Russian Voltage Regulators
(Реле-регулятор напряжения)

Part XXVIII-2: PP-302 / PP-302A
for the Г-414 Generator

Ernie Franke
eafranke@tampabay.rr.com
02 / 2018
6-Volt Electro-Magnetic (Relay-Type) Regulator (PP-302/PP-302A) for the Г-414 10-Amp Generator

• Background
  – Voltage Regulators Paired with Specific Generators/Alternators
  – Time-Line for Generators/Alternators/Regulators
  – Specs for 6-Volt Г-414 Compatible Generator

• What Is the PP-302?
  – External Voltage Regulator for Г-414 (10-Amp/65-Watt) Generator
  – Electro-Magnetic (Relay-Type) Design
  – Years of Application: 1963 -to- 1974
  – Upgraded from PP-31/31A (6-Volt Regulator)
  – Later Superceded by PP-330 Regulator in 1974

• How Does It Work?
  – Regulates Generator Output Voltage to 6-Volts
  – Supplies Exciter Current to Vary Stator Magnetic Field
  – Provides Constant Voltage Regardless of Rotor Speed and Load

• Circuit Description and Operation

• Replacement
  – Replacement Purchased On-Line over Internet

The Relay-Regulator (PP-302, a.k.a. RR-302) was the final 6-Volt and the first 12-Volt regulator used on Ural and Dnepr motorcycles.
### Types of Generators/Alternators for Ural (Урал) and Днепр (Днепр)

<table>
<thead>
<tr>
<th>Generator/Alternator</th>
<th>Type</th>
<th>Vintage</th>
<th>Nominal Voltage</th>
<th>Current</th>
<th>Nominal Power</th>
<th>Regulator</th>
<th>Motorcycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Г-11 (G-11)</td>
<td>DC Generator</td>
<td>1941-1951</td>
<td>6-Volt (7-Volt)</td>
<td>7-Amp</td>
<td>45-Watts</td>
<td>PP-1 PP-31 (1950)</td>
<td>Ural (IMZ) M-72</td>
</tr>
<tr>
<td>Г-11А (G-11А)</td>
<td>DC Generator</td>
<td>1952-1957</td>
<td>6-Volt (7-Volt)</td>
<td>7-Amp</td>
<td>45-Watts</td>
<td>PP-31 (1950) PP-31A (1956)</td>
<td>M-72, M-72M, M-61</td>
</tr>
<tr>
<td>Nippon Denso (P/N: IMZ-8.1037-18092)</td>
<td>Alternator (Built-in Rectifier &amp; Regulator)</td>
<td>2004-present</td>
<td>12-Volt (14-Volt)</td>
<td>55-Amp</td>
<td>770-Watts</td>
<td>Internal to Alternator (126000-0600)</td>
<td>IMZ 8.103, 8.103X, 8.123, 8.123X “750” Series</td>
</tr>
</tbody>
</table>

**Notes:**
1. Nomenclature: The Cyrillic letter “Г” transliterates (Russian-to-Latin) to “G” or “L” or “T.” Thus we see Г-414 or G-414 or L-414 or T-414, all for the same part.
2. Cannot use Alternator with discharged battery or without battery.
Alternators have progressed in output voltage and power, from the $\Gamma$-11 ($\Gamma$-11) generator of 6-Volts/45-Watts in 1941, the $\Gamma$-11A in 1952, the $\Gamma$-414 of 6-Volts/65-Watt in 1957, the $\Gamma$-424 of 12-Volts/150-Watts in 1974, the 14.3771 of 12-Volts/500-Watts in 1998.5, to the present-day Nippon-Denso alternator of 12-Volts/770-Watts.
Г-414 (G-414) 6-Volt Generator (1957-1974)

- 6-Volt / 10-Ampere / 65-Watt DC Generator
- Used on:
  - Ural: M-62, -63 & -66
  - Dnepr: K-650, later K-750, K-750M, MB-750, MB-750M, MT-8, MT-9 & MT-12
- Negative-Ground Case (Frame)
- Works in Conjunction with PP-302 / -302A Regulator
- Rotation Speed for 6.5-Volt Output
  - Zero Load: 1,350 rpm
  - Full Load (10-Amps): 1,950 rpm
6-Volt PP-302 / -302A Regulator

- Operates in Conjunction with Г-414 Generator
- Current & Voltage Regulator with Two Elements:
  - Reverse-Current Relay
    - Cut-In Voltage of Reverse-Current Relay: 6.0 to 6.6-V
    - Reverse Current for Cut-Off Reverse-Current Relay: 0.5 to 3.5-A
  - Voltage Regulator Relay
    - Regulated Voltage @3,500 rpm Generator Speed
      - Load Current 10-Amp: 6.5 to 7.0-Volts
      - Load Current 0-Amp: < 8 V

The PP-302 maintains a constant supply voltage by controlling stator exciter (magnetic field) current from terminal Ш.
Russian generators differ from alternators in that the magnetic (exciter) field is stationary and the generator windings are rotated. The output at the commutator is DC.
The open gap between the magnetic core and the armature (3) of the Reverse-Current Relay should be 0.6-0.8 mm. The gap between contacts 1 and 2 should be greater than 0.25 mm. The gap between the armature (3) and the Voltage Regulator core in the closed (un-energized) position should be 0.9-1.0 mm. The gap between contacts 6 and 7 should be greater than 0.25 mm.
PP-302 Gap Adjustments

Reverse-Current Relay (POT)  Voltage Regulator Relay (PH)

0.7mm (0.6 to 0.8mm)

0.4mm (>0.25mm)

1.5mm

Series Winding of Voltage-Regulator
PP-302 Regulator Description

• Reverse-Current Relay (POT) Has Two Positions:
  – 1. Armature Normally-Open: Contact 1 Disconnected from Battery
    • Non-Charging Position
    • Non-Energized or Large Shunt Winding Current
    • Spring Tension Greater than Exciter Current (Non-Energized or Charged Battery)
    • Direction of Series Winding Current Changed to Repel Armature:
      : Battery Voltage Too High (>8-Volts)
  – 2. Armature Closed: Contact 1 Connected to Battery
    • Charging Position
    • Exciter Current Greater than Tension Spring (>0.5-Amps)

• Voltage-Regulator Relay (PH) Armature (3) Has Three Positions:
  – 1. Armature Normally-Closed: Contact 8 to Contact 7 (Ground)
    • Non-Energized
  – 2. Armature in the Middle Position: Between Contacts 6 and 7
  – 3. Armature Open: Contact 8 Connected to Contact 6 (Generator)

PP-302 connects the generator to the battery when the exciter current is greater than 0.5-Amps. It disconnects when the generator voltage is too high (>8-Volts).
PP-302 Regulator Operation (cont.)

- **Ignition On / Engine Off:**
  - Battery Not Connected to Generator thru Reverse-Current Relay
  - Battery Voltage Should Be Between 6 to 6.3-Volts
  - Generator Exciter Coil Current Passes from Brush "+" of the Generator Rotor Winding, thru Exciter Winding, thru Shunt Winding (Voltage-Regulator Relay $P_H$ un-energized), thru Relay Yoke, thru Armature (3), thru Contact (7-8) to Ground
  - Voltage Starts to Build Based on Residual Magnetic Field in Stator

- **Engine On:**
  - Fast Idle: Voltage Should Be Between 7.4 to 8.1-Volts
  - In Middle Position: Current in Excitation Coil Goes from "+" of Generator, thru Excitation Coil, thru Voltage-Regulator Relay Shunt Winding, thru Yoke, thru Series Resistors (R1+R2), to Ground
  - Two Resistors Decrease Exciter Coil Current, Yielding Reduced Generated Voltage, which Decrease Armature Attraction to Regulator Core
  - Armature Position Continues Until Core Magnetization Opens Armature Tension Spring Pulls Armature to Close Contact (8) Back to Contact (1)

- **As Generator Revolutions (rpm) Increase:**
  - Armature Breaks Contacts (7 and 8) of Voltage-Regulator Relay, Leading to Voltage Fluctuations at Generator Terminals
  - When Armature Goes to Contact (6), Exciter Coil Current Is Off
  - Cycle Continues with Regulator Armature Oscillating between Contacts

- **When Exciter Current is Large:**
  - Pulls Reverse-Current Relay Armature (3) Down, Overcoming Tension Spring, and Connects Generator Directly Charge Battery

Annually, take the cover off and give it a spray with WD-40.
Relay Regulator PP-302

- The voltage regulator has two fixed contacts between which a two-contact armature is located. At low revolutions, the magnetic flux of the electromagnet is also weak, and the armature as a result of the spring pressure is closed by the contact 1 to ground. The current in the excitation winding of the generator bypasses the resistance, so that the voltage in the circuit is rapidly increasing.

- At average power of the generator through the windings of the voltage regulator, a current of the same magnitude will flow, which magnetizes the regulator core and attracts the armature, and it will take intermediate position. Then the current will flow to the generator excitation winding through additional resistance, which will weaken the magnetization of the core and the spring will again short the armature with pin 1.

- At high revolutions and low load, the voltage will increase so much that the armature is shorted to contact 8, and then the generator excitation winding will close "briefly", the generator will temporarily stop supplying the current, there will be a break in the magnetization of the core and the armature spring will take initial position.

PP-302 Diagram:
1 – Ground "mass" contact
2 - Voltage regulator armature
3 - Main winding of voltage regulator
4 - Generator excitation coil winding
5 - Generator
6 - Reverse current winding
7 - Voltage regulator winding
8 - Voltage contact
POT - reverse circuit breaker
PH - voltage regulator
R1, R2 - resistance
Relay Regulator PP-302 (cont.)

- Composed of a reverse current and voltage regulator, mounted in a common housing.
- To understand the operating principle of the voltage regulator of the relay-regulator PP-302, it is necessary to consider three positions of armature (2):
  - Armature 2 is closed through pin 1 to "ground".
  - Armature 2 is in the middle position between pins 1 and 8.
  - Armature 2 is closed on contact 8.
- In the first case, current into the excitation coil passes from ground "mass" thru contact (1), the armature (2) of the regulator, and enters winding (7), to the "+" terminal of generator (5), until the force resulting from magnetization of the core of the regulator, will not open the armature with pin 1.
- In the second case, that is, at the moment of contact opening, the current to the excitation coil comes from ground thru both resistors, to winding (7) and thru the excitation coil again to the "+" terminal of the generator.
- When the two resistances are serially connected to the excitation circuit, the current passing through the excitation coil drastically decreases, and consequently the voltage in the generator circuit decreases and the force that attracts the armature to the regulator core decreases. As a result, the armature is again closed to contact (1) under the action of the return spring.
- With the increase in the speed, the frequency of the opening of the contacts (1) and the armature of the regulator (2) drops, which leads to considerable voltage fluctuations at the generator terminals. Contact (8) serves to increase the frequency of opening of these contacts.
- With sufficient force of attraction of the armature (2) to the core, it closes on contact (8) and the excitation circuit is switched off from the generator.
- Thus, as a result of the fact that there is no current in the winding (7), its magnitude decreases significantly in windings 3 and 6, the total magnetic flux in the magnetic system of the regulator will drop sharply, and consequently the force that keeps the anchor closed to contact (8). The return spring will be able to it is easy to return the armature to the position when it is again closed to pin 1, after which the cycle will be repeated again.
- When installing the PP-302 relay controller and the G-414 generator on the motorcycle, it is necessary that the wire from the "+" battery be connected to the relay-controller terminal B, and the wire from the "-" battery is connected to "ground".
Ural (Урал) M-52, M-61 and M-72K, M-72M with PP-302 Regulator

1. Turn Signal
2. Battery (3MT-6 or 3MT-7)
3. Hi/Lo Beam Switch
4. Flasher Unit
5. Manual Spark Advance
6. Breaker/Distributor PM-05
7. Horn Button
8. Generator (Г-11А)
9. Ignition Coil (B2B)
10. Horn
11. Hi/Lo Beam Switch
12. Battery (Battery, Б)
13. (Output, Я)
14. (Exciter, Ш)
15. (Battery, Ш)
16. Foot Brake-Light Switch
17. Ignition Coil (B2B)
18. Flasher Unit
19. Turn Signal
20. Battery (3MT-6 or 3MT-7)
21. Horn
22. Battery (Battery, Б)
23. (Output, Я)
24. Regulator

14
Ural (Урал) M-62, M-63 (Ural-2) and M-66 (Ural-3) and Dnepr (Днепр) K-650, MT-9

10. Generator Charge Indicator

13. Generator (Г-414)
   Battery (3MT-6 or 3MT-12)

15. Regulator (PP-302/PP-302A)
   (Battery, Б)
   (Output, Я)
   (Exciter, Ш)

Turn Signal & Horn Button

Flasher Unit

Horn

Ignition Coil (B201)

Breaker Points (PM-302)
Ural (урал) M-62, M-63 and M-66

10. Generator Charge Indicator
13. Generator (Г-414)
15. Regulator (PP-302A)
Dnepr (Днепр) K-750, K-750M and MT-12

15. Generator (Г-414)

24. Regulator (РР-302)

Battery (3MT-6 or 3MT-7)

Foot Brake-Light Switch

Flasher Unit

Turn Signal

Hi/Lo Beam Switch

Manual Spark Advance

Breaker/Distributor (PM-05)

Ignition Coil (B2B)
Dnepr (Днепр) K-750M, MB-750, K-650 and MB-750M

1 - passing-beam and high-light lamp A6-32 + 32; 2 - key; 3 - fuse; 4 - head of the FG-116; 5 - central switch; 6 - wire "mass"; 7 - high voltage wire; 8 - the tip of the candle; 9 - ignition lights A8U; 10 - high voltage wire; 11 - ignition coil B2B; 12 - overall lamp; 13 – sidecar front lamp PF-200; 14 - horn C-37A; 15 - a wire of a forward lantern of sidecar; 16 - wire connector; 17 - rear lamp ФП-220; 18 - "stop" lamp A16-15 brake signal; 19 - rear lamp (A6-3); 20 - stroke lantern cable; 21 - brake lamp switch lamp; 22 - wire to license plate illumination lamp; 23 - stop light sensor; 24 - relay controller; 25 - direct current generator Г-414; 26 - portable lamp PLTM (only for motorcycles MB-750 and MB-750M); 27 - socket 47K (only for MB-750 and MB-750M); 28 - wire to socket; 29 - battery "mass" wire; 30 - rechargeable battery 3MT-12; 31 - interrupter-distributor PM-05; 32 - horn button; 33 - signal wire; 34 - ignition coin; 35 - speedometer illuminator; 36 - control lamp of generator activation A6-0,25; 37 - Bowden cable for light switch; 38 - high and passing light switch; 39 - parking lamp A6-2

24. Voltage Regulator (PP-302)

25. Generator (Г-414)

36. Generator Charge Indicator
Dnepr (Днепр) МТ-9

1 - bulb of the dipped and dipped beam A6-32 + 32; 2 - lamp A6-15; 3 - turn-lamp УП-223; 4 - ignition key; 5 - fuse at 15a; 6 - bulb of control lamp PD-20; 7 - lamp indicator; 8 - emergency pressure oil pressure sensor MM106A; 9 - central switch; 10 - connector of wires; 11 - turning switch P-201; 12 - lamp A6-2; 13 - front lamp stroller PF-200; 14 - candle tip; 15 - a spark plug A8U; 16 - ignition coil B-201A; 17 - interrupter PM-302; 18 - horn C-37A; 19 - sidecar rear lantern ФП-230; 20 - lamp A16-15; 21 - lamp A6-3; 22 - brake signal switch VK-854; 23 - relay controller PP-302; 24 - direct current generator Г-414; 25 - rechargeable battery ЗМТ-12; 26 - illuminated speedometer lamp A6-2; 27 - horn button; 28 - relay-breaker of the index of turns PC419; 29 - light switch P-25A; 30 - neutral sensor (contact button); 31 - bulb of control lamp ПД20Г; 32 - signal lamp neutral position A6-1; 33 - control lamp of generator activation A6-0.25; 34 - parking lamp A6-2; 35 - head of FG-116. Color of wires: I - black; II - white; III - red; IV - green; V - brown; VI - yellow; VII - blue; VIII - purple; IX - gray
Voltage Regulator PP-302 (Реле регулятор РР-302)

**PP-302**
List Price: $12.00
(www.zpmoto.net)

Реле-регулятор РР-302
List Price: 1500.00 rubles
(www.rosopt.com)

Реле-регулятор РР-302
List Price: 274 rubles
(ukrtmmp.com.ua)

Реле регулятор РР-302
List Price: 200 грн.
(www.olx.ua)

List Price: 327.60 rubles
(motozapchast.com.ua)

PP-302
List Price: 297 rubles
(motozapchasti.zakupka.com)

PP-302 Реле регулятор
(www.mazepper.ru)
Adjustment of Regulator PP-302 Gaps

• Burned Contacts Should Be Cleaned with a Thin Strip of Steel Sheet with a Thickness of No More than 0.1 mm (0.4 mil) – Do Not Use Files or Abrasive Paper

The open gap between the magnetic core and the armature (3) of the Reverse-Current Relay should be 0.6-0.8 mm. The gap between contacts 1 and 2 should be greater than 0.25 mm. The gap between the armature (3) and the Voltage Regulator core in the closed (un-energized) position should be 0.9-1.0 mm. The gap between contacts 6 and 7 should be greater than 0.25 mm.
Do not close all three contacts of the voltage regulator at the same time, as this could lead to damage. If necessary, the tension can be adjusted by changing the spring tension of the armature (1) by bending the bracket (2). Increasing the tension of the spring will increase the voltage and vice versa. When bending the bracket, the engine must be switched off.

The voltage of the reverse circuit breaker should be 6 to 6.6-V, and the reverse current causing the circuit breaker should be 0.5 to 3.5-A. The voltmeter must be connected between the terminal “Я” and the ground of the controller. Check through the smooth rotation of the generator rotor rotation until the switch is turned on, then smoothly reduce the rotation until it is switched off. The battery voltage should be 6.1 to 6.3-V.

The rated voltage of the generator without load at rotor speed 3,500 rpm should not exceed 8-V. When the rotational speed of the rotor is between 3,500 to 7,000 rpm and the load is 10-A, the deviation of the adjustable voltage should not exceed 0.5-V.

Equipment adjustment requires experience and skills. Incorrect handling of the regulator can damage other electrical devices associated with its operation.
Retro-Fit of Solid-State Regulator to Replace PP-302

- Purchased 6-Volt VAPE Electronic Regulator
- Available at http://www.powerdynamo.biz/eng/parts/805058803.htm
- Retro-fit Inside Original PP-302 Case