Model A Generator Troubleshooting – Tips and Tricks
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Between the two of us, we have reconditioned, serviced and tested many Model A generators. The purpose of this article is to share some of our experiences with malfunctioning Model A generators. This article has been divided into two parts. Part 1 examines big picture items involved with a generator and car electrical charging circuit. Part 2 gets into the details on problems that would be identified upon disassembly of the generator in addition to presenting the benefits of installing an Electronic Voltage Regulator (EVR).



Generator with EVR Installed

This article assumes you have some rudimentary understanding of the Model A generator and its electrical system. If you would like some high-level background on generator theory, please see the APPENDIX at the end of this article.

Steve has published some great information on YouTube (Steve B's Workshop) which is referenced below. If the links provided don't work, please search YouTube.

About the Authors

Steve Blancard – Located in Fredericksburg, Virginia, is a lifelong old car and motorcycle enthusiast. He currently drives a '31 pickup and '35 Fordor Touring car. Steve is a retired US Navy veteran, where he learned electronic and electromechanical skills. Antique 6 volt generator restoration and repair has been his hobby of over 30 years.

Mike Hill – located in Calgary, Canada, has a '30 Tudor and has been involved in the repair and restoration of many Model A cars and restores generators. Mike produces Electronic Voltage Regulators for the long-style and 3 and 5 brush powerhouse generators based on the Tom Wesenberg design which has been around for over 20 years.

PART 1 – THE BIG PICTURE

Electrical System

Abnormal ammeter readings are often the first indication the something is wrong with the Model A charging circuit. If the electrical system in the car is not performing well, it could be related to generator, cutout, car wiring or battery issues. People immediately assume the generator is at fault, however, this may not be the case. Below are some big picture things to consider.

- **Unstable ammeter readings** - a fluctuating/vibrating ammeter needle may indicate an out of round or rough commutator, loose wiring connection or a faulty cutout.
- **Car wiring integrity and continuity** - to check the car wiring continuity a 6V test lamp/bulb with wire leads is better than using an ohm meter as it induces current into the test process. With one end of the test lamp attached to ground (chassis), work backwards from the generator to the ammeter connections testing each connection point along the way. The intensity of the test bulb should not change from connection to connection.
- **Battery condition** - batteries typically last 3 to 5 years depending on storage and use. Even though an older battery could start the car, a poor battery may be revealed by high and erratic charge rates. If in doubt of the battery's condition, check its specific gravity with a quality hydrometer and have it load tested at a local auto parts store.

- **Generator history** – it is important to understand the history of the generator. Is there obvious damage especially things indicating the generator overheated? Did somebody try and rebuild it previously and it didn't work? Was it rewired for 12V output?
- **Noise and shaft movement** - a noisy generator, or pulley moving in or out, may mean the bearings or bushing are worn.

The easiest generator test is to see if the generator "motors". Take the fan belt off the generator pulley and apply power from the negative terminal of the battery to the generator output post (assuming the car is still set up for positive ground). The generator should run slowly. Although this likely indicates a functioning generator, it may not indicate problems with the generator field coil circuit.

Third Brush Setting

The third brush controls the generator output so its setting affects battery, horn and light performance. The third brush setting also impacts the voltage output produced by the generator. High generator output voltages (>7.2 V) can impact battery charge rates and battery life. More on this in Part 2.

There are lots of resources on how to set the third brush. Steve has an excellent video on how to properly set the third brush: *Ford model A generator 3rd brush adjustment*.

Poor generator output can be related to the third brush setting or the condition of the third brush. Is the third brush worn so that it is not properly contacting the commutator? Also check the third brush wire insulation. If it is worn or damaged the third brush output may be grounded. Make sure the brush travels freely in its holder and the brush has room to travel. Brush spring tension can deteriorate over time. Pulling back on the brush, tension should be 25 – 40 ounces and can be measured with an inexpensive trigger pull gauge. These checks also apply to the output and ground brushes.

With the Powerhouse generator, one needs to be very careful adjusting the third brush. Make sure the holding screw is fully backed off and the brush can move freely by hand. Often people force the brush which can result in the brush holder breaking.

Cutout Problems

The generator cutout disconnects the generator from the battery when the car is not running – otherwise the generator would attempt to motor and drain the battery. There are two types of cutouts – electromechanical and diode. Once the generator starts producing voltage higher than the battery voltage, the cutout allows the generator to provide electricity to the car and battery.

To determine whether you have a diode or electromechanical cutout, using a multimeter, connect the meter leads to the two cutout terminals, then reverse the meter leads. If you have a diode cutout, the meter should show near zero resistance in one direction but show infinite resistance in the other direction. There should also be no continuity between the cutout case and the terminals. If there is continuity in both directions, or to the cutout case, the diode cutout may be damaged.

It is important to understand the proper orientation of the cutout or it will not work. As shown in the picture below, the feet are not centered on the cutout but offset to one side. The terminal closest to the feet connects to the generator output stud. The other terminal to the wiring harness and battery.



Generator Cutout Orientation

An electromechanical needs to be grounded to the generator body for proper operation. Be sure to scrape away a little paint on the generator where the cutout feet mount. Put a very thin film of dielectric grease under the feet to inhibit corrosion.

A 6V battery at rest should read around 6.35 volts. For the cutout to conduct electricity, the generator output voltage needs to exceed the battery voltage. For a properly adjusted original cutout, the points should close between 6.5 – 7.0 volts. A diode cutout requires no adjustments and can be considered an electrical one-way valve. When making measurements on a running car, an analogue electrical meter is required. Electrical interference from the car ignition system will result in erroneous readings using a digital meter.

When the engine is not running there should be no continuity from the battery terminal on the cutout to the generator terminal on the cutout. This can be measured using a multimeter on the "Ohm" setting. If there is continuity it indicates the cutout points are stuck closed with an electromechanical cutout. This condition is fairly rare and easy to diagnose as the generator would motor and quickly drain the battery. When the car is running, with an electromechanical cutout, the voltage at the generator output terminal should be the same as at the terminal on the other side of the cutout indicating the cutout is engaged. With a diode cutout there will be a voltage drop across the cutout, but the voltage difference should be within 0.5 to 0.6V.

If the electromechanical cutout is not engaging, it needs to be repaired or replaced. Steve has an excellent video on how to properly test and adjust cutouts: *Service, adjustment and repair of a Ford model A cutout*.

Armature and Field Coils

In our experience, if a generator was functioning properly and now isn't, it is likely not due to a faulty armature or field coils. The exception is if these items were physically damaged, or the generator was overheated and the field coil and armature wiring compromised.

Disconnecting a generator from the battery with the engine running causes a runaway effect resulting in high currents to the field coils and commutator arcing ultimately creating high temperatures which can destroy the generator wiring. As a precaution, always ground the output post of the generator if the generator becomes disconnected from the battery while driving.

Steve has a video on how to properly test the generator armature: *Testing a generator armature on a growler for opens, shorts and grounds*. Complicating things further, the armature wiring can experience a "flying short" caused by the armature windings shifting as the armature spins. This is a result of a deterioration of the winding insulation or poor wiring contact with the commutator bars.

If the generator output is less than 2V, it is likely that there is a problem with the field coils. A generator, with a faulty field coil circuit will usually put out a voltage of less than 2V based on the residual magnetism in the field poles.

Although the continuity of the field coil circuit can be tested with an ohm meter, the condition of the field coils is best tested using a variable power supply. One side of the power supply should be connected to the generator case and the other to the field coil wire lead (disconnected from the third brush or with an insulator placed

between the brush tip and the commutator). At 6.5V, the field coils in the long-style generator will draw around 4A to 5A. With a Powerhouse generator the field coils will draw around 2A. If there is no current draw it likely indicates the field coils or connections to the case are compromised. Check the connections between the field coils and also the field coil ground connection to the case.

A loose generator output post can indicate a short or a bad connection. Over the Model A production period, the field coil circuit was grounded 3 different ways. By a ring around the output terminal, by grounding to a 6x32 screw on the side of the case and being clamped and held captive by a field pole shoe. The ring type is more susceptible to problems as it can have poor contact to the case or be shorted to the generator output post.

Field coils are difficult to remove and replace. The pole shoe screws are extremely tight and removing them cannot simply be done with a screwdriver. Specialty tools such as a screw jack or impact screwdriver is necessary for both disassembly and assembly. If you end up removing the field coils from the case, remember to mark the orientation of the field pole shoes as they have north and south residual magnetism. Steve has a video on how to remove and install pole shoes: *Tool for removing/installing generator and starter pole shoe screws*.

Polarizing a Generator

Polarizing the generator restores the residual magnetism in the field coil shoes. Polarizing the generator is a valid fix if the generator has sat for an extended period, however, if there are problems with the field coil circuit, it likely won't result in a quick fix because current won't be going through the field coil wiring.

Polarizing the generator is effectively the same as the "motor" test above, however, if the fan belt is still on, the current should only be applied for a very short period. Steve has a video on how to polarize a 3-brush generator: *Polarizing a Ford 3-brush positive ground generator*.

Alternators – A quick fix?

Often, a quick fix cited by some people for Model A generator problems is just to install a modern alternator. In our somewhat biased view, it is unnecessary to go this direction. The Model A generator is dependable, relatively easy to maintain and fix. Installing an alternator takes away from the authenticity of the Model A engine compartment look. An alternator requires a higher RPM than a generator to start charging. People generally don't need the plus 60A output amperage an alternator provides unless they are running a fridge, cigarette lighter, flood lights or run Christmas decorations. Alternators, although dependable, are not without their own problems.

The Model A generator can be replaced or fixed for a lot less than purchasing a Model A look alike alternator. For simple repairs, often all that is needed is some basic mechanical and electrical skills, and there is nothing electrical that can harm you! A full rebuild is more challenging as specialty tools and equipment are needed. If you are not inclined to tackle repairing your generator, there are people in the Model A community familiar with generators willing to lend advice and others who can repair or restore it for you.

The biggest plus for an alternator is that it controls the output voltage to the car to preserve battery life, however, there are ways to achieve voltage regulation with the stock Model A generator. More on that in Part 2.

PART 2 – CHECKING A DISASSEMBLED GENERATOR AND VOLTAGE REGULATION

Part 1 of this article examined big picture items involved with a generator and electrical charging circuit. Part 2 will focus on potential problem areas specifically related to the generator and presents the benefits of installing an Electronic Voltage Regulator.

Generator Checking and Fixing

If you have gotten to the point of disassembling the generator to fix or refurbish it, there are a number of things to check:

- **Wire Connections** – make sure all wire connections to the brushes are tight and the wire/terminal connections are soldered and secure. We often see generators where just tightening a screw connection fixes a problem or we find the wire into its terminal is loose or frayed and is weakly conducting.

  Check the integrity of the ground strap/wire on the ground brush to make sure it has continuity and is not partially broken. Electrical tape on the wires will not work – the tape will heat up and fall off over time.

  Wire connections between the field coils may also be a problem as the twisted and soldered connections can be easy broken.

- **Shorts** – ensure no wires touch the case. This includes the connection wire between the field coils touching either the case or the through bolt. The accompanying picture on the right shows the correct way to route the wire with the cardboard insulator.





The generator output post can be shorted to the case caused by generator through bolts contacting the post or the output terminal post not being isolated from the case. Using an ohm meter, check that the output post has no continuity to the case and the proper insulators are being used.

The field coil wire is usually attached to a grounding ring which is held against the case using an insulated washer. Sometimes the grounding ring moves such that it contacts the output post thus shorting the post to the case. If there is any doubt about the condition of the output post assembly, consider purchasing a new Generator Post Kit from one of the Model A parts vendors.

Ensure the field coil ground wire is not touching the generator output post. The field coil ground wire should be against the case in this area. It is fine if the field coil ground wire touches the through bolt but not the generator output post as shown in the image on the left.

- **Brushes not seated properly to the commutator** – this really affects generator performance. Steve has a great video on how to properly seat brushes: *Installing and sanding in generator brushes*. In addition, a brush may be worn such that the spring cannot push it onto the commutator.

  When brushes are replaced, the commutator may need to be machined on a lathe if it is worn or dished. The idea is to remove only enough material to make the commutator surface flat. Many a good armature has been compromised by removing too much material.

  The insulation material between the commutator segments may need to be undercut. This can be done using a thin hobby saw or using a special mica undercutting machine. Please refer to Steve's video *Undercutting mica on a generator armature*.

- **Terminal post wire** – over the years many generators have had the generator output wire replaced with whatever was handy. In some cases, it may be smaller gauge wire than the original. A smaller wire adds resistance and can become overheated. In other cases, the wire may be too stiff which restricts the brush movement and contact with the commutator. Always use flexible (fine strand) 12 gauge wire.
- **Third brush touching the ground brush** – in an effort to maintain low generator output voltages, people often move the third brush to its lowest setting. In some cases, this will put it in contact with the ground brush, resulting in no generator output.

- **Damaged or missing insulators on the output and third brush mounting and spring studs –** The output and field brushes must be insulated from the brush plate. Missing or damaged insulators can ground these brushes resulting in no generator output.
- **Field or output wire rubbing on the armature** – Always look inside the generator after assembly to be sure these wires are not laying against the armature. Anytime the third brush is adjusted, its wire moves. Always be sure it is clear of the armature before use.
- **Lubrication** – Generators rebuilt today almost always use sealed or shielded bearings that require no further lubrication. On 1930-1931 generators with a bushing in the rear plate, very little oil is needed – only a drop or two of 30wt every 1000 miles. The oil felt canister can be unscrewed and the felt in the reservoir oiled directly.
- **Cutout** – electromechanical cutout voltage set too high or too low (see Part 1). Be sure the cutout is properly grounded to the generator case.
- **Generator grounding** – The ground circuit is often overlooked. The Model A generator bolts to a boss on the engine. The generator mounting ears and boss should be clean, bright metal with a very thin film of dielectric grease added to inhibit corrosion.

Model A Generator Voltage Regulation

The output voltage of a Model A generator is not regulated. Typically, the generator will put out 8V to over 9V until the car's electrical load approaches the output setting of the third brush. After that, as load increases, generator output voltage drops.

Ideally the maximum charge voltage for a 6V battery is 7.2 volts. Above 7.2V the battery electrolyte starts to gas off. If the electrolyte drops below the level of the battery plates, the battery life will be compromised. The electrolyte gassing can also cause battery terminal corrosion. On the other end, the minimum 6V battery charge voltage is 6.45V, so if the generator is putting out less than that, the battery is being drained. The challenge is finding the optimum third brush setting to match the car's electrical needs so that the battery is neither being drained nor being overcharged.

Ford engineers knew that the generator could easily overcharge the battery. This is why the Model A owner's manual said to adjust the third brush depending on day or night driving conditions (headlamps on or off). The owner's manual also said to regularly check the battery electrolyte!

Some people think they are resolving the battery overcharge problem with LED bulbs and using the lowest brush setting, however, they often aren't. As the ignition typically draws 2A, the third brush setting can't be set low enough to compensate. Then when headlights are turned on, even with LED headlamps drawing an additional 2A to 3A, the output voltage may drop below what is needed to charge the battery.

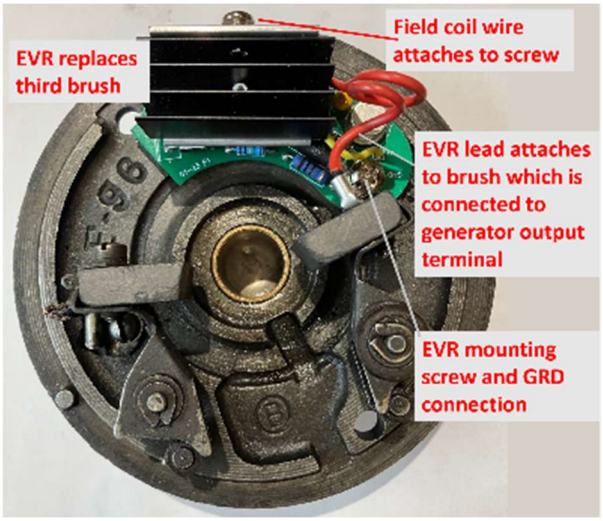
Safety Moment

We always recommend using LED lights - not only for the lower power consumption but mostly for better visibility. The new Focused Beam LED bulbs from Logo Lites provide a proper upper light cutoff line. LED brake and taillights also have a brightness advantage over incandescent bulbs. Additionally, a center mounted LED brake light can be installed for extra visibility.

As electrical loads increased in the mid to late 1930s Ford caught up to other manufactures and introduced voltage regulators. In 1934 Ford introduced the optional 2-charge regulator for use with radio equipped cars. This proved less than ideal. In 1939, Ford began installing what we know today as a modern electromechanical voltage regulator. The electromechanical voltage regulator at the time adjusted the current to the field coils to maintain the generator output below 7.2V. It also restricted the maximum current output of the generator to protect wiring and the battery.

To add voltage regulation to the Model A generator, Tom Wesenberg designed an electronic voltage regulator (EVR) for the Long-style and Powerhouse generators that fit within the generator case. James Petersen also had a similar

circuit design that attached to the cover band. James passed a couple years ago. The Wesenberg EVR, which replaces the third brush, does the same thing as the electromechanical voltage regulator – regulates current to the field coils to limit voltage output to 7.2V. It works up to the maximum output of the stock Model A generator which is around 10 to 12 A. A side benefit of an EVR is that it protects the generator from a potential meltdown if it is disconnected from the car's electrical system (see Part 1). Tom sold his EVRs for over 20 years until he sadly passed in 2022.



EVR Installation on Long-Style Generator

An alternative voltage regulator design for the Model A was to have it incorporated within the cutout housing. This design regulates the output voltage of the generator by shorting the generator output to ground – not by controlling the power to the field coils. Fun Projects sold this type of design for many years until one of the key electrical components became obsolete. There are pros and cons to this approach, however, this design is no longer available.

Mike Hill is now producing the Tom Wesenberg style EVRs for the long-style and 3 and 5 brush powerhouse generators.

Electronic Voltage Regulator Symptoms

Despite inadvertently wiring the EVR the wrong way and performing other mechanical and electrical abuses, the authors have experience few to no problems with the EVR itself. Nearly all "EVR problems" are related to the generator and generally fall into the following areas: loose wiring or connections within the generator, poor brush contact, shorts to ground in the generator case and cutout malfunctions.

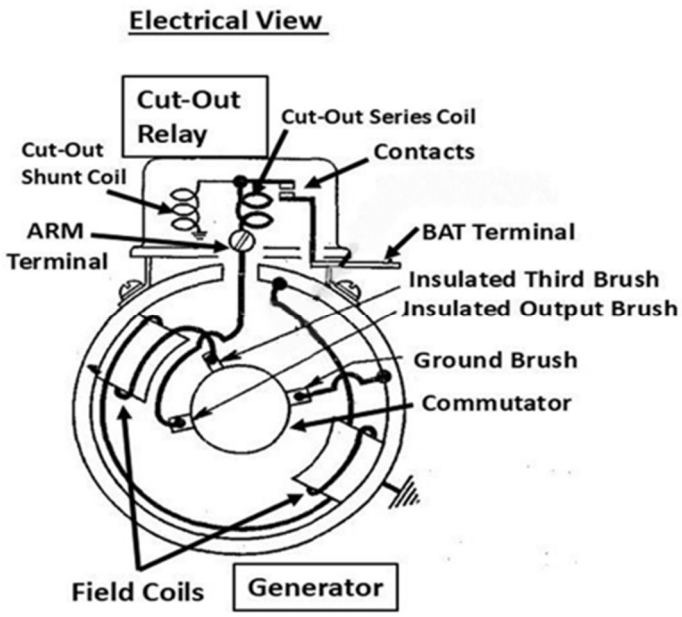
With an EVR and a good battery, at driving engine RPM, the car ammeter will usually show around 5 A right after starting the engine. Within a few minutes the charge should taper back to 1 or 2 A. The output amperage tapers back to almost zero when the battery achieves a charge voltage of 7.1v.

If a Tom Wesenberg style EVR is installed, it often reveals things that would normally not be evident with a third brush-controlled generator. These issues are often not related to the EVR itself.

- **No output** - ensure the wire from the EVR to the field coils is not touching the case when the generator is bolted up.
- **Fluctuating/vibrating Ammeter needle** – it is normal to see the ammeter needle fluctuate at low RPMs as the generator does not have enough RPM to create power. If the needle still fluctuates at driving RPM check the cutout and loose wiring conditions that are usually not related to the EVR.
- **High initial charge rate** – normally after starting the car, the ammeter will read 5 A of charge until the battery is replenished. Thereafter the charge rate will be steady in the 1 to 2 A range. A very high initial charge rate, sustained more than 10 minutes at driving RPM, may indicate a problem with the battery.
- **Damaged EVR** – this is not typical; however, the EVR can be easily tested to see if it is working. Contact Mike Hill for more information.

APPENDIX - Generator Theory (adapted from article by Joseph Marsh)

At some point we may have learned Faraday's Law of Magnetic Induction which essentially says that by moving a wire through a magnetic field, you will induce a current into that wire. That is the basis on how generators and motors work.

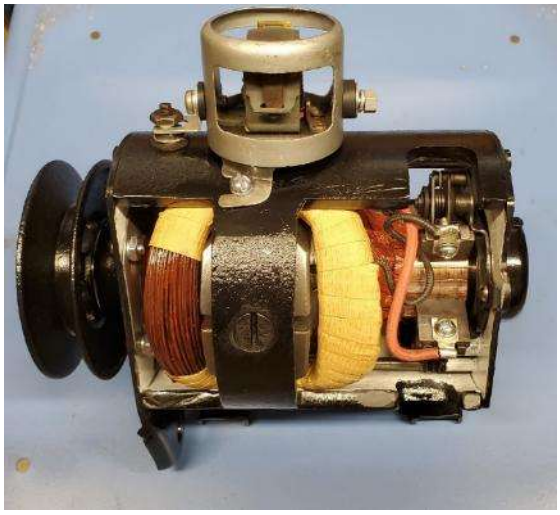


The Model A generator has two key parts. First are the field coils which generate a magnetic field when current flows through them. Remember making that electro-magnet in grade school by wrapping a coil of wire around a nail. That is effectively how the field coils work. They are stationary and located on the outside of the generator case. The field coil wiring encircles the generator pole shoes which are effectively the same as the nail in the example above. Also remember how the nail retained some magnetism – this is the same as the residual magnetism that remains in the field poles.

The second part is the armature which are also coils of wire that rotate or move through that magnetic field that is produced by the field coils. As the armature rotates through the magnetic field produced by the field coils, a current is induced in the coils of the Armature. That current is the generator output current. Connections are made to the armature windings through carbon type brushes rubbing on copper bars called the commutator. One brush goes to ground (case) and the other connects to the output wire.

Model A generators prior to the late 1930s also have a third brush rubbing on the commutator. The purpose of this third brush is to pick up current from the armature and feed it to the field coils to create that magnetic field that the armature coils are passing through. The location of this brush on the commutator governs how much current goes to the field coils. The higher the current, the higher the generator output. The third brush has a special mount and can be rotated closer to the output brush or further away. The closer to the output brush, the stronger the generator output will be because you will be feeding more current to the field coils creating a stronger magnetic field.

When the generator starts, current is initially produced by the residual magnetism in the field poles. This small current then feeds the field coil circuit through the third brush thereby creating a stronger magnetic field in the field poles. This positive feedback loop continues until it becomes limited by the third brush setting and ultimately the electromagnetic field dynamics and saturation.



The generator output can't be directly connected to the battery because if the engine wasn't running the generator would act like a DC motor and drain the battery. To prevent this there is a cut-out relay (electromagnetic switch) external to the generator that is open until the generator is producing a voltage and enough output current to close the cut-out relay and connect the generator to the battery. This cut-out relay is found on top of the generator.