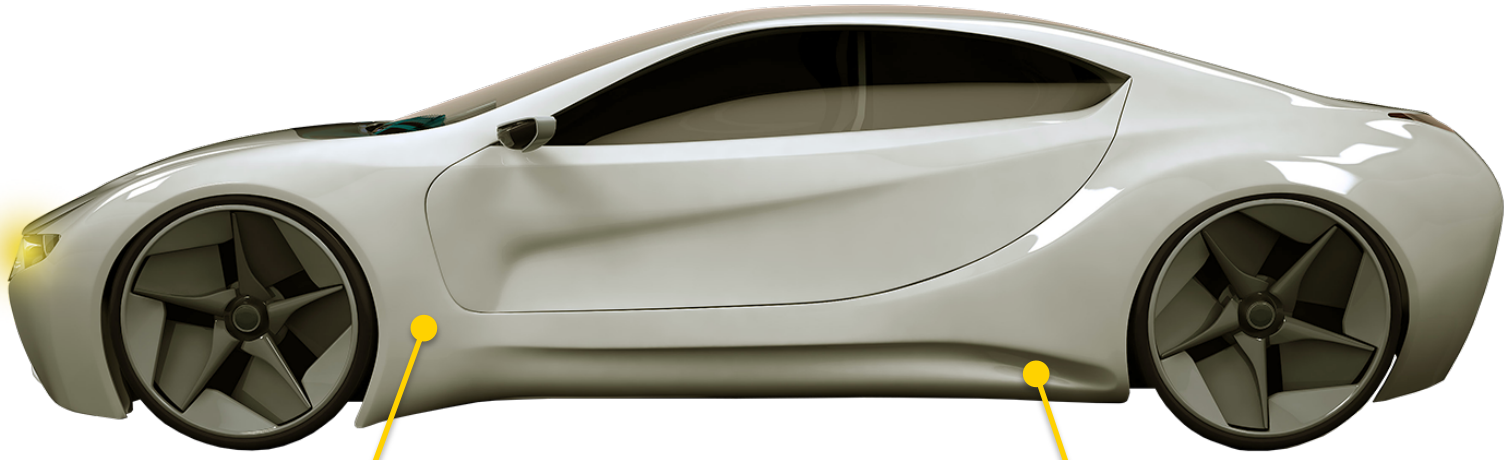
新能源汽车零部件的高效加工

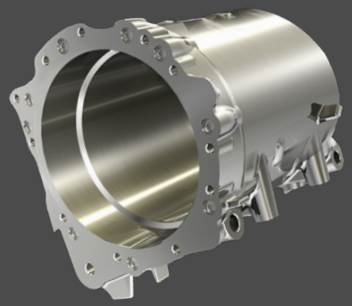
王佳
肯纳项目部
2021_07

KENNAMETAL®

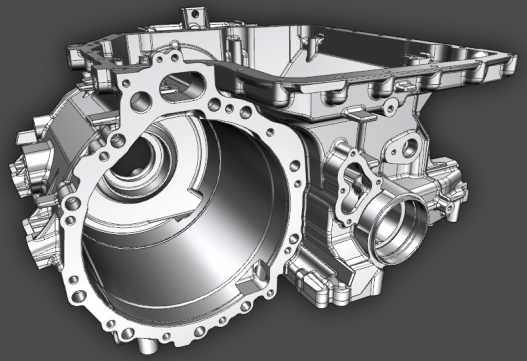
主要零部件



电机壳



变速箱



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NON FERROUS

Transmission Housing/变速箱

以下内容主要涉及：

- 网纹精铣刀
- 复合刀具
- 轴承孔加工
- 标准PCD产品

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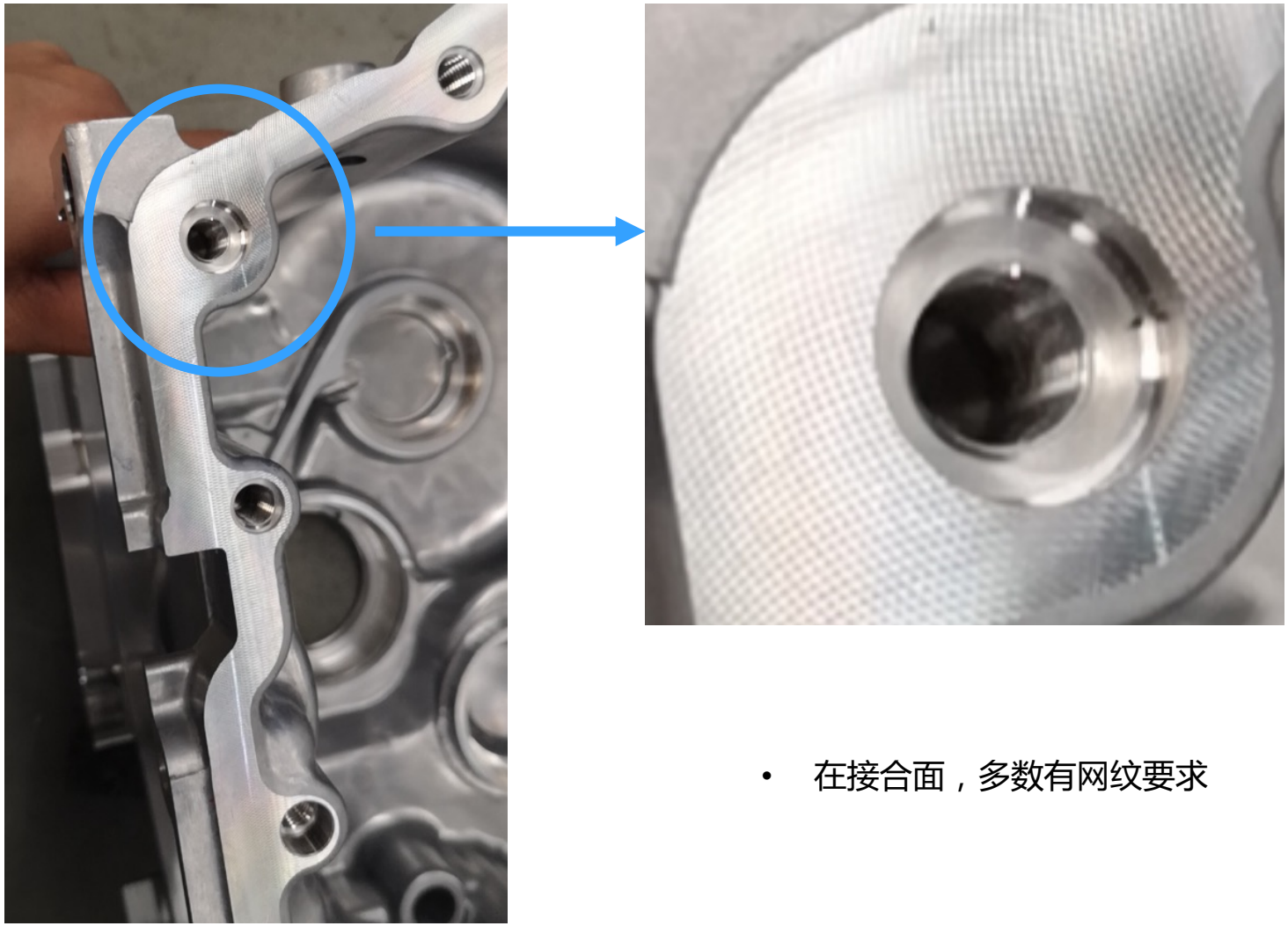
网纹精铣刀



- 在接合面，多数有网纹要求

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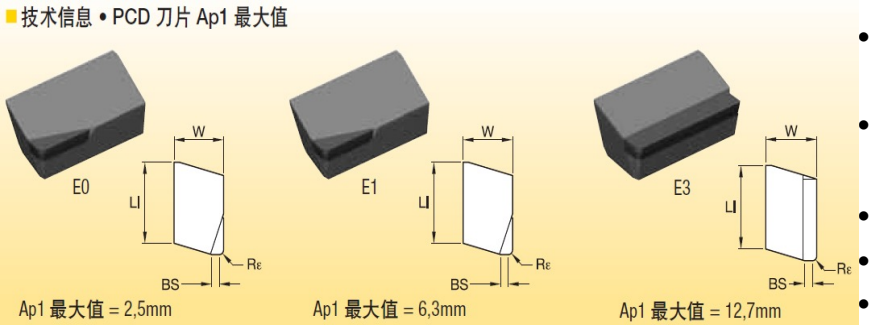
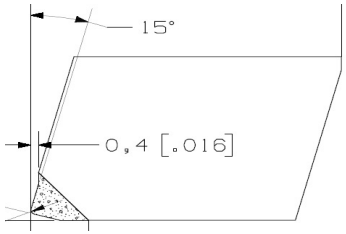
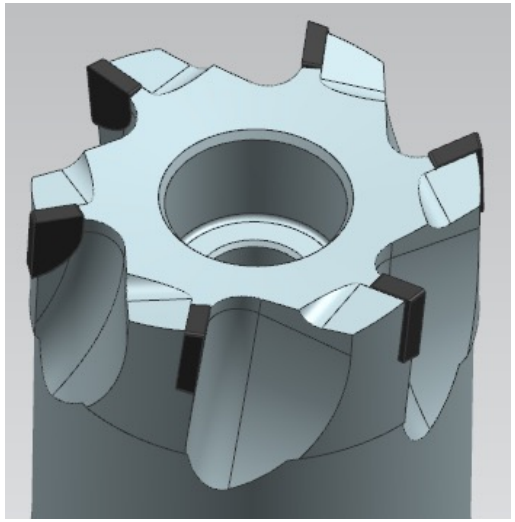
网纹精铣刀

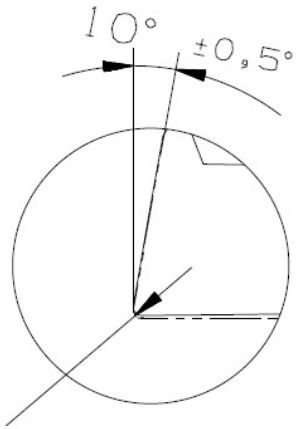
KBDM PCD 端面铣刀



- 标准品直径D63-250，可非标定制
- 全刃轴向可调，调整范围0.8mm
- 全铝刀体，阳极氧化
- 有多型号标准PCD刀片可选
- 非标设计网纹刃（无修光刃）







- 小直径铣刀（D<50)
- 焊接PCD，多刃
- 取消修光刃，用大后角代替
- 可设计不同的接口或者整体

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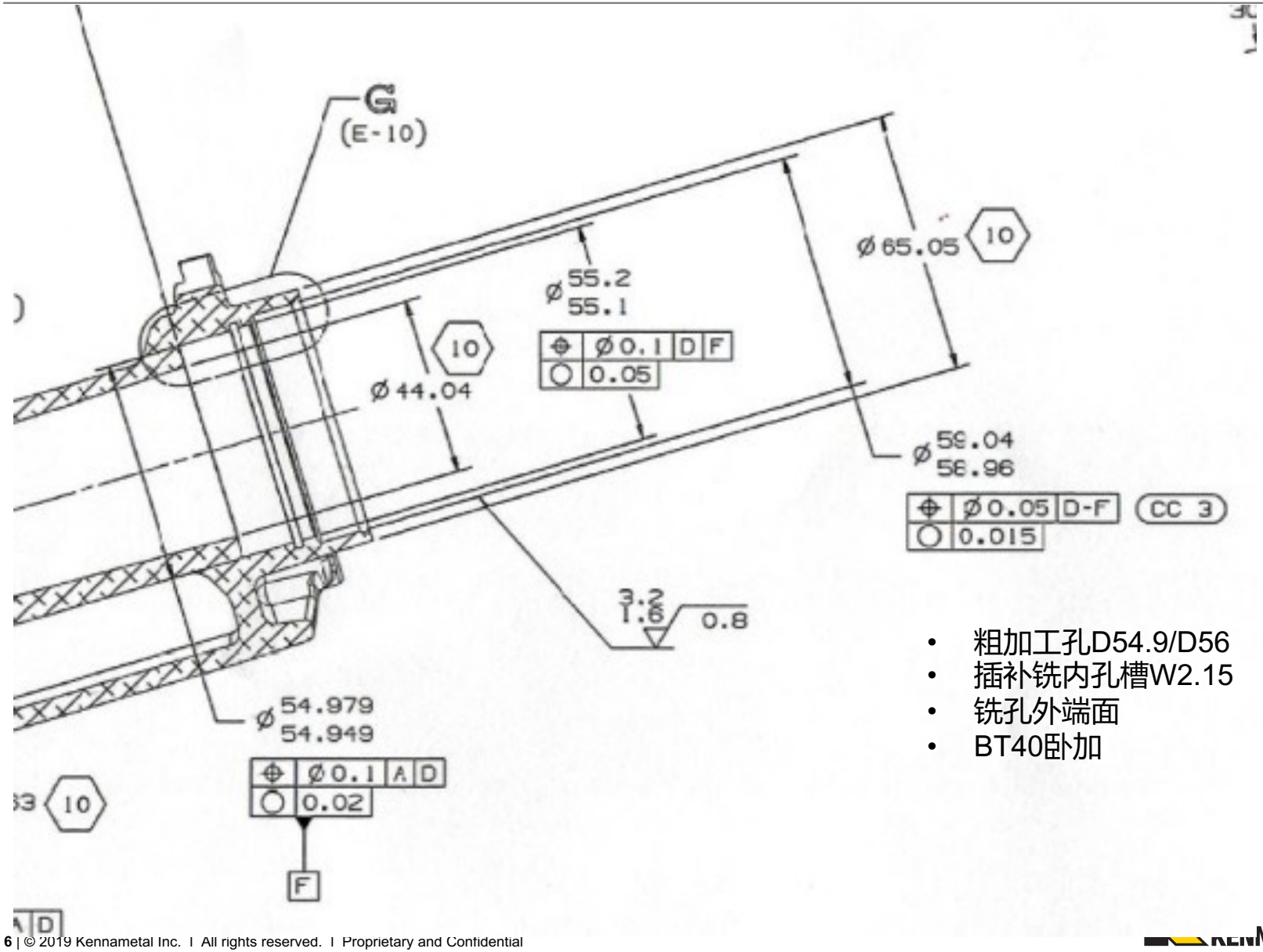
复合刀具



- 粗加工孔D54.9/D56
- 插补铣内孔槽W2.15
- 铣孔外端面
- BT40卧加

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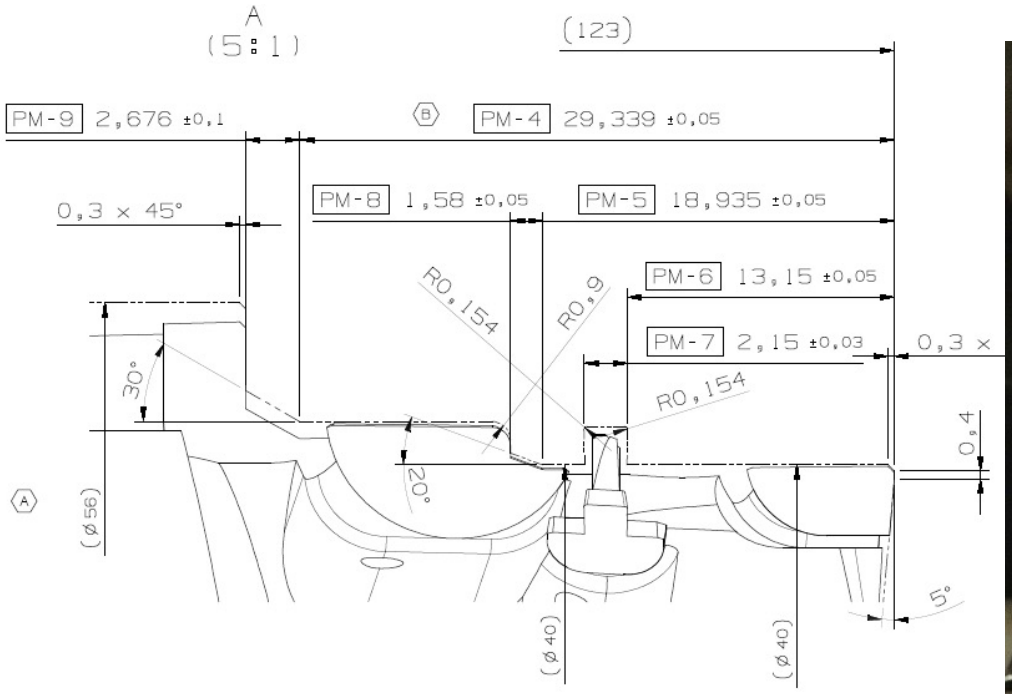
复合刀具



- 把粗镗孔和插补铣复合成一把刀
- BT40整体设计， ，Zeff=4
- 多台阶内孔+槽+外端面一次成型
- 高动平衡等级 G2.5 @ 6000RPM
- S 9000 rpm/min F 0.45
- 节约时间超过8s

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轴承孔加工

加工部位特征：

- 孔径公差要求高 （IT6)
- 形位公差要求高（圆柱度/圆度）
- 粗糙度要求高（Ra0.8,部分会要求Ra范围）
- 孔出口倒角/圆角过渡
- 盲孔基本都有清根/刮底要求
- 有破孔

刀具要求：

- 高效率
- 高精度
- 高稳定性（cpk）
- 复合多台阶/多孔加工

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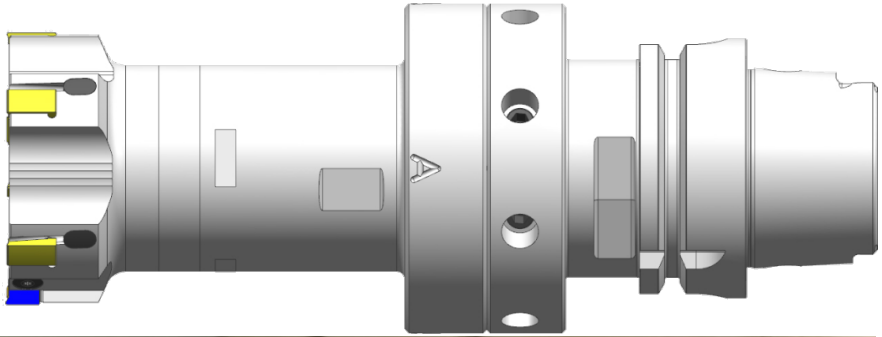
轴承孔加工

整体单刃精镗刀+ 非标PCD倒角刀夹

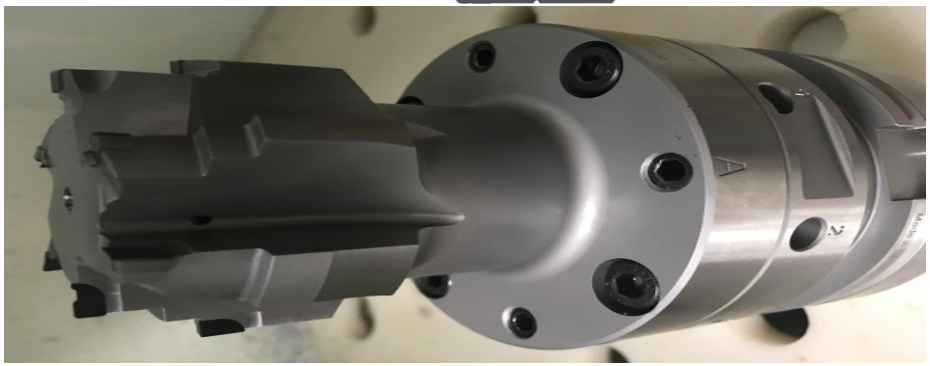
- 好处： 刀具成本底，刀具尺寸可调
- 缺点： 效率底，不便清根，形位公差弱

单刃铰



- 好处： 形位公差最佳，刀具尺寸可微调
- 缺点： 刀具使用成本高，交货期最长

多刃PCD铰



- 好处： 形位公差佳，效率最高
- 缺点： 刃具尺寸固定，有缩孔风险

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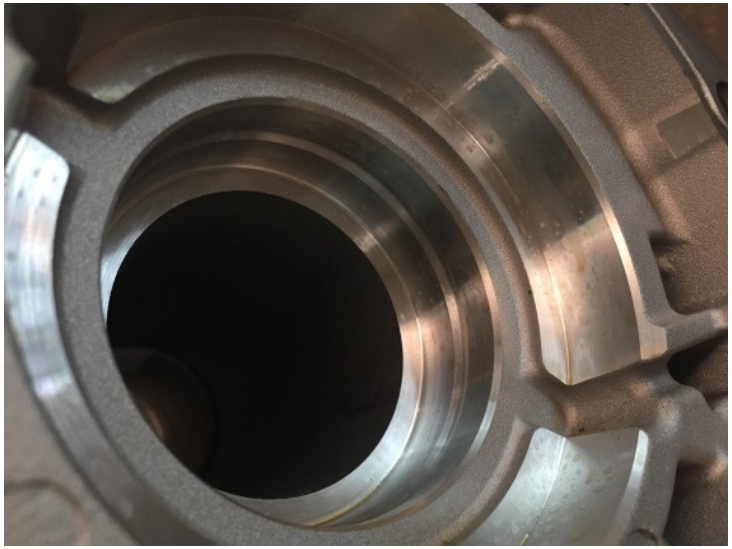
轴承孔加工



- D55H8/D75P6两处轴承孔精加工/反铣出口倒角
- D55段要求Rz10-16范围
- Z=6
- D55增加了可调破坏刃CCGW060202FST
- 高动平衡等级 G2.5 @ 6000RPM
- Vc400m/min Fz0.1
- 达到Ra范围/圆柱度0.002~0.004

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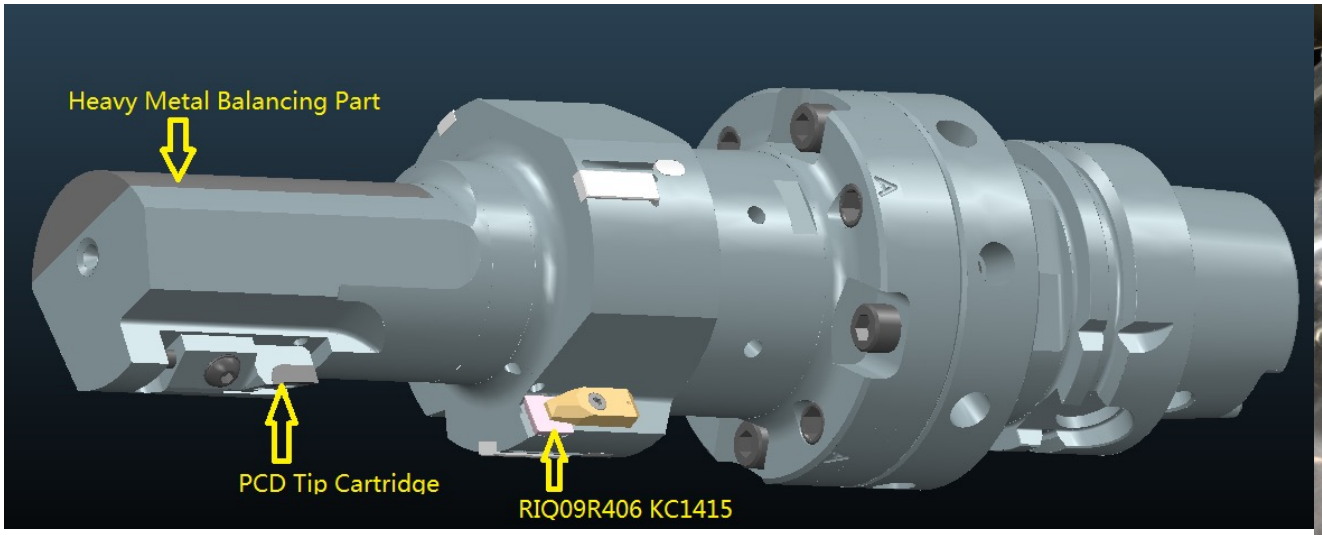
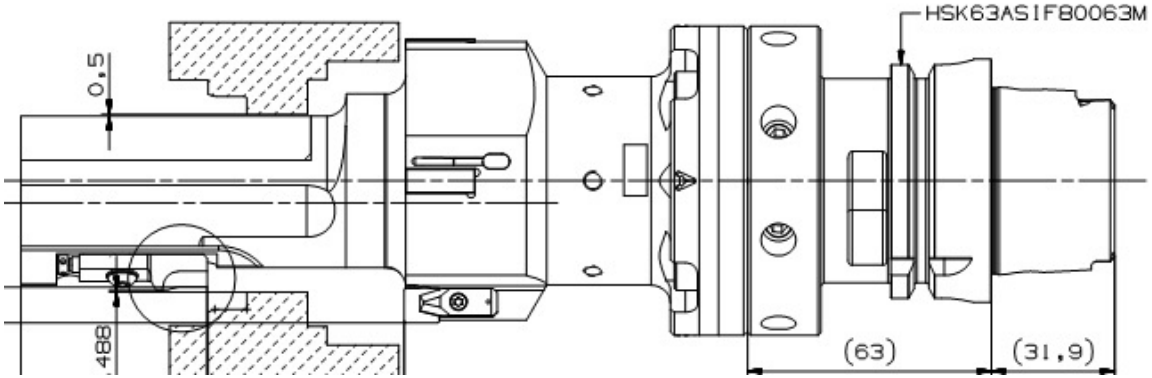
轴承孔加工



- 复合了正反轴承孔精加工
- 正向采用单刃导条支撑铰刀
- 反向采用PCD成型精刀夹
- 反镗重金属配重
- 正镗Vc345m/min Fz0.12
- 反镗Vc175m/min Fz0.15
- 达到Ra0.4/圆柱度0.005



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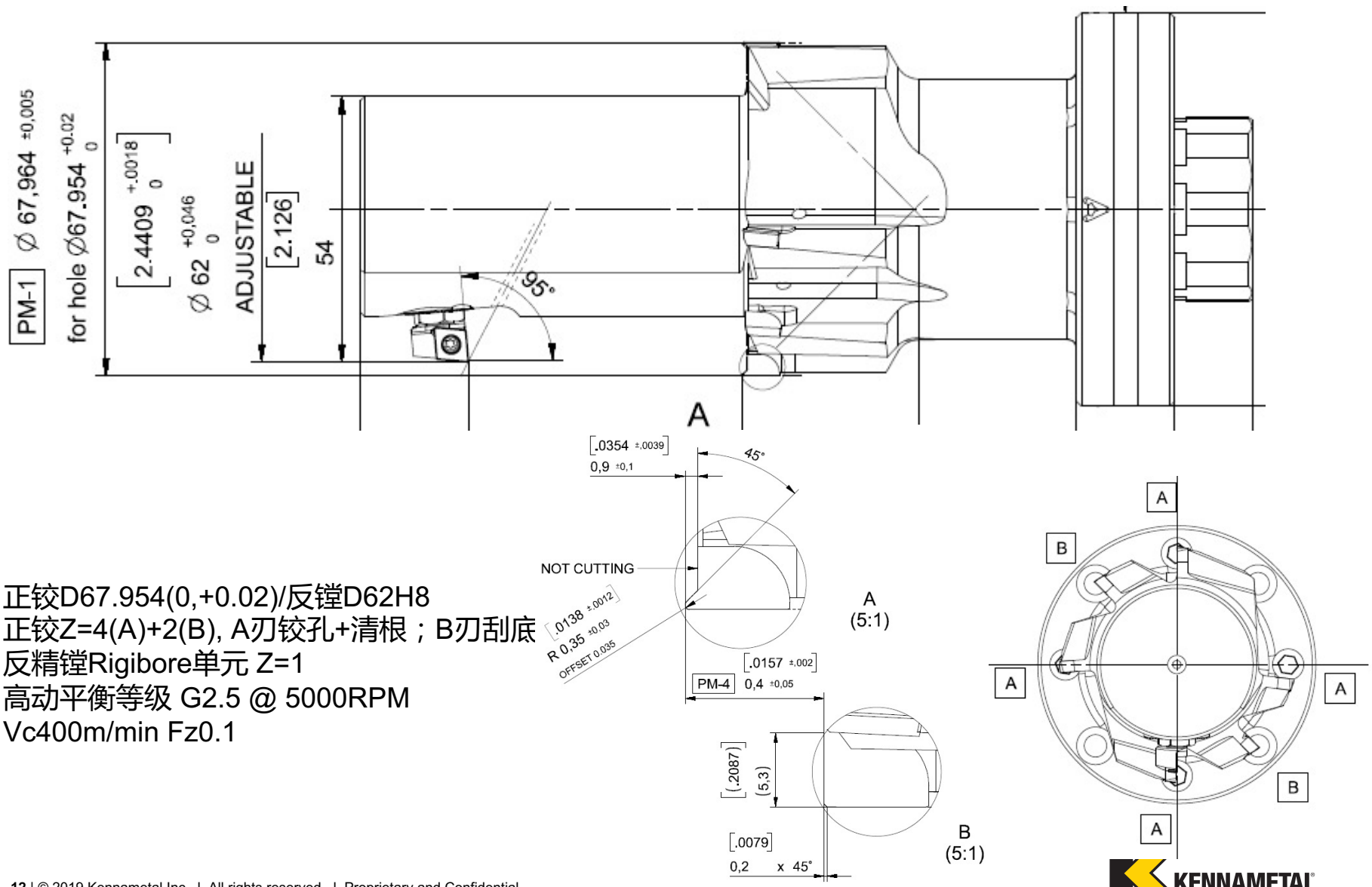
轴承孔加工



- 正铰D67.954(0,+0.02)/反镗D62H8
- 正铰Z=4(A)+2(B), A刃铰孔+清根；B刃刮底
- 反精镗Rigibore单元 Z=1
- 高动平衡等级 G2.5 @ 5000RPM
- Vc400m/min Fz0.1

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全新可供的PCD标准刀具

钻头

- 公制 Ø6-20mm (in 0.5mm 递增)
- 英制 Ø1/4 - 3/4“
- 拐角处焊片形式

铰刀

- 公制 Ø6-42mm (通孔和盲孔)
- 英制 Ø1/4 – 1 5/8“
- 模块式铰刀起始直径 Ø20mm or ¾"

立铣刀

- 公制 Ø6-40mm (端面和台肩铣刀)
- 英制 Ø1/4 – 1 9/16“

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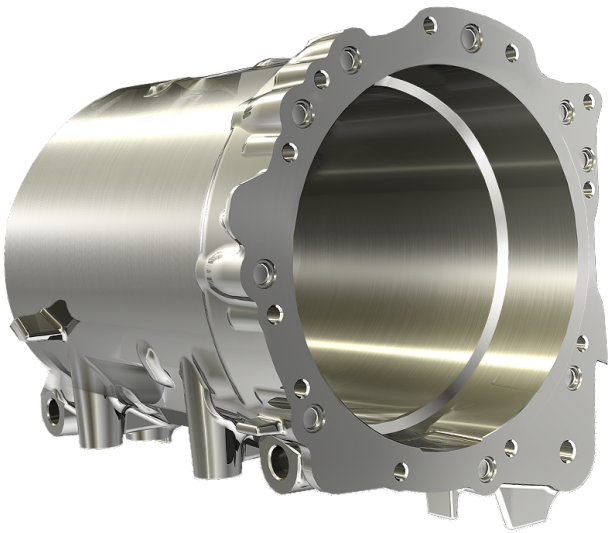
NON FERROUS

Moto Housing/电机壳



加工难点：

- ◆ 大直径主孔，IT6直径公差等级
- ◆ 主孔与轴承孔间高形位公差要求，部分轴承孔为钢套
- ◆ 主孔薄壁，易产生变形和振动
- ◆ 刀具轻量化要求
  - ✓ 自动换刀尺寸限制
  - ✓ 最大换刀扭矩限制
  - ✓ 减小震颤
  - ✓ 转动惯量限制

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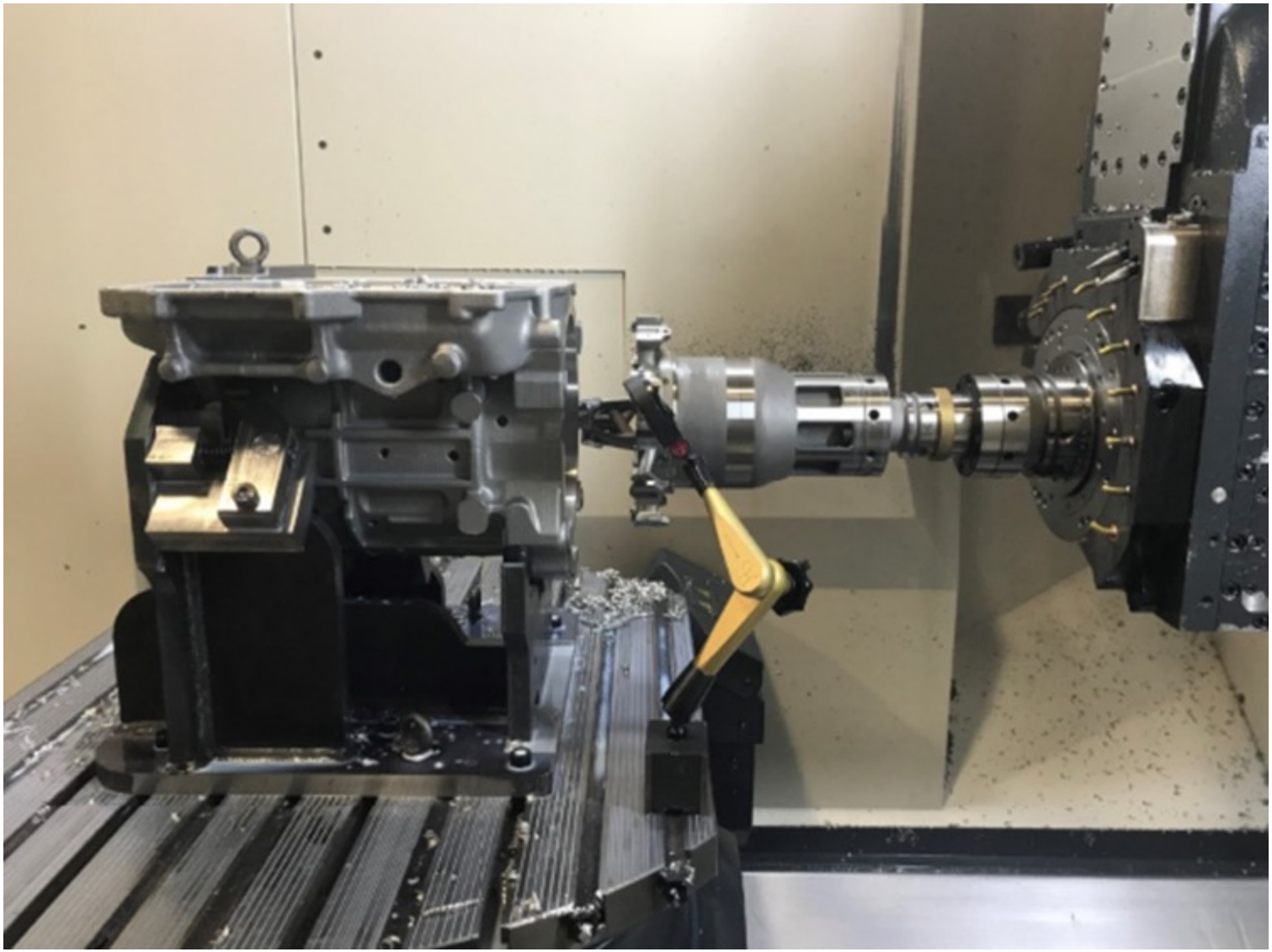
主孔精加工/3D打印导条铰刀



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主孔精加工/3D打印导条铰刀

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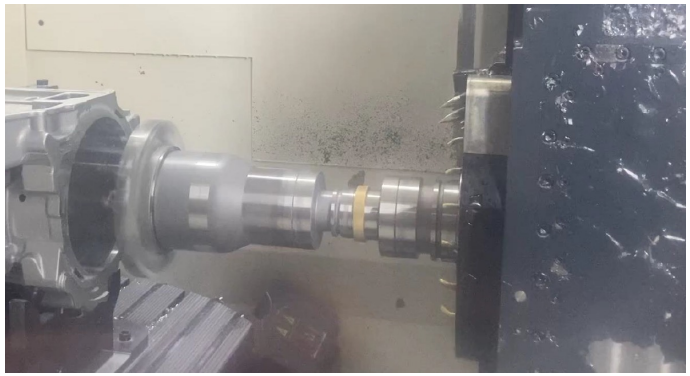
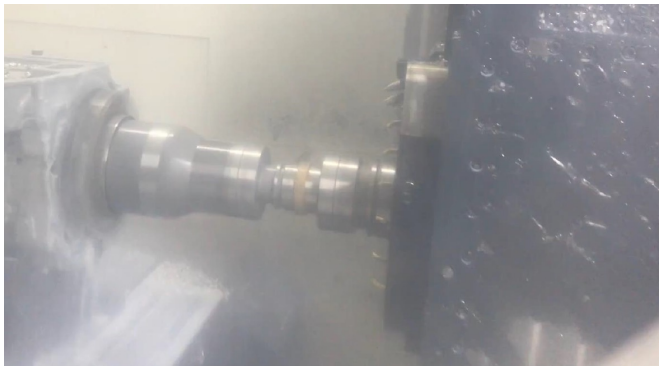
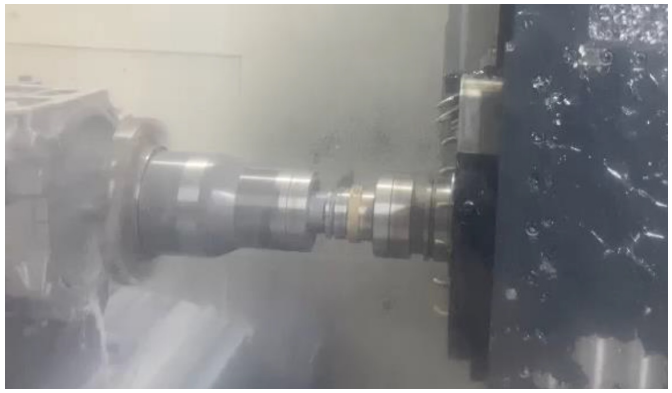
主孔精加工/3D打印导条铰刀

加工参数:
Vc=500-800m/min
(D210)
Fz=0.08-0.15 mm
Stock=0.3-1mm
内冷: 80 Bar

工件材料:
ALSi7Cu3Mg







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主孔精加工/3D打印导条铰刀

断削情况良好

不同的参数，产生的削形状类似

上方为D72产生，下方为D210产生

上方厚度约为下方三倍

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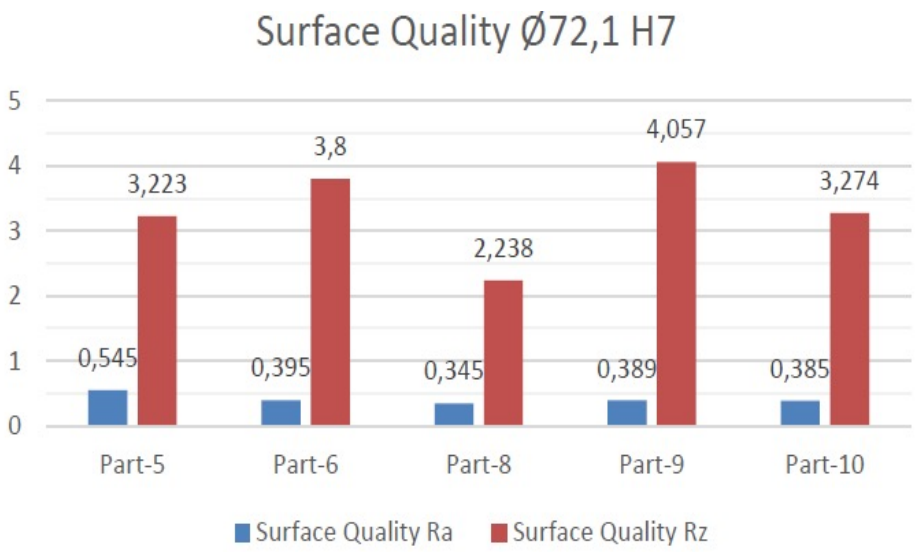
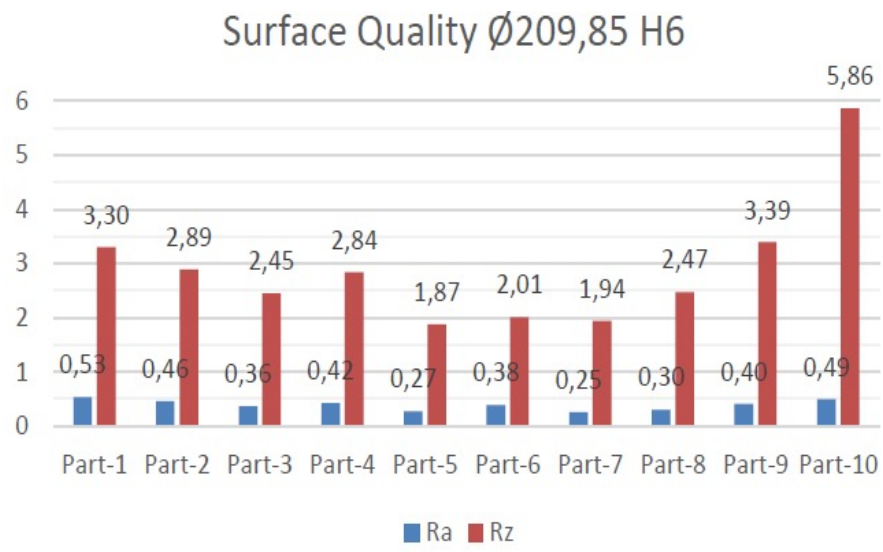
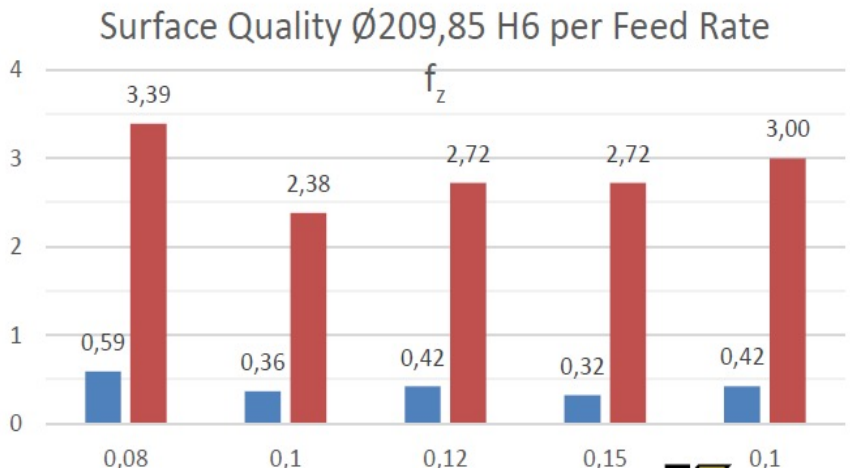
主孔精加工/3D打印导条铰刀





Mobile Roughness Measuring Instrument: MARSURF M 300

Source: https://www.mahr.de/en-us/Services/Production-metrology/Products/MarSurf---Mobile-Roughness-Measuring-Units/MarSurf-M-300-C---Mobile-roughness-measuring-instrument/#



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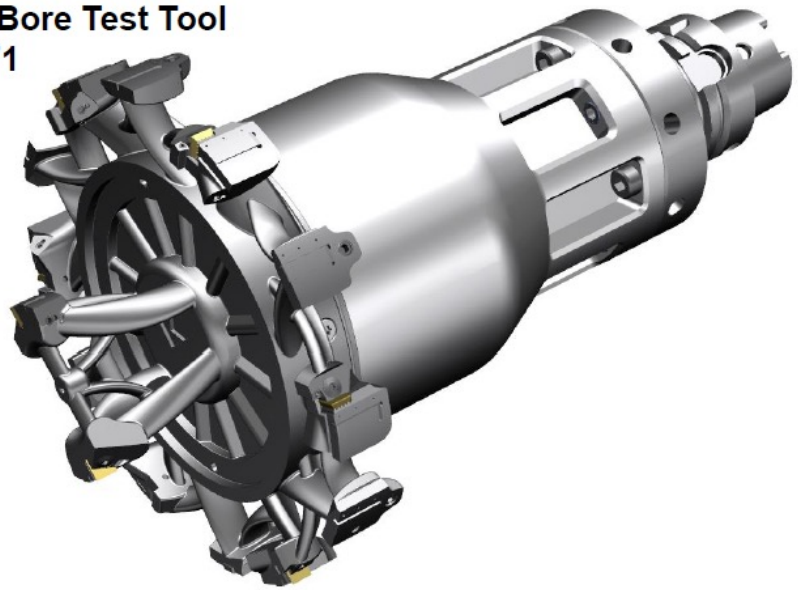
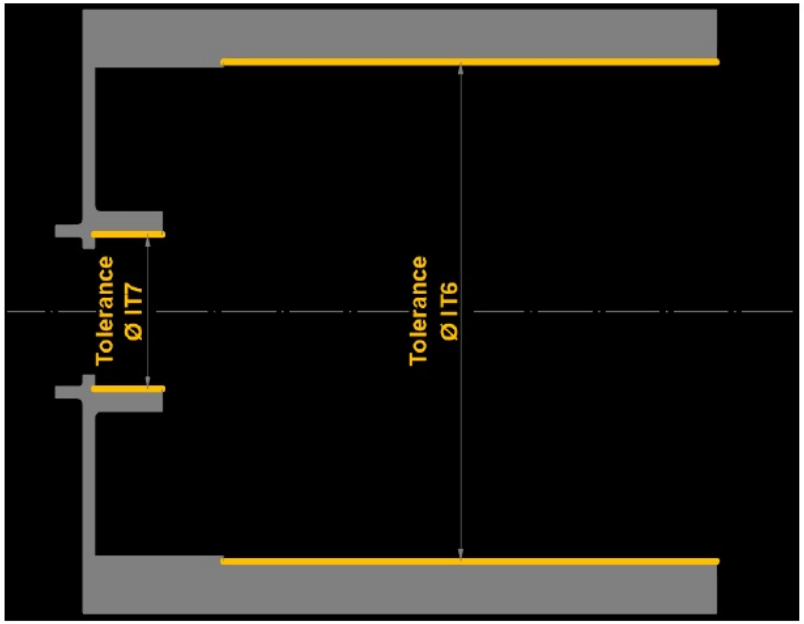
主孔精加工/3D打印导条铰刀

Stator Bore Test Tool
6899771





Test Tool Design (3D-Print / Steel):

- Max. Tool Diameter: ~ 72 IT7 / 210 IT6
- Overall Length: ~ 335 mm
- Spindle Connection: HSK-A63
- Effective Teeth: z = 2 + 6
- Tool Mass: ~ 13,85 kg
- Tilting Moment (Gripper Slot): ~ 19,28 Nm

Typical Results:

- Roundness: < 0,008 mm
- Straightness: < 0,007 mm
- Cylindricity: < 0,010 mm
- Concentricity: < 0,030 mm
- Surface Quality R_a: < 0,5

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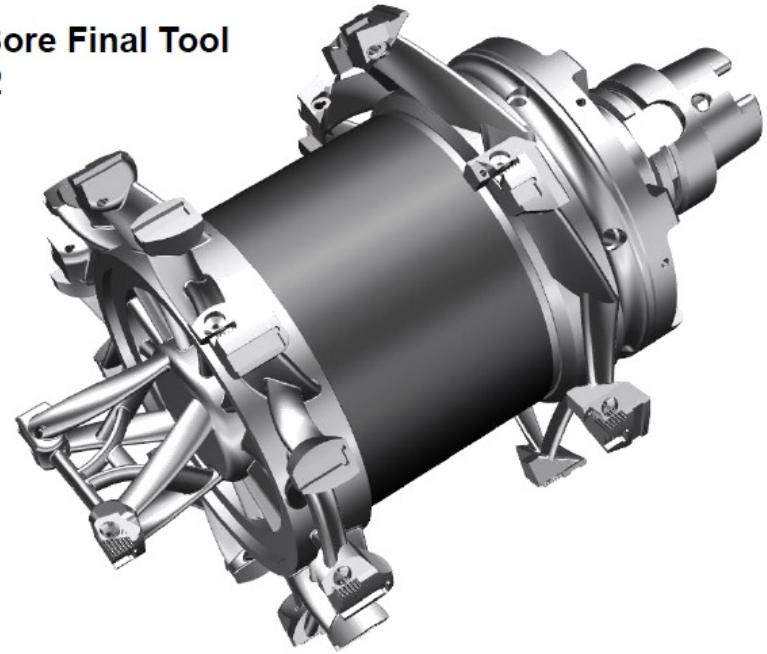
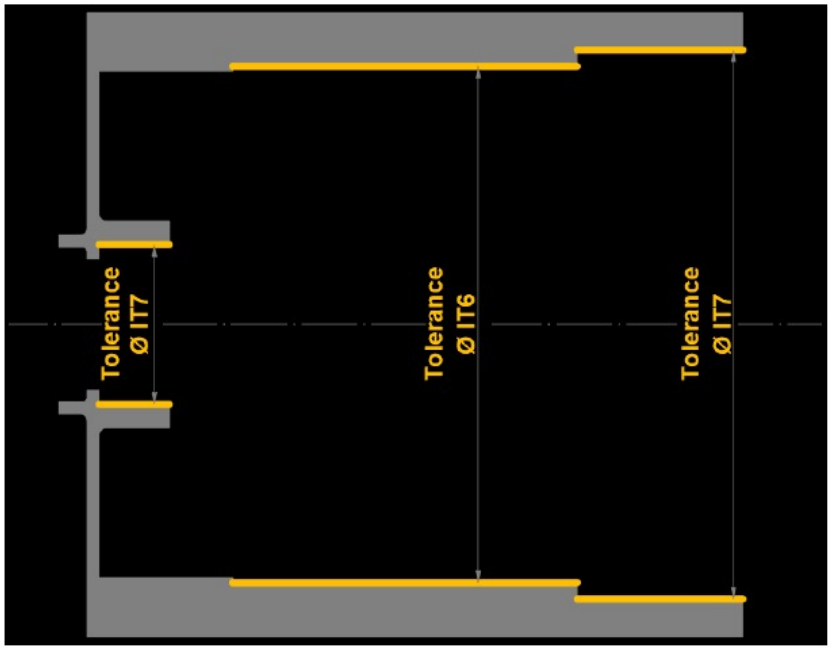
主孔精加工/3D打印导条铰刀

Stator Bore Final Tool
6899772





Hybrid 3D-Print / Carbon Fiber Tool Design:

- Max. Tool Diameter: ~ 210 mm
- Overall Length: ~ 290 mm
- Spindle Connection: HSK-A63
- Effective Teeth: z = 2 + 6 + 6
- Tool Mass: < 8 kg
- Tilting Moment (Gripper Slot): < 9 Nm

Expected Results:

- Roundness: < 0,008 mm
- Straightness: < 0,007 mm
- Cylindricity: < 0,010 mm
- Concentricity: < 0,030 mm
- Surface Quality R_a: < 0,5

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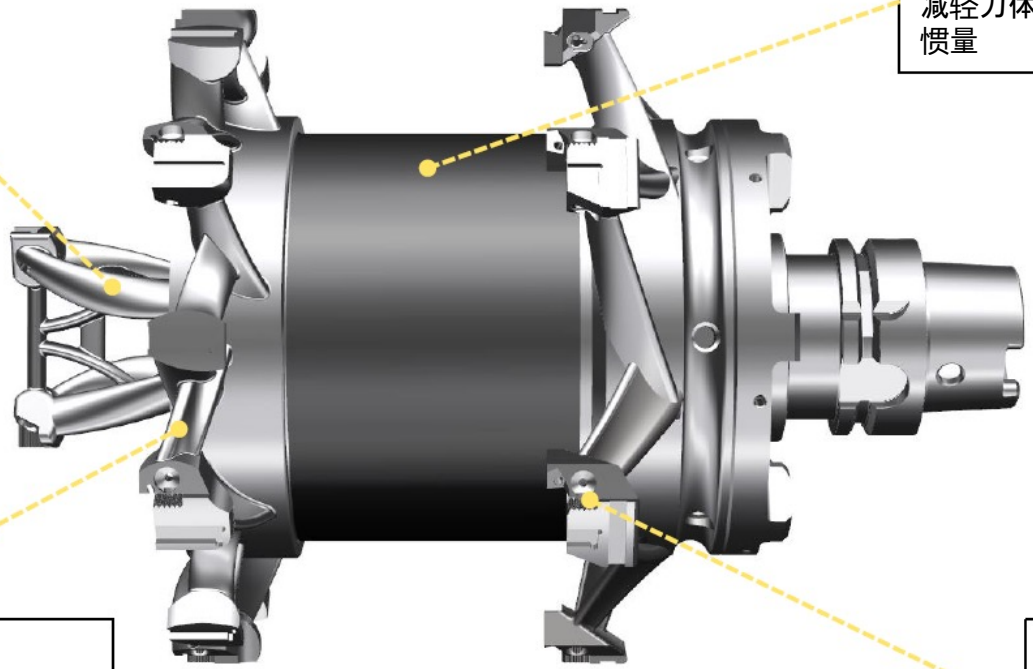
主孔精加工/3D打印导条铰刀

主要特点 & 优势

内冷:
3D打印出的内冷通道可在刀体内自由定义走向和大小

减重设计:
减轻刀体重量,减小倾斜力矩和转动惯量



改善排削:
反向冷却液冲流,创新性的臂结构设计支持无障碍排削

RIQ刀片:
成熟技术,提供了高精度保障

更小的机床
更快的加减速
更少的主轴损耗

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AUTOMOTIVE