

“How Generators & Regulators Work”

Once you understand the basics of how a battery works and how it is constructed, we can move on to the generator, which is the second most important parts of the electrical system.

To sound bona fide, I might as well give you the official job description of the generator. It is “a machine that converts mechanical energy, supplied by the engine, into electrical energy used for either recharging the battery or supplying power to the electrical system.”

While the description seems a little confusing, if you follow along a little further we will make sense out of it all. Come on, it'll be better than you think.

THE WORK SCHEDULE FOR THE GENERATOR FAMILY

When the engine speed is at idle or at low rpm, the generator has little or no output, and the battery provides all the electrical energy needed for the electrical system.

When vehicle speed reaches about 20 mph or engine rpm reaches about 1200, the generator will begin to charge. The output will help the battery with some of the electrical load. (This speed is known as the generator “cut-in” speed.)

At higher engine rpm of about 1800, the generator is capable of providing all of the electrical current needed to run the accessories, as well as recharge the battery as needed.

Generators will usually provide their maximum output at about 1800 to 2300 rpm engine speed. Normally the pulley diameter of a generator is designed so the engine will spin the generator at, or close to, its ideal rpm, (the rpm at which the generator operates most efficiently.) This rpm is matched to the rpm at which the engine will spend most of its time.

IN MOST OLDER CAR APPLICATIONS, THE GENERATOR ARMATURE TURNS ABOUT TWICE FOR EVERY RPM THE ENGINE TURNS.

When a generator spins at high speeds (above 3500 rpm engine speed) the output of the generator will actually drop off quite a bit, as the brushes are lifted off of the armature by centrifugal force. If heavier brush springs were used (a great idea), it would cause excessive brush wear at the slow speeds.

An interesting note: Did you ever wonder why over the road trucks get such long life out of their generator brushes as compared to a car? Here are the reasons. One is the constant rpm that make it easy to match the correct engine to generator speed.

The other factor is called air gap. This is when the brushes lift off of the commutator just slightly due to the centrifugal force. The brushes will then experience minimum wear because the brushes are not physically touching the commutator and the loss in output will be slight.

Cars driven in town will wear out generator brushes at a much faster rate than those that spend their life traveling up and down the highway. The same principle applies.

WHILE WE ARE ON THE SUBJECT OF BRUSHES...BUICK CARS OF THE LATE 1940's AND EARLY 1950's HAD AN INTERESTING SAFETY FEATURE.

They had what they called a “brush protected generator.” The “field” wire of the charging system was routed through the ignition system. When the brushes in the generator got too “short” from wear, the field wire would “ground out” the ignition and the car would not start.

While this was a good idea in theory, it left a lot of early-day Buick owners stranded without warning (and very unhappy). The servicemen of the day carried a jumper wire in the tow truck. If this was the problem (a simple check), they used the jumper wire to bypass the generator to ignition circuit. If the car started, they simply drove it back to the dealership and installed new brushes in the generator. And the customer was happily on his way.

HEY, HOW COME THERE ARE SO MANY DIFFERENT SIZE PULLEYS USED ON THE SAME STYLE OF GENERATOR?

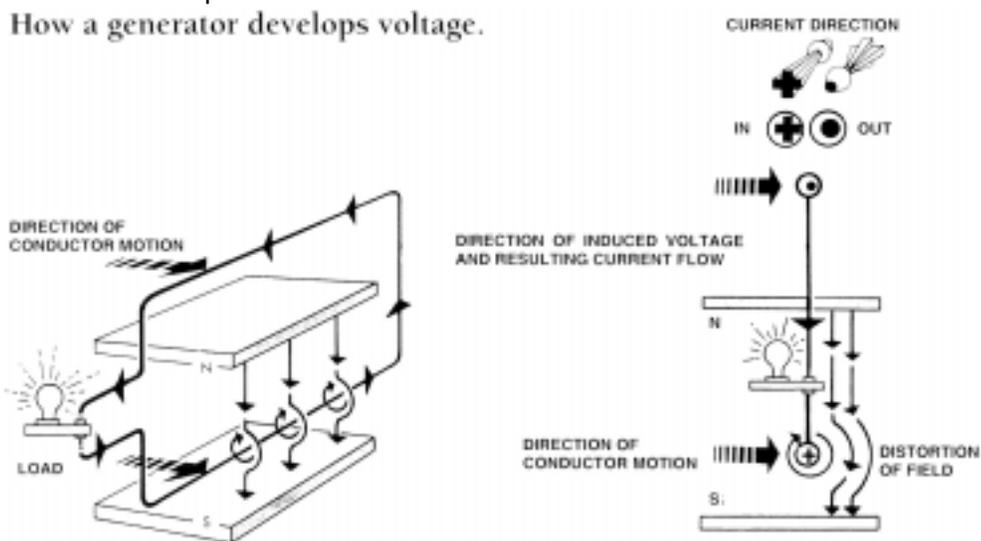
As we learned earlier, the pulley size is matched to the rpm at which the engine will spend most of its time running. In-town delivery trucks had a small diameter pulley so the armature turned faster at the low engine rpm, increasing the output at the slow speeds.

MAKING ELECTRICITY

All generators “make” electricity in much the same way. Let’s take a look and see what parts make up a generator and what job each of those parts has to perform. As I have done before, I will give you the official description of what a generator does, then explain things in common English.

Generator operation is based on the principle of electromagnetic induction. This means that voltage is generated when any conductor is moved at right angles through a magnetic field. When voltage is produced in this manner, it will cause the current to flow in the conductor if that conductor is a complete circuit. Whew! Got all that? Now let’s explain that in common sense terms, starting with the internal parts.

ARMATURE - An armature starts out as a bare hardened steel shaft. To this shaft is added a series or group of non-insulated copper wires wound close together. They in turn will form what is called a loop.



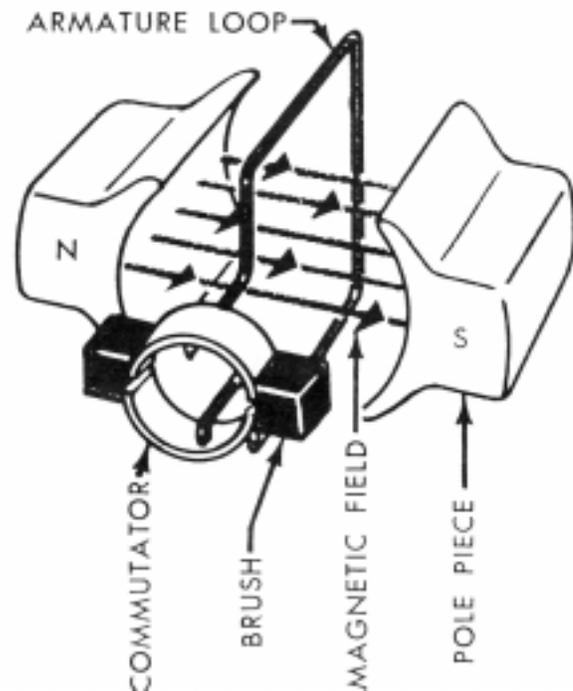
The loops of wire are then embedded in a series of slots in an iron core. This iron core is

then attached to the armature shaft. This shaft spins and helps to generate the electrical current. As you might guess, the size of the wire and the number of wires in the loop will affect the output of the generator.

COMMUTATOR - The commutator is a series of segments or bars that are also attached to the armature shaft at the rear of the armature. It is the wire ends from the loops of the armature windings in the iron core that are attached to the commutator. When this is done, a complete circuit is formed.

FIELD COILS - Field coils are the windings or the group of wires that are wrapped around the pole magnet. It is the job of the field coils to take the current drawn to the pole magnet, and make it stronger. (Field coils are the windings that are attached to the inside of the generator housing.) This increased strength in current will force even more current to be drawn to the pole magnets, which will continue to build up current.

This is how the current produced by the generator is built up and increased, until it can be used by the battery and the accessories.



The ends of the armature loop are securely attached to a split ring called a commutator.

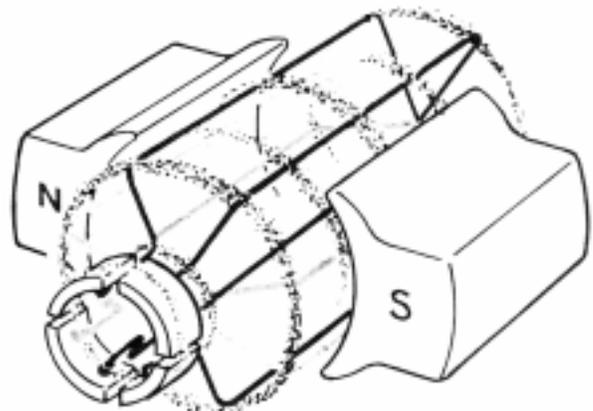
BRUSHES - After the generator develops the current, it is the brushes that carry the current to the “field” circuit and the “load” circuit, so the electricity can be used by the battery and the accessories. This process is called “commutation.” The brushes will ride on the commutator segments of the armature. Brush holders hold the brushes in position by way of spring tension.

Most automotive generators will contain two brushes, one that is grounded to the frame of the generator, one that will be insulated from the frame.

The insulated brush is the positive brush and is connected to the “A” terminal of the generator, and to one end of the field coils. The other end of the field coil is connected to the insulated “F” terminal of the generator.

BEARINGS AND BUSHINGS - At either end of a generator you will find a bushing or a bearing. They have the job of making the armature shaft run true in the housing between the field coils and pole shoes.

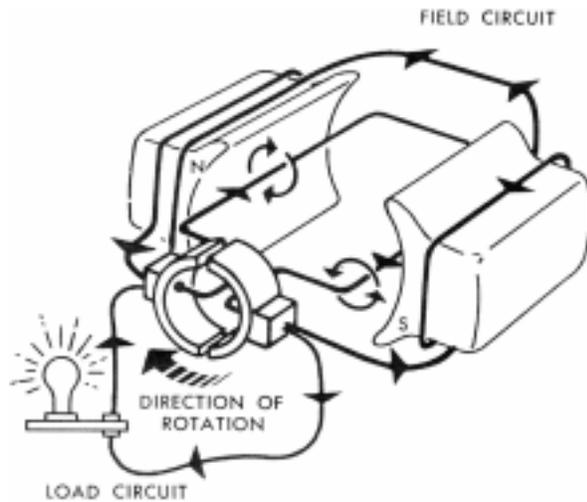
Bushings will be made of copper or brass and are soaked in oil before they are installed. The brass or copper bushing material is porous and able to absorb the oil like a



sponge. This provides the lubrication between the shaft and the bushing. They can also be re-oiled from the oiling tube on the outside of the generator.

Some heavy-duty generators will use ball bearings instead of bushings for the armature shaft to ride . This is done to support a radiator fan or other accessory.

BUILDING A WORKING GENERATOR



An assembled generator will look something like this: The electrical rule that applies to a generator states that “electrical voltage will be generated when any conductor is moved at right angles through a magnetic field.”

To demonstrate this theory to yourself take a simple horseshoe magnet and stand it on its side. (It will have a north pole and a south pole, just like in your generator.)

Now take a piece of plain copper wire and move it back and forth between the poles of the magnet. You will be breaking the magnetic field, which will produce a magnetic current inside of your wire. This is exactly

what the armature does to the field coils.

When current is produced this way, it will cause current to flow in the conductor if it is a complete circuit. (Remember the armature with the loops of wire embedded in the slots of an iron core? Didn't the ends go down and connect to the commutator to form a complete circuit?) Okay, so you're lost...

First let's look at a simple generator with an armature that has only one turn or loop of wire and two pole pieces. These pole pieces (actually magnets) will always have some “magnetism” left over from the last job they did.

However, these magnets are weak because of the magnetic field between them. (Remember these two magnets are exactly opposite of each other. That is the cause of the weak current. They will tend to cancel out each other.)

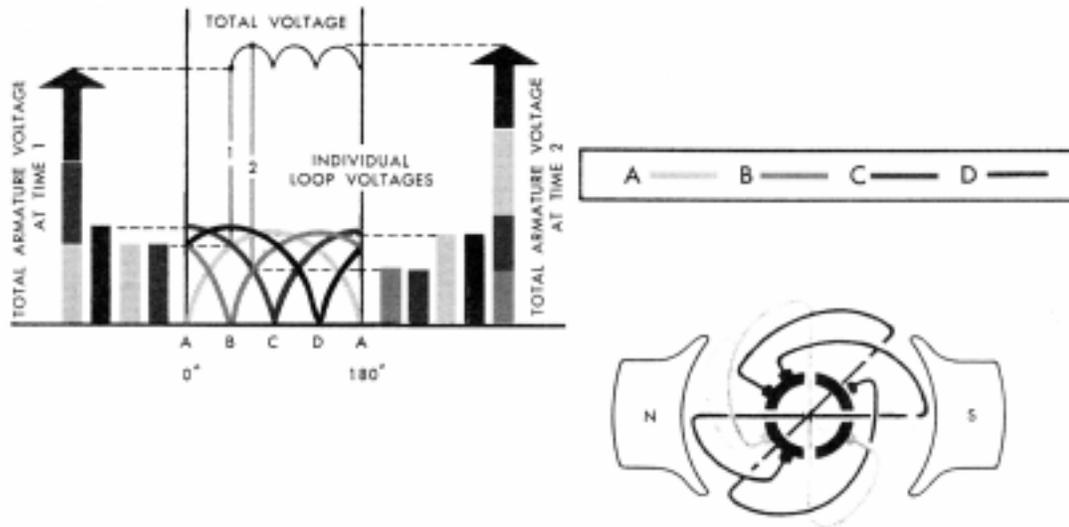
If we place the armature between these two magnets and then spin it in a clockwise direction, a weak voltage will be “generated.” Remember, the rule of generators says that any current generated will flow to the conductor if it is a complete circuit. Because the armature is a complete circuit, the current will flow to the armature and then to the field coils where the voltage will be increased.

The rotating armature cutting through the current produced by the field coils forces even more current through the field coils that makes still more stronger voltage. This is how the voltage generated by the loops is increased into voltage that can be used by the battery and the accessories.

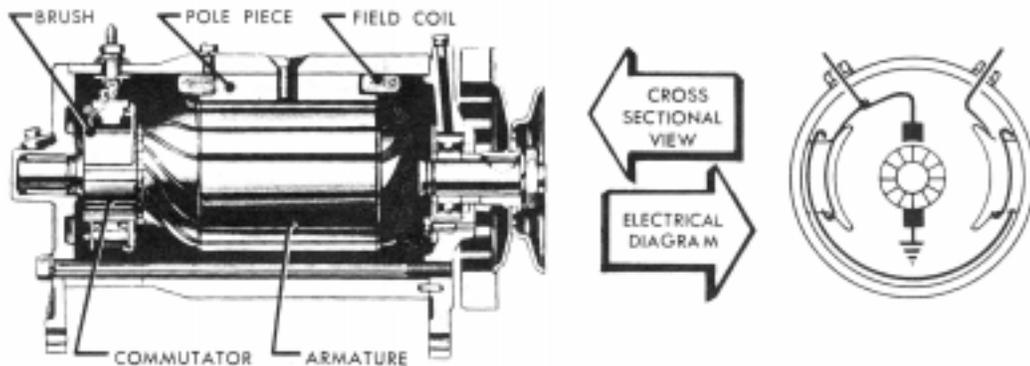
Now, if we were to add a real armature to our generator with additional loops of wires imbedded in an iron core and connected to the commutator, what is going to happen? That's right. Any voltage generated by any one loop will be added to the voltage developed by any of the other loops. By having multiple loops, an almost constant supply of voltage is developed, finally!

As you might guess, the strength of the magnetic field, the number of conductors on

the armature, and the speed at which the armature is turned will affect the output of the generator. Just like the internal parts of a battery, all of these things are matched to the application.



OK, SO OUR GENERATOR IS CHARGING. WHAT HAPPENS IF WE SPIN THE ARMATURE REALLY FAST TO PROVIDE A HIGH OUTPUT FOR A HEAVY ELECTRICAL LOAD?



Right. Things are going to get hot, in part because of the resistance or electrical friction and in part due to the mechanical friction. What will happen to our generator then?

The high heat can melt the “varnish” and damage the insulation used to hold the loops or conductors in the armature slots. Also, the soldered connections of the armature coils and the commutator bars will melt from the heat. When this happens, it is commonly called “throwing the solder” out of the generator. Besides losing all of the solder, the bars of the commutator separate from the shaft that holds everything together; in simple terms, everything just flies apart, and the generator is ruined.

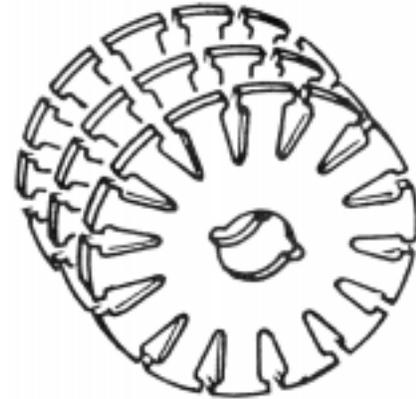
To prevent this damage, a current regulator is necessary. Just as it sounds, a current regulator limits the amount of current the generator is allowed to produce for both the electrical demand of the accessories, and the safe limit of current the generator can produce without damage to the generator itself.

Another source of internal heat that has to be dealt with is called “iron loss.” The iron core of the armature will act as a large electrical conductor, and will “cut” magnetic

“lines” of energy as the armature spins. As a result, the armature core itself will generate unwanted current. The current developed by the core of the armature is mixed with the current developed by the regular conductors of the armature.

This creates excess heat inside of the generator that is not wanted. To overcome this problem, the iron core of an armature is made up of thin sections of steel material that is laminated together. By doing this the lamination or varnish will act as an insulator and help to prevent the flow of core current to the regular conductor of the armature.

Last on our parts list is the fan. It is mounted behind the pulley and has the job of keeping the generator cool. In some heavy-duty applications, the fan gets a little help from the engine intake where some of the air intake from the engine is used to cool the generator.



To overcome the problem of excess heat, the iron core of an armature is composed of thin sections of steel material that is laminated together.

WE NOW KNOW THE PARTS OF A GENERATOR AND WHAT EACH PART DOES. WE ALSO KNOW ABOUT PULLEY SIZE AND COOLING THE GENERATOR. NEXT ON OUR LIST ARE “REGULATOR.”

TIME-SAVING TIP: Before we go on, here’s a quick reminder to check the wiring between the regulator and the generator. While this sounds like no-brainer, you would be surprised how many times the wiring gets switched by accident. So as a simple review, and in order for everything to work properly, things should be connected as follow.

- 1 The positive wire from the generator will be connected from a post on the generator (marked either “B” for battery or “A” for armature) and should be connected to the (armature) terminal of the regulator.
- 2 The field terminal of the generator should connect to the field terminal of the regulator.
- 3 And finally, the wire that travels down from the amp gauge in the dash to the regulator should connect to the “BATT” terminal of the regulator.

Did you know...The amp gauge only tells you what is going into or what is being drawn out of the battery? It is not connected directly to the generator to tell you if the generator is actually charging or not charging as commonly believed. (This idea comes from the belief that the generator has to be working if the gauge shows a charge.)

Volt meters are also sometimes used instead of an ammeter in the dash of a vehicle to show the condition of the charging system. Volt meters became quite common in the 1960s with the introduction of alternator charging systems.

This was done so no “heavy” current had to be carried up to the dash. By using a volt meter, a much smaller gauge of wire could be used with less danger of electrical fire when a wire shorted out under the dash. With a volt meter, only minimal amps were on hand, as opposed to an amp gauge where all of the generator’s output passed through the gauge.

THERE IS SOME ARGUMENT OVER WHICH GAUGE IS MORE ACCURATE IN READING THE TRUE CONDITION OF AN ELECTRICAL SYSTEM. HERE IS THE DIFFERENCE; YOU CAN THEN DECIDE FOR YOURSELF.

An **amp gauge** will tell you the amount of amps passing into or being drawn out of the battery. The **volt meter**, on the other hand, will tell you the “pressure” behind the amps.

EXAMPLE: If the electrical load is light, and there is not much resistance, in theory a problem can occur with the alternator’s output; however, it will not show up on the voltage gauge because the amp demand is low, so the pressure will remain strong. But when the electrical load increases, then the voltage will drop, exposing the problem. From a safety standpoint, some engineers believe the minimal amps is better.

This problem will occur more often with cars of the 1960s and with alternator charging systems. (We will get into alternators in an upcoming chapter). An alternator can have a blown diode that will take away (in most cases) one-third of the alternator’s charging ability. But if the amp load is light, the voltage will not drop until the amp load increases.

Generator Review:

- 1 The **cut-in speed** of a generator is the rpm that a generator begins to provide an output, typically about 1200 rpm vehicle engine speed or about 20 mph.
- 2 **Generator pulley diameter** is determined by the rpm at which the vehicle engine spends most of its time, and the rpm at which the generator operates most efficiently. In other words, the goal is to spin the generator at the rpm it is most efficient while the vehicle engine is running at the rpm it is most efficient.
- 3 **Throwing the solder** out of a generator means that because of high rpm and excessive heat caused by a high amp load, the solder that holds the segments to the armature has melted. The centrifugal force of the spinning armature has caused the segments to break away from the armature. In short, you have just toasted your generator.

Keeping Track of The Generator’s Output

Now that we understand how a generator manufactures electricity, we need to figure out how to control the output of current from the generator. As we said in the last chapter this is done by the use of a voltage regulator.

Let’s start at the beginning and see how this happens. Inside the voltage regulator is a set of contact points, much like those found in an ignition distributor. To these contact points is connected a wire from the field coils. When the points in the regulator open and close it will start and stop the flow of current to the field coils, battery, and accessories.

NOW THAT WE HAVE A BRIEF UNDERSTANDING OF WHAT THE REGULATOR DOES, LET’S TAKE A FEW MINUTES AND TALK TERMINAL. THE TERMINAL ON A REGULATOR ARE CLEARLY MARKED. BUT SOMETIMES THEY STILL DON’T MAKE SENSE...UNTIL NOW.

TERMINAL TALK:

BATT - This is the battery terminal. This terminal connects the voltage regulator to the amp gauge in the dash, on its way to the battery.

GEN or ARM - This terminal is always connected to the armature post on the generator.

F or FLD - This terminal is always connected to the field post of the generator.

IGN - This is a terminal used mainly before the war (1944). This terminal was used on the early regulators that controlled the voltage of the entire electrical system at the ignition switch. In the old days, it was believed that controlling the voltage at the ignition switch was the best way to furnish an even voltage to the entire electrical system. Later on, the voltage was controlled by the battery terminal of the regulator and this ignition terminal disappeared.

WHAT IF YOU REPLACE ONE OF THESE OLD STYLE REGULATORS WITH THE NEWER STYLE THAT DOES NOT HAVE THE IGNITION TERMINAL?

It will not be necessary to have this terminal and with the replacement regulator you won't use it, but the ignition wire will still be "hot," so you need to fold it back into the original harness and wrap it with black electrical tape in order to insulate the end well to prevent a short. In case someone wants to do a 100 percent restoration in another lifetime, everything else will match up perfectly for them.

Meanwhile, when our original generator begins charging and produces enough current to begin recharging the battery, it will travel up through the regulator to the contact points. Beside the contact points is a shunt coil. A shunt coil is made up of many windings of a fine wire that is shunted (wire connecting two points in an electric circuit that has the ability to turn away part of the circuit) across the generator. The current here is not allowed to reverse.

When the voltage is strong enough, the magnetism developed from this shunt coil will close the contact points and allow the current to pass through the series windings and on to the battery and accessories.

In turn, when the generator slows down or stops, current begins to flow in reverse from the battery to the generator. This reverses the direction that the current travels through the series winding. This will cause the magnetic field in the series windings to reverse. But as we learned earlier, the magnetic current from the shunt coil is not allowed to reverse. So instead of helping each other out, they work against each other. When this happens, the resulting magnetic field is not longer strong enough to overcome the spring tension on the contact points. The points are opened, stopping the flow of current to the field coils.

Just when you thought things couldn't get any more difficult, and we had everything figured out, there is one more factor to consider for regulator control. That is temperature compensation. Because a cold battery is harder to charge than a warm one (due to higher resistance), the regulator must allow for this. To do that, a regulator is built with a bi-metal "thermostatic" hinge. What this means is the material the contact point arm is made of is temperature-sensitive to cause the regulator to regulate to a higher voltage during colder weather in order to charge a cold battery.

CURRENT REGULATION

Besides the voltage being regulated, the current output (amps) of a generator is also regulated by what is called a current regulator. The current regulator is built inside of the voltage regulator and works in much the same way as the voltage regulator.

The main difference you will notice is that located on the inside of the voltage regulator, the current side of the regulator is made up of wire that is thicker (heavier gauge), and there are less turns or wraps of wire on the coil. Remember, the current regulator has to carry all of the amps the generator is producing.

OK, DO THESE REGULATORS WORK TOGETHER OR SEPARATELY?

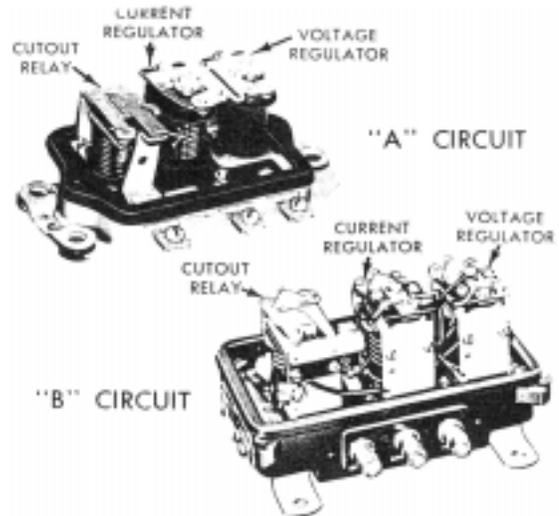
They are unfriendly and will never work together. One or the other will do the work depending on the load. For instance, if the generator is spinning fast, the battery has a good charge, but most of the accessories are turned on, then the voltage regulator is the

one doing the work.

If, on the other hand, the generator is turning slowly, the battery is in need of a charge, and all of the accessories are turned on, it will be the current regulator doing the work.

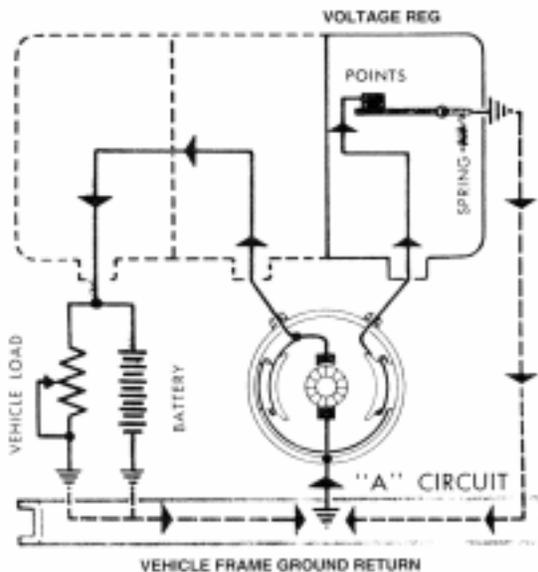
This type of circuit where the regulator is a part of the field circuit is called an "A" circuit. An "A" circuit is easily identified because the contact points are always located after the field coils. This type of circuit is common to the General Motors family of vehicles.

The voltage regulator and current regulator are units in the external circuit used to "sense" either high voltage supplied to the electrical system or high current supplied to the external loads...see diagram at right.



OK, MY SHOP MANUAL SAYS I HAVE A "B" CIRCUIT REGULATOR. HOW IS THAT DIFFERENT FROM AN "A" CIRCUIT REGULATOR?

A "B" circuit regulator works in much the same way that an "A" circuit type regulator does. The only difference is the contact points are located before the field coils instead of after. There is no advantage to either location and they both work equally well. "B" circuit regulators are common to Ford cars and trucks.



CHECKING REGULATOR OUTPUT

"SO DO YOU CHECK AND ADJUST "A" AND "B" CIRCUIT REGULATORS THE SAME WAY?"

No, they are both checked differently. If you have to adjust the regulator at some point in time, it is best to follow the directions in your shop manual. The secret is to know how the regulator works; then reading those directions will make sense.

This illustration shows the various factors involved in voltage regulation and the manner in which it is done.

Check out the following illustrations. A simplified circuit employing both current and voltage regulators is illustrated. The regulator or contact points are located "after" the field coils ("A" circuit). The field current is attached to the insulated brush inside the generator.

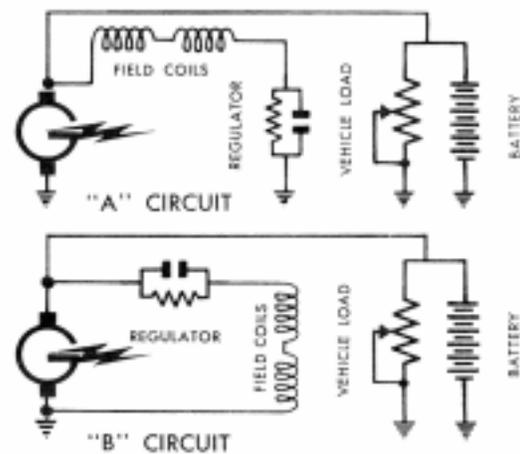
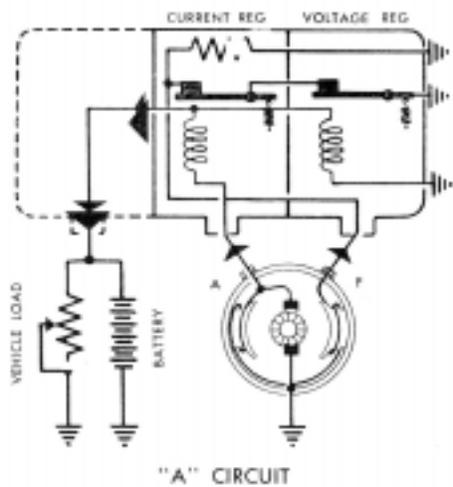
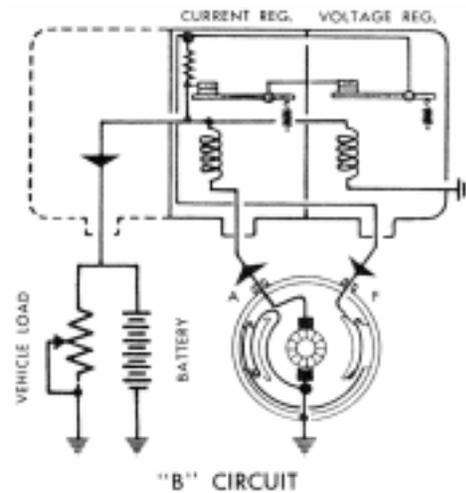
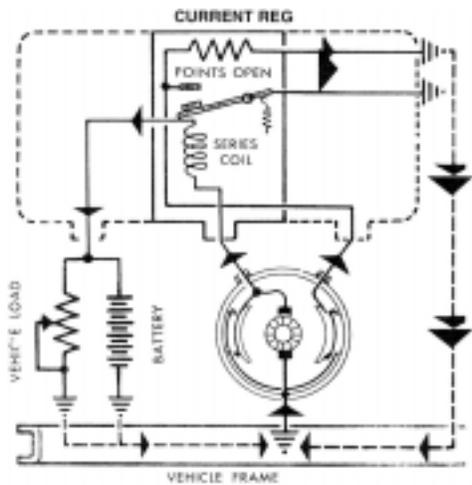
BUT WAIT, THERE IS MORE...

The "A" and "B" circuit are by far the most common types, but not the only types of regulator circuits. There are a few others you may encounter. They include Third Brush, Bucking Field, and Split Field.

**OK, ALL I HAVE IS A GENERAL REPAIR MANUAL,
HOW DO I KNOW IF I HAVE AN "A" CIRCUIT OR A "B" CIRCUIT REGULATOR?**

Simple. All you have to do is check the connections at the brushes and the field. If the generator field coil is connected to the insulated brush at the back of the generator, you have an "A" circuit.

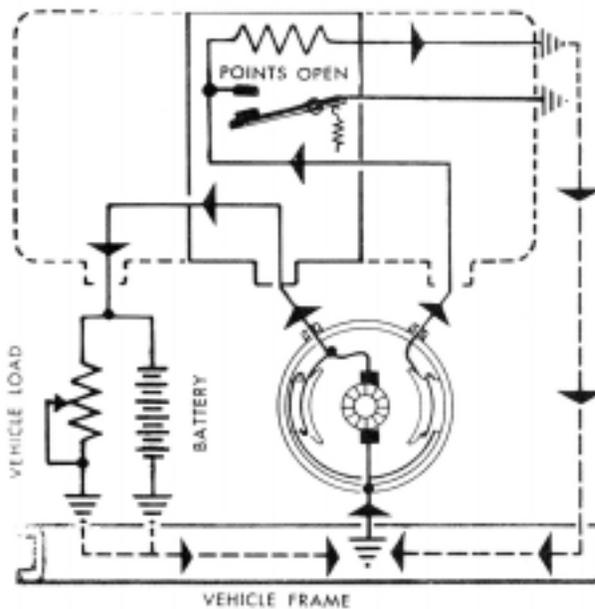
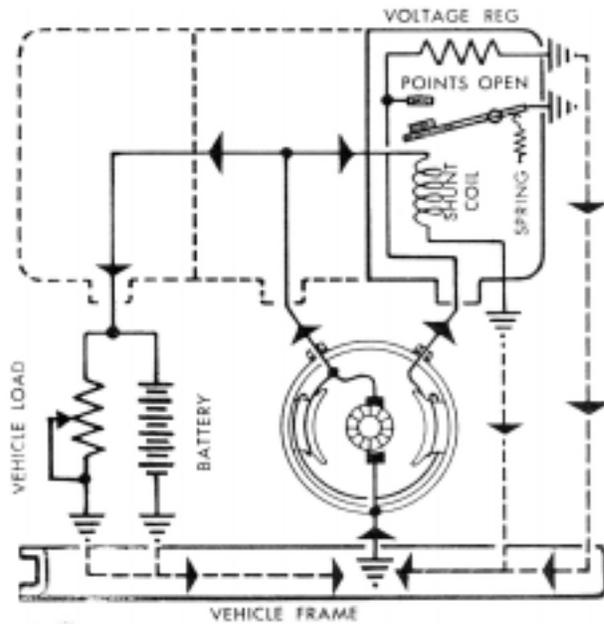
If the generator field coil lead is connected to either the grounded brush (a brush that goes to ground) inside of the generator, or is connected to the inside of the generator frame itself, you have a "B" circuit. From there all you have to do is follow the directions given in the repair manual.



As seen in the diagrams above, a set of contact points is placed in series with the field coil circuit and all field coil current passes through them. If these points were to open, current would not

longer pass through the points, but travel through a resistance to ground and then through the ground conductor back to the ground brush of the generator.

The diagram below show the various factors involved in current regulation and the manner in which this is done.



A BRIEF RUNDOWN OF HOW THESE OTHER CIRCUITS WORK

THIRD BRUSH GENERATORS - This type of generator uses three brushes instead of two. As a way of controlling the generator output, the field circuit is connected so the current sent to the field coil windings is taken off of the commutator by this third brush. The third brush is placed between the two main brushes and is adjustable.

The closer the third brush is to the main brush, the more output the generator will have. And as you have figured out by now, the further away from the main brush the third brush is moved, the less output the generator will have.

This third brush system works similarly to a voltage regulator. When the third brush is moved away from the main brush, the current to the field windings is reduced and the output drops.

Third brush generators were used a lot on farm tractors and cars of the early days. The advantage was that they did not need a voltage regulator. In car, for instance, when you turned on the lights at night, you also “turned up” the third brush in the generator to increase the output.

The bad side was if you forgot to return the third brush to its original setting the next morning, it would overcharge during the day and boil all of the water out of the battery.

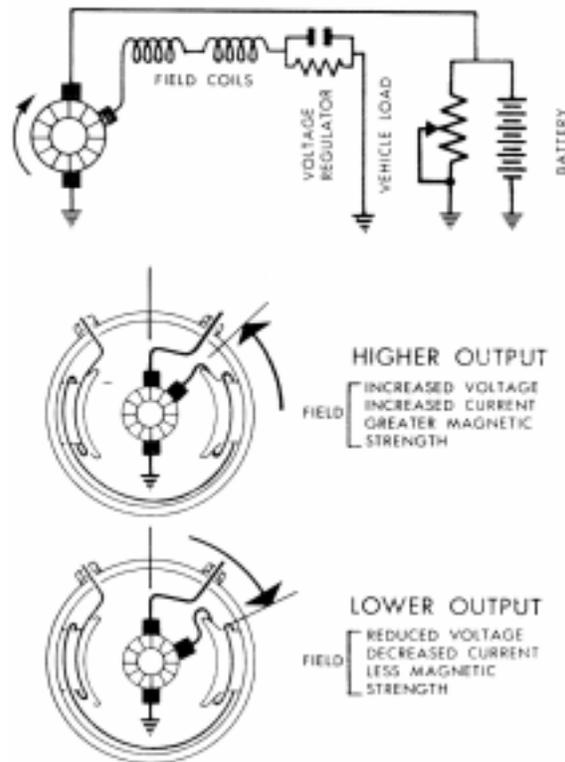
Because most of the early generators were low output of about 20 amps max, this setup worked pretty well. There were not many accessories to run and the electrical load was light.

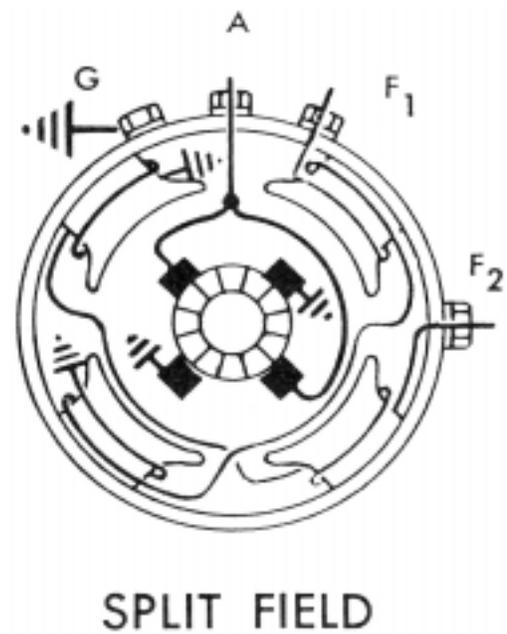
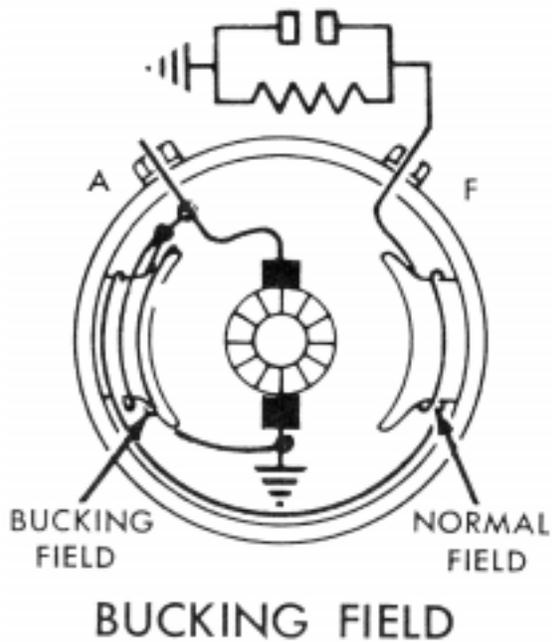
CUTOUTS - These were simple early regulators. The cutout had a set of single contact points and a small shunt coil mounted inside a little metal box that mounted to the top of the generator.

When the battery was low, the points closed and generator current was allowed to pass on to the battery. When the battery became fully charged, the magnetic field developed and opened the points, stopping the flow of current to the battery.

Most of the cutouts were used on cars and trucks of the late 1920s and early 1930s. They were also quite common on farm tractors of that era. Most were used on generators that had a 20 amp output or less.

While they worked okay, cutouts were affected by moisture and vibration. Moisture would cause the points to stick together and cause overcharging. Sometimes vibration would cause the cutout to lose its ground, causing the generator not to charge. On a rare occasion, the points would stick together after they had “arced” a number of times. When the vehicle was turned off and the points would stick together, it would run the battery down in about three to four hours, while also welding the points together.





A bucking field coil is a shunt coil of high resistance that controls voltage on a bucking field generator. A split field generator was designed with an additional field coil circuit.

THE OTHER STYLE OF GENERATOR/REGULATORS INCLUDE:

BUCKING FIELD GENERATORS - Some generators will have additional turns of wire on the armature to enable them to develop voltage at idle and low speed. An example is some of the marine application that are 32-volt systems and require the extra output at the slow speeds, in order to produce 32 volts at the higher rpm. When these generators are operated at high rpm, it is possible for them to produce more than the required voltage. When this happens, the regulator can no longer control the voltage. This means trouble in paradise.

The solution to this problem is what is called a Bucking field Coil. (Pay attention here because this is pretty tricky.) This is a shunt coil regulator just like in a normal regulator except that it has high resistance. It is also connected to one of the pole pieces of the generator that in turn is connected “directly across the brushes of the armature.”

The trick here is that the shunt coil is wound backwards and has the opposite effect of a normal shunt coil. At low speeds, the magnetic field of this shunt coil is small compared to the normal output. But at high speeds, when the output of the generator is high and the resistance is high, the reverse winding will tend to cancel out the extra voltage. Pretty slick, huh?

WHAT ABOUT THE POINTS IN A REGULATOR; DOES IT MATTER HOW MANY AMPS PASSES THROUGH THEM?

So glad you asked. As a matter of fact, it does. Each and every time the points open and close to break the current, a small “arc” of electricity occurs. This arc of electricity will burn off a little of the contact surface each time. The more amperes present, the bigger the arc and more of the contact surface will be lost (just like it does in a set of igni-

tion points).

SO IF THE AMPERAGE THAT PASSES THROUGH THE CONTACT POINTS IS KEPT LOW, THEN THE LIFE OF THE POINTS WILL BE EXTENDED. OK, SO HOW MUCH IS TOO MUCH?

In general, the engineers say 6-volt systems should handle 2 amps as the max for the field circuit. For the 12-volt system, 1.5 amps is the maximum limit. What all of this means is that when the engineers design a charging system, they have to design the regulator first because of the design limits. This will insure that they will have a reliable charging system.

SPLIT FIELD GENERATORS - This is another special application generator. When the engine in a car spends most of its time idling or at low rpm, the generator does not turn fast enough for any current to be produced. Soon the battery will become discharged. So a way was devised to increase the output of a generator at idle and low rpm.

The answer is a split field generator. As you might guess, this generator has two field circuits. The magnetic field is increased by using a second field coil circuit. Generator output can begin at low rpm to keep the battery charged and supply power for the accessories.

This is done by placing a second set of brushes, field coils and pole shoes (magnets) inside of the generator. For all practical purposes, it is like two generators in the same case. Some of the applications that use this style of generator include city buses and home delivery vans.

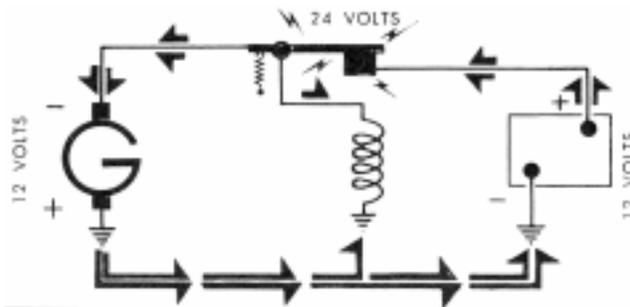
REGULATOR POLARITY - Some regulators are designed for use with negative ground systems, while others are designed to be used with positive ground systems. Using the wrong regulator on an application (which happens fairly often) will cause the regulator points to pit and burn badly, resulting in a short regulator life. Not polarizing a generator can also cause these same problems.

OK, SO HOW CAN I TELL BY LOOKING AT A REGULATOR WHAT POLARITY IT IS?

Normally, when they were new, most regulators were marked. The other way to tell is that positive ground regulators will have copper-colored current and voltage regulator coils, while the negative ground regulators will have cadmium or straw-colored coils.

GENERATOR POLARITY - This is simply the direction the current is flowing between the battery and the charging system. As we learned earlier, the pole pieces in a generator will store up magnetism. When a generator produces voltage, the leftover magnetism will cause the current to flow in the direction it last traveled.

When a generator has been removed for repair, the magnetism is sometimes lost in the pole pieces. So when the generator is reinstalled, it must be "polarized." This means the magnetism must be reinstalled in the pole pieces to insure the current travels to the battery in the right direction.



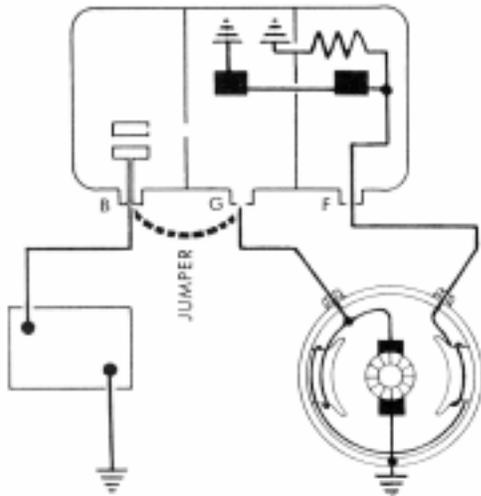
An illustration of what happens when the generator is of the opposite polarity from that of the battery. The plus and minus signs indicate the direction of current flow.

Remember our example in the battery chapter? We said in order to recharge the battery, we had to deliver current to the battery in the opposite way it left the battery. When we polarize a generator, we are matching the flow of current to the battery.

OK, SO IF I FORGET TO POLARIZE MY GENERATOR, WHAT WILL HAPPEN?

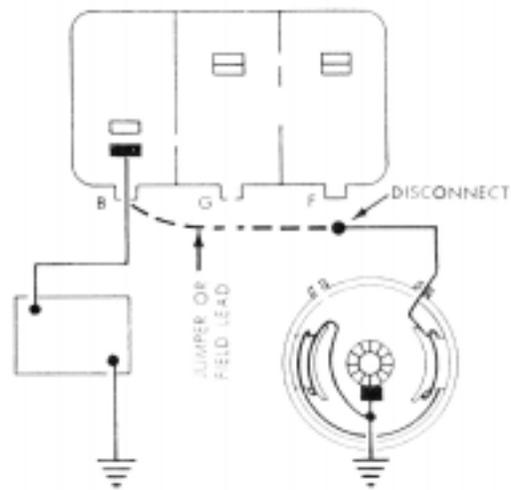
Just as we learned earlier in this chapter, it will cause the points in the voltage regulator to stick and burn. It can also run your battery down, as well as cause serious damage to the generator itself.

HOW DO I POLARIZE MY GENERATOR?



Polarization of "A" circuit generators. Polarization of "B" circuit generators.

To polarize an "A" circuit charging system you can use your jumper



wire. First connect one end to the field terminal of the regulator. Now strike the "BATT" terminal with the other end. Once or twice will do, just until you see a few sparks at the terminal. That's it, you're done! (FYI: General Motors products typically used "A" circuit charging systems.)

To polarize a "B" circuit charging system, disconnect the Field wire from the regulator and strike it on the "BAT" wire of the regulator. DO NOT use your jumper wire to do this; it will burn the points inside of the regulator. Again, only briefly, when you see sparks you are done! (FYI: Ford products typically used "B" circuit regulators.)

TOOL TIME - YOUR TOOLS ARE FINALLY GOING TO WORK

The old reliable 1950 Chevrolet ain't what she used to be. The battery is always dead, and driving home at night you kind of hope for a full moon. Okay, so it is pretty obvious the charging system is not working. You even consider taking the Weber grill out of the trunk.

The question is, what is at fault? You have already checked out the battery so it has to be either the generator or the regulator. How do you check? What if your neighbor isn't home, so you can't borrow his volt meter, can you still find the problem with just a jumper wire, the electrical tool you have? Yes, you can! Here is how.

How to Perform the Full Fielding the Generator Test

- First round up your jumper wire. To check the regulator, start the car with the garage door open, brake set, etc. Turn the idle speed up to about 1000 or 1100 rpm. (This is the speed that your generator will begin to charge, also known as the cut-in speed.)
- Start by checking the ground of the regulator. One end of your jumper wire will connect to the frame of the regulator; the other end to a good ground. If things begin to charge again, you have found your problem--poor ground. (This is quite common.)
- If you still have a no-charge condition, connect one end of your jumper wire to the field terminal of the regulator, and the other end to a good ground (like the intake manifold or the engine block). What you are doing is bypassing the regulator to see if the generator is working.
- Now look at your dash gauge. If the dash gauge shows an increase in the output, the chances are quite good that your regulator is at fault. But if there is no increase in output, the chances are good that your generator is at fault.

To be sure, you can remove the jumper wire ground from the engine block, and strike it against a metal surface. No sparks will confirm that the generator is indeed not working.

This test should take just a few minutes at most, then you will want to remove your jumper wire. The test you have just completed is called **Full Fielding the Generator**. What you just did was allow the generator to charge at its maximum capacity for a brief time, just as if there was not a regulator attached in the circuit, to see if the generator was still working.

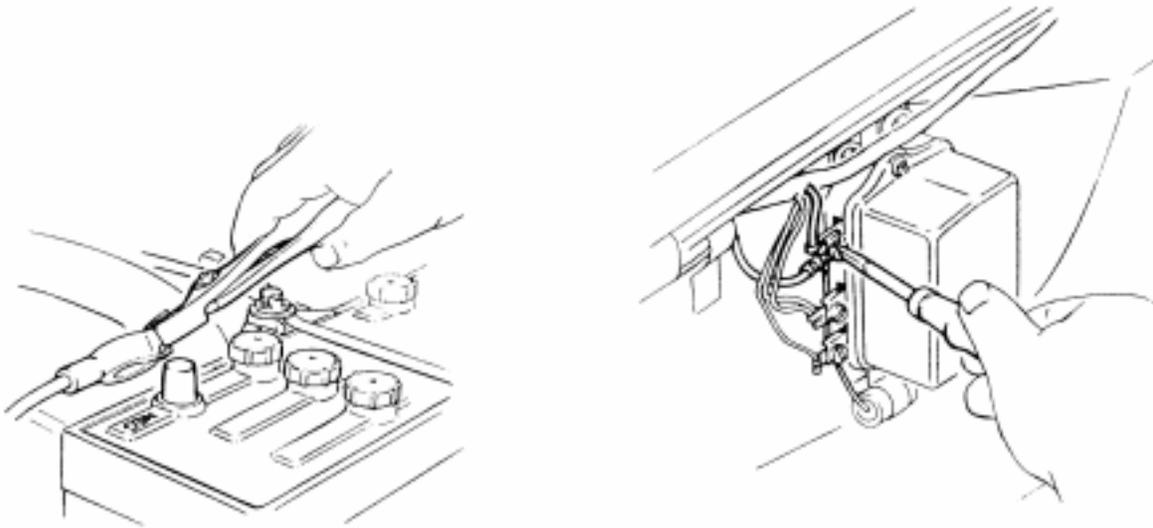
OK, ARE THERE ANY OTHER TESTS I CAN DO TO CHECK OUT THE CHARGING SYSTEM?

You also can hook up your volt meter to the "A" terminal on the generator. With the car running at a fast idle, if you have a low reading of 2-4 volts, and increasing the rpm doesn't increase the voltage, the chances are good you have an open field circuit (broken wire). It could be inside of the generator itself or outside of the generator in the wiring harness or other connections.

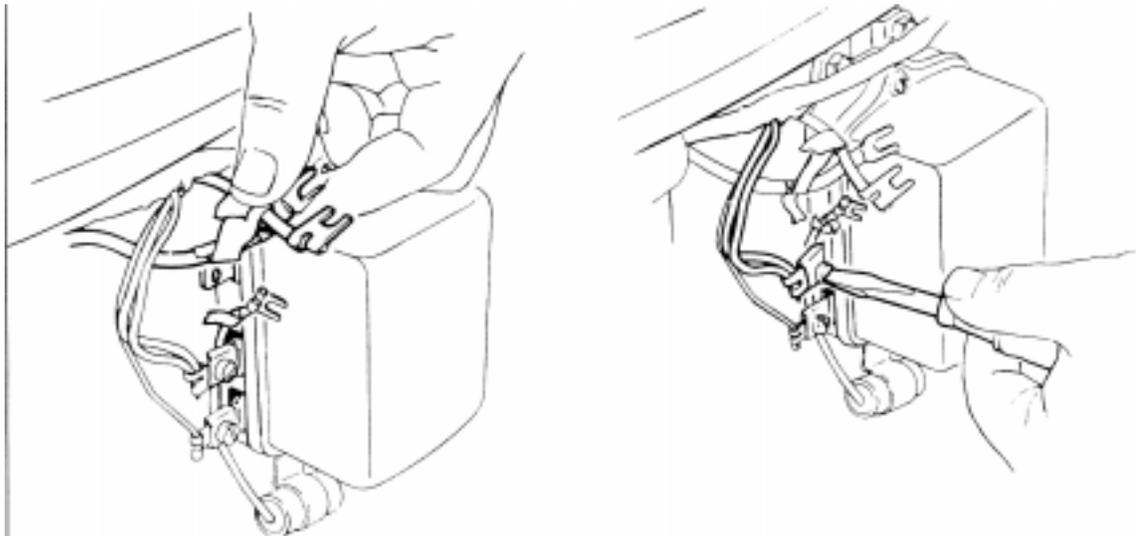
An open circuit in the armature windings will cause severe arcing between the brushes and the commutator. This arcing of the commutator and brushes can be seen at the back of the generator while the generator is working. Another gave away to this condition is that it will take about twice the rpm to get the normal output from your generator.

An armature with a grounded circuit will also have a low output. A grounded armature circuit means that the normally insulated part of the armature is now touching the ground or return side of the winding, causing a short.

Service Tips for Removing and Installing Generator Regulators

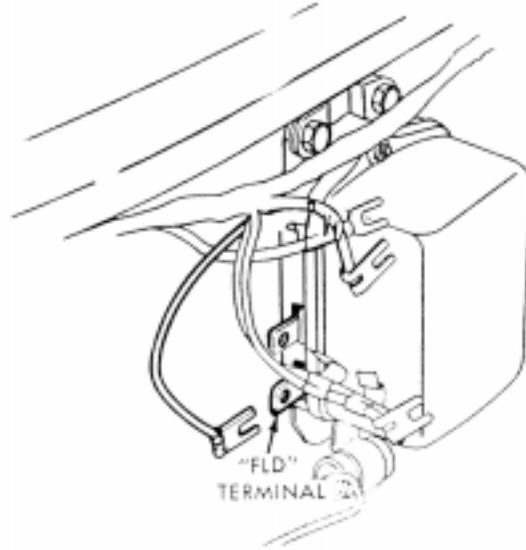
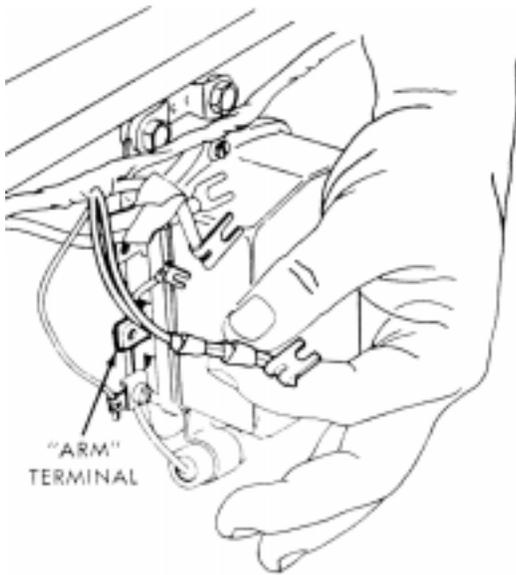


1. When working on regulators, it is always wise to first remove the battery ground strap lead from the battery post. This prevents any short circuits or accidental grounds from occurring.
2. Then remove the lead or leads connected to the battery or "BATT" terminal of the regulator.

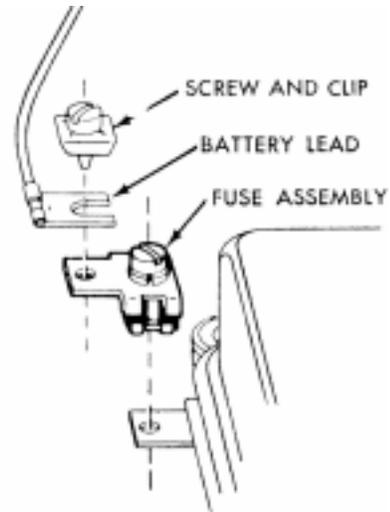
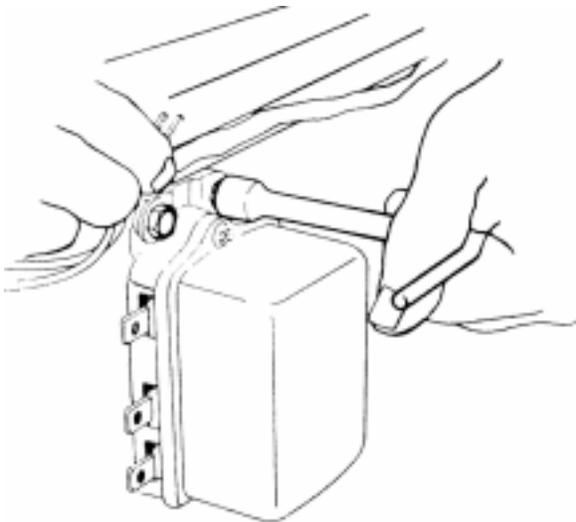


3. To aid in correctly rewiring to the replacement regulator, code the wires in some manner that will aid in proper installation. In this case, one piece of tape has been used to identify those wires that come off the first, or battery, terminal.
4. Then remove the lead or leads connected to the generator, or "ARM" terminal of the regulator.

Service Tips for Removing and Installing Generator Regulators

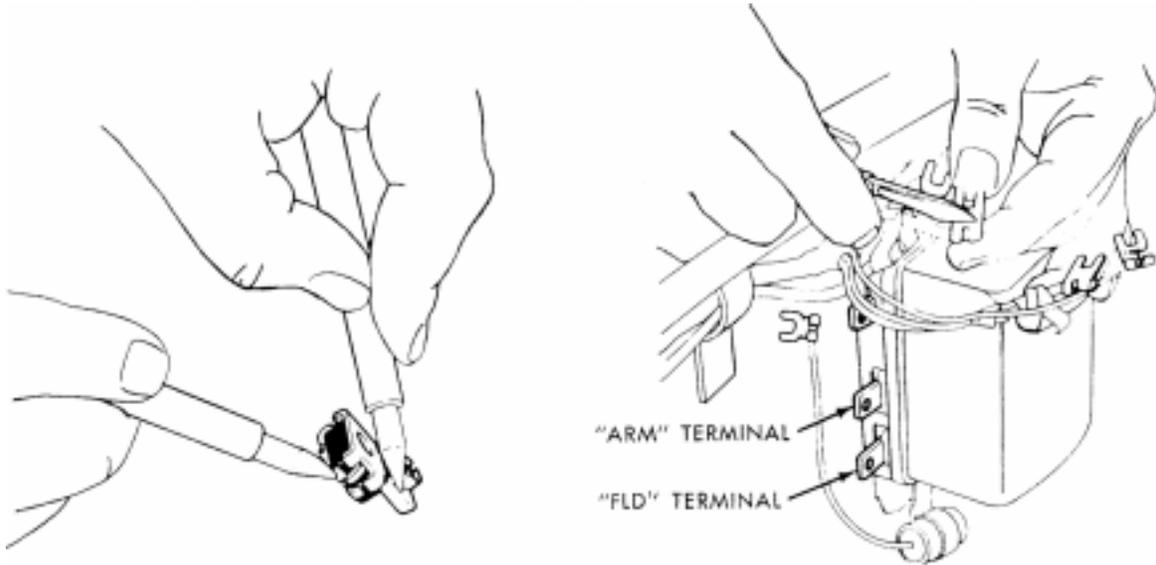


5. Code the lead or leads in some manner to facilitate correctly rewiring the new unit. In this case, two strips of tape have been used to denote those leads removed from the second, or "ARM" terminal.
6. Then remove the lead from the Field or "FLD" terminal of the regulator. Since this is the remaining lead, no coding or tape is necessary. Note that the condenser is never attached to this terminal.



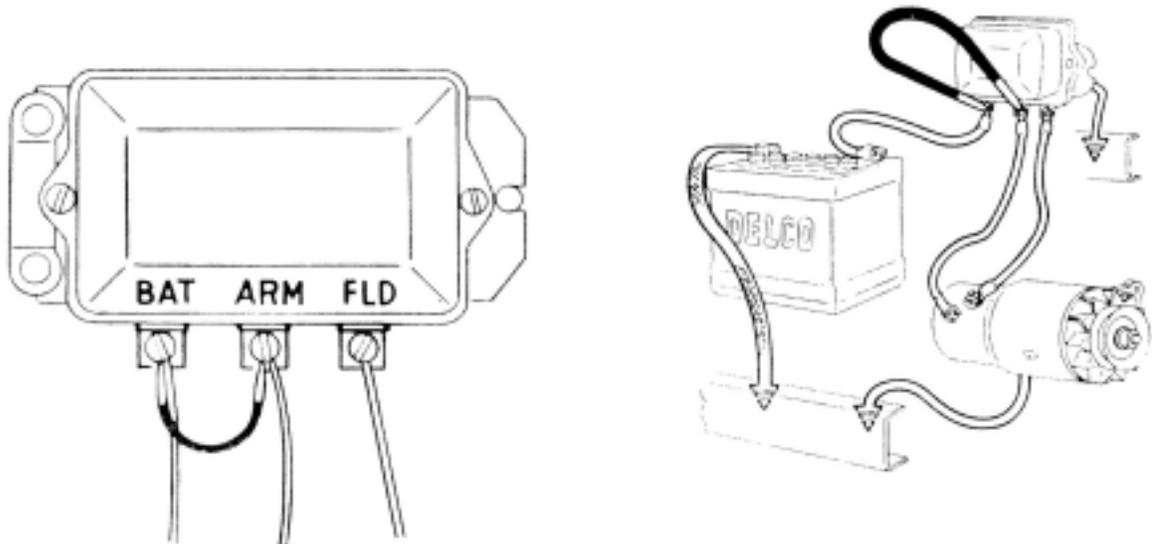
7. The position of any leads attached to either the mounting screws or attached to the base of the regulator should be noted to insure the proper reassembly process, before removing the regulator. With all wires disconnected, the regulator can be removed from its mounting
8. Some regulators have a fuse attached to the "BATT" terminal. This should be removed for use with the new replacement regulator.

Service Tips for Removing and Installing Generator Regulators



9. Before using the fuse on the replacement regulator, it should be tested for continuity with a test lamp. This is to make sure the fuse is not defective or "blown", which would result in an open circuit.

10. After replacement regulator has been remounted into position, scrape all lead connections or terminals clean to provide a good metal-to-metal contact when reconnected to the regulator terminals.



11. After all leads are reconnected and before the engine is started, the generator should be polarized by momentarily connecting a jumper wire between the "GEN" and "BATT" terminal of the regulator. Just a touch of the jumper to both terminal is all that is required.

TESTING “B” CIRCUIT REGULATORS

The tests for a “B” circuit regulator will be outlined in your shop manual and will be similar to those for an “A” circuit. The results you get will also help you to determine which parts of your charging system is at fault. Again, most of these tests are easy to perform if you first understand how things work.

CAN I CHECK THE GENERATOR BY ITSELF OFF OF THE CAR TO SEE IF IT WORKS?

Yes, you can. This is called “motoring” the generator, and is a simple test. (This test can also be done on the car, if you loosen and remove the fan belt first). All that it requires is a fully charged battery of the same voltage as your generator.

Using battery jumper cables, connect the positive post of the battery to the armature “A” terminal of the generator.

Now connect the battery ground cable to the negative post on the battery and the frame of the generator. A working generator should run or spin just like an electric motor.

If you hook up your ammeter for this test, (positive to positive, negative to ground) a 6-volt generator should draw from 4-6 amps, while motoring.

Excessive amp draw tells you the generator needs some work. Be sure you hook up the battery cables to the generator correctly or you will reverse the polarity of the generator.

As a reminder, it is always a good idea to polarize a new or rebuilt generator after it is installed on the car but before the car is started. This will allow a surge of current to flow through the generator, which will remind it which way the current is supposed to flow. And don't forget to check the water in the battery after all of this playing around. Overcharging generators will boil the water out of a battery in a short time.

One final thing: undercutting. While we are not getting into the actual repair of your generator, as that is best left to the repair shops, there is a term used quite often when repairing generators and starters. You will hear about having to “undercut” the armature. What is that anyway, and does it hurt? No.

As the brushes wear on the commutator, the “fillings,” or the part of the brush that wears off, will collect in the space between the commutator bars. In addition, dirt and grease, along with these fillings, will collect on the commutator bars themselves. A dirty commutator will cause poor generator performance.

The solution to cleaning dirty commutator bars is placing the armature in a metal lathe and polishing the commutator bars with 00 sandpaper. Another way is by using a special cutting tool to remove a small amount from the surface of the bars.

After the commutator bars are clean, the grooves between the bars must also be cleaned. Again a special tool is used to cut a 1/32-inch groove between the commutator bars. This process will restore the commutator bars to like-new condition.

This process is also done to starter armature as well, for the same reason: To clean the surface area so the brushes can make good contact with the armature.

Let's Review "Keeping Track of the Generator's Output"

Generator to regulator connections:

The "A" terminal of the generator will always connect to the "ARM" armature terminal of the regulator.

The "F" terminal of the generator will always connect to the "FLD" field terminal of the regulator.

The "BATT" terminal of the regulator will always connect to the wire coming down from the "AMP" gauge.

An "IGN" terminal was common on pre-1944 regulators. These regulators ran the entire electrical system output through the ignition switch. This style of regulator can be replaced with a newer style, which we learned to do in this chapter.

"A" or "B" circuit?

"A" circuit regulators will ALWAYS have the contact points located AFTER the field circuit.

"B" circuit regulators will ALWAYS have the contact points located BEFORE the field circuit.

Another way to tell the difference is check the generator itself. If the generator "F" terminal wire is connected to the insulated brush at the back of the generator, you have an "A" circuit.

If, on the other hand, the generator "F" terminal wire is connected to the grounded brush or is grounded by a bolt or screw to the inside of the generator case, you have a "B" circuit charging system.

To polarize an "A" circuit charging system you can use your jumper wire. First connect one end to the field terminal of the regulator. Now strike the "BATT" terminal with the other end. Once or twice will do, just until you see a few sparks at the terminal. That's it, you're done! (FYI: GM products typically used "A" circuit charging systems.)

To polarize a "B" circuit charging system, disconnect the "Field" wire from the regulator and strike it on the "BATT" wire of the regulator. DO NOT use your jumper wire to do this; it will burn the points inside of the regulator. Again, only briefly; when you see sparks, you are done! (FYI: Ford products typically used "B" circuit regulators.)

**We would like to thank Randy Rundle
for allowing us to use this excerpt from his
"Wired For Success" book**