

A \$10 D Model Alternator Regulator

By John D. Titus

As a mechanical engineer, I have always admired the Citroën hydraulic suspension system. However, my admiration for Citroën engineering does not extend to the Ducellier and Paris-Rhône automotive electronics. Therefore, when my 1970 DS 21 charge indicator light came on, I went to work to design a method for using an inexpensive replacement for the Ducellier voltage regulator.

The replacement turns out to be an after-market electronic replacement for the mechanical voltage regulators found on most Fords from 1966-1976. Ask for a regulator for a 1970 Mustang and the parts man will probably give you the right unit. It is important that you get the electronic replacement, rather than a genuine mechanical regulator as I will explain later. To tell whether you have the electronic replacement, turn the unit upsidedown. If you see one or more wire wound resistors, it's a mechanical regulator, which will not work without modification.

The first problem to overcome in substitut-

ing a common voltage regulator for the Ducellier is the lack of a clear wiring diagram of the charging system. Figure 1 is a charging system diagram for the DS-21 that I made.* The two most interesting features of the system are that the starter switch is grounded through the relay that operates the charge indicator light. This prevents the starter from being engaged while the engine is running. Or, more precisely, this prevents the starter from being engaged when the charge indicator light is not illuminated. The other interesting feature is that the alternator field current is switched directly by the ignition switch. Thus, if you leave your ignition switch "on" without the engine running, your battery will discharge through the alternator field windings in short order. In a normally functioning Citroën with the key off, the indicator light relay is shorted to ground through the ignition switch. (The reason for shorting the field to ground is not clear but is probably to prevent voltage spikes from occurring when the alternator field collapses as the engine is switched "off".) When the key is switched "on" but before the engine is started, one terminal of the charge indicator light is exposed to battery voltage and the other terminal is shorted

to ground by the indicator light relay. The starter switch is also shorted to ground through the indicator light relay. Current flows from through the ignition switch to the "+" terminal of the regulator through the voltage regulator relay to the field coils and to ground.

When the engine is started, the stator windings, excited by the energized field begin to develop voltage. The half-rectified voltage (which is on the average about 6 volts) appears at the stator terminal and energizes the indicator light relay which goes open thereby extinguishing the indicator light and disabling the starter switch.

Figure 2 shows the Citroën wiring after the one modification that is necessary to accommodate the Ford regulator. The necessary modification is to ground the starter switch directly rather than through the voltage regulator. (This modification disables the interlock that prevents the starter from being engaged while the engine is running).

To ground the starter switch, find the two leads at the switch. On models with the Citromatic transmission, the starter switch is located on the gear selector shaft well forward of the gear selector. To reach it you will have to remove the gear selector cover and instrument panel. Using a voltmeter, determine which lead is "hot." Leave that lead connected to the switch and remove the other. Mark the removed lead in case you ever want to refit a stock regulator, cover the end of the lead with electrical tape and tie it out of the way. Connect a new lead to the starter switch and pull the wire through the fire-wall and ground it to any convenient bolt.

To connect the new regulator, obtain a Ford regulator "pigtail" available at Pep Boys and other parts stores and wire the pigtail to the Citroën leads as shown in figure two. Mount the regulator so that it is securely grounded and plug in the pigtail.

With the new regulator installed, the charging system will function slightly differently. With the ignition key "on" but before the engine is started, the charge indicator light is now grounded through the field coils rather than a dead short. (Which is why you had to separately ground

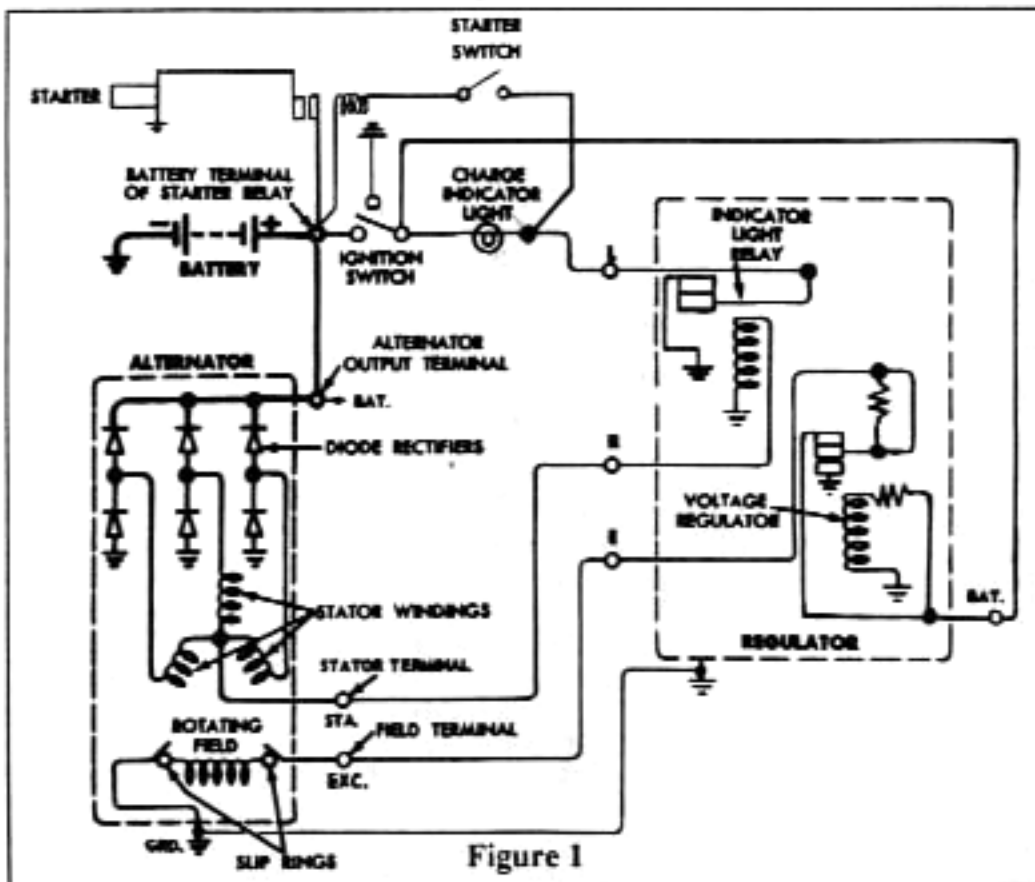


Figure 1

the starter switch.) When the engine is started, the stator windings excited by the limited current through the indicator light to the field coils will cause a voltage to appear at the stator terminal. The current sourced by the stator excited by the limited field is not sufficient to close the mechanical field relay, but is sufficient to close the electronic field "relay." (This is why only the electronic replacement for the Ford mechanical relay will work.) When the field relay is energized, the charge indicator light is connected to "+" therefore, current stops flowing and the indicator light goes out. (Note that the disconnected starter switch lead is also now "hot" which is why you carefully covered the lead with electrical tape and tied it out of the way.) When the field relay is energized, the "+" lead from the ignition switch is connected directly to the field windings and full excitation is accomplished. Voltage regulation is automatic. It is important to note that with this setup, if the charge indicator burns out, no excitation will be supplied to start up the alternator. Thus, you will have to develop the habit of checking the charge indicator light each time you start the car (which you should do anyway.) Moreover, a spare bulb should become part of your roadside repair kit.

Although the above is all that is necessary to have your Citroën back on the road, several options are possible.

1. If you do not want to disable the starter switch interlock, ground the starter switch through a relay such as a Marchal auxiliary headlamp relay. Connect the ground terminal of the starter switch to the input terminal of the of the relay. Connect the normally open relay terminal to ground. Connect the input of the relay field to switched battery battery voltage. Ground the relay field through the oil pressure switch. When the key is "on" and the oil pressure indicator is lit, the starter switch will be grounded through the relay. When the engine is started and the oil pressure switch goes open, the starter switch is disabled. This will not be a completely transparent fix, because now you will be unable to crank the engine using the starter switch unless the key is on.

2. The second option is to make the

Citroën compatible with the both the mechanical and electronic regulators. This option will also assure that the alternator will function even if the indicator light burns out. As I mentioned earlier, with field excitation sourced through the indicator light during start-up, the stator current is insufficient to activate the mechanical field relay. The solution is to connect a 1-watt 12-18 ohm resistor between the switched supply and the indicator lead, i.e. between the "A" and "I" terminals of the regulator. The added excitation current will be sufficient to energize the field coil relay. Additionally, the parallel source will provide backup excitation if the indicator light burns out.

3. A third option is to connect the "A" terminal directly to the battery. Since the Ford regulator does not connect the "A" terminal to anything unless the field relay is energized, the "A" terminal can be "hot" all the time. The advantage is, you take some load off the (expensive) Citroën ignition switch, and you can use a heavier gauge wire to source more current for a higher output alternator. (See option 4).

4. Many of you have probably figured out that once the Ford voltage regulator is connected to the Citroën wiring harness it would

be a simple mechanical fit to replace the S350 Paris-Rhône or Ducellier alternator with a S35 Ford alternator. You are right. Moreover, if you have a Citroën with air conditioning and maybe a modern stereo, the same 45 amp stock alternators do not keep up with the load. The Ford alternator is available in everything up to a 95 amp version. The 75-95 amp alternator is in a larger housing than the 45-65 amp version and costs a little more, but even the expensive Ford alternator is less than 1/4 the price of a Paris-Rhône.

There is an alternative to having to replace the indicator bulb immediately after it burns out in order to provide regulator source current under emergency conditions. Most of the aftermarket "pig-tails" for the Ford regulator come with two tandem leads (leads with two wires coming off a single spade connector.) Before wiring the "pigtail" into the Citroën wiring harness, move the tandem leads in the pigtail to the "I" and "A" positions and leave the secondary leads intact. Usually the ends of the leads are shrink wrapped so they won't short, but you may want to add some electrical tape for insurance. In the event of an indicator bulb failure, simply start the car's engine, then briefly short the secondary "I" and "A" leads together, this will energize the stator windings sufficiently to begin regulation and get you home.

