LUCAS RB106 ELECTRONIC DYNAMO REGULATOR CONVERSION USING THE BOSCH 30019 REGULATOR:

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(As per previous notices: Do not attempt to work on the electrical systems of your vintage car unless you are qualified to do so, or can get help from someone who is. The use of my freely given designs by any party is entirely at their discretion and at their own risk).

Bosch produced an electronic control module for dynamos for VW's and Porches (the 912) and they are very well designed unit. This is an example of the very few electronic dynamo regulators ever made and is a true current & voltage regulator and not a "compensated" type like the two bobbin Lucas RB106, but like the electronic equivalent of the 3 bobbin electromechanical regulator.

The only issue to solve when using this one is that the Bosch unit was configured to drive a Bosch dynamo field winding, where the field winding was not earthed (as it is in the Lucas unit) but rather it was connected to the armature or D output instead. Therefore the Bosch regulator unit's field drive output pulls the field winding connection to earth (sinks current) rather than sourcing it, as in the Lucas system. The fix for this merely involves adding a few parts, which can be enclosed near the Bosch Unit. An MJ2955 transistor to ***invert*** (reverse the polarity of the field coil drive), some drive resistors and the 6A10 diode to damp the field coil's reverse voltage and protect the transistor. I chose to mount the Bosch unit to a stainless steel plate adapter onto an RB106 base, which is a convenient place to mount the MJ2955 transistor. The circuit connections for this version are shown in Figure 5A.

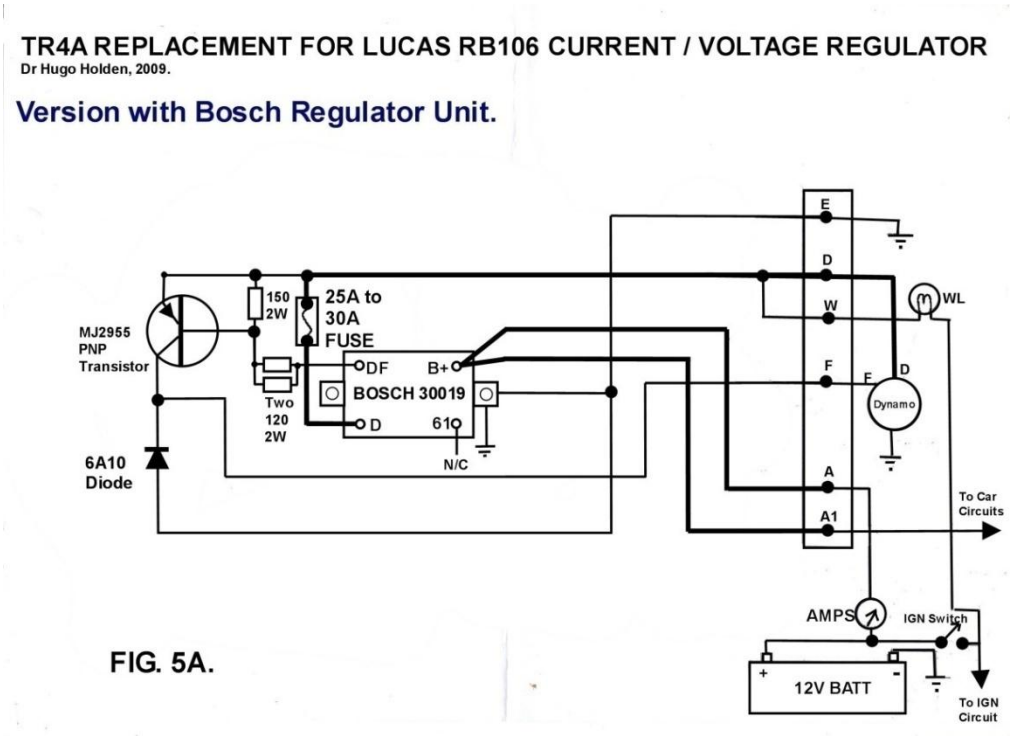


FIG. 5A.

(Experiments have shown that only one 120R 2w resistor is needed as the MJ2955 has sufficient current gain and the 150 R can be replaced with a 1k8 ½ watt resistor. Also another option for the 6A10 diode is a 1N5404).

The Bosch regulator is an excellent example of rugged automotive electronics and I find it quite impressive. It uses three parallel silicon power rectifiers (diodes). This assembly is separated away from the "regulator module" which is potted in a small housing within its base which is a very smart design.

Be cautious of the fact that the main housing/aluminium body is connected to the D connection, not negative or ground so avoid any possible shorts to this.

The Bosch unit is a precision temperature stable regulator with a rock stable output voltage at 14.4 volts.

The Bosch unit does incorporate a current limiter. Testing indicates it becomes active approximately between 30 and 35A. This means in a standard TR4 with a C40 dynamo it will not be active unless there is an extremely low state of charge battery combined with very high engine RPM and all electrics on and perhaps some added accessories. So it is wise to incorporate a 25A fuse. When added in with the Lucas C40 dynamo, as shown, the result is solid or "stiff" voltage regulation, causing the charging system to behave as though it was an Alternator system, with no significant change in battery charging current with the normal external loads such as headlamps and electrical accessories in the car.

The Bosch unit ensures that the voltage on its B+ terminal remains a constant value and solves all the problems of the original electro-mechanical RB106, while allowing the TR owner to keep the Lucas dynamo original.

The wiring shown in bold must be at least 30A capable, this can be seen as the thicker red wire in he photos.

The additional terminal labelled 61 is for the warning lamp system in the VW or Porsche and is not needed or connected in this application.

When the DF output sinks current (as it would do driving the Bosch dynamo field coil) this forces the MJ2955 into conduction and the collector of the MJ2955 sources the current to the Lucas field coil. In this application the transistor is said to be inverting the polarity of the drive.

The 60 ohm base drive resistor (composed from two easy to get 120 ohm 2watt resistors) provides enough base current to ensure the MJ2955 acts as a saturated switch. The maximum value of this resistor should be no more than 120 Ohms which is also satisfactory unless the MJ2955 is a sub-standard clone transistor with poor current gain. (Transistors with older date codes are less likely to be fakes or clones).

Given that the current limiter is set to be active over 30A it is worthwhile incorporating a 25A fuse in the Dynamo's connection to the D terminal. This would protect the C40's

dynamo's armature from current overload but may not be necessary in a standard TR4 car. However fuses are always sensible.

Figure 5B shows the basic arrangement of the adapter plate so that the Bosch unit can mount on a donor RB106 base. It is secured with two 3mm screws from the under surface of the RB106 body, the exact locations are best determined when the plate is laid over the RB106 base after all the coils/parts except the base and spade connectors are removed from the RB106 body. Also as shown in the photo (but not shown in the diagram of figure 5B) two large holes are made with burs removed from their edges so that the wiring can pass from the Bosch unit into the base of the RB106.

The unit was constructed this way so it could be a drop in replacement for the RB106 in a TR4A car. If the environment around the regulator body is more crowded than in a TR4 car then this option may not be ideal as the 30019's metal body, which is connected to the dynamo output (armature), must not short to other objects nearby.

In my prototype, the spacer washers have a small projection so they could be pressed into the plate, so that they would not fall away when mounting the unit. This could also be achieved by bonding them to either the regulator body, or the plate.

ADAPTER PLATE TO ALLOW BOSCH UNIT TO MOUNT TO DONOR RB106 BASE.

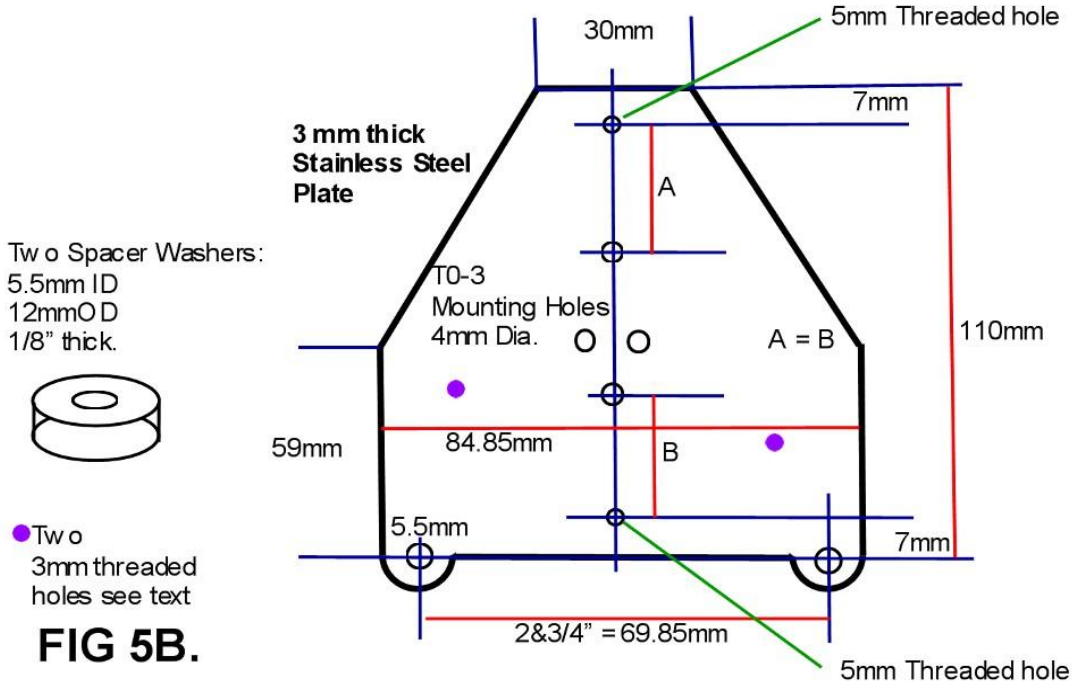


FIG 5B.

Ideally the screws are brass for low electrical resistivity. Brass 4BA screws are about the same diameter as 6-32 screws and are available from RS components, Newark or Element 14.

Figure 5C Shows the rivets drilled out from the RB 106 base. Use a 3.5 mm drill to take the tops off the rivets. These are very thick rivets, 1/4 inch outside diameter and they act as spacers inside the base. The ends can be trimmed on the lathe and 3.5 mm holes drilled through them to save having to make new spacers from scratch.

Figure 5D Shows the arrangement of the screws/spacer and nuts and washers. The screws and first nut are fitted to the RB106 body as show in figure 5E and done up very firmly with Loctite to form studs that the wire lugs can be attached to later, see **Figure 5E**.

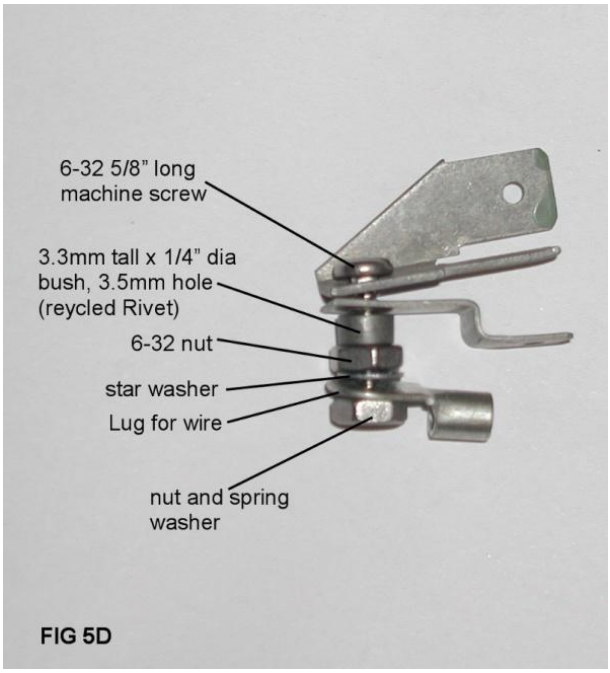


FIG 5D

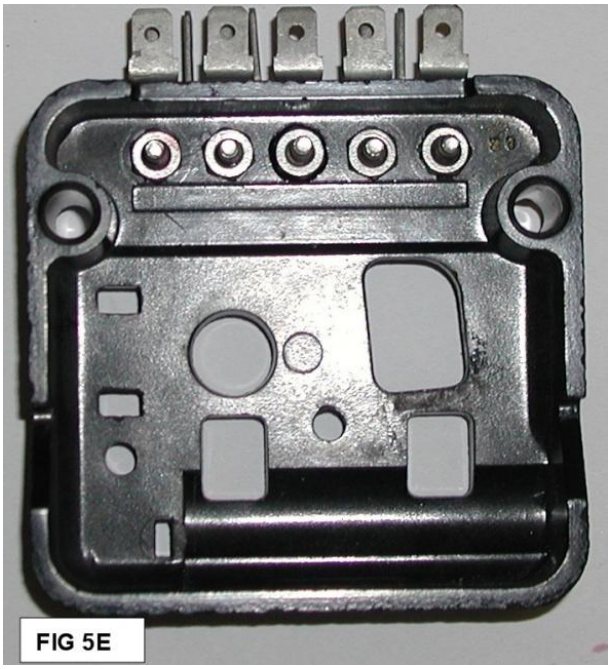


FIG 5E

Figure 6 shows a plate and two metal spacers added to the RB106 base.

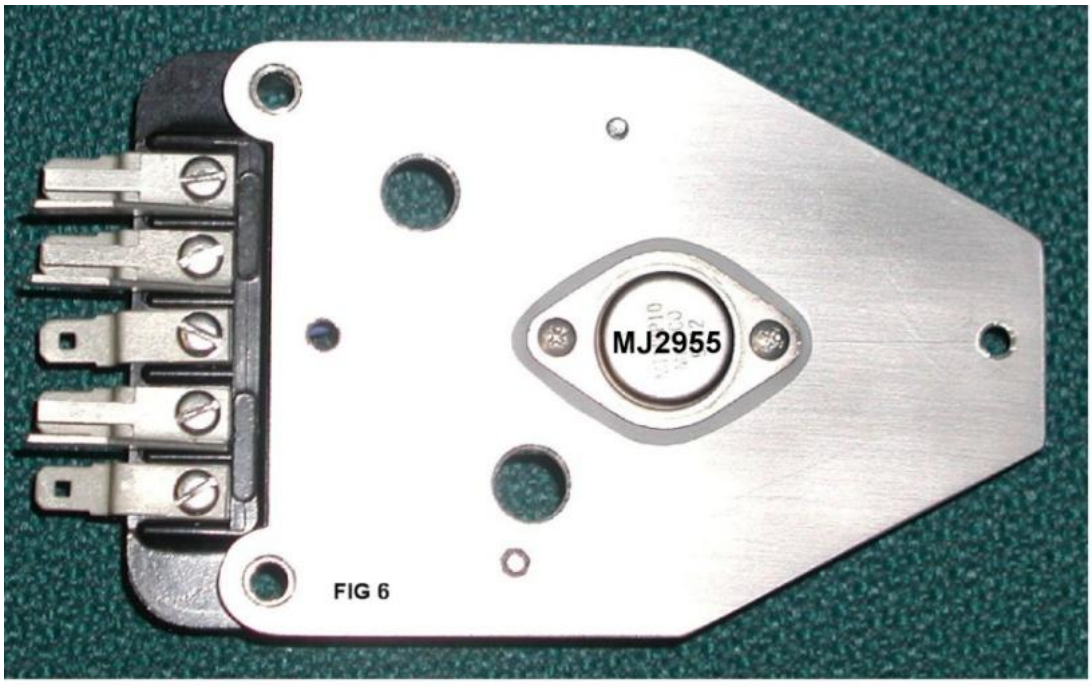


FIG 6

Figure 7 shows a side view and how the MJ2955 transistor fits under the voltage regulator module part of the Bosch unit.

Note the spacers under the adapter plate to the RB106 body. The RB106 mounting screws pass through those. The MJ2955 transistor case (collector) is insulated from the adapter plate with the usual T0-3 transistor mounting hardware. The screw passing through to the RB106 base conveys the collector connection, and the other screw is insulated from the mounting plate.

There could be a number of ways to mount the Bosch unit and this method provides the three features of a home and an excellent heat sink for the MJ2955, a place to house the three added resistors and the diode and a solid physical mount for the Bosch unit and the same spade terminal configuration as the RB106. Therefore no changes are need to the TR car wiring.

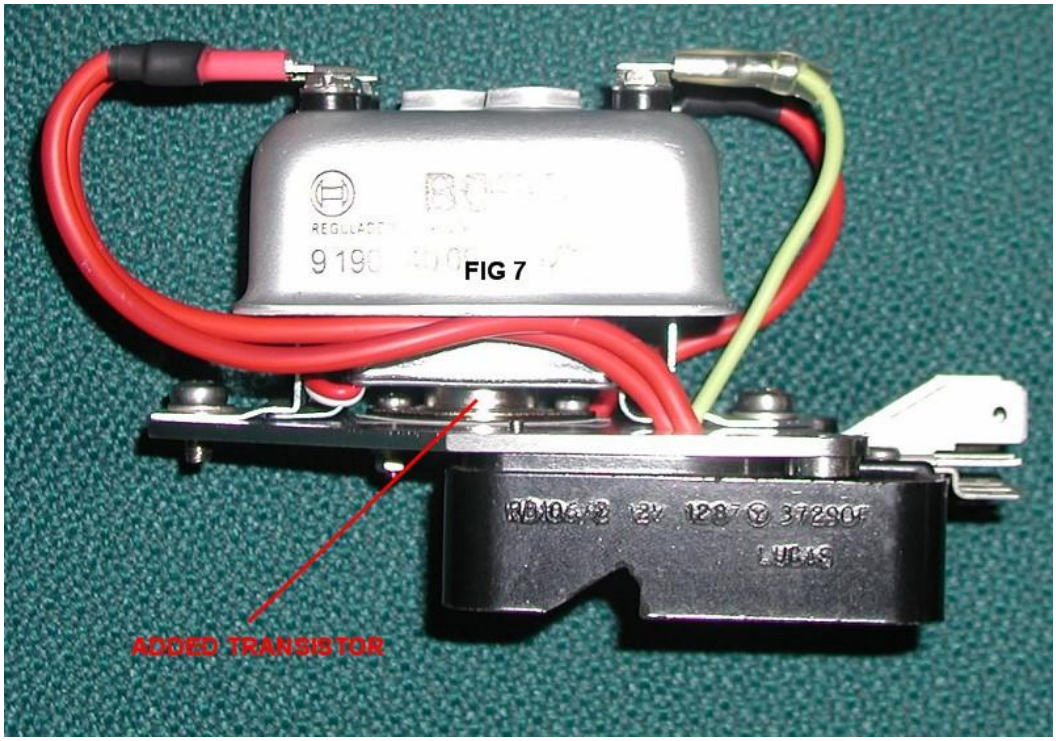


Figure 7B shows a later photo, showing how the inline fuse can be connected between the Dynamo connections on the RB106 base and the D connection on the Bosch unit.

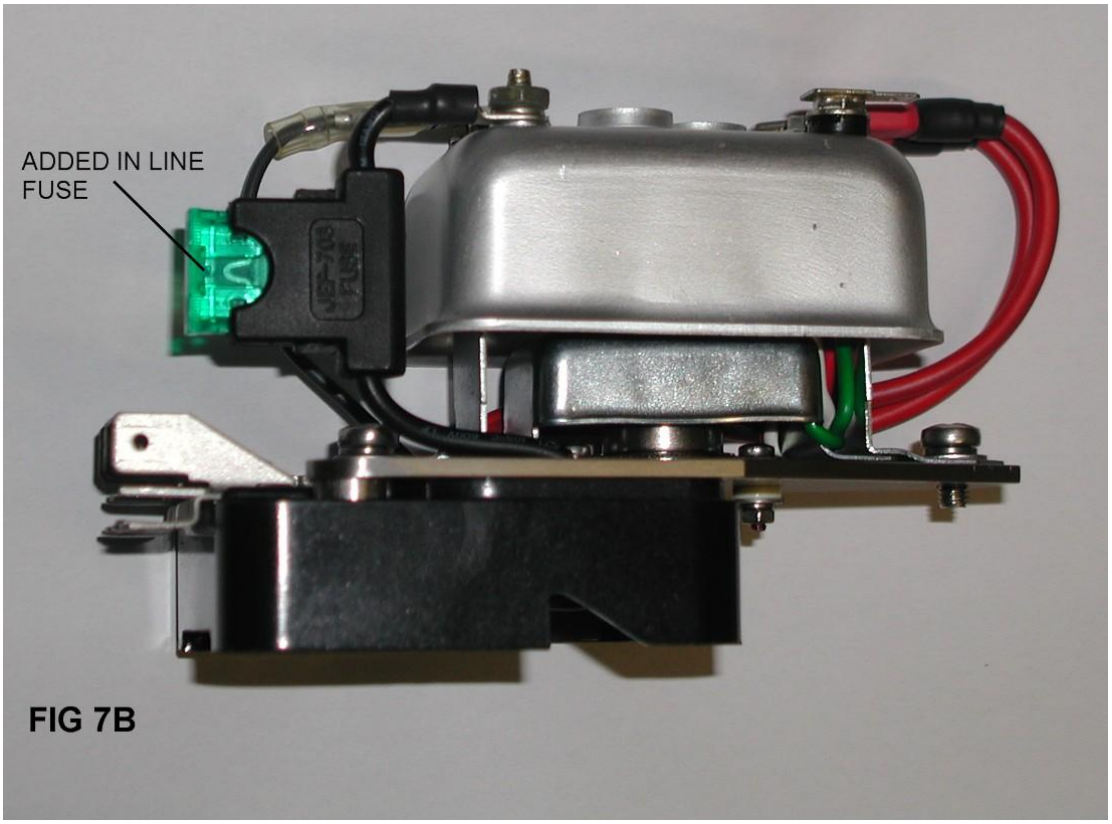


Figure 8 shows the underside view. The blue wire conveys the collector connection and the brown wire the emitter connection of the MJ2955. A tag is added to support the resistor connections and mounted with a spacer using one of the 3mm holes threaded into the top plate.

The other 3mm hole provides and additional link wire (green) for earthing. The two parallel 120 ohm resistors connect to the black wire which runs to the DF terminal of the Bosch unit. The regulator body acquires an additional earth via the mounting screws and metal plate. As can be seen from the figures there was just enough room for the MJ2955 transistor body to clear the Bosch unit's sub assembly and still gain access to the transistors base and emitter connections passing into the regulator body. The 6A10 diode is conveniently mounted across the screw lugs. One of the large plate holes was positioned to be over a pre-existing rectangular hole in the RB106 base.

A unit could be made without a donor RB106 base and it would have to have the same spade terminal array and the same mounting holes to be a drop in replacement. Some regulator units also have screw terminals which usually damage the wires that are screwed into them and are probably better replaced with the spade terminal RB106 versions.

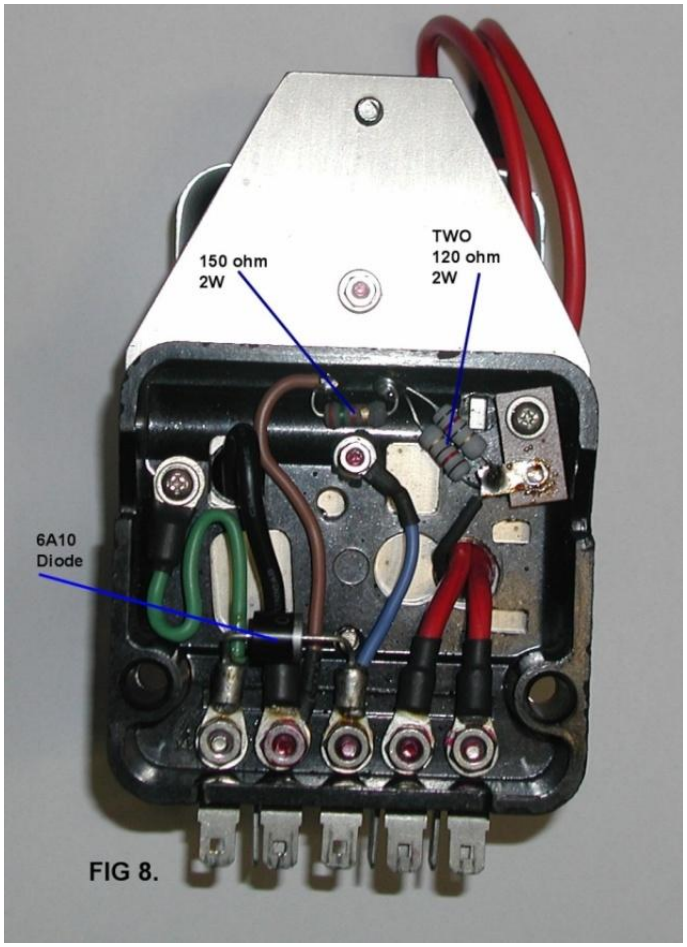
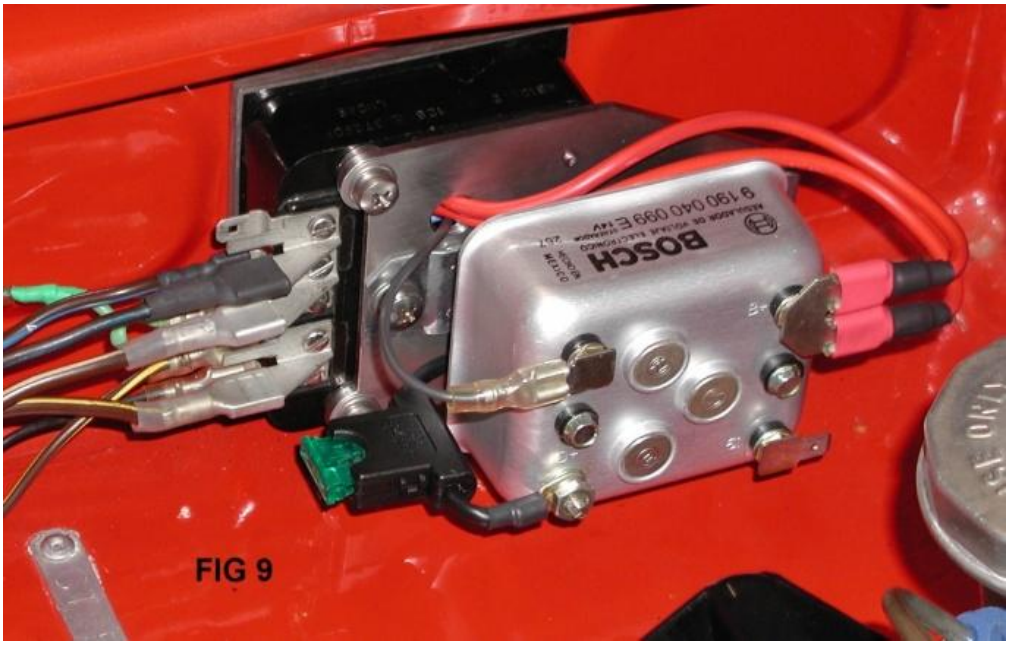


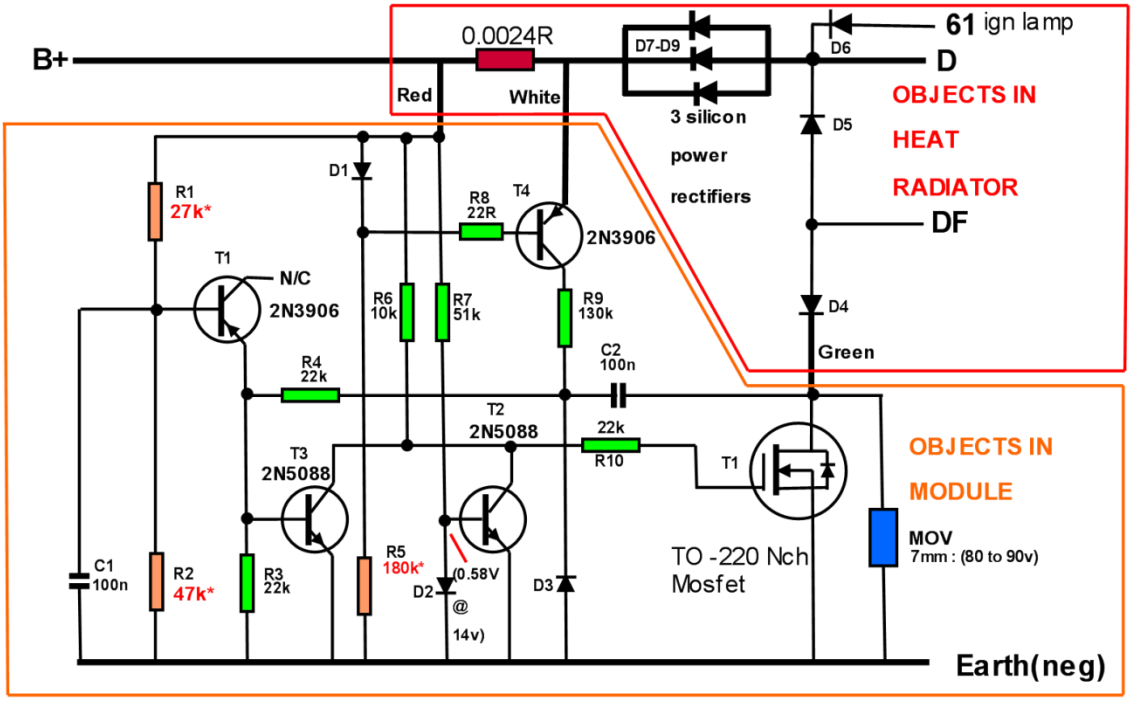
Figure 9 shows the under bonnet photo in my TR4A. The unit has an interesting look to it albeit a non standard look, but a good talking point and far superior performance to the original electro-mechanical RB106.

Note the blade fuse holder in series with the connection to the D terminal. I recommend a 25A fuse for this application. A 20A fuse also works, providing even more dynamo protection but might increase the incidence of a nuisance fuse blow. I also included an insulating sheet of phenolic material underneath it which is not a bad idea even for the original RB106.

The part number of this Bosch unit is 9 190 040 099 E for circa 1968-1980's Volkswagen, they are also called “30019” regulators and used in some Porsche 912 cars. All of the ones I have seen were made in Mexico, they also turn up on eBay from time to time and stocked by various suppliers. I think these electronic units were manufactured in the mid 1990’s.



Although the 30019 regulator is for vintage dynamo regulator applications it is worth looking at what this 1990's vintage design had to offer as an electronic solution to the electromechanical regulator problem. A circuit of what I was able to find is shown below and probably represents the typical type of circuit found in such an electronic dynamo regulator such as the 30019 of the period:



* = Calibration Resistors.

How it works:

The unit is a combined voltage & current regulator. It also has over-voltage protection and reverse polarity protection.

The design of the voltage regulator part is the same is a typical alternator regulator. An input resistor divider of R1 and R2 has voltage subtracted by a zener diode (in this case the base-emitter junction of T1 used in zener mode) and this voltage is presented to the base-emitter of a NPN transistor T3. Of note a signal transistor's base emitter zener voltage is around 7 to 8 volts, and this is the typical value of zener used for the application in alternator regulator modules. This method, as in all typical simple alternator regulators, ensures that the positive temperature coefficient of the zener cancels the negative coefficient of the base-emitter voltage of T3 and also its hfe temperature dependence of T3.

T3's collector current climbs sharply when the B voltage is 14.2V or over and this cuts off the N channel mosfet TI which powers the dynamos field winding. This mosfet is turned on via the battery power on B+ via R6 and is always conducting unless T2 or T3 are turning it off. This allows excitation of the dynamo at the lowest possible rpm. In most electronic regulators the excitation voltage is used to bias on the field driver device so the excitation requires the rpm be a little higher for self excitation to occur.

D2 and T2 form an over-voltage protector to switch off the field, however it might have limited utility as the B voltage has to get to over 40v to get enough bias voltage across D2 via the 51k series resistor to allow T2 to conduct. It might have been better here to have had a resistive divider and had T2 turn on at something like 20V.

The current is detected across a conductor with a resistance close to 0.0024 Ohms in the main body of the unit by T4. The negative temperature coefficient of T4's base-emitter is cancelled by the diode D1 so that the current detection threshold is basically thermally stable. When T4 turns on it provides some base current to T3 which cuts off the mosfet T1. This threshold is in the vicinity of 30 to 35A.

This unit has a low residual current drain with the car not on use of about 0.45mA which is a suitably good low figure. Some alternator regulators can consume as much as 5 or 10mA.

The MOV on the mosfet's drain helps protect the mosfet from high voltage spikes. The diode D4 is used to prevent catastrophic destruction of the mosfet's internal parasitic drain-source diode in the event that the battery polarity got reversed by accident. D5 is the usual field coil snubber diode.

The C2 and R4 feedback pathway is AC positive feedback as used in typical Alternator regulator modules and prevents multiple transitions at the switching points from noise (commutator voltage spikes).

Below is a Lucas machine sensing alternator regulator circuit which is very similar, sans the presence of the current limiter and over voltage detector and they tend to use a Darlington output stage rather than a mosfet:

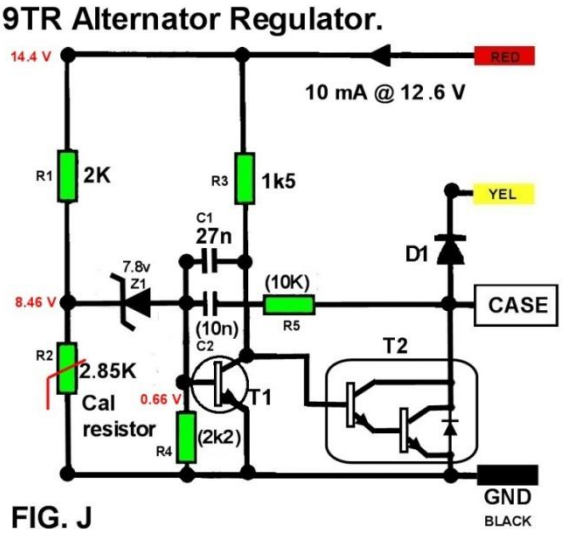


FIG. J

The reason why the current limiter part is required for a dynamo and not for an alternator is explained in the article on Alternators vs Dynamos on the www.worldphaco.net website.

Summary:

The Bosch 30019 regulator unit is one of the few examples of a commercial Electronic Dynamo regulator. The reason few existed is because as electronic solutions were becoming available the dynamos were becoming obsolete for car charging systems. The increasing electrical demands in cars meant that Alternators were the only solution. All new cars are manufactured with Alternators. Bosch built the 30019 as a replacement for the electro-mechanical dynamo regulator units of yesteryear.

The 30019 makes a very appealing controller for the C40 dynamo in a TR4 car and works very well. It does not look original but it does look attractive and is a very well made unit with the kind of automotive electronics quality typical of Bosch products. I would recommend it as a replacement for the Lucas RB106 . It requires the additional transistor interface as described above. The other option could be to modify the internal field connection within the Lucas C40 dynamo, so that it was connected to the output (D connection) and not ground. Then the Bosch 30019 would work as standard without the added transistor, albeit with a non original dynamo connection.

If high current electrical accessories are added to the TR4 car, which mean that there could be a sustained load over 25A, then the C40 dynamo is no longer a suitable charging machine and a 35A or above alternator should be fitted. The C40 dynamo has enough capacity for the standard car only and a few accessories only.

It is worthwhile using a 25A fuse as the current limiter setting in the 30019 appears to be higher than the C40 dynamo capacity.

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