SERVICE BULLETIN No. 14-38

COMBINATION VOLTAGE AND CURRENT REGULATORS

This type of regulator is used on many 1938 cars, equipped with two-brush generators.

It consists of three units mounted on one base and under one cover: a cutout, a vibrating voltage regulator and a vibrating current regulator. The two vibrating regulator units have been described in Service Bulletins 12-38 and 13-38.

In the Current and Voltage Regulator only one of the two units operates at one time, i.e., when the current regulator is in operation, the voltage unit is idle and vice-versa. At no time do both units operate together.

This is what happens: when the electrical load is high, as with headlights turned on, for instance, and the battery is low, a maximum of current is delivered by the generator. To prevent the current from going beyond a safe value, the current regulator operates and limits the current to the predetermined maximum amperage (See Service Bulletin 13-38).

When the load is cut down and the battery comes up to full charge, the voltage regulator cuts in and reduces the charging rate (See Service Bulletin 12-38).

With the above arrangement it is possible to reach a maximum charging rate at slow generator speeds and yet to keep the charging current and voltage at predetermined safe values.

The diagram shows the condition described above, i.e., with the battery low, so that not enough current flows through the voltage unit to operate it. The points "P1" are therefore closed. The points "P" of the current regulator are also closed.

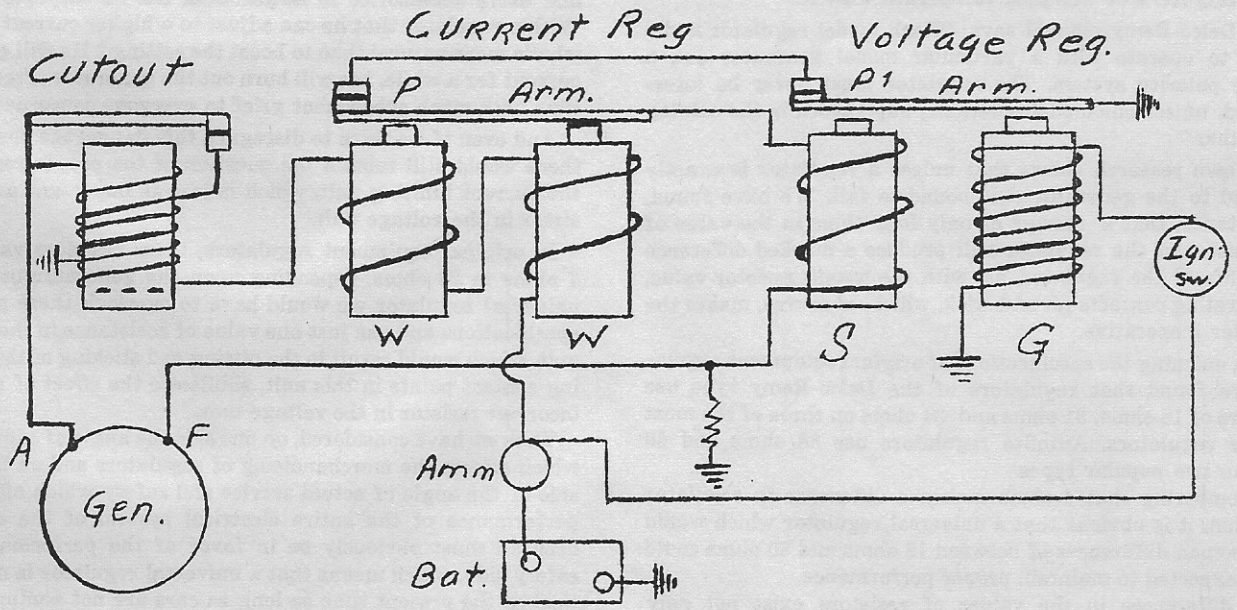
With this setup, the generator field current flows from "F" of the generator, through the very low resistance "S" winding of the voltage unit through the armature of the current unit, through the points "P", through the points "P1", through the armature of the voltage unit and to ground. This constitutes a direct connection of the generator fields to ground, which produces a strong field current and therefore a high charging current.

This high charging current runs from "A" of the generator. through the cutout, through the windings "WW" of the current unit and to the battery. When the charging current builds up to maximum, which is around 28 amperes in the late type generators, the current regulator is sufficiently energized by it to go into operation. As the armature is pulled down, the points "P" open, and then vibrate as described in Bulletin 13-38. This keeps the charging current at the 28 ampere value, thus charging the battery at the maximum rate.

When the battery becomes charged, its voltage rises sufficiently to operate the voltage unit (See Bulletin 12-38). As soon as the voltage unit cuts in, the charging current is automatically reduced, so that not enough current flows through the windings of the current unit to operate it, and it returns to its inoperative position.

In this manner both the maximum charging current and the maximum voltage are regulated by the Current and Voltage Regulator.

NOTE: All the regulators described in these bulletins are of the Delco-Remy types. The Autolite types operate on exactly the same principles, although they vary somewhat in construction and in internal wiring.



SERVICE BULLETIN No. 35-41

IS A UNIVERSAL VOLTAGE REGULATOR PRACTICAL?

We have been asked by the trade why a universal regulator could not be designed, at least for passenger car use.

The advantages of such a regulator would be obvious:

The repairman could carry a couple of universal regulators and yet be able to service the various cars without the danger of being out of a certain type with consequent loss of sales.

The jobber would not be required to stock a variety of regulator types. His counter men could handle regulator transactions faster.

The manufacturer could standardize his production and effect manufacturing savings which could be passed on to the trade.

On the surface, therefore, a universal regulator setup is really the ideal to strive for. We went into the matter with all the seriousness it deserved and did extensive research and experimentation in order to determine whether or not the universal regulator is practical and whether the arrangement, considered from all angles, would be beneficial or detrimental to the trade and to the car owner.

First of all, it must be realized that a voltage regulator is a precision apparatus. Its purpose is to precisely balance the generator output against the battery condition and thus keep the electrical system of the car operating at full efficiency. To maintain this balance, the regulator must be designed to have the same characteristics as the generator it is to work with, just as a carburetor must be designed for a particular engine or a generator brush for a generator.

Let use see what the original equipment manufacturers have to say on this question in their service manuals.

The Autolite manual says: "Before any work is done on the regulator, the following conditions should be carefully checked and corrected, if at fault. Check to see that the regulator is the one designed for the generator with which it is operating. **A regulator will function satisfactorily only when installed with the generator designed to operate with it.**"

The Delco-Remy manual says: "Each model regulator is designed to operate with a particular model generator and a definite polarity system. **The regulator must never be interchanged,** unless one model is actually superseded in the catalog by another."

Our own research shows that unless a regulator is exactly matched to the generator it is bound to fail. We have found, for instance, that a change of only four ohms in the value of the resistor of the regulator will produce a marked difference in the life of the regulator, as, with the wrong resistor value, the vibrating contacts pit and stick, which, of course, makes the regulator inoperative.

Upon examing the specifications of original equipment regulators, we found that regulators of the Delco-Remy type use resistors of 18 ohms, 31 ohms and 34 ohms on three of the most popular regulators. Autolite regulators use 38 ohms and 60 ohms on two popular types.

Remembering that 4 ohms makes a difference in regulator operation, it is obvious that a universal regulator which would have to span differences of between 18 ohms and 60 ohms could not be expected to maintain proper performance.

The differences in the values of resistors exist not only between the two systems, Delco-Remy and Autolite, but even between different regulators of the same system. This precludes the use of an individual universal regulator for each system.

In addition, the Ford system is entirely different and the generator is built in such a manner that none of the other regulators can be used with it. It requires a regulator with entirely different internal connections from the others.

Then, again, cars with batteries grounded on the negative side cannot use regulators designed for cars with positive grounds and vice versa.

Another very important angle is that of current regulation in the three-unit regulators used with the modern two-brush generators. The passenger car generators of this type are made with three maximum outputs: 22 amperes, 28 amperes and 35 amperes. If a 22 ampere generator is permitted to deliver 28 amperes, for instance, it will overheat and burn out. As the regulator for the two-brush type of generator is the sole means of limiting the maximum amperage output of the generator, it is obvious that we must have a different regulator for limiting the output of each type of generator.

There have been attempts made to universalize regulators by providing an easy method for varying the maximum current setting of the regulator from 20 amperes all the way to 40 amperes. An easily accessible adjustment screw is used for this purpose, and the adjustment is made with an ordinary screwdriver and without removing the cover. A dial marked in amperes is provided so that anyone can adjust the regulator to any current limit from 18 to 40 amperes. Again, this may strike one as a very desirable feature as it would considerably reduce the number of regulator types required.

But let us see how well this works out in practice. Let us take the case of a popular car like the 1937 Dodge, for instance, which is equipped with a 22 ampere generator. The car owner has put on a radio, a heater and foglights and finds that his battery runs down, as the current demand for regular operation and extra accessories is larger than the 22 amperes supply. With a regulator that he can adjust to a higher current setting, what's more natural than to boost the setting? He will get more current for a while, but will burn out the generator after a short time with much subsequent grief to everyone concerned.

And even if we were to disregard this dangerous possibility, there would still remain the question of the proper resistor in the current limiting unit, which is just as important as the resistor in the voltage unit.

In original equipment regulators, these resistors vary from 7 ohms to 25 ohms, depending upon the generator used. In a universal regulator we would have to overlook these precision specifications and use just one value of resistance in the current unit, which would result in the pitting and sticking of the vibrating contact points in this unit, similar to the effect of using an incorrect resistor in the voltage unit.

Thus we have considered, on one side the angle of convenience which affects the merchandising of regulators and on the other side of the angle of actual service and safety which affects the performance of the entire electrical system of the car. Our decision must obviously be in favor of the performance and safety side, which means that a universal regulator is not practical at the present time so long as cars are not equipped with universal generators.

DO NOT USE A VIBRATING REGULATOR TO REPLACE THE TWO-STEP TYPE

We do not recommend using a vibrator type of voltage regulator to replace the older, two-step control type, unless the older generator is also replaced with a newer type.

Generators designed for use with two-step regulators have low resistance field windings, which draw from 3.5 to 4 amperes, while the later generator fields draw only from 1.6 to 2.6 amperes. As the contact points of the regulator are directly in the field coil circuit, they have to handle whatever current exists in that circuit.

Whenever contacts open in any electrical circuit, a certain amount of arcing takes place at the moment of break, and the intensity of the arc depends upon the amount of current flowing

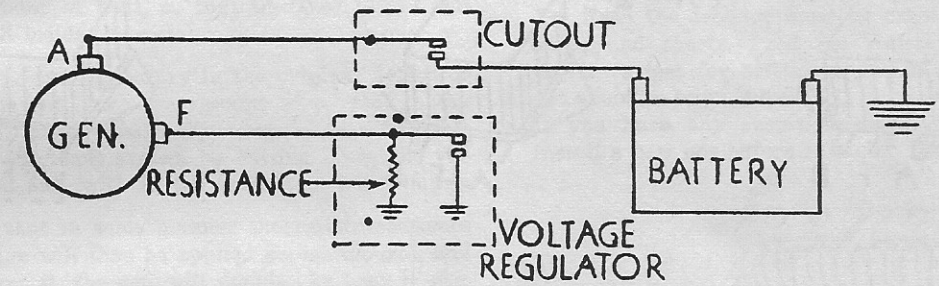
In a two-step regulator, the number of makes and breaks is comparatively small, as the operation of the unit is such that the points close when the motor is started and open only when the battery reaches a certain voltage, after which they remain open. The arcing between the points will therefore be infrequent, and the points can last a long time even if they operate with higher current.

In the vibrator type of regulator, however, the points open and close continuously at the rate of 150 to 250 times per second, and, correspondingly, the arcing is at the same high rate. If the current in the points is high, this continuous arcing will destroy them in a short time.

Therefore, when a vibrating voltage regulator is used with a generator designed for two-step regulation, the regulator is compelled to handle too much current and the vibrating contacts will probably stick and may even cause the generator to burn out.

SERVICE BULLETIN No. 23-40

5-MINUTE TEST OF VOLTAGE REGULATORS



Voltage regulation is now practically universal on all makes of cars. Daily it becomes more important that automobile mechanics have a thorough knowledge of the principles, operation and trouble shooting on voltage regulators. As a matter of hard fact, any mechanic who in this day and age cannot analyze voltage regulator trouble will find himself in increasing difficulties, as the efficiency of the entire electrical system of the car depends upon the performance of the voltage regulator.

In our Service Bulletins No. 10-38, 12-38, 13-38, 14-38, we have explained the principles of operation of the various types of voltage and current regulators. That part of the problem should therefore no longer remain a mystery to any mechanic who reads and studies these bulletins. When it comes to the practical side of the problem—actual trouble shooting and correct analysis of voltage regulator troubles, certain systematic steps can be taken that, while as simple as A. B. C., will magically point out the seat of the trouble in as little as five minutes of your time.

First, let us briefly summarize the principles of voltage regulator operation, so that you may have a clear picture in your mind of what the regulator does. A voltage regulator consists of two parts—a generator cutout and a regulator unit. The cutout is of the same type as and functions exactly like the conventional cutout that has always been used on cars: it automatically closes and opens the circuit between the generator and the battery. The regulator unit, also an automatic switch, alternately cuts a resistance into and out of the generator field circuit. The physical difference between a generator built for voltage regulation and the older type is that in the latter the field coils are grounded in the generator itself, while in the voltage regulated type the field coils are grounded through the regulator. In other words, if you run a wire from the field terminal of a voltage regulated generator to ground, you convert it into an old time generator that operates without regulation. Keep this idea in mind in connection with some of the tests that will be given later.

When a car comes in to you with charging trouble, you may find either of the following conditions:

(A) No charge comes through from the generator. In this case the trouble may be either in the generator itself, in the regulator or in a broken battery connection.

(B) A charge comes through from the generator, but it is either too high or too low. In this case the trouble may be either in the battery or in the voltage regulator.

For condition B certain instruments are needed which will be described in a later bulletin together with the method of procedure.

TO LOCALIZE TROUBLE WHEN NO CHARGE COMES THROUGH

(1) Make sure that the regulator base is properly grounded, as without a ground there can be no action of the regulator. Do not take the ground for granted—temporarily connect a wire from the regulator base to a good ground. Now run the engine at about twenty five miles per hour, and if the ammeter on the car now shows charge, the trouble was in a defective grounding of the regulator. If no charge comes through . . .

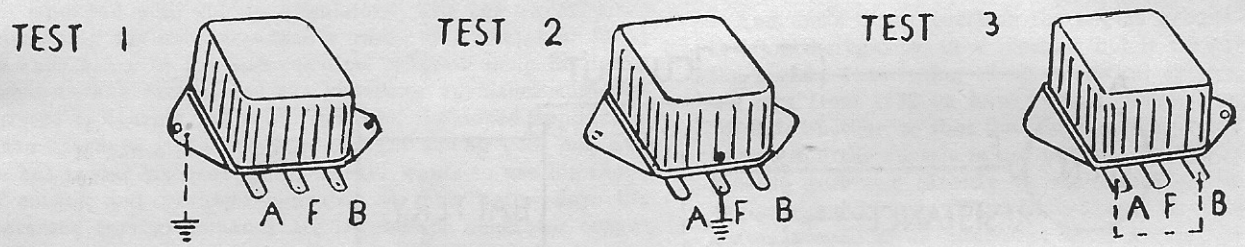
(2) Connect the wire from terminal "F", which is present on all regulators, to a good ground. This completes the field circuit of the generator outside of the regulator, i.e. it converts the generator into an old type non-regulated generator and cuts out the voltage regulator. (For Ford connect terminal "F" to terminal "G"). If you now get a charge—the voltage regulator is at fault. Otherwise . . .

(3) Connect a wire from terminal "A" (or "G" on some regulators) to "B" of the regulator. This shorts out the cut-out as well as the current regulator winding on regulators that have current regulation, giving you a direct circuit from the generator to the battery. If you now get a charge—the regulator is at fault. If the charge still does not come through, the trouble is elsewhere in the generator charging circuit or in the generator itself.

These three tests will definitely establish whether the trouble is in the regulator or elsewhere. The tests should not take more than five minutes and if the connections are made as explained above and the trouble still persists, you will only waste time if you do anything at all with the regulator itself. Do not try to adjust or replace it, but concentrate your efforts to locate the actual trouble which may be in the generator itself, such as an open field coil or defective brushes, or in an open connection somewhere in the charging circuit.

If any of the above tests show the regulator to be defective return it to the manufacturer (through your jobber).

CAUTION: On regulators which have a separate "Ground" terminal guard against accidentally touching any battery lead to this terminal, as that will immediately burn out one of the internal connections of the regulator.



SERVICE BULLETIN No. 24-40

QUICK TEST OF VOLTAGE REGULATORS

(CONTINUED)

In this bulletin we will take up the method of locating trouble when the voltage regulator operates and charges the battery, but an incorrect charging rate is suspected. (See Page 2 of Service Bulletin No. 23-40).

When the rate of charge is in question, the following conditions may be encountered:

A. The battery is FULLY CHARGED and the charging rate is LOW.

B. The battery is FULLY CHARGED and the charging rate is HIGH.

C. The battery is LOW and the charging rate is also LOW.

Quick checks of these conditions can be made without the use of instruments. These checks will localize the trouble and show which part of the charging circuit is at fault.

A. The battery is FULLY CHARGED and the charging rate is LOW.

When this condition is observed it indicates that the generator and the regulator are operating satisfactorily. To make sure that this is so:

1. Run the engine at a speed corresponding to about 25 miles per hour and note the charging rate as shown by the car ammeter.

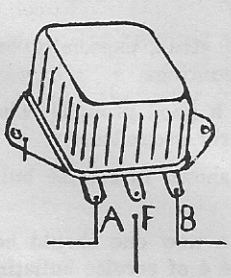
2. Turn off the ignition and step on the starter for about ten seconds in order to partially discharge the battery.

3. Start the engine and run it at about 25 miles per hour. The charging rate should now show an increase, as the battery voltage has been reduced by the use of the starter—Otherwise see Condition C.

4. After a while, with the engine running as in (3), the charging rate should drop again as the battery voltage rises to normal. This proves that the conditions in the charging circuit are normal and that the generator and regulators are both O. K. — Otherwise see Condition B.

B. The battery is FULLY CHARGED and the charging rate is HIGH.

When this occurs, the indication is that the charging rate is not being reduced when it should be. This condition will cause armature trouble; it will injure ignition coils, burn out breaker points and shorten the life of headlight bulbs. To localize the trouble:



1. Run the engine at 25 miles per hour.

2. Remove the wire from the "F" terminal of regulator.

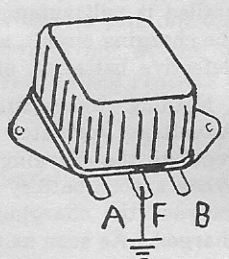
If the charging rate now drops to zero the regulator is at fault. If the high charging rate continues with the wire removed from the "F" terminal of the regulator, the generator is faulty or there is a grounded wire in the wiring harness.

C. The battery is LOW and the charging rate is also LOW.

In order to localize the trouble with this condition, a preliminary check-up of the battery and battery cables must be made. Sulphated or hardened battery plates increase the resistance of the charging circuit to an extent that will pull down the charging rate at the wrong time. You must make sure, therefore, that this is not the case before making any other checks.

Special attention should also be paid to the battery cables and terminals. A battery cable terminal may "look" perfectly clean, but if it is of the "non-corrosive" lead composition type, it may fool you plenty. A film of lead oxide often forms on the inside surface of these terminals, where they come in contact with the battery posts; this film is of a high resistance and, if allowed to remain, will sometimes even prevent starting of the engine. Even a slight film of the oxide on the terminal will cause a low charging rate when the battery is low, as it increases the resistance of the charging circuit. We emphatically recommend that whenever you come across a battery cable equipped with a lead terminal, do not fail to remove the cable and scrape the inside surface of the terminal until you see shiny lead. Do this before you even attempt to check the regulator, otherwise your time will be wasted and any conclusions arrived at will be wrong.

After you have checked the battery and cleaned the battery cables, proceed as follows:



1. Run the engine at 25 miles per hour.

2. Temporarily ground the "F" terminal of the regulator and increase the engine speed somewhat.

If the charging rate now jumps up, the trouble is in the voltage regulator.

If the charging rate remains low, the trouble is either in the generator or in some other connection in the charging circuit.

The quick checks in Service Bulletin No. 23-40 and in this Bulletin, although made without the use of instruments are conclusive in determining whether the voltage regulator is at fault or whether the trouble lies elsewhere. To check the exact generator and regulator performance, however, you must have complete data and specifications and use instruments. Guesswork will not do.

For specifications of the hundreds of generators and regulators found on cars and trucks, it is absolutely essential that you have one of the Manuals that are published for this purpose. These Manuals contain all the information on all the electrical units on the car, without which it is not possible to conduct a successful automotive electrical business.

We do not sell Manuals but we will gladly furnish upon request full details regarding them.

So far as instruments are concerned, a number of reliable equipment manufacturers make a tester which consists of a precision ammeter and voltmeter with the proper scales and tabulations for voltage regulator and general electrical testing. Information about these instruments will also be furnished upon request.

SPECIAL INSTRUCTIONS FOR INSTALLING REGULATORS

Whenever a regulator is installed, it must be mounted and fastened to the dash before any connections are made.

The wire to the "F" terminal of the regulator must always be disconnected FIRST and connected LAST.

The wire to the "GRD" (ground terminal) if any, must always be disconnected LAST and connected FIRST.

If this sequence is not followed, the polarity of the generator may be reversed. This will burn out the cutout points inside the regular unit.

To make sure that the polarity of the generator has not been reversed:

1. Make all connections to the regulator, but do not start the engine.

2. Momentarily connect a wire between terminals "GEN" and "BAT" of the regulator. This will automatically polarize the generator.

3. Remove the temporary wire and start the engine.

CAUTION: On regulators equipped with a "GRD" terminal extreme caution must be used in connecting the wires. If the wire that goes to the "BAT" terminal is even touched to the "GRD" terminal, the regulator will be damaged.

SERVICE BULLETIN No. 30-40

STOP VOLTAGE REGULATORS FAILURES!

As time goes on, the trade is becoming familiar with the checking and correcting of voltage regulator troubles.

We note, however, that a good percentage of repairmen still work on the theory that once a voltage regulator is installed it will automatically eliminate all of the troubles in the charging circuit, such as corroded battery cable terminals, defective batteries, etc.

Nothing can be further from the truth than this theory. A voltage regulator is designed for one purpose only; to regulate the charging rate in the normal system of the car. When a good battery is low, the regulator will automatically increase the charging rate until the battery becomes fully charged. As soon as the battery is charged up, the regulator will automatically cut down the charging rate.

That, and nothing else.

The regulator will NOT correct a bad battery condition; it will NOT put water into a dry battery; it will NOT correct a high resistance condition caused by loose battery cable terminals or a broken starter cable or strap.

On the contrary: the voltage regulator will be damaged by any of the above conditions and may even cause a generator to burn out.

The most frequent effect of a high resistance in the charging circuit is a fusing of the regulator points, which, if allowed to continue, will burn out the generator.

Whenever the Resistance Unit or a Winding On the Regulator Burn Out or When the Contacts Are Fused, the Only Possible Causes Are:

(1) Open circuit operation, i.e. a broken charging circuit connection.

(2) Extreme high resistance in the charging circuit, such as an oxidized all-lead cable terminal, a sulphated battery or a dry battery.

In other words, every time a car comes in with generator or voltage regulator trouble, the job must be checked before a new generator or regulator is installed. Otherwise the new unit may also fail.

The following procedure is recommended, before new units are installed:

(1) Thoroughly check the battery, see that there is water in it, and, what is still better, temporarily install a battery you know to be good.

(2) Clean all battery cable terminals.

(3) Check the starter cable and ground strap for tight connections to the starter and chassis, respectively. Make sure there is no rust on the chassis where the ground strap is bolted to it.

(4) Check the special engine ground strap, especially on cars with "floating power" engine mountings.

(5) Check the voltage regulator for a good ground. The regulator will not operate unless properly grounded.

(6) Check the present regulator as shown in service bulletins Nos. 23-40 and 24-40.

If you find the regulator defective, a new one should be installed according to directions on page 4 of service bulletin No. 24-40.

SERVICE BULLETIN No. 40-42

DON'T LET VOLTAGE REGULATORS THROW YOU

BE A VOLTAGE REGULATOR EXPERT

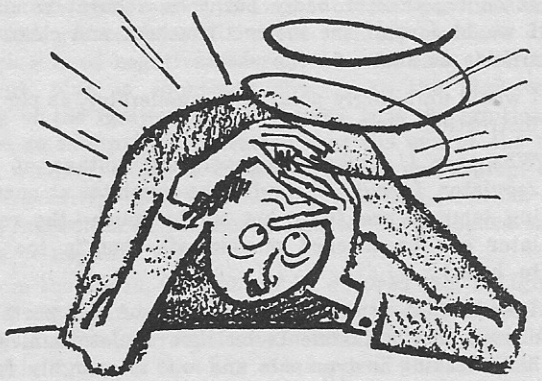
From the inquiries being received and the questions asked by the trade, it is obvious that too much cannot be said on the subject of voltage regulators.

A typical recent query reads as follows: "I have a 1940 Ford on which we have burned out three generators and five voltage regulators. When I put on a new regulator, everything seems alright for a while, then all at once one or the other is gone. Any advice you can give me in regard to this trouble will sure be appreciated."

This case is only one of a multitude and represents hours of wasted effort, dollars of wasted parts and many dissatisfied customers. We can reply to this cry for help only by pointing out that the trouble is, most likely, not with the generators or regulators but with the method used in servicing the car and taking care of the trouble.

Let us try to reason it out just as if we, ourselves, had this trouble on our hands. A car comes in with a bad regulator, let us say. Without much ado, we replace the regulator with a new one. Everything works fine and we feel that we have done our duty by the customer.

Unfortunately, three days later our customer comes back with the same car, which now has a burnt out generator. "Well," we say to ourselves, "we must have pulled a boner. We should have changed the generator also as well as the regulator. We guess we had better replace the burnt out generator and that will fix it."



And so it does — for a few days, when in comes the same customer with the same trouble. At least at this late time, a clammy suspicion should hit us that maybe something is wrong outside of the generator and the regulator and that we had better find it and clear it before more damage is done.

Instead, as related in the quoted letter, we trust to luck and keep on replacing units, until we have the grand total of three generators and five regulators and still the trouble persists. Now what do we do? How can we find and fix the trouble and keep the customer satisfied?

Now, let us picture a different procedure of reasoning and action. The car comes in with a burned out regulator. The first thing that comes to the mind is: "What caused the burn-out? Was it the regulator itself that broke down or was something wrong elsewhere that put an abnormal load on it?"

So, we grab the Blue Streak Service Bulletin binder, locate Service Bulletin No. 30-40 and find that certain parts of the charging system *must* be checked in cases of regulator trouble to make sure that the job will be satisfactory and that any unit we replace will not be ruined by the same defect that killed the old unit.

In service bulletin No. 30-40 we find reference to Service Bulletins Nos. 23-40 and 24-40, which give a detailed description of a five-minute regulator test and will establish beyond the shadow of a doubt whether the trouble is in the regulator itself or elsewhere. We proceed according to the instructions in these bulletins and locate the trouble which was, let us say, a loose wire on the ammeter.

As a result of this method, the job is completed satisfactorily the very first time it comes into the shop and we have the satisfaction of knowing that the car will not come back for the same trouble. We have also gained the goodwill of the customer.

We emphasize the fact that only five minutes is the time required for the checkup and also want to call your attention to the simplicity of the checkup which requires only a piece of wire and no meters or instruments whatsoever.

If you compare the small amount of effort required in making the test, with the waste of time and material (three generators, five regulators) which results from the hit-or-miss method of servicing regulators, you are bound to agree that it does not pay to do it the wrong way.

We claim that by following the procedure recommended in the service bulletins, you can become a bona-fide voltage regulator expert with a minimum of effort and a maximum of results.

SERVICE BULLETIN No. 44-45

YOU CAN, YOU MUST MASTER VOLTAGE REGULATORS

The Voltage Regulator situation at the present time leaves much to be desired. Voltage regulators are a bug-a-boo and a "pain in the neck" in the minds of some mechanics. And yet, while the regulator is a precision apparatus, its handling and installation is a comparatively simple matter, provided certain methods and procedures are conscientiously followed.

You would really be amazed if you were the factory engineer and had the job of following up some of the complaints on voltage regulators. You would come across many cases where the cause of the trouble was so obvious as to leave no doubt whatsoever that the installer completely disregarded all of the instructions so clearly given in the instruction sheet. You would also find numerous instances where two and even three new regulators were installed on the same car and they all failed to perform because the basic defect in the system had not been detected and removed.

This condition brings in difficulties for everyone. The manufacturer is blamed for defects in his product which do not exist; the repairman loses the customer's confidence and business; the car owner is put to unnecessary expense and is compelled to go elsewhere for expert advice. And you must remember that if he goes elsewhere with his voltage regulator troubles, he will probably take his other work there also.

Now, if I were a repairman and realized that I was losing valuable voltage regulator business and other business with it, I would look for some way to regain this business and really develop it into something worthwhile, as the voltage regulator is here to stay and must be serviced. I would decide that as long as servicing is necessary, I would do the servicing.

Having come to this decision, I would next determine just how I would go about it. I know that the best way would be to install a regulator tester and check regulators in the approved manner, so that I would know exactly what the particular regulator does. I would have to learn how to operate the tester and how to test the regulator, but the equipment manufacturer would help me out and I would be set up for regulator business in a way that would inspire my customer's confidence and enable me to give him the type of service that would make him my customer permanently.

Yes, that would seem to be the ideal thing to do. On the other hand, I know that testing equipment is still not immediately available, and that I cannot afford to wait for it and in the meantime keep on handling regulators by guesswork. So I would do the next best thing and check regulator troubles by faithfully following the instruction sheet which is furnished by the manufacturer of the regulator and which, like the Blue Streak instruction sheet for instance, shows in detail the various steps necessary for localizing regulator troubles.

I would pay particular attention to the following instructions, which are absolutely essential to regulator operation:

1. Before changing the regulator, I would make sure that the old regulator is really defective and the trouble is not elsewhere, as shown in the instruction sheet.
2. If I found the trouble to be in the old regulator, I would examine it carefully before installing a new regulator. If I found a burnt resistance, contacts fused together or badly burnt or a burnt winding, I would consult the instruction sheet and clear the trouble as shown in the sheet.
3. I would unfailingly polarize the generator, as per the instruction sheet.
4. Whenever I checked the operating voltage of the regulator, I would do it with the regulator at operating temperature (very hot to the touch—the regulator can be touched momentarily but is too hot to hold.)
5. I would not attempt to bend any of the parts or change any adjustments on the regulator unless I had checking instruments and was thoroughly familiar with voltage regulator operation.

That is what I would do while waiting for my test equipment. I know that in this way, I would be doing myself a good turn by preparing for business that will be profitable but which will demand more expert handling than was heretofore required.