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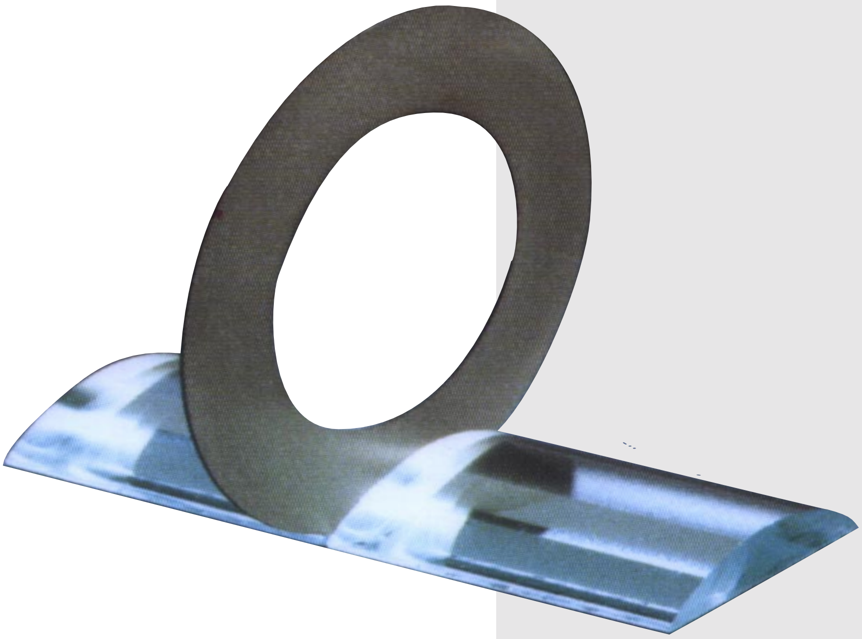
ADT
Advanced Dicing Technologies Ltd

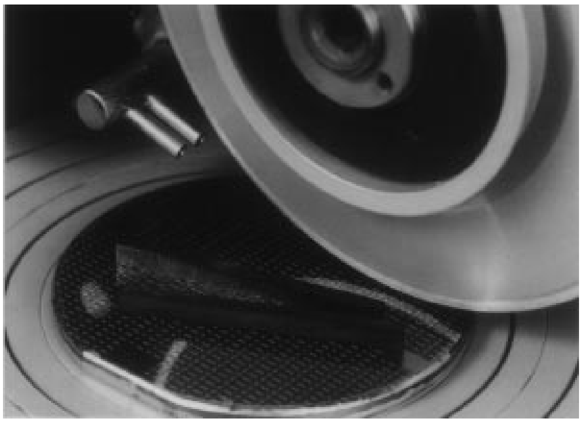
Dicing Blades for 4“-Spindles



minitron
elektronik gmbh

Industry Background

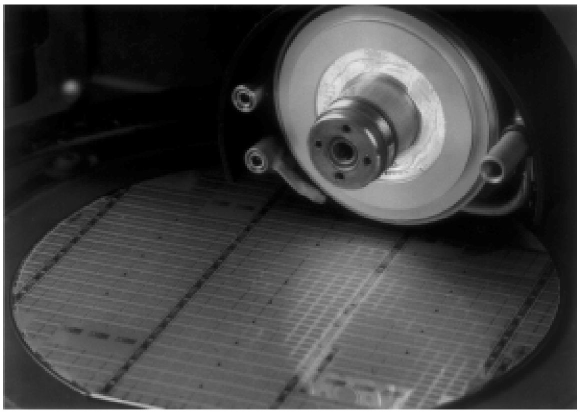
Towards the year 2000 we face a new, complex set of demands as the microelectronics industry grows more sophisticated. Increasing miniaturzation of components depends on super accurate cutting. The use of very hard, brittle and exotic substrates creates special problems. The wide range of materials needs blades based on hard or soft binders with a choice of diamond particle sizes. Large volume production and high productivity rely on low, consistent blade wear, and in some cases, on specially designed accurate flange assemblies. All these demands are met by ADT and our commitment to stay at the frontier of blade technology. This will also guarantee continued customer satisfaction.



Titanium carbide bars diced with a nickel blade
Figure 1

The Art of Successful Cutting

The wide variety of materials to be cut today, and the high accuracy needed, require understanding and control of the cutting process. After choosing the correct blade, the most important step is dressing. While the resinoid blade requires minimum dressing due to the soft binder, the metal bond (nickel hubless) requires a longer dressing for free cutting and good kerf quality. Hub-type blades are predressed and therefore ready to go. Cooling is another very important parameter. Adequate cooling flow and nozzle proximity are a must for good kerf quality and long blade life. Additives in the cooling system are helpful in many applications. The correct exposure is crucial for blade stability and cut quality. Choosing the appropriate blade binder, diamond grit size, spindle speed and feed rate is essential for optimizing production yield, throughput and blade life.

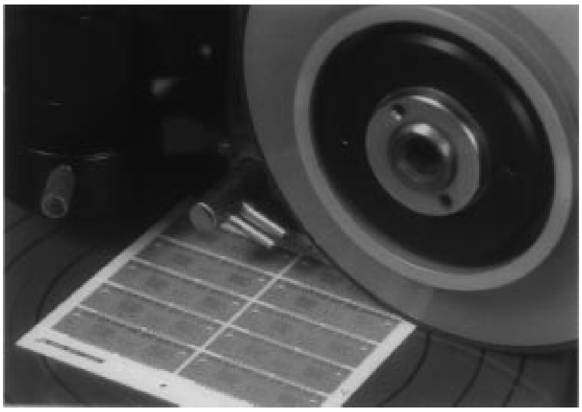


Hub-type blade cutting a silicon wafer
Figure 2

ADT Hubless Blades

ADT offers a wide range of nickel hubless, resin hubless and nickel hub-type blades. All blades fit the ADT 7100 Fortis saws, K&S 780 saws, as well as those of most major competitors in the micro-electronic market.

Nickel blades are recommended for cutting applications of TIC., P.Z.T., green ceramics and others. Resinoid blades are recommended for hard and brittle materials such as hard-alumina, glass, quartz, sapphire and others. Hub-type blades are used mainly for silicon and GaAs wafers. ADT is currently working on secial requests for various binder characteristics to meet special application requirements.



Alumina substrate diced with a resinoid blade
Figure 3

Process Control

Consistency of blade performance is ensured by process control during blade manufacture. All ADT blades undergo a strict 100% quality control, and are inspected using the most advanced testing methods. We also test our blades on ADT precision dicing systems, which provide a test bench to simulate the actual cutting process.

Figure 4

Selection of Diamonds in Blade Manufacture

To ensure superior kerf quality and long blade life, ADT carefully controls the quality, purity, size and reliability of the diamond particles used in their blades. In nickel-bonded blades best results are obtained by using well-formed, strong, blocky, single crystal diamonds, (see figure 1).

In resin-bonded blades friable diamond particles are used to achieve self-sharpening and free cutting action (see figure 2). The diamond particles are coated with a nickel alloy to improve the bond between the diamond and the resin. This coating also acts as a heat sink for heat generated during cutting.

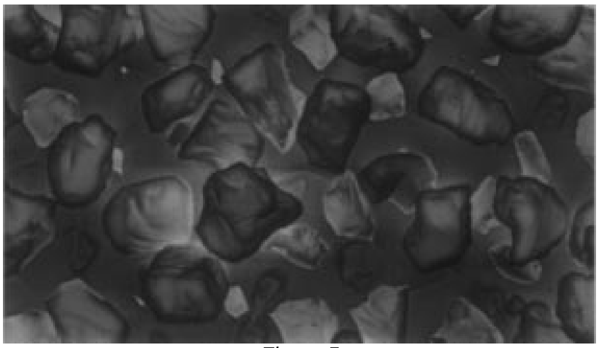


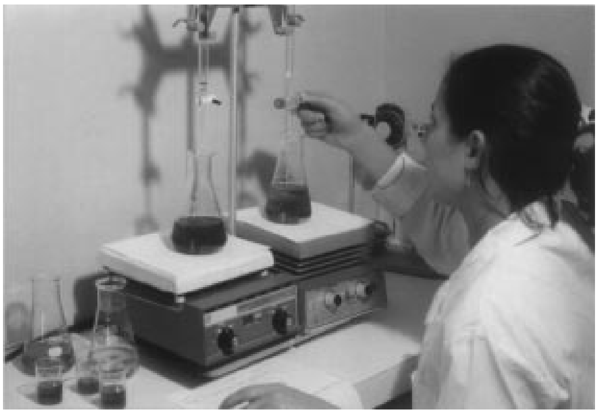
Figure 5

Figure 6

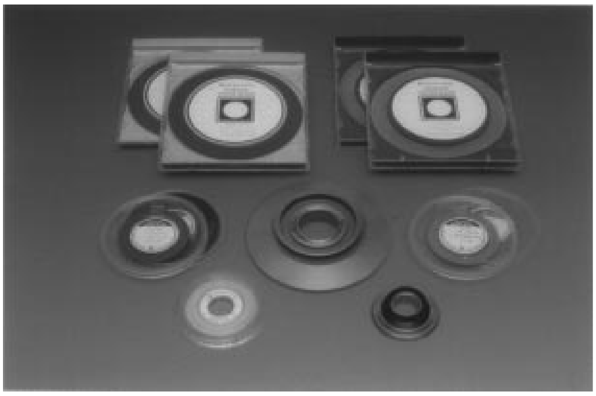
Choosing the Correct Diamond Particle Size

The size of diamond particles to be used in cutting various materials is indicated in figure 4. This chart is only intended as a guide, because each customer`s needs are unique. ADT, together with our saw application lab offers a laboratory service to identify the ideal diamond size required for each customer`s application. The solution is tailor-made, based on experiments which take into account the following parameters:

- Hardness and crystallographic structure of the material to be cut
- Depth of cut required
- Quality of cut required
- Throughput and feed rate
- Blade wear



Chemical analysis
Figure 7



Each ADT blade is individually packed and marked with its production lot number to allow monitoring of in-use performance
Figure 8

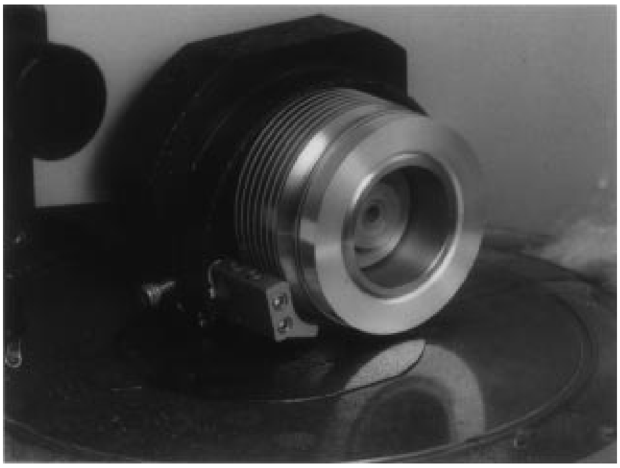
Material	Nickel (microns)	Resinoid (microns)
Alumina		45, 53, 63
Ferrite	3-6	9
Glass		45
Garnet		35
Barium Titanate		45
Kovar		53
Quartz		30
Silicon	2-4, 3-6	
Germanium	3-6	
GaAs	2-4,3-6	9
Sapphire		53-63
Ruby		53
Titanium Carbide	3-6, 17, 30	53
Piezoelectric (PZT)	3-6, 10	
Lead Telluride	3-6	
Alumina Nitride		88, 105
Lithium Niobate	3-6	25, 30

Figure 9

Flanges and Special Flange Sets

Designed and Tailor made to Meet the Most Complicated Application Requirements

ADT engineers continually face new applications requiring unique, accurate gang assemblies to meet special throughput requirements. The flange sets are state-of-the-art designs machined to highest precision dimensions.
Together with (or in addition to) special flange sets, ADT supplies a wide range of standard flange sets, high cooling flange sets and lapping kits for improved maintenance of flange sets.



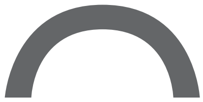
A titanium 2“ flange set with 7 x .001“ nickel blades
Figure 10

The Best Results from the Best Saw-Blade Combination

Best cutting results come from perfect compatibility between machine and tools. ADT nickel-bonded and resin-bonded blades were beveloped along with the 7100 series of saws.
They are manufactured by the ADT team of dedicated engineers and technicians. Quality control and maximum reliability are obtained through testing in our own 7100 cutting laboratory.
Finally, many complex and high volume applications of the blades and saws in use by customers prove the success of this perfect combination.

Metric dimensions are approximate. All specifications are subject to change without notice.
Figure 11

NICKEL BLADE SELECTION
4.256“ O.D. x 3.500“ I.D. (108,10 mm x 88,90 mm)
4.600“ O.D. x 3.500“ I.D. (116,84 mm x 88,90 mm)



Diamond-Grit		Thickness Range												Blade O.D.	
	mm	0,030-0,036	0,036-0,041	0,041-0,051	0,051-0,063	0,063-0,076	0,076-0,102	0,102-0,127	0,127-0,178	0,178-0,229	0,229-0,279	0,279-0,330	0,330-0,381		
Mic.	inc-h	.0012-.0014	.0014-.0016	.0016-.0020	.0020-.0025	.0025-.0030	.0030-.0040	.0040-.0050	.0050-.0070	.0070-.0090	.0090-0110	.0110-.0130	.0130-.0150	inch	mm
3-6														4.256"	108,10
														4.600"	116,84
10														4.256"	108,10
														4.600"	116,84
17														4.256"	108,10
														4.600"	116,84
30														4.256"	108,10
														4.600"	116,84
50														4.256"	108,10
														4.600"	116,84
70														4.256"	108,10
														4.600"	116,84
		012	014	016	020	025	030	040	050	070	090	110	130		

Figure 12

BLADE THICKNESS

Not Available as standard

ADT 12 DIGIT PART NUMBER 00 776 - 4 5 0 1 - 090

NICKEL BINDER

4.256" O.D.	1
4.600" O.D.	4

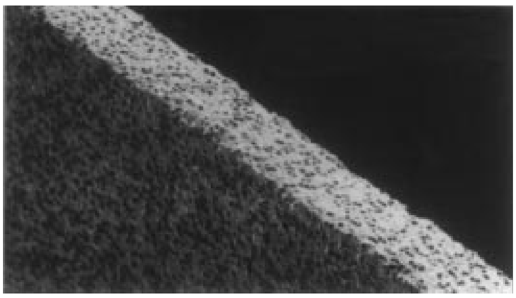
0	REGULAR BLADE
1	PRE DRESSED BLADE

DIAMOND GRIT SIZES	
2	3-6 Mic.
3	10 Mic.
4	17 Mic.
5	30 Mic.
6	50 Mic.
7	70 Mic.

* 4.600“ O.D. blades, over .009“ thick, are pre-dressed as standard.
All other blades, .005“ and thicker, can be supplied pre-dressed on request.

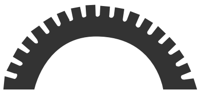
All blades are 3.500“ (88,90 mm) I.D. to fit ADT flage sets.

All blade thicknesses, diamond grit sizes and diameters are available on request.



Pre-dressed Blade
Flat blade edge with diamond exposed
Figure 13

NICKEL SERRATED BLADE SELECTION
4.256“ O.D. x 3.500“ I.D. (108,10 mm x 88,90 mm)
4.600“ O.D. x 3.500“ I.D. (116,84 mm x 88,90 mm)



Diamond Grit Mic.	Thickness Range					
	mm	0,127-0,178	0,178-,.229	0,229-0,279	0,279-0,330	0,330-0,381
	inch	.0050-.0070	.0070-.0090	.0090-.0110	.0110-.0130	.0130-.0150
3-6						
10						
17						
30						
50						
70						
		050	070	090	110	130

Figure 14

BLADE THICKNESS

ADT 12 DIGIT PART NUMBER 00 776 - 4 5 1 1 - 110

NICKEL BINDER	

4.256" O.D.	1
4.600" O.D.	4

0	REGULAR BLADE
1	PRE DRESSED BLADE *

SERRATED TYPE

DIAMOND GRIT SIZES	
4	17 Mic.
5	30 Mic.
6	50 Mic.
7	70 Mic.

* 4.600“ O.D. blades, over .009“ thick, are pre-dressed as standard.
All other blades can be supplied pre-dressed on request.

Serrated blades are designed for freer cutting with less load. The slots eliminate continuous blade and material contact and improve blade and substrate cooling.

4.256“ O.D. blades are available up to .0130“ thickness as standad.

Available on request are blades with different blade thickness, diamond grit size, slot geometry and number of slots.

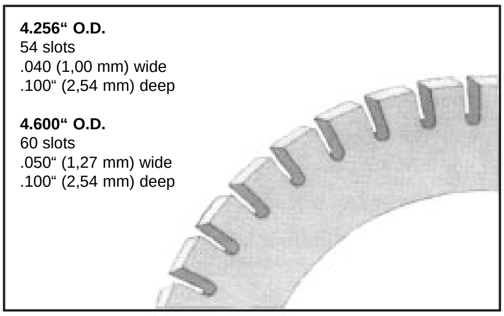
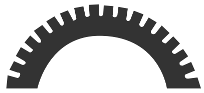


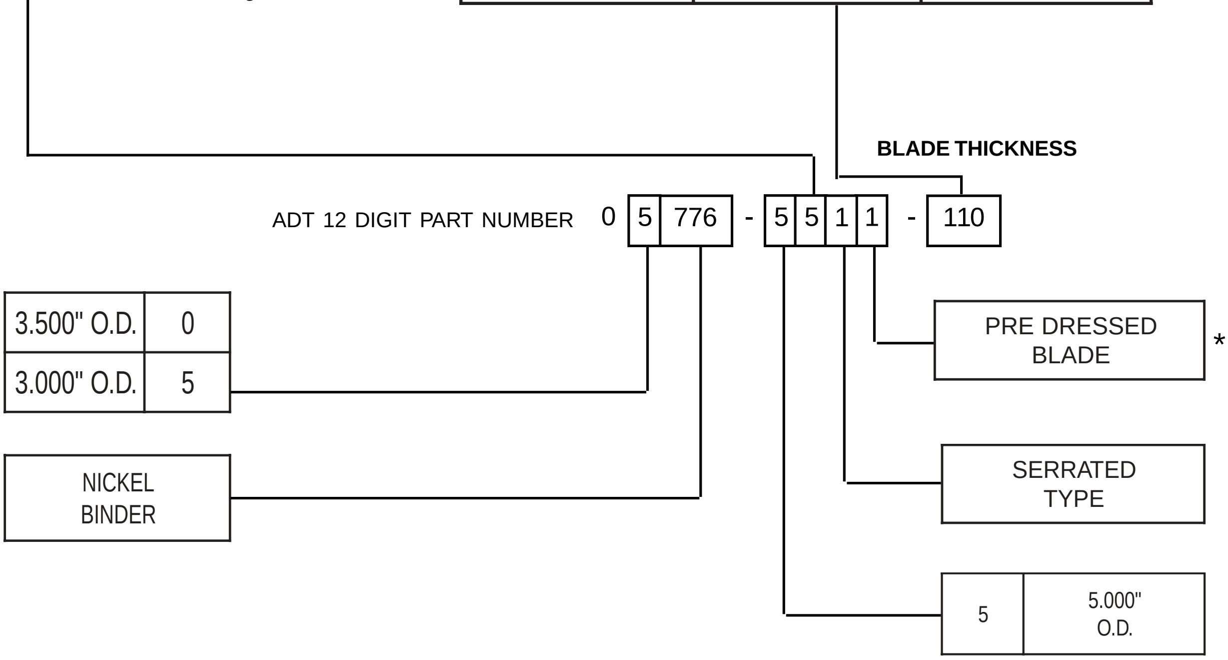
Figure 15

NICKEL SERRATED BLADE SELECTION
5.000“ O.D. x 3.500“ I.D. (127,00 mm x 88,90 mm)
5.000“ O.D. x 3.000“ I.D. (127,00 mm x 76,20 mm)



Diamond Grit Mic.		Thickness Range			
		mm	0,229-0,279	0,279-0,330	0,330-0,381
		inch	.009-.011	.011-.013	.013-.015
5	30				
6	50				
7	70				
			090	110	130

Figure 16



* All blades are pre-dressed as standard.

Serrated blades are designed for freer cutting with less load. The slots eliminate continuous blade and material contact and improve blade and substrate cooling.

Blades are 3.500“ (88,90mm) and 3.000“ (76,20mm) I.D. to fit ADT flange sets.

Available on request are blades with different blade thickness, diamond grit size, slot geometry and number of slots.

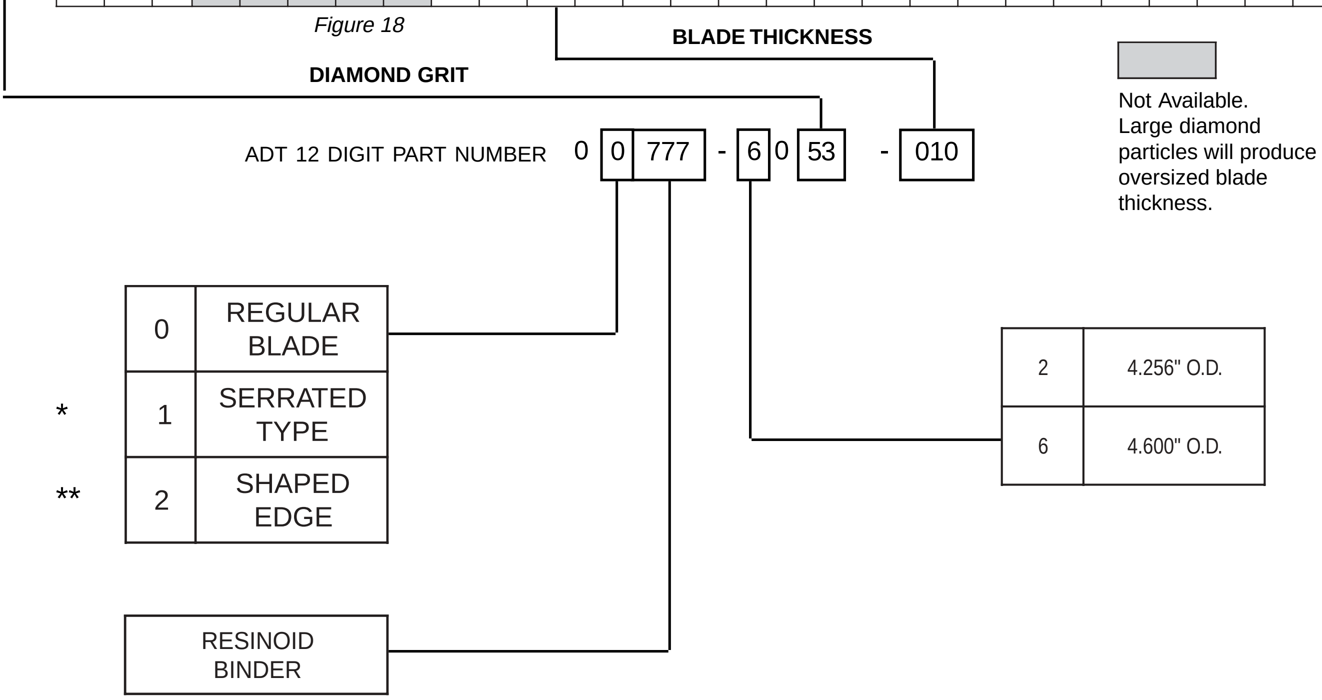
Figure 17

.600“ thick green ceramic substrate cut through with 5.000“ O.D. nickel serrated blade.

RESINOID BLADE SELECTION
4.256“ O.D. x 3.500“ I.D. (108,10 mm x 88,90 mm)
4.600“ O.D. x 3.500“ I.D. (116,84 mm x 88,90 mm)

Diamond Grit Mic.		Thickness Range																							
		mm	0,076	0,102	0,127	0,152	0,178	0,203	0,229	0,254	0,279	0,305	0,330	0,356	0,381	0,406	0,432	0,457	0,483	0,508	0,635	0,762	0,889	1,016	1,143	1,270
Mic.	Mesh	inch	.003	.004	.005	.006	.007	.008	.009	.010	.011	.012	.013	.014	.015	.016	.017	.018	.019	.020	.025	.030	.035	.040	.045	.050
6	3000																									
9	1800																									
15	1200																									
20	1000																									
25	800																									
30	600																									
35	400																									
45	325																									
53	270																									
63	230																									
86	170																									
105	140																									

Figure 18



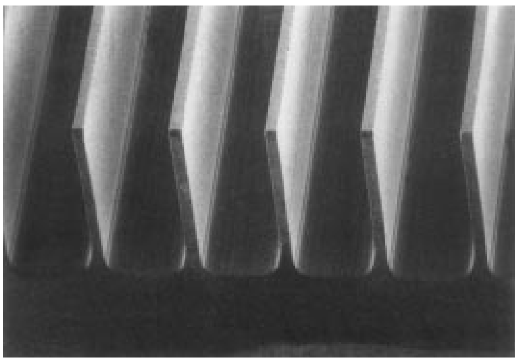
* Blades .015“ (0,381mm) and thicker can be supplied serrated.
Please consult factory.

** Blades .020“ (0,508mm) and thicker can be supplied with special edge geometry.
Please consult factory.

All blades are 3.500“ (88,90mm) I.D. to fit ADT flange sets.

Available on request are blades with different blade thickness and diamond grid size.

Blades are electrically conductive.



Ferrite application with 4.600“ O.D. resinoid blade.
Figure 19

RESINOID COARSE FINE COMPOSITION - BLADE SELECTION
4.256“ (108,10 mm) O.D. x 3.500“ I.D. (88,90 mm) I.D.
4.600“ (116,84 mm) O.D. x 3.500“ I.D. (88,90 mm) I.D.

Fine Diamond Grit		Thickness Range																				Coarse Diamond Grit	
		mm	0,203	0,229	0,254	0,279	0,305	0,330	0,356	0,381	0,406	0,432	0,457	0,483	0,508	0,635	0,762	0,889	1,016	1,143	1,270		
Mic.	Mesh	inch	.008	.009	.010	.011	.012	.013	.014	.015	.016	.017	.018	.019	.020	.025	.030	.035	.040	.045	.050	Mic.	Mesh
6	3000																					30	600
9	1800																					35	400
15	1200																					45	325
20	1000																					53	270
25	800																					63	230
30	600																					88	170
35	400																					105	140

Figure 20

BLADE THICKNESS

ADT 12 DIGIT PART NUMBER 0 | 3 | 777 - | 6 | 0 | 63 | - | 012

COARSE DIAMOND GRIT *

COARSE/FINE COMPOSITION

RESINOID BINDER

2	4.256" O.D.
6	4.600" O.D.

When ordering please specify the following:

Blade O.D.
Total blade thickness
Fine and coarse grits.
* P/N includes only the coarse grit

All blades are 3.500“ (88,90 mm) I.D. to fit ADT flange sets. Available on request are blades with different blade thickness and diamond grit size.

Cutting very brittle materials requires a very fine diamond grit to minimize chipping. Fine diamond grit blades have a higher blade wear and can only cut with very low feed rates.

In some applications, ADT state-of-the-art resinoid coarse/fine composition blade is the answer.
The coarse center of the blade performs as the majority stock remover, and the finer, outer layers provide the fine chip-free kerf edge.

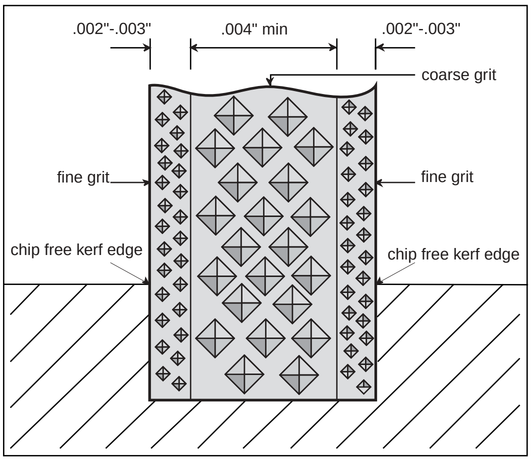


Figure 21

Selecting blade composition
Selecting the right blade composition is an experimental process for every customer based on the following parameters:

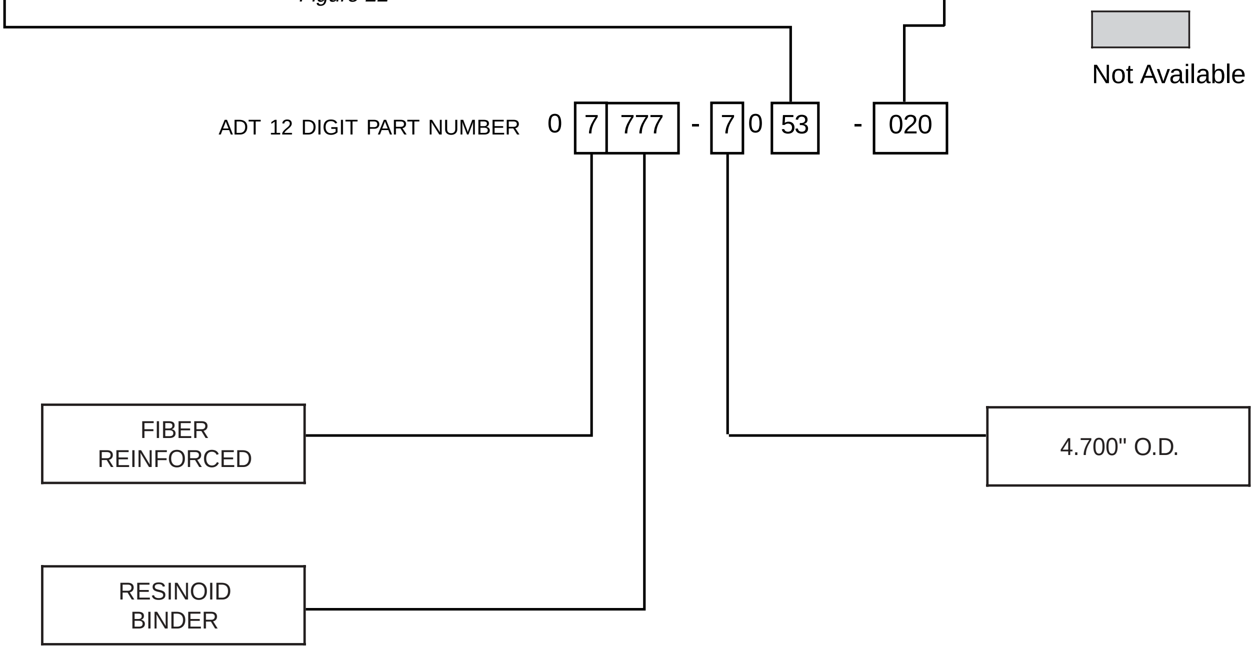
- Hardness and crystallographic structure of the material to be cut.
- Depth of cut.
- Quality of kerf edge required.
- Throughhput and feed rate.
- Blade wear.

FIBER REINFORCED RESINOID BLADE SELECTION

4.700“ O.D. x 3.500“ I.D. (119,38 mm x 88,90 mm)

Diamond Grit Mic.		Thickness Range																			
		mm	0,203	0,229	0,254	0,279	0,305	0,330	0,356	0,381	0,406	0,432	0,457	0,483	0,508	0,635	0,762	0,889	1,016	1,143	1,270
Mic.	Mesh	inch	.003	.009	.010	.011	.012	.013	.014	.015	.016	.017	.018	.019	.020	.025	.030	.035	.040	.045	.050
15	1200																				
20	1000																				
25	800																				
30	600																				
35	400																				
45	325																				
53	270																				
63	230																				
86	170																				
105	140																				

Figure 22



Reinforced blades are made with fiberglass mesh laminated in the center. The fiberglass mesh adds flexural strength which allows for more blade exposure.

These special 4.700“ O.D. blades are designed for deeper cuts where large exposure is needed.

All blades are 3.500“ (88.9mm) I.D. to fit ADT flange sets.

Available on request are blades with different O.D., blade thickness, and diamond grit size.

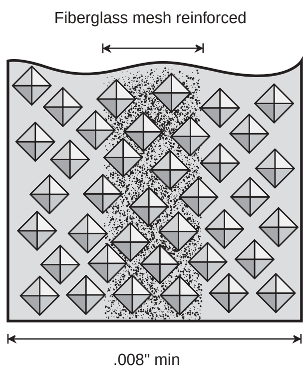
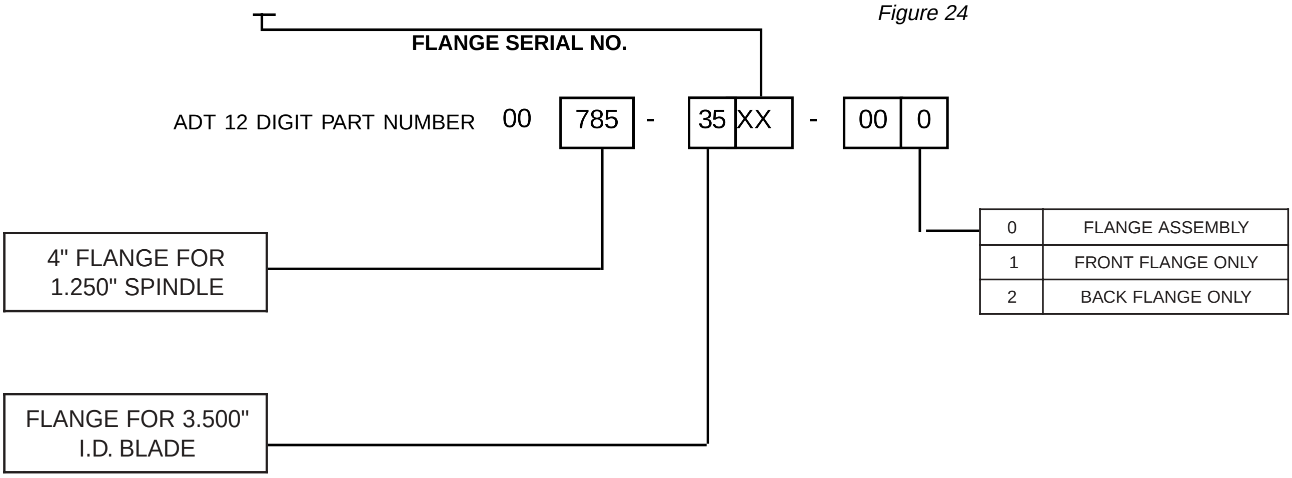


Figure 23

FLANGE SELECTION FOR 4.256“ (108,10 mm), 4.600“ (116.84 mm) and 5.000“ (127,00 mm) BLADE O.D. x 3.500“ (88,90 mm) Blade I.D., for 1.250“ (31,75 mm) SPINDLE O.D.

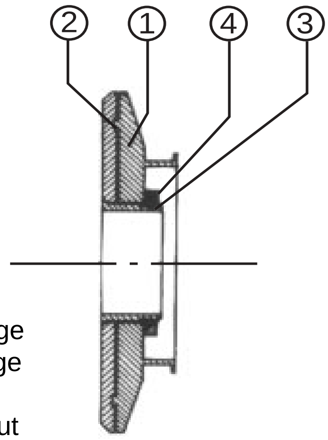
P/N	FLANGE O.D.		EXPOSURE					
			4.256"		4.600"		5.000"	
	INCH	mm	INCH	mm	INCH	mm	INCH	mm
785-3515-000	4.550	115,57	×	×	.025	0,63	.220	5,59
785-3514-000	4.500	114,30	×	×	.050	1,27	.250	6,35
785-3513-000	4.450	113,03	×	×	.075	1,90	.275	6,98
785-3512-000	4.400	111,76	×	×	.100	2,54	.300	7,62
785-3511-000	4.350	110,49	×	×	.125	3,17	.325	8,25
785-3510-000	4.300	109,22	×	×	.150	3,81	.350	8,89
785-3509-000	4.260	108,20	×	×	.170	4,32	.370	9,40
785-3508-000	4.236	107,59	.010	0,25	.182	4,62	.382	9,70
785-3507-000	4.220	107,19	.018	0,45	.190	4,83	.390	9,90
785-3506-000	4.213	107,01	.022	0,56	.194	4,93	.393	9,98
785-3505-000	4.200	106,68	.028	0,71	.200	5,08	.400	10,16
785-3504-000	4.180	106,17	.038	0,96	.210	5,33	.410	10,41
785-3503-000	4.140	105,15	.058	1,47	.230	5,84	.430	10,92
785-3502-000	4.100	104,14	.078	1,98	.250	6,35	.450	11,43
785-3501-000	4.000	101,60	.128	3,25	.300	7,62	.500	12,70

Figure 24



Part No. for Bushing: 775-8711-001
Part No. for Bushing Nut: 775-8711-002

The above flange list is the ADT standard O.D. size list. Other O.D. sizes and special flanges for thick blades or double blade assemblies are available on request.



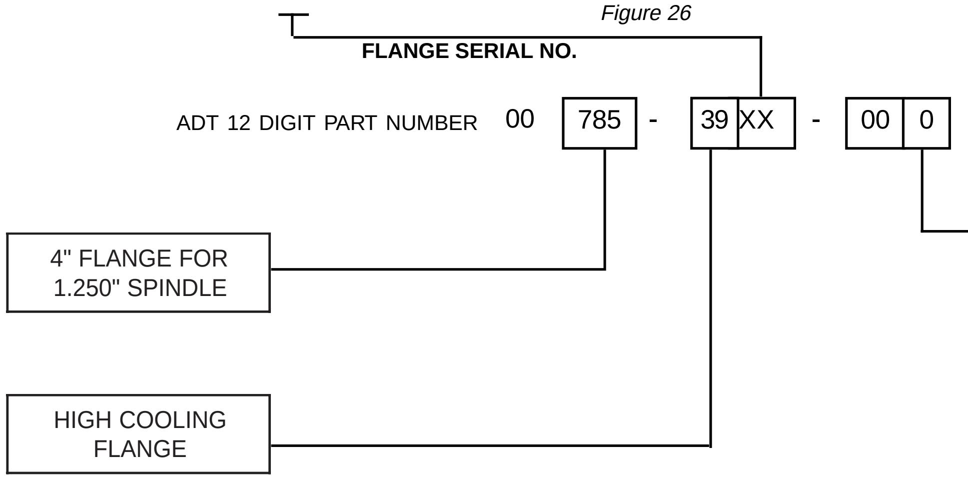
1. Front Flange
2. Back Flange
3. Bushing
4. Bushing Nut

Figure 25

HIGH COOLING FLANGE SELECTION FOR 4.600“ (116,84 mm), and 5.000“ (127,00 mm) BLADES O.D. x 3.500“ (88,90 mm) Blade I.D.

P/N	FLANGE O.D.		EXPOSURE			
			4.600"		5.000"	
	INCH	mm	INCH	mm	INCH	mm
785-3911-000	4.55	115,57	.025	0,63	.220	5,59
785-3910-000	4.50	114,30	.050	1,27	.250	6,35
785-3909-000	4.45	113,03	.075	1,90	.275	6,98
785-3908-000	4.40	111,76	.100	2,54	.300	7,62
785-3907-000	4.35	110,49	.125	3,17	.325	8,25
785-3906-000	4.30	109,22	.150	3,81	.350	8,89
785-3905-000	4.25	107,95	.175	4,44	.375	9,52
785-3904-000	4.20	106,68	.200	5,08	.400	10,16
785-3903-000	4.15	105,41	.225	5,71	.425	10,79
785-3902-000	4.10	104,14	.250	6,35	.450	11,43
785-3901-000	4.00	101,60	.300	7,62	.500	12,70

Figure 26



0	FLANGE ASSEMBLY
1	FRONT FLANGE ONLY
2	BACK FLANGE ONLY

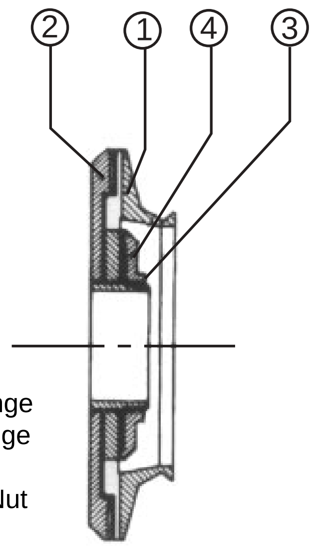
Part No. for Bushing: 775-8711-001
Part No. for Bushing Nut 775-3725-002

High cooling flange sets are designed for better cooling of the blade and the substrate which results in better cut quality and blade life.

For installation of high cooling flange please consult factory.

The above flange list is the ADT standad O.D. size list.

Other O.D. sizes are available on request.



1. Front Flange
2. Back Flange
3. Bushing
4. Bushing Nut

Figure 27

Principles of Dicing

Gideon Levinson
Dicing Tools Product Manager

Background

Dicing (or diamond-wheel sawing) is used in the microelectronics industry for die separation and also for fine, accurate, partial and cut-through of exotic, very hard and brittle materials. The wide range of materials processed makes it necessary to use different blades. These may be based on hard or soft binders, with various diamond particle sizes. Large-scale production and high productivity rely on low, consistent blade wear as demanded by today´s sophisticated industrial environment

History and other separating techniques

Other techniques have been used, mainly for die separation.

Diamond scribing

This is the oldest separating method, mainly used for silicon wafers. In Figure 1 a diamond tip, with an angle of about 125°, scribes a shallow scratch on the wafer. The edge quality of a scribed and broken die is poor. Breaking produces dies that are irregular in size and shape.

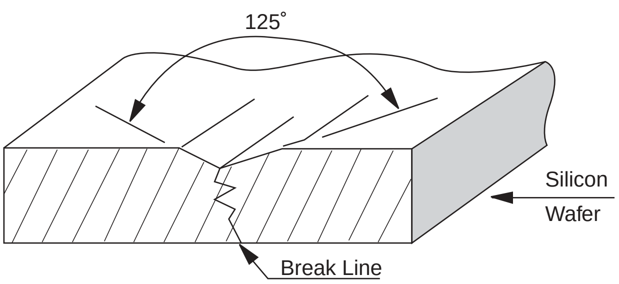


Figure 28: Diamond Scribe

Laser scribing

This technique is used mainly to separate hard alumina substrates.
In laser scribing, a laser beam moves rapidly along a street producing cone shaped perforations. The dies are then broken apart, as in diamond scribing. The edge of a laser-cut die is not smooth because the scribe-line consists of a series of holes burned out of the top of the substrate. Mechanical and cosmetic edge quality are limitations in laser scribing (Figure 2). Laser scribing is a fast technique and is being used in large-scale production where quality is not the main consideration.

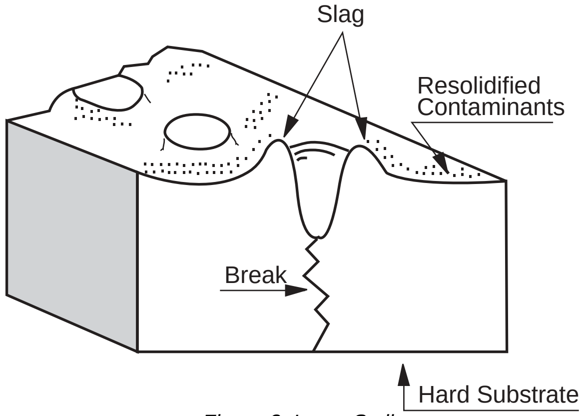


Figure 2: Laser Scribe

Diamond wheel dicing

This is the most common technique in the industry. The cut quality is higher than other techniques. Also, it is possible to keep cut width, depth, and straightness as well as edge quality under tight control (Figure 3).

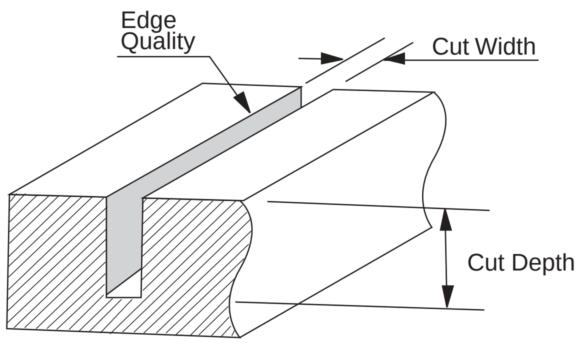


Figure 30: Dicing with Diamond Blade

Blade Basics

A diamond blade is actually a ring composed of abrasive grains (diamond particles) held together by a binder - either nickel or phenolic resin or metal-powder sintering.

Each individual diamond particle acts as a single-point tool, pushing a chip of material ahead of it. As there are many diamond particles on a blade edge, there are therefore many single-point tools pushing out the substrate and creating a kerf (Figure 4.)

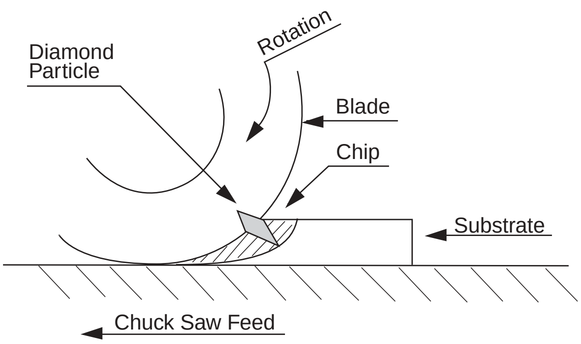


Figure 31

Blade binders

Materials used nowadays in the microelectronics industry exhibit a wide range of hardnesses, from relatively soft to extremely hard and brittle. This large variety requires a range of soft and hard blade binders.

A hard and brittle material requires a soft blade binder. A phenolic resin binder is used on those materials to archieve free cutting action, with very fine chip-free kerfs. Cutting performance is based on the binder´s ability to release dulled diamonds and expose, new sharp ones at the same time.

On softer, less brittle substrates a harder matrix is necessary. Nickel and metal sintered binders are normally used tor these applications. The nickel-type blade is a state-of-the-art electroformed product. It has a very hard nickel matrix, with diamonds distributed homogeneously through it. This bond is the key for very low wear.

Choosing the right binder is a matter of experience. See page 3 for a blade selection table; however, as each application is unique, it should de used only as a guideline. Final selection should be done only after the process has been optimized in production mode.

Diamond selection

It is important to control the quality, purity, size and reliability of the diamond particles in order to ensure superior kerf quality and long blade life. With nickel-bonded blades the best results are obtained by using well-formed, strong, blocky, single-crystal diamonds.

In resin-bonded blades friable diamond particles are used to achieve self-sharpening, free cutting action. The diamond particles are coated with a nickel alloy in order to improve the diamond-resin bond. The coating also sinks the heat generated during cutting.

Again, selecting the right diamond size for each application is a matter of experience and process optimization. See page 3 for general guidelines.

Blade and substrate cooling

Cooling of the blade and the substrate is basic and essential for any dicing application.

Following are the main basic points to be aware of:

- Alignment of the cooling nozzles with the blade and substrate.

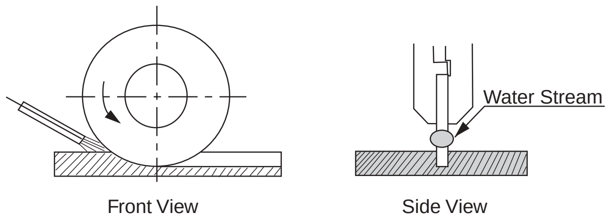


Figure 32: Front View and Side View

- Cooling pressure - consult the recommendations of the manufacturer of the saw
- The ability of the blade to cool itself. We have discussed this when mentioning blade binders, resin bond. More on this in the section about blade dressing.

Cutting heavy substrates .100 to .500 thick creates cooling and overloading problems. Nozzle alignment and coolant pressure are not the only solutions. A serrated blade is used for these applications.

The serrated blades are designed for freer cutting with less load. The slots eliminate continuous contact between blade and material, and improve cooling of both blade and substrate. Nickel serrated blades are a standard product. Resinoid serrated blades can be made on request.

Advantages and disadvantages of serrated blades

Advantages
1. Less contact between edge and substrate, which translates into less load during cutting.

2. Better cooling, due to serrations.

Disadvantages
Kerf width is not as accurate as with regular blades.

Some vibrations.

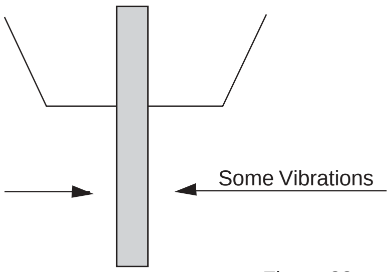


Figure 33

Another solution for cooling blades on heavy substrates is the ADT high cooling flange (Figure 10). This unique design spreads the coolant from the center of the flange to the outer edge of the blade on both of its sides. The high velocity (spindle r.p.m.) translates into high pressure on the coolant, which is forced to the bottom of the kerf.

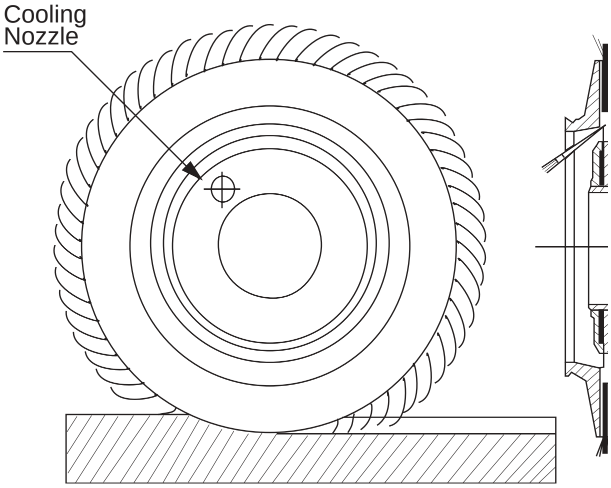


Figure 34

The high cooling flange makes a standard cooling nozzle unnecessary.

Dressing

One of the most important steps to assure accurate dicing is dressing the blade before cutting. Dressing is important for the following reasons:

- Excess binder material or loose diamond particles are machined off.
- The binder holding the diamonds is machined off, exposing the diamonds
- It trues the outside diameter runout
- It trues the blade edge geometry.
- Minimizes the load, creates a cooler and freer cut.

Dressing techniques

The best method is grinding the blade in the same flange that is being used on the saw. This will result in a perfect runout of the blade on the saw.

Grinding can be done on a cylindrical grinder (Figure 13) or on a dressing machine. The dressing wheel used is a silicon carbide type, with about 320 mesh.

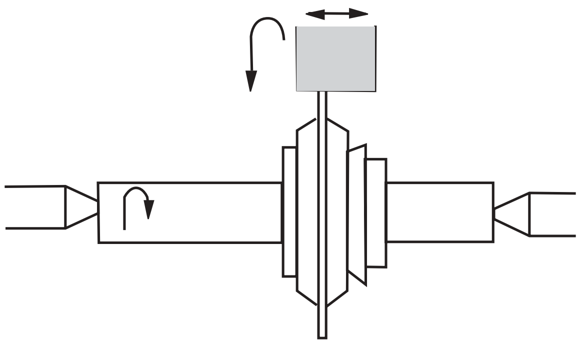


Figure 35

Our standard nickel heavy blades (over .009“ thick) are predressed. However, for a perfect runout and better performance, it is important to grind them as mentioned.

Resinoid blades require minimum dressing because of their soft binder and their ability to self-dress. For most applications, a resinoid blade may be used without special dressing requirements.

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