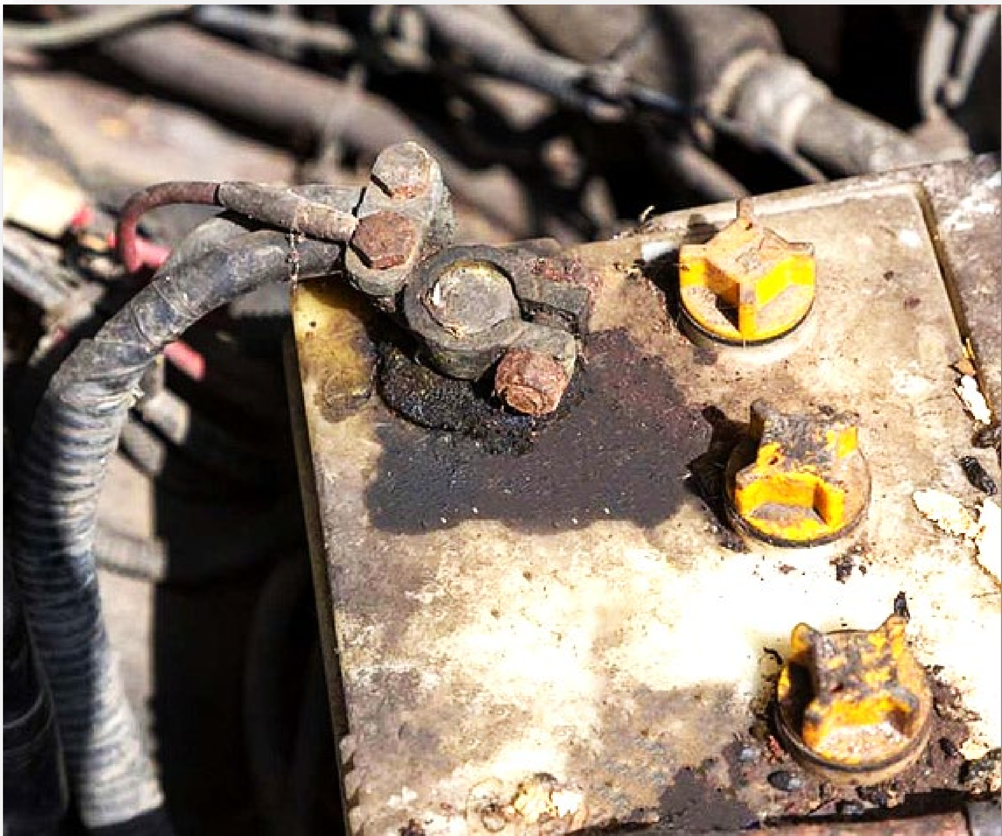
2CV BATTERY PROBLEMS SOLVED

Revision 10



Graeme Dennes

2CV BATTERY PROBLEMS SOLVED

Revision 10

Graeme Dennes

Background

Have you experienced some frustrating battery issues with your 2CV such as the battery being flat or almost flat when it really shouldn't be? Sounds like an undercharging problem? Perhaps you've had battery fluid overflowing from the cell vents onto the battery case, the battery tray and the firewall area, leaving a trail of white powder and corrosion? Sounds like an overcharging problem? Both of these conditions are caused by faults in the battery charging system, and neither condition augurs well for a long and healthy battery life and a happy owner!

Sulphation: The leading cause of battery failure with flooded lead-acid car batteries is sulphation, which is the deposition of lead sulphate crystals on the surfaces of the battery plates. It reduces the effective plate area and thus the amount of charge taken in. Major sulphation can develop when the battery is *undercharged, overcharged or stored uncharged*. The source of the lead sulphate is the water and the sulphuric acid which together form the electrolyte within the battery. There is an ongoing electro-chemical reaction taking place, and when the battery is maintained at its correct, fully charged point, the battery chemistry is in an optimum state and lead sulphate deposition is minimized.

If the sulphation is allowed to continue, the charge taken in continues to be reduced, exacerbating the sulphation. This is a downward spiral to the point where the sulphation deposits will eventually prevent the battery from taking in sufficient charge to start the engine. At that point, the battery has reached the end of its useful life and will need to be replaced, which usually occurs at a most inconvenient time and place!

Water loss: Gassing (bubbling at the surface of the electrolyte) occurs naturally during normal charging, and results from the water in the electrolyte being broken down into its constituent (gaseous) hydrogen and oxygen molecules through electrolysis. The resulting water loss can eventually destroy the battery if the electrolyte level falls below the top of the plates. Should this happen, the exposed plates will sustain damage and the battery's capacity and life will be reduced.

Excessive gassing: One of the hazards from overcharging is excessive gassing, where the electrolyte can overheat and produce excessive hydrogen and oxygen gasses, "boiling off" (depleting) the water in the battery.

The most hazardous situation is when a lead-acid battery is overcharging *and* overheating, producing more combustible hydrogen and oxygen than can be vented, until finally, the pressure is relieved – instantly – by explosion. You definitely don't want this to happen anywhere near you or under the bonnet of your car. Hot sulphuric acid is not a nice friend!

In summary, if the battery is being undercharged or stored uncharged, sulphation occurs, while if it is being overcharged, sulphation *and* excessive gassing occur, each of which has an impact on battery health and life. To ensure these conditions don't occur, it helps to understand why they occur and how to prevent them.

Come on Baldrick. Speak up!

Um, yes m'lord.

The battery: Supplies power to the car's electrical systems, equipment and accessories before the engine is started. It supplies power to the starter motor when starting the engine. Very importantly, the battery acts as a voltage stabiliser for the alternator, stabilising the voltage fed to the car's electrical system. (More follows).

The alternator: Acts as the battery charger for the car's battery and provides the electrical power for the car's electrical systems and equipment while the engine is running.

The voltage regulator: Controls the output voltage of the alternator so the battery is optimally charged and maintained in an optimal state to maximise the battery's life.

Well Baldrick…?

As shown on the circuit diagram at the last page, the 2CV voltage regulator is a three-terminal electrical device. The connections are named D+ (Dynamo+), D- (Dynamo-) and DF (Dynamo Field). Although car alternators have been around for over 60 years, the earlier Dynamo (Generator) terminology has generally remained in the automotive electrical field.

Consider the voltage regulator wiring for the 2CV. The regulator's D+ terminal connects to the battery positive terminal via the ignition switch, the D- terminal connects to the battery negative terminal via the chassis ground connection, and the DF terminal connects to the rotor (exciter) of the alternator to regulate the battery charging. Refer to the writer's article, *2CV Battery Charging Circuit* for more details.

As manufactured, the D+, D- and DF wires from the wiring loom terminate at a three-pin socket (shown on the circuit diagram), which connects to the three mating pins on the bottom face of the standard 2CV voltage regulator. This forms the voltage regulation and battery charging arrangement for the 2CV.

As background, the factory-fitted 2CV voltage regulator is an adjustable electro-mechanical device which was calibrated (adjusted) before the vehicle left the factory. It can lose its calibration over time, resulting in the battery being either undercharged or overcharged. Adding to this is the fact that the regulator is now several decades old and much older than Citroen ever envisaged its working life would be.

Mmmm, he says knowingly… By now, the voltage regulator in your 2CV may be well outside of its specifications and require recalibrating. Yes, this would return the voltage regulator back to specifications, but because of the regulator's age and wear, expecting it to retain its calibration could be futile, so it may not be very long before it has to be done once again, by which time the battery has been through another period of longer-term damage and the car owner has been through another period of (aaaaaaagh!!!!!!!) frustration!

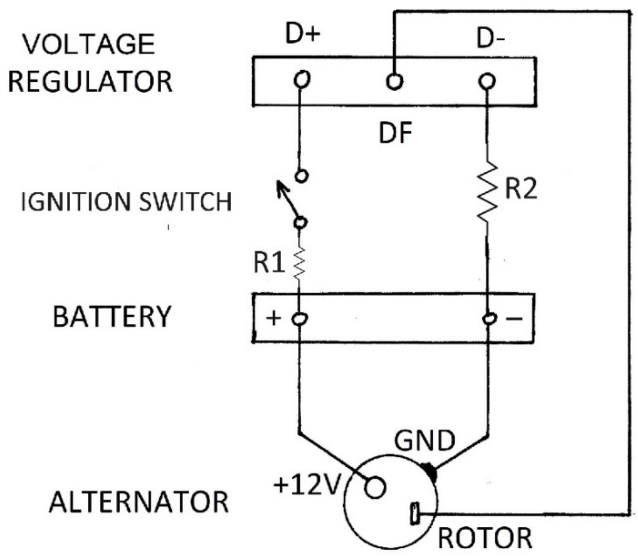
But it gets even worse m'lord.

Worse? Surely not.

Not only does the original electro-mechanical voltage regulator lose its calibration over time which results in the battery being either undercharged or overcharged, but there is a further issue of even greater significance affecting the health and life of the 2CV battery.

How do we maximise the health and life of the battery? By ensuring the voltage regulator is monitoring the **true** battery voltage. This can only be achieved if the wiring resistances between the regulator and the battery is zero ohms. However, as all wiring has resistance of some amount (well, above zero Kelvin!), we need to take steps to **absolutely minimise** the wiring resistances between the regulator and the battery. This is to ensure the voltage across the regulator's D+ and D- terminals is *identical* to the voltage across the battery's + and - posts. Whenever and wherever wiring resistances are in play, these voltages will **never** be the same, and the battery is *always* going to be overcharged during vehicle operation! Dead set!

The 2CV Charging Circuit



We will consider the 2CV battery charging circuit shown in the writer's article, *2CV Battery Charging Circuit.* We'll add to the circuit the critical wiring resistances, shown as resistors R1 and R2 in the figure above. Resistor R1 represents the wiring resistance between the voltage regulator's D+ terminal and the battery positive post via the ignition switch, and resistor R2 represents the wiring resistance between the regulator's D- terminal and the battery negative post.

Why is the wiring resistance of importance Baldrick?

Any series wiring resistances (R1 and R2) between the regulator and the battery *will guarantee that the true battery voltage will* ***never*** *be sensed by the regulator!!*

During 2CV vehicle operation, when the ignition switch is on, several electrical items draw their power via the ignition switch, including the ignition system, the wiper motor and the turn indicator lights. This results in current flow through the resistance R1, so a voltage is dropped across R1.

In operation, the regulator's D+ terminal senses the voltage at the ignition switch. However, the voltage at the ignition switch may be perhaps **half a volt lower** than the voltage at the battery positive post because of the voltage drop across the wiring resistance R1.

In a similar vein, the regulator's D- terminal senses the voltage at its ground connection point. There are resistances between (1) the regulator's D- terminal and its ground connection point, (2) the wire link between the chassis and the gearbox, and (3) the gearbox and the battery negative post.

Keep in mind also that the various vehicle electrical items usually use the body or chassis as their return path to the battery negative terminal, so again, any circuit resistances in these paths will result in voltages dropped across them, further tricking the voltage regulator.

Looking at the figure above, the resistances R1 and R2 are real, not theoretical.

Take an example. Say the voltage across the battery posts is 14.2V when the engine is running. We consider the battery to be fully charged (or close to it) when it reaches the 14.2V point. However, due to the half volt dropped across the wiring resistance R1 between the battery and the ignition switch, then at that same moment, the regulator's D+ terminal is sensing 13.7V at the ignition switch as the battery voltage! This figure will be reduced even further when the voltage drop across the resistance between the chassis and the battery negative post is included.

Come on Baldrick. Don't hold back!

Here is the nub of the issue. Continuing with the example. With 14.2V at the battery posts, the battery is fully charged, so we want the alternator to reduce its output so the charging rate of the battery is reduced, so the battery doesn't enter the overcharged state. *That is what is intended.* Yet at that *very same instant*, the voltage regulator is sensing 13.7V at the ignition switch as the battery voltage. Thus the regulator is sensing that the battery has still not reached the fully-charges state (14.2V), so it cracks the whip and keeps the alternator charging the battery at its maximum rate, driving the already-fully-charged battery headlong into the overcharged zone! *That is what is achieved!* (Ah, now I know what that "boiling" sound is!). This is how the 2CV was manufactured, and is a constant predicament facing all 2CV owners, *whether they know about it or not!* In fact, this was a design compromise adopted by *most* of the car manufacturers of *most* of the vehicles made over *most* of the last century!! The 2CV was not alone in this commonly-implemented approach to cutting vehicle manufacturing costs.

In summary, the overcharging of the battery has all come about because of the small voltage drops across the wiring resistances between the battery and the regulator due to the numerous electrical currents flowing in the ignition wiring, and occurs even if the regulator is set to specifications! This small voltage drop is sufficient to convince the regulator to continue to charge the battery, even when the battery is fully charged! Yes, because of the voltage drops in the wiring, the regulator will *always cause the battery to be overcharged – through no fault of its own!* It's a sure-fire way to guarantee electrolyte overheating, excessive gassing and "boiling", loss of water from the cells, damage to the plates by sulphation, and damage to the plates from not being covered by fluid, and all caused by the vehicle's wiring resistances.

Yes, the battery is hurtling flat strap towards its twilight zone! Keep in mind that this relentless, unwanted overcharging of the battery is not caused by the voltage regulator. (This would occur identically with a brand new, calibrated voltage regulator.) *It's caused by the vehicle's wiring resistances between the battery and the voltage regulator!!*

Alright Baldrick. What's your cunning plan?

This article describes a small modification to the 2CV electrical system to ensure the battery is charged in an optimum, controlled manner by using a modern solid-state voltage regulator, the Bosch RE57, in conjunction with a relay. The RE57 regulator sets the correct battery charging conditions, the wiring resistances in the ignition circuit are bypassed using a relay and a *direct* connection to the battery positive post, and the wiring resistances in the ground connections are bypassed using a *direct* connection to the battery negative post. By this means, the voltage regulator is able to sense the **true** voltage appearing at the battery posts, just as we require.

The RE57 regulator and relay ensure the battery is neither undercharged nor overcharged but optimally charged, promoting longer battery life! Utopia! The battery is *optimally* charged to its fully charged state and is *optimally* maintained at its fully charged state! Yes, a perfect solution to achieve long battery life **and** a very happy owner!

This is the most cunning plan a Baldrick has had for five hundred years!

The RE57 regulator and relay, when wired in accordance with this article, will ensure the battery is always optimally cared for. The RE57 regulator and the battery will be on the same voltage page! Note, however, that this doesn't dispense with the need to be vigilant about keeping an eye on the battery fluid levels. Ensure the plates are *always* covered by fluid. Add distilled water as necessary. Note: There is nothing preventing a relay from being wired to the original electro-mechanical regulator in a similar manner so the true battery voltage is sensed, but it does depend on the (now) old voltage regulator maintaining its calibration as already noted, otherwise no benefit will be gained because the battery will still end up being overcharged or undercharged, so nothing gained.

Although this article applies to the 2CV, the underlying principle applies to other vehicles which employ an external three-terminal electro-mechanical voltage regulator controlling an alternator.

On the left is a photo of the Bosch RE57 voltage regulator, packaged in a small die-cast case. It is a sealed, non-adjustable three-terminal (D+, DF, D-) device which provides an install-and-forget solution. It has a voltage set point of 14.2V. More follows. The regulator's metal case is a heatsink, so mount the unit firmly on the firewall.

Note: A similar voltage regulator is the Bosch RE55 which has two terminals ((D+, DF). **It uses the metal case of the regulator as the D- terminal and this connects to the battery negative post via the vehicle body!** Don't use this regulator. You want the three-terminal RE57 regulator with its separate ground terminal which can be wired *directly to the battery negative post* to achieve an electrically "stronger" (i.e. more direct) connection, resulting in the vehicle wiring/chassis resistances being bypassed as previously noted.

If someone tries to convince you the RE55 can be used in place of the RE57, they definitely don't understand the intricacies of voltage regulation and the effects that even milliohms of wiring resistances can have on the charging of a battery! The problem? The RE55 uses the vehicle chassis to connect the regulator's ground (D-) connection (its case) to the battery negative post, and the chassis is comprised of steel - and paint! It can be a long way (resistance-wise) from the voltage regulator's case, to the firewall, to the gearbox, to the heavy battery negative lead, and finally to the battery negative post. We use the RE57 so *all* of these series resistances are bypassed and *all* the resulting voltage drops are removed, allowing the voltage regulator to sense the true battery voltage as already noted - our *raison d'être*! Thus why we use the RE57.

So what have you got for us Baldrick?

The attached circuit diagram shows the modified wiring needed to connect the RE57 voltage regulator and relay to your 2CV to replace the original electro-mechanical voltage regulator. Briefly, when the ignition switch is turned on, the original D+ (12V) connection from the ignition switch is used to activate the relay. When the relay is activated, its closed contacts connect the D+ terminal of the RE57 regulator to the battery positive post. So now, with the RE57 regulator's D+ and D- terminals connected *directly* to the battery posts, the voltage regulator can (finally) sense the *true* battery voltage and ensure the battery is properly charged and kept properly charged.

At the lower section of the circuit diagram is shown the pin layout diagrams and pin designators for the original 2CV voltage regulator, the RE57 voltage regulator and the Narva 68044 relay and 68084 socket **when looking directly at the connection pins**. As may be seen in the photo above, **the same pinout** for the RE57 regulator is also provided on the top face of the regulator, just below the "RE57" designator. After attaching the small metal mounting bracket supplied with the relay to the relay cover, mount the RE57 regulator and the relay and socket next to each other on the firewall, close to the battery, with their connection pins pointing downwards. Three short wires with spade crimp terminals can be made up to extend the three connections (D+, D- and DF) from the original regulator socket if necessary. Alternatively, the socket could be removed and the wires extended. The D+ and D- wires connect to the relay coil while the DF wire connects to the DF terminal on the RE57 regulator. Note that relay pin 87a is not used. The colours of the three wires at the original regulator socket may vary and sometimes they are all the same colour! Photograph, trace, label and record the socket wiring details **very** carefully and keep the information in a safe place.

The photo above shows the underside view of the Bosch RE57 regulator with its three connection terminals. Note the end of a resistor projecting above the epoxy fill. **Not all RE57 regulators have the exposed resistor.**

If the exposed resistor wire is cut, the regulator's voltage set point is increased from the default of 14.2V to 15.2V. This compensates for diode-isolated charging situations such as in dual-battery setups, where voltage drops occur across the diodes. The 2CV uses one standard lead-acid battery which requires the 14.2V regulator setting, so **don't** cut the resistor wire (if it's present)!

The Bosch RE57 regulator and Narva relay and socket are usually available at auto parts stores, and often appear on eBay. Do an ebay search on "RE57". Don't use substitute products for the voltage regulator, the relay or the socket. Below is a photo of the relay.

Four wires connect to the relay socket via brass spade connectors and these are pressed into and locked in the bottom of the relay socket after being crimped to the wires. Identify the correct orientation for the brass spade connectors *before* inserting them into the relay socket. These connectors are usually supplied with the socket. Three red-coloured crimp connectors are needed for connecting to the RE57 voltage regulator pins. Two crimped connectors of a size suitable for mounting under the battery post bolts are also needed to connect pin 30 of the relay socket to the battery positive post and to connect the regulator D- terminal to the battery negative post. Ensure all crimps are correctly fitted to the wires using correctly sized and adjusted crimping tools.

Make the wiring between the RE57 regulator, the relay and the battery no longer than necessary. Terminate the red and black wires *directly at the battery posts* – no other place! A suitable wire size for the connecting wires is a *conductor* diameter of 1.5 mm.

Run, dress and secure the wiring in a professional manner. Make it reliable, neat and secure, and make the RE57 regulator, the relay and the wiring appear to be originally fitted parts on the vehicle. Be proud of your work!

Final Electrical Checks.

Do the following checks to confirm the rest of the car's charging system is in good condition:

1. Ensure all electrical wiring, connecting/terminating screws, bolts, washers, nuts and all crimped wiring terminations discussed below are disconnected, brass-wire brushed on all surfaces to remove all oxidation and corrosion products, and then reconnected and solidly tightened. Ensure all crimped connections provide a solid connection, otherwise replace the crimp.

   This sequence of checks provides the pathway to achieve the lowest-possible wiring resistance and the highest reliability for your car's charging circuitry.

2. Ensure the heavy starter cables at the battery posts are solidly connected to the battery.

3. Ensure the heavy positive cable is solidly connected to the starter solenoid.
4. Ensure the heavy negative cable is solidly connected to the gearbox stud.
5. Ensure the battery negative post is also solidly connected to a metal grounding point on the firewall with a 3mm (minimum) diameter copper cable. (This is the *conductor* diameter, not the insulation diameter).
6. Ensure the D- wire at the original regulator socket is solidly grounded to the firewall.
7. Ensure the DF wire at the original regulator socket is solidly connected to the alternator rotor terminal.
8. Ensure the alternator's output terminal is solidly connected to its crimp connection, and the crimp is solidly connected to the cable.
9. Ensure the alternator body (negative) is solidly grounded to the exhaust manifold on which it is mounted. Ensure the mounting bolt, washer and nut are tight.
10. Ensure the ground wires from the wiring loom are solidly connected to the ground stud on the firewall. These will have been in place for a long time!
11. Poor ground connections seem to be the eternal bane of the 2CV. Every ground connection should be disconnected, thoroughly cleaned and replaced *tightly*.

Some of the above connections may never have been disturbed since the 2CV was new. Take your time and do the job once, do it thoroughly and do it methodically, one step at a time. Make it right.

The finish line!!

After the job is finished and your State's Electrical Licensing Inspector has inspected your work and issued a Certificate of Compliance – only joking!! – start the engine and turn on the lights.

After a couple of minutes of running, the voltage measured *at the battery posts* should be around 13.2-13.6V at idle. With the engine running at perhaps 2000 RPM, the battery voltage should be around 13.8V to 14.0V, reaching a maximum of 14.2V around 3000 RPM. **It should not rise above 14.2V, the regulator's voltage set point, at any engine speed.** This confirms the modification is working as intended. Congratulations!

Anecdotally, many external voltage regulators from all vehicle brands have been replaced in the past in valiant, and usually unsuccessful, attempts to fix overcharging problems which were eventually found to be caused by wiring resistances between the voltage regulator and the battery! Much money was spent and much money was earned!

Finally, if a vehicle is not being used regularly, as can happen with our classic cars, connect a good quality multi-stage battery charger to the battery to maintain it at its best state of health. It maximises the life and reliability of the battery, ensuring it will be fully charged and ready to operate our 2CV the next time we decide to take it for a drive.

As an aside, recent advice provided to the writer by an industry insider is that after several years of life when running with headlights on, some Citroen vehicles equipped with alternators and electro-mechanical voltage regulators could experience an electrical malaise which causes the car's headlights to pulse in brightness when the engine was running around 1500 RPM with a fully charged battery. If the problem arose, the solution was to fit a relay as described herein while retaining the original voltage regulator.

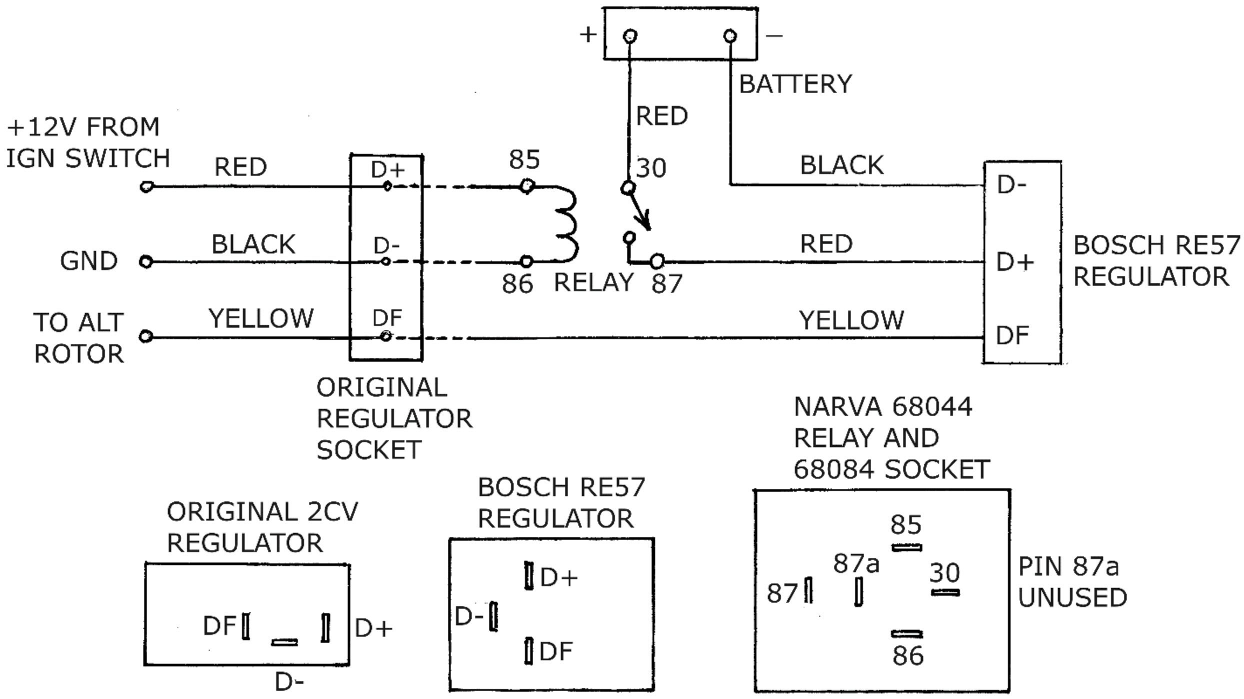
An Important Warning

To prevent extensive and expensive electrical system damage to your vehicle:

Never disconnect the battery while the engine is running!

The battery loads the alternator and stabilises the entire electrical system, preventing high peak voltages (perhaps up to 100 volts) and voltage surges occurring. These can damage the vehicle's electrical/electronic systems and equipment, including the vehicle's management computers, alternator, voltage regulator, ignition system, Sat-Nav, radio, light globes, etc, etc. $Ouch!!

2CV VOLTAGE REGULATOR AND RELAY WIRING (2024)



PIN DESIGNATORS ARE SHOWN WHEN LOOKING DIRECTLY AT THE PINS

LIST OF ARTICLES BY THE WRITER

The articles written by the writer, listed below, may be freely downloaded from either of the following club websites by clicking on the adjacent links and locating the articles. Both websites maintain the latest revisions of the articles. Before using the articles, please ensure the latest revisions are being used, as the articles are updated on an as-required basis by the writer and given new revision numbers.

Citroen Classic Owners' Club of Australia: Technical Articles

Citroen Car Club of Victoria: Tech Tips

1. 2CV 40-Litre Fuel Tank
2. 2CV API GL-4 Gearbox Oil
3. 2CV Battery Charging Circuit
4. 2CV Battery Problems Solved
5. 2CV Brake Saga
6. 2CV Buyer's Questions
7. 2CV Carburettor Cover Screws
8. 2CV Carburettor Jets and Adjustments
9. 2CV Engine Problems
10. 2CV Fuel Filter
11. 2CV Fuel Gauge and Battery Meter
12. 2CV Gearbox Output Hubs
13. 2CV Gearbox Unwinding Debacle
14. 2CV Hard Luck Stories
15. 2CV Headlights Improvement
16. 2CV Ignition Coil
17. 2CV Knife Edges Replacement
18. 2CV Low Oil Pressure Beeper and Lights On Beeper
19. 2CV Maintenance - Part 1 of 2
20. 2CV Maintenance - Part 2 of 2
21. 2CV Oil Breather
22. 2CV Oils and Maintenance Advice From Burton
23. 2CV Points Ignition Reinstallation
24. 2CV Roof Rack
25. 2CV Secondary Choke Butterfly Adjustment
26. 2CV Spare Parts to Carry
27. 2CV Valve Clearance Adjustment
28. 2CV Workshop
29. Better Fuel Hose Clamps – **applies to all vehicles**
30. Better UHF CB Car Radio Performance – **applies to all vehicles**
31. Ignition Coil Ballast Resistors – **applies to all vehicles**

FINAL STATEMENT

My acknowledgement and grateful appreciation is given to the web sites from which photos/drawings/diagrams have been sourced.

If material copyrighted by others has been inadvertently used in this document without permission, then upon receiving advice, the writer will remove the material immediately.

This article may be updated in the future and assigned a new revision number.

Before using the information in this article, ensure the latest revision is being used.

If you have questions about the information in this article, if you find errors or incorrect statements, if you have suggestions for improvement, or should you wish to republish this article in your club magazine, please - contact the writer at: gdennes@gmail.com