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White Paper

AN INTRODUCTION TO TUBULAR STAMPING

SYNOPISIS

Tubular stamping is a method for making a tubular work piece by subjecting flat metal stock to a series of stamping operations. It can be used to create complex shapes, including any rod-like structure previously made from solid or tubular stock. Tubular stamping generates little waste, produces generally lighter parts than other metal forming methods, and is very economical for large production runs.

Figure 1. *Tubular stamping can be used to produce complex shapes, such as this adjustment screw for a flooring system.*

WHAT IS TUBULAR STAMPING?

Tubular stamping, or tube stamping, is a patented method for making a tubular work piece by using a series of stamping operations. In its basic form, tubular stamping begins with a blank punched from a coil of sheet metal. The preformed blank is then moved into a die that gives it a "U" shape. The U-shaped piece of metal is then subjected to another stamping operation that rolls the legs of the U shape toward one another to begin to close the piece into a tubular shape. Another tool then completes the roll, delivering a usable tubular structure.

Following the initial formation of the tube, the work piece can be subjected to re-striking steps that force the edges together even more, tightening the seam. Movement from one station to another may be accomplished through hand transfer or progressive tooling to increase production and cut labor costs.

Compared to other available metal forming methods used to produce tubes, tubular stamping offers the following advantages:

» Tubular stamping works with less-expensive flat stock metal as a basis, rather than a solid or welded tube stock.
» It can be used to create complex shapes such as axles, tubular frames, handles, or any rod-like structure previously made from a solid or tubular stock.
» Tubular stamping produces relatively little waste when compared to other metal forming methods.
» Parts created through tubular stamping are generally lighter than parts created through other means.
» Tubular stamped products are tightly seamed.

TUBULAR STAMPING VS. OTHER METAL FORMING TECHNIQUES

In order to understand completely each of the benefits of tubular stamping enumerated above, the limitations of other prevalent metal forming techniques used to create tubular products need to be assessed. These alternative methods include roll forming, hydroforming, casting, and machining.

ROLL FORMING

Roll forming is a widespread method of metal forming that can be used to manufacture pipes and tubes from flat sheets of metal. In its most fundamental form, roll forming passes flat metal stock through a series of rollers — known as roller dies — multiple times until the flat stock takes on a curve. This iterative process gradually changes the profile of the metal sheet, which can be closed into a tubular structure through iteration. Metal tubes created in this manner are used in manufacturing, commercial building, aerospace, and other applications.

Roll forming cannot be used to produce asymmetric profiles, which means that complex shapes such as those used in automotive exhausts are all but impossible to produce using this method.

HYDROFORMING

In contrast to roll forming, hydroforming is a method often used to produce complex asymmetric tubular shapes. It is also a method of tube production that begins with a basic tube, making it a supplementary technique that is used to transform metal products with simple shapes into more complex components.

To start the hydroforming process, a metal tube is filled with water and pressurized inside of a mold. As pressure is applied to the assembly, the liquid within the tube forces the walls of the tube to conform to the shape of the mold cavity. A variation on this method is to push high-pressure liquid into the tube while the press simultaneously applies external pressure.

In general, hydroforming is somewhat limited due to its material requirements and the fact that the expansion of a tube can only be taken so far. This will occasionally make it an unfeasible solution for some parts.

CASTING

While it is one of the oldest methods of metal forming available, casting is a relatively cost-intensive process that makes it impractical for most production lines.

To cast a metal tube, a mold must first be created. During production, metal must be melted and then poured into the mold and left to cool. Once the metal has hardened, the mold is removed. Depending on the manufacturing process, the mold may even be destroyed in the process of extracting the finished product, meaning that the manufacture of each finished piece could also require the creation of a separate mold.

MACHINING

Thanks to the integration of computer programming, complex metal shapes — including tubular ones — can now be created relatively easily and quickly with machining techniques.

Machining's main limitation when it comes to tubular products becomes apparent when a curved or complex-shaped tube is needed. Machining techniques simply cannot bore curvilinear holes through metal, which means that tube production through machining is limited to straight shafts.

THE BENEFITS OF TUBULAR STAMPING

While all of the metal forming techniques listed above have their advantages and are suitable for a wide variety of applications, they all have their limitations. In contrast, tubular stamping offers advantages over each of them when it comes to the formation of metal tubes.

Tubular stamping and roll forming both begin with flat stock, but tubular stamping can produce more complex shapes. Like hydroforming and casting, tubular stamping can be used to produce complex parts — but in a manner that overcomes the expansion limitations of hydroforming and that is much faster and less expensive than casting. And while machining cannot produce complex shapes, tubular stamping can. Lastly, like roll forming and hydroforming, tubular stamping's products are lightweight and strong.

	Roll Forming	Casting	Hydroforming	Tubular Stamping
Flat Stock	X			X
Complex Shapes		X	X	X
Cost-Effective	X		X	X
Lightweight	X		X	X

Figure 2. *Key Benefits of Metal Tube Forming Processes Compared.*

In conclusion, if one is looking to manufacture light metal tubes with complex shapes while minimizing expenses, tubular stamping may be the ideal production method.

PRODUCTION CONSIDERATIONS FOR TUBULAR STAMPING

Tubular stamping is a versatile process that accommodates many different metals. The basic process can also be supplemented with a wide range of additional steps to work with pre-finished materials, add holes or notches to parts, or tighten seams in order to maximize a part's structural integrity.

MATERIALS THAT CAN BE TUBE STAMPED

Metals that can be used in this process include:

- Draw quality steel
- Stainless steel
- Aluminum
- Copper
- Brass
- Martinsite
- High-strength steel
- Alloys

Pre-polished and pre-painted materials can also be tube stamped. Usually, pre-finished parts are equipped with PVC tape to protect the parts during the forming processes. Post-forming touch-up finishing may be required and can be integrated into production.

Figure 3. *A tubular stamped stainless steel refrigerator handle. Tubular stamping can be performed on pre-polished or pre-painted materials.*

DIAMETERS & THICKNESSES ACHIEVABLE WITH TUBULAR STAMPING

Tubes created by using a tubular stamping process can have a diameter of anywhere from 1/4" up to the maximum diameter allowed by the stamping equipment employed, accommodating for size and tonnages.

Material thicknesses are dependent on the same parameters, as well as a rule-of-thumb ratio between the thickness of the metal and the diameter of the part. As a rough guide, the material thickness for a tube stamped product should be 15 percent of its diameter. This ratio can be increased or reduced based on part design and materials, of course, but this figure is a good starting point for any tube stamped project.

***Figure 4**. Tubular stamped components' seams can be minimized or welded shut, as in the case of this automotive exhaust component.*

METHODS OF INCREASING STAMPED PRODUCT SEAM INTEGRITY

As noted above, all tubular shapes created via a tube stamping process have seams because they originate with flat pieces of metal — whether sheets, blanks, or coils. The integrity of this seam is typically increased to some degree with successive re-striking.

Seams can also be welded shut after the tubular stamping process has been completed. Suitable welding techniques include laser welding, resistance welding, plasma welding, TIG, and MIG welding.

ADDITIONAL OPTIONS

Depending on the complexity of the part in question, the following options can also be included in a tube stamping process:

- Coining
- Stamping a pierce nut through a blank
- Stamping a nipple through a blank
- Interlocking the opposing edges in butt-end contact
- Stamping legs extending from a tubular work piece

CONCLUSION

Tubular stamping is a complex process that offers a wide array of options. With the right equipment, nearly any tubular metal product for any application can be formed with tube stamping — including ones that previously could only be produced using techniques such as casting and hydroforming. In most cases, tubular stamping is less costly than both of these techniques thanks to the increased speed in production it affords.

This is tubular stamping's prime advantage over other metal tube forming techniques capable of creating complex shapes — it can be incredibly cost-effective because it is fast and depends on less expensive flat stock material.

If you'd like to evaluate if tubular stamping is the right approach for you and your production needs, please contact us at 615-661-6570. We are also experts at hydroforming and roll forming and can help determine which of these metal-forming techniques would be best suited for your project, weighing important factors such as budget, design, quantity, and schedule.