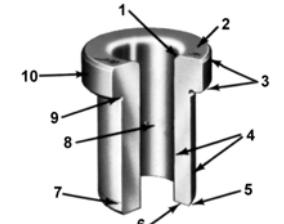


Guides, Tech Service, & Reference Charts

Technical
Information

MEASUREMENTS and CONVERSIONS

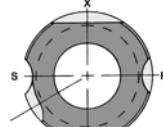
UNITED features
an assortment of
TECHNICAL INFORMATION
in **SECTION V**,
including several types of
BUSHING USES,
DRILL SIZE CONVERSION TABLES,
INDUSTRY CONVERSION TABLES,
UNITED FACILITIES INFORMATION,
PART NAME INDEX
and
PART NUMBER INDEX.



BUSHING
CHARACTERISTICS Pg V7



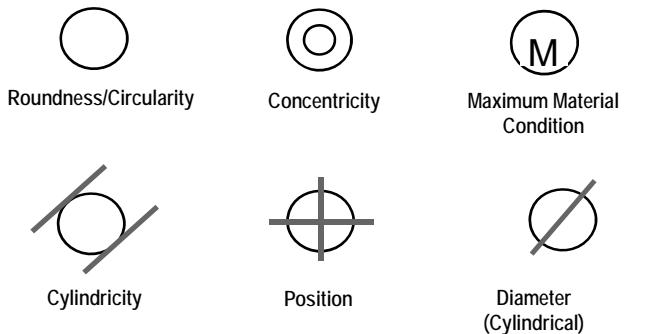
HOW TO SELECT
THE CORRECT BUSHING Pg V6



SFX HEAD
MULTI-USSES
Pg V9



MACHINIST GUIDES Pg V2



GUIDE FOR TOLERANCES & DIMENSIONING Pg V4

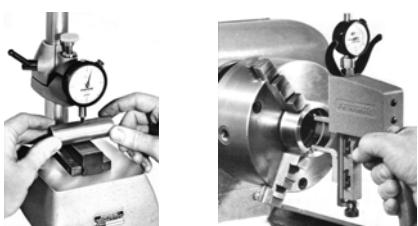
EASE IN

RADIUS
BUSHINGS



Pg V10 - V11

PUSH RODS
Pg V18 - V19



DRILL BUSHING USES & INSPECTION
Pg V14



STRESS COINING METHODS Pg V17



STRESS COINING TYPES Pg V16



3 - HAAS CNC Turning
Centers
Pg V15



28-Sunnen Stroker Automatic
Honing Gauging
Machines Pg V15

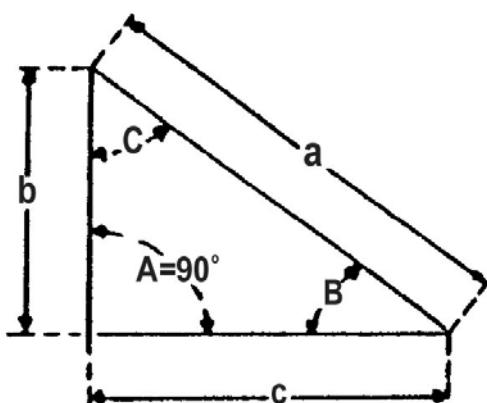
UNITED Headquarters DOWNEY, CA



UNITED FACILITIES AND EQUIPMENT LIST Pg V15

Machinists Guide Angles and Triangles

RIGHT ANGLE TRIANGLES



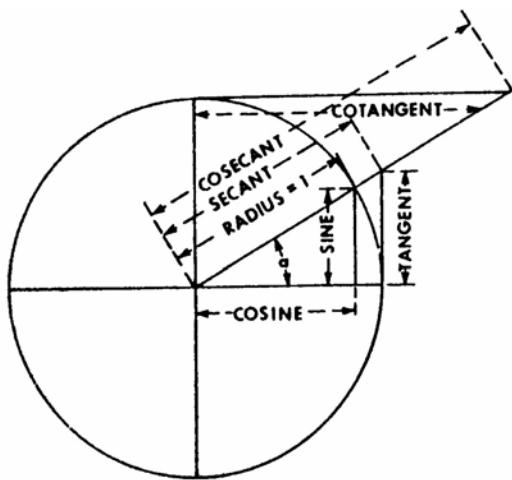
Solutions of Right-Angled Triangles

The sides of the right-angled triangle are designated a , b and c , as shown in the illustration to left. The angles opposite each of these sides are designated A , B and C , respectively.

Angle A , opposite the hypotenuse a is the right angle, and is always one of the known quantities.

Sides and Angles Known	Formulas for Sides and Angles to be Found		
Sides a and b	$c = \sqrt{a^2 - b^2}$	$\sin B = \frac{b}{a}$	$C = 90^\circ - B$
Sides a and c	$c = \sqrt{a^2 - b^2}$	$\sin C = \frac{b}{a}$	$B = 90^\circ - C$
Sides b and c	$c = \sqrt{a^2 - b^2}$	$\tan B = \frac{b}{c}$	$C = 90^\circ - B$
Side a and angle B	$b = a \times \sin B$	$c = a \times \cos B$	$C = 90^\circ - B$
Side a and angle C	$b = a \times \cos C$	$c = a \times \sin C$	$B = 90^\circ - C$
Side b and angle B	$a = \frac{b}{\sin B}$	$c = b \times \cot B$	$C = 90^\circ - B$
Side b and angle C	$a = \frac{b}{\cos C}$	$c = b \times \tan C$	$B = 90^\circ - C$
Side c and angle B	$a = \frac{c}{\cos B}$	$b = c \times \tan B$	$C = 90^\circ - B$
Side c and angle C	$a = \frac{c}{\sin C}$	$b = c \times \cot C$	$B = 90^\circ - C$

FUNCTIONS of ANGLES



FORMULAS for finding the LENGTH of SIDES for RIGHT-ANGLE TRIANGLES when an ANGLE and SIDE ARE KNOWN.

Length of Hypotenuse	Side Opposite x Cosecant Side Opposite x Sine Side Adjacent x Secant Side Adjacent x Cosine
Length of Side Opposite	Hypotenuse x Sine Hypotenuse x Cosecant Side Adjacent x Tangent Side Adjacent x Cotangent
Length of Side Adjacent	Hypotenuse x Cosine Hypotenuse x Secant Side Opposite x Cotangent Side Opposite x Tangent

FORMULAS for finding FUNCTIONS of ANGLES

Side Opposite = SINE Hypotenuse	Side Adjacent = COTANGENT Side Opposite
Side Adjacent = COSINE Hypotenuse	Hypotenuse = SECANT Side Adjacent
Side Opposite = TANGENT Side Adjacent	Hypotenuse = COSECANT Side Opposite

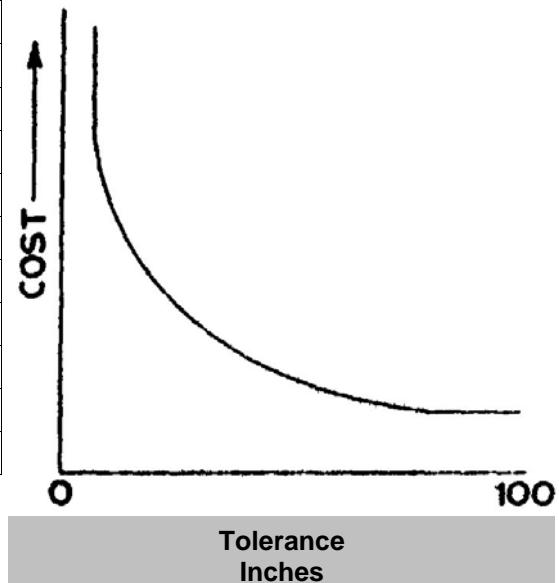
Machinists Guide

Surface Roughness

Technical Information

MACHINE FINISHES	VERY ROUGH								VERY FINE		
ROUGHNESS VALUES	1000	500	250	125	63	32	16	8	4	2	1
Cutting Torch, Chip and Saw	500										
Hand Grind	250										
Disk Grind or File	125										
Lathe, Shaper, Mill	32										
Bore	16										
Drill	125										
Rearm	125										
Surface Grind	16										
Cylindrical Grind	16										
Hone or Lap	16										
Polish or Buff	16										
Superfinish	8										

COST—TOLERANCE— SURFACE ROUGHNESS

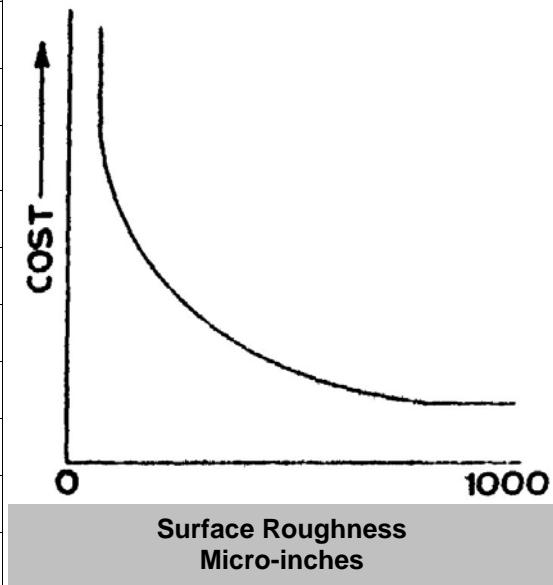


The Relationships of Cost, Tolerance and Surface Roughness
Are shown above and below.

Machining to Close Tolerances and Low Surface Roughness
Consumes more time than does rougher work.
Hence, the cost is higher.

SURFACE ROUGHNESS ASSOCIATED WITH COMMON PRODUCTION OPERATIONS

RANGE of TOTAL TOLERANCE, INCHES	SYMBOL (in Micro-inches)	TYPICAL MACHINING OPERATIONS
0.062 to 0.125	1000 \AA	Flame Cutting
0.015 to 0.062	500 \AA	Snag Grind, Sand Casting
0.010 to 0.015	250 \AA	Saw, Forging, Permanent Mold Casting
0.005 to 0.010	125 \AA	Rough Turn, Drill, Shape, Mill, Bore
0.002 to 0.005	64 \AA	Smooth Turn, Shape, Mill, Bore, Reram
0.0005 to 0.002	32 \AA	Grind, Smooth Turn and Polish
0.0002 to 0.0005	16 \AA	Grind, Hone, Burnish
0.0001 to 0.0002	8 \AA	Grind, Hone, Burnish
0.0004 to 0.0001	4 \AA	Lap, Polish, Superfinish



Guide for Tolerances and Dimensioning

SYMBOLS and THEIR CHARACTERISTICS

CHARACTERISTIC	ANSI Y14.5
Straightness	—
Flatness	
Roundness (Cirularity)	
Cylindricity	
Profile of a Line	
Profile of a Surface	
Parallelism	
Perpendicularity (Squareness)	
Angularity	
Position	
Concentricity (Coaxiality)	
Symmetry	
Maximum Material Condition	
Diameter (Cylindrical)	
Circular Runout	
Total Runout	
Datum Identification	
Reference Dimension	(X.XXX)
Basic Dimension	
Regardless of Feature Size	
Projected Tolerance Zone	
Datum Target	
Part Symmetry	NONE
Taper per Inch	T.P.I.
Shape of Tolerance Zone	Zone is total width. Specified where Zone is Circular or Cylindrical.
Radial Tolerance and Zone	
Sequence within the Feature Control Symbol	

The allowances given in the tables on the right have been found useful in the manufacture of machine parts. For special cases, it may be necessary to increase or decrease these allowances.

ALLOWANCES FOR FITS

RUNNING FITS		
Diameter, Inches	For Shafts with Speeds under 600 rpm. Ordinary Working Conditions Allowances, Inches	For Shafts with Speeds over 600 rpm. Severe Working Conditions Allowances, Inches
Up to 1/2	-0.0005 to -0.001	-0.0005 to -0.001
1/2 to 1	-0.00075 to -0.0015	-0.001 to -0.002
1 to 2	-0.0015 to -0.0025	-0.002 to -0.003
2 to 3-1/2	-0.002 to -0.003	-0.003 to -0.004
3-1/2 to 6	-0.0025 to -0.004	-0.004 to -0.005

SLIDING FITS		
Diameter, Inches	For Shafts with Gears, Clutches or Similar Parts which Must be Free to Slide Allowances, Inches	
Up to 1/2	-0.0005 to -0.001	
1/2 to 1	-0.00075 to -0.0015	
1 to 2	-0.0015 to -0.0025	
2 to 3-1/2	-0.002 to -0.003	
3-1/2 to 6	-0.0025 to -0.004	

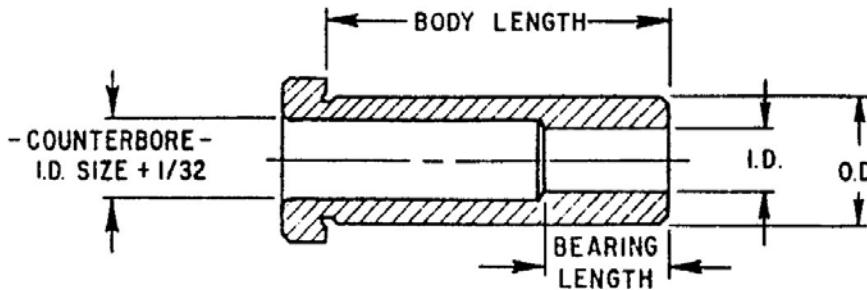
STANDARD FITS		
Diameter, Inches	For Light Service where Part is Keyed to Shaft and Clamped Endwise—No Fitting Allowances, Inches	With Play Eliminated—Part should Assemble Readily—Some Fitting & Selecting may be required Allowances, Inches
Up to 1/2	Standard to -0.00025	Standard to +0.00025
1/2 to 3-1/2	Standard to -0.0005	Standard to +0.0005
3-1/2 to 6	Standard to -0.00075	Standard to +0.00075

DRIVING FITS		
Diameter, Inches	For Permanent Assembly of Parts so Located that Driving Cannot be Done Readily Allowances, Inches	For Permanent Assembly and Severe Duty and where there is Ample Room for Driving Allowances, Inches
Up to 1/2	Standard to +0.00025	+0.0005 to +0.001
1/2 to 1	+0.00025 to +0.0005	+0.0005 to +0.001
1 to 2	+0.0005 to +0.00075	+0.0005 to +0.001
2 to 3-1/2	+0.0005 to +0.001	+0.00075 to +0.00125
3-1/2 to 6	+0.0005 to +0.001	+0.001 to +0.0015

FORCED FITS		
Diameter, Inches	For Permanent Assembly and very Severe Service—Hydraulic Press Used for Larger Parts Allowances, Inches	
Up to 1/2	+0.00075 to +0.001	
1/2 to 1	+0.001 to +0.002	
1 to 2	+0.002 to +0.003	
2 to 3-1/2	+0.003 to +0.004	
3-1/2 to 6	+0.004 to +0.005	

Counterbore Tables

Technical
Information



COUNTERBORE TABLES

For use when it is necessary to specify Counterbores in A.N.S.I. Standard or Thinwall Series Bushings in Ground or Unground O.D.s.

For SLIP, SLIP FIT and SLIP FIXED RENEWABLE TYPE BUSHINGS

Types: S, SF, and SFX

Counterbore 1/32 Larger than I.D. leaving Bearing Length Shown.

Bearing Length for I.D. Range Shown: O = No Counterbore X = Not Standard Manufacture

BODY LENGTH	.0135 To .0280	.0292 To .0469	.0520 To .0625	.0635 To .0995	.1015 To .1406	.1440 To .1875	.1890 To .2500	.2570 To .3125	.3160 To .4375	.4531 To .6875
1/4	1/4	5/16	0	0	0	0	0	0	0	0
5/16	5/16	5/16	5/16	5/16	0	0	0	0	0	0
3/8	5/16	5/16	5/16	7/16	7/16	0	0	0	0	0
1/2	5/16	7/16	7/16	7/16	7/16	0	0	0	0	0
5/8	5/16	7/16	7/16	7/16	7/16	0	0	0	0	0
3/4	5/16	7/16	7/16	7/16	5/8	5/8	0	0	0	0
1"	X	7/16	7/16	7/16	5/8	5/8	5/8	5/8	0	0
1-3/8	X	X	X	X	1	1	1	1	0	0
1-3/4	X	X	X	X	X	1	1	1	1-1/2	0
2-1/8	X	X	X	X	X	X	1	1	1-1/2	0
2-1/2	X	X	X	X	X	X	X	1-1/2	1-1/2	1-1/2
3"	X	X	X	X	X	X	X	1-1/2	1-1/2	1-1/2

For HEAD and HEADLESS PRESS FIT TYPE BUSHINGS

Types: P and H

Counterbore 1/32 Larger than I.D. leaving Bearing Length Shown.

Bearing Length for I.D. Range Shown: O = No Counterbore X = Not Standard Manufacture

BODY LENGTH	.0135 To .0280	.0292 To .0469	.0520 To .0625	.0635 To .0995	.1015 To .1406	.1440 To .1875	.1890 To .2500	.2570 To .3125	.3160 To .4375	.4531 To .6875
	P	H	P	H	P	H	P	H	P	H
1/4	O	O	0	0	0	0	0	0	0	0
5/16	O	1/4	0	0	0	0	0	0	0	0
3/8	1/4	5/16	0	5/16	0	0	0	0	0	0
1/2	5/16	5/16	5/16	5/16	5/16	0	5/16	0	0	0
5/8	5/16	5/16	5/16	5/16	5/16	0	5/16	0	0	0
3/4	5/16	5/16	5/16	5/16	7/16	7/16	7/16	7/16	0	0
1"	5/16	5/16	5/16	5/16	7/16	5/8	5/8	5/8	5/8	0
1-3/8	X	X	X	X	X	5/8	5/8	5/8	5/8	0
1-3/4	X	X	X	X	X	5/8	5/8	5/8	5/8	0
2-1/8	X	X	X	X	X	X	X	5/8	1	1
2-1/2	X	X	X	X	X	X	X	X	1	1
3"	X	X	X	X	X	X	X	X	1	1

DRILL BUSHINGS are precision tools that guide cutting tools into precise locations of a workpiece.

PROBLEM: During the drilling process, a drill point is brought to bear on a workpiece. Thrust causes deflection of the drill axis. As the drill bends, the point will wander on the workpiece surface until the thrust force is sufficient to cause the cutting edge of the drill to break through the workpiece metal. The actual point at which the cutting begins can be anywhere in the area traversed by the wandering drill point. **Accurate location under those circumstances is impossible.**

SOLUTION: To assure accuracy of hole location and to minimize drill bending and breakage, **mount a UNITED Drill Bushing directly above the intended hole location in a jig or fixture. The drill will then pass thru the bushing before engaging the workpiece. The bushing will support the drill as thrust is concentrated on the drill chisel point. Bending and wandering are eliminated and accurate hole size and location are assured.**

Drill Bushing Types are designed for Specific Applications. Select below. Refer to Section A for variations.

	P	<p>Headless Press Fit Bushings are used in single stage drilling operations. They are the least expensive bushing type and are ideally suited for low production runs in low cost jigs or fixtures where bushings don't need replacement. To install, use a hand arbor to press the bushing into the drilled hole in the jig until the bushing is flush with the jig plate. These plain bushings have hundreds of alternate uses from I.D. gauges to molds for resistors. Headless bushings allow closer spacing of holes than others.</p>
	H	<p>Head Press Fit Bushings are also used in single stage operations. The head provides an additional location reference and prevents the bushing from passing through the jig when drilling pressure is extreme.</p>
	SF	<p>Slip Fixed Renewable Bushings are ideally suited for use in long run production jobs where a bushing needs occasional replacement. They are used with either head or headless type Liners and are fastened in place with a lock screw that couples with a milled recess in the head. They are used in multiple operations such as drilling and reaming performed on the same jig. With a simple turn, the bushing can be removed without removing the lock screw. Thinwall types are also available.</p>
	N	<p>Nurlock Embedment Bushings are designed for use in jigs fabricated from plastic laminated castable materials. These bushings will securely mold into these materials for a permanent bond. When properly installed, they will not twist or pull out under normal drilling conditions.</p>
	L	<p>Liner Bushings are Headless Press Fit that are pressed permanently into a jig plate when renewable types of bushings are used. The Liners remain in location throughout the life of the jig serving as an accurate location for the renewable bushings.</p>
	HL	<p>Head Liner Bushings have a head and are used in a similar manner as headless liners. These Head Liners usually necessitate counterboring in the jig to offset the head. Head Liners are used where excessive pressure or pounding will occur from the drilling operation.</p>

Guides for Bushing Characteristics & Use

Technical Information

UNITED DRILL BUSHINGS

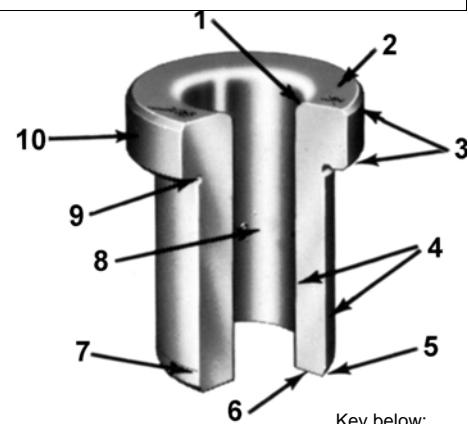
Bushing Materials	Bushings are usually made of premium tool steel. They are also manufactured from special materials such as alloy steels, tungsten carbide, graphitized steel, aluminum, bronze, brass and other alloys that will produce a variety of improved bushing effectiveness.
Bushings O.D.	Bushings with grinding stock on the O.D. are available (unground). O.D. is oversize (.015) so the toolmaker can custom fit bushing into jig or fixture.
Life of Bushings	Life of an average bushing is usually 5,000 to 10,000 pieces. Variables affecting bushing life are the skill of the operator, use of cutting fluid, tool sharpness and whether the operation is by hand or automatic drill machine.

Jig Boring and Grinding Size Chart			
NOMINAL BUSHING O.D.	JIG BORE HOLE SIZE	BUSHING O.D.	
		PRESS FIT TYPE	SLIP FIT TYPE
13/64	.2037 .2040	.2046 .2043	.2031 .2029
1/4	.2507 .2510	.2516 .2513	.2500 .2498
5/16	.3132 .3135	.3141 .3138	.3125 .3123
13/32	.4069 .4072	.4078 .4075	.4062 .4060
1/2	.5007 .5010	.5017 .5014	.5000 .4998
5/8	.6257 .6260	.6267 .6264	.6250 .6248
3.4	.7507 .7510	.7518 .7515	.7500 .7498
7/8	.8757 .8760	.8768 .8765	.8750 .8748
1"	1.0007 1.0010	1.0018 1.0015	1.0000 .9998
1-3/8	1.3757 1.3760	1.3772 1.3768	1.3750 1.3747
1-3.4	1.7507 1.7510	1.7523 1.7519	1.7500 1.7497
2-1/4	2.2507 2.2510	2.2525 2.2521	2.2500 2.2496

Tips to Increase Bushing and Cutting Tool Life	
1	Insert Press Fit Bushings with an arbor press. Lubricate the bushing O.D. and lead.
2	Follow recommended interference fits and do not over-press. Check I. D. for collapse before using.
3	Align drill with axis of bushing. Poor alignment wears out drills and bushings.
4	Use sharp cutting tools. Dull tools wear bushings and produce poor results
5	Cool your drilling operation with either a flow or mist lubricant. Drill life is increased many times.
6	Allow one to one-and-a-half times the drill diameter between the exit-end of the bushing and the work piece. Chips need to clear, or they will choke the I.D. of the bushing.
7	When drilling extremely close tolerance holes, hold the exit-end of the bushing flush against the workpiece. Use Slip Fixed Renewables whenever possible for this type accuracy.
8	Use the longest possible bushing guide while allowing for chip clearance.
9	Use the Slip Fixed Bushing in place of either Fixed or Slip. Its versatility will lower your costs.
10	Keep sets of bushings in your crib. You will lower your emergency costs.

REFERENCE: See our **Catalog Section A** for details of all types of Bushings available.

ORDERING: See page A2 for format of Bushing Part numbers. On the following pages in Section A are Specifications.



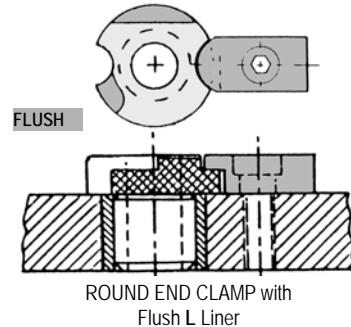
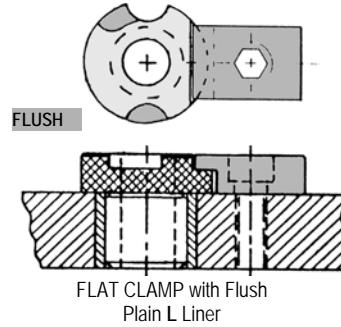
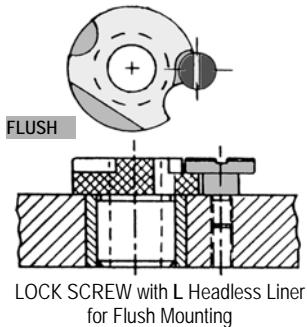
Key below:

- 3,400 ADDITIONAL standard types / sizes not catalogued by competitors.
- COMPLETE EXTENDED RANGE sizes from 3/4" to 7" in length to 5" I.D.
- A FULL LINE of Circuit Board Bushings at standard catalog prices.
- UNITED manufactures precision parts and tooling to your specifications.
- THE MAJORITY of our bushings in stock are non-counterbored full bearing and are provided at catalog prices. If you have a preference, add the suffix NCB for non-counterbore and CB for counterbore. We reserve the right to provide counterbore in micro sizes and extra long lengths at catalog prices.

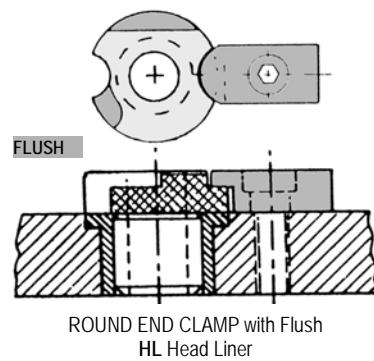
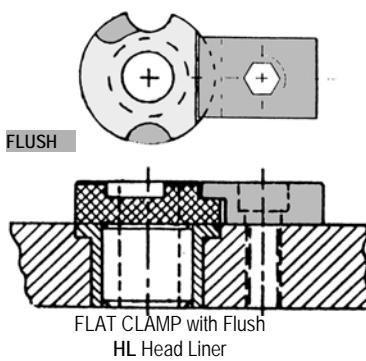
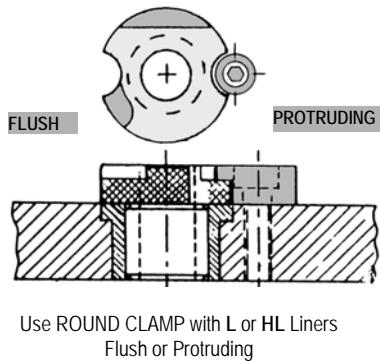
1. RADIUS blended and polished for smooth entry of drill.
2. SIZE clearly marked on each Bushing
3. HEAD double-chamfered and polished. Replaceable types are knurled for easier handling.
4. CONCENTRICITY .0003 to .0005 T.I.R. depending upon size.
5. 45° CHAMFERED and polished end eases entry into jig.
6. TOLERANCE on length held ±.010.
7. CONCENTRIC LEAD ground lead provided initial alignment.
8. HARDNESS in hole: Rockwell C61-65.
9. DOUBLE UNDERCUT keeps bushing flat against jig plate.
10. 100% FINAL INSPECTION of every Bushing.

Recommended Bushing Installations

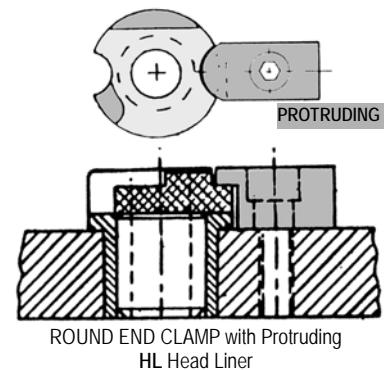
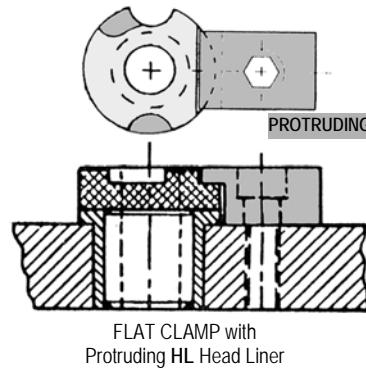
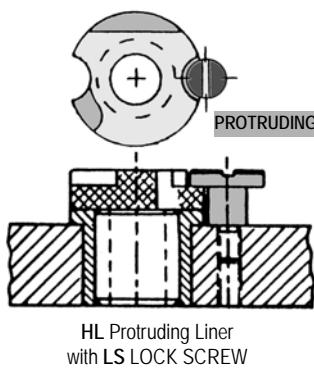
With HEADLESS LINER (Type 'L') FLUSH Mounting



With HEAD LINER (Type 'HL') FLUSH Mounting



With HEAD LINER (Type 'HL') PROJECTED Liner



LOCK SCREWS

Provide Close Hole Spacing

ROUND CLAMPS

Give Greater Security than Lock Screws with Close Holes

ROUND END CLAMPS

Have a Larger Bearing Surface

FLAT CLAMPS

Provide Maximum Clamping Security

Guides for Bushings

Technical
Information

ANSI I.D. TOLERANCES and ORDERING FORMAT

CONCENTRICITY — T.I.R. (Total Indicator Reading):

1/8" to 1/2" I.D. — .0003" max. All other sizes are T.I.R. .0005" max.

HARDNESS:

Rockwell RC61-65 in the hole.

RADIUS COUNTERSINK:

UNITED features a radius countersink at the drill exit end.

LEAD:

Concentric ground lead .001 to .002 smaller than O.D.



P-PU-PTE
HEADLESS PRESS FIT



H-HU-HTE
HEAD PRESS FIT

TOLERANCE ON INSIDE DIAMETER

For DRILL BUSHINGS

I. D. RANGE	TOLERANCE OVER NOM.		
Up to .2500	+.0001	to	+.0004
Over .2500 to .7500	+.0001	to	+.0005
Over .7500 to 1.5000	+.0002	to	+.0006
Over 1.5000 and Up	+.0003	to	+.0007

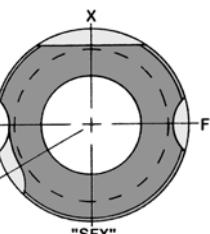
For REAMER BUSHINGS

Up to .2500	+.0005	to	+.0008
Over .2500 to 1.0000	+.0006	to	+.0010
Over 1.0000	+.0008	to	+.0012

REAMER BUSHINGS: Specify "Reamer Bushing." Bushings will be furnished at extra charge with correct clearance according to your specifications. Reamer Bushings are stamped with the letter "R" and are normally supplied in type SF only. Specify Reamer Size if different than chart.



UL
UNI-LOCK LINER



**SFX — One size
does it all!**



SF-SFX-SFTE-SFXN
SLIP FIXED RENEWABLE



HL-HLU
HEAD LINER



L-LU-LTE
HEADLESS LINER

EASY STEPS FOR ACCURATE ORDERING THE UNITED WAY

5-STEP	1	2	3	4	5	UNITED QUALITY DRILL BUSHINGS
ORDER PLAN	QUANTITY	TYPE	I.D.	O.D.	LENGTH	
EXAMPLE:	25	P	1/4	1/2	1	
ANSI EXAMPLE:	25	P	1/4	32	16	
Over 2,500,000 Units Finished Stock, 3,000,000 Units In-Process and 2,000,000 Blanks in stock.						

Ease In Radius

Easy Entrance to Bushing I. D.s

NOW!
YOU CAN'T MISS THE HOLE
WITH UNITED'S EXCLUSIVE

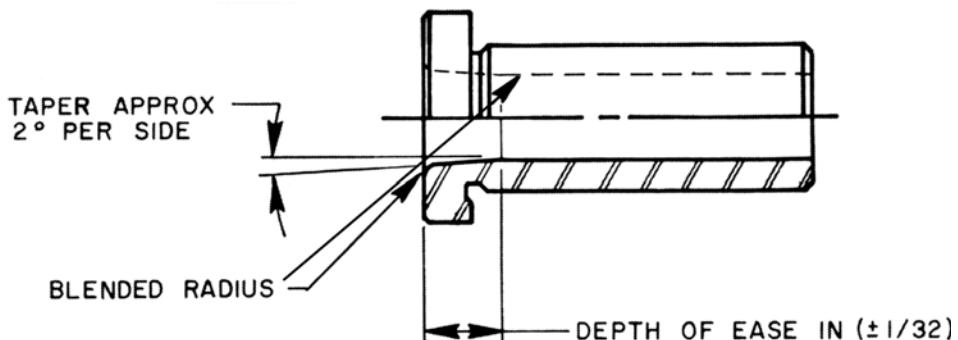


EASE IN

RADIUS

Close tolerances are required to warrant accuracies between Renewable Bushings and Liners. Tedious minutes are saved when inserting Renewables and Pins into Liners of types L and HL.

Provides radial relief, eliminating critical initial alignment.



The **UNITED** "EASE IN" RADII
Provide an easy entrance to the Bushing I.D.

THIS RADIUS ASSURES *UNITED* CUSTOMERS OF

- ① EASY ENTRY THAT IS IDEAL FOR 'SF' BUSHINGS AND LINERS**
- ② SIMPLICITY OF DRILL ENTRANCE AND LOCATION**
- ③ GREATER DRILL POINT LONGEVITY**
- ④ ELIMINATION OF COUNTERBORED BUSHINGS**
- ⑤ RETAINMENT OF FULL BEARING ADVANTAGES.**

Ease Out Chips With Non-Counterbored Bushings

Call Us, It's Easy!

UNITED's "Ease In" Radius is provided at Minimal Additional Cost while complementing all Non-Counterbore, Full Bearing Standard Liners and Head Liners or Special Bushings.

SLIP AND FIXED-STANDARD

O.D. NOMINAL	EASE IN I.D. RANGE	EASE IN DEPTH		LENGTHS EASED IN
		SLIP	FIXED	
3 / 32	0135 - 0330	3 / 16	3 / 16	3 / 8 and LONGER
	0135 - 0330			3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
	0460 - 0550			3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0135 - 0330			3 / 8 and LONGER
1 / 8	0135 - 0330	3 / 16	3 / 16	3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
	0460 - 0550			3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0135 - 0330			3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
5 / 32	0460 - 0550	3 / 16	3 / 16	3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0730 - 0890			5 / 8 and LONGER
	0935 - 1000			5 / 8 and LONGER
	0135 - 0330			3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
3 / 16	0460 - 0550	1 / 4	1 / 4	3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0730 - 0890			5 / 8 and LONGER
	0935 - 1000			5 / 8 and LONGER
	0135 - 0330			3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
5 / 16	0460 - 0550	7 / 16	5 / 16	3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0730 - 0890			5 / 8 and LONGER
	0935 - 1000			5 / 8 and LONGER
	1015 - 1150			3 / 4 and LONGER
	1160 - 1400			3 / 4 and LONGER
1 / 2	1405 - 1520	1 / 2	5 / 16	1 and LONGER
	1540 - 1770			1 and LONGER
	1800 - 1990			1 and LONGER
	2010 - 2280			1-3 / 8 and LONGER
	2340 - 2570			1-3 / 8 and LONGER
	2610 - 2811			1-3 / 4 and LONGER
3 / 4	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480	1 / 2	5 / 16	1-3 / 4 and LONGER

SLIP AND FIXED - THINWALL

O.D. NOMINAL	EASE IN I.D. RANGE	EASE IN DEPTH		LENGTHS EASED IN
		SLIP	FIXED	
3 / 16	0600 - 0700	1 / 4	5 / 16	3 / 8 and LONGER
	0730 - 0890			1 / 2 and LONGER
	0935 - 1000			1 / 2 and LONGER
	0935 - 1000			1 / 2 and LONGER
	1015 - 1150			1 / 2 and LONGER
	1160 - 1400			5 / 8 and LONGER
1 / 4	1405 - 1520	1 / 4	5 / 16	3 / 4 and LONGER
	1405 - 1520			1 and LONGER
	1540 - 1770			1 and LONGER
	1800 - 1990			1 and LONGER
	2010 - 2280			1-3 / 8 and LONGER
	2340 - 2570			1-3 / 8 and LONGER
5 / 16	2610 - 2811	5 / 16	5 / 16	1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
3 / 8	1800 - 1990	5 / 16	5 / 16	1 and LONGER
	2010 - 2280			1 and LONGER
	2340 - 2570			1-1 / 2 and LONGER
	2610 - 2811			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
7 / 16	2812 - 3480	5 / 16	5 / 16	1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
9 / 16	2812 - 3480	7 / 16	5 / 16	1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER

HEAD PRESS FIT - STANDARD

O.D. NOMINAL	EASE IN I.D. RANGE	EASE IN DEPTH		LENGTHS EASED IN
		SLIP	FIXED	
3 / 32	0135 - 0330	3 / 16	3 / 16	3 / 8 and LONGER
	0135 - 0330			3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
	0460 - 0550			3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0135 - 0330			3 / 8 and LONGER
1 / 8	0135 - 0330	3 / 16	3 / 16	3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
	0460 - 0550			3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0135 - 0330			3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
5 / 32	0460 - 0550	3 / 16	3 / 16	3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0730 - 0890			5 / 8 and LONGER
	0935 - 1000			5 / 8 and LONGER
	0135 - 0330			3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
13 / 64	0460 - 0550	1 / 4	1 / 4	3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0730 - 0890			5 / 8 and LONGER
	0935 - 1000			5 / 8 and LONGER
	0935 - 1000			5 / 8 and LONGER
	1015 - 1150			3 / 4 and LONGER
1 / 4	1160 - 1400	5 / 32	5 / 32	3 / 4 and LONGER
	1405 - 1520			1 and LONGER
	1540 - 1770			1 and LONGER
	1800 - 1990			1 and LONGER
	2010 - 2280			1-3 / 8 and LONGER
	2340 - 2570			1-3 / 8 and LONGER
5 / 16	2610 - 2811	9 / 32	9 / 32	1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
	2812 - 3480			1-3 / 4 and LONGER
3 / 8	1800 - 1990	5 / 32	5 / 32	1 and LONGER
	2010 - 2280			1-1 / 4 and LONGER
	2340 - 2570			1-1 / 2 and LONGER
	2610 - 2811			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
7 / 16	2812 - 3480	5 / 32	5 / 32	1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
9 / 16	2812 - 3480	5 / 32	5 / 32	1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER

HEAD PRESS FIT - THINWALL

O.D. NOMINAL	EASE IN I.D. RANGE	EASE IN DEPTH		LENGTHS EASED IN
		SLIP	THINWALL	
3 / 16	0135 - 0330	5 / 32	5 / 32	3 / 8 and LONGER
	0350 - 0420			3 / 8 and LONGER
	0460 - 0550			3 / 8 and LONGER
	0600 - 0700			1 / 2 and LONGER
	0730 - 0890			5 / 8 and LONGER
	0935 - 1000			5 / 8 and LONGER
1 / 4	0935 - 1000	5 / 32	5 / 32	5 / 8 and LONGER
	1015 - 1150			3 / 4 and LONGER
	1160 - 1400			3 / 4 and LONGER
	1405 - 1520			1 and LONGER
	1405 - 1520			1 and LONGER
	1540 - 1770			1 and LONGER
5 / 16	1800 - 1990	5 / 32	5 / 32	1 and LONGER
	2010 - 2280			1-1 / 4 and LONGER
	2340 - 2570			1-1 / 2 and LONGER
	2610 - 2811			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
	2812 - 3480			1-1 / 2 and LONGER
3 / 8	1800 - 1990	5 / 32	5 / 32	1 and LONGER
	2010 - 2280			1-1 / 4 and LONGER
	2340 - 2570			1-1 / 2 and LONGER
	2610 - 2811			1-1 / 2 and LONGER

THOSE NOT LISTED ARE SPECIALS IN METRIC AND INCHES.

METRIC	INCH	DECIMAL	METRIC	INCH	DECIMAL									
80	.0135		49	.0730	4.10		.1614		J	.2770	11.50		.4528	
0.35	.0138	1.90		.0748	4.20		.1654	7.10		.2795		29/64	.4531	
79	.0145		48	.0760		19	.1660		K	.2810	11.80		.4646	
0.38	.0150	1.95		.0768	4.25		.1673		9/32	.2812		15/32	.4687	
1/64	.0156		5/64	.0781	4.30		.1693	7.20		.2835	12.00		.4724	
0.40	.0157		47	.0785		18	.1695	7.25		.2854	12.20		.4803	
78	.0160	2.00		.0787		11/64	.1719	7.30		.2874		31/64	.4843	
0.42	.0165	2.05		.0807		17	.1730		L	.2900	12.50		.4921	
0.45	.0177		46	.0810	4.40		.1732	7.40		.2913		1/2	.5000	
77	.0180		45	.0820		16	.1770		M	.2950	13.00		.5118	
0.48	.0189	2.10		.0827	4.50		.1772	7.50		.2953		33/64	.5156	
0.50	.0197	2.15		.0846		15	.1800		19/64	.2968		17/32	.5312	
76	.0200		44	.0860	4.60		.1811	7.60		.2992	13.50		.5315	
75	.0210	2.20		.0866		14	.1820		N	.3020		35/64	.5469	
0.55	.0217	2.25		.0886	4.70	13	.1850	7.70		.3031	14.00		.5512	
74	.0225		43	.0890	4.75		.1870	7.75		.3051		9/16	.5625	
0.60	.0236	2.30		.0906		3/16	.1875	7.80		.3071	14.50		.5709	
73	.0240	2.35		.0925	4.80	12	.1890	7.90		.3110		37/64	.5781	
72	.0250		42	.0935		11	.1910		5/16	.3125	15.00		.5906	
0.65	.0256		3/32	.0937	4.90		.1929	8.00		.3150		19/32	.5937	
71	.0260	2.40		.0945		10	.1935		O	.3160		39/64	.6094	
0.70	.0276		41	.0960		9	.1960	8.10		.3189	15.50		.6102	
70	.0280	2.45		.0965	5.00		.1969	8.20		.3228		5/8	.6250	
69	.0292		40	.0980		8	.1990		P	.3230	16.00		.6299	
0.75	.0295	2.50		.0984	5.10		.2008	8.25		.3248		41/64	.6406	
68	.0310		39	.0995		7	.2010	8.30		.3268	16.50		.6496	
1/32	.0313	2.55		.1004		13/64	.2031		21/64	.3281		21/32	.6562	
0.80	.0315		38	.1015		6	.2040	8.40		.3307	17.00		.6693	
67	.0320	2.60		.1024	5.20		.2047		Q	.3320		43/64	.6719	
66	.0330		37	.1040		5	.2055	8.50		.3346		11/16	.6875	
0.85	.0335	2.65		.1043	5.25		.2067	8.60		.3386	17.50		.6890	
65	.0350	2.70		.1063	5.30		.2087		R	.3390		45/64	.7031	
0.90	.0354		36	.1065		4	.2090	8.70		.3425	18.00		.7087	
64	.0360	2.75		.1083	5.40		.2126		11/32	.3437		23/32	.7187	
63	.0370		7/64	.1093		3	.2130	8.75		.3445	18.50		.7283	
0.95	.0374		35	.1100	5.50		.2165	8.80		.3465		47/64	.7344	
62	.0380	2.80		.1102		7/32	.2187		S	.3480	19.00		.7480	
61	.0390		34	.1110	5.60		.2205	8.90		.3504		3/4	.7500	
1.00	.0394		33	.1130		2	.2210	9.00		.3543		49/64	.7656	
60	.0400	2.90		.1142	5.70		.2244		T	.3580	19.50		.7677	
59	.0410		32	.1160	5.75		.2264	9.10		.3583		25/32	.7812	
1.05	.0413	3.00		.1181		1	.2280		23/64	.3594	20.00		.7874	
58	.0420		31	.1200	5.80		.2283	9.20		.3622		51/64	.7969	
57	.0430	3.10		.1220	5.90		.2323	9.25		.3642	20.50		.8071	
1.10	.0433		1/8	.1250		A	.2340	9.30		.3661		13/16	.8125	
1.15	.0453	3.20		.1260		15/64	.2344		U	.3680		21/00	.8268	
56	.0465	3.25		.1280	6.00		.2362	9.40		.3701		53/64	.8281	
3/64	.0469		30	.1285		B	.2380	9.50		.3740		27/32	.8437	
1.20	.0472	3.30		.1299	6.10		.2402		3/8	.3750	21.50		.8465	
1.25	.0492	3.40		.1339		C	.2420		V	.3770		55/64	.8594	
1.30	.0512		29	.1360	6.20		.2441	9.60		.3780	22.00		.8661	
55	.0520	3.50		.1378		D	.2460	9.70		.3819		7/8	.8750	
1.35	.0531		28	.1405	6.25		.2461	9.75		.3839	22.50		.8858	
54	.0550		9/64	.1406	6.30		.2480	9.80		.3858		57/64	.8906	
1.40	.0551	3.60		.1417		E	.2500		W	.3860	23.00		.9055	
1.45	.0571		27	.1440		1/4	.2500	9.90		.3898		29/32	.9062	
1.50	.0591	3.70		.1457	6.40		.2520		25/64	.3906		59/64	.9219	
53	.0595		26	.1470	6.50		.2559	10.00		.3937	23.50		.9252	
1.55	.0610	3.75		.1476		F	.2570		X	.3970		15/16	.9375	
1/16	.0625		25	.1495	6.60		.2598	10.20		.4016	24.00		.9449	
1.60	.0630	3.80		.1496		G	.2610		Y	.4040		61/64	.9531	
52	.0635		24	.1520	6.70		.2638		13/32	.4062	24.50		.9646	
1.65	.0650	3.90		.1535		17/64	.2656		Z	.4130		31/32	.9687	
1.70	.0669		23	.1540	6.75		.2657	10.50		.4134	25.00		.9843	
51	.0670		5/32	.1562		H	.2660		27/64	.4219		63/64	.9844	
1.75	.0689		22	.1570	6.80		.2677	10.80		.4252		1"	1.0000	
50	.0700	4.00		.1575	6.90		.2717	11.00		.4331		1-1/64	1.0156	
1.80	.0709		21	.1590		I	.2720		7/16	.4375	26.00		1.0236	
1.85	.0728		20	.1610	7.00		.2756	11.20		.4409		Series continued next page...		

LARGER STANDARDS METRIC: Plus 1.00MM increments up to 50.00MM — Plus 5.00MM increments up to 125.00MM
INCHES: Plus 1/64" increments up to 2" — Plus 1/32" increments up to 3" — Plus 1/16" increments up to 4" — Plus 1/8" increments up to 5"
 NON-STANDARD I.D.s ARE PRICED AS SPECIALS.

Extended Metric & Inch Sizes for Drills and Drill Bushings

STANDARD METRIC and STANDARD INCH

Extended Metric – Inch
Decimal Conversions
of Drill Sizes

METRIC	INCH	DECIMAL	METRIC	INCH	DECIMAL	METRIC	INCH	DECIMAL	METRIC	INCH	DECIMAL	METRIC	INCH	DECIMAL
	1"	1.0000		1-23/64	1.3594		1-23/32	1.7187		2-3/16	2.1875		3-1/8	3.1250
	1-1/64	1.0156		1-3/8	1.3750	44		1.7323		2-7/32	2.2187	80		3.1496
26		1.0236	35		1.3780		1-47/64	1.7344		2-1/4	2.2500		3-3/16	3.1875
	1-1/32	1.0313		1-25/64	1.3906		1-3/4	1.7500		2-9/32	2.2812		3-1/4	3.2500
	1-3/64	1.0469		1-13/32	1.4062		1-49/64	1.7656		2-5/16	2.3125		3-5/16	3.3125
	1-1/16	1.0625	36		1.4173	45		1.7717		2-11/32	2.3437	85		3.3465
27		1.0630		1-27/64	1.4219		1-25/32	1.7812	60		2.3622		3-3/8	3.3750
	1-5/64	1.0781		1-7/16	1.4375		1-51/64	1.7969		2-3/8	2.3750		3-7/16	3.4375
	1-3/32	1.0937		1-29/64	1.4531	46		1.8110		2-13/32	2.4062		3-1/2	3.5000
28		1.1024	37		1.4567		1-13/16	1.8125		2-7/16	2.4375	90		3.5433
	1-7/64	1.1093		1-15/32	1.4687		1-53/64	1.8281		2-15/32	2.4687		3-9/16	3.5625
	1-1/8	1.1250		1-31/64	1.4843		1-27/32	1.8437		2-1/2	2.5000		3-5/8	3.6250
	1-9/64	1.1406	38		1.4961	47		1.8504		2-17/32	2.5312		3-11/16	3.6875
29		1.1417		1-1/2	1.5000		1-55/64	1.8594	65		2.5591	95		3.7402
	1-5/32	1.1562		1-33/64	1.5156		1-7/8	1.8750		2-9/16	2.5625		3-3/4	3.7500
	1-11/64	1.1719		1-17/32	1.5312	48		1.8898		2-19/32	2.5937		3-13/16	3.8125
30		1.1811	39		1.5354		1-57/64	1.8906		2-5/8	2.6250		3-7/8	3.8750
	1-3/16	1.1875		1-35/64	1.5469		1-29/32	1.9062		2-21/32	2.6562	100		3.9370
	1-13/64	1.2031		1-9/16	1.5625		1-59/64	1.9219		2-11/16	2.6875		3-15/16	3.9375
	1-7/32	1.2187	40		1.5748	49		1.9291		2-23/32	2.7187		4"	4.0000
31		1.2205		1-37/64	1.5781		1-15/16	1.9375		2-3/4	2.7500		4-1/8	4.1250
	1-15/64	1.2344		1-19/32	1.5937		1-61/64	1.9531	70		2.7559	105		4.1339
	1-1/4	1.2500		1-39/64	1.6094	50		1.9685		2-25/32	2.7812		4-1/4	4.2500
32		1.2598	41		1.6142		1-31/32	1.9687		2-13/16	2.8125		4-3/8	4.3750
	1-17/64	1.2656		1-5/8	1.6250		1-63/64	1.9844		2-27/32	2.8437	110		4.3307
	1-9/32	1.2812		1-41/64	1.6406		2"	2.0000		2-7/8	2.8750		4-1/2	4.5000
	1-19/64	1.2968	42		1.6535		2-1/32	2.0313		2-29/32	2.9062	115		4.5276
33		1.2992		1-21/32	1.6562		2-1/16	2.0625		2-15/16	2.9375		4-5/8	4.6250
	1-5/16	1.3125		1-43/64	1.6719		2-3/32	2.0937	75		2.9528	120		4.7244
	1-21/64	1.3281		1-11/16	1.6875		2-1/8	2.1250		2-31/32	2.9687		4-3/4	4.7500
34		1.3386	43		1.6929		2-5/32	2.1562		3"	3.0000		4-7/8	4.8750
	1-11/32	1.3437		1-45/64	1.7031	55		2.1654		3-1/16	3.0625	125		4.9213
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												5"		
												5.0000		

INCH TAP GUIDE BUSHINGS—Select Type, O.D. & Length

INCH TAP SIZE	ACTUAL I.D.	INCH TAP SIZE	ACTUAL I.D.
0 - 80	.0616 - .0619	1/4 - 20	.2551 - .2555
1 - 64	.0746 - .0749	1/4 - 28	.2536 - .2540
1 - 72	.0746 - .0749	5/16 - 18	.3181 - .3185
2 - 56	.0876 - .0879	5/16 - 24	.3166 - .3170
2 - 64	.0876 - .0879	3/8 - 16	.3811 - .3815
3 - 48	.1011 - .1014	3/8 - 24	.3791 - .3795
3 - 56	.1006 - .1009	7/16 - 14	.4446 - .4450
4 - 40	.1146 - .1149	7/16 - 20	.4426 - .4430
4 - 48	.1141 - .1144	1/2 - 13	.5076 - .5080
5 - 40	.1276 - .1279	1/2 - 20	.5051 - .5055
5 - 44	.1271 - .1274	9/16 - 12	.5701 - .5705
6 - 32	.1411 - .1414	9/16 - 18	.5681 - .5685
6 - 40	.1406 - .1409	5/8 - 11	.6331 - .6335
8 - 32	.1671 - .1674	5/8 - 18	.6306 - .6310
8 - 36	.1666 - .1669	3/4 - 10	.7592 - .7596
10 - 24	.1941 - .1944	3/4 - 16	.7562 - .7566
10 - 32	.1931 - .1934	7/8 - 9	.8852 - .8856
12 - 24	.2201 - .2204	7/8 - 14	.8822 - .8826
12 - 28	.2196 - .2199	1 - 8	1.0112 1.0116
		1 - 14	1.0072 1.0076

METRIC TAP GUIDE BUSHINGS—Select Type, O.D. & Length

MM TAP SIZE	MM DRILL	INCH	MM BUSHING	INCH EQUIV.	BUSHING ACTUAL
1.6 x .35	1.25	.0492	1.65	.0650	.0651 - .0654
2 x .40	1.60	.0630	2.05	.0807	.0808 - .0811
2.5 x .45	2.05	.0807	2.56	.1007	.1008 - .1011
3 x .50	2.50	.0984	3.04	.1197	.1198 - .1201
3.5 x .60	2.90	.1142	3.50	.1378	.1379 - .1382
4 x .70	3.30	.1299	4.10	.1614	.1615 - .1618
4.5 x .75	3.70	.1457	4.60	.1811	.1812 - .1815
5 x .80	4.20	.1654	5.11	.2012	.2013 - .2016
6 x 1.00	5.00	.1969	6.12	.2049	.2050 - .2053
8 x 1.00	7.00	.2244	8.16	.3213	.3214 - .3217
8 x 1.25	6.80	.2677	8.20	.3228	.3229 - .3233
10 x 1.25	8.80	.3465	10.18	.4007	.4007 - .4012
10 x 1.50	8.50	.3346	10.20	.4016	.4017 - .4021
12 x 1.25	10.80	.4252	12.20	.4803	.4804 - .4808
12 x 1.75	10.20	.4016	12.25	.4823	.4824 - .4828
14 x 1.50	12.50	.4912	14.20	.5591	.5592 - .5595
14 x 2.00	12.00	.4724	14.25	.5610	.5611 - .5615
16 x 1.50	14.50	.5709	16.20	.6378	.6379 - .6383
16 x 2.00	14.00	.5512	16.25	.6398	.6399 - .6403
18 x 1.50	16.50	.6496	18.20	.7165	.7166 - .7170
18 x 2.50	15.50	.6102	18.25	.7185	.7186 - .7190
20 x 1.50	18.50	.7283	20.22	.7961	.7963 - .7967
20 x 2.50	17.50	.6890	20.26	.7976	.7978 - .7982
22 x 1.50	20.50	.8071	22.22	.8748	.8750 - .8754
22 x 2.50	19.50	.7677	22.26	.8764	.8766 - .8770
22 x 2.00	22.00	.8661	24.25	.9547	.9549 - .9553
22 x 3.00	21.00	.8268	24.34	.9583	.9585 - .9589

Drill Bushing Uses

DRILL BUSHINGS ARE USED IN:

Bearings
Build Ups
Cable Guides
Ceramic Rod Molds
Chain Guides
Chip Breaker Bushings
Circuit Board Drilling
Coolant Bushings
Counterboring
Custom Applications
Die Inserts and Liners
Drill Clearing Grinding
Bushings
Drill Flute Grinding
Bushings
Drilling
Gun Drilling
Handle Bushings
Hinge Bushings
Hole Reinforcers
I. D. Gauges
Indexing Plate Guides
Locating Buttons
Mold Inserts and Guides
O. D. Gauges
Oil Hole Bushings
Paper Punches and Punch Guides
Pilots
Pharmaceutical Measuring Pins,
 Dies and Tubes
Profile Spacers
Pins: Alignment
 Anchor
 Dowel Guide
 Stop
 Swing
Pulley Bushings
Reaming
Rivet Templates
Roller Bearing Bushings
Rollers
Sizers
Sleeves
Spacers
Spot Facing
Stripper Plate Guides
Swing Pin Fulcrums
Tapping
Template Bushings
Tool Holder Bushings
Valve Stem Guides
Wear Inserts
Wire Guides
Workholding Bushings

A Partial List for Drill Bushing Applications

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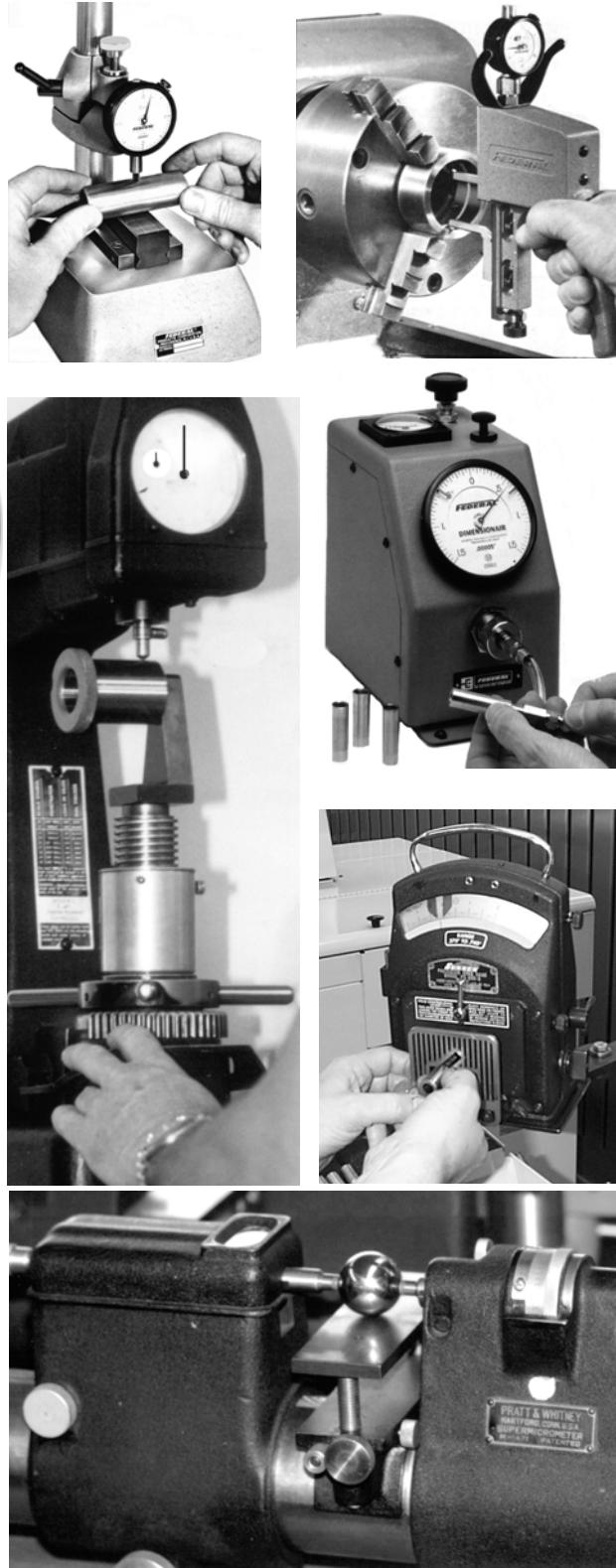


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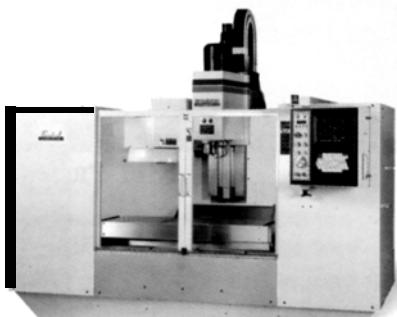


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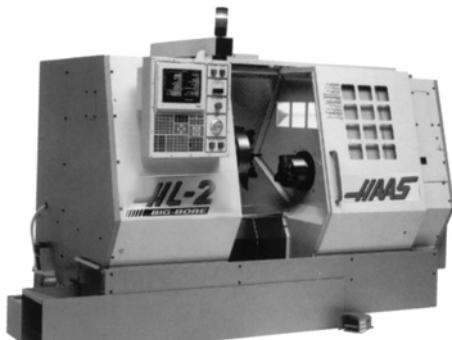


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4 - Vertical CNC Super Max Milling Centers

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3 - HAAS CNC Turning Centers to 14.5 x 34" Capacity
4 - Super Max CNC Turning Centers

MOLD PINS and BUSHINGS



40 - Acme Gridley Six Spindle Automatics with Bar Feeds

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28 - Sunnen Stroker Automatic Honing Machines

ROLLERS

PINS

WEAR PARTS

SPACERS

Federal & Starret Dial Bore Intermikes to 6" diameter Precisionaire Gauges
26 - Federal .000050 Air Gauges
15 - Black Granite Surface Plates
900 Carbide Plug Gauges
66 - Vernier Dial Bore Height Gauges
40 - 1/8" to 8" Sunnen & Federal Dial Bore Gauges
Pratt-Whitney Micro Finish Automatic Surface Analyzers
3 - Rockwell ABC Micro Surface Analyzers

Over 2,000 Micrometers, Dial Bore Gauges, Indicators, Electronic Gauging Equipment — to .00001

LATHE DEPARTMENT

12 - Turret Lathes — capacities to 6" Bar Feed
8 - Engine Lathes — capacities to 12" x 36"
10 - Hardinge Six Station Turret Lathes
4 - Levin Six Station Micro Hole Driller Lathes

MILLING DEPARTMENT

4 - Vertical CNC 2 & 3 Axis Mills 15" x 62"
4 - Fadal CNC Machining Centers — 3 and 4 axis
12 - Vertical Bridgeport 2HP Mills — 15" x 62" work tables
8 - Horizontal Mills — 15" x 72" work tables

GRINDING DEPARTMENT

24 - Landis External Grinders with .000010 readout — capacities to 8" x 18"
8 - Cincinnati & Centerless Grinders — capacity 1/32" to 6"
3 - Crystal Lake Center and Concentricity O.D. Grinders
8 - Heald Internal Grinders — capacities to 1/8" to 10"
3 - Bryant 1316 Semi Automatic Internal Grinders — 1/4" to 12" I.D.
6 - 1209 Bryant Automatic Internal Grinders to 3" I.D. x 4" Stroker
3 - 1109 Semi-automatic Internal Grinders to 3" I.D. x 4" Stroker
12 - 5A Bryant Internal Custom Precision Grinders 1/8" to 3" x 3"
4 - Automatic Surface Grinders — capacity to 15" x 42"
14 - Custom True Center and Concentricity O.D. Grinders
4 - Cincinnati Tool, Cutter and Carbide Tool Grinders
2 - Cincinnati Internal-External Universal Grinders — capacities to 18"
2 - Center Grinders

HONING AND LAPPING DEPARTMENT

28 - Sunnen Stroker Automatic Honing Machines — capacities to 3-1/2" diameter to 12" length
6 - Diamond Lapping Machines for small hole finishing to .005 diameters .0001 Min. Hole Tolerances

MISCELLANEOUS EQUIPMENT

6 - El Dorado Gun Drill Spindles .050-1.75
10 - Drill Presses
8 - Sunnen Reaming Machines
8 - Tumbling & Deburr Machines
5 - Polishing Machines
4 - Power Cold and Band Saws
5 - Cadillac Stamping Machines
4 - Marking Machines
4 - Etching Machines
18 - Deburring Machines
4 - Second Operation Hardinge Lathes
4 - Electromark Chemical Marking Machines
2 - Graphotype Machines
8 - Washing Machines
3 - Spitfire Lapping Machines
2 - Continuous Oil Groovers

40 AUTOMATIC SCREW MACHINES

3 - Five Spindle Davenports to 1"
1 - 6" Automatic Screw Machine
2 - Automatic Indexing Drillers

INSPECTION DEPARTMENT

3 - HAAS CNC Turning Centers to 14.5 x 34" Capacity
2 - Super Max CNC Turning Centers
Walden Radial Rake Cutting Tool Analyzer
Stocker & Yale Cutting Tool Analyzer
3 - J & L 10 to 50 Power 18" Universal Comparators
2 - Wilson Hardness Testers
8 - Set Precision Gauge Blocks
66 - Vernier Dial Bore Height Gauges
40 - 1/8" to 8" Sunnen & Federal Dial Bore Gauges
Pratt-Whitney Micro Finish Automatic Surface Analyzers
3 - Rockwell ABC Micro Surface Analyzers

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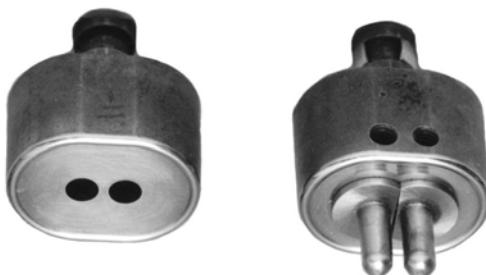
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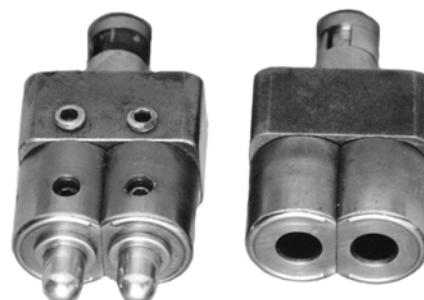
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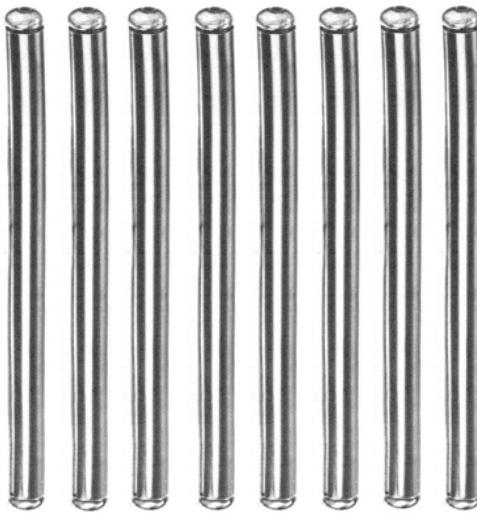
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