Precision jump at shaft grinding

Tailstock with hydrostatic bearings

Long shafts are supported by tailstock in cylindrical grinder or lathes during machining. Normally center pin of tailstock in grinders does not rotate, which result machined roundness close to tailstock depends on quality of center hole in work piece.

At high weight or big bore of work, there is danger of damage of centers at sliding contact areas. There, most time rotating centers are used, which typically have runout is 2 to 5 µm, so runout is not good enough for most precision grinding shafts. Also rigidity of these rotating centers is low by the roller bearings inside.

Please find the complete press release in the appendix and on enclosed CD.

We will send you our press release via email on request. Please send a short message to M.Roeding@technikpresse.de. We will send you the complete information as soon as possible.
**Actual limitations by use of conventional tailstocks**

At high precision finish grinding or hard turning, long shafts are fixed between centers with axial pushing force of tailstock. When work piece weight is small and it rotates slowly, non-rotation hard metal center pins can be used. The roundness of machined diameters close to the tailstock center depends on geometrical quality of center hole in work piece, which often require grinding before and good lubrication.

If shafts have big bore or are too heavy or need high rotation speed, there is too much wear when using fix center in tailstock. At this application rotation tailstock centers are used to support work piece without wear. The radial runout quality of rotating centers is typically in range of 2 to 5µm, which is not enough for high quality shafts, where roundness should be less than 1µm.

When axial move of tailstock is done in sliding bushings, a gap is necessary between bearing and linear moving shaft. When there is no move, there is high start friction which result variation in axial tailstock clamping force. When work piece change length e.g. heating of grinding or by cooling of fluid around, machining precision is influenced by variation of axial tailstock pushing force.

By the gap in the bushing, X-position of center rotation axis change depending on axial tailstock position. This change of work diameter at same grinding wheel position must be adjusted by X-position of tailstock.

At grinding of long cylinder, variation of diameter must be adjusted by fine positioning to compensate gap in bushings. Some tailstock use ball bushings to reduce play, but this reduce machining quality because there is no more damping.

**The solution: tailstock with hydrostatic bearings**

The sleeve shaft of new developed hydrostatic tailstock has flange type fixed center at front and is supported in 2 hydrostatic radial bearings for rotation and linear move.

Hydrostatic bearing fix shaft in housing free of play and without friction to axial move. By oil flow control with PM-flow controller, hydrostatic bearings are very rigid and have excellent damping.

The radial runout - more specific - the variation of position of rotation axis of center, is less than 0,2µm in whole speed range. Because the rotation is so precise, work piece can be machined close to the tailstock in same roundness quality, almost independent of quality of center on work piece.

In production of company Hyprostatik Schönfeld GmbH on cylindrical grinder Kellenberger Kel-Varia with hydrostatic work head and hydrostatic tail stock, long shafts are grinded in roundness 0,2µm on complete length.

By missing friction to axial move, the hydrostatic tail stock is able to adjust axial clamping force on work piece very precise from 0 N to max. force. If work piece change length e.g. by thermal influence or forces, hydrostatic supported sleeve shaft move axial in 0,1µm steps and keep pushing force constant. As result of this, labile long shafts, e.g. cam shafts, crank shafts, balance shafts of...
automotive industry can be grinded much more precise, because its form keep same during complete machining.

Up to now usual centers with morse cone (MK) are not useful to work with hydrostatic tail stock, because morse cone has too large influence on diameter and form of sleeve shaft and hydrostatic bearings. Flange type center parts with different diameter and different shape, with hard metal inserts or hard metal coated can be fixed on nose of sleeve shaft and changed for different work pieces. By radial work screws it is possible to do fine adjustment. Because center does rotate, spindles with big bore can be fixed without glued bushings inside. For this big centers are available.

The center with sleeve shaft is driven by work piece by friction or by driving pin. Speed of sleeve shaft can be measured by speed sensor, which make possible to limit acceleration or deceleration when speed of work head and tail stock is different if there should be no relative move in center. If center should drive itself for fast acceleration or deceleration synchronal to main spindle, usually a hydrostatic motor spindle is used with short stroke axis below. Same is used, if stroke or weight load must be much higher. In this way, big hydrostatic tailstock uses max. radial load of 100to for big lathe.

Actually hydrostatic tail stocks are available for work piece 0 to 70kg with sleeve shaft ø35mm for max. axial and radial force 400N, for work pieces up to 400kg with sleeve shaft ø70mm for max. axial and radial force and radial force 2500N and shaft ø100mm for work piece up to 1000kg for max. axial force 6000N. Axial move is between 40 and 60mm.

This tail stocks are used for grinder with max. speed 500rpm to 2000rpm most with oil viscosity VG32 and for hard turning machines with 3000 to 6000 rpm with oil viscosity VG2 to VG4. At very high combination of radial load and speed, as usual by standard turning machines, ball or taper roller bearings are used for support of rotation and friction freed hydrostatic bearing are used for axial move of sleeve shaft to have good damping and precise pushing force.

The axial force of tailstock is adjusted either by controlled pushing pressure in servo cylinder or by servo motor pushing through ballscrew. Both systems work in force mode at contact with work piece. Apart from this it works in axis mode, where position is kept or sleeve shaft move with position control. The axial position of sleeve shaft is measured by absolute position sensor. By this move can be limited and speed can reduces short before expected contact with work piece. In serial production with automatic work piece loading, axial position measuring give information if center tip get in center hole of work piece or if work piece is in machine.

Thermal length change of work piece can be measured and tolerance of long axial distance can be reduced by this information. If axial tailstock clamping force is selected too small, pop out of work piece by too large machining force can be detected and reaction of alarm or automatic increase of clamping force to keep in part, is possible.
Press release

In rear side is a spring loaded clamping device, keeping work piece clamped, while machine is turned off.

Hydrostatic tail stocks are available for new machine tools or hard turning machines. Housing geometry, axial stroke, load capacity and max. speed is adapted by pressure, oil type and oil flow for the bearings. Also hydrostatic tail stocks are available for used machines, where existing tailstock can be replaced by hydrostatic tailstock together with small hydraulic unit and control.

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Photo 2: Hydrostatic tailstock Ø70mm for heavy shafts

Photo 3: Hydrostatic tailstock Ø70mm with servo motor