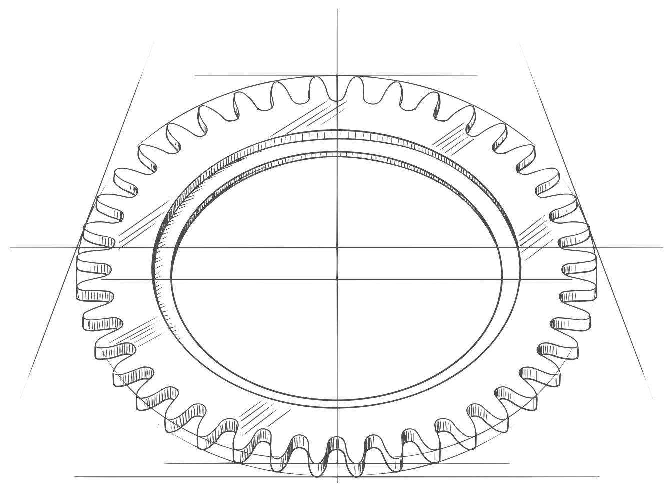
Watch gears

Challenges in machining gears in the watchmaking industry
Watch gears are crucial for the precision and function of a movement. Their machining poses special challenges due to their extremely small dimensions, tight tolerances and unique material properties.

1. Choice of materials and their machinability
Watch gears are made from various materials, each presenting their own specific challenges:
- Brass (CuZn37, CuZn39Pb3) → Good machinability but soft material → high tool wear on fine structures
- Nickel silver (CuNi12Zn24/CuNi18Zn20) → Harder than brass, but poorer machinability
- Stainless steel (316L, 17-4 PH) → Corrosion-resistant, but difficult to mill and turn
- Titanium (Ti6Al4V) → Light and robust, but tends to work hardening
- Silicon → Used for ultra-precise gears in high-frequency applications (via etching or laser processes)

2. High precision and tight tolerances
- Tolerances in the range of ± 2–5 µm → Even the slightest deviations affect accuracy
- Perfect tooth geometry → Essential for smooth transmission and minimal energy loss
- Coaxiality and run-out accuracy → Essential for ensuring uniform meshing with other gears

3. Machining methods and challenges
a) Milling/Hobbing/Shaping
- Rapid tool wear when machining hard materials
- Precise positioning is essential to ensure minimal deviations in tooth geometry
- High demands on clamping systems to prevent vibrations



b) Wire or sinker EDM (for high-precision gears)
- Slow process, but extremely precise → ideal for prototypes and small-scale production
- Risk of heat impact on thin teeth → can lead to dimensional deviations

c) Laser cutting/etching (for silicon gears)
- Etching is particularly suitable for fine structures (e.g., anchor escapement)
- Requires special rework to remove burrs and residual stresses

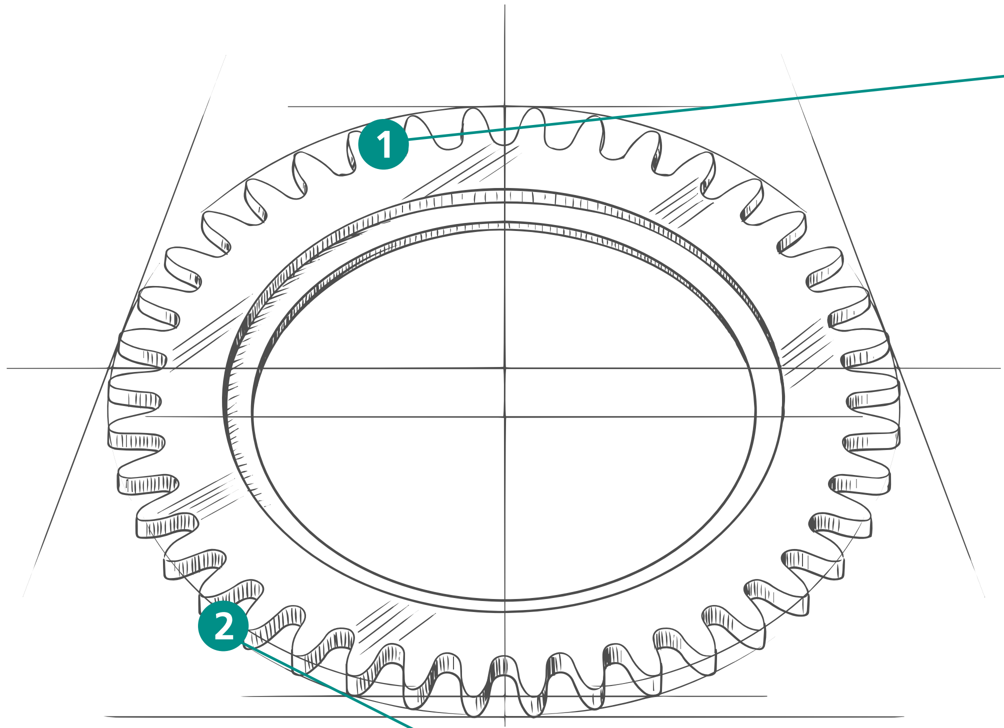
4. Tool life and wear
- Carbide or PCBN/CBN tools required for hard materials such as stainless steel or titanium
- High wear due to extremely small tools (cutters Ø <0.1 mm for micro gears)
- Cooling is crucial → often minimum quantity lubrication (MQL) or dry machining

5. Surface quality and rework
- Minimal roughness required → Less friction, higher efficiency
- Honing or vibratory finishing to improve tooth flank quality
- Electroplating (gold-plating, rhodium plating, nickel-plating) for protection and reduced friction

CONCLUSION

Machining gears in the watch-making industry demands utmost precision, specially adapted manufacturing processes and high-quality materials. The challenges lie in burr formation, tool life, perfect tooth geometry and rework.

Machining



2 GEAR-MODULE MILLING

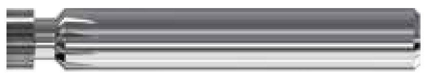
Gear cutter Type 3355
Module sizes from 0.5 – 3.0 mm

DIXI polytool

Hobbing cutter 1675
Hobbing cutters for cycloidal tooth profiles, designed for hobbing through the generation of pinions and gears (NIHS, EVJ, CETEHOR standards)

DIXI polytool

Monoblock hobbing cutter 1672
For cycloidal tooth profiles, used for generating small gears by hobbing (NIHS, EVJ, CETEHOR standards, etc.), including a regrindable logarithmic profile



DIXI polytool

Special adjustable hobbing cutter
Used for hobbing to create asymmetric pinions and gears, including colour wheel and wolf-tooth profile

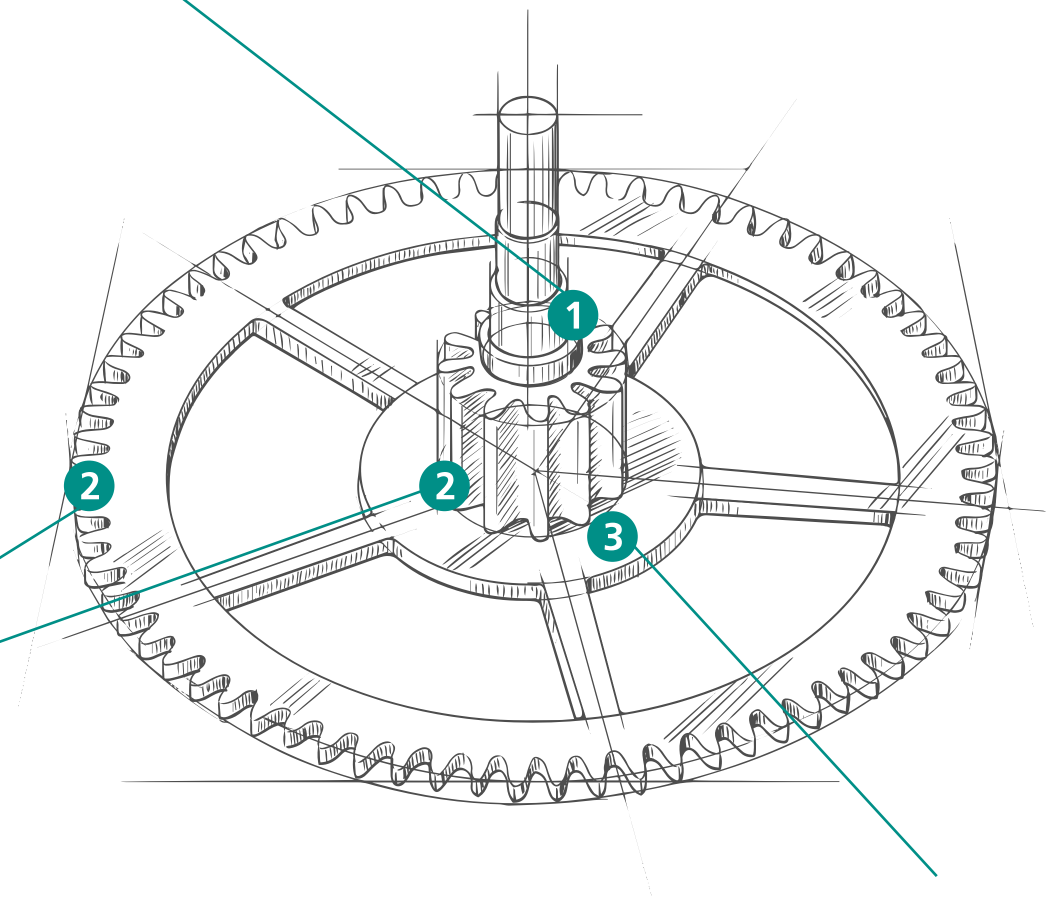
1 MICRO BORING

FUTURO

Micro boring head with cylinder shank
Precision boring head for perfect roundness and diameter cylindricity, adjustable to 1 µm

SWISS TOOLS

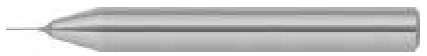
Micro boring head with HSK-EZ15 / ATC15
Precision boring head for perfect roundness and diameter cylindricity, adjustable to 1 µm



3 MICRO-REAMING OF INTERNAL ADJUSTMENT IN TOOTHED PULLEYS

magafor

Magaforce 8610 Reamer
Step size of 0.005 mm for the most precise holes, from Ø 0.2 mm, with left-hand flutes



DIXI polytool

POLY 4007-TC
Solid carbide machine reamer with left-hand helix angle, from Ø 0.37 mm, featuring unequal pitch