatever that may be, such as in the brake lines, up to about 150ºF in the pump output. So waxy deposits can cause delay and chatter in the brakes even after the rest of the system has warmed up, especially in very cold weather. With Low Pour 70 in my car's system I had no braking delay at -15ºF.

This oil is sold in 5 gallon and larger containers. A 5-gallon pail is about $28 plus shipping here in Nashville. Having a large quantity on hand encourages changing the fluid on schedule. Since oil is cheap compared to hydraulic system repairs I recommend changing it every 10 or 12,000 miles rather than 18 or 20,000 like the manuals recommend. This gets wear particles out of the system. Also, it should be changed every year even if the mileage doesn't pile up that fast.

Company description - Lubriplate Special Low Pour Hydraulic Oil is a special hydraulic oil with extra low pour and low temperature operating characteristics. This oil is a heavy duty, high pressure, anti-wear fluid designed for high performance in cold weather operations without sacrificing any of the qualities that result in lower maintenance costs. This oil has a high viscosity index insuring optimum performance over a wide operating temperature range. The low Brookfield torque test results in low starting torque under extreme cold conditions.

Lubriplate Special Low Pour Hydraulic Oil features:

* fluid zinc for anti-wear properties
* high natural viscosity index for stable viscosities throughout a wider operating temperature range
* high aniline point for controlled seal-swelling characteristics
* rust and corrosion resistance properties
* chemical and mechanical stability
* foam suppression properties
* good heat transfer properties
* thermal oxidation stability
* -70ºF pour point and low Brookfield test for low torque under cold weather operations

Lubriplate Special Low Pour Hydraulic Oil is available in the gallon cans, 5-gallon pails and 16- and 55-gallon drums.

Typical Tests:

Viscosity, SUS	Temperature
46.5	210ºF

126	100ºF
1,750	0ºF
2,800	-10ºF
4,100	-20ºF
6,500	-30ºF
Brookfield viscosity @ -55ºF	43,000 cps.
viscosity index	210
API gravity	29.45
flash point, ºF	315
fire point, ºF	350
color	pale yellow
Aniline point	191
pour point, ºF	-70
approximate SAE no.	-75 very slow
ISO grade	5W to 10W
dielectric strength (ASTM D-877)-36 KV	22

Editor: Thanks for the advice on changing fluid often. Most enthusiasts never bother to change their fluid until they get a major leak and lose it all. I took the liberty of getting a spec sheet on the Lubriplate, and it is thicker than Texaco #15, and it also does not have as high a viscosity index, but performance in cold weather should be good. Best of all, it is a hydraulic fluid, and not automatic transmission fluid, so it should have good lubricating and air separation qualities. Be sure that you know exactly what you are pouring into your hydraulic tank!

(Tony Jackson and I complied a "Summary of Citroen Hydraulic Fluids," which is available on the Internet at http://citroen.cappyfabrics.com/tony.html. It has fairly complete coverage of the prevailing knowledge of both LHS and LHM fluids and their substitutes. [MB])

Pipe fitting removal without damage
(Apr. 1981, p.3)

When attempting to repair hydraulic lines, especially in their usually rusted condition, one of the hardest and most frustrating parts of the job is extricating the compression fitting that holds the line secure. When trying to undo them with a 9 mm open-end wrench (spanner), the fitting is usually rounded off and then the battle continues with the use of Vise-Grip pliers, the end result being the fitting is mangled and useless.

Next time try it this way. First, scrape as much crud and rust from the fitting, line and threads as possible. One of the handiest things for this job is a double steel brush designed for cleaning BBQ grills. It can be found in most hardware and discount stores and sell for about one dollar. It is small enough to get in the small areas around the fitting and works on the hydraulic line the same way it works on the BBQ grill.

Second step is to soak the fitting, if possible, for several hours or overnight with a quality penetrant, such as Tri-Flon or Tri-Flow. If you can't let it soak, put it on anyway. As soon as the rust bond is broken, the penetrant fluid will seep in the threads and make further removal much easier.

The final thing to get is a metric flare wrench, 9 mm or 12 mm for the large fittings on the accumulator and the high pressure pump. Sears sells a set of five wrenches under their Craftsman trademark. The part number is 9-4434 and includes sizes from 9 to 21 mm. The advantage of the flare wrench is that it allows five of the six sides of the fitting to be used instead of two with the open-end wrench. It is almost as good as a six-sided socket. With this tool, there will be few, if any, hydraulic fittings that will not come off successfully and in good enough condition to be reused. The flare wrench works very well on other nuts and bolts on the car that are in positions that preclude the use of a regular socket.

(My favorite penetrating oil is PB Blaster. [MB])

Pipe next to regulator replacement is advised
Reprinted from Citroën Autoclub Canada (Nov. 1976, p.2)

If you must replace a faulty accumulator sphere, it is advisable to replace the little coiled pressure pipe beside the high pressure pump and the accumulator at the same time. If the accumulator is not holding its pressure properly, the constant thud you hear from it and the corresponding knock in the pipe mean that the pipe is being subjected to continuous pressure charges. After a while the pipe may crack from fatigue (you can feel an occasional knock in this pipe as the accumulator charges during normal operation).

Pipe replacement, 3/16" copper pipe
Dave Root, FL (Jun. 1995, p.10-condensed)

As is often the case when you have to disturb hydraulic components, a rusted line began to leak. A short section with a bend next to the rear height corrector had to be replaced. Where short bends are involved, I sometimes use 3/16" copper tubing as it is easier to bend. Some may disagree with my occasional use of copper tubing, but I've never had or heard of any failing.

To duplicate the bulge that Citroën put in the steel tubing at the fittings, I used a brass bead from a 3/16" brass compression fitting. In spite of what I used to hear, 3/16" copper compression fittings will hold the pressure and can be used equally well on copper or steel tubing. To seat the bead on tubing 5/16" from the end as required, I drilled through the center of a compression fitting with a #10 drill and cut one of the threaded ends off at the hex. This enabled me to see the tubing end and it needed to be about 1/8" in from the hex, to locate the bead 5/16" from the end.

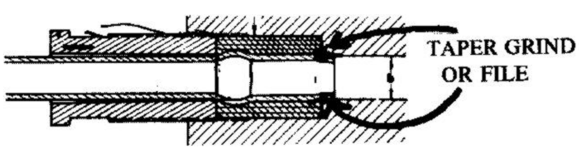
I also needed to run a #10 drill through the original Citroën tubing fitting so that it would fit over the slightly larger 3/16" diameter tubing. To help in engaging the fitting threads, I countersunk the end of the fitting opposite the 9 mm hex with a 60-degree countersink or center drill as deep as I could go without cutting into the outer threads. I made my "bead" on a piece of tubing that was straight so that you could slide the Citroën fitting in place afterwards (I trial fit it first to make sure it would slide on).

I have found it helpful when loosening tubing fittings to have a 9 mm box end six point and 12 point box end wrench. I slot the end 3/16" wide with a thin grind wheel, making a 9 mm flare nut wrench, which would be hard to find. The 6-point wrench would be for the loosening of the fitting and the 12 point one for quicker use when the fitting is loose. If the 6-point box end will not loosen the fitting, try heating half of the exposed part red hot with an acetylene torch, but withdraw the torch as soon as the fitting gets red hot. Slightly overdoing it can melt the hex causing you to have to destroy the fitting to remove it with vise-grips. Use a water-soaked rag to protect any rubber or combustible things from burning. If you want to do yourself a real favor, get a supply of the improved J.B.M. tubing fittings. These have a larger hex, which can take more wrench pressure than the original 9 mm ones.

(I cannot abide using copper tubing on an automobile. It cannot withstand the high pressure found in brake lines and it does not tolerate vibration. And no, do not use compression fittings except in am emergency. Remember that the original Citroën fitting do not require a lot of tightening. If the original fittings are not damaged, they do not need to be replaced. Always replace the compression seals. [MB])

Pipe replacement, 3/16” steel brake line
Dave Paulin (Apr, 1977, p.3 & Jan. 1978, p.4-combined)

Failure of a rear hydraulic line of my '72 D-Special lead to a complete replacement of all the hydraulic lines in the rear half of the car. Since all the French fittings had to be saved, they were removed as carefully as possible and soaked overnight in rust remover jelly to get the accumulations of rust off before re-using.



The new pipes were made from 3/16" U.S. steel brake line. Old lines were cut at staggered distances under the left rear door cavity. Steel double compression fittings were used to make the connections. Brass double compression fittings were used in the trunk compartment to join the lines going from the left rear side to the right. Where the lines were connected to the suspension and brakes and the French 3- and 4-way unions, small brass compression rings were brazed near the ends simulating the bulge at the end of the original pipes. Ends of the U.S. pipes were carefully ground so that they fit inside the French receptacles as shown above. All rubber seals were re-used. After refilling with automatic transmission fluid to test, the right rear sphere feed leaked and had to be remade and reground. A second test revealed that the repair held and all other connections were dry. Success!

Pipe replacement, Parker Hannifin junction fitting
Dave Paulin (Mar. 1978, p.3)

When 3/16" American-size brake lines are used in the left rear-wheel area and three- and four-way connections are needed where the lines come together, you can do away with the original three-way connection as Parker Hannifin makes a three-way "T" fitting that is the same principal as their 3PHU butt fittings.

Instead of taking out the original French fitting and taking three American lines and hoping they will fit, all you do is take this three-way "T", cut your American lines and put them in and tighten. The only reason for the three-way "T" is to divert the fluid. 3PHU pressure fittings cost about $1 per piece, the "T" about $3 per piece and the four-way would be $35.00! I redid the back end of the '72 and it held beautifully. No leaks at all and it was all American pipe. I used steel compression fittings and brass compression fittings. The brass was used in areas of non-stress, i.e. trunk and no problems at all. Once you put the Parker-Hannifin compression fitting on that line it won't leak, come apart, etc. You can bear down on it has hard as you can physically and it won't give under stress.

Pressure loss due to clogged tank filter, silicone fluid cleaned with soda
Michael E. Cannon, VA (May 1991, p.7-condensed)

Soon after leaving a Northfield Mountain Rendezvous, I realized my DS19 was not providing me with the soft ride that I was accustomed to. I pulled over to the side of the road, opened the hood, and the supply line from the vital fluid reservoir to the high pressure pump was flat. I found the reservoir filter clogged with black gunk. My car had been converted to silicone fluid last year and it can take a while for all the crap to dislodge within the system.

In spite of knowing this, I had not been checking and cleaning the filter like a wise person should have.

While I was attempting to clean the filter, Randall Jones stopped to inquire about my predicament (or at least I believe it was him–we never did trade names). He insisted I use a bottle of soda that he had stashed away in his trunk to aid in the cleaning. With it I was able to get the filter quite clean and after a rinse of fresh silicone fluid (which I had a whole gallon of) the filter was good as new. When I started the car, the system pressurized and went right to the normal driving height–all fixed. All it took was rags and Diet Coke!

Pressure regulator bleed screw has steel ball behind it
Don James, OH (Sep. 1988, p.20)

If you have ever removed the bleed screw from the pressure regulator to "check for pressure from the bleed plug", you may have lost the steel ball that is in the bottom of the hole. Without this ball to seal the bleed port, the hydraulic system is unable to build up pressure. The bleed screw is only loosened to bleed the system– NEVER REMOVED.

Pump and regulator checked with 3000 psi gauge
Don James, OH (Nov. 1984, p.8)

If the pump runs continually, the pump may be defective and not able to pump up enough pressure to achieve "cut out". To test, you will need a gauge to see what is happening as far as pressure goes. You can use an old piece of original hydraulic line and fitting, with a 3/16" compression fitting to adapt it to a 0 - 3000 psi gauge. Disconnect the small high pressure line from the regulator (open the bleed screw first). Connect the gauge in its place, start the car and close the bleed screw. Cut out pressures are different for older and newer cars, so consult your shop manual. Newer cars reach 2500 psi.

Pump and regulator operating time and pressure checks
Submitted by Jerry Seville, PA (850817)

Reprinted from Citroën Factory booklet
"CITROEN HYDRAULIC SYSTEM, Possible Incidents With Suggested Causes & Remedies"

Slacken pressure regulator bleed screw by one full turn; place manual height control in lowest position; (for DS19 only, place auxiliary clutch control in clutch lock position), start engine, tighten pressure regulator bleed screw and pressure regulator should cut-out:

- For cars without power steering (ID19) - within 60 seconds
- For cars with power steering (all models) - within 20 seconds after screws have been tightened

The term "cut-out" means that pressure has been built up and is detected by the falling off of the working noise made by the pump under load; this can also be ascertained by removing the filler cap of the reservoir and observing when the fluid is diverted into the reservoir.

The above "Quick Check" is fairly satisfactory, but not necessarily completely accurate in all instances. If it is considered desirable to make a more definite check, it becomes necessary to make use of a high pressure gauge.

This must be connected to the high pressure outlet of the pressure regulator by means of a suitable length of high pressure piping. The high pressure gauge should indicate a rise of pressure from zero:

- In 60 seconds for cars without power steering (ID19) to 130 - 140 kg/cm2 (1850 - 2000 psi)
- In 20 seconds for cars with power steering (all models) to 150 - 175 kg/cm2 (2133 - 2490 psi)

This is after the pressure regulator bleed screw has been tightened and the engine is running at between 550 - 650 rpm.

The engine should then be switched off and a period of ten seconds allowed to elapse for stabilization of high pressure recorded. If no appreciable further loss of pressure is recorded, it can be assumed that the high pressure pump and pressure regulator are functioning satisfactorily. If pressure does drop rapidly, the pressure regulator is faulty and must be changed.

Should it be necessary to increase the speed of the engine to above 1,000 rpm to obtain cut-out, this indicates that the high pressure pump is faulty, providing the pressure regulator itself has no internal leak as previously established.

NOTE: When working on the DS19, do not forget to release the auxiliary clutch control when the check is finished.

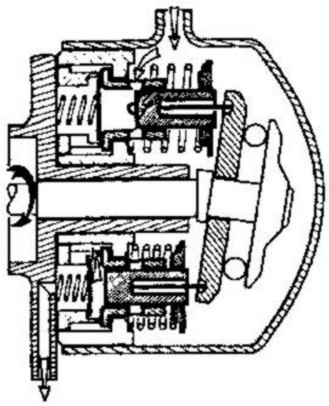
When the above check has been concluded satisfactorily, it is proved that the high pressure has been built up and contained between the high pressure pump and the pressure regulator; therefore any further loss of high pressure that takes place when the whole hydraulic system is reconnected must occur within one or more of the hydraulic circuits. The source of such internal leaks can be pinpointed with the use of the high pressure gauge and isolation of each circuit end hydraulic unit.

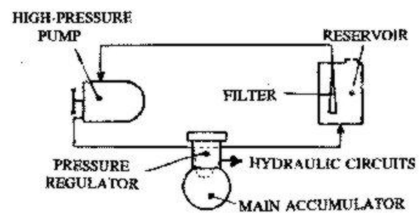
Following the stopping of the engine, and after an interval of several hours, some loss of pressure can occur. This is not an unusual feature and can be due to small internal pressure leaks. For example, the brake warning light may come on to indicate a pressure loss, but providing this light is extinguished within a short time after the engine has started, it is not indicative of a hydraulic defect. Similarly, any height loss should also quickly be restored when the engine is again running, indicating that full pressure is resumed.

Pump can be damaged by flat accumulator
Don James, OH (Mar. 1984, p.14-excerpt)

Running a D-model with a flat main accumulator thrashes the hydraulic pump to death. The main accumulator is very important to the life of the pump. The reason that we made the steel pump bodies that we use in our pump rebuilding is that people will install a rebuilt pump on a car with a flat main accumulator. It is a wise idea to have your main accumulator recharged anytime you have a pump rebuilt. Accumulators should be recharged every two years.

Pump cross-section and circuit drawings
(Aug. 1985, p.36)





Pump driven by electric drill if engine won't run
Aaron Engel (Dec. 1983, p.3)

An easier way to pump up a car that has an engine that won't run is to use an old V-belt and a pulley attached to a small electric drill. The car's belts must be loosened but there is no need to remove the radiator. It will take about 2 to 3 minutes to pump up.

Pump metallic noise when cold from thick fluid
Don James, OH (Mar. 1985, p.10)

Q. My rebuilt hydraulic pump is still doing it's job well, but recently has developed a terrible loud rattle as when one rattles loose metal pieces inside a metal sphere. It usually happens when the car is cold and disappears after a while. Should I ignore it or worry that it may be indicating trouble. - Felix Delerme

A. The fact that it only does this when it is cold is a good indication of fluid problems–you didn't say what fluid you are using. If it is too thick, the pistons are stuck in the "goo" and can't draw back. Only a spring makes the pistons follow the swash plate. The noise you hear probably comes from the "needle like" push rods that work the pistons. They can't fall out, so I do not think you can damage anything, but I still would not over rev the engine until it has had time to warm up a little. Dirt or a burr on the pistons could cause the same problem, but the noise would not go away with a change in temperature. Check your filter, too.

Pump of early ID19 can be unfrozen
Jim Eastman (Jan. 1983, p.3)

A stuck single cylinder hydraulic pump from an early ID19 that has sat for a long time can be rebuilt quite easily if you use some common sense. Test it by putting it in a vise and pushing the piston in and out with your hand. The pump should be able to build up some air pressure if you cover the output hole.

Pump operates when turned in either direction
Don James, OH (Aug. 1985, p.11)

The hydraulic pump will work with the pulley and shaft turned in either direction. The Derwin Brothers maintained the suspension of a car they were towing by stopping occasionally and turning the pump back and forth with an old piece of V-belt. This is a good thing to remember when trying to move a car that won't run.

Raising car all the way should be avoided
Ken Betsh, PA (Apr. 1999, p.14)

One aspect of using the Citroën hydraulic system to raise the car up for service or testing that's frequently heard but not too often–don't raise the car to the highest position if you don't have to. When I need to change tires or check the rear brakes, I only use the next-to-the-highest setting of the height control. If the supplied prop stand is attached in this position and the car then lowered, there is amble clearance under the wheels on that side to remove them.

The reason to minimize going "all the way" is that in the three in-between settings, the hydraulic system only applies sufficient pressure to the suspension pistons and spheres to lift the car to a specific point. Once this is reached, the height corrector valves (one for the two front wheels and one for the two rear wheels) shuts off the flow. At the maximum setting, these valves never close and entire system pressure reaches the spheres. This excessive pressure is likely to shorten the life of the sphere and may bring about an early failure.

Getting under the car to change oil and to get some of the grease fittings to line up with the openings does require lifting all the way. When I do use the maximum position, I stop the engine just as soon as the height is reached. I check fluid level at the next-to-the-highest setting and add fluid, if required, to be at the maximum line. With this, I know that if I do go to the maximum position, the fluid won't drop below the minimum line.

Rapid fluid loss due to leaky return hose
Jack Carmichael (Jul. 1986, p.19-condensed)

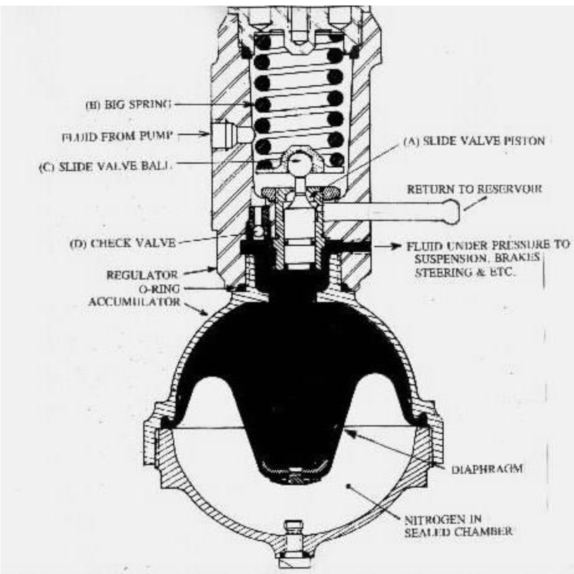
Traveling in Florida, the first symptom was trouble steering. After pulling over, the steering wheel rotated back and forth and the hydraulic pressure light came on. We drove slowly down a country road a short distance to a dairy farm. As we guessed, farms have tractors with hydraulic gadgets on them and a supply of mineral base oil for the hydraulics. One of the farmers gave me a gallon that I poured in the reservoir. With the engine running, oil poured out in a stream as large as a pencil from under the alternator. One of the farm employees came to help and found a leak in a hose about 10 inches long with a 90 degree bend–the return line from the regulator.

After considerable trouble with the clamps, he extracted the damaged hose and replaced with a length cut from some spare hose he had. We then filled the reservoir, started the car and found we were ready to resume our travels. When asked how much I owed him, he replied we used about 1-1/2 gallons of oil at $3.08 per gallon.

The oil was by Chevron and a bit thicker than Texaco #15, so on my return home I flushed the system and filled with Texaco #15. Moral of the story: carry extra clamps, hose and oil and always check when the car reacts differently than normal.

Editor: A return hose failure is most likely cause for a sudden massive fluid leak. Generally a slit first develops at the 90 degree bend.

Regulator-accumulator cross-section drawing
Don James, OH (Feb. 1990, p.1-notes added)



The picture above shows the cross-section of the cast aluminum supplied on D-models until the late '60s. It shows fluid under pressure (in solid black) has applied sufficient pressure to the bottom of the slide valve piston (A) to overcome the force of the big spring (B) and lift the slide valve ball (C).

Once this ball is lifted, fluid from the pump can return directly to the reservoir. A check valve (D), though which fluid under pressure first entered the lower area, is now closed. As pressure in the lower area falls, the slide valve drops and eventually allows the ball (C) to seal the return and allow pressure to again build.

The beauty of this system is a toggle action that separates the approximate 1900 psi pump cutout point from the 1500 psi cut-back-in point. With a good accumulator to first supply pressure needs, the pump cycle times should vary from many seconds up to a few minutes. A defective accumulator will cause the regulator to chatter and place a burden on it and the pump they were not designed to withstand.

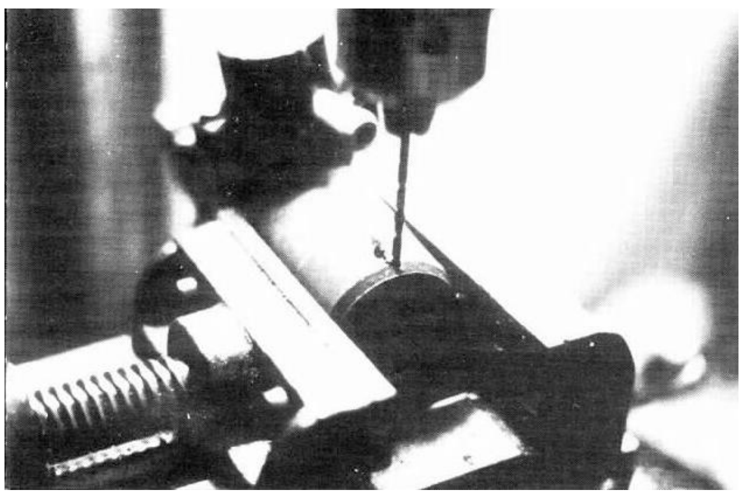
Not shown is the bleed screw and the 7 mm ball valve behind it (which may be lost if the bleed screw is completely removed). Also not shown is a replaceable o-ring around the slide valve piston. Late D-models came with a steel-body regulator with a somewhat different means to achieve the same effect. It differs in appearance by a side appendage from which a vertical connection returns fluid to the reservoir. According to the parts manual, this version has a 7.5 mm ball behind the bleed screw.

Regulator disassembly/reassembly requires care
Jim Eastman (Jan. 1983, p.3)

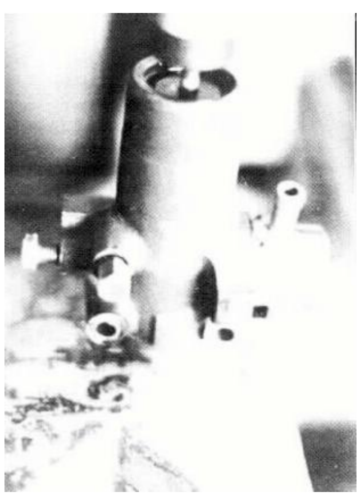
Should you need to rebuild the pressure regulator, remove the end cap with a pipe wrench and a large bench vise to assist. Be careful, there is a large spring compressed inside. Getting the cap back on isn't as hard it might be expected. You can compress the spring by standing on the cap with your foot and rotating yourself in a doorway.

Editor: This applies to the older cast aluminum type.

Regulator resealing procedure, steel body type
John Titus (2000 #2, p.8)



Drilling hole in regulator to facilitate circlip removal



Using arbor press to release pressure on circlip

Removing circlip holding spring-loaded regulator cap

If your driveway is wet with LHM underneath your HP regulator and you have tried replacing the main accumulator O-ring and the tube seals, it may be time to reseal the regulator itself. To do this, it is necessary to remove the regulator from the car and remove the regulator end cap from the regulator body. The end cap is retained in the regulator housing by a circlip that prevents the cap from being ejected by the VERY STRONG cut-in pressure spring on the main slide valve of the regulator. Accordingly, proceed with caution when performing this operation.

It has been my experience that the circlip is virtually impossible to dig out of its groove in the regulator housing. Therefore, I recommend drilling a 1/8 inch hole in the regulator housing about 0.187 inch from the end, as shown in the upper picture. So that you don't break a drill bit when the drill breaks through into the circlip groove and hits the hardened steel circlip, drill the hole so that it coincides with the gap in the circlip. Once the hole is drilled, thread a 7mm bolt into the regulator end cap and place the regulator in a press with the bolt engaging the ram of the press, shown in the lower left. Keep everything CLEAN throughout this operation and protect the main accumulator threads when performing this operation (I use a JBM sphere plug threaded into the end of the regulator). Depress the end cap, using the press until the circlip groove is completely exposed. Using a small screwdriver, push the circlip around in the groove until one end is over the hole you drilled. Then using an awl, punch, or other tool working through the hole in conjunction with the small screwdriver, push the circlip out of the groove (lower right). Slowly release the pressure being applied by the press and allow the end cap to rise out of the bore in the regulator. Be careful not to lose any of the shims between the cap and the spring. These shims were used at the factory to set the cut-in pressure of the regulator.

Replace the O-ring on the cap with a standard dash number "-123" O-ring. LHM uses nitrile O-rings available at automobile parts stores, LHS2 must use ethylene propylene O-rings from a hydraulic equipment supplier such as Parker Seal Co.

Then, using the press, insert the end cap back into the regulator bore. Snap the circlip back into its groove aligning the gap in the circlip with the hole you drilled and slowly release the press to permit the end cap to reseat itself against the circlip. There are two more O-rings in the regulator that rarely need replacing, because they are not exposed to the high-pressure fluid. The first is under the "top hat" banjo fitting that leads back to the fluid tank. The "top hat" also has a spring underneath, but not as strong a spring. A bench vise works for retaining the top hat while unscrewing the two screws. Be careful of the shims. These control your cut out pressure. The top hat takes a dash number -125 O-ring. You might also want to take the opportunity to perform the "Ted Jenson" modification to the top hat nipple, i.e., grind off most of the bulge in the nipple. This saves wear and tear on the hoses which are retained by a hose clamp anyway. Finally, the bleed screw takes a dash number -011 O-ring. Just back the bleed screw all the way out. There is no spring this time, but be careful not to lose the check ball that is underneath the bleed screw.

That's all there is to resealing the steel body regulator. Please note that this operation only stops external leaks and will not stop a "fast cycling" regulator. For that you will need to repair the check ball seat and/or the bleed screw seat.

Return line, avoid clear neoprene hose/plastic ties
Charles Fowler (Feb. 1990, p.3)

Plastic ties played a part in the failure of my main regulator return line. After relocating the main regulator, I used clear neoprene fuel hose as a return line. This stuff is soft enough that the constant heating and cooling of the LHM caused a rupture where the plastic tie had it slightly crimped. Replacement with black rubber reinforced fuel hose was the cure. I've also learned that a plastic tie is definitely not a replacement for the radiator hose clamp securing a thermostat.

(I think he was using vinyl tubing. Even reinforced vinyl is a no-no. [MB])

Seals made from windshield washer tubing
Don James, OH (Jan. 1984, p.10)

Q. I need new sealing sleeves for the hydraulic lines on my car. I read someplace that these seals could be made from tubing. Can I get this rubber tube?

A. Windshield squirter (washer) tube will work. You should have no problem finding a size that will work, but it may not be exact. I have used Pylon brand washer tube that was purchased from a local K-Mart for $1.47. This seems to work fine on cars of both fluid types. The old seals can be used over and over again. (I wouldn't [MB]). Just be sure that you install it in the same direction that it was removed. One end will always get chewed up. Why waste money buying such a simple thing?

Silicone brake fluid characteristics
John Bamberg (Reproduced Article–Dec. 1983, p.5)

Mechanical Arts & Services, Inc. 8107 Dunlap, Houston, Texas 77074

History of Brake Fluid
In 1924, Chrysler introduced hydraulic brakes to the automotive industry and for the first time. Because hydraulic principles were used to accomplish equal braking at the wheels, front brakes became practical.

Henry Ford resisted hydraulic brakes because he felt that even though the other cars could stop quicker and straighter, his mechanical linkage would not fail. You see, the major drawback of hydraulic brakes is simply this: no fluid, no brakes!

By 1939, all U.S. cars had hydraulic brakes.

At that time the only seals available were leather and natural rubber and because leather was unthinkably un-dependable, natural rubber had to be used. As a hydraulic fluid, water could not be used because it froze and boiled easily and corroded parts quickly. Mineral oils, like engine oils and transmission fluids, could not be used because they quickly destroyed natural rubber.

So this left only alcohol and later, glycol brake fluids. Until 1974, there were no further developments.

Moisture, the enemy of brake fluid
Glycol has some serious deficiencies, though. Most notably, it is hygroscopic; it absorbs water at an alarming rate, drawing most of it from the atmosphere right through the rubber hoses, boots, and seals! These rubber parts are semi-permeable. In coastal areas and areas where salt is used to remove ice from the road, highly corrosive dissolved salts are absorbed in the same way.

This absorption process starts at the time of fluid manufacture and continues until the saturation point is reached. Anytime moisture content is over 3%, the corrosion inhibitors are overwhelmed and serious trouble occurs. This can happen in as little as eight to ten months in some areas.

Moisture contaminated fluid also has a lower boiling temperature. It is not uncommon for fluid to have a boiling temperature of about 250ºF, which may result in temporary brake failure.

In the past many thought that brake fade was a drum and lining relationship. Now we think that many of those cases were really a boiling fluid situation. In a disc brake, even though a disc has better heat dissipating ability, especially the ventilated kind, the fluid is much closer to the source of heat than in a drum brake.

These four major factors affect the rate at which water will be absorbed by the brake fluid:

1. The degree of humidity. A dark, damp, littered area will have a higher humidity than a bright sunlit area. A coastal area will have a higher humidity than an inland area.
2. The passage of time, especially vehicle inactivity time. A car in motion heats up from the engine and from the action of the tires and brakes and thus lowers the humidity around the car. Also, the hydraulic pistons are moving, thereby dispersing the water contamination.
3. The care with which the fluid is manufactured and stored. Is the seal and cap tight?
4. The integrity of the brake system itself. Are the brake hoses without cracks and the cylinder seals tight? Is the bladder in the master cylinder without tears or the master cylinder float (some foreign cars) still there?

So, even though no one wanted water as a brake fluid, brake fluid becomes more water-like because of these factors.

Futile Efforts to Keep Moisture Out
Instead of attacking the problem of the unsuitable fluid, manufacturers have gone to extreme means to keep atmospheric moisture out of the fluid. Instead of the master cylinder mounted low, it is now high. Heat from the engine lowers the humidity in its vicinity.

Instead of screw-in plug vented to the atmosphere, there is now a bladder separating the fluid from the air and, in some foreign cars, plastic floats seal the surface of the fluid. To minimize electrolytic corrosion, cylinder pistons are chrome plated, made of plastic, anodized aluminum or sintered iron. The cylinder boots have metal reinforcements fitting to a machined surface of the cylinder instead of a rough, cast surface.

But little has been done to educate the mechanic! Numerous articles about brakes bear out this writer's contention that there is rampant ignorance on the subject of brake fluid. The first standards for brake fluids were established by the Society of Automotive Engineers (SAE) in 1946, and these were officially recognized throughout the world until 1979, when the Department of Transportation (DOT) took over the regulation of brake fluids, as well as many other things related to transportation safety. SAE specs seldom appear on brake fluid anymore; but if they do, they are obsolete and meaningless. Brake fluid is covered by the Federal Motor Vehicle Safety Standard 116, with more than 29 pages of regulations; it covers DOT 3, DOT 4, and DOT 5 brake fluids and hydraulic system mineral oils.

DOT 3 fluid is the standard of the world. It is glycol, an active chemical (proof is that it destroys paint on contact). It is hygroscopic, causes corrosion, and its boiling temperature diminishes with the absorption of water.

DOT 4: This fluid is very similar to DOT 3 and its only significant difference is that it has an initially 50ºF higher boiling point. It is not a fluid for foreign cars. “Foreign fluids for foreign cars” in the past was true, but no longer. A commonly known fluid thought to be foreign is actually manufactured in Hackensack, New Jersey!

DOT 3 fluid is required to have a minimum boiling temperature of 284ºF when contaminated with 3% moisture: DOT 4’s is 311ºF. Note: All DOT 3 and DOT 4 fluids will destroy the hydraulic system in which they are working, if given enough time.

DOT 5: This could be any fluid which meets the new standard for DOT 5 fluids, but at this time, only silicone brake fluid (S.B.F.) can meet these requirements. It is chemically inert, cannot harm paint, has a consistently high boiling point (500ºF is required, but actually about 750ºF, which is higher than any rubber compound can withstand) and is characteristically a rubber preservative. DOT 5 fluids must also be compatible with existing fluids and systems. Silicone brake fluid became a legal fluid on October 1, 1974.

Specification 116 also covers the testing and analyzing of the fluids and the packaging and labeling requirements. These standards are enforced by the American Association of Motor Vehicle Administrators for all of the United States and Canada and again, these standards are officially recognized throughout the world. Also, ten of the fifty states reserve the right to certify brake fluids used in their states.

While the United States Army experiences over 15% moisture contamination in two years in the Panama Canal Zone, they experience nearly no contamination by moisture in Yuma, Arizona. In Panama, they routinely overhaul military vehicle brakes every six months because of this corrosion. We would not have silicone brake fluid now were it not for the Army wishing to have more dependable brakes on military vehicles. Initially, three companies were involved in the development of low water-tolerant brake fluids: General Electric, Dow Corning and Union Carbide. Union Carbide dropped out rather early and now all silicone brake fluid originates with either General Electric or Dow Corning.

Automotive engineers would like brake fluid to have a minimum boiling point of 400ºF, be unaffected by any ambient condition, be inert and thermally stable and be non-corrosive and friendly to paint. While glycol is none of these things, silicone brake fluid is superior in every respect.

Don't expect to see silicone brake fluid produced by the major parts manufacturers in the near future because extensive use of this material will reduce their hydraulic parts replacement business to nearly zero. Only public demand or government regulations will cause silicone brake fluid or mineral oil to be universally used.

Silicone brake fluid works equally well in hydraulic clutches and power window, seat and top systems. It is not worthwhile to convert to silicone brake fluid in other hydraulic systems where mineral oil is used. Its only advantage over mineral oil is that silicone brake fluid won't burn.

People trust their brake fluid; but conventional fluid has been committing atrocities to hydraulic brake systems for 57 years. Of all the world's hydraulic systems, only automotive brakes use glycol. The first 20 years can be forgiven: but after World War II, new rubber technology would have permitted the use of mineral oil. (Have you ever seen corrosion in an automatic transmission?) If it were compatible with the rubber used in brake systems, WD-40 would be a better brake fluid than those we have been using. We have been locked into the use of these unsuitable glycol fluids by industry standards, tradition and ultimately, government regulation.

Citroën (France) was the first to break new ground. In 1966, for their European versions, they used mineral oil (HSMO) and solved their hydraulic corrosion and sludge problems and at the same time offered it to Rolls Royce. While Rolls bought the rights to use certain features of Citroën's braking system, they rejected the fluid. Fourteen years later they finally took it. See how hard old ideas die? In this country most Citroën owners use automatic transmission fluid with perfect success (only in cars with green components [MB]). Rolls has looked at silicone brake fluid and has admitted that it is a better fluid than theirs, but rejected it because they felt it was not universally available enough. Certainly it is more available than Citroën's mineral oil. This author has successfully converted about 40 Rolls and Bentleys (1954 to 1977 models) to silicone, as well as hundreds of other cars.

How to Use Silicone Brake Fluid (S.B.F.)
Enough about history, tradition and bureaucracy. Now for the details about using silicone brake fluid. The ideal time to use S.B.F. is on the manufacturer's assembly line. All Avanti automobiles, one brand of motorcycle (Harley-Davidson), and the new AMC Jeeps produced for the U.S. Postal Service do this.

The second best time to use S.B.F. is when the vehicle is brand new. If this is your position, follow instructions under section 4 below. When the SAE extensively tested S.B.F. in the early 70's, they used three different methods of incorporating S.B.F. into the brake system:

1. Deliberate contamination with S.B.F. A system topped up with S.B.F. will be an improved system because it prevents absorption of atmospheric moisture at the master cylinder and displaces some of the trouble-causing glycol.

2. Flush/Fill. Push the old fluid out with S.B.F. Tests showed that even though clear S.B.F. emerged from the bleed ports, there was still some 30% original fluid left in the system. Examination showed that although corrosion took place, it tended to take the form of surface staining rather than pitting, a definite advantage. If you use the flush/fill method, use as high a pressure as possible to get a sweeping effect of fast moving fluid.

3. Complete tear down and rebuild. There will always be some residual fluid lurking in the pores of the iron castings and other places. Don't despair, it won't be enough to matter. The Post Office rebuilds their old equipment with S.B.F.

4. The method that I advocate is next best to (3) above. It's a method I developed after much trial and evaluation: Remove the bleed screws from the wheels. Pump the pedal until the system is empty (it won't be dry). Remove the master cylinder and dismantle it, wash it with water and blow dry (water and conventional brake fluid get along fine) and the condition of the master cylinder will pretty well be representative of the condition of the whole system. Connect a source of compressed air (about 100-125 psi) to the pipes, which were removed from the master cylinder. Blow until no fluid can be detected on a finger tip when held close to the bleed ports. It may take 10 to 20 minutes of blowing. Examination of the master cylinder will determine if it should be reassembled with existing parts, overhauled, or replaced in its entirety. Reinstall the master cylinder, fill with S.B.F. and bleed in the usual manner; I recommend the use of a bottle and hose at the bleed ports to catch the fluid bled from the system. The bottle may reveal many minute bubbles. In a dry system, the fluid may aerate when it passes pipe junctions or restrictions much like a spray gun works, so press the pedal slowly and calmly. Any contaminants left in the system will settle to the bottom of the bottle, leaving reusable S.B.F. at the top. The amount of residue at the bottom of the bottle is a rather accurate indication of how well you cleaned out the system.

CAUTION: Liquid glycol fluid will damage paint almost instantly, but I have never known fluid vapor to damage paint. If liquid glycol gets on the paint, rinse it with a large amount of low pressure water immediately. Do not touch it or rub it with anything. The solvents will evaporate out of the paint in several hours and the paint will again lie down. Its appearance can be restored with a small amount of finishing compound.

As stated previously, the Federal Government dictates brake fluid standards, not the vehicle manufacturers. Many have stated their concern that to use S.B.F. would void their warranty. Most hydraulics will last through the warranty period, although in some cases, weaknesses have already manifested themselves. Interestingly enough, many manufacturers of hydraulic brake components actually use silicone as an assembly and preservative fluid. Those who still use glycol are helping to insure the premature failure of their parts.

If You Insist on Using Glycol Fluid
If you are still not convinced about the merits of S.B.F., follow these recommendations for glycol fluid: buy any brand at any price as all must meet government standards. Reject any container which is rusty, or has fluid between the cap and inner seal. Do not store open cans.

Change fluid often–more often in areas of high humidity. Whenever the fluid being bled out is darker than the new fluid going in, it is an indication that corrosion is taking place.

In Summary
If you enjoy the problems of sludge and corrosion in your brake system, if you enjoy the excitement of no brakes because of boiling brake fluid and if you want more of these problems, all you have to do is add water to the brake fluid, because this is happening anyway and you can't stop it! If you don't like these problems, you have only two alternatives: (1) periodically change the brake fluid (at least every two years and oftener in areas of high humidity), or (2) change for the last time to the "forever fluid," silicone brake fluid.

S.B.F. should be available in every parts house in this country. The only reason it isn't is that not enough is generally known about the subject and too few are asking for it.

Auto manufacturers today are dragging their feet on introducing silicone brake fluids for various reasons. Ford Motor Company is waiting for General Motors to take the lead. If it were not for their troubled economic status, Chrysler Corporation might have taken the lead because of their experience with S.B.F. in military applications. Foreign manufacturers have shown varied reaction to S.B.F.; it is verboten for Mercedes-Benz vehicles and it is against the law to use S.B.F. in Japan. Dow-Corning Corporation is currently conducting talks with Honda, Volkswagen and other foreign auto-makers about using S.B.F. in their vehicles sold in the United States. The aftermarket parts industry is actively opposed to the universal use of S.B.F., since it would drastically reduce their lucrative sales. There is some light at the end of the tunnel, however.

The entire U.S. military vehicle network will be switching over to silicone brake fluids starting in July, 1981, after ten years of testing. Some vehicles built by AM General for the U.S. Postal Service are using S.B.F. Commercial, utility and delivery vehicle fleets are switching to S.B.F. in large numbers. Within the next few years, consumers will hopefully be able to buy a new vehicle with factory-installed S.B.F.

Silicone conversion shouldn’t affect ride
Don James, OH (Nov. 1985, p.8)

Q. I've been doing a variety of things with a 1966(7) DSM21 I got not too long ago, including changing over to silicone brake fluid. In the process I put new boots, return hoses, and sphere diaphragms in and the fluid has stayed pretty clean for about six weeks since doing so. The steering rack and pump were rebuilt in the past year or so and there have been no leaks. I don't know if silicone fluid will be more reliable, but at least it's not nearly as nasty as brake fluid or LHS2 if it leaks or you have to work with it. The ride seemed slightly stiffer to me. Did you notice that when you changed? Perhaps silicone fluid is slightly more viscous. -Everett Austin

A. There was no significant change in ride when I switched.

Silicone effect on paint: proper solvents for removal

Dow Corning Form 22-450A-80 submitted by Jack Shotton, MN (Jun. 1993, p.12)

Unlike conventional polyglycol fluids, Don Corning silicone brake fluid will not attack painted surfaces. However, before painting over this material, it must be removed using Ditler-Ditzo 4-4-0, Mobil Celsol, kerosene or other cleaning solvent having a mineral spirits base.

Silicone fluid conversion is complex
Everett Austin (Feb. 1984, p.3)

For now, I think I will stick to LHS-2 in my D-model, although I have silicone brake fluid in my 2CV and Peugeot 404 (brakes and clutch) and 403. I talked to Chris Dubuque about his experiences with silicone brake fluid. His experience was that if the return lines are not replaced when changing to silicone brake fluid, in many cars the small return lines may quickly become obstructed by that black residue and eventually burst. Likewise the standard hydraulic filter or accessory front filter quickly accumulates liberated black residue. He was convinced that one shouldn't change over without replacing all return lines.

I have been using Pentosin LHS-2 fluid, which seems a little better than Wagner 21B brake fluid that I was using.

Editor: I would recommend before you change to silicone fluid that you flush out all of the old scum and residue with alcohol. Alcohol can be purchased in any good paint department for about $7 a gallon. Do not use rubbing alcohol as it contains water. Flush well by operating the car up and down and steering back and forth. You may need to flush twice. You will be surprised at the dirt that will show up in your hydraulic tank. Getting all of the alcohol out is a bit of a problem, and suspension boots should be removed and the tank thoroughly cleaned. Return lines should be blown out with compressed air. I have been using silicone brake fluid in my '65 ID19 with no problems.

Silicone fluid conversion is complex
Don James, OH (Jan. 1986, p.33 & Sep. 1988, p.18 - combined)

The conversion of Citroën hydraulic systems to DOT 5 silicone fluid has become a subject of interest to those having older cars that need LHS or brake fluid. Silicone fluid eliminates the problems of water absorption and rusting, as well as the terrible black goop and awful smell that comes from vegetable based fluids. Silicone fluid will not harm any of the rubber. Some folks say that silicone does not lubricate very well, and this may be true, but it is an excellent lubricant for rubber parts, while brake fluid is a terrible lubricant for metal to metal parts. I find it doubtful that the silicone fluid could be any worse than brake fluid.

Don't be fooled into thinking that you will never need to change the silicone fluid. Dirt will get into it, same as any fluid. Change it after 5000 miles or one year and every two years after that. If your car has any known hydraulic leaks, you will probably find silicone fluid to be a bit expensive and not readily available in the quantities you need.

There is absolutely no reason to use silicone fluid in cars that use LHM and mineral based fluids. LHM solves the rust problems caused by brake fluid, so there is no problem to solve. If your car has a green colored hydraulic tank and green stripes on the hoses, please read no more. If you are not sure of what fluid to use or what is OK to put into your hydraulic tank, do nothing until you ask someone!

Switching earlier D-models from brake fluid to silicone fluid is not easy. It is not just a simple matter of draining your tank and refilling with fresh silicone. As most long-time owners of these cars know, there is a black algae that covers all metal and rubber parts in the system. This can not be helped with a vegetable based fluid. Silicone and any remaining vegetable based fluid will not mix and the silicone will eventually clean out and knock loose all of the goop and dirt in your system. An inadequately cleaned system will result in a clogged intake filter such as shown in the right side, below. A completely clogged filter will shut down the hydraulic system.

Alcohol will easily remove the slime, but DO NOT USE RUBBING ALCOHOL as this contains water. The alcohol you use to flush the system must not contain water. It's impossible to drain and remove all of the old vegetable based fluid. You may think you can get all the fluid out, but you cannot! All you can do is remove as much as possible.

The hydraulic tank must be removed and completely cleaned after the car's system has been flushed by operating the car with straight alcohol (after the old fluid has been removed). All of the suspension boots must be removed and washed with alcohol. When you flush the system, alcohol will not circulate through the return lines. So, they must be blown out with compressed air.

It's a good idea to remove all of the suspension spheres, open all bleed screws and blow everything out with compressed air to remove all of the alcohol. The steering back and forth must be worked back and forth to eject all fluid.

Brakes must be bled, also. Even if you did a pretty good job cleaning everything, you may have a problem with the black goo in the hydraulic tank filter every 1000 or so miles, so keep an eye on it. Also, you will need to bleed your brakes frequently because of the alcohol vapor that will form in your brakes. After a few months driving, you will have no more problems and will find that your system stays clean, your car and lines will not rust if you get a leak and rubber parts will last forever. I have had Silicone DOT 5 fluid from Muskegon Brake in my '65 ID19 for 3 years and have traveled in it extensively with no problems.

Detailed procedure - items you will need to do a thorough job include:

1. two gallons of silicone brake fluid
2. two gallons of denatured alcohol (sold at paint stores as a solvent for shellac–not the rubbing type)
3. new rubber return boots for front and rear suspension (old ones can be reused if they are in good shape and thoroughly cleaned with alcohol)
4. an air compressor
5. an assistant
6. (optional) an in-line spin-on filter assembly (J.C. Whitney or Pep Boys).

Step #1 - Drain all the fluid that is now in the hydraulic tank and throw it away. Set the manual height control to the lowest position and open the bleed screw on the pressure regulator. Remove the filter and start the car while holding the filter up out of the hydraulic tank. Run the car for 30 seconds to remove the pint of fluid held in the hydraulic pump. Squeeze all of the suspension boots to return fluid to the tank (with the aid of an assistant, squeeze both sides of same axle at the same time). Now empty the tank again.

Step #2 - Pour about 3 quarts of denatured alcohol solvent into the hydraulic tank. Place the filter back in the tank and start the car. After about 3 minutes at idle, close the bleed screw and run the car up and down on the suspension while working the steering wheel back and forth. Operate the Citromatic, if the car is so equipped. Be sure to bleed alcohol through the brakes by opening the bleed screws at each wheel cylinder (the bleed points for the front brakes of Citromatic-equipped cars are at the carburetor and centrifugal regulator). Clear vinyl tubing can be used to return the fluid to the tank. Press on the brake pedal to allow alcohol to flow from the brake bleeders to the tank. Remember that the rear wheels must have weight on them to bleed (and height control not at the lowest position). Close the brake bleed screws after 5 minutes. Bleed the Citromatic to allow alcohol to flow. With the car in neutral, operate the manual clutch engagement button located under the dash. Do this repeatedly. Operate the car for 30 minutes to one hour with alcohol in the system. Do not try to drive the car with alcohol in the brakes.

Drain the tank and examine the alcohol from the tank for how dirty it is. If it is not reasonably clear, refill the tank with alcohol and repeat the above. Alcohol will remove the brake fluid quickly, but the slime sometimes takes a little time to break free. Open the bleed screw on the pressure regulator and run the engine for about 30 seconds to empty the alcohol from the pump.

Step #3 - Remove all of the suspension boots and spheres. Drain the fluid from them and wash them with alcohol. You must then remove the height correctors from the car and remove the retaining rings from the diaphragms located on each end of the corrector, so that you can wash out all of the crud, such as shown in below, that has accumulated there. Blow out the return lines from the hoots and the return lines from the height correctors. This should blow the fluid into the tank. While you have the rear boots off is an excellent time to grease those rear suspension balls. Replace the height correctors, boots and spheres.

Step #4 - Remove all of the hoses from the hydraulic tank after you have blown all the fluid back into the tank. Remove the tank and rinse it completely with alcohol by vigorous shaking. If much dirt and sediment remain, you can use strong soap and hot water to flush the tank since it is removed from the car.

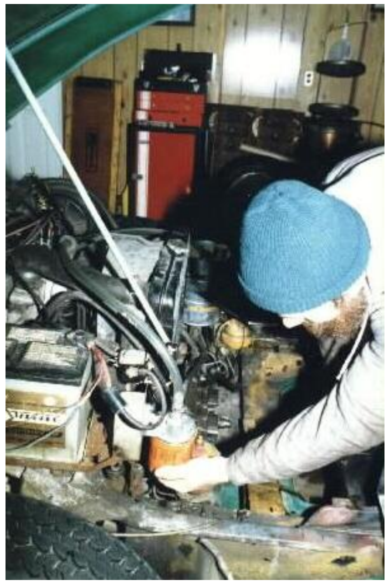
After you finish, be sure to dry the tank completely! You may force dry it in an oven that has been preheated to 275ºF, if you wish. Turn off the oven when you place the tank in it, and let it cool slowly. Be sure that the tank filter is clean.

Step #5 - Remount the tank and fill it with fresh silicone fluid. Operate for 3 minutes with the bleed screw open, then turn off the engine. Let the car stand for 10 minutes. Now start the engine and idle for three more minutes with the bleed screw open. While doing this last bleeding, rap gently on the tank filter with something soft to jar loose trapped air bubbles in the filter screen. Tighten the bleed screw and allow the car to build to pressure. Raise and lower the car and work the steering.

Step #6 - Bleed the brakes into a pan to remove any traces of alcohol that remain. Allow about 1 pint of fluid to flow from each screw into a separate container. Do not return to the tank as this fluid contains alcohol! Then bleed the front brakes into the tank, as shown, until no trace of air can be seen. Stopping the car for ten minutes to let air bubbles raise is helpful if too much bleeding seems to make a froth. Air bubbles in your silicone fluid do not rise as fast as in the vegetable based fluid. Careful bleeding must be done to eliminate this problem. On cars with Citromatic, you will need to bleed the Citromatic by opening the front bleed screw on the centrifugal regulator. Allow another pint of fluid to flow into a container.

The car should now shift and drive properly, but some adjustment of the Citromatic may be required to get proper clutch action. Be careful with the brakes for a time as some traces of alcohol will remain in the system and the vapor will give you "air in the brakes" syndrome for a time.

After all of this, you still may have black slime returning to the tank and this will get trapped in the filter. The filter should be cleaned or at least checked every 1000 miles. Traces of black goop will turn up in the filter for about a year. Alcohol can give traces of air in the brakes, so a complete change of silicone fluid should be in order after 6000 miles. After that you should have 99% of the alcohol, dirt, and slime out of the system and no problems.



I have seen several ideas to "filter" out the slime and dirt; some involve a filter on the suction line to the pump, such as shown above. Others involve an "in-line fuel filter" in the return lines to the hydraulic tank. If you choose to try to filter out the dirt and slime, be sure your filter is easy to check and replace if it should get clogged.

Silicone foam preventative/breaker
Jack Shotton, MN (May 1997, p.10)

The hydraulics in my '69 DS21 have been doing reasonably OK since I decided to switch the hydraulic system to silicone (DOT 5) fluid. However, I've always had a problem with air in the brakes. Talking with folks in this business, I believe that this has been a minor glitch when using silicone. You're always bleeding the brakes because the silicone fluid tends to foam more than DOT 3/DOT 4 fluid.

Recently I called the manufacturer of the silicone fluid, Dow Corning, and described the application. They sent me samples of their "200 Fluid," two bottles of different viscosity, 1000 cs and 350 cs. One of the specific applications of "200 Fluid" is as a "foam preventative or breaker," and I believe that the fluid affects the surface tension of the bubbles. I was supposed to try a couple of tablespoons of one, and if that didn't work, then the other. Unscientifically, I ended up with four or five tablespoons of each in the hydraulic tank.

I've been driving around now for few weeks, and I have not had to bleed the brakes. It seems to be helping. Dow Corning sent me quite a bit, so if you would like to try some, let me know. Or call Dow Corning at 800/FOAM FREE.

Silicone fluid problems and remedies
Jack Shotton (2001 #2 p.12)

I've owned a '69 DS-21 for many years, and most hydraulic components have been changed at one time or another. The car started life as a brake fluid Citromatic and more than a decade ago, consistent with the fashion of the time, I changed the car's hydraulics over to silicone fluid. At the time I had brake fluid leaking into the transmission and when I saw the corrosion in the transmission's hydraulic components, I decided that I would make the change. Had I known then what I know now, then I probably would have changed the whole car to LHM fluid. I had the parts and ultimately it would have been less work. So for whatever it's worth, here's my advice.

If you've got a brake fluid car and everything is working as it should, then I would use LHS-2 fluid. I'd change it often, and I'd bleed everything that's bleedable at least once a year. If you can't find or afford LHS-2, then I'd get in touch with Mark Bardenwerper in Wisconsin who has a carefully formulated recipe. (See the Revised Summary of Citroën Hydraulic Fluids. [MB])

If you are doing major restoration work, engine overhaul, clutch replacement, etc. and you know that all hydraulic components are less than tip-top, then you might consider replacing all of the hydraulic components with LHM parts at that time. Again, I'll refer to Mark Bardenwerper. His non-Citromatic brake-fluid car sat many years without running before being acquired and the system works perfectly. If it ain't broke, don't fix it! (I will qualify this. I rebuilt most major components, though I was fortunate not to have had to replace any lines. I also did not have to replace or rebuild my power steering rack. If your car is not a Citromatic, that is your most costly and difficult replacement and therefore, might be your decision point. I am a devoted LHS user, nonetheless. It has a few advantages over LHM, one being that the spheres, when properly rebuilt tend to last longer and the other being that older cars had better ride and I like to keep cars original. One day this will be a strike against any car. [MB])

You will realize several well-documented benefits if your car has been converted to silicone fluid. However, there are two problems that you will have to contend with. The first problem is that black gunk clogs small orifices along with the screen in the hydraulic reservoir. The second problem is that silicone is an incredible insulator. The slightest residue on the breaker points and the car won't run and on cars equipped with the mushroom brake button, the brake light switch won't work. Both sets of points can be cleaned, but the solution is temporary. So I recommend the following modifications:

A large screw-on paper filter should be added. The factory screen can't cope, but a spin-on filter solves the problem handily, completely and entirely. The capacity of the filter is relatively large, and the factory screen and everything else in the system stays clean. On my car the filter is placed in the valence under the right front fender in the return line from the regulator to the reservoir. I've seen quite a few LHM and brake fluid cars with extra filters installed, and this is not a bad idea.

Replace the factory-original breaker points with a breakerless system. I'm using a one hundred-dollar system from Crane Cams that works fine. A good system from Luminition is also available and should be easier to install. Tune the car once and forget it.

On mushroom brake button-equipped cars, replace the brake light switch with an in-line pressure switch. You cannot use a generic Ford or Volkswagen part. Harley Davidson part no. 72023-51 might work because Harley uses silicone. However, I do not know the pressure rating of the Harley switch. The switch in my car is Suco part no. 0166-40504-2-020, rated at about 4500 psi. I would like to thank Jack at Suco for sending me the part to try. I would also like to thank Neil Schoenheider for tapping a Citroën tee fitting to fit the 1/8" NPT of the pressure switch. Suco's tele no.: (800) 473-7313, (330) 666-7313. (They have a web page and the part is still in their catalogue. [MB])

So what do I plan to do next? Well probably not very much. The car has been running with silicone for tens of thousands of miles over several years, the brakes don't stick, and the silicone fluid is kind to the various hydraulic components. Other than the two sets of electrical point contacts mentioned above, I haven't had electrical problems either.

I should also mention that I changed the car from Citromatic to standard several years ago. I had blamed the Citromatic transmission for my problems, when in fact the problem was a gunked up Citromatic brain box. At the time I had converted the car to silicone, but I had not yet added the extra filter.

I remember having polled the Citroeniste readership to find out how many Citromatic cars use silicone. To date, I still haven't found one. However, I think that it would probably work OK if a very good filter were installed right at the beginning along with the silicone. If you don't do this, then I can tell you from experience that it won't work.

More advice: It has been said that you cannot paint a car that has been contaminated with silicone. This is not true, because three of my fenders have been painted nicely. The manufacturer of the silicone fluid recommends naphtha-based mineral spirits as a solvent. You will want to clean the surface very carefully, and then it is best to strip the old paint completely, and clean the surface down again. If you are dealing with a body shop, then make sure that they are aware of the problem.

One last bit of advice: A friend of mine and English car guy has a hunch that silicone does not work well with brass parts. If you are using silicone fluid you might want to avoid using brass parts in the rear wheel cylinders. I cannot give you a rational explanation for this, and I don't even know if it is true. If you are doing brake work on one of your other cars, then you might want to convert it over to silicone. My daughter's Alfa Romeo uses silicone in the brake and clutch circuits. It works great and I don't have to worry about the parts seizing up over winter storage.

Silicone grease harmless to rubber seals and O-rings in LHS (brake fluid) cars
Don James, OH (Mar. 1992, p.15)

Owners of older LHS (brake fluid) cars can benefit by using "silicone grease" when installing seals or o-rings in the hydraulics. This stuff is harmless to rubber and is also used as a lube on sparkplug boots and distributor cams. While it is more expensive than regular grease, it is not unreasonably priced and is available at most automotive parts stores as a lubricant for use when installing brake hydraulic parts. NAPA part #765-1351 is a small tube of Sil-Glide. This stuff is a big help in solving the problem of storage of LHS-2 type components when they are not used or put in service quickly. Those things will rust together almost overnight!

Silicone has strong disadvantages
Chris Dubuque, WA (May 1993, p.8)

Although I recognize that silicone fluid has some tremendous advantages over conventional brake fluid, it is only fair to show its disadvantages as well. I compiled some silicone brake fluid pros and cons that are the result of my personal experience and the experience of some of my friends (fellow automotive enthusiasts).

Silicone Brake Fluid Pros

- Noncorrosive
- Does not remove paint
- Resists mixing with water
- May have better lubricating qualities (i.e., less wear on metal and rubber parts).

Silicone Brake Fluid Cons

- PAINTING: Surfaces that have come in contact with silicone fluid can never be adequately painted. I'm not kidding. No amount of cleaning or use of solvents can clean the surface adequately to have the paint stick properly. As an example, we recently restored a '66 DS21 Station Wagon that had been run many years on silicone fluid. Both the front fenders and the inside of the hood for love-nor-money could not be adequately painted. Spraying the paint was like trying to spray paint onto a bar of wax. The paint just hit the surface and within seconds, massive fish-eyes appeared. The worst place of all was directly above the hydraulic fluid reservoir on the inside of the hood. I've seen this problem written-up in other automotive publications as well. If you don't believe me, try taking a piece of metal, dip it in silicone brake fluid, do the best cleaning job you can, and then try spray painting it. This is a very serious consideration if you intend to restore/repaint your car!
- AIR BUBBLES: Some cars have problems with the silicone fluid foaming, resulting in air in the hydraulic system. This seems to be especially pronounced on cars with Citromatic, but can also be a problem in the brake system on any D-model. This has been

a problem to some level on conventional cars as well, as evidenced by wording on some silicone brake fluid containers recommending, "... pour the fluid slowly and carefully as to not create air bubbles..." Some people seem to be able to combat the problem with frequent brake bleedings and for others, it does not seem to be a problem at all.

> SLUDGE: A frequent problem with silicone fluid is thick black sludge (resembling chocolate mousse) that appears in the bottom of the reservoir. This can happen on conventional cars as well as in Citroën hydraulic systems. It is quite common on D-models that the sludge clogs the hydraulic filter and prevents the hydraulic pump from sucking fluid, resulting in the poor driver being stranded with no hydraulics. The only apparent cure for this is to frequently change the fluid and clean the filter regularly. I once assumed that the sludge was somehow "released" by the silicone fluid from all the 25 year old rubber parts in the system. In light of my theory, I once tried replacing all the hoses, sphere diaphragms and suspension boots when converting a car to silicone fluid. But the same sludge appeared and clogged the filter within about a year.

> COST: The silicone fluid costs several times as much as conventional brake fluid.

> ELECTRICAL CONTACTS: Silicone fluid has had some history of contaminating electrical contacts that are in the vicinity of the fluid, rendering the component or system inoperative. Examples are hydraulic pressure switches and brake light switches.

> SEEPAGE: I've personally seen several cases of silicone fluid seeping past hydraulic seals. I have also read similar accounts in the MG car club newsletter. An example is rear brake wheel cylinders. An MG mechanic noticed that brand new wheel cylinders wept silicone fluid past the seals and resulted in eventual contamination of the brake shoes. I have had similar problems with new and rebuilt D-model rear brake wheel cylinders.

All in all, my experience with silicone brake fluid has not been satisfactory. I would highly recommend that before one converts any car to silicone brake fluid, that you talk to several people who have tried it. For me, the disadvantages highly outweigh the positives.

Sluggish action due to LHM gumming cleared with temporary use of SAE 10
Technical Bulletin #114 dated 10/24/69 (May 1993, p.17)
(Supplement to Technical Bulletin #68)

On cars equipped with LHM liquid, should it become apparent that various hydraulic units (shifting block (DX, DXF), pressure regulator and etc.) are acting in a sluggish manner, it is possible the condition is due to "gumming."

In such cases, the following corrective measure are recommended:

1. Drain the hydraulic system.
2. Refill the system with SAE 10 motor oil.
3. Drive the car 100 to 300 miles.
4. Re-drain the hydraulic system.
5. Refill the system with LHM (green) liquid.

Texaco #15 for aircraft replaces LHM green fluid
Don James, OH (Aug. 1985, p.14)

It has been proven to the satisfaction of most that Texaco Hydraulic Oil #15 is an adequate substitute for green fluid – at least equal to it if not better. At an aircraft maintenance company at a major airport I got a gallon can of it for $14. Later at a smaller airport I found a similar concern who had a drum of it and sold it to me for $6.25 a gallon. This seems to show it pays to find a source that has it in drums. The slight inconvenience of having to bring your own container is not a big factor. Plastic jugs will do.

Troubleshooting check list
Reprinted from Citroën Factory booklet, "Citroën Hydraulic System-Possible Incidents With Suggested Causes and Remedies"

Submitted by Jerry Seville, PA (Aug. 1985, p.17)

This is not difficult, but a good knowledge of the whole of the hydraulic system is necessary to enable the operator to carry out such a hydraulic test, and reference to the appropriate operation in the repair manual will be required to obtain full details of procedure and repair.

This is a small part of the Citroën Factory booklet, "CITROEN HYDRAULIC SYSTEM, Possible Incidents With Suggested Causes & Remedies." (The entire booklet can be found on the Internet. This is just the first few sections. [MB])

The suggested causes and remedies in the following article include some which may seem obvious, but all are based on experience over a long period. In other instances it will be necessary to recourse to the appropriate repair manual, which these suggestions in no way supersede.

In relation to any work on the hydraulic system, it is important that strict cleanliness is observed. Before any part of the system is disconnected or disturbed, all foreign matter should be cleaned off, including surrounding areas. Use only industrial alcohol or methylated spirit for such a cleansing operation and for the further cleaning of any dismantled part of a brake-fluid car (use kerosene on LHM/mineral fluid cars-Ed).

Before disconnecting any high pressure pipe, release pressure from the main accumulator and from the circuit being disconnected.

To release pressure from the whole hydraulic system it is necessary to:-

(a) Unscrew the bleed screw on the pressure regulator by one full turn.

(b) Place the manual height control lever in the lowest position and insure that the suspension spheres can be rocked freely by hand.

(c) Operate the hydraulic brake pedal until the car can be pushed with the brake pedal fully depressed.

(d) Turn the steering wheel from lock to lock.

After disconnection and/or draining or replacement of the following parts, refill them with hydraulic fluid before reconnection.

(a) High pressure pump.

(b) Rubber feed pipe from reservoir to high pressure pump.

(c) Reservoir filter unit.

When the high pressure pump, rubber feed pipe, reservoir filter unit, pressure regulator or main accumulator have been removed and refitted for any reason it is necessary to bleed the system by running the engine with pressure regulator bleed screw slackened off by one full turn until all traces of air bubbles disappear from the fluid being returned to the reservoir. To check this, remove the filler cap from the reservoir and observe through the aperture the fluid being returned to the reservoir. Tighten pressure regulator bleed screw and allow pressure to build up until pressure regulator cuts out. Release the pressure regulator bleed screw and again observe if all traces of air have disappeared from the fluid so released. Finally, tighten the pressure regulator bleed screw.

If difficulty is experienced in making high pressure pump function as indicated by the absence of any flow of fluid into the reservoir, it becomes necessary to prime the high pressure pump. This can be affected by removing the complete filter assembly from the reservoir, inverting it and filling it with hydraulic fluid with the engine running. When fluid is observed being drawn into the high pressure pump, top up the inverted filter with fluid and replace it as quickly as possible into the reservoir.

After reconnection of any pipe or unit associated with the brake circuit, it is advisable to bleed the brake circuit by means of the bleed screws provided for this purpose.

INCIDENT	POSSIBLE CAUSES	REMEDIES
1) High pressure absent or low	Insufficient fluid in reservoir	Top up to level
	Pressure regulator bleed screw loose	Tighten
	Ball behind pressure regulator screw missing	Replace
	Rubber pipe from reservoir to high pressure pump empty of fluid or obstructed	Clear obstruction and prime pump and pipe
	Filter in hydraulic reservoir dirty or obstructed	Thoroughly clean filter
	High pressure belts broken or slipping, DS19, DW, & ID19 power-steering	Replace and/or adjust tension

	High pressure pump pulley loose on shaft (key sheared or missing), DS19, DW, & ID19 power-steering	Replace key
	Pipe between high pressure pump and pressure regulator obstructed	Clear
	Filter outlet pipe obstructed	Clear
	Joint between filter outlet pipe and flange unsound	Fit new joint
	Filler cap air vent hole obstructed	Clear
	High pressure pump faulty	Replace
	Pressure regulator faulty	Replace
2) Rapid loss of high pressure and/or height after engine has stopped:	Main accumulator gas pressure at zero.	Change main accumulator
	Abnormal internal leak in gear selector unit.	Change gear select unit
	Abnormal internal leak in power steering.	Change power-steering
	Abnormal internal leak in control pedal unit.	Change brake control brake pedal unit
	Abnormal internal leak in height corrector.	Change height corrector
	Leak from suspension cylinder.	Fit new seals or change suspension unit
3) Hydraulic fluid level in reservoir drops with no sign of external loss	Obstruction or blocking of the return pipe from the suspension bellows to the reservoir can be due to the return pipe being trapped or pinched. This incident is confirmed by the affected bellows swelling to abnormal size.	Trace source of obstruction or trapping and clear, or fit new return pipe.
	Leak at gearbox cover piston/cylinder ring seals, indicated by a rise in the level of the oil in the gearbox	Fit new ring seals. Drain gearbox, refill with gear oil E.P. 90
	Excessive evaporation of solvent from the hydraulic fluid, due to over-heating for prolonged periods.	Change hydraulic fluid.

When a car is new some fall in fluid level can occur as the fluid becomes fully distributed throughout the system. Similarly, the level will drop if for any reason the suspension bellows have been changed or drained. Fluid must partially fill these bellows before it can be returned to the reservoir. In these circumstances top up as necessary.

(For further details, see Citroën Booklet F. 139 "Draining and Flushing Hydraulic System." [MB]) Other parts of the Citroën factory booklet in which the above appears are in this book under the following chapters: 3 - Brakes, 8 – Citromatic, 25 – Steering and 27 - Suspension

Vented cap prevents brake fluid damage to paint
Ken Butler, NM (Apr. 1984, p.10)

Air flowing in and out of the hydraulic tank through the vented cap carries brake fluid vapors (pre-LHM cars not converted to silicone) with it, resulting in paint peeling off the engine room structures, with rust forming soon after.

The cure: Obtain a cap from a paint thinner can or similar product which is 1-3/8" to 1-1/2" diameter, which is smaller than the diameter of the Citroën cap. Cut six or eight discs of aluminum screen wire to a diameter which will just fit inside the smaller cap. Remove the gasket and baffle plate carefully from the Citroën cap. With an ice pick or similar tool, punch six or eight small holes near the center of the cap, from the outside. Using the same tool, punch six or eight holes near the outside edge of the smaller cap, not in line with the holes in the Citroen cap.

Clean all parts well and assemble the screens into the smaller cap. Clamp the smaller cap on top of the Citroën cap and carefully solder them together. Wash the unit, preferably in alcohol. Reinstall the baffle plate and the gasket.

The top of my tank has remained dry for the past year since I installed this altered cap.

Warning light cuts off at 900 psi
Paul Fontaine (Apr. 1988, p.20)

The hydraulic circuit idiot light cuts off at 900 psi after standing overnight. When full height is achieved in normal operating position, the regulator cuts out at 2300 psi (gauge) and cuts back in at 2000 psi approximately. This is correct according to the manual. So, if the red STOP flashes, the hydraulic pressure is below 900 psi.

Warning light while using brakes indicated bad brake accumulator
Don James, OH (Mar. 1984, p.10)

Q. My hydraulic pressure warning light flashes on when I tramp on the brakes or go over a deep road bump. I use Texaco #15 Fluid. What do you think is wrong?

A. The brake accumulator is shot. Have it rebuilt.

Chapter 19–Ignition

Adjustment of ignition timing

August 12, 1969 Citroën Technical Bulletin #107

Edited by Mark Bardenwerper (Mar. 2016)

Models: all "D" models

The adjustment of the ignition advance on the motor of all "D" models can now be done with the motor running, with the use of a "strobe" timing light.

On the motors of all 1969 "D" models with LHM (green) liquid the adjustment of the ignition advance must be done with the motor running at a speed of 2000 R.P.M.

Only the use of a strobe light will permit obtaining this adjustment.

Principle of operation:

I Strobe light (timing gun):

The strobe light furnishes a series of brilliant flashes of very short duration.

When it is connected to a spark plug, each firing of this spark plug corresponds to a flash of light. The flashing of the light and the firing of the spark plug occur simultaneously.

II Principle of the method of adjusting the advance with a strobe light.

As stated above, when a strobe light is connected to a spark plug and if the motor is running, a flash of light will produce itself at the point of ignition, that is, it will occur at a specific position of the distributor rotor turning at a constant motor speed.

The flash, therefore, will occur in accordance with a known angular position of the camshaft.

If a reference (timing) mark is made on the drive pulley attached to the end of the camshaft, and if this mark is lit with a strobe light connected to a spark plug, the mark will be in the same position at each flash. It will appear to be stationary.

If the position of the distributor is changed, the timing mark on the pulley will appear to move. Since the angel of rotation of the distributor is being changed, the mark will move to a distance proportional to this angle. The movement of the mark is measured in degrees and reflects the angle or rotation of the distributor, also measured in degrees. The movement of the timing mark also reflects the change in the point of ignition.

If the speed of the motor varies, the centrifugal advance mechanism will also change the point of ignition. The reference mark on the pulley will appear to move to a distance proportional to the variation of the angle of advance caused by the change of motor speed.

When using the strobe light it is necessary to place a scale, graduated in degrees as close as possible to the rim of the pulley. (A diagram for making a tool incorporation such a scale is attached. The scale accompanying this bulletin has a self-adhesive back. It is to be placed in the position shown in the diagram.)

By running the motor at a certain speed the position of the timing mark on the pulley will permit reading on the scale the number of degrees of advance in relation to the initial position of the mark.

Method of Adjustment:

Notes:

- On the 1968 “D” Models with LHM liquid, the calibration of the distributor should be done at 2000 R.P.M.
- The specification of the ignition advance angle differs for the U.S. models with the anti-pollution system (see tables below). Consequently, the initial position of the timing mark on the camshaft pulley will be places so as to correspond with the top dead center of no. 1 piston, or 0º, for these models.
- On all other models this initial position is at 12º advance (crankshaft). (Until July, 1971, when all cars acquired TDC timed flywheels [MB])
- The timing tool, referred to above, is attached to the upright support of the alternator on cars equipped with the Anti-Pollution System. On all other “D” models, the tool can be lengthened or modified so as to be placed as shown in Figure 1.
- On cars equipped with the Anti-Pollution System, the timing hole in the flywheel corresponds to top dead center (TDC) of piston no. 1. The position of the piston can be determined by means of a dial indicator with its extension positioned through the hole of No. 1 spark plug. This can be check with a timing rod indexed through the hole in the clutch housing.
- On all “D” models the initial position of the timing mark on the camshaft pulley will correspond to the “0” mark on the scale when the motor is not running. However, at 2000 R. P. M. the number of degrees of advance as shown on the scale will be different according to the specifications shown in the table below for the particular model.

The reason is that the figure 20 on the scale represents the total advance in crankshaft degrees at 2000 motor R.P.M. From this figure we deduct:

12º for cars without the Anti-Pollution System.

0º for cars with the Anti-Pollution System.

For example: $20^\circ - 12^\circ = 8^\circ$

$20^\circ - 0^\circ = 20^\circ$

Since these figures represent crankshaft degrees and, since the point of ignition is adjusted in distributor degrees, it is necessary to divide the crankshaft speed by distributor speed to obtain the correct point of ignition to be indicated on the scale. Thus:

$20^\circ - 12^\circ = 8^\circ \div 2 = 4^\circ$

$20^\circ - 0^\circ = 20^\circ \div 2 = 10^\circ$

Each division of the scale corresponds to 2º. Therefore 4º will be indicated by the second division; 10º by the fifth division.

Tables:

All “D” models <u>without</u> the Anti-Pollution System:

Model	Remarks	Motor speed for making the timing adjustment (R.P. M.)	Total advance (crankshaft degrees)	Advance in relation to the initial positioning of the timing mark (distributor degrees)
DS-19 (10/55-7/59)	Distributor with double contacts	2000	22	5
ID-19 (until 2/64)	Vacuum advance disconnected	2000	22	5
DS-19 (7/59-9/65)		2000	22	5
ID-19 (2/64-9/64)	Vacuum advance disconnected	2000	22	5
ID-19 (9/64-9/65)		2000	26	7
ID-19 (9/65-9/66)	DE	2000	22	5
DS-21 (9/65-9/68)	DX-DJ-DJF Dist. no. DX-05b	3000	18	3
DS-19a (9/65-9/68)	DY-DL-DLF Dist. no. DY-05	2000	16	2
ID-19b (9/66-9/68)	DV Dist. no. N-05b	2000	15	1º 30’
(Data in the rows below was added from Citroën manual no. 814. [MB])				
DX, DJ, DXF, DJF (10/68-9/72) DP (since 9/72)	Dist. No. DX-05i	2000	20	4
DY, DL, DYF, DLF, DV, DT (10/68-5/69)	Dist. no. DV-05 d	2000	24	6
DY, DL, DYF, DLF, DT (since 5/69) DV (since 9/72)	Dist. no. DY-010A	2000	28	8
DV (5/69-9/72	Dist. no. DV-010A	2000	24	6
DX, DXBW, DJ, DXF, DJF	Dist. no. DV-010A	2000	23	

(since 9/72)				
(No further information is available at this time. [MB])				

All “D” models equipped with the Anti-Pollution System

Model	Remarks	Motor speed for making the timing adjustment (R.P. M.)	Total advance (crankshaft degrees)	Advance in relation to the initial positioning of the timing mark (distributor degrees)
ID-19b (1/68-12/68)	DV Dist. no. DV-05a	2000	18	9
ID-19b (after 1/69)	DV Dist. no. DV-11a	2000	24	12
(The next 2 rows were taken from Citroën Note D’Information no. 142 date 5/9/69. [MB])				
DS-20, ID-20 (1/68-12/68)	DY, DL, DLF, DT Dist. no. DY-05e	2000	16	8
DS-20, ID-20 (after 1/69)	DY, DL, DLF, DT Dist. no. DY-11a	2000	28	14
DS-21 (1/68-12/68)	DX, DJ, DJF Dist. no. DX-05g	2000	20	10
DS-21 (after 1/69)	DX, DJ, DJF Dist. no. DX-010a	2000	20	10
(No further information is available at this time. [MB])				

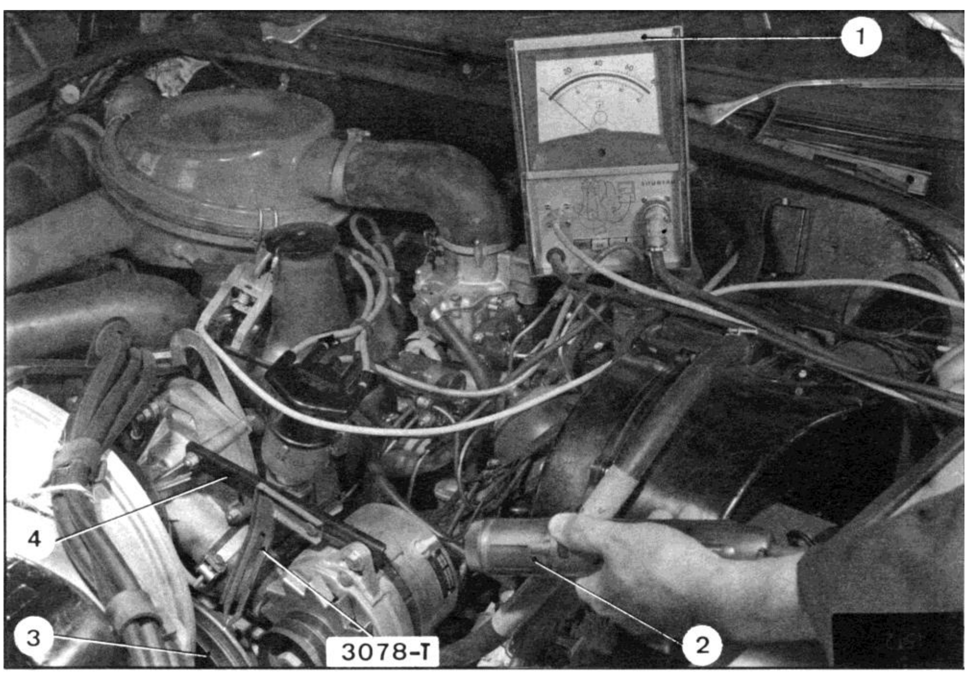


Figure 1

1. If the distributor has been removed, make a pre-adjustment so as to be sure the motor will run. (See Op. DX-211-0, Citroën factory manual no. 518)

   a.) Remove the distributor cap and check that the gap at the contact breaker points is 0.4 mm (.016”). If not, adjust to this.

   b.) Bring no. 1 piston to the top of the compression stoke. Insert a 6 mm (.236”) diameter locating pin into the hole provided in the clutch bell housing (under the alternator).

   c.) Slowly turn the engine until the locating pin falls into the slot in the flywheel. At this position the engine is at the firing point of no. 1 cylinder.

   Note - On cars equipped <u>with</u> the Anti-Pollution System, this position is at 0º. (And all cars built after July, 1971. [MB])

   \- On cars <u>not</u> equipped with the Anti-Pollution System this position is 12º advance.

   d.) Withdraw the locating pin.

   e.) Fit the leads from a continuity test lamp to the condenser terminal (or – terminal on the coil [MB]) and to ground.

   f.) Switch the ignition “on.”

   g.) Loosen the securing nut of the distributor clamp plate.

   h.) Place the clamp plate at the position marked “SUP” and tighten the securing nut.

   i.) Slacken the nut of the clamping screw at the split end of the clamp plate behind the distributor.

   j.) Slowly turn the body of the distributor counter-clockwise.

   k.) Stop the moment the lamps lights, which is the point at which the points just open.

   l.) Tighten the screw behind the distributor.

   m.) Switch the ignition “off.”

2. Connect a tachometer

3. Attach the timing tool (figure 2) to the upright bracket of the alternator (models with the Anti-Pollution System) or to the cross bracket of the alternator as shown in Fig. 1 (models without Anti-Pollution System). Attach the tool so that the scale is level with the rim of the drive pulley.

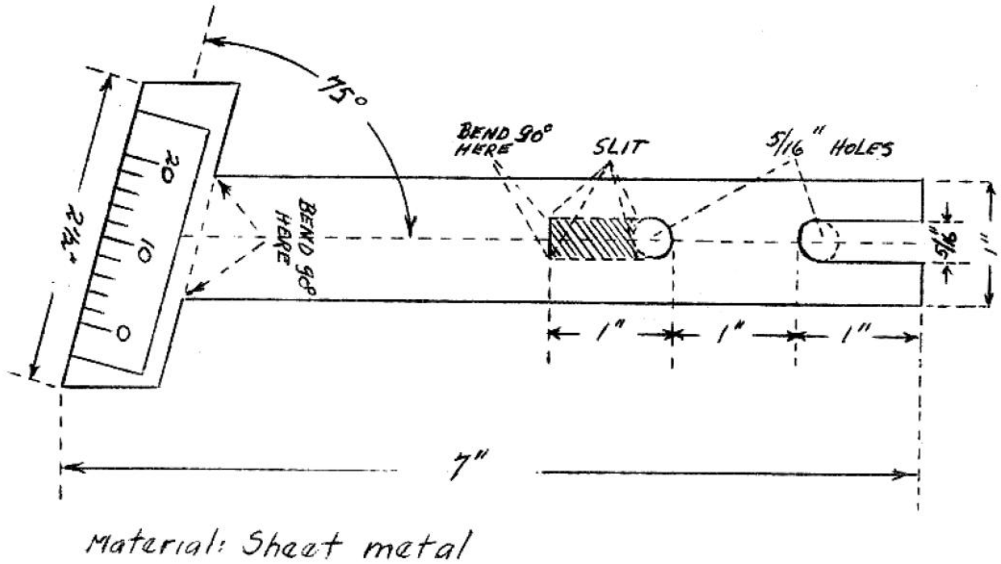
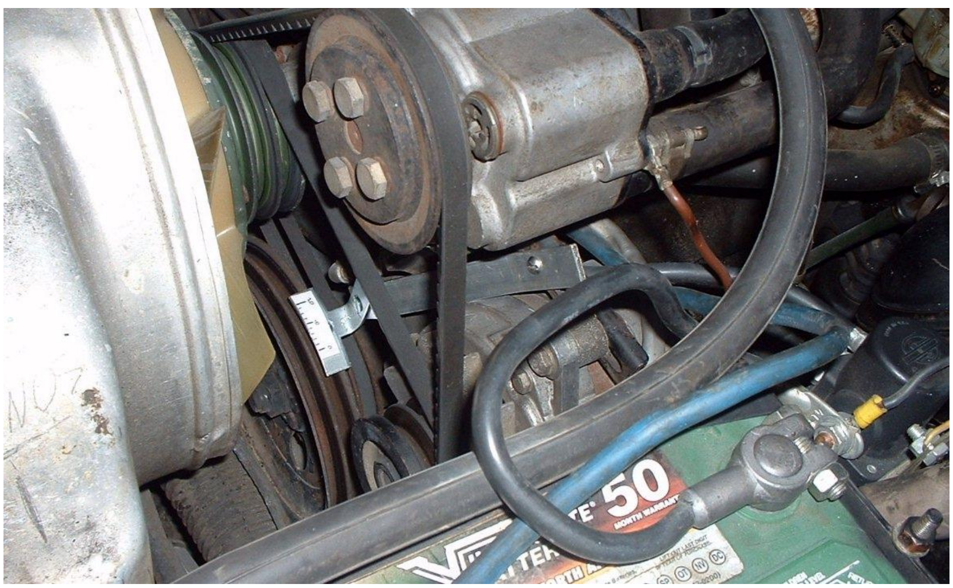


Figure 2



I made this one from hardware store parts for my U. S. specification 1968 ID-19 [MB]

4. With the motor at the point of ignition (0º for cars with the Anti-Pollution System; 12º advance for cars without the Anti-Pollution System) trace a fine line on the rim of the drive pulley coinciding with "0" on the scale Be sure the timing rod has been removed.
5. Connect the strobe light to the source of current and to the ignition circuit of no. 1 cylinder.
6. After the motor is started and the speed increased, the flashes from the light aimed at the timing mark will seem to make the mark move.
   When the motor is running at 2000 +/- 50 R.P. M., the timing mark should be at the position shown in the last column of the tables above (each division is equivalent to 2º).

7. If the position is not correct, loosen the screw at the split end of the distributor clamp and turn the distributor to bring the timing mark on the pulley to the proper graduation (the ignition advance increases by turning the distributor counter-clockwise).
8. Tighten the distributor clamp screw to 0.3 m.kg (30 in. lbs.).
9. Switch the ignition "off."
10. Remove the light, the timing tool and the tachometer.

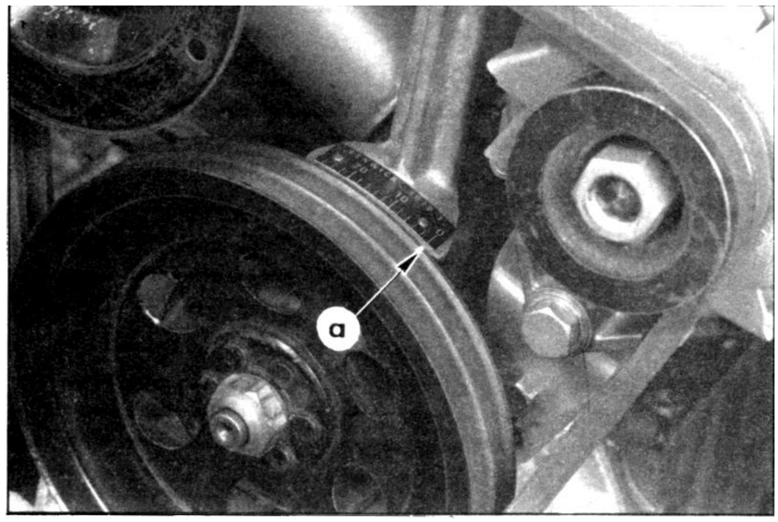


Figure 3

Timing mark on the drive pulley motor stopped, locating pin in place, or (cars <u>with</u> Anti-Pollution System) dial indicator at "0" (a) in hole of no. 1 spark plug with piston at top dead center of compression stroke.

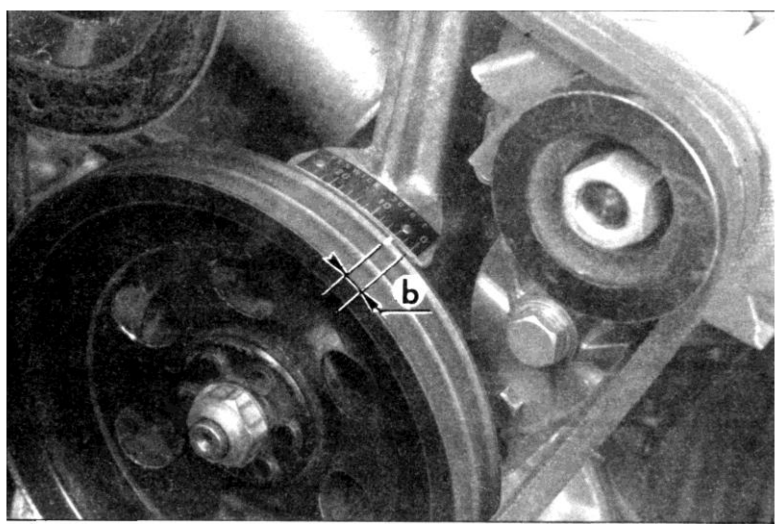
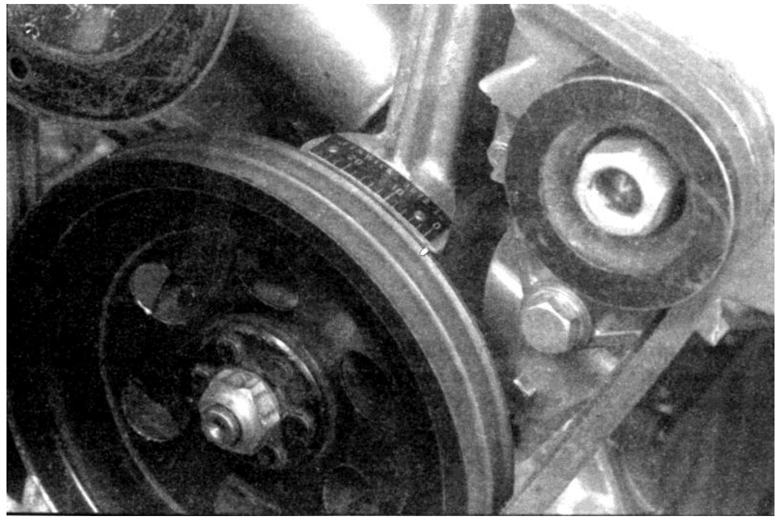


Figure 4

Motor running at 2000 R.P.M., position of timing mark on the pulley when the distributor is adjusted correctly (cars <u>without</u> the Anti-Pollution System). Distance between arrows at (b) is 2 marks, or 4 distributor degrees.

Figure 5

Motor at idle, the mark on the pulley can be below the "0" of the scale (cars without the Anti-Pollution System). (This is the entire reason for setting the timing on these cars while at maximum advance; the advance curves almost always begin a very low R.P.M., making it impossible to do it at idle. [MB]



Addenda:

We list below the value, in millimeters and inches, of the travel of the piston starting from top dead center, in relation to the angle of rotation of the crankshaft.

The angle 0º corresponds to top dead center.

These values permit learning in a precise manner the angular position of the crankshaft by measuring the travel of the piston with a dial indicator.

Crankshaft Angle (in degrees)	Piston Travel (in inches and millimeters)			
	DX, DJ, DJF		DV	
	mm	in.	mm	in.
1	.004	.000157	.008	.000315
2	.024	.000945	.032	.00126
3	.060	.0236	.074	.00291
4	.113	.00445	.131	.00516
5	.183	.0072	.206	.00811
6	.269	.01059	.296	.01165
7	.371	.0146	.403	.01586
8	.490	.01929	.526	.02071
9	.624	.02457	.666	.02622
10	.775	.03051	.821	.03232
11	.943	.03713	.993	.03919
12	1.126	.04433	1.181	.0465
13	1.344	.05291	1.406	.05535
14	1.540	.06062	1.604	.06315
15	1.771	.06972	1.839	.0724
16	2.017	.07941	2.090	.08228
17	2.279	.08972	2.356	.09276
18	2.556	.10063	2.638	.10386

19	2.848	.11213	2.935	.11555
20	3.156	.12425	3.247	.12783
21	3.479	.13697	3.574	.14071
22	3.186	.15024	3.916	.15417
23	4.168	.16409	4.272	.16819
24	4.534	.1785	4.643	.18279
25	4.915	.1935	5.028	.19795
25	5.130	.20905	5.427	.21366
26	5.719	.22516	5.840	.22992
28	6.142	.24181	6.267	.24673
29	6.587	.25898	6.708	.26409
30	7.027	.27665	7.161	.28193

Adjustment of points gap using dwell
(Jan. 1978, p.4)

There is a relatively easy way to set the gap on the contact points in your D-model that is much more accurate than using a feeler gauge. It involves the correct setting of the dwell (cam) angle using a dwell/tach meter. Dwell angle is the degree value for the closed period of the ignition points for each "make-and-break" of the distributor cycle. During this "dwell" time, the ignition coil becomes saturated (builds up stored voltage) for the next high tension spark that is delivered at the instant of point opening. Proper intensity of the spark delivered to the spark plug is vital to good engine operation and is therefore directly related to the point dwell time. Too short a dwell time will result in a weak spark, while too long a time will reduce point opening and may cause arcing.

After installing new points, connect the dwell meter red lead to distributor side (-) of the coil and the black lead to engine ground. Set the cylinder number selector to four. Remove the coil high-tension lead from center terminal of the distributor cap. Use a jumper wire to connect the end of this lead to good ground. Remove the distributor cap and tie cap and cables to one side. Remove the rotor. Loosen the set-screws for the points, but not too much. Crank the engine a couple of times while watching the dwell reading on the meter. Adjust the points to get a reading of 59 degrees.

Tighten the hold-down screws and reinstall all other parts. Start the engine and run for awhile. Watch the dwell reading while giving sharp accelerations to see that the dwell does not jump around significantly.

Bosch W6 spark plug works well
Betsh, Ken (2001 #3, p.13)

I have been running from 12,000 to 15,000 miles between spark plug changes and have been pleased with Bosch W6 type after years of using Champion. I also check, and adjust as necessary, for a gap of .025 inch before installing each plug. There's always been a debate as to inserting them dry or with some lubrication. I usually put on just a tiny drop of oil or high-temperature grease.

I try to follow the factory recommendation to change plugs only when the engine is cold and to only tighten to 15 foot-pounds. I never forget that if the steel plug threads bond to the threaded aluminum head, the head will suffer first.

Cassette comes in two versions
Ken Betsh, PA (Jan. 1997, p.14)

D model owners with cassette-type ignition distributors should be aware that the lowest cost replacement point assembly, S.E.V. Marchal #41200503, differs from the type you may now be using. This new plastic-base assembly lacks a gap adjustment screw that allows dwell to be set with the engine running. Just like the old-style point set and distributor, a cut-and-try process to adjust dwell with the distributor cap and rotor removed is needed. Also, the point contact area is smaller–perhaps even less than that of the old, screwed-in-place points.

The good news is that the original points cassette is still available. The bad news is that the price is more than 50% greater. My favorite Pennsylvania parts source has the deluxe item in a green blister-pack marked Valeo S426 (Ref. 41210003 marked on the back). According to the package, the same part is also used on several Peugeot and Renault models.

There seems to be a love/hate attitude towards the cassette distributor. One of my two D-models came with it and I put a used one in the other car several years ago. I find they last longer but tend to die suddenly. The last death was on a recent cold night returning from Baltimore. The engine quit while waiting to make a left turn five miles from home and wouldn't restart. Dwell measured well over the normal 57 degrees. A quick substitution of an old points cassette restored operation. The difficult part is that a visual examination shows no cause such as a broken spring–I can't tell what went wrong. Even if I could reset it and make it work, I wouldn't trust it. (The most common reason for point failure is lack of lubrication of the points cam. Place a tiny daub of points grease on the lee side of the cam bumper and set the well towards the low end of tolerance so as the bumper wears, the dwell moves gradually past the prime reading. [MB])

Cassette distributor causes problems for unknown reasons
Andrew Hathaway, NJ (Feb. 1995, p.6)

I had heard for some time that the cassette type of distributor could cause a variety of problems. When I got my D-model I replaced the condenser and points cassette and for quite some time everything vis-a-vis the engine was free. I would check the dwell on occasion and found that it was very stable.

About a year and a half ago I began to notice that there were a number of problems with the engine. Although the car would run, sort of, I didn't have a lot of confidence in it, and I stopped using it on a regular basis. I could never pin down anything in particular because it wouldn't be consistent. I repair things for a living and without doubt the hardest thing to find is something that's intermittent. I cleaned out the carburetor and blew out the various passages and while it did some good, there was still the problem of the engine running badly.

The engine originally had a one-barrel Solex on it. Due to the one mounting nut that people could see and tighten, the plate got warped and was sucking in air. I decided to get a two-barrel manifold and carburetor. There had always been a stumble when the secondary opened up. And as time went by, it got worse. Even though the dwell with the old cassette was on the money, I decided to change the cassette. I couldn't get the new one to adjust properly and decided to throw in the sponge and put a regular points distributor in the car.

There were some problems, as it came out of a parts car I have and the plate that the points mount on was very rusty. I finally had to resort to glass-beading it to get all the rest off of it, navel jelly not withstanding. I'll have to keep a watch on it so that it doesn't rust over again.

Cassette distributor causes problems for unknown reasons
Ken Betsh (2000 #4 p.16 & 2000 #6 p. 9)

Those who have read of my pro-position for cassette-type distributors should know I've returned to the old-style type on one car. While in Florida last Spring with the DS, the engine started missing under load just like a plug was fouled. After pulling two plugs and finding them clean and not having spare Bosch plugs of the type I prefer with me, I tried two alternate used cassettes I carried as spares. While missing continued, both had different characteristics. Fortunately, I also had the original old-style distributor which solved the problem.

I've been keeping records of repairs to both cars on a home-computer program started in 1984 and in reviewing tune-up data, I found long life of cassettes in the '72 that came with this type distributor but cassettes had less than half the lifetime in a used cassette-type distributor mounted in the '71 about six years ago.

What causes the problem in the '71 remains an uncertainty. I've put the cassette that failed in Florida along with the rotor and cap from that distributor in the '72 and they initially worked fine. After a couple of weeks I noticed some minor missing at low RPMs and suspected reduced high-speed performance. Even though the dwell was normal, I went back to the cassette that had been in the wagon for over 20,000 miles. No more missing and more zip on the highway. I now suspect there is an unidentified wear factor in the mechanical part of the cassette distributor housing.

One reason I favored the cassette was the ease in replacing it if something went wrong while on the road. It didn't work out that way this time. I now have a easy way for the '71 if there's a next time. At Northfield Rendezvous, I was able to buy a collar clamp for an old second spare old-style distributor. I've cleaned it, installed new points, fitted a spare condenser, rotor and cap, and checked it out for timing and performance in the car. Next time I have a suspected ignition trouble, I can make a quick swap without upsetting the timing.

Cassette distributor trouble follow-up
Ken Betsh, PA (Feb. 1999, p.6)

The deluxe Valeo S426 points cassette that I discussed in a previous article (Cassette comes in two versions) had a disappointing short lifetime–14,300 miles. In the last few hundred miles, there were several instances of momentary loss of ignition, perhaps a half-second or so.

Typically this would be after letting off the gas slightly such as after passing or reaching a hilltop. Twice the engine stalled at idle and only restarted after several tries.

A frustrating part of the problem was that no obvious cause of failure could be seen. My guess was that the points surface wore by a transfer of material from one side to the other. The design allowed a small sideways shift of the contacts that may have allowed the peak on one side to touch an unworn side on the other. This would have resulted in reduced gap that would delay the opening (which is when the spark is generated).

Unfortunately the points could not be separated for a detailed investigation without damaging the cassette to the extent it could not be reused with any confidence. I did try filing the points on two old cassettes. The first one ran fine for about 200 miles and started to miss a couple of times briefly.

The second worked fine for about 300 miles until I replaced it with a new SEV type. The SEV type, the so-called plastic cassette, is less expensive and does not have the easy dwell adjustment. However, the adjustment slot and locking screw are accessible with the rotor and cap removed, which means its dwell can be adjusted while running the engine on the starter. This should be OK since I've never seen any difference in dwell between cranking and high speed. The good news with the new SEV cassette I bought was that the dwell was exactly to specification as received so that no adjustment was needed.

Champion L87YC ceramic-to-metal failure
John D. Titus, AZ (Feb. 1993, p.8-condensed)

I have shell seal failures of several Champion L87YC spark plug and subsequent damage to the cylinder head of my '72 Pallas. To Champion's credit, they did reimburse my repair costs. However, they apparently have not yet determined the exact cause of the plug failures, nor have they taken any corrective action in their manufacturing process.

Until such time as Champion has taken corrective action I would advise club members to use Champion L87YC spark plugs with caution. If anyone is currently running Champion plugs and hear what sounds like a sudden exhaust leak, I would advise that person to shift into neutral immediately, turn off the engine, and coast to a stop. If you find that a spark plug wire has been dislodged, or that you can move any spark plug extension up and down, remove that plug and replace it before restarting the engine. You may save your cylinder head.

Excerpt of my letter to Champion dated January 20, 1993:

"Approximately a year ago I purchased a classic 1972 Citroen DS21 Pallas. It came equipped with Champion L87YC spark plugs. Last July 3, while driving the car, I suddenly heard a loud clattering as if the exhaust manifold had separated completely from the cylinder head. When I investigated, I discovered that the cause of the noise was not the exhaust manifold, but the spark plug in the #4 cylinder. It seems the ceramic-to-metal seal had failed, allowing the ceramic part of the plug to reciprocate about 1/4 of an inch inside the metal part of the plug thereby allowing compression to vent past the broken plug. I have enclosed this plug for your examination. I replaced the plug with another L87YC Champion and drove for a few weeks until another plug (this time the #1 cylinder) failed in the same manner as the #4 plug had.

"I did not know the age of the plugs since they had come with the car and I considered the failures to have been flukes. Accordingly, I replaced all four plugs with new Champion L87YC plugs. Less than five months later, the same failure occurred with the new plugs (again the #1 cylinder). This time, however, the jackhammer effect of the reciprocating ceramic ripped the entire plug out of the cylinder head. I found the plug on top of the engine lying next to the carburetor. The plug shows signs of the identical failure.

"The engine doesn't knock or overheat and, as you can see, there is no damage to the spark plug lower electrode, accordingly, mechanical interference must be ruled out. I would appreciate an explanation from Champion as to why the L87YC plugs do not hold up."

Excerpt of reply from Champion dated February 4, 1993:

"The returned plug may have been manufactured with a marginal shell seal. Obviously, such a condition is not up to our usual high quality standards. It has been forwarded to our Quality Control Department for their information and corrective action.

"Of additional concern is your report that the entire spark plug blew out of the engine. Examination of the threads on the returned plug found they conform to proper manufacturing tolerances and not in any way related to shell seal failure. When an entire plug blows out of an engine, this usually indicates the threads in the plug port are in very poor condition and not properly engaging the plug thread itself. Obviously, this is a serious mechanical condition and requires immediate attention to insure the plugs are properly engaged in the head."

Excerpt of my second letter to Champion dated February 17, 1993:

"I apologize if my previous letter caused you some confusion regarding which plug blew out of my cylinder head. The plug that I sent you was the first plug that failed. Because it failed in town, I was able to pull over and change it out before it caused any noticeable damage to the cylinder head.

"The final failure occurred at highway speed. While driving at approximately 65 mph, I heard what sounded like the noise the engine made when the ceramic-to-metal seal had failed previously. Then, before I could move out of traffic, I heard a bang against the car's hood. At the same time, the sound of the engine became noticeably louder. Once I pulled over, I found the spark plug lying on top of the engine. The ceramic-to-metal seal had failed on this plug also. From this I concluded that the bang I heard was the plug being blown out of the cylinder head.

“Because the catastrophic failure of the cylinder head threads followed moments after what must have been the failure of the ceramic to metal seal, I do not believe that the threads in the head or the plug were faulty. Nor do I believe that installation was improper. Instead, I believe that once the ceramic-to-metal seal failed, the reciprocating ceramic acted like a slide hammer and the impact load simply sheared the threads out of the cylinder head (you will observe that the remains of the aluminum threads from the cylinder head are still attached to the plug)."

Excerpt of reply from Champion dated March 3, 1993:

"One of the returned plugs has aluminum thread material still engaged within the spark plug threads. A close examination of this plug reveals the shell seal failure and torn aluminum threads may have been the result of an over-torqued situation with the plug. Further evidence of that is the fact the compression gasket on the plug has been crushed to a .053-.054" dimension indicating approximately 50 ft. lbs. of torque has been applied. This excessive amount of torque can, some cases, literally cause a spark plug shell to stretch and loosen the insulator internally and be a major contributing factor to this type of problem.

Note from Champion entitled "Gasket Compression vs. Installation Torque"

One of the problems in trying to determine installation torque by examining gasket thickness is the wide variations which occur due to the amounts of, or lack of oil on the threads and the friction characteristics of aluminum and cast iron.

The following data can be used as a rough guide within approximately 0.002" when plugs are installed in clean dry aluminum heads.

Installation Torque (Lb. Ft.)	FGN-8A Gasket	FGN-8B Gasket
20	0.060"	0.061"
30	0.056"	0.057"
40	0.055"	0.054"
50	0.054"	0.051"

It is safe to say, any time either gasket is below 0.050", installation torque is excessively high.
Summary to Club dated March 17, 1993:

Champion's correspondence suggests I over-torqued the L87YC spark plugs upon installation, as evidenced by the excessive compression of the plug gasket. It is entirely possible that I did over-torque the plug, since I use the original Citroen spark plug wrench and a "calibrated hand." On the other hand, since I use anti-seize on the spark plug threads, Champion's data on torque vs. compression (which is for dry threads) is probably not reliable.

Moreover, although I believe that over-torquing could have contributed to the thread failure, I still remain unconvinced that an over-torque condition could contribute to a structural failure of the shell seal of the plug itself. And given the choice between over-torque or the slide hammer effect of a shell seal failure as the most probable cause of an on-the-road thread failure, I would choose the shell seal failure.

Nevertheless, the letter from Champion does have some information relating to torque specifications that I have never seen printed in one place before. I personally have resolved henceforth to use a torque wrench on all spark plugs–just to be sure.

Editor: Champion's torque specifications appear in separate article, Spark plug removal and installation." (Reproduced, below [MB])

Champion L87YC ceramic-to-metal failure
Barton Milligan (Apr. 1993, p.9-condensed)

I too have had a Champion spark plug fail by loss of the ceramic element and have had a plug strip out of its hole, but at entirely different times. Having experienced first hand the little bits of aluminum adhering to the threads of the spark plugs of #1 cylinder when I removed them over several years, I know that weakened threads was the reason that I had to be towed home one day and have a helicoil installed. This all happened in spite of the fact that I did use a torque wrench to install spark plugs in my earliest days as a Citroen owner in the early '70s and learned the "feel." I will even concede that failure of the ceramic to metal seal in a plug could generate enough stress to cause weakened but serviceable threads to fail. But John Titus needs to give a lot more detailed explanation of how a slide hammer effect would take place, much less how the inertia of a 1 or 2 ounce ceramic spark plug element could cause the failure of sound 14 mm threads.

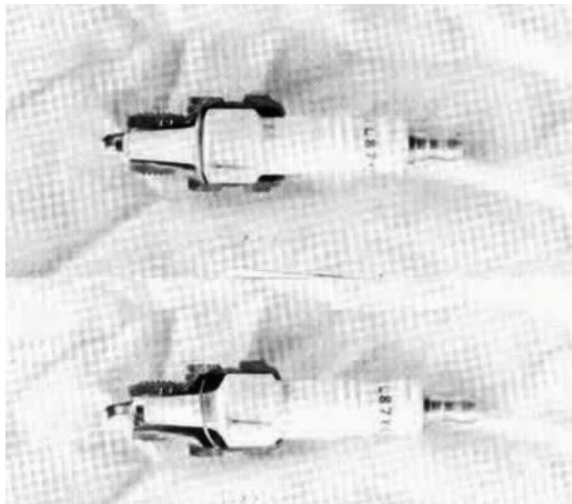
I don't mean to be hypercritical, but keeping our old cars running requires that we be accurate in our assessments of cause and effect when things go wrong. I'm willing to listen to any detailed argument.

Champion L87YC ceramic-to-metal failure
John D. Titus, AZ (May 1993, p.10-summarized), Chris Dubuque, WA (Jan. 1994, p.8-summarized), John D. Titus, AZ (Jan. 1994, p.9-summarized)

I still believe, however, the shell seal failure caused the failure of sound threads because the threads were pulled from the cylinder head in a continuous helix of approximately five revolutions. This is nearly the entire thread engagement of an L-type plug. It seems to me that if the threads had previously suffered any significant damage, they would not have come out in a single continuous coil, but would have been broken into pieces by the pre-existing damage (i.e. there would have been bits and pieces missing from the helix).

The slide hammer effect to which I referred is possible because of the manner in which the plug is constructed. As shown (upper, below) the lower part of the metal plug body has an internal contour similar to a bottleneck. A copper washer is put into the plug body, and the ceramic insert, which is molded with a wide section in the middle, is then placed on top of the washer so that the wide section bears down on the washer. Another washer made of a soft ceramic material approximately 1/4" thick is placed over the insert and the plug body is roll crimped to compress the assembly. Thus, the plug has no true ceramic-to-metal gas seal as I had earlier thought. Instead, the gas seal is provided simply by the copper washer being crushed between the insert and the plug body. As the plug is installed, however, the tension on the threads tends to bow the lower part of the plug body slightly, thereby relieving some of the preload on the copper washer. If the plug was manufactured with marginal preload and slightly over-torqued, or if a "good" plug is severely over-torqued on installation, the small amount of relaxed preload may cause this gas seal design to fail.

When the gas seal fails, the soft ceramic washer at the top of the assembly is quickly pulverized, but the ceramic insert is still held captive at the bottom by the internal contour of the plug body and at the top by the roll crimp. This permits the ceramic element, driven alternately by the compression and intake cycles of the piston, to reciprocate approximately 1/4" between these two rigid stops (lower, below).



The best explanation to reconcile the forces calculated according to classical physics with the observed physical evidence suggests it was the excessive preload on the threads that, when combined with the impact load of the jackhammering ceramic, exceeded the shear strength of the threads. It is not inconceivable that such preload, combined with the jackhammering ceramic, would be sufficient to cause previously undamaged threads to fail all at once and shear out in the single continuous helix that I observed.

This re-emphasizes the importance of using a torque wrench to install spark plugs. Not only will over-torque contribute to the failure of a marginally constructed spark plug, but once the failure occurs, overtorque will contribute the additional preload necessary to enable the oscillating ceramic to shear the cylinder head threads.

Editor: The original newsletter articles included John's and Chris' differing force calculations.

Champion L87YC, good experience, faith kept
Ken Betsh, PA (Apr. 1993, p.16)

After using Champion L87YC spark plugs for over 90% of at least 600,000 miles of driving post-'66 Citroens, my faith and trust in them is not shaken by the experience of John Titus as reported in the 1993 #2 issue (above). I have never had any failures other than fouling due to other causes. I have to feel there is more to the story.

While I occasionally install new plugs without a torque wrench, I would NEVER reinstall a plug without one. I believe the compression gasket that comes pre-mounted on the plug allows a reasonable tolerance to the 15 foot-pounds tightening specification. However, once this gasket has been compressed, the range between inadequate and excessive tightening is extremely small.

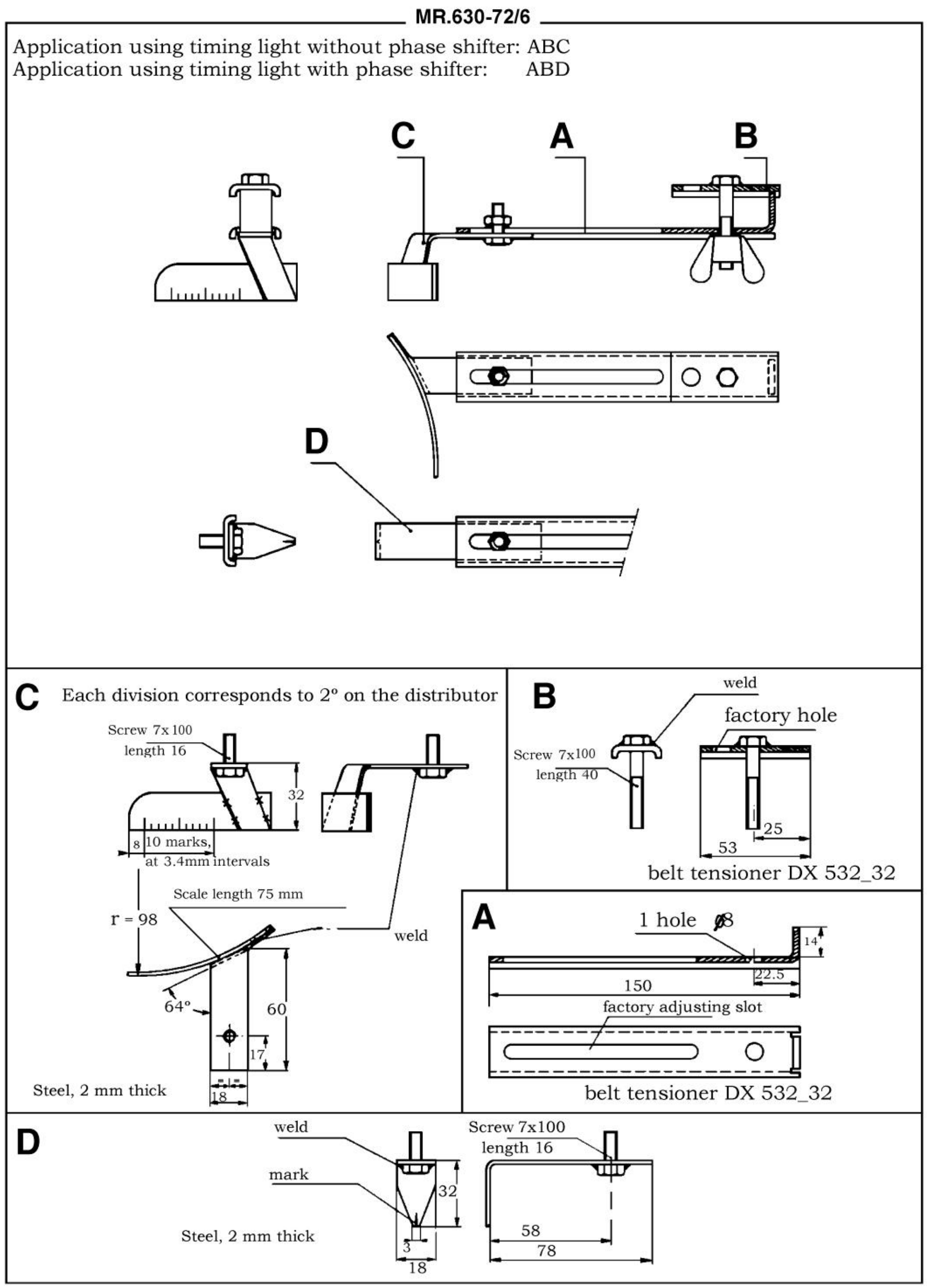
While many American spark plugs have long used a 14 mm thread, I once was told the exact SAE dimensions for this thread made them very slightly larger than those made to European 14 mm standards. For this reason I have never used alternate plugs designed for American cars. On a few cases I've had trouble in removing fouled plugs apparently due to carbon at the end of the threads. I've found they do loosen easier with the engine warm (but not hot).

Champion spark plugs, a good experience
Peter Lee, MD (Mar. 1999, p.13)

For 28 years I have used only Champion spark plugs on my D models (total mileage - 390,000) and on my AMI-6 (90,000 miles). After stripping threads on my new 1969 ID19B using a torque wrench at 20 ft-lbs with Never-Seez on the spark plug threads (Champion L92-Y), I reduced the torque to 10 ft-lbs. This was in 1970. I have not stripped spark plug threads since then.

Some people say the plugs will back out with this low torque, but I have never experienced a loose plug. I used L92-Ys as long as they were available, then I switched to L87-YCs mentioned by John Titus. Using a torque wrench set at 10 ft-lbs and Never-Seez on the threads I have never had a problem.

Diagram of the factory timing mark tool
Citroën factory tool 630-72-6, translated from a German drawing
Edited by Mark Bardenwerper (Mar. 2016)



Distributor cap failure due to carbon track
Don James, OH (Aug. 1987, p.19)

The distributor cap shown above failed because of "carbon tracking." Moisture or dirt can make an artificial path for high voltage to follow. Only a few miles of driving with a spark jumping across the surface of the cap will create a permanent path of carbon from the burned plastic. Sanding may remove it if not too deep, but a new cap is usually needed.

The cap shown was new, but when used with a CDI ignition, the voltage was more than the cap was designed for. Drilling a 1/8" hole in both front and rear of the distributor will give enough ventilation and prevent moisture in the cap. Moisture can also rust point springs. Some caps have holes in them as original, but a hole in the distributor is better.

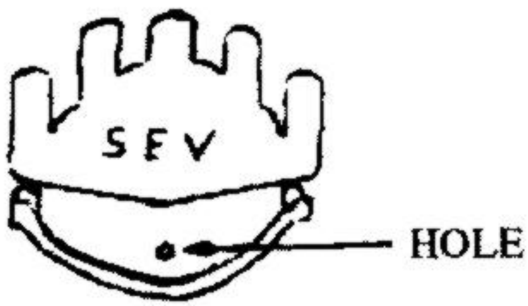
Always be sure to check that the carbon brush has not fallen out of the center of the cap.

(Caps usually fail because of fatigue of the plastic due to expansion and contraction of the metal terminals and weakness in the casting. Having a vent in the housing might do no good, as the moisture rises up inside the cap and is trapped. Bad wires or defective spark resistor plugs can aggravate the problem due to excessive resistance, giving cause for the spark to stray from its intended path. [MB])

Distributor cap for older cars replaced with Echlin EP164
Ken Butler, NM (Jul. 1984, p.22)

On the older D-models, try an Echlin EP164 Distributor cap the next time you need a change. They are the standard straight up type and rarely crack. (Crosses to Bosch 03151. [MB])

Distributor cap should have ventilation holes
Charles Fowler (Jul. 1983, p.5)



The figure above shows one of two tiny holes provided in the sides of original Citroën distributor caps for ventilation. Some replacement caps lack this feature and the resultant moisture buildup promotes rust. One of the Rendezvous convoy cars suffered a broken ignition points spring due to rust. Check the caps–drill the holes.

Distributor clamp with wing nut easier to adjust
Charles Fowler (Feb. 1984, p.5)

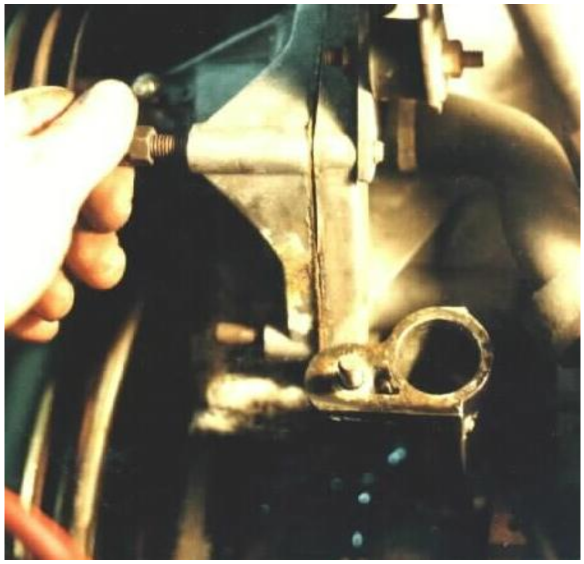
Replacing or setting points isn't so bad but that accursed nut tightening the distributor clamp is impossible to find. Here is a solution that I've been using for years. Remove distributor cap and rotate the engine until the rotor points to front of car. Remove low voltage wires and hold down bolt that is located below distributor toward front. Remove the distributor, pulling hard. Now you can see that the little "bugger" is a bolt and nut squeezing together the distributor clamp. Remove and take with you to the hardware store. Here you will need to buy a bolt of similar diameter: 10-24 x 3-1/2" long. Purchase a piece of steel pipe 2" long that will fit over the bolt and wing nut and flat washer to fit. Back home, push your new bolt through the clamp (bolt head is toward the engine). Place the pipe over the exposed end of bolt, then the flat washer, then the wing nut. Replace the distributor in car, rotor pointing forward and tighten hold down bolt. You will find that the wing nut is in easy reach for loosening to adjust distributor in place.

Distributor removal when frozen in position
Don James, OH (Feb. 1988, p.9)

A distributor that cannot be removed can probably be blamed on some well-intentioned mechanic who removed the distributor and wiped oil and grease from it and probably out of the hole, also. An aluminum distributor in an aluminum hole equals frozen parts. Be sure to use plenty of grease or oil on the distributor before you install it. Never Seize is better!

Removal of frozen distributors requires an acetylene torch for rapid heating of the housing around the hole and pry bars to lift the distributor out. When the housing gets to the right temperature, there will be a few seconds when the distributor can be pried out, but be quick since the aluminum transfers heat quickly.

Distributor removal with clamp preferred
Don James, OH (Feb. 1988, p. 9)



The distributor (except in some IDs) mounts in a hole near the water pump as shown here. A nut goes on the one stud that is sticking up next to the hole. Removal of this one nut will allow you to pull the distributor straight up and out of the car. This makes changing points easy!

There is a "D" drive at the bottom of the hole so that the distributor can only engage one way and the engine will be very close to the original timing if the clamp plate is not removed from the distributor, and if the weights are not removed from the advance mechanism.

Also shown is the use of the double-nut technique to remove a water pump mounting stud.

Distributor removal with clamp best
Ken Betsh, PA (Apr. 1995, p.14)

If there's a need to remove the entire distributor assembly, try to do it with the mounting clamp still attached. Remove the nut on the stud passing through the slot in the clamp (on the side toward the front of the car), take note where the stud is in respect to the range of slot and then just pull the entire distributor assembly straight up. You probably won't have to go through the timing operation if (1) you don't loosen the clamp after removing the distributor and (2) remount with the slot and stud in the same relative position.

Once the distributor is removed, check for lengthwise play due to wear of the bushings and washers. With the rotor and cap in place you can check that with the shaft pushed up as far as the play will allow, the shaft turns freely without a drag as the rotor passes the cap contacts. I shaved one original-type SEV with a rotor that was very slightly bent up at the end.

Before removing the keyed collar at the bottom of the center shaft of the distributor, note that it is offset. That way, the distributor can only be reinstalled in one correct position. However, once this keyed collar is removed from the shaft to which it is attached, it can be put back in either of two positions (of which only one is correct). Therefore, first make a sketch showing the relationship of the key offset to the notch for the rotor at the other end. The manuals do not show which position is correct.

When remounting the distributor, be sure the shaft is turned to the one position where the offset keyed bottom end will seat properly. If seated correctly, the clamp plate will fully drop over the stud and the rotor will turn just the limited amount noted before. Something's wrong if it is locked tight or turns very far.

Dwell adjustment with meter
Ken Betsh (2000 #4, p.16)

I still strongly recommend that every D-model owner carry a dwell meter for emergencies. Unfortunately, they're not so widely available since new cars have gone to non-adjustable, electronic-controlled ignition. While everyone frets about the difficulty of checking timing of the D-models, I have found that once properly set, there's no need to bother with a rod in the hole and/or timing lights unless the distributor is loosened or removed. As long as the points are readjusted for wear to maintain the original dwell, the timing remains the same. As the points wear, it causes a gradual reduction in dwell, meaning the points are closed less than the specified 57 of 90 degrees. The cam position where they close is delayed and the time where they open (where ignition occurs) is advanced. For this reason, it's not unusual to hear some or more pinging when an adjustment is needed. (For complete information is adjusting the timing using dwell and timing light, see Adjustment of ignition timing earlier in this chapter. [MB])

Ignition switch failure still allows light and gauges to work
Don James, OH (May, 1986, p.14)

A frequent ignition problem is a bad ignition switch. There are two circuits that are made when you turn on the key. One works gauges, lights, and charging system and the other works the ignition. It is possible to have your dash lights work and have it appear that the ignition is on, but have no ignition and no spark at the plugs. When this is the problem with the switch used from 1965 to 1970, drill out the rivets, open it and clean the little inside brass balls.

Starting in 1970, the switch was made differently with three circuits.

Ignition switch failure still allows lights and gauges to work
Ken Betsh, PA (Jan. 1999, p.9)

Finding a friend's trouble getting his '69 D-model to start lead to a replay of the same problem a long time ago with a '67 that used the same type ignition switch– the kind that used the same two-sided key operating the door locks.

The switch has two independent simultaneous-operating circuits. One feeds only the ignition coil and the other operates the lights, alternator field and controlled accessories. The side operating the coil fails preventing any spark while the warning lights go on and off as normal.

Don James wrote about this in the previous article and described how the switch can be repaired. It's necessary to drill out two small eyelets and have two 4-40 screws and nuts to replace them. There's two brass balls less than 1/2" OD that may have become pitted and corroded. The fixed contacts may also need cleaning. A word of caution, two very small compression springs behind the balls may pop out and disappear as you dismantle the switch. Opening slowly while holding it inside a small box with high sides may save your day.

It must be 25 years since my switch failure but both Polly and I remember the temporary fix. The ignition switch was next to the heater blower switch and both used the same kind of round push-on pin connectors. We simply moved the two ignition leads over to the heater switch. Turning on the "heater" to start the car in warm weather may seemed strange, but we were able to continue a long trip we had just started.

I dismantled that car over 20 years ago and put that switch plus a few other parts in a "can't use them on my current cars but who knows what" box. After temporarily fixing my friend's switch I took my old switch apart again and found whereas his had corroded and pitted balls and almost intact fixed contacts, my old switch had the opposite. I plan a merger and to again prove 1/2 + 1/2 = 1.

Make a sketch of wire positions when disconnecting the old switch. The color code markings are strange and hard to see. Reversing two of the four wires will keep a repaired or replacement switch from working and/or allow the accessories to operate from an unfused battery connection. There is no fuse in the line feeding the ignition coil.

The '70-'72 models using a can-opener-type key have three switched circuits with a separate circuit for the ignition coil. While the same failure mode is possible, I've never heard of it happening.

I always turn off the windshield wiper and heater fan, if in use, before turning off the ignition– not only because I won't want to restart the car with them operating. An electric motor causes an arc at the switch turning it off as the switch contacts separate. I'd rather have this arc wear the individual switches and not add to the ignition switch contact wear.

Missing stopped with new insulation between condenser tabs
Charles Fowler (Feb. 1990, p.3)

If your D-model misses intermittently and you have exhausted all other cures, try replacing the insulating gasket between the two tabs of the condenser. A good replacement can be made from a plastic coffee can lid.

Points cassette falsely accused, condenser is culprit
Ken Betsh, PA (Mar. 1999, p.7)

The final answer to problems with cassette-type points on my '71 DS as reported recently turned out to not be the points. Replacing the condenser with an old removed part stopped the occasional momentary loss of ignition that began again a short time after installing the SEV cassette. Measurements on the removed part showed a DC resistance path. While this resistance was very high, it could have shunted some of the spark voltage. The SEV cassette has been used now several thousand miles with no problems.

Rod in hole alternative: watch balloon at spark plug hole
Fred Nieuwenhuijs (Feb. 1996, p.9)

Putting a rod, screwdriver, or whatever through the spark plug hole to locate TDC (top dead center) can be hazardous to the health of the engine. Instead, I use a 1/2" outside diameter piece of rubber hose, e.g., a foot or more of fuel hose and tie a surgical (rubber) glove at one end. One could use a small balloon or even a condom. Stick the hose in the spark plug hole (#1 cylinder) and turn over the engine by hand. When the glove/balloon is fully blown up, you're very close to TDC.

I jack up one front wheel of a Citroën, set the gear in the highest position and turn the front wheel by hand while watching the glove/balloon inflate. Totally harmless!

Rod in hole alternative: watch rod in spark-plug hole
Barton Milligan, Bahamas (Jun. 1995, p.9)

An alternative method of locating TDC (top dead center) is to remove the spark plug from cylinder #1 and put something into the cylinder that is long enough that it won't fall in when the piston is at the bottom of its travel and watch it as one turns the crank. I use a speed wrench handle because the movement of the horizontal portion is easy to follow. It is necessary to be sure that the piston is at the top of the compression stroke and not the exhaust stroke when using this method. Remove the cap from the distributor. At the top of the cylinder #1 compression stroke the rotor is at "one o'clock" as one views it from the side of the car. This method is probably not as precise as using the official method, as above, but is surely as precise as one can set the position of the distributor.

I strongly recommend that, having gone to the trouble of locating #1 TDC, the Citroën owner should make a paint mark on the main pulley that drives the alternator and high pressure pump opposite some convenient reference point. In my experience, the mark will last more than ten years and serve to make subsequent tuneups and timing checks with a timing light easy. In addition, the operation of the centrifugal advance can be easily checked. I made a reference scale marked off in degrees that I hung from the bottom bolt of the air pump bracket about twenty years ago, but I'm not sure it was worth the effort.

Spark loss while driving may be due to loose connectors
Dave Root, FL (Jun. 1980, p.3)

I have lost spark a number of times while driving because wire connectors around the coil lose their tension and electrical contact. My remedy is to disconnect the connectors, clean them and restore the spring tension by squeezing the terminals with pliers before putting them back on.

Spark plug insulators replaced with Mopar 1479232
Ken Butler, NM (Jul. 1984, p.22 & Feb. 1987, p.8-combined)

A set of four Mopar # 1479232 insulators as used on Chrysler hemi-head engines solved a shorting problem in the spark plug wells after a Delta Mark 10 ignition was installed. Ream or file the original Citroen insulators used at the top of the tube to fit the small end of the insulators, to provide support at the top. Discard the metal plug extensions, thread a new set of wires through the insulators. They now snap directly on to the spark plugs and cover nearly all of them. (Very costly nowadays. [MB])

Spark plug overtightening strips threads in head
Mark Levinson, MD (Jan. 1983, p.5)

I managed to over-tighten the spark plugs in my '70 D-Special to the point of stripping the threads of one of the holes in the head. I caution other members to be sure the threads are clean, and to use care when installing new plugs. Heads are made of aluminum and the deep wells make a trap for dirt to fall into the threads. I've removed the head and am making good progress in getting a Helicoil installed in the hole. I will check for worn lifters and valve gear while the head is off. (Helicoils can easily be installed with the head in place. [MB])

Spark plug removal and installation
Champion Information (Feb. 1993, p.11)

When tuning any engine, some consideration should be given to the removal of the used plugs. After the normal service life of a spark plug, you may find one or more of the plugs a little difficult to loosen. Allowing the engine ample cool-down time will facilitate plug removal. The use of a penetrating oil is recommended if the plug appears to be overly tight. Place a socket wrench over the plug and apply steady pressure until the plug breaks loose.

Usually when this occurs, dirt that has collected around the plug during service will also break loose. Before removing the plug completely, blow or brush this residue out of the port area. This will prevent it from falling into the combustion chamber when you remove the plug.

If the spark plug appeared to be overly snug when removed by hand, it may be because of carbon and other material that have collected in the threaded area of the cylinder head. This condition may be more prominent in older engines. The threads should be cleaned with a thread chaser. Not only will this make plug installation and removal easier, but it will provide for better contact between the spark plug shell and the cylinder head, thus improving the ability of the plug to dissipate heat. Last, but not least, wipe the plug port seat clean with a clean, dry cloth. This will assure a good, sound seating of the spark plug.

Before installing the new plug, be sure to check the electrode gap and set it to the specifications recommended by your particular engine manufacturer. Spark plugs preset at the factory may not be set at the gap specified for your engine.

Install the spark plug by hand until finger tight and place a socket wrench over it. If a gasket type plug is installed, it will require about 1/4 turn to affect a gas-tight seal. Tapered seat spark plugs do not use gaskets and due to the metal-to-metal contact only about 1/16 turn (snug from finger tight) is required for correct torque.

Use the following Champion torque recommendations as a guide for tightening the spark plug. Torque wrenches are not widely used when installing spark plugs. It may, however, prove to be advantageous to use one a few times on an easy to reach spark plug to determine how much movement is required or how far the wrench must be turned to reach the torque recommendations. A habit for correctly tightening spark plugs can then be developed for use with a standard socket wrench.

Proper installation of the spark plug will provide many miles of trouble-free service. It will also facilitate easier removal during the next tune-up. By following the simple guidelines we have suggested here, you should be able to develop a procedure for handling spark plugs that you and others will come to appreciate again and again.

SPARK PLUG RECOMMENDED INSTALLATION TORQUES

THREAD SIZE	CAST IRON HEADS		ALUMINUM HEADS	
	w/Torque Wrench	w/oTorque Wrench	w/Torque Wrench	w/oTorque Wrench
Gasket type				
10 mm	8-12 lb.ft.	1/4 Turn	8-12 lb.ft.	1/4 Turn
12 mm	10-18 lb.ft.	1/4 Turn	10-18 lb.ft.	1/4 Turn
14 mm	26-30 lb.ft.	1/4 to 3/8 Turn	18-22*lb.ft.	1/4 Turn
18 mm	32-38 lb.ft.	1/4 Turn	28-34 lb.ft.	1/4 Turn
Tapered seat				
14 mm	10-20 lb.ft.	1/16 Turn (Snug)	10-20 lb.ft.	1/16 Turn (Snug)
18 mm	15-20 lb.ft.	1/16 Turn (Snug)	15-20 lb.ft.	1/16 Turn (Snug)

* Mazda Rotary Engine requires only 8-13 lb.ft. (1/4 turn)

Editor: D-model engines require 14 mm spark plug threads. Citroen specifies 15 lb.ft. installation torque limit.

Spark plug threads lubricated with powdered graphite
Don James, OH (Jan. 1983, p.5)

It is a good idea to lubricate the threads on spark plugs before you install them. Powdered graphite is the best lube to use for this because it will not get gooey from heat.

Spark plug wire characteristics, resistance types
Paul Fontaine (Mar. 1984, p.20)

> 7 mm, 28 gage tinned steel wire with wire wound resistor over ceramic core located in spark plug connector: good quality wire.

7 mm spiral wound metallic conductor around a ferro-magnetic core. This is the type original ignition wire on late D-models, generally considered to be the best type of wire.

7 mm carbon core, carbon impregnated fiberglass with hypalon jacket. The lowest grade of suppression wire, not recommended.

7 mm aramid-fiber core carbon impregnated with hypalon jacket. Strongest suppression core available, good quality.

It is difficult to determine the type of ignition cable in off the shelf replacement ignition sets. The writer checked the resistance of two sets of ignition from local supply stores. K-mart set KM3254 had half the resistance of Corbra IM545.

Heat attacks the outer jacket causing breakdown of shell allowing moisture and oil to perpetrate and short circuit the high tension voltage–causing misfires and hard starting. Vibration will eventually break the continuity of the carbon core causing the same problems as above.

Spark plug wire kit for Toyota Corolla 1600 adapts to fit
Ariel Robinson, WV (Jul. 1982, p.5)

A nice replacement spark plug wire set for D-model Citroens was shown at a recent Rendezvous. It is for early to mid-'70's Toyota Corolla 1600's. The wires have long, hard plastic tin extenders that clamp directly to the spark tip. They come with covers for the spark plug wells. However, cement a rubber o-ring near the base of these covers to make a better protective seal. The length of the wires will probably have to be shortened. The set is usually available in discount auto stores for under $10. The set looks quite good and the addition of the rubber o-rings is a good idea as it virtually guarantees that water and/or oil will not enter the spark plug wells.

Spark plug wire kit for Toyota Corolla 2TC ('71-'81) fits
Paul Fontaine (Mar. 1984, p.19)

Four kits of spark plug wires for 1971-81 Toyota Corolla 2TC engines that can be modified for use with D-model engines are:

Corbra #IM545; Corbraline Mfg Co; Westbury, NY

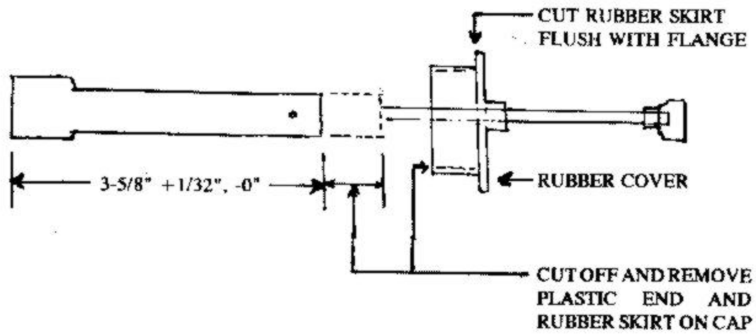
K-Mart #KM 3254

Autowise Belden #700179 / 1RS/350

IAPCO #C301b.

(Belden might still be available through NAPA stores. [MB])

The modifications are shown here:



Spark plug wire replacement cut longer, eliminates extensions
Dave Paulin (Jan. 1978, p.2)

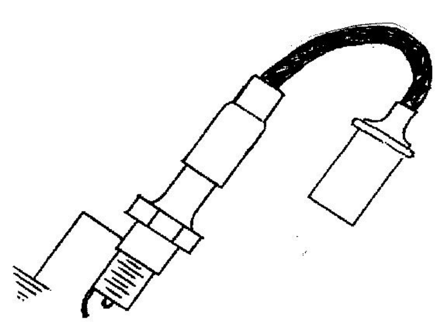
One of the nasty little winter problems of Citroen maintenance is the tendency for the original equipment spark plug wires to become very stiff and brittle in the average cold of Ohio. You can obtain good quality wire from an auto supply store and make your own for as little as $4.50 for the set. Make them about 4" longer than the originals and, using a pair of angled needle-nose pliers, connect directly to spark plugs, thereby eliminating the extensions which constantly come loose at the worst times.

Spark plugs, Bosch WR7BP with platinum tip

Ken Butler, NM (Feb. 1987, p.8 & Feb. 1988, p.9-combined)

A set of Bosch platinum tipped spark plugs WR7BP work well in my '68 ID and '70 DS.

Test system with old spark plug and lead
Don James, OH (Aug. 1985, p.15)



Here a very simple tool can be made to quickly check for spark. Many times, enthusiasts are faced with the problem of an engine that has cut-out and won't run. An old spark plug lead and an old plug can be easily carried in your tool box or glove box. Set the gap on the old plug at 1/4". To test for spark, just pull out the coil wire and plug in the tester. With the ignition on, you should see a strong spark when the engine is cranked. Be sure the spark plug body touches the engine or car frame.

Timing marker simplifies distributor adjustment
Charles Fowler (Feb. 1984, p.5)

One of life's little irritants is the ignition timing on a D-model. Late models have timing marks on the camshaft pulley and a block mounted scale, which allows use of a timing light. Earlier models are supposed to be static timed via a rod inserted through a hole in the block located below the alternator mounting bracket. Of course, this requires one person to rotate the engine with the crank while another pokes about for the hole, feeling for the matching detent in the flywheel. Somehow, my wife doesn't visualize herself as either of these people.

A timing marker can be easily fabricated out of scrap sheet metal using snips. Simply cut a piece of the heaviest sheet your snips will handle 1/2" wide and 6" long. Make a point on one end and bend that end to a right angle 1/2" back of the point. Sit the right angle on top of the camshaft pulley with the other end in line with the nut and stud holding the block mounting for the alternator bracket. Raise the pointer 1/2" off the pulley and mark for a hole matching the stud. Drill appropriate size hole. Remove nut and bracket and place your pointer over the stud. Replace bracket and nut tightening so that pointer is directly over top of pulley.

Remove number one spark plug and insert dowel or rod onto top of piston. Turn engine with crank until piston is at top of stroke. To be sure this is the power stroke, check distributor and ensure that the rotor is pointing toward the water pump or right headlight. With a small brush or toothpick and some yellow or white paint, draw a line across both sheaves of the pulley. Draw several more lines about 1/4" apart along the pulley toward the left fender.

Allow the paint to dry before you start the engine and bring to operating temperature. Use your timing light to determine the current ignition timing. If your car is running satisfactorily now, you can shut down and mark the current ignition timing point across the pulley to use as baseline for future tuneups.

Tune-up procedure outlined at 1995 Rendezvous by David Burnham
Ken Betch, PA (Apr. 1995, p.10)

One of the highlights of the 1995 Rendezvous East at Northfield Mountain was the D-model tune-up clinic conducted by Dave Burnham. Michael Cox's '71 DS-21 was used to demonstrate some of the tests and adjustments–a good choice since Dave had never worked on the car and Michael hadn't checked the ignition for quite a while.

Dave's first step was to remove a spark plug and examine its spark gap. His first warning was to not remove plugs when the engine is hot–too much danger of stripping the threads in the aluminum head. Light gray deposits around the plug gap is normal–black deposits indicate an excessively rich carburetor mixture and/or poor ignition. Spark gap of the plugs should be checked and adjusted if necessary to .025" inches.

If Dave is not familiar with the car he will want to measure the compression of each cylinder as he removes the spark plugs. The best tune-up won't make an engine with widely different compression pressures run smooth. This is measured with a gauge screwed into the spark plug hole and the engine turned on the starter (ignition disconnected). Whitney sells an adequate gauge with necessary extension hose to reach the spark plug opening for about $15. Theoretically one would measure 8.75 times 14.7 or slightly under 130 psi.

Dave worries less about the actual reading than any differences between cylinders. A cylinder with a bad piston ring or valve seal may read less than 100. I always repeat a test where the reading is below normal.

Dave finds little difference between the correct plugs from the various manufacturers. I generally use Champion L87YC (now #312) because if left in too long, they first start missing at low rpm--a problem I can live with until they can be replaced. My limited experience with Bosch is that they first miss at high rpm and high road speed. Dave applies a small amount of Never-Seize compound to the plug threads before installing. He recommends we owner-mechanics use a torque wrench to tighten new spark plugs. It's a must when reinstalling plugs with a flattened compression seal washer.

The fiber tubes originally fitted over the plugs may prevent misfiring in wet weather. Tubes burnt on one end should be turned end-to-end or replaced. Oil around the outside of plugs when removed indicate o-rings under the head cover are no longer sealing the top of the metal tubes surrounding the plugs.

The last step regarding the plugs is to check the wires to the distributor. The original red wires are wound with a fine resistance wire to control radio and other electronic interference. The brass end fittings are crimped with the resistance wire wrapped over the end of the wire insulator. Poor contact under the crimp may develop when the insulation gets hard and possibly shrinks with age. The best check of wire resistance is with an ohmmeter while the end pieces are lightly flexed. In reconnecting the original wires, check for a double click sound or feel indicating a tight fit. If you lost track, the wire to the spark plug for cylinder #1 (front of the engine) goes to the cap connection nearest the rotor when the rotor points to about the 10 o'clock position (as viewed from the left side of the car). The clockwise sequence at the distributor is cylinders 1, 3, 4 and 2.

The next step is to check the points and distributor. First, however, I prefer to drive the car for enough time to be sure I haven't accidentally caused a new problem. Also, I'll know where to credit any improved performance.

The distributor cap can be inspected without removing the connecting wires. Release two spring steel retainer clips to remove the cap. Be careful with the clips–they'll break if stressed too much. A cap that is cracked or with severely burned contacts should be replaced. Such burning may mean a new rotor is in order. Otherwise a cleaning of the contacts and rotor tip may suffice. Actually these are non-touching electrical contacts. There is a very small clearance in the firing position and a small arc completes the circuit. Excessive burning opens the contact distance to the point where the arc at the spark plug is decreased.

Be sure to firmly seat the rotor when replacing it. It has a location key and will only fit properly in one position. The presence of brass dust inside the distributor indicates the rotor was not fully seated and scraped the distributor cap contacts. Actually the shaft onto which the rotor is attached has a small amount of play (that increases with wear) that allows the rotor to lift slightly as it turns at a high speed. Removing a distributor to check for this and/or remove brass dust (which must be done) will be described later.

Check that even when properly in place, the rotor can be turned clockwise about 10 degrees and that springs return it against a hard counter-clockwise stop. In operation, the rotor turns clockwise and the springs and small weights allow centrifugal force to advance the timing at higher engine speeds. Occasionally lubricate the advance mechanism when the rotor is off with a few drops of light oil inside the top center of the rotor shaft.

Dave always uses a dwell meter to check and adjust the points (and so do I). If the points are correctly adjusted, the meter will indicate they are closed 59 out of a full cycle of 90 degrees. Citroen's adjustment tolerance is 2 degrees. Check the dwell meter to read 90 degrees with the engine stopped and the points closed. The alternative is to use a feeler gauge to set the points for a maximum open clearance of .016 inches. Access to measure clearance on cassette points is almost impossible. Whitney sells a dwell meter (called an engine analyzer) for about $37.

Because adjusting the points changes both the dwell and the timing (for which there is a separate adjustment), it is vital to first accurately adjust the dwell. Two wear factors affect dwell. Friction and a minute amount of arcing at the surface of the points will cause the gap to increase and, as a result, the dwell will decrease. The point assembly has a block that rides on the four-lobe cam of the distributor shaft. As this block wears the part of the cycle the contacts remain closed increases and, as a result, the dwell increases. I check the dwell every 6000 miles and readjust as needed. I know from experience that if the dwell gets down to 40 degrees with no separate timing adjustment, the engine pings a lot and will have lost a lot of power.

Dave recommends a light coating of high-temperature lubricant between the block and the shaft. Don't use conventional grease–it can be flung onto the points when hot. I generally get over 20,000 miles of life to a set of points (even more with the cassette type). If points burn in a few thousand miles and leave black deposits nearby, the condenser is either defective or the wrong type.

Even though it is mounted on the distributor, the condenser must be electrically mated to the ignition coil. D-models used two types of coils. The type before 1970 requires a condenser with a nominal electrical capacity of 0.225 microfarads (0.18 to 0.27 limits) and the coil with an external resistor used after 1969 requires a nominal 0.275 microfarad condenser (0.25 to 0.30 limits).

Be sure a replacement condenser for a non-cassette type distributor is the correct type. If in doubt ask your radio-TV serviceman to measure it (he'll call it a capacitor). The only type made for the cassette-type distributor is for use with the coil with an external resistor. If a cassette-type distributor is installed on a pre-70 car, the coil must be changed. Otherwise, the points cassette will have a very short life. Condensers don't wear out from use and need not be replaced as often as points. A condenser with a loose center terminal or cracked insulation around the terminal should be replaced before moisture gets inside.

Speaking of the cassette type, the dwell can be adjusted with the distributor assembled and engine running if there is a small hole in the plastic mounting such that an allen wrench can be inserted into the end of the knurled adjustment screw. I've added such a hole after the idea was shown to me by Red Dellinger.

The standard method of adjusting timing is to use the crank to turn the engine to the point where the piston of cylinder #1 is the ideal position for idle speed firing and to rotate the entire distributor assembly so the points have just opened. The "good news" is the neat means Citroën provides to set this engine position. A 6 mm (15/64") pin is placed in a hole perpendicular to the outer edge of the engine flywheel. The engine is turned with the crank (NOT THE STARTER) until the pin drops into a slot. The "bad news" is that the hole is in an almost impossible location under and behind the alternator. You might be able to see the hole by looking between the alternator and the battery in a stooped position and with the aid of a "hose" light (see separate note). Remove the pin as soon as you have found the correct position. Don't walk away from the car with the pin in place. Anyone attempting to start the car with the pin in place could make the worst possible Citroën mistake.

The means of adjusting the ignition timing is by rotating the entire distributor assembly. It is held in place with a flat compression clamp that grips the distributor in the narrow portion under the area where the points are mounted. This clamp is held to the engine with a single stud and nut toward the front of the car (easy to find and reach if no anti-pollution air pump). The clamp has a slot for this stud to allow a limited range of adjustment. Loosening a single screw and nut on the side of the clamp towards the back of the car allows the distributor to be turned over a wide range. If I loosen the clamp this way, I tighten the nut over the slot so that I'll have an adjustment range in both directions when I'm done.

Finding the point where the points just open can be done by (1) disconnecting the wire from the junction of the points and condenser on the distributor that goes to the ignition coil and (2) connecting the dwell meter or a test light between the hot battery terminal and the point on the distributor where the wire was disconnected. At the moment where the points just open, the meter will go from 90 degrees to zero or the light will go out. Be sure the rotor is against its counter-clockwise stop and that you are turning the distributor clockwise when finding the correct spot (to prevent error caused by the centrifugal advance). Tighten the distributor clamp and remove the meter or test light. If it's still in the hard-to-find hole, remove the locator pin before reconnecting the distributor-to-coil wire.

Fortunately this difficult timing adjustment is rarely needed–as long as the distributor clamp never becomes loose and the dwell has been adjusted exactly to what it was when the timing was previously adjusted (this is why a dwell meter is desired). Because this process is even more difficult in a car with an air pump or even just the massive bracket to which it is mounted, Citroën added an indicator marker to allow electronic strobe adjustment. Dave didn't go into this and it's too long a story to add at this time.

Returning to Michael Cox's DS' his spark plugs looked good, the dwell was very low, idling speed increased a lot as the dwell was reset and we all gave up on finding the place for the pin. Last, but not least, he and Cherise got home OK.

Chapter 20–Lubrication

Front end greasing, molybdenum disulfide recommended
James O'Gara (Dec. 1988, p.4)

One of the most commonly neglected areas on the D-model is front-end lubrication. Most enthusiasts know that there are fittings that need to be tended to, but the commonly available manuals are simply too vague about how to get to all of them. On most D-models there are eight zerk fittings on each side. Each and every one of these fittings must be reached in order to ensure the maximum in longevity and performance.

To lubricate your D-model, first have at the ready a standard grease gun (a flex hose or an angle fitting on the end make life much easier). The choice of grease is deeply personal for most shade-tree mechanics, but choose one brand and stick with it. Not all greases are mutually compatible. Molybdenum disulfide grease (MoSO2) has excellent all-around characteristics and is well worth the extra fifty cents per tube.

Collect your jacking strut, some rags and a standard mechanic's floor jack. Remove both hubcaps and lightly loosen the bolts. Start the car with the height in the next-to-highest position. Attach the jacking strut, shut the car off, and place the height selector in the low position. Unbolt and remove one of the front wheels and wheel the floor jack into position under the lower-front transverse arm (the lower-front transverse arm is the thick metal arm that connects the suspension to the lower ball joint; it is shaped like a half wishbone). Pump up the jack until the car has been raised up high enough to take the pressure off the jacking strut. (I am going to add this note twice, as I think it is of dire importance that owners of cars with hydropneumatic suspension MUST NEVER TRUST their suspension systems to hold the car up for servicing. ALWAYS use jack stands or other devices to hold the car firmly and stably at working height! Several owners have been severely injured, a few killed by falling cars. [MB])

By this time you are wondering if it is even worth the trouble to proceed. You may be having vaguely suppressed thoughts about only doing the driver's side and maybe leaving the passenger's side for the spring. Do not yield to such temptation. A Citroën should be lubricated every 3000 miles. If you do not follow the manufacturer's recommendation, you may be faced with prematurely worn outboard CV joints, bad ball joints, or even creaky worn out anti-roll bar bushings.

Remove the rubber plugs which grace the inside fender well and the one identical plug which is found on the bottom of the car by the corner of the rocker panel and the edge of the fender well. Have an assistant start the car and put it in regular driving position. Once the car has stabilized reach your index finger into the uppermost of the two unplugged holes and try to locate the zerk fitting. This can take some doing at first. If you are not successful, withdraw your finger and have your assistant raise the car incrementally until the zerk slides into finger range. Once you can feel it you may still have to do some fine tuning with the height control knob inasmuch as your index finger is a more dexterous implement than the most flexible grease gun.

It is important to realize that as the car rises the internal suspension parts are moving relative to the lube hole–in a way which can be unpleasant to exposed bodily appendages, index fingers included. So remember to withdraw yours when the time comes to tell your assistant to raise the car up a notch!

Next wipe off the zerk as best you can. You do not want to inject all of the grime that is sitting on the zerk into the joint. Put the grease gun on the zerk. Give a few quick squeezes. Wrench it free. And voila, you have done the most difficult of the eight zerks. The remaining seven should only take a few minutes.

Just to spell things out, you still have a zerk on the bottom of the car (also on the anti-roll bar). There is the other zerk on the fender well. There is a fitting on the drive shaft, which I always grease liberally (5-7 squeezes). (Do not do this. Only a small amount of grease is needed, as this fitting does not service the outer CV joint, it only greases the central pivot within the outer joint assembly. Use too much and you will find grease sprayed all over inside your wheel, a horrible mess! I can personally attest to this. [MB])

And there are four fittings on the ball and steering joints. These must be dealt with carefully. Too much grease will cause the rubber covers to distend. When that happens the grease does not stay in, and the water does not stay out. So stop pumping when you just begin to see the joint bulge with grease. With the two small ones that usually means 1-2 pumps. For the larger joints, 2-3 pumps are usually needed before you get into the danger zone.

If you see grease emerging from the fitting at the same time as you begin to pump, then something is wrong. Somebody in the past has put in too much grease at one time, and the rubber cover has been blown off of its retaining ring. What to do? First clean out all the grease near the joint. Pull the rubber cover off somewhat to expose a little of the joint. Find and clean the wire circlip, which has come loose from the cover and is usually found hiding underneath. Locate the tab on the rubber cover (note that some cars have none). Hold onto the tab with needle-nose pliers with one hand, holding the cover in place. With hands two and three, slip the circlip into position. Then grease and go.

Next put the wheel back on, start the car, put it in next-to-highest position, remove the jack strut, and slowly let down the jack. Apply final tightening torque of 65 ft/lbs to the wheel. Replace the hubcap.

Don't you feel better knowing that you won't have to do that again for a while? Don't forget the other side! (I am going to add this note twice, as I think it is of dire importance that owners of cars with hydropneumatic suspension MUST NEVER TRUST their suspension systems to hold the car up for servicing. ALWAYS use jack stands or other devices to hold the car firmly and stably at working height! Several owners have been severely injured, a few killed by falling cars. [MB])

Front end greasing procedure
Ken Betsh, PA (Jun. 1999, p.5)

I try to follow Citroen's recommendations for the 1965 and later D-models to add grease to all the front suspension grease fittings every 3000 or so miles. I do it myself at the same time I change the engine oil. I use a hand-operated gun that takes the standard grease cartridges that are about nine inches long and about 2 inches in diameter. Mine has a rubber output hose about 12 inches long–a vital option needed to reach some difficult spots.

Citroën discouraged the use of high-pressure, compressed air guns for fear of blowing out seals or boots. Watching and controlling the inserting of grease may be important to long-term reliability.

There are either 6 or 8 fittings for grease on each side either on or near the front wheel assembly. While all of them are accessible by reaching around the wheel, I remove the wheel at least every other time. This allows me to check the boots covering the some of the joints being greased and better measure the amount of grease being added.

Perhaps the most important two fittings on each side are on the upper and lower main ball joints. These joints are covered with boots that flex with up and down movement of the wheel. Old grease works it way out around the edges of the boots and needs replacement. I put in enough grease to gently expand the boot until the small end reaches the arm to which the ball-joint is bolted. Sometimes this will be one stroke of the grease gun and sometimes it will be three or four. If I find a lot of grease has come or is coming out the larger end of the boot, I usually find it's not properly seated, a retainer clip is missing or broken, or, rarely, there's a tear in the boot.

The only time grease comes out around the grease fitting is when the hose on the gun is not being held at the correct angle. What I'm doing must be OK since I haven't had to replace a ball-joint in a very long time.

The driveshaft has a grease fitting about half-way between the inner and outer joints. However, grease inserted here all goes to the outer joint where old grease works its way out under a boot. For many, many years I've been putting six stokes of grease into each fitting. Brad Nauss recently verified the Citroën factory directed dealers to use this amount. I will admit to a small build-up of old grease inside the wheel rims–but I've never had a outer universal joint fail. (Only use a very small amount; see the last article. [MB])

The tie-rods that connect the lower side of the steering relays to the wheel assemblies on my '71 D-model have grease fittings at both ends while those on my '72 do not. An earlier ID of mine came from the factory with these joints drilled and tapped for grease fittings but with metal plugs screwed into these holes. I replaced these plugs with fittings.

The tie-rod ball-joints also have boots. I insert just enough grease to keep these boots somewhat inflated. This generally requires two-thirds to one full stroke of the gun.

The last three fittings on each side lubricate the anti-roll bar and its connecting links. Two are behind large rubber plug buttons on the vertical metal pan behind the front wheel and behind the driveshaft. The remaining one is on the bottom of the car immediately behind the front wheel opening above an identical rubber plug-button. These plug-buttons can be easily pried out of holes large enough to insert the end of my grease gun hose and the plug-buttons can be put back in place afterwards. The first time I greased a newly-acquired D-model, I removed the front fenders and metal pans to see the condition of the joints and determine how much grease to put in. One some cars I've found one or more of these fittings turned so that I would never be able to add grease through the access holes.

Of these three, the fitting closest to the front feeds the center of a rather large bearing in which the anti-roll bar rotates. Both ends of the bearing are open allowing excess grease to freely exit. Almost no resistance is felt when adding grease. I put in one full stroke of the gun.

The last two fittings, the one closest to the rear under the fender and the one reached from underneath are on small ball-joints at the ends of a connecting link between the suspension and the roll-bar. The entire link moves down as the car goes up. The fittings only line up with the access holes when the car is in the highest position (the fitting for the roll-bar described in the previous paragraph does not move with the height of the car). These ball-joints have a very small gap to release excess grease. There's considerable resistance to adding grease. I put about a half-stroke slowly into each fitting.

None of these grease fittings reach the main large bearings supporting the front wheels. These bearings are in a sealed area. The only problem I've had with these is one that became quite noisy after the engine compartment was steam-cleaned by someone without supervision.

The inner CV (constant velocity) driveshaft joint is separately lubricated with grease retained by a boot. I periodically check for defects that would allow the grease to be thrown out.

There's a spot in the rear on each side that I occasionally add or change grease. But that's another story. When buying a grease cartridge, I go for the highest quality since it's only a matter of pennies for something that lasts a long time.

(Once again I am going to add this note as I think it is of dire importance that owners of cars with hydropneumatic suspension MUST NEVER TRUST their suspension systems to hold the car up for servicing. ALWAYS use jack stands or other devices to hold the car firmly and stably at working height! Several owners have been severely injured, a few killed by falling cars. [MB])

Rear end ball joint needs periodic greasing
Ken Betsh (2000 #1, p.13)

One place on each side of the rear that needs occasional greasing is the ball joint by which the hydraulic suspension strut lifts the car. While a prudent mechanic or knowledgeable do-it-yourselfer will clean and re-grease this joint whenever a suspension boot is replaced, this may not be as often as needed. Citroën recommended changing transmission fluid every 12,000 miles and that may be a good distance for re-greasing the rear ball joints.

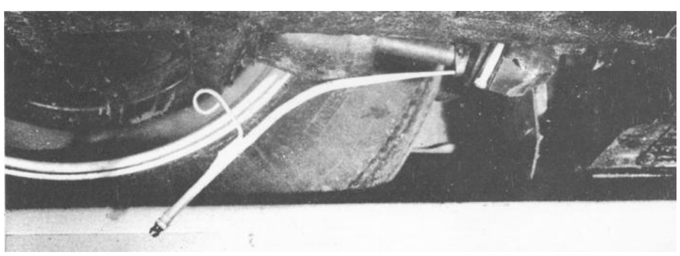
If a cracking sound comes from this area as the rear lifts up, there's a good chance the ball is dry of lubrication causing friction that has damaged the mating surface of strut. It will have worn in the area of contact when the car is at the driving height, leaving a ridge between that point and the point when the car is "on its haunches".

There is no grease fitting for this ball. I lubricate it with a small adapter made to fit my grease gun. I start with the smallest replacement grease fitting I can find (it's been so long ago I don't remember if I bought it or removed it from an old Citroën front-end part). I stretch a 2-inch length of windshield-washer hose over the threaded part of the grease fitting and attach an improvised clamp. This hose is 1/4-inch diameter. I then push a 2-inch length of 1/8-inch diameter plastic tubing into the other end. Mine fits so tight that no clamp is needed. To grease the ball I attach the adapter to my grease gun and slide the end of the 1/8-inch tubing between the end of the strut next to the ball and the rubber boot that surrounds it. I do not dismantle the joint. About one or two strokes of the grease gun seems to be adequate.

An exception would be if the joint has been dismantled for replacing a boot. Then I just put enough grease with my finger to surround the ball and then after it is assembled with the boot, add several strokes with the adapter.

Again, the only claim I will make for my technique is that it works. I haven't replaced a worn strut in many, many years.

(A Citroen maintenance service bulletin addresses this issue in a similar way. Their tool is basically a piece of steel tubing with a Zerk fitting threaded into one end and the other flattened slightly. The tube has a slight curve. They brazed a fancy curled handle on it which I considered unneeded. Here it is: [MB])



Chapter 21–Prevention

Camshaft pulley causes troubles
Don James, OH (Dec. 1983, p.13)

It seems that Dick Unnuh was on a short trip when the pulley on the end of the camshaft that drives all of the engine accessories stripped the spline after working loose. The nearest place to have repairs done was Longshore Automotive in Carson City. It cost $56 for a new pulley and $475 for labor to install it. Dick was not permitted to watch the operation that supposedly took 14 hours labor to install.

Steve Varso reports the same problem was causing loss of hydraulic pressure and overheating because the belts were not being driven. Loss of brakes and no power-steering forced a tow home aid cost him $80. He wants us to warn others.

Most of our readers will remember us mentioning this happening to Robert Kast and Vic Hedl on their trip out west. Just goes to show–if you read about it in this book it can happen to you. We suggest checking the pulley before leaving on any trip, and if the pulley is removed while working on the car, be sure that it is tight when you reinstall it. Loctite on the spline to prevent working loose will help. Your editor has even had the rivets work loose on the pulley hub.

New owner advice
Jack E. Davis, NM (Oct. 1987, p.27)

The comments below are meant for the new, or about to be new, owner of a D-series Citroen. I've been addicted to Citroëns for about 2 years–really more as I had a 11B in 1960 while living in Venezuela. I bought a '69 DS21 a couple of years ago, and since then I have acquired a '66 DS21M and a '66 ID21F. I recently sold the '69, so I'm down to only two Citroëns. What I'm trying to say is: they grow on you!

There is a good chance your spouse will not have the same addiction to your Citroën, especially if it stops a few times while she is driving and more so if it spews oil on the road. These minor problems will be ignored by a really hooked Citroën owner.

What is so intriguing about the Citroëns is the ride, handling, and mechanics. We recently bought a 1981 Buick Skylark, a wife car. The ride is very good, but I don't think it compares with the Citroën. And if it breaks down, I'll probably have to take it to GM dealer for repairs–too many electronics.

Rust is a Citroen problem like many other cars. Don't let rust turn you away from buying a Citroën. Unless it is a basket case, a Citroen can be repaired as good as new and should last indefinitely. It is a great help if you can do the work yourself.

Owning a Citroën can be a problem if you are not mechanically inclined, or if you do not have a good friend who is, or if you cannot afford to have it repaired by a competent mechanic, if available.

Many people shy away from brake fluid Citroëns as they do not hold up as well as the mineral fluid models. Living in a relative dry climate like I do does not present the same problems as someone living in m more humid climate. Brake fluid is hygroscopic, which means it attracts water, which causes rust and does not lubricate well. Depending on location, owners of Citroens with brake fluid should replace the fluid at yearly intervals at least. Some replace brake fluid with silicone brake fluid, which has superior qualities but is more expensive. A more practical thing to do is to move to Silver City, New Mexico like I did. The bottom line is, a brake fluid model is not all that bad.

If you can, it's not a bad idea to own at least two of the same year and vintage. Sure makes it easier to keep at least one running at all times. This makes sense if you consider what it costs to buy one new car.

The Citroën has superb ride and handling qualities. Coming back from a car show in Alamogordo recently, I thought that I had encountered a rough area of the road. I hadn't. What I had was a left front tire that was about to blow and did. Then and there the Citroen proved it's handling abilities! The moral to this is if your Citroën is riding rough, you had better stop and check those tires. After changing to the spare, I was back riding on air again.

A Citroën, like any other car, will at some time need parts. Don't shy away from buying a Citroën because of a fear of lack of parts; there are many businesses selling parts.

Lastly, I would advise you to join one of the many Citroën car clubs–as a source of information and friendship.

New owner advice check it out first
Jack E. Davis, NM (Jan. 1990, p.6)

If you are about to acquire a D-series Citroën or already have, please read what problems I have had and what I did to correct them. By looking ahead and doing some preventive maintenance you can make owning a Citroën a very pleasurable experience instead of a hassle.

Remember that you have purchased a 15 to 20 year old car and no matter what the previous owner has told you, this car will have some parts or areas that need attention. The first thing you should acquire is a repair manual. I received one with the first Citroen I bought and don't think I could have made it without the manual. You will find that Citroens are different, but nice if they are feeling right, like the female gender.

One weak and very unsafe part is the brass inlet tube attached to the carburetor. This can work loose and will allow gasoline to spray onto the hot engine; you can imagine the results. I remove the tube and reinstall it with a coating of steel epoxy glue. This has worked well for me. What ever you do, MAKE SURE THAT TUBE STAYS PUT!

Another very important item is the proper installation of the oil filter. This can be done incorrectly which will result in the loss of oil pressure. This is why you want a good service manual–one that describes the proper method of oil filter installation. The older Citroens didn't have a low oil pressure warning light, which means you really don't know if you have any oil pressure or not. Several years ago I purchased a Citroën many miles from home. On the way home the engine locked up. You guessed it, the oil filter had not been installed properly. I had to tow the Citroen home, then remove the engine and replace the crankshaft. Not a lot of fun.

Originally the pressure regulator-accumulator was mounted on the left side of the engine block and was a "beach" to get at. Most Citroën owners relocate them to the frame on the right side just ahead of the radiator. If you ever have to work on the regulator or accumulator you will wish you had relocated the unit at your leisure. The return hose from the regulator to the supply tank gets quite a work out and should be replaced before it fails and sprays fluid all over your driveway or the mall parking lot. This will happen when the wife is using the Citroen. I reroute this hose so it runs directly to the tank.

The rear suspension piston rod sockets will more than likely need to be greased. Also, you may find the suspension boots deteriorated. While you are in this area, loosen the rear spheres. They will probably be frozen and tough to loosen. At some time you will have to remove the spheres, so you might as well loosen them at your convenience. Make sure to release the pressure first. Again this is why you want a good service manual, which should explain how to do these chores. The front sockets, boots, and spheres are better protected from the elements and do not need attention as often as the rear ones. While you are looking at this part of the car, check those rear brake line swivel joints. They also tend to fail after time.

At some time, the suspension, the pressure accumulator and the brake accumulator spheres will need to be recharged or rebuilt. You will notice a harsh ride when the suspension spheres are flat or near flat. You will be aware of a low pressure accumulator sphere condition by a short regulator on/off cycle or no cycle at all. This condition can also be caused by a leak in the high pressure side of the hydraulics. A flat or low brake accumulator will reduce the safety margin in the brake system. The best way to check this, to my knowledge, is to release the pressure at the regulator and see how many brake applications you end up with. I believe it should be twenty or so.

If your Citroën has air conditioning (A/C) you should check out the belt drive pulley driven by the camshaft. The rivets holding the pulley to the hub tend to break off. This is not a serious problem with Citroëns without A/C, but should be checked anyway. There are several articles on this problem in this book.

NEVER, EVER WORK UNDER A CITROEN UNLESS IT IS PROPERLY POSITIONED ON JACK STANDS OR BLOCKS! The vehicle is normally held up under hydraulic and air pressure. If something lets go and you are underneath–squash, splat!

I have repeatedly mentioned that having a repair manual is essential. This book and other Citroën club newsletters have covered most of the common problem areas at one time or another. The items I have mentioned are those common to Citroëns; it is not a conclusive list.

Travel preparation
Don James, OH (Jun. 1982 p.3)

We travel a lot in our "DS" and people always seem amazed that we would venture so far from home with it. We have found the car to be very dependable (138,000 miles) and fan belts, spark plugs, wires, etc. can be had at the nearest auto parts store, same as any car. If trouble should occur, I feel that I would be very good at improvising a part or a clamp to get my Citroën going again (this is called confidence). It is easy to improvise on a Citroën. This can not be said for a lot of today's cars with their "black box technology" (the wife's SAAB 99 for example).

One day, on my way home from work, my car stopped rather suddenly. A quick check showed no spark. Opening the distributor I found that the spring on the points had broken. I found a twig on the ground and wedged it against the broken spring. The car would not rev very high, but it got me home and it only took five minutes to fix. But what if the car had no spark and no points? I rather doubt that I could fix it on the spot, or that the local gas station jockey could help.

You can easily carry a spare set of points, but who would carry a spare black box? You can drill new holes and install Ford points, but could you install a Ford "black box"?

The Citroën is a car that you can fix yourself. You should realize that in the event of trouble, you must know as much about your car and all of its functions as you possibly can. If you don't do the work yourself, you can direct a service station attendant as to the cars disassembly features and unique construction.

If you do travel in your DS, you should carry the following: the club roster, soft picture wire, black electrical tape, straight pin, some spare bolts and screws and a motorcycle elastic tie-down cord.

Hydraulics should not stop you from carefree travel in your Citroën. All cars have hydraulic brakes and they do not fail suddenly except in rare cases or if a rusty line breaks. A 3/16" "French connection tool" will give you "confidence". If you have a "French connection tool", you can have a leaky line repaired at any gas station. To test before you leave on a trip, put the car in the "high" position and push the brake pedal hard. If you have a weak line it will show up as a leak (also a good test before you buy a "DS").

Carry an emergency sphere if you are in doubt about the condition of your car's spheres. You can't get one at an auto parts store. A spare o-ring for under the sphere is also an important item.

Carry tools if you think you may work on the car yourself. How many depends on how big a repair you would try to fix, and what you have room for. You can't have too many.

A tube of Silicone sealant is good for repairs to rubber boots and you can fix a lot with five minute epoxy glue.

The oil pressure sending unit has been known to leak suddenly when the diaphragm ruptures. This loss of oil will cause the contacts to fail, so the light on the dash may not work. Plenty of

DS engines have been ruined this way. Replace the unit, or at least carry a spare metric bolt to screw in should it fail–thread size 10 mm x 1.5 pitch.

Watch pulley, fan and belts
Don James, OH (Oct. 1982, p.2)

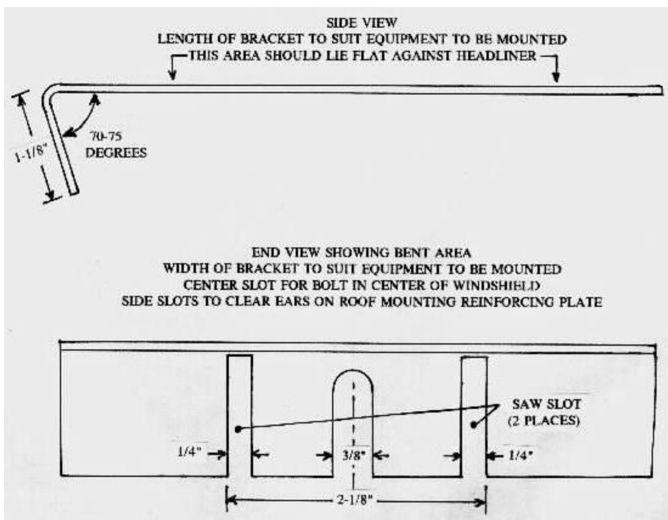
To prevent water pump failure on your D-model, watch for bent or out of round pulleys, fan blades not running true with the shaft (wobble) and for belts that are too tight. Never hammer on the end of the shaft.

Chapter 22–Radio

Bracket allows installation above windshield
Ken Butler, NM (Jun. 1989, p.13)

A location which is rarely considered for radio equipment is at the roof line where the sheet metal of the top is bolted to the chassis. This location keeps the knobs, dials, etc. in easy reach and view and tends to conceal the units from casual inspection. No panel cutting is required, and wiring is simple, running in the trough at the inner roofline then down to the dash under the rubber trim of the windshield. Speakers internally mounted in these sets are up where they can be heard.

Material required is an aluminum plate 1/16" in thickness, the length and width determined by the unit to be mounted. A typical plate for my CB unit was 5" wide by 8" long with 1-1/8" of the length bent sharply back in a vise to an angle of 105 to 110 degrees as shown.



Do not cut the rubber trim around the edge of the roof. Pull it down when installing the bracket and push it back after it is secure.

Chapter 23–Safety & Health

Gasoline swallowed in siphoning must not be vomited

Michael Cannon, VA (May 1992, p.14)

At the time it seemed like a good idea with just one week until the Rendezvous, I wanted to be ready for the road. So at 11 PM one night I found myself heading out to fill the fuel tank of my DS Cabriolet. The late night hours are when my wife and I finally get some time of our own after our three kiddies have been wrestled into bed. It's also a good time to slip unnoticed into the 24 hour gas station and pump gas without having to answer that perpetual chorus of, "What is it?"

I tanked up with no problems and was back home in a flash–well, not exactly, but pretty quick. When I got out to open the garage door before backing the car in for the night the smell of gas very nearly knocked me over. It didn't take long to discover fuel pouring out from the rear underside of the car. Poking, looking, etc. led me to believe the leak was coming from somewhere around the fuel tank.

Although I am a night owl, I prefer not to start new projects at such an hour–but a gas leak like this cannot be ignored. To get at the tank I needed to take out the rear side panels, the seat, and the cover panel. Then it dawned on me that the leak might simply be originating from the filler pipe or vent pipe connections and that taking a little gas out would stop the leak.

After scrambling to find a suitable hose to force down the filler pipe (a short length of garden hose), I tried to siphon out some gas. While not counting siphoning as one of my areas of expertise, I have done it quite a few times over the years with no ill effects. This time was to be different though. Because of the large diameter of the hose or my haste to get the gas out, I wasn't ready for the gush that instantly filled my mouth with gas. I was unable to spit it out and ended up swallowing quite a mouthful. UGH!

What a taste and what a burn. Once I managed to stop coughing I figured it would be wise to drink some water. Then I ran for help.

My wife agreed that throwing up might be wise. I found our store of ipecac, which we keep on hand for our children. Ipecac is supposed to make one throw up immediately. But after quaffing down 2 or 3 bottles followed by great quantities of water as directed by the instructions, I waited and waited, but nothing happened. Meanwhile, my wife called Poison Control. Busy, busy, busy. Maybe people all over town were gulping gas and calling for help just like me. Fortunately I wasn't dying, just feeling miserable with a burning throat.

Unfortunately when my wife finally got through she was told that vomiting was not the recommended procedure at all; the real damage results from breathing the fumes. Maybe this was good news, but I had already consumed all that Ipecac and was finally beginning to feel like vomiting. This was bad news.

Vomiting brought all that gas back up right across my throat–aaah! Modern gas just doesn't taste like it used to or so it seems to me.

After all this I still hadn't found the source of the leak. When I felt sufficiently recovered I resumed work to access the fuel tank. I eventually discovered that a small black rubber hose connecting the fuel tank and to the nylon vent tube was cracked and allowing gas to leak from the filled tank. I put a couple of rags to catch the last few drops (I had managed to siphon some gas after all) and was then able to wait until the next day to make the repair.

My adventure in finding a piece of fuel hose in the correct diameter is practically a story in itself. Everything about these cars is different.

Take my advice, don't use your mouth as a pump for anything you wouldn't willingly drink.

Hydraulic leak must not be stopped by a finger
Reprinted from Citroën Autoclub Canada (Nov. 1976, p.2)

DO NOT under any circumstances attempt to cap a live hydraulic pressure leak by hand. Working pressures in the system (spheres and hydraulic lines) are high enough to push the fluid through the skin and cause you serious injury. Never take a hammer or chisel to any hydraulic component.

Jack stand use on one side causes delayed collapse
Dave Root, FL (Apr. 1991, p.24)

We were sitting on the porch behind our garage one quiet evening when suddenly we heard a tremendous crash near enough to be right in the garage! I had been working on my D-model earlier–I had removed the left front fender in order to remove the access cover, which is just back of the front wheel, to look at something. I had put the cover and the fender back on, but had left for supper with the wheel still off. The side of the car was supported by a jack stand under the jacking support (the sturdy square tubing that extends out from the frame just under the back of the front fender).

I entered the garage to see the "D" with its frame flat on the floor on the left side with the left front fender sticking up about a foot at the back! The noise was produced when that much steel fell about a foot to the cement floor.

I know better, but in haste I had supported the car on one side only. As the suspension dropped on the right side, the angle of slant gradually got greater to the point where the support slid off the jackstand. As the car fell, the jackstand pushed up on the back of the fender, pushing it off its support pins, making a small dent in the bottom of the fender. Had the fender not come off the support pins, the damage to it would have been far greater. I wondered how the fender could come off these pins but don't want to do this again to find out!

After removing the fender it took only about 20 minutes to repair the minor damage and it went back in place with no problems. I am very glad that I was not under it when it fell, or I might not be writing this.

When using these supports, both sides should be supported at about the same height. I knew this. As a neighbor once quipped, "Most of us are not dumb, but we sometimes do dumb things."

As an added safety factor it would be good to drill holes vertically up through the ends of these supports for 1/4" diameter bolts. The bolts would prevent the ear from sliding off the jack stands when using these points to suspend the car.

Editor: Working under an inadequate jacked-up Citroen can be lethal. Van Newberry was killed when his parts car on a small jack came down on him as he was removing the oil pressure switch (Aug. 1985, p.8). Oscar Turner was crushed to death under his D-model when the floor jack he was using rolled out (Jun. 1989, p.3). Be safe, use a jack-stand on each side.

Muriatic acid precautions
Don James, OH (Nov. 1982, p.9)

You must use caution when using muriatic acid to clean components in your cooling and heating system as well as derusting parts. It is sold in hardware stores for the purpose of cleaning concrete before painting and is inexpensive.

BE CAREFUL OF THE FUMES. Do not get a good whiff or you will need a new lining for your nose. Wear eye protection, because it could splash into your eyes. A pair of rubber gloves will help protect your hands. While it won't hurt your skin immediately, if you get it on your hands for more than a minute or so, you will have a definite urge to get it off. Wear old clothes too, as it will put holes in them.

Do not use this acid on aluminum. Do not put it in your engine block if you still have the aluminum head or water pump on the car. The acid will not harm rubber.

See additional information about using muriatic acid under "Radiator cleaned with muriatic acid" and "Core unplugged with muriatic acid."

Chapter 24–Starter

Bendix drive #A1660 fits 65-67 type starter
Ken Butler, NM (Jun. 1984, p.22)

Allegedly an exact fit for the starter Bendix drive used on the 1965-67 D-models is the American substitute Bendix assembly #A1660, complete including pinion, shaft, springs, etc. at one-half the Citroën price.

Dying after short effort may be due to bad brush
Dave Paulin (Oct. 1980, p.3)

When the Paris-Rhone starter on our '69 ID wagon went bad, it would crank for a few seconds and then slowly die. The battery was checked and found to be fully charged. All wiring was cleaned and resistances checked and all proved OK. The trouble had to be in the starter itself. Since the '69 had the single exhaust downpipe, loosening the collar and turning the pipe slightly to the side from its connection to the exhaust manifold allowed for fairly easy withdrawal of the starter from the top of the engine compartment.

Upon disassembly, everything was fine except that one of the brushes had worn much more than the other due to brush holder being slightly bent. After carefully straightening the holder to make sure it was square, we were off to the local auto parts store to find some other brushes that might come close to fitting. Size EX37 is the right thickness and length, but too wide. Grinding or filing them down to the right size is very easy since the material is a copper-graphite substance. Make sure equal amounts are taken off from each end and that the embedded wires are not exposed. Solder new brushes to the original wires and the starter is good as new (providing mechanical parts are OK).

Failures due to solenoids, drives and brushes
Betsh, Ken (2002 #1, p.8)

I suppose I've had my equal share of starter problems over the many years of driving D-models. That's not counting battery, battery cable, and dashboard switch or associated wiring problems. If I turned the key to start (or push a button or move the Citromatic lever to the start position) and nothing happened – the startup warning lights didn't dim and I didn't hear a definite clicking sound from under the hood – I'd look for an electrical problem. On my earlier cars with a starter solenoid at the plus-side battery terminal, I'd try pushing up the shaft protruding from the bottom. If that allowed me to get started (making sure the gearshift was in neutral), most times the problem was the solenoid and I repaired it by cleaning and adjusting the contactor and the one side of the contactor plate that was accessible.

I believe the reason I was able to get the car started by manually operating the solenoid is that I was pushing the plunger in it with more force than that made by the magnetic field of the electrical solenoid coil.

Earlier D-models, at least up through my '67 ID19, used a starter with a Bendix-type centrifugal starter drive with a heavy coil spring. A couple of times with these cars when the starter motor would wind up to a relative high speed with no effort to turn over the engine, I'd find (after laboriously removing the starter) that this spring had broken and had to be replaced.

My '70 D-wagon was the first Citroën I owned that had a starter with a solenoid mounted on the side of it. Actually, I didn't know this at first since the starter was hidden under a heat shield. My first trouble was when the starter cut out too soon, before the engine started running. At first I could try again or several times and the engine would start. But, I had no doubt something was failing and soon I could be stranded unless parked on a hill. Buying and installing a new drive unit solved the problem.

Examining this starter (also after a laborious removal) showed the solenoid on the side of it performed two functions. The front end has a yoke that mechanically pushes a sealed drive unit to engage the starter to the engine flywheel. The other end had a set of electrical contacts that closed the connection to the battery.

The next failure was when nothing happened, except that I'd hear a fairly loud clunking sound from the starter. The dash warning lights would dim only slightly, not as much as during normal starting. This was an annoying and threatening problem since it never happened at home with a cold engine and was most likely to occur after stopping with a fully heated engine, after ten to thirty minutes. I've long known that engine accessories, such as the starter, don't get as hot from the engine when driving as they do for a while after stopping. While driving there's a stream of fresh air to carry away the heat.

Because I know the electrical resistance of the copper wire used to wind the solenoid coils increases significantly as the temperature increases, I rationalize the problem as insufficient magnetic force to overcome worn or corroded contacts. At that time replacement solenoids were available and that was the best solution, especially since this was in the car my wife always used on her shopping errands.

A couple of times when the starter turned over slow, it wasn't the fault of the battery and the answer was to replace the starter brushes. I remember the one time when I was so sure the battery was at fault, I took it to Sears for an exchange. The salesman ran a check and told me there was nothing wrong with it and what trouble I was having would continue with a new battery.

Removal by removing motor mount only
Betsh, Ken (2002 #1, p.9)

Back when I had to remove the starter from a '67 ID19, I soon realized I needed more than the available clearance behind it to get it out. Removing the one-piece exhaust manifold seemed the only answer. Getting the manifold mounting bolts out of the engine head wasn't so bad, but the two screws attaching it to the down-pipe to the exhaust was a real challenge. Later, when I had to remove the starter from the replacement DS21, I found trying to remove the 2-piece exhaust manifold from the 21 engine was worse. It had a dual pipe with four bolts attaching it to the down-pipe. I soon learned the answer was in temporarily removing the right-side engine mount instead of the exhaust manifold.

See "Motor mounts removed by jacking engine block" above for caution and procedure for removing a motor mount.

Removal without removing the manifold or motor mount
Betsh, Ken (2002 #3, p.11)

My above article on removing a late D-model starter by removing the right rear motor mount to get clearance drew a "there's an easier way" response. Others have found a way to remove a starter in the late models without removing a motor mount or the exhaust manifold. A good friend and fellow CCNA member passed on this procedure, demonstrated to him many years ago on a '71 DS.

(1) Remove the heat shield
(2) Replace battery cable connection on starter with an old (or spare) cable leaving the other end free
(3) Unbolt the starter
(4) Being able to lift the starter straight up with the old cable means one needs only a little extra clearance, which can be achieved by prying up on the exhaust manifold with a 2x4
(5) Do the reverse to reinstall.

I think this may have worked for me since the real problem was in lacking space for my hands to get a grip on the starter to pull it out. Another person thought this would work, but might be easier if the four bolts securing the two rear motor mounts to their brackets were temporarily removed.

Regarding the position of the rear of the engine after lifting or shifting it to remove the starter and/or the mounts, before beginning the project I note the clearance between the left edge of the exhaust manifold flange (as viewed from the front of the car) and a nearby vertical part of the frame rail. It's usually about a half-inch. Whatever, it should be about the same when I'm finished. Another means of checking the motor position is to see if the rod from the carburetor to a bearing in a bracket attached to the firewall is about parallel to the side of the engine head. This rod is part of the accelerator pedal linkage.

Replacement and repair procedure
Pgh Citwrench (Oct. 1987, p.24)

Removing the starter - Raise the car as high as possible and put jack stands or blocks under the front jacking supports just below the front of the front doors. Lower the car and release the hydraulic pressure. Disconnect the positive battery terminal. Remove the front fender on the passenger side (U.S.A.). Remove the air cleaner assembly. If your car has air conditioning remove the compressor and compressor brackets. Remove the suspension sphere and cap the end of the cylinder. Remove the engine manifold heat shield.

Remove the nut from the motor mount to the engine support bracket. Place a scissors jack under the engine at the rear of the engine–I put the jack on the lip of the oil filter plate. Raise the ngine about 0.5" to 0.625". Remove the 2" x 2" cast steel block that is the damping weight. This block is on the side of tile firewall and just in front of the motor mount. Remove the small firewall plate, the anti-drumming plate, that is under the damping weight just removed. There are three 8 mm bolts for this. Remove the engine support bracket from the engine and the motor mounting block.

Loosen the three 8 mm bolts at the front of the starter that hold on the starter heat shield. Just turn these bolts about 2 turns each, since the heat shield is slotted for easy removal. Remove the nut at the rear of the starter heat shield that holds it onto the rear of the starter. You should now be able to remove the starter heat shield. Remove the nut holding the starter main power cable and the nut holding the starter solenoid wire. Remove the two bolts holding the rear of the starter to the engine block (some starters don't have these bolts). Remove the three bolts holding the starter at its face. These bolts are long and come through the engine casting (if you want to take the pain out of this operation, try a 3/8" drive ratchet and a short extension).

Working on the starter - If your starter is Paris-Rhone you will not have any pins or marks to help you put the starter back together. Put some punch marks or small chisel marks on both front and rear rings of the starter and starter body. The two bolts at the rear of the starter allow you to take the unit apart. Disconnect the main power lead from the starter to the solenoid.

There is a plastic pin with a spring retainer that serves as the pivot pin for the solenoid mechanism. This plastic pin will more than likely break as you try to take the retainer off. You will find it difficult to find another of these plastic pins. Just use a steel bolt with double locking nuts to replace it, since there is no electrical problem. There is a rubber plug at the front of the starter to be removed and four 8 mm nuts. These allow the solenoid to come apart.

Depending on the starter problem, proceed to repair parts needed. I had a bad Bendix clutch. These starters come with a short gear and a long gear. The gear length doesn't seem to matter as long as the total length of the replacement Bendix assembly is the same as the old one. Putting the starter back together is a challenge. Get the solenoid almost back in place. Don't forget the solid rubber block that fits between the solenoid and the starter body. Slide the long bolts back through the assembly, watching the marks you put on before.

Now use a long thin screwdriver and start to press the brushes out and slip them onto the commutator. Slowly work your way around and you will finally get it. Push the end bell all of the way on and put on the two back nuts loosely. Watch the marks on the ends. Put the four 8 mm nuts on the solenoid and tighten. Now put the pin in the solenoid arm or replace with the bolt as I mentioned above. Now tighten the back two nuts. Replace the starter main power wire to the solenoid. Put in the front rubber plug. Be sure it spins freely.

Test starter before reinstallation - I suggest at this point to use a set of starter jumper cables and try the unit to be sure it is working.

Reinstalling the starter - Put the starter back in place in the car. The first thing to do is try and put in the two bolts at the rear of the starter, that go into the engine block. At least get them started. Put in the three long bolts that go into the starter front face. Now that you have the two support bolts at the rear started and the three front bolts started you can tighten them all. Replace the main power lead from the battery to the solenoid and the starter lead from the ignition to the solenoid. Replace the heat shield.

Replace the engine mount bracket and the motor mount. Lower the engine back onto the motor mount and put on the motor mount nut. Replace the firewall plate and the engine sway limit block. Replace the manifold heat shield.

Replace the suspension sphere. Replace the air conditioner mounting plate and the air conditioner compressor. Reconnect the battery cable. Tighten the hydraulic pressure regulator, pressure relief nut. Try the starter. Lots of luck. Replace the air cleaner assembly. Replace the front fender. This should do it for you.

Solenoid adapted to new battery clamp
Paul Hutchinson (Jul. 1984, p.21)

If the alternator light goes on occasionally and you experience hard starting or a battery that is badly run down, don't run out for a new battery. You may just need to clean the battery terminals. Most Citroëns are so old that their battery terminals have been tightened and cleaned so many times that the terminals are fused together so they can't be tightened anymore. Often the nut and bolt are so corroded they can't be tightened.

If your terminals are in such a state, you might be well advised to replace them. On most Citroëns it is not that easy to replace the cable that goes to the starter. The unit that trips the solenoid is actually part of the battery cable and it would be expensive to replace the whole unit.

I repaired my cable by cutting off the badly worn clamp of the old battery terminal. I then removed the insulation material from the piece that is left. I then sanded down the exposed lead and drilled a hole through it.

The next step is to attach a short battery cable to the lead stub. I used a bolt through the drilled hole and the short cable. To insure a good connection, I wrapped a piece of copper flashing around the connection and drilled two holes in it and formed a ring that the joining bolt passed through. I had to insulate the connection very thoroughly.

I replaced the ground cable with a standard heavy gage cable. I used a 30 inch ground cable. One advantage to this set-up is that you can use just about any battery that you want because of the extra cable length. Cost of the parts was about $12. Sure beats buying a new battery.

Solenoid on later cars have accessible contact adjustment
Betsh, Ken (2002 #1, p.8)

The starters with an attached solenoid have an adjustment screw that's under a small plastic cover at the front end of the solenoid (front as in the front of the car when mounted). While the shop manual specifies this adjustment only to be made while measuring the engagement of the starter drive, which can only be done while off the car, I know from experience that this can affect the making or non-making of the electrical contacts. I've tried adjusting it on the car (with a flat-blade stubby screwdriver) but only by turning it a fraction of a turn and remembering its original position so I could return to it if no benefit was obtained.

Solenoid replacement mounted to battery hold down
Ken Butler, NM (Jul. 1984, p.22)

When faced with an acid eaten starter solenoid, use the Eichlin ST67 solenoid switch. It has all four leads coming out to terminals so it can be adapted to any car. I bolted it to the battery hold down with flat head screws, with the nuts facing outward. A short length of cable, a new positive battery terminal and two large lugs and you are ready to hitch it up. Since the Citroën starter switch grounds the line from the solenoid to activate it, the original wire will go to one of the small terminals. The other small terminal will be connected to the battery positive terminal. The larger terminals are merely series connected between the battery and starter.

Solenoid used on old flathead Fords almost equivalent
Jerry Lugert, NV (Jan. 1991, p.11)

The solenoid next to the positive post on the battery terminal may be replaced with the old flat-head Ford solenoid which also has a start button on its base as well as the same number of electrical attachment posts. However, such solenoids are difficult to find. The solenoids with multiple wire connectors and without start button at the base are more readily available, but require a completely different wiring hookup than the original.

Regardless of how you arrange the wire, no power will go to the starter unless a knowledgeable person runs an additional hot wire to the correct places, both on this solenoid and the one attached to the starter. My only experience is with the Citroën D-model after 1969. Perhaps what I'm describing here does not apply to earlier models.

Starter models and their repair
Chris Dubuque, WA (Jan. 1996, p.14)

Most of the starter motors for DSs and SMs are not available new and therefore, rebuilding becomes a necessity. The following provides some tips and suggestions for dealing with a sick Citroën starter motor. The table below shows some of the most common starter configurations which fit DSs and SMs. It should be noted that a starter of horsepower rating less than about 1.5 is generally not powerful enough for use in a DS21.

Model/years	Manufacturer/model	No. of brushes	Horsepower
ID 66-69	Paris Rhone D10E49	2	1.4
DS 66-69	Paris Rhone D11E23	4	2.2
DS 66-69	Ducellier 6182	4	2.0
ID 70-75	Ducellier 6201 or 6215	2	1.25
DS 70-75	Ducellier 6200 or 6225	4	1.48
DS 70-75	Paris-Rhone D10E52 or D10E55	4	1.55
SM >72	Ducellier 6211	4	1.5
SM 73>	Ducellier 6229	4	-

Armatures **-** Whenever a starter is disassembled, it is well worth having the armature tested at a professional starter rebuild shop. They will have a machine called a "growler" which somehow detects shorts or other defects in the armature windings. There is no way you can duplicate this test at home. Also, they might recommend "skimming" the commutator. Bad armatures can be rebuilt by some professionals, but this is very expensive and therefore is probably a last resort. Beware that many armatures for the above starters have a "brake" installed on the end of the armature which is held in place with a reverse threaded M6 screw. If someone damages the screw threads by not realizing the screw is reverse threaded, the armature may be scrap.

Solenoids – Ducellier and Paris Rhone solenoids seem to be quite reliable and therefore can usually be re-used. A good starter shop can test solenoids for proper resistance of windings and other checks which might catch internal shorts. Paris Rhone solenoids can be partially disassembled for further inspections.

Drive gears **-** The drive gears can be a trouble spot. Many drive gears develop internal cracks and other problems which allow their internal ratchets to slip. Slipping ratchets tend to sound like the gear teeth are grinding in the flywheel teeth. Fortunately, this noise is usually internal to the drive gear. Although some claim to be able to rebuild drive gears, it is generally much better to find a new one or a good used one.

Brushes **-** Brushes can need replacing on occasion. Replacing brushes, although simple in concept, is actually quite difficult to do without damaging the very old and delicate field windings. Replacing brushes requires a very powerful soldering iron. Again, best left to a professional.

Starter feedwire **-** There is a heavy gage wire leading from the solenoid into the starter motor body. This wire is always heavily damaged by years of heat and corrosion. This wire must be replaced and as with the brushes, requires a skilled solderer.

Bushings **-** Bushing wear is not a very prevalent problem on Citroën starters. Also, local starter rebuilders or machine shops can make and replace worn bushings if necessary.

Parts availability **-** The parts availability for D-model starters is unfortunately not very satisfactory in this part of the world. Parts sources such as Western Hemispheres, Brad Nauss Auto, and SM World have some new parts. Local starter rebuilders may be able to come up with simple parts such as brushes, but they will generally not have access to more critical parts.

Recommendations **-** Used starters are always an option. However, they will generally not be a very good investment unless they are very cheap. First, starter replacement is difficult so repeated replacement is an unsatisfactory situation. Furthermore, any used starter will itself be 20 to 30 years old. It will likely have the same or similar problems to your present one.
Local starter rebuilding shops with good reputations are a reasonable option. Just remember that they will not have access to many parts, so you may have to assist them in finding new or used parts. Supplying a starter shop with several starter cores of the same series would be an excellent idea if at all possible. Professional starter rebuilders will have experience, machines and tools that you cannot easily duplicate yourself.

For 1966 to 1969 D-models, the best option may be to purchase a rebuilt starter from Western Hemispheres. They generally stock rebuilt starters for these cars. However, rebuildable cores and new parts for these years of starters are exceedingly difficult to obtain and therefore the price is high. Brad Nauss Auto in Pennsylvania can also provide used or rebuilt starters and/or some new starter parts for these years of starters.

For late model D-models, the best option by far is from Western Hemispheres. They sell a starter motor from a Citroën C32/35 truck that fits the DS and is available new from Valeo/Paris Rhone. Since the starter is slightly different from the originals, a new heat shield must be purchased separately which is made for the C32/35 starter. Considering other options, the price for the C32/35 starter is very reasonable (about $300).

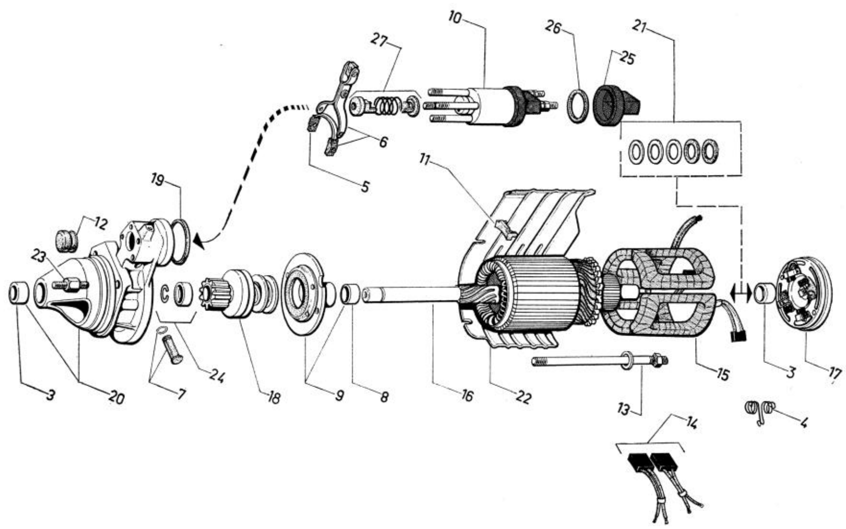
Summary **-** Although it seems difficult to accept, rebuilding D-model starter motors is generally not a do-it-yourself job. This is especially true now that all of the cores are very old. Special tools and test equipment are required as well as is a supply of new and/or used parts.

Starter repair and adjustment notes
Don James, OH (Mar. 1986, p.27)

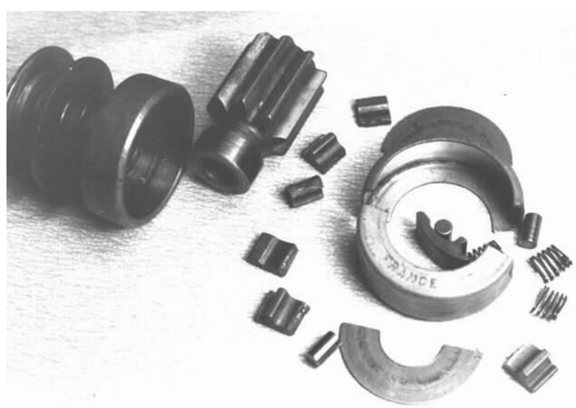
Many D-models have the problem of a starter motor that runs, but there is a delay in engagement. This problem occurs on "later model engines" and seems to be rather common on high mileage cars. Many folks replace the entire starter, but seldom is there a seriously damaged starter, and they can be easily repaired.

Removal of the starter is basically just getting everything out of the way, such as heat shields, air filter, air conditioning hoses or compressor. In most cases, a small bottle jack must be placed under the rear of the engine to lift it slightly in the rear so that the motor mount and it's mounting ear can be removed (this is an excellent time to replace a collapsed rear mount).

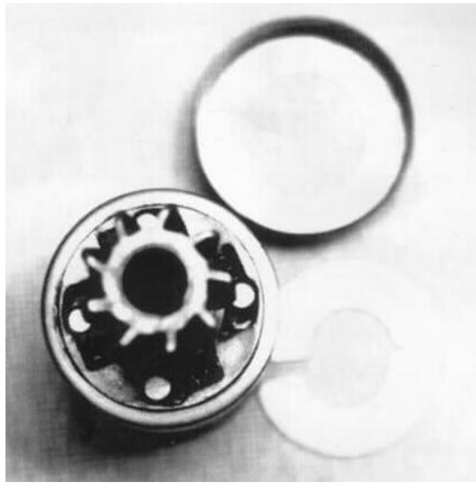
Remove the three long bolts that go through the aluminum clutch housing and the two shorter bolts at the rear of the starter found on some models. Turn the motor just right and it comes out of there.



The problem with the whirling starter is not in the solenoid (item 10, above), but in the starter's "over-running clutch"–a sort of one-way drive found in the Bendix (item 18). The next picture shows what happens. Springs push rollers along a little ramp to jam between the clutch drum and the starter gear. What happens is the ramps shatter and are broken into pieces, usually all except for one. The binding caused by one roller and ramp assembly causes a more gentle engagement and seems to prevent the last assembly from breaking (there are four assemblies).



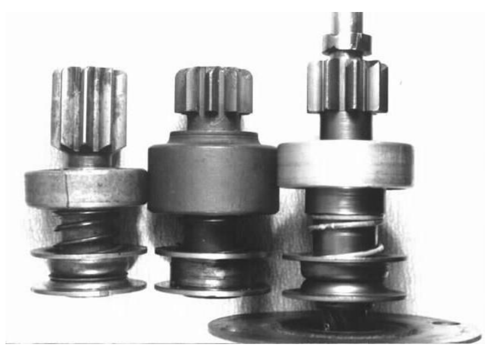
The other thing that can happen is shown in the next picture. There are no broken parts, but the springs have been compressed too much (springs have a rectangular cross section). When the springs are shot, it is just luck when the starter does engage.



The purpose of the entire clutch assembly is to prevent damage to the starter motor by those owners who hold the starter in engagement after the engine is running.

Most enthusiasts will have no big problem in getting the starter motor apart, but watch the position of parts and thrust washers. Also note the key indentations on both end plates that align everything.

To remove the starter Bendix and over-run clutch assembly, you must first drive back the collar at the end of the shaft to expose the ring clip underneath. Drive the collar back towards the motor. It should be noted that this starter drive assembly is not a serviceable item and parts for it are not available. The entire Bendix drive must be replaced.



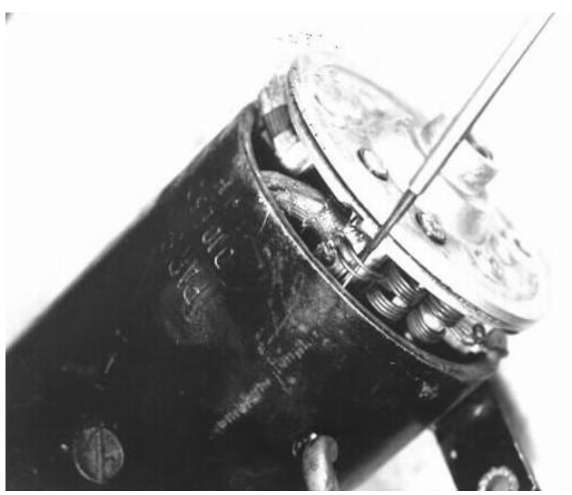
Here are three of the various types of starter drives. They are all interchangeable and are the same. Gears are of different lengths and the one in the center has a clutch that is designed to be opened.

The next picture shows the armature (rotor) of the starter with the copper commutator near the right end. Inspect the commutator. It's generally in good shape. But if not, it can be turned down at any good motor shop. Be very sure that the "mica" separators between the copper bars on the commutator are undercut and free of any dust if you have it turned.

Failure to undercut will cause the copper to pull across when the starter is under load and this will give you a very weak motor that will run, but will turn the engine very slowly.

An electric motor shop should be able to quickly check your armature for shorts or opens on a growler. A growler is just an electromagnetic plate that generates an eddy current in the armature. The only check the home enthusiast can do is to make sure that there is continuity between all the strips of copper on the commutator, and that there is no continuity between the copper commutator strips and the armature shaft. This would indicate a short.

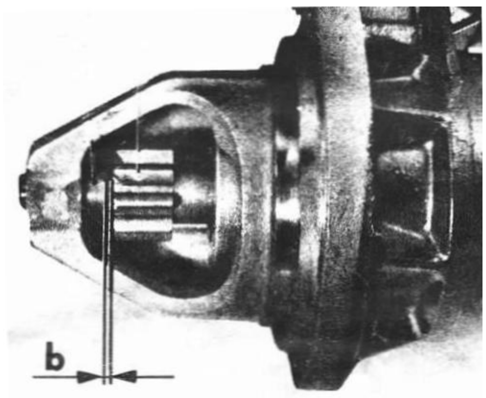
Brushes do not wear very fast because the starter motor is used only for a few seconds, but any dust (carbon or copper) should be removed. Wash parts in alcohol if you need help cleaning them. Dust hurts the efficiency of the motor, so for maximum power get the motor as clean as possible. Use caution to prevent bearing lubrication from coming in contact with the brushes or commutator.



the above picture shows the use of a dental pick (a coat-hanger wire would do) to hold the brush springs back while you push the armature into the housing. Be sure all contacts and connections are shining brightly. Remove the copper and nuts from the solenoid and polish them.

WD-40 or other electrical lubrication and corrosion prevention should be applied to the clean contacts. Remove all abrasive that remains from polishing.

When the starter solenoid is energized, the dimension at (b, below) should be between 0.5 and 1.0 mm. There is a screw adjustment under the rubber plug (item 12 in the first drawing) on the end of the solenoid to adjust this. Reason for this adjustment is that the contacts that are inside the solenoid to actuate the motor will not connect properly if the gear comes to the end of the shaft first.



Please remember that you should be sure to have a good big, heavy new battery cable to the starter, and that all connections on both ends of the cable should be clean. The cables that came on these cars were terribly undersize. If your car is equipped with the extra solenoid as shown, be sure it is clean and is working properly. These can be disassembled and cleaned by drilling out the rivets and replacing them with 6-32 screws.

Period of use of various starters was:

Until September, 1968 ....Ducellier 6166 A or Paris-Rhone D10 B 45

From Sept., 1968 until Sept., 1969 ....Paris-Rhone D 10 E 49

From September, 1969 on..................Ducellier 620

The following charts list the horsepower and other specifications of the various starters

Make	----------- Ducellier -----------			
Type	6164A	6166A	6182A	6201A
Max amps	600	420	600	410
Running amps	190-210	150-170	190-210	150-170
Unloaded Amps	50-85	30-50	50-85	35-55
HP	2	1.35	2	1.25
Torque (ft.lb.)	340	245	340	190
Loaded Amps	410	285	410	290

Make	---------------- Paris Rhone --------------				
Type	D10B45	D11B116	D11E123	D10E49	D10E52
Max amps	470	630	630	470	425
Running amps	150-170	190-210	190-210	150-170	190-210
Unloaded amps	30-50	50-70	50-70	30-50	40-60
HP	1.4	2.2	2.2	1.4	1.55
Torque (ft.lb.)	5.8	5.8	5.8	5.8	5
Loaded amps	220	250	250	220	200
Torque @ 1,000 rpm (ft.lb.)	6.8	9.8	9.8	6.8	7.2
Amps @ 1,000 rpm	260	380	380	260	255

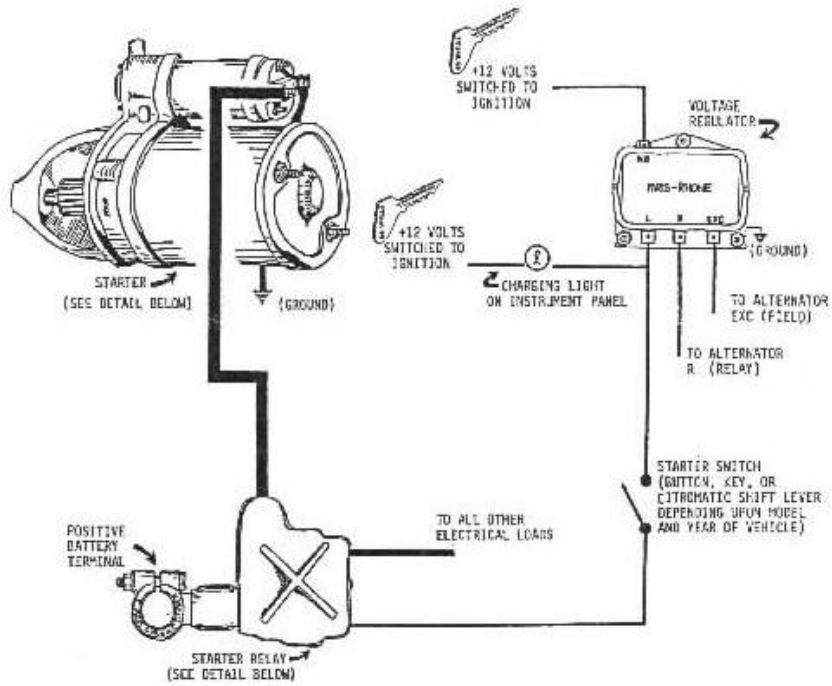
Starting a car with no solenoid at the battery
Betsh, Ken (2002 #1, p.8)

Neither of the two D-models I now own (late models with manual transmissions) have starter solenoids by the battery. The starter switch circuit is in the plus ("hot") side of the battery and goes to the solenoid on the starter through a small wire bundled with the heavy battery cable from the battery to the starter. This small wire has a plug-in disconnect next to the battery with red insulating sleeves. I just pull them apart and hold the male side, the side going to the starter, to the "hot" terminal of battery.

The cars with battery-mounted solenoids had the starter switch wired so as to ground the small wire coming out of the solenoid. On these cars, the starter switch grounded this wire.

Voltage regulator failure can prevent starter operation
Chris Dubuque, WA (Dec. 1987, p.17)

As with other parts of the vehicle, the D-model starter wiring is somewhat unconventional. First, most D-models are equipped with a starter relay located on the battery positive terminal. This relay has the under-hood starter button on it. The purpose of this relay is to reduce the electrical load that the starter switch is subjected to and I suppose, the under-hood starter button is convenient (note that the "starter switch" referred to is either a dash-mounted button on pre-'70 manual shift cars, a key switch on '70 to '74 manual shift cars, or the Citromatic shift lever in Citromatic equipped cars). The second wierdity is why the voltage regulator is in the starter circuit (see below).



The "ground" for the starter switch AND the charging idiot light is achieved through the voltage regulator "L" (light) terminal. This ground exists within the voltage regulator when the engine is not running (i.e. the charging system is not charging). Once the engine is "running" (i.e. charging), this ground is broken within the voltage regulator–thus turning off the charging light. Since the ground is now open, the starter is also disabled. This feature prevents the starter from trying to engage if one were to inadvertently actuate the starter switch when the engine is running.

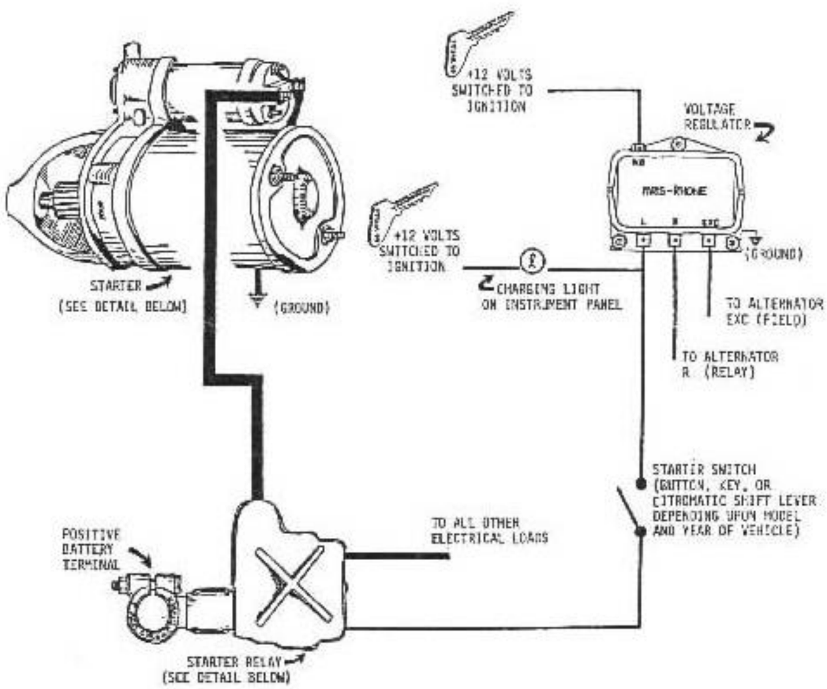
This introduces an interesting failure mode for the starting system. If the charging light is not working, or is working intermittently, the starter may not work. An example would be if the contacts that provide the ground inside the voltage regulator were burned or dirty and not making good contact, the starter won't work from inside the car. However, the under-hood button should still work.

When troubleshooting the starting systems, keep in mind the following points:

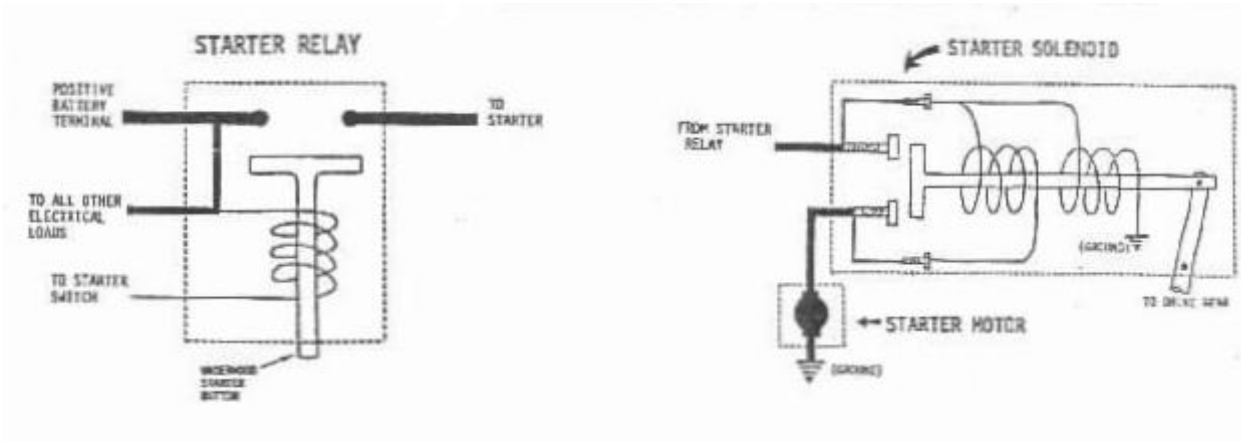
1. Before wasting any time troubleshooting, make sure the battery, battery terminals and battery cables are in good shape. For some reason, battery terminals on Citroëns seem to be neglected worse than any other type of car.
2. If the charging light is behaving unusually, starter operation may be affected. This is usually caused by the voltage regulator.
3. Actual starter buttons on early manual shift cars will never fail, but the starter contacts on the Citromatic shift lever on Citromatic equipped cars could be a trouble spot. The key switches used on '70 onwards manual shift cars are another sore point, especially on cars without the under-hood starter relay.

4. On cars that are not equipped with the under-hood starter relay, the starting system wiring is quite different. Additionally, the starter solenoid is electrically different, so be aware when putting a used or different starter in your D-model (make sure that the brass contacts on the back of the solenoid are the same).
5. The starter relay itself is quite reliable, if battery corrosion is kept away from it. If there is a lot of corrosion around the battery, it could mean that the charging system is overcharging, but usually is simply a crummy battery. Buy a good battery, and you will save money in the long run.

Wiring schematic diagram
Chris Dubuque (Dec. 1987, p.19 & Feb. 1991, p.15)



Starter Circuit Wiring Diagram for '68-'74 D-Models



Starter Relay and Solenoid Schematic Diagrams

Chapter 25–Steering

Alignment rarely required
Ken Betsh (2000 #6, p.9)

The extremely rugged construction of the D-model front wheel suspension (aside from the hydraulic height control) precludes the need for routine front-end alignment as with other cars. The only adjustment provided, other than for toe-in, is on the roll/sway bar for balancing the camber of the two front wheels. The Citroën shop manual describe unique procedures for adjusting camber balance and checking caster. I put these in the "if it ain't broke, don't fix it" category and only in the hands of the fully experienced. Toe-in adjustment is conventional and I have had this done by a reputable shop after each time a tie-rod has been replaced.

Crossover pressure adjustment critical, not the same for all years
Don James, OH (Mar. 1984, p.21)

Q. The steering wheel of my '68 DS21 would turn back and forth when I touch the steering wheel when the car was running and under pressure. According to my Citroen shop book, this meant the crossover pressure needed adjustment. After readjusting the crossover pressure according to the instructions in my book and using a J.B.M. Industries crossover gauge set, the steering is very hard to turn. – John Young

A. Your cross-over pressure is now too low. This adjustment is very sensitive and the shop book does not explain just how sensitive. You must move the wheel very slowly and adjust the screws evenly. If the steering is notchy or too heavy, pressure is too low. Don't worry about the steering wheel twitching. Older cars use a lower pressure, so be sure your manual is for your year car.

Crossover pressure adjustment difficulties
Ken Betsh (2009 #3, p.15)

A replacement rack performed well when maneuvering my D-model, but not so well on the highway while making slight corrections. It had a sort of all-or-nothing feel. It didn't have the old Citroën feel and left me wondering if this particular rack had always been that way or if my freeing the sticking valve made a change.

Citroën D-models have what many call assisted power steering. There's a complete mechanical linkage and it's aided by a double-acting piston to which system hydraulic pressure is selectively applied. The designers apparently found the smoothest action was to apply about half of the system pressure to both sides of the piston when travelling straight ahead. Then as one started to turn, the pressure on one side would gradually increase to maximum as the other side decreased to zero.

Company service manuals give specifications for this equalized or "crossover" pressure. There was a rather subtle change made to the power steering in the late '60s – the numbers in my 1972 manual are slightly different from those in my '67 manual. I didn't give this much concern since I didn't know if my replacement rack was a "before" or an "after."

The manuals show this being checked with two identical pressure gauges connected to the pair of pipes normally connected to the right end of the rack. During checking (and making any subsequent adjustment) no pressure is applied to the rack.

I was able to borrow a set of pressure gauges assembled specifically for measuring the performance of the D-model power steering system. Connecting it near the right end of the steering rack was rather easy since my car doesn't have an air conditioner compressor and the battery is on the left side. Before opening the hydraulic lines, I completely drained the system pressure by opening the bleed screw on the pressure regulator and then turning the steering wheel back and forth a few times.

What I found fully explained what was happening on the road. After tightening the bleed screw, starting the engine and waiting for system pressure to build up, there really wasn't any crossover pressure. Instead, there was a definite, but small, interval at dead center with no pressure on either gauge. Turning the steering wheel slightly in one direction caused the pressure reaching one gauge to jump up quickly with the other staying at zero. Turning the wheel the other way had an equal but opposite effect on the gauges.

Obviously, an adjustment was needed. As I soon found out, the effort to check the pressures was a mere token of that needed to make a correction.

Mounted in the car, the rotating valve assembly at the base of the steering column was directly under the battery on the left side and there was no way to get at it for an adjustment without removing the battery and the steel platform on which it sat. This platform was held by two bolts at the rear, threaded into tapped holes in the side frame and by two harder-to-get-at bolts and nuts at the front. Then, to make it still more difficult, the two straps holding the hydraulic fluid reservoir to a vertical part of the battery platform had to loosened, plus a small screw holding the heater fan assembly to the rear of the platform. I was able to do this without removing the left fender, but did have to remove the radiator air duct to reach the nuts holding the front of the platform.

Before any adjustment could be made, I first had to loosen the boot covering the valve assembly to expose the two adjustments (one for each valve). I already knew this had to be done carefully to avoid tearing it. I knew a replacement boot was available, but changing it would be expensive and would require loosening and moving the steering column.

A part of the mechanical linkage of the steering system looked like a double-ended paddle. It overlayed the valve assembly, which contained two good-size adjustment screws with locking nuts. They varied the degree to which the actual valve cores are moved. The manual asked for equal changes be made to both and suggested changes of 1/12 turn (which would be 30 degrees).

I think it took me about six tries to even find the point where I had partial pressure on both meters and close to full pressure on one by the time the other dropped to zero. Each try was a major effort. First, I loosened the adjustment lock nuts, then turn the adjustments. I then tightened the lock nuts, tighten the bleed screw. I temporarily set the battery in position resting on a piece of wood, connected the battery, started the engine and waited for pressure to rise.

Finally, I would turn the wheel back and forth while watching the gauges which were set in a position to be seen from behind the steering wheel.

It all had to come back apart to make each set of adjustments. After I got close to the desired readings, I was making much finer changes, perhaps less than 10 degrees and to just one of the adjustments. By doing this just to the one nearest the center of the car, I found I could leave the battery in place, still resetting on a wooden block and reach down beside it.

The manual warned against letting the power steering system oscillate for fear of damaging the gauges. Their suggestion was for an assistant to hold the wheel. Working alone, I had no problem as long as I relieved the system pressure as soon as I could after stopping the engine, following each reading. I assumed the possibility of this oscillation came from having the hydraulic system piston disconnected.

The difference between the old and new specifications became a mute point. By the time I got close to the average of the two, what seemed like a hair's change threw me way beyond that point. The manual specifications also included the differences in the two pressures as one started to turn one way or another. For me these seemed to track the centerpoint (halfway) pressure and didn't complicate the procedure.

The other thing I found was the need to wait each time until the system reached full pressure. This wasn't hard to tell – I just note the highest pressure on one of the gauges when turning the wheel just a bit in either direction. After making the final adjustment, I also took note that the changes in pressure in the two directions was quite symmetrical.

The last major chore was putting everything back together. I did it all except for removing the gauges so that I could make one last check that showed the same readings. The final test, about eight solid hours after starting, was driving the car around the block and finding a steering miracle had taken place. My efforts were really rewarded when we drove the car to Carlisle. The only regret was in waiting so long to make the improvement.

Fluid wetness normal around rotating union
2/14/68 Citroen Technical Bulletin #59 (Mar. 1992, p.18 & Jun. 1993, p.11)

The rack control pinion of the hydraulic steering does not have a leakage return line. Because of this, a normal sweating appears at the ends of the valves, at the seals of the rotating union and around the rubber cover protecting the pinion, giving them the appearance of being covered with grease.

This does not make it necessary to overhaul these parts unless a notable consumption of hydraulic fluid is discovered due to a leak in the rack control pinion.

Non-petroleum grease for LHS steering racks
Andrew Turner, Canada (Apr. 1998, p.12)

I have just rebuilt the rack and pinion steering on my '67 DS21. This is the second time that I have done this in 3 years. I thought that this time I should try to find a grease for the rack and pinion that is compatible with the brake fluid seals as I had previously used a multi-purpose bearing grease. I thought that the petroleum-based grease may have come into contact with the piston or end seal and caused the rubber to swell and allow the power end to leak.

The original grease was castor oil grease (made from the castor bean). I tried to obtain this from all the local auto parts suppliers, but none had heard of castor oil (I was regularly offered a Castrol grease!) and one distributor thought it was probably only available in Europe. So I then started to look for a 100% silicone grease, but again without success. I did not wish to risk using a silicone di-electric grease because often these have petroleum fillers.

Eventually, I came across Eze-Slide brake lubricant (stock #331), produced by Kleenflo Tumbler Industries. I wrote to the company and told them why I needed a silicone or castor oil grease and its intended application. I received a very quick and informative reply from Marcel Deveau of quality control. It turns out that Eze-Slide is made up of silicone and castor oil grease. This product has several uses on LHS2 cars. In addition to being used where a castor oil grease is required, such as the rack and pinion and the push rods for the forks at the top end of the pinion, it is useful for lubricating the LHS2 reservoir cap and lubricating the threads of the brake bleed screws and hydraulic line connectors as well as being used as a dielectric compound for the battery post terminals, plug leads, etc.

Rack reassembly without alignment tool
Everett Austin and Chris Dubuque, WA (May, 1984, p.9)

This simple hint helped me to reinstall D-model steering racks without the special alignment tool. Once the rack is in place with the fixing caps lightly fitted so that the rack can still be rolled up and down, and the steering column is attached to the spline fitting on the rotating union, but not tightened yet.

Pull up and down at the point where the steering column fits the rotating union spline. Do this to get a feel of the amount of play. While holding that point exactly in the midpoint of the play, tighten the steering rack fixing collars. Tighten the steering column fixing bolt.

This seems to give the proper angle and is much better than guess work or trial and error if you don't have the alignment tool. The steering should move smoothly and evenly in either direction from lock to lock, if properly aligned and all is in order.

Rack rebuilding error causes hard turning
Don James, OH (Jan. 1984, p.10)

Q. I have installed the Teflon seals in my rotating union and had no trouble installing them. Now I am having trouble with the steering. When the car is on jacks, the wheels turn easy, but as soon as I put the car on the ground, I have a very hard time turning the steering wheel. It seems when I turn to the right it is not so bad, but to the left is very hard. After I put the seals in, it turned very hard on the work bench. What did I do wrong?

A. Only two things possible here. You have tampered with the screws that adjust the cross-over pressure or one of the seals is not in the right groove or is pinched. You may have left out the shaft spacer. My guess is faulty assembly someplace. Remove the rack and check your work. The rack should turn fairly easily on the bench. Lubricate as you reassemble. Follow the factory manual.

Rack reconditioning procedure
Don James, OH (Oct. 1987, p.17–revised)

As our cars let older and they get higher and higher mileage on them, some parts wear and need replacing. Internal leakage in the rotating union can cause the car to sink faster when parked and overwork the hydraulic pump when running. Internal leakage is what you have in a hydraulic jack that leaks down. It is not bad if you only need to pump it up once a day, but if the jack only supports the car for a few minutes, it makes for a lot of pumping and wasted energy. Worn union seals can also wear unevenly causing the steering to pull to one side and not the other.

External leakage of the power steering can be the reason you see a spot under your car. In most cases fluid can be seen on top of the transmission. External leakage is usually caused by leaking piston end seals. High pressure hydraulic fluid leaks past the seals forming a grease that fills the steering and leaks out at the center shackle near the top of the transmission.

While many hydraulic components on the car need special equipment tools and knowledge to repair, the steering comes into the realm of a good and skilled mechanic or enthusiast. It does require some special tools, but these are not expensive if all that is needed is seal replacement. Setting crossover pressure requires more expensive equipment, but it can be done on the car.

Seal replacement is easy and requires installation cones and a pin extractor. Removal and replacement of the steering rack requires an alignment tool as this adjustment is critical for proper feel. The alignment tool should be used every time the rack is placed in the car, such as for engine removal, clutch jobs, work on the cam pulley, etc.

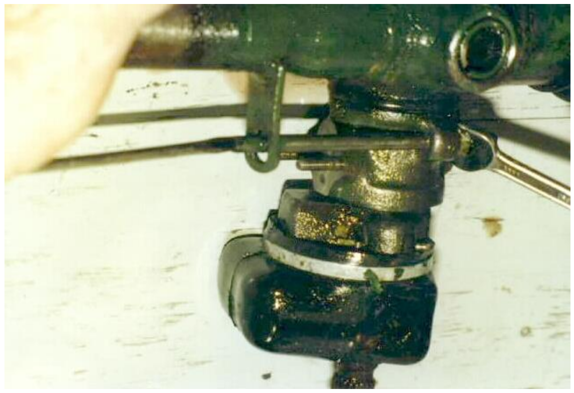
The steering rack on the D-model is very well made and will last a long time. Worn seals are easily replaced if they begin leaking. Most other cars that have power steering have leakage problems at much lower mileage than Citroën and their systems are not nearly as efficient.

Cars made prior to '67 require a 21 mm diameter piston and seals to match. Later cars had a 19 mm piston and more power assist because of this.

Reconditioning the Rotating Union:

Step 1 - Clean the exterior thoroughly. It is very important when working on hydraulic components to keep things clean and handle parts carefully.

Step 2 - Remove the manifold lines that go from the rotating union to the piston end of the rack. Be careful not to scratch the ends or the seal plate. Seal plates can be lapped on a piece of plate glass with #240 wet or dry paper.



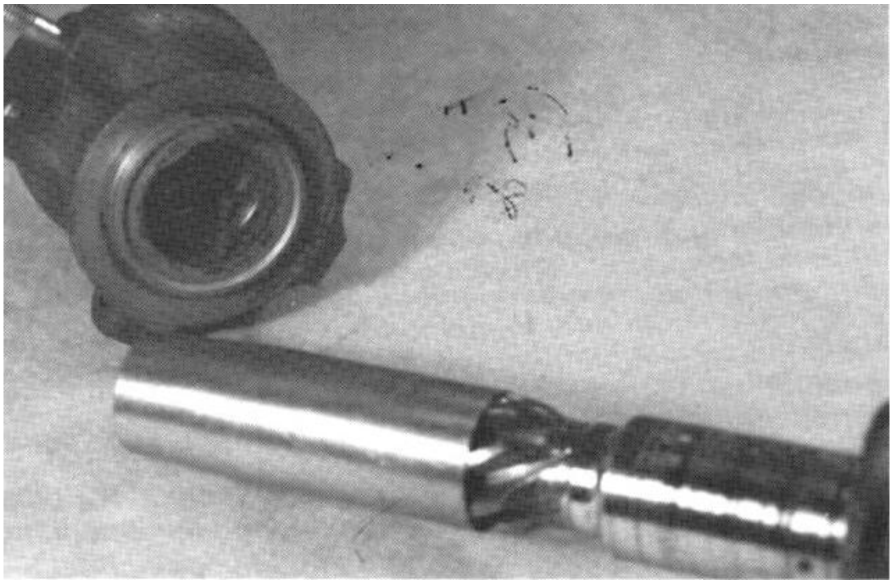
Step 3 - Remove the stay from the rotating union. The twist in the retainer is there for a reason; so do not straighten it. It takes the play out.

Step 4 - The pressure foot can be removed after extracting the cotter pin. This foot keeps the looseness out of pinion and rack. It is spring loaded. Remove the cap that covers the nut at the end of the pinion. The cap does not look like it is pressed in fully, but this gap is for use with the alignment tool.

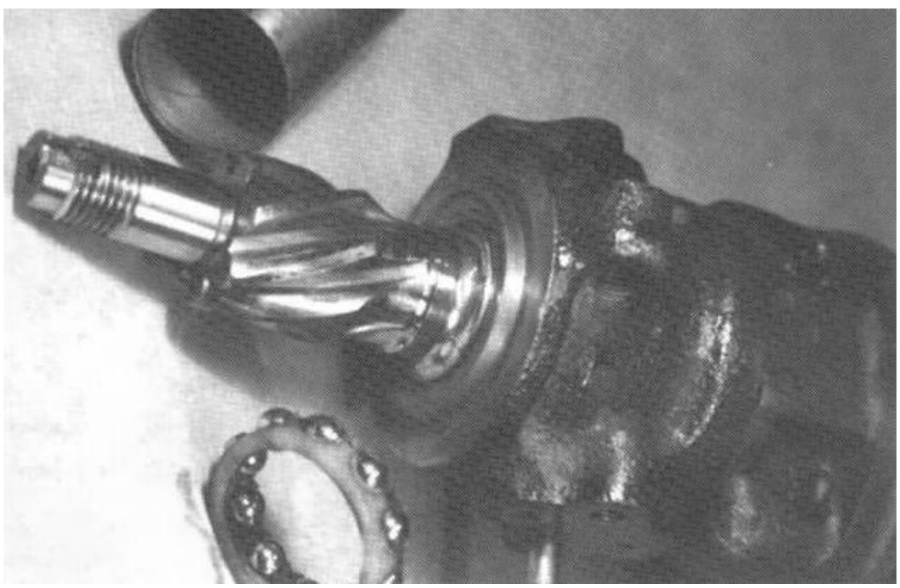
Step 5 - Remove the nut from the end of the pinion, and with care and over a bench, withdraw the pinion shaft along with the union. Note carefully the position of the bearing and the spacer on the shaft so that they will be reassembled correctly.

Step 6 - After the union has been slid off of the shaft, the Teflon seals can be easily removed with a dental pick. Seals have a rubber backing and this backing generally will not need to be replaced. There are four of these with one plain rubber O-ring at the top. This last one is for the passage of low pressure return fluid. If the seals in your steering are quite old, you may wish to change the rubber backing rings to restore the proper "squeeze" on the Teflon. The backing rings will have to be changed to a different type if a change in fluid is being made (brake fluid to/from mineral). LHM (mineral) steering racks are painted green and will always be in excellent condition inside. Be sure the rubber backing ring is installed properly in the groove before you install the Teflon seal. Take care not to twist the rubber.

Step 7 - The new Teflon seals should be bent into the shape of "C" and placed into the grooves on top of the rubber backings. Be sure to get the teflon seals into the proper grooves. Be very careful not to nick or scratch the inside of the seal. Push the seal into the groove with your fingers.

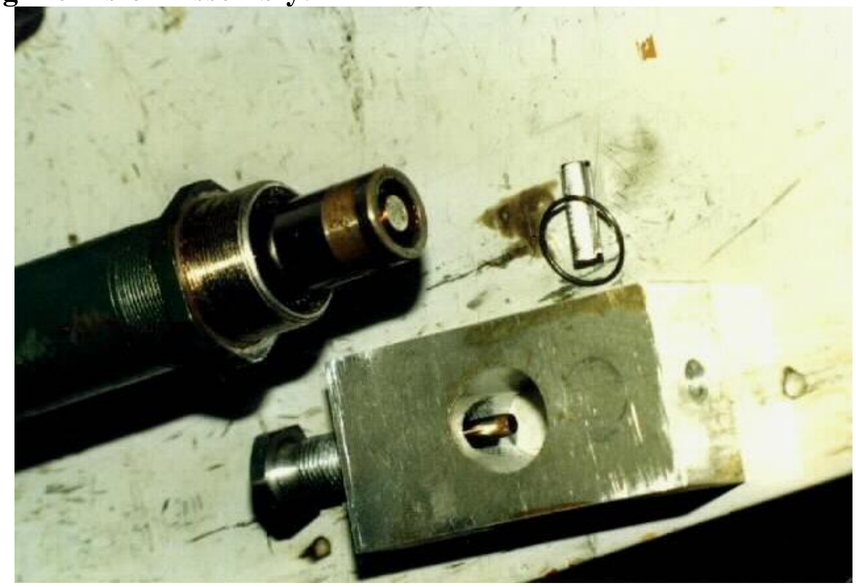


Step 8 - Slide an installation cone over the pinion gear during assembly. It is essential to insure getting the shaft into the union without damage to the seals. Lubricate with fluid to ease assembly.

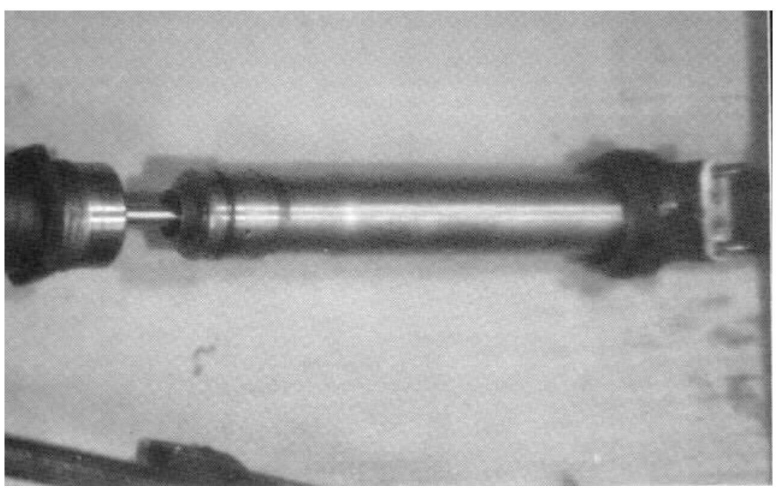


Step 9 - After the pinion gear shaft is installed in the rotating union, slide the bearing cage and spacer washer over it in the same positions from which they were removed. Thick grease can be used to hold balls in place in the nylon cage. (For LHS cars, use silicone-castor based grease as mentioned in another article. [MB]) This unit is ready to place in the housing, but this should be done as a "last operation" if you plan to replace any accordion boots.

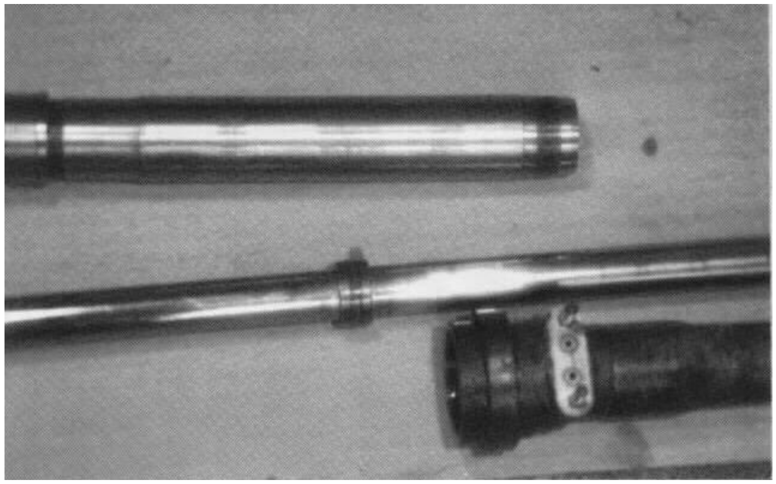
Reconditioning the Piston Assembly:



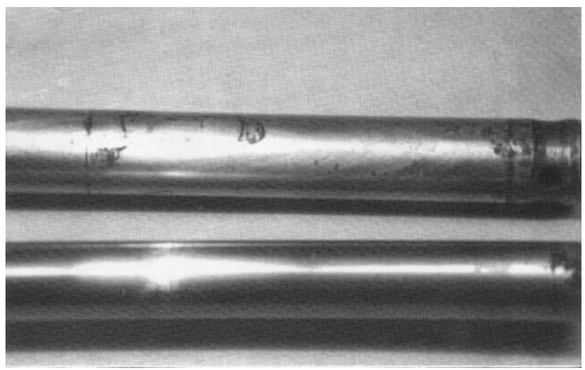
Step 10 - The first step in replacing piston seals is the removal of a pin that links the steering control rod to the hydraulic piston. It's accessible at the right end of the rack after removing the end cap and turning the steering toward that end. Remove a wire ring used as a safety to retain the pin. Use a piston pin extractor such as shown to remove the pin. It is sometimes possible to drive the pin out using a "V" block and pin punch, but you MUST have a pin punch of exactly the right diameter or the pin will be damaged making removal impossible. This pin is a very tight press. Bungs and nicks can be cleaned up with #240 paper if the pin is spun in an electric drill. Bungs or nicks on the very end of the piston should be filed off before it is removed from the cylinder.



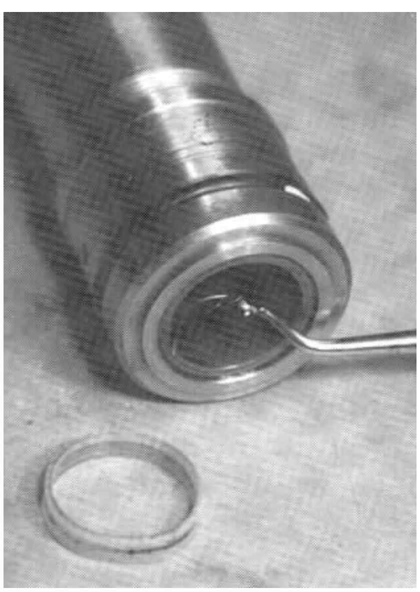
Step 11 - Loosen the large jamb nut between the right end of the right side accordion boot and the right side hydraulic connecting block. USE EXTREME CAUTION in grasping or holding rack in a vise to avoid distorting the cylinder inside. Unscrew the right end (including the hydraulic connecting block) from the center part of the rack. Usually the piston and two-piece cylinder come out as shown. Sometimes sticking of the static seal on the outside of the cylinder causes one half to unscrew from the other half and stay in the end of the rack.

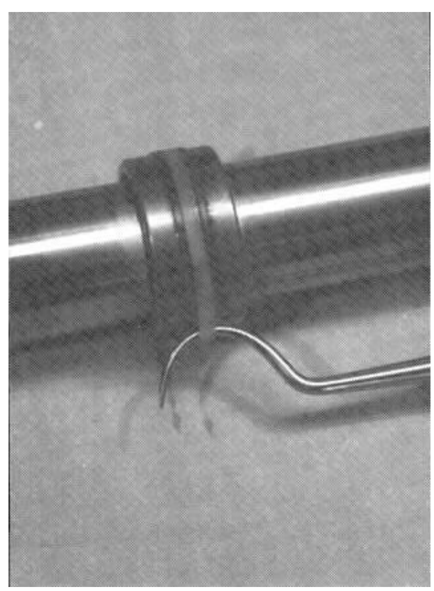


Step 12 - Separate the two-piece cylinder into the piston normally inside it and the housing end. Use a dental pick to remove the old Teflon end seals.

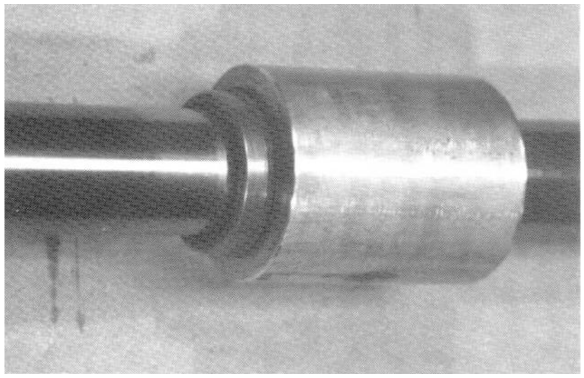


Step 13 - Examine the parts carefully. Lower piston shown can be polished with #400 wet or dry paper. The upper piston is from an LHS-2 rack that was removed from a car and not properly plugged and sealed. (Air, moisture and LHS are corrosive. [MB]) Extreme pitting makes this piston useless.

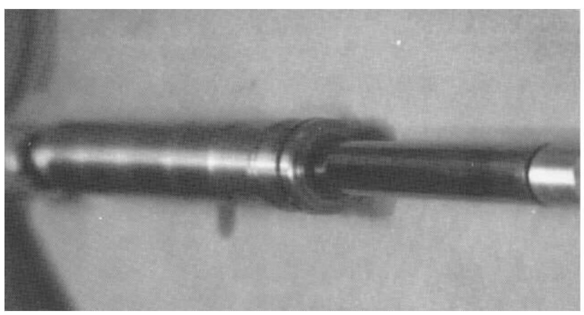




Step 14 - Remove seals from the inside of the end the cylinder with a dental pick as shown in the left picture and from the center of the piston with a dental pick as shown at right. Take care not to switch the center seal with a union seal. They look almost the same, but are dimensionally different!

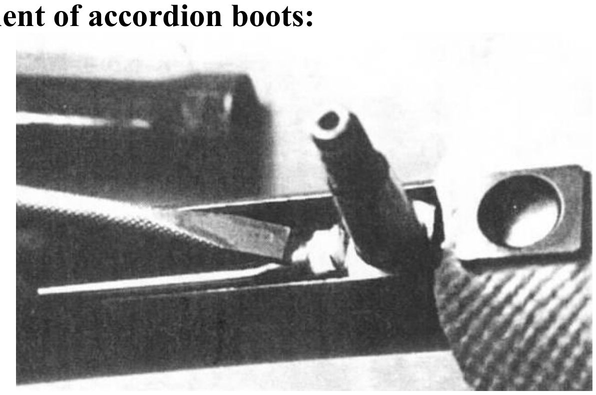


Step 15 - Install a new Teflon piston seal. An installation cone with a taper on the inside is used to compress the center seal into its groove. Wobble the cone over the seal several times to be sure seal is compressed between the washers. Teflon will stretch a bit, but is very slow to recover, and will not recover completely on it's own.

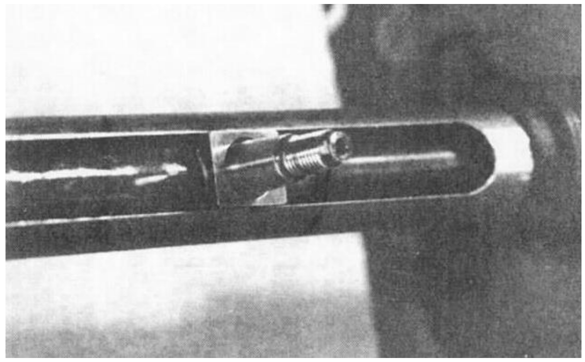


Step 16 - Slide the piston back into the cylinder. Use a protection cone on both ends and screw the piston and cylinder assembly together. Use a piston end cone to protect the seal. The entire assembly is now ready to reinstalled in the rack. This should be delayed if the accordion boots are to be replaced.

Steps to allow replacement of accordion boots:



Step 17 - Replacement of accordion boots requires removal of the center shackle pin. This is easy to do and requires only one special tool. Unstake the metal tab on the nut as shown above.



Step 18 - Unscrew the nut from the shackle with a long extension welded to a sparkplug wrench as shown (this wrench can be made). With the union, piston, and cylinder assembly removed from the rack housing, hold the rack vertically and slide the shackle pin against the end of the slot. The shackle pin fits on a taper and, if banged against the end of the slot, will come loose. Do this over a cushion to catch the rack when it comes free.

Reassembly:
Assembly is the reverse, but you must install the union and pinion, along with the pressure foot, to hold the rack in the proper position while you tighten the shackle nut. Install the pin with the slot aligned so that the wire retainer can be replaced. Be sure to replace the steering stop cap in the same position as this determines your amount of steering travel. Screwing these caps "in" reduces steering travel, lock to lock.

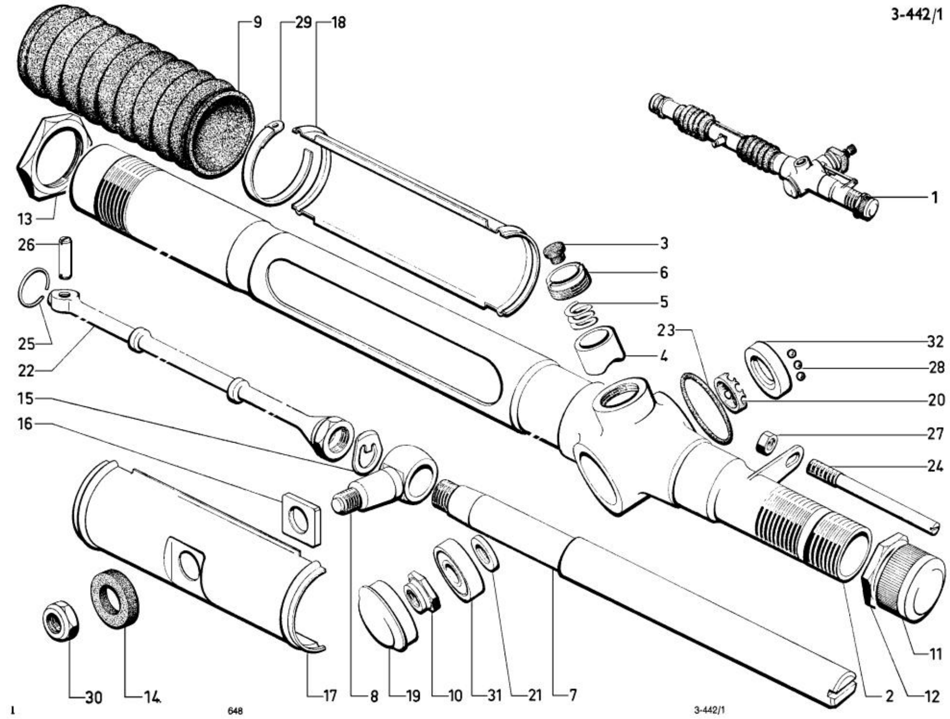
When replacing the assembly in the car, it is very important that the steering column, spline diameter and the end cap groove of the rack be in perfect alignment. If this is not right, the car will not steer properly. An alignment tool for this purpose is a virtual necessity.

The Citroën power steering system is basically a double acting piston linked to the steering rack. The unique part of the piston is a hole thru its center so that the actual link is thru a pin at the extreme right end of the rack. This extra length prevents binding in case of misalignment or movement.

Partial pressure, called the cross-over pressure, is applied to both sides of the piston when no steering effort is being made. There should be no need to adjust this pressure after the seals have been replaced as long as no tampering has ever been done on the adjusting screws in the fork at the end of the spline.

Teflon seals may take some time to seal perfectly. If installed correctly, any leakage past a seal should disappear with wear, unless the seal has been deeply scratched, cut, or damaged.

Dimensions or Descriptions of Selected Parts:



Housing, rack and shafts:

9..Sheath, Rubber, 40 mm ID (2 req'd)

14..Washer, Rubber, 16.5 x 28.5 x 9 mm

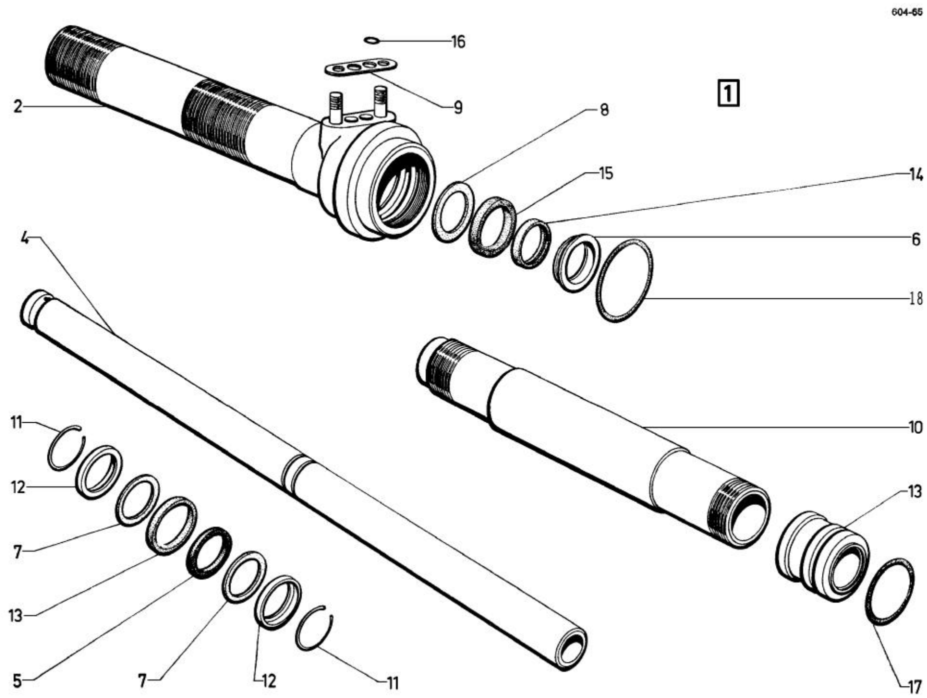
20..Cage, Nylon

23..Seal, Rubber, 37 x 47.6 x 5.3 mm

28..Ball, 6 mm OD (10 req'd)

32..Ball Bearing, 12 x 32 x 10 mm

33..Ball Race, 29 x 35 x 7.5 mm



Right end, cylinder and piston:

4..Piston, 19 mm OD

5..Seal, Rubber, 18.5 x 24 x 2.2 mm

7..Washer, Rilsan, 19 x 25.3 x 1 mm (2 req'd)

8..Washer, Rilsan, 19 x 26.6.x 0.3 mm (2 req'd)

10..Cylinder, 25.4 mm ID

12..Washer

13..Joint, Teflon, 24.2 x 25.7 x 2.3 mm

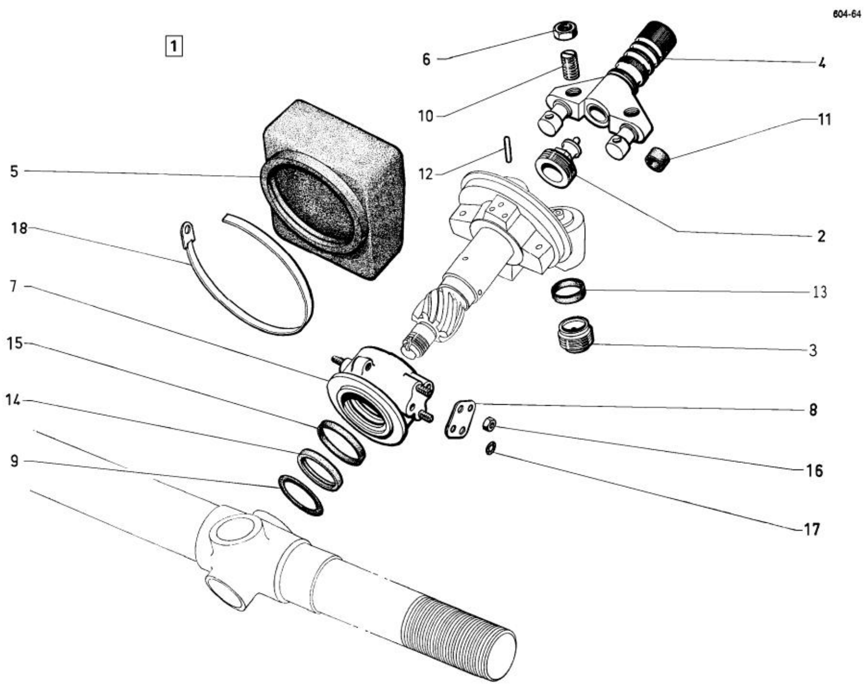
14..Joint, Teflon, 18.6 x 20 x 4.4 mm (2 req'd)

15..Joint, Rubber, 20 x 26.6 x 4 mm (2 req'd)

16..Sealing Ring, 4.2 x 8 x 1.9 mm (6 req'd)

17..Sealing Ring, 27.7 x 33.1 x 2.7 mm (2 req'd)

18..Sealing Ring, 37 x 44 x 3.5 mm



Rotating union:

9...Seal Ring, 24.5 x 29.9 x 2.7 mm

11..Bush, Rubber, 8.8 x 11.5 x 9 mm (2 req'd)

14..Gasket, Teflon, 23.7 x 25 x 2.9 mm (4 req'd)

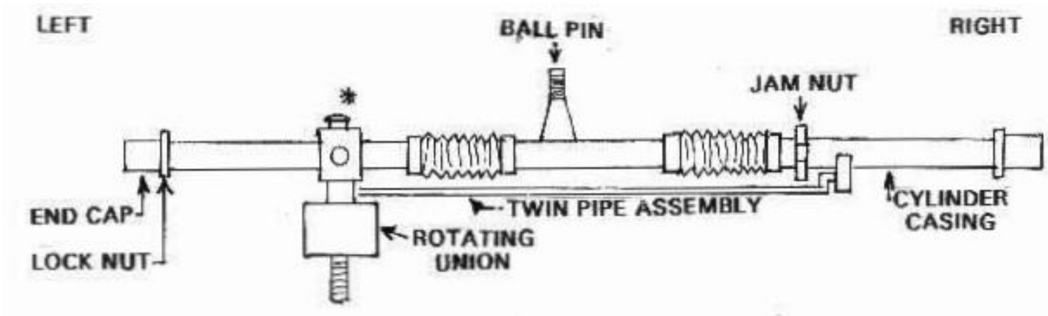
15..Joint, Rubber, 25 x 29 x 2.5 mm (4 req'd)

Rack and pinion steering is named for the teeth on the rotating union pinion gear assembly meshing with the linear teeth of the sliding rack.

The piston (4, middle picture) fits within the cylinder (10, middle) which screws to end piece (2, middle). The entire sub-assembly screws onto the main housing (2, top) such that cylinder (10, middle) is within the end of the main housing (2, top) and piston (4, middle) slides over the control rod (22, top). Pin (26, top) links the piston (4, middle) to the control rod (22, top) at the far end. A second set of end cap (11, top) and nut (12, top) attaches to far the end of end of piece (2, middle).

These parts drawings and dimensions are from the 1972 parts book. They apply to cars using LHM mineral fluid. Dimensions may differ in pre '67 models using a 21 mm piston (4, middle). The illustration from an earlier parts book was used for the original newsletter article. It showed the nylon ball bearing cage (20, top) in wrong position.

Rack reconditioning procedure
Ed Noguerola (Apr. 1990, p.20)



Rack Components

These procedures describe the renewal of the hydraulic seals on the steering assembly of a Citroën. It is based on the official Citroën shop manual, the J.B.M. Industries instruction sheets and first hand experience.

In the following, some operations are indicated as "optional". This means that the particular step is not necessary when renewing the seals. However, it is highly recommended since the steering assembly is already out of the car.

Unless otherwise noted, left and right are the same when viewed from the drivers seat. Reference is made to certain tools, e.g. dowel pin remover, cones, etc. These are available from J.B.M. or, of course, Fenwick in France! The use of gasoline to wash the parts refers to green fluid (LHM) cars.

Editor: The use of gasoline to wash parts is NOT recommended. For safety, use kerosene for green (LHM) cars and denatured alcohol for red (LHS) fluid cars.

Remove the steering from the car

1. Drain the radiator. Put the front of the car on jack stands.
2. Remove:
   - the spare wheel
   - the radiator cowl along with the spare wheel support
   - the fenders
   - the radiator
3. Release the hydraulic pressure
   - put the manual height controller in the low position
   - release the system pressure on the regulator.
4. Disconnect:
   - the steering column from the steering pinion
   - the hydraulic pipe assembly from the pinion
5. Remove the sealplate with seals. Cover the opening with a blanking plate or masking tape.

6. Disconnect the steering levers from the relay spindles.
7. Mark the position of the steering clamp caps with paint. Remove these.
8. Disconnect the steering rack assembly from the steering column.
9. Remove the triangular plates from under the end caps.
10. Remove the steering rack from the left-hand side of the car.

Recondition the steering

A. Dismantle the steering

1. Loosen:
   - the right lock nut
   - the cylinder housing lock nut
   - the left lock nut (optional).
2. Remove:
   - the nut on the steering ball pin
   - the yoke (with relay arms).
3. Drain the remaining hydraulic fluid within the steering by turning the pinion back and forth a few times.
4. Remove the end caps (optional for left cap).
5. Rotate the pinion until the end of the piston is exposed on the right end.
6. Remove:
   - the circlip on the piston end. Do not deform it!
   - the connecting pin using the dowel pin remover
   - the cap on the end of the pinion. Do not deform it!
   - Unstake the nut on the pinion end.
7. Remove:
   - the nut from the pinion end
   - the cotter pin holding the split nut
   - the split nut
   - the spring
   - the pressure foot.
8. Wash these in gasoline.

B. Work on the rotating union

1. Remove the pinion-rotating union assembly from the steering. Do this over a clean area to catch any ball bearings that may fall from the upper bearing cage. Do not lose any. Make note of the position and orientation of this cage–it faces up, towards the steering wheel. Also note the orientation of the spacer. The machined side is towards the pinion.

2. Cover the pinion gears with tape and withdraw the pinion from the rotating union. The four teflon seals and single rubber seal are readily visible within the rotating union.

3. The seals are easily removed with a (dental type) pick tool. Take care not to scratch the bore.

4. Remove:
   - the teflon seals
   - the rubber backing (optional)
   - the upper rubber seal.

5. Clean the rotating union.

6. Replace:
   - the upper rubber seal
   - the rubber backing seals (if removed)
   - the teflon seals; these should all be previously moistened in hydraulic fluid. They go in easily if gently bent into the shape a "c" and placed into the proper groove within the rotating union. Use only your fingers.

7. It is possible to overhaul the pinion controller, under the square rubber boot, but this requires different seals in addition to special gauges to adjust the cross-over pressure. Usually there should be no need to open this area.

8. Place the cone on the pinion teeth, previously lubricated with hydraulic fluid.

9. With the cone in place, push the rotating union back on to the pinion.

10. Remove the cone. This assembly is ready to install back on the steering. Put it aside.

C. Work on the cylinder-piston assembly

1. Unscrew the cylinder end casing from the main body of the steering.

2. Three parts should come out as a set:
   - the steering end-casing containing
   - the cylinder, which in turn contains
   - the piston.

3. Unscrew the cylinder/piston combination from the end-casing.

4. Remove the piston from the cylinder.

5. Strip down the end-casing. Remove:
   - the large o-rings using a (dental type) pick tool
   - the metal spacer
   - the teflon seal
   - the rubber backing seal (optional)
   - the rilsan washer; CAUTION: do not damage the rilsan washer and be careful not to scratch the bore with the pick tool. Removing everything, makes it easier to clean the parts.

6. Clean the end casing in gasoline.
7. Renew the seals. Moisten the parts in hydraulic fluid. Fit:
   - the rilsan washer
   - the rubber backing seal
   - the teflon seal
   - the metal spacer
   - the two large rubber o-rings.
8. Strip down the cylinder. Remove:
   - the large rubber o-ring on the outside
   - the teflon seal
   - the rubber backing (optional)
   - the rilsan washer; CAUTION: do not damage the rilsan washer when removing the rubber backing if you plan to reuse it. It is easily damaged with the pick tool.
9. Clean the parts.
10. Place new seals on the cylinder. Moisten the parts in hydraulic fluid. Fit:
    - the rilsan washer
    - the rubber backing seal
    - the teflon seal
    - the o-ring around the outside of the cylinder end; the rubber seal and teflon seal will go in easier if they are gently bent into the shape of a "c" and placed into the groove with your fingers.
11. Strip down the piston. Remove:
    - the teflon seal
    - the rubber backing seal (optional)
    - the locking rings under the metal bushings (optional)
    - the metal retaining washers (optional)
    - the rilsan washers (optional).
12. Clean the parts. Do not remove the rubber backing if you do not intend to renew it.
13. Fit the seals. Moisten all parts in hydraulic fluid. Fit:
    - a locking ring (if removed)
    - a retaining washer
    - two rilsan washers
    - a retaining washer
    - a locking ring
    - a rubber backing seal; be careful, do not stretch it when passing the rubber seal over the retaining washer
    - a teflon seal.

Observe the same caution as for the rubber backing seal. Moisten the inside of the piston tool with hydraulic fluid. Pass this cone with the larger inside diameter first over the piston and on to the teflon seal until the narrow end is just on the teflon. Let the tool stay in this position.

D. Work on the rack

This part of the overhaul procedure is performed when the left accordion boot is to be replaced and/or the rack is to be regreased (highly recommended!).

1. Unstake the lock washer on the central ball pin. This washer is going to be reused, so do not damage it.

2. Remove:
   - the piston control rod
   - the lock washer from the ball pin
   - the left end cap
   - the left end lock nut.

3. The ball pin is pressed on to the rack on a taper. There are two ways to remove the pin from the rack: hold the steering housing vertically over a pillow or bunch of rags (with the rack down). Move the pin to the upper part of the slot and let it drop. The rack may fall out! This may have to be done a number of times. An alternative is to fashion a puller that will pull off the pin from the rack. DO NOT BANG ON THE END OF THE RACK WITH A ROD. The rack is not hardened and the tapered end is split in addition to threaded. To repeat: DO NOT BANG ON THE END OF THE RACK! It is easily damaged. Once removed, the rack is easily cleaned. Clean also the inside of the steering with gasoline.

4. Grease liberally:
   - the rack
   - the pinion gears.

E. Assemble the cylinder and piston

1. Moisten the piston, cylinder and cylinder end-casing with hydraulic fluid.

2. Moisten the piston end cone with hydraulic fluid and place it into the end of the piston that will enter the cylinder. Insert the piston (with the compression tool still in place) into the cylinder.

3. Remove the piston end tool from the piston. Moisten it with hydraulic fluid and place it on the end of the piston that will enter the end casing (opposite end).

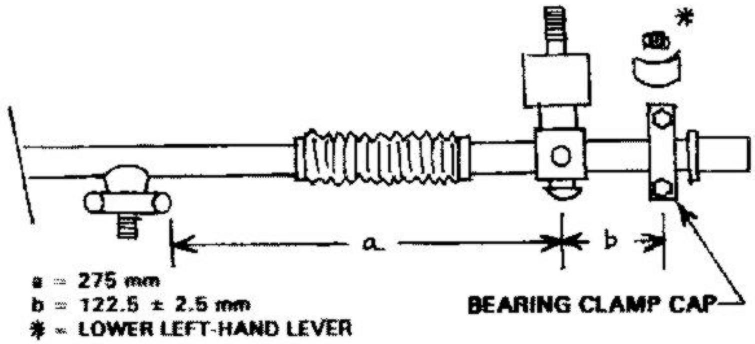
4. Moisten the threaded part of the cylinder and screw it into the end-casing. Screw firmly, but do not over tighten. Remove the tool from the piston. This assembly is now ready to place back on to the steering.

5. Place the rack back into the steering housing.

6. Place a large o-ring on the rotating union.

7. Replace the rotating union/pinion assembly into the steering. This will hold the rack in place.

Replace the power steering rack



A. Position the steering

1. Insert the steering from the left side of the car.
2. Turn the steering pinion until the outside (the right side when standing in front of the car and facing the rear) of the steering track rod (at the yoke) is a = 275 mm from the center line of the rack pinion pressure pad (the split nut).
3. Rotate the steering wheel until the spoke is 30 degrees below the horizontal and on the left-hand side.
4. Engage the steering pinion into the steering column splines.
5. Place the steering rack assembly on its clamps; adjust the lateral position in order to obtain a distance of b = 122.5 +/- 2.5 mm between the center line of the spindle of the lower left-hand lever and the center line of the rack pinion pad (split) nut.
6. Replace the clamp caps, respecting the marks made during dismantling. Do not tighten the screws yet.
7. Fit the coupling screw to the steering column and tighten the nut.

B. Adjust the angular position of the steering

1. Place the steering alignment tool on the steering column and pinion. The lower end fits in the gap under the pinion end cap.
2. Rotate the rack assembly in its clamps until the steering pinion touches the center pin of the tool. While doing this, have an assistant pull the steering wheel. Tighten the screws securing the clamp caps. Recheck the angular position of the steering and adjust as necessary.
3. Connect:
   - the steering levers to the relay spindles (nuts facing outwards)
   - the hydraulic pipe assembly; do not forget the seal plate with O-ring seals.
4. Replace the radiator and connect the hoses.
5. Tighten the radiator screws.
6. Connect the battery cables.

7. Fill the radiator.
8. Pressurize the system and check for leaks. Attend to any found.

C. Adjust the steering lock

1. Position the wheels for straight ahead running (steering wheel spoke at 30 degrees below horizontal and on the left).
2. Turn the steering wheel EXACTLY 1-1/2 turns to the left (power steering models only). Make sure that the tires are not touching the mud shields.
3. Screw in the left end cap until it contacts the rack (make sure that the lock nut is far enough in so as not to obstruct this movement).
4. Tighten the locknut.
5. Return the wheels to the straight ahead position.
6. Turn the steering wheel EXACTLY 1-1/2 turns to the right (for power steering models only). Make sure that the tires are not touching the mud shields.
7. Screw up the right end cap until it contacts the piston and tighten the locknut (make sure that the locknut is far enough away so as not to obstruct this movement).
8. Replace:
   - the triangular plates under the endcaps
   - the fenders
   - the radiator cowl with spare tire cross member
   - the spare tire.
9. Lower the car to the ground.

Watch your car stay up longer!

Rack removal and realignment
Jack Shotten (2000 #2, p.13)

I recently did battle with the power steering in my '69 DS-21. The car was originally shipped with brake fluid, and was converted to silicone several years ago. The main hydraulic piston in the rack was corroded and it's a wonder that the rack held a tight seal for as long as it did. I've installed metal parts from an LHM ear along with new seals, and now everything seems to be working well. However, I wasted a lot of time trying to make used parts work, and I've gotten pretty good at getting power steering racks in and out of D-model Citroëns. So here are a couple of notes from a pro.

It is possible to change out the hydraulic rack actuator from the right side of the ear without moving the rack if you have a pin extractor. I borrowed a tool from a friend that had been made by Don James several years ago and performed this operation as described in the shop manual. I do not recommend this method. The mechanical portion of the rack may have been contaminated by leaking fluid and the hydraulic parts do not tend to come out cleanly. I believe that it is better to remove the rack from the car.

The battery on my car is on the left. In order to remove the steering, I remove the left fender and the battery. I drain the hydraulic tank and remove the battery box. Position the wheels in the straight ahead position and mark the position of the steering rack as well as possible with paint. I then disconnect the hydraulic lines to the rack, the steering wheel and the rack from each side of the car. The rack will come out from the left, out from under the radiator hose. It is not necessary to remove the radiator or radiator hoses. I did turn the left wheel to make room for the rack, but did not have to disturb the right wheel. Leaving one wheel in place makes it easier to get the rack back in the same way that it came out. If your battery is on the right you might also have to remove the right fender. However, you do not have to remove the radiator. The rack comes out easily enough from under the bottom radiator hose. The entire operation should not take a huge amount of time.

In order to take the steering apart, I used the aforementioned pin extractor. However, with the steering out of the car, an arbor press should do the job. A punch and hammer used with care might do the job, but I don't recommend this. New seals were installed using installation cones purchased from Don James several years ago. New seals cannot be installed without this tooling.

The steering will not work correctly unless the rack is aligned with the steering wheel. In order to do this, I use another tool purchased from Don James. Align the rack with the tool, tighten the shackles and recheck the alignment with the tool. Tightening the rack can change the alignment, so you might have to loosen and retighten a couple of times to get it right. It is very important for this alignment to be correct.

What if you don't have the alignment tool? Rod Burwell, from his knowledge of how engineers design things, has discovered that the steering column is in alignment if it is roughly parallel with the frame of the car. A further suggestion is to leave the shackles loose, start up the car, turn the steering wheel and rotate the rack until the steering works OK. Then tighten down the shackles. If you go around a corner and the car wants to keep going around the corner totally out of control, then the steering rack is probably misaligned.

Let's assume that the steering rack is installed correctly and is not leaking, but is overly sensitive while you're driving down the road – as if you have to concentrate on not steering the car. Take your hand off the wheel and the car goes straight, but nudge the wheel and the car wants to go too far one way or the other. If the steering is twitchy or notchy, then it is possible that the cross-over pressure is set too high.

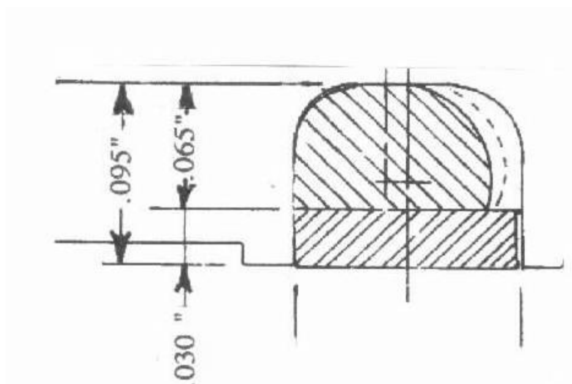
We set the cross-over pressure on my car using friend's dual gauges. However, I am sure that good results can be achieved through trial and error. Push the rubber dust cover on the rack out of the way where the steering wheel connects. There is a pair of adjusting screws and lock nuts. Loosen one lock nut and turn the screw 1/12 turn counterclockwise in order to reduce the crossover pressure. If the steering effort (the force necessary to move the steering wheel) increases, then you should put the screw back where it was. If the steering feels better, then you might try another 1/12 turn. The adjustment is very sensitive, and 1/12 turn at a time is all that should be attempted. My steering required 1/6 turn.

Conversely, if the force necessary to turn the wheel is excessive, try turning one of the screws clockwise 1/12 turn. Note that D-model power steering requires more effort than most cars with power steering but is very precise and civilized.

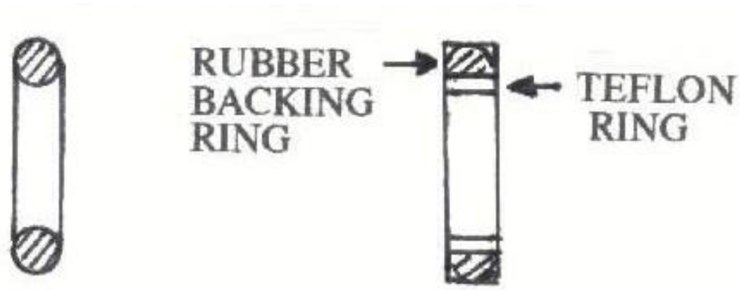
Rack rotating union seals are a rubber and Teflon pair
Don James, OH (May 1985, p.6)

Problems with leakage in the D-model rotating union for the power steering are usually solved by replacing Teflon seal. Fortunately, replacements for the special rubber backing seal are not needed in most cases. Racks that had bad rubber backing rings usually had just plain o-rings installed in place of the rubber-Teflon combination. This initially works well, but tends to cut grooves in the shaft and require replacement of the rubber rings at about 40 or 50,000 miles.

Club member Arthur M. Fleitas has invented a method for making the rubber backing ring on a "one at a time" basis for the rotating union seals. Several of our members have installed them and they seem to work very well. This means is that those with plain o-rings installed can now switch back to the rubber-Teflon combination for a reasonable price. Assembly of the two seals with thickness dimensions are shown in Fig. 176.



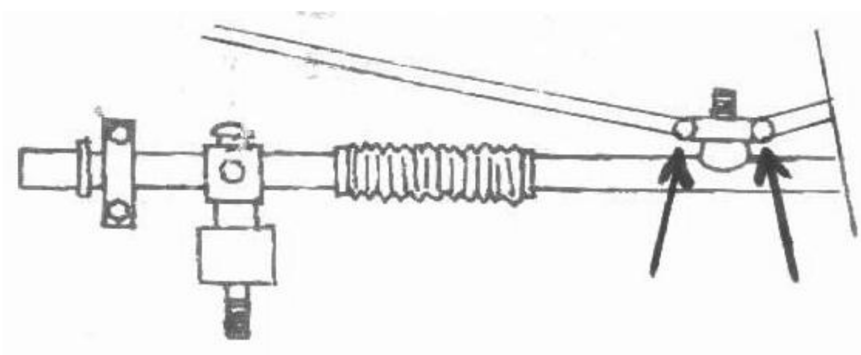
Rack rotating union Teflon seals replaced with O-rings
Everett Austin (Feb. 1984, p.3)



I replaced my rotating union seals with the rubber o-rings, and it works fine. The job was much simpler than I imagined, although I didn't realize how critical and delicate the angular steering adjustment was to the feel of the steering. I would eventually like to put in the Teflon seals, so I am anxious to hear if rubber backing rings are available for these.

Editor: The rubber o-rings in the rotating union will not last as long as Teflon, but are easy to install. The only cars that must use the plain o-rings are those that have had their Teflon seals and rubber backings replaced. These cars seem to be on the west coast. The steering rack is very difficult to put back straight in line with the steering shaft without an alignment tool.

Rack-to-rod bushing causes shimmy, replacement
Jack E. Davis, NM (Jun. 1990, p.14)



A small, short-lived shimmy every now and then in my '66 ID21F lead me to take a look at the steering linkage. I found the tie rod bushings, where they connect to the steering rack in pretty sad shape. I removed the radiator and was able to remove both the tie rods easily.

The bushings are made up of an outer steel sleeve, a rubber bushing and an inner steel sleeve. After removing the rubber I cut a piece of 1/2" heater hose the length of the old bushing and pressed it onto the inner steel sleeve. I then ground down the outer diameter of the hose so it would make a tight press fit into the outer steel sleeve. Should you think this an unprofessional way to fix the problem, it turned out real well and was just as good as a new bushings.

Relay arm life increased with grease fitting
Don James, OH (May 1992, p.22)

The life of a good relay arm or tie-rod for a pre-'65 D-model can be increased if you drill a 13/64" hole in the cap, tap for 1/8-28 thread and install a grease fitting. Use grease on the drill and tap to make the chips stick to the drill and tap and not stay in the hole.

Shimmy may be to to worn tie rod ends
Ken Betsh (2000 #6, p.9)

Over my many Citroën driving years, whenever I've had a front-end shimmy (vibration) in the 55 to 65 MPH range that wasn't due to tire balance, the cause has been a worn ball joint in the steering tie rods (not the main suspension ball-joints). There's one on each side connecting the lower side of the steering relay to the wheel. Each is about a foot long with a ball joint on each end.

The last time one failed, I could, with the problem side of the car jacked up, feel the play and hear a faint clicking sound when I tried to turn the wheel around a vertical axis (as if to change the direction the car heading). This time, it was the inner joint that was worn and the source of the clicking had me concerned that the problem was in the steering relay. I've replaced steering relays damaged in major collisions but never from normal wear. There's no repair kits for these ball joints; the expected fix is to replace the entire tie-rod. I once knew a do-it-yourselfer who could mix/match two half-bad tie rods into one all-good and one all-bad part.

Some tie rods have grease fittings and some don't. If I recall correctly, the '67 ID I owned years ago came from the factory with plug screws in the place of grease fittings. I was told the reason for not providing grease fittings is that damage could be done with a high-pressure grease gun. I replaced the plugs with grease fittings with no worry since I do my own greasing with a hand pump.

I've never had a problem with the set of rods that connect the center of the steering rack to the upper sides of the steering relays. These rods have similar ball joints at the outer end and sleeves with rubber bushings on the inner end. It's logical these ball joints last longer since they don't have to move with up and down movement of the wheel in passing over bumps. The right-side rod has a threaded coupling to vary the length. This is the means to adjust toe-in alignment.

Speedometer cable caught by steering wheel shaft clamp
Jack E. Davis, NM (Apr. 1990, p.8-condensed)

A few months ago I removed the engine/transaxle from my '66 ID21F for some adjustments and general repairs. This means undoing and reconnecting lots of cables, tubing and wiring. Getting it all back and in the right position should be done with utmost care. While backing out of my driveway some two months later, more than two thousand miles (at high speeds sometimes) after I reassembled the car, I found the steering to be notchy and the steering wheel was hard to impossible to turn.

I removed the fenders and other parts to get at the steering and there I found the speedometer cable wrapped around the steering column. I was very careful when I had reassembled the engine/transaxle to see that nothing would get caught on the steering column. There are many things such as hydraulic lines, wires, and a cable leading to the gear box that can get tangled onto the steering column. The problem can be the clamp that joins the steering gear to the steering shaft or the part of the rotating union that holds the spool valves. These both protrude enough to catch anything in the way when the steering turns.

When I removed the tangled cable everything returned to normal except, naturally, the speedometer didn't work. The steering was back to its normal operation. Of course, the speedometer cable was beyond repair.

Maybe you should check out the placement of anything close to the steering before you have an unpleasant surprise like I did. I can't help but think what would have happened if the steering had locked up while I was on a curvy road at a brisk speed.

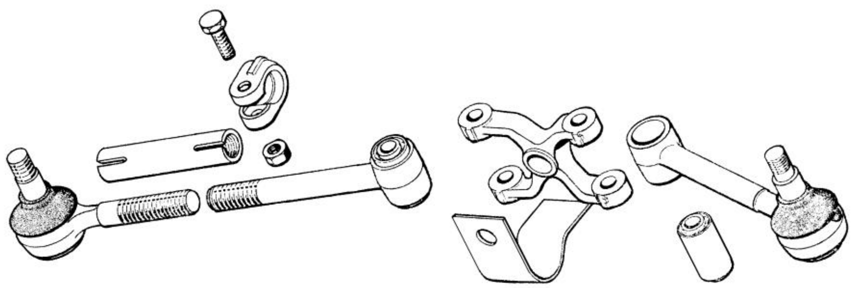
Suspected rack leaks traced to front brakes
Ken Betsh (2009 #3, p.14)

A series of hydraulic leak problems started at the right end of the steering rack. I was able to obtain some replacement seals for the steering rack, but an attempt at repair was unsuccessful – I damaged some of the new seals trying to install them. My only reasonable option was to buy a used rack with an unknown history from a fellow Club member. After installing it, the leak changed but didn't go away. Plus I now was aware of another leak nearer the left end of the rack. Since every attempt to locate the exact source of the leaks still pointed to the rack, a second used rack was installed. Initially this seemed to solve the problem but on the second day, puddles of the same size and position appeared on my garage floor after driving the car.

The leaking fluid appeared to drop down from the rack in two places, first onto each inboard brake unit, thence to the bottom pan, and finally to my garage floor. But, I never saw it drip – just wet spots where it had flowed. My guess was that the source was just like a leaky pump shaft seal. Full pressure on the seal holds it tight, but after parking as the residual pressure declines, the seal leaks until the pressure is gone.

The thought that the problem might be the brakes didn't seem logical. First, they worked fine with no indication poor seals were letting in air. Second, the o-ring seals with mineral-based LHM fluid seem to last forever. Since I had a brand-new set of these seals, I installed them expecting to prove the brakes were not the problem. Surprise! This did solve the problem. The old seals had very little wear, but they had become rather hard and inflexible.

Tie rod ball joint removal
Paul Fontaine (Mar. 1986, p.30)



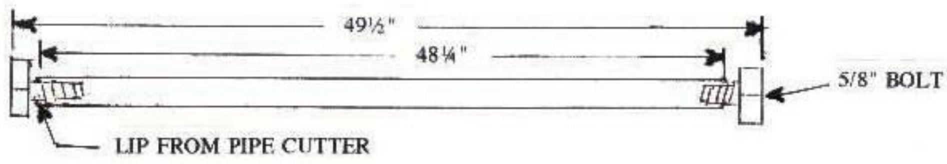
Steering Rack Tie-Rods As Seen From Front of Car

The outer ball joint on the right side steering rack tie rod was worn to the point that the wheel could be turned about 1/4" at the tread. This is the tie rod with the toe-in adjustment. Obviously this caused excessive scuffing of the tire tread to the tune of a loss of half the normal tread life of a set of Michelins. My error was in not checking the front wheels when the front end was completely off the ground. However, I studied the situation and decided that the ball joint stud could be driven down if the relay arm could be supported on the frame. I scrounged around in my goodie collection and found two 1" x 1" x 2" steel blocks combined with a 6" long piece of 3/8" plate that had been machined to a taper. They just fit under the arm.

I backed the nut off of the ball stud to a flush fit with the top of the stud. This prevented damaging the stud thread when I drove the stud off the taper. A few good licks with a three-pound persuader popped the taper out of the arm. Now, the safety nut would not back off the stud without jamming the ball with a pry bar, in this case, a 30" screw driver. (Never remove a tapered type tie rod end like this. Either use a tie rod press-type tool or at worst, hit the knuckle that the taper fits into with a large hammer; this will shock it apart. [MB]) With the stud and taper loose, I found there was just enough room to clear the bottom of the arm. By turning the right wheel to the right, the ball joint assembly could be unscrewed from the tie rod. The section that screws into the tie rod is a left-handed thread.

I marked the location of the tie rod thread with white paint so that I could install the replacement in approximately the same position. This turned out to be a fallacy as the replacement ball joint screwed in to the same number of threads, ended up with 1/2" of toe in. However, there is sufficient adjustment at tie rod to compensate for the 1/2" over specifications (See the next article).

Toe-in alignment measuring tool
Paul Fontaine (Mar. 1986, p.30)



Steering Toe-in Measuring Bar

The shop manual calls for 2 to 4 mm of toe-in. Now how do you measure the proper amount without the usual tool in a professional front end shop? I found a piece of electronite tubing long enough to fabricate a solid measuring bar. The bar turned out to be 48-1/4" long with a 5/8" bolt screwed into each end. The slight lip left when you cut the tubing with a typical pips cutter is enough to screw the 5/8" bolt into the tubing with a solid fit. The bar or tubing was held in position with a large bar magnet affixed to the floor pan. The final measurement was made with my internal micrometer with a 1" extension. Overall length of bar with 5/8" bolts was 49-1/2". Grind or file the marks off the head of the bolt.

Troubleshooting check list
Submitted by Jerry Seville, PA (Aug. 1985, p.25)

Reprinted from Citroën Factory booklet, "Citroën Hydraulic System, Possible Incidents With Suggested Causes & Remedies"

INCIDENT	POSSIBLE CAUSES	REMEDIES
14) High pressure low or absent.	General system pressure too low or absent.	Trace cause, rectify.
	Internal pressure leaks in power steering.	Change steering
	Excessive internal leaks in other hydraulic system circuits.	See Incident 1, found in Chapter 18 - Hydraulics, "Troubleshooting."
	External leaks.	Rectify.
15) Steering wheel oscillates.	Control valves mal-adjusted.	Adjust as per instructions in workshop manual.
	Steering column and rack mal-aligned.	Align.
	Excessive tightening of rack pressure pad plug.	Adjust.

Should it be necessary to hold the steering wheel hard on extreme lock and perhaps leave it in that position as for instance when parking, some "kick" or oscillation can occur.

16) Steering pulls to left or right.	Front tires worn on outside tread.	Change or rotate.
	Incorrect tire pressures.	Adjust pressures.
	Incorrect wheel alignment.	Adjust track.
	Front castor angle incorrect.	Re-adjust.
	Front axle camber incorrect.	Re-adjust.

Variation In front to rear axle centers (axle arm distorted).	Correct or change damaged arm.
Centering cam on steering column incorrectly positioned.	Re-position.

Other parts of the Citroën factory booklet in which the above appears are in this book under the following chapters: 3 - Brakes, 8 – Citromatic, 18 – Hydraulics and 27 - Suspension

Used replacement racks checked prior to installation
Ken Betsh (2009 #3, p.15)

My source for two replacement steering racks was a Club member who was selling parts stripped from rusted-out D-models by a now-deceased dealer. No history of the particular racks was known so appearance seemed about the only way to judge the parts. I had five to choose from and was permitted to remove and replace the right end caps for inspection. All had green markings to note they were for mineral hydraulic fluid. It's normal to find a minute amount of fluid inside the cap, but one was rejected for having a lot, suggesting an internal leak. Two others with traces of red fluid were also rejected. While this could have been from the use of mil-spec aviation fluid like I had been using, and would have not bothered me, it more likely could have been from extended use of Dexron fluid, known to eventually cause problems. All five racks had boots that still appeared to be in good condition, important since they're expensive and not easy to replace.

What I didn't check at the time, but now would do if I could, was whether the short medal rods forming the core of the two valves in the rotating union (at the base of the steering column) were free to move. Each is a less than a quarter-inch in diameter and rides snugly in a medal sleeve. With no system pressure, a light internal spring should allow the rod to be easily depressed and then return by itself to the off position. Visual inspection requires careful loosening of a flexible cover that should be still intact.

I checked this out after buying what I thought were two "good" racks and getting them home. Both valves on one rack moved freely, but one on the other didn't return after being pushed down. While this made it easy to decide which rack to install in the car, I fixed the "dragging" valve. It's easily removed by unscrewing a dome-shaped cover on the other end. A little cleaning with crocus cloth cleared the problem. What I didn't know at the time, but found later when the second rack (the one with a cleared sticky valve) was installed in my car, was that the setting of the valve for correct crossover pressure is very critical. Merely reassembling it in the same position it is not good enough. (See a separate article about the effect and adjustment of crossover pressure.)

Wandering, possible causes
Don James, OH (Jan. 1984, p.9)

Q. I've read some of your responses to various Citroën questions and find them far more authoritative than others. Therefore, as a long time owner of many Citroens, I've come across most problems and have found solutions one way or another. I'm currently perplexed by one that perhaps you can answer.

I describe it as a wandering down the highway (won't track) and a "crabbing" back and forth. Some of the remedies I've tried are: (a) placing all new Michelin XAS’s of the correct size, (b) wheel alignment per the shop manual by reputed specialists and (c) checking for looseness of all four wheels, linkages and bearings. I also checked tire pressures. The car is a '72 D-Special. -- Jerry Lugert

A. You did not say what you are using for hydraulic fluid. A notchy steering could be caused by too thick of a fluid. Remember, fluid gets thicker with age. We will assume that the fluid and other checks you made are OK.

Steering problems could be caused by a flat main accumulator sphere, misadjusted centralizing cam on the steering column or leaking seals in the rotating union. You didn't say how many miles you have on the car, but after 80,000 miles, those Teflon seals are probably shot. If the steering is notchy, cross-over pressure is too low. The adjustment for this is very touchy, so you need gauges. If the steering is tight in certain places, the rack is not installed in line with the steering column.

"Crabbing" would mean that the car goes sideways down the road, and would indicate rear wheel alignment is out. If the car is rusty or has ever been run on a flat sphere, it could be all bent out of shape. Low or bad suspension spheres will not cause any problems with tracking.

It’s hard to say exactly what is wrong without seeing the car, but I hope this gives you some ideas.

Chapter 26–Storage

Concrete or plastic under car better than covered ground
Don James, OH (Nov. 1982, p.8)

Here's a tip for winter storage of your car. Citroëns settle very close to the ground due to their unique suspension. Because of this, it is very important that the car be stored on concrete if at all possible. If you must store the car on the turf, be sure to lay down a ground cloth first. This will help keep the dampness from the ground from getting into the frame of your car. If you want to see the moisture that comes from the ground, place a clear piece of plastic over the ground for just a few minutes. You will be surprised at the water that will collect under the plastic.

Any type of plastic can be used for a ground cloth. A few small pinholes in the low spots near the tires will allow any rain water that gets on top of the cloth to escape.

Engine with oil in the cylinders less likely to get stuck
Don James, OH (Aug. 1983, p.6)

Any Citroën that is to be stored for a time should have the plugs removed and a teaspoon of oil poured down each cylinder. Citroën engines can get stuck in as little as two months storage–even less if the head gasket is leaking.

Ground clearance increased with suspension spacers
Don (Red) Dellinger, PA (Aug. 1985, p.16)

Moving a car around that does not run or that has bad hydraulics can be made much simpler by jacking the car up, removing the spheres and placing hardwood broom handles cut to length in the suspension cylinders. (D-models need a longer piece on the heater side because of the extension piece.) Replace the spheres and the car can be easily moved around with plenty of ground clearance. This also gets the bottom of the car up away from the damp ground to help prevent rust in the frames of cars that are in storage and not placed on blocks. (Hard rubber rods are even better. They are less likely to damage the suspension dampers. [MB])

Ground clearance increased with wedges between arms and pads
(Oct. 1979, p.2)

To keep a car off the ground when being stored for a long period, wedge pieces of hardwood or stones between the rubber pad on the suspension rocker arm and the car body frame. As the pressure releases over time, the suspension arm will be blocked from moving to the lowest position. The car will be easier to move around and easier to use a jack under in the future.

Mice discouraged by peppermint leaves
Yankee Magazine (Jun. 1990, p.12)

To keep mice from making a nest in some part of a car stored for the winter, crush some peppermint leaves and place them in some bags made from old pantyhose. Put these bags around in the engine and passenger compartments, trunk and don't forget those air ducts.

Mice kept out with screen at ventilation air intake
Dave Paulin (Oct. 1976, p.5)

One of the little annoying things that plague some of us that live in the country is the tendency for mice to build their nests in the fresh air ducts of post-'69 D-models. The pesky things not only block up the passageways with their little homes, but to add insult to injury, they use the wool matting on the hood for their material. I have cleaned out about five or six of these nests until I finally got mad enough to do something about it. The solution was seemingly simple. I cut some stiff wire mesh (the holes should be at least 1/4" in diameter) in a strip 1-3/4" by 33" long. I then inserted it to cover the complete front of the air-intake of the front bumper. By wedging the strip of mesh between the upper metal and heads of the small bolts below, I got the piece to stay fairly rigidly in place without screws. At either end of the intake near the headlights, however, it is necessary to fasten the mesh to the bumper metal by using a clip resembling a bobby pin. The whole job took about 15 minutes and can hardly be seen from the front unless you crouch down and look closely. So if you notice that you're not getting much air flow through the fresh-air vents, you might have a case of "mouse-in-the-tube."

Winter preparation
Don James, OH (Sep. 1984, p.23)

Be sure that your Citroën has plenty of antifreeze in it for winter. If you must store your car outside, try to get it up in the air on blocks to let the air circulate under the frame. Store it on concrete if possible. If you must store it on the turf, lay down a ground cloth to stop the dampness. Cover the car with a tarp, but be sure that the tarp does not come clear down to the ground. Remember, you want the air to circulate to help keep the dampness from the ground away.

Be sure the car is good and warm before you shut it off. This will prevent condensation in the muffler and the cylinders. It is a good idea to pour a teaspoon of oil through each sparkplug hole to prevent the dreaded "locked up engine". This is very common on Citroëns and has caused many needless deaths.

Be sure to remove the battery. The battery will loose it's charge over the winter months and freezing may crack the case. Battery acid every-where!

Change the oil and grease the suspension before you make that last run. Also, remember to oil the frame and doors. Don't be a Cit Killer!

These small things can be done in less than one hour, and it is a small price to pay for all of the hours your Citroën will be sitting out in the cold.

Winter preparation
Erik de Widt, MD (Jun. 1996, p.9)

Some careful maintenance in late Fall will ensure that by next Spring our Citroëns will be ready for service with a minimum of effort.

COOLING SUSTEM - If winter temperatures in your storage area can drop below freezing, add antifreeze solution to the system, or in case of doubt about the age of your cooling liquid flush it out and replace with a new mixture, following the instructions on the antifreeze container. Inexpensive testers are available at car parts stores to help you determine if your antifreeze mixture offers enough protection. In any case the cooling system must be protected with a concentration of at least 50% antifreeze–regardless of climate (pay attention Florida members!). A minimum of a 50/50 mixture with protection to -34F to a maximum of 70/30 protection to -84ºF must be adhered to in winter and summer. Flush this mixture out and renew it every two years and you will be protected for both cold weather and more importantly corrosion. Consult your manual for the capacity of the cooling system of your particular Citroën(s)!

Antifreeze solutions do much more than to protect your engine from the dangers of ice formation. The liquid in your car's cooling system circulates through passages made of several dissimilar materials: plastics, rubber, iron, aluminum, copper, brass and so on. Water contains impurities that make it an electrical conductor resulting in galvanic action, i.e., one component of your engine may thus dissolve another component! Modern antifreeze solutions are designed to combat this. For example, running straight water or old, worn-out antifreeze or antifreeze diluted by topping off with straight water corrodes aluminum which yields a pasty white goop. The agents in antifreeze that protect against corrosion–silicates–wear out and replacing the antifreeze every 30,000 miles or two years is the only cure. So, while you may have freezing protection if your coolant is old, it won't protect against aluminum corrosion. Another source of this radiator clogging white contaminant is silica dropout. This occurs in all-iron engines running high-silicate antifreeze, where there is no aluminum for the silicates to chemically work with. If you have an iron engine, inspect the antifreeze label for a phrase about compatibility with heavy-duty engines. It is a good sign that antifreeze is a low-silicate blend. This is because the long-haul engines from Cummins, Detroit Diesel and others are always all-iron and require a low-silicate antifreeze. Just for the record, distilled water can cause its own problems because it has such a low pH. Water will seek its own balanced pH, and when distilled water is placed next to aluminum, it leaches the minerals it wants from the alloy and black soot forms in the coolant. That's why silicates are put in aluminum-compatible antifreeze; they're sacrificial mineral deposits.

FUEL TANK - When storing your car it is very important to keep the fuel tank topped up to prevent water from condensing inside the tank. Today's reformulated fuels have a one month shelf-life before significant evaporation of the lighter distillates begins and varnishing occurs. To prevent this from happening (for up to three years) use a good fuel stabilize such as Sta-bil from your local auto parts store. Follow the instructions: one ounce treats 2-1/2 gallons of fuel. Put it in and run the car to get it completely through the fuel system. This product is not just for your lawnmowers and chain saws any more.

BODY AND TIRES - Dirt eats away at paint and chrome, especially if allowed to stay on for long periods of time. Wash the car thoroughly, including the under carriage. Dry the body work with a clean chamois and take the car for a good drive to dry the bottom. Then give the body a complete wax job and polish the bright work.

Check top and bottom for any signs of rust. Prepare any damaged areas well. Do not apply paint or undercoating over rust. This will only make matters worse because the rusting process will simply continue underneath the paint. Always remove all rust, then apply a rust resistant primer, followed by a top coat. In addition, under-body components should receive a layer of under body coating. Citroëns are notorious for their many hollow box sections in frame and body, which until quite recent model years received no rust protection whatsoever from the factory. The Europeans have for years used an ML-Tectyl treatment to combat rust in these areas. Small holes are drilled in all hollow areas and a high pressure mist of tar droplets is injected. Afterwards, the holes are closed with plastic plugs. Many scholarly articles have been written about the relative merits of the various substances that can be injected. FluidFilm, available from Bill Stevenson (and many other places, nowadays [MB]), a regular advertiser in these pages, is one of those and is highly recommended.

Adjust your tires to the proper pressures and place the car on jack-stands. Do this in such a way that the suspension and not the body carries the weight of the vehicle. Radial tires are particularly sensitive to deformation after long periods of sitting in the same location. Under the influence of the weight of the car the tire can develop a flat spot, which will be highly noticeable when you start driving again!

The car should be covered with a material that consists of two layers. The inner cloth should be soft so as not to scratch the paint and the outer material should be waterproof. There should be enough void-space in the material to allow air circulation. This way your car will remain dust free and you will avoid mildew and unpleasant odors. Only the very best car covers meet these criteria. Advertisers can be found in magazines such as Road & Track and Hemmings.

ENGINE - After taking the car for a spin to dry the undercarriage, the engine will be at the proper operating temperature. Drain the old oil and replace with fresh engine oil. Change the filter if so equipped. Do not run the engine again. To prevent the rings from sticking, remove the plugs and pump a few squirts of engine oil into each cylinder with your oil can. Turn the engine over a few times using the hand crank and replace the plugs. Grease all the lubricating points and oil all hinges following your instruction book.

BATTERY - Remove the battery from the car and store it in a cool, dry and frost-free place. Clean the outside of the battery well and remove any oxidation (sulfonation) from around the terminals. Apply a coating of special "battery terminal anti-corrosion gel" obtainable at your local car parts store. This is not a grease and unlike Vaseline, it contains special acid neutralizers.

The battery should be maintained throughout the winter. All batteries discharge slowly by themselves, a process that goes faster in older batteries. A discharged battery will sulfonate internally. This is a chemical reaction resulting in a permanent loss of capacity. Also, in cold weather a discharged battery can freeze and crack open. When things warm up again the acid will run out of the battery–all the more reason to remove the battery from your car during winter storage. I once saw a Traction that had suffered this fate. Steel dissolves in sulfuric acid and most of the firewall and front floor had vanished completely.

Once a month hook the battery up to an ordinary battery charger of 4 to 6 amps. Do not use a fast charger as this can seriously reduce the life expectancy of your battery. Remove the battery caps (if your battery is so equipped). Hydrogen gas is formed when a battery is charged. Hydrogen gas is very explosive, so make sure you charge in a well-ventilated space and don't smoke when you check your battery!

It can take a couple of hours to properly charge a battery; it all depends on the state of discharge of your battery when you started. When the battery is properly charged you will notice that the charging current slows to one amp or less. In addition gas bubbles will form in the cells. Stop charging at this point and check that the battery plates are still completely covered. Dry battery plates are also detrimental to the life of the battery. Add ONLY distilled water. Never use tap water as it contains impurities, which will seriously reduce the effectiveness of the battery. You can keep an eye one the state of charge of your battery with a simple battery charge meter, available for just a few dollars from your friendly local parts store. The specific gravity of the electrolyte is measured as an indicator of the available charge.

BRAKES - Common problems observed after winter hibernation are stuck, dragging and/or leaking brakes. This is definitely an area where preventive maintenance is called for. When we drive our car and use the brakes, the level of the fluid in the master cylinder reservoir falls and rises. There is a pinhole in the reservoir's cap to allow this to happen, and air is thus sucked into and expelled from the reservoir.

The moisture contained in air gets absorbed by the brake fluid and will make its way throughout the entire brake system. Brake cylinders will rust then leak and stick. The proper solution is to flush your entire brake system every other year. A good time to do this is along with these other winter preparation!

I am sure all owners of LHM equipped cars are beaming with satisfaction at this point.

LHM is a mineral-based fluid. It repels water and so LHM cars do not have to have their brakes flushed quite as often as cars whose brakes operate with alcohol-based fluids. Silicone-based fluid is entirely acceptable for use in a brake system designed for alcohol-based fluid, but ONLY after a complete rebuild with ALL NEW PARTS. No old parts must remain because traces of the alcohol-based fluid when mixed with silicone fluid can form unwanted compounds which may attack the rubber seals in your brake cylinders causing either seepage or sticking.

RETURN TO THE ROAD - When the weather improves and we feel the urge to take our Citroën for a spin, only a few minor chores await us. Check the tire pressure and remove the jack stands. Replace the properly charged battery. Clean the cable clamps and the terminals before hooking them up. Remove the spark plugs and squirt a little oil into each cylinder, turn the engine over with the hand crank and replace the plugs. Check the levels of the cooling fluid, the brake fluid and the engine oil. If your fuel pump is so equipped, pump the lever to fill the carburetor's float chamber. Doing so will greatly reduce the strain on your starter motor and your battery.

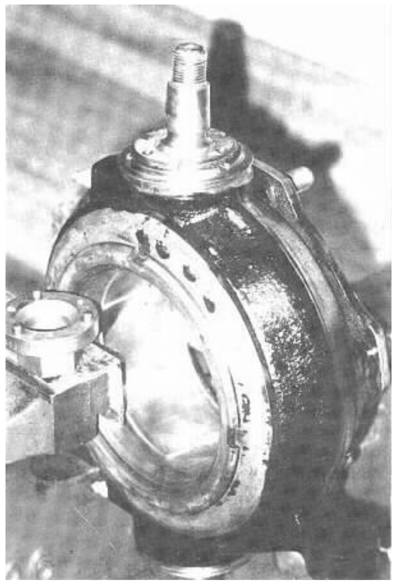
Start the engine and let it idle quietly for a few minutes so the oil can circulate and warm up a bit. Do not start it up with high revs or put it under load right away. With the engine running, check it for leaks in the fuel, cooling, and lubrication systems.

Once the engine is well-warmed up, do an oil change to get that winter storage oil out. Replace with fresh oil of the proper weight. Replace the oil filter. Immediately after driving off check the brakes for proper operation. All together the prep work amounts to a nice day's work. Well worth it to preserve your beloved Citroën throughout the long cold winter and to be ensured of a rapid start, come spring.

Much of the information in this article appears courtesy of Traction Avant Nederland - author Cees de Jongh, Road & Track magazine - Tom Wilson, and Denis Foley of North Mountain Frame.

Chapter 27–Suspension

Ball joint replacement
Chris Dubuque (May, 1998, p.8)



Lower ball joint on inverted pivot assembly, clamped in a vice

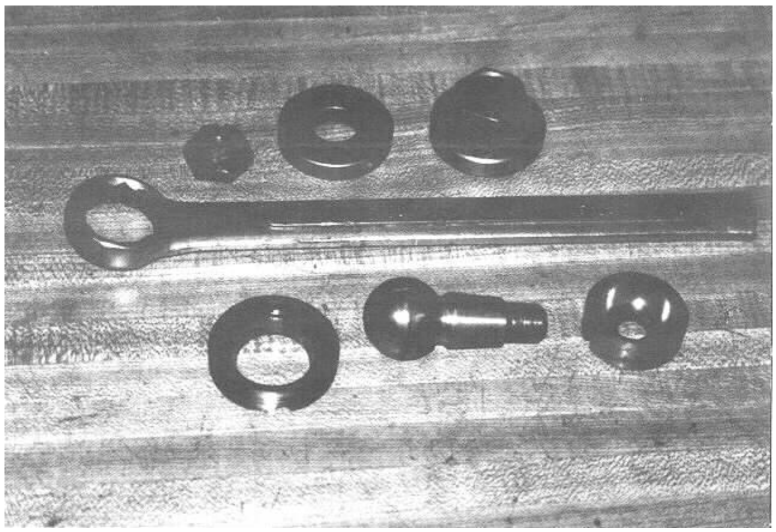
Does your DS or SM emit terrible rattling noises from the front suspension area when you drive over an irregular surface (such as cobblestones)? If so, the problem may very well be a worn lower ball joint. The following paragraphs are not intended to be a step-by-step procedure to replace the ball joint. Rather, the following briefly describes the scope of the project.

While both the upper and lower ball joints are susceptible to wear, it will be the lower ball joint that will emit rattling noises. The upper ball joint is always loaded with the car's weight and hence is less likely to make noises when driving over irregular surfaces. The first clue will be the condition of the rubber boot that protects the ball joint. If the boot is torn or is not securely fitted, water will enter the ball joint and quickly wash out the grease, allowing rust and high wear rates to destroy the ball joint. If the boot has not been properly protecting the ball joint, chances are high that the ball joint will be bad.

Wiggle the ball joint to feel for "slop." Even a small amount of slop in the ball joint will make horrendously awful noises when driving over brick or stone roads. When I say "small amount," I mean if you can feel any slop at all by hand, the ball joint is bad and needs replacing. It may be necessary to remove the lower suspension arm from the ball joint's taper to properly assess the ball joint's condition. Please note that pitman arm pullers, such as K-D Tools model 2289 (available at most auto parts stores), are satisfactory to separate the suspension arm from the taper on the ball joint. This taper-fit joint will be very tight, so a proper tool is a must. A "pickle-fork" type separator will not work.

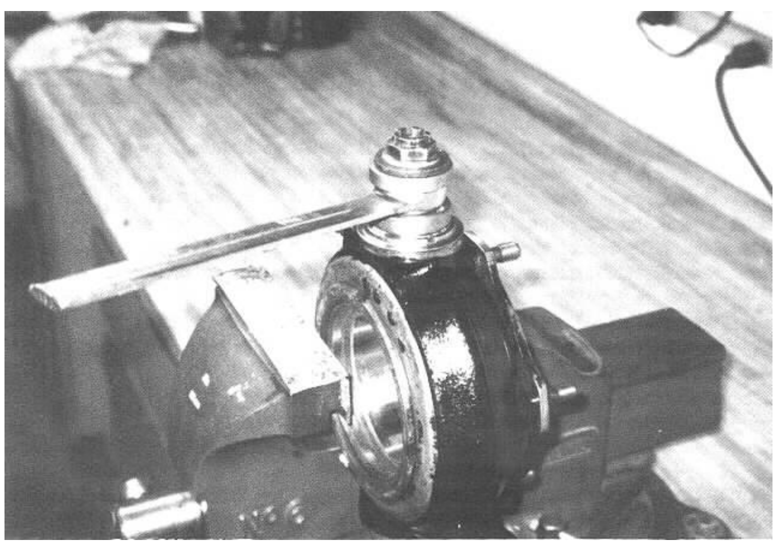
As noted above, if you can feel any slop in the ball joint, it will need replacing. It is not possible to "shim" or otherwise adjust a worn ball joint, so a new ball joint is required. A perfect used ball joint is also satisfactory. The lower ball joint has been sold under several part numbers, but the most common is a "kit," P/N 5 467 693. Costs seem to vary from supplier to supplier, but expect roughly USD $200. Your favorite parts haunt is likely to have one in stock. Try Western Hemispheres; Brad Nauss, JBM, or SM World.

And yes, it takes a very special tool to replace the ball joint. And yes, the tool is different for the upper and lower ball joints (for no apparent reason other than to be annoying). Unless you have a machine shop at your disposal and can make the tool, you will have to borrow, rent, or buy the tool to unscrew the ball joint from the pivot.



Tools and parts required to service a ball joint

In the first picture, the pivot is inverted so the lower ball joint can be seen. The second picture shows the three pieces of the ball joint along with the wrench, the special tool, a washer and a nut. The latter two items hold the tool securely onto the ball joint during loosening or tightening.



Tool ready to remove ball joint nut

The third picture shows the special tool in place, ready for lower ball joint removal. The tool has three high-strength pins that engage holes in the ball joint nut. These pins transmit the torque to unscrew the nut from the pivot.

Normally, it is not necessary to remove the entire pivot from the car to replace the ball joint (we did this only for the photos). In many ways, it is easier to leave the pivot installed on the car, since the car acts like a giant vise. With the tool installed on the ball joint, a 6-foot long pipe is slipped over the handle of the wrench for the much needed leverage.

Is this a do-it-yourselfer project? Well, it is fairly simple if you have access to the special tools. One of the Citroën repair shops in Seattle charges only 1 to 1.5 hours labor to replace a lower ball joint. But as mentioned earlier, don't even think of trying this without the proper tools.

Clunking sound due to loose shock absorber
Chuck Daley (Jan. 1985, p.22)

A loud clunking sound when going over bumps was caused by a shock absorber on one of my front spheres coming apart. The nut that came off gouged the hydraulic piston and bent the remaining parts of the shock absorber.

Editor: This may be the reason that Citroën started using a rivet to fasten the shock damper into the sphere permanently. With the removable type shocks, be sure to stack the valving washers properly and then tighten the assembly firmly. Only after you are sure it is tight should you screw the shock assembly into the sphere. Then it too should be tightened firmly. The possible problem here is not being able to hold the sphere tight enough to get some torque on the nut. Use your chain wrench to hold the sphere tightly.

Cylinder boot LHM leak damages rubber stop
Andrew Brodie, Great Britain (Feb. 1995, p.7-excerpt/revised from SM article)

An unexpected age-related item is caused by the front suspension strut gaiters (boots). They age and crack, letting LHM flow over the front lower bump stop that controls wheel down movement. You do not always notice this because the strut seals are very good and the leak is often very slight. However, the bump stops are natural rubber, and always dissolve in the LHM, becoming detached and ineffective. This leads to loss of roll control and to self-leveling on acceleration or stopping. Amazingly, Citroën realized this effect and introduced a modified (boot) to reduce the problem for the SM. However, as it was never updated to the D-model parts book and carried an SM ID code, it got dropped from production and now you can only buy the D-model version.

The replacement of these (boots) is very easy. It is also very good preventive maintenance. Your original (boots) will fail; they are mostly over 20 years old. Bump stops are now remanufactured (they also fit DS Safari fronts), but they are far from cheap because the volumes are very low. You will avoid them needing replacement if you catch the (boots) in time!

You will also get the opportunity to bash your suspension covers back to shape, grease the anti-roll bar properly and buy and fit the bungs for those bloody great holes in the covers.

Cylinder in rear replaced with front part
(Oct. 1980, p.3)

D-model front suspension cylinders can easily be converted to use on the rear of the car. As most of us who do our own repair know, the rear cylinders are extremely prone to corrosion. The steel bracket that holds them to the car body is a perfect receptacle for dirt, salt, and moisture. This deadly combination makes a perfect battery and the aluminum body of the suspension cylinder always ends up being pitted and weakened to the point of cracking.

The first step in correcting this situation is cleaning out the dirt and corrosion in the bracket – now - before it cracks while you're on the road. Some are corroded so bad that extensive chiseling with a screwdriver is required before the cylinder can be knocked forward and loose from the bracket. A schedule of chiseling for awhile and then doing some pounding (always with a piece of hardwood between hammer and cylinder) will eventually loosen the cylinder and allow it to be withdrawn towards the front of the car after the small fixing screw has been removed.

Once the cylinder is out, the bracket can be more easily cleaned and scraped out. The cylinder itself should be checked for extensive pitting. Using a screwdriver, chip away at the corrosion to check for weak spots. If the cylinder needs replacing and you can't locate one for the rear, you can adapt one meant for the front of the car by cutting and filing a flat similar to that found on the rear cylinders. Since the body is aluminum, it cuts and files quite easily. Just make sure that the cylinder you are installing is meant for the fluid you have in the car. There should be some red paint on the cylinder for brake fluid cars and some green paint if it's for the LHM (green fluid) cars.

When reassembling the cylinder into its bracket, make sure the small fixing screw at the front actually holds the cylinder from moving forward. The cylinder should be able to be wiggled by hand. To prevent further corrosion between the bracket and the cylinder, you can stuff the empty space with unfaced fiberglass insulation and then pour oil over the wadding through the drain holes on the upper and outboard sides of the suspension bracket. The wadding should periodically be re-wetted with oil. If the packing is fairly tight it will effectively keep dirt and salt from entering the bracket and the oil should keep the water from doing damage.

Editor: This interchangeability is only true for sedans; the wagons have larger diameter rear cylinders. (I would advise against packing anything in there. It will inevitably trap water and instead of corrosion, you will have rust. Just keep it clean. [MB])

Cylinder seal replacement
Don James, OH (Jan. 1986, p.31)

Constant high speed movement from bumps causes the Teflon suspension seal to wear. To replace this seal in the rear suspension cylinders, first remove the boot. See "Rear boot replacement procedure," earlier in this chapter, for details.

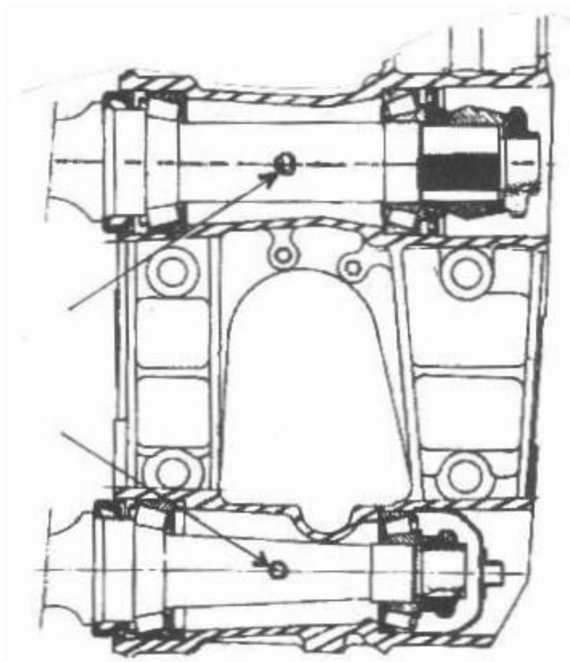
Remove the piston as shown above. Take care not to scratch it. It pulls out easily with your fingers. Use a dental pick (any similar sharp tool could be used) to remove the old Teflon seal as shown in below. Take care when prying it from it's groove that you do not scratch the soft aluminum cylinder. If you do raise a burr, file it smooth or the piston will not fit.

Install the new seal being by folding it as shown in the last picture. Push it into the groove with your fingers. The Teflon is a little like a rubber band, but has been carefully machined, so don't scratch it. J.B.M. Industries Teflon seals are now made of "Graphite Impregnated" Teflon. This will improve wear. While carefully machined, complete sealing may take a few hundred miles running.

The front suspension cylinders have the same seals. For these, however, the only practical way to change a seal is to remove the cylinder from the car, which isn't all that difficult. When reassembling, adjust the two retaining bolts and their jamb nuts so that the cylinder can pivot on the ends of these bolts. On the other hand, don't leave them so loose the cylinder/sphere assembly can rattle on bumps.

The rubber rings behind the Teflon rings have a special cross section, do not wear and need only to be changed if ruined by the wrong fluid, or the system fluid is being changed from brake/LHS or silicone to LHM/mineral or vice-versa.

Front arm bearing lubrication
Peter Raffels; Pleiades Enterprises, England (May, 1985, p.10)



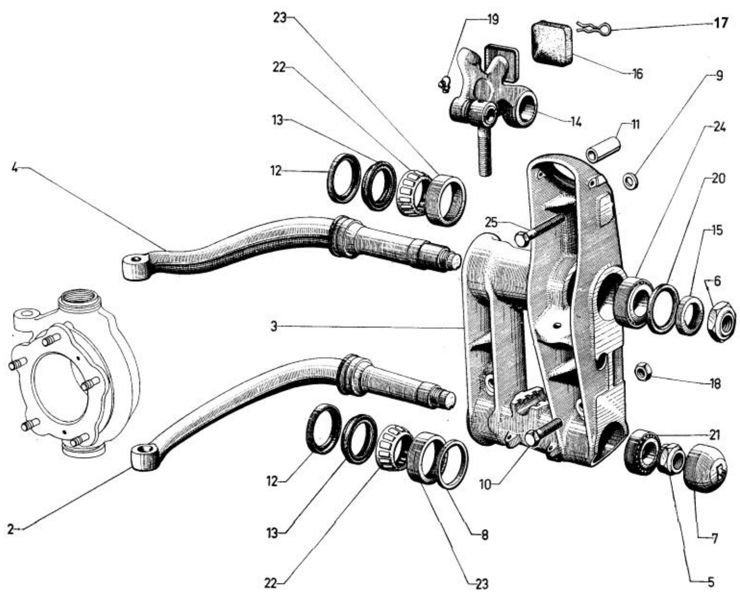
Arrows show location of lubrication holes drilled in arms

The front suspension arms bearings tend to become notchy and stiff due to lack of lubrication. Oil will stop this from happening. At a point on the centerline and mid-way between the bearings, drill and tap M5 x 0.8 mm (I.S.O. metric coarse) – tapping drill size 4.2 mm. Hold a vacuum cleaner spout adjacent to the drill and tap in use. Grease on the tap will hold the swarf.

Fill the housings with heavy oil to the level of the drilled holes. Cut a standard M5 (5 mm) metric screw to a length of about 8 mm. Coat the thread with sealant and use it to plug the tapped hole.

Never fit a grease nipple. Pumping grease into the housing will blow the seals if there is no vent. Blown seals will allow water to enter the bearings.

Front arms rebuilding procedure
Chris Dubuque, WA (Jun. 1992, p.14)



One part of the D-model that very few people have ever bothered to take apart is a front suspension arms assembly (which are referred to as half-axles in the repair manual). The half-axle assemblies consist of a cast aluminum housing that serves as a support for the upper and lower forged steel suspension arms. Tapered roller bearings are installed in the aluminum housing at each end of each suspension arm to provide a long-lasting and low friction suspension arm pivot. The hydraulic suspension cylinder and sphere are also mounted in the top of the aluminum casting and apply force to raise and lower the car through a bell crank affair attached to the upper suspension arm.

I think the reason nobody ever takes the axles apart is that they seem to be so reliable. Having grown up around D-models, I can only think of two cases where the suspension arms have ever given trouble. One was a bent lower arm due to some sort of accident damage (usually sliding into a curb in the snow) and the second was a shattered lower bearing causing the lower arm to rattle terribly as the car is driven over bumps. Partly due to curiosity and partly due to a slight suspension rattle I have never been able to find, I recently decided to take apart the half-axles in my D-Special.

Removing the half-axle from the car was not too difficult. It was held on, quite simply, by five large bolts. As is the case so often on Citroëns, there was a bunch of stuff in the way that also had to be removed. Among things that had to be removed or disconnected were:

- front fenders and splash pans
- the anti-roll bar
- the front height corrector and some hydraulic tubes to it

- the exhaust manifolds (to gain access to one of the five big mounting bolts)
- the brake pedal unit (to gain access to one of the five big mounting bolts)
- the drive shafts had to be disconnected from the half- axles at the ball joints (requires a special puller).

Once the units were off, disassembly was quite straightforward. I had a big vise to hold the whole thing during disassembly. The first thing that I noticed was that the grease in the roller bearings was in extremely poor shape black, dirty, and very gritty. Next I found that the bearing surfaces on the arms were very poor, necessitating replacement of the whole arm. I had access to a number of spare half-axle assemblies from parts cars and found most to be no better. It took four spare half-axles to obtain a good set of suspension arms for reassembly. The roller bearings themselves all appeared excellent. There were also several grease seals on each unit that needed replacing. I was able to find appropriate grease seals at a local bearing store since the original ones appear to not be available.

Reassembling the half-axles was quite easy and satisfying since the arms pivoted/rotated very smoothly after reassembly with good condition parts and fresh grease.

One step I was sure to not miss was a check of the caster measurement, particularly because parts had been replaced. Unfortunately, a special Citroën gauge was needed and no substitute would do. Luckily I found one and borrowed it. The picture above shows the caster gauge installed and in use. The D-model repair manual spells out this procedure quite well and caster is quite easily adjusted (if necessary) by shims under the bearings. Mine needed no adjustment at all even though I had used different suspension arms and bearings.

Once installed back on the car, one could try checking the camber angle. However, since I did not have the camber tool, I elected to skip it (an alignment shop can check camber quite quickly once the car is reassembled). Maybe I have just been lucky but I never had to deal with a camber problem on a D-model.

In summary, it appears that 20 or 30 years is just too long to expect the grease in the half-axles to still be in good condition. If I had disassembled and greased them sooner, I might not have had to replace parts. Fortunately, rebuilding them is quite straightforward, but does require a special tool or two. I recommend that if you are going to take this on, get a spare set of half-axles from a parts car and rebuild those first. Finally, use the factory repair manual as it is quite easy to follow.

Front arms straightened
Ken Nelson (Nov. 1982, p.6)

I was able to straighten a badly bent suspension arm on my DS with a 7 foot piece of square section steel tubing. The tubing was placed over the bent suspension arm after the wheel bearing and driveshaft were removed. With the car's other wheels blocked, two people pulling on the long length of tube straightened the bent arm.

Front leveling failure due to jammed roll bar
Jerry Lugert (May 1985, p.16 & Jan. 1991, p.11)

The D-model has the front anti-roll/sway bar "buried" within the front cross-member. The question as to why I couldn't raise and lower my D-model was answered when I found the cross member was dented, perhaps by being hit by a large rock, in such a manner to restrict the sway bar linkage. I had to place a Port-a-Power under cross member (which lifted the car slightly) and then use an air powered chisel to provide sufficient clearance for the sway bar. What a hassle! But it works fine now without the restriction.

Height control sticking due to frozen control lever
Paul Fontaine (Jan. 1985, p.27)

A few days ago I had a flat on the left front tire. The old beat up wagon rose to its full height, the tire was changed, but when I raised the control lever to remove the jack stand, the lever was stuck. I guessed that the height corrector was not receiving the message. I pulled the rear wheel and the splash shield and found the road crud had frozen the control lever. With a liberal amount of WD-40 and some SAE 20 in the area where the control rod goes thru the guide bushings, the rod freed itself. Keep this area oiled.

Height corrector replacement fixes dropping in rear
Dave Root, FL (Mar. 1997, p.18)

Here are some suggestions for changing the rear height corrector, mostly learned on a second attempt. The problem with my D-model was that the rear would sink very soon after stopping the car.

For turning the Citroën 9mm tubing fittings, I recommend a combination wrench with the 12-point box end slotted so the wrench may fit over the tubing and onto the 9mm hex. This makes it like a 6-point flare nut wrench, only the 12-point allows a smaller angle of turning where clearance for the wrench movement is less. This wrench action is tedious on the bottom fitting where you can barely see the hex and you have to relocate and turn the wrench 12 times for one revolution of the nut. To save time, I would hold the wrench on the bottom fitting and turn the height corrector instead, both when removing one and when re-installing one.

Re-installing: With the bottom fitting almost tight, it is time to fasten the height corrector in place. It will help get the bolts started if the holes are made 1/32" to 1/16" larger as the location need not be precise. The next step is mounting the two top tubes. If there is tension on the tubing that goes in the top, it is quite difficult to get the fitting threads started into the tapped holes. By installing compression couplings about 4" from the two Citroën fittings and leaving them apart, you can start the Citroën tube fittings into the top of the height correctors with no tubing tension hindering you. Then the compression unions may be joined easily as tubing tension does not hinder this being done. (I do not recommend using compression fitting anywhere on the brake or suspension system. I have found that the best way to install these lines it to start them before attaching the corrector to the chassis. Tighten them after the corrector is bolted in place. [MB])

To complete the installation, finish tightening the bottom fitting with a wrench, push on the return tube, and hook up the rod that ties the height corrector lever with the manual linkage.

I have heard it said that compression fittings would not hold the high pressure in Citroën hydraulic systems, but I never hesitate to use one when expedient and have never had one fall. Nor has anyone ever been able to tell me an instance of where one has failed. (Again, I do not recommend it. [MB])

I am not saying that, when a D-model sinks rapidly, it is always the fault of the height corrector, but in this case I eliminated the lift cylinders, regulator and power steering from being contributing factors to the problem. When I replaced the height corrector with a used one and the sinking time went from 10 minutes to over 1 hour, I knew I had finally found the culprit! If I decide to invest sometime in a new height corrector, I believe I will see even more improvement.

Height drop soon after parking reduced
Dave Root, FL (May 1996, p.14)

My '69 ID19B must have missed me just going into stores for short errands. By the time a came out, it would drop down. The cycling of the pump every ten seconds had become annoying and I grew concerned that this would shorten its life.

Don James had written that the ball valve in the hydraulic pressure regulator could be a source of internal hydraulic leakage. I admit I had some reservations as to whether it would help, because I often found solutions to Citroën problems to be complicated. Since this seemed to be the simplest remedy, I decided to try it first anyways.

After relieving the pressure and removing the regulator sphere, I located the ball but found it reluctant to come out. A strong magnet brought it out, but it fell off the magnet and dropped through my fingers. After trying for some time, I found it lurking partly under part of the power steering mechanism, lodged in such a way as to be nearly invisible.

After blowing out the passageway with air, I replaced the ball along with its retainer plate and screw and put the sphere back in place. I bled the system several times with the regulator valve. Now the car stayed up about an hour and a half instead of just a few minutes after shutting off the engine.

And the pump cycle time was increased from 10 seconds to an average of 35 seconds! This was a significant improvement and it should make it easier on the pump. It will be less annoying because the car will stay up longer after shutting off the engine.

Editor: Dave subsequently reported this helped, but didn't solve the additional problem of the rear dropping quickly. He found a borrowed rear height corrector made a big difference. See the next article.

Height irregularity cures
Dave Root, FL (Jun. 1995, p.10)

Sometimes Grant Swartz's '62-wagon's rear suspension refused to rise. Other times, putting the height control in the jack position would raise it, then putting the lever in the normal position would hold it. On occasion it would drop after a while. One day when the rear was down, I got it working temporarily. But soon it got so it wouldn't "get its back up" at all.

Obviously the trouble was not just in the height corrector. Conferring with Dave Burnham, Denis Foley and Don James led me to the priority valve located in back of the left front wheel. To work on this unit, it is best to remove it from the car, removing the three lines connected to it.

Removing the end caps, I found the tiny pistons free, but one of the balls of the check valves had a crust on it which I cleaned off. To get the pistons out I put the unit back on the car minus the check valves and put the system under pressure. This pushed out one of the pistons and the other easily came out by putting a punch through the open end.

I still had no suspension in the rear. With friend Andre Garnier's help, we found the line coming from the priority valve to the bottom of the height corrector was almost completely plugged. It took 150 psi of air to blow out the debris. I had been fooled by the fact that there was enough fluid at the height corrector, but there was not enough pressure to do any good.

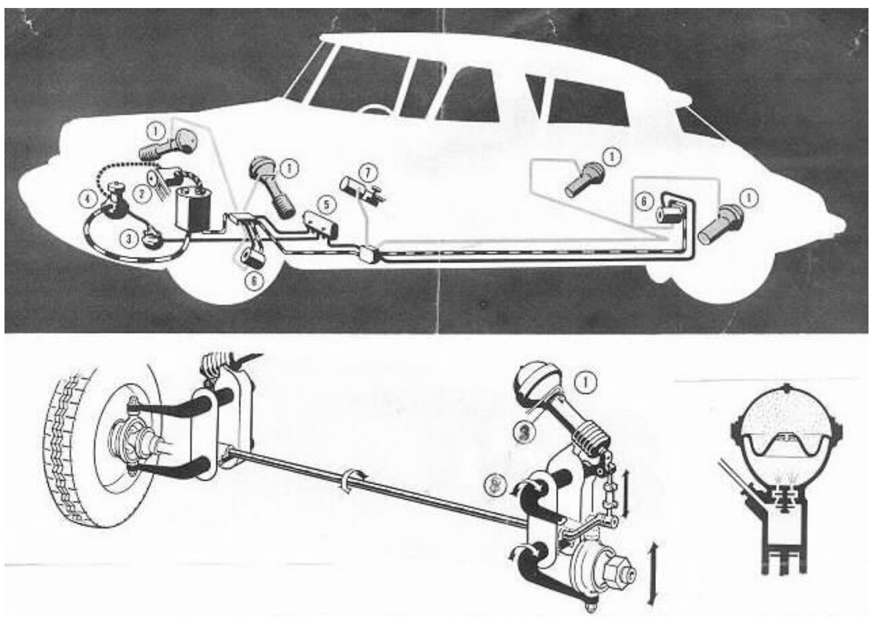
One of the sources of trouble was at the height corrector. The slide valve would move freely, but mysteriously, it would freeze up when I bolted the unit in place. To keep it free, I had to put a 1/8" shim between it and its mounting surface. One thing is evident: if you cannot push the height corrector by hand to move the car up and down, the system won't work. Check if you can do that. (This sounds as if the height control actuator is out of adjustment or the piece on the end of the corrector is slightly turned wrong; shims should never be needed. [MB])

Height variation troubleshooting
Don James, OH (Jan. 1984, p.9)

Q. My front height corrector is being fickle. The car does not want to remain at the correct height. It is either too high or low. I replaced the corrector but the problem persists. I have noted that the problem begins after being on a garage hoist with the wheels hanging. – Jerry Lugert

A. Misadjustment of the linkage to your height corrector may be the problem with it. Sounds like the torque rod is being pushed past it's yield point. It is a good idea to place the height control lever in the high position when the wheels are hanging. If the torque rod has ever been heated, it may have lost it's temper. A sluggish height corrector could also be caused by too thick of a fluid. Low or bad suspension spheres will not cause any problems with ride height.

Leveling system basic description
Dave Paulin (Dec. 1976, p.3) & Citroën literature (Jan. 1986, p.13)



Components of leveling system

Did you ever try to explain to other car buffs how your famous Citroën suspension works? Sometimes they nod their heads in seeming understanding, but you sense they really don't comprehend? Perhaps this will make it easier.

Four air-oil suspension units (item 1, above) eliminate steel springs and conventional shock absorbers. Units on all four independently-suspended wheels are linked in circuit with pressure pump (2), pressure control (3), pressure accumulator (4), pressure distributor (5), height correctors (6) and a proportional braking control (7). The variable volume of fluid in each air-oil suspension unit matches the "ride" to the load.

Citroen’s suspension system differs because it is an air-oil principle (air acts as the spring). Previous suspension designs, first the leaf spring, then the coil spring and then the torsion bar, had one thing in common: they all were mechanical.

One of the unique features of this system is the constant road clearance. When three adults climb in the back seat, for instance, the rear dips as it does on other cars–but momentarily, as it then returns to its normal (unloaded) height. A "height corrector" responds to the heavier rear suspension loading. It automatically opens a sliding valve that sends a compensating volume of fluid to the rear air-oil suspension spheres. Another height corrector works the same way on the front suspension spheres. In this manner, Citroën maintains a constant road clearance regardless of front or rear axle loading.

Another feature of the air-oil system is that road clearance is manually adjustable. By simply moving a lever, the car can be raised to three higher positions to drive over deep snow, rutted roads or other unusual conditions. Moving the lever simply injects an additional volume of fluid in all four air-oil suspension units. Raising the car in this manner is also used to change tires–without a jack.

The lower part of the picture shows a front wheel air-oil suspension unit (1) linked to the rotation of upper suspension arm (8).

Editor: An important point is that this and the lower arms are free-mounted and not torsion bars. The air-oil suspension unit (1) is also linked by an anti-roll bar to an identical unit on the other side. Not shown is a lever attached to the center of the anti-roll bar to actuate the hydraulic height corrector (6). The two rear wheels are also linked by an anti-roll bar with center-connected mechanical linkage to operate the rear height corrector.

While the two height correctors are mounted on the left side of the car, they respond equally to right-side conditions. Note there is no mechanical linkage between front and rear–each pair of air-oil units are controlled separately. Each height corrector is a slide valve with end positions to admit additional hydraulic fluid under pressure and release excess pressure to a reservoir plus a center "status quo" position. It acts to raise or lower its end of the car until the associated roll-bar is in its status quo position.

The lower right side of the picture shows the air of the system, actually pure nitrogen, is sealed in the upper "sphere" part of the "air-oil" suspension unit. A set of valves at the neck of the sphere provide a shock absorbing function through fluid damping.

Citroen’s remarkable hydraulic system also provides power brakes, power steering and, in some models, hydraulically operates the transmission and clutch. A unique braking safety feature is made possible by the Citroën central hydraulic system. A special device enables the braking effort of the front and rear wheels to be divided in proportion to the actual load they carry. This "proportional braking" feature works on separate front and rear hydraulic braking systems, which, in itself, is another safety feature.

Rear axle removal
Ted Ax (2009 #2, p.26)

My first advice if you're going to repack D-model rear bearings is to get a decent shop manual and consider this article to be supplemental reading. Second, I'm told they weren't overburdened with grease from the factory.

The first step, after putting the car up on jack stands and removing the fender and wheel, is to remove the hub sealing cap. This cap is hard to remove without mutilating it. It fits tightly into the trailing arm, with a flange that doesn't stick out beyond the arm to help you in any way. Unless you have a special tool, take a sharp chisel (or grind your best screwdriver so as to ruin things other than just the car) and tap it under the lip of the cap chasing it around in circles gently until it comes out enough to get a non-ruined screwdriver under the lip and continue prying until it comes off.

From here, it's a lot like any other wheel bearing job you may have dealt with, but for two important exceptions. First, the typical spindle is stationary and attached to the suspension with the hub and brake drum or disc revolving around it. Here, the spindle is attached to the brake drum and spins inside the trailing arm. Second, many wheel bearings can be adjusted by simply turning the bearing retaining nut in or out to get the right amount of play. Here, there is a distance piece and variable thickness washer which determine the bearing clearance. You simply tighten down the nut, with no adjustment possible without an assortment of those variable thickness washers. This only matters to you if there is wear in the bearings and you have to replace them. If you feel clever and think you can delete these pieces between the bearings, you should note that it all clamps down and holds the separate seal race against the stub axle (spindle) to keep it from grinding metal to metal and leaking grease out or getting swarf into your newly repacked bearings. Sorry, I got ahead of things.

Next, use the brake shoe adjusters to lock the drum in place so that you can get the bearing retainer nut off. Bend back the lockplate so you can get a socket on the nut. When reinstalling, bend up a different side to prevent metal fatigue, or better yet replace it if possible. Pluck out this washer and the one behind it. Release the shoes from the drum and, I suppose, remove the drum from the hub. Should the drum not want to come free, don't pry between it and the backing plate, for fear of bending the backing plate. Instead, pull on one side of the drum with the best perch possible by hand while smacking the opposite side of the drum with a heavy but soft hammer toward your hand doing the grabbing, then switch sides and repeat.

Now is where the grief may begin. Service agents use an extractor No. 2018-T to remove the stub axle. This tool is like any puller with a threaded center that pushes on the stub axle where the bearing nut was just removed, except that it has a sleeve that keeps it going straight through the stub axle carrier even though the part that grabs the carrier is at an angle and wraps around the trailing arm which would normally make its use impossible. My version of this tool looks more like a lead hammer and a MAPP gas torch. Before you cross the point of no return, make sure you have whatever parts you intend to replace, and even some that you don't currently intend to replace, just as backup. At the very least, have a replacement grease seal on hand. If it's not leaking now –and it probably isn't as the grease you'll find in here is minimal and pretty dried up by now anyway – it will be leaking once the bearings are grease filled, especially if you use the MAPP gas part of the puller tool, thus ruining a once great seal.

First try without heating anything. Put the wheel bearing nut back on the threads or, better yet, use an expendable one. The nut needs to be loose enough to allow the stub axle to begin moving, but on far enough to protect the stub axle threads. Just the last few threads are not enough, as the nut could just take these out when you begin beating it. If it comes loose easily, congratulations, if not then on to Plan B. Heat the inner bearing race near the stub axle. You won't get it red hot with MAPP gas, and that's good, you don't want to, but get it good and toasty and then try beating again. Hopefully by now it has come loose, because I'm out of other ideas, short of making the special tool for this job or borrowing the real puller from someone who has one.

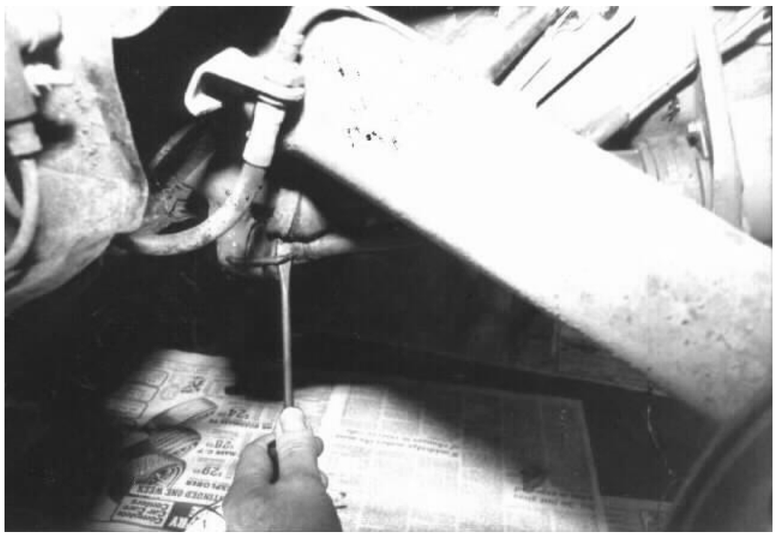
Now for the "servicing." Pray that the bearings and races are all in good condition and simply need to be cleaned and greased. If so, remove the grease seal, since you've probably ruined it anyway, and remove all of the balls, cages, spacers, variable thickness washers, and anything else that falls out easily. Keep track of this stuff. Don't mix it up with stuff from the other side. Clean all of these innards thoroughly with a solvent and dry.

Reassembly is largely the "reversal of removal" but generally easier than the tear down. Keep everything operating room clean, grease up the bearings, fit the one near the seal before fitting the seal itself. See the book(s) for things like making sure the new seal is fitted with its face 4.5 mm below the outer face of the axle arm. I like to make sure the seal race – the surface on which the lip rides – isn't pitted from rust or grooved from the lip seal and dust eating at it, but that is never mentioned, and they tend not to leak anyway. If you did have to replace any of the pieces involved (except the seal), then bearing "adjustment" must be done by altering the distance piece or variable thickness washer. For is "whole 'nuther opera" involving painful trial and error or careful measuring with a surface (read FLAT) plate and dial indicator.

Anyhow, put the thing back together, tighten the nut to 72 ft-lb of torque or thereabouts, bend over the new locktab that you dutifully ordered or decide whether or not to fatigue the used one, and put some reasonable amount of grease in there. The book says 50 grams. How many of you could eyeball 50 grams of grease? Just put a bunch in there, but not so much as to blowout the grease seal that you just spent so much time getting 4.5 mm below that surface, and remember that you still have to tap that grease cap over all of this and it will compress whatever grease is in there. If there isn't room left for it, the seal will pop out the other side, and you will have to take all this apart again. Now replace the drum, wheel, and fender before anyone sees your beautiful car in an undignified position.

This last paragraph is a special cheat for lazy people who just want to take the placebo fix for this instead of going through all of the aforementioned headache. Get a couple of grease Zerks that use 1/4"-28 threads, a #3 drill bit (13/64" or 7/32" is close enough) and a 1/4"-28 tap. Find a logical place between the imagined location of the two bearings (inner and outer) and begin ever so gingerly drilling into the trailing arm at this point. You don't want to go through, and you don't know how thick it is and neither do I, so just small bits at a time. Use a sharp punch and hammer to test. Put the final hole through the arm with the punch so as not to introduce swarf into the grease cavity. Take your tap and begin tapping the hole for the Zerk. To prevent these inevitable shavings from getting in the grease cavity, use grease on the cutting threads of the tap. Cut only enough threads to start the Zerk into place. Don't over do it, it just makes more shavings and the Zerk doesn't need to be cranked all the way in or anything. Use a shop vac with a very necked down attachment to suck any metal shavings away from the hole, anything you can do to keep this stuff out of the cavity. Install the Zerk and get a loaded grease gun. Insert 50 grams of grease (even easier to judge 50 grams as it passes invisibly through a hose!) through the Zerk and you're done. If you pop out the seal, well, you should have been doing this job the right way anyhow.

Rear boot replacement procedure
Don James, OH (Jan. 1986, p.31)



Removing retaining wire at rear ball joint

The rear of the car must be on sturdy jack stands with parking brake set and front wheels chocked. The height control lever must be in the low position. The wheels must be hanging.

Remove the rear fenders and wheels. Free the suspension pushrod at the ball joint by removing the wire retaining clip by bending it with a pry as shown above. Don't worry if you cannot remove the wire completely, as it can be bent many times. (The wire is frequently stuck in the hole. You may have to grind it off then knock the broken piece out with a thin punch. [MB])

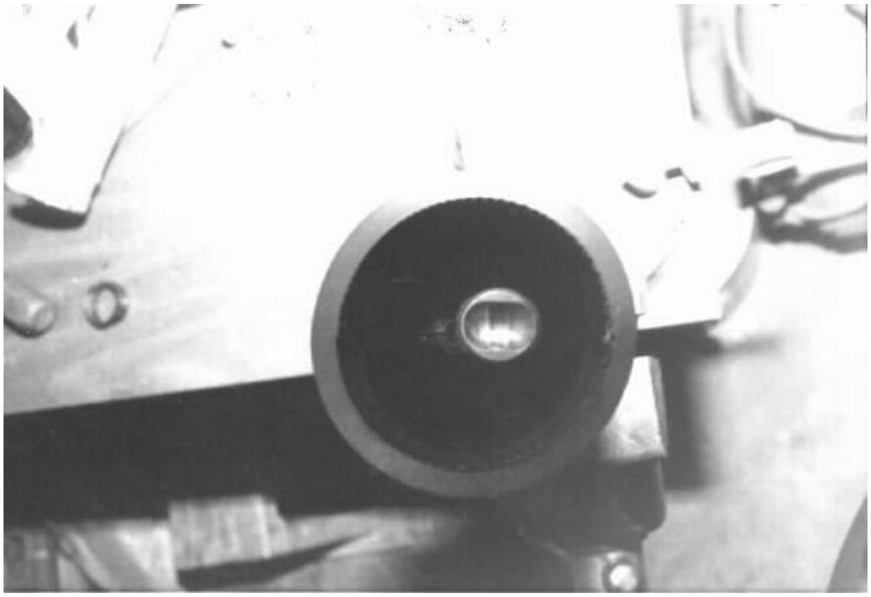
Clean the area around the rubber boot (teapot) and remove the boot together with the pushrod. You may need to push the piston up into the cylinder (this is easier to do with the sphere removed, but not essential). The plastic return line just pulls out of the boot. Turn the old boot inside out as shown in the next picture as the first step to removing it from the pushrod. Take note of two things before loosening the clamp shown: (1) the position of the boot on the push-rod in reference to the position of the return line to the position of the small hole for the retaining wire and (2) the distance from the edge of the clamped end of the boot from the end of the push-rod. The new boot must be mounted in the same way.

Old boot turned inside out for removal

Remove the ball at the base of the pushrod from its socket–a magnet may help get it out. No need to remove the entire socket as shown below. Clean all of the parts using alcohol for brake fluid/silicone cars, kerosene for LHM. Be sure ball's dust cover boot is in good condition. This ball joint must be greased every 20,000 miles!

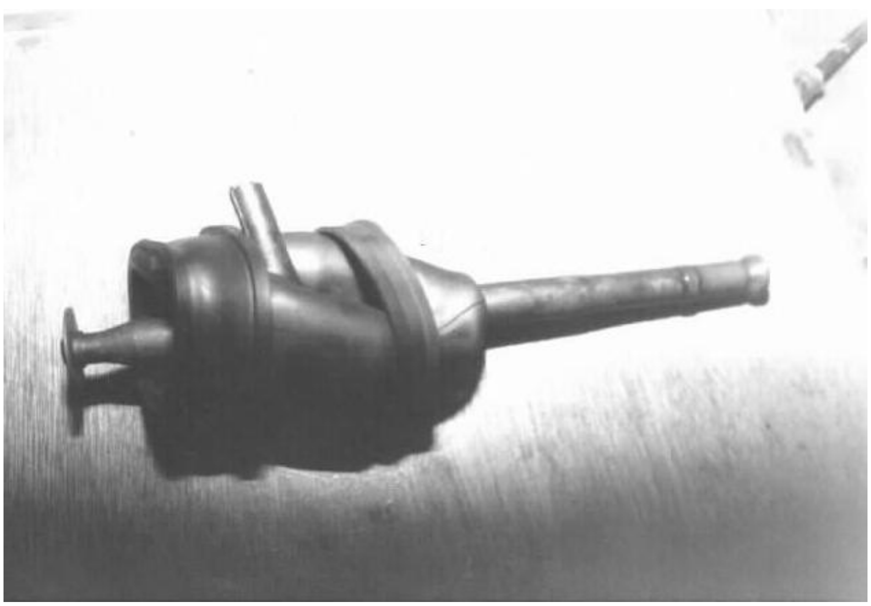
Ball at base of pushrod removed from socket

Examine the end of the push-rod, as shown below, for a groove worn in the center. This groove causes a cracking sound as the car raises up. It can be easily removed with a small hand grinder such as a Dremel Tool. This grinding does not need to be perfect as it will wear-in. Just get rid of the "groove" that the ball falls into.



Examine pushrod end for unwanted groove

Clamp the new boot to the pushrod using the old band, or a nylon wire tie. (No, do not use a nylon pull tie. The fat bit will eventually poke a hole in the edge of the boot. Reuse the original outer Ligarex band here and put a new band on the outside. [MB]) Be sure to get the boot oriented right on the pushrod so that the return line will come in line with the ball race on the end of the pushrod.

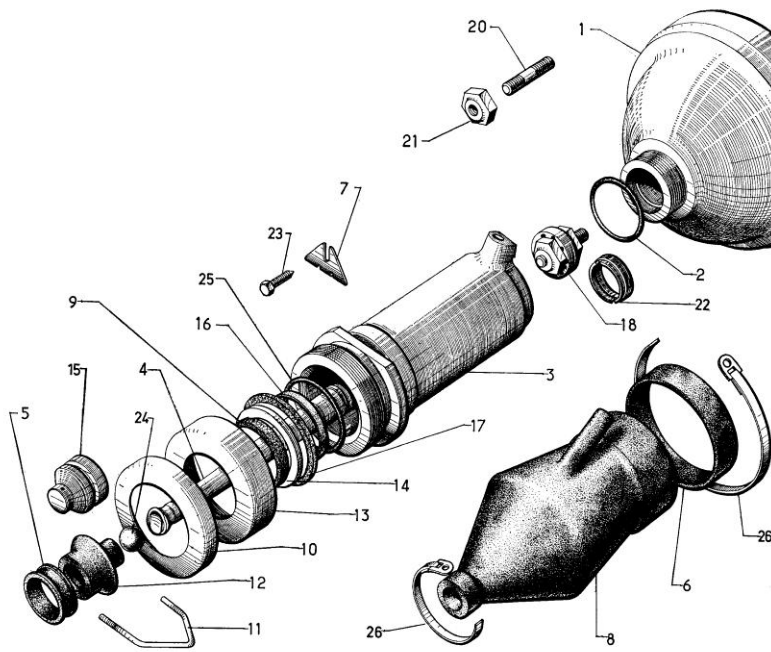


New boot ready for reinstallation

The above picture shows the end of the new boot turned inside-out to make it much easier to fasten to the cylinder. Just flip it over the cylinder. If you have had trouble with boots swelling, check the return line for an obstruction. Use a wire tie or standard hose clamp to attach the new boot.

(If there is one place where the original type clamping is necessary, it is at the inner boot clamp. See "Ligarex band and tool usage" in the "Work Aids" chapter. Also, it is wise to carefully examine the pushrod pivot ball and socket. The ball can be so rusted in place that it is nearly impossible to remove or the push rod can make a divot in the inner wall of the socket, greatly aggravating the clicking sound that the article alludes to. If you are at all unsure, order a new rubber boot, a socket and the ball along with a new clip. [MB])

Rear boot replacement procedure
Ken Betsh, PA (Dec. 1987, p.12)

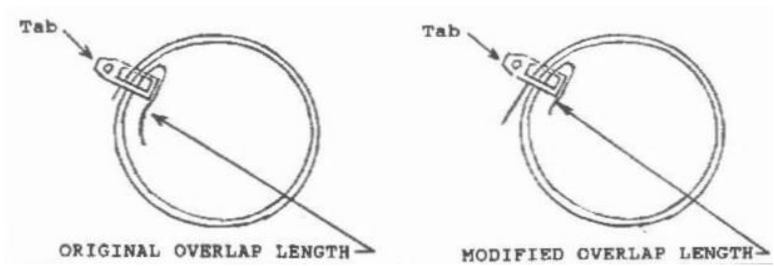


The first step in replacing a rear suspension boot is to be sure of having the correct replacement part. Part number DV434-274A for station wagons is considerably larger in diameter than part number 1D5410161Y / DX434-274A for sedans. The replacement part must also be compatible with the type of hydraulic fluid in your car. The numbers just listed are for those USA cars made since mid-1969 with green LHM fluid. These replacements should be have a green or white color code mark. A green mark indicates it must NOT be used on a car using brake fluid (vegetable) in the hydraulic system. A white mark indicates it can be used with either type of fluid. A boot with a red mark indicates is must NOT be used on a car using (or originally used) green LHM fluid. Use caution in reusing a boot removed from another car–Citroën never color coded hydraulic system components before they developed the mineral-based system. An old unmarked boot may only be suitable for brake fluid cars. Check labels on any new replacement boots from non-Citroën sources.

Item numbers in the following description refer to the above drawing, taken from Citroën parts book No. 611. Both new style and old style part numbers (but both for mineral-type cars) listed in that parts book are noted.

1. Preparation starts with removing the fender and jacking the car. Before removing the wheel, I mark the brake drum to show the position of the tire valve stem. I balance the rear tires on the car and this assures any compensation for an unbalanced drum is maintained.
2. Clean the inside of the fender area in the area of the boot so that loose dirt won't fall into exposed places. If the defective boot still contains fluid, squeeze the boot so as to force as much fluid as possible back to the tank.
3. Remove the rod pin (item 11, part #1D5412332W/DX434-80) that holds the strut (item 4, part #1D5410068M/DS434-3) in place. The longer side of the rod pin goes through a hole in the base and extends about a half inch beyond. This extending part is generally bent to keep it from falling out and must be straightened before it can be removed. I find my vise-grips to be the best aid here. This step can be the worst one in cars subjected to rust. Even though the pin is hardened steel, rust can cause it to weaken and break. There are temporary-fix instructions in Step 18 in case it does break. I've had cases where I couldn't remove the pin but could bend it sufficiently to remove the strut. (Always remove it, even if you need to grind it smooth on both sides and drive the broken bit out with a thin straight punch; always have a new one on hand. [MB])
4. Except for the very early D-models, the ball seat (item 15, part #1D5412334T/DX434-259A) is a separate part retained by the long side of the rod pin. The strut has a cupped end that rides on a 5/8" diameter (15.875 mm) steel ball (item 19, part #ZD9410800U) inside this seat. A small dust cover (item 12, part #lD5412331K/DX434-81) covers these parts and retains their lubrication. These parts must be dismantled in order to replace the boot. While this can be done after removing the assembly from the car, I prefer otherwise. Remove the strap clamp that retains the small dust cover by unbending the end of it at the retainer and loosening it. Do not cut the strap. Slide the small dust cover and the rubber bushing (item 5, part #1D5409990P) that was under the strap clamp up the strut about an inch.
5. Remove the return fluid tube from the nipple for it on the side of the boot. Even though it isn't clamped in place, it may take some effort to get it loose. The easy way is to cut the boot–using care to avoid damage to the tube.
6. Remove the clamp from around the large end of the boot to be replaced. If the boot had been previously replaced, you probably will find the original strap clamp has been replaced with a large radiator hose clamp. I recommend this substitution. Completely remove the clamp and slide the rubber ring under the clamp toward the center of the boot.
7. Loosen this end of the boot–it has a retaining lip and may be stuck in place. Push down on the wheel hub so as to open a space between the end of the strut and the base to which it was clipped. This will let you move the strut to one side and pull it - with the attached boot - free from the suspension cylinder. You'll note the strut is not fastened inside the cylinder. The weight that it supports keeps it in place.
8. Remove the small dust cover and associated rubber bushing from the base end of the strut.

9. Turn the boot inside-out and note another strap clamp used to hold it to the strut. Before loosening this clamp, carefully measure the distance from this end of the boot to the end of the strut that goes inside the cylinder. The new boot MUST be clamped in the very same position. You'll note ribs on the strut in the area of the clamp. They don't exactly locate the boot, however.
10. Remove this strap clamp without cutting it and remove the old boot from the strut.
11. Turn the new boot inside-out and place in the EXACT same position on the strut. Rotate the boot on the strut so that the drain nipple is 90 degrees to the hole through the end of the strut for the rod pin removed in step 3 above.



12. I prefer to reuse the old strap clamp and not substitute a miniature hose clamp. I fear the hose clamp will damage the boot when the boot is stretched to the position it takes when the car is raised to its upper limit. The old strap clamp can only be reused if its length is extended about 3/8". This is possible by rebending the inside end of the strap clamp so as to reduce the length folded under as shown in the above illustration. I tighten the strap clamp without the special tool by using vise-grips to hold the tab and using regular pliers to pull the end of the strap after inserting the end thru the tab. Note the strap makes two turns. Fold the end of the strap over the tab when you're done. Turn the boot so that its outside surface is on the outside. Slide the old small dust cover over the end of the strut and move it beyond its normal position toward the center for the time being.
13. Use solvent, if necessary, to dissolve dried lubricants around the ball inside the ball seat (removed in step 4 above). Extract the ball and be sure it and the ball seat are clean. I replace the ball with just a small amount of grease from the gun I use to lubricate the front wheel and suspension bearings (more will be added later). Clean the rod pin and apply a thin covering of grease to it. Clean the area where the ball seat mounts (a thin covering a grease won't hurt). Remount the ball seat (with the ball inside it) and temporarily reinstall the rod pin.
14. Reinstall the strut with the new boot in the same way it was removed with the old boot. As you're installing it slide the rubber bushing (item 5) over the end of the strut and the large rubber ring (item 6) over the boot. Rotate the strut and boot so that the drain tube nipple faces up. If the boot was properly attached to the strut, the hole through the end of the strut for the rod pin should be horizontal.
15. Fit the large end of the boot in place with the inner lip in the groove intended for it. Slide the rubber ring in place and replace the "radiator hose" clamp.
16. Install the drain tube in the boot nipple. Be sure to get it in all the way (compare with the other side if in doubt).

17. Slide the small dust cover over the ball seat and rotate so the holes in it line up with the holes in the strut for the rod pin. Slide the rubber bushing in place and reinstall the strap clamp. I use the same technique here as in step 12 above in reusing and reinstalling the strap clamp.
18. Place the rod pin in its proper location and bend over the far end so that it can't fall out. If the rod pin broke such that you have just a short piece (a half-inch or so) to insert in the fixed side and don't have the time or equipment to extract the remaining piece at this time, add an adjustable radiator hose clamp around the strap clamp that also goes around the broken rod pin. CAUTION: This is only a temporary measure.
19. I complete the lubrication of the ball with the aid of my grease gun and a grease fitting with two short attached pieces of tubing. The smallest piece is about 3/16" OD and 3" long. One end is forced inside the end of a larger two inch piece that is clamped to a grease fitting matching the gun. The free end of the small piece is slid under the dust cover along the strut. I pump several strokes from the gun until the air under the cover is pushed out. (The best tool for this job is called a "pig needle." It is a large hypodermic needle attached to a Zerk fitting You parts man will know what you are talking about it you ask for one. Just take care with it as the tip is very sharp and it will easily poke you of your rubber boots. You just want the tip to slip behind the edge of the boot. [MB])
20. This completes the repair and all that remains is to replace the wheel and fender. I always use this opportunity to inspect the tire tread for defects and any trapped pieces of glass or metal that could later cause a flat tire.

While it is possible to tighten the clamps with a vice-grip, it is far better to use a Ligarex pliers. You could reuse the outer band to do up the inside, then use another type of band on the outside, but by all means make sure your inner band has no raised portions or it will cut the boot in short time through abrasion. See my article, "Ligarex band and tool usage" in the Work Aids chapter. Also, make sure you inspect the end of the push rod for wear as described in the previous article. [MB])

Rear cylinder corrodes from packed mud and salt
(Aug. 1979. p.2)

When our left rear suspension cylinder cracked and spewed out most of the car's hydraulic fluid in about ten seconds, we found the cylinder was packed tightly with dirt and small stones into its body support and could not be budged at all. Electrolytic action between the car body and the suspension cylinder had eaten away at the cylinder, weakening it and causing it to crack lengthwise under pressure. An amazing amount of dirt was scooped out through the three holes of the support bracket and then a rust dissolver was sprayed around the collar holding the cylinder in the bracket.

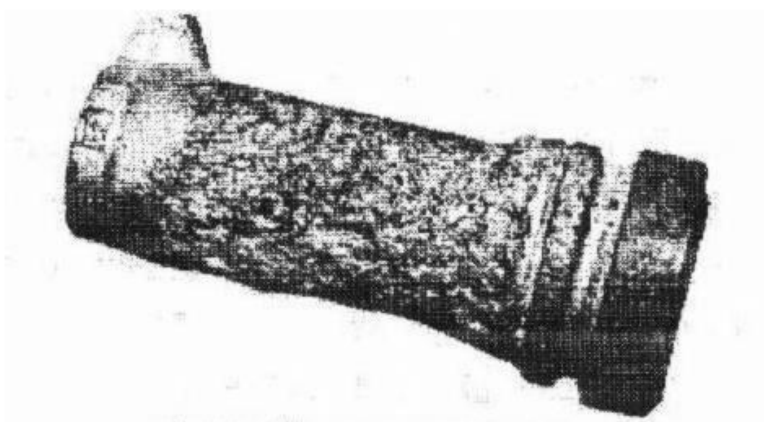
After removing the suspension arm with its rubber boot and the sphere, the cylinder was knocked loose by heavy pounding on a piece of hardwood. Prevention of this problem would be to regularly clean out the suspension bracket or better yet to fill the cleaned out bracket with as much chassis grease as the bracket will hold.

At this time it would be a good idea to replace the hardened steel ball that the suspension arm rocks on with a 5/8" diameter ball easily and cheaply available from any bearing supply firm. Clean out the socket and repack fully with chassis grease.

After proper reassembly, of course, the brakes and the main hydraulic system must be bled. With the rear of the car on supports and the suspension lever in the highest position, the engine is run and the bleed screw on the main regulator is closed. An assistant then depresses the brake pedal as you bleed first the rear (right first then left) and then the front brakes. Those who have Citromatic should use the rear bleed screw on the centrifugal regulator for the front right and the bleed screw on the accelerated idling device on the carburetor for the left front brake. The hoses from these two can be bled directly into the opening at the top of the reservoir.

Editor: Bleeding should not be necessary if the brake pedal was not pushed or any brake lines opened during the repair process. Air (and nitrogen from a defective sphere) is the suspension cylinders will automatically work its way back to the reservoir.

Rear cylinder corrodes from packed mud and salt
Don James, OH (Apr. 1983, p.5 & May 1985, p.8)

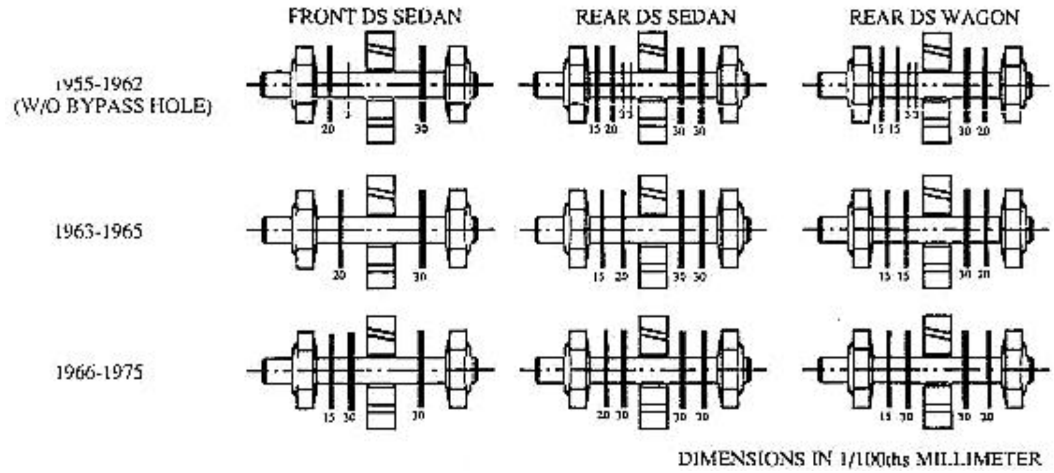


Corroded Rear Suspension Cylinder

A leak from inside the bracket that holds the rear suspension cylinder can only come from severe corrosion of the aluminum suspension cylinder. Lots of dirt, mud and salt can get packed inside the steel bracket mount. The aluminum cylinder acts as a sacrificial anode and corrodes instead of the steel bracket.

The aluminum cylinder protects the area, at it's own expense. This seems to be a common problem. Keep those brackets clean and oiled. Front and rear sedan suspension cylinders are the same except for the locating flat. The wagon has larger rear cylinders.

Removable shock absorber identification
Chris Dubuque (Feb. 1984, p.10 & Jun. 1990, p.13)



Identification of Removable Shock Absorbers (Dampers)

Roll bars on early D-models gave softer ride
Don James, OH (Jan. 1983, p.7)

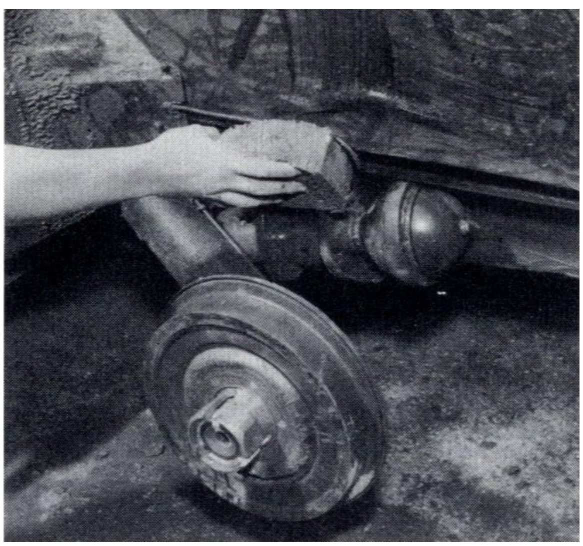
Many owners have asked why they can not get the same smooth ride as their old '60 model. The older cars had a much smaller anti-roll bar that was not so stiff. This made a much smoother ride. (Additionally, the lower powered engine allowed for softer damping in sphere dampers. [MB])

Shock absorber reconditioning
Mark Bardenwerper (May, 2016) Adapted from a French article similar to factory booklet, F.137

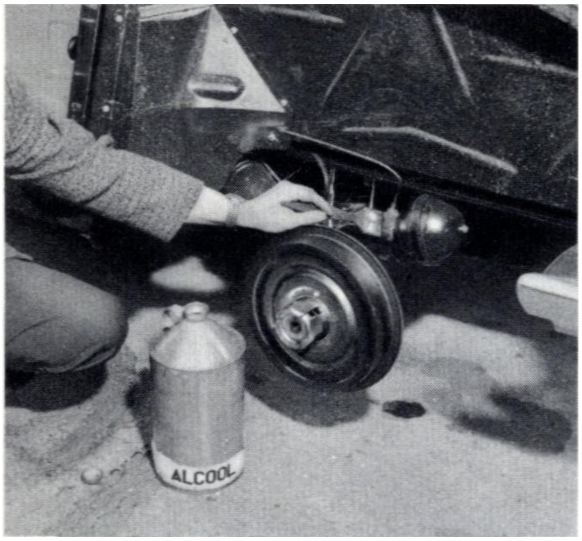
Refurbishing the dampers on ID's, DS's and Breaks is simple. However, one can not achieve a satisfactory result without observing the precautions of CARE and CLEANLINESS. This is described in the factory manuals, but it is perhaps important to recall and clarify important points. Work begins with removing the suspension sphere.

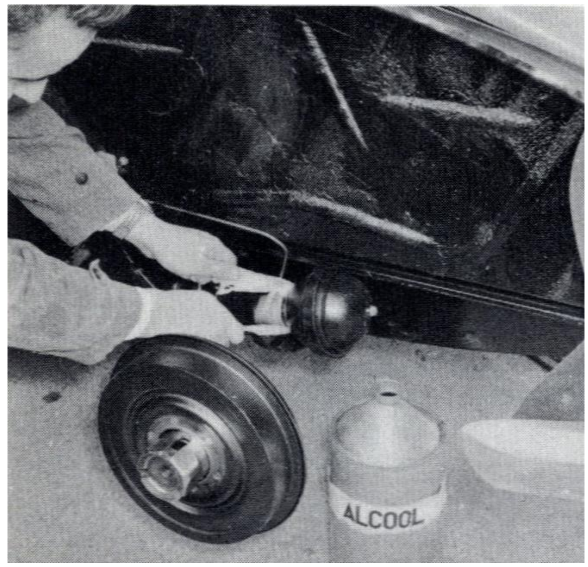
Removing the pneumatic suspension unit

Clean the exterior of the suspension cylinder, the sphere and the entire surrounding area with a water spray gun.

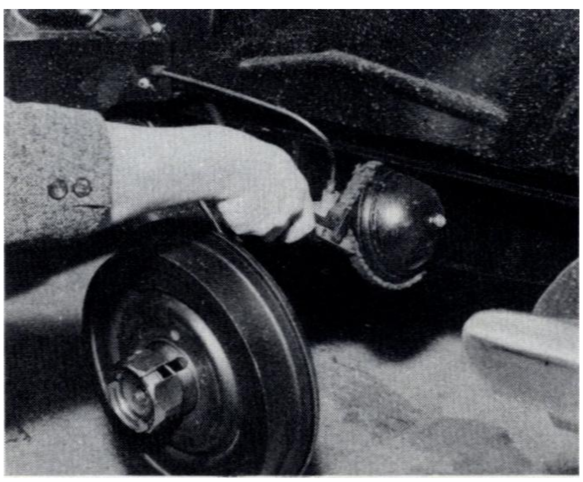
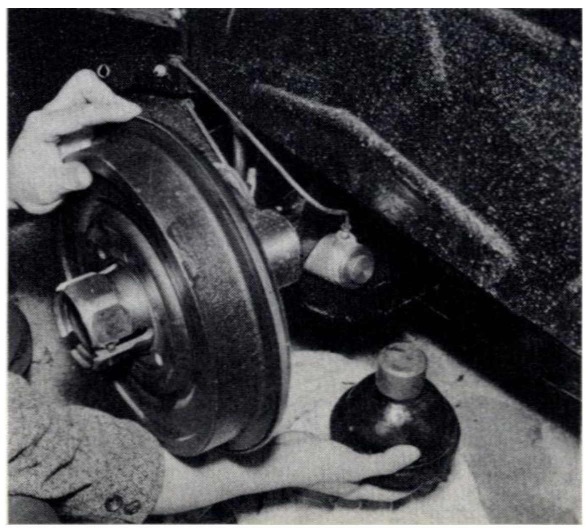


Dry the parts properly to avoid introducing water into the cylinder or the sphere while dismantling. Use compressed air if possible.

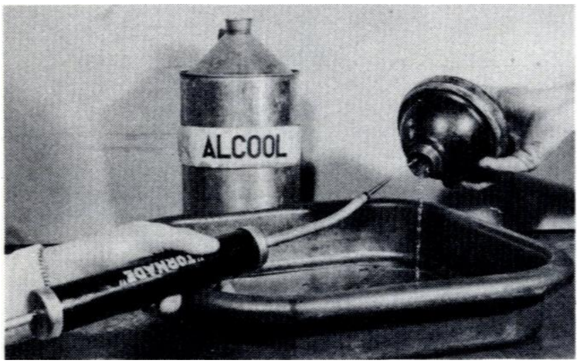




At the back and front, finish cleaning with brake cleaner or other light solvent spray or a brush and clean cloth. These precautions are necessary to prevent the introduction of gravel, dust and other "sludge" in the cylinder or sphere.



Screw on to the cylinder and sphere special protection caps upon removal. Again, cleanliness should be as perfect as possible (keep in reserve in a container containing the alcohol or compatible solvent).

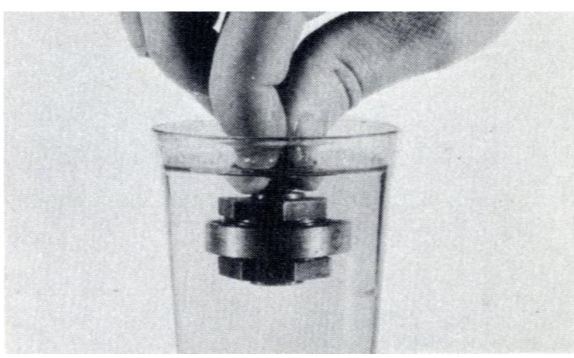
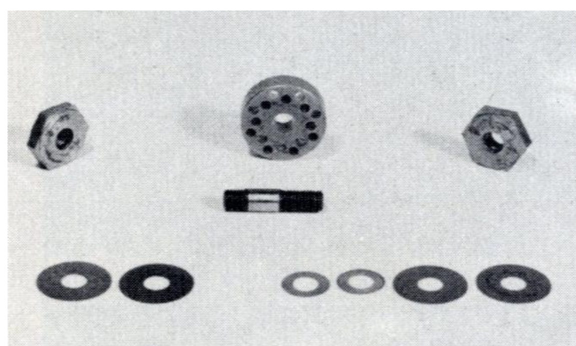
Removal and disassembly of the damper
Work in a room reserved for the review of hydraulic components or, failing that, on an established area thoroughly cleaned. Clean tools with compatible solvent.



After removing the protection plug from the sphere, unscrew the damper and extract it. Wash the housing of the shock absorber in the sphere. Use a syringe or spray and replace the plug immediately. Do not use a brush. Cleanliness is difficult to control and hairs can shed.

Unscrew the damper. Use a torque wrench or a spring scale to check the loosening torque. It should be close to the tightening torque (noted later). Notice whether the full damper turns or only the outer nut. It should come out in one piece. If not, carefully remove one part at a time, placing them in order of disassembly. If the outer nut moves, the damper was improperly assembles and torque of the damper into the sphere was higher than that of the 2 nuts holding it together.

While dismantling the damper spare parts (upper right), clean and check each one. Search for possible causes of malfunction. If something is not satisfactory while removing the shock absorber, make notes.

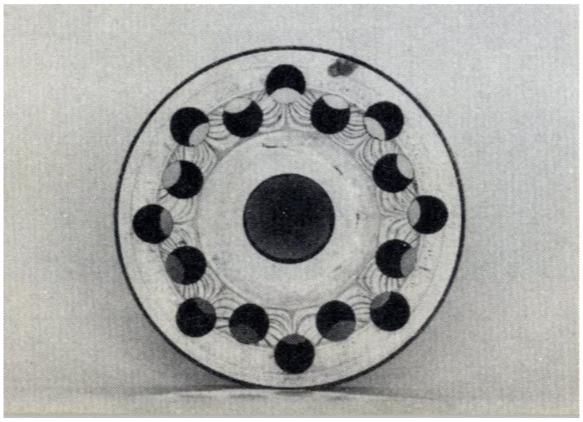



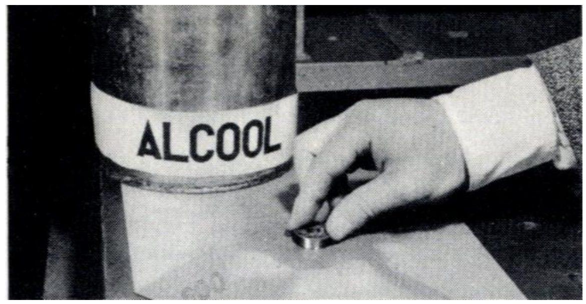
If it came out as a unit, dip the complete damper in a clear vessel filled with solvent. Look for impurities that collect in the bottom. If there are deposits of dirt, cleaning was not done properly or the hydraulic system is contaminated.

Dismantle the damper. Arrange the pieces in the removal order on a sheet of white paper, to allow to absorption of impurities, to check the condition of the damper and the rest of the parts. Note the type of impurities (small chips, rubber debris from the joints, foreign bodies, gravel) for diagnosing the cause of failure.

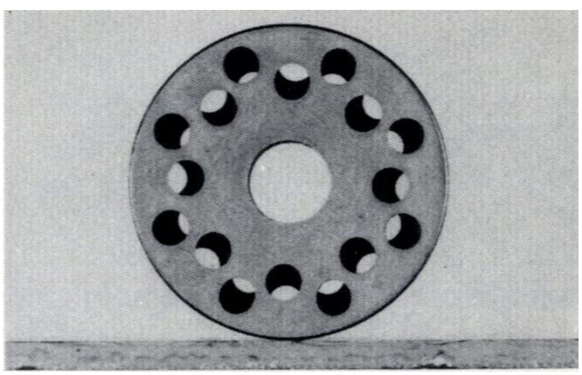
Check the individual parts. Use a micrometer or caliper to carefully check the thickness of the valve plates. Make sure they match the specifications and order of assembly for the particular vehicle.

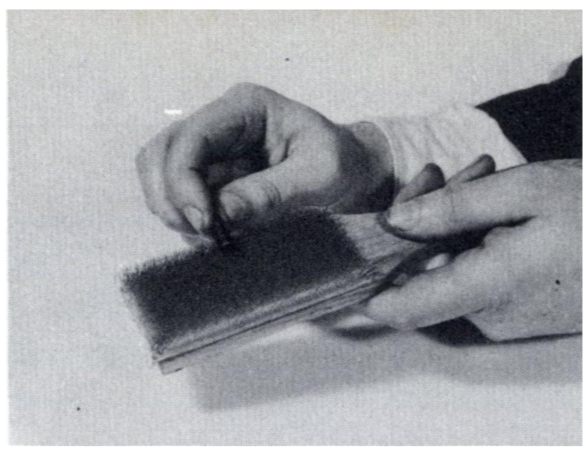
The next examination is easier to do if you have a magnifying glass. All relevant surfaces of the parts, those in direct contact with each other, must be very flat (the spacers and plates) or curved smoothly (the nuts) and perfectly polished. Pay particular attention to deformations that can be found around the stud hole.





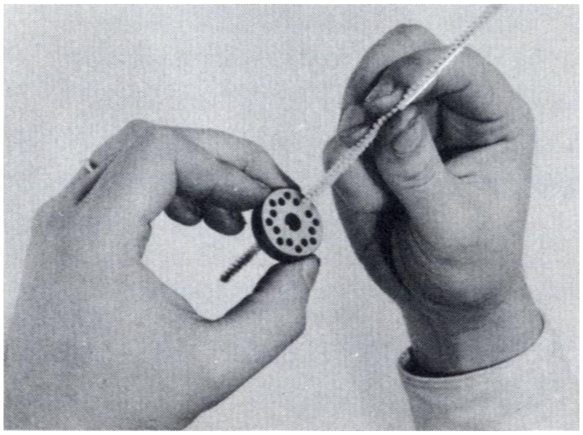
Only light polishing and cleaning are permissible. All deformed parts, deeply etched or scratched should be replaced. Use only No. 400 wet abrasives with alcohol, moving to a finish with No. 600. Place the abrasive paper on a marble or, failing that, on a thick ice or glass, well supported and very flat. Rub the pieces very lightly, in small circles, to avoid scratches. Complete work on an old part of the paper. They must be perfectly polished or replaced. It will consist of a slight "scrub" only to remove unevenness often difficult to detect otherwise.

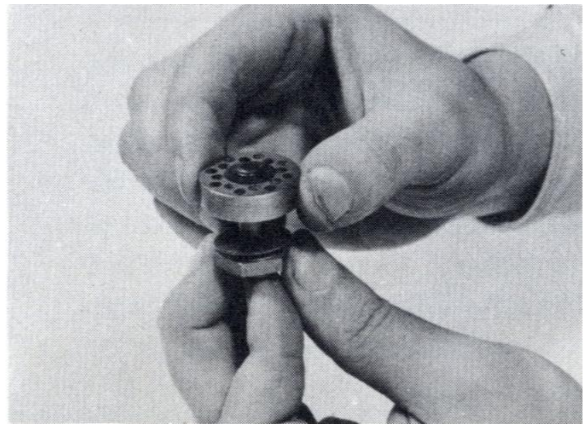




For curved surfaces of the nuts, the work must be done by hand. Care must be taken not to press the vicinity of the center hole to change the shape of dome.

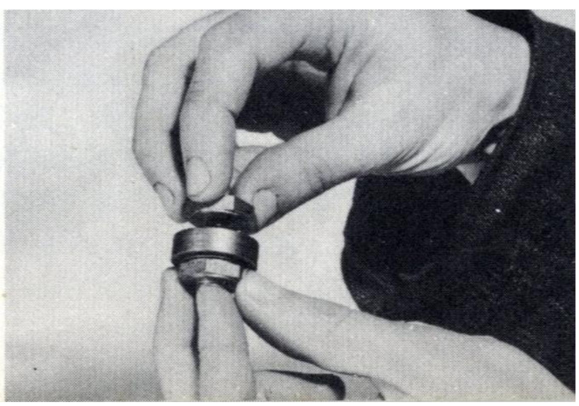
The smooth portion of the stud must also be cleaned by hand. Only shallow scratches can be removed. Surface must show good polish. Clean the threads of the stud carefully using a small brush or a wire card.

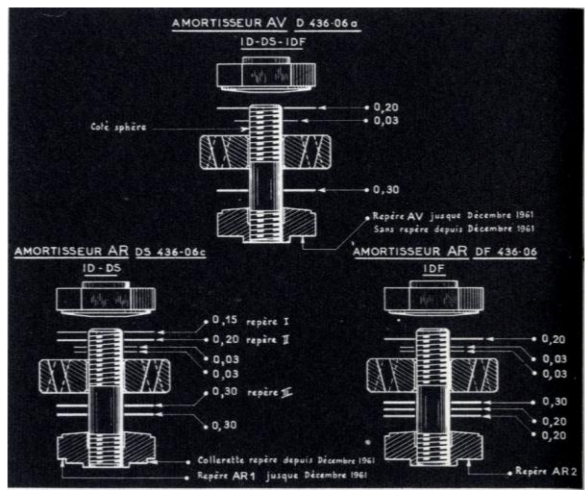




For holes of the damper body and the threads of nuts, small brushes can be used or pipe cleaners, on sale in any tobacco shop.

Clean the parts with alcohol and blow them with compressed air except spacers 0.03 mm that are too fragile to withstand this treatment.

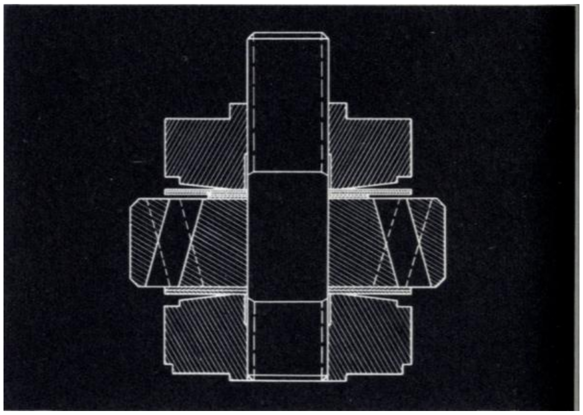
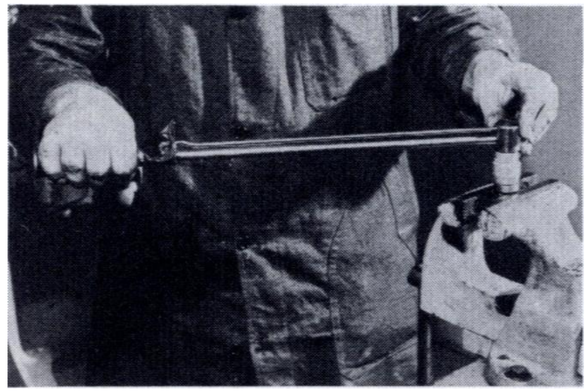




Damper assembly

Screw one of the nuts (the one specially marked in the case where there is one) on the shorter threaded portion of the stud until the outer face of the collar of the nut flush with the end of the bolt, making sure that no threads are visible on the inner end side. Dip reeds plates in compatible fluid as you place them on the stud making certain they are in the correct order and the correct thickness. They must be perfectly centered so that the stud threads do not damage them. Keep the damper over by the nut and place a finger under the pin to prevent rotation.

Stack the pieces in the order indicated by the above diagram or the one found in Chapter 27, Suspension, “Removable shock absorber identification.” Screw the second nut, ensuring that the valves in the smooth part of the stud (below left).

Then place the damper in a vice to tighten nuts with a torque of 2 to 2.2 kgm (170-190 in.-lbs), using a torque wrench.

If no torque wrench, use a spring scale utilizing the formula

$$\frac{C}{L} = F$$

where:
C = Torque specification

L = wrench length

F = Effort to read on the scale.

Example:
To attain a torque of 2.1 mkg using a wrench having 0.30 m in length between the axis of the damper and the axis of the attachment hole of the socket, one will have to read on the scale an effort of:

$$\frac{2.1 \text{ m-kg}}{.3 \text{ m}} = 7 \text{ kg} \quad \text{-or-} \quad \frac{170 \text{ in-lbs}}{11 \text{ in}} = 15.5 \text{ lb}$$

Installation of the damper

Remove sphere cap. Screw the damper in place. Hold the sphere firmly against the chest (above right) or vise between two V-shaped pieces of wood (below). Tighten the shock absorber with a torque of 1.9 m kg (164 in. lb.) using a torque wrench or, alternatively, a scale. This torque must be less than the torque used on the two nuts of the damper so as not to change the torque of the clamping valves and allow for proper disassembly. Replace the cap on the sphere.

Installing the pneumatic suspension unit

Remove the cap of the suspension cylinder. Rinse the inside of the cylinder using a syringe or compatible solvent spray. Remove the cap for the sphere. Install a new seal soaked in liquid for hydraulic circuit. Screw the valve block to the cylinder. Hand tighten only.

Causes of failures
In case of repeated failures, if the examination of the dampers detects the presence of impurities, it is possible that all the liquid suspension is contaminated. In this case, the entire system should be drained, flushed and refilled. If necessary, replace the suction filter.

Note: Draining the hydraulic circuit is recommended every 30,000 kilometers but it is also necessary if there is evidence that the fluid is the cause of a problem.

If testing of dampers does not identify the cause of the incident, it is possible that the problem may have another cause. Check the inflation pressure of tires, suspension stops and torque of the wheel nuts. Also, check for wear in the ball bearings and axle joints, steering rods pivots and hubs. Check the axle half-axles nuts and studs for tightness.

Sphere degradation questions and answers
Don James, OH (Mar. 1993, p.17)

How does the nitrogen get out of the sphere?

The gas escapes by molecular diffusion or permeation of the rubber diaphragm. The gas dissolves into the rubber on one side and emerges on the other side to go into the fluid. This happens mostly when the car is running due to the large surface area of the diaphragm. Spheres store very well if they are not used.

How do I know if my spheres need to be recharged or rebuilt?

There is no way to tell the condition of the diaphragm without opening the sphere. If you don't know the age or condition of the sphere, it is best to rebuild. LHS-2 spheres last a very long time and if the diaphragm is not ruptured, a recharge is usually all they need.

Can I tell how much pressure is in my spheres while they are still on the car?

Not exactly, but you can get some idea. The trouble is, by the time you notice that the car does not ride right, it is too late and there has been serious damage done to the diaphragm. The car will still run and ride very well even with one-fourth of the proper amount of nitrogen. With a small amount of skill, you can push on each corner of the car and get an idea of the condition of the spheres. A flat sphere will feel rock solid and because of the anti-roll bar, may make you think that the opposite side is flat.

Sphere diaphragm deterioration
Don James, OH (Jan. 1986, p.29)

(left) Inside lower sphere half showing diaphragm turned to "goo"
(right) Diaphragm removed when half of edge no longer sealed nitrogen

There are always people who have never seen the inside of a sphere and do not understand why they must be rebuilt from time to time. The "LHM" sphere shown above was run on nothing but LHM. The black goo that is inside is the remains of the factory diaphragm. This goo is just like chewing gum, but much more sticky. When a sphere reaches this stage of deterioration (it obviously has been flat for a long time), the rubber goo will travel with the fluid and go everywhere.

What causes this deterioration of the rubber? This is the result of "hydrolysis". The polyurethane rubber that was used is very tough, but the polyester base urethane frequently fails due to poor water resistance.

How does the water get into the fluid? Air is constantly going in and out of the hydraulic tank, and air has water in it. Salt air near the ocean is worse, and speeds the process.

How can you tell if you fluid is contaminated? It is easy if you use genuine LHM, because it will turn yellow in color. Red colored hydraulic fluids do not change color because the dye is too strong.

The best way to prevent this from happening is to change your hydraulic fluid every two years. The deterioration starts on the fluid side of the diaphragm and works it's way to the nitrogen gas side. With some types of diaphragm materials, the opposite affect can happen. The rubber gets stiff and hard from age resistors and anti-oxidants in the hydraulic fluid. It is very important to use correct hydraulic fluids in your car.

Most owners do not let their suspension spheres get in this condition. The ride is most unpleasant and since all of the weight on the front suspension is carried by the top suspension arm, it is easy to see how damage to the arm will occur at the first big bump or chuckhole!

This condition is seen most on brake accumulator spheres. The car will run and the brakes will work, even if the accumulator is in this condition. SMs have an accumulator for the brakes that is hidden under the hydraulic tank and the front fender must be removed to see it. SM owners usually get a surprise when, after the rubber turns to goo as above, the last remnant of rubber at the sealing rim of the sphere dissolves, and the sphere begins leaking at the equator!

All Citroëns will start, pump up and drive with every sphere on the car flat, or in the condition shown above. Operating the car with flat spheres is very hard on the car and the entire hydraulic system. The newer "welded" type of spheres can not be rebuilt and the latest ones use a "cast polyurethane" that is brown in color. Cast polyurethane can also be affected by hydrolysis, but seems more resistant to it.

Sphere diaphragm made of Viton failure
Don James, OH (Mar. 1984, p.11)

Spheres that have been rebuilt with diaphragms made from "Viton" will likely fail in a car operated at sub-freezing temperatures. A quick check in your freezer of such a diaphragm will show you that it gets hard as a rock. It is no longer elastic and if you operate the car the seal will be lost. These diaphragms can be identified by a distinct "cinnamon" odor. One Club member had three supposedly good spheres go flat after a sub-zero night.

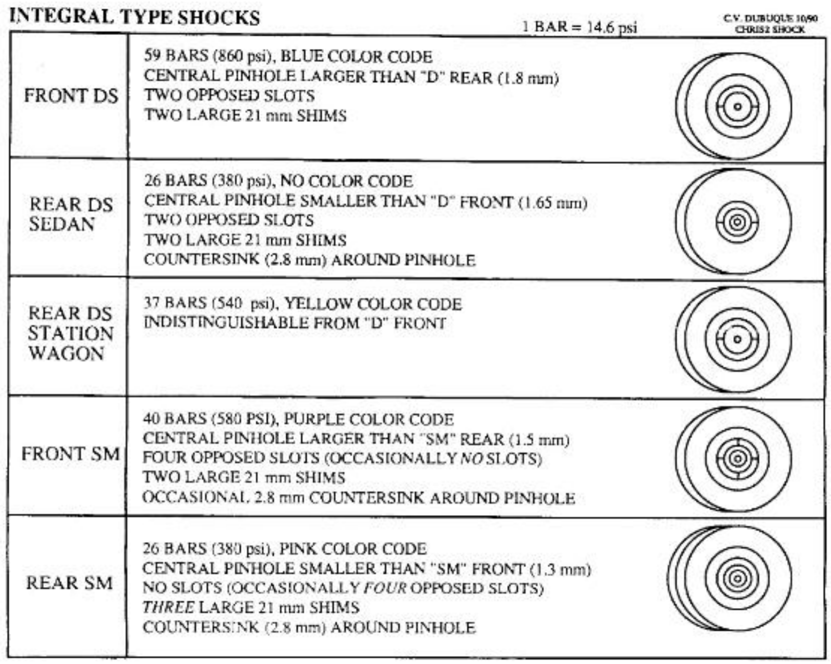
Sphere identification, age of welded type
Don James, OH (May, 1984, p.9)

Do you have a set of the welded "pineapple type" spheres on your car? You can get an idea of how old they are by the size and shape of the fill plug on the top of the sphere. The first ones made had a fill plug that was about 5/8" diameter. Next they made them about 3/4" in diameter. In about 1980 or so they started making them 3/4" diameter but with one important difference: There is no cut in the top of the fill plug to drive it closed. So the newest version of these spheres have a smooth flat top and are about 3/4" in diameter.

The welded pineapple type of sphere can last up to about 10 years if it is kept properly charged.

Fill plugs with an extra step or "knob" on them are coming from Spain or Belgium. Recharging spheres with these fill plugs is not possible.

Sphere identification chart with integral dampers
Chris Dubuque (Feb. 1984, p.10 & Jun. 1990, p.13)


INTEGRAL TYPE SHOCKS   1 BAR = 14.6 psi   C.V. DUBUQUE 10/90 CHRIS2 SHOCK

FRONT DS	59 BARS (860 psi), BLUE COLOR CODE CENTRAL PINHOLE LARGER THAN "D" REAR (1.8 mm) TWO OPPOSED SLOTS TWO LARGE 21 mm SHIMS
REAR DS SEDAN	26 BARS (380 psi), NO COLOR CODE CENTRAL PINHOLE SMALLER THAN "D" FRONT (1.65 mm) TWO OPPOSED SLOTS TWO LARGE 21 mm SHIMS COUNTERSINK (2.8 mm) AROUND PINHOLE
REAR DS STATION WAGON	37 BARS (540 psi), YELLOW COLOR CODE INDISTINGUISHABLE FROM "D" FRONT
FRONT SM	40 BARS (580 PSI), PURPLE COLOR CODE CENTRAL PINHOLE LARGER THAN "SM" REAR (1.5 mm) FOUR OPPOSED SLOTS (OCCASIONALLY *NO* SLOTS) TWO LARGE 21 mm SHIMS OCCASIONAL 2.8 mm COUNTERSINK AROUND PINHOLE
REAR SM	26 BARS (380 psi), PINK COLOR CODE CENTRAL PINHOLE SMALLER THAN "SM" FRONT (1.3 mm) NO SLOTS (OCCASIONALLY *FOUR* OPPOSED SLOTS) *THREE* LARGE 21 mm SHIMS COUNTERSINK (2.8 mm) AROUND PINHOLE

Identification of Spheres with Integral Shock Absorbers

Sphere Pressures:

Main Accumulator, DS/SM:	65 bars (950 psi); ID: 40 bars (580 psi)
Brake Accumulator, DS/SM:	40 bars (580 psi)

Sphere leak through small side hole
Paul Fontaine (Sep. 1983, p.3)

When one of the front suspension spheres on my car began leaking, I removed it and put it on my sphere tester. Sure enough, a thin stream of fluid was coming from a hole in the side of the sphere. Unable to see it when there was no fluid squirting out, I figure that it is a very small pin-hole in the steel sphere housing.

Sphere may leak after rebuild
Don James, OH (Jan. 1983, p.6)

Sphere rebuilders use different methods of rebuilding. J.B.M. Industries uses a lot of fluid on the threads where the halves screw together. This makes them easier to open next time but the threads may ooze fluid for a time. All spheres are submerged to check for nitrogen leaks.

Editor: J.M.B. Industries now uses grease on the threads. Oozing should no longer happen.

Sphere mixups cause ride problems
Don James, OH (Jan. 1983, p.7 & Nov. 1983, p.8)

There is an increasing problem with both D-models and SMs having the wrong spheres. Spheres may all look the same and may have the same pressures, but the damper valve in the sphere is different. Many D-model owners who complain of a harsh ride have spheres with the wrong type of dampers (shocks absorbers) in their cars.

An example of where spheres have the same static pressures but different dampers, D-model rear spheres have the same static pressure as for the spheres used on the rear of an SM (26 bar). But, the spheres are NOT the same–the damper valve is different. One difference and a means of identifying the type, is in the size of the small by-pass hole in the center of the rivet that holds the damper together. This hole is much smaller on spheres used on the SM. Another means of identification is a color code on the outside of the sphere. Only the D-model sedan rear spheres are uncoded and the SM rear has a pink color code. See article, "Sphere identification chart with integral dampers," for additional details.

The damper valves are the shock absorbers on your car. They put resistance on the suspension in the same manner that telescopic shock absorbers do. This resistance or damping varies according to the way that the car is to perform. Front and rear dampers are different.

Because there are so many uninformed enthusiasts working on their cars, many cars have the spheres all mixed up. Some dealers got the bright idea of only stocking one part number for rear spheres because they knew that the pressure was the same. Do not go by the pressures marked on the fill plug because these have been switched around by many sphere rebuilders. See the article, "Working with removable dampers" for additional information about the older spheres with removable dampers.

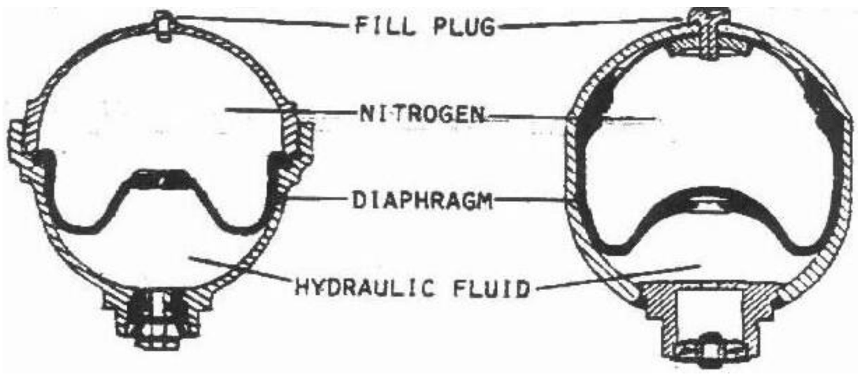
Sphere O-ring substitute
Dave Root, FL (Jun. 1988, p.20)

Citroën spheres take a special o-ring, a size that you cannot find in auto parts stores or hardware stores. It rarely happens, but you can lose one or, as recently happened to me, the original o-ring can expand so that it was impossible to get it to stay down in the groove in the cylinder. Since the need is so seldom, I hadn't keep a spare o-ring on hand.

Available rings of the right diameter have the wrong cross-section, 1/8". These will not work because the ring will not compress enough to bring the shoulder of the sphere in contact with the cylinder end surface. The high pressure eventually causes the o-ring to "extrude" itself out the small gap. I learned this lesson abruptly when I saw fluid spraying on my windshield while my hood was open!

I then found that if I would get a 1" ID O-ring (1-1/16" OD) with a 1/8" cross-section and stretch it over the threaded section of the sphere, the cross-section would be reduced just enough to provide the compression needed for the seal and also allow the shoulder of the sphere to come in contact with the cylinder. This has the added feature that since the o-ring has been stretched over the threaded part of the sphere, it cannot slip off and be lost when removing the sphere. By using this o-ring which is readily available locally you can save the time it would take to get a special one mailed to you. AND, it works!

Sphere pressure loss after two years with welded spheres
Dan Colabuno, OH (Jul, 1983, p.6)



Cross-section of two types of spheres, older screwed-together type (L); newer welded type (R)

Measurements were taken on welded-type spheres were taken from a 1960 CX with 30,000 miles after two years of use:

	Required	Measured
Main accumulator (static)	62 bar	40 bar
Front suspension (static)	75 bar	45 bar
Rear suspension (static)	40 bar	20 bar

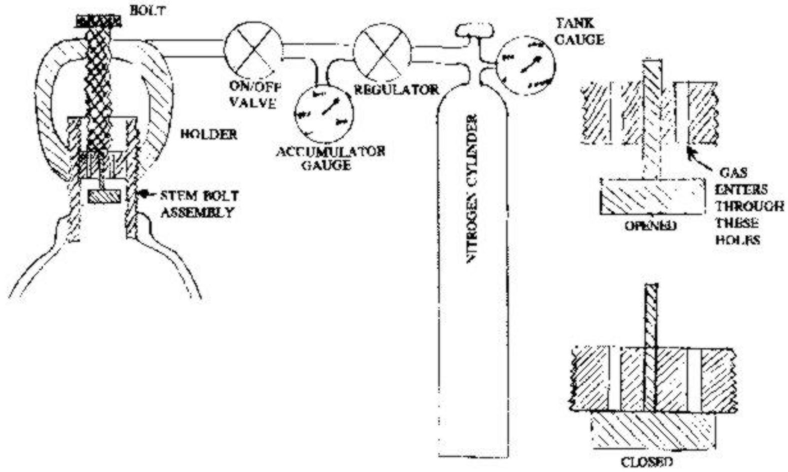
Editor: Welded types can not be rebuilt. Like a tire, once it has been run flat, it is shot. Both types of spheres can be recharged if they have not been run completely flat. Rubber diaphragm in the screw-together type can be replaced. Cross-section drawings of both types are shown above.

Sphere pressure loss by high position parking
Charles Fowler, Dec. (Jul. 1975, p.1)

A suggestion for leaving the car parked in high position overnight is not worthwhile. The theory was that this exercised and lubricated the ends of cylinders and stretched the rubber boots.

This also leaves the sphere bladders fully compressed, a condition which aggravates leakage of the nitrogen charge. After several days of this, my car began to ride like a mustang. A Citroën floats and bottoms enough to exercise everything.

Sphere recharged with added filling valve
Greg Lamb (Mar. 1986, p.21)



Farm hydraulic accumulator recharging system

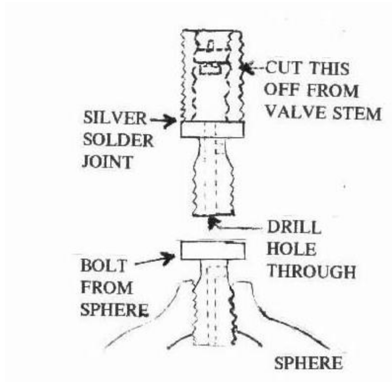
As my brother Gary, father Andrew and I started looking into what it would take to build a rig to recharge spheres, we stumbled upon something we consider better.

Some farm machinery sold today has a hydraulic system that allows the plowshare, tang, etc., to spring up if it hits a rock or something else in the ground while working the land. The springing action is provided by what the manufacturers call an accumulator, a cylinder of pressurized nitrogen that compresses if hydraulic pressure is generated when a rock is hit. Sound familiar?

The accumulators on farm machinery are charged to 2400 psi. The local welding supply house has the facilities to recharge these spheres. The system they use to refill the accumulators is quite ingenious and I have diagramed it above.

OPERATION

1. Thread holder over valve stem with on/off valve closed
2. Set regulator until accumulator gauge reads desired pressure
3. Turn bolt down until it stops
4. Open on/off valve
5. Turn out bolt when accumulator gauge returns to set pressure
6. Close on/off valve
7. Remove holder



Modification to Fill Plug to Add Valve

We have done some looking and figure the best way to adapt this to a Citroën sphere is modify the bolt (fill plug) in the top of the sphere as shown in Fig. 205. We drill an entry hole through the top and then silver solder a metal tire valve stem on to the top. We then tighten the bolt back into the sphere and it's ready to be recharged. The local welding supply house can do it instantaneously when we bring in a sphere. They did not even charge us for the first pair we had done. They say the small amount of nitrogen it takes has a very low cost.

The advantageous to us are: (1) they have the equipment already so we have no investment, (2) we do not have to carry the cost of the nitrogen bottle and rental, and (3) the equipment that they have has been tested and is not going to kill us by an explosion. The only change we make to the spheres is in the bolt and if the owner wishes to have his spheres recharged later by a different source all that is needed is to replace the bolt with an unaltered one.

We are going to check that the tire valves we used are satisfactory for this application. If not, we will find a more suitable stem. The ones used for farm implements are sold only through farm equipment dealers and are about $58 a piece, mainly because they are a low stock item for the dealers. So, we do not consider them an alternative.

Editor: This type of modification has ruined a lot of spheres. I consider an attempt to silver solder a metal tire valve stem onto a fill plug to be a crazy and dangerous idea. While some enthusiasts have found this method of recharging spheres works very well, most that have had success use an expensive valve. Tire valves or air conditioning charging valves are not built to withstand the 2500 psi that your car's spheres can be under when the car is running.

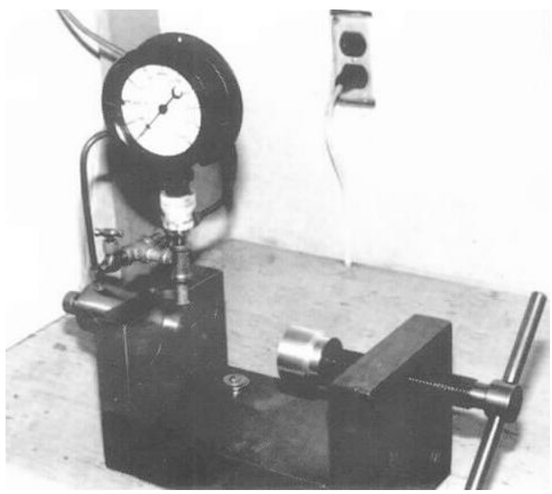
The thing you must be most careful of with this idea is the fact that the valve for filling sticks out of the accumulator in such a way that it could easily be clipped off by a wrench that slips, or by dropping the sphere while carrying it. The protruding valve is just like a bullet and would have the same affect with the pressure that is behind it when the car is under pressure. It appears the "Farm Accumulator" has a valve that does not protrude much, and I bet that there is a heavy metal cap with a rubber seal that covers what does protrude. The way it is installed makes it very strong, and there is probably a good reason why these farm accumulator valves cost so much, other than just low production.

The good thing about the way Greg plans to do it is that if he drills the hole through the "fill plug" or bolt from the sphere as he calls it, the small diameter of the hole should easily limit the effects of the valve being clipped off. Also, it is good that the sphere can be put back to original condition by installing a new fill plug.

Sphere recharged with added filling valve not recommended
Don James, OH (Jan. 1983, p.7)

Several enthusiasts want to know about installing filling valves in the top of their spheres. This is just one more place that spheres can leak and loose gas. Also, since the valve sticks up, it is easy to have a wrench slip off while working on your car and accidentally shear off the valve. Cracks some-times develop where the valve is installed. Also, unless the owner knows what he is doing and has the right equipment, it is unlikely that he will be able to get the proper amount of gas into the sphere. I know that it seems like a good idea, but I have seen spheres made worthless in the attempt.

Sphere recharging without added valve
Don James, OH (Mar. 1986, p.24)



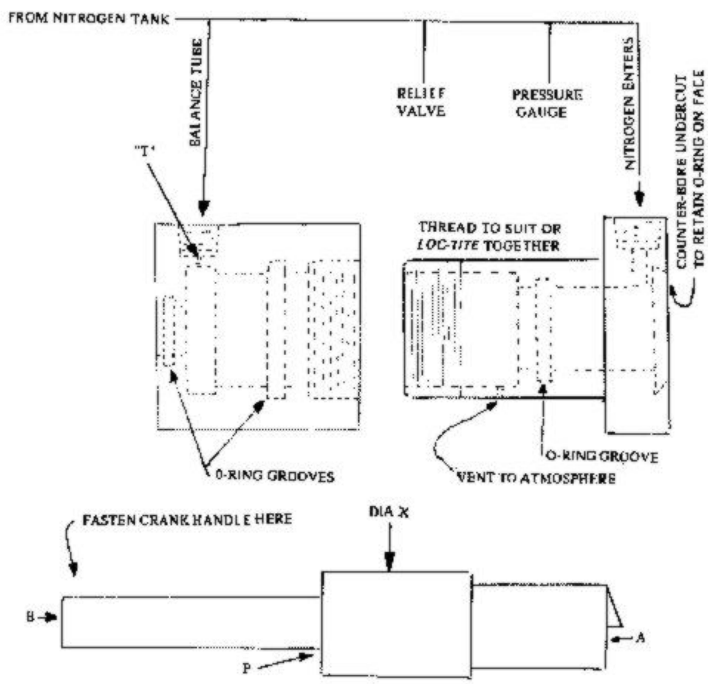
Sphere Recharging Frame

Many club members have asked how J.B.M. Industries puts gas into a sphere without the use a valve. First the sphere is cleaned and the top made smooth so that the charging head can properly seal. The fill plug is carefully loosened to release the original charge. Once removed, the fill plug is given a new O-ring and replaced at the top of the sphere. It is left loose enough to expose a very small hole to admit nitrogen. The sphere is clamped in a strong steel frame tightly against an O-ring on the charging head, which has a cavity above the filler port of the sphere. The picture above shows the frame without, unfortunately, a sphere mounted in it. To the left is the charging head and to the right is the handle that turns to press the round silver colored bit against the bottom of the sphere.

Nitrogen gas is admitted directly from the nitrogen tank through a regulator. There are two gauges, one showing full bottle pressure and the other the pressure at the regulator, set to the final sphere pressure. Initially, the regulator gauge drops, as it reads pressure in the head and not inside the sphere, because there is a lag as gas transfers pressure through the small fill hole. As the sphere fills, pressure rises in the charging head.

Once the gauge stabilizes, the proper pressure is reached and the tank valve is closed. Turning a crank on the charging head rotates a piston inside the head that bears against the top of the fill plug, closing it.

Before the sphere can be removed from the filling fixture, the pressure in the charging head and its feed line from the tank is relieved by means of a small valve.



The principal of the charging head is very simple and it is an easy and very interesting project to make if you have an engine lathe. The end of the driving piston should be heat-treated. The piston should be made large enough to work on all sizes and types of spheres. The above figure should answer your questions about a charging head. It is not to scale, but should give you an idea of how it works. Figure your own dimensions. The piston is balanced in that the pressure that fills the sphere on the face of diameter (A) by placing pressure equally on face (P). All you need to do is find the area of diameter (X) and deduct the area of (B) and be sure it is equal to the area of (A).

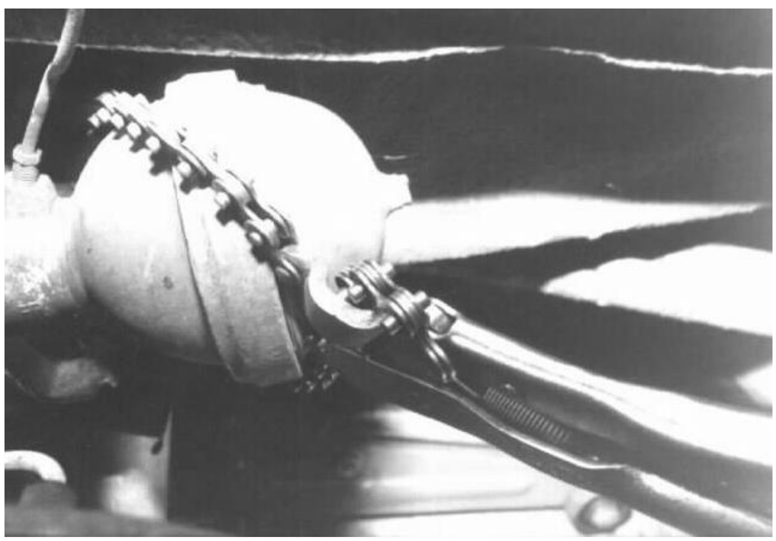
There are no threads on the piston, but face (A) should be hardened, so you may want to make this from two pieces. The cylinder of the charging head and the lay-out of the pressure balance system are shown below. The pressure balance port at "T" should be drilled as small as possible to prevent any surge from forcing the piston forward into the sphere.

It has been quite some time since enthusiasts have been able to see sphere recharging and rebuilding at the Rendezvous. Rod Burwell used to bring his portable equipment and work himself to a frazzle doing spheres. Most of the time a great number of enthusiasts trying to tear the spheres from their cars turned the event into a fiasco with washing of dirty spheres in the restrooms.

One problem with charging the "welded" type of sphere is that it only takes a very small amount of force pushing in on the fill plug to knock the "nut" loose from the sheet metal crimp that holds it inside the sphere. This cannot be repaired and makes the sphere useless.

Nitrogen gas is used because it's molecular structure will not permeate the rubber diaphragm. It is very difficult for the average owner to tell when his spheres are low on nitrogen. When a sphere gets low on nitrogen, it is very hard on the rubber parts inside the sphere. Recharge every two years for best performance and a very long life. With the new welded type of "non-rebuildable" sphere costing $118 each, don't take a chance.

Sphere removal in rear using a chain wrench
Charles Fowler (Jul. 1975, p.1) & Don James, OH (Nov. 1985, p.26)



Use of Chain Wrench to Loosen a Rear Sphere

The lack of clearance between the rear spheres and body of the car requires that you wrap a chain wrench around the sphere diagonally. To start the sphere turning, you must leave the system pressurized or the cylinder will turn. In extreme cases you might have to use a hammer and chisel (and heat, too) to crack them loose. Of course, once it's started, release the pressure.

I've never been able to completely drain the pressure from the front spheres. Even after lowering the control lever and opening the bleed valve, I still get that dreaded hiss and escape of fluid when I crack loose on the first sphere.

Editor: I strongly disagree on the use of a hammer and chisel. Don't butcher your sphere–you could ruin it. Clean around base of sphere before loosening so that dirt doesn't fall into cylinder as sphere is removed. Seals can be reused unless crushed. Don't use the chain wrench to tighten afterwards–a firm hand tightening is adequate.

Sphere removal in rear using oil filter wrench
(Jan. 1078, p.2 & Apr. 1978 p.2)

For those rear spheres that are a pain to get off without the recommended strap wrench, try a truck oil filter wrench. One that has given good results is #2322 from K-D Tools, Lancaster, PA, 17604. It handles diameters from 5-5/32" to 5-21/32", making it ideal for D-model spheres. You'll need a 1/2" extension from a socket set or a torque wrench with a 1/2" nose to pull the filter wrench tight. The steel band of the wrench is narrow enough to fit easily between the fullest diameter of the rear sphere and the car frame next to it. It can be obtained from any auto store carrying K-D tools and the cost should be around $11 (1978 prices). The biggest strap wrench was quoted at $17 and would only hold up to 5" diameter.

Sphere removal requires all pressure to be drained
Jay Brosius (Jul. 1984, p.20)

When removing the spheres even with the height control lever in the lowest position, there still may be some pressure in the system and the spheres will be difficult to turn. Anyone that knows how the system works knows that if the sphere does not turn easily after it breaks free, there is still pressure in the system. Removing the sphere while there is still pressure on it will result in a fluid bath for the person removing the sphere! You must wait until the pressure is gone before you remove the sphere.

If you don't have time to wait, use this tip. Raise the car and place the jackstand on the frame pin, just as if you were going to change the tire. Lower the car and when the tire comes off of the round you can safely remove both of the spheres on that axle. While this seems to be a common problem with the SM, it should work on those D-models with rusty linkages or sticking height correctors. If there is pressure in the system, get those wheels hanging!

One other point: when you replace your spheres, tighten them only hand tight.

Sphere use when flat causes trunk wall to buckle
Carl Mason (Mar. 1983, p.3)

It took a good deal of pounding to straighten a buckled trunk wall and bent suspension bracket after I noticed my D-model's ride was getting rough and then one rear suspension cylinder got stuck. I now know a D-model will not take the pounding from a bad sphere if it is even a little rusty.

Editor: Driving the car in the "low" position will buckle the stops.

Troubleshooting check list
Reprinted from Citroën Factory booklet, “Citroën Hydraulic System-Possible Incidents With Suggested Causes and Remedies," submitted by Jerry Seville, PA (Aug. 1985, p.21)

INCIDENT	POSSIBLE CAUSES	REMEDY
4) Suspension hard or too stiff in operation.	Incorrect tire pressures.	Adjust.
	Suspension sphere(s) partially or wholly deflated.	Change affected spheres. Drain, flush and refill hydraulic system with fresh fluid.
	Front & rear spheres interchanged.	Refit spheres in their correct positions.
	Sphere Identification	
	Front (all types)	- Stamped "59" on plug of top half, with blue paint around plug.
	Rear (ID19, DS19, DW)	- Stamped "26" on top half plug.
	Rear (Safari)	- Stamped "37" on plug of top half and a ring of green paint around sphere.
	Shock absorbers interchanged, incorrect type fitted, or faulty.	Fit shock absorbers in their correct position, change for correct type or recondition. (See booklet F. 137.
	Shock Absorber Identification	
	Front (all types)	- "AV" stamped on nut or unmarked.
	Rear (Sedan)	- "AR1" stamped on nut or unmarked where shoulder nut is fitted.
	Rear (Safari)	- "AR2" stamped on nut.
	Hydraulic pressure too low or absent.	Trace cause an rectify. See Incident 1, found in Chapter 18 - Hydraulics, "Troubleshooting."
	Suspension piston seized or sticking in its cylinder.	Free off or change piston cylinder assembly.
	Front anti-roll bar bushes too tight (mal-adjusted).	Adjust.

	Front anti-roll bar linkage rod ball ends overtightened.	Adjust.
	Axle bearings seized or overtightened.	Free off, or fit new bearings. Re-adjust.
	Front hub upper and/or lower pivot balls too tight.	Adjust.
	Normal height setting too high or too low.	Re-adjust.
	High pressure feed pipe obstructed.	Clear.
5) Height correction sluggish and heights slow in rising.	Suspension spheres partially deflated.	Change spheres.
	High pressure supply pipes or height corrector passages obstructed.	Clear obstruction.
	Manual height control linkage not moving freely.	Clean and free off.
	Height corrector slide valve sticking in its bore.	Clean and free off.
	Height corrector control rod not functioning correctly.	Free off or change rod.
	Height corrector restrictor and/or pressure return pipe obstructed.	Clear obstruction.
	Front anti-roll bar bearings too tight.	Adjust anti-roll bar bearings.
	Front anti-roll bar linkage rod ball ends too tight.	Adjust linkage rod ball ends.
	Front axle arm bearings and/or front hub pivot balls too tight.	Adjust bearings and pivot ball caps.
	Shock absorbers not functioning correctly.	Recondition or change shock absorbers.
	Hydraulic pressure too low.	Trace cause and rectify. Check as in Incident 1 (under "Hydraulic System" in Chapter 17, “Troubleshooting check list”).
6) Height correction and	Air in height corrector and/or suspension system.	Drive car for a few miles until air is dispersed.

over-correction continuing and altering.	Manual height control linkage maladjusted.	Re-adjust.
	Height corrector control movement restricted.	Free-off.
	Height corrector restrictor ineffective.	Rectify or change height corrector.
	Shock absorbers faulty.	Change.
7) Knocks or noises in suspension.	Shock absorbers not functioning correctly.	Recondition shock absorbers per instructions in booklet F.137 ("Shock absorber reconditioning" earlier in this chapter).
	Excessive play in front anti-roll bar bearings.	Adjust or change bearings.
	Excessive play in ball-ends of front anti-roll bar linkage.	Adjust ball ends.
	Rear anti-roll bar clamp(s) loose.	Adjust and tighten.
	Excessive play in front hub pivot balls and caps.	Adjust hub pivot caps.
	Excessive play in upper or lower axle link arm bearings.	Adjust bearings and grease.
8) Car will not attain normal height with engine running.	Manual height control lever in wrong position.	Check its position.
	Normal height incorrectly adjusted.	Re-adjust to specifications.
	Height control rod clamp(s) not securely tightened on anti-roll bar(s).	Adjust and tighten clamps.
	Total or partial loss of hydraulic pressure.	Trace source of trouble, rectify as in Incident 1 (under "Hydraulic System" in Chapter 17, "Troubleshooting check list").
	Height corrector slide valve seized or sticking in its bore.	Free off slide valve.
	Height corrector fixing bolts loose.	Tighten bolts.

9) Suspension too soft.	Shock absorbers not functioning correctly.	Recondition shock absorbers per instructions in booklet F.137 (“Shock absorber reconditioning” earlier in this chapter).
	Suspension spheres at inadequate pressures.	Change suspension spheres.
	Height corrector faulty.	Change height corrector.
10) Excessive variation between L.H. & R.H. side heights. (difference not to exceed 3 mm)	Front anti-roll bar linkage mal-adjusted.	Re-adjust.
	Front anti-roll bar bearings too tight.	Re-adjust.
	Incorrect tire pressures.	Correct.
	Axle arm distorted.	Change.
	Body twisted.	Repair as necessary.
	Suspension piston sticking in its cylinder.	Free off or change.
	Front hub swivel ball too tight.	Re-adjust.

For further details, see Citroën Booklet F. 137 "Overhauling Shock Absorbers," (“Shock absorber reconditioning” earlier in this chapter). Other parts of the Citroën factory booklet in which the above appears are in this book under the following chapters: 3 - Brakes, 8 – Citromatic, 18 – Hydraulics and 25 – Steering

Working with removable dampers
Don James, OH (Jan. 1983, p.7 & Nov. 1983, p.8)

There is an increasing number of enthusiasts having the wrong or mismatched dampers on their cars. Most informed enthusiasts know that the static pressures are different from front to rear, and that the pressures are different in the spheres from car model to car model. Some spheres have the same static pressures. For example: D-model rear spheres have the same static pressure as for the spheres used on the rear of an SM (26 bar), but the spheres are NOT the same; the damper valves are different.

The damper valves are the shock absorbers on your car. They put resistance on the suspension in the same manner that telescopic shock absorbers do. This resistance or damping varies according to the way that the car is to perform.

Front and rear dampers are different. Because there are so many uninformed enthusiasts working on their cars, many cars have the spheres all mixed up. Some dealers got the bright idea of only stocking one part number for rear spheres because they knew that the pressure was the same.

The biggest part of this problem is with the spheres that have the damper valve permanently affixed. In the center of the rivet that holds the damper together, there is a small by-pass hole. This hole is much smaller on spheres used on the SM. The older type of sphere that uses the removable type of damper has a much larger by-pass hole in the side of the valve body. The oldest type does not have a by-pass hole and uses spacer shims to prevent complete sealing of the valve washers against the body. If your car has the oldest style valve body, but no spacers, you will feel every pebble in the road.

All spheres can be visually checked to see what car they fit. Do not go by the pressures marked on the fill plug because these have been switched around by many sphere rebuilders.

It used to be that you could buy telescopic shock absorbers for most cars that would give you the type of ride that you wanted. The ride type or stiffness was specified as a percent of total damping. For a very soft easy ride, you would want your wheel and time to travel upward into the wheel well very easily at the slightest bump. For a stiffer ride that would hold the road better on washboard surfaces, you need more resistance on the wheel to keep it from leaving the ground after a bump.

Shocks were sold as 10/90 or 30/70 or even 50/50. This is the ratio of resistance of the wheel's upward movement to it's rebound, or downward movement. A 10/90 would give a good soft easy ride, but would give control and handling problems when the car was driven hard. 10/90 shocks are much harder to find now. They worked well with bias-ply tires, but today's cars use radial type. Radial tires tend to "bounce" more. After hitting a bump, they will bounce up off of the road unless special "radial tuned' shocks are installed.

Radial tires require more upward resistance such as 40/60, 50/50, or even 60/40. The idea is to hold the tire on the road and damp out any bounce in the chassis of the car. Remember that the required damping will vary with the way the car is to be used and the speeds the car is to be driven.

Various Citroën shock dampers are shown in the figure shown. You will see that a ring of holes are drilled through the valve body at an angle. Fluid that is forced through the holes must bend back the spring washer on the opposite side. When you hit a bump, the spring washers closest to the sphere are the ones that control the "upward" resistance. The thickness and quantity of spring washer discs control the amount of resistance. A damper that requires a washer of 0.3 thickness needs one that is three-tenths of a millimeter thick.

With removable damper spheres you can adjust the ride to the way you want it. Remember that you should not get the front and rear dampers mixed up when you remove them. Note the cutting on the nut to help you identify the rear damper without taking it apart and measuring all of the washers. Removable shock-type spheres should have the shocks removed before you send them in for rebuilding.

A worn valve body or pitted washers can be lapped with a piece of wet or dry sand paper on a piece of plate-glass. Assemble the damper valve first, and then screw it snug into the sphere. Be sure it is snug because these have been known to come loose in the suspension cylinder and cause damage.

Shock dampers that are riveted into the sphere can not be removed. They are trouble-free unless one of the spring washers break. This cannot be repaired.

Chapter 28–Tires

Alternatives, original sizes
Garrett Rea (Mar. 1992, p.10)

Regarding suitable tires for D-models, 180-15 was the standard size for the Pallas, Pallas M and first generation of the five-bolt wheel DS19 and DS21.

Later, Citroën used 185-15 on the DS23 and the DS21 EFIs. For the ID19 and ID20, the first generation of the five-bolt wheel cars used 180-15 front and 155-15 rear. Later ID19/20/21F, D19, D-Special and D-Super cars were equipped with 180-15s on all wheels. I have also read that some DSs had 165-15 on the rear, but I have no other support for this.

So, with the sizes listed (155-15, 165-15, 180-15, and 185-15), what tires are available? 180-15's are gone, but how about an upgrade to the 185-15 tires, which are available from most European tire dealers? 165-15 and 155-15 tires can still be found in Volkswagen ads.

Another thing that has not been given much thought is a switch to a lower profile tire. My D-model is equipped with 205/70-15 Michelin XH's on the front, with 165-15 Pirellis on the rear. The 205's are fatter and do rub in very tight (parking lot) turns, but are not all that much larger in diameter. Conversion charts are around (Euro-Tire catalogs have charts in them) that show all of the dimensions for tires. Just look and see which ones are close in size.

Check your tire pressure (27 psi front, 24 psi rear, and 30 psi spare). (I advise against using these pressures. These were specified for tires built in the early days of radial design. Though tires can be purchased new that look like these older tires, they are in fact, modern tires internally and so should be inflated to more modern specifications. Depending upon the cross section of the tire and the maximum capacity of the tires you are using, your pressures should be much higher. My 1968 ID19 had 195/70R15 Springfields, now unavailable. I was running 35 lb in my front tires and 32 in the rear. [MB])

Balance of front wheels checked on car with care
Betsh, Ken (2001 #5, p.10)

This is the method I use to determine if a front wheel has a balance problem. With one side of the car jacked up ON LEVEL GROUND using the Citroën jack stand and the engine running, I release the parking brake, shift to 4th gear, release the clutch and slowly increase the engine speed to about 1800 rpm on the tachometer. Because one front wheel can't move, the differential will cause the free wheel to spin at double speed. Thus, it will be spinning at about a 70 mph rate at 1800 engine rpm. If the tire is properly balanced and the ball joints and tie rod joints are OK, only a minor vibration will be observed, with the greatest around 1500 rpm. Caution: I won't allow anyone to stand in front of or behind the car while I'm doing this. If I were doing this on a car with any rust around the jack stand post, I'd place a wooden block under that side of the car just in case any vibration dislodged the jack stand. I've never done this on Citromatic D-model but don't know why it shouldn't work. I've found some out-of-round tires will vibrate while spinning even though statically balanced.

Changing tires does not require raising all the way
Ken Betsh, PA (Apr. 1999, p.14)

One aspect of using the Citroën hydraulic system to raise the car up for service or testing that's frequently heard but not too often–don't raise the car to the highest position if you don't have to. When I need to change tires, I only use the next-to-the-highest setting of the height control. If the supplied prop stand is attached in this position and the car then lowered, there is ample clearance under the wheels on that side to remove them.

The reason to minimize going "all the way" is that, in the three in-between settings, the hydraulic system only applies sufficient pressure to the suspension pistons and spheres to lift the car to a specific point. Once this is reached, the height corrector valves (one for the two front wheels and one for the two rear wheels) shuts off the flow. At the maximum setting, these valves never close and entire system pressure reaches the spheres. This excessive pressure is likely to shorten the life of the sphere and may bring about an early failure.

Kelly 165SR15 replaces Michelin XAS 180R15
Barton Milligan, Bahamas (Feb. 1991, p.12)

A friendly and helpful Florida tire dealer identified a tire that resembles the size of the XAS 180R15–a 165R15 86S. The width of the tread is the same and the diameter is about an inch (4%) less. Not everyone will be willing to have every trip of 96 miles appear to be 100 or settle for an S rated radial tire. However, on an island where work is three miles away, nothing is more than 50 miles distant and the speed limit is 45 mph, I certainly can't care. My car rides and steers fine. Oh yes, the tires (Kelly) with tubes were $53 each.

(Not only are these tires undersized, but they are overloaded. [MB])

Matched tires give best handling
Ken Betsh, PA (Mar. 1996, p.7)

There was such a major difference in the handling of my D-model years ago when I mixed pairs of Michelin red-stripe and XAS types that I will now only drive with the same brand and type of tire on all four wheels. I'm now driving on four Uniroyal 195/75-15 tires since my local Michelin dealer no longer can obtain the XA4s I've been using. The rear ones are mounted on the narrower 5" rims (round center hole) that came with my '67 ID and the fronts on the wider 5-1/2" rims (square center hole) that came with all later models. I thought I could tell a minor difference in the two makes of tires at first.

Michelin 180R15, 165R15, 165R400 and 185R400 from Coker, XRX red wall
Charles Fowler (Apr. 1988, p.17)

Coker Tire (1-800-999-8973) claims to have Michelin 180-15 XAS tires for $168.67 (1988 prices), 165-400 Stop-Tread for $158.13, and soon the 185-400 for $195.00 each. Before you D-model owners bankrupt yourselves, check your local dealers for the XRX (Redwall). They only cost $67.00 and come in 185-15.

Michelin 185-15 "Red Stripe" available from Triumph parts dealer
Chris Dubuque, WA (Jun. 1991, p.19)

I've always known that Triumph TR6s used 185-15 Michelin "Red Stripe" tires, and I've assumed that TR6 people had trouble getting tires also. Not so! The original Michelin red stripe tires (which fit and look good on D-models) are available through certain British car supply houses.

In addition to the Michelin, a cheaper replica of the red stripe tire is available, that looks very similar to the Michelin, both with the distinctive red stripe on the sidewall. The full tire designations are: 185-15 Michelin Red Stripe at $199.95 and 185-15 Commander Redline at $149.95. I have a feeling that the Michelin is probably the better of the two tires.

Both of the above tires are available through: The Roadster Factory, PO Box 332, Armagh, PA 15920, 1-800-283-3723.

Editor: Some D-model owners have experienced excessive hydroplaning with the red stripe tires on their cars, an experience not shared by the TR6 owners.

Michelin 195/75R15 XA4 suggested
Brad Nauss, PA (Jan. 1992, p.8)

Michelin 185-15 and Commander Red Stripes are also available from Coker Tire at about the same price as the Triumph parts source. It has been my experience that D-models do hydroplane with 185-15 Michelin Red Stripes at higher speeds. But, it has also been my experience that D-models hydroplane at higher speeds with any tire which (a) does not have an aggressive tread pattern and (b) is worn to any extent.

Coker also has the original 180HR15 Michelin XAS at $169–which is a much better tire for D-models although the XAS does not have a great tread life, especially if the car is driven "hard."

A much more reasonable approach for the tires is the Michelin 195/75R15-XA4 at about $100 each from local outlets. They are oversize which does not create any special problem; rear fender clearance is minimal and fenders may have to be adjusted slightly. Front tires may rub slightly on full lock hard turns, but you don't get in that situation often and you learn the limits so you don't aggravate the situation by doing full lock turns.

Editor: Michelin has discontinued the 195/75R15-XA4.

Michelin marking code
Michelin (2008 #4, p.11)

Michelin = Manufacturer's name

Energy = Name of the range of tires, usually a logo (eg. Energy)

185 = Nominal section width of the tire (SW = 185mm)

65 = Aspect ratio or series (HIS = 0.65 ie. 65%)

R = Radial construction

15 = Nominal interior diameter of the tire in inches: 15 (corresponds to the rim diameter)

88 = Load capacity index (88 = 560 kg) The load index is an assigned number ranging from 0 to 279 that corresponds with the maximum load carrying capacity of a tire. Most passenger car tires load indexes range from 62 to 126.

H = Speed category symbol (H = 210 km/h) The speed index is an assigned letter ranging from J to Z that corresponds to the reference maximum speed at the associated load index.

XVS = Tread pattern

Mixing some types affect handling
Ken Betsh (2008 #2, p.11)

I had some bad results with mixed types of tires front and back. I once had a set of the Michelin tires that had a red sidewall. A full set was OK but two of these with two XAS's either front or back had a pronounced effect on the car's handling.

Recapping must be done on exact sized mold
(Oct. 1979, p.2)

If you are planning to try and have some 180-15 Michelins retreaded by a shop using the 'hot' process, e.g., Orbitread, make sure they have the mold that fits the 180-15 size exactly. One club member had two 180-15s ripped apart because the shop didn't have the 180-15 mold and used the 185-15 size. The 'hot' process uses a very high pressure 'doughnut' inside the carcass to push the tread area out to meet the mold. If the mold is too big, the tire will rip.

Recapping not worth the bother
Charles Fowler (Jun. 1976, p.2)

After approximately 5000 miles with retreaded Michelin tires on a van, I am sorry to say I don't recommend doing it, even though they cost less than half the price of new ones. The two on the front developed blisters and bubbles.

The dealer replaced them at cost ($20) but they weren't worth the bother. I also ruined a new Michelin by using the old tube with a consequent blowout at 70 mph.

Rims work fine with tubeless tires without inner tubes
Betsh, Ken (2001 #3, p.13)

I've been using tubeless tires on my original rims without inner tubes for years without any problems. I only mention what certainly can't be a secret because in compiling the D-Book, I never found this mentioned.

Shake after balancing may be due to cord separations and age
Don James, OH (Jan. 1983, p.4)

Several members have complained that their car shakes from out of balance wheels, but that no amount of balancing will cure the problem. In all cases the cars were found to have old tires. Tires had plenty of tread. Shake is caused by cord separation inside the tire. This is common with Michelin tires since they last so long. Michelin tires if mounted properly should not require any extra balance weights. You can balance a square tire to spin perfectly, but it will still make the car shake.

When dealing with anyone that mounts your tires for you, be sure that they know what they are doing. The tire will have a line molded near where the rim fits. This line should follow the edge of the rim at the same distance (concentric) all of the way around. Check both the inside and outside of the rim. Knock any dents out of the rim before mounting the new tire and be sure to remove rust.

Eugene Codd (Citroën Kid) of Spokane, Washington, reports that he has been able to fit 205-15 tires on the front of his DS. He reports greater traction and road holding with the wider tires.

Sizes varied on D-models
Chris Dubuque (2008 #1, p.12)

A club member recently expressed some confusion about the correct tire size for a late-model DS sedan. The confusion surfaced after he purchased a set of new tires. He discovered that they were too wide and scraped on the rear fenders while driving. The reader asked the Club to verify the correct tire sizes for a DS.

We researched this issue and were somewhat surprised that the answer is not simple It turns out that there are many factors to consider, such as the year of the car, the specific DS model, sedan, wagon, or convertible, and whether the car was destined for North America or for France. Even after a lot of research, we are not sure that the following information is complete!

BASICS

We thought it might first be helpful to discuss the sizing conventions for DS tire sizes. Older Citroëns use tires that are identified by all metric units (millimeters) or by a mix of metric and standard units (millimeters and inches). An example that uses pure metric units is the l65X400 tire that is used on a DS 19. This tire has an inflated width at its widest section of 165 millimeters and fits on a wheel that has a diameter of 400 millimeters. An example of a tire that uses mixed units is an l80HR15. This tire has a width of 180 mm at its widest point and fits on a 15-inch diameter wheel. The "H" refers to a speed rating and the "R" indicates that it is a radial.

As we discuss the various tires used on DS's, you will notice that some tires designations have a simple "X" between the width dimension and the wheel diameter (e.g. 180X380) while others have letters between the width and diameter (e.g. 180HR15). The reason is that the tire naming convention changed in this time period. The callout "HR" indicates that the tire is a radial (R) and has a speed rating of 130 mph (H). Also, notice that a 380 mm diameter wheel is equivalent to a 15-inch wheel.

Tire sizing nomenclature has changed considerably over the years and continues to change, making it nearly impossible for a novice to memorize and understand all of the different naming conventions, codes, and numbers. For the purposes of this article, you can ignore these designation differences. Just focus on the width (e.g. 180 mm) and the wheel diameter (e.g. 380 mm).

OLD DS's VERSUS NEW DS's

DS's prior to about model year 1966 have single lug wheels (DS19 and IDI9). Technical specifications for French DS19's show that they use 165X400 tires in the front and 155X400 tires in the rear. The tire model was the Michelin X. This was apparently true for sedans, wagons, and convertibles, DS's or ID's.

But were cars intended for the North American market delivered this way? Apparently not. Several sources we found indicate that all five tires on North American cars are 165X400. The following table shows what we believe to be true for DS19's:

DS19/ID19 sedans, wagons and convertibles (1955-1965)

Vehicle Type	Front	Rear	Spare
French model	165X400 “X”	155X400 “X”	155X400 “X”
North American	165X400 “X”	165X400 “X”	165X400 “X”

The situation is much more complicated for DS's after 1966 that have five lug wheels. Read on. Detailed technical information about DS's manufactured for the North American market is scant at best. However, we believe that all DSIID cars (sedans and wagons) after model year 1966 with five lug wheels and intended for the North American market were delivered with l80X15

Michelin tires. Furthermore, we believe that 1966 and 1967 DS's were delivered with the Michelin 180X15 XAS. Later on, all North American DS's were delivered with an unusual tire called an XH, (full designation; Michelin 180HRl5 XH). The XH does not seem to show up in European publications leading us to believe that it was intended solely for the North American market.

Unlike the North American cars, most French Market DS's after 1966 have narrower tires in the rear of the car than the front. A review of the factory Characteristics, Adjustments and Checks manual for DS's after 1966 reveals a complex matrix of tire sizes for the various French model DS versions after 1966, most having narrower tires in the rear. Also, the Michelin XAS was apparently the sale tire model used on French cars.

Michelin claims that the XAS, launched in 1965, is the first asymmetric tread design radial tire. Why an asymmetric tread? The asymmetry allows Michelin to design various parts of the tread differently to optimize the specific function of each part of the tread. For example, the outboard shoulder of a tire sees very different circumstances during daily driving than the inboard shoulder. Michelin likened the asymmetry to that of the human foot, which has optimized asymmetry for various activities (e.g. walking, running, etc).

The tire configuration table in the Characteristics, Adjustments, and Checks book is confusing, but we have attempted to extract pertinent information as follows:

Cars manufactured October 1965 to October 1968 (French model)

Vehicle Type	Front	Rear	Spare
All Sedans	180X380 XAS	155X380 XAS	155X380 XAS
All Wagons	180X380 XAS	180X380 XAS	180X380 XAS

Cars manufactured October 1968 to 1975 (French model)

Vehicle Type	Front	Rear	Spare
Sedan (D-Special/ID19)	180HR380 XAS	155HR380 XAS	155HR380 XAS
Sedan (DS21)	180HR380 XAS	165HR380 XAS	165HR380 XAS
Wagon	180HR380 XAS	180HR380 XAS	180HR380 XAS
Fuel Injected	185HR380 XAS	185HR380 XAS	185HR380 XAS

As you can see from the above tables, a typical French DS sedan has narrower tires in the rear. We count a total of four different tire sizes (155 's, 165 's, 180's, and 185's) used on late French model DS's. The spare tire is always the smaller of the two tire sizes.

REAR FENDERS

Notice that Citroën used 185 mm width tires on the rear of some cars. Citroën had to change the rear fenders on DS sedans to accommodate these wider 185 mm tires. As such, newer sedans have a "flare" at the back edge of the rear fender so the wider tires will fit. We think that the wider rear fenders first appeared when the fuel injected DS's started showing up, in late 1969. So the rear fenders on a 1968 DS21 sedan, while they look just like the fenders on a 1970 DS21 sedan, are in fact, different.

One hundred eighty (180) mm width tires usually fit cars that have the narrow rear fenders, but without much margin. One hundred eighty five (185) mm width tires rarely fit the narrow rear fenders and will likely scrape. As such, we do not recommend attempting to use 185's (or larger) on the rear of a sedan equipped with the narrow rear fenders (1966-1969 1/2).

CONVERTIBLES

We believe that Euro spec. DS convertibles follow the previous tables for Euro sedan DS's. However, we were unable to find documentation about tire sizes that were delivered on convertibles intended for the North American market.

The rear body sections of DS convertibles were hand-built by Henri Chapron's studio in Paris. There is no adjustment available to ease clearances for rear tires as the entire rear body section is welded onto the frame. This became readily apparent during a recent restoration of a 1967 DS21 convertible in the Seattle-area, where it was found that neither 180's or 185's tires would fit in the rear. Based on the above tables, the car very probably was delivered with 180's in the front and 155's in the rear. In this case, the restorer elected to modify the rear body section slightly so 180's would fit, although 155's and 165's are available.

If any of our readers have documentation about what tires were delivered on North American bound convertibles, please write.

SUGGESTIONS

DS19 WITH SINGLE LUG WHEELS. If you have a DS19/ID19 with single lug wheels, the choice is simple. Buy the 165R400X-STOP Michelin. These tires work on the front or rear of sedans, wagons, and convertibles.

DS WAGONS AFTER 1966. You can use the same tire size front and rear. We suggest using either the original 180HR15 XAS or the 185HR15 XVS (the XVS is the replacement for the XAS and is a wonderful tire for DS's).

DS SEDAN (1966 - 1969 1/2). We do not recommend using anything wider than 180 mm in the rear due to likely interference with the narrow rear fenders. As a result, we suggest using the 180HRl5 XAS in all five positions. Alternatively, you can follow the above tables directly and use narrower 155 or 165 tires in the rear, as would a French model car.

DS SEDAN (1969 1/2 - 1975). Since the rear fenders are flared, you have the choice of having the same tire size in all five positions. We suggest using either the 180HR15 XAS or the 185HR15 XVS in all positions. Alternatively, you can follow the above tables directly and use narrower 155 or 165 tires in the rear, as would a French model car.

CONVERTIBLE (1966 - 1975). As noted above, it would appear that convertibles in this year range were intended to have 155 or 165 mm tires in the rear. Also, there is some reason to believe that 180 or 185 mm width tires may not always fit in the rear. So to be safe, our recommendation would be to follow the above tables directly and use narrower tires in the rear. If you want to use 180's or 185 's in the rear, it will be prudent to perform a test fit before purchasing a full set of tires!

AVAILABILITY
All of the tires that we need for our DS's, 2CV's and Tractions are still in production by Michelin. But Michelin has transferred responsibility of these tires to their vintage production division, called their Collector Tyres Range. This division builds older tire sizes on an "as needed" basis and in much smaller quantities than their standard production. This low volume production can cause the price of their vintage series tires to be a bit higher than equivalent sizes of high volume tires. The tires discussed above are in the US $175 - $250 range.

Coker Tire in Tennessee is the single source for the vintage series Michelin tires in North America. Coker lists all of the above tire sizes in their catalog, and a recent check with Coker reveals that they typically have all of these sizes in stock. Coker can be reached as follows: Coker Tire, 1317 Chestnut Street, Chattanooga, TN 37402 USA, Phone: 1-800-251-6336 (website: http://www.coker.com/).

SUMMARY
We recommend that owners of DS's use the proper Michelin tires since DS's drive better, handle better, and are worth more with the proper tires. In the case of a DS19, there is no other choice. In the case of the later DS's, there are other modem tires that can be mounted on the wheels, but they are typically too low in profile and too wide. Fortunately, all of the tires we need are readily available through Coker.

Vredestein Sprint ST 185R15 tires from Eurotire
(May, 1990, p.6)

An answer as to where to go to get tires for a D-model that send you over the limit of your gold card may be Euro-Tire of Fairfield, NJ. They have a tire which they don't always stock, but can order very easily. It is the Vredestein Sprint ST radial, and it sells for about $57.00 (1990 price and availability) for the 185-15. It is a very good tire made in Holland. I have personally had these tires on two different cars and know of about one dozen other club members who have them and are quite satisfied with them for the price.

Wider tires fit when using narrower rims
Ken Betsh (2009 #4, p.14)

After Michelin 180R15 XAS and Michelin 185R15 XVS tires were no longer available through regular dealers, I used 195/75R15 tires (now also not available) since the rim and outer diameters were the same. I had no problem with clearance around these slightly wider tires at the rear of my ‘71 DS as long as the tires were mounted on narrower wheels (the ones with round center holes).

Chapter 29–Towing

Factory approved limits for towing and roof load
Edited from Citroën Technical Bulletin #82 Dated 12/18/68 (Mar. 1992, p.17)

Maximum trailer weight			Tongue weight	Maximun grade for starting under load	Maximum load on the roof
No braking system	Inertia braking system	Continuous braking system			
1,100 lb.	2,750 lb.	3,300 lbs.	65 lbs.	12%	175 lbs.
1,100 lb.	2,750 lb.	3,200 lbs.	65 lb.	12%	175 lb.

Modifications aid towing 4000 lb. trailer
Alain Roshardt, France (Jan. 1985, p.24)

A DS is the best car to pull my (25 foot, 4000 lb) trailer. I have improved it by replacing the 21 engine with a 23, mounting two double carburetors with a special pipe. I have modified the transmission by changing the standard 8 x 35 conic couple with a 7 x 34. I have also improved the cooling by mounting the radiator of the injection model and installing one fan in each (fender).

Hot air is blown from the motor compartment to the outside by two holes made in the underside of each (fender). This makes it easier to reach inside the (fenders) to treat them against rust. The warm and not-humid air from the motor avoids any corrosion.

The DS pulls with no difficulty. Every year we drive (3,700 to 5,000 miles) during holidays with the trailer on. We specially like the south of Italy and Greece. Out normal speed on European motorways is (70 mph). Single axle trailers are more pleasant to drive. They give less reaction to the car and the comfort is not changed.

Editor: Photograph of car and single axle trailer with original article shows what appears to be an air deflector on the back of the roof of the DS. (I would not have the heart to do this to a car as old as a D. [MB])

Chapter 30–Transmission

Fluid change and level check procedures
Ken Betsh (2000 #3, p.13)

While most of us routinely change the engine oil (every 3000 miles per factory recommendation), it's easy to forget that the transmission oil should be replaced every 12,000 miles. I do it myself using Quaker State SAE 80W/90 EP gear lubricant. Finding the drain is easy, but access to the filler and check points in the D-model requires removal of the air duct in front of the radiator. The filler is on top of the gear box partially covered by the radiator base.

The only way to check the desired level of the gear oil is to remove a small screwed-in plug on the right side of the gear box (actually the left side as one looks in from the front of the car). The idea is to add oil in until it starts to run out of this hole.

To fill it, I use a 4-inch length of flexible tube on the tapered spout that comes on quart bottles of the gear oil. It takes slightly less than two quarts and I go slow when I think it's about full. Otherwise, because of the thickness of the oil, quite a bit will run out even after I stop adding more. Because the oil is quite thick, squeezing the bottle speeds things up. This is definitely a warm or hot weather job, the oil is like molasses in cold weather (the reason why when starting a cold car in below freezing temperatures, I let the engine idle in neutral with the clutch engaged - foot off the pedal - for about 15 seconds before moving the car).

When the drain plug is out, I remove any small metal fragments clinging to the magnet in the center of the drain plug.

Fluid level checked at plug on side of case
Don Dellinger (2000 #3, p.12)

All Citroën transmissions, except cars with Borg Warner automatics, have to be checked at the check plug on the side of the transmission. Most all use 80 or 90W EP oil and should be checked on level ground. The correct oil level is at the bottom of the threads of the check plug.

Noises and synchronizing problems with age
Ken Betsh (2000 #3, p.13)

Two things mark a worn transmission: (1) a humming or whining sound on the highway that's louder with applied throttle and quieter or inaudible when coasting and (2) gear crunching when shifting rapidly from first to second gear. Both seem inevitable in high-mileage cars and I'm not sure to what extent they are delayed by faithfully following the 12,000 mile recommendation and/or the quality of the gear oil used. My philosophy is, "why take a chance?"

The first problem appears to be due to wear of the gears and/or bearings in the differential part of the transmission. I know it's not a warning sign; my transmissions still run fine even though the noises have been going on for years and don't seem to get any worse.

The second problem is the synchronizer gear separate from, but attached to, the actual gear for the second speed. Replacing it requires complete dismantle of the gear box which would be very expensive and might introduce new problems. My interim solution is just to pause slightly in neutral when shifting from first to second. This would even work with Citromatic since the shift lever for it has a neutral position between these two gears.

Refill of oil eased by raising radiator, heating oil
Jerry Lugert, NV (Jan. 1991, p.11)

Old transaxles tend to leak their lubricant and often do not as readily get refilled since the refill plug is difficult to reach. If you value this large, expensive part, I suggest making the small effort of partly releasing the base of the radiator to permit lifting the radiator approximately one inch and propping it. Then the plug may be removed with a 21 mm wrench and a small rubber vacuum hose may be attached to the top of the lubricant container.

After inverting the container, I suggest placing an air hole on the opposite end of pouring and placing a heat source, like a light bulb, near the fluid to facilitate flow. Of course, garages have easier methods. Few of us have pumps. Knowing the level of lubricant is less important than it being empty.

It's a case of where too full is better than too empty!

(Following Jerry’s suggestions, it would be easier if the oil is set in hot water. An unpierced bottle can be squeezed to force oil through the slender hose. To ensure accurate filling, remove the side plug (shown as part no. 18 in the first illustration of the previous article). When oil emerges, the transmission is full. [MB])

Removal easier with parking brake calipers removed
Dave Root, FL (Jun. 1989, p.10)

In removing a transmission, such as to work on the clutch, don't overlook a bolt back of the driver's side parking brake caliper. It's almost impossible to see with the caliper in place and to remove it you must remove the caliper first. This brings up a little lesson I learned: it's easier if you remove both calipers. You then don't have to put up with those aggravating springs you have to deal with in removing the parking brake cables.

Reverse gear lockup may be due to backup light switch
Terry Tekushan, OH (Feb. 1991, p.12)

After a clutch job on my D-Special, I noticed that the back-up lights no longer worked. Wires leading to the switch (located on the front of the transmission case), fuse, bulbs and connections checked out fine. At this point, I figured I gave the problem enough attention, so of course, I ignored it. This, however, was the wrong thing to do for a very odd reason.

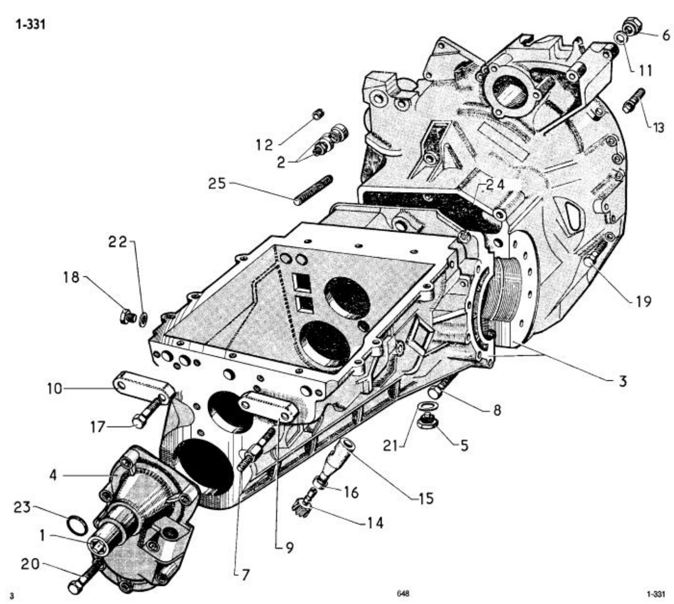
There is a little rod (or plunger) that appears on the inside end of the backup switch that contacts a large and important looking rod that moves only when reverse is engaged. The reason this is important is that if the plunger falls out of the switch, it can fall in the path of the large rod and prevent the reverse gear from engaging!

I realized this after making a hard turn into a parking lot (which slid the plunger in the path of the large and important looking rod). Fortunately, I wanted to back into the spot and did not find myself stuck in the parking space. I was contemplating what was wrong with the linkage or transmission and how much I hated tearing the whole front end apart to get the transmission out, when Don James suggested I check the backup switch. There it was, a bent and displaced plunger. Apparently, if the transmission is tilted at a sharp angle, the plunger can fall out, causing this problem.

So, keep this in mind before you tear down the transmission because reverse won't engage.

See: "Chapter 8 – Citromatic - Backup light switch defect causes reverse gear lockup."

Sealant failure causes oil leak
Red Dellinger, PA (Jan. 1992, p.5)

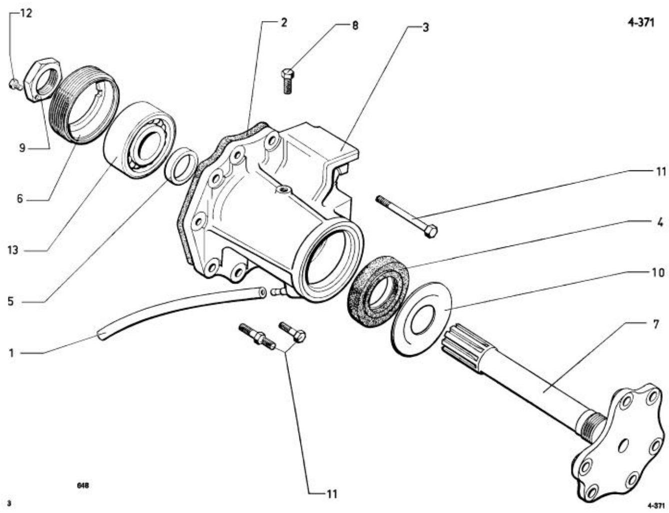


The output shaft housings attach to the transmission case at the end of lines 3.

The transmission output shaft flanges that bolt up against the gearbox housing have a lot of strain applied to them both by the axle and by brake vibration. The illustration above, taken from factory parts book no. 648, shows the area where these flanges are mounted. These have to be checked about once per year. Unfortunately, all of the bolts cannot be reached because the brake calipers are in the road. The best one can do is to tighten all that can be reached from the bottom after removing the steel splash pan to the rear of the valance and the brake air chutes.

This is a good time to clean them and tighten all lines and fittings. The heads of the bolts are 14 mm and 12 mm on early cars, and 14 mm and 11 mm on later cars. 6-point wrenches are preferred.

When the housings come loose, the gear oil leaks out slowly, and since this is "out of sight, out of mind," many people forget about it until a whine or growl starts to come from the front of the car–then it is too late. The second illustration, from the same book, shows where the bolts are located around the gearbox housing.



Various bolts holding the output flanges are shown as 11.

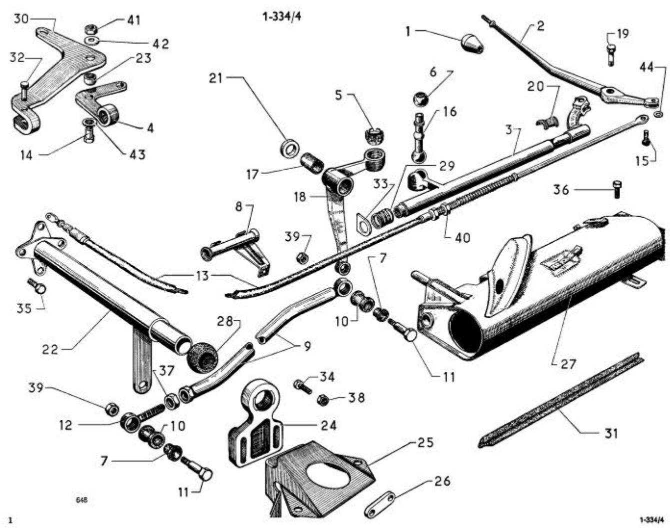
The front cover, 4 in the first illustration, is another source of leaks. Also the top cover (not shown). The factory used a black, rubberized compound to seal them, and the oil ate the sealant. Any time these are exposed and they can be serviced (clutch job, etc.) they should be attended to and sealed with blue silicone sealer.

Shift fork accidentally broken
Ken Betsh, PA (May, 1997, p.16)

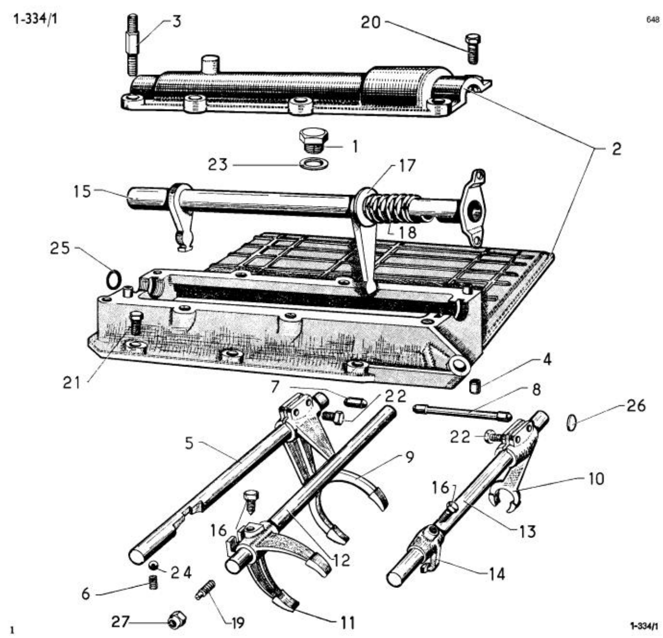
For one who always parks his manual transmission Citroens in gear, I've always made it a rule to place them in neutral before opening the hood for any kind of investigation or repair. I still remember when one of my early cars tried to run over my foot when I unintentionally touched the bottom button on the starter solenoid.

I didn't follow my rule recently because I needed to find out if a problem with the switch on the front of the transmission was keeping the backup lights from working and also look at the left-side brake pads for causing a random flashing of the pad warning light. In attempting to remove the pads, the means I used to retract the brake pistons applied pressure to the (manual) transmission shift spindle. Because the transmission was in reverse, this pressure caused a fork inside the transmission to break off. This article is to warn others of this possibility and to tell how I was able to repair the damage without removing the transmission.

I wasn't aware of this damage until I had solved both the backup light problem, replaced a worn brake pad, reassembled the radiator air duct and closed the hood. My usually precise stick shift lever now flopped all over the place and the only gear I could engage was reverse. I removed the air duct for the second time and quickly found no problem in the linkage. Whatever was wrong was wrong inside the transmission itself.



Before proceeding, it may help some to review the shift lever linkage, shown above. It's a combination of a rod (part numbers 3, 16, 18, 9, 12 and 22) and a cable (13). The up and down motion of the lever (first to neutral and second gears, third to neutral and fourth gears and from neutral to reverse rear) is by a rod linkage that rotates a shaft extended from the cover of the transmission case, shown below. Pulling the lever towards the driver to get first or second, or pushing it away to get into reverse operates a cable that pushes this shaft (part numbers 15, 17 and 18, below) in for first and second and pulls it out to get into reverse by manipulating the proper shift forks (9, 10 and 11). An interesting detail is that the spring tension you must overcome to get into first or second is built into the steering column linkage, whereas the heavier spring tension you must overcome to get into reverse is built into the transmission. I became aware of this after disconnecting the linkage at the side of the transmission.



As I feared, the worst in how to solve the problem (I do a lot of my own repairs but have never attempted a clutch job, which is basically a transmission removal and replacement), I noticed a narrow plate on the top of the transmission case that lined up with the shaft coming out of the side (upper line, part 2). It can be removed without doing any more than loosening the radiator to get clearance to the back screws. I removed it without much difficulty and found what happened. The shaft to which the linkage connects (part no. 15 above) has two dogs welded to it. The shorter one towards the right side of the car selects one of the four forward gears while the larger dog near the left side stays in the clear. This larger dog only meshes a gear train shaft to engage reverse and when it does the first dog clears the forward gear trains. A jagged end made it obvious the end of the forward gear dog had broken off.

While I wasn't aware I did it, I must have applied pressure to the flange on the end of the shaft where the shift linkage is attached while trying to free the brake pad. Since the transmission was in reverse, this pressure only pushed the larger dog into a free space but pushed the smaller dog against a channel in a forward gear train that is stronger than the dog. The end of the dog snapped off at a narrow point.

A comparison of part books showed the same part (DJ334-30) was used in my old '67 transmission still collecting dust in a corner of my garage. So, the good news was that I had a replacement part. The bad news appeared to be in finding and removing the piece that broke off. Since I didn't have to remove the transmission to replace the part, I didn't want to have to do it anyway just to get the broken piece out.

The first step was to drain the transmission oil (it was almost time for a change, anyway). But I still didn't see the piece. The "hose" light I described in a newsletter article a couple of years ago wasn't too much help. Clearances around the sides of the gear trains is less than a half-inch. I hoped the piece was underneath a gear near the opening but careless probing could push it towards the back where I couldn't hope to extract it through this opening. I assembled a much smaller "hoseless" light by soldering one of small baseless lamps used in the speedometer to a piece of lamp cord long enough to reach the battery (with insulating tape, of course). This could be slid down along side the gears to produce a shadow where the piece was located. With a solid wire I pushed it where a flexible extractor tool could grasp it.

Getting the replacement shaft and cover back in place took a lot of attempts. My old repair manual calls for a special tool to compress that spring mentioned above that one must overcome to get into reverse. My only advice is to keep trying. Once back together, shifting was just as easy and pleasant as ever.

Incidentally, the cause of the backup light problem was obvious when the radiator air duct was first removed. The push-on wire connectors to the switch on the front of the transmission were hanging free. The two wires were in a plastic tube that had become so hard over the years, an apparent movement of the tube had pulled the connectors loose. The solution was to add a plastic tie-wrap to anchor the tube to the side of the transmission case. I did tighten the grip of the connectors before pushing them back on the switch.

Chapter 31–Ventilation

Boot for firewall duct from Western Hemispheres
(Feb. 1994, p.17)

The silver vinyl "boot" that ducts outside air from the fender vent hose to the plastic firewall duct (on the right side) has not been available from Citroën for many years. Western Hemispheres has duplicated the vinyl/foam boot in materials and colors that appear very original. It is sold under part number DS6436.

Ducts under hood from dryer hose
Randall (Pete) Jones, KY (Apr. 1995, p.18)

Changing your fresh air ducts to metal dryer ducts will get rid of all that deteriorated foam and dirt that blows inside your car, but the new ones will increase the noise level considerably. One way to cut the noise and help keep the fresh air fresh is to wrap the ducts in foam rubber carpet pad. This works fine and is very cheap.

You can glue the foam to the ducts by using contact cement. It can be applied with a paint brush. Reduce the contact cement about 10% with lacquer thinner. You need to apply one coat to the duct; the foam needs two coats. The first one seals the pores and the second lays on top of the first.

An easy way to apply the contact cement is with an external mix spray gun. I use an upholstery gun called the E-Z-E Sprayer. They are about $40 from your local upholstery shop. You could also use the same gun that you use to spray oil into your frame. If you use this method, mix the contact cement 50/50 with lacquer thinner. Another product that may work is furnace duct insulation that comes in rolls 12" x 15 feet in either 1/8" or 1/4" closed cell foam with heavy aluminum foil on one side and self-stick glue on the other. Although I haven't used it for fresh air ducts, I have used it for my air cleaner and it should work for any ducts. You can buy these at your local building supply store. A 4" x 3" dryer duct reducer works great to connect the 4" duct to the 3" duct. They come in aluminum or plastic. I like the aluminum ones best (from your local building supply).

If you don't like the metal ducts, you can get rubber-impregnated ones with coil wire in them from J.C. Whitney. I use one each to do the ducts on my '72 DS21 with only a small piece left over. If you use the J.C. Whitney hose, you'll need to stretch it out before you apply the contact cement and foam rubber. I used a yardstick on the inside and a couple of clamps to hold them stretched out. Take the screens out of the 4" end of your old ducts and install them in the new ones. A little duct tape comes in handy here to tape the small end to the bumper intake duct.

To keep mice and chipmunks from building nests in the ducts, make two screens out of 1/4" x 1/4" hardware cloth to go in the bumper intake from the engine side. Cut two circles that will fit inside the ducts but leave three small tabs on them. Bend these tabs back toward the engine. Clean the insides of the duct with solvent. Use a hot glue gun to glue in the screens.

Dust stopped with panty hose over vent screen
Don James, OH (Apr. 1988, p.21)

Here is a tip for keeping the horrible dirt and pieces of insects from blowing all over you when you open the fresh air vents on your D-model. Next time you have your front fenders off, cover the screen in the air duct with lady’s pantyhose. This fine mesh material will stop the finest pieces of dirt and yet does not restrict air flow. The original screen does not need to be removed, just covered with this "final filter."

Hold the material in place with a rubber band, then cover with black electrical tape. This makes a tight and neat joint that does not affect installation of the air duct. It is still a good idea to blow out the ducts on a yearly basis, as it stops a pile of dirt. Some members report good results from placing the pantyhose filter where the air first enters the hose. If you have not cleaned out this duct in the past year, you should do so, as this is a yearly chore to keep heater and cool fresh air vent working properly.

Chapter 32–Wheels

Balance done on rear axle of car
Ken Betsh (2000 #1, p.13)

For years I've been successfully doing my own wheel balancing on the rear axles of my D-models. Because I found the rear brake drums are not balanced in them selves (the larger wagon types are the worst), I feel the rear wheels must be balanced on the car and I don't think anybody does that any more with a machine.

In warmer weather, or soon after driving the car awhile, the sealed lubricant in the rear axles allows the wheel to freely rotate. A wheel out of balance such that only the smallest regularly-available weight will correct it will tend to rotate by itself on the axle--at least it will continue to rotate once started. Since it may not stop at the exact spot where the weight needs to be added (at the top), I test by rotating in both directions. Once I determine the approximate spot to add the weight, I turn it 180 degrees. Now the balance point where it won't rotate is more critical and easier to find. At this point (turned 180 degrees), weights would be added at the bottom. If a lot of weight must be added, I put some on the inside and some on the outside of the rim. For a smaller weight, I put it all on the outside.

Before starting to balance a tire, I will have done any switching (rotating) of wheels and removed existing weights and any accumulation of dirt or grease on the inside of the rims. Naturally the brakes must be adjusted so as to not drag at any position. While there's a good chance existing weights will go back where they were, it's easier to find or check the exact position with them off.

Because this procedure is balancing the tire, inner tube (if one is still being used), wheel, brake drum and axle as a package, I want to be sure that if I later remove the wheel or the wheel and the brake drum that I put them back in the same relative position (unless I am going to repeat the balancing procedure). To make this easy, each of my rear axles have a line marked with a red grease pencil across the drum and the center part of the axle that lines up with the air filler stem of the tire.

I balance the front tires by temporarily mounting them on a rear axle with the brake drum removed. I mount the tires and wheels on the front so that the air stem lines up with the grease fitting on the driveshaft. This assures me of putting tires and wheels back on in the same position they were in before and that there should be no new vibration problem.

I realize that other D-model owners may disagree with my procedure. I only write this to tell how I handle the problem and make no claims that it is as good or better than other methods.

Balance retained by marking rear drums and hubs
Ken Betsh, PA (Dec. 1987, p.14)

Ever since discovering an unbalanced brake drum on one of my earlier Citroën station wagons, I have the rear tires balanced while on the car and mark my hubs and drums so that I can replace the drum and the wheel in the same positions they had been in. Next time you have to remove a wheel to check the brakes, place a temporary mark on the end of the lug-nut stud (the stud, not the lug-nut) closest to the valve stem. After the wheel is removed, use a waterproof marking pen - preferably red -to draw a line across both the hub and drum to show where the valve stem is in respect to the stud you marked. Always replace the drum so the line matches and replace the wheel so the valve stem matches the line.

Carbon fiber SM wheels fit D models
Andrew Brodie, Great Britain (Feb. 1993, p.7)

The carbon fibre wheels (on some SMs) can be fitted to any DS or SM. Be aware the contact area around the fixing studs is larger for these wheels. The uplifted area in the center of the hub should not exceed 122 mm in diameter. DS's and Sm's made from 1971 onwards usually have this modification. It is a quite easy fix if you need to. The wheels were rally-proven on both cars, and there is one instance of a DS finishing a stage with one front tire missing.

These wheels are available from Hypertronics for - wait for it - $1999 for five wheels and fittings.

Covers held firmly with center bolt and all-thread rod
Bob James, OH (May, 1985, p.10)

My Pallas wheel covers still look good after adding a center retaining bolt so that they to not come off on the rough Ohio roads. A hole is drilled in the center of the wheel cover, then an upset punch is used to make a small depression for the central screw to fit in. A short piece of all-thread rod connects to a cross piece that bridges the center hole in the wheel.

Editor: J.M.B. Industries once, but no longer, supplied a kit for this modification.

Covers held firmly with center bolt and drywall anchor
Philippe Devingt, Canada (May, 1994, p.10)

After losing two wheel covers in the last three years, I found a way to stop it. Drill a hole in the center of the cover and use a drywall anchor inside the wheel hole. Buy a 1/4" stainless steel bolt 2" long.

Covers marked with owner's phone number usually returned
Ken Betsh, PA (May, 1993, p.21)

Most of my wheel covers are marked on the inside with the word "REWARD" and my name, address, and telephone number. When lost in situations such as after dark and on expressways where they cannot be immediately found, I am frequently contacted by the finder. The most recent case was from hitting a pothole on I-81 about 50 miles from home late one night. Several weeks later I received a telephone call from a "collector" who didn't see my message until after taking it home. I usually offer a $10 - $15 reward for a Pallas wheel cover that has not been damaged.

My only advice to minimize the accidental loss of a wheel cover when hitting a pothole is to NOT bend the stainless steel rim to which the spring steel clip is riveted. Instead, bend the spring steel clip and leave the rim in its original circular position 90 degrees to the plane of the wheel cover.

My strangest case occurred when hitting a pothole just as I was coming to a stop for a red light years ago on a busy city street. While a loud rattle noise wasn't typical, I jumped out to find the right front cover missing. I was about to give up looking (I was blocking my lane when the light changed) when I noticed the left front tire was resting on the inverted missing cover. I was able to drive off of it. Needless to say, this cover, a non-Pallas type, suffered some deep scratches.

Rims with square holes half inch wider
Ken Betsh (2008 #2, p.9)

According to the Citroën DS parts book, it was with the beginning of the 1969 models that they changed from using 5J to 5-1/2J Michelin wheels. The number refers to the number of inches between the shoulders for the tire bead. The 5J wheels have a small round hole in the center whereas the wider one has a square hole. Both have the number and Michelin name stamped around this hole on the inside. According to my measurements, the extra half-inch was added to the "outside" of the wheel so that a car with the wider "square hole" wheels would have a tire tracking width (distance between centers of tires on opposite sides of the car) a half-inch greater than with the "round hole" wheels. I’ve driven many miles with “wides” on the front and “narrows” on the rear without noticing any unusual effect on handling or steering. I've used 195/75 x 15 tires mounted on the narrower wheels with no problems. One source of info said this was an acceptable combination though at about a minimum recommended wheel width. Both sizes of wheels have worked fine for me with tubeless tires.

Rims with square holes half inch wider
Ken Betsh (2009 #4, p.14)

While both my ‘67 and '70 D-models came from the factory with the same 180 x 15 XAS tires, the wheels to which the tires were attached weren't the same. The wheels on the '67 had small round center holes and were narrower than those on the '70 which had small square center holes. It wasn’t until I had removed worn tires from one of each wheels that I found the wheels with square center holes are a half-inch wider than the older ones with a round center hole. Upon closer examination, I found "Michelin 5J" stamped on inside of the wheels around the small center hole on the narrower '67 wheels and "Michelin 51/2J" on the wider wheels. Measurements confirmed the numbers are the inside rim width in inches. Perhaps Michelin made, or had made, the wheels and delivered premounted tires and wheels to the Citroën factories.

A recent comparison of the different wheels shows that while there is a half-inch difference in the rim width, there is no difference in the distance from the inside rim to the center mounting surface of the wheel. That is, there would be no difference in the clearance between the inside of a mounted tire and the inside wall of the fender in the front or trunk wall in the rear for the same tire mounted on either wheel.

What this does mean is that the center of a tire mounted on wide rim is a quarter-inch further from the center of the car. In other words, the tire-to-tire tread width of a D-model with wide rims is a half-inch greater than one with narrow rims.

Having the outside of a tire on a wide wheel further from the center of the car poses no problem on a front wheel or a station wagon rear wheel, there is a potential clearance problem with the lower edge of a rear sedan fender. According to Chris Dubuque's recent Citroenthusiast article, the later D-models, presumably after introducing the wider wheels, had a flare added to the bottom edge of the rear fender to increase clearance.

While first owning '67 and '70 models and unaware of the wheel difference, I freely swapped mounted tires between the two cars oblivious to the width difference. I never could tell any difference in mixing the wheel widths (but always using identical tires) in either handling or the life of the tire. After this discovery, however, I never mixed wheel widths between sides although I'd often end up with a pair of "wides" at one end of the car and "narrows" at the other end.

Shaking caused by hidden rim rust damage
Don James, OH (Aug. 1987, p.20)

Rust damage under wheel cover (L) and inside rim (R)

Wheel rims can rust inside with the owner unaware of the condition. The wheel cover hid this split in the wheel rim on my '65. The above pictures shows the whole story. Water gets between the inner-tube and rim when it enters at the valve stem hole. Wheels rusted badly are dangerous, and at best will cause shaking in the steering.

Editor: If the appearance of the wheel above looks strange to those who have only owned '66 or later D-models, this is the single-bolt wheel for 165 x 400 mm tires used on earlier models. The end of the axle had a segmented hex shape that expanded to clamp the wheel as the bolt was tightened.

Chapter 33–Windshield

Crack in cold weather from using mirror adhesive kit
Betsh, Ken (2001 #4, p.11)

There's a potential disaster in reattaching the rear-view mirror base directly to the windshield (done after 1970), I will never again use the adhesive kits sold in the parts stores. I and others have had the glass under the mirror base crack in cold weather after using this strong adhesive. I now use black double-sided tape sold for attaching body trim.

Washer pump replacement
Dave Paulin (Dec. 1976, p.2)

Now that winter is well upon us and salt spray on the windshield is a constant nuisance, problems with the wipers and washer pump system become especially irritating. If your exterior ball type spray nozzles are becoming blocked regularly, either (1) your washer solution doesn't have the proper amount of anti-freeze solution (you may have a summer-type solution still in there) or (2) upon disassembly and inspection, you may find tiny bits of rubber clogging up the nozzle. The rubber is coming from either the rubber hose lines or from a deteriorating rubber impeller, which is the heart of the washer pump. When the impeller goes, you have to replace the entire washer pump. Your alternatives for replacing the pump are (1) buy from the dealer, (2) buy from NORI, or (3) find a used one. The first two possibilities are expensive and the last unsatisfactory.

A fourth, and much less expensive method, is to purchase a Trico Electro-Matic Windshield Washer Service Kit. The part number is AWE-1 or AWE-1S. The kit contains a washer pump, rubber hose, tee and reducer, and electrical connectors and wire. The pump looks very much like that found in the late '60's D-models. It is available at most places that carry the Trico line of windshield service products. Western Auto carries it for $13.49, but the same kit can be had for as little as $8.61 at some auto parts wholesalers who sell at below the list price. When you compare this cost to the price of original equipment at $20 and up just for the pump, this alternative is the least expensive and most satisfactory.

Wiper blade alternative
Dave Paulin (Dec. 1976, p.3)

Trico Arctic Wiper Blades really help you see better by staying flexible and curving to the contours of the D-model's windshield. Regular blades have exposed metal parts and ice usually forms and makes them rigid. You may have a hard time finding the 13" size to fit the 'shepherd's crook' wiper arm, so an order to J. C. Whitney might be necessary. The cost is $2.98 per blade, and the part number is 54-1045R.

Wiper delay provided with Zemco kit
Andrew Hathaway, NJ (Apr. 1992, p.13)

I have installed the Zemco Group, Inc. model DE731 Windshield Wiper Delay kit. It gives me from 2 to 20 seconds delay, a very nice range. For an inexpensive delay it has the most thorough book on how to install such an item.

It is a small oblong box that I mounted on the bottom of the small box (?) that holds the light controls and the various types of transmission shifting apparatus. I mounted it in the center, on my '72 D-model, but some of the older cars have the ignition switch there, so you would have to find another place. In any case mount it where it is convenient and doesn't impede anything else. Be careful where you drill the holes, you don't want to drill into anything sensitive. Be careful where you run the wires so they don't get pinched, and use a fuse as suggested. I cut wires on the switch side of the white plug because the switch can be replaced if it gets messed up. Trying to repair part of the permanent harness can be very difficult.

Chapter 34–Work Aids

9 mm bolts with 14mm hex heads not in most stores
Betsh, Ken (2002 #4, p.10)

The hex-headed bolts and hex-nuts using a 14 mm wrench are properly termed 9 mm hardware and even though Citroën used this size with the ISO standard thread spacing, 9 mm hardware won't be found in most stores selling metric hardware. ISO standards omit this size in their list of preferred sizes. They go from a 8 mm size using a 13 mm wrench to a 10 mm using a 17 mm wrench.

Anaerobic adhesive hardens when air is removed
Don James, OH (May, 1984, p.20)

It is common practice to use splines on shafts which drive or deliver heavy loads. Because of design and machining variations, spline fits have clearance which allows wallowing and "chucking." Anaerobic adhesives (such as Loc-tite) are used to fill the clearance and prevent backlash. Anaerobic adhesives are one part, ready-to-use liquids that harden only when deprived of air. Applied directly from the bottle, or by brushing or wiping onto a surface, the anaerobic liquid flows into all surface irregularities.

After the parts are assembled and air is excluded, the adhesive hardens creating thousands of small surface keys that increase the strength of the assembly. The cured adhesive film also provides a distinct advantage of sealing the joint against fluids such as oil, gasoline, water and various other fluids. The adhesive bonded joint is also sealed against oxidation and corrosion. The adhesive provides a higher strength joint than could be attained with a press fit. It also seals the joint permanently.

The important thing to remember about these retaining liquids is that they harden when air is excluded. The first thing that is noticed is that the container that it comes in is not completely full. This is because the air inside the bottle or container is required to prevent the liquid from getting hard before it is used. Any liquid that is exposed to the air will remain a liquid.

The second thing to remember is that these compounds hold by mechanical strength only. They are not a glue! They fill a void between two strong materials, and hold in shear on the rough surfaces. A mirror finish will not hold as well as a rough one. These compounds have a very high shear strength. When used with a slip fit, they will indeed hold better than a press fit.

The amount of clearance controls how fast they will set, as does the temperature. If parts have a press fit, use of these compounds will cause much more strain on the press and possibly stop it. The reason for this is the extremely small clearance and the heat generated, affecting an "instant cure" of the retaining compound.

Because these compounds hold by mechanical strength, a small amount of oil or grease on the parts will not stop the cure and will only affect the holding power slightly. Some materials are more active than others and take much longer to reach full strength.

A priming spray is sold to clean oil or grease and it contains a catalyst to promote a fast cure. The use of this spray can effect a cure in as little as ten minutes, with full strength in an hour. After a part has been sprayed, the catalyst will remain active up to a year and the parts may be assembled at anytime. Use of the spray primer will cause the retaining compound to harden even if it is exposed to the air. Without the spray primer, cure can take up to 24 hours. Full strength may take seven days.

These retaining compounds are sold in a variety of strengths. Do not under estimate the strength of these compounds. They will hold a lot, and are much stronger then even the best press fit. Gears can be fastened to shafts with no keyway or spline.

The next question is how do you remove a part that has been installed with an anaerobic adhesive? The best way is with heat. If the parts are heated to 400º F., they may be easily removed because the retaining compound turns to powder.

Every mechanics tool box should contain at least one type of retaining or locking compound. They are easy to use and will do the job. The only precautions that you need to make when using the one of these compounds is to be sure that you do not get any in a moving mechanism. Clearance when using most types of retaining compounds should not exceed .005", but some are good to .020" for worn parts and bearings. High strength retaining sealant is available at local bearing distributors and some auto parts stores.

Cut-off tool not easy to break
Don James, OH (Nov. 1982, p.6)

Those of you that have ever tried to remove a rusty nut may be interested in a new type of abrasive cut-off wheel that is now on the market. It is called Tuff Wheel and is designed to fit small hand held grinders such as the Dremel Moto Tool. The wheel is about .030" and lasts a very long time. Also, it is not easy to break. If you don't have a Moto Tool or similar type of grinder, you don't know what you are missing. Abrasive cut-off wheels can be used to cut rusty bolts and old nuts in tight places and even hardened steel pins can be cut with no effort. These wheels will also cut sheet metal without distortion. The new type Tuff Wheel costs more.

Engine stand made from D-model rear suspension arm
Dave Burnham, NY (Aug. 1987, p.19)

Home-made stand for D-model engines

Here is my home-made stand for D-model engines. Some of you may recognize that the main part of the stand is made from the rear suspension arm from a D-model. It mounts on the center pillar in my workshop. I have a steel I-beam mounted in the roof of the workshop which has a chain-pull on rollers attached to it. After I pull and engine out of a car, I roll it down the I-beam and attach it directly to the engine stand. The threaded rod at the top of the stand is used to lock the head into place. The head can be locked into five different positions, making it very easy to assemble and disassemble engines.

For three other unique D-model tools, see: Chapter 2–Body and trim - Hood released with tool when cable breaks or is disconnected, Chapter 3–Brakes - Cam adjusting tool prevents rounding hex-head adjusters on rear brakes, Chapter 18–Hydraulics - Pipe fitting removal without damage and Chapter 25–Steering - Toe-in alignment measuring tool.

Garage floor cleanup using detergent and kerosene
Don James, OH (Feb. 1984, p.6)

Oil or grease stains on your garage floor? A mixture of laundry detergent (Tide) and kerosene made into a thin soup will clean your concrete floor or engine components. Rub briskly with a broom or brush. The abrasive action of the powdered soap will help cut the grease. Hose off after it stands for five minutes. No need to buy commercial cleaners.

(There are now products for cleaning that are a lot safer and less toxic. Remember, kerosene is highly flammable. [MB])

Hose lamp can save the day working around engine
Ken Betsh, PA (Apr. 1995, p.15)

One of the best hints from Red and Brad at the old Dellinger shop was to make a "hose" lamp so as to be able to see down in the "bowels" of the engine compartment. Things like dropped hardware, fine spraying leaks around the hydraulic regulator and that elusive hole for the timing pin can only be seen with a light source where the action is. Shadows can hide too much from a trouble light or flashlight held above.

Simply take a single filament 12 volt bulb like the type used for rear turn signals, solder a five foot length of two-conductor lamp (zip) cord to the shell and single contact of the base of the bulb, thread through an old 18" length of garden hose (the lamp base with soldered wire should just fit snugly) and attach two alligator clamps to the other end. Now you have a light source that you can quickly connect to the car battery and slide down to see what you need. And if you keep it in the trunk, you have an emergency after-dark, away-from-home trouble light.

Hood support in garage eases work around engine
Ken Betsh, PA (May, 1999, p.13)

Working under the hood of a D-model is much easier if the hood is raised higher than what the self-contained prop allows. A simple tool inserted into holes in the hinge support will hold it almost vertically. I have a "C" shaped heavy wire bracket and have just seen a short iron bar tapped for two 1/4" fully turned-in screws, each about one inch long and about 4 inches apart, that works very well.

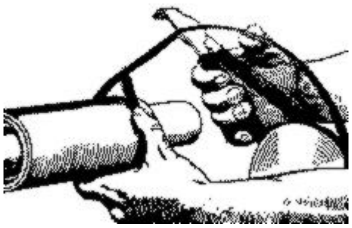
However, I don't have enough overhead clearance in my garage for this. Instead, I have a hook hanging from the ceiling to support the hood high enough to avoid blocking a ceiling fluorescent light. The hook was cut from a piece of one-inch-wide sheet metal about six inches long. It hangs on a piece of guy wire and the hook catches the underside of the front of the hood. A short piece of dangling rope aids in pulling it in and out of position. On the other side of the garage, a hanging loop of clothes line rope holds the hood by one of the two studs that lock the closed hood. The bottom of the hook and loop are slightly over 7 feet above the garage floor.

Ken mentioned his hood support aid earlier in the book. We also included there a drawing of a factory tool for holding the hood nearly straight up for repair work. See Chapter 2–Body and trim - Hood prop modified to support center. [MB])

Ligarex band and tool usage
From a Ligarex pamphlet, edited by Mark Bardenwerper and Tony Jackson (Apr. 2016)

Citroëns of our era utilized a simple universal banding system that is utterly unfamiliar to most other foreign car people. The Ligarex system utilized an long, coiled galvanized band, simple clips and a rather formidable-looking tool that, when properly wielded, made smooth and powerful clamps. Once installed, they could not loosen and the joints were smooth. Yet they were easy to remove, even after many years. The French company is still making this remarkable product.

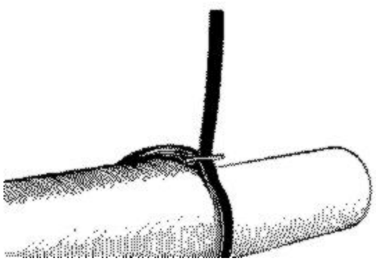
The single challenge to using it is overcoming the fear of learning how to use the pliers. This set of illustrations should get you on your way. Once you make a few joints, you might not ever use a worm gear clamp again. Here we go!



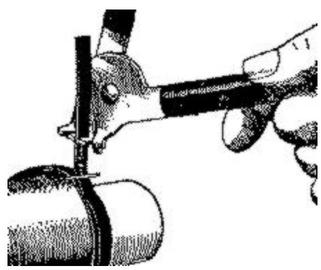
1. Roll off a sufficient length of Ligarex® strip so that it wraps twice around the hose to be fastened. Add about 3 inches of strip and cut it off with the Ligarex® pliers. If you wish to make the band re-usable, add 5 inches.

2. Slip a short piece of the strip end into the slotted end of the buckle and bend it back against itself, retaining the buckle. To be able to use the same strip twice on the same hose, leave 3 inches of extra stripping.

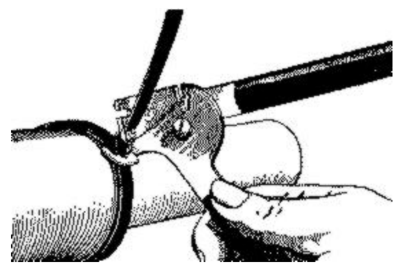
3. Place the strip on the hose, letting the small round hole of the buckle face you. Wrap the strip twice around the hose, passing it each time through the square opening in the buckle, as shown in the next picture.



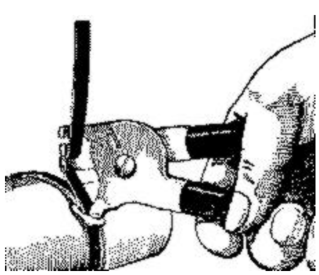
4. Hold the buckle against the hose and pull the strip through tightly, then bend strip end slightly backwards to prevent it from springing back and loosening.



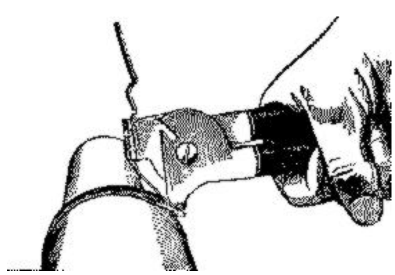
5. Holding the tool in your right hand, open the Ligarex® pliers completely. With the square tip pointing downward, hold the lower handle and put the free end of the strip into the small slit of the plier, leaving a distance of about 1 inch between buckle and slit.



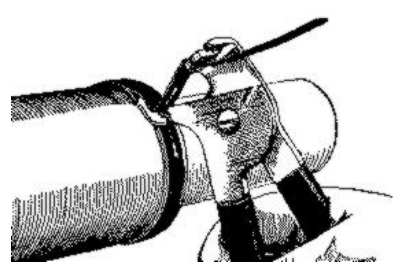
6. Holding the loose end of the band with your left hand, slip the plier down along the end of the strip towards the buckle, while engaging the point of the opposite jaw of the pliers into the round opening in the buckle.



7. Tilt the pliers upward to re-move the slight crease in the



7a. If the strip is not tight enough, tilt the plier slightly



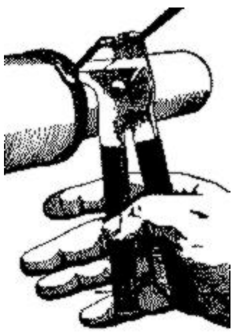
Important

This picture shows clearly

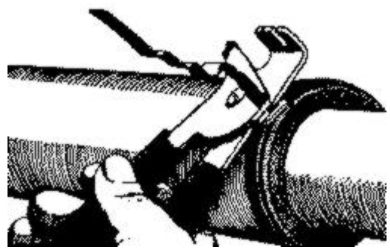
stripping. Now tighten the strip by closing the pliers. The loose end of the strip grips as it kinks into the slot of the upper plier jaw, while the point on the lower jaw holds the buckle motionless. To ensure that the strip does not bind or crease as it pulls through the buckle, keep the pliers at a constant angle to the work.

downwards to create a slight crease, retaining the tension already attained. Repeat steps 5-7, as necessary to obtain a strong tension on the strip. During tightening, take care that the strip slides straight and evenly through the buckle without creasing.

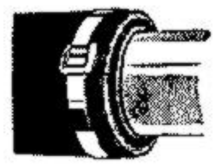
what happens when the strip is not allowed to pull straight through the buckle. Do not allow the pliers to angle downward except while readying for a new pull. This may cause the strip to break. While tightening, force on the strip must remain in a straight line.



8. This picture shows how pressure is released on the pliers after making the final crease, accomplished by tilting the pliers downward until the crease is about 90º.



9. When strip is tight enough, the pliers are slipped off side-ways. The cutter can then remove the surplus, leaving a short length standing off the buckle. The remaining end should be slightly longer than the length of the buckle. The tool can then be used as a hammer to knock it flat, com-pletely covering the buckle and going slightly past it. This prevents the end of the strip from snagging and pre-maturely opening.



10. This picture shows the finished Ligarex® coupling. It will never loosen itself or injure your hands or tear your clothes. When it is necessary that the coupling resist 300 P.S.I. of pressure, it is ad-visable to draw the strip three times around the hose and through the buckle instead of twice. If it is needed, two Ligarex® may be affixed one beside the other. To open the Ligarex® clamps, loosen the buckle with a screwdriver.

LPS sells useful line of lubricants, inhibitors, etc.
Dave Paulin (Oct. 1976, p.4-condensed)

LPS Research Laboratories, Inc. sells four lubricants/inhibitors of possible interest to D-model owners. LPS 1 is a light, colorless lubricant/rust inhibitor that penetrates and displaces rust and is generally similar to WD-40. It leaves a .0001" oily transparent film and is used quite a bit by the aircraft industries for protecting electrical connections from rust, drying out electrical connections, loosening and lubricating frozen parts. LPS 3 is dark-colored, heavier substance that leaves a .0002" transparent waxy film that not only lubricates well but leaves a fairly heavy residue to protect against corrosion.

I have used this on the tailgate hinge of my wagon and sprayed it in the air conditioning compressor assembly to quiet a knocking bearing. Works great on any hinges or pins, etc. LPS Instant Contact Cleaner is excellent for cleaning points or electrical contacts throughout the car and it leaves absolutely no film or residue at all. LPS Instant Cold Galvanize when sprayed or painted on iron or steel generates a positive electrical current that flows to the base metal. This fuses the zinc compound to the metal. It's particularly good after welding as it restores a galvanize over areas destroyed by the welding process.

(LPS is still going strong and offers a wide range of products. Find them on the Internet.

Rubber parts repaired with athletic shoe patch
Ariel Robinson, WV (Jul. 1984, p.20)

If you have a rubber part such as a hose, boot, seal or grommet that cannot be cheaply replaced, you can probably repair it using a product called Shoo-Goo or Shoe-patch. It is available at stores selling athletic shoes.

Screw thread changes around 1970 can cause problem
Ken Betsh, PA (May, 1995, p.13)

Those of us who have saved hardware from stripped older D-models know some sizes changed on the later cars. The M7 hex-head bolts and nuts that once needed 12mm wrenches later required 11mm tools. But at least the threads were the same. And, more importantly, had the ISO standard thread which means replacements can be bought at many hardware stores.

The real trouble is with the M5 hex-head screws and nut that need 8mm wrenches. Apparently about the time they went to using 11mm tools, the factory switched from M5 x .75 threads to ISO standard M5 x .80 - a slight change in the thread pitch. (Pitch in the metric system is the distance between adjacent threads in millimeters.) This change was more subtle since the same tools are used. If you try to mix the two, they bind after about two turns.

Anyone who has removed a fuel pump knows a 13mm socket wrench is required and the mounting studs and nuts are slightly larger than those using 11 or 12mm tools. These are M8 x 1.25, also an ISO standard thread. I found replacement nuts at a Sears hardware store. Knowing this might save the day since it's easy to drop the nut while remounting the pump and have the nut "consumed" in the engine compartment never to be found again.

Metric tap drill sizes
Don James, OH (Nov. 1985, p.15-condensed)

This chart lists what size drill for you to use for what size metric tap and thread pitch. You must use a proper size drill or the tap will break. You may drill the holes slightly larger in tough materials, but never smaller than that shown in the chart.

Chamfer the opening to the hole to make the tap start more easily. When drilling or hand tapping into a flat surface, lay a mirror as close as possible to the base of the drill or tap (where it enters the work). This will help keep you square as it is easy to see deflection in the mirror.

Note metric thread pitch is specified as the distance between adjacent threads, not the number of threads per inch. Thus, a 8 x 1.25 thread is coarser than a 8 x 1.00 thread. Metric thread sizes are frequently written with a "M" in front of the numbers.

Tap size (mm)	Drill size	Decimal equivalent (in.)	Nearest fraction (in.)
3 x 0.50	No. 39	0.0995	3/32
3 x 0.60	3/32"	0.0937	3/32
4 x 0.70	No. 30	0.1285	1/8
4 x 0.75	1/8"	0.125	1/8
5 x 0.80	No. 19	0.166	11/64
5 x 0.90	No. 20	0.161	5/32
6 x 1.00	No. 9	0.196	13/64
7 x 1.00	15/64"	0.234	15/64
8 x 1.00	J	0.277	9/32
8 x 1.25	17/64"	0.265	17/64
9 x 1.00	5/16"	0.3125	5/16
9 x 1.25	5/16"	0.3125	5/16
10 x 1.25	11/32"	0.3437	11/32
10 x 1.50	R	0.339	11/32
11 x 1.50	3/8"	0.375	3/8
12 x 1.50	13/32"	0.406	13/32
12 x 1.75	13/32"	0.406	13/32
1/8-28BSP	21/64"	0.3281	21/64