BY LOREN KNUTSEN

TROUBLESHOOTING AND REPAIR OF AUTOMOTIVE GENERATORS

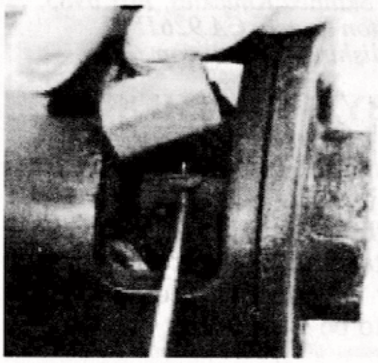
In the first part of this series *(SK* May 2012) the parts of a simple generator were identified so it should be easier to troubleshoot and repair one. Of course the first step is to find out if the problem is within the generator or whether it is some other problem.

Indications that a generator or charging problem exists could be no charge indicated on the dash-ammeter or a dead battery. The first obvious check can be made with a volt/ohm meter while the generator is still installed in the car. Do not rely on the ammeter on the car; that may be the problem because of the output from the generator must pass through that meter. To locate the problem connect the appropriate lead (+ or -) to a good ground and the other lead to the output of the generator before it goes to the cutout or regulator. If that reads the approximate proper voltage, check at the output from the regulator or cutout . If that is correct, then the problem is probably not in the generator.

Assuming the first case shows no or very low, voltage and the generator is a three-brush type, the problem is almost surely the generator, and since this article is about repairing the generator we'll start there. If you are doing a show quality restoration, it will be necessary to perform all of the following operations. If you are simply trying to get the generator working, omit whatever you want, but things left undone will often eventually come back to haunt you. Repair of both two and three brush generators is mostly the same process except for a few small details. In either case one of the first things to check is the condition of the brushes. To do this, be sure to stop the engine, disconnect the battery ground cable, and remove the generator from the engine. Remove the cover band from the case to get access to the brushes, if there is a cover band Otherwise it will be necessary to partially dis-assemble the generator to gain access to the brushes. The first thing to look for is solder splattered on the inside of the cover band or inside the case close to the brushes. If a generator is overworked for any reason the first thing that happens the solder where the armature wires are attached to the commutator bars begins to melt. Any solder bits means the armature will need work or replacement.

The brushes are held in contact with the commutator by spring pressure. Check to be sure that there are no broken springs in the brush holders. If they are okay, check the brushes to see that they aren't so far worn that they are not in constant contact with the commutator.

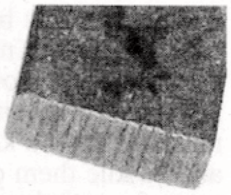
It should be noted that there are two basic types of brush holders used by different manufacturers. One type has a guide for the brush and spring loaded arm with a small roller to apply pressure which holds the brush in contact with the commutator. The other type has the brush attached to a spring loaded arm with a screw holding the brush to the arm. Be sure to get the correct type of brushes for the generator you are working on. Each of the spring brush holders can be lifted with a simple wire hook to



observe the condition, length and angle of the brush without disconnecting the lead wire. Do not use the lead wire from the brush to lift the spring arm as that may pull the lead loose from the brush.

If the brush is worn crooked or is very short, you may have found the problem, and that can be fixed by simply installing new brushes. Generally replacement brushes can be found with some careful shopping. Most generator or starter motor shops will sell you the correct replacement brushes. Note the direction of the angle on the end of the brush, if it is angled and not just worn to an angle. Be sure the new

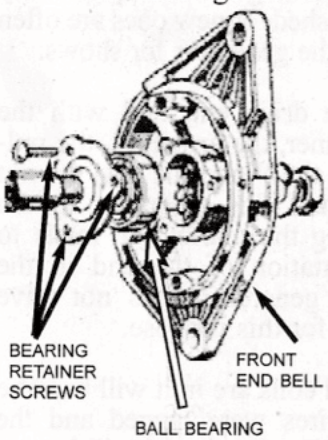
ones are installed in the proper direction to match the commutator surface. Be sure to get generator brushes as they are similar to starter brushes but are made of a different material, and starter brushes will damage the commutator. Generator brushes are mostly carbon, and they are made to run steadily while starter brushes have a high copper content and are made to run only for short periods and then are allowed to cool.

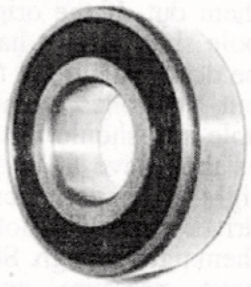


Note the direction of the angle at the edge of the brush.

If new brushes are in order, it is best to remove the generator, if you haven't already done so, as there are several steps that can't be done well while it is still in the car. If it is a two- or three-brush type with a regulator, be sure to tag the wires coming out of it so you can get them reconnected to the correct terminals later. With a non regulated three-brush type there will be only one wire coming out, so a tag is not necessary. At this point, a thorough cleaning of the exterior will save a lot of messy work, but don't attempt to clean the interior as that can't be done well until the end bells are removed and the armature is taken out. Before removing either end bell make some small center-punch marks on the main frame and end bells to orient them correctly during final assembly. (Many generators do have a small locating pin and corresponding hole to provide correct orientation). In removing the brush end bell you will have to disconnect some wires, so tag these to get them back correctly. Never commit these connections to memory because it's a good probability that almost immediatelyyou will forget where they go.

In most generators the drive end will have a ball bearing to support the armature shaft. The brush end will usually have a bushing except in some Packards and other expensive models. Once you have the end bells removed and the armature out, start with the drive pulley. Remove it, and save the key, lock washer and nut. Next remove the bearing retainer, usually held in with three screws. This will permit you to slip the armature with its bearing out of the end bell. If the commutator shows signs of wear or any burned commutator bars, it's probably time to have a specialty shop check it out and do any repairs that are needed. They can use a growler (see sidebar) to check for shorts or broken connections within the armature coils, and either replace the armature, have it rewound, or re-solder any solder joints where the coils have become un-soldered from the commutator bars. Be sure to take the information from the nameplate on the generator with it as there are many different armatures that all look similar. You want to get the correct one, if it's a replacement. Generally the ball bearing will be of the open type. I would recommend replacing it with a more modern sealed bearing to eliminate the need for oiling the open type. Some bearings are sealed with rubber seals and some only have metal shields. Get the rubber-sealed type. A good bearing supply source can provide a substitute bearing and preferably a U.S. made bearing as some imports have been troublesome.



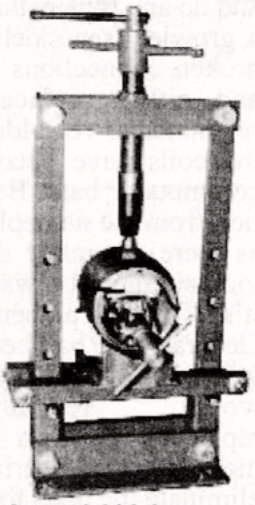


A sealed bearing does not require further lubrication.

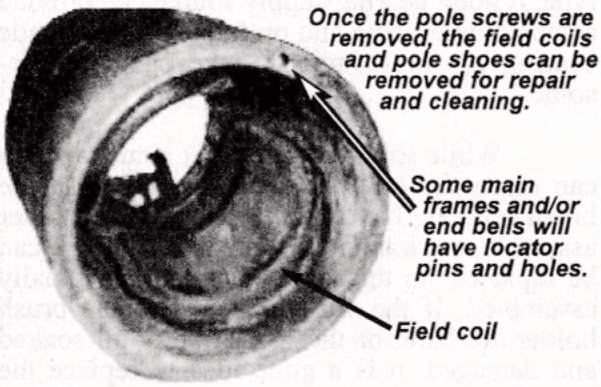
While the shop has your armature you can clean the brush end parts along with the brush holders. If you remove the brush holder assembly, mark it and the end bell so that it can be replaced in the same position as originally assembled. If the wires attached to the brush holder are bare, or the insulation is oil soaked and damaged, it is a good idea to replace the wires with new wire and terminals. Be sure to replace each one with the same gauge and length as the old ones. The brush guides should be cleaned and the brushes should fit close but freely when the assembly is replaced in the end bell. If the bushing is loose on the shaft or worn, it should be replaced with a new one, usually available at an auto parts store, hardware store or your bearing supplier.

Next, clean the inside of the case (main frame) with Stoddard solvent or kerosene. Never use paint thinner or MEK or any other solvents as these may damage the enamel insulation on the field coils. Once all the old grease

and grime is removed, check the insulation wrapping on the coils for holes or wear that exposes the coil windings. If there is damage to that insulation, it will be best to remove the pole shoes and the field coils to replace the damaged insulation. Removing the pole shoes is not easy. Sometimes the pole shoe screws are rusted in place and have to be drilled out. In any case, it will take some amount of force to remove those screws, and again, the shop that is servicing your armature will be best equipped to take them out. If the original pole shoe screws had to be destroyed to get them out, new ones are available and should be used as they have to be very tight. Damaged screwdriver slots will not get them tight enough. Shops have pressure screwdrivers to remove and tighten pole shoe screws.



A special high-torque screwdriver is required to remove and reinstall the pole screws.



Once the screws are removed the pole shoes and the coils will come out easily. Make a drawing or sketch to show where the coil terminations were located. The coils will be connected in series, and generally the same wire the coils are wound with will be soldered to each other. This wire is single stranded and will not tolerate much bending before it breaks. If you are lucky, a new field coil set can be purchased ready to install. If that is not the case, the original coils are probably good but will need to be stripped of the cloth tape insulation and rewrapped with new tape. I always use a ½" wide fiberglass tape with an adhesive side, and this is available from industrial supply sources or from 3M dealers. It's best to unsolder the coils from each other after numbering them and making a drawing of the coils showing how they are connected. When removing the old insulation use masking tape to keep the coils from unwinding, and handle them carefully to avoid moving any turns from their original position.

Clean the coils of any oil and dirt with solvent, and let them dry. Wrapping the new insulation is easier this way. There is less chance of breaking the wire, and it is possible to use heat shrink insulation sleeving on the ends after re-soldering them together to keep them from shorting to the case. The end terminations can be made using new stranded wire and terminals, but here again, use the same lead length as the original leads and the same gauge wire. It is best to use soldered terminals rather than crimped type although the crimped type can be soldered after removing the plastic sleeve. Remember to put the heat shrink sleeve over the wire before soldering the terminal on as it will not go over the terminal ring.

After the coils are removed, the case can be cleaned, and even bead blasted for a new paint job. Be sure to get any rust and dirt out so the pole shoes can make good contact with the case walls as this is the magnetic path that makes it all work. One good reason to remove the shoes and coils is to remove the rust that accumulates between the shoes and the case. It's a good idea to put a light coat of paint on the inside of the case to prevent future rust, but it must be a very thin coat. When painting the exterior of the case be sure that the ends where the end bells are attached are free of any paint so that a good electrical ground is made. Now is the time to repaint the end bells, but mask off the areas where they contact the main frame. If you are doing a show quality restoration, the original nameplate may be removed and refinished, or new ones are often available to dress up the generator for shows.

Assemble the drive end bell with the bearing, bearing retainer, the armature, the pulley and any washers, the Woodruff key, the nut and lockwasher. Install this assembly in the main frame observing the marks you made to get the proper orientation of the end in the frame in case your generator does not have guide pins and holes for this purpose.

Once the field coils are in it will become apparent why the wires were tagged and the sketches were made. The brush end will have a

small oil cup on it, and there will be a round felt oiler wick leading to the bushing. If the wick is hard and very dirty, new wick is available, and this should be done. One of the leads from the field coils will go to one of the brushes. In a three brush generator without a regulator this lead will go to the movable third brush. Next cut a narrow strip of wet-or-dry 150 grit sandpaper (NEVER USE EMORY CLOTH) just the width of the commutator and long enough to go around the commutator about 1 ½ times. Use a small piece of masking tape to attach the strip of sandpaper to the commutator with the abrasive side out. Insert the brushes in the appropriate holders. To do this use a wire hook to retract the brush spring arms, and insert the brush in the appropriate holder. The movable third brush will normally be half as thick as the others. The sandpaper will sand the brush ends to match the curvature of the commutator bars to insure they have total contact and will carry the current necessary to keep your battery up to full charge. Once the brushes are installed rotate the armature in the direction that will tend to tighten the sandpaper strip enough to sand the brush ends for total contact.. Use the wire hook to remove a brush to see if it is totally contoured or just partially. Then reinstall the brush, and keep turning the shaft until all the brushes are fully seated. Blow out the sanding dust, and remove the sandpaper and tape.

Connect all the wires and terminals like your sketches show. If you have done all of this correctly, the generator will work well for as long as would a new one. You will have saved a few dollars to say the least, and you will have a better job than most shops would have done. A few words of caution here. When you re-assemble the end bells and through bolts be sure that the field coil or brush wires are not tangled or pinched by the bolts. I always use a length of heat shrink over the through bolts to insulate them. Make sure the third brush wire is free to move with the brush to set the voltage. Always use new lockwashers in place of the old ones.

When you install the generator it must be polarized according to the manufacturer's instructions before you start the engine. As soon as it is running, the voltage of 7.4 volts should be set by positioning the third brush. With regulated generators of the two brush type polarization is all that is required.

Regulators and cutouts are a subject all by themselves, and we'll get into those in a later article. If you have no reason to believe the regulator or cutout is defective, just reconnect it as it was. If you suspect those items are not reliable, it's best to replace them. If you have a shop that can do a bench test on your finished project, it's a good idea to do that. If that is unavailable, install the generator, connect it correctly, polarize it and give it a try. Set the third brush, check your ammeter and you are finished with a completely rebuilt generator.

S.K.

WHAT IS A GROWLER?

A growler is a bench mounted test instrument that is used to test and troubleshoot armatures in generators, motors and starters. It consists of a laminated iron core shaped to support an armature for testing, an ammeter with a dual test probe to detect output and a pilot light and lead wires to test for continuity. At the base of the core there is a coil that, when energized with 120 volt, 60 Hz causes the core to become an AC electromagnet. This magnetism changes polarity 60 times a second. This changing energy causes the armature to react much as it does in a working generator where it rotates in the magnetic field established by the field coils and pole shoes.

With the power on and the armature in place it is possible to detect defective coils by placing a thin magnetic metal, such as a hacksaw blade, parallel to the armature shaft and spanning the separations where the armature coils are buried. If there are open or shorted coils, the blade will vibrate strongly and will make a growling noise thus detecting the problem coil and giving the device its name. The armature is rotated by hand during this test while the test strip is moved to cover each coil slot in the armature core.

In practice the growler will cause the armature to produce current which is detectable by probing the commutator bars with the dual leads from the growler and observing the ammeter on the growler. If there are any open or shorted coils or unsoldered commutator bars this test will show that as there will be little or no current shown on the ammeter.