

**CHAPTER XIII**

**Tables of Useful Information**

**Summary of Grinding Wheel Recommendations**

**HIGH-SPEED STEEL AND CAST ALLOY MULTI-TOOTH CUTTERS:**

Milling cutters (plain, side, face, etc.):  
 Straight wheel ..... 38A46-K8VG  
 Cup wheel ..... } 32A46-K8VG or  
 Ingersoll Cutter Grinder ..... 19A46-J5VG

Form cutters (circular):  
 Dish wheel ..... 32A46-J8VG  
 Fellows Gear Shaper cutter ..... 32A80-I8VG  
 Hobs (Barber-Coleman hob grinder):  
 Sharpening, 7" wheels ..... 32A60-J8VG  
 10" wheels (large hobs) ... 19A54-J8VG

Saws (Metal Cutting):  
 Backing off ..... 32A46-K8VG

Reamers:  
 Cylindrical grinding ..... 19A54-L5VG  
 Backing-off ..... 32A46-K8VG  
 Barber-Coleman reamer sharpener ..... A80-GB11

**CARBIDE MULTI-TOOTH CUTTERS (Face Mills, End Mills, Reamers, etc.):**

*Type D11V9 (D11B) Cup Wheels (on T. & C. Grinders):*

	<i>Dry</i>	<i>Wet</i>
Roughing .....	{ SD100-R100B6 <sup>1/8</sup>	SD100-R100B <sup>1/8</sup>
	or	or
	{ SD100-R75B6 <sup>1/8</sup>	SD100-R75B6 <sup>1/8</sup>

	<i>Dry</i>	<i>Wet</i>
Finishing .....	SD180-R100B6 <sup>1/8</sup> *	SD180-R100B <sup>1/8</sup> *
Combination Roughing and Finishing .....	} SD150-R100B6 <sup>1/8</sup> *	} SD150-R100B <sup>1/8</sup> *
<i>Straight Wheels (Ingersoll M.M. 10 x 1/4 x 1"):</i>		
Roughing .....	SD100-R100B6 <sup>1/8</sup> *	
Finishing .....	SD180-R100B6 <sup>1/8</sup> *	
Combination Roughing and Finishing .....	} SD120-R100B6 <sup>1/8</sup> *	

**CARBIDE SINGLE-POINT TOOLS—Offhand Grinding:**

*Cup Wheels:*  
 Roughing (dry) ..... 39C60-18VK  
 39C60-G+8VKP  
 (10" and 14" cups)  
 Roughing (wet) ..... 39C60-J8VK  
 39C60-H8VKP  
 (10" and 14" cups)  
 SD100-P50V<sup>1/8</sup>  
 (fast cut, long life)  
 D100-N50M<sup>1/8</sup>  
 (slower cut, longest life)  
 Finishing or touching up  
 ordinary dull tools  
 (wet) ..... SD220-P50V<sup>1/8</sup>  
 (fast cut, long life)  
 D220-N50M<sup>1/8</sup>  
 (slower cut, longest life)  
 D120-N50M<sup>1/8</sup> or  
 SD150-P50V<sup>1/8</sup>  
 for large, steel-cutting tools  
 39C100-H8VK  
 for large steel-cutting roughing tools  
 Finishing (dry) ..... 39C100-H8VK  
 for large steel-cutting roughing tools

\*Optional recommendation: Same specification except 75 diamond concentration.

Combination roughing SD150-P50V<sup>1/8</sup>  
and finishing (wet) (fast cut, long life)  
D120-N50M<sup>1/8</sup>  
(slower cut, longest life)

Backing off steel shank 32A36-K5VBE  
up to carbide tip (cup wheel)

*Straight Wheels:*

Roughing (dry) ..... 39C60-I8VK  
Roughing (wet) ..... 39C60-J8VK  
Backing off steel shank A24-N5VBE  
up to carbide tip

**CARBIDE SINGLE-POINT TOOLS—Machine Grinding:**

*Cup Wheels:*

Roughing (wet) ..... SD100-L100V<sup>1/8</sup> or  
39C60-I8VK  
Finishing (wet) ..... SD220-L100V<sup>1/8</sup>  
Heald Tool Sharpener SD320-L50B<sup>1/8</sup>  
(boring tools)

**CHIP BREAKER GRINDING:**

*Straight Wheels:*

Wheels 1/4" thick ..... SD150 or SD220-N100V<sup>1/8</sup>  
Wheels thinner than 1/4" SD150-R100B11<sup>1/8</sup>

**HIGH-SPEED STEEL AND CAST ALLOY  
SINGLE-POINT TOOLS—Offhand Grinding:**

Bench and pedestal grinders (coarse) . 44A36-NVBE  
Bench and pedestal grinders (fine) .... 44A60-MVBE

*Wet tool grinders:*

Up to 20" wheels ..... 19A36-O5VG  
24" and larger ..... } A24-PS silicate  
or 44A24-MVBE

*Machine grinding:*

15" diameter wheels ..... 44A36-LVBE

24" diameter wheels ..... 44A24-MVBE

*Cup or cylinder wheels:*

Gisholt ..... 44A24-LVBE

**MISCELLANEOUS HIGH-SPEED STEEL  
GRINDING OPERATIONS:**

*Drills:*

*Sharpening (drill grinders):*

Drills 1/4" to 1" ..... 19A60-L5VC  
Numbered sizes ..... A100-I8VC  
Point thinning ..... A60-N5VC

*Cutting-off:*

Dry\* ..... A60-M8B2  
Wet ..... A60-POR30

*Taps:*

*Sharpening (tap grinders):*

Bench type (small taps) ..... 32A60-K8VC  
Pedestal type (large taps) ..... 19A46-L5VC

*Touching up flutes:*

Large taps ..... 32A60-K8VC  
Small taps ..... A60-POR30

Cutting-off ends ..... A60-N4E

*Broaches:*

*Sharpening (face grinding):*

Dish wheel ..... 32A60-K8VC

*Backing-off:*

Cup wheel ..... 32A46-K8VC

*Thread Chasers:*

*Milled and tapped chasers:*

On chaser grinder fixtures:  
Chamfer or throat ..... 32A80-K8VC  
Cutting face ..... 32A60-J8VC

\*Use 1/32" thick for 6" diameter or smaller wheel.

On Geometric chaser grinders:

9" Straight wheel .....	38A46-K8VG
9" Straight wheel (Model 1G only) ..	A60-K4E
9" Dish wheel .....	38A60-J8VG

Tangent chasers:

On chaser grinder fixtures:

Straight wheel .....	32A60-J8VG
Cup wheel { flaring .....	32A46-J8VG
{ straight .....	32A46-J8VG

On Landis chaser grinders:

Straight wheel .....	32A60-M7VG
Cup wheel .....	32A46-L7VG

Circular chasers:

Straight wheel .....	32A46-K8VG
Cup wheel .....	32A46-K8VG
Dish wheel .....	32A46-J8VG

*Dies:*

Surface grinding—hardened dies:

Straight wheel (dry) .....	{ 32A46-H8VG or 32A60-F12VBEP
Straight wheel (wet, fast traverse) ....	32A46-I8VG
Cup wheel (wet) .....	32A46-G8VG

Surface grinding—annealed dies:

Straight wheel (dry) .....	32A46-I8VG
Cup wheel (wet) .....	32A36-I8VG
Cylindrical grinding (wet) .....	19A60-L5VG

Internal grinding (wet) .....

32A60-K8VG

Offhand grinding:

Straight wheels (coarse) .....	44A46-OVBE
Mounted wheels (coarse) .....	38A60-MV
Mounted wheels (medium) .....	38A90-MV
Mounted wheels (fine) .....	38A120-MV

**MISCELLANEOUS TOOL ROOM GRINDING OPERATIONS:**

*Cylindrical Grinding:*

High-speed steel .....	32A60-K8VG
Hardened steel .....	19A60-L5VG
Soft steel .....	44A54-LVBE
Stainless steel (No. 300 series) .....	37C46-MVK
Cast iron, brass, aluminum .....	37C36-KVK
General purpose wheel .....	44A54-KVBE

*Surface Grinding:*

Reciprocating table (straight wheel):

High-speed steel .....	{ 32A46-H8VG or 32A60-F12VBEP
Hardened steel .....	32A46-I8VG
Soft steel .....	19A46-J5VG
Cast iron and bronze (soft) .....	37C36-JVK

*Internal Grinding:*

HSS and hardened steel .....	32A60-K8VG
Soft steel .....	32A60-L7VG
Cast iron and bronze (soft) .....	{ 37C46-J5V or 37C46-JVK

*Cutting-off Tool Bit Stock, Drills, etc.:*

Cooler-cutting but shorter life* .....	A60-N4E
Most durable wheels** .....	A60-M8B2

**MISCELLANEOUS CARBIDE GRINDING OPERATIONS:**

*Cylindrical Grinding:*

Roughing (wet) .....	SD100-N100B $\frac{1}{16}$ or SD100-L100V $\frac{1}{8}$ or (up to 10" diameter) or 39C60-J8VK
Finishing (wet) .....	SD150 to SD400-N100B $\frac{1}{16}$ , depend- ing upon finish desired

\*Use  $\frac{1}{16}$ " thick wheels for diameters 6" and less.

\*\*Use  $\frac{1}{16}$ " thick wheels for 7" diameter and larger.

**SURFACE GRINDING**

*Straight Wheels:*

Roughing (wet) ..... SD100-R100B $\frac{1}{8}$  or  
SD120-L100V $\frac{1}{8}$   
(up to 10" diameter) or  
39C60-I8VK

Finishing (wet) ..... SD180 to SD400S-R100B $\frac{1}{8}$   
(depending upon finish desired) or  
SD180 to SD400-L100V $\frac{1}{8}$   
(up to 10" diameter)

**INTERNAL GRINDING**

SD100 to SD400S-L100B  
(depending upon finish desired) or  
SD100 to SD400S-L100V  
(depending upon finish desired)  
Both types available molded on steel  
spindles in smaller sizes

**CUTTING OFF AND GROOVING**

See diamond wheel cata- D100S, D120 or D150-R100B $\frac{1}{8}$  (or  
log, form 1233, for stand-  $\frac{1}{4}$ ) for fast cutting; N100M $\frac{1}{8}$  for  
ard diameters and thick- slower cut and long life  
nesses

**FLAT FORM TOOLS**

*Thin Straight and Dish Wheels (on Optical Form Tool Grinders):*

Roughing (dry) ..... SD100-R100B6 $\frac{1}{8}$  or SD100-R75B6 $\frac{1}{8}$   
Finishing (dry) ..... SD220-R100B6 $\frac{1}{8}$  or SD220-R75B6 $\frac{1}{8}$

*Straight Wheels (on Surface Grinders):*

Sharpening ..... SD220-N100B $\frac{1}{8}$  or  
SD320-N100V $\frac{1}{8}$

**CIRCULAR FORM CUTTERS**

*Flaring Cup or Dish Wheels:*

Sharpening ..... SD150-N100B $\frac{1}{8}$  wet  
SD150-N100B6 $\frac{1}{8}$  }  
or } dry  
SD150-N75B6 $\frac{1}{8}$  }

**SCRAPERS**

*Cup Wheels:*

Sharpening ..... SD320-R50V $\frac{1}{8}$

**MASONRY DRILLS**

*Straight or Cup Wheels:*

Reconditioning and  
Sharpening ..... 39C80-I8VK or  
D120-N50M $\frac{1}{8}$  (or any other grit size  
or bond type of diamond wheel that  
is used for sharpening carbide single-  
point tools)

**LAMINATION DIES**

*Straight Wheels:*

Sharpening ..... SD220-N100B $\frac{1}{8}$  or  
SD320-L100V $\frac{1}{8}$

**CENTERLESS GRINDER WORK REST BLADES**

*Straight Wheels:*

Regrinding ..... SD220-N100B $\frac{1}{8}$  or  
SD320-L100V $\frac{1}{8}$

**HAND HONING OR STONING**

*Diamond Hand Hones:*

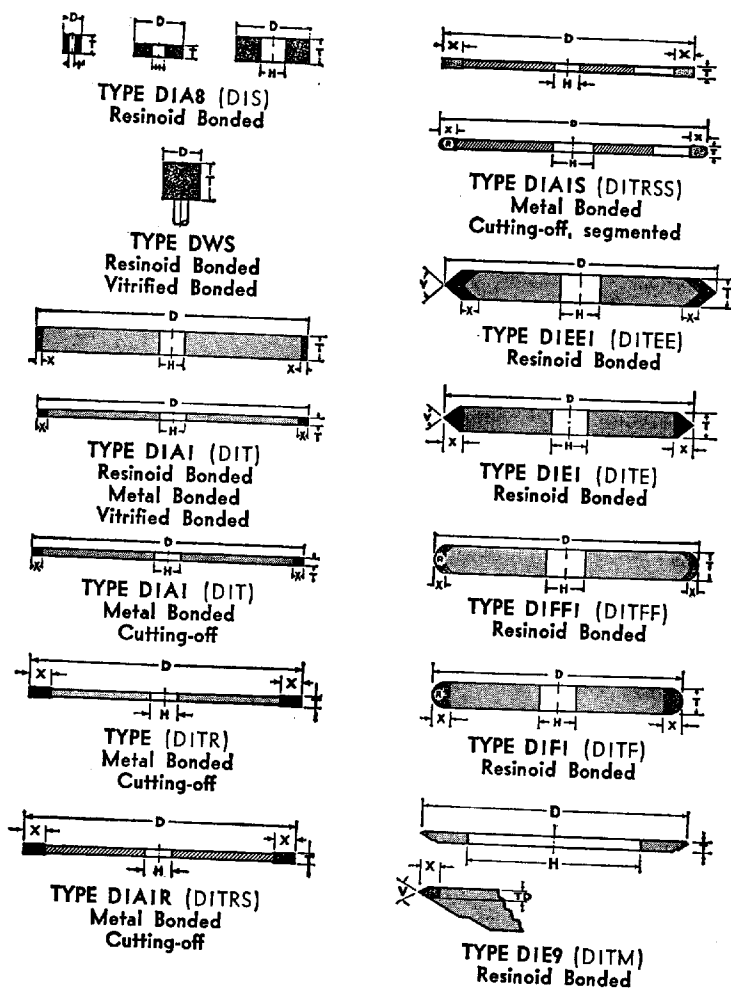
Popular Size: ..... D320-V $\frac{1}{8}$  (type DH1)  
 $\frac{1}{4}$  x  $\frac{1}{8}$  x 4" D320/400-V $\frac{1}{8}$  (type DH2)

*Crystolon Stones:*

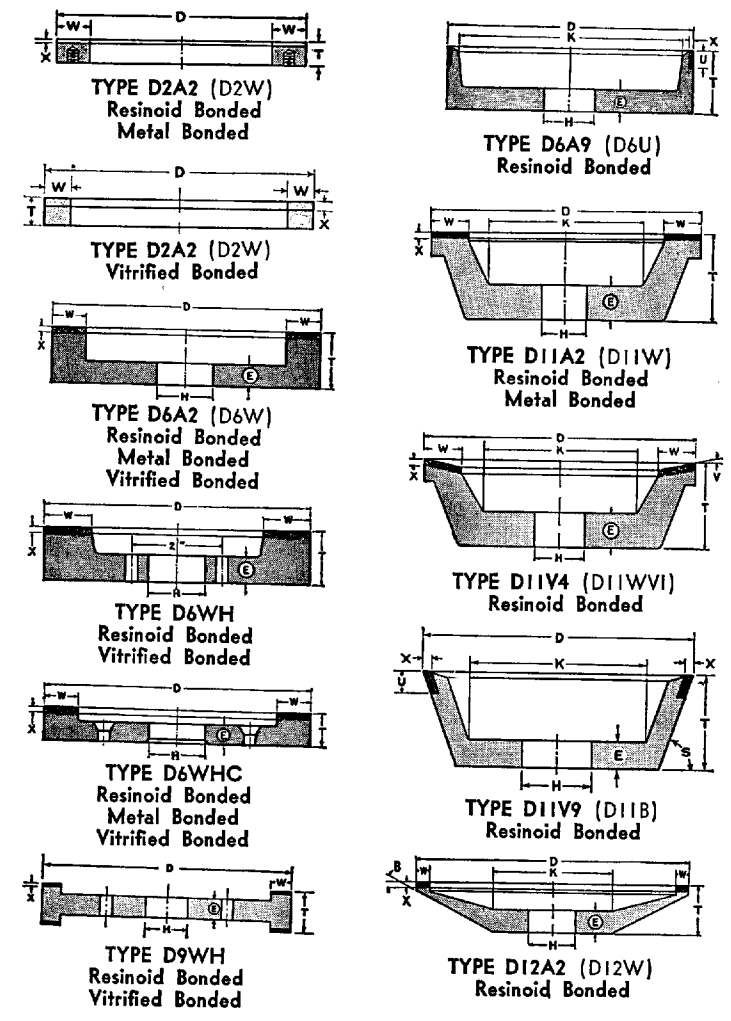
Popular Size: ..... 37C280-NV  
 $\frac{1}{4}$  x  $\frac{3}{4}$  x 4"

These recommendations may be used as a general guide in selecting  
wheels, but conditions surrounding the operation must be considered  
and may cause some modification of grit size or grade.

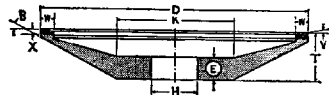
**Standard Shapes of Diamond Wheels**



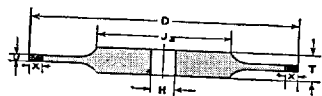
**Standard Shapes (continued)**



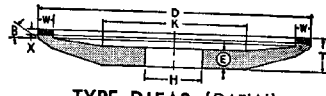
Standard Shapes (continued)



TYPE D12V4 (D12WV1)  
Resinoid Bonded



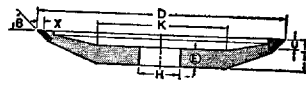
TYPE D14A1 (D14U)  
Resinoid Bonded



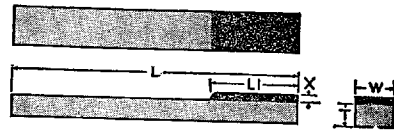
TYPE D15A2 (D15W)  
Resinoid Bonded



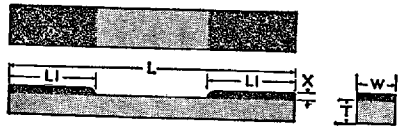
TYPE D15V4 (D15WV1)  
Resinoid Bonded



TYPE D15V9 (D15B)  
Resinoid Bonded



TYPE DH1  
Resinoid Bonded  
Vitrified Bonded



TYPE DH2  
Resinoid Bonded  
Vitrified Bonded

Available and Standard Grades  
of Norton Diamond Wheels

RESINOID BONDED (B) { Specify **B6** for dry grinding:  
**B** for wet grinding.

Type of Wheel		Grade*
D1A8 (D1S)	Solid to Hole . . . . .	H J L <b>N</b> R
DWS	Solid—Mounted . . . . .	H J L <b>N</b> R
D1A1 (D1T)	Straight . . . . .	J L <b>N</b> R
D1EE1 (D1TEE)	"E" Face (V Form) . . . . .	J L <b>N</b> R
D1E1 (D1TE)	"E" Face . . . . .	J L <b>N</b> R
D1FF1 (D1TFF)	"F" Face (U Form) . . . . .	J L <b>N</b> R
D1F1 (D1TF)	"F" Face . . . . .	J L <b>N</b> R
D1E9 (D1TM)	Thread Grinding . . . . .	J L <b>N</b> R
D2A2T (D2W)	Cylinder . . . . .	J L <b>N</b> R
D6A2 (D6W)	{ 3 to 4" Diameter . . . . . H J L <b>N</b> R 5" through 14" Diameter . . . . . J L <b>N</b> R	
D6A2H (D6WH)		
D6A2C (D6WHC)		
D11A2 (D11W)	{ 3", 3 1/2", 4" and . . . . . H J L <b>N</b> R 5" Diameter Flaring Cup . . . . . H J L <b>N</b> R	
D11V4 (D11WVI)	Same—Rim Bevel inside . . . . .	H J L <b>N</b> R
D11V9 (D11B)	Special Flaring Cup . . . . .	H J L <b>N</b> R
D12A2 (D12W)	Dish . . . . .	H J L <b>N</b> R
D12V4 (D12WVI)	Dish—Rim Bevel inside . . . . .	H J L <b>N</b> R
D15V9 (D15B)	6" and 8" Special Dish . . . . .	H J L <b>N</b> R
D15A2 (D15W)	{ 1/8", 3/16", 1/4" and . . . . . H J L <b>N</b> R 3/8" Rim—Special Dish . . . . . H J L <b>N</b> R	
D15V4 (D15WVI)	Same—Rim Bevel inside . . . . .	H J L <b>N</b> R

\*Grade letters in heavy type are standard. Where shape and size of wheel is such that a narrow grinding contact is presented to the work or where it is important to hold the corners or special face on the wheel, one of the harder available grades can often be used to advantage. Examples are thin DIT wheels used for chip breaker grinding, DITE (or D1TEE) and D1TM.

**METAL BONDED (M)**

	<i>Type of Wheel</i>		<i>Grade*</i>
Steel Centered Cut-Off	.....		<b>L N</b>
All Others	.....		<b>N</b>

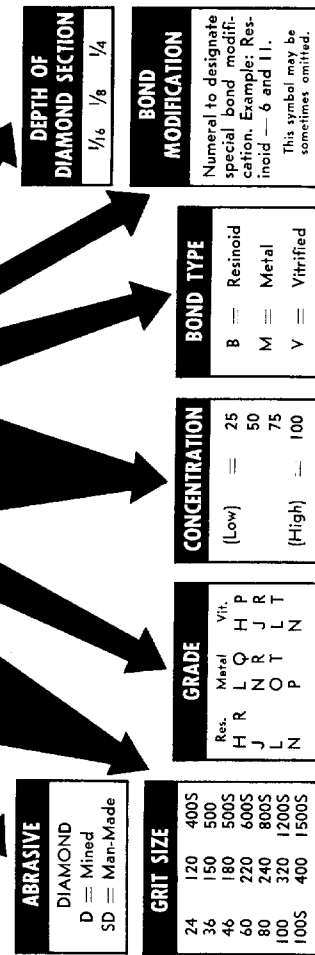
**VITRIFIED BONDED (V)**

	<i>Type of Wheel</i>		<i>Grade*</i>
<b>D1A1 (D1T)</b> —Straight			
All Grit Sizes through 500S	.....	<b>J L N P R T</b>	
<b>D6A2 (D6W), D6A2H (D6WH), D6A2C (D6WHC)</b>			
—Straight Cups			
All Grit Sizes through 500S	.....	<b>J L N P R T</b>	
<b>D11A2 (D11W)</b> —Flaring Cup			
Grit Sizes 100S through 500S	.....	<b>J L N P R T</b>	

\*Grade letters in heavy type are standard.

**Analysis of Typical Norton Diamond Wheel Specification**

**D100-N100B 1/8 \***



NOTE: No grade is shown for Hand Hones.  
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\* Manufacturer's Identification Symbol

### *Explanation of Marking Symbols*

The chart on the preceding page graphically illustrates the method of marking NORTON diamond wheels.

This marking system follows the general pattern of the standard marking for grinding wheels, and in the interests of standardization, it has been adopted by some of the other manufacturers of diamond wheels.

There are eight positions in the marking describing the following characteristics—

Position 1—Letter D denoting Mined Diamond or  
SD denoting Man-Made Diamond

Position 2—Grit Size

Position 3—Grade

Position 4—Diamond Concentration

Position 5—Bond

\*Position 6—Bond Modification

Position 7—Depth of Diamond Section

Position 8—Manufacturer's Identification Symbol

### *Grade Letter*

Norton diamond wheels are now made in different grades of hardness. These grades are designated in the proper position by grade letters the same as other NORTON grinding wheels. The letters of the alphabet designate progressively harder grades. See list of available and standard grades on pages 195 and 196.

\*NOTE: This symbol may sometimes be omitted.

### *Norbide Abrasive for Carbide Lapping*

For lapping cemented carbide tools, a special boron carbide abrasive, trade-marked "Norbide," has been developed by Norton Company for use in place of costly diamond powders. It is available in a variety of standard grit and flour sizes, ranging as fine as #600, and has proved extremely effective for lapping carbide dies and cutting tools.\*



\*A descriptive folder, Form 559, will be mailed upon request.



**Relief Tables for High-Speed Steel Cutters**  
**I—Using Straight Wheels**

C = Distance in inches to set center of cutter and tip of tooth rest below (or above) center of wheel when grinding with a straight wheel.

Wheel Diameter (Inches)	C for 4° Relief Angle	C for 5° Relief Angle	C for 6° Relief Angle	C for 7° Relief Angle
3	.104	.131	.157	.183
3 1/4	.113	.141	.170	.198
3 1/2	.122	.152	.183	.213
3 3/4	.131	.163	.196	.227
4	.139	.174	.209	.242
4 1/4	.150	.185	.222	.259
4 1/2	.157	.195	.235	.274
4 3/4	.165	.207	.248	.289
5	.174	.218	.261	.305
5 1/4	.183	.228	.274	.319
5 1/2	.191	.239	.287	.335
5 3/4	.200	.250	.300	.350
6	.209	.261	.313	.365
6 1/4	.218	.272	.326	.381
6 1/2	.226	.283	.339	.396
6 3/4	.235	.294	.352	.411
7	.244	.305	.365	.426

**II—Using Cup Wheels**

C = Distance in inches to set tip of tooth rest below or above center of cutter when grinding the peripheral teeth of cutters with a cup wheel.

Cutter Diameter (Inches)	C for 4° Relief Angle	C for 5° Relief Angle	C for 6° Relief Angle	C for 7° Relief Angle
1/2	.017	.022	.026	.031
3/4	.026	.033	.040	.046
1	.035	.044	.053	.061
1 1/4	.044	.055	.066	.077
1 1/2	.052	.066	.079	.092
1 3/4	.061	.076	.092	.108
2	.070	.087	.105	.123
2 1/2	.087	.109	.131	.153
2 3/4	.096	.120	.144	.168
3	.104	.131	.158	.184
3 1/2	.122	.153	.184	.215
4	.139	.174	.210	.245
4 1/2	.157	.197	.237	.276
5	.174	.219	.263	.307
5 1/2	.192	.241	.289	.338
6	.207	.262	.315	.368

**Basic Angles for H & G Insert Chasers  
Recommended by  
The Eastern Machine Screw Corp.**

	Face Grind (Hook Angles) for Chasers		
	Chamfer Grind	All series 000 and 00, and dia. $\frac{1}{8}$ " and less for 101, 102, 103 die heads	All dia. above $\frac{1}{8}$ " for 101, 102, 103 heavy duty die heads
Carbon steels—S.A.E. 1010 to 1050.....	20°	10°	15°
Carbon steels—S.A.E. 1090.....	15°	10°	15°
Screw stock—S.A.E. 1112, 1120, 1330.....	20°	10°	15°
Ni steels—S.A.E. 2315, 2330.....	20°	10°	15°
Ni Cr steels—S.A.E. 3120, 3135.....	20°	10°	15°
Cr V steel—S.A.E. 6150.....	15°	10°	15°
Brass rod.....	30°	5°	10°
Brass, cast.....	30°	0°-5°	5°-10°
Brass, drawn tube.....	30°	10°	15°
Bronze.....	30°	10°	15°
Copper.....	30°	10°	15°
Fibre.....	30°	0°	5°
Aluminum.....	30°	10°	15°
Dural forgings.....	20°	5°-10°	10°-15°
Rubber, hard.....	30°	5°	10°
Steel tubing.....	20°	10°	15°
Tool steel.....	15°	10°	15°
Cast iron.....	30°	5°-10°	10°-15°
Malleable iron.....	30°	0°-10°	0°-15°
Stainless steel.....	20°	10°	15°

30° Chamfer = one thread; 20° Chamfer = 2 threads;  
15° Chamfer = 3 threads.

**H & G (Tapped) Chasers—Basic Angles  
Recommended by  
The Eastern Machine Screw Corp.**

Material	Face Grind*	Chamfer
Aluminum.....	15°	20°
Brass, cast.....	5°	30°
Brass, rod.....	5°	30°
Brass, drawn.....	10°	30°
Bronze.....	10°	30°
Copper.....	15°	30°
Drop forging.....	5°	20°
Fibre.....	Straight	30°
Cast iron.....	5°	30°
Malleable iron.....	5°	30°
Monel metal.....	15°	20°
Rubber, hard.....	Straight	30°
Machinery steel.....	10°	20°
Tool steel.....	15°	15°
Bessemer screw stock.....	10°	20°
Carbon steels—S.A.E. 1010 to 1025.....	10°	30°
Carbon steels—S.A.E. 1045.....	15°	20°
Carbon steels—S.A.E. 1050 and 1095.....	15°	15°
Ni steels—S.A.E. 2315 and 2330.....	15°	20°
Ni Cr steel—S.A.E. 3120.....	10°	20°
Ni Cr steel—S.A.E. 3135.....	15°	20°
Cr steel—S.A.E. 5120.....	15°	20°
Cr V steel—S.A.E. 6150.....	15°	20°

30° chamfer = one and one-half thread.

20° chamfer = two thread.

15° chamfer = three thread.

\*Hook angles given are for cutting edges approximately 1/10 of the diameter ahead of center. If further ahead, less hook may be used. If below 1/10, hook should be gradually increased.

*Tap and Die Chasers—Cutting Face Angles*

Material	Chasers for Die Heads
	Milled
Aluminum and aluminum alloys.....	7° hook
Brass, cast.....	7° snub
Brass, bar.....	4° hook
Brass forging and stamping.....	7° hook
Brass tubing.....	4° hook
Bronze, cast.....	Straight
Copper.....	10° lip hook
Fibre.....	7° snub
Cast iron.....	Straight
Malleable iron.....	7° hook*
Monel metal.....	7° hook
Rubber.....	7° snub
Bessemer and open hearth screw stock.....	7° hook*
Drawn steel tubing.....	7° hook*
Steel forgings.....	7° hook*
Carbon steels—S.A.E. 1010 to 1095.....	7° hook*
Ni steels—S.A.E. 2315 to 2350 and 2512.....	7° hook*
Ni Cr steels—S.A.E. 3115 to 3450.....	7° hook*
Cr steels—S.A.E. 5120 to 52100.....	7° hook*
Cr V steels—S.A.E. 6120 to 6195.....	7° hook*
Tool steel.....	7° hook*
Stainless iron and steel.....	Lip hook
Iron and steel pipe—Taper threads.....	4° hook*
Iron and steel pipe—Straight threads.....	7° hook*

*Recommended by Modern Tool Works*

Chasers for Die Heads	Chasers for Taps	
	Hobbed	Straight Thread
10° hook	10° hook	10° hook
7° snub	5° hook	5° hook
4° hook	5° hook	5° hook
10° hook	10° hook	10° hook
4° hook	5° hook	5° hook
Straight	5° hook	5° hook
15° lip hook	Radial hook	Radial hook
7° snub	5° hook	5° hook
Straight	5° hook	5° hook
10° hook*	10° hook	10° hook
10° hook	10° hook	10° hook
7° snub	5° hook	5° hook
10° hook*	10° hook	10° hook
10° hook*	Lip hook	Radial hook
10° hook*	Lip hook	Radial hook
10° hook*	10° hook	10° hook
10° hook*	Lip hook	Radial hook
10° hook*	Lip hook	Radial hook
10° hook*	Lip hook	Radial hook
10° hook*	Lip hook	Radial hook
10° hook*	10° hook	10° hook
Lip hook	Lip hook	Radial hook
4° hook*	.....	Radial hook
10° hook*	Lip hook	.....

Where "radial hook" and "lip hook" are specified, each equals 15°.

*Use lip hook when cutting:*

In Die Head	Diameter Incl.	Pitch
1/2" T and 3/16" W	1/4" to 3/16"	24 and coarser
1/2" T and 9/16" W	1/2" to 9/16"	16 and coarser
3/4" T and W	5/8" to 3/4"	14 and coarser

*Tap and Die Chasers—Cutting Face Angles*

Material	Chasers for Die Heads
	Milled*
Aluminum, cast.....	10° radial hook
Bakelite.....	7° snub
Brass, bar.....	4° hook
Brass, cast.....	7° snub
Brass forging and stamping.....	7° hook
Brass tubing.....	7° hook
Bronze, cast.....	7° hook
Copper.....	Straight
Fibre.....	12° radial lip hook
Cast iron.....	7° snub
Malleable iron.....	Straight
Monel metal.....	7° hook
Rubber.....	7° hook
Bessemer screw stock.....	7° snub
Steel, cast.....	7° hook
Steel forgings.....	7° hook
Steel tubing.....	10° hook
Carbon steels—S.A.E. 1010 to 1035.....	7° hook
Carbon steels—S.A.E. 1112 to X1340.....	7° hook
Carbon steels—S.A.E. 1040 to 1095.....	7° hook
Cr steels—S.A.E. 5120 to 52100.....	10° hook
Cr V steels—S.A.E. 6115 to 6195.....	10° hook
Ni steels—S.A.E. 2015 to 2515.....	10° hook
Ni Cr steels—S.A.E. 3115 to 3450.....	10° hook
Stainless steel (stringy).....	12° lip hook
Tool steel.....	10° hook
Zinc—die casting.....	10° radial hook

\*For Straight thread only; for Taper thread, use chaser manufacturer's recommendations.

*Recommended by Geometric Tool Co., Div. Greenfield Tap and Die Corp.*

Chasers for Die Heads	Chasers for Taps	
	Tapped*	Straight Thread
15° radial hook	20° radial hook	20° radial hook
7° snub	5° hook	5° hook
4° hook	10° hook	10° hook
7° snub	5° hook	5° hook
10° hook	10° hook	10° hook
10° hook	10° hook	10° hook
Straight	5° hook	5° hook
15° radial lip hook	20° lip hook	20° radial hook
7° snub	5° hook	20° radial hook
Straight	5° hook	5° hook
10° hook	10° hook	10° hook
10° hook	10° hook	10° hook
7° snub	5° hook	5° hook
10° hook	10° hook	10° hook
10° hook	10° hook	10° hook
15° hook	20° lip hook	15° radial hook
10° hook	20° lip hook	15° radial hook
10° hook	10° hook	10° hook
10° hook	10° hook	10° hook
15° hook	20° lip hook	15° radial hook
15° hook	20° lip hook	15° radial hook
15° hook	20° lip hook	15° radial hook
15° hook	20° lip hook	15° radial hook
15° lip hook	20° lip hook	20° radial hook
15° hook	20° lip hook	15° radial hook
15° radial hook	20° lip hook	20° radial hook

**Tangential Chasers—Basic Rake Angles  
Recommended by Landis Machine Company**

Material	Rake Angle
Aluminum, cast.....	10°
Aluminum, drawn.....	25°
Bakelite.....	0°
Brass, cast.....	5° negative to 0°
Brass, drawn.....	10° to 22°
Bronze.....	10°
Bronze, manganese.....	0° to 10°
Copper.....	28°
Cast iron.....	15°
Malleable iron.....	18°
Monel metal.....	25°
Mild steel.....	22°
Seamless steel tubing.....	25°
Annealed nickel steel.....	25°
Heat treated nickel steel.....	18° to 22°

**Tangential Chasers—Top Rake Angles Recommended  
by Jones and Lamson Machine Company**

Material	Top Rake
Aluminum, rod, bar, die cast.....	20° to 30°
Brass, cast.....	0° to 5°
Brass, free machining.....	0° to 10°
Bronze, manganese.....	0° to 10°
Copper.....	30° to 35°
Cast iron.....	15° to 25°
Monel metal.....	25° to 30°
Steel, cast.....	25°
Steel, alloy.....	25° to 30°
Steel, stainless 416, 430F.....	25°
303, 410, 420F, 440F.....	25° to 30°
302, 304, 321.....	30°

**Helix Tangent Chasers—Cutting Face Angles  
Recommended by The Geometric Tool Company,  
Div. Greenfield Tap and Die Corp.**

Material	Hook, or Lip Hook Angle
Aluminum, cast.....	26°
Bakelite.....	4°
Brass, cast.....	15°
Brass, bar.....	15°
Bronze, cast.....	11°
Bronze, manganese.....	21°
Copper.....	26°
Cast iron.....	11°
Malleable iron.....	21°
Monel metal.....	21°
Rubber.....	4°
Steel.....	21°
Alloy steels.....	26°

For threads 19 and coarser, lip hook must include one full tooth beyond chamfer. For threads 20 and finer, lip hook must include two full teeth beyond chamfer.

*Non-Helix "Circometric" (Circular) Chasers—Angles Recommended by The Geometric Tool Company Div. Greenfield Tap and Die Corp.*

Material	Hook Angle	Chip Clearance Angle*
Aluminum, cast	26°	5°
Bakelite	4°	5°
Brass, cast	4°	5°
Brass tubing	21°	5°
Bronze, cast	11°	5°
Copper	26°	5°
Cast iron	11°	5°
Fibre	4°	5°
Malleable iron	21°	5°
Monel metal	21°	5°
Rubber	4°	5°
Bessemer screw stock	21°	5°
Carbon steels	21°	5°
Alloy steels	26°	5°
Cast steel	21°	5°
Stainless steel (stringy)	26°	5°
Steel tubing	21°	5°
Tool steel	26°	5°
Zinc-die casting	26°	5°

On straight thread chasers the cutting face is straight; on taper thread chasers the cutting face has a lead control angle which usually is equal to the helix angle of the thread to be cut.

The angles specified above are approximate and due to various conditions may have to be changed slightly to obtain best result.

\*On  $\frac{1}{8}$ " chasers, capacity  $\frac{3}{16}$ " to  $\frac{7}{16}$ ", the chip clearance angle is straight or 0°.

*Circular Chasers—Angles Recommended by The National Acme Company*

Material	Face Angle "B"	Hook Angle "C"	Chip Clearance Angle "D"
Aluminum	2°	20°	12°
Brass, cast	1° 30'	5° neg.	12°
Brass tubing	1°	5°	12°
Bronze	1° 30'	20°	12°
Copper	2°	20°	12°
Cast iron	2°	10°	12°
Fibre	2°	5° neg.	12°
Malleable iron	1° 30'	10°	12°
Monel metal	1° 30'	20°	12°
Taper pipe	0°	20°	12°
Rubber	2° 30'	0°	12°
Alloy steels	1° 30'	20°	12°
Tool steel	1°	20°	12°
Steel tubing	1° 30'	20°	12°
Bessemer screw stock	1° 30'	20°	12°

The above angles should be considered as approximate only. They are based on average conditions and will vary with the machineability of the material, the condition of the machine, the cutting speeds and the kind of lubricant used as well as with the length of throat allowed. For example, a smaller face angle should be used with high cutting speeds and vice versa.

**Types of Cutting Face Grinds on Milled and Tapped Die Head Chasers and Tap Chasers**

*Die Head Chasers:*

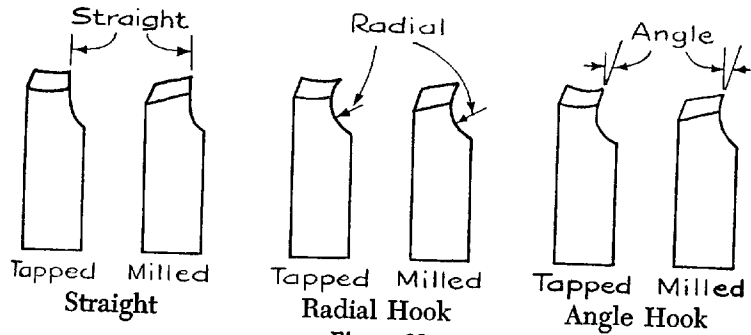


Figure 29

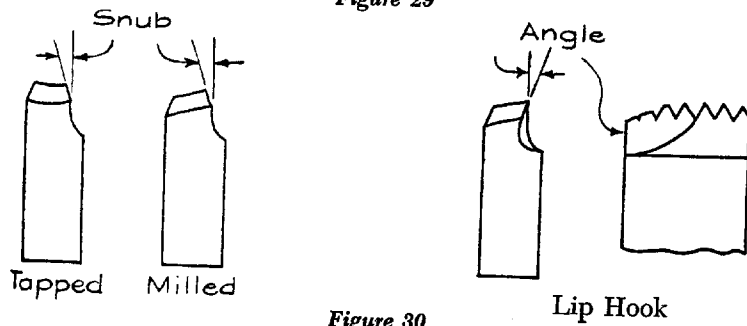


Figure 30

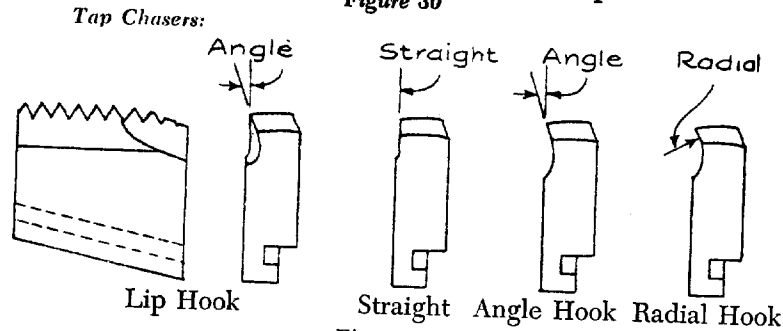


Figure 31

(Courtesy of The Geometric Tool Co.)

**Table of Grinding Wheel Speeds**

To find the number of revolutions of the wheel spindle, having been given the surface or peripheral speed and the diameter of the wheel, divide the surface speed in feet per minute by the circumference (diameter x 3.14) in feet.

To find the surface speed of a wheel in feet per minute, multiply the circumference in feet by the revolutions per minute.

Diam. of Wheel in Inches	Mm (Approx.)	Peripheral Speed in Feet per Minute					
		4000 Ft	4600 Ft	5000 Ft	5500 Ft	6000 Ft	6500 Ft
		1200 M	1350 M	1500 M	1650 M	1800 M	1950 M
Revolutions per Minute							
1/4	6	61,116	68,756	76,392	84,032	91,672	99,212
3/8	9	40,744	46,594	50,928	56,021	61,115	66,141
1/2	13	30,558	34,378	38,196	42,016	45,836	49,656
5/8	16	24,446	27,502	30,557	33,615	36,669	39,685
3/4	19	20,372	22,918	25,464	28,011	30,557	33,071
7/8	22	17,462	21,826	21,826	24,009	26,192	28,346
1	25	15,279	17,189	19,098	21,008	22,918	24,828
2	50	7,639	8,594	9,549	10,504	11,459	12,414
3	75	5,093	5,729	6,366	7,003	7,639	8,276
4	100	3,820	4,297	4,775	5,252	5,729	6,207
5	125	3,056	3,438	3,820	4,202	4,584	4,966
6	150	2,546	2,865	3,183	3,501	3,820	4,138
7	175	2,183	2,455	2,728	3,001	3,274	3,547
8	200	1,910	2,148	2,387	2,626	2,865	3,103
10	250	1,528	1,719	1,910	2,101	2,292	2,483
12	305	1,273	1,432	1,591	1,751	1,910	2,069
14	355	1,091	1,228	1,364	1,500	1,637	1,773
16	405	955	1,074	1,194	1,313	1,432	1,552
18	455	849	955	1,061	1,167	1,273	1,379
20	505	764	859	955	1,050	1,146	1,241
22	560	694	781	868	955	1,042	1,128
24	610	637	716	796	875	955	1,034
26	660	588	661	734	808	881	955
28	710	546	614	682	750	818	887
30	760	509	573	637	700	764	828
32	810	477	537	597	656	716	776
34	860	449	505	562	618	674	730
36	910	424	477	530	583	637	690

*Comparative Brinell, Rockwell and*

Vickers or Firth Diamond Hardness Number	Brinell		Rockwell Hardness		Shore Hardness	Tensile Strength 1000 lbs./ sq. in.
	Diameter of Impression for 3000 kg. Load and 10 mm. Ball	Hardness Number	C Scale 150 kg., 120° Diamond Cone	B Scale 100 kg., $\frac{1}{16}$ " Ball		
	MM.					
1220	2.20	780	68	...	96	...
1114	2.25	745	67	...	94	...
1021	2.30	712	65	...	92	354
940	2.35	682	63	...	89	341
867	2.40	653	62	...	86	329
803	2.45	627	60	...	84	317
746	2.50	601	58	...	81	305
694	2.55	578	56	...	78	295
649	2.60	555	55	...	75	284
608	2.65	534	53	...	73	273
587	2.70	514	51	...	71	263
551	2.75	495	50	...	68	253
534	2.80	477	48	...	66	242
502	2.85	461	47	...	64	233
474	2.90	444	46	...	62	221
460	2.95	429	44	...	60	211
435	3.00	415	43	...	58	202
423	3.05	401	42	...	56	193
401	3.10	388	41	...	54	185
390	3.15	375	39	...	52	178
380	3.20	363	38	...	51	171
361	3.25	352	37	...	49	165
344	3.30	341	36	...	48	159
335	3.35	331	35	...	46	154
320	3.40	321	34	...	45	148

By courtesy of the International Nickel Co.

*Scleroscope Hardness Table*

Vickers or Firth Diamond Hardness Number	Brinell		Rockwell Hardness		Shore Hardness	Tensile Strength 1000 lbs./ sq. in.
	Diameter of Impression for 3000 kg. Load and 10 mm. Ball	Hardness Number	C Scale 150 kg., 120° Diamond Cone	B Scale 100 kg., $\frac{1}{16}$ " Ball		
312	3.45	311	32	...	43	143
305	3.50	302	31	...	42	139
291	3.55	293	30	...	41	135
285	3.60	285	29	...	40	131
278	3.65	277	28	...	38	127
272	3.70	269	27	...	37	124
261	3.75	262	26	...	36	121
255	3.80	255	25	...	35	117
250	3.85	248	24	100	34	115
240	3.90	241	23	99	33	112
235	3.95	235	22	99	32	109
226	4.00	229	21	98	32	107
221	4.05	223	20	97	31	105
217	4.10	217	18	96	30	103
213	4.15	212	17	95	30	100
209	4.20	207	16	95	29	98
197	4.30	197	14	93	28	95
186	4.40	187	12	91	27	91
177	4.50	179	10	89	25	87
171	4.60	170	8	87	24	84
162	4.70	163	6	85	23	81
154	4.80	156	4	83	23	78
149	4.90	149	2	81	22	76
144	5.00	143	0	79	21	74
136	5.10	137	-3	77	20	71



**Metric and Decimal Equivalents of Common Fractions**

Fractions of an Inch	Decimals of an Inch	Milli-meters	Fractions of an Inch	Decimals of an Inch	Milli-meters
$\frac{1}{64}$	.0156	0.397	$\frac{33}{64}$	.5156	13.097
$\frac{1}{32}$	.0313	0.794	$\frac{17}{32}$	.5313	13.494
$\frac{3}{64}$	.0469	1.191	$\frac{35}{64}$	.5469	13.891
$\frac{1}{16}$	.0625	1.588	$\frac{9}{16}$	.5625	14.287
$\frac{5}{64}$	.0781	1.985	$\frac{31}{64}$	.5781	14.684
$\frac{3}{32}$	.0938	2.381	$\frac{19}{32}$	.5938	15.081
$\frac{7}{64}$	.1094	2.778	$\frac{39}{64}$	.6094	15.478
$\frac{1}{8}$	.1250	3.175	$\frac{5}{8}$	.6250	15.875
$\frac{9}{64}$	.1406	3.572	$\frac{41}{64}$	.6406	16.272
$\frac{5}{32}$	.1563	3.969	$\frac{21}{32}$	.6563	16.688
$\frac{11}{64}$	.1719	4.366	$\frac{43}{64}$	.6719	17.085
$\frac{3}{16}$	.1875	4.762	$\frac{11}{16}$	.6875	17.462
$\frac{13}{64}$	.2031	5.159	$\frac{45}{64}$	.7031	17.859
$\frac{7}{32}$	.2188	5.556	$\frac{23}{32}$	.7188	18.256
$\frac{15}{64}$	.2344	5.953	$\frac{47}{64}$	.7344	18.653
$\frac{1}{4}$	.2500	6.350	$\frac{3}{4}$	.7500	19.050
$\frac{17}{64}$	.2656	6.747	$\frac{49}{64}$	.7645	19.447
$\frac{9}{32}$	.2813	7.144	$\frac{25}{32}$	.7813	19.843
$\frac{19}{64}$	.2969	7.541	$\frac{51}{64}$	.7969	20.240
$\frac{5}{16}$	.3125	7.937	$\frac{13}{16}$	.8125	20.637
$\frac{21}{64}$	.3281	8.334	$\frac{53}{64}$	.8281	21.034
$\frac{11}{32}$	.3438	8.731	$\frac{27}{32}$	.8438	21.430
$\frac{23}{64}$	.3594	9.128	$\frac{55}{64}$	.8594	21.827
$\frac{3}{8}$	.3750	9.525	$\frac{7}{8}$	.8750	22.224
$\frac{25}{64}$	.3906	9.922	$\frac{57}{64}$	.8906	22.621
$\frac{13}{32}$	.4063	10.319	$\frac{29}{32}$	.9063	23.018
$\frac{27}{64}$	.4219	10.716	$\frac{59}{64}$	.9219	23.415
$\frac{7}{16}$	.4375	11.112	$\frac{15}{16}$	.9375	23.812
$\frac{29}{64}$	.4531	11.509	$\frac{61}{64}$	.9531	24.209
$\frac{15}{32}$	.4688	11.906	$\frac{31}{32}$	.9688	24.606
$\frac{31}{64}$	.4844	12.303	$\frac{63}{64}$	.9844	25.003
$\frac{1}{2}$	.5000	12.700	1	1.0000	25.400

**Classification and Nominal Composition of Principal Types of Tool Steels**

AISI-SAE Designation	C	Mn	Si or Ni	Cr	V	W	Mo	Co
<b>WATER-HARDENING TOOL STEELS</b>								
W1	0.60/1.40	...	...	...	...	...	...	...
W2	0.60/1.40	...	...	...	0.25	...	...	...
W3	0.60/1.40	...	...	...	0.50	...	...	...
W4	0.60/1.40	...	...	0.25	...	...	...	...
W5	0.60/1.40	...	...	0.50	...	...	...	...
W6	0.60/1.40	...	...	0.25	0.25	...	...	...
W7	0.60/1.40	...	...	0.50	0.20	...	...	...
<b>SHOCK-RESISTING TOOL STEELS</b>								
S1	0.50	...	...	1.50	...	2.50	...	...
S2	0.50	...	1.00 Si	...	...	...	0.50	...
S3	0.50	...	...	0.75	...	1.00	...	...
S4	0.50	0.80	2.00 Si	...	...	...	...	...
S5	0.50	0.80	2.00 Si	...	...	...	0.40	...
<b>OIL-HARDENING COLD WORK TOOL STEELS</b>								
O1	0.90	1.00	...	0.50	...	0.50	...	...
O2	0.90	1.60	...	...	...	...	...	...
O6	1.45	0.75	1.00 Si	...	...	...	0.25	...
O7	1.20	...	...	0.75	...	1.75	0.25	(optional)
<b>AIR-HARDENING MEDIUM-ALLOY COLD WORK TOOL STEELS</b>								
A2	1.00	...	...	5.00	...	...	1.00	...
A4	1.00	2.00	...	1.00	...	...	1.00	...
A5	1.00	3.00	...	1.00	...	...	1.00	...
A6	0.70	2.00	...	1.00	...	...	1.00	...

(table continued on next page)

AISI-SAE Designation	C	Mn	Si or Ni	Cr	V	W	Mo	Co
<b>HIGH-CARBON HIGH-CHROMIUM COLD WORK STEELS</b>								
D1	1.00	...	...	12.00	...	...	1.00	...
D2	1.50	...	...	12.00	...	...	1.00	...
D3	2.25	...	...	12.00	...	...	...	...
D4	2.25	...	...	12.00	...	...	1.00	...
D5	1.50	...	...	12.00	...	...	1.00	3.00
D6	2.25	...	1.00 Si	12.00	...	1.00	...	...
<b>CHROMIUM HOT WORK TOOL STEELS</b>								
H11	0.35	...	...	5.00	0.40	...	1.50	...
H12	0.35	...	...	5.00	0.40	1.50	1.50	...
H13	0.35	...	...	5.00	1.00	...	1.50	...
H14	0.40	...	...	5.00	...	5.00	...	...
H15	0.40	...	...	5.00	...	...	5.00	...
H16	0.55	...	...	7.00	...	7.00	...	...
<b>TUNGSTEN HOT WORK TOOL STEELS</b>								
H20	0.35	...	...	2.00	...	9.00	...	...
H21	0.35	...	...	3.50	...	9.00	...	...
H22	0.35	...	...	2.00	...	11.00	...	...
H23	0.30	...	...	12.00	...	12.00	...	...
H24	0.45	...	...	3.00	...	15.00	...	...
H25	0.25	...	...	4.00	...	15.00	...	...
H26	0.50	...	...	4.00	1.00	18.00	...	...
<b>MOLYBDENUM HOT WORK TOOL STEELS</b>								
H41	0.65	...	...	4.00	1.00	1.50	8.00	...
H42	0.60	...	...	4.00	2.00	6.00	5.00	...
H43	0.55	...	...	4.00	2.00	...	8.00	...
<b>TUNGSTEN HIGH-SPEED TOOL STEELS</b>								
T1	0.70	...	...	4.00	1.00	18.00	...	...
T2	0.85	...	...	4.00	2.00	18.00	...	...
T3	1.00	...	...	4.00	3.00	18.00	...	...
T4	0.75	...	...	4.00	1.00	18.00	...	5.00
T5	0.80	...	...	4.00	2.00	18.00	...	8.00
T6	0.80	...	...	4.50	1.50	20.00	...	12.00
T7	0.80	...	...	4.00	2.00	14.00	...	...
T8	0.80	...	...	4.00	2.00	14.00	...	5.00
T9	1.20	...	...	4.00	4.00	18.00	...	...
T15	1.55	...	...	4.00	5.00	12.00	...	5.00

AISI-SAE Designation	C	Mn	Si or Ni	Cr	V	W	Mo	Co
<b>MOLYBDENUM HIGH-SPEED TOOL STEELS</b>								
M1	0.80	...	...	4.00	1.00	1.50	8.00	...
M2	0.85	...	...	4.00	2.00	6.00	5.00	...
M3	1.00	...	...	4.00	2.75	6.00	5.00	...
M4	1.30	...	...	4.00	4.00	5.50	4.50	...
M6	0.80	...	...	4.00	1.50	4.00	5.00	12.00
M8	0.80	...	...	4.00	1.50	5.00	5.00	1.25 Cb
M10	0.85	...	...	4.00	2.00	...	8.00	...
M30	0.85	...	...	4.00	1.25	2.00	8.00	5.00
M34	0.85	...	...	4.00	2.00	2.00	8.00	8.00
M35	0.85	...	...	4.00	2.00	6.00	5.00	5.00
M36	0.85	...	...	4.00	2.00	6.00	5.00	8.00
<b>LOW-ALLOY SPECIAL-PURPOSE TOOL STEELS</b>								
L1	1.00	...	...	1.25	...	...	...	...
L2	0.50/1.10	...	...	1.00	0.20	...	...	...
L3	1.00	...	...	1.50	0.20	...	...	...
L4	1.00	0.60	...	1.50	0.20	...	...	...
L5	1.00	1.00	...	1.00	...	...	0.25	...
L6	0.70	...	1.50 Ni	0.75	...	...	0.25	(optional)
L7	1.00	0.35	...	1.40	...	...	0.40	...
<b>CARBON-TUNGSTEN TOOL STEELS</b>								
F1	1.00	...	...	...	...	1.25	...	...
F2	1.25	...	...	...	...	3.50	...	...
F3	1.25	...	...	0.75	...	3.50	...	...

Cb—Columbium

## Instructions for THE SAFE USE OF GRINDING WHEELS

Grinding wheels are safe and necessary cutting tools, but they are not unbreakable. They must be handled, mounted and used carefully, and with adequate protection. The American Standard Safety Code regulations tell how to use wheels safely and with confidence. Be sure to follow the basic instructions below.

### Mounting Wheel

1. Select correct wheel for your operation. "Ring" wheel and inspect for cracks. Never use cracked wheel.
2. Never exceed maximum safe speed established for wheel. Be sure machine speed is not excessive.
3. Never alter hole in wheel or force wheel on spindle.
4. Use clean recessed matching flanges at least 1/3 wheel diameter.
5. Use one clean, smooth blotter on each side of wheel under each flange.
6. Tighten nut only enough to hold wheel firmly.
7. Adjust wheel guard and put on safety glasses before starting wheel.

### Using Wheel

1. Adjust dust hood and coolant nozzle for wet grinding. Keep work rest adjusted within 1/8" of wheel face (Periphery).
2. Stand aside and allow wheel to run idle a full minute before starting to grind.
3. Dress wheel if out of true.
4. Make grinding contact without "bumping" or impact.
5. Grind only on face of straight wheel. Use disc wheels for side grinding. Light side grinding permitted on cup or saucer wheel.
6. Never force grinding so that motor slows noticeably or work gets hot.
7. Protect wheel when not in use. Store safely if removed from grinding machine.

The above brief general rules cannot cover many questions on special grinding applications. If in doubt, ask a Norton grinding specialist, or write Norton Company, Worcester 6, Mass.

## NORTON PRODUCTS

### Abrasive Products

Abrasives for Polishing, Pressure Blasting, Barrel-Finishing and Wire Sawing  
Norbide Abrasive Grain and Sticks  
Grinding, Diamond and Cut-off Wheels  
Mounted Wheels  
Bricks, Sticks and Segments  
Pulpstones for the Paper Industry

### Non-slip Floor Products

Terrazzo and Cement Floor (c.f.) Aggregates  
Stair and Floor Tile  
Non-Slip Abrasive

### Machinery

Machines for Grinding, Lapping, Shaping, Gear Cutting and Encapsulating

### Electro-Chemical Products

Metallurgical Additions  
Source Materials  
Chemical Intermediates

### Refractory Products

Molded—Bricks, Blocks, Plates, Tubes, Crucibles, Pebbles and other Furnace and Kiln Components  
Laboratory Ware  
Refractory Cements  
Catalyst Carriers  
Silicon Carbide Heating Elements  
Porous Media  
Products for the Nuclear Program  
Refractory Grain—Fusion-stabilized Oxides, Carbides and other materials in powdered, granular and lump form  
Rokide Spray Coatings  
Ceramic Cutting Tools for Turning Metal  
Norbide Pressure Blast Nozzles and other Molded Shapes

### BEHR-MANNING CO.

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NOTES

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Manufacturing plants: Worcester, Mass., and Santa Clara, Calif.

**District Offices:**

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\*Chicago 32: ..... 4737 So. Christiansa Avenue  
\*Cleveland 3: ..... 1306 East 55th Street  
\*Detroit 8: ..... 5805 Lincoln Avenue  
Indianapolis 2: ..... 1301 West 16th Street  
Los Angeles Area (Huntington Park, Calif.): ..... 5905 Pacific Blvd.  
New York Area (Teterboro, N. J.): ..... Green and North Sts.  
\*Philadelphia 44: ..... 4732 Stenton Avenue  
\*Pittsburgh 23: ..... 1130 Butler Plank Road (Glenshaw)  
St. Louis 16: ..... 4085 Bingham Avenue  
West Hartford 17: ..... 10 Crossroads Plaza, Bishop's Corner  
\*Warehouse facilities and stock at these locations.

**BEHR-MANNING CO. (a Division of Norton Company)**

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Cincinnati 41: 3154 Exon Ave.  
Cleveland 13: 4101 W. 150th St.  
Detroit 27: 13140 Foley Ave.  
Grand Rapids 7: 1529 Division Ave., S.  
High Point (N. C.): 301 W. Green St.  
Indianapolis 2: 1301 W. 16th St.  
Los Angeles 58: E. 49th St. at District Blvd.  
New York Area (Teterboro, N. J.): Green and North Sts.  
Philadelphia Area (Camden 3, N. J.): 1601 Haddon Ave.  
San Francisco 7: 1001-16th St.  
Seattle 4: 540 W. Idaho St.  
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**NORTON PIKE (a Division of Norton Company)**

**Littleton, New Hampshire**

**Export: NORTON INTERNATIONAL INC.**

**Cable Address: NORCOINT**

Main Office: ..... 1 New Bond St., Worcester 6, Mass., U.S.A.  
Branch Offices: ..... 680 Fifth Ave., New York 19, N. Y., and Troy, N. Y., U.S.A.  
Branch Office and Warehouse: Norton Belgique, 11 Allee Verte, Brussels, Belgium

**Subsidiary Plants:**

Argentina: ..... Abrasivos Norton S.A., Buenos Aires  
Australia: ..... (affiliated) Australian Abrasives Pty. Ltd., Auburn, New South Wales  
Brazil: ..... Behr-Manning (Australia) Pty. Ltd., Lidcombe, N.S.W.  
Canada: ..... Abrasivos Norton-Meyer, S.A., Sao Paulo  
..... Behr-Manning (Canada) Ltd., Brantford, Ontario  
England: ..... Norton Company of Canada, Ltd., Hamilton, Ontario  
France: ..... Norton Grinding Wheel Co., Ltd., Welwyn Garden City  
..... Behr-Manning de France, Conflans-Ste.-Honorine  
..... Compagnie des Meules Norton, La Courneuve  
Germany: ..... Deutsche Norton Gesellschaft m.b.H., Wesseling bez Cologne  
Italy: ..... Mole Norton S.p.A., Corsico (Milano)  
Northern Ireland: ..... Behr-Manning Limited, Belfast  
Union of South Africa: ..... Norton Abrasives S.A. (Pty.) Ltd., Isando, Transvaal

**Electric Furnace Plants:** Huntsville, Alabama, Chippawa, Ontario and Cap-de-la-Madeleine, Quebec, Canada; Belo Horizonte, Brazil; Mendoza, Argentina; and (affiliated) Hull, England.

**Bauxite Plant:** Bauxite, Arkansas.