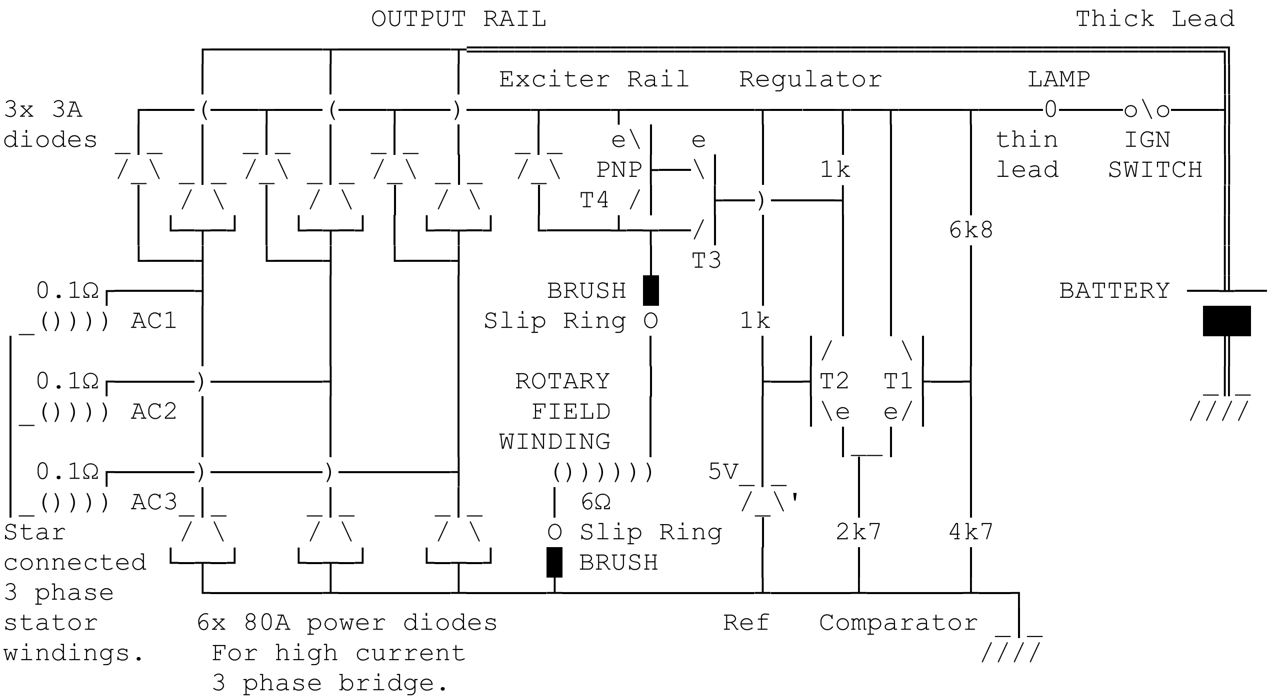
Car Alternators

By G8MNY (Updated Sep 09)

(8 Bit ASCII Graphics use code page 437 or 850)

Here is a typical circuit.



The modern car AC Alternator with its integral rectifiers and Regulator took over from the old DC Dynamo and integrated regulator box in the 1970s after the high current Silicon diode became readily available. The main advantage is a much higher current output for the size, this is due to the heavy output winding now being on the stationary outside stator. Other advantages are better regulation and output at low revs (tick over), enabling a smaller light weight low capacity starting type battery to be used.

WARNING LAMP

Turning the ignition switch on, the dash board lamp puts a few mA of current through the Rotary field winding (6Ω), because the voltage on the exciting rail is lower than 14.5V, the lamp lights up.

When the engine is running this low level exciting current plus residual magnetic field in the rotor is enough to build up the generated voltage in the 3 stator star connected windings. This is high enough to overcome the 3 phase bridge voltage drop (1.4V) and continuously increases the exciter rail voltage until the regulator cuts in at 14.5V. The lamp goes out.

If the lamp goes open circuit then the alternator may not self excite until very high engine revs are used. This could cause damage to the alternator or car electrics if the regulator is a bit slow in it's action!

REGULATOR

The voltage regulator compares the exciter rail voltage, not the actual battery voltage, as other than the difference in the top 3 diode losses the voltages should be the same. In this circuit a sample of the voltage is attenuated to about 5V and compared by NPN T1 and T2 a longtail pair, with a 5V reference. When the sample is less than 5V, T2 is on and turns on PNP power Darlington to increase the exciting field winding current. T4 and T3 are protected from back emf with a diode across them or to earth. When the sample is above 14.5V the reverse happens and the excitation is reduced.

All this happens in a fraction of a second, as the engine RPM can be as low as 500 revs (due to belt pulleys 1500 on the alternator) and the alternator regulator will be at max excitation 12V at 2A through field winding, giving about 10-20A only at 13V to the battery. While a second later the engine could be at 7000 RPM (21000 on the alternator) and the output would try to rise the voltage to 360V at 500A if the regulator failed to cut the excitation current down to 1/14th of what it was!

ALTERNATOR WHINE

It is common for alternators to have 2 or more pairs of poles on the rotor and matching the sets of load windings. The battery current is fed with pulses of current from the 3 phase rectifier.

From the above example the AC ripple frequency across the battery at tickover will be 1500/60 x 4 x 6 = 300Hz rising to 14 times this at full revs 4200Hz.

So it is easy to see why it takes only a small amount of these communications frequencies across the battery to affect a Radio/Transceiver etc. The cure is NOT to add C across the many Farads of battery, but to put an iron cored choke (of a few turns) in series with the radio, assuming the radio has a C inside it anyway.

```
 BATTERY──o─o──(((()─────┬── Rig C
         Fuse  ═════    === 1000uF
              > 10mH     ├──
              < 0.01Ω   _|_
                        ////
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REGULATOR FAILURE

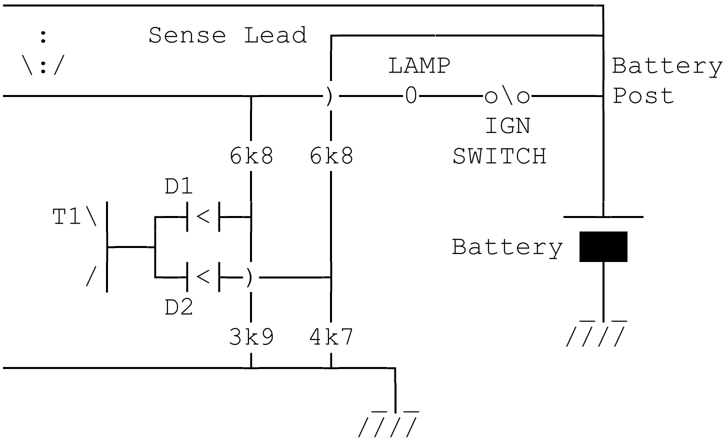
Regulator failure, either results in no charging, or excessive charging causing damage/symptoms usually in this order:-

a) Fan belt squealing noises when engine is revved up.
b) Blowing many car lamps.
c) Blowing up the battery.
d) Snapping the fan belt once a new battery is fitted!

A new/replacement regulator is a fiddly thing to fit, but may only cost a tiny fraction of a replacement alternator, if you can find a matching regulator that is!

REMOTE SENSE
On larger alternators it is usual to have remote sense. This can give 2 advantages:-
1/ True Battery voltage sensing ignoring the lead losses.
2/ Output current limiting to protect the alternator.

..... up to 2.4V of Drop ....>



There are 2 attenuator samples, the normal internal exciters voltage, as well as a lead sending the actual battery voltage. The 2 attenuators are slightly different permitting 14.5V on the battery terminals or 16.9V on the internal sensor.

When there is more than 1 volt drop across the battery lead/high current diodes (compared to the internal diodes) then D1 will conduct to reduce the alternator voltage. 1.4V drop across the thick battery charging lead may represent the safe 60A current limit of the alternator.

Using D1 and D2 steering diodes rather than just resistive adding both inputs is important so that the alternator does not blow up if remote sense lead is disconnected!

Tony, G8TBF says, on some alternators there is an additional output terminal connected to the star point of the main winding. This is used for automatic choke - it feeds a heater winding next to a bimetal coil in the (carburettor) choke assembly. (In effect, it's a regulated feed at half the alternator output voltage, as long as the engine is running).
On cars with this system, a failure of an alternator rectifier diode messes up the choke operation!
If one of the positive o/p diodes goes open circuit, the star point voltage rises significantly and the choke goes off far too quickly. Likewise, if a diode on the ground side fails, the star point goes low and the choke stays on way too long, if it goes off at all...

Why Don't U send an interesting bul?

73 De John, G8MNY at GB7CIP