

Bearing system development

turn-table motors for CD/DVD application

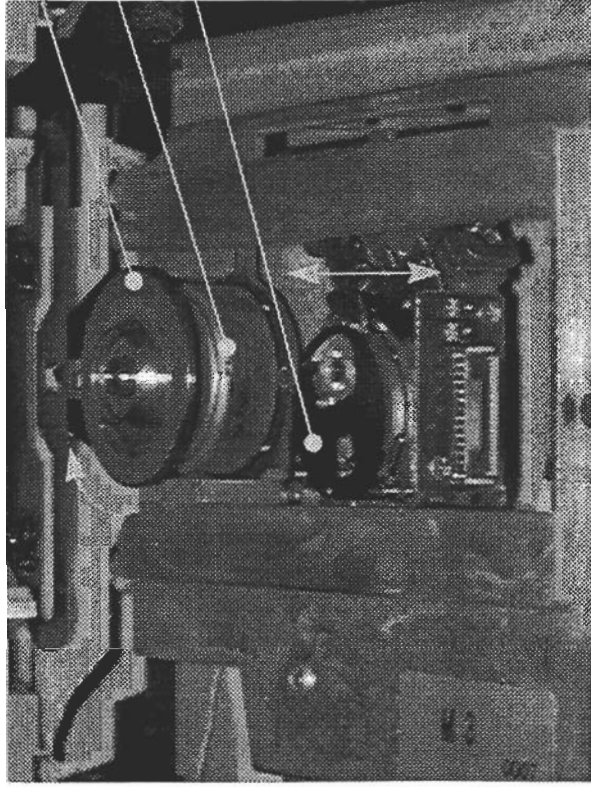
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- CD/DVD systems
- Trends and consequences for the turn-table motors
- The bearing system in 3 motors for different applications
- Verification
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CD/DVD systems

- 1: turn-table
- 2: turn-table motor
- 3: Optical Pick-up Unit (OPU)
 - lens (focus actuator)
 - long stroke actuator



CD/DVD applications: bearing systems in turntable motors

Trends and consequences for bearing system

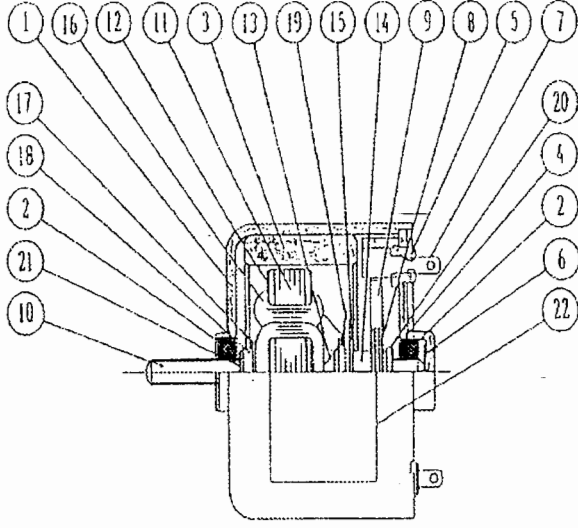
- speed of data-processing increases
 - motor speed increases
 - bearing load increases
 - number of revolutions during life increases

$$F_{unb} = (m \cdot r)_{unb} \cdot \omega^2$$

$$W = C \cdot \frac{\eta \cdot R^3 \cdot L}{\Delta R^3} \cdot \omega$$

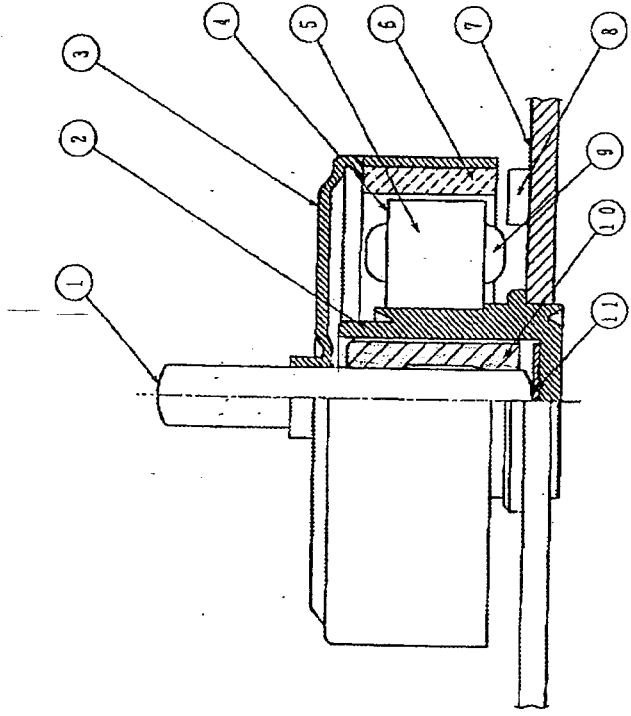
- information density increases
 - allowable tilt error decreases (motor + bearing stiffness)
 - running accuracy of motor must increase (full film bearing)

Type 1: Turntable motor for CD-audio



- low operating speeds
- “low” info-density
- porous radial bearings
 - small bearing surfaces
 - poor bearing-alignment
 - small oil reservoir (bearing pores)
 - no sealing
- thrust bearing
 - grease lubricated pivot plate

Type 2: Motor for CD ROM

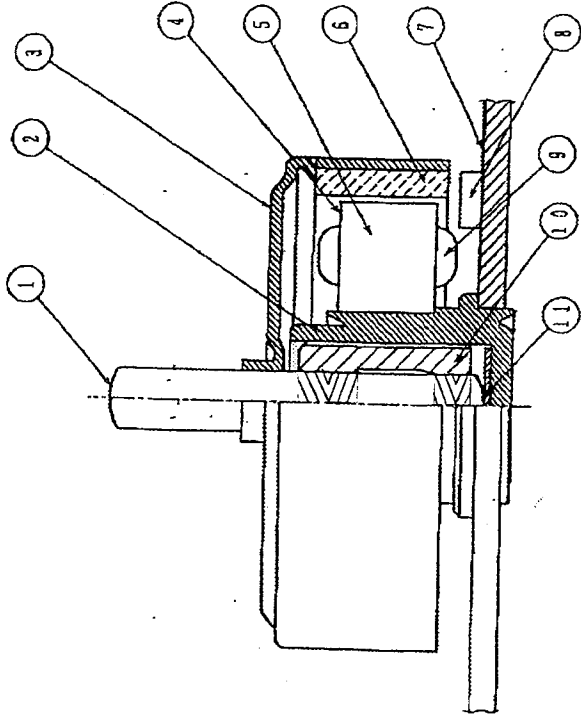


- high operating speeds
- “low” info-density
- porous radial bearings
 - large bearing surfaces
 - optimised bearing-alignment, clearance and porosity
 - reservoir filled with oil
 - sealing measures
 - optimised lubricant
- thrust bearing
 - oil lubricated pivot plate

CD/DVD applications: bearing systems in turntable motors

Type 3: Motor for DVD ROM, DVD RW,.....

- high operating speeds
- high info-density
- spiral groove bearings
 - large bearing surfaces
 - optimised bearing-alignment + clearance
 - optimised herringbone pattern in bearing bush
 - reservoir filled with oil
 - sealing measures
 - optimised lubricant
- thrust bearing
 - oil lubricated pivot plate



CD/DVD applications: bearing systems in turntable motors

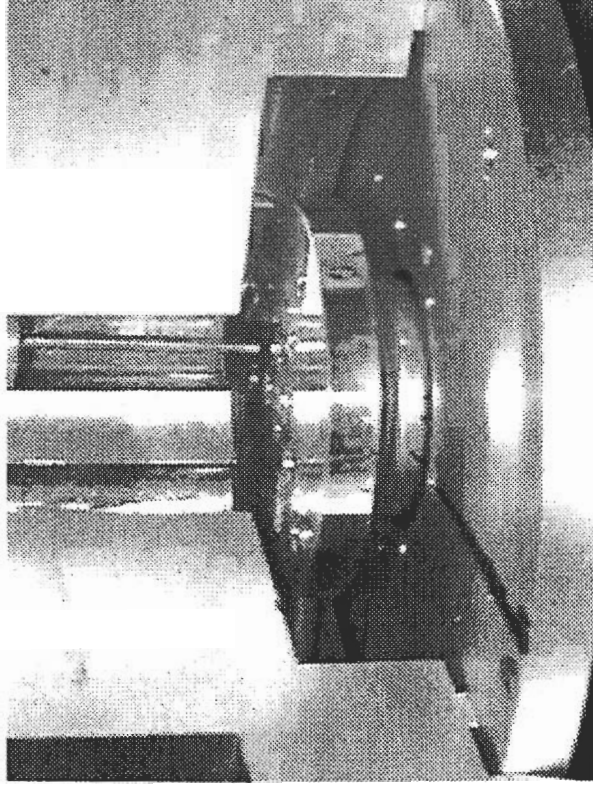
Spiral Groove Bearings (SGB)

- Compared to plain bearing:
 - bearing gap filled with oil
 - no side leakage (during operation)
- Compared to roller bearings
 - low non-repeatable run-out
 - shock proof

Verification of bearing performances

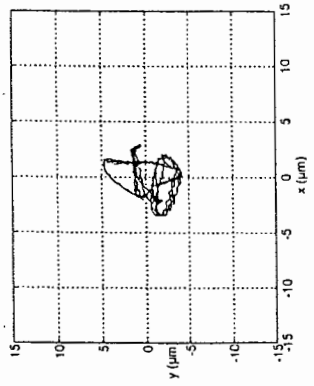
1 first evaluation: Run-out measurements

- turntable motor
- perfect "round" disk
- add unbalance masses
- displacement transducers
 - x
 - y
- triggering device
- $Run-out = f(T, (m.r), v, t, \eta, \dots)$



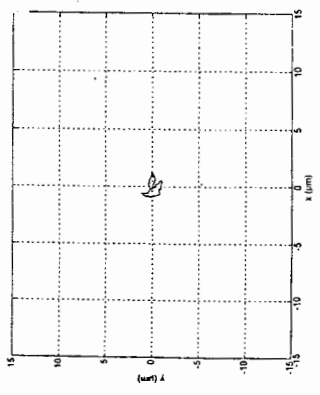
Conditions: unbalance 3 gmm, temperature 20°C (4U, 55, 7U)

Type 1



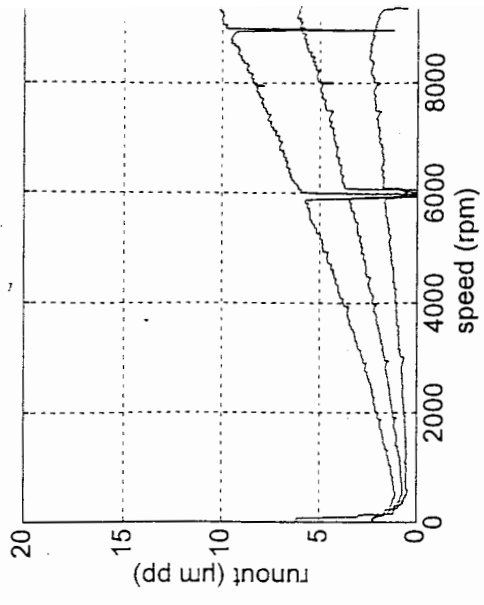
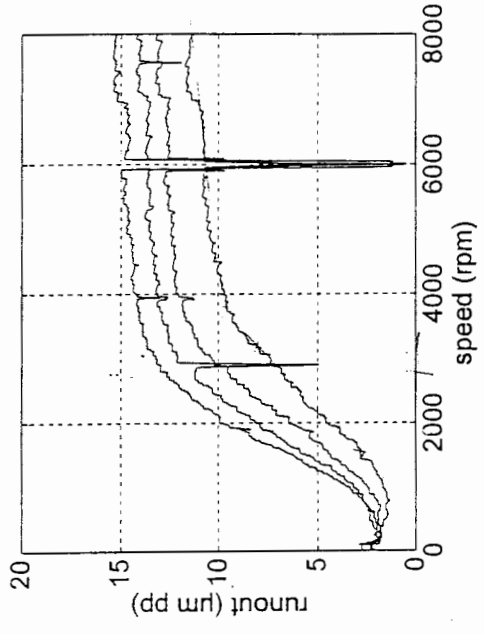
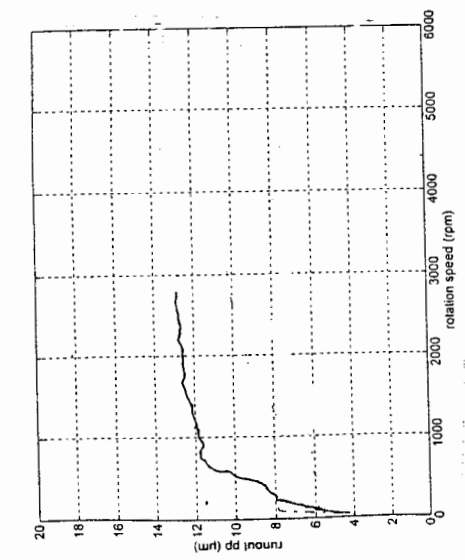
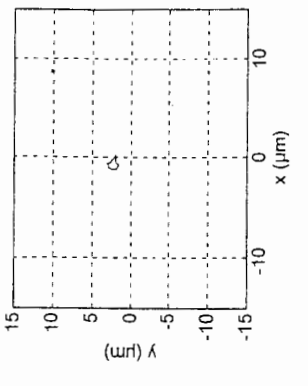
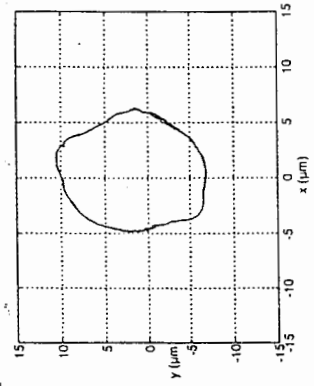
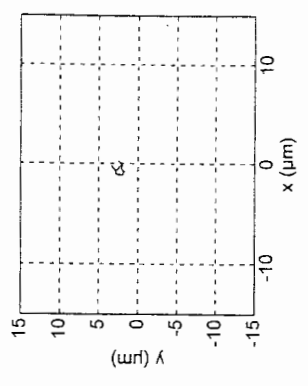
300 RPM

Type 2



1200 RPM

Type 3



Conclusions

- Optimisation of porous bearing bushes results in enhanced film build up (type 2 vs type 1)
 - parameters: R, L, ΔR , porosity
- Spiral Groove Bearings show an improved oil film build up compared to optimised porous bearings (type 3 vs type 2)
- SGB's show promising results for (future) CD/DVD turn-table motors