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# BATTERIES AND BATTERY CHARGING

BATTERIES AND BATTERY CHARGING CONCERNS

I'm not a battery expert, but I'd like to offer a few observations concerning battery charging and chargers. These comments are based on simple observations, and I think they can be of some help in trying to deal with your battery while your car is laid up, either for restoration, service, or for the winter season.

GENERAL OBSERVATIONS

A good battery, with a full charge, produces 12.6 volts. An alternator is regulated to produce a steady 14.6 volts under all conditions, within it's capacity. If the load on the alternator increases, the internal regulator increases the field current to maintain the 14.6 volt output. With 12.6 volts from the battery and 14.6 volts from the alternator, all of the automobile's electrical loads are being supplied by the alternator. The battery cannot supply current as long as it is being fed from a higher voltage source.

On a long trip, such as the ones I take on a regular basis of 15-16 hours duration, the battery is constantly being fed the 14.6 volts from the alternator. No harm is done to the battery by this constant higher voltage. The only time the battery ever supplies current on these trips is when I start the car after refueling and eating -- about five times total. I don't believe the battery would be harmed by this if I drove the car 24 hours a day, seven days a week, for weeks at a time, without ever restarting the car. It doesn't seem to be a problem for long haul tractor/trailer rigs. As a rule, the drivers of these rigs never shut the engine off unless they are going to be parked for a long spell, often even running the engine during an overnight stay

An ideal battery has zero internal resistance. A real battery has two types of resistance -- resistance to charging current, and resistance to discharge current. On a fully charged battery, the resistance to charging current is high, and the resistance to discharge current is low. On a weak, or discharged, battery, the opposite situation exists -- the resistance to charging current is low, and the resistance to discharge current is high.

I have a heavy duty battery charger (60 amps charge, 240 amp boost). The only components in the charger are a transformer with a multi-tap primary, a rectifier, a switch, an ammeter, and a timer. The switch has three positions-- slow charge, fast charge, and boost. The only difference in the three positions is the tap on the primary of the transformer, which changes the output voltage of the secondary. There is no regulation whatever.

When I connect the charger to a very flat battery, the ammeter shows an initial charge current of up to 60 amps. As the battery charges, the charging current slowly tapers off to a minimum value, on the order of 10 amps. On the slow setting, the output voltage is 13.4 V; on the fast setting, it is 14.8 V; and on the boost setting, it is 17.6 V. These measurements were made with no load. I haven't measured the voltage when it is charging a flat battery at 60 amps, but I'm certain the voltage goes down from the heavy loading. The label on the unit states that the output voltage drops to 7 volts at the full 240 amp output.

Given the above, it appears that the battery itself provides a degree of regulation of the charging current, for a given charging voltage. A constant charging voltage, whether in storage on in operation, of 14.6 volts will maintain a full charge without any damage to the battery. I don't know if the battery needs to be used occasionally or not, but I don't think so. Not as long as it maintains a full charge. I would think that a power supply, set to deliver 13.5 V or so, would do the job of maintaining a battery for long term storage. Just for "feel good" until better information is available, you might want to rig up the charger setup with a switch so that you could shut it off, and connect the battery to a load for a short period of time. You would only need to do this on occasion, just whenever you happened to think of it. (I don't believe that is necessary, but I'm not a battery expert, so I can't be sure).

As a point of reference, at our nuclear power plants (at the Tennessee Valley Authority), we maintain the equivalent of 13.5 volts on our batteries at all times, with an equalizing voltage of 13.98 applied on a periodic basis. I say "the equivalent" because our batteries are either 125 volts or 250 volts, and consist of multiple 12 volt batteries, very similar to car batteries, arranged in series/parallel as required to produce the needed voltage and current capability. Because of the large number of cells involved, and the fact that they are arranged in parallel, it is necessary to equalize the charge on these battery setups. Because these batteries are used to perform safety functions, they are tested on a very frequent basis, so the need for discharging on occasion is never addressed -- they are automatically discharged as part of the testing.

Not directly related to charging, but of interest none the less, is the internal resistance to discharge current. A fully charged battery has a terminal voltage of 12.6 V, whereas a very flat battery has a terminal voltage of about 11.6 V. The difference of one volt is not enough to cause real problems in an automobile. The problem stems from the high internal resistance of the flat battery. When you measure the voltage, the meter has very little current draw (compared to the typical battery load, it is virtually zero), so no voltage is dropped over the internal resistance, and the terminal voltage stays high. When a heavy load is placed on the battery, the high current draw causes a large voltage drop on the internal resistance, reducing the terminal voltage to a very low value. The low voltage, combined with the high circuit resistance, is what causes the starter to groan rather than spin the engine. To get a true measure of a battery's condition using a voltmeter, it is necessary to load it heavily, heavily enough to get a voltage drop across the internal resistance.

As an aid to understanding the above, consider the batteries used in portable radios. The next time you have a 9 volt radio battery go flat, replace it with a good 6 V battery, just as an experiment. You will find that it will work just fine, although the volume won't be as high. What happens when a 9 volt battery goes flat is the same as what happens when a car battery goes flat -- the internal resistance goes up. This internal resistance causes distortion. When the radio is playing a loud passage, the high current causes a voltage drop across the internal resistance, dropping the output voltage of the battery, and, in effect, turning down the volume. Conversely, on soft passages, the voltage drop is not as pronounced, and the battery voltage goes up, cranking up the volume. Turning down the loud sounds and turning up the low ones is not the way to enjoy music! Replacing the 9 volt with a good 6 volt cures the problem, as the internal resistance is still quite low. On any radio, when the volume is turned up to the point that the battery can't keep up, you get distortion. Operating a 9 volt radio with a 6 volt battery will lower the volume at which this distortion occurs.

## BATTERY TESTING

For the most part, I don't think it is worth the trouble to test your battery at home, as most battery dealers will test it for you at no charge. They have the necessary equipment to test it properly, and, should the battery turn out to be bad, you can have a new one installed on the spot.

If you should desire to test it yourself, there are two ways to do it. The first is with a hydrometer. The simplest hydrometer consists of a clear, hollow tube, containing a smaller cylindrically shaped glass float, . The chemical makeup of battery acid varies with its charge, and this variation in chemical makeup causes a variation in the specific gravity of the acid. The higher the battery charge, the higher the specific gravity. When the hydrometer is filled with battery acid, the float will be higher or lower in the tube depending on the acid's specific gravity. By reading the float marking that matches the acid level, the charge condition can be determined.

A fully charged battery will give a reading of 1260, indicating a specific gravity of 1.26, while a discharged battery will give a reading of 1070, indicating a specific gravity of 1.07. Temperature also affects the specific gravity of the acid, so compensation must be made for this. Using 80°F as a reference, add four points to the reading for each 10°F above, and subtract 4 points for each 10° below.

The second method for testing at home is to measure the battery voltage. Under no load conditions, a battery with a full charge will read 12.6 volts, while a completely discharged battery will read 11.64 volts. Just as with using a hydrometer, there are other variables that will effect the voltage readings. If the battery has just been charged, the voltage will be higher; conversely, if it has just been supplying a heavy load, the voltage will be lower. The amount of the voltage differences will depend on how heavy the charge or discharge current was, so no hard and fast conversion factors can be given.