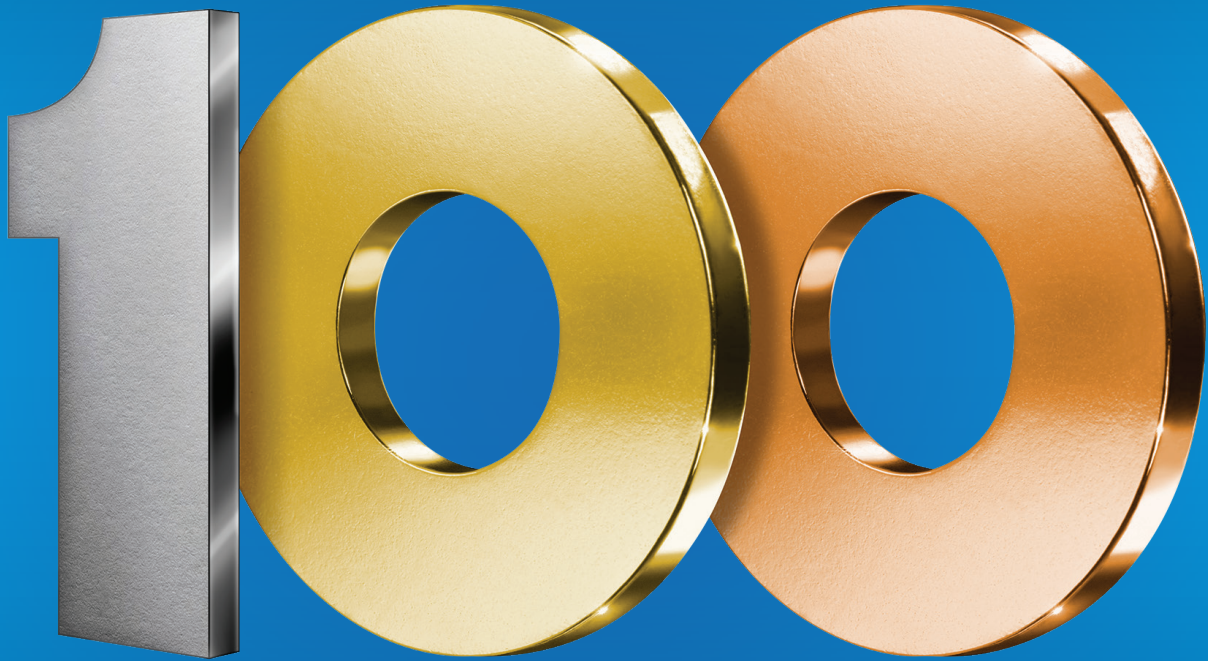




OUR STORY: PAST, PRESENT, FUTURE

**CELEBRATING**



**YEARS** SINCE 1919

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PROVIDING QUALITY STAMPINGS, WASHERS, SPACERS AND SHIMS SINCE 1919.

Learn more at [bokers.com](http://bokers.com)

# Boker's Reaches a 100 Year Milestone: The Past, Present and Future

## Beginning a Legacy

It all began in the basement of a young, passionate and focused gentleman named Vitus Boker in Minneapolis, Minnesota. With a background of extensive tooling knowledge gained from previously working at a manufacturing company in Denmark, Vitus decided to take the leap and build his own company with his son, John, in 1919, called V.A. Boker and Sons, Inc. As time went on Vitus' other children: William, Richard, and Marie, also joined in the family business. Initially, Vitus intended to build the company around its first products, an envelope folding machine and a small hand check protector. However, with his tooling knowledge the enterprise began generating more revenue from manufacturing prototypes and custom parts for automated machinery. As the word spread of Boker's unique process for producing high-quality, short-run, stamped metal parts, demand grew. Vitus quickly found himself entrenched within the stamping industry as one of the pioneers of short-run stampings. The business boomed and has continued to flourish throughout the years, growing in space and customer base.

In 1968, Boker's was purchased by four of its employees: William Tedlund, Joseph Basara, Chester Engquist, and Joseph Kantorowicz, and was run successfully for many years. In 1986 William (Bill) Tedlund became the sole owner. He continues to lead the business with the Boker's values and traditions, instilling those principles with his own family. He has also taught his family and others an important humbling truth to live by saying, "It is important to know what you know, but more important to know what you don't know and who to go to."

Today, Boker's is still a privately held family-owned business, in its fifth generation, guided by Vitus Boker's principals of hard work and attention to detail with Bill Tedlund as Chairman of the Board. From starting to help out the family business as children, and growing into leadership positions, the legacy continues. "I remember

assembling advertising sample packs at home with my sister and brother," said Amy Kersey, CEO/President. "We have all been involved with the business throughout our lives and love working here. As other employees learned and grew into other positions, so did I, working my way through most every office position. Today, I

**"Customers trust Boker's because of our service, quality and on-time delivery. They would come to us with a difficult part that they were struggling with and we would figure out how to manufacture the part to their exact specifications, and that is where they found their trust in Boker's."**



continue to focus on our customer needs and our people. Every job is important here."

"Our father knew every employee and kept the pulse on the business by wandering around the shop and talking to the employees," said Barry Tedlund. "He really knew the people and their families and what was important to them. Bill Boker, a past second generation owner, wanted to make sure the employees would continue to be taken care of when the transfer of ownership was made, and my dad made sure of it."



Being a values-driven company from the start also meant giving back and being good stewards for the surrounding community. As an employer for skilled tradespeople, Boker's first employed local people within walking distance. These days, they draw employees from across the Twin Cities and outlying communities.

"There are a vast number of industries out there and we have had a hand in almost all of them," said Randy Clementson, Class A Inspector. "Every time I see a payphone, I remember making those parts for the coin slots on top of the phone. It's fun and exciting to be at a place that serves every industry."

One of the many customers of Boker's is a major aerospace manufacturer who came to Boker's for various parts including small parts for the gauges in the cockpit, parts for the fuel system and even a part that was used for the inflation slide on an airplane. Another longstanding customer of over 80 years, is a dental company that needed a part made for a mouth piece that was used for absorbing fluids during procedures.

In times of crisis, Boker's has been counted upon to manufacture component parts that are urgently needed. Whether it was for urgent combat efforts during WWII, or making a custom stamping used in rescue efforts at Ground Zero during the 9/11 disaster, Boker's was there. Employees banded together to get these high-

quality parts out quickly, sometimes within a 24-hr turnaround, knowing that many others counted on them and failure to deliver was not an option.

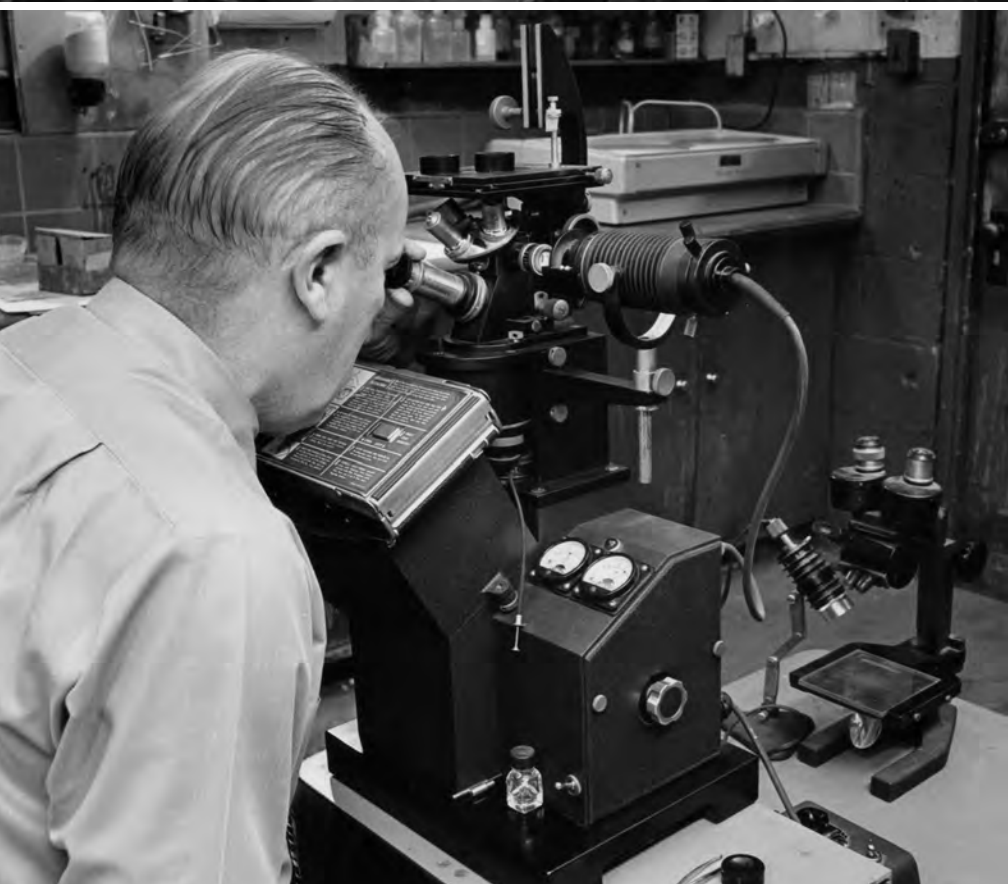
"Customers trust Boker's because of our service, quality and on-time delivery," said Nick Todora, retired Advertising Manager. "They would come to us with a difficult part that they were struggling with and we would figure out how to manufacture the part to their exact specifications, and that is where they found their trust in Boker's."

*continued*



## A Part of Every Industry

Boker's has manufactured parts for almost every industry and product imaginable: from payphones, coffee makers, medical devices, missiles, mail sorting machines to dental instruments, snowshoes and aircrafts. Stampings and washers are needed in virtually everything we use or come in contact with on a daily basis. "The parts we make affect everyone we care about and that's why delivery of quality components through certified processes are important." says Tony Kersey, Marketing Manager.





## The Spirit of Boker's

"Our employees and the culture they create are the core of Boker's long-lasting success," said Mark Kersey, Vice President. "Boker's was founded on the principles of hard work, camaraderie and creating an atmosphere where employees feel appreciated and encouraged to grow personally and professionally. Some of us have been with Boker's for 40-50 years and have worked many different positions throughout our careers. Our culture is very customer-orientated and continues to be one of our greatest strengths."

"You get one year of experience 46 times and soon you know every position on the shop floor," said Randy. "All the employees are willing to help each other out - we have a real strong bond. It's like family."

Boker's works in a fast paced and high demand industry. Over the past 100 years Boker's has embraced and been on the forefront of technology, which has gone from largely manual processes to utilizing automated controls and equipment. Tolerances have gone from loose to tight as the parts and components have gone from large to small. With a solid community of employees, a culture of friendship and our care for the customer, the company will continue to grow and evolve in the future.

## Continuing the Legacy

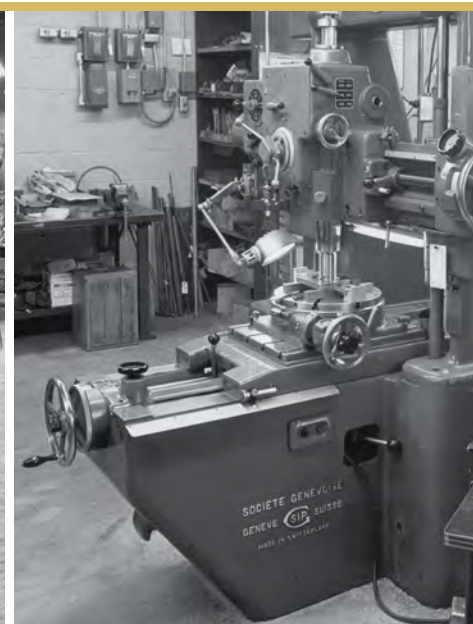
Back in 1974, Bill Tedlund had the vision of expanding the business into every industry. Boker's continues to evolve with new technology while embracing the ever-changing needs of our customers. "Our customers are diverse. Our employees are smart, quick and pay attention to the details needed to produce the component that the customer needs in a timely fashion," said Mark Kersey. "Years ago, lead times were 14-20 weeks to deliver parts and today the turn-around time is about 2 weeks."

Boker's is currently expanding their manufacturing facility to streamline processes and add capacity as product diversification continues to grow. The new space adds 66,500 square feet, almost doubling their current manufacturing space. "I'm looking forward to getting the new plant up and running," said Amy Kersey. "This expansion will help us continue to exceed our customers' requirements into the future without ever losing sight of their needs, nor our team."

"The future of Boker's is sticking to the wheelhouse of what we are known for, expanding our customer base and serving markets on the forefront of technology," said Tony Kersey. "I'm focused on learning everything about the industry and growing the business for future generations to be a part of. We will continue to adapt and pursue new technologies, in keeping up with changing customer requirements. Our customers depend on our flexibility in dealing with an ever-changing environment."

**"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 for the next 100 years."**

"Our controlled processes coupled with our employee base is what sets us apart," said Chuck Kersey, Assistant Sales Manager. "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 for the next 100 years."



# Boker's Today



## Looking forward to the next 100 years!

**THANK YOU** to all of our customers who have supported Boker's over the past 100 years. We are sincerely grateful for your continued business. At Boker's we are honored to serve our customers and to be a part of so many diverse industries across the globe. You can rest assured that we are here now and will be in the future, we will continue to work hard to meet or exceed our customers' expectations.

Sincerely,

Amy Kersey  
CEO/President

CELEBRATING  
**100**  
YEARS SINCE 1919

### 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. In case of an urgent requirement, your order can also be expedited for even faster delivery.



### Minimum Quantity

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.

100

### High-Volume Orders

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





# STAMPINGS

## Quality Stampings Made to Order

Boker's has specialized in producing high quality metal stampings for over a century. Our precision manufacturing covers a complete range of sizes up to 12" x 12" (flat) with thicknesses from .005" to .190" (varies by material) and draws up to 3" deep and 8" in diameter.



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"

### Draws, Forming, Blanking and Piercing

At Boker's, we utilize the latest stamping technologies and manufacturing concepts to continually provide you with stampings of the highest quality. This diligent effort to achieve and retain the highest quality possible in our metal stamping processes goes back to 1919.

Our process begins with our in-house tool department, where wire EDM-produced tooling provides the dimensional tolerances you require. Complete Statistical Process Control (S.P.C.) is available upon request to further assure accuracy throughout the manufacturing process. Our "Dock-to-Stock" capability saves you inspection time and is another example of our commitment to customer service. Boker's can also meet your delivery requirements with flexible Just-In-Time (J.I.T.) programs.



# WASHERS

## Metric Sizes No Problem! Washers, Spacers and Shims

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 0.080" to 5.140" and a wide variety of inside diameters, you have millions of flat washer possibilities.



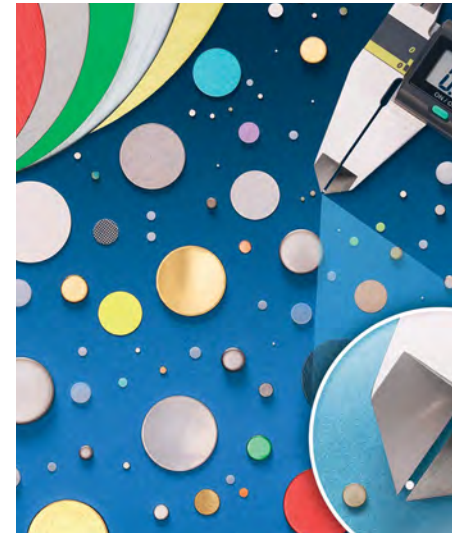
### Special Shapes and Sizes

As the photo shows, Boker's can make special washer shapes and sizes, up to 12" in outside diameter. These custom items are made with very low tooling costs. They can be easily quoted by mailing, faxing or emailing us your print. Tell us what you need, and we'll make it to your exact specifications. All Boker's washer sizes are also available in metric measurements and searchable at [bokers.com](http://bokers.com).



### Precision Fabrication

It's important for you to know that the washers and spacers you get from Boker's are going to meet your specifications. "From the first part to the last..." Those are not just words at Boker's, but the goal of the quality-conscious personnel who produce your precision parts with tolerances as close as the specifications demand, and sometimes even closer. Metallic washers and spacers are flat, tumble deburred, and can be heat treated or plated. As a final check, your parts are sent to the inspection department before your order is shipped.



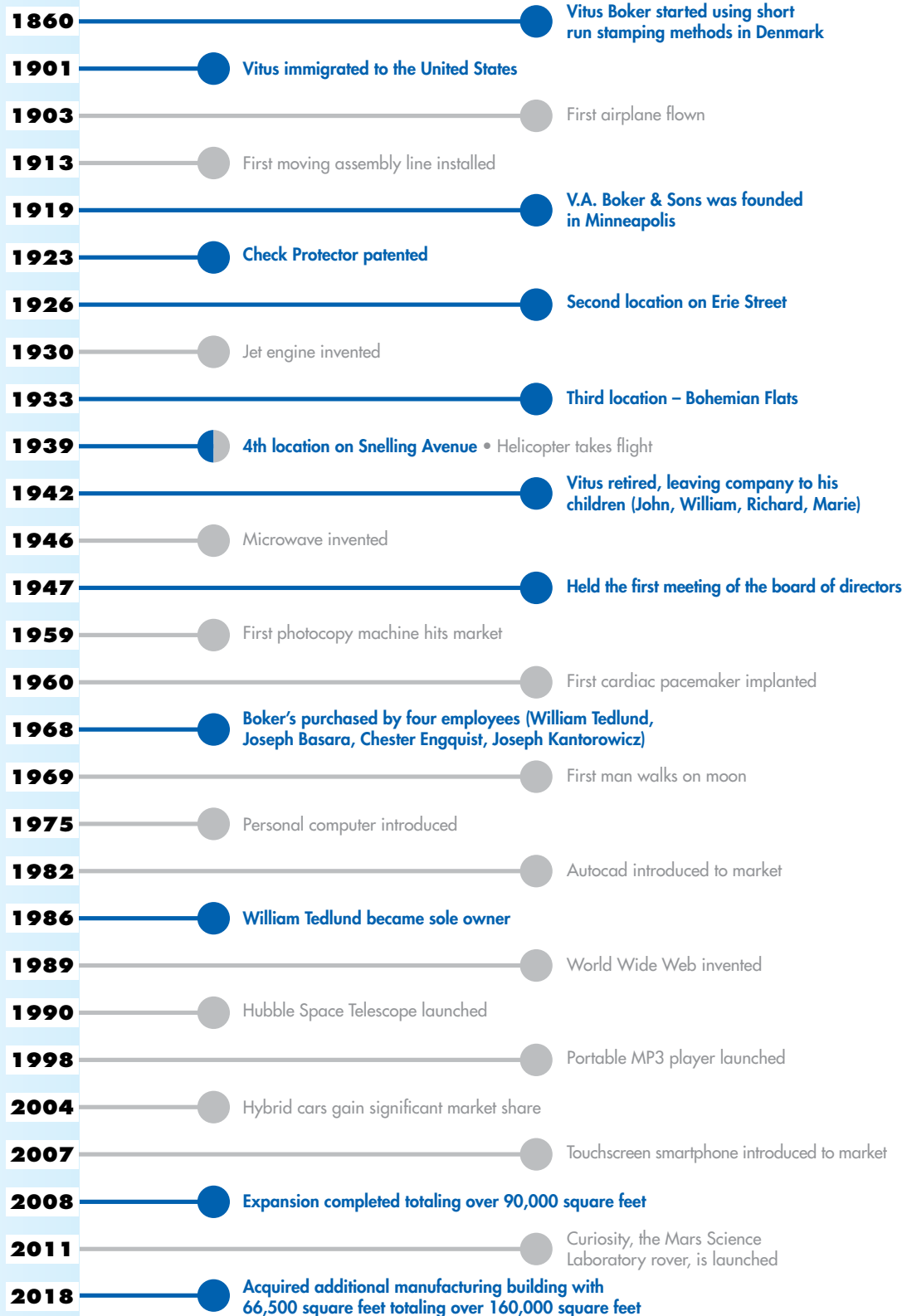
### The Widest Range of Disks Available

All of Boker's 32,000+ flat washer sizes are available without the I.D. hole. Disks, commonly referred to as discs, circles, plates and/or slugs, are typically round washers with or without a center hole. Functional uses of disks include providing a precise space between components or materials as well as load disbursement.

Our manufacturing processes cover a complete range of sizes up to 12" x 12" (flat) with thicknesses from .005 to .190 (varies by material) and draws up to 3" deep and 8" in diameter. Boker's produces disks in more than 2,000 commonly specified and difficult-to-find materials.



# BOKER'S TIMELINE



# STAMPINGS & WASHERS

## Edge Conditions for Stampings and Washers

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

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*

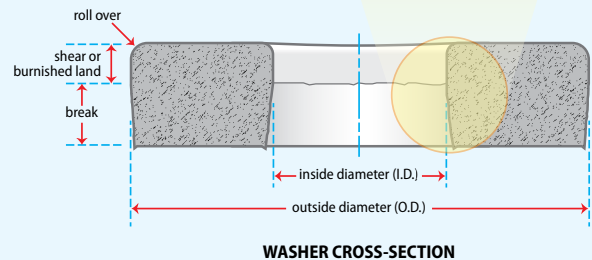
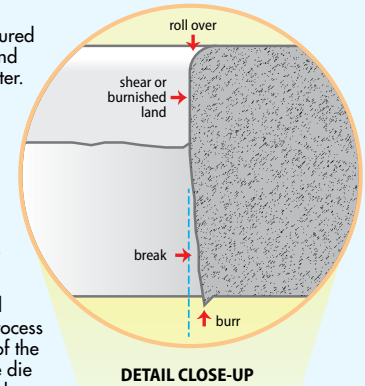
For more information please contact one of our estimators for assistance at **800-927-4377**.

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

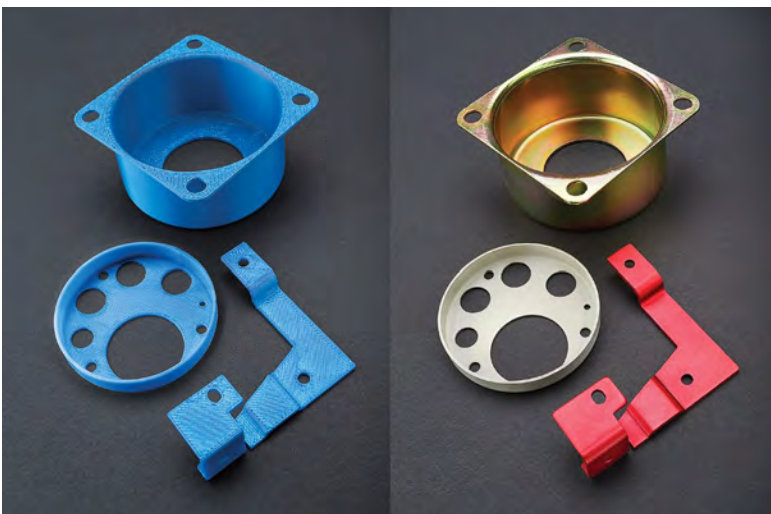
**Shear or Burnished Land:** This is a burnished area which is approximately one third of the material thickness.

**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.



## Boker's 3D Printing Prototyping Services



Boker's now offers additive manufacturing (3D printing) to provide customers with 3D prototypes. With our Stratasys 3D Printer, you'll be able to see how your product will turn out in advance. No more guess work or uncertainty. Only precision. This service allows customers to test parts for form, fit and function prior to production of the actual stamped part. Make sure to take advantage of our capabilities next time you work with us.



# 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 including 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 several non-metallic materials such as acetal, PTFE, polyester, nylon, fiber, polyethylene, various phenolics and NEMA grade laminates. Plus varieties of wrought cobalt, iron and nickel-base superalloys for demanding, high-performance applications. Certificates of Compliance or chemical/physical analysis are available upon request. Whatever your requirements, if it can be stamped, Boker's can turn it into the part you need.

**Stay In The Loop with Boker's Bulletin**

Your FREE online source for the latest stamping news and offerings from Boker's. This electronic newsletter is sent out on a quarterly basis and contains industry news as well as other metal forming industry information. Subscribe today by going to [bokersbulletin.com](http://bokersbulletin.com)

## Secondary Operations

Boker's provides the secondary operations you require including deburring, tapping, counterboring, reaming, and spotfacing to name a few. Boker's also has approved vendors for heat treating, grinding and plating. See page 71 for a full list of equipment and capabilities.



## AS9100/ISO9001 Certified



At Boker's, we take our manufacturing practices very seriously. Our Quality Management System (QMS) is AS9100/ISO 9001 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
- ✓ F.A.I.
- ✓ Dock-To-Stock
- ✓ PPAP
- ✓ AS9102
- ✓ Conflict Minerals
- ✓ DFARS
- ✓ REACH
- ✓ CA Proposition 65
- ✓ RoHS
- ✓ ITAR
- ✓ Latex-Free
- ✓ S.P.C.
- ✓ IMDS

## Boker's Environmental Compliance Statement

Boker's, Inc. is committed to responsible business practices that portray our dedication to our employees, customers and country. Boker's sources conflict-free material and services, in addition to materials that do not contain regulated or hazardous substances, from validated suppliers. These include, but are not limited to, tin, tantalum, tungsten and gold. It is important that our suppliers adhere to the laws put in place to ensure our values and commitments are reflected in our customer offering.

**bokers.com is Your Complete Resource**

This complete catalog of stampings, washers and spacers is also available by accessing our website at [bokers.com](http://bokers.com). This valuable resource makes finding the right size stamping, washer or spacer faster and easier than ever. Key in the desired size range by OD or ID and get an immediate display of all available sizes in inch or millimeter measurements. There's nothing easier! Visit our mobile-friendly website today!



# Selecting the Optimal Washer

Though this catalog's primary focus is to provide you with thousands of non-standard, round flat washer sizes that are available without tool charges, there are many specific applications that demand a more specialized washer type. Following is an overview of just some of the many washer styles Boker's produces, and what they are optimally designed for. To review Boker's complete Optimal Washer Solution guide, visit [bokers.com/washerguide](http://bokers.com/washerguide).

**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 disburse load without deforming the assembly.

**Cylindrically Curved:** They 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.

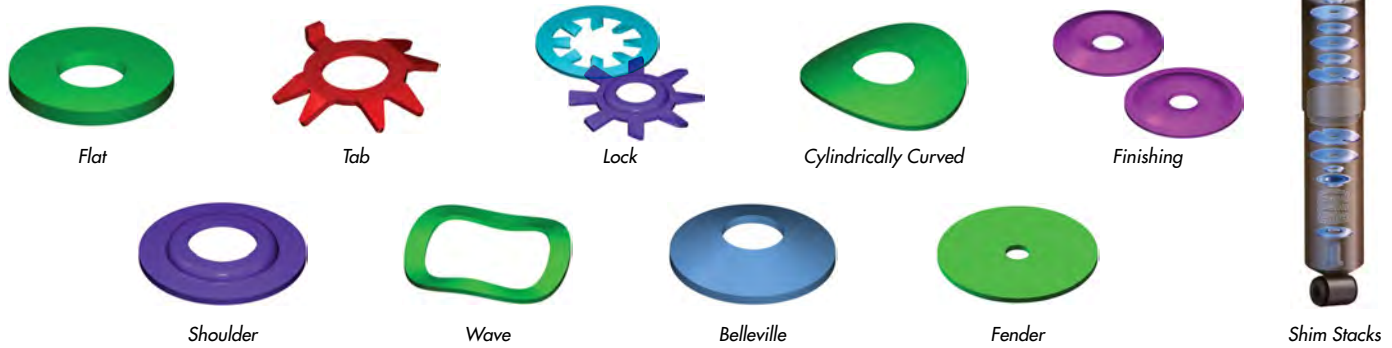
**Wave:** These washers are ideal for obtaining loads when the load is static or the working range is small and the amount of axial space is limited.

**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.

Visit [bokers.com/washerguide](http://bokers.com/washerguide) for more information.



## Non-Metallic Washers and Spacers

The thickness ranges stated in this catalog are minimum and maximum values for metallic washers and spacers but may be suitable for non-metallic pieces as well. For easy reference, tools listed in **BOLD TYPE** can be considered for non-metallic items from .005" to .125" thick.

When determining the proper sized tool for your washer or spacer, the outside diameter (O.D.) listed in the catalog typically remains the same for both the metallic and non-metallic part. The inside diameter (I.D.), however, may shrink by as much as ten percent of the material thickness depending on the material used and its thickness.

Boker's estimates of these shrinkage factors are as follows:

MATERIAL	FACTOR %	MATERIAL	FACTOR %
Polycarbonate	10-12	Polypropylene	5-10
Nylon	10	PTFE	5
Polyethylene	10	Polyester	5
Acetal	10	Linen Phenolic	5
PVC	10	Vulcanized Fiber	0-5
A.B.S.	10	FR-4	0-5
MD Nylon	10	G-10	0-5

For assistance in determining the actual tool to be used, please contact one of our estimators at (800) 927-4377.



# 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 (i.e. – 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 Levelled** – 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** – Vee 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.



# Equipment and Capabilities List

Housed in over 160,000 square feet of buildings, the equipment listed below, as well as all tooling, are protected by a central station security and fire system.



## Tool & Die Department

- CAD CAM Drawing System
- Kitamura Vertical Machine Center
- Mori Seiki Vertical Machine Center (20" x 40")
- Mori Seiki High Precision C.N.C. Lathes
- Digital Optical Comparator
- (2) Clausing Surface Grinders
- Matsui Precision Grinder
- (3) Charmilles Wire E.D.M.s (14" x 21" x 8")
- Charmilles E.D.M. Drill
- Okamoto Precision Grinder
- Stratasys Dimension SST 1200ES 3D Printer

## Washer Department

- (18) 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)
- Digital Servo Feeders
- Electric Coil Reels (6,000 lb. capacity)
- 48" Press Brake
- Optical Part Detection Systems
- Press Control Automation
- Tonnage Monitors
- (2) Material Handling Conveyors

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## Heat Treating Department

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

## Raw Stock & Shear Department

- (2) 10' Shears (.25" 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

## Secondary Operations Department

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

## Shipping Department

- Toledo Electronic Scales & Printer
- Precision Electronic Scales & Printers
- Automated Protective Packaging Bagger
- Polychem Automatic Plastic Strapping System
- Hercules Ergo Container Handling System
- Wulftec Pallet Wrapper

## 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

## Material Capabilities

- Material Thickness: .005" to .190" (varies by material)
- Blank Size: 12" x 12" maximum (flat)
- Draws: 8" diameter, 3" deep



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