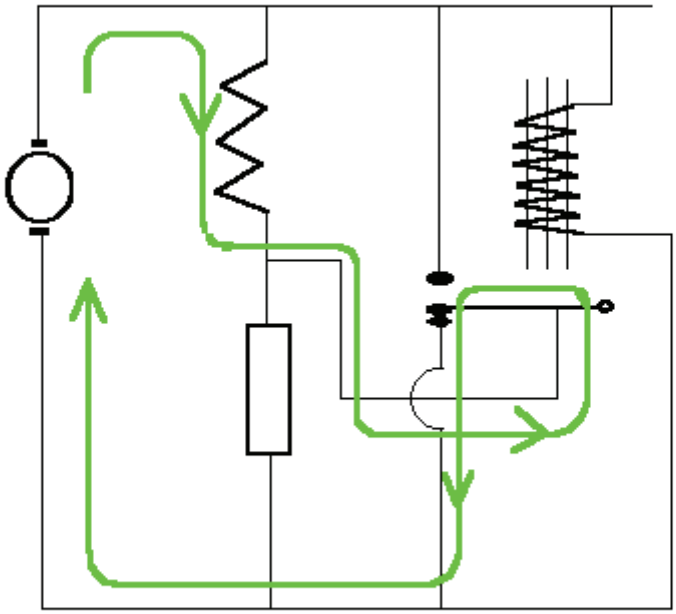
DYNAMO AND REGULATOR

Most /2 BMW's are equiped with a 6 Volt 60/90 Watt dynamo and a mechanical Bosch regulator. Only a few came with a 75 Watt dynamo, a 12 Volt version or even a three phase generator, like on the later /5 series. The older R51/3 and the R67, which have the same engines, had to do with a 45/60 Watt dynamo. Because a lot of people are shy of electrics, I try to explain a little bit. Don't despair when looking at the schematics, it's all logic, and in fact quite simple. These days, a lot of people have thrown away their machanical regulator and installed an electronic version. Nonetheless it is usefull to know what all this stuff is about.

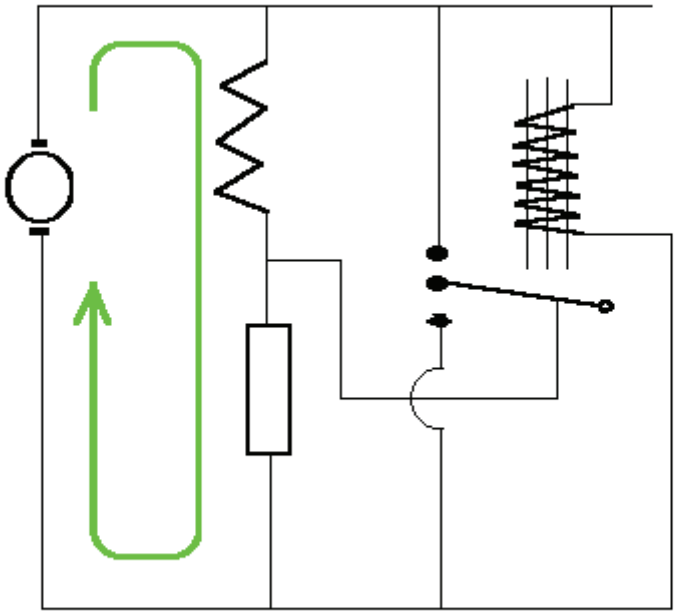
For them who realy have no cue about electrics, I have put together a short tutorial , that explains the basics. You don't realy need to know anything more to understand your dynamo.

The dynamo itself consists of the rotating rotor, which has a commutator and two brushes that pick up the current. This rotor rotates inside the fieldwindings. You can completely forget how this precisely works. Only remember that the rotor develops the electric power, and the field windings are there to help in this proces. A voltage is generated on the commutator and the current is picked up via the brushes. The rotor and the field-windings have almost eternal life, unless they have been overloaded or overheated. The BMW singles also vibrate their dynamo apart. The only things that wear are the brushes and the commutator. Make sure that the brushes are long enough, and slide easily up and down in their holders. The commutator should be lightly glossy. If it is not, or has dark burned spots, it can be turned down on a lath. After turning, the isolation be-tween the copper segments must carefully be cut back. You can measure the rotor with an Ohm (resistance) meter. Put the probes on each adjacent pair of copper segments of the commutator. It should read about 0.1 Ohm. Then measure between each segment and the iron core, it should read infinity. Likewise you can meas-ure the fieldwindings. Between D+ and F should be about 2.5 - 4 Ohm. But these measurements don't realy show what will happen with high currents and under high temperatures.

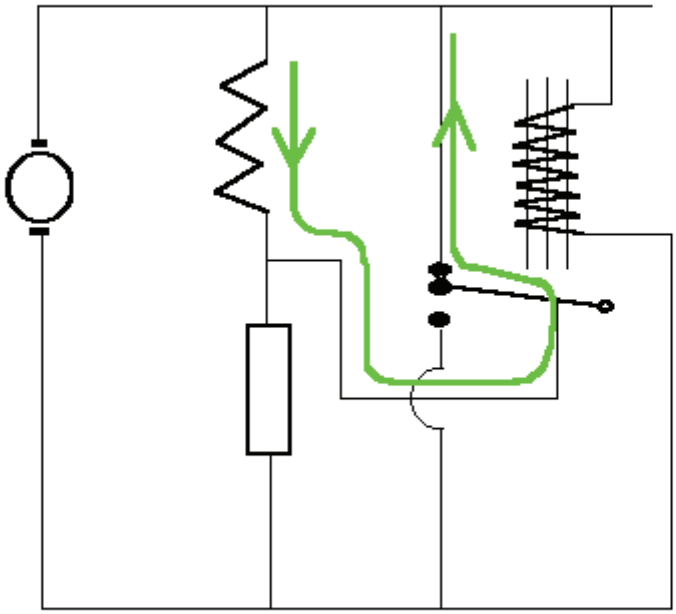
So what we have here is an electric voltage source, that can be regulated by varying the current through the fieldwindings. If we don't regulate the dynamo, the voltage will rise and rise with the engine speed. We need a constant voltage though and that's what the regulator is for. The regulator has a voltage coil and a set of regulator points. The voltage coil "measures" the generated voltage from the dynamo. This electro magnet pulls on the middle regulatorpoint. There are three phases:



As long as the voltage is low enough, the regulator points are unaffected by the voltage coil. The current will flow from the rotor, through the field windings and the closed regulator points to ground. Thus the field windings get the maximum current.

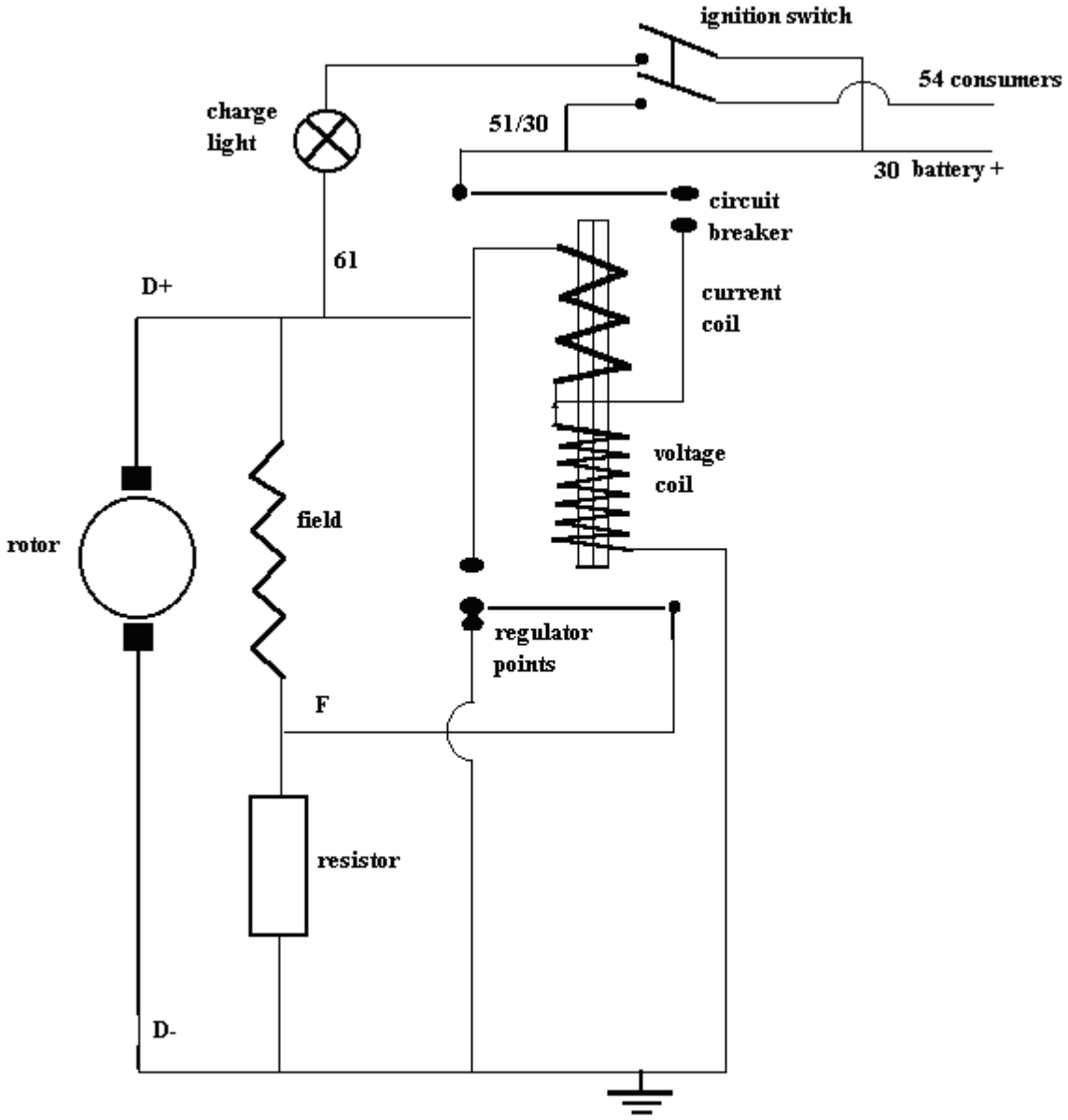


But as soon as the voltage rises above a certain level (7 - 7.5 Volt), the voltage coil pulls on the middle regulator point until it floats in the air. Now the current flows from the rotor, it can't go through the regulator points anymore, so it must flow through the resistor. The current is thus reduced, and the rotor voltage won't rise so fast anymore.



But the voltage can rise even heigher. At that level (7.5 - 8 Volt) the voltage coil completely pulls up the regulator points, until the top pair are closing. Now the field winding is shunted, both its ends are connected to each other, and their won't flow current through it anymore. The dynamo voltage completely colapses, and the whole process starts all over again. This repetition goes on and on and you can hear the regulator ticking at a high frequency, while the voltage remains relatively constant.

Alas, that's not all there is. The regulator has two other functions. It must protect the dynamo for over-current, and it must prevent that the battery drains itself through the dynamo, when the engine is not running (then the dynamo is just a low resistance piece of wire).



The complete diagram shows that there is also a current coil. This coil measures how much current is flowing from the dynamo to the battery and the other consumers. It acts on the same pair of points as the voltage coil. Its function is to drop the voltage as soon as the current rises too much.

The complete diagram also shows another set of points, the circuit breaker, which is normaly open. Only when the dynamo voltage reaches a certain level (6.5 Volt), the voltage coil will be strong enough to close the circuit breaker, and open the path from the dynamo to the consumers. But this is not enough. When the dynamo voltage drops, the voltage coil will now measure the battery voltage and the circuit breaker stays closed, until the battery has drained. There is a nice trick here. As the dynamo voltage drops, the battery will drain in the dynamo, thus REVERSING the current. The current coil is wound in such a way, that it now presses the circuit breaker open, against the will of the voltage coil.

To check the function of the dynamo and the regulator, you must make 4 measurements. Use a precise voltage meter, because you must be able to measure with a 0.1 Volt precision. A modern digital multimeter is precise enough. - Dynamo voltage at a no-load condition. Disconnect the battery, and switch off all the lights, horns, radios, electric vests etc. Connect a voltage meter between 61 and ground. Start the engine and rev it slowly until the voltage no longer rises. Should be 7.2 - 7.9 Volt. - Dynamo voltage at 60 Watt. You can switch on the light and press on the brakeswitch, that is about 60-70 Watt. Leave the battery disconnected. Voltage between

51/30 and ground should be 6.5 - 7.4 Volt. - Cut in voltage of the circuit breaker. Connect the battery again, a voltage meter between 61 and ground. Disconnect the lead from 51/30 and connect an ammeter between the terminal and the lead. Slowly rise the revs from idle until you see the ammeter take a jump. Read the voltage meter at that point. Should be 6.4 - 7.1 Volt. This is difficult to read with a digital meter. They are usually too slow. - Reverse current to close the circuit breaker. The same setup, but the ammeter should be able to measure negative currents, or you must reverse its leads. Rise the revs until the circuit breaker is closed. Now slowly drop the revs. The current from the battery to the dynamo will rise to 2.5-9.0 Amp, and then suddenly drops to zero, indicating that the circuit breaker has opened.

This all sounds nice and simple, but there are some caveats. In fact this whole setup is one big compromise to get the best results in average conditions.

The biggest problem is the function of the current coil. It protects the dynamo for too high currents. But the stupid thing starts regulating the voltage down as soon as there is a current flowing. So with a rising current, the voltage drops gradually. Thus the setting of the regulator is a compromise. The voltage is too high when there are not much consumers, thus boiling the battery, and it is too low when everyting is switched on, thus starving the battery.

The regulator is also sensitive for temperature. The higher the temperature, the higher the dynamo voltage. Because the regulator is mounted on a nice hot place, you shouldn't forget this. Well at least the battery won't starve now, but it will be cooked a lot in summer.

The best compromise is to use a 14 Ah battery and have the regulator adjusted at the low end of the above mentioned voltages. Then keep an eye on the battery, and if it starves, give it an extra load.

The next bad feature of this regulator is the circuit breaker. These points are switching currents of 2.5 to 9 Ampere. That's not healthy for a mechanical switch, and it realy is the weakest point of the whole regulator. This is especially an issue when you are riding for long times at slow enginespeeds, for example durin downtown rush-hour. The circuit breaker is then constantly switching on and off. Also the regulator points are constantly switching, but they switch much smaller currents, and don't break down so quickly.

These problems can be solved with an electronic regulator. Here you don't have mechanical contacts anymore. And most electronic regulators have a constant voltage over the whole current range. An electronic regulator also has the electronic version of the circuit breaker, a diode. This diode is like a one-way valve, and only lets current through in one direction, the current can flow from the dynamo to the battery, but not the other way around. But not every electronic regulator on the market is useable. Apart from regulating the voltage, it also needs an over-current protection. As soon as the current is too much for the dynamo, the regulator should switch of the fieldcurent, to protect the dynamo. And, you wouldn't believe it, I once had an electronic regulator that didn't have a diode, so the battery could drain itself through the dynamo.

Electronic regulators are great stuff, and much more durable then the mechanical ones, but they are temperature sensitive too. And one drawback of electronics is that they don't like heat. Above 80 degrees Celcius, they tend to die, especially when they must switch big currents. So probably it is wise to mount your regulator somewhere on the frame, under the tank. This is also not a bad idea for the mechanical regulator. BMW put the regulator always under the seat (and the ignition coil under the tank), when they prepared a bike for racing. Don't put a mechanical regulator in the headlight shell, because that is almost always a high vibration area.

Sometimes when the dynamo has been disasembled or the battery has been connected the wrong way round, the dynamo doesn't work anymore. The "startup" mechanism of the dynamo is then disturbed. When you start the engine, there is no voltage comming from the dynamo, so the field windings get no current. This would prevent the dynamo from working ever if there wasn't a little bit of residual magnetism left in the field. That little bit is enough to start up the dynamo proces. When this residual magnetism gets lost or has its polarity the wrong way round, you must repolarise the dynamo. That is simply sending a current in the right direction through the field windings. Just connect the battery plus to D+ for a few seconds, and it's done. The easiest way to accomplish this is to close the circuit breaker contacts with your fingers for a few seconds. Watch out for the sparks.

Whatever regulator you use, your electronic system will never be maintenance free. Watch your battery. If you

have electric power in the garage, use a trickle charger. If you are loosing a lot of water from the battery, then the regulator must be adjusted a little lower, at the other hand, if your battery is always drained, adjust it a little higher. The electronic regulator has a potentiometer for this purpose.