

TOOTH TIPS

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When laying out the sequence of operations, the teeth must run true with the diameters and faces that will be used for their actual mounting.

THE REQUIRED GEAR ACCURACY IS DIRECTLY RELATED to the costs of manufacture. The highest accuracy available by current processes is considered to be AGMA 15 (A2). On a 6-inch diameter gear, this is accuracy in the order of 0.00011". There is also a limit on how wide tolerances can be to be economical. For example, an involute with a tolerance of 0.015" is exceptionally generous, and any further increase would not provide any savings. There is a major increase in cost from A5 to A3 and an even larger increase to achieve A2. An A4 gear is not feasible with a cutter. Shaving is more economical than grinding. An A9 gear has a lead tolerance in the range of 0.003"–0.004", easily achievable by hobbing or milling. If properly prepared and manufactured, high quality gearing can be manufactured with a lower manufacturing cost than gears of a greater mass and lower quality. Gears with a disproportionately wider face are to be avoided. In the past 30 years, designing high power density gearing with reductions in size,

weight, and cost has resulted in helical gear units of less than half the previous size. In the past century, torque capacities have increased eighteen-fold in automotive bevel gears, eleven-fold in helical gearing, and fourteen-fold in worm gears. The most prevalent manufacturing errors involve the pressure angle that affects the slope profile, curvature errors that occur when crowning or otherwise modifying the profile, misalignment that affects the lead slope, and lead crown errors.

The final assembly of the gears is crucial to their operation and lifespan. They must be assembled to provide the optimum contact area. This area may only occur when the gears are running in a fully loaded condition. The gears must be supported in correct alignment on shafts that provide for the absolute minimum amount of deflection.

The most complex and costly tools used for metal cutting are those used for cutting teeth—particularly form cutters. Coatings are successfully used to improve tooling economics by increasing the time between sharpenings and in keeping most of the heat away from the substrate material. Coatings for shaper cutters


Normal High Quality			Special Manufacturing High Quality	
B Class Hob	AGMA Q9	New A8	AGMA Q10	NEW A7
A	Q10	A7	Q11	A6
AA	Q11	A6	Q12	A5
Azumi Skiving Hob	Q12	A5		
Shaper Disc Cutter	Q10	A7	Q11	A6
Shaper Rack Cutter	Q11	A6	Q12	A5
Shave	Q12	A5	Q14	A3
Free Form Honing	Q10	A7	Q12	A5
Rotary Honing	Q12	A5	Q15	A2
CBN/CNC Form Finish	Q13	A4	Q14	A3
Grinding	Q15	A2		
Lapping	Q10	A7		
Plastic	Q6		Q8	

QUALITY LEVELS (CHANGES IN AGMA QUALITY NUMBERING)

and hobs have been in widespread use since 1980. The latest hob technology involves coated carbides or high-speed steels. The thin, ultra-hard film increases the tool's abrasion resistance and reduces tool-part adhesion. The first coating to find general use was the gold colored titanium nitride (TiN). An estimated increase in tool life of 200-300% is considered conservative.

The better the surface before the coating is applied, the better the overall results. Research has continued, and other coatings such as the purple gray color titanium aluminum nitride (TiAlN) and the blue gray titanium carbon nitride (TiCN) have been developed. These latter two have an increased micro-hardness. When the hob is re-sharpened, the original coating is lost. A TiN hob can be recoated three or four times. If an uneven buildup results, the layers must be removed. Other coatings are difficult to recoat. Sintered and tin-coated

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high-speed steels are established as the cutter materials. Nodular irons are difficult to machine and cutters with carbide inserts that have CVD (chemical vapor disposition) are required. An alternate coating method PVD (physical vapor disposition) offers advantages in certain operations with its lower deposition temperature. 

ABOUT THE AUTHOR:

William P. Crosher is former director of the National Conference on Power Transmission, as well as former chairman of the AGMA's Marketing Council and Enclosed Drive Committee. He was resident engineer-North America for Thyssen Gear Works, and later at Flender Graffenstaden. He is author of the book *Design and Application of the Worm Gear*.



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