Reishauer Generating Gear Grinding
Gear Grinding

Generating Grinding
- Dis-Continuous
- Continuous

Form Grinding
- Dis-Continuous
- Continuous

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RZ 410, 2010
Flexible

RZ 60 / 160 / 260 / 360
from 2012 – Automotive, Truck

RZ 550, 2010
Flexible

RZ 630, 2007
Industrial Transm.

RZ 800, 2007
Printing Machines

RZ 1000, 2007
Wind Power

Reishauer Gear Grinding
Setup

Operator

- quick-change of diamond tool
- quick-change of grinding wheel
- integrated clamping

Automatic setting of all axis positions and automatic positioning of the diamond tool, the grinding wheel and the workpiece.

First automatic dressing of the grinding wheel and grinding of the first workpiece.
Productivity
Noise Reduction

- Minimized waiviness in profile direction
- Minimized vibration and frequency in drive system
- Specific profile- and lead modification

LNS (Low Noise Shifting)
Noise Reduction

LNS (Low Noise Shifting)

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Low Noise Shifting  LNS

Yesterday:
generating grinding without LNS

Today:
generating grinding with LNS

Statisticallly shortened waviness in axial direction (Low Noise Shifting)

Functionality
Noise Reduction

- Minimized waiviness in profile direction
- Minimized vibration and frequency in drive system

LNS (Low Noise Shifting)
Waiviness and Ghost Frequency

“Macro-waviness”


graphs showing past and today comparisons with labels:
- past
- today

“Ghost frequencies”

Improved by:
- Fine balancing
- Defined number of grinding wheel starts
- Increased Machine stiffness

Functionality
Noise Reduction

- Minimized waiviness in profile direction
- Minimized vibration and frequency in drive system
- Specific profile-and lead modification

LNS (Low Noise Shifting)
Functionality
Option:

Line Dressing
Topological Dressing of Profile

profile angle
crowning	
tip and root relief

Line Dressing
Diamond Tools

Diamond Roll Set 1-start
Module 1.5 - 5

Diamond Full Profile Roll
Module 0.5 – 1.5

Diamond Profile Roll
Module 1.0 – 5 (10)

Diamond Double Taper Disk
Module 1.0 – 5 (10)

Diamond Dressing Tools
Outer diameter 123 mm
Outer diameter 160 mm
Bore diameter 52 mm

Diamond Radius Form Roll
Change of pressure angle modifications and corrections separate for:

- Left flank
- Right flank
Constant Contact Pattern
Lead modification

Functionality
Lead modification

Today on all Reishauer machines possible, tomorrow requested from R&D
Root and Lead Load Capacity

- Constant contact pattern due to accuracy of profile, lead and pitch
- Modifications — specific to load conditions
- Compressive residual stress $\sigma$

Functionality
Defined Root Grinding

- Not allowed because of grinding step
- Protuberance requires excellent pre machining
- Defined root radius
- Full form grinding

\[ a_{o} = \text{Stock allowance per flanc} \]
\[ a'_{o} = \text{Stock allowance in the root} \]
Compressive Residual Stress

Compressive residual stress in tooth flank

Compressive residual stress in tooth root

Functionality
Compressive Residual Stress

Functionality
Standard and Polish Ground Gear
The Reishauer-Superfinishing use one grinding worm for the total grinding operation as grinding tool. The grinding wheel is divided in two zones with different specifications.

The geometry of the grinding wheel is done with standard Reishauer dressing tools and the same dressing technology used for generating grinding.
Polish Grinding Prinziple

Rauheitsprofil nach DIN 4768

Standard-Walzschleifen
- Rz 2.11 µm
- Ra 0.35 µm

Reishauer-Feinschleifen
- Rz 0.96 µm
- Ra 0.07 µm
Reishauer Process Development

Results

Standard-generating grinding

Reishauer Superfinishing

Material fraction left flank

0.81 µm

Material fraction right flank

1.08 µm

With removal of the material peak the material fraction of the superfinished surface increase.
Gear load bearing capacity

Gear wear behaviour

Rk, Rpk, Rvk, Mr1, Mr2 - Parameters according to ISO 13565

Source: jenaoptik.com

Abbott Material Ratio Curve
Special Profile

Functionality
fully shaped tooth tip

fully shaped root

involutes

Functionality
Inspection of full shape

Inspection of involute area

Functionality
Special Application

Without negative crowning bad pattern
Profile Grinding

Special Application
Profile Grinding Dressing Condition
Hardness

Maximum Hardness 62 HRc (740 Hv)

Hardness over HRc 62:

- Difficult / impossible to grind
- High risk for cracks
- High risk for burning
Quality

Pre-work quality better than DIN 10

Runout and Accumulated Pitch Error better than DIN 9
Fp and Fr less than 100 µm
Thank you for your attention