I was given the first regulator for repair and comments. I was the layman here, and the friend already heard a lot about this regulator.

The failure was quickly found and I stopped simply there, not expecting any more consequences.

1) Failed regulator Selectronic N°1

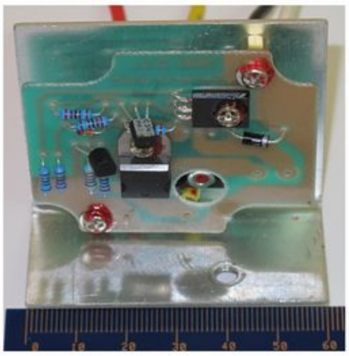
1.1) Selectronic claim

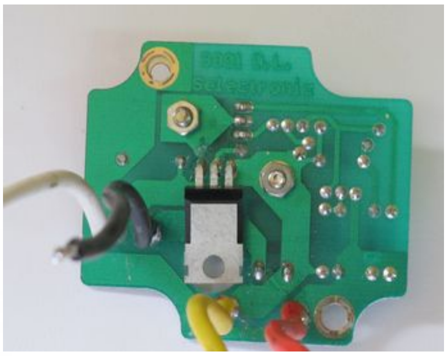
« for ANY vintage bike »

« fits in Lucas original case »

As advertised from their website, may 2013. As the quantity lowers, the prices goes down and up !

1.2) General view





External view of radiator | PCB view, component side | PCB view, bottom side

1.3) Function

It is a dynamo regulator for british dynamo (positive earthed)

The dynamo regulates the field of the dynamo to provide up to 8,5A at the battery (7V). Precise working explained later.

1.4) Composition

1.4.1) Printed circuit board

Single side, gold plated FR4 epoxy with solder mask

ref 3801D.L. Selectronic

Well manufactured. Gold finish is OK because the quantity of solder is big enough to dilute gold in tin at an acceptable for the intermetallic combination. Double side PCB ensures good holding of feed-through components.

The circuit is correctly cleaned from flux residues after soldering. Then, a second phase of manufacturing (output wires) was done without cleaning

No general protection with varnish.

1.4.2) Pinout

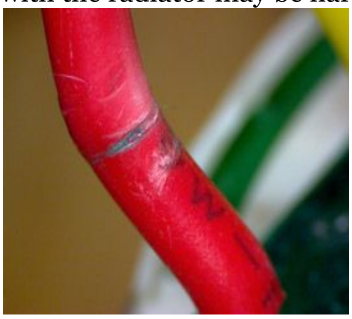
- Red = Ground = +Battery
- Blach = - Battery
- White = Field
- Yellow = dynamo OUT

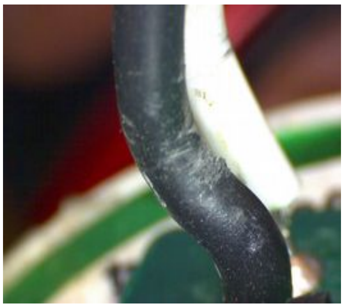
A diode links the yellow and black wires, avoiding current flows from battery to armature (cut-out). All charge current flows through this diode.

1.4.3) Wires, wires assembly

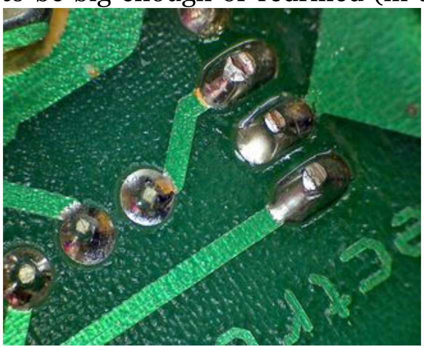
External links are made with 3mm wire 16AWG copper = 1,29mm dia, section $1,31mm^2$, labelled for use at 105°C.
Good quality wire, listed UL possibly made of reticulated polyethylen, much better than PVC. The copper has white metallic finish, poor solderability.
The wires are fed directly through the aluminium radiator in a 4mm hole, no bonding NOT CONFORM (IPC610, class = toys !)
All wires are wounded by the radiator (not deburred) but the wires are too big to go into the PCB holes, they are soldered butt to the PCB, with various angle at the radiator.

All wires are wounded by the radiator (not deburred on one side, fortunately, on this sample on inner side, where the wire moves less). Because the wires are NOT going through the PCB, the angle at the radiator varies, and the contact with the radiator may be hard.



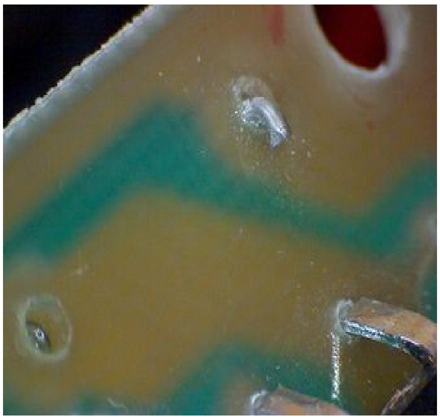



RECOMMENDATION = bond the wires to the PCB and to the radiator,
Ideally, the wire should have a stress relaxing loop. Anyway the holes HAVE to be big enough or redrilled (in this case, solder on both sides) .



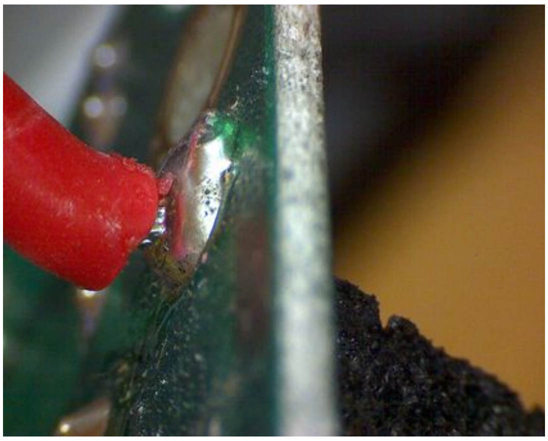
- Correct solder except big wires
- leaded solder (probably illegal for sale since 2006)

The solder flux residues are cleaned on the PCB, except for added elements, probably added in a second phase of manufacturing : big wires and TO220 transistors. This may induce long term corrosion problem and moisture sensitivity. NOT CONFORM anyway, but probably not so important here because of the presence of solder mask and no high impedance circuitry
No wire goes rhrough the PCB because the copper diameter is bigger than the hole ! So, the wires are butt soldered and not centered.
A traction stress is not welcome here ! NOT CONFORM
The red wire is very bad soldered : no wetting of the copper and an excess of solder flowed through the PCB hole (a touch of soldering iron showed that it not a wire going through the PCB, NOT CONFORM



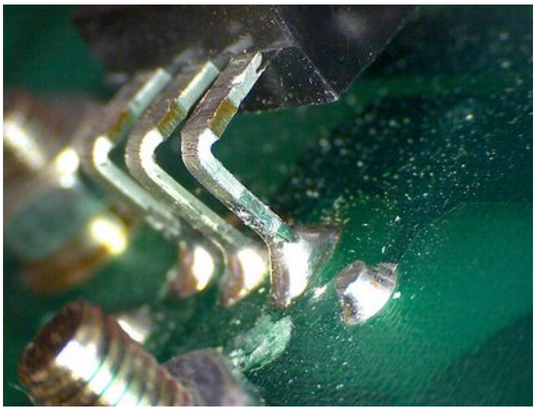
flowing of solder,

not even correct on other side!



Solder to be made again, after drilling a correct hole and total insertion of wire
The transistor screwed on the radiator has a too sharp bending radius, and cracks appeared in the electrode NOT CONFORM

The electrodes which survived to assembly, may break eventually under vibrations
(remember, this is made for british vintage bikes, and they have a reputation of high level of vibrations, mostly in the range of 10 to 100Hz)

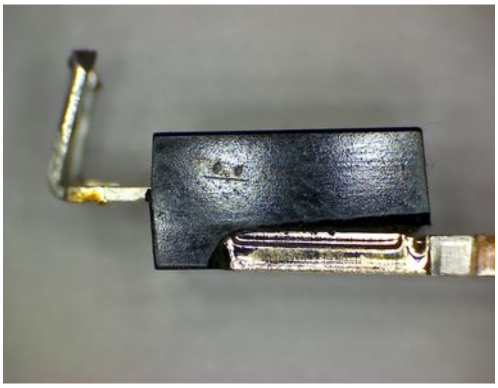


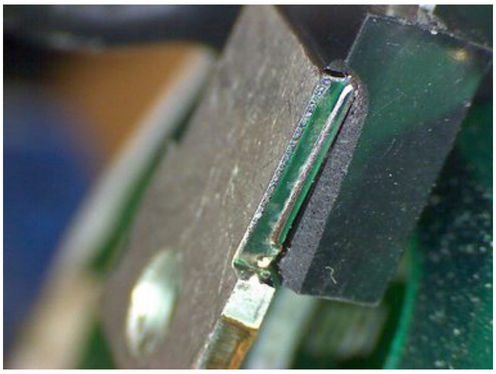
1.4.4) Components

- dated 3 = 2003 or 1993
- Resistors : ALL in 1% tolerance = OK but not necessary for all (to be seen in schematics analysis)
- STPS1545 = diode Schottky ST Semiconductor 45V , 15A, 175°C, NO radiator
- BD136 power transistor Philips PNP, 45V , 1,5A, 10W, 150°C, no radiator
- two C547 (= BC547) transistor NPN, 60V , 100mA, 0,5W Philips
- power transistor on radiator: TIP41C Fairchild NPN, 60V , 6A, 65W, soldered bottom side of PCB
- one diode 1N4007 1A 1000V field back surge absorption . Usually this diode withstand the nominal current of the coil protected, I expect then a 1A max current with some possibles peaks.

The Schottky diode STPS1545 allows 15A on infinite radiator, and able to work at 175°C (but at zero current) The assembly without radiator allows the current no more than a few tens of seconds, computation to be done, according to real parameters of the dynamo.
Active components from « big » brands : OK
The TIP41 transistor is badly assembled and destroyed himself!
Hyperstatic assembly, not any chance of flexibility NOT CONFORM bending radius smaller than two times the lead thickness NOT CONFORM. The transistor is fixed on the radiator ans his leads are soldered on the PCB. As he is soldered to the bottom side of the PCB, he is placed approximately on place before the assembly of the radiator. The stiffness of the leads, vibrations and temperature increased the cantilever effect and splitted the epoxy from the

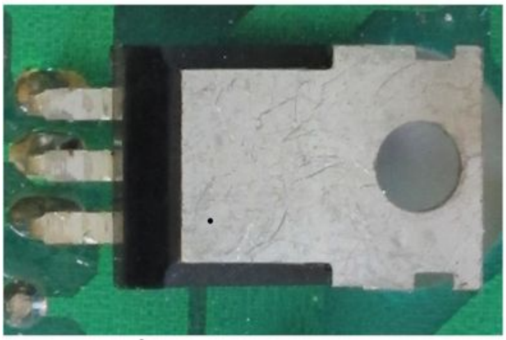
copper base plate. The side of the copper plate are not visible in a healthy transistor.





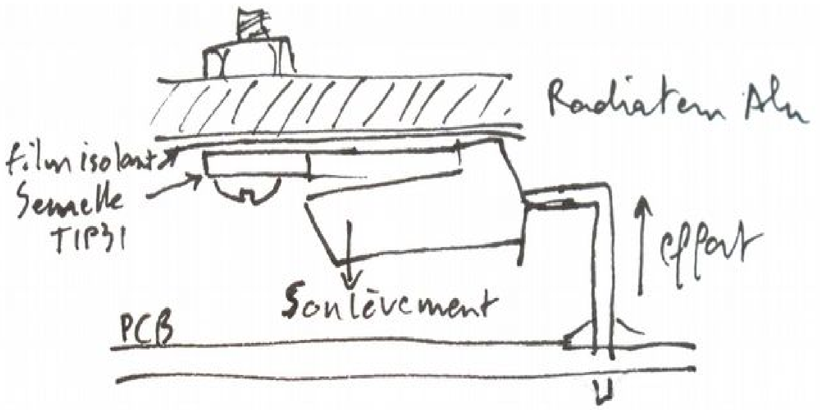
In fact the broken transistor could have been seen by very careful inspection (and by somebody aware of this very uncommon failure)

the abnormal aspect of the transistor deep and bright black color for the normal part of the transistor, grey and finely grainy aspect of the broken part



1.4.5) Explanation of the stresses:

The stress is in that direction (« effort »), because the vertical part (in this drawing) of
the lead was slightly too long. The solder spot in this position gives a strong application point to the force. And the lenghts are just short enough to avoid bending.
It is possible than if the lead is too short, when the screw is torqued, the copper plate can be bended (restricting the thermal transfer), or the lift of the epoxy may occur on the other side.

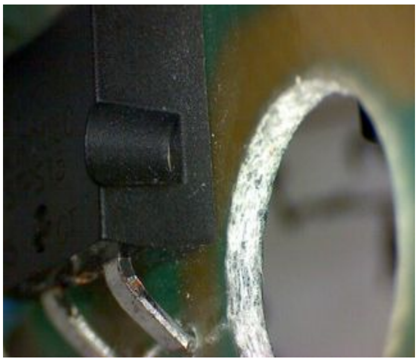


Film isolant=isolating sheet (silicon)
semelle=plate of transistors
soulèvement=lift up
effort=stress

In this assembly, the destructing effects of this design are dependant of the torque applied to the silicon sheet because of the « elasticityé of the silicon sheet and of the nylon screw insulator.
In addition to that, the solder spots are located in the worst place : exactly in the axis of the two PCB fixation screws !
Because it is now obvious that there is no electric relation with the remaining of the circuit, and the schematics seems simple, I simply replaced this transistor only. **It works !**

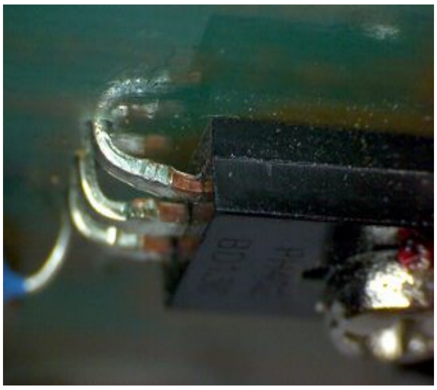
1.4.6) Mounting of other components

<u>Diode STPS1545</u> : the bending of the leadsdos not start at a minimum distance from the body NOT CONFORM, risk of moisture penetration and internal corrosion. In addition, the mounting without radiator does not allow the maximum current of 15A (this current is specified by the manufacturer, but only with <u>correct radiator</u>)



diode

BD136



<u>BD136</u>
One lead is bended too close to the body, we can see a black line showing separation bodylead. It is preferable to replace it.

<u>TIP41</u>

An example of more tolerant mounting of the transistor.
This one was not a new one, that explains the irregularities.
This transistor, was only used for checking the hypothesis of single failure.

1.5) Electrical measurements

Regulated voltage (measured on lab power supply, not on dynamo circuit) = 8.26V . It is consistent with values I already observed on some Zener regulators for alternators, I don't say it is correct ! It seems to me that it is a boiling voltage for the battery, and is probably not good for long term. For example in a 12V car circuit, the voltage is limited to 14.4V or14V (7.2V on « 6V » circuit). For reference purpose, the reference diode voltage is 5.48V .
The regulator shows no linear behaviour, (maybe for a few millivolts only). This proves the insensibility to individual chracteristics of the transistors, allowing the replacement by any other, in the power range.
For replacing the dead TIP41 (not knowing the exact need, I just want a type withstanding at least the 6A of the TIP41, I finally decided for a MJE3055 NPN, 100V , 15A, 90W, just because it was available in my drawer. Mounted obviously with short wires, so the PCB and the transistor on the radiator are now mechanically decoupled.

<u>RECOMMENDATION : dismount the TIP41, place linking wire between transistor and PCB</u>
of course, after checking the good health of the transistor, and shortening the leads to 5mm, because the solder has NOT to go up to the body, the copper diameter could be reduced to 1mm, considering the short lenght of 2cm max.

1.6) Conclusions on the assembly of the regulator

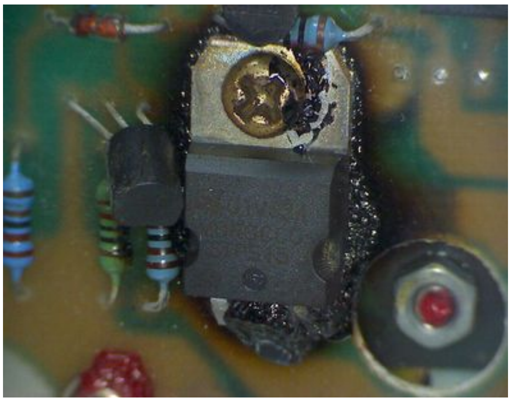
Not knowing the schematics (not yet reconstructed, but knowing how a classic regulator should be), I can say that the components are from good quality, some are overspecified (no need to bother to compute exactly the necessary power or precision) not a problem, only somewhat pricier (except schottky diode)
Most of the PCB is well made, soldered and cleaned

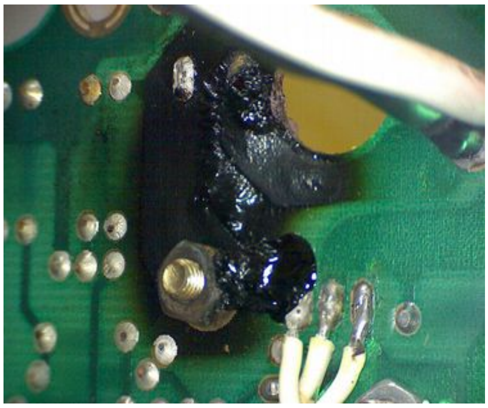
But the mechanical design is BAD (some points not conform to IPC 610 standard, class : toys). The mounting of the wires and specifically of the transistor TIP41 is BAD. This failure is the consequence of truth.
In my (humble) opinion, it is necessary to :

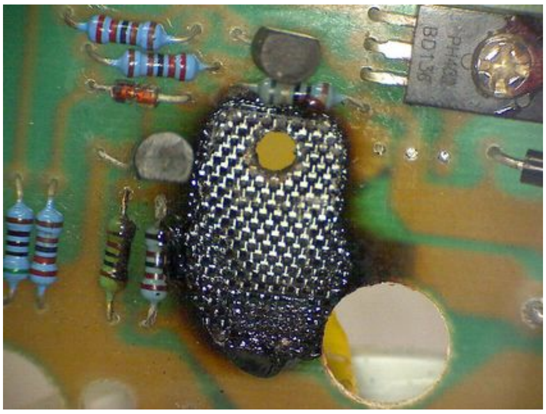
- **change the assembly of the TIP41, and add wires to link the transistor to the PCB, change the transistor if any suspicion of stress**
- **redrill the wire holes in the PCB and resolder them correctly (two sides)**
- **glue the transit of wire to the PCB**

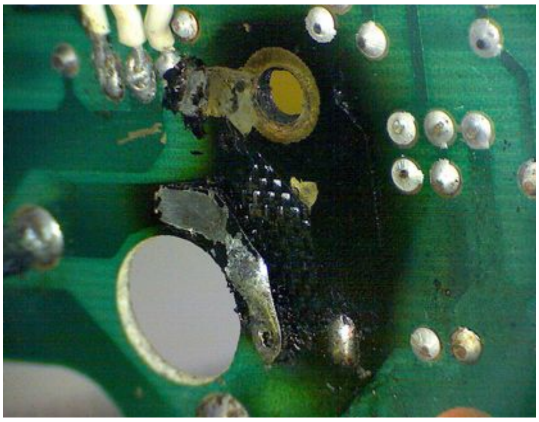
This analysis was sent to Selectronic on March 2012, in hope (I had a dream) the future deliveries will be reliable.

(completed May 2012)
This regulator came back with a new failure, after being mounted on a Sunbeam. The owner wanted to ride with headlight on (not mandatory in France for vintage bikes)
The result is impessive !!









Catastrophic result, visible to nacked eye, with characteristic smell of « burnt electronics ». But it is only the PCB which apparently suffered. Copper tracks separated from the rest of PCB, migration of solder underneath, it means that the temperature went over 183°C (because I suspect the use of tin-lead solder) Anyway the temperature of the diode never should have been over 175°C.
Of course, the diose is dead, showing unstable resistance from .1 to 10 ohms, both directions.
Could be a way to create carbon look parts !
The diode is totally unable to work at nominal 8.5A dynamo current with its genuine mounting
It's even destructive and now the battery current flows to the armature with great risk of burning it.

I'm now reconsidering my first opinion :
<u>**Selectronics delivers a device unable to work with the Lucas dyamos, 40 & 60W.**</u>
They clearly did neither test the device, nor simulate it !

2) Regulator N°2

Received in « working » condition

2.1) Measurements, components values

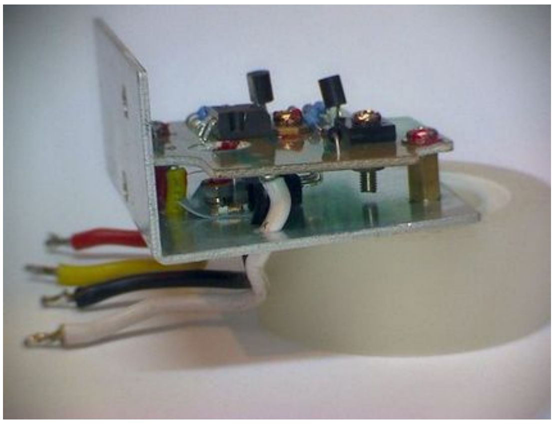
The resistors are exactly the same, it mesna there is NO adjustment made by Selectronic.

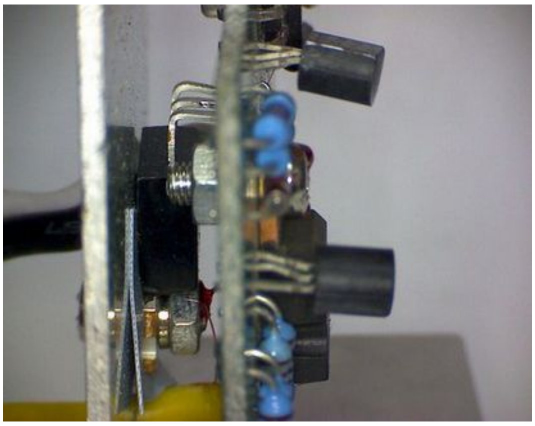
The Zener diode shows a different value, means a different charging voltage on the battery.

Zener voltage	= 5,79V (regulator #01 is 5,48V)
regulation voltage	= 8,77V (regulator#01 is 8,26V)

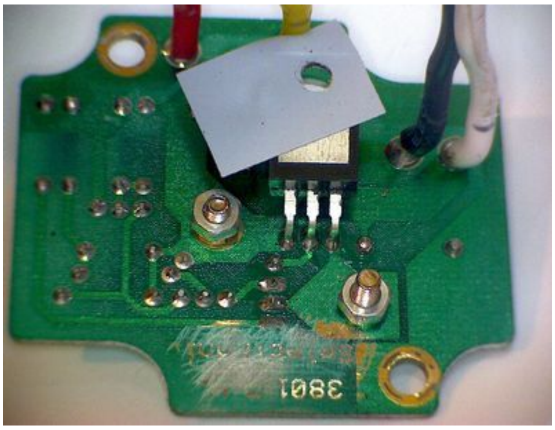
2.2) Observations

- TIP leads shows not a too short bending radius : OK
- silicon insulation sheet is wrongly placed underneath the TIP41, no correct heat transfer, nor electric insulation : NOK
- only one wire goes trhough the PCB, no correct soldering : NOK
- PCB wrong placed

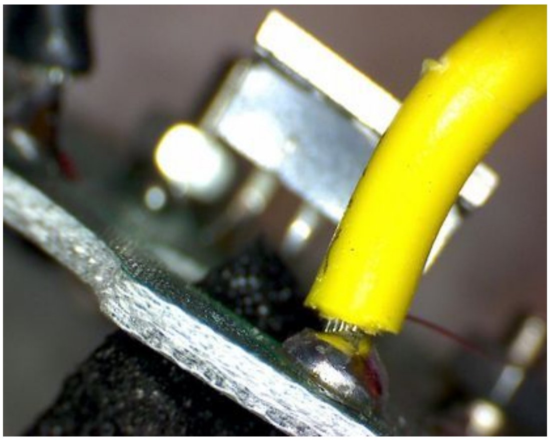




PCB & eadiator non parallel
Wire is bent forced
silicon sheet wrongly placed



bad placement of silicon sheet
unexplained scratching of solder mask



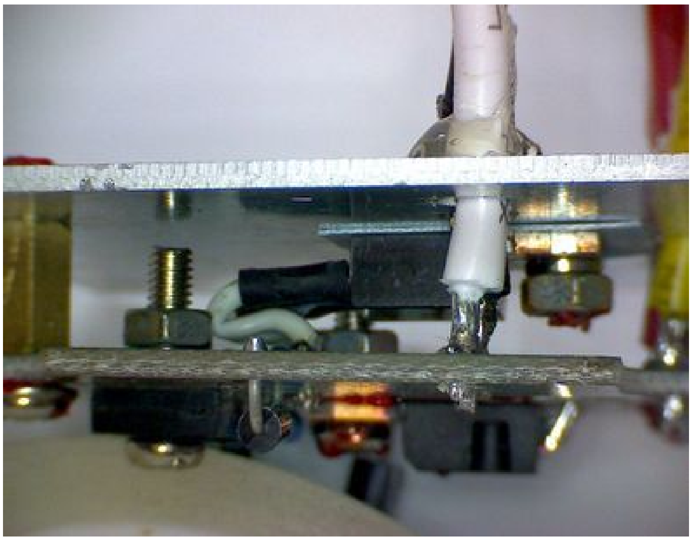
bad solder spot
bad wetting of wire, wire not going through PCB

wounded wires on radiator thru-going :



2.3) Back to conformance

This unit was put back to conformance, with above recommendations.



2.4) Electrical tests

Obviously, no change in regulation voltage
Tests unde rload 9A, as expected the D1 diode died prematurely, **died after one and half minute no margin, unacceptable**
D1 is replaced by a MBR545 (1,3€ at Selectronic) The two diodes were put in parallel. Diode on radiator. The temperature rise to 35-40°C, from 25°C, **very acceptable**.

After adjustment with resistor parallel to R3, regulation oltage becames 7,2V, at regulator level.

The regulator is mounted on a S8 Sunbeam 1952 built, Lacas dynamo 6V 60W, withstand hours, at air temp of 30°C

3) Regulator #03

Received by the friend Roland (from « geriatric institute of motorbikes »)
D1 diode was already dead : open circuit. Unit was reworked and adjusted for 7,2V.

Mounted on BSA 350, 1954

works just fine

4) Regulator #04

Wrong identification, does not exist

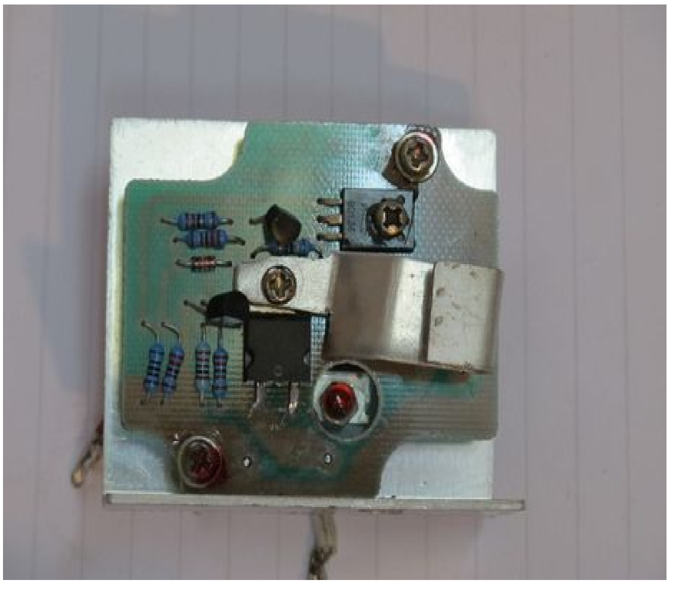
5) Regulator #05

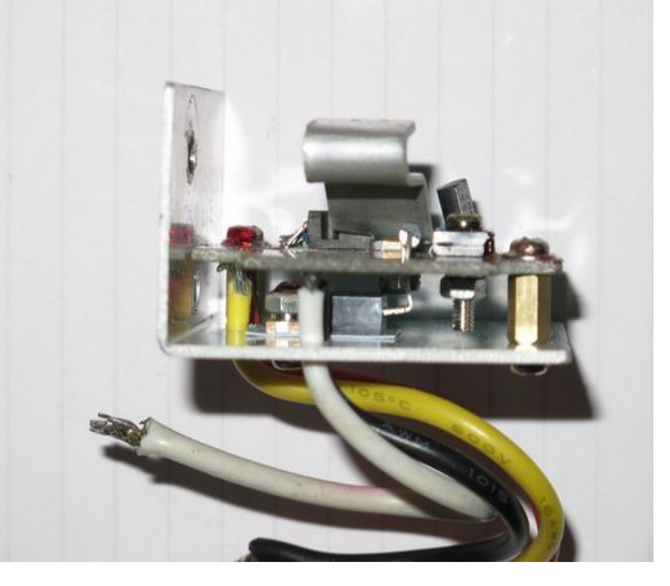
Zener voltage 5,75V

regulation vltage 8,85V

reworked an adjusted for 7,3V

6) Regulator # 06 (Fred)





Sent to me by a member of the french BSAmicale wit following remarks :

fred to zibuth, 2012-12-27

hello, where are you located ?

Regulator is actually on MCR2 base, I observed tha one component was heating a lot, I added a small radiator **point 1** probably not with state of the art rules. In fact it worked for around 450km

After 400km the old armature burnt out and lamps burnt, like chromated inside **point 2**

after 50 more km, new armature burnt out and alive regulator

Disgusted, I simply replaced by a « good » MCR2, still works

I bought the Selectronic, only for the delay of finding a working MCR2

later message ...

point 3 bike is a M20 from 1943, measurements directly on battery

later ...

point 4 new wiring (2 years) 2,5mm mltitthread wire. New bullet connectors. Wiring seems over suspicion

later ...

point 5 battery is a 6V 10Ah, **point 6** lighting 45W hi and 20W lo **point 7** magneto ignition

later ...

point 8 battery fully charged before departure

later ...

point 9 ammeter is the one on bike, dial +10, 5, 0, -5, -10, around +6 or +7 with lights off, 5-6 lo-light, 3-4 hi-light

later...

point 10 with MCR2 +2-3 no light, 1-2 lo-light 0-1 hi-light, obviously less power boosts less than Selectronic !!

later ...

point 11 voltmeter I used is AOP Multipreci, taped on tank, never above8V, always between 7,5 and 7,9V, only for a few seconds 8,2V

later ...

point 12 every failure was detected by reading the bike ammeter (in headlamp case) when the needle stayed at zero. Right after, no longer charge, lamp goes down, voltmeter under 6V, even high throttle

later ...

point 13 first armature burned when I was lo light, smells burnt device, blueish iron, molted solder spots

later ...

point 14 I realized the D1 overheating by opening the case : smells burnt electronics, my fingers felted the overheating of D1. After installing mini-radiator, I felt D1 still hot but much mower, all observed in lo-light

later ...

point 15 new armature has the same figure, smell, molted solder, iron blueished

later ...

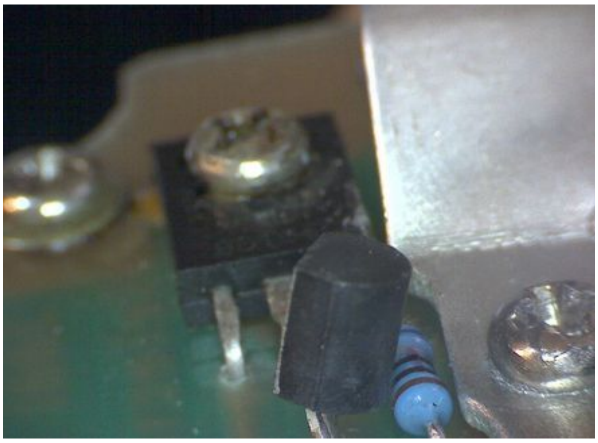
point 16 no apparent battery electrolyte loss,

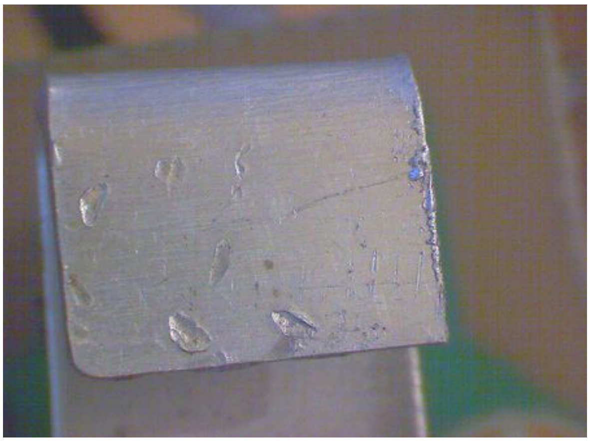
6.1) My observations

The printed circuit is parallel to the radiator, wires are straight, slightly wounded (no consequences yet to the failure). Transistor TIP41 directly mounted (no wires), withstanded faliure.

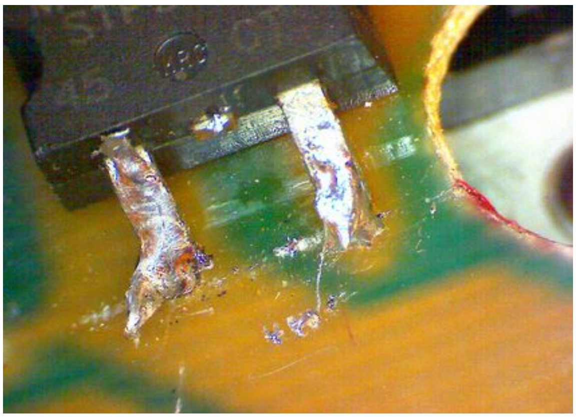
D1 diode has a small radiator added by owner, thermically somewhat better than genuine assembly. He could have been a bit better if the aluminium plate goes underneath the diode body, approximatively in the middle of the epoxy body, where the heat source is placed. Anyway, this fisrt aid radiator, allowed the diode to survive (at the price of two armatures !)

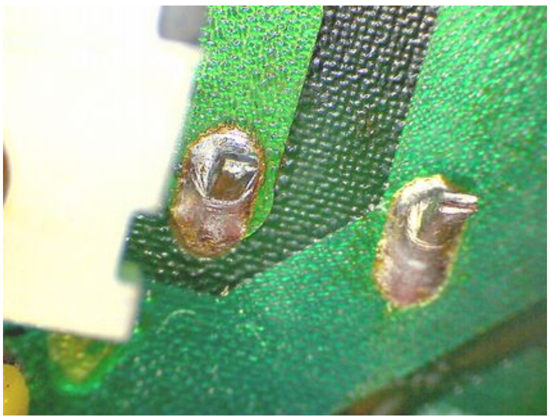
The radiator does not touch the closeby resistor . No trace of touching of this radiator with a live conductor , nor with ground.

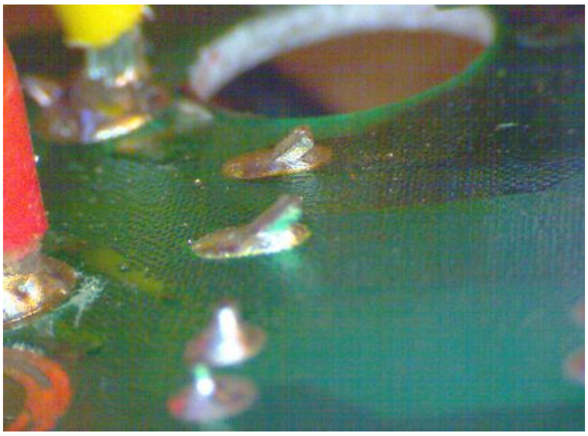


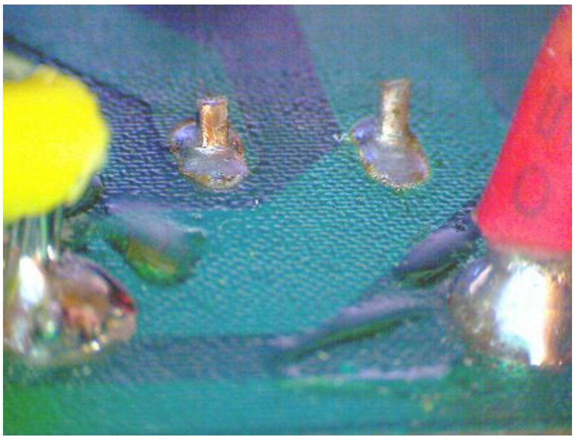


D1 diode shows remains of solder on top face of PCB. Cautious looking shows no trace of a soldering iron touching the PCB, it is then molted solder, by temperature effect of the leads, which migrated on the surface of the leads. One can see reflow traces and concentric traces in solder on bottom side pf PCB, with los of material (of course, some went to the other face). Slight discoloration of epoxy and lifting of the copper track.









6.2) Answser to Fred's points and analysis

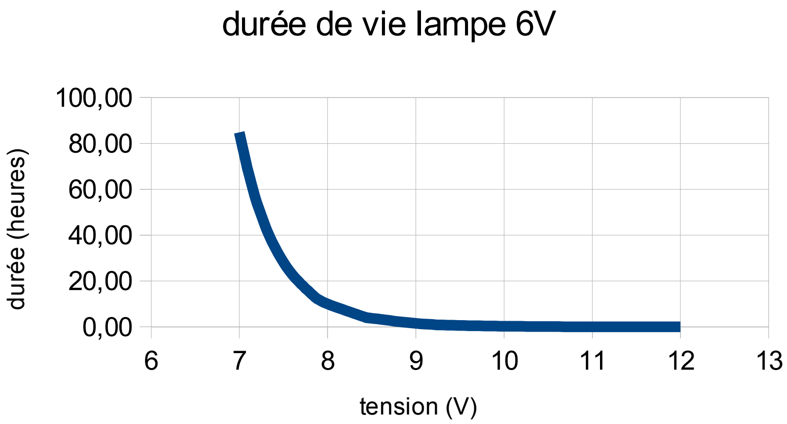
Point 16 when the battery « boils » only gas flows out the vent. I tried it, in lab conditions, on a Tashima battery with a single transparent vent hose : nothing to see. Anyway, it needs a long time : to vaporize 9 grams of water, 26Ah are needed (equiv to 96500 coulombs), making 3 grams by battery cell, not visible, but 22 liters of gas.

Fred observed observed chromated lamps (**point 2**) it is the classical aspect of largely overvstressed lamps, this reduces considerably its lifespan. The lamps lasted 400km, meaning 10 hours at 40km/h, the voltage should have been 8V. Of course, at lamp electrodes level ; including all series resistances, wiring, switches, obviously lower than regulated voltage

based on relation :

d=1000 x V/6 x EXP-16

durée = time (hours)
tension = voltage



Points 9, 10,12 we never see current being negative, and when armature is broken, this current stays at zero (when battery discharges). This means that the ammeter is placed in the dynamo output, between star point and regulator (position 1 in the next figure) It shows only the current going out of the dynamo. Strange cabling …

point 10 with genuine regulator Fred reads 3A (no lights) 2A (lo light) 1A (hi light). We see the same ratio with Selectronic regulator (**point 9**) current diminishes when electrical load increases. This shows that he ammeter is now located between star point and battery (position 3) Contradictory with **point 12**.

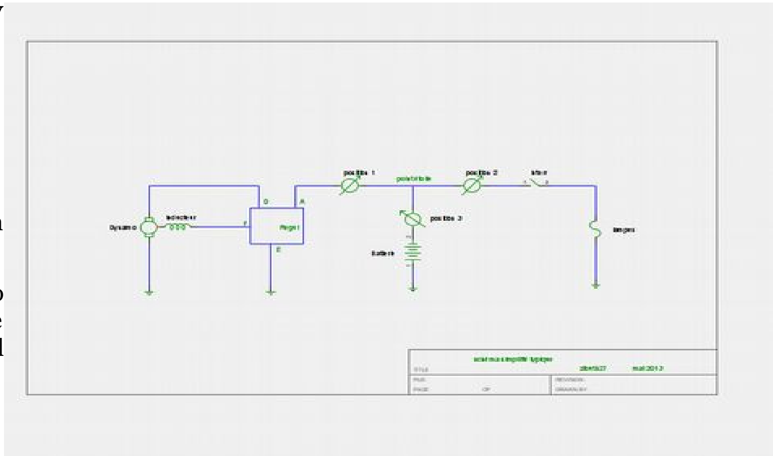
Star point = common point between dynamo, battery and electrical loads

possible ammeter mounting

pos1 : never shows current if discharge

pos 2 : never shows current in charge, current increases with load

pos3:shows charge and discharge of battery. At hi rpm : no load all current goes in battery, with lamps the more the lamps draws, the less the battery charges (**classical mounting**)



points 7 & 10 : Selectronic hi light = 4A, MCR2 hi light = 1A, consistent with Selectronic overcharging. Lucas « boosts less »

point 11 : the AOIP voltmeter Fred used is almost as old as the bike. We could assume if Fred is not electronician and not familiar with instruments comparison or calibration. Here the accuracy of instruments is important, because the results are very sensitive to the voltage (lifespan sensitive to the power 16 of the voltage)

point 4 : wiring rebuilt with correct copper sections, goob, and probably better than the original loom. But tle Lucas technology of « connectors » in the regulators is far from perfect

point 8 : battery fully charged before departure. Good, less questions left to be asked.

Lucas regulator regulates to 7V, the lamps will then absorb 57,6W and 4,11A. **Point 10** shows that the difference of current between lamps ON and OFF is 2A, showing unaccuracy of ammeter.

6.3) Electric balance

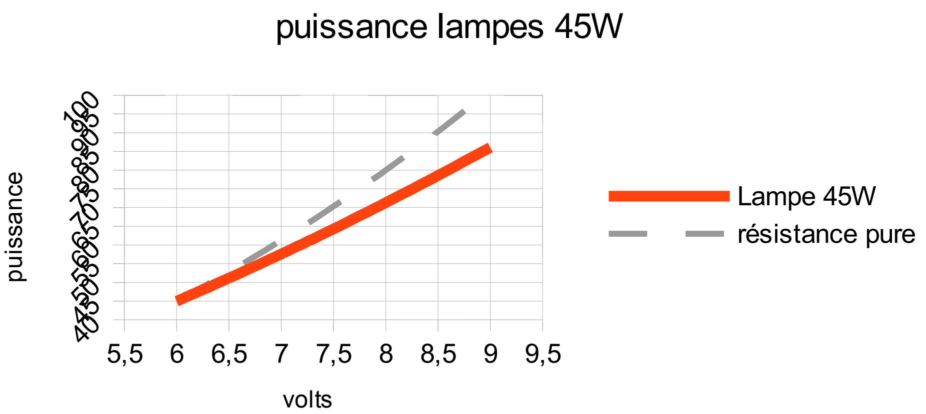
6.3.1) Normal behaviour

Normal working is with the Lucas regulator

Remark on ammeteres, these are not (at all) known for their accuracy. We can only believe the zero position by reading it when all is OFF .

About lamps (supposed here old technology no halogen) We will assume they are powered at 7V, this means a slight overvoltage 16 %, power overlasting becomes 25 %, lifespan becomes 200 hours (I remember having read such values somewhere sometime)

(puissance = power)



With 45W, Fred overloads the dynamo by 55 %

6.3.2) Behaviour with Selectronic at 8,45V

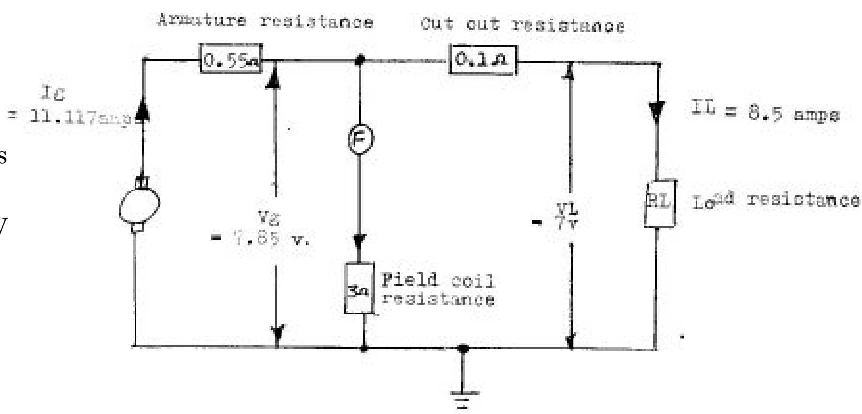
8,45V is the regulation voltage I measured on my bench with a 2A load on Ameter output.

John Gardner ate for E3L (60W) dynamo

60W are with 7V on battery

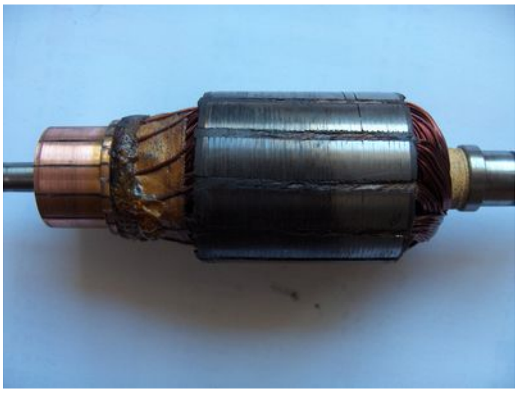
E3N : armature resistance is 0,5ohms, current is 5,7A

main information : systems works with 7V battery and 7,85V dynamo out (anf field coil in)



Overloading is now 148W !!

This overloading, due to Selectronic lack of accuracy, requests an over power of 300 % from dynamo. This a sufficient explanation of armature destruction



Fred's poor armature !

Blueished iron , molted solder spots, shows an impressive overloading

point 14 : Fred added a radiator on Schottky diode D1, gives a thermal resistance of around 20°/W, compared to the 45°/W from the original Selectronic mounting. This could have leaded th the melting of solder fo D1 instead of its destruction.

I tested the Fred's D1 with a 10A current on his small radiator. Temperature increases from 20°C lab, to 130°C on diode package. The diode will be off authorized limits if amient temp rises.

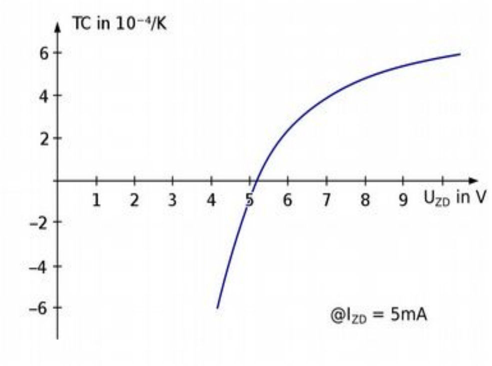
Its is necessary to mount D1 on the main radiator of Selectronic regulator

Selectronic regulator gives voltages way too high, I measured up to **8,45V on battery** output (e**quivalent to 16,9V on 12V battery, way too much !**

Values on some regulators I tested

régulator	zener	V dynamo	V battery
Reg 1	5,48	8,26	7,76
Reg 2	5,79	9,27	8,77
Reg 3	N/A	N/A	N/A
Reg 5	5,71	8,85	8,35
Reg 6	5,72	8,89	8,45
Reg 7	5,70		
Reg 8	5,70		

Remember, the lead-acid batteries have a temp coefficient of minus 2mV/°C by 2V cell. The zener diodes used here have a temp coeff of plus 0,1 to ,02mv/°C, exactly the reverse of expected (although Lucas did it well on his old regulators)



The output voltage on Selectronic depends on Zener voltage and on the resistors values (here with a good 2 % tolerance) and Selectronic delivers regulators with various intarnal references 'Zener) and does not adjust the output voltage : all resistors of all regulators are the same.

6.4) Conclusions on regulator #6

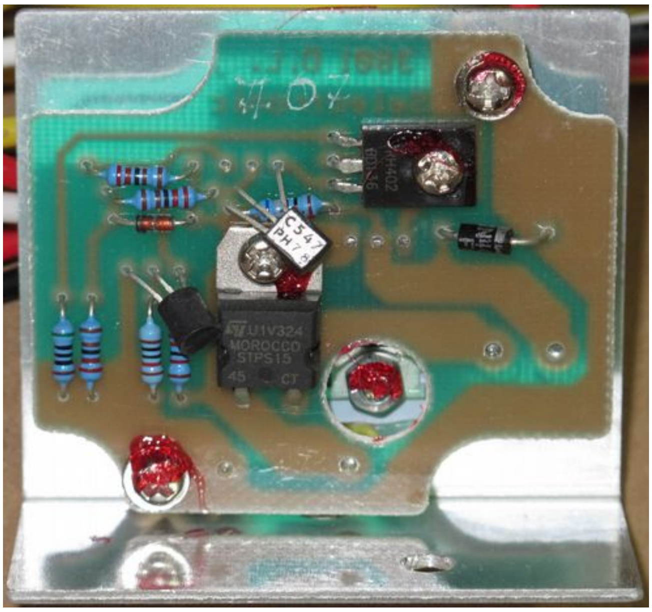
Fred overloads dynamo with 45W lamps, this alone is not catastrophic, the dynamo may survive
this regulator was modified for protecting diode D1, but his output voltage , the higher of thos I have tested, was not corrected and caused important damages
lamps with short lifespan (10 hours)
important charging current in an already fully loaded battery
important current for the dynamo, caused destruction of 2 armatures

it is absomitely necessary to adjust the Selectronic regulators an to protect D1 diode.

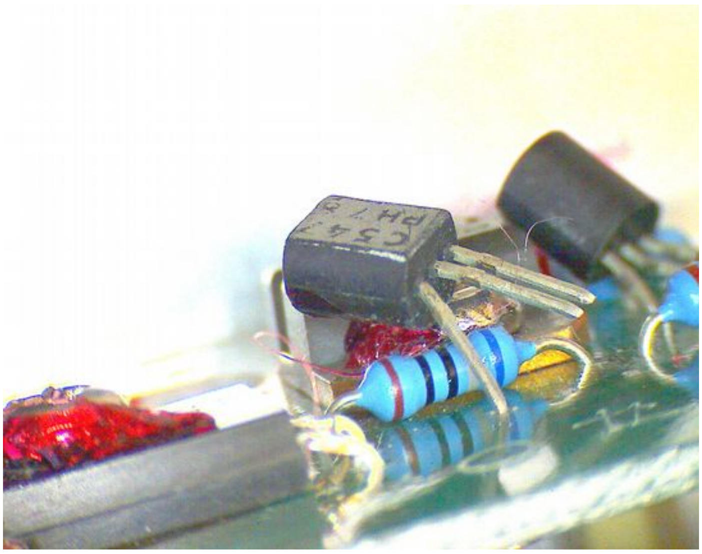
A fuse protects armature and is necessary as the Selectronic does not limit the current (Lucas does)

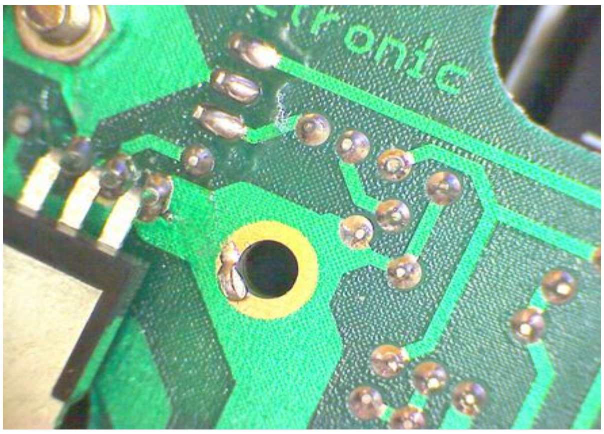
7) Regulator #07

Received DOA T1 transistor ha two cut leads
zener voltage is 5,70V



wires almost well soldered but not in the PCB holes (too small)





fixing screw of D1 had no residual torque. A solder drop was on the pad
Even if it had been good torqued, the creepage of lead was in charge of untorquing

8) Regulator #08

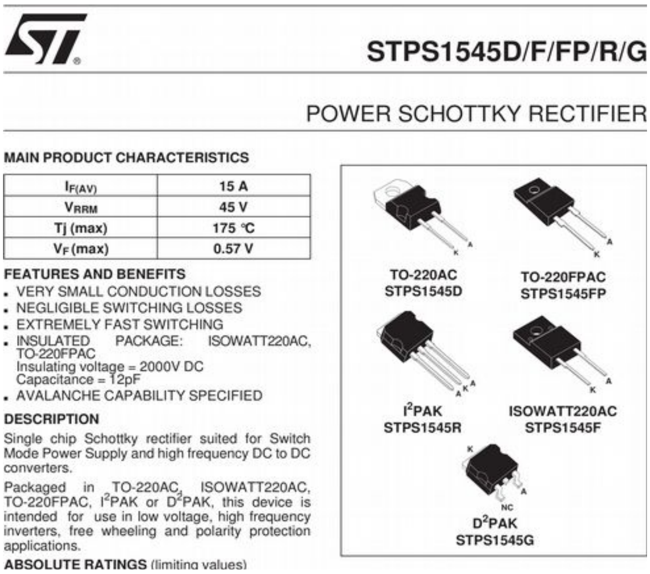
Zener voltage 5,7V

9) Regulator #09 (Yves)

Corrected by e-mail. Yves worked on the regulator with instructions.
New discovered failure, because as I recommended, I replaced diodes D1 by MBR1545.

10) D1 diode, new bad surprise !

In addition to all problemes listed, the infamous diode caused new problem. Some diodes sold by Selectronic, labelled ST, are not conform to the datasheet. The package is TO-220, the datashet shows no connection on the radiator an anode & cathode connected to the pins (standard case). The D2PACK package has the radiator connected to the cathode (K) and no connection to tle left pin (NC), this exactly the pinout of the TO-220AC package sold by Selectronic.
When one installs the STPS1545 on a radiator , the pins are connected normally to the pins of the STPS1545, but in Yves's case, nothing works
How many wrongly connected diodes are sold by Selectronic ?


STPS1545D/F/FP/R/G

POWER SCHOTTKY RECTIFIER

MAIN PRODUCT CHARACTERISTICS

$I_{F(AV)}$	15 A
V_{RRM}	45 V
Tj (max)	175 °C
V_F (max)	0.57 V

FEATURES AND BENEFITS
- VERY SMALL CONDUCTION LOSSES
- NEGLIGIBLE SWITCHING LOSSES
- EXTREMELY FAST SWITCHING
- INSULATED PACKAGE: ISOWATT220AC, TO-220FPAC
  Insulating voltage = 2000V DC
  Capacitance = 12pF
- AVALANCHE CAPABILITY SPECIFIED

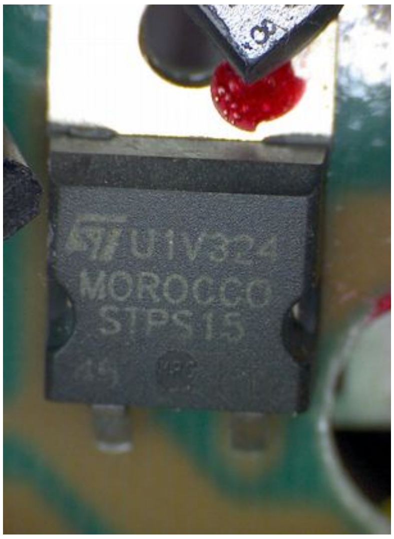
DESCRIPTION

Single chip Schottky rectifier suited for Switch Mode Power Supply and high frequency DC to DC converters.

Packaged in TO-220AC, ISOWATT220AC, TO-220FPAC, I^2PAK or D^2PAK, this device is intended for use in low voltage, high frequency inverters, free wheeling and polarity protection applications.

TO-220AC STPS1545D
TO-220FPAC STPS1545FP
I^2PAK STPS1545R
ISOWATT220AC STPS1545F
D^2PAK STPS1545G

ABSOLUTE RATINGS (limiting values)

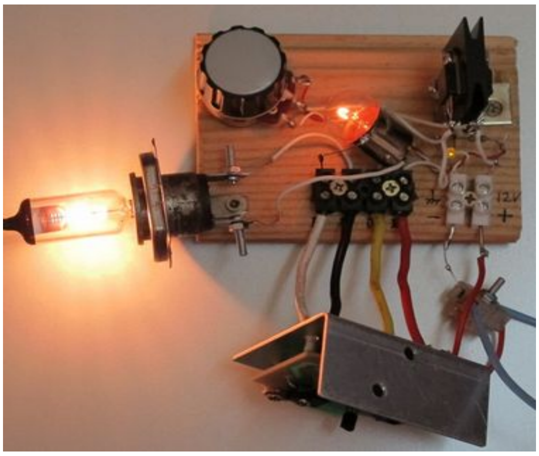


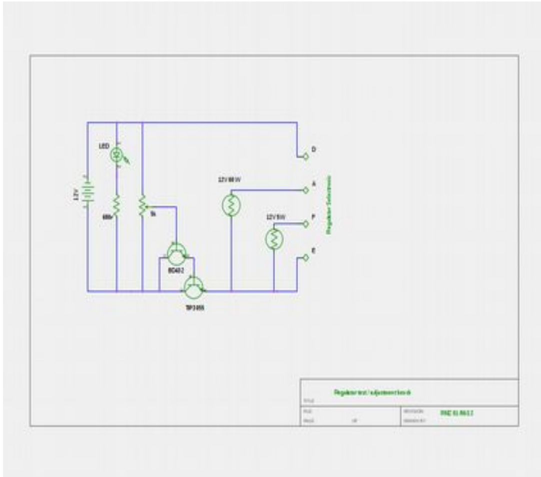
I keep my recommendation to replace D1 by a MBR1545 and putting his wo internal diodes in parallel, to fix it to the main radiator, and to connect it by wires to the PCB.

<u>I hope I have seen all failures from this regulator</u>

11) Test bench / adjustments

The test bench is a simple circuit, powered by 12V battery





The transistors are mounted on a small radiator. Electrical loads are made of lamps (the 60W lamp is used for test the diode D1 with 5A. The 5W lamp is used for measuring the threshold of the regulation. To test the regulator, decrease the voltage with the potentiometer and note the last voltage before light goes on (because when light goes on, all voltages drops).

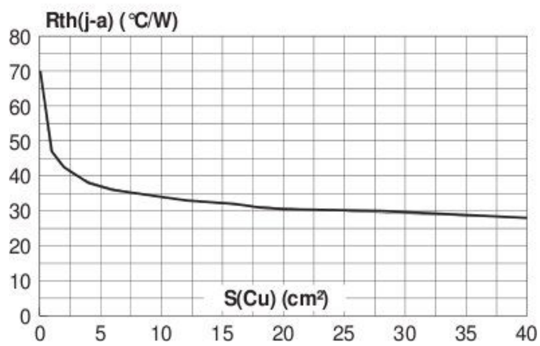
12) Regulator electronics modification

12.1) D1 diode STPS1545

For qualified people, under your own risk

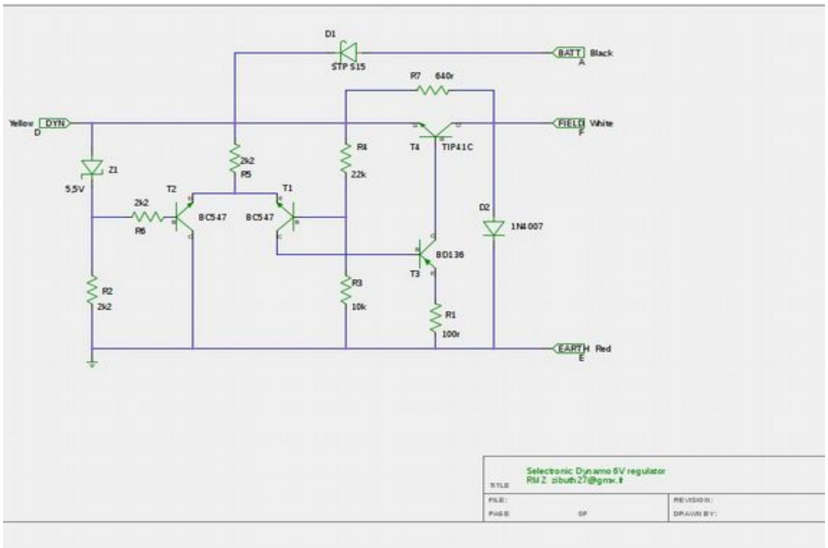
This is the diode which has the cut-out function. The armature is connected to the battery only when voltage is high enough. This is an important function ans was never made in any regulator by the hand of the rider only.
As expected (§1,3,4, components) D1 diodes heats up a lot : goes from 21°C up to 130°C (measured on the external body) in a minute and half with a 9A current. I obviously did not wait for asymptotic temp, and because the diode died. A this temp and current, the direct voltage is 0,5V (power dissipation 4,5W). The power of 4,5W makes a junction-radiator temp difference of 202°C with the tab and has a copper surface of 1,5cm² (the Selectronic design has NO copper in contact with the diode, only tracks on the bottom side)
Selectronic made a big design error on thermal aspect !

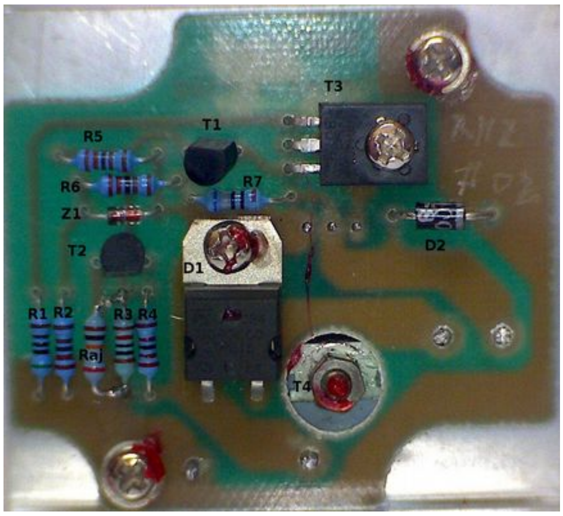
Fig. 10: Thermal resistance junction to ambient versus copper surface under tab (epoxy printed circuit board FR4, Cu=35µm) (D^2PAK).



The thermal resistance of Selectronic mounting is in the range of 45 to 50°/W and D1 HAS to be on radiator with insulating silicon sheet and insulating washer.
I used the diode MBR1545 with two diodes inside, parallelized (this is possible, because the two diodes are on the same chip)
It is ,ot good for the dynamo to give a power over 60W (E3L and 40W E3N E3H), except occasionnaly and for a short duration, so a fuse is the good device for protection.

12.2) Schematics redrawing





12.3) Remarks on design

This regulator is with almost classical design : op amp and power amp. The output voltage is given by comparaison between a reference voltage (zener diode) with a part (R3-R4) of the battery voltage. But we are far away from the 3 % allowed by a battery manufacturer like Yasa.
How to adjust : if battery voltage is too high, put a resistor in parallel with R3, if voltage is too low, put adjusting resistor on R4.
The diodes delivered by Selectronic have a wide spreading of values, so voltage of regulators is diffferent on each unit.
Erratum : on this drawing the collectors of T1 & T2 are swapped. T1 coll goes to T3 base, T2 coll goes to ground.

12.4) D2 diode : 1N4001

This diode short-circuit the reverse voltage. It absorbs the energy accumulated in the inductance. With Lucas E3 series this energy is in the range of ($1/2Li^2$) 12mjoules at a rate depending of the regulator cycling frequency, 50 to 200Hz. 1N4001, as mounted by Selectronic, will do the job.

12.5) T4 transistor T4 : TIP41

He is built for 6A and is used at 3A max : OK. Saturation voltage max 1,5V, usually 0,8V , anyway higher than MCR2 points. A redesign may have to consider the use of a MOS transistor.
This transistor controls the field current, as long as the voltage is under the threshold, the regulator sends current in the field coil. As soon, the voltage reaches threshold, current stops, and battery voltage drops, restarting the regulator. This oscillate at 50 to 200Hz.
The base control of T4 is made with a 100 Ω resistor. This value is not giving enough current if the transistor is at the minimum gain as published in datasheets. A Spice simulation gives a maximum field current of 0,9A with nominal values and shows a non saturated transistor (heating expected). I do not recommend to change the value, as everything has to be recalculated. I rather prefer to work on a New Regulator.
A 680 Ω resistor shunts the transistor and allows self-starting of the dynamo.

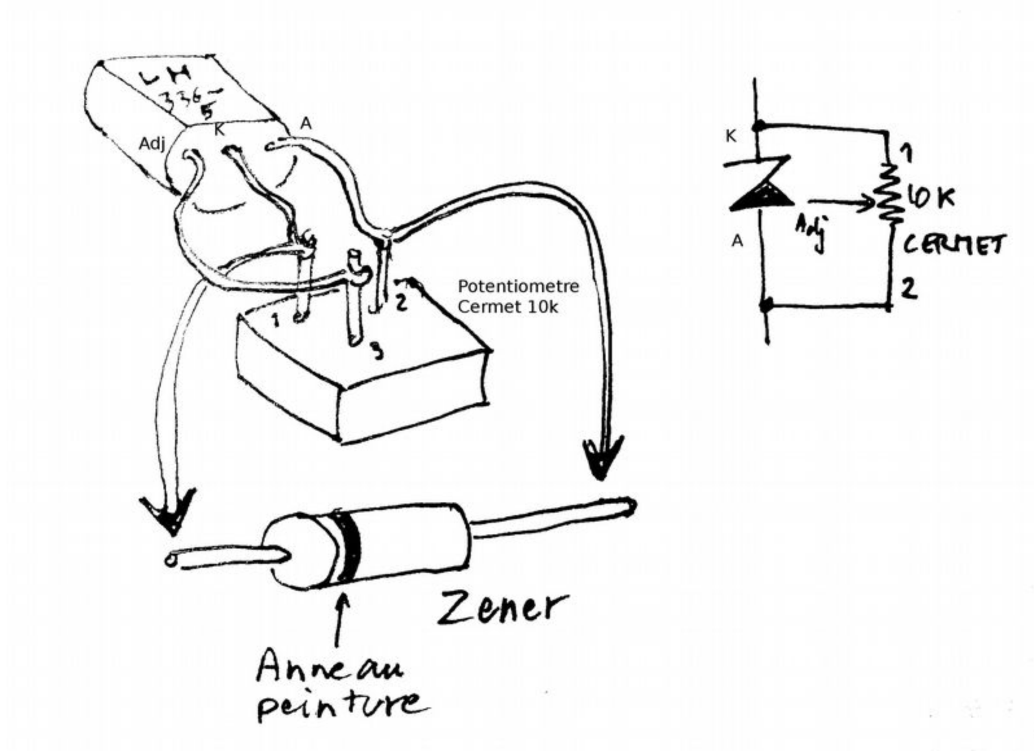
12.6) Z1 voltage reference

The value of this reference gives the the regulation voltage of the device.
Selectronic clearly does not select the diodes, as their voltage varies from 5,48 to 5,79 on the regulators I've seen, and regulation voltage varies from 7,76 to 8,45V, values TOO high.
The reference value should be close to 5,2V, It is absolutely necessary to adjust.

12.6.1) Replacement of the zener diode

The zener diode from Selectronic are not selected. It will be better replaced by by a voltage reference as the LM336-5. This one has a tempo of -0,2mV/°C. This reference can be adjusted up to 6V, right in the range needed for the regulator. The LM 336 can be replaced by LM236 or LM136, for better temperature performance.
The adjusting potentiometer has to be of Cermet type (ceramic-metal) for better lasting in harsh environment. Do not ad resistor (trimer).
Following drawing shows replacement of zener diode (zener is obviously put away)
Use Araldite for mounting and adjust potentiometer for the selected working temperature, by measuring the battery voltage at high enough rpm, lamps off, battery not externally charged since some hours.

temp	Setting (volts) ±0,25V
-20	7,71
-10	7,51
0	7,47
10	7,36
20	7,24
30	7,12
40	7,00
50	6,88



12.7) Protections

<u>Lucas MCR1-MCR2 regulators have a current limiting function</u>, contrary to the Selectronic. It is important to protect the armature by a fuse of 7,5A (for E3H or E3N), available in blade fuse. For a E3L, a fuse of 10A has to be

used.
No need of fuse for the field coil, as it was expected to work with the full charge voltage of the battery.

13) Conclusion

The Selectronic regulator, sold without applicable dynamo specs, nor current information, seems to have been developped for 40 to 60W Lucas dynamos. But its lifespan appears to be very short, with risks for the battery and the dynamo. There are also some assembly mistakes, some come to customer DOA. With rework, they can provide almost acceptable job (in a narrow temperature range),
recommended reworks

- put diode D1 Schottky diode on the main radiator with insulating film & washer
- replace STPS1545 diode by a MBR1545 or MBR20100
- if you want to keep original diode, check internal pinout or solder wire on tab (by a pro or drilled operator)
- put T4 (TIP41) on main radiator, with wires and sleeves to the PCB
- redrill the holes for the output wires
- bond the the wires to radiator with silicon
- zener diode. If by chance, its value is good, leave it, elsewhere replace by selected diode or by adjustable reference as showed above
- put a fuse (mandatory) in the dynamo line, no need on field coil

Selectronic regulator is catastropic as is. He colud give an acceptable job if reworked and adjusted
The better is to use another regulator. They are probably some good ones out there. I develop a new one (smewhere on my website), at least with the Selectronic mistakes not repeated.