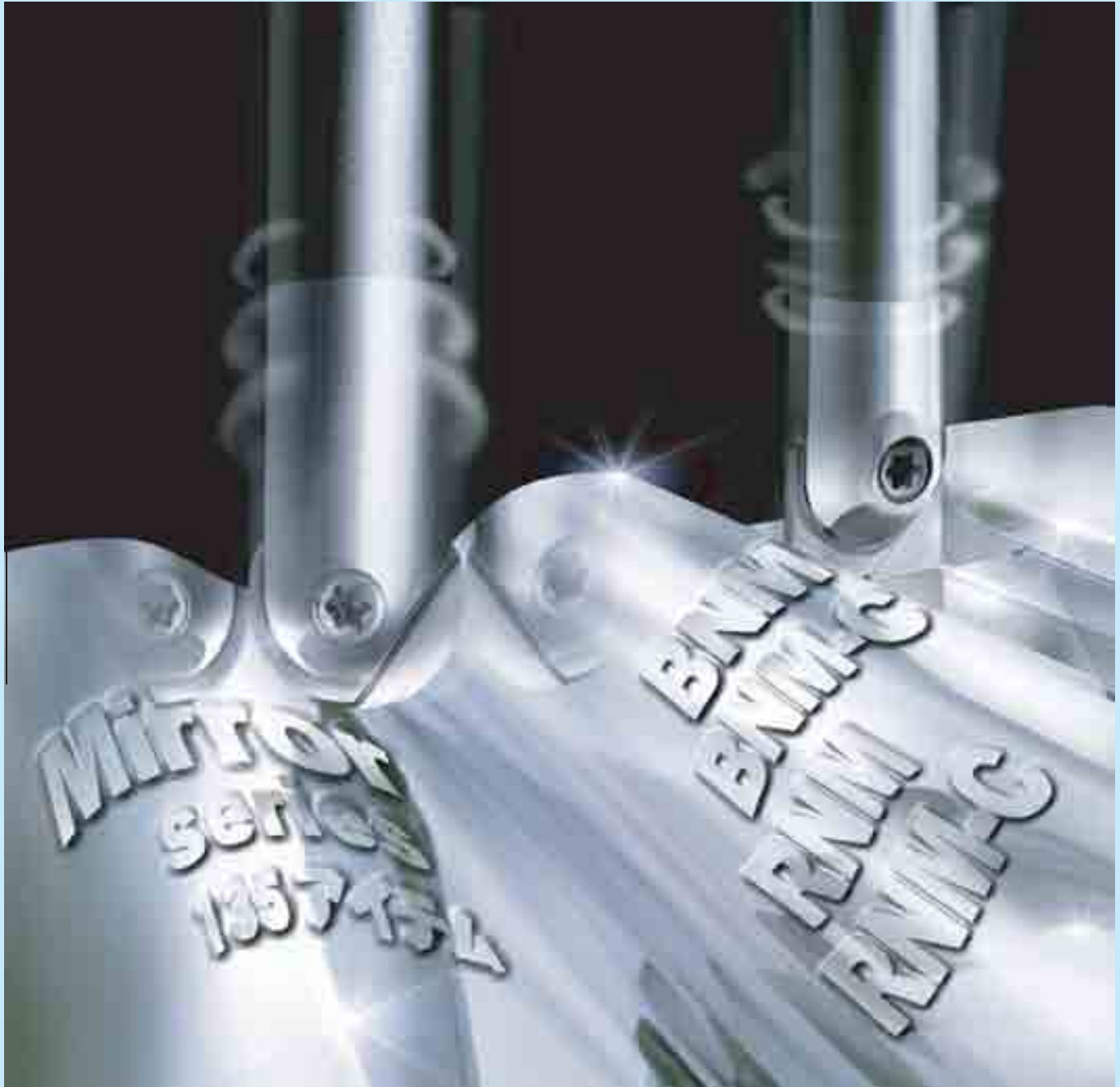


BNM type



- " Mirror Ball " Steel Shank
- " Mirror Ball Head " **NEW**



- " Mirror S " New inserts for Mirror Ball **NEW**
- " Mirror Ball " Carbide Shank

" Mirror Ball "



■ BNM Steel Shank

BNM-S type (Straight neck)

BNM-T type (Taper neck)

NEW BNM-T-LS type (Long shank)



Mirror Ball bodies can fix Mirror Radius inserts for finishing application of cutting stock below 1/40xD.

■ Body

Cat. No.	Stock	Fig.	Dimensions (mm)								Parts		Inserts	
			R	øD	l ₀	l ₁	L	ød ₁	ød MT.No.	α°	Clamp Screw	Wrench	Inserts	
BNMS-060030T-S10	●	3	3	6	15	30	80	5.4	10	4°14'	FSW-2005H	A-06	BNM-060	
BNMS-080035T-S12	●				18.5	35	92		12	3°41'	FSW-2506H (0.9 N-m)	A-07	BNM-080	RNM-080....
BNMM-080053T-S12	●	3	4	8	18.5	53	110	7.2	12	2°20'				
BNML-080075T-S12	●				18.5	75	132		12	1°37'				
BNMS-100035T-S12	●				21	35	92		12	1°55'	FSW-3007H (1.2 N-m)	A-08	BNM-100	RNM-100....
BNMM-100053T-S12	●	3	5	10	21	53	110	9	12	1°12'				
BNML-100075T-S12	●				21	75	132		12	0°49'				
BNMS-120026S-S12	●	1			-	26	83		12	-	FSW-3509 (2.0 N-m)	A-10	BNM-120	RNM-120.... RNM-130....
BNMM-120053S-S12	●				-	53	110		10	-				
BNMM-120053T-S12	●	3	6	12	22	53	110		12	-				
BNML-120085T-S16	●				22	85	145		16	1°27'	FSW-4013 (3.0 N-m)	A-15	BNM-160	RNM-160.... RNM-170....
BNMS-160032S-S16	●	1			-	32	92		16	-				
BNMM-160063S-S16	●				-	63	123		14	-				
BNMM-160063T-S16	●	3	8	16	28	63	123		16	-	FSW-5016 (4.0 N-m)	A-20	BNM-200	RNM-200.... RNM-210....
BNML-160100T-S20	●				28	100	166		20	1°13'				
BNMS-200038S-S20	●	1			-	38	104		20	-				
BNMS-200038S-MT2	●	2			-	38	106		MT2	-	FSW-5016 (4.0 N-m)	A-20	BNM-200	RNM-200.... RNM-210....
NEW BNM-200050T-S25LS	●	3			34	50	170		25	3°33'				
BNMM-200075S-S20	●	1	10	20	-	75	141	17	20	-				
BNMM-200075T-S20	●	3			34	75	141		20	-	FSW-5016 (4.0 N-m)	A-20	BNM-200	RNM-200.... RNM-210....
BNML-200115T-S25	●	3			34	115	191		25	1°22'				
BNML-200115T-MT3	●	4			34	115	200		MT3	1° 7'				

Note: Torque for FSW-2005 (0.5 N-m)

“ Mirror Ball ”



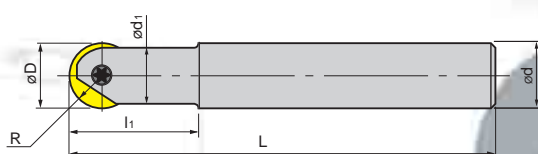
■ BNM Steel Shank

BNM-S type (Straight neck)

BNM-T type (Taper neck)

NEW BNM-T-LS type (Long shank)

Fig.1 (Straight neck)



Run-Out accuracy ± 10 µm

Fig.3 (Taper neck)

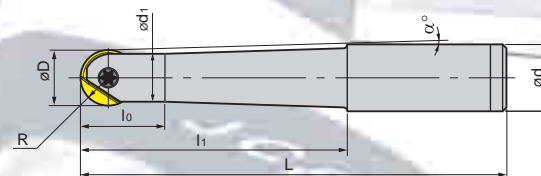


Fig.2 (Straight neck, Morse taper shank type)

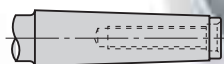
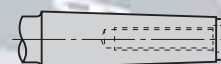


Fig.4 (Taper neck, Morse taper shank type)



Mirror Ball bodies can fix Mirror Radius inserts for finishing application of cutting stock below 1/40xD.

■ Body

Cat. No.	Stock	Fig.	Dimensions (mm)								Parts		Inserts	
			R	øD	l ₀	l ₁	L	ød ₁	ød MT.No.	α°	Clamp Screw	Wrench		
BNMS-250045S-S25	●	1			-	45	121		25	-	FSW-6020 5.0 N-m	A-30	BNM-250	RNM-250.... RNM-260....
BNMS-250045S-MT3	●	2			-	45	130		MT3	-				
NEW BNMS-250060T-S32LS	●	3			41	60	200	21	32	4°10'				
BNMM-250090S-S25	●	1	12.5	25	-	90	166		25	-				
BNMM-250090T-S25	●	3			41	90	166		25	-				
BNML-250135T-S32	●	3			41	135	215		32	1°38'				
BNML-250135T-MT4	●	4			41	135	243		MT4	1°33'				
BNMS-300053S-S32	●	1			-	53	133		32	-	FSW-8025 6.0 N-m	A-40	BNM-300	RNM-300....
NEW BNM-300080T-S32LS	●	3			49	80	220	26	32	0°53'				
BNMM-300106S-S32	●	1	15	30	-	106	186		32	-				
BNMM-300106T-S32	●	3			49	106	186		32	0°38'				
BNML-300160T-S32	●	3			49	160	240		32	0°24'				
BNMS-320053S-S32	●	1			-	53	133		32	-	FSW-8025 6.0 N-m	A-40	BNM-320	RNM-320....
BNMS-320053S-MT4	●	2			-	53	161		MT4	-				
BNMM-320106T-S32	●	3	16	32	49	106	186	26	32	-				
BNML-320160T-S32	●	3			49	160	240		32	-				
BNML-320160T-MT4	●	4			49	160	268		MT4	-				

Note : Please see page 63-68 for cutting conditions.

● Stock in Japan

"Mirror Ball"

"MIRROR BALL"



"MIRROR BALL CARBIDE SHANK" INDEXABLE BALL NOSE END MILL

Mirror Ball carbide shank series are possible to machine deeper mold making with consistent machining and high accurate finishing at high speed cutting, due to the increase tool rigidity and minimize the vibration.

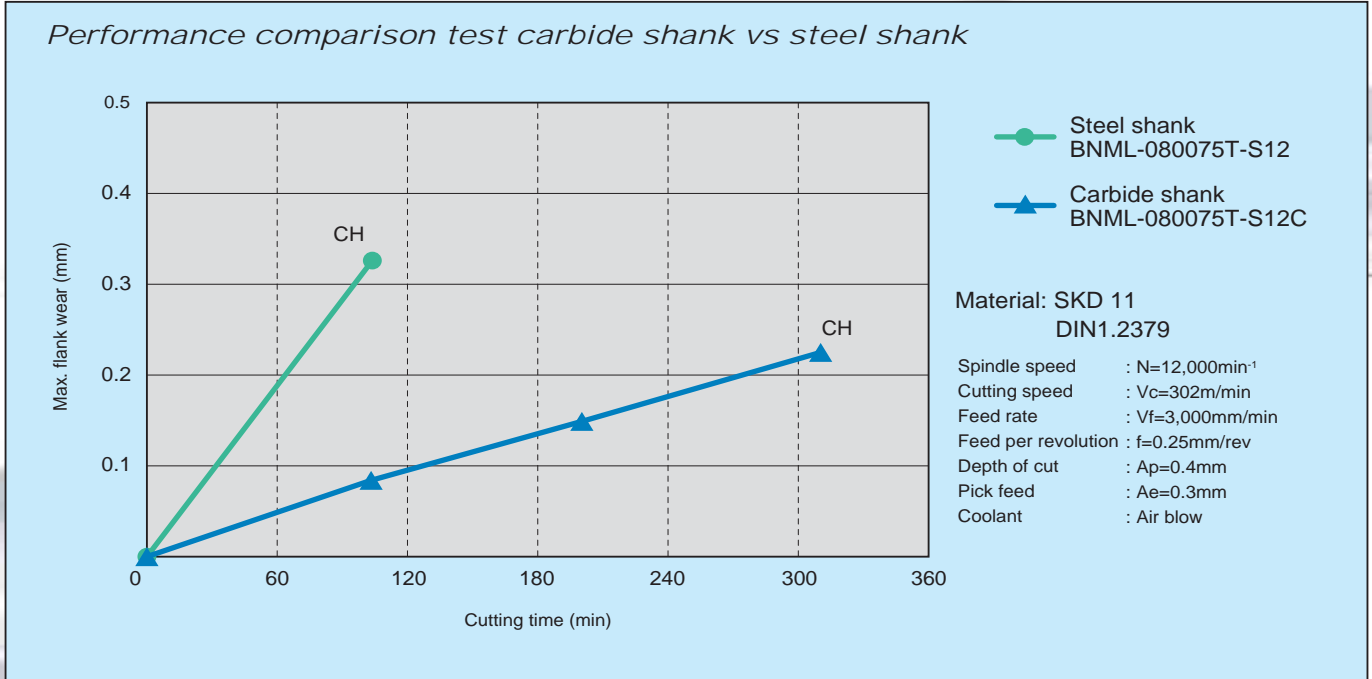


■ Features

1. By adopting carbide shank, tool rigidity is equal to solid carbide ball end mill.
2. Tool life increased to twice the tool life comparing with Mirror Ball steel shank is possible.
3. Carbide shank can be adopted to shrink fit type holders.

“ Mirror Ball ”

■ Example of cutting performance



Performance comparison test "Mirror Ball vs Competitors"

Condition

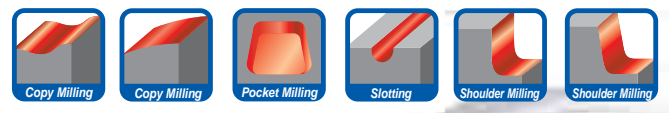
Work material:	Hardened die steel
Hardness:	60HRC
Part name:	Press die
Spindle speed:	8,000min ⁻¹
Cutting speed:	Vc=402m/min
Feed rate:	Vf=4,000mm/min
feed per revolution:	f=0.5mm/rev
Depth of cut:	Ap=0.2mm
Pick feed:	Ae=0.3mm
Coolant:	Dry
Spindle:	HSK50E

Test results

Tool name	Contact time	Wear of rake face	Wear of flank face
DIJET Mirror-Ball Carbide shank ø16	9 Hours	Normal wear	Normal wear
Competitor A (Carbide Shank)	6 - 7 Hours	Worn	Worn

Competitor A maintained tolerance of 0.05 for about 4 Hours only and after that got worse and worse until 6-7 hours when it was finished.
Dijet Mirror-Ball C-Body finished the workpiece and the wear could not be measured.

" Mirror Ball "



■ BNM Carbide Shank

BNM-S type (Straight neck)

BNM-T type (Taper neck)

NEW BNMU type (Straight shank)

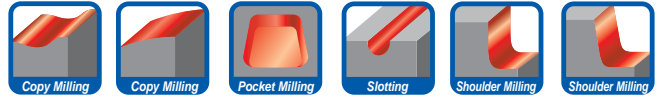


Mirror Ball bodies can fix Mirror Radius inserts for finishing application of cutting stock below 1/40xD.

■ Body

Cat. No.	Stock	Fig.	Dimensions (mm)								Parts		Inserts	
			R	øD	l ₀	l ₁	L	ød ₁	ød	α°	Clamp Screw	Wrench	Inserts	
BNMM-060035S-S06C	●	1				35	92		6	—	FSW-2005H (0.5 N-m)	A-06	BNM-060 BNM-060-S	
BNML-060017S-S06C	●	2	3	6	—	17	120	5.4	6	—				
BNMS-060030T-S10C	●				15	30	80		10	4°14'				
BNMM-080035S-S08C	●				35	92		8	—	FSW-2506H (0.9 N-m)	A-07	BNM-080 BNM-080-S	RNM-080....	
BNML-080075S-S08C	●	1	4	8	—	75	140	7.2	8					—
BNML-080095S-S08C	●				—	95	160		8					—
BNML-080075T-S12C	●	2			20	75	132		12	1°37'	FSW-3007H (1.2 N-m)	A-08	BNM-100 BNM-100-S	RNM-100....
BNMM-100043S-S10C	●	1	5	10	—	43	100	9	10	—				
BNML-100075S-S10C	●				—	75	140		10	—				
BNML-100080S-S10C	●	1	5	10	—	80	220	9	10	—	FSW-3509 (2.0 N-m)	A-10	BNM-120 BNM-120-S	RNM-120.... RNM-130....
BNML-100095S-S10C	●				—	95	160		10	—				
BNML-100140S-S10C	●	2	5	10	—	140	220	9	10	—				
BNML-100075T-S12C	●				23	75	132		12	0°49'				
BNMS-120028S-S12C	●				28	83		12	—	FSW-4013 (3.0 N-m)	A-15	BNM-160 BNM-160-S	RNM-160.... RNM-170....	
BNMM-120053S-S12C	●	1	6	12	—	53	110	11	12					—
BNML-120095S-S12C	●				—	95	160		12					—
BNML-120100S-S12C	●	1	6	12	—	100	220	11	12	—	FSW-4013 (3.0 N-m)	A-15	BNM-160 BNM-160-S	RNM-160.... RNM-170....
BNML-120130S-S12C	●				—	130	200		12	—				
BNML-120150S-S12C	●	—	150	220	12	—								
BNML-120085T-S16C	●	2			27	85	145	10	16	1°27'	FSW-4013 (3.0 N-m)	A-15	BNM-160 BNM-160-S	RNM-160.... RNM-170....
BNMS-160033S-S16C	●	1	8	16	—	33	92	15	16	—				
BNML-160070S-S16C	●				—	70	140		16	—				
BNML-160090S-S16C	●	1	8	16	—	90	160	15	16	—	FSW-4013 (3.0 N-m)	A-15	BNM-160 BNM-160-S	RNM-160.... RNM-170....
BNML-160100S-S16C	●				—	100	220		16	—				
BNML-160110S-S16C	●	8	16	—	110	180	—	16	—					
BNML-160150S-S16C	●	3	8	16	—	150	220	15	16	—	FSW-4013 (3.0 N-m)	A-15	BNM-160 BNM-160-S	RNM-160.... RNM-170....
BNMU-160220-S15C	●				—	—	220		15	—				
BNMM-160063T-S20C	●	2	8	16	30.5	63	123	14	20	2° 5'				
BNML-160100T-S20C	●				30.5	100	166	14	20	1°15'				

" Mirror Ball "

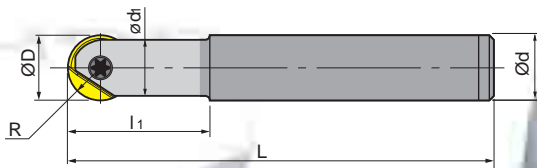


■ BNM Carbide Shank

BNM-S type (Straight neck)



Fig.1 (Straight neck)



BNM-T type (Taper neck)

NEW BNMU type (Straight shank)

Run-Out accuracy
10 µm

Fig.2 (Taper neck)

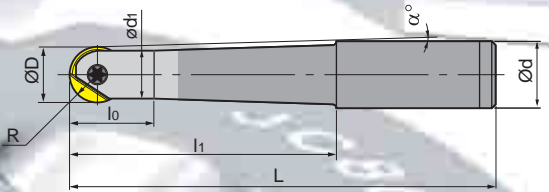
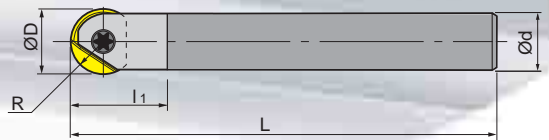


Fig.3 (Straight shank)



Mirror Ball bodies can fix Mirror Radius inserts for finishing application of cutting stock below 1/40xD.

■ Body

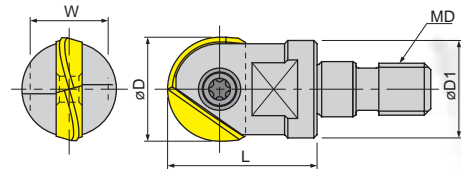
Cat. No.	Stock	Fig.	Dimensions (mm)								Parts		Inserts				
			R	ØD	l ₀	l ₁	L	ød ₁	ød	α°	Clamp Screw	Wrench	Inserts	Inserts			
BNMS -200039S-S20C	●	1	10	20	-	39	104		20	-	FSW-5016 (4.0 N-m)	A-20	BNM-200 BNM-200-S	RNM-200.... RNM-210....			
BNMM-200075S-S20C	●				-	75	141	19	20	-							
BNML -200100S-S20C	●				-	100	220		20	-							
BNML -200105S-S20C	●				-	105	180		20	-							
NEW BNMU -200270-S18C	●	3			-	40	270	19	18	-							
BNML -200115T-S25C	●	2			36	115	191	17	25	1°22'							
BNML -200125S-S20C	●	1			-	125	200		20	-							
BNML -200170S-S20C	●				-	170	250	19	20	-							
BNML -200220S-S20C	●				-	220	300		20	-							
BNMS-250045S-S25C	●							-	45	121						25	-
BNMM-250090S-S25C	●	1			-	90	166	24	25	-							
BNML-250100S-S25C	●		12.5	25	-	100	220		25	-							
BNML-250135T-S32C	●	2			43	135	215	21	32	1°38'							
BNML-250140S-S25C	●	1			-	140	220		25	-							
BNML-250170S-S25C	●				-	170	250	24	25	-							
BNML-250220S-S25C	●				-	220	300		25	-							
NEW BNMU -250300-S23C	●				3			-	50	300						23	-
BNMS-300053S-S32C	●	1			-	53	133		32	-	FSW-8025 (6.0 N-m)	A-40	BNM-300 BNM-300-S	RNM-300....			
BNMM-300120S-S32C	●				-	120	200	29	32	-							
BNML -300100S-S32C	●				-	100	220		32	-							
BNML -300160T-S32C	●				2	15	30	48	160	240					26	32	0°24'
BNML -300170S-S32C	●	1			-	170	250		32	-							
BNML -300220S-S32C	●				-	220	300	29	32	-							
NEW BNMU -300300-S28C	●				3			-	30	300						28	-
BNMS -320053S-S32C	●							-	53	133						32	-
BNMM-320120S-S32C	●	1	16	32	-	120	200		32	-	FSW-8025 (6.0 N-m)	A-40	BNM-320 BNM-320-S	RNM-320....			
BNML -320170S-S32C	●				-	170	250	31	32	-							
BNML -320220S-S32C	●				-	220	300		32	-							

Note : Please see page 63-68 for cutting conditions.

“ Mirror Ball ”



■ MBN Modular Head Type



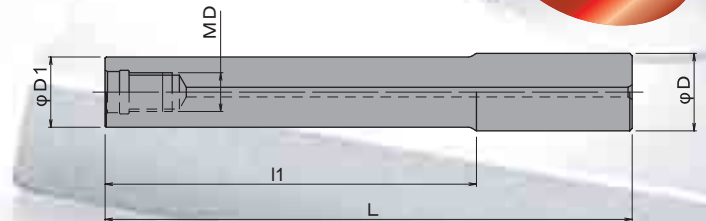
■ Body

Cat. No.	Stock	Dimensions (mm)						Applicable Inserts		Clamp screw	Wrench
		R	øD	L	øD1	MD	W				
MBN-100-M6	●	5	10	18	9.7	M6	8			FSW-3007H (1.2 N-m)	A-8
MBN-120-M6	●	6	12	20	11.5	M6	8			FSW-3509 (2.0 N-m)	A-10
MBN-160-M8	●	8	16	23	15	M8	12			FSW-4013 (3.0 N-m)	A-15
MBN-200-M10	●	10	20	30	18.5	M10	17			FSW-5016 (4.0 N-m)	A-20
MBN-250-M12	●	12.5	25	35	24	M12	22			FSW-6020 (5.0 N-m)	A-30
MBN-300-M16	●	15	30	43	29	M16	22			FSW-8025 (6.0 N-m)	A-40
MBN-320-M16	●	16	32	43	30	M16	22			FSW-8025 (6.0 N-m)	A-40

Note : Please see page 63-68 for cutting conditions.

■ MSN Straight Neck type (Through Coolant Hole)

- For high productivity
- High rigidity



■ Body

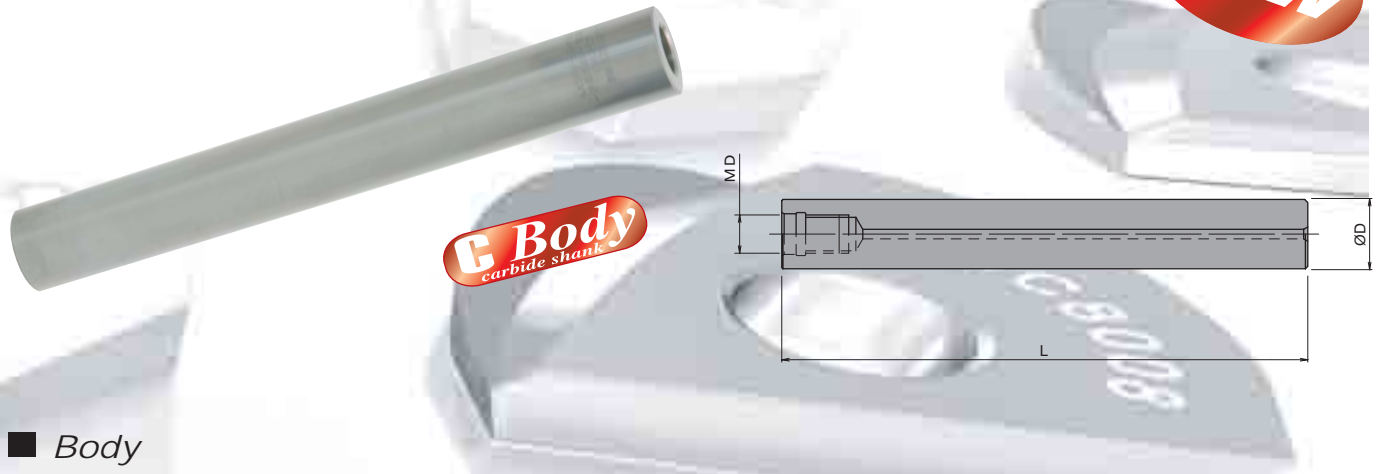
Cat. No.	Stock	Dimensions (mm)					Applicable head
		øD	l ₁	L	øD ₁	MD	
MSN-M6-30-S10C	●	10	30	80	9.7	M6	MBN-100-M6
MSN-M6-50-S10C	●		50	100			
MSN-M6-80-S10C	●		80	130			
MSN-M6-30-S12C	●	12	30	80	11.5	M6	MBN-120-M6
MSN-M6-50-S12C	●		50	100			
MSN-M6-80-S12C	●		80	130			
MSN-M8-40-S16C	●	16	40	95	15.5	M8	MBN-160-M8
MSN-M8-80-S16C	●		80	135			
MSN-M8-120-S16C	●		120	175			
MSN-M10-40-S20C	●	20	40	100	19.5	M10	MBN-200-M10
MSN-M10-90-S20C	●		90	150			
MSN-M10-140-S20C	●		140	200			
MSN-M12-55-S25C	●	25	55	120	24	M12	MBN-250-M12
MSN-M12-105-S25C	●		105	170			
MSN-M12-155-S25C	●		155	220			
MSN-M16-55-S32C	●	32	55	120	29	M16	MBN-300-M16 MBN-320-M16
MSN-M16-105-S32C	●		105	170			
MSN-M16-155-S32C	●		155	220			
MSN-M16-195-S32C	●		195	260			

“ Mirror Ball ”



■ **MSN Straight Arbor Type (Through Coolant Hole)**

- For high productivity
- High rigidity



■ *Body*

Cat. No.	Stock	Dimensions (mm)			Applicable holders	
		ØD	L	MD		
MSN-M10-130S-S18C	●	18	130	M10	MBN-200-M10	
MSN-M10-190S-S18C	●		190			
MSN-M10-130S-S20C	●	20	130			
MSN-M10-190S-S20C	●		190			
MSN-M10-250S-S20C	●		250			
MSN-M12-185S-S23C	●	23	185			M12
MSN-M12-265S-S23C	●		265			
MSN-M12-145S-S25C	●		145			
MSN-M12-215S-S25C	●	25	215			
MSN-M12-285S-S25C	●		285			
MSN-M16-160S-S28C	●		28	160	M16	
MSN-M16-230S-S28C	●	230				
MSN-M16-310S-S28C	●	310				
MSN-M16-157S-S32C	●	32		157		
MSN-M16-217S-S32C	●			217		
MSN-M16-287S-S32C	●			287		
MSN-M16-357S-S32C	●			375		

Note : Please see page 63-68 for cutting conditions.

■ *Recommended tightening torque for modular head*

Tread Size	Tightening Torque	Wrench Size mm.
M8	23 Nm	10,12
M10	46 Nm	14,15
M12	80 Nm	17
M16	90 Nm	22,26

Attention to mounting head !

Clean the contact surface of head and carbide holder, and also confirm there is no gap between head and holder after tightening.
Please check and try to obtain good run-out.

“ Mirror Ball ”



Mirror S

“ Mirror - S ” Inserts for Mirror Ball

Features:

1. "S" shaped geometry.
"S" shaped geometry insert is suitable for high hardened material in high speed cutting and can cut more smoothly.
2. New coating.
Adopting new coating achieves longer tool life for finishing operation in high speed cutting.

■ Newly developed "VALUE COATING"

VALUE COATING gives stable and high-performance machining on high hardened materials and cast iron even with high speed dry condition, due to higher hardness and higher oxidation resistance than the existing DZ coating.

● Characteristic value of various PVD coatings

	TiN	TiCN	TiAlN	DV coat
Hardness	2,200	2,800	2,900	3,500
Oxidization temperature	400~500	300~400	700~800	1,000
Wear resistance	△	○	○	◎
Thermal resistance	△	×	○	◎

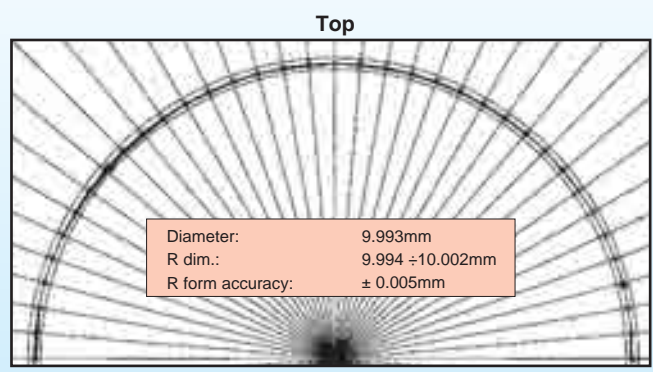
■ "S" shaped geometry



"S" shape geometry insert is suitable for high hardened material in high speed cutting and can cut more smoothly.

■ High precision

● Radius form accuracy of Mirror-S



Realization of insert radius form accuracy below ±6µm and possibility of equal or more high precision machining comparing with solid ball nose end mill machining.

" Mirror Ball "

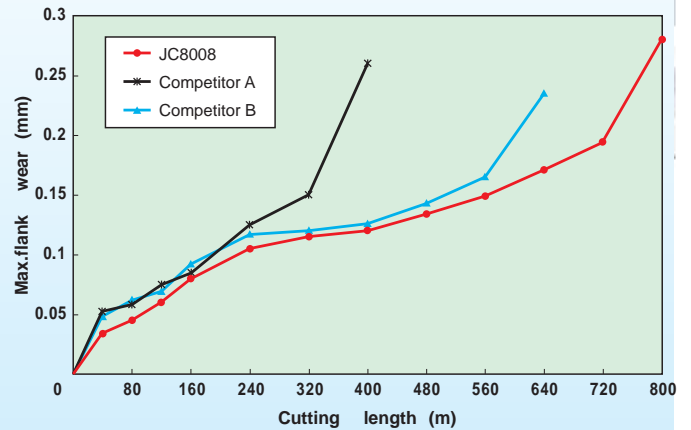
Cutting performance

● Performance (Tool life comparison)

● H.S.C copy finish milling on die steel 60HRC.

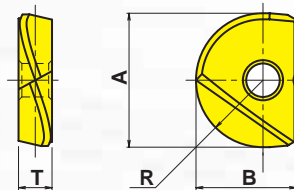
Material	1.2379, wavy shaped surface
Hardness	60HRC
Tool	Body: BNMM-200075S-S20C Carbide shank) Insert: BNM-200-S, JC8008 Overhung length: 80mm
Cutting conditions	Vertical MC V=377m/min, N=6,000min ⁻¹ F=3,000mm/min, fr=0.5mm/rev Ap=0.1mm, Ae=0.4mm Air blow, up & down cut

● Result (Vb wear)



Cutting length: 800m
Cutting time: 4h30min

■ BNM-S Inserts for " Carbide Mirror Ball Body "



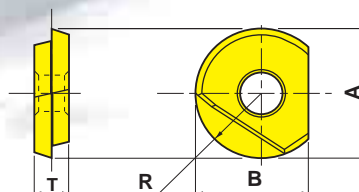
Radius accuracy
± 6 μm

Cat.No.	PVD Coated			Uncoated KT9	Dimensions (mm)			
	NEW JC8008	JC8015	JC5003		R	A	B	T
BNM-060-S	●				3	6	5	2
BNM-080-S	●				4	8	7	2.4
BNM-100-S	●				5	10	8.5	2.6
BNM-120-S	●				6	12	10	3
BNM-160-S	●				8	16	12	4
BNM-200-S	●				10	20	15	5
BNM-250-S	●				12.5	25	18.5	6
BNM-300-S	●				15	30	22.5	7
BNM-320-S	●				16	32	23.5	7

Note: "Mirror S" inserts is exclusive use of Mirror-Ball. Please use only in Mirror Ball bodies.

“ Mirror Ball ”

■ BNM Insert Type

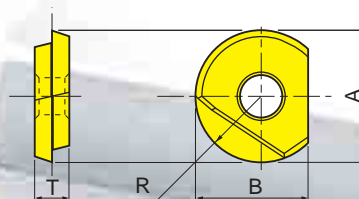


Radius accuracy
 $\pm 6 \mu\text{m}$

Cat.No.	PVD Coated			Uncoated KT9	Dimensions (mm)			
	JC5003	JC5010	JC5015		R	A	B	T
BNM-060	●		●	●	3	6	5	2
BNM-080	●	●	●	●	4	8	7	2.4
BNM-100	●	●	●	●	5	10	8.5	2.6
BNM-120	●		●	●	6	12	10	3
BNM-160	●	●	●	●	8	16	12	4
BNM-200	●		●	●	10	20	15	5
BNM-250	●	●	●	●	12.5	25	18.5	6
BNM-300	●	●	●	●	15	30	22.5	7
BNM-320	●	●	●	●	16	32	23.5	7

Note : Grade JC 5010 will be replace by JC 5015 at end of current stocks.

■ BNM Super precision inserts



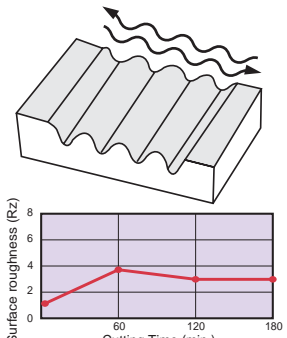
Radius accuracy
 $\pm 2 \mu\text{m}$

Cat.No.	PVD Coated			Uncoated KT9	Dimensions (mm)			
	JC5003	JC5010	JC5015		R	A	B	T
BNM-060-AAA			●		3	6	5	2
BNM-080-AAA			●		4	8	7	2.4
BNM-100-AAA			●		5	10	8.5	2.6
BNM-120-AAA			●		6	12	10	3
BNM-160-AAA			●		8	16	12	4
BNM-200-AAA			●		10	20	15	5
BNM-250-AAA			●		12.5	25	18.5	6
BNM-300-AAA			●		15	30	22.5	7
BNM-320-AAA			●		16	32	23.5	7

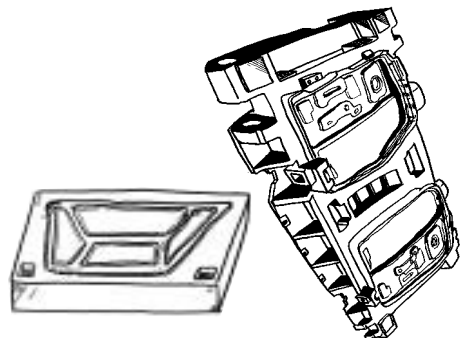
“ Mirror Ball ”

■ Cutting data for BNM


1. Surface roughness in machining hardened steel

 <p>After 2 hours Rz = 2.95µm</p> <p>After 3 hours Rz = 2.95µm</p>	Work	Part name	Test work
		Material	Alloy steel
Cutting conditions	Tool	Tool No.	BNMS-120026S-S12
		Insert No.	BNM-120, JC5010
	Cutting speed	90 m/min (2,387 min ⁻¹)	
	Feed speed	955 mm/min, 0.4 mm/rev	
	Ap	0.4 mm	
	Ae	0.3 mm	
	Coolant	Dry cut	
Machine	Vertical MC		

2. Reduced hand finishing by carbide shank (10h reduction)

	Work	Part name	Stamping die
		Material	GM241
Hardness		250-300 HB	
Result Total cutting length in GM241 was 5,080 m. Carbide shank improved surface finish and reduced 10 hours of hand finishing.	Tool	Tool No.	BNML-300170S-S32C (C-body)
		Insert No.	BNM-300, JC5015
	Cutting conditions	Cutting speed	565 m/min (6,000 min ⁻¹)
		Feed speed	5,000 mm/min, 0.83 mm/rev
		Ap	0.4 mm
		Ae	0.3 mm
		Coolant	Dry cut
Machine	MC		


3. High speed machining by BNM06

	Work	Part name	Forging die
		Material	1.2344 (Test steel)
Hardness		22-24 HRC	
Result Programmer said he has never seen anything like this before. The finishing and the feed rate.	Tool	Tool No.	BNML - 060053T - S037C (C-body)
		Insert No.	BNM-060, JC5015
	Cutting conditions	Cutting speed	339 m/min (18,000 min ⁻¹)
		Feed speed	6,100 mm/min, 0.34 mm/rev
		Ap	0.1 mm
		Ae	0.05 mm
		Coolant	Dry cut
Machine	MC		

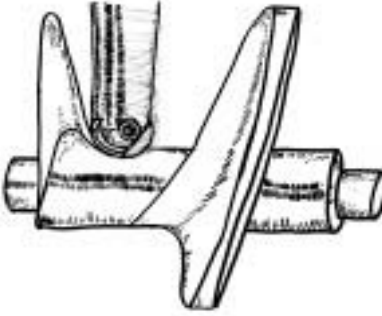
" Mirror Ball "

Cutting data for BNM


4. Replace from 6mm solid ball (Mat'l: SUS630)

Semi-finishing & finishing 	Work	Part name	Rubber die
		Material	SUS630
Hardness		35 HRC	
	Tool	Tool No.	BNMM-060035S-S06C
		Insert No.	BNM-060, JC5015
Result	Cutting conditions	Cutting speed	271 m/min (14,400 min ⁻¹)
		Feed speed	2,880 mm/min, 0.2 mm/rev
Ap		Semi-finishing 0.1 mm, Finishing 0.05mm	
Ae		0.1 mm	
Increased speed 20% more than solid carbide of N=9000, F=2400. Mirror Ball improved surface finish and reduced hand finish time.		Coolant	Mist coolant
		Machine	H.S.C. MC

5. JC5015 is suitable for stainless steel

Screw for food mixer 	Work	Part name	Screw
		Material	SUS316
Hardness		30 HRC	
	Tool	Tool No.	BNMS-300053S-S32
		Insert No.	BNM-300, JC5015
Result	Cutting conditions	Cutting speed	221 m/min (2,350 min ⁻¹)
		Feed speed	6,600 mm/min, 2.8 mm/rev
Ap		0.15 mm	
Ae		0.5 mm	
Competitor could cut 3 pcs only, but Mirror Ball could cut 12 pcs. Improved tool life 4 times.		Coolant	Dry cut
		Machine	Vertical MC

6. High speed & accuracy machining (6.3 micron Rz)

Surface finish requirement: Below Rz 6.3 µm 	Work	Part name	Aircraft parts
		Material	SCM440
Hardness		40 HRC	
	Tool	Tool No.	BNML-120095S-S12C
		Insert No.	BNM-120, JC5015
Result	Cutting conditions	Cutting speed	337 m/min (10,000 min ⁻¹)
		Feed speed	800 mm/min, 0.08 mm/rev
Ap		0.2 mm	
Ae		0.1 mm	
Stable machining at the wall because no interference problem by Mirror Ball. Improved surface finish and reduced the lead time very much.		Coolant	Water soluble oil
		Machine	H.S.C. MC

“ Mirror Ball ”

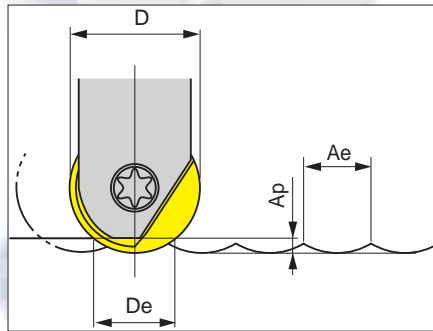
■ General Cutting Data Recommendations for BNM

● Calculation of cutting data

1. Spindle speed

$$N = \frac{V_c \times 1000}{\pi \times D_e} \quad (\text{min}^{-1})$$

$$D_e = 2 \times \sqrt{A_p \times (D - A_p)} \quad (\text{mm})$$



2. Feed

$$F = N \times f_R \quad (\text{mm/min})$$

$$f_R = h_{\text{max}} \times \frac{D_e}{\sqrt{A_p \times (D - A_p)}} \quad (\text{mm/rev})$$

- N = Spindle speed (min⁻¹)
- V_c = Cutting speed (m/min), see table 1.
- D_e = Effective tool diameter (mm), see table 3.
- A_p = Axial depth of cut (mm)

- A_e = Pick feed, radial depth of cut (mm)
- F = Feed speed (mm/min)
- f_R = feed / rev (mm), see table 1. & 4.
- h_{max} = Max. chip thickness (mm), see table 4.

Table 1. Nominal cutting speed and feed values for steel shank

Work Materials (Mat No.)	Hardness	Insert Grade	Cutting speed V _c (m/min)	Nominal feed : f _R (mm/rev)									Max. Depth A _p (mm)	Max. Pick A _e (mm)
				Cutter dia. : D (mm)										
				6	8	10	12	16	20	25	30	32		
Grey cast iron (GG25, GG30)	160-260HB	JC5003 JC5015	200-400	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.7	0.7	D/10	D/10
Nodular cast iron (GGG60, GGG70)	170-300HB	JC5003 JC5015	150-350	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.7	0.7	D/15	D/15
Carbon steel (C50, C55)	180-280HB	JC5003 JC5015	180-230	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	D/15	D/15
Low alloy steel (1.7225)	180-280HB	JC5003 JC5015	150-200	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	D/15	D/15
Mold steel (1.2311, P20)	280-400HB	JC5003 JC5015	110-170	0.15	0.25	0.3	0.4	0.4	0.4	0.5	0.5	0.5	D/20	D/20
Tool & die steel (1.2344, 1.2379)	180-255HB	JC5003 JC5015	130-180	0.15	0.25	0.3	0.4	0.5	0.5	0.6	0.6	0.6	D/20	D/20
Hardened die steel (1.2344, 1.2379)	40-55HRC	JC5003 JC5015	70-90	0.15	0.25	0.3	0.4	0.5	0.5	0.6	0.6	0.6	D/30	D/30
Stainless steel (1.4301, 1.4401)	150-250HB	JC5015	90-130	0.15	0.25	0.3	0.4	0.4	0.4	0.5	0.5	0.5	D/20	D/20
Copper alloys	80-150HB	JC5003 KT9	150-200	0.25	0.4	0.5	0.6	0.7	0.7	0.8	0.8	0.8	D/10	D/10
Aluminum alloys	30-100HB	JC5003 KT9	200-300	0.25	0.4	0.5	0.6	0.7	0.7	0.8	0.8	0.8	D/6	D/6
Graphite		JC5003	200-400	0.3	0.5	0.6	0.7	0.8	0.8	0.9	0.9	0.9	D/5	D/5

Note : Data is relevant to short series tools & middle series tools (over ø 12mm).

See table 5 for additional data e. g. using long series tools & middle series tools (up to ø 12mm).

“ Mirror Ball ”

General Cutting Data Recommendations for BNM

Table 2. H.S.C. data recommendation for carbide shank

Work Materials (Mat No.)	Hardness	Insert Grade	Cutting speed Vc(m/min)	Nominal feed : f_R (mm/rev)										Max. Depth Ap (mm)	Max. Pick Ae (mm)
				Cutter dia. : D (mm)											
				6	8	10	12	16	20	25	30	32			
Grey cast iron (GG25, GG30)	160-260HB	JC5003 JC8008	400-500	0.4	0.5	0.5	0.6	0.8	0.8	1.0	1.0	1.0	0.1-0.3	D/40	
Nodular cast iron (GGG60, GGG70)	170-300HB	JC5003 JC8008	300-400	0.3	0.4	0.4	0.5	0.6	0.6	0.8	0.8	0.8	0.1-0.3	D/40	
Carbon steel (C50, C55)	180-280HB	JC5003 JC5015	300-400	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.7	0.1-0.3	D/50	
Low alloy steel (1.7225)	180-280HB	JC5003 JC5015	300-400	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.7	0.1-0.3	D/50	
Mold steel (1.2311, P20)	280-400HB	JC5003 JC5015	300-350	0.25	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.6	0.1-0.2	D/50	
Tool & die steel (1.2344, 1.2379)	180-255HB	JC5003 JC8008	300-350	0.25	0.3	0.3	0.4	0.4	0.4	0.6	0.6	0.6	0.1-0.2	D/50	
Hardened die steel (1.2344, 1.2379)	40-55HRC	JC5003 JC8008	250-350	0.25	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.6	0.1-0.2	D/50	
Hardened die steel (1.2344, 1.2379)	55HRC-	JC5003 JC8008	150-250	0.2	0.25	0.3	0.4	0.5	0.5	0.6	0.6	0.6	0.1-0.2	D/50	
Stainless steel (1.4301, 1.4401)	150-250HB	JC5003 JC5015	200-300	0.25	0.35	0.45	0.6	0.65	0.7	0.8	0.8	0.8	0.1-0.2	D/50	
Copper alloys	80-50HB	JC5003 JC5015	300-400	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.7	0.1-0.5	D/40	
Aluminum alloys	30-100HB	JC5003 JC5015	400-500	0.35	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.8	0.1-0.5	D/40	
Graphite		JC8008	600-800	0.4	0.6	0.6	0.7	0.8	0.8	0.9	0.9	0.9	0.1-0.5	D/40	

Note : Data is relevant to short series tools & middle series tools.

Table 3. Effective tool diameter chart

Cutter dia. D (mm)	Effective tool diameter : D_e (mm)													
	Axial depth of cut : A_p (mm)													
	0.2	0.3	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
8	2.5	3	3.9	5.3	6.2									
10	2.8	3.4	4.4	6	7.1	8								
12	3.1	3.7	4.8	6.6	7.9	8.9	9.7							
16	3.6	4.3	5.6	7.7	9.3	10.6	11.6	12.5						
20	4	4.9	6.2	8.7	10.5	12	13.2	14.3	15.2	16				
25	4.5	5.4	7	9.8	11.9	13.6	15	16.2	17.3	18.3	19.2	20		
30	4.9	6	7.7	10.8	13.1	15	16.6	18	19.3	20.4	21.4	22.4	23.2	24
32	5	6.2	7.9	11.1	13.5	15.5	17.2	18.7	20	21.2	22.2	23.2	24.1	25

Table 4. Maximum chip thickness chart

Work Materials (Mat No.)	Hardness	Max. chip thickness : h_{max} (mm)									
		Cutter dia. : D (mm)									
		6	8	10	12	16	20	25	30	32	
Grey cast iron (GG25, GG30)	160-260HB	0.07	0.09	0.12	0.15	0.18	0.18	0.21	0.21	0.21	
Nodular cast iron (GGG60, GGG70)	170-300HB	0.05	0.07	0.10	0.12	0.15	0.15	0.17	0.17	0.17	
Carbon steel (C50, C55)	180-280HB	0.05	0.07	0.10	0.10	0.12	0.12	0.15	0.15	0.15	
Low alloy steel (1.7225)	180-280HB	0.05	0.07	0.10	0.10	0.12	0.12	0.15	0.15	0.15	
Mold steel (1.2311, P20)	280-400HB	0.03	0.05	0.065	0.09	0.09	0.09	0.11	0.11	0.11	
Tool & die steel (1.2344, 1.2379)	180-255HB	0.03	0.05	0.065	0.09	0.11	0.11	0.13	0.13	0.13	
Hardened die steel (1.2344, 1.2379)	40-55HRC	0.02	0.04	0.05	0.07	0.09	0.09	0.11	0.11	0.11	
Stainless steel (1.4301, 1.4401)	150-250HB	0.03	0.05	0.065	0.09	0.09	0.09	0.11	0.11	0.11	
Copper alloys	80-150HB	0.10	0.12	0.15	0.18	0.21	0.21	0.24	0.24	0.24	
Aluminum alloys	30-100HB	0.12	0.15	0.18	0.22	0.26	0.26	0.30	0.30	0.30	
Graphite		0.15	0.20	0.24	0.28	0.32	0.32	0.36	0.36	0.36	

" Mirror Ball "

■ H.S.C. recommended cutting conditions for MBN and Carbide MSN

Materials	Grades	Cutting speed Vc(m/min)	Tool dia. (mm)								Max. D.O.C. Ap(mm)	Max. Pick Ae(mm)	
			16		20		25		30 / 32				
			N (min ⁻¹)	F (mm/min)	N (min ⁻¹)	F (mm/min)	N (min ⁻¹)	F (mm/min)	N (min ⁻¹)	F (mm/min)			
Gray cast iron	JC8008 JC5003	750	15,000	10,000	12,000	9,000	9,600	8,000	8,000	8,000	8,000	0.1-0.3	0.02D
Nodular cast iron (170-300HB)	JC8008 JC5003	600	12,000	7,000	9,600	6,700	7,700	6,000	6,500	6,000	6,000	0.1-0.3	0.02D
Carbon steel (180-280HB)	JC8008 JC5003	600	12,000	7,000	9,600	6,700	7,700	6,000	6,500	6,000	6,000	0.1-0.3	0.02D
Low alloy steel (180-280HB)	JC8008 JC5003	600	12,000	7,000	9,600	6,700	7,700	6,000	6,500	6,000	6,000	0.1-0.2	0.015D
Tool & die steel (180-255HB)	JC8008 JC5003	600	12,000	7,000	9,600	6,700	7,700	6,000	6,500	6,000	6,000	0.1-0.2	0.015D
Hardened die steel (40-55HRC)	JC8008 JC5003	450	9,000	4,500	7,200	3,600	5,750	3,450	4,800	3,360	3,360	0.1-0.2	0.015D
Hardened die steel (56-63HRC)	JC8008 JC5003	300	6,000	3,000	4,800	2,400	3,850	2,300	3,200	2,200	2,200	0.05-0.01	0.015D
Stainless steel (150-250HB)	JC8008 JC5015	500	10,000	6,000	8,000	4,800	6,400	4,500	5,300	4,200	4,200	0.1-0.2	0.015D
Copper alloy (150-250HB)	JC8008 JC5003	600	12,000	8,400	9,600	7,600	7,700	6,200	6,500	6,500	6,500	0.1-0.3	0.02D
Aluminum alloy (30-100HB)	JC8008 JC5003	800	16,000	11,200	12,700	10,000	10,200	8,200	8,500	8,500	8,500	0.1-0.5	0.02D

N: Spindle speed, F: Feed speed

■ Recommended cutting conditions for MBN and Carbide MSN

Materials	Grades	Cutting speed Vc(m/min)	Tool dia. (mm)								Max. D.O.C. Ap(mm)	Max. Pick Ae(mm)	
			16		20		25		30 / 32				
			N (min ⁻¹)	F (mm/min)	N (min ⁻¹)	F (mm/min)	N (min ⁻¹)	F (mm/min)	N (min ⁻¹)	F (mm/min)			
Gray cast iron	JC8008 JC5003	450	9,000	4,500	7,200	4,300	6,000	4,000	5,000	4,000	4,000	0.02D	0.025D
Nodular cast iron (170-300HB)	JC8008 JC5003	350	7,000	3,500	5,600	3,000	4,500	2,700	4,000	2,800	2,800	0.02D	0.025D
Carbon steel (180-280HB)	JC8008 JC5015	350	7,000	3,500	5,600	3,000	4,500	2,700	4,000	2,800	2,800	0.02D	0.02D
Low alloy steel (180-280HB)	JC8008 JC5015	350	7,000	3,500	5,600	3,000	4,500	2,700	4,000	2,800	2,800	0.02D	0.02D
Tool & die steel (180-255HB)	JC8008 JC5015	350	7,000	3,500	5,600	3,000	4,500	2,700	4,000	2,800	2,800	0.02D	0.02D
Hardened die steel (40-55HRC)	JC8008 JC5003	250	5,000	2,000	4,000	1,800	3,200	1,600	2,700	1,400	1,400	0.015D	0.02D
Hardened die steel (56-63HRC)	JC8008 JC5003	200	4,000	1,400	3,200	1,300	2,600	1,300	2,000	1,000	1,000	0.01D	0.02D
Stainless steel (150-250HB)	JC8008 JC5015	300	6,000	3,000	4,800	2,400	3,850	2,100	3,200	2,000	2,000	0.02D	0.02D
Copper alloy (150-250HB)	JC8008 JC5003	350	7,000	3,850	5,600	3,400	4,500	3,150	4,000	3,200	3,200	0.02D	0.025D
Aluminum alloy (30-100HB)	JC8008 JC5003	500	10,000	6,000	8,000	5,600	6,400	4,500	5,300	4,800	4,800	0.03D	0.03D

N: Spindle speed, F: Feed speed

“ Mirror Ball ”

General Cutting Data Recommendations for BNM

Table 5. Reduced cutting data for longer series tools.

Cutter dia. øD(mm)	Short series				Middle series				Long series			
	l ₁	l ₁ /D	min ⁻¹ %	Feed %	l ₁	l ₁ /D	min ⁻¹ %	Feed %	l ₁	l ₁ /D	min ⁻¹ %	Feed %
6	30	5.0	100	100	35	5.8	100	100				
8	35	4.4	100	100	53	6.6	60	65	75	9.4	50	50
10	35	3.5	100	100	53	5.3	70	80	75	7.5	60	65
12	26	2.2	100	100	53	4.4	90	90	85	7.1	65	65
16	32	2.0	100	100	63	3.9	100	100	100	6.3	70	70
20	38	1.9	100	100	75	3.8	100	100	115	5.8	75	75
25	45	1.8	100	100	90	3.6	100	100	135	5.4	80	80
30	53	1.8	100	100	106	3.5	100	100	160	5.3	80	90
32	53	1.7	100	100	106	3.3	100	100	160	5.0	80	90

Note : Long tools need to be used with reduced cutting data and the above percentages should be applied.

☹ Attention to mounting insert

1. Clean the insert seat carefully.
2. Clean the insert, especially hole and location face.
3. Change the clamp screw when the screw gets worn out. (10-15 inserts)
4. Do not tighten the clamp screw too hard. (See table 6.)

Table 6. Recommended torque

Cutting dia. (mm)	Recommended Torque
D	N · m
6	0.5
8	0.9
10	1.2
12	2.0
16	3.0
20	4.0
25	5.0
30	6.0
32	6.0

BNM Type

Torque control wrench

- Torque limiting when loosening and tightening a screw.

Torque control wrench are fitted with a special limited stop that controls the loosening torque. In this way, screws components and the tool itself are all protected against damage during both the tightening and loosening process. This wrench is recommended for use with the Mirror Ball.

- Size: T6, T7, T8, T10.
- Exchange blades.



Torque control wrench (with replaceable blade)

Cat. No.	Torx No.	Torque value	Applicable blades	Applicable inserts
TQC-06	T6	0.5Nm	B-06	BNM-060
TQC-07	T7	0.9Nm	B-07	BNM-080
TQC-08	T8	1.2Nm	B-08	BNM-100
TQC-10	T10	2.0Nm	B-10	BNM-120

Delivery on request