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Understanding the Basics of Gas Spring Application

When choosing a gas spring for a particular application, it's imperative to have a basic understanding of the workings and terminology used when specifying gas springs. This article offers recommendations and guidelines for different mounting positions and describes the different orientation and damping effects that are to be expected with the chosen mounting position.

WHAT IS A GAS SPRING?

Principally, a gas spring is the same as a mechanical coil spring: a device for storing energy. A gas spring, however, stores energy by compressing the gas contained inside, rather than using straining material that makes up a coil spring.

A gas spring is a closed system that requires no further gas to be introduced for the system to operate once charged with inert nitrogen gas and manufactured. The pressure on either side of the piston (reference point one in Figure 1) remains equal no matter where it is positioned; this is due to the small cross-sectional area of the rod (reference point two in Figure 1) where the gas is unable to exert any pressure.

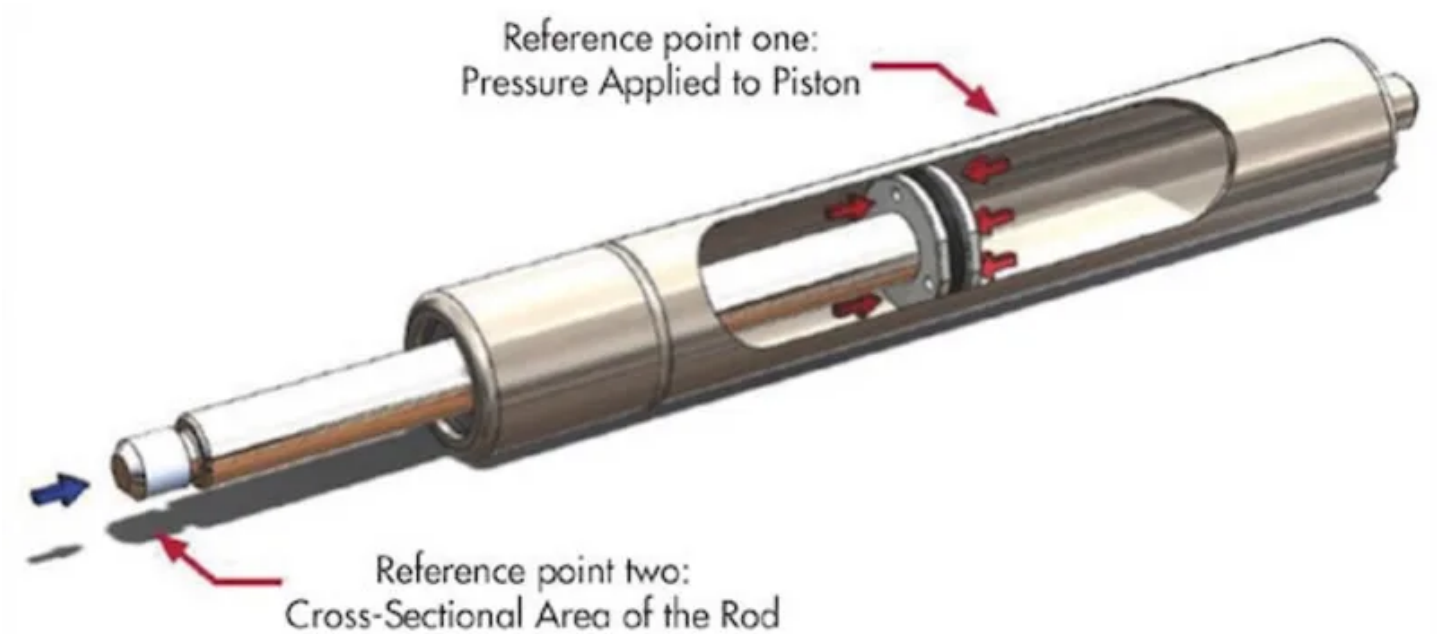

Figure 1. Basic operation of a gas spring.

As the rod is pushed into the tube, the gas contained in the spring is compressed, increasing the pressure, with the compression of the gas creating the spring-like behavior. The piston attached to the rod allows the

flow of gas across the piston and provides the means of controlling the flow of gas as the rod is depressed and extended.

GAS SPRING TERMINOLOGY

Some common terminology used when specifying a gas spring includes:

- *Stroke:* The maximum amount of distance the rod can travel from closed length to extended length.
- *Extended length:* The total length of the gas spring measured from the center of one end fit to the center of the next end fit.
- *Closed Length:* The total closed length measured from the center of one end fit to center of the next end fit. There may be times when no end fits have been specified; this measurement will refer to the length from rod end to tube end (excluding threads).
- *Beadroll:* The grooved section of the tube. This feature is used to retain the guide and seal package and prevent the piston from damaging the seal package during extension.

CONSTRUCTION OF A GAS SPRING

A gas spring contains several components, each of which is integral for the safe and successful operation of the component. Figure 2 illustrates these components.

Figure 2. Components of a gas spring.

Rod. A rod comes as either precision-ground, polished carbon, or stainless steel. The surface is treated to improve wear and increase corrosion resistance. Generally, the rod will always be longer than the stroke of the spring and shorter than the length of the tube. Carbon steel can be treated in several ways such as chrome-plating, salt-bath nitriding, and using a Nitrotec surface layer treatment, which has a number of advantages over the other methods including:

- Better wear resistance
- Lower frictional characteristics
- Corrosion resistance equivalent to stainless steel

- The process is environmentally friendly, non-toxic, and produces no acidic by-products.

Tube. A gas spring tube comprises a high-integrity powder-coated, carbon, or stainless steel seamless welded tube suitable for high pressures. The internal surface finish and tensile strength of the tube are critical for a gas spring's longevity and burst pressure performance.

Guide and Seal Package. Manufactured from plastic composite, the guide and seal package provides a bearing surface for the rod and prevents the escape of gas and ingress of contamination.

As well as plastic composite, the guides used in gas springs can also be manufactured from zinc, brass, or other materials with a suitable bearing sleeve incorporated. Rubber is used as standard for seals.

Piston Assembly. The piston assembly is manufactured from zinc, aluminum, or plastic. For factors involving safety and preventing the rod from being expelled from the spring, the integrity of the piston-to-rod attachment is critical. The piston assembly controls the rate at which the gas spring extends and compresses.

End Plug. The end plug is used to seal the tube end of the gas spring and attach to the tube end fitting.

Nitrogen Gas Charge. Nitrogen is used inside gas springs as it is inert and nonflammable; it does not react with any of the internal components.

DAMPING

In addition to providing lubrication for the seals, piston, and piston rod, oil contained within a gas spring also provides velocity control for the spring at the end of its extension stroke. The oil acts to slow the spring and prevents shock loadings as it reaches full extension. Without this damping control, rapid control extension of the gas spring would occur that could result in product failure, damage, or injury.

Damping is usually achieved by regulating the flow of gas and oil through the piston. When mounted in the preferred rod down position, maximum damping is achieved once the piston reaches the internal column of oil near the point of full extension. This is referred to as the oil damping zone.

The level of damping can be influenced by a number of factors:

Operating temperature. This affects damping in two ways. As the temperature increases, the force within the spring increases and the oil will reduce in viscosity. As a consequence, the spring will extend faster and have less damping. In lower temperatures, the opposite will occur, with extension force reducing and oil viscosity increasing; thus, the spring will extend at a slower rate and have higher damping.

Oil viscosity. Viscosity, by definition, is a fluid's resistance to flow and shear. Oil is a high-viscosity fluid, so as temperature increases, the viscosity of the oil reduces, meaning it will flow faster and have less resistance to objects passing through it (such as the piston or gas spring). Oils can be specified with differing viscosities (resistance to flow); the higher the viscosity number, the higher the resistance.

The higher the viscosity of the oil, the greater the damping effect will be on the gas spring; however, a further factor to take into consideration is the Viscosity Index of the oil. This indicates the rate of change between

two temperatures. The rate at which viscosity changes is nonlinear and viscosity charts are plotted as a logarithmic function against linear temperature. Higher-viscosity oils tend to have a higher Viscosity Index. This indicates they are subject to greater levels of viscosity change than a lower-viscosity oil. The result on the gas spring will be a more pronounced change in damping behavior with temperature fluctuations.

The greater the tube diameter relative to rod diameter, the greater the volume of fluid that is required to pass through the piston (and subsequently, the greater the damping effect will be). If consistent damping is required over the entire stroke to achieve a controlled rate of extension or compression, then fully fluid dampers should be used.

Oil volume. The higher the volume of oil contained within the spring, the earlier the gas spring will hit the oil damping zone and the slower the extension speed will be.

Pour point of oil. The pour point of a liquid is the temperature at which it becomes semi-solid and loses its flow characteristics. For a gas spring, this means that once the pour point is reached, the oil effectively becomes a solid. The full stroke of the gas spring cannot be fully utilized and no damping will occur.

METERING AND EXTENSION SPEEDS

Metering controls the rate of extension and/or compression of a gas spring. Different manufacturers use different techniques to achieve this, from altering piston orifice sizes to creating restrictive flow paths through the piston. Fundamentally, whichever method is used, the purpose remains to create a pressure drop across the piston to control the rate of extension. The larger the piston orifice or shorter the flow path, the less the pressure drop, the less restricted the flow path, and the faster the spring will extend.

A further factor affecting spring performance is breakaway friction (also referred to as stiction). This occurs when a spring has been allowed to remain stationary for a period of time; this can be as little as a few hours. Because of the pressure contained within the spring, the tendency is for the lubrication to migrate away from the seals and the rubber is forced into the minute cracks and crevices within the metal. When the spring is cycled for the first time, additional force is required to overcome friction and free the rubber from the cracks and crevices.

This article was contributed by Camloc Motion Control Ltd., Leicester, UK. For more information, visit here [http://www.camloc.com] .

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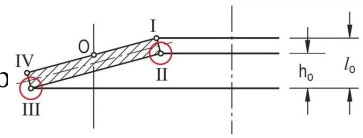

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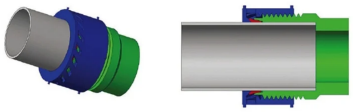

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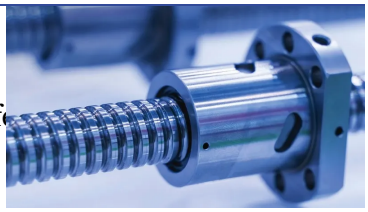

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