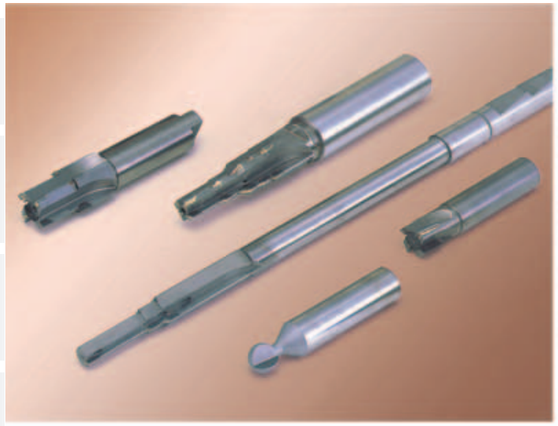


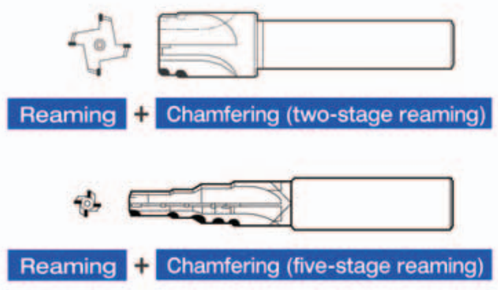
■ Features

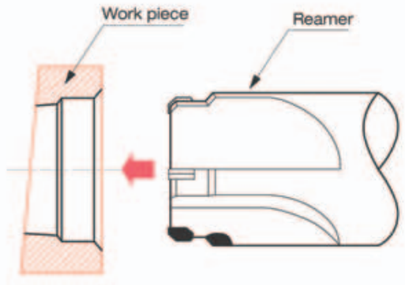
1. Multiple surfaces can be finished on the first try by using a full-shaped, shouldered integrated tool
2. Tool life becomes extremely longer by the usage of sintered diamonds (more than ten times longer than that of carbide tools)
3. Surface without a burn can be achieved even with the cutting speed of 300 m/min or more
4. Stable cutting can be achieved with emulsion type water-based coolant. (Adaptable for environmentally friendly semi-dry cutting)
   DC reamers and end-mills

DC Reamer & End-mill

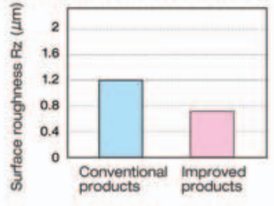
1 Feature — Capable of forming shouldered parts in a single process

Integrated shouldered tools can form multiple areas in a single process.
With our improved technology of manufacturing the forming edges, outstanding accuracy is achieved resulting in longer tool life and surface finish.

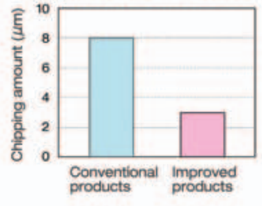




Surface finish of the cutting surface



Runout (TIR) of cutting edges



Finer surface finish on the cutting edges and the improved precision of the cutting edges successfully control the deposition of aluminum and result in much more accurate bore finish.

● Sample:
Cutting of a compressor cover

■ Cutting results

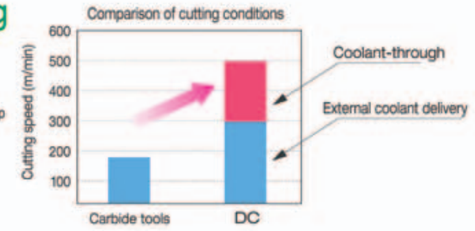
Work piece	Aluminum alloy	
Bore diameter	Ø20 mm	
Coolant	Water-based	
Cutting conditions	Cutting speed	V=160m/min
	Revolutions per minute	N = 2,500 min⁻¹
	Feedrate	0.05 mm/edge
Surface roughness	Rz = 3.0 μm or less	

DC Reamer End-mill

2 Feature — Capable of high-speed cutting

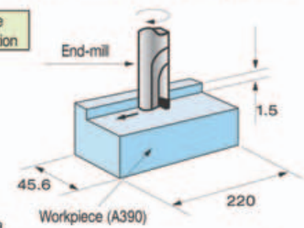
Even with the cutting speed of 300 m/min or more, finished surfaces are burn-free, and the tool still maintains its long life. (Compared with carbide tools, life is ten times longer or more)

* Our improved grinding technology produces uniform and sharp cutting edges
* Cutting tips are of material with good toughness and are scarcely troubled by chipping, which results in long-lasting sharp edges.



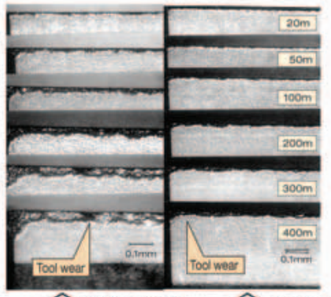
Example 1: Cutting experiment using an end-mill

Rough sketch of the experiment construction



■ Machining data

Cutting conditions	Rotational speed	20,000rpm
	Cutting speed	754m/min
	Feedrate	0.1mm/rev
	Stock removal	Ad=1.5mm
		Rd=0.1mm
Cutting method		Wet (water-based coolant) down-cutting
Tool specification		Straight tooth X12-1NT
Workpiece		A390
Machine-tool		Machining center for full-shaped tools



■ Effects

Characteristics	conventional	improved
Sharpenability	○	◎
Toughness	○	◎
Tool life	1	2 or more

Example 2: Reduction of Tool Cost and Increase in Productivity

Tool specification: Ø20mm X 4NT, Workpiece: A390, Bore depth: 20mm

■ Longer tool life (as opposed to carbide tools)

	Carbide alloy	D C
ADC12	1	10≦
A390	1	20≦

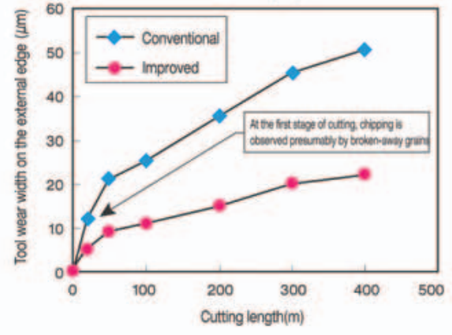
■ Shorter cutting time

	Carbide alloy	D C
Spindle rotation (rpm)	2000	6000
Cutting speed (m/min)	125	380
Feedrate (mm/min)	400	1200
Feed amount (mm/rev)	0.2	0.2
Cutting time	3	1

■ Fewer tool changes

	Carbide alloy	D C
Tool changes	10	1

Correlation between Cutting length and Tool Wear

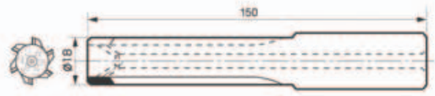


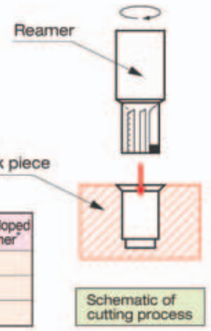
3 Feature — Eco-friendly tool specifications

Cutting performance is stable even with emulsion type water-based coolant. Capable of semi-dry cutting which is environmentally friendly.

Today, the preservation of environments on a global scale has become an important issue in various fields.
Especially, in the manufacturing of automotive parts, the disposal of the sludge and effluent produced in a cutting process (wet) is argued.
As the solution to this issue, the semi-dry cutting, which produces little sludge and is less burden on the environments, draws attention.
Our newly developed semi-dry compliant "DC Reamers" successfully achieve almost equivalent tool life in semi-dry cutting, which has been considered to be disadvantageous to the wet cutting.

Case 3 : Semi-dry cutting





Schematic of cutting process

■ Cutting data

Cutting conditions	Revolutions per minute	7500min^{-1}
	Cutting speed	400m/min
	Feedrate	0.05mm/rev
	Lubrication	80cm^3/hr
Cutting tool specifications		Ø18-6NT
Work piece material		Aluminum alloy

■ Tool performance

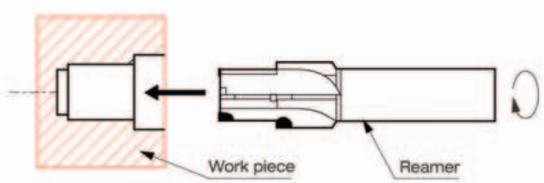
Characteristics	Conventional products	Newly developed "DC Reamer"
Grindability	○	◎
Toughness	○	◎
Tool life	1	2

4 Feature — Chip discharge

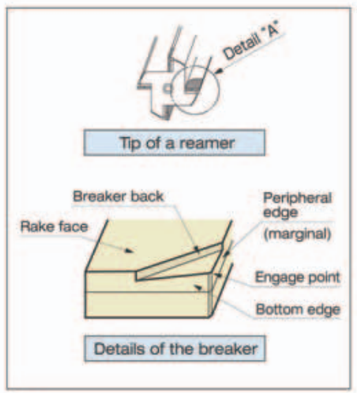
The breakers provided near the cutting edges realize smoother chip discharge.

- Special finish is applied on the rake faces of the cutting edges.
- The chips produced during the machining are broken into fine pieces by the breaker wall.

Aluminum is a cohesive material with a low melting point and is known to easily cause twining chips, deposition or damaged surfaces during machining.
The newly introduced breaker by the cutting edge controls the twining, deposition and surface damages.



Schematic of machining



Details of the breaker

※Note
This reamer having a limitation on the number of re-sharpening and repairing, we recommend the usage of the reamers with normal edges if currently no twining or other inconveniences are experienced.

■ Cutting data

Cutting conditions	Revolutions per minute	3500min^{-1}
	Cutting speed	208m/min
	Feedrate	0.8mm/rev
Cutting tool specifications		Ø19-4NT
Work piece material		Aluminum alloy

■ Effects

Characteristics	Without breaker	With breaker
Sharpness	○	◎
Deposition resistance	○	◎
Tool cost	○	◎

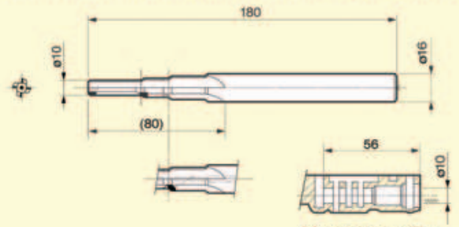
General Info
Negative Inserts
Positive Inserts
Ace-Fix Inserts
Threading, Grooving, & Cut-Off Inserts
Ceramic Inserts
PCBN & PCD Inserts
Toolholders
Swiss Toolholders
Boring Bars
Technical Info
ALMT

Data — Sample machining data using "DC Reamer"

DC Reamer End-mill

■ Sample machining data using "DC Reamer"

Reaming of a regulator valve of an automotive part



Machining profile

Cutting conditions	Carbide alloy reamer	"DC Reamer"
Cutting speed (m/min)	120	120
Feedrate (mm/rev)	0.2	0.2
Stock removal (mm/diameter)	0.4	0.4
Coolant	Oil	Water-based
Surface roughness (μm Rz)	8	3
Roundness	10	5
Cost ratio	1	0.5

Recommended cutting conditions for "DC Reamers"

■ External coolant supply

Tool diameter (mm)	Material to be cut	Aluminum alloy 12% or less silicon	Silicon-rich aluminum alloy Over 12 % silicon	Copper alloy
Ø5~	V	80~300	60~200	80~200
10	f	0.03~0.1	0.05~0.1	0.03~0.1
Ø10~	V	100~300	90~200	100~200
15	f	0.05~0.15	0.05~0.12	0.05~0.12
Ø15~	V	120~300	100~200	120~200
	f	0.08~0.2	0.08~0.16	0.08~0.16

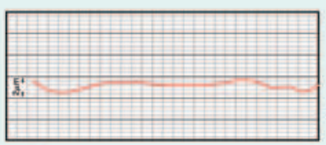
V(cutting speed) = m/min, f(feedrate) = mm/rev

■ Coolant through (with oil holes)

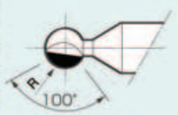
Tool diameter (mm)	Material to be cut	Aluminum alloy 12% or less silicon	Silicon-rich aluminum alloy Over 12 % silicon	Copper alloy
Ø5~	V	80~500	60~350	80~350
10	f	0.03~0.12	0.05~0.12	0.03~0.12
Ø10~	V	100~500	90~350	100~350
15	f	0.05~0.18	0.05~0.14	0.05~0.14
Ø15~	V	120~500	100~350	120~350
	f	0.08~0.24	0.08~0.19	0.08~0.19

V(cutting speed) = m/min, f(feedrate) = mm/rev

Data — Sample machining data using "DC Ball-end mill"



Profile errors of the cutting edge

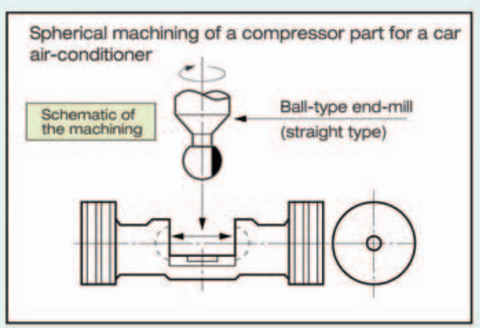


(Measured area)

■ Features

1. High precision surface finish and cutting edges produce profile errors of 2.5μm or less can finish the surface with the roughness of Rz 1.6μm or less and the roundness of 5.0μm.
2. Tool change time is greatly reduced. With more than ten times the life of a carbide-alloy tools, time consuming tool changes and the consequent adjustments decrease greatly.

Spherical machining of a compressor part for a car air-conditioner



■ Sample machining data

Finish accuracy	Surface roughness Rz =1.6μm or less Roundness 5.0μm
Work piece	ADC12 [including11.5% of silicon]
Cutting conditions	Revolutions per minute N = 1,200 [min^{-1}] Feedrate f = 0.005 [mm/rev] finish
Tool specifications	Ø15.9×L100 mm Ball diameter tolerance ±0.01 mm Radius tolerance ±0.01 mm

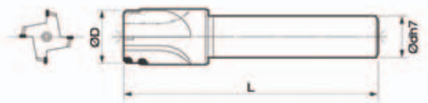
DC Reamers ●Product model

DC Reamer (single-stage reamer)

Application	Body material
HDDs, CD-ROMs, FDD motor shafts, Locker-arms, etc.	(1) Solid carbide (2) Carbide tip (3) Hardened steel

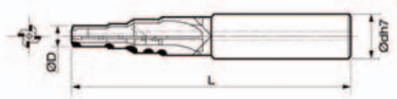
DC Reamer (with chamfering tip)

Application	Body material
Compressor-bodies, ABS actuators, Power-steering bodies, etc.	(1) Solid carbide (2) Carbide tip (3) Hardened steel



DC Reamer (multiple-stage forming reamer)

Application	Body material
Oil pumps, steering devices, AT hydraulic control bodies, etc.	(1) Solid carbide (2) Carbide tip (3) Hardened steel

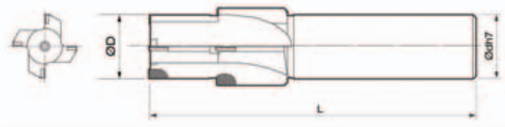


DC Gun Reamer (multiple-stage reamer)

Application	Body material
AT hydraulic control bodies, etc.	(1) Carbide tip

DC Reamer (with breakers)

Application	Body material
ABS bodies, oil pumps, AT hydraulic control bodies, etc.	(1) Carbide tip



■Specifications

Tool diameterØD	number of teeth	Other specifications
3mm - 4mm	1 tooth	Tool diameter tolerances Standard ØD±0.0025 mm High precision ØD±0.0015 mm (between Ø5 and Ø25) Tool length maximum length 450 mm (Standard L/D to be between 3 and 5)
4mm - 6mm	1-3 teeth	
6mm - 8mm	1-4 teeth	
8mm - ≤	1-6 teeth	

DC End-mill ●Product model

DC Reamer End-mill

DC End-mill (Ball-type end-mill)

Application	Body material
Compressor parts, etc	(1) Solid carbide (2) Hardened steel

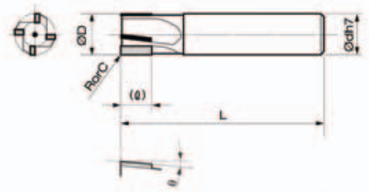
Tool diameterØD	number of teeth	Other specifications	
2mm - 4mm	1 tooth	Tool diameter tolerances	Standard ØD± 0.1 mm High precision ØD± 0.01 mm (between Ø5 and Ø25)
4mm - 6mm	1-2 teeth		
6mm - 8mm	1-2 teeth	Tool length	maximum length 450 mm (Standard L/D to be between 3 and 5)
8mm - ≤	2 teeth		

DC End-mill (T-slot)

Application	Body material
T-slotting	(1) Solid carbide (2) Hardened steel

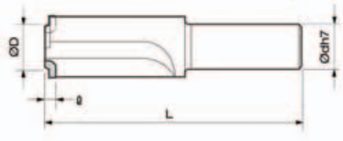
DC End-mill for deburring cast parts

Application	Body material
HDD and FDD cases, cylinder blocks	(1) Solid carbide (2) Hardened steel



DC spot-facing cutter

Application	Body material
Various spot-facing	(1) Solid carbide (2) Hardened steel



■ Specifications

Tool diameterØD	number of teeth	Other specifications
3mm - 4mm	1 tooth	Tool diameter tolerances Standard ØD±0.0025 mm High precision ØD±0.0015 mm (between Ø5 and Ø25) Tool length maximum length 450 mm (Standard L/D to be between 3 and 5)
4mm - 6mm	1-3 teeth	
6mm - 8mm	1-4 teeth	
8mm - ≤	1-6 teeth	

■Availability

Blade length (ℓ)	No more than 8 mm (up to 25mm available with zero degree rake angle)
Rake angle θ (axial rake)	No more than 5 degrees (blade length to be no more than 4 mm at10 degrees)