STAMPINGS & WASHERS

SERVING A WORLD OF INDUSTRIES 2026

WOMEN OWNED

BOKER'S, INC.

AS9100:2016
ISO9001:2015
CERTIFIED

STAMPINGS, WASHERS, SPACERS & SHIMS – MADE TO ORDER SINCE 1919

1860 — *Vitus Boker started using short run stamping methods in Denmark*

1901 — *Vitus immigrated to the United States*

1919 — ***V.A. Boker & Sons** was founded in Minneapolis*

1923 — *Check Protector patented*

1926 — *Second location on Erie Street*

1933 — *Third location at Bohemian Flats*

A Note from Boker's

For over a century, Boker's has been honored to provide precision stampings, washers, spacers and shims across every industry. In past years, Boker's created an annual Stampings & Washers Catalog which included an updated list of our more than 32,000 non-standard washer sizes available. For 2026, we are pleased to share with you our new Stampings & Washers Brochure.

In response to ongoing customer feedback, as well as the growing use of the Fast Quote Form and Washer Search Tool on Boker's website, we have redesigned our traditional print catalog. This updated brochure showcases our complete range of products and services, while also including specific guides designed to support engineering and procurement teams.

We invite you to explore the new brochure and share your thoughts. Additional details on the Company and our capabilities are readily available online at Bokers.com.

Boker's is well positioned to continue serving you now and into the future with short, medium or long runs. I invite you to contact our experienced Sales Associates who can answer your questions, provide quotes or discuss solutions.

Thank you for your continued trust in Boker's.

It is our greatest pleasure to serve you!

Amy Kersey
CEO

WOMEN OWNED

CONTENTS

1939	1942	1947	1968	1986	2008	2018	2019
4th location on Snelling Avenue	*Vitus retired, leaving the company to his children (John, William, Richard, Marie)*	*Held the first meeting of the board of directors*	*Boker's purchased by four employees (William Tedlund, Joseph Basara, Chester Engquist, Joseph Kantorowicz)*	*William Tedlund becomes sole owner*	*Expansion completed totaling over 90,000 square feet*	*66,500 square foot expansion totaling over 165,000 square feet*	*Boker's celebrates* ***100th Anniversary***

Precision Manufacturing
FOR 100 YEARS AND COUNTING

It all began in the Minneapolis basement of a young, passionate and focused man named Vitus Boker. He instilled the values of hard work and attention to detail throughout the company as it grew. These values still guide the company today, which inspires the team to provide an exceptional customer experience while producing the highest quality component parts.

> **"Our team works hard and is dedicated to following and continually improving processes. This is the reason Boker's is successful and will continue to be so for at least the next 100 years."**
>
> *— Tony Kersey, President*

A Part of Every Industry

Boker's has been serving companies on the forefront of technology innovation for over 100 years. As a result, almost every day you come into contact with components that Boker's has manufactured. From airplanes, appliances and medical devices to outdoor recreational equipment, furniture and alternative energy, you interact with items that feature stamped components manufactured by Boker's. Customers trust Boker's because of their quality, on-time delivery and service. Oftentimes, customers come with a difficult part they were struggling with and Boker's figures out how to manufacture the part to their exact specifications.

Experience and Industry Reputation

In business since 1919, Boker's is recognized as both a pioneer and a leader in the metal stamping industry. Today, Boker's is still a privately-held, family-owned and operated business in its fifth generation.

Boker's is a women-owned company dedicated to consistently meeting or exceeding quality objectives, on-time delivery and customer service expectations through continuous process improvements, trained and engaged employees, and cost-effective processes. Being a value-driven company also means giving back and being good stewards for the surrounding community. From drawing skilled tradespeople from across the Twin Cities to volunteering with local non-profits, Boker's brings passion and attention to detail to everything we do.

Continuing the Legacy

Boker's works with and serves all fast-paced and high-demand industries. Over the past 100+ years, we have embraced and been on the forefront of technology evolution and integration.

The future of Boker's is sticking to our wheelhouse of what we are known for while expanding our customer base and serving emerging markets. We will continue to expand capabilities by adapting and pursuing new technologies and processes in an effort to continue exceeding customer expectations.

No detail too small...

The Boker's Advantage

Over 2,000 Materials

To expedite your order and shorten delivery time, Boker's has immediate access to over 2,000 commonly specified and hard-to-find materials. **Whatever your requirements, if it can be stamped, we can turn it into the part you need.**

Metallic Materials: Low carbon, cold rolled strip and sheet steel, SAE 1050, 1075, and 1095 spring steel, blue and black temper spring steel, low alloy steel sheets, brass, copper, nickel silver, beryllium copper, phosphor bronze, stainless steel, aluminum and others.

Non-Metallic Materials: Acetal, PTFE, polyester, nylon, fiber, polyethylene, various phenolics and NEMA grade phenolics and others.

Superalloys: Iron, cobalt and nickel based alloys such as: Hastelloy, Inconel, Monel and others.

Secondary Operations

Boker's provides secondary operations including deburring, tapping, counterboring, reaming, and spotfacing to name a few. We also have approved vendors for plating, heat treating, grinding, testing and others.

Boker's Environmental Compliance

Boker's, Inc. is committed to responsible business practices that portray our dedication to our employees, customers, country and world.

Certified Quality Management System

Our Quality Management System (QMS) is AS 9100:2016 & ISO 9001:2015 Certified. When you purchase products from us, you can be confident that our processes are efficient and effective.

Quality Assurance and Certification

- ✔ C of C
- ✔ PPAP
- ✔ DFARS
- ✔ RoHS
- ✔ S.P.C.
- ✔ F.A.I.
- ✔ AS9102
- ✔ REACH
- ✔ ITAR
- ✔ IMDS
- ✔ Conflict Minerals
- ✔ CA Proposition 65
- ✔ Latex-Free
- ✔ WBENC
- ✔ WOSB

AS9100:2016
ISO9001:2015
CERTIFIED

WOMEN OWNED

Inspection Reports

Certificates of Compliance, Chemical/Physical Analysis, PPAP, FAI, AS9102 and more are available upon request.

Fast Delivery

At Boker's, fast delivery is the standard practice. Boker's can also meet your delivery and stocking requirements with flexible "Just-In-Time" (J.I.T.) and "Dock-to-Stock" programs. Your order may also be expedited for faster delivery.

Minimum Quantity

100

Orders require a minimum production run of 100 pieces, though deliveries of lesser quantities can be arranged. Per-unit costs rapidly decrease as the quantity increases.

High-Volume Orders

Increased production capacity and enhanced technology allows Boker's quality stampings and non-standard washers to be manufactured quickly, well into the millions.

Your Complete Resource

BOKERS.COM

Explore Boker's website to discover the company's full-service capabilities for manufacturing made-to-order, precision-stamped components. Easily search our industry-leading selection of more than 32,000 non-standard washer tool sizes available, request a fast quote or access reference tools to help solve your latest design challenge.

Stay in the Loop with

BOKER'S BULLETIN

This e-newsletter is sent out on a quarterly basis and contains information about capabilities, product or industry highlights, certifications, customer feedback, upcoming trade shows, as well as industry news.

Subscribe today!
Scan or visit **bokersbulletin.com**

When quality and precision matter the most, turn to Boker's for your stamped components.

Boker's has long been known for our ability to produce critical components for applications across many industries. We specialize in producing a large variety of stamped components, including flat round non-standard washers, spacers and shims, more complex formed or special shaped washers, as well as complex formed parts—including draws up to 3" deep and 8" in diameter. Boker's standard tolerance is often acceptable for form, fit and function, as well as satisfying engineering requirements; however, tighter tolerances can be held in many instances. Our in-process inspection, as well as final inspection processes, ensure that you receive the quality parts your application demands.

Sales & Estimating

Boker's has several Sales Associates whose knowledge in the industry is second to none, and whose dedication to helping meet your custom metal stamping needs is unparalleled. While Boker's does not design components, we do routinely provide feedback on manufacturability within the metal stamping process. Consideration is given for anticipated annual usage, critical dimensions and features, edge condition, tooling life, etc., while keeping top of mind the necessity of delivering quality parts on time. Contact Boker's via email, sales@bokers.com to connect with a knowledgeable Boker's Sales Associate. If you already know what you need, submit your specifications for a fast quote.

Quality Assurance

Boker's Quality Management System is AS9100:2016 & ISO 9001:2015 certified. Available certifications include: C of C, PPAP, DFARS, RoHS, REACH, ITAR, AS9102, IMDS, SPC and more. As a certified Women-Owned, BBB-accredited business, quality is a company-wide mission backed by a century of experience.

Customer Service & Order Processing

World-class customer service is the mission at Boker's. Short-run stamping is our roots dating back to 1919 and we will continue to honor the tradition of supporting production throughout the full product life cycle. We manufacture in short-, medium-, or long-runs from 100 pieces well into the millions. "Dock-to-stock" and "Just-in-time" programs add flexibility to ensure you have the correct amount of inventory on hand to meet your production needs. Our experienced team ensures orders are completed accurately and on time, often ahead of schedule.

No Matter the Project – Our #1 Goal Will Always be

CUSTOMER SATISFACTION

Driven by our commitment to continuous improvement, we surveyed a representative group of customers to capture feedback on our service. Our customer service team, comprised of key personnel, reviewed every response and created targeted action plans to elevate the value and overall support we provide. Thank you for your insights—your feedback continues to shape our next steps.

"BOKER'S IS ONE OF **OUR MOST TRUSTED SUPPLIERS**."

Customer in Off-Road Racing Industry

"BOKER'S ALWAYS PROVIDES **QUALITY PARTS AND QUICK RESPONSE TIMES**."

Customer in Machine Tool Industry

"I HAVE BEEN ***PLEASED WITH OUR EXPERIENCE*** WITH BOKER'S. **WE ALWAYS RECEIVE QUALITY PRODUCTS** AND THAT IS WHAT OUR CUSTOMERS HAVE COME TO EXPECT FROM US."

Customer in Military Communications Industry

"BOKER'S STAFF HAVE ALWAYS **JUMPED THROUGH HOOPS TO ACCOMMODATE US** WHENEVER WE WERE IN DIRE STRAITS. I ENJOY WORKING WITH THEIR STAFF EVERY TIME WE NEED TO PLACE AN ORDER."

Customer in Defense Industry

"WE'VE BEEN A **SATISFIED BOKER'S CUSTOMER FOR OVER 20 YEARS**. THE QUALITY OF THE PRODUCTS, CUSTOMER SERVICE, AND ***LEAD TIMES HAVE ALWAYS BEEN EXCELLENT***."

Customer in Prosthetics & Orthotics Industry

"YET AGAIN, ***I WOULD LIKE TO THANK YOU FOR THE LAST BATCH OF WASHERS.*** **THEY WERE FLAWLESS!**"

Customer in the Aftermarket Performance Automotive Industry

Across space, air, land and sea…

BOKER'S MEANS BUSINESS

Since 1919, Boker's has been manufacturing precise, made-to-order stamped components for applications in nearly every industry across the globe. Below is a general overview of the markets we serve.

AEROSPACE, AVIATION & DEFENSE

CIVIL AVIATION | AERONAUTICS | ASTRONAUTICS
MILITARY EQUIPMENT | WEAPONS SYSTEMS

MEDICAL

IMPLANTABLE | SURGICAL TOOLS | DIAGNOSTIC | IMAGING

ALTERNATIVE ENERGY

WIND | SOLAR | HYDROELECTRIC | TIDAL | NUCLEAR

AGRICULTURE

IRRIGATION | PLANTING | SPRAYING | HARVESTING | PROCESSING

RECREATIONAL VEHICLES

ATVS | UTVS | SNOWMOBILES | MOTORCYCLES | BICYCLES | MARINE

HVAC

HEATING & COOLING EQUIPMENT | CONTROLS | MEASUREMENT

TELECOMMUNICATIONS

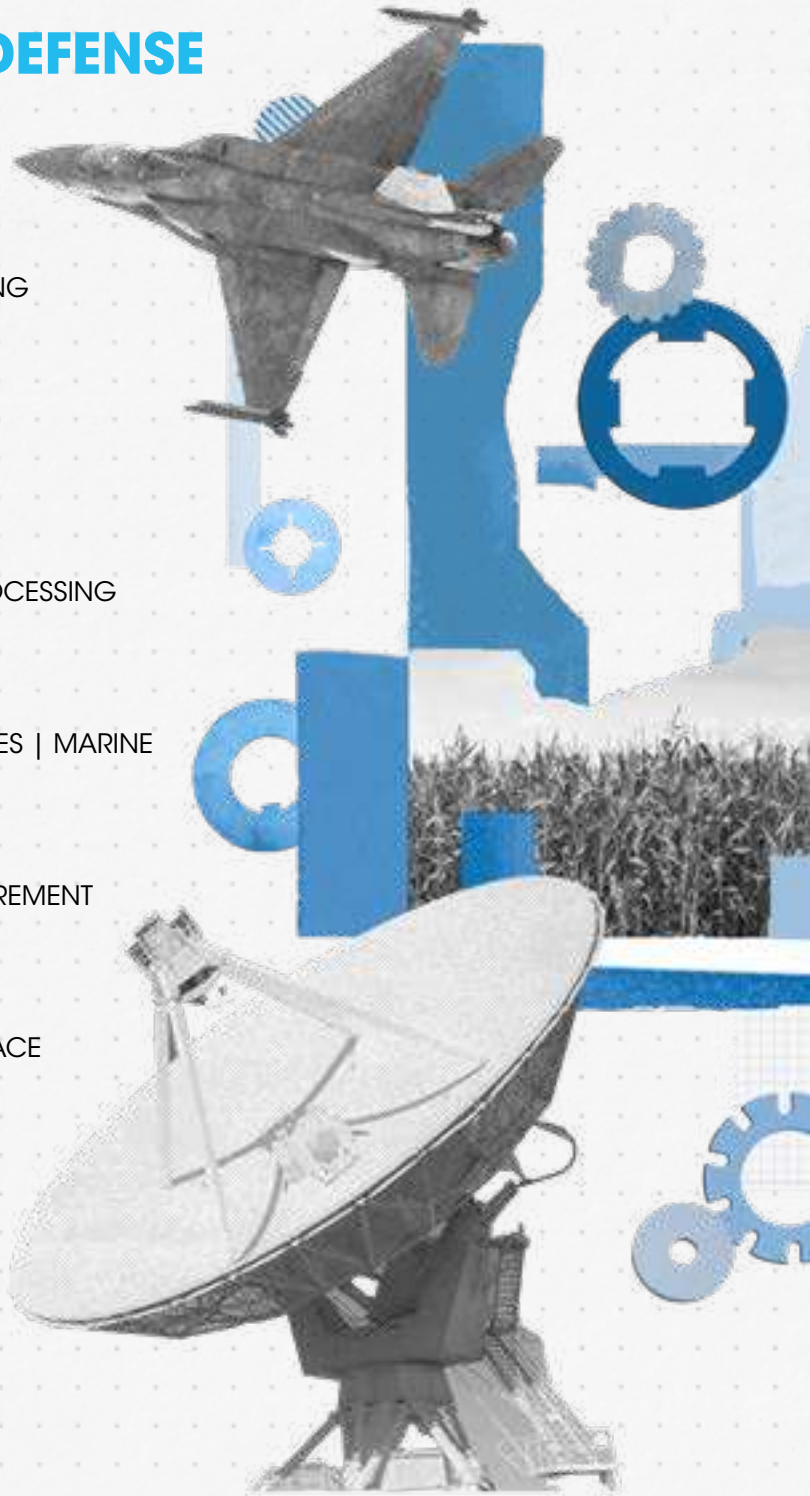
INFORMATION TRANSMISSION & RECEIPT—GROUND & SPACE

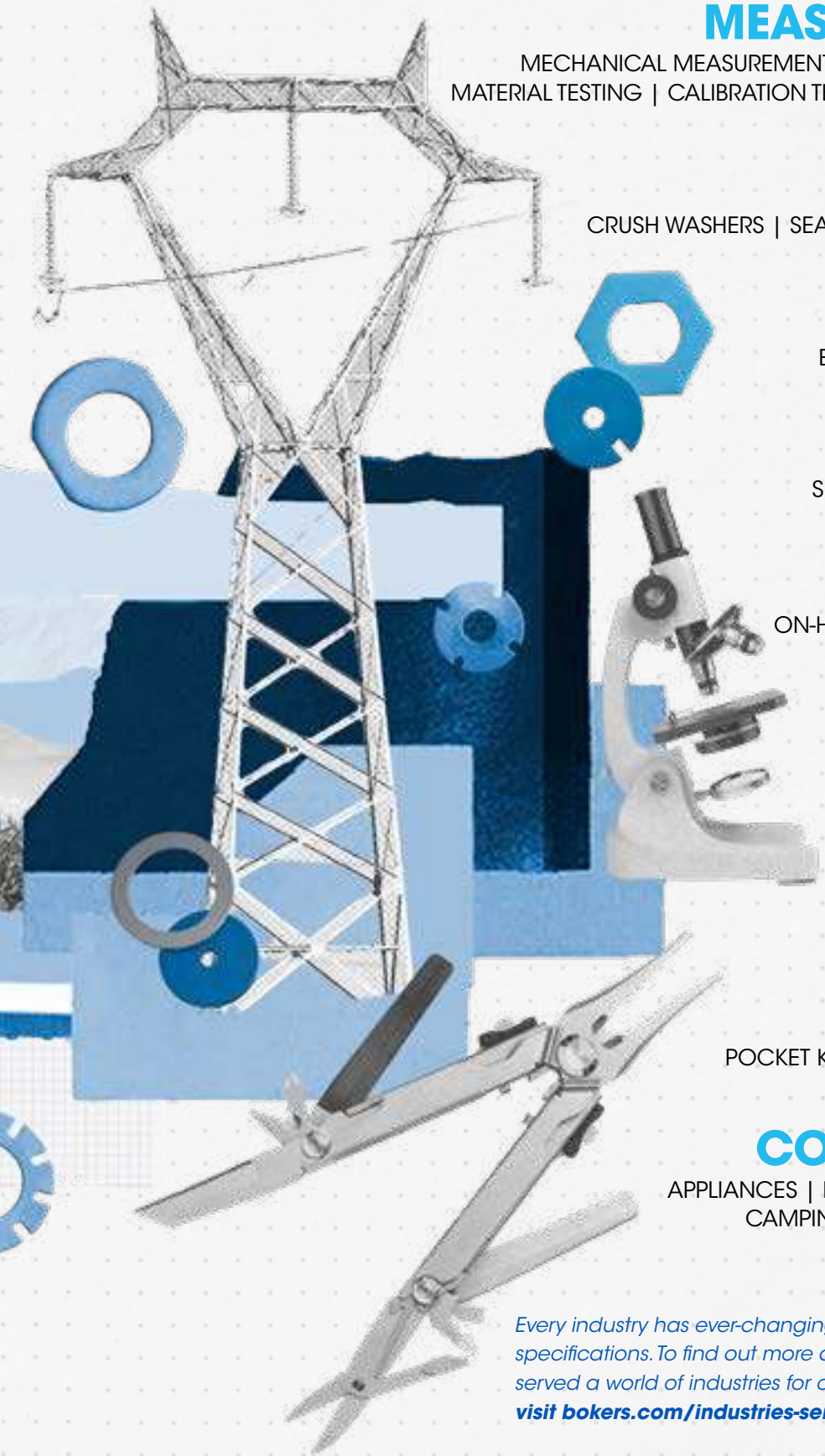
PHOTOGRAPHIC & IMAGING EQUIPMENT

LENSES | TRIPODS | ACCESSORIES | PROCESSING
MEDICAL IMAGING | QA IMAGING

CABINET & FURNITURE

MEDICAL | COMMERCIAL & RESIDENTIAL FURNITURE
CABINETRY & ACCESSORIES





ELECTRONIC MEASUREMENT & TESTING

MECHANICAL MEASUREMENT | ELECTRICAL TESTING | PRESSURE TESTING
MATERIAL TESTING | CALIBRATION TESTING | MAGNIFICATION & MICROSCOPES

HYDRAULICS

CRUSH WASHERS | SEALS | GASKETS | MEASUREMENT | BRACKETS

OIL & GAS

EXPLORATION | EXTRACTION | PROCESSING

APPLIANCES

SMALL, MAJOR & COMMERCIAL APPLIANCES

AUTOMOTIVE

ON-HIGHWAY & OFF-HIGHWAY | TRANSMISSIONS
SUSPENSIONS | ASSEMBLY COMPONENTS

INFORMATION TECHNOLOGY

COMPUTER SYSTEMS | SERVER SYSTEMS
COMMUNICATION SYSTEMS

CUTLERY & HAND TOOLS

POCKET KNIVES | FIXED-BLADE KNIVES | MULTI-TOOLS

CONSUMER PRODUCTS

APPLIANCES | FURNITURE | SPORTING EQUIPMENT | TOOLS
CAMPING & OUTDOOR RECREATIONAL EQUIPMENT

Every industry has ever-changing needs and application specifications. To find out more about how Boker's has served a world of industries for over 100 years,
visit bokers.com/industries-served or scan the QR code.

The DESIGNER'S GUIDE

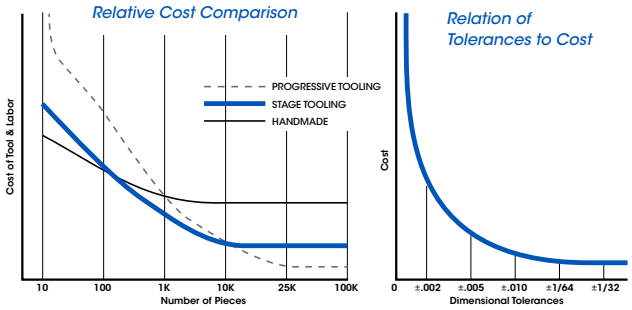
Precision Metal Stampings

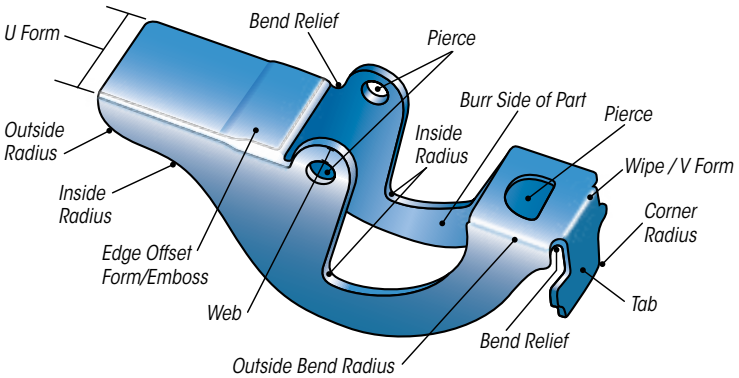
From traditional compound dies and stage tooling to more advanced progressive tooling, it is important to understand the various stamping operations and considerations when designing engineered components. *This guide is a quick reference for helping design engineers solve their latest challenges for precision-stamped parts.*

For more information on the basics of metal stamping and the various stamping operations to be considered for a particular application, ***visit bokers.com/stamping-guide or scan the QR code*** *to access the full guide.*

THE BASICS OF METAL STAMPINGS

Precision metal stampings are produced by converting flat metal sheet or coil into engineered component parts for equipment and technology. Parts can be flat and simple or complex formed profiles. Stampings are produced using a variety of punch presses that bring to bear ten to hundreds of tons of stamping pressure onto the sheet or coil. In their most basic operation, punch presses use a corresponding die and punch tool for **flat blanking**—a flat metal cutout of the exact periphery shape and size of the part. Additional metal forming stages are often employed to produce complex parts and profiles including **piercing**, and **metal forming operations** such as **bending, drawing, flanging, embossing, rolling**, and others.



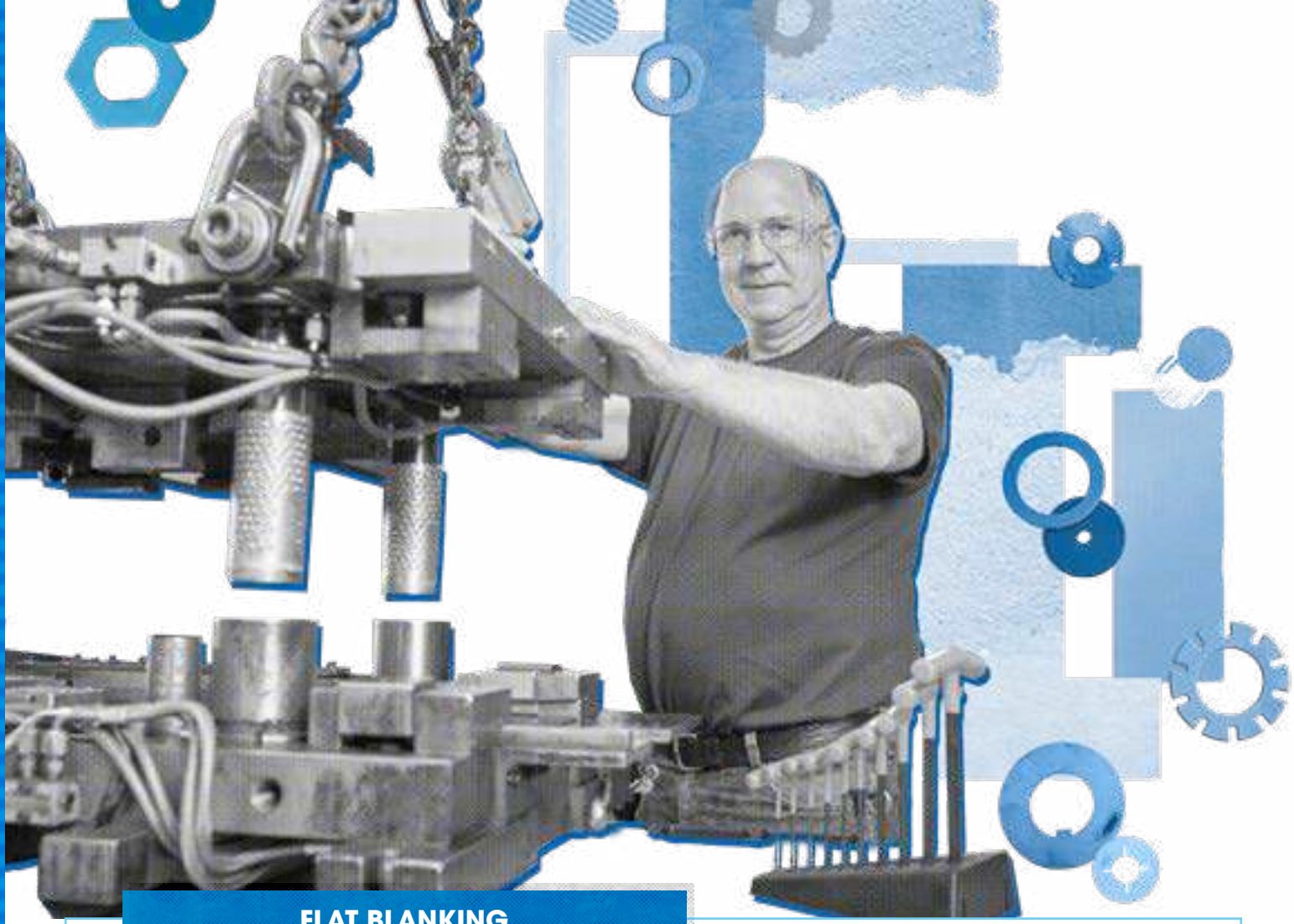


What are the advantages of short-run custom stampings? The quality of stamped components produced with stage tooling, compared to more advanced progressive tooling, is comparable and offers the same high quality custom part for the application. A key advantage to short-run stamping is the savings in cost and time for short to medium runs. Significantly lower initial tooling costs versus progressive tooling offers savings that give manufacturers greater design and component inventory flexibility. Small-quantity needs, customization, pilot runs, testing, frequently-changing designs, functional prototypes and limited production runs are all opportunities for short-run stampings that would be less feasible with expensive progressive tooling.

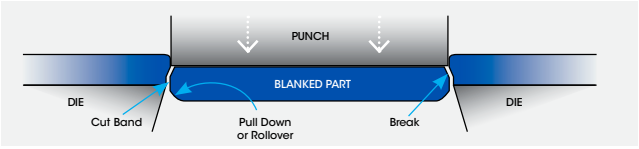
Draws up to 3" deep and 8" in diameter

Complex metal forming needs in thicknesses from .005" to .190" (varies by material)

Flat blanking and piercing up to 12" by 12"



FLAT BLANKING



Flat Blanking
Flat blanking uses sheet or coil material to stamp out the outer profile of a component part. This process works for both metallic and non-metallic materials.

Pull-Down and Breakage
In blanking, a punch and die with proper clearance are used to cut the material. As the punch penetrates, the material deforms and pulls down until it breaks, always leaving a burr. Pull-down and breakage are influenced by die clearance, material hardness, and grain structure.

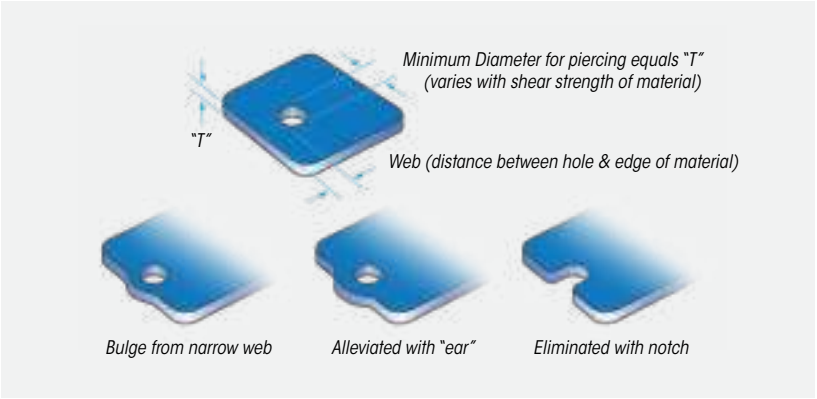
Blank Design Considerations
Minimum blank width should be 1½–2x material thickness and no less than 1/32". Corners should have at least a ½x thickness radius unless the material is thin (1/16" or less), where sharper corners may be acceptable. Avoid sharp corners in close-tolerance notches; add a radius or plan for a secondary operation.

When cutting to length from rolled, sheared, or slit strips, a sharp 90° cut is most efficient. Tighter radii can distort edges and cause burring.

Blanking can be completed using single-stage or compound dies for further processing, or within progressive dies for multiple operations in one setup.

METAL PIERCING

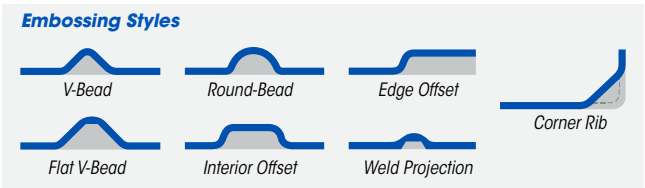
Metal Piercing
Piercing is a shearing process that creates holes, slots or notches with tight tolerances in metal. It offers faster output and cleaner cuts than drilling, machining, or laser cutting. Boker's uses CAD, over 70 punch presses, servo feeders, and both compound and progressive dies for complex components.



Piercing Considerations
Precise round holes and slots can generally be produced with tight tolerances if the hole diameter is equal to or greater than the material thickness. A material with high shear strength, such as stainless steel, may require a minimum diameter of 2x material thickness.

Tolerances on hole diameters apply only to the punched side; a degree of breakage on the reverse side occurs on all punched holes due to clearance between the punch and die. If a precise hole diameter is required all the way through the material, the punched hole should be undersized and reamed to the correct size.

METAL FORMING



Metal Forming
Metal forming is the process of converting a flat piece of metal into a three-dimensional part. Metal forming can be done in a variety of ways including bending, drawing, embossing, rolling, etc.

Forming & Bending Considerations
In design for bending forms in blanks, allow 1½x to 2x material thickness for relief. Ensure the form is completely outside the blank profile and create a relief notch or radius on the form to avoid material tearing and fatigue failure at the bend. Extend the stock on the inside height of forms to accommodate the radius of bends and the thickness of stock. A rule of thumb is adding 2½x material thickness plus the required bend radius to arrive at the desired form height, which may or may not require to be cut off in an additional operation.

Available edge conditions include as-formed, die trimmed, hemmed edges in open, teardrop or closed styles, curled edge and lance-formed.

Drawing Considerations
Drawing forms flat metal into shapes like cups, boxes, or pans. "Deep drawing" occurs when depth equals or exceeds diameter. Softer metals (e.g., aluminum, brass) are easier to draw.

Boker's, drawing metal since 1919, produces parts up to 3" deep and 8" in diameter using in-house tooling (up to 180-ton capacity). With CAD systems and onsite machining, we handle material from .005" to .190", offering additional services like plating and heat treating through approved vendors.

JUST YOUR SIZE

32,000... and counting

Boker's maintains over 32,000 stock tools for non-standard flat round washers, spacers, shims and disks. You can choose from a wide variety of sizes, thicknesses and materials, including non-metallics. With outside diameters of 0.080" to 5.140" and a wide variety of inside diameters, you have millions of flat washer possibilities. Looking for a disk? Request any size without the I.D. If we don't already have the right tool for your part, and the specifications are within our standard parameters, we'll build it at no extra charge in just a few hours.

MAX O.D.

12"

MIN O.D.

0.080"

...and nearly everything in between

Our complete list of stock tools, from which our washers, spacers, shims and disks are made to your order in any quantity without a tooling charge, is available online. We do NOT carry any washers in stock. You can choose an exact thickness for washers within the tool range indicated.

To review the most up-to-date list of sizes using the Search Flat Washers tool, please ***visit bokers.com/washers or scan QR code***

The

DESIGNER'S GUIDE

Washers, Spacers & Shims

Washers are a vital component in nearly every assembly and fastening process, so it's important to understand the variety of functions beyond just securing bolts, nuts, and screws. *This guide is a helpful resource for being able to select the most optimal type of washer for a specific application.*

For more information on the variety of sizes, styles, materials, and other variable factors for selecting washers for specific assembly applications, ***visit bokers.com/washer-guide or scan the QR code*** *to download the full guide.*

Selecting the OPTIMAL WASHER

Following is a condensed overview of just some of the many washer styles Boker's produces, and what they are optimally designed for.

Flat: Most common washer category generally used for load disbursement. Internal and external shape may be round, symmetrically square, hexagonal or rectangular.

Tab: A type of lock washer designed with one or more tabs or notches to effectively lock a part into place, generally used where heat or heavy vibrations are a factor.

Lock: Designed to secure fasteners that have a tendency to rotate or lose friction. Often paired with a flat washer to evenly disperse load without deforming the assembly.

Cylindrically Curved: Offer the most uniform spring constant of any of the spring washer types.

Finishing: Also referred to as "countersunk" washers, finishing washers are often found on consumer products and used as an appearance part where the washer catches the head of a fastener, allowing it to sit flush with its surrounding surface.

Shoulder: Shoulder washers, also known as "step" or "flange" washers, have an appearance of a low-crowned top hat and an integral cylindrical sleeve. The sleeve is designed to mate with a cutout and segregates the fastener from the material it is secured to.

Wave: These washers are ideal for obtaining loads when the load is static or the working range is small and the amount of axial space is limited.

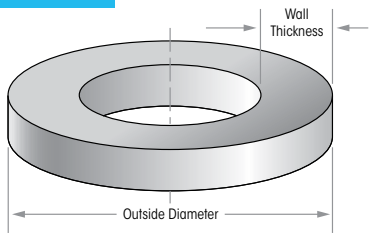
Belleville: Deliver the highest load capacity of all the spring washers and are very common in thermal expansion applications.

Fender: Fender washers have an outside diameter that is much larger in proportion to the center hole to distribute a load evenly across a large surface area.

Shim Stacks: Ideal for simple and complex applications as they offer exact dimensions for precise spacing.

WASHER WALL THICKNESS

Acceptable limits for minimal wall thickness on flat washers can be determined by reviewing the table below. There can be exceptions but you should always check with a Boker's Sales Associate for more information.



WALL THICKNESS TABLE

O.D. RANGE		MINIMUM WALL THICKNESS	
Inches	*Millimeters*	*Inches*	*Millimeters*
.1875 – .375	4.76 – 9.5	.0625	1.6
.375 – 1	9.5 – 25	.09375	2.4
1 – 2	25 – 51	.125	3.2
2 – 3	51 – 76	.1875	4.76
3 – 5	76 – 127	.25	6.35

For:	*Minimum Wall:*
Low carbon steel—annealed 1050 high carbon steel—annealed Copper alloys—all tempers Aluminum alloys—all tempers	Two times material thickness but not less than above chart
Stainless steel annealed blue steel* Pre-tempered high carbon steel*	Three times material thickness but not less than above chart

*Note: Contact your Boker's Sales Associate for exceptions. Special tooling or setup procedures sometimes permit a narrower wall thickness. There is a limit of up to .020" maximum thickness of blue steel and pre-tempered high carbon steel.

EDGE CONDITIONS

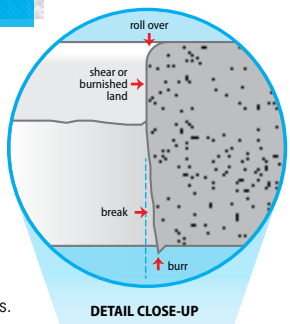
Burrs are a normal by-product of the metal stamping blank and piercing process. They can have ragged, sharp and uneven edges.

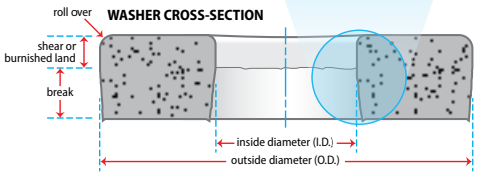
Feature Size: This is to be measured only in the cut portion of the hole and cut portion of the outside diameter.

Shear or Burnished Land: This is a burnished area which is approximately one third of the material thickness.

Break: This is an area which is tapered about three degrees. This area has a rougher surface than the shear area.

Roll Over: This area is a natural consequence of the punching process and the mechanical properties of the material being punched and the die application techniques employed.





MATERIAL THICKNESS	When deburring is NOT specified	When deburring is specified, such as "Must be burr free"
.010" or less	.001"	.0005"
.011" – .039"	.002"	.001"
.040" – .079"	.003"	.002"
.080" – .125"	.004"	.003"
.126" or more	.006"	.004"

Boker's maximum burr on metallic washers and stampings

Assembly & Fastening

Efficient, accurate assembly is vital across all industries. Washers play a critical role in nearly all machines with moving parts, serving not only to secure fasteners but also to seal, insulate, align, distribute loads, and more.

Washer Materials

Washers can be made from most stampable materials, including various steels, copper alloys, titanium, aluminum, nylon, PTFE, rubber, and phenolics. Material choice matters—high-strength alloys or spring steel are ideal for high-load applications, while non-metallic materials suit lighter loads or delicate surfaces.

Washer Selection

Selecting the correct washer ensures reliability and prevents costly downtime.

When specifying a washer, consider:

Tolerances: Tighter tolerances increase cost; when possible, follow industry standards.

Materials & Thickness: Match the material and thickness to performance needs using corrosion-resistant alloys; it may save costs over plated parts.

Temper, Hardness & Heat Treating: Specify only if required; otherwise, omit for simplicity.

Compatibility: Ensure all specs are aligned: size, hardness, load rating, etc.

Flatness: Should not exceed 0.010 T.I.R. per inch of O.D. to avoid costly secondary operations.

Burrs: Deburring adds labor and material costs, so address burrs only if necessary.

Finish: Coatings improve appearance and/or corrosion resistance—specify if full or partial finish is required.

Boker's stocks over 32,000 tools to manufacture washers, spacers, shims & disks: a subset of those tools are suitable for stamping non-metallic materials as well.

When determining the proper sized tool for your washer or spacer, the outside diameter (O.D.) typically remains the same for both a metallic and non-metallic part. The inside diameter (I.D.), however, may shrink by as much as 12% of the material thickness depending on the material used and its thickness. **Rely on Boker's experienced Sales Associates to determine the proper tool to manufacture the part size you specify.**

Special Shapes and Sizes

Boker's also makes special washer shapes and sizes—up to 12" in outside diameter. We can produce a vast number of custom washer types with little to no tooling costs. Tell us what you need, and we'll make it to your exact specifications. Visit bokers.com to submit a drawing for a fast quote or to search stock tool sizes.

Metric Sizes No Problem! Boker's maintains over 32,000 stock tools for flat washers, spacers and shims. You can choose from a wide variety of sizes, thicknesses and materials, including non-metallics. With outside diameters of 2.032mm to 130.556mm and a wide variety of inside diameters, you have millions of flat washer possibilities.

The Widest Range of Disks Available

Disks, commonly referred to as discs, circles, plates and/or slugs, are typically round washers with or without a center hole and are typically used to provide a precise space between components or materials or for load disbursement.

All of Boker's 32,000+ flat washer sizes are available without the I.D. hole in more than 2,000 commonly specified and difficult-to-find materials.

- **Sizes up to 12" x 12" (flat)**
- **Thicknesses from .005" to .190" (varies by material)**

Equipment & Capabilities

Housed in over 165,000 square feet, Boker's manufactures domestically at our single site manufacturing plant. All equipment, listed below, as well as all tooling, are protected by a central station security and fire system.

TOOL & DIE DEPARTMENT

- CAD CAM Drawing & Programming Systems
- Kitamura Vertical Machine Center
- Mori Seiki Vertical Machine Center (20" x 40")
- (2) Mori Seiki High Precision C.N.C. Lathes
- (4) Fanuc Wire E.D.M.s
- Okamoto Precision Grinder
- Mitsui Precision Grinder
- (2) Clausing Surface Grinders
- CNC E.D.M. Drill
- Hardinge Toolroom Lathe
- (2) Manual Lathes
- (3) Bridgeport Mills
- Trinco Sandblaster
- Torit Dust Collection

RAW STOCK & SHEAR DEPARTMENT

- (3) 10' Shears (.20' thick maximum)
- Stanat Model Rolling Mill
- IRM Rolling Mill
- Cooper Weymouth Roller Levelers
- Coil Set Straightener
- Wilder Coil Slitter
- Computer Inventory & Control System
- (2) Material Slitting Machines

WASHER DEPARTMENT

- (20) Punch Presses (10 to 75 tons)
- Digital Servo Feeders
- Electric Coil Reels (1,200 lb. capacity)
- Coil Straighteners
- Tonnage Monitors

STAMPING DEPARTMENT

- (46) Punch Presses (10 to 180 tons)
- Aida Servo Press
- (2) High Speed Minster Progressive Die Presses (60 to 150 tons)
- High Speed Aida Progressive Die Press (121 tons)
- Digital Servo Feeders
- Electric Coil Reels (6,000 lb. capacity)
- Optical Part Detection Systems
- Press Control Automation
- Tonnage Monitors
- (2) Material Handling Conveyors

INSPECTION DEPARTMENT

- Numerex Coordinate Measuring Machine
- Digital Optical Comparator
- Digital Buehler Hardness Tester
- Digital Profilometer
- Ceramic Gauge Block Sets
- Plug Gauge Sets
- Height Gauges
- Thread Gauges
- Statistical Process & Capability Studies Available
- Climate-controlled & Monitored
- Keyence Vision System

CLEANING & DEBURRING DEPARTMENT

- Agitated Chemical Washing System
- Rotary Deburring Machines
- Vibratory Deburring Machines
- Centrifugal Tumblers
- Heated Centrifugal Dryers
- Lewis Ultrasonic Cleaner
- High Energy Deburring Machines
- Mass Finishing Machines
- Custom Parts Dryer
- Custom Automated Multi-Station Deburring System
- Custom Multi-Station Vibratory Deburring Machine
- Peeling Centrifuge – Water Recycler

SECONDARY OPERATIONS

- Trimming Lathes
- Production Milling Machines
- Pneumatic Presses
- Tapping Machines
- (6)Spindle Machine Centers (multiple head drilling, tapping & reaming)
- (4) Straight-liners up to 18"
- Parts Washing System

HEAT TREATING DEPARTMENT

- Electric High Temperature Hardening Furnaces
- Electric Tempering Furnaces (all furnaces calibrated)

SHIPPING DEPARTMENT

- Toledo Electronic Scales & Printer
- Precision Electronic Scales & Printers
- Automated Protective Packaging Bagger
- Automated Orbital Tape Bander
- Hercules Ergo Container Handling System
- Wulftec Pallet Wrapper

PROUDLY MADE IN THE USA WITH DOMESTIC AND FOREIGN MATERIALS.

We'll do our part.

Since 1919, the team at Boker's has been driven by the values and traditions established by the founder, Vitus Boker, for high quality parts, hard work and attention to detail.

The stampings, washers, spacers and shims manufactured by Boker's will meet your specifications. From the first part to the last. Time and time again. Those are not just words said here, but the goal of everyone in the company from Order Entry and Receipt to Quality Assurance and Shipping.

Boker's understands that our reputation as a stamping industry leader needs to be earned every day. There's a pride that runs deep throughout the organization to keep improving and raising the bar, to address the ever-changing needs and product diversification of our customers.

Quality parts. World-class customer service. Fast delivery.
Because at Boker's, doing our part means helping you do yours.

PRODUCTION PROCESS OVERVIEW

For over 100 years Boker's has been improving and refining our manufacturing processes. Customers from around the globe have trusted Boker's to manufacture their most critical components.

- In-house tool and die department designs and produces custom tooling to be used in the stamping process.
- Material warehouse shears sheets of material into strips or issues a coil of material, either metallic or non-metallic.
- The material then transfers to the production floor to be stamped using the custom or stock tool(s) in one or more of our many varieties of punch presses.
- Parts are then (in any combination) blanked, pierced, formed, drawn, deburred or tapped in house.
- After in-house production is complete parts may be sent to an approved vendor for plating, heat treating, grinding, testing or further processing before going to Boker's Quality Assurance Department.
- In our Q.A. Lab, parts are inspected to ensure they meet customer specifications before being released for shipping.

Glossary of Terms

Bar Coding – Machine readable alphabetic and/or numeric information used for identification of packaged parts.

Barrel Tumbling – Process in which parts to be deburred are put together with abrasive material into a barrel and rotated for prolonged periods for the purpose of burr removal.

Bend Radius – Inside radius.

Bend Relief – Clearance notch at an end of flange to allow bending without distorting or tearing adjacent material.

Bending – Generally applied to forming. Creation of a formed feature by angular displacement of a sheet metal workpiece. See also "Drawing" and "Forming."

Blank – (1) Sheet metal stock from which a product is to be made. (2) Workpiece resulting from blanking operation.

Blanking – Die cutting of the outside shape of a part.

Bow Distortion – Out of flatness condition in sheet material commonly known as "Oil Canning" in which, with the edges of the sheet restrained, the center of the sheet can be popped back and forth but cannot be flattened without specialized equipment.

Breakout – Fractured portion of the cross section of a cut edge of stock. A condition naturally occurring during shearing, blanking, punching and other cutting operations.

Burn Mark – Heat discoloration created in the contact area of a welding electrode.

Burr – Raised, sharp edge inherent in cutting operations such as shearing, blanking, punching and drilling.

Burr Direction – Side of the stock on which burrs appear.

Burr-Free – Edge without sharp protrusions.

Burr Height – Height to which burr is raised beyond the surface of the material.

Burr Rollover – Condition of burr displacement resulting from mechanical deburring operation.

Chain Dimensioning – Drafting practice which dimensions repetitive features from each other rather than a common datum.

Clamp Marks - Slight indentations at the edge of one side of stock caused by pressure from turret press holding devices.

Coining – Compressive metal flowing action.

Compound Die – Tool used to pierce, form and blank a part at the same time, with one stroke of the press.

Concentricity – Dimensional relationship of 2 or more items sharing a common center line.

Corner – Three surfaces meeting at one point.

Corner Radius – Outside radius.

Counterboring – Machining or coining operation to generate a cylindrical flat-bottomed hole.

Countersinking – Machining or coining operation to generate a conical angle on a hole.

Cumulative Tolerance – Progressive accumulation of tolerances resulting from multiple operations or assembly of multiple parts.

Datums – Theoretically exact planes, lines or points from which other features are located on design drawings.

Deburr – To remove the sharp, knife-like edge from parts.

Dedicated Tooling – Commonly referred to as "hard tooling"— tooling made to produce a specific part.

Die – Tool with a void or cavity which is precisely fitted to a "Punch" used to shear or form sheet metal parts.

Die Clearance – Amount of space between the punch and die opening.

Die Marks – Scratches, scrub marks, indentations, galling or burnishing of sheet metal workpieces by tooling.

Drawing – (1) Engineering document depicting a part or assembly. (2) In metalforming, the stretching or compressing of a sheet metal part into a die by a punch to create a 3-dimensional part. See also "Bending."

Ductility – Ability of a material to be bent or otherwise formed without fracture.

Edge Bulge – Condition resulting from any forming, piercing, hardware insertion or spot welding operation too close to an edge.

Edge-to-Feature – A dimension between the edge of the part and a feature.

Feature-to-Feature – Dimension between two features on a part.

Fixture – Tooling designed to locate and hold components in position.

Flange – Formed projection or rim of a part generally used for stiffness or assembly.

Flat or Matte – Coating surface which displays no gloss when observed at any angle; a perfectly diffused reflecting surface.

Formed Tab – Small flange bent at an angle from the body of a metal workpiece.

Forming – Operation converting a flat sheet metal workpiece into a three-dimensional part. See also "Bending" and "Drawing."

Gauge – (1) Instrument for measuring, testing, or registering. (2) Numeric scale for metal thickness.

Go/No-Go Gauge – Measuring device with two registration elements which determine if a feature to be measured is between two established limits.

Gouge – Surface imperfection, deeper than a scratch, often with raised edges.

Grain Direction – (1) Crystalline orientation of material in the direction of mill rolling. (2) Orientation of a surface finish generated by abrasive method.

Grinding – Process of removing material by abrasion.

Half Shearing – Partial penetration piercing, creating a locating button with a height of about 1/2 material thickness.

Hard Tooling – Tooling made for a specific part. Also called "dedicated tooling."

Hem (Dutch Bend) – Edge of material doubled over onto itself for the purpose of safe handling or to increase edge stiffness.

Hold-Down Marks – Slight indentations or scuff marks on one side of the stock which can result from the pressure of hold-down devices during shearing operations.

Hole Rollover – Rounding of the top edge of a pierced feature caused by the ductility of the metal, which flows in the direction of the applied force.

Hole-to-Form – Distance from the edge of a hole to the inside edge of a formed feature.

Hole-to-Hole – Dimension between the centers of holes.

Hydraulic Press – Machine which exerts working pressure by hydraulic means.

Inspection Criteria – Characteristics by which the part will be evaluated both dimensionally and cosmetically.

Lead Time – Time required to manufacture a product from order placement until availability.

Master Die – Universal tool receptacle for holding changeable tool systems.

Metal Thinning – Thickness reduction during any forming operation.

Model – Pre-production sample made with limited emphasis on tolerance to test a design concept. See also "Prototype."

Nesting – (1) Grouping of identical or different parts in multiples within a workpiece to conserve material. (2) In packaging, stacking of parts whose shape permits one to fit inside another.

Nibble Marks – Slight irregularities at the edge of the stock surface after progressive punching ("nibbling") operations in a turret press.

Notching – Operation in which the punch removes material from the edge or corner of a strip or blank.

Penetration – (1) Depth of a cutting operation before breakout occurs. (2) In welding, the depth of material through which fusion occurs.

Perpendicularity – Dimensional relationship of a part or datum located at right angles (90°) to a given feature.

Piercing – Punching of openings such as holes and slots in material.

Pinch Trim – Trimming excess material from a drawn part at the bottom of the stroke. Leaves drawn shell without an inside burr, but with an outside burr and a thinned edge.

Progressive Tool – Die using multiple stations or operations to produce a variety of options. Can incorporate piercing, forming, extruding and drawing, and is usually applied to high quantity production runs.

Prototype – First part of a design which is made to test tolerance capability, tooling concepts and manufacturability.

Pull Down – Area of material next to the penetrating edge of a piercing punch, or die edge of the blanking station, where the material yields, i.e., flows in the direction of the applied force creating a rounded edge. Also known as "roll-over."

Punch Press – Machine supplying compression force for reshaping materials.

Punch Side – Opposite side from burr side for pierced features; side on which the punch enters the material.

Quick Change Inserts – Tool sections or parts which may be changed without removing the entire tool from the press.

Rerolling – Final cold rolling operation, usually done to achieve specific thickness control and improved finish.

Roundness – Extent to which a feature is circular.

Run Out Flange – Feature on a formed part which is designated by the designer to absorb the tolerance accumulations created by multiple forming operations.

Scrap – Leftover, unused material relegated to recycling.

Shear-to-Feature – Shearing of an edge of stock to an exact dimension from an already existing feature.

Shearing – Cutting force applied perpendicular to material causing the material to yield and break.

Shut Height – Clearance in a press between ram and bed with ram down and adjustment up.

Slide Forming – A high-volume stamping process in which a machine with multiple slides sequentially performs various operations (e.g. – blanking, piercing, forming, etc.).

Slug – Scrap from a piercing operation.

Slug Marks – Surface defects caused by scrap being indented into the metal surface.

Spot Face – Circular flat surface as a bearing area for hardware.

Squareness – Measure of perpendicularity of adjacent edges or surfaces.

Spring Back – Partial rebounding of formed material caused by its elasticity.

Staking – Method of fastening using displaced material for retention.

Stiffening Rib – Embossed feature in a sheet metal workpiece which is added to make the part more rigid.

Stretcher Leveled – A flattening process in which a material is stretched to achieve a desired flatness tolerance.

Stripper – Mechanical hold-down device applied to the workpiece during the punching process.

Stripper Marks – Imprints on one side of the stock around pierced holes, caused by punch strippers.

Stripping – Process of disengaging tooling from the workpiece.

Strips – Sheet material, sheared into narrow long pieces.

Stroke – RAM travel from top dead center (TDC) to bottom dead center (BDC).

Tapping – Operation to create internal threads by either cutting or forming.

Tolerance – Permissible variation from a specification for any characteristic of the product.

Transfer Die – Variation of a progressive die where the part is transferred from station to station by a mechanical system. Mainly used where the part has to be free from the strip to allow operations to be performed in a free state.

Turret Press – Automatic punch press indexing the material and selecting the intended tool out of the rotary tool holding device (turret) totally by computer control for piercing, blanking and forming workpieces as programmed.

V Die – Tool used in conjunction with a V punch.

V Punch – V shaped tool used for angle forming.

Vibratory Finishing – Burr removal process in which an appropriate number of parts, depending on part size and abrasive material, is accelerated and decelerated by mechanical means inside of a drum-like enclosure.

Webs – Material between two openings or edges.

Wipe Die – Forming tool using two opposing edges, separated by one material thickness, moving past each other to form material.

Terms provided courtesy of the Precision Metalforming Association

Decimal & Millimeter Equivalents

	DECIMALS	MILLIMETERS
1/64	0.015625	0.397
1/32	.03125	0.794
3/64	.046875	1.191
1/16	.0625	1.588
5/64	.078125	1.984
3/32	.09375	2.381
7/64	.109375	2.778
1/8	.1250	3.175
9/64	.140625	3.572
5/32	.15625	3.969
11/64	.171875	4.366
3/16	.1875	4.763
13/64	.203125	5.159
7/32	.21875	5.556
15/64	.234375	5.953
1/4	.2500	6.350
17/64	.265625	6.747
9/32	.28125	7.144
19/64	.296875	7.541
5/16	.3125	7.938
21/64	.328125	8.334
11/32	.34375	8.731
23/64	.359375	9.128
3/8	.3750	9.525
25/64	.390625	9.922
13/32	.40625	10.319
27/64	.421875	10.716
7/16	.4375	11.113
29/64	.453125	11.509
15/32	.46875	11.906
31/64	.484375	12.303
1/2	.5000	12.700

1 mm = .03937"

	DECIMALS	MILLIMETERS
33/64	0.515625	13.097
17/32	.53125	13.494
35/64	.546875	13.891
9/16	.5625	14.288
37/64	.578125	14.684
19/32	.59375	15.081
39/64	.609375	15.478
5/8	.6250	15.875
41/64	.640625	16.272
21/32	.65625	16.669
43/64	.671875	17.066
11/16	.6875	17.463
45/64	.703125	17.859
23/32	.71875	18.256
47/64	.734375	18.653
3/4	.7500	19.050
49/64	.765625	19.447
25/32	.78125	19.844
51/64	.796875	20.241
13/16	.8125	20.638
53/64	.828125	21.034
27/32	.84375	21.431
55/64	.859375	21.828
7/8	.8750	22.225
57/64	.890625	22.622
29/32	.90625	23.019
59/64	.921875	23.416
15/16	.9375	23.813
61/64	.953125	24.209
31/32	.96875	24.606
63/64	.984375	25.003
1	1.000	25.400

.001" = .0254 mm

MM	INCHES	MM	INCHES
.1	.0039	46	1.8110
.2	.0079	47	1.8504
.3	.0118	48	1.8898
.4	.0157	49	1.9291
.5	.0197	50	1.9685
.6	.0236	51	2.0079
.7	.0276	52	2.0472
.8	.0315	53	2.0866
.9	.0354	54	2.1260
1	.0394	55	2.1654
2	.0787	56	2.2047
3	.1181	57	2.2441
4	.1575	58	2.2835
5	.1969	59	2.3228
6	.2362	60	2.3622
7	.2756	61	2.4016
8	.3150	62	2.4409
9	.3543	63	2.4803
10	.3937	64	2.5197
11	.4331	65	2.5591
12	.4724	66	2.5984
13	.5118	67	2.6378
14	.5512	68	2.6772
15	.5906	69	2.7165
16	.6299	70	2.7559
17	.6693	71	2.7953
18	.7087	72	2.8346
19	.7480	73	2.8740
20	.7874	74	2.9134
21	.8268	75	2.9528
22	.8661	76	2.9921
23	.9055	77	3.0315
24	.9449	78	3.0709
25	.9843	79	3.1102
26	1.0236	80	3.1496
27	1.0630	81	3.1890
28	1.1024	82	3.2283
29	1.1417	83	3.2677
30	1.1811	84	3.3071
31	1.2205	85	3.3465
32	1.2598	86	3.3858
33	1.2992	87	3.4252
34	1.3386	88	3.4646
35	1.3780	89	3.5039
36	1.4173	90	3.5433
37	1.4567	91	3.5827
38	1.4961	92	3.6220
39	1.5354	93	3.6614
40	1.5748	94	3.7008
41	1.6142	95	3.7402
42	1.6535	96	3.7795
43	1.6929	97	3.8189
44	1.7323	98	3.8583
45	1.7717	99	3.8976
		100	3.9370

Sheet Metal Gauge Chart

GAUGE NO.	STEEL HOT ROLLED, P&O, COLD ROLLED		STAINLESS STEEL		GALVANIZED STEEL		ALUMINUM		BRASS		COPPER	
	GAUGE DECIMAL (INCHES)	GAUGE DECIMAL (MM)	GAUGE DECIMAL (INCHES)	GAUGE DECIMAL (MM)	GAUGE DECIMAL (INCHES)	GAUGE DECIMAL (MM)	GAUGE DECIMAL (INCHES)	GAUGE DECIMAL (MM)	GAUGE DECIMAL (INCHES)	GAUGE DECIMAL (MM)	GAUGE DECIMAL (INCHES)	GAUGE DECIMAL (MM)
0000000	—	—	0.5	12.7	—	—	—	—	—	—	—	—
000000	—	—	0.4686	11.902	—	—	0.58	14.732	—	—	—	—
00000	—	—	0.4375	11.113	—	—	0.5165	13.119	—	—	—	—
0000	—	—	0.4063	10.32	—	—	0.46	11.684	—	—	—	—
000	—	—	0.375	9.525	—	—	0.4096	10.404	—	—	—	—
00	—	—	0.3438	8.733	—	—	0.3648	9.266	—	—	—	—
0	—	—	0.3125	7.938	—	—	0.3249	8.252	—	—	—	—
1	—	—	0.2813	7.145	—	—	0.2893	7.348	—	—	—	—
2	—	—	0.2656	6.746	—	—	0.2576	6.543	—	—	—	—
3	0.2391	6.073	0.25	6.35	—	—	0.2294	5.827	—	—	—	—
4	0.2242	5.695	0.2344	5.954	—	—	0.2043	5.189	—	—	—	—
5	0.2092	5.314	0.2187	5.555	—	—	0.1819	4.62	—	—	—	—
6	0.1943	4.935	0.2031	5.159	—	—	0.162	4.115	—	—	—	—
7	0.1793	4.554	0.1875	4.763	—	—	0.1443	3.665	0.144	3.665	0.18	4.572
8	0.1644	4.176	0.1719	4.366	0.1681	4.27	0.1285	3.264	0.129	3.264	0.165	4.191
9	0.1495	3.797	0.1562	3.967	0.1532	3.891	0.1144	2.906	0.114	2.906	0.148	3.759
10	0.1345	3.416	0.1406	3.571	0.1382	3.51	0.1019	2.588	0.102	2.588	0.134	3.404
11	0.1196	3.038	0.125	3.175	0.1233	3.132	0.0907	2.304	0.091	2.305	0.12	3.048
12	0.1046	2.657	0.1094	2.779	0.1084	2.753	0.0808	2.052	0.081	2.053	0.109	2.769
13	0.0897	2.278	0.0937	2.38	0.0934	2.372	0.072	1.829	—	—	—	—
14	0.0747	1.897	0.0781	1.984	0.0785	1.994	0.0641	1.628	0.064	1.628	0.083	2.108
15	0.0673	1.709	0.0703	1.786	0.071	1.803	0.0571	1.45	—	—	—	—
16	0.0598	1.519	0.0625	1.588	0.0635	1.613	0.0508	1.29	0.051	1.291	0.065	1.651
17	0.0538	1.367	0.0562	1.427	0.0575	1.461	0.0453	1.151	—	—	—	—
18	0.0478	1.214	0.05	1.27	0.0516	1.311	0.0403	1.024	0.04	1.024	0.049	1.245
19	0.0418	1.062	0.0437	1.11	0.0456	1.158	0.0359	0.912	—	—	—	—
20	0.0359	0.912	0.0375	0.953	0.0396	1.006	0.032	0.813	0.032	0.812	0.035	0.889
21	0.0329	0.836	0.0344	0.874	0.0366	0.93	0.0285	0.724	—	—	—	—
22	0.0299	0.759	0.0312	0.792	0.0336	0.853	0.0253	0.643	0.025	0.644	0.028	0.711
23	0.0269	0.683	0.0281	0.714	0.0306	0.777	0.0226	0.574	—	—	—	—
24	0.0239	0.607	0.025	0.635	0.0276	0.701	0.0201	0.511	0.02	0.511	0.022	0.559
25	0.0209	0.531	0.0219	0.556	0.0247	0.627	0.0179	0.455	—	—	—	—
26	0.0179	0.455	0.0187	0.475	0.0217	0.551	0.0159	0.404	0.016	0.405	0.018	0.457
27	0.0164	0.417	0.0172	0.437	0.0202	0.513	0.0142	0.361	—	—	—	—
28	0.0149	0.378	0.0156	0.396	0.0187	0.475	0.0126	0.32	0.013	0.321	0.014	0.356
29	0.0135	0.343	0.0141	0.358	0.0172	0.437	0.0113	0.287	—	—	—	—
30	0.012	0.305	0.0125	0.318	0.0157	0.399	0.01	0.254	0.01	0.255	0.012	0.305
31	0.0105	0.267	0.0109	0.277	0.0142	0.361	0.0089	0.226	—	—	—	—
32	0.0097	0.246	0.0102	0.259	0.0134	0.34	0.008	0.203	—	—	—	—
33	0.009	0.229	0.0094	0.239	—	—	0.0071	0.18	—	—	—	—
34	0.0082	0.208	0.0086	0.218	—	—	0.0063	0.16	—	—	—	—
35	0.0075	0.191	0.0078	0.198	—	—	0.0056	0.142	—	—	—	—
36	0.0067	0.17	0.007	0.178	—	—	0.005	0.127	—	—	—	—
37	0.0064	0.163	0.0066	0.168	—	—	0.0045	0.114	—	—	—	—
38	0.006	0.152	0.0062	0.157	—	—	0.004	0.102	—	—	—	—

Base Element Index

ELEMENT	SYMBOL
Actinium	Ac
Aluminum	Al
Antimony (Stibium)	Sb
Argentum (Silver)	Ag
Arsenic	As
Aurum (Gold)	Au
Barium	Ba
Beryllium (Glucinum)	Be
Bismuth	Bi
Boron	B
Cadmium	Cd
Calcium	Ca
Cassiopeium (Lutetium)	Lu
Cerium	Ce
Cesium	Cs
Chromium	Cr
Cobalt	Co
Columbium (Niobium)	Nb
Copper (Cuprum)	Cu
Cuprum (Copper)	Cu
Dysprosium	Dy
Erbium	Er
Europium	Eu
Ferrum, Cast (Iron, Cast)	Fe
Gadolinium	Gd
Gallium	Ga
Germanium	Ge
Glucinum (Beryllium)	Be

ELEMENT	SYMBOL
Gold (Aurum)	Au
Hafnium	Hf
Holmium	Ho
Hydrargyrum (Mercury)	Hg
Indium	In
Iridium	Ir
Iron, Cast (Ferrum, Cast)	Fe
Kalium (Potassium)	K
Lanthanum	La
Lead (Plumbum)	Pb
Lithium	Li
Lutetium (Cassiopeium)	Lu
Magnesium	Mg
Manganese	Mn
Mercury (Hydrargyrum)	Hg
Molybdenum	Mo
Natrium (Sodium)	Na
Neodymium	Nd
Niobium (Columbium)	Nb
Osmium	Os
Palladium	Pd
Platinum	Pt
Plumbum (Lead)	Pb
Plutonium	Pu
Potassium (Kalium)	K
Praesodymium	Pr
Promethium	Pm
Rhenium	Re

ELEMENT	SYMBOL
Rhodium	Rh
Rubidium	Rb
Ruthenium	Ru
Samarium	Sm
Scandium	Sc
Selenium	Se
Silicon	Si
Silver (Argentum)	Ag
Sodium (Natrium)	Na
Stannum (Tin)	Sn
Stibium (Antimony)	Sb
Strontium	Sr
Tantalum	Ta
Tellurium	Te
Terbium	Tb
Thallium	Tl
Thorium	Th
Thulium	Tm
Tin (Stannum)	Sn
Titanium	Ti
Tungsten (Wolfram)	W
Uranium	U
Vanadium	V
Wolfram (Tungsten)	W
Ytterbium	Yb
Yttrium	Y
Zinc	Zn
Zirconium	Zr

Drill Bit Conversions

DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
80	.0135	
79	.0145	
1/64	.0156	
78	.0160	
77	.0180	
76	.0200	
75	.0210	
74	.0225	
73	.0240	
72	.0250	
71	.0260	
70	.0280	
69	.0292	
68	.0310	
1/32	.0312	
67	.0320	
66	.0330	
65	.0350	
64	.0360	
63	.0370	
62	.0380	
61	.0390	
60	.0400	
59	.0410	
58	.0420	
57	.0430	
56	.0465	
3/64	.0469	0 - 80
55	.0520	
54	.0550	
53	.0595	1 - 64, 72
1/16	.0625	
52	.0635	
51	.0670	
50	.0700	2 - 56, 64
49	.0730	
48	.0760	
5/64	.0781	
47	.0785	3 - 48
46	.0810	
45	.0820	3 - 56
44	.0860	
43	.0890	4 - 40
42	.0935	4 - 48
3/32	.0938	
41	.0960	
40	.0980	
39	.0995	
38	.1015	5 - 40
37	.1040	5 - 44
36	.1065	6 - 32
7/64	.1094	
35	.1100	
34	.1110	
33	.1130	6 - 40
32	.1160	
31	.1200	
1/8	.1250	
30	.1285	
29	.1360	8 - 32, 36
28	.1405	
9/64	.1406	
27	.1440	
26	.1470	
25	.1495	10 - 24
24	.1520	
23	.1540	
5/32	.1562	
22	.1570	
21	.1590	10 - 32
20	.1610	
19	.1660	
18	.1695	
11/64	.1719	
17	.1730	
16	.1770	12 - 24
15	.1800	
14	.1820	12 - 28
13	.1850	
3/16	.1875	
12	.1890	
11	.1910	

DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
10	.1935	
9	.1960	
8	.1990	
7	.2010	1/4 - 20
13/64	.2031	
6	.2040	
5	.2055	
4	.2090	
3	.2130	1/4 - 28
7/32	.2188	
2	.2210	
1	.2280	
A	.2340	
15/64	.2344	
B	.2380	
C	.2420	
D	.2460	
1/4	.2500	
E	.2500	
F	.2570	5/16 - 18
G	.2610	
17/64	.2656	
H	.2660	
I	.2720	5/16 - 24
J	.2770	
K	.2810	
9/32	.2812	
L	.2900	
M	.2950	
19/64	.2969	
N	.3020	
5/16	.3125	3/8 - 16
O	.3160	
P	.3230	
21/64	.3281	
Q	.3320	3/8 - 24
R	.3390	
11/32	.3438	
S	.3480	
T	.3580	
23/64	.3594	
U	.3680	7/16 - 14
3/8	.3750	
V	.3770	
W	.3860	
25/64	.3906	7/16 - 20
X	.3970	
Y	.4040	
13/32	.4062	
Z	.4130	
27/64	.4219	1/2 - 13
7/16	.4375	
29/64	.4531	1/2 - 20
15/32	.4688	
31/64	.4844	9/16 - 12
1/2	.5000	
33/64	.5156	9/16 - 18
17/32	.5312	5/8 - 11
35/64	.5469	
9/16	.5625	
37/64	.5781	5/8 - 18
19/32	.5938	
39/64	.6094	
5/8	.6250	
41/64	.6406	
21/32	.6562	3/4 - 10
43/64	.6719	
11/16	.6875	3/4 - 16
45/64	.7031	
23/32	.7188	
47/64	.7344	
3/4	.7500	
49/64	.7656	7/8 - 9
25/32	.7812	
51/64	.7969	
13/16	.8125	7/8 - 14
53/64	.8281	
27/32	.8438	
55/64	.8594	
7/8	.8750	1 - 8
57/64	.8906	
29/32	.9062	

DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
59/64	.9219	1 - 12
15/16	.9375	1 - 14
61/64	.9531	
31/32	.9688	
63/64	.9844	1 1/8 - 7
1	1.0000	
1 3/64	1.0469	1 1/8 - 12
1 7/64	1.1094	1 1/4 - 7
1 1/8	1.1250	
1 11/64	1.1719	1 1/4 - 12
1 7/32	1.2188	1 3/8 - 6
1 1/4	1.2500	
1 19/64	1.2969	1 3/8 - 12
1 11/32	1.3438	1 1/2 - 6
1 3/8	1.3750	
1 27/64	1.4219	1 1/2 - 12
1 1/2	1.5000	

METRIC TAP DRILL SIZES

METRIC TAP	TAP DRILL (mm)	DECIMAL (inch)
M1.6 x 0.35	1.25	.0492
M1.8 x 0.35	1.45	.0571
M2 x 0.4	1.60	.0630
M2.2 x 0.45	1.75	.0689
M2.5 x 0.45	2.05	.0807
M3 x 0.5	2.50	.0984
M3.5 x 0.6	2.90	.1142
M4 x 0.7	3.30	.1299
M4.5 x 0.75	3.70	.1457
M5 x 0.8	4.20	.1654
M6 x 1	5.00	.1968
M7 x 1	6.00	.2362
M8 x 1.25	6.70	.2638
M8 x 1	7.00	.2756
M10 x 1.5	8.50	.3346
M10 x 1.25	8.70	.3425
M12 x 1.75	10.20	.4016
M12 x 1.25	10.80	.4252
M14 x 2	12.00	.4724
M14 x 1.5	12.50	.4921
M16 x 2	14.00	.5512
M16 x 1.5	14.50	.5709
M18 x 2.5	15.50	.6102
M18 x 1.5	16.50	.6496
M20 x 2.5	17.50	.6890
M20 x 1.5	18.50	.7283
M22 x 2.5	19.50	.7677
M22 x 1.5	20.50	.8071
M24 x 3	21.00	.8268
M24 x 2	22.00	.8661
M27 x 3	24.00	.9449
M27 x 2	25.00	.9843
M30 x 3.5	26.50	1.0433
M30 x 2	28.00	1.1024
M33 x 3.5	29.50	1.1614
M33 x 2	31.00	1.2205
M36 x 4	32.00	1.2598
M36 x 3	33.00	1.2992
M39 x 4	35.00	1.3780
M39 x 3	36.00	1.4173

PIPE THREAD SIZES (NPSC)

THREAD	DRILL	THREAD	DRILL
1/8 – 27	11/32	1 1/2 – 11 1/2	1 3/4
1/4 – 18	7/16	2 – 11 1/2	2 7/32
3/8 – 18	37/64	2 1/2 – 8	2 21/32
1/2 – 14	23/32	3 – 8	3 1/4
3/4 – 14	59/64	3 1/2 – 8	3 3/4
1 – 11 1/2	1 5/32	4 – 8	4 1/4
1 1/4 – 11 1/2	1 1/2		

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