Flexible Deep Rolling and Roll Straightening Machine

Type 7893R

For high volume or flexible production of crankshafts

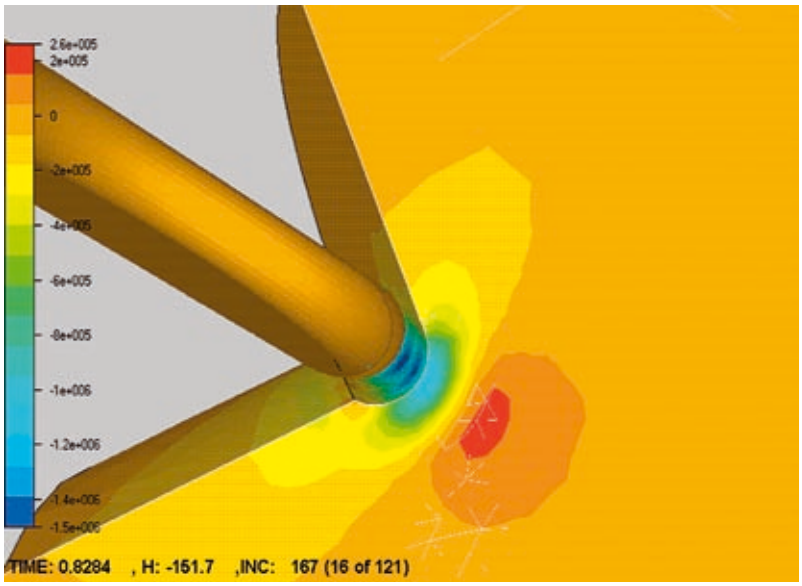
...technology in motion

Hegenscheidt MFD

Increasing Fatigue Strength by Deep Rolling

The Deep Rolling Process

Deep rolling of fillet radii to improve the fatigue strength of highly stressed crankshafts is an universally accepted process technology within the automotive powertrain engineering field. The deep rolling process induces residual compressive stresses into the fillet radii, increasing the fatigue limit and significantly increasing service life of the product. The deep rolling process offers a particularly economical and capable method of optimizing the fatigue strength of high performance crankshafts in a high volume production environment.



Deep rolling of journal fillets

Hegenscheidt-MFD has decisively shaped the development of deep rolling technology. Crankshaft fillet deep rolling technology has been applied in the automotive industry since 1957. By deep rolling the VW 'Beetle' crankshaft, engine output was increased by 30% without design changes.

Simultaneous deep rolling of main and pin journals

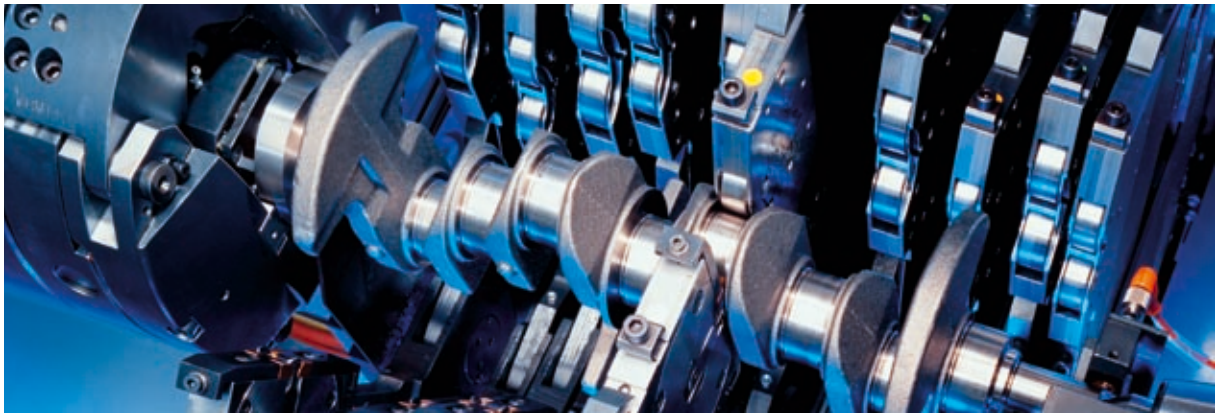
Enhancing Material Properties

The deep rolling process results in the plastic deformation of the surface layer of material. This induces positive three-dimensional residual compressive stresses within the bearing fillet areas, which are subject to the highest performance stresses.
The surface pressure exerted during the deep rolling process induces residual compressive stresses that prevent the creation of tensile stress under load conditions. With optimised deep rolling processes, increases in fatigue strength of more than 200% can be achieved. In addition, the process work hardens the material, improves surface hardness and considerably increases the crankshaft's resistance to dynamic stresses and stress corrosion.

Machining Process

After the crankshaft has been loaded, pre-centered and fixed by using a compensating chuck, the integrated PLC-operated spindle positioning system rotates the crankshaft into the correct deep rolling position. The tools automatically encircle the crankshaft main and pin bearings. The undercut fillet radii of these journals are then deep rolled with angle dependent rolling force control, after which the total indicated run-out TIR is minimised during roll straightening. The incorporated process management system monitors the penetration depth within the radii undercut for optimum process reliability.

Improving Radial Run-Out by Roll Straightening



Roll straightening of a pin journal

Angle Dependent Deep Rolling

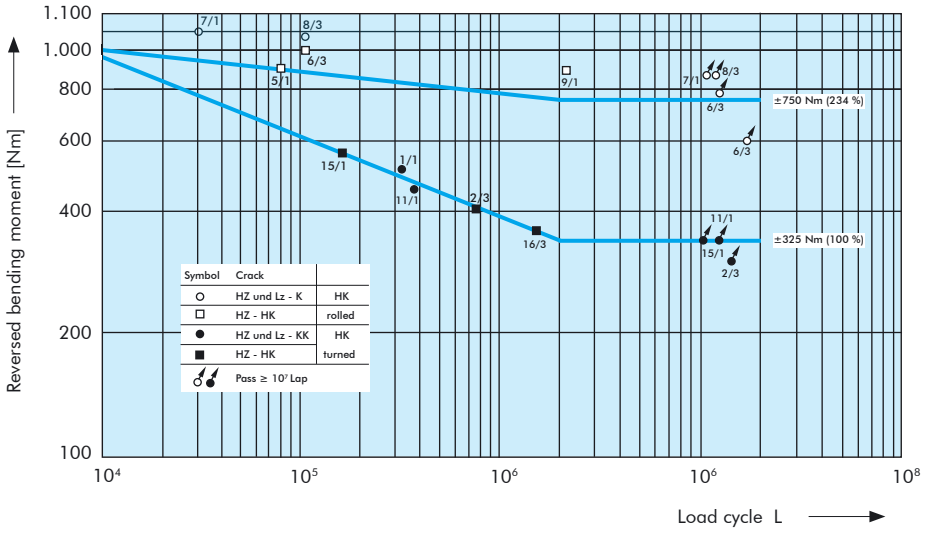
The angle dependent deep rolling process effectively counteracts axial run-out deviations caused by varying degrees of rigidity in the upper shoulders of the pin journals.
This run-out deviation reduction is achieved by automatically reducing rolling force when contact is made with the bearing shoulders during the rolling sequence, rolling force is increased again to improve fatigue strength in the fracture line portion of the crankshaft.

Roll Straightening

Roll straightening reduces radial run-out. The process developed by Hegenscheidt-MFD is the only cold straightening method that does not impair fatigue strength. The Hegenscheidt-MFD roll straightening process actually increases fatigue strength of the crankshaft through the application of additional residual compressive stresses in the fillet radii. Alternative straightening methods can reduce the fatigue strength by up to 40 %. During the combined deep rolling and roll straightening process, the degree of TIR affecting the crankshaft is measured following the deep rolling phase and then minimised by a calculated increase of deep rolling force during the roll straightening cycle.

High-Performance Process

Hegenscheidt-MFD's combined deep rolling and roll straightening machines improve both fatigue strength and radial run-out of crankshafts. Combining these two features in one machine enhances product quality, process capability and improves process efficiency.



Wöhler fatigue test

of a deep rolled/unrolled nodular cast iron crankshaft

Machine Design

Economic Advantages

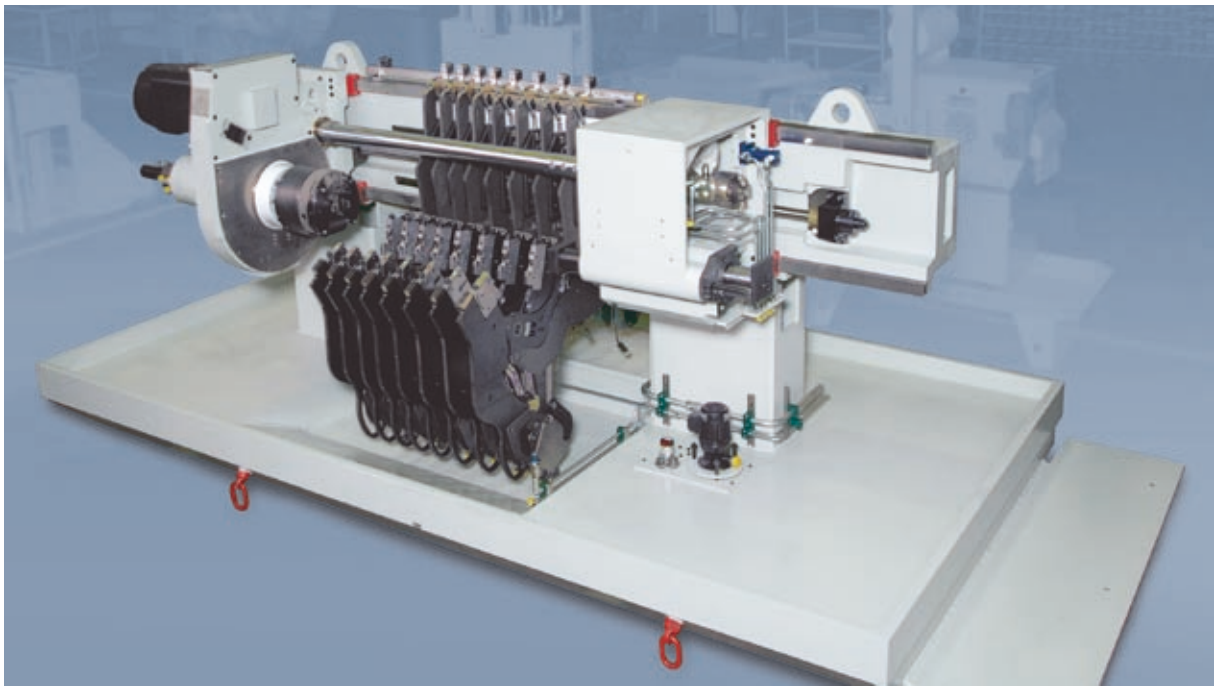
Hegenscheidt-MFD's innovative 7893R deep rolling and roll straightening machines offer the following economic advantages to the manufacture of crankshafts:

- Energy saving process
- Low production costs
- High production rate
- Low maintenance costs
- High machine availability

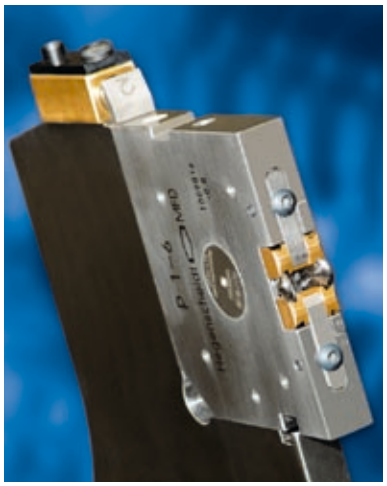
System Advantages

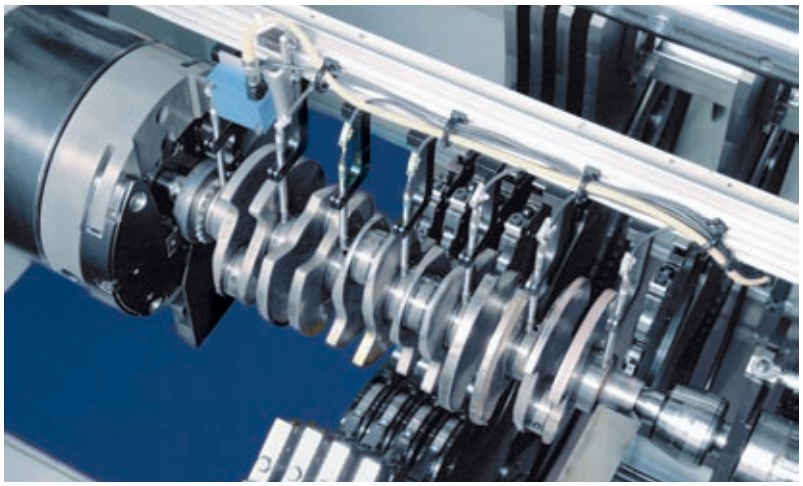
All 7893R machines provide the following features:

- High flexibility for crank families with varying stroke, journal spacing and quantity of journals
- Automatic stroke adjustment
- Quick change-over from one family type crankshaft to another in less than 30 minutes
- Direct loading into machining position
- Low loading height of 1100 mm
- Automatic radial positioning
- Integrated laser measuring probe to check stroke and angular position
- Angle dependent rolling for minimised run-out and reduced deformation of shoulders
- Measuring of the total indicated run-out on all main bearings
- Measuring of run-out with reference to centers or to vee-blocks
- Straightening of crankshafts without loss of fatigue strength
- Roll straightening computer with software for all common types of crankshafts
- Self teaching straightening program
- High degree of process capability by monitoring all parameters
- Monitoring of fillet penetration depth
- Tool monitoring system
- Tool design for long tool life



Extensive Machine Features





High Performance Tool

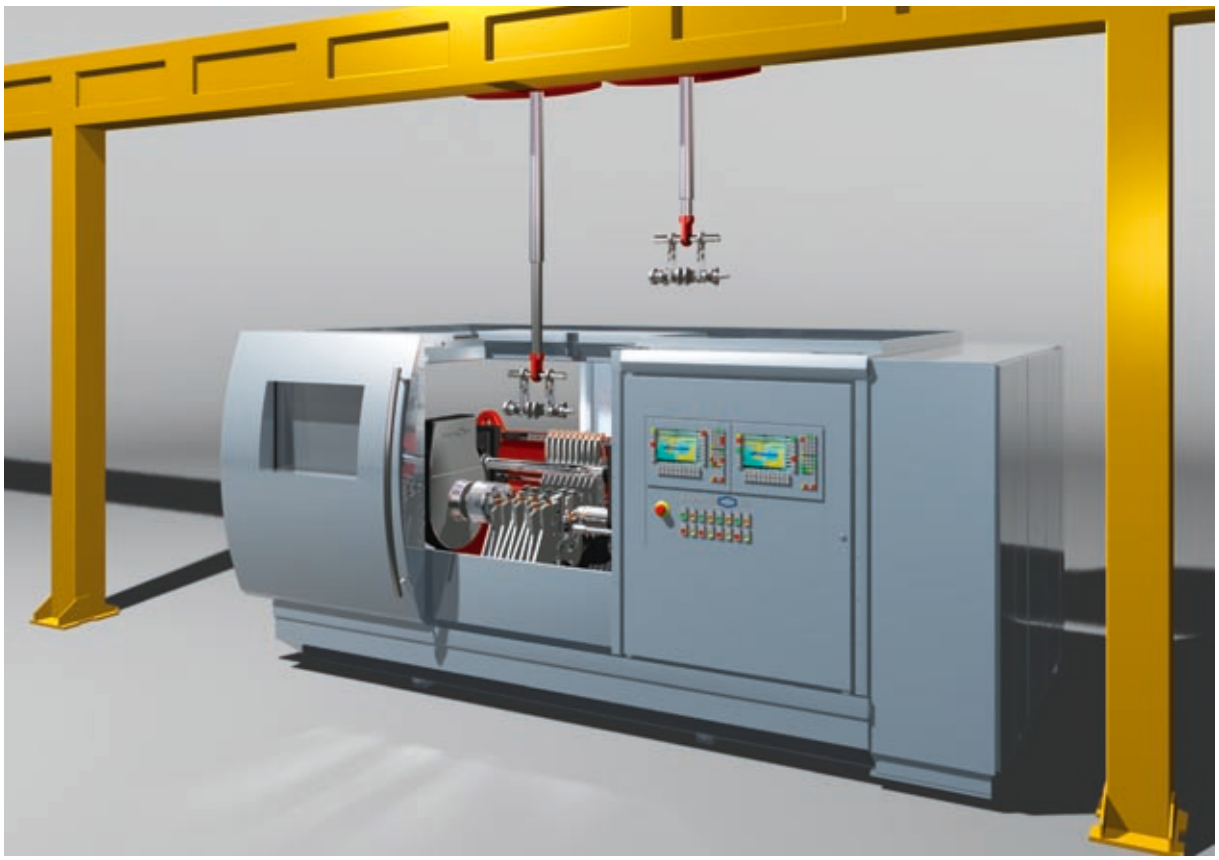
Hegenscheidt-MFD's latest generation of crankshaft deep rolling machines are equipped with new Hegenscheidt-MFD high performance deep rolling tools for high tool life.

Laser Sensor

The integrated laser sensor gages the radial position and stroke of the crankshaft.

Measuring Probes

Precision probes measure the TIR at the main bearings. The measured values are relayed to the roll straightening program for evaluation and precise identification of the direction and degree of radial run-out. This data is the basis for the roll straightening process.



Customised design solution for Individual Applications

Type 7893R-01

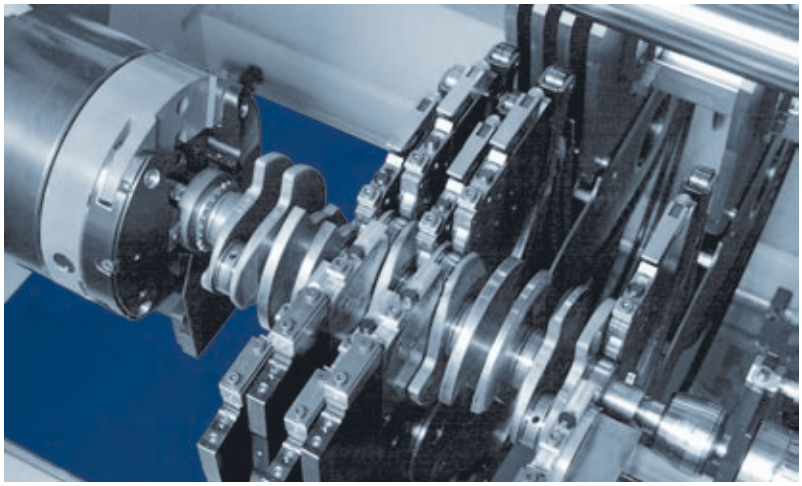
A machine for high volume production with fixed headstock and tailstock positions suitable for families of crankshafts with uniform main bearing widths, lengths and pitch dimensions. Accommodates crankshafts with variable stroke and bearing diameters.

Type 7893R-03S

A flexible machine design that incorporates automatically adjustable headstock and tailstock positions. Suitable for multiple crankshafts with varying dimensions and quantity of bearings.
Machining of several crankshaft bearings consecutively by laterally shifting the crankshaft in front of the axially fixed deep rolling units.

Type 7893R-02

A machine suited for high volume production with automatically adjustable headstock position. Accommodates various families of crankshafts with differing length dimensions and varying quantities of pin bearings.



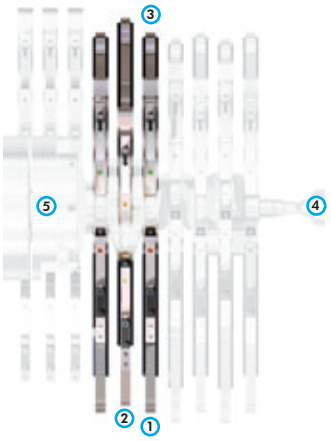
Processing of an inline 6-cylinder crankshaft with machine type 7893R-03S equipped with 5 deep rolling units.

Machines for every manufacturing requirement

Hegenscheidt-MFD's 7893R series of deep rolling and roll straightening machines was designed to fulfill all crankshaft production requirements.
The extensive range of products includes models suited for high volume production as well as highly flexible models for use with crankshaft families with varying quantities of bearings.
Simple tool changing ensures minimized set-up times.

Crankshaft Specific Tool Components

1: Deep rolling tool for main bearings
2: Deep rolling tool for pin bearings
3: Axial support for main bearings
4: Rotary live center
5: Clamping chuck jaws



Birds eye view into the Hegenscheidt-MFD crankshaft deep rolling and roll straightening machine assembly.

Technical Specifications

	Type 7893R-01	Type 7893R-02	Type 7893R-03	Type 7893R-03S
Machine Details	Headstock and tailstock manually adjustable. Ideally for the machining of one type of crankshaft. Accommodates variable stroke	Headstock automatically shiftable. Tailstock manually adjustable. Ideally for machining of one crankshaft family with different quantity of bearings and variable stroke	Headstock and tailstock automatically shiftable. Ideally for machining of different crankshaft families	Similar to 7893R-03, except the quantity of deep rolling units is less than the quantity of crankshaft bearings. Machining several crankshaft bearings consecutively by shifting the crankshaft axially in front of the fixed deep rolling units. Ideally for machining of different crankshaft families in lower quantities.
Crankshaft				
Max. pitch of enter main bearings:	920 mm	920 mm	920 mm	920 mm on inquiry > 920 mm
Max. radius of counterweight: (depending on stroke and bearing width)	195 – 270 mm	195 – 270 mm	195 – 270 mm	195 – 270 mm on inquiry > 270 mm
Max. radius of counterweight for shifting:	-	-	-	Dependant upon individual requirements
Max. quantity of bearings:	8 main bearings 6 pin bearings	8 main bearings 6 pin bearings	8 main bearings 6 pin bearings	Dependant upon individual requirements
Min./max. main bearing diameter:	30 / 88 mm on inquiry>88 mm	30 / 88 mm on inquiry>88 mm	30 / 88 mm on inquiry>88 mm	30 / 88 mm on inquiry>88 mm
Min./max. pin bearing diameter:	30 / 84 mm on inquiry >84 mm	30 / 84 mm on inquiry >84 mm	30 / 84 mm on inquiry >84 mm	30 / 84 mm on inquiry >84 mm
Min. bearing width:	18.5 mm	18.5 mm	18.5 mm	18.5 mm
Max. stroke:	140 mm	140 mm	140 mm	140 mm
Min. pitch between main and pin bearing:	29,5 mm	29,5 mm	29,5 mm	29,5 mm
Deep rolling units				
Max. deep rolling force:	30.000 N optional 40.000 N	30.000 N optional 40.000 N	30.000 N optional 40.000 N	30.000 N optional 40.000 N
Headstock				
Main drive power:	20 kW	20 kW	20 kW	20 kW
Deep rolling speed:	120 min^{-1}	120 min^{-1}	120 min^{-1}	120 min^{-1}
Roll straightening speed:	60 min^{-1}	60 min^{-1}	60 min^{-1}	60 min^{-1}
Measuring speed:	30 min^{-1}	30 min^{-1}	30 min^{-1}	30 min^{-1}
Machine				
Weight including auxiliary equipment:	approx 13.800 kg	approx 13.800 kg	approx 13.800 kg	approx 13.800 kg
Dimensions including integrated control panel and hydraulic unit (L/W/H):	4,5 x 2,5 x 2,2 m	4,5 x 2,5 x 2,2 m	4,5 x 2,5 x 2,2 m	4,5 x 2,5 x 2,2 m
Machine center height:	1.100 mm	1.100 mm	1.100 mm	1.100 mm

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THE TECHNOLOGY PROVIDER

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