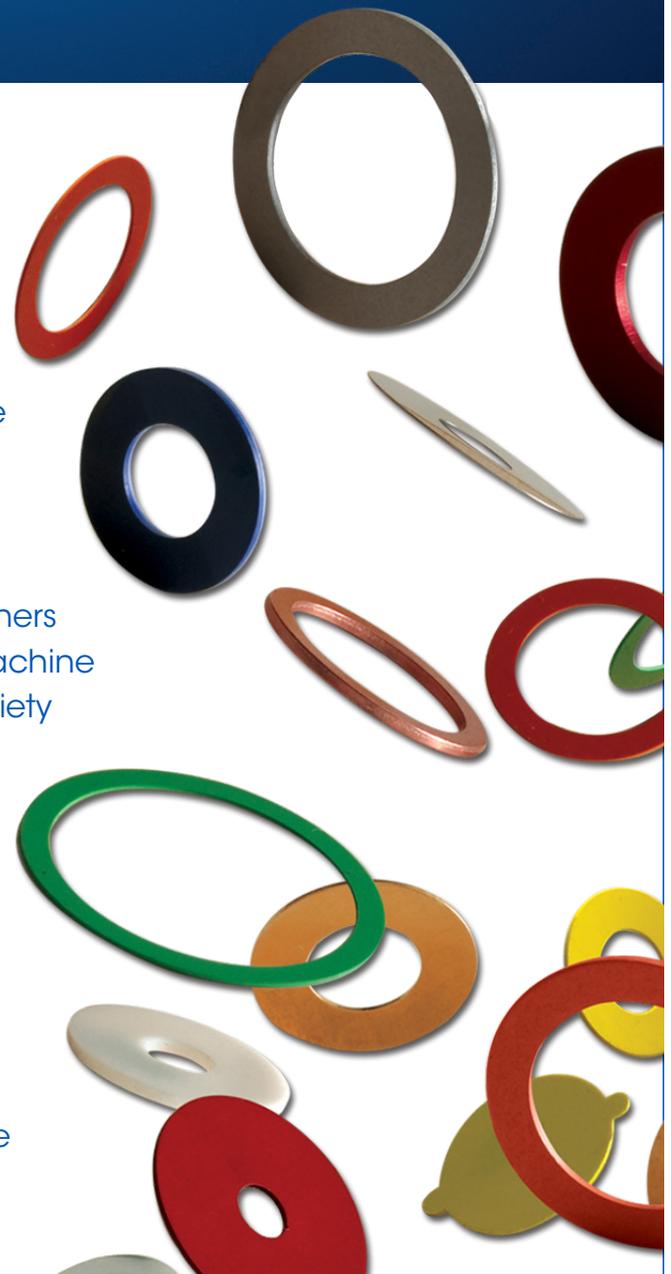


# SELECTING THE OPTIMAL WASHER SOLUTION FOR ASSEMBLY APPLICATIONS

Efficient, accurate assembly and fastening processes are critical in manufacturing applications, as they ensure the right parts or components are utilized to build, sort or package products in a variety of applications, including the automotive, medical, aerospace and appliance sectors.

While every assembly and fastening process requires a variety of components for successful operation, washers are a vital component. Washers are critical to the operation of virtually every machine or device with moving parts. They perform a variety of functions beyond securing bolts, nuts, screw and rivets, including insulate, seal, lock, space, improve appearance, provide spring take-up, align and distribute loads.

With what appears to be almost limitless varieties of washers available, it is important to select the most optimal type of washer for a specific application. Failure to specify the correct washer can result in machine downtime and associated lost production costs.



## WASHER MATERIALS

Any type of material that can be stamped can be made into a washer. Washers are manufactured in a broad range of metallic and non-metallic materials, including low and high carbon steels, stainless steel and steel alloys, copper-based materials, beryllium copper, phosphor bronze, titanium, aluminum, fiber, mica, mylar, rubber, nylon, PTFE and phenolic.

Washer material is important because some applications require a specific material to ensure the washer withstands environmental conditions. For example, if a washer goes through cyclic loading, strength and fatigue resistance are important design criteria and require the use of high-alloyed steels or spring steel. Alternatively, non-metallic materials are used when washers are subjected to lighter loads or soft surfaces that could be damaged by a metallic washer.

## WASHER STYLES

There are a variety of washer styles available in today's industry. This article will discuss the six basic types of washers: flat, shoulder, tab, lock, countersunk and spring, in addition to a few specialty styles.



**Flat** washers is the most common category, which includes a large number of washer configurations. These washers are thin, flat and circular general-purpose washers with a centrally located hole. Internal and external shapes may be round, symmetrically square, hexagonal or rectangular. They also may be non-symmetrical depending on the function of the washer.



**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. These washers are used primarily in the electronic equipment industry as insulators and made of non-conductive materials.



**Tab** washers are a type of lock washer, round in shape and often manufactured with a single tab or multiple tabs and notches that can be formed to shape around bolts/nuts or designed to lay flat. These washers are ideal for use in harsh environments, effectively locking a part into place in applications requiring extreme heat conditions or heavy vibrations.



**Lock** washers are designed to secure fasteners that have a tendency to rotate or lose friction. Lock washers exert a load, partially deform and lock a fastener in place. A split coil or teeth of the lock washer bite into the head of the fastener and against another flat surface. In some applications they are deployed along with a flat washer in order to distribute the load evenly without deforming the assembly that the fastener is secured to.



**Countersunk** washers, also referred to as finishing washers, have a countersink that captures the head of the fastener. When secured, they provide a flush surface and are available in several shapes including: 90 degree countersunk, angle countersunk, flanged, un-flanged, and rolled flange among others. These types of washers are often found on consumer products.



**Spring** washers, also known as disc springs, feature irregularities that compress with a proportionate resistance to return to their pre-deflected shape. Spring washers are employed in applications where assemblies need a part to take up play, maintain assembly tension, compensate for expansion or contraction in materials, or to absorb intermittent shock loads and provide a controlled reaction under dynamic loads.

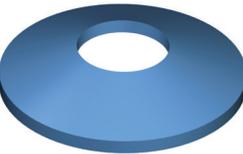
Spring washers are economical, small and generally weigh less than alternative fastening solutions. There are three basic types of spring washers: cylindrically curved, wave and Belleville.



**Cylindrically Curved** washers, also known as "Crescent," "Bowed" or "Curved" washers, have the most uniform spring constant over the widest deflection range of any of the spring washer types. Their spring rate is approximately linear throughout the entire deflection range. These washers are ideal for lighter loads ranging from a few ounces to about 100 pounds and are ideal for flexible, load-cycling applications.



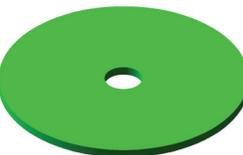
**Wave** washers, sometimes referred to as "Wave Springs," have multiple waves—generally three, four or six—within their washer design and are available in many sizes. By increasing the number of waves, the thickness can be reduced for a given load, but only by decreasing the amount of deflection and increasing the radial stress. Wave uniformity is important because the load/deflection rate will not start until all waves are evenly loaded. Wave 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. These washers are typically used as cushions or spacers to take up variations in assembled parts.



**Belleville** washers are often described as conical or spherical spring washers, as they have the form of a truncated cone or truncated sphere. These washers have the smallest deflection ranges of any of the three types of spring washers and the highest load capacity. The load and deflection capability is dependent on height/thickness ratio. Belleville washers are common in thermal expansion applications, and are used to solve spring problems of high loads, limited space and small deflections.



**Valve Shim Stacks** feature a smooth finishing design to ensure shim stacks work together to dampen suspension movement. With exact, consistent thicknesses, inside diameters and outside diameters, shim stacks are ideal for simple and complex applications. Shim stacks are heat treated to operate in temperatures exceeding 500 degrees without losing strength. They are optimal for achieving precise spacing or filling space between mismatched components.



**Fender** washers have a large outside diameter in comparison to the inside diameter. The name, "Fender," is derived from their use in the automotive industry where they are used to mount fenders. Fender washers distribute a load evenly across a large surface area. Flat washers whose outer diameters measure more than three times the inner diameter are commonly referred to as fender washers.

## WASHER SELECTION

In addition to determining washer material and style, it is important to consider additional factors before specifying a type of washer, including tolerances, material and thickness, temper, hardness and heat treating, compatibility, flatness, burrs and finish.

**Tolerances:** As a general rule, “the tighter the tolerances the more expensive the part.” Washer tolerances should be specified in accordance with accepted industry standards.

**Materials and Thicknesses:** Material and thickness selection should be based upon a specific application’s requirements and within standard tolerances. For example, a corrosion resistance alloy used in place of a steel part plated to resist corrosion may result in significant savings.

### **Temper, Hardness and Heat Treating:**

If hardness is of no importance to an application, temper does not need to be specified. If hardness needs to be specified on heat-treated parts, it should comply with standard ranges for the material.

**Compatibility:** All specifications, such as a washer’s physical dimensions, heat treatment and load, must be mutually compatible to ensure optimal performance.

**Flatness:** Industry guidelines recommend that flatness should not be greater than 0.010 total indicator reading (T.I.R.) per inch of outside diameter to eliminate expensive secondary operations such as grinding or flattening on special tooling.

**Burrs:** Burrs, ragged, sharp protrusions on the edges of metal stampings, should be considered as deburring can result in additional costs if not specified.

**Finish:** Surface finish or coatings can be used to improve appearance or corrosion resistance on a washer. Finish should be considered to determine if full or partial coating on a washer is needed.

## CONCLUSION

While the above factors provide a helpful guide in understanding and specifying washers, operators can also benefit from the experience and capability of an established industry manufacturer that consistently solves unique problems ranging from engineering and custom manufacturing.



Boker’s, Inc. maintains a Quality Management System that is AS 9100:2016 and ISO 9001:2015 certified and is a woman-owned manufacturer of precision stampings and non-standard washers and spacers. To request a complimentary copy of Boker’s Stampings & Washers Catalog or Sample Pack contact:

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