Ural (Урал) - Dnepr (Днепр)
Russian Motorcycle
Part XXXI-6: Gears and Gear Ratios

(Also See Part XXXI: Drive Chain Evolution,
Part XXXI-1: One-Wheel Drive (1WD),
Part XXXI-2: Two-Wheel Drive (2WD),
Part XXXI-3: Full-Time 2WD with non-Locking Diff
Part XXXI-4: Full-Time 2WD with Locking Differential
Part XXXI-5: Full-Time 1WD with Engageable 2WD (non-Diff),
Part XXXI-7: Drive Train Components,
and Part XXXI-8: Disassembly of Drive Chain)

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10 / 2018
Gears and Gear Ratios: Agenda

• History of Ural / Dnepr Gear Ratios
• Final Drive Gear Ratios
• List of Components
  – Multiple Gear Suppliers
    • Especially for Sidecar (8/37/ Ratio) and Solo (9/35 Ratio) Versions
    • Large Variations in Listed Prices (listed in 2013 dollars, euros or rubles)
History of Ural / Dnepr Gear Ratios on Russian Motorcycles with Sidecars

• Final Gear Ratio Is Relationship between Turns of the Propeller Shaft Relative to the Wheel
  – Gear Ratio Determined by the Number of Teeth on Crown Gear Set (Pinion Gears)
  – Example: Crown Ring Gear (35 teeth) / Small Pinion Gear (9 teeth) = 3.89:1
• In 1938, Original Ratio German BMW Offered with the R-71 Was 9/35 Ratio (3.89:1)
• In 1944, Final Drive Gear Ratio of 4.625 Introduced to Russian M-72
  – 9/35 (3.89:1) Ratio Too Optimistic for Russian Roads When Copying Design in 1941
  – Quickly Switched to 8/37 (4.625:1) Ratio to Cope with Muddy Roads
• In 1994, Ural Began Selling 650cc Motorcycles with Sidecar in the United States, Using the Old 9/35 Ratio (3.89:1) to Take Advantage of Paved Roads in the U.S.
  – Soon Ural Regretted the Switch as Bikes Equipped with 9/35 (3.89:1) Ratio Started Breaking Crankshafts
• Ural Quickly Re-introduced 8/37 (4.625:1) Ratio
  – Later Acknowledged That 9/35 Ratio Good with 18” Wheels at Elevations near Sea Level
  – Urals with 19” Wheels or Those Sold above 3,000 ft Elevation Came with 8/37 Ratio
  – When Ural Started Selling 750cc, They Designed a Much Stronger Crankshaft Which Could Easily Cope with the 9/35 Ratio
    • But That Ratio Had Gotten Such a Bad Reputation that Ural Switched 3rd and 4th Gear Ratios
    • The New Ratios Pretty Much Made the 8/37 "look" like a 9/35
    • Didn't Matter If You Had 18” or 19” Wheels or Lived at Sea Level, Your 750cc Ural Got the 8/37 (and the new 3rd & 4th Gear Ratios)
  – 9/35 (3.89:1) Ratio Fine with a 650cc Ural with Sidecar on Flat Terrain with 18” Wheels
    • Not Good for a 750cc Ural with Sidecar
    • Good for Solo
  – Both 9/37 (4.10:1) and 10/36 (3.60:1) Ratios Offered on e-bay
    • Both are Russian "aftermarket" ratios, built be folks who may or may not have any idea of how to machine the proper helix, ramp, undercut, etc.
  – 10/35 (3.50:1) Ratio Is Unrealistic
    • Perhaps a Supercharged 750cc Could Pull That Steep a Ratio
• All Ural and Dnepr Motorcycles with Sidecars Have have 8/37 (4.625) for Rear Gear Ratio
Final Drive Gear Ratios

- **Original German BMW R71** (father of Russian M-72)
  - Solo: 3.6:1 (10/36 pinion teeth / ring teeth)
  - Sidecar: 3.89:1 (9/35 pinion teeth / ring teeth)
- **Standard Ural / Dnepr**
  - Solo: 3.89:1 (9/35 pinion teeth / ring teeth)
  - Sidecar: 4.625:1 (8/37 pinion teeth / ring teeth)
- **Aftermarket Ratios** of 3.4:1 (10/34), 3.5:1 (10/35) and 4.11:1 (9/37)
  - Available via Internet
  - Generally Expensive and Speedometer Gears Aren’t Readily Available
- **Simple Test to Determine Rear Wheel Ratio**: Vance Blosser, www.crawfordsales.info
  - Put Bike Up on Center Stand
  - Put It in Neutral
  - Turn Back Wheel until Tire Valve Is at Top
  - Turn Wheel 1 Full Rotation until Valve Is Back to Top
  - Count Number of Turns of the Flexible Coupling (Driveshaft Flange)
    - If It Turns Just under 4 Complete Turns, You Have Solo Gearing: 3.89:1
    - If It Turns Just over 4 Complete Turns You Have Sidecar Gearing: 4.625:1
  - It Could Be Another Ratio, But Unlikely

Ural / Dnepr produced two types of cone beveled paired gears: the so-called "eight" (the number of teeth on the small pinion), which has 4.625 gear ratio and is used on motorcycles with sidecars, and "nine", with a ratio of 3.89, used on solo motorcycles.
2012 Gear-Up Gear Ratio Test (sovietsteeds.com)

- 2012 Ural Gear-Up’s Transmission Ratios Are on the Tall Side, Making It Difficult to Haul the 866.5-lb. Rig Up to Speed with Any Urgency
  - 4.625:1 (8/37 pinion teeth / ring teeth) Rear Drive
- Test Unit Went from 0-to-60 mph in 15.97 sec.
  - 1.19 4th Gear & 4.625:1 Rear Drive Cause Engine to Rev at 4850 rpm at 65 mph, Making Sustained Interstate Motoring an Impractical Strain on the Engine
  - Bit Gutless Up Hills and in Head Winds
- Other Gear Ratios
  - 9/35 (3.91:1) Found on Solos and Some Retros
  - 10/35 (3.50:1) Insufficient Torque and Horsepower
- People Used 3.89 Gears with 19" wheels on a 750cc, but with Limited Success
  - Motor Doesn't Have the HP to Pull 4th Gear Up-Hill or into Any Wind
  - Retro Is Most Road-Friendly Ural
- Urals Come in Two Gear Ratios: 3.89:1 (Solo) and 4.625:1 (with Sidecar)
  - Years Ago You Could Get Either but They Found the 3.89 Was Breaking Crankshafts in the 650's Due to Lugging, So Now You Only See 3.89 in Solo’s
  - Motorcycles with 18” Wheels, such as Retro's, Deco's and B.C.'s, can Go with 3.89:1 Gears
  - Installed 18” Wheels on My ‘99 Patrol and Really Like Them
- Ideally IMZ Eventually Will Become Solvent Enough to Fund R&D to Develop a New Transmission with a Lower 1st and 2nd Gear and Even Add a 5th OD Gear

A lower gear ratio (higher numerically) yields a little more grunt (torque) at the low-end, sacrificing at the top-end. A higher ratio (numerically lower) will boost your top-end speed a little bit sacrificing low-end grunt.
Pinion gears are stocked as a mated pair, typically purchased as a pair held together with a small wire.
The gear ratio is stated as the number of teeth in the small pinion gear divided by the number of teeth in the large rim gear.
Bevel Gears (Driver Gear / Driven Gear): 9/35
(3.889:1 Ratio; for use on solo bike, not sidecar)

Final Drive Gear and Pinion 9x35
CMH-8.15505210-07
IMZ-8.123-05015
(Ural; M-61, M-62, M-63, M-66, M-67, M-67.36, IMZ-8.103-10,
IMZ-8.103-30, IMZ-8.103-40 "Tourist", IMZ -8.103-50, MZ-8.107,
IMZ-8.123, Dnepr ;MT-11 (CMH-8.155), MT-16 (CMH-8.922),
MT-10.36)
Leading Pinion Z = 9 teeth, D = 46.0 mm.
Driven Pinion Z = 35 teeth, D = 142.5 mm. d = 82.0 mm
List Price: 2,500 rubles
(mazepper.ru)
Final Drive Gear and Pinion 9x35
Vendor ID: 451
List Price: 55.00€
(www.ural-hamburg.de)
Final Drive Gear and Pinion 9x35
(K-750, M-72, Dnepr MT)
Vendor ID: 200867525726
List Price: 39.00€
(www.ebay.co.uk)
Final Drive Gear and Pinion 9x35
(MT-11, MT-16)
Part #: 7205202/7205227
List Price: $60
(www.dnepr-kiev.com)

Dnepr Conical Pair
(Коническая пара Днепр)
9:35 teeth (зуб)
List Price: 597 rubles
(avto-moto.in.ua)

Final Drive Gear and Pinion 9x35
List Price: 97.00€
(www.henriksson.ee)
Final Drive Gear and Pinion 9x35
Vendor ID: S604-9
List Price: 62.50€
(www.ural-zentrale.de)
Final Drive Gear and Pinion 9x35
Vendor ID: 1234
List Price: €63.72
(moto-boxer.com)
Final Drive Gear and Pinion 9x35
Vendor ID: 260828566629
List Price: $89.00
(www.ebay.com)

New Final Drive Gear ratio 9/35
(MT-11, MT-16)
Vendor ID: 260828566629
List Price: $59.00
(www.ebay.com)
Final Drive Gear and Pinion 9x35
(M-72, K-750)
Vendor ID: 190443404647
List Price: 42.90€
(www.ebay.de)

The paired bevel gears are typically referred to as a Crown Wheel Set.
Bevel Gears (Driver Gear / Driven Gear): 9/38

Final Drive Gear and Pinion, 9x38
Part #: 7205202-b + 7205227-b
List Price: 59€
(www.henriksson.ee)

Final Drive Gear and Pinion, 9x38
(M-72, K-750)
Part #: 7205227-B/7205202-B
Vendor ID: 000.867
List Price: 250.00€
(www.oldtimergarage.eu)

Final Drive Gear and Pinion, 9x38
(MB-750, MT-16)
Part #: MB750M48101-A + 7205202-A
List Price: 105€
(www.henriksson.ee)

38 teeth divided by 9 teeth yields a gear ratio of 4.22
Bevel Gears (Driver Gear / Driven Gear): 10/34

Final Drive Gear and Pinion, 10x34
(M-72 / K-750)
Part: 7205227-B/7205202-B
Vendor ID: 003.492
List Price: 250.00€
(www.oldtimergarage.eu)

34 teeth divided by 10 teeth yields a gear ratio of 3.40
Bevel Gears (Driver Gear / Driven Gear): 10/35

<table>
<thead>
<tr>
<th>Description</th>
<th>Vendor ID</th>
<th>List Price</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Drive Gear and Pinion, 10x35</td>
<td>290422002941</td>
<td>$89.99</td>
<td><a href="http://www.ebay.com">www.ebay.com</a></td>
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<td>Final Drive Gear and Pinion, 10x35, Mfgr in KMZ</td>
<td>160833965598</td>
<td>$110.00</td>
<td><a href="http://www.ebay.com">www.ebay.com</a></td>
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<td>Final Drive Gear and Pinion, 10x35, M-72, K-750</td>
<td>190766017353</td>
<td>$180.00</td>
<td><a href="http://www.russiangelarage.com">www.russiangelarage.com</a></td>
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<td>Final Drive Gear and Pinion, 10x35, M-72, K-750</td>
<td>190530553197</td>
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<td><a href="http://www.ebay.de">www.ebay.de</a></td>
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<td>Final Drive Gear and Pinion, 10x35, M-72, K-750</td>
<td>200867094140</td>
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<td><a href="http://www.ebay.co.uk">www.ebay.co.uk</a></td>
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<td>Final Drive Gear and Pinion, 10x35, Dnepr, Ural</td>
<td>S604-10</td>
<td>79.99€</td>
<td><a href="http://www.ural-zentrale.de">www.ural-zentrale.de</a></td>
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<td>Final Drive Gear and Pinion, 10x35, M-72, K-750</td>
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<td>65.00€</td>
<td><a href="http://www.ural-hamburg.de">www.ural-hamburg.de</a></td>
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<td>Final Drive Gear and Pinion, 10x35, MT-16</td>
<td>7205202/7205227</td>
<td>$80</td>
<td><a href="http://www.dnepr-kiev.com">www.dnepr-kiev.com</a></td>
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<td>Final Drive Gear and Pinion, 10x35, Dnepr, Ural</td>
<td>200867094140</td>
<td>45.00€</td>
<td><a href="http://www.ebay.co.uk">www.ebay.co.uk</a></td>
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35 teeth divided by 10 teeth yields a gear ratio of 3.50
Pinion Gear Assemblies: Differential Housings

Satellite Housing with Ring and Pinion, Lock-Ready
(MB-750, MB-650, MT-16)
Vendor ID: 000.833
List Price: 200.00€
(www.oldtimergarage.eu)

Sidecar Drive Differential Half w/ Pinion and Gear
Part #: MW750M48101 + 7205202 + WP48121
Vendor ID: 1231
List Price: 199.42€
(moto-boxer.com)

Rear Drive
Satellite Housing with Ring and Pinion
(Dnepr)
Vendor ID: 002.808
List Price: 120.98€
(www.oldtimergarage.eu)

Final Drive Gear with Flange
(MT-16)
Vendor ID: 2250
List Price: 155.00€
(www.ural-hamburg.de)
Differential Planetary Gears: Satellite and Idle

Differential Gears
(MT-16)
Vendor ID: 1345
List Price: 49.00€
(www.ural-hamburg.de)

Differential Gears
(MT-16, MB-650, MB-750)
Vendor ID: 2589
List Price: 80.00€
(www.ural-hamburg.de)

Satellite Gear, 8 teeth
(MT-16)
Vendor ID: 2249
List Price: 13.00€
(www.ural-hamburg.de)

Final Drive Gear, 12 teeth
(MT-16)
Vendor ID: 2247
List Price: 13.00€
(www.ural-hamburg.de)

Idler Gear Assy
(Ural/Dnepr)
Vendor ID: 290558936198
List Price: $9.99
(www.ebay.com)

Satellite Gear, 8 teeth
Part #: BL48014
Vendor #: 2048
List Price: 16.50€
(www.henriksson.ee)

Sidecar drive satellite gear
Part #: BP48014
Vendor #: 2048
List Price: 18.88€
(moto-boxer.com)
Sidecar Drive Satellite & Idle Gear Axle
Part #: ВП48806 / WP48806
Vendor #: 1641
List Price: 5.66€
(moto-boxer.com)

Axle, Planet Gear
(MB-750, MT-16)
Part #: ВП48806 / WP48806
Vendor ID: 000.646
List Price: 11.59€
(www.oldtimergarage.eu)

Differential Drive
(MT-16, MB-650, MB-750)
Vendor ID: 200867094164
List Price: 71.00€
(www.ebay.co.uk)

Planet Gear
(MB-750, MT-16)
Part #: ВП48015
Vendor ID: 000.651
List Price: 18.15€
(www.oldtimergarage.eu)

Sidecar Drive Idle Gear
Part #: ВП
Vendor ID: 2047
List Price: 18.88€
(moto-boxer.com)

Satellite Gears
(Ural)
(www.mc78.ru)
Output Gear: Locking Differential

- Output Gear, 24 teeth (MT-16)
  - Vendor ID: 2249
  - List Price: 15.00€
  - (www.ural-hamburg.de)

- Output Gear Differential Drive (MT-16)
  - Vendor ID: 200867947580
  - List Price: 15.00€
  - (www.ebay.co.uk)

- Coupling "Dnepr" Shift Part #: MT804419
  - List Price: 190 rubles
  - (mazepper.ru)

- Sidecar Drive Differential Gear Set (MT-16, MB-750, MB-650, MT-12)
  - Vendor ID: 190586412762
  - List Price: 289.00€
  - (www.ebay.de)
Ural 650cc Rear-Drive Gear Wear Limits
(2000 Ural Repair Manual)

- Tolerated Wear Limits and Clearances of Rear Drive Gears
  - Parts Worn Beyond Recommended Limits Should Be Replaced
  - Replace All Seals and Gaskets at the Same Time

<table>
<thead>
<tr>
<th>Name of Parts and Mating Members</th>
<th>Maximum Tolerances</th>
<th>Measuring Point and Method</th>
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<tbody>
<tr>
<td></td>
<td>Wear on Diameter</td>
<td>Diameter Clearance</td>
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<tr>
<td>Ring Gear Hub Splines</td>
<td>Tooth Thickness 0.75 mm</td>
<td>-</td>
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<tr>
<td>Propeller Shaft Cross Pins</td>
<td>0.05 mm</td>
<td>-</td>
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<tr>
<td>Final Drive Gears</td>
<td>Tooth Thickness</td>
<td>-</td>
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<tr>
<td>Ring Gear Hub Bearing</td>
<td>0.15 mm</td>
<td>0.12 mm</td>
</tr>
</tbody>
</table>

- Rear Drive Gear Backlash Should Be within 0.003 to 0.006” (0.07 to 0.16 mm)
  - If Backlash Is Incorrect, Change Adjusting Shims on Ring Gear, Substituting Thicker or Thinner Shims to Achieve Backlash within Tolerance

- Before Tightening Nut in Case Cover, Hub Gear Flange with Seal and Ball Bearing Should Be Installed
  - Bronze Ring Should Be Positioned onto Hub Gear Neck Next After the Steel Ring

- After Putting Main Drive Together, Check and Adjust Side-Play of Conical Gears by Tightening or Loosening Nut in Casing Cover
  - When Side-Play of 0.004 to 0.012” (0.1 to 0.3 mm) Is Achieved, Stop Adjusting and Fix the Nut with the Retainer
Final Drive Upgrades

• 2003: New 750cc Ural Engine Replaced the 650 cc Engine
  – New Drive Shaft with Course Splines to Reduce Chance of Stripping Out Drive Coupling

• 2006 Final Drive Changes & Improvements
  – Use of Final Drive Lock-Nuts
  – Knob Style Dipstick Removable by Hand
  – Nylock Nuts to Secure Final Drive to Swing -Arm
  – Labeled Final Drive Engagement Lever

• 2007 Final Drive Improvements
  – Reversed Style Driveshaft with Larger Spline Surface Area
  – Improved 2WD Engagement Rod with UNI Balls

• 2007 Urals Have Herzog Precision-Cut Timing Gears in Engine and in Gearbox

• Unofficial Quality Improvements for 2008 Ural Models
  – Precision German-Made "Herzog" Gears to Replace the Old, Cast Russian Gears
    • CNC-Machined to Tight Tolerances, in Comparison to Old, Square-Cut Gears
    • Herzog Final Drive Bevel Gears
      • Stronger and Properly Heat-Treated for Prolonged Life
      • Tighter Tolerances
      • Cooler Running Temperatures
      • Note: Earliest Availability Is Summer 2008
    – Didn’t Happen

• Ural Makes Bevel Gears in Irbit
  – Because Herzog Gears Are Expensive, Cost of Production Would Be Too Expensive
**Chang Jang (Chinese M-72) Drive Gears**

- Part 41 is shim that fits between the bearing and the "star" washer
  - Maybe it’s missing on your CJ
- According to the parts manual, the shim is available in thicknesses from 0.4 to 1.15 mm in 0.15 mm steps (0.006 inch)
- Adjustment Listed in Ural 650 manual:
  - If new gears or pinion bearings have been installed, gear tooth contact should also be checked:
    1. Remove the ring gear and smear a coating of gear marking compound on several of the pinion teeth (lipstick can be used for this purpose)
    2. Install the ring gear again. Pushing the ring gear towards the pinion, rotate the gears through several teeth to transfer the marking compound onto the other gear teeth
    3. Remove the ring gear and observe the pattern left on the teeth of the pinion
  - The ideal wear pattern is with contact centered in the middle of the pinion tooth surface
  - If the contact pattern is towards the edges of the pinion tooth, the pinion shaft should be moved in or out of the case by changing the shim to a thicker or thinner shim

When backlash and tooth pattern is acceptable, remove all traces of the gear marking compound and assemble the final drive