# CARBIDE TIPPED END MILLS TECHNICAL INFORMATION

| TOOL SELECTOR | CHIP CLASS | MATERIAL MACHINED | PAGE # |
|---|---|---|---|
| | 20 | NON-FERROUS - LONG CHIPS | 189-191 |
| | 40 | NON-FERROUS - SHORT CHIPS | 189-191 |
| | 60 | CAST IRONS | 189-191 |
| | 80 | LOW STRENGTH STEELS | 189,192 |
| | 100 | MEDIUM STRENGTH STEELS | 189,192 |
| | 120 | HIGH STRENGTH STEELS | 189,192 |
| | 140 | HIGH TEMPERATURE ALLOYS | 189,191 |

## END MILL BASICS

**END MILLS** have cutting edges on both the end and sides, permitting end cutting and peripheral cutting. Center cutting types permit plunge and traverse milling.

**CUTTING EDGE:** Select **sharp edged** for faster speeds. Select radial edged for longer tool life.

**SHANK DIAMETER:** Select **largest diameter** available to maximize rigidity and minimize axial deflection and chatter.

**NUMBER OF FLUTES:** Select **fewer flutes** for milling softer materials at higher feeds and speeds where more chip space is required or when machine horsepower is limited.

Select **more flutes** for milling tougher materials at reduced feeds and speeds or for increased table feeds using the same cutting speeds.

**TOOL DIAMETER:** Select **largest practical diameter** to maximize rigidity, minimize chatter and improve tool life. If machine spindle speed is limited, the largest practical diameter permits higher cutting speeds

**COATINGS** are especially effective (see "Coating Selector" on page 10).

**FLUTE AXIAL RELATIONSHIP:**
Select **straight flutes** for a wide variety of applications.

Select **right spiral flutes** for improved cutting action and easier chip removal.

Select **left spiral flutes** for use in absorbing impact shock when entering steel workpiece – maintains constant hold down pressure and minimizes chatter. Useful in profiling applications where recutting chips causes premature cutter dulling.

Select **high spiral** (15° or more) to **dramatically** improve cutting action, finish, chip removal, and tool life. High spirals distribute impact load more evenly throughout the tool's entire revolution.

## END MILL SPECIFICATIONS AND TOLERANCES

- Geometry, carbide grade, O.D. relief and end clearance appropriate for material being machined
- Flute long carbide tips brazed to tough hardened alloy steel body
- Spiral flute carbide tips formed to true helix angles
- Straight shanks have standard Weldon drive flats
- Non-center cutting end mills have the ends cleared to depth of carbide
- Precision ground cutting edges
- USCTI
- Tool diameter tolerance:
  Radial edged: plus .002", minus .000"
  Sharp edged: plus .005", minus .000"
- Shank diameter tolerance:
  minus .0001", minus .0005"

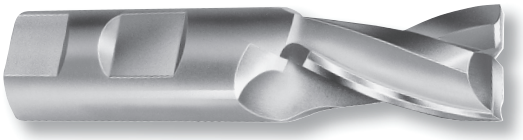
## END MILL PROBLEM SOLVING GUIDE — CARBIDE TIPPED

| MILLING PROBLEMS | POSSIBLE CAUSES | POSSIBLE SOLUTIONS |
|---|---|---|
| 1. ROUGH FINISH | Dull cutting edge<br>Wrong feeds & speeds | Resharpen to original tool geometry<br>Increase speed—also try reduced feed |
| 2. EXCESSIVE CUTTING EDGE WATER | Wrong feeds & speeds<br><br>Rough cutting edge<br>Insufficient coolant | Increase feed (should always be over .001" per tooth) — especially when machining ductile or free machining materials. Also try reduced speed<br>Lightly hone cutting edge with fine grit diamond hone<br>Increase coolant flow — review type of coolant |
| 3. CHIPPED CUTTING EDGE | Poor chip removal<br>Recutting work hardened chips<br>Vibration<br>Incorrect carbide grade | Use tool with larger flute space — larger diameter or fewer flutes<br>Increase coolant flow<br>Increase rigidity of set-up, especially worn tool holders<br>Change to appropriate carbide grade |
| 4. CHATTER MARKS | Insufficient machine horsepower<br>Vibration | Use tool with fewer flutes as correct feeds & speeds must be maintained<br>Consider climb milling<br>Use larger diameter cutter<br>Resharpen tool with more clearance |
| 5. GLAZED FINISH | Feed too light<br>Dull cutting edge<br>Insufficient clearance | Increase feed<br>Resharpen tool to original geometry<br>Resharpen tool with more clearance |
| 6. POOR TOOL LIFE | Excessive cratering<br><br>Milling abrasive material<br><br><br>Milling surface scale<br>Milling hard material<br>Insufficient chip room<br>Delayed resharpening<br>Thermal cracked carbide | Increase speed or decrease feed<br>Change to harder grade of carbide<br>Decrease speed and increase feed<br>Increase coolant flow<br>Climb milling better than conventional milling<br>Conventional milling better than climb milling<br>Reduce speed — rigidity very important<br>Use larger diameter tool<br>Prompt resharpening to original geometry will increase total tool life<br>Maintain adequate coolant flow at all times<br>Climb milling is cooler than conventional milling |

# END MILLS INDEX AND COMPARISON CHART

| DESCRIPTION | HANNIBAL PAGE | HANNIBAL TOOL TYPE | FULLERTON | PUTNAM | MORSE | NIAGARA |
|---|---|---|---|---|---|---|
| **CENTER CUTTING END MILLS** | | | | | | |
| Straight Flutes | | | | | | |
| For Non-Ferrous & Cast Irons | **189** | 314 | 60SK | SKM | 5935 | 4800 |
| For Steels | **189** | 312 | 60SKS | – | 5936 | 4780 |
| 25° Right Spiral Flutes | | | | | | |
| For Non-Ferrous & Cast Irons | **189** | 318 | 60CS | – | 5966 | – |
| **HIGH SPIRAL SHEAR CUTTING END MILLS** | | | | | | |
| 15° Right Spiral Flutes | | | | | | |
| For Non-Ferrous & Cast Irons | **191** | 375 | – | HLS | 5962 | 4840 |
| For Cast Irons & High Temp Alloys | **191** | 320 | – | – | – | – |
| For Steels | **192** | 350 | 60GSS | HES | 5960 | 4820 |
| 25° Right Spiral Flutes | | | – | – | – | – |
| For Non-Ferrous (Sharp Edged) | **191** | 327 | – | – | – | – |
| For Non-Ferrous | **191** | 325 | 60FS | HNS | 5958 | 4860 |
| **SLOW SPIRAL END MILLS** | | | | | | |
| 6° Right Spiral Flutes | | | | | | |
| For Non-Ferrous (Sharp Edged) | **190** | 307 | – | – | – | – |
| For Non-Ferrous & Cast Irons | **190** | 306 | 60RS | RSEM | 5921 | – |
| For Steels | **192** | 308 | 60RSS | – | – | – |
| 6° Left Spiral Flutes for Steels | **192** | 310 | 60LSS | LSEM | 5964 | – |
| **STRAIGHT FLUTES END MILLS** | | | | | | |
| Sharp Edged | | | | | | |
| For Non-Ferrous (4 Flutes) | **190** | 305 | – | – | – | – |
| Radial Edged | | | | | | |
| For Non-Ferrous & Cast Irons (2 Flutes) | **190** | 302 | 60TF | TFEM | 5923 | 4700 |
| For Non-Ferrous & Cast Irons (4 or 6 Flts.) | **190** | 304 | 60EM | EM | 5925 | 4750 |
| For Steels (2 Flutes) | **192** | 300 | 60TFS | – | 5927 | – |

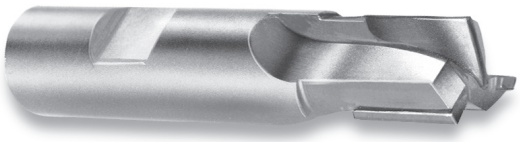
## CENTER CUTTING TYPE TYPES 318, 312, 314 FRACTIONAL



### 25° RIGHT SPIRAL FLUTES
### TYPE 318 - FOR NON-FERROUS & CAST IRONS

- Larger flute capacity for heavy milling
- Center cutting design for plunge, slot, profile and peripheral milling including splines, keyways, and spotfacing
- Radial edged for longer tool life
- Detailed specifications on page 188

| TOOL DIAMETER FRAC. | TOOL DIAMETER DECIMAL | DIMENSIONS SHANK DIAM. | LENGTH CARBIDE | LENGTH OVERALL | NO. OF FLUTES | TYPE 318 FOR NON-FERR. EDP NO. | TYPE 318 FOR NON-FERR. PRICE |
|---|---|---|---|---|---|---|---|
| ½ | .5000 | ½ | 1 | 3 | 2 | 31816 | $183.05 |
| ⅝ | .6250 | ⅝ | 1 ¼ | 3 ⅜ | 2 | 31820 | 204.60 |
| ¾ | .7500 | ¾ | 1 ¼ | 3 ⅜ | 2 | 31824 | 216.80 |
| ⅞ | .8750 | ⅞ | 1 ½ | 3 ¾ | 2 | 31828 | 238.45 |
| 1 | 1.0000 | 1 | 1 ½ | 4 | 2 | 31832 | 274.00 |
| 1 ¼ | 1.2500 | 1 ¼ | 1 ¾ | 4 ¼ | 2 | 31840 | 372.45 |
| 1 ½ | 1.5000 | 1 ½ | 2 | 4 ¾ | 2 | 31848 | 434.60 |



### THREE STRAIGHT FLUTES
### TYPE 312 - FOR STEELS
### TYPE 314 - FOR NON-FERROUS & CAST IRONS

- Three straight flutes provide generous capacity for chips
- Center cutting design for plunge, slot, profile, and peripheral milling including splines, keyways, and spotfacing
- Radial edged for longer tool life
- Detailed specifications on page 188

**MODIFICATIONS** (See list on page 190)

| TOOL DIAMETER FRAC. | TOOL DIAMETER DECIMAL | DIMENSIONS SHANK DIAM. | LENGTH CAR-BIDE | LENGTH OVER-ALL | NO. OF FLTS | TYPE 314 FOR NON-FERR. & C.I. EDP NO. | TYPE 314 FOR NON-FERR. & C.I. PRICE | TYPE 312 FOR STEELS EDP NO. | TYPE 312 FOR STEELS PRICE |
|---|---|---|---|---|---|---|---|---|---|
| ⅜ | .3750 | ⅜ | ½ | 2 ½ | 3 | 31412 | $109.45 | 31212 | $113.75 |
| 7⁄16 | .4375 | ⅜ | ¾ | 2 ½ | 3 | 31414 | 111.90 | 31214 | 116.30 |
| ½ | .5000 | ½ | ¾ | 3 | 3 | 31416 | 114.85 | 31216 | 119.15 |
| 9⁄16 | .5625 | ½ | ¾ | 3 | 3 | 31418 | 119.25 | 31218 | 123.90 |
| ⅝ | .6250 | ⅝ | ¾ | 3 ¼ | 3 | 31420 | 139.60 | 31220 | 144.85 |
| ¾ | .7500 | ⅝ | ¾ | 3 ⅜ | 3 | 31424 | 146.05 | 31224 | 151.70 |
| ⅞ | .8750 | ⅞ | ¾ | 3 ¾ | 3 | 31428 | 170.50 | 31228 | 177.10 |
| 1 | 1.0000 | ⅞ | ¾ | 3 ¾ | 3 | 31432 | 187.30 | 31232 | 194.55 |
| 1 ⅛ | 1.1250 | 1 | ¾ | 4 | 3 | 31436 | 200.65 | 31236 | 208.25 |
| 1 ¼ | 1.2500 | 1 | ¾ | 4 | 3 | 31440 | 232.45 | 31240 | 241.50 |
| 1 ½ | 1.5000 | 1 ¼ | ¾ | 4 | 3 | 31448 | 276.40 | 31248 | 287.05 |

END MILLS

# END MILLS FOR NON-FERROUS & CAST IRONS CARBIDE TIPPED TYPES 302, 304, 305, 306, 307, FRACTIONAL

MATERIAL SPECIFIC

## BASIC TYPES

### MODIFICATIONS (Prompt delivery)

- Modified tool diameter
- Metric tool diameter
- Cutting diameter reduced for step or pilot
- Corner chamfer or corner radius
- Shortened shank or reduced shank diam.
- Additional shank drive flat(s)
- Coolant outlets (except on Type 318)
- Coatings available:

TITANIUM NITRIDE – TiN

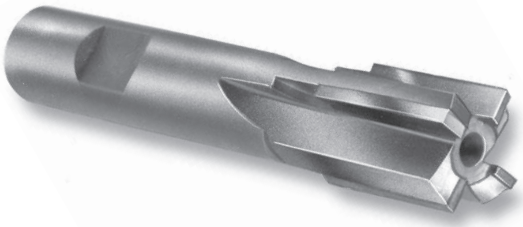
TITANIUM CARBONITRIDE – TiCN

ZIRCONIUM NITRIDE – ZrN

AL TITANIUM NITRIDE – AlTiN

### RADIAL EDGED WITH TWO STRAIGHT FLUTES TYPE 302 - FOR NON-FERROUS MATERIALS & CAST IRONS

- Two large flutes for easy chip removal
- Use when machine horsepower is too low for high chip capacity end mills



### RADIAL EDGED WITH FOUR OR SIX STRAIGHT FLUTES TYPE 304 - FOR NON-FERROUS MATERIALS & CAST IRONS

- More flutes for improved finish
- Use when machine horsepower allows for a higher chip capacity end mill

### SHARP EDGED WITH FOUR STRAIGHT FLUTES TYPE 305 - FOR NON-FERROUS MATERIALS

- Four flutes for improved finish
- Use when machine horsepower allows for a higher capacity end mill

### RADIAL EDGED WITH 6° RIGHT SPIRAL FLUTES TYPE 306 - FOR NON-FERROUS MATERIALS & CAST IRONS

- Spiral flutes aid in chip removal, permitting heavier feeds and faster speeds
- Radial edged for tough aluminum alloys and castings

### SHARP EDGED WITH 6° RIGHT SPIRAL FLUTES TYPE 307 - FOR NON-FERROUS MATERIALS

- Same as Type 306 above, but sharp edged for improved finish

### ALL TYPES:

- Detailed specifications on page 188

| TOOL DIAMETER | | DIMENSIONS | | | TYPE 302 2 STRAIGHT FLUTES | | | TYPE 304 4 OR 6 STRAIGHT FLUTES | | | TYPE 305 SHARP EDGED 4 STRAIGHT FLTS | | | TYPE 306 RADIAL EDGED 6° RIGHT SPIRAL | | | TYPE 307 SHARP EDGED 6° RIGHT SPIRAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | LENGTH | | | | | | | | | | | | | | | | |
| FRAC. | DEC. | SHANK DIAM. | CAR-BIDE | OVER-ALL | NO. OF FLTS | EDP NO. | PRICE | NO. OF FLTS | EDP NO. | PRICE | NO. OF FLTS | EDP NO. | PRICE | NO. OF FLTS | EDP NO. | PRICE | NO. OF FLTS | EDP NO. | PRICE |
| 1/4 | .2500 | 3/8 | 1/2 | 2 1/2 | 2 | 30208 | $59.50 | 4 | 30408 | $60.05 | 4 | 30508 | $60.05 | 2 | 30608 | $60.85 | 2 | 30708 | $64.50 |
| 5/16 | .3125 | 3/8 | 5/8 | 2 1/2 | 2 | 30210 | 61.75 | 4 | 30410 | 64.15 | - | - | - | 2 | 30610 | 63.00 | - | - | - |
| 3/8 | .3750 | 3/8 | 5/8 | 2 1/2 | 2 | 30212 | 66.25 | 4 | 30412 | 67.60 | - | - | - | 2 | 30612 | 67.45 | - | - | - |
| 7/16 | .4375 | 3/8 | 1 | 2 11/16 | 2 | 30214 | 66.25 | 4 | 30414 | 67.60 | 4 | 30514 | 65.05 | 2 | 30614 | 67.45 | 2 | 30714 | 71.50 |
| 1/2 | .5000 | 1/2 | 1 | 3 1/4 | 2 | 30216 | 67.90 | 4 | 30416 | 69.20 | 4 | 30516 | 69.10 | 2 | 30616 | 69.25 | 2 | 30716 | 73.30 |
| 9/16 | .5625 | 1/2 | 1 | 3 3/8 | 2 | 30218 | 75.05 | 4 | 30418 | 77.70 | 4 | 30518 | 77.55 | 2 | 30618 | 76.70 | 2 | 30718 | 81.10 |
| 5/8 | .6250 | 1/2 | 1 | 3 3/8 | 2 | 30220 | 75.05 | 4 | 30420 | 81.35 | 4 | 30520 | 81.25 | 4 | 30620 | 79.65 | 4 | 30720 | 84.30 |
| 11/16 | .6875 | 5/8 | 1 | 3 3/8 | 2 | 30222 | 81.25 | 4 | 30422 | 89.55 | 4 | 30522 | 89.35 | - | - | - | - | - | - |
| 3/4 | .7500 | 5/8 | 1 | 3 5/8 | 2 | 30224 | 84.30 | 4 | 30424 | 83.75 | 4 | 30524 | 92.80 | 4 | 30624 | 91.00 | 4 | 30724 | 96.25 |
| 13/16 | .8125 | 5/8 | 1 | 3 5/8 | 2 | 30226 | 101.90 | 4 | 30426 | 98.95 | 4 | 30526 | 106.20 | - | - | - | - | - | - |
| 7/8 | .8750 | 5/8 | 1 1/4 | 4 | 2 | 30228 | 102.55 | 4 | 30428 | 98.95 | 4 | 30528 | 109.85 | 4 | 30628 | 121.65 | 4 | 30728 | 128.90 |
| 15/16 | .9375 | 7/8 | 1 1/4 | 4 | 2 | 30230 | 109.85 | 4 | 30430 | 109.90 | 4 | 30530 | 116.85 | - | - | - | - | - | - |
| 1 | 1.0000 | 7/8 | 1 1/4 | 4 | 2 | 30232 | 110.10 | 4 | 30432 | 114.30 | 4 | 30532 | 126.75 | 4 | 30632 | 140.55 | 4 | 30732 | 148.85 |
| 1 1/8 | 1.1250 | 1 | 1 1/4 | 4 1/4 | 2 | 30236 | 113.00 | 4 | 30436 | 129.65 | 4 | 30536 | 143.60 | 4 | 30636 | 159.40 | - | - | - |
| 1 1/4 | 1.2500 | 1 | 1 1/4 | 4 1/4 | 2 | 30240 | 136.25 | 4 | 30440 | 145.80 | 4 | 30540 | 161.50 | 4 | 30640 | 179.15 | 4 | 30740 | 189.40 |
| 1 1/2 | 1.5000 | 1 1/4 | 1 1/2 | 4 1/2 | 2 | 30248 | 168.75 | 4 | 30448 | 187.95 | 4 | 30548 | 200.05 | 4 | 30648 | 221.75 | 4 | 30748 | 226.15 |
| 1 3/4 | 1.7500 | 1 1/4 | 1 1/2 | 4 1/2 | 2 | 30256 | 200.05 | 6 | 30456 | 242.25 | - | - | - | 6 | 30656 | 286.25 | - | - | - |
| 2 | 2.0000 | 1 1/4 | 1 1/2 | 4 1/2 | 2 | 30264 | 223.15 | 6 | 30464 | 279.10 | - | - | - | 6 | 30664 | 329.60 | 6 | 30764 | 335.90 |

# END MILLS FOR NON-FERROUS & CAST IRONS CARBIDE TIPPED TYPES 325, 327, 375, 320 FRACTIONAL

MATERIAL SPECIFIC

## HIGH SPIRAL SHEAR CUTTING TYPES

### MODIFICATIONS (Prompt delivery)

- Modified tool diameter
- Metric tool diameter
- Cutting diameter reduced for step or pilot
- Corner chamfer or corner radius
- Shortened shank or reduced shank diam.
- Additional shank drive flat(s)
- Coolant outlets
- Coatings available:

TITANIUM NITRIDE – TiN

TITANIUM CARBONITRIDE – TiCN

ZIRCONIUM NITRIDE – ZrN

AL TITANIUM NITRIDE – AlTiN

### SHARP EDGED WITH 25° RIGHT SPIRAL FLUTES TYPE 327 - FOR NON-FERROUS MATERIALS

- Higher spiral permits faster chip removal
- Spiral flutes distribute the milling impact load evenly, improving finish and increasing tool life

### RADIAL EDGED WITH 25° RIGHT SPIRAL FLUTES TYPE 325 - FOR NON-FERROUS MATERIALS

- Same as Type 327 above, but radial edged for tough aluminum alloys and castings

### RADIAL EDGED WITH 15° RIGHT SPIRAL FLUTES TYPE 375 - FOR NON-FERROUS MATERIALS & CAST IRONS

- 15° spiral flutes for improved chip removal
- Radial edged for tough aluminum alloys and castings
- Spiral flutes distribute the milling impact load evenly, improving finish and increasing tool life

### RADIAL EDGED WITH 15° RIGHT SPIRAL FLUTES TYPE 320 - FOR CAST IRONS & HIGH TEMP ALLOYS

- 15° spiral flutes for improved chip removal
- More flutes than Type 375 for use where less feed per tooth is required, but table feed is maintained for same productivity

### ALL TYPES:

- Detailed specifications on page 188

| TOOL DIAMETER | | DIMENSIONS | | | TYPE 327 OR 325 - 25° RIGHT SPIRAL FOR NON-FERROUS | | | | TYPE 375 - 15° RIGHT SPIRAL FOR NON-FERROUS & CAST IRON | | | TYPE 320 - 15° RIGHT SPIRAL FOR CAST IRON & HIGH TEMP ALLOYS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRAC. | DECIMAL | SHANK DIAM. | LENGTH CARBIDE | LENGTH OVERALL | NO. OF FLTS | TYPE 327 SHARP EDP NO. | TYPE 325 RADIAL EDP NO. | PRICE | NO. OF FLTS | TYPE 375 RADIAL EDP NO. | PRICE | NO. OF FLTS | TYPE 320 RADIAL EDP NO. | PRICE |
| ½ | .5000 | ⅜ | 1 | 3 | 2 | - | 32516 | $108.80 | 2 | 37516 | $100.25 | - | - | - |
| ½ | .5000 | ½ | 1 | 3 | 2 | - | 32517 | 108.80 | 2 | 37517 | 100.25 | 4 | 32017 | $108.80 |
| 9⁄16 | .5625 | ½ | 1 | 3 | 2 | - | 32518 | 116.85 | 2 | 37518 | 107.80 | - | - | - |
| ⅝ | .6250 | ½ | 1 ¼ | 3 ¼ | 2 | - | 32520 | 125.80 | 2 | 37520 | 115.85 | - | - | - |
| ⅝ | .6250 | ⅝ | 1 ¼ | 3 ⅜ | 2 | 32721 | 32521 | 125.80 | 2 | 37521 | 115.85 | 4 | 32021 | 125.80 |
| 11⁄16 | .6875 | ½ | 1 ¼ | 3 ¼ | 2 | - | 32522 | 131.05 | 2 | 37522 | 120.80 | - | - | - |
| 11⁄16 | .6875 | ⅝ | 1 ¼ | 3 ⅜ | 2 | - | 32523 | 131.05 | 2 | 37523 | 120.80 | 4 | 32023 | 131.05 |
| ¾ | .7500 | ½ | 1 ¼ | 3 ¼ | 2 | 32724 | 32524 | 139.95 | 2 | 37524 | 128.95 | - | - | - |
| ¾ | .7500 | ⅝ | 1 ¼ | 3 ⅜ | 2 | 32725 | 32525 | 139.95 | 2 | 37525 | 128.95 | 4 | 32025 | 139.95 |
| 13⁄16 | .8125 | ⅝ | 1 ½ | 3 ⅝ | 2 | 32726 | 32526 | 151.00 | 2 | 37526 | 139.15 | 4 | 32026 | 151.00 |
| ⅞ | .8750 | ⅝ | 1 ½ | 3 ⅝ | 2 | - | 32528 | 160.25 | 2 | 37528 | 147.75 | - | - | - |
| ⅞ | .8750 | ⅞ | 1 ½ | 3 ¾ | 2 | - | 32529 | 160.25 | 2 | 37529 | 147.75 | 4 | 32029 | 160.25 |
| 15⁄16 | .9375 | ⅝ | 1 ½ | 3 ¾ | 2 | - | 32530 | 181.30 | 3 | 37530 | 218.75 | - | - | - |
| 15⁄16 | .9375 | ⅞ | 1 ½ | 3 ¾ | 2 | - | 32531 | 181.30 | 3 | 37531 | 218.75 | - | - | - |
| 1 | 1.0000 | ⅞ | 1 ½ | 3 ¾ | 2 | 32732 | 32532 | 185.05 | 3 | 37532 | 207.05 | - | - | - |
| 1 | 1.0000 | 1 | 1 ½ | 4 | 2 | 32733 | 32533 | 185.05 | 3 | 37533 | 207.05 | 6 | 32033 | 224.80 |
| 1 ⅛ | 1.1250 | 1 | 1 ¾ | 4 ¼ | 2 | - | 32536 | 202.65 | 3 | 37536 | 243.85 | 6 | 32036 | 264.55 |
| 1 ¼ | 1.2500 | 1 | 1 ¾ | 4 ¼ | 3 | 32740 | 32540 | 268.75 | 4 | 37540 | 279.45 | 6 | 32040 | 303.20 |
| 1 ⅜ | 1.3750 | 1 | 1 ¾ | 4 ¼ | 3 | 32744 | 32544 | 291.40 | 4 | 37544 | 326.30 | 6 | 32044 | 354.25 |
| 1 ½ | 1.5000 | 1 ¼ | 2 | 4 ½ | 3 | 32748 | 32548 | 325.45 | 4 | 37548 | 321.55 | 6 | 32048 | 348.90 |
| 1 ⅝ | 1.6250 | 1 ¼ | 2 | 4 ½ | 3 | - | 32552 | 385.20 | 4 | 37552 | 393.25 | - | - | - |
| 1 ¾ | 1.7500 | 1 ¼ | 2 | 4 ½ | 3 | - | 32556 | 413.30 | 4 | 37556 | 419.35 | 8 | 32056 | 438.70 |
| 1 ⅞ | 1.8750 | 1 ¼ | 2 | 4 ½ | 3 | - | 32560 | 444.90 | 4 | 37560 | 448.55 | - | - | - |
| 2 | 2.0000 | 1 ¼ | 2 | 4 ½ | 3 | 32764 | 32564 | 475.60 | 4 | 37564 | 473.80 | 8 | 32064 | 495.70 |

END MILLS

# END MILLS FOR STEELS
# CARBIDE TIPPED TYPES 300, 308, 350, FRACTIONAL

MATERIAL SPECIFIC

## BASIC TYPES

**MODIFICATIONS** (See list on page 191)

### TYPE 300 - TWO STRAIGHT FLUTES

- Two large flutes for easy chip removal
- Use when machine horsepower is too low for high chip capacity end mills

### TYPE 308 - 6° RIGHT SPIRAL FLUTES

- Spiral flutes aid in chip removal, permitting heavier feeds and faster speeds

### TYPE 310 - 6° LEFT SPIRAL FLUTES

- Left spiral flutes maintain a constant pressure on the workpiece and absorb the impact shock on entering steel
- Left hand helix best when milling tough steel alloys
- For peripheral milling

### ALL TYPES:

- Radial edged for longer tool life
- Detailed specifications on page 188

| TOOL DIAMETER | | DIMENSIONS | | | TYPE 300 - 2 STRAIGHT FLUTES | | | TYPE 308 OR TYPE 310 - 6° SPIRAL FLUTES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | LENGTH | | | | | | | | |
| FRAC. | DECIMAL | SHANK DIAM. | CARBIDE | OVERALL | NO. OF FLTS | EDP NO. | PRICE | NO. OF FLTS | TYPE 308 RIGHT EDP NO. | TYPE 310 LEFT EDP NO. | PRICE |
| ¼ | .2500 | ⅜ | ½ | 2 ½ | 2 | 30008 | $68.40 | 2 | 30808 | 31008 | $70.40 |
| 5/16 | .3125 | ⅜ | ⅝ | 2 ½ | 2 | 30010 | 71.25 | 2 | 30810 | 31010 | 75.95 |
| ⅜ | .3750 | ⅜ | ⅝ | 2 ½ | 2 | 30012 | 76.05 | 2 | 30812 | 31012 | 80.50 |
| 7/16 | .4375 | ⅜ | 1 | 2 1⅛ | 2 | 30014 | 76.05 | 2 | 30814 | 31014 | 80.50 |
| ½ | .5000 | ½ | 1 | 3 ¼ | 2 | 30016 | 77.80 | 4 | 30816 | 31016 | 86.70 |
| 9/16 | .5625 | ½ | 1 | 3 ⅜ | 2 | 30018 | 86.30 | 4 | 30818 | 31018 | 93.20 |
| ⅝ | .6250 | ½ | 1 | 3 ⅜ | 2 | 30020 | 86.30 | 4 | 30820 | 31020 | 115.00 |
| ¾ | .7500 | ⅝ | 1 | 3 ⅝ | 2 | 30024 | 96.85 | 4 | 30824 | 31024 | 128.10 |
| ⅞ | .8750 | ⅝ | 1 ¼ | 4 | 2 | 30028 | 114.45 | 4 | 30828 | 31028 | 154.35 |
| 1 | 1.0000 | ⅞ | 1 ¼ | 4 | 2 | 30032 | 126.45 | 6 | 30832 | 31032 | 177.45 |
| 1 ⅛ | 1.1250 | 1 | 1 ¼ | 4 ¼ | 2 | 30036 | 129.55 | 6 | 30836 | 31036 | 188.20 |
| 1 ¼ | 1.2500 | 1 | 1 ¼ | 4 ¼ | 2 | 30040 | 144.45 | 6 | 30840 | 31040 | 227.45 |
| 1 ½ | 1.5000 | 1 ¼ | 1 ½ | 4 ½ | 2 | 30048 | 186.05 | 6 | 30848 | 31048 | 276.60 |
| 1 ¾ | 1.7500 | 1 ¼ | 1 ½ | 4 ½ | 2 | 30056 | 208.65 | 8 | 30856 | 31056 | 333.10 |
| 2 | 2.0000 | 1 ¼ | 1 ½ | 4 ½ | 2 | 30064 | 249.15 | 8 | 30864 | 31064 | 371.85 |

## HIGH SPIRAL SHEAR CUTTING TYPES

### TYPE 350 - 15° RIGHT SPIRAL FLUTES

- 15° right spiral flutes for improved chip removal
- Spiral flutes distribute the milling impact load evenly, improving finish and increasing tool life
- Radial edged for longer tool life
- Detailed specifications on page 188

| TOOL DIAMETER | | DIMENSIONS | | | TYPE 350 - 15° RIGHT SPIRAL 4 TO 8 FLUTES | | |
|---|---|---|---|---|---|---|---|
| | | | LENGTH | | | | |
| FRAC. | DECIMAL | SHANK DIAM. | CARBIDE | OVERALL | NO. OF FLTS | EDP NO. | PRICE |
| ½ | .5000 | ⅜ | 1 | 3 | 4 | 35016 | $108.80 |
| ½ | .5000 | ½ | 1 | 3 | 4 | 35017 | 108.80 |
| 9/16 | .5625 | ½ | 1 | 3 | 4 | 35018 | 116.85 |
| ⅝ | .6250 | ½ | 1 ¼ | 3 ¼ | 4 | 35020 | 125.80 |
| ⅝ | .6250 | ⅝ | 1 ¼ | 3 ⅜ | 4 | 35021 | 125.80 |
| 11/16 | .6875 | ½ | 1 ¼ | 3 ¼ | 4 | 35022 | 131.05 |
| 11/16 | .6875 | ⅝ | 1 ¼ | 3 ⅜ | 4 | 35023 | 131.05 |
| ¾ | .7500 | ½ | 1 ¼ | 3 ¼ | 4 | 35024 | 139.95 |
| ¾ | .7500 | ⅝ | 1 ¼ | 3 ⅜ | 4 | 35025 | 139.95 |
| 13/16 | .8125 | ⅝ | 1 ½ | 3 ⅝ | 4 | 35026 | 151.00 |
| ⅞ | .8750 | ⅝ | 1 ½ | 3 ⅝ | 4 | 35028 | 160.25 |
| ⅞ | .8750 | ⅞ | 1 ½ | 3 ¾ | 4 | 35029 | 160.25 |
| 15/16 | .9375 | ⅝ | 1 ½ | 3 ¾ | 4 | 35030 | 237.40 |
| 15/16 | .9375 | ⅞ | 1 ½ | 3 ¾ | 4 | 35031 | 237.40 |
| 1 | 1.0000 | ⅞ | 1 ½ | 3 ¾ | 6 | 35032 | 224.80 |
| 1 | 1.0000 | 1 | 1 ½ | 4 | 6 | 35033 | 224.80 |
| 1 ⅛ | 1.1250 | 1 | 1 ¾ | 4 ¼ | 6 | 35036 | 264.55 |
| 1 ¼ | 1.2500 | 1 | 1 ¾ | 4 ¼ | 6 | 35040 | 303.20 |
| 1 ⅜ | 1.3750 | 1 | 1 ¾ | 4 ¼ | 6 | 35044 | 354.25 |
| 1 ½ | 1.5000 | 1 ¼ | 2 | 4 ½ | 6 | 35048 | 348.90 |
| 1 ⅝ | 1.6250 | 1 ¼ | 2 | 4 ½ | 8 | 35052 | 465.15 |
| 1 ¾ | 1.7500 | 1 ¼ | 2 | 4 ½ | 8 | 35056 | 496.10 |
| 1 ⅞ | 1.8750 | 1 ¼ | 2 | 4 ½ | 8 | 35060 | 530.55 |
| 2 | 2.0000 | 1 ¼ | 2 | 4 ½ | 8 | 35064 | 560.30 |