Russian Voltage Regulators (Реле-регулятор напряжения)

Part XXVIII-3: PP-330 for the Г-424 Alternator

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12-Volt Electro-Magnetic (Relay-Type) Regulator (PP-330) for the Г-424 11-Amp Alternator

• Background
  – Voltage Regulators Paired with Specific Generators/Alternators
  – Time-Line for Generators/Alternators/Regulators
  – Г-424 Alternator Performance
  – Specs for the Г-424 Alternator
  – Alternator Application in Ural (M-67, -67.3 and “650cc” Series) / Dnepr (MT-10, -11 and -16) Wiring

• What Is the PP-330?
  – External Voltage Regulator for 11-Amp Г-424 Alternator
  – Electro-Magnetic (Relay-Type) Design
  – Years of Application: 1974 -to- 1992
  – Upgraded to 12-Volts from 6-Volt PP-302 Regulator
  – Later Superceded by Solid-State (Electronic) 33.3702 Regulator in 1992

• How Does It Work?
  – Regulates Alternator Output Voltage to 14-Volts
  – Supplies Exciter Current to Vary Magnetic Field in Rotor
  – Provides Constant Voltage Regardless of Rotor Speed and Load

• Circuit Description and Operation
• Replacement
  – Replacement Purchased On-Line

Relay-Regulator (PP-330, a.k.a RR-330) was the first 12-Volt regulator used on a Russian motorcycle (Ural M-67 and Dnepr MT-10).
### 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>
<th>Notes:</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</td>
<td>M-72</td>
<td></td>
</tr>
<tr>
<td>Г-11A (G-11A)</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>
<td></td>
</tr>
<tr>
<td>Hitachi (Limited Appearance)</td>
<td>Alternator/ Starter</td>
<td>1998-1998.5</td>
<td>12-Volt (14-Volt)</td>
<td>18-Amp</td>
<td>300-Watts</td>
<td>Internal to Alternator??</td>
<td>IMZ 8.103 and 8.107 “650” Series</td>
<td>Not Used</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 Г-11 (G-11) generator of 6-Volts/45-Watts in 1941, the Г-11А in 1952, the Г-414 of 6-Volts/65-Watt in 1957, the Г-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.

- 12-Volt / 11-Ampere / 150-Watt Alternator (a.k.a. 14-Amp)
- “Full-Time” (Continuous) Current Rating: 11-Amperes
- Alternator Г-424 Used on:
  - Ural: M-67, M-67.36, IMZ 8.103 Series
  - Dnepr: MW-650, MW-650M, MT-10, MT-10.36, MT-11, MT-14, MT-16
- Used with Mechanical (PP-330) & Solid-State (33.3702) Regulators
- 3-Ø (three-phase), 12-Pole Stator Winding for Smooth Output Voltage
- Built-in Full-Wave Rectifier (MSF-2A)

The Г-424 alternator surfaced in 1974 on Ural’s M-67 and Dnepr’s MT-10, as Russian motorcycles migrated to 12-Volts.
Russian 11-Amp Г-424 Alternator

### Current Generated by Alternator versus Speed of Rotation of the Alternator

<table>
<thead>
<tr>
<th>Engine (Crankshaft) Speed</th>
<th>Alternator (Rotor) Speed</th>
<th>Motorcycle Speed (mph/kmph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle (900-to-1,000 rpm)</td>
<td>1,200 rpm-to-1,333 rpm</td>
<td>10 mph/16 kmph</td>
</tr>
<tr>
<td>2,500 rpm</td>
<td>3,333 rpm</td>
<td>25 mph/40 kmph</td>
</tr>
<tr>
<td>3,500 rpm</td>
<td>4,667 rpm</td>
<td>40 mph/65 kmph</td>
</tr>
</tbody>
</table>

Г-424 alternator rotor turns 1.33X crankshaft

Indicator light may blink when motorcycle moves at 20 mph (30 km/h) and at the instance an additional load is connected!

The Г-424 alternator provides rated current (11-Amps) at 2,000 rpm of the crankshaft. Thus for urban driving (low-speed & traffic lights), the alternator was sufficient to supply the necessary charging current (prior to electric-start).
Typical Current Consumption for Г-424 Alternator

- Typical Load Using Standard Lights and Low-Beam
  - Running Lights
    - Sidecar Front Right (A12-8 or #97): 10-Watt
    - Sidecar Rear Right (A12-21-3 or #1156): 21-Watts
  - Motorcycle Rear (A12-21-3 or # 1156): 21-Watts
  - Speedometer Face (A12-1 or Sylvania 3893): 4-Watts
  - Head-Light (A12-45+40 or H6024, 7” sealed): 40/45-Watts (Low/High)
  - Ignition System: 18-Watts
  - Total Consumption (assuming low-beam): 114-Watts (8.9-Amps)

- Typical Load Using Standard Lights and High-Beam
  - High-Beam Indicator Lamp: 4-Watts
  - Head-Light (A12-45+40 or H6024, 7” sealed): 45-Watts
  - Total Consumption (assuming high-beam): 123-Watts (9.6-Amps)

- Typical Load Using Halogen Head-Light
  - Halogen Sealed-beam (low-beam): 55-Watt
  - Total Consumption (assuming low-beam): 129-Watts (10.1-Amps)

Clearly, even prior to electric-start, the current demands are nearly equal to the output capability of the alternator.
**Relay-Regulator PP-330 (Реле-регулятор PP-330)**

- Regulates Voltage of G-424 Alternator 14-Volts and Nominal Current Value of 11-Amps
- Connected by Negative Conclusion to the Ground "mass"
- Signal Indicator "Charging-Discharge" of Battery
- Consists of Single-Stage Vibration Regulator of Voltage and Control Relay of Control (Indicator) Lamp
- PP-330 Has Five Connection Terminals:
  - "BЗ" - Connection to Positive Terminal of Rectifiers thru Ignition Switch Contacts
  - "Ш" - Connection to Alternator's Ш terminal
  - “ЛК” ("LC"") - Connection to Indicator Lamp
  - "~" - Attach to Output of Alternator Phase
  - "M" - On Body of Regulator to Connect Wire from Ground "mass" of the Rectifier
- Relay-Regulator (Voltage Regulator) PP-330 Shown
The PP-330 voltage regulator varies the current in the rotor coil (terminal \( \Omega \)) to maintain a constant output voltage at the “+” terminal.
Monitoring Relay Control Lamp

• When switching on the ignition switch when the engine is not running or at low engine speeds, the control relay is off (armature not attracted to core) and the contacts are closed. Therefore, the test lamp, which is switched on to the battery through the contacts of РВЛ is lit, signaling that there is no charge.

• As the generator rises, the voltage rises and when it exceeds the battery voltage (voltage on the main winding of the relay РВЛ0 will reach the level of the relay operation), the armature of the РВЛ is attracted to the core, the contacts of the РВЛ are opened and the control lamp goes out.

• When the speed decreases, the generator voltage decreases. РВЛ is switched off, the contacts close and the indicator lamp lights up. The auxiliary winding РВЛ0 serves to increase the accuracy of the relay operation.

• When using the relay controller PP-330 with alternator G-424, it is forbidden to start the engine with the positive wire disconnected between the alternator and the voltage regulator, since this will lead to an overvoltage and possible burn-out of the rectifier. For example, the connection of the alternator terminals and the relay-controller to "ground" for the purpose of checking for a spark, is not allowed.

• The minus terminal of the relay-controller must be permanently connected to ground "mass" of the alternator.

• If the motorcycle battery is systematically undercharged (it is difficult to start the engine), it is necessary to measure the voltage value with a voltmeter by connecting it to the “ВЗ” and "-" terminals of the relay-controller. If the voltage is less than 13.5 volts, adjust the coil spring (stretching it) to 14.4 volts.

• When the voltmeter shows a voltage equal to the voltage of the battery, and when the voltage regulator is not adjustable, clean the contacts and rinse them with gasoline.

• If the battery during operation receives an increased charging current and voltage exceeds 14.6 volts, you need to adjust the voltage.
The PP-330 utilizes two electro-magnetic relays to maintain a constant output voltage from the alternator, and to control a red “alternator fault” indicator light.
Schematic of Voltage Regulator PP-330

Circuit Diagram of Voltage Regulator PP-330

РН: Voltage Regulator Contacts; РН₀ – Shunt (main) Winding, РНₑ – Compensating Winding, Р₃ – Accelerating Resistor, Р₄ – Series Resistor, РВЛ₉ – Contacts of Lamp Switching Relay, РВЛ₀ – Auxiliary Winding of Lamp-Switching Relay
• PP-330 Regulator Construction
  – Consists of Two Relays;
  – Voltage Relay $P_H$: Maintains Alternator Voltage within Specified Limits (13.5-to-14.5-Volts)

  – Lamp Control Relay $P_{ВЛ}$: Controls Red, Dash-Mounted “Fault Indicator Lamp (when extinguished, alternator is charging properly)


  – Caution: Alternator Cannot Stand Working without Load (breakage or disconnection of wires). Open-Loop Voltage Capable of Destroying Rectifier Bridge.

  – Helpful Hint: If Battery Discharged, Engine can be Started by Connecting Small Flashlight Batteries (4.5-V) "plus" to terminal $W$ (Ш) and "minus" to Chassis Ground.
PP-330 Voltage Regulator Operation

• Ignition Switch On / Engine Off:
  – Current from Battery thru Ignition Switch and Rear Terminal B3 (BZ) of Regulator, to Normally-Closed Relay \( P_\text{H} \) and Compensating Windings Enters Excitation (Rotor) Winding
  – Caution: If Ignition Off & Engine Not Running, Battery Discharge thru Rotor Winding May Overheat

• Ignition Switch On / Engine On - Idle:
  – As Rotor Speed Increases, Terminal Voltage Increases
  – When Voltage Reaches 13.5-to-14.5-Volts, Magnetic Forces Generated in Core Exceed Armature Spring Tension, Opening Relay Contacts
  – Exciter Winding Current Now Flows Thru Two Series Resistors, thereby Reducing Current and Consequently the Alternator Terminal Voltage
  – Electro-magnetic Force Decreases on the Armature and Spring Closes Contacts
  – Current Entering Winding Excitation Increases, Increasing the Alternator Terminal Voltage, thus, Turning On and Off the Charging Current

• Lamp Control Relay - \( P_\text{ВЛ} \)
  – Connected to Alternator Terminal "~" phase
  – When Ignition On
    • Current from Battery thru Normally-Closed Relay \( P_\text{ВЛ} \) Contacts
    • Current Flows to Light “Fault” Indicator
  – When Alternator Output Voltage Exceeds Battery Voltage
    • Relay Pulls In and Opens Contacts
    • Lamp Goes Out

Relay-Regulator PP-330 consists of two relays; voltage relay \( P_\text{H} \) and lamp control relay \( P_\text{ВЛ} \).
Application of PP-330 Voltage Regulator with Г-424 Alternator

1. Ignition Switch "Run" Position
2. Red "Alternator Failure" Indicator Lamp
3. Lamp Control Relay P_{вл}
4. Over/Under-Voltage Relay P_{H}
5. Fuse Block
6. Full-Wave 3-Phase Rectifier
7. Rotor (Field)
8. Stator
9. Over/Under-Voltage Relay P_{H}
10. Terminal Block
11. Voltage Regulator
12. Ground
13. Lamp Control Relay P_{вл}
14. Power (positive) Terminal
15. Excitation Terminal
16. Battery
17. Г-424 Alternator
18. Generator Г-424
19. Alternator Terminal Block
1. Turn Signal Switch
2. Turn Signal Flasher
3. Instrument Illumination
4. Headlight
5. Parking light
6. Ignition Switch
7. Front Left Turn Signal – Bike
8. High Beam Switch
9. Right Turn Signal – Sidecar
10. Front Right Turn Signal – Bike
11. Battery
12. Fuse
13. Turn Signal Indicator
14. Oil Pressure Indicator
15. High Beam Indicator
16. Charge Indicator
17. Oil Pressure Switch
18. Neutral Switch
19. Neutral Indicator
20. Horn
21. Coil
22. Voltage Regulator
23. Generator
24. Sparkplugs
25. Points/Contact Breaker
26. Rear Right Turn Signal – Bike
27. Wire Connector
28. Ground
29. Brake Light
30. Tail Light

1974 Dniepr MT-10
**Dnepr (Днепр) Early MT-11 and MT-16**

with PP-330 Regulator, later replaced with 33.3072 (solid-state)
Migration from the Mechanical (PP-330) to Electronic (33.3702) Regulator

Diagram is useful when unmarked wires are removed from unmarked terminals!

'+ ' (output) goes to the battery
'W' (field) goes to the regulator
'-' is not used. Used only with the old electromechanical regulators (PP-330).
Check-Up of Alternator Г-424 on a Running Motorcycle

- Place motorcycle on a Stand
- Shift the Gear to 4th
- Change the Speed to Achieve 25 km/hr on Speedometer
  - Voltmeter (V) Should Indicate at Least 14-Volts
  - In Case of No Voltmeter Reading, Connect the Battery by Briefly Pressing the Excitation Button $K_B$
- Accelerate Engine to Achieve 37 km/hr
  Voltmeter Should Indicate 14-Volts, While Ammeter Indicates 2-Amps ($R_H + R_D, K_H$ open) and 11-Amps ($R_H, K_H$ closed) with Full Load
- Accelerate Engine to Maximum
  - Voltmeter Should Indicate 14-Volts, While Ammeter Indicates 2-Amps with, 11-Amps with Full Load
- Shut-Down Motorcycle

Circuit Diagram for Check-Up of Alternator Г-424 and Voltage Regulator PP-330
$R_H = 1.27\pm0.03\Omega$
$R_D = 5.73\Omega$
$A12-1 = Lamp Bulb$
$K_H = K_B = Test Switches$
Checking the Voltage Regulator PP-330 Alone

• Check the Contact and Armature Gaps
  – Lamp-On Relay: Gap between Armature and Core with Contacts Closed: 0.35 to 0.45 mm
  – Voltage Regulator: Gap between Armature and Core with Contacts Closed: 0.35 to 0.45 mm
  – Voltage Regulator: Gap between Armature and Core with Contacts Open: 1.3 to 1.4 mm

• Relay-Regulator PP-330 Repair Similar to PP-302.

• Determine the Speed at Which the Lamp Switching Relay Contacts Open
  – Voltage Should Be 5.5-Volts ±0.5
  – The Moment of Contact Breaking Is Seen by the Ammeter Deviation

• To Check Voltage Regulation:
  – With a Generator Armature Speed of 3,500 rpm and Load of 11-Amps, Voltage Should Be Between 13.5 and 14.5-Volts
PP-330s Available on the Internet

Voltage Regulator 12V, PP-330
Dnepr 11/16
List Price: $28.00 New
(soviet-moto.com)

Relay-regulator 12V RR-330
Ural, Dnepr
List Price: 110.70€ NOS
(moto-boxer.com)

Voltage Regulator 12V, PP-330
Ural, Dnepr
List Price: $55.00 New
(www.ebay.com)