SPRINGS IN VARIOUS INDUSTRIES

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Springs In Various Industries – European Springs Brochure

Springs are used in a whole host of products and applications in a variety of industries. It's fair to say that without springs, the world as we know it today would be completely different, with many of the applications we use on a day to day basis requiring springs to operate efficiently and normally.

In this brochure, we take a closer look at some of the most common uses of springs, including how they are used in industries such as construction, rail, electronics and vehicle manufacturing – as well as how springs are used in toys and even prosthetics.

CONTENTS

CONSTRUCTION

Construction is a vast and fast-paced industry with a never-ending variety of projects, each requiring thousands of various components to complete a given task. From big projects to small, there is a spring designed to suit all jobs.

COMPRESSION SPRINGS

Compression springs are among one of the most common types of spring available due to their energy storing properties. When the coil is pressed, it stores the energy until it is released: ideal for everything from trampolines to mattresses, and shock absorbers. Whereas an extension spring is designed to pull things together, compression springs are designed to keep things apart.

As an open-coiled spring which is wound in a helical shape, they are designed to oppose compression, meaning they can push back when they are pushed on. Typically, compression springs are positioned over a rod or fitted into a hole, so when the spring is subject to pressure caused by weight on its axis, it compresses and becomes shorter. The more the spring compresses, it gains more potential to push back in an effort to return to its original position. In order to make the spring dependably robust, the pitch, or 'distance between coils' must be kept the same throughout the wire. This can be a problem if done manually, using a lathe.

However, our highly-calibrated machinery at European Springs is specifically designed to keep the pitch consistent, and we can specify the length of the pitch in the design process.

WHAT ARE THEY USED FOR?

Because compression springs are so versatile, they are used in a whole host of industries, and extensively used within the construction sector. Because compression springs have a variety of applications, there are a number of factors that need to be considered before construction, such as the spring rate, wire diameter, number of active coils, solid height and the stress level.

TORSION SPRINGS

Torsion springs work by storing energy through being twisted, which creates torque. This mechanical energy can then be stored and released on demand. The really impressive part about torsion springs is the fact they release the same amount of energy that was put in. The formula goes, 'Torque = Force x Leg Length' and can be applied to torsion springs of any size.

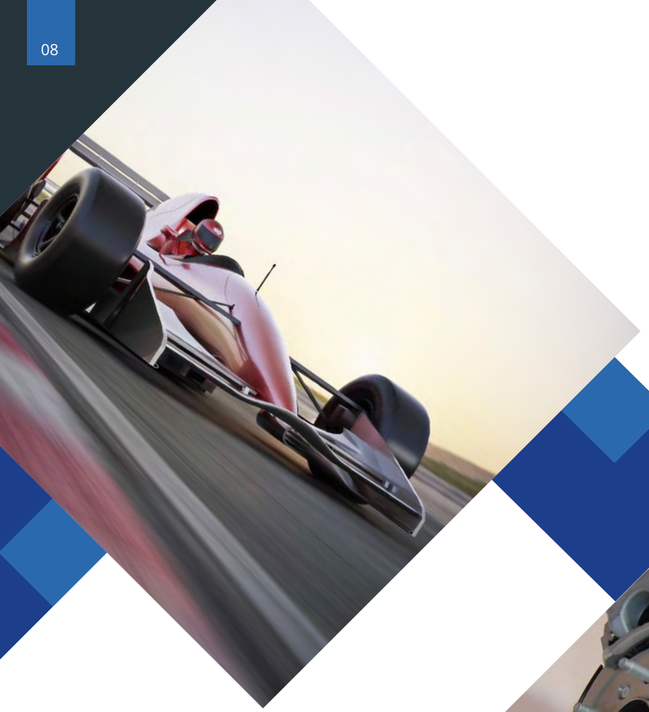
Their helical design allows them to exert rotary force, which is ideal when there is a need for an angular movement, with the legs of the spring attached to other components.

Leonardo Da Vinci was famous for his hidden inventions, and in 1478 at the age of 26, he created what is considered by many to be the first automobile using a combination of torsion springs. Even more impressive is the fact that Da Vinci's mini-car did not simply move forward on its own; it also had steering capabilities.

WHAT ARE THEY USED FOR?

You can find torsion springs in a whole host of useful items and mechanisms, from mousetraps and garage doors to siege weapons. The standard model for a torsion spring is, of course, the common mousetrap, but they can also be found in the housings of certain automatic door systems. With the exception of electronic doors, the counter-balance device in most garage doors relies on the backward pull of the torsion springs in the hinges.

Torsion springs are capable of storing and releasing angular energy but are also adept at simply holding a mechanism in place. Most commonly, torsion springs are used to provide and maintain a rotational pressure between two surfaces by allowing components to rotate around the centre of a spring.



RACING CARS

When you're watching Lewis Hamilton bring home the title at Silverstone in Formula 1, you can be forgiven for overlooking just how much work has gone into each of the cars used during the Grand Prix. Each component is carefully selected and crafted to give each vehicle optimal performance.

The stakes are high with each team striving for the best speed, and the incredible technology that they use is the pinnacle of design, which has been proven under unbelievably harsh conditions. One of the most overlooked and yet important components in ensuring each car is ready to perform is the use of springs and pressings, with racing cars virtually unable to operate without these marvels of engineering.

DISC BRAKES

It was way back in the early days of Formula 1 that the sport first began to use disc brakes to stop cars from high speeds safely consistently. Now almost every car that's currently in production (including commercial automobiles) utilises disc brakes, and they are far more durable and effective than 'drum' style brakes that used to be the norm.

The disc brakes used in F1 cars feature rotating discs that are attached to the wheels and then squeezed between the brake pads, slowing the vehicle down or bringing it to a stop.

PULL-ROD FRONT SUSPENSION

It took 20 years for pull-rods to be introduced to the world of racing cars, but looking back now, it is clear to see how it changed the sport entirely.

Pull-rods run from the outer end of the upper wishbones, diagonally to the lower edge of the chassis and pull a rocker that operates the damper spring, alleviating any harsh impacts or uneven surfaces the course may entail.

The suspension system allows for a better mechanical grip as the pull-rods make the nose of the car lower, thus lowering the height of the centre of gravity and improving handling.

PUSH-ROD FRONT SUSPENSION

Although pull-rods were introduced first, push-rods have since taken over in popularity due to their ease of implementation in a high nosed racing car.

Simply put, push-rods are the complete opposite to pull-rods, flexing with the wheel as they encounter any bumps as the car manoeuvres the course, providing better aerodynamics for a more streamlined race.

As previously mentioned, push-rods are used by most of the teams competing in Formula 1 today due to the vast difference in installation, making them a lot easier to install.

With pull-rods, critical geometry in spring damper layouts proves too challenging to execute, which is less of an issue with push-rods due to their high nose.

In both modes of suspension, the spring is absolutely vital due to the absorption of shock. Energy is transferred through the car with the help of a good suspension system and can make or break a team's effort, regardless of driver skill.

That being said, the existence of springs within a suspension device means that any component of the car above the level of the suspension – which is everything apart from the wheels, brakes and lower suspension – is classed as a sprung mass.

The rule is that the smaller the ratio of the unsprung mass to sprung mass, the greater the comfort and easier the ride for the driver, contributing further to overall success.

THE FITNESS INDUSTRY

The fitness industry is currently worth in excess of £5 billion with 1 in 7 fitness conscious Brit's flocking to their local gym in a bid to shed weight. Whilst it may not be evident at first glance; springs play a vital role in a wide range of machines you'll likely use on a weekly basis at the gym.

CHEST PULL EXPANDER

A more obvious choice, as the springs used on a Chest Pull Expander are exposed. This versatile piece of equipment works by applying resistance to a variety of areas on the body, through a simple pulling motion.

HAND FOREARM GRIP

A smaller, yet still useful piece of gym equipment is the Hand Forearm Grip. Similar to the Chest Pull Expander, this grip works through the applying of pressure around a resistant spring, which is held in hand. The grips are an effective way to train the forearm and can be used in a range of environments, from the gym to the office, to at home.

SHOCK ABSORPTION TREADMILLS

This piece of gym equipment includes springs in the belts, decks and shock systems. The treadmill operates in the same way as traditional machines of the same name; however, a Shock Absorption Treadmill absorbs any sharp increases in pressure, ensuring the rebound holds less of a negative impact on the user's joints.

MULTI-STATION TRAINER

The Multi-station Trainer uses Lockable Gas Springs to increase pressure, thus promising a more intense, and worthwhile all over workout. With several variations in exercises available, most multi-station trainers focus on one part of your body at a time, creating a multitude of possibilities in your routine.

THE RAIL INDUSTRY

SPRINGS IN TRAINS

We encounter springs every day, sometimes without even knowing it. Because of this, you may not have noticed that they are a vital factor in trains and their functionality.

The hydraulics system makes the trains run the way they do, and, without them, the smooth and comfortable ride wouldn't be as we experience today. All of the weight of the train is sustained by a hydraulic system, making the movement almost slide with insignificant friction and abrasion.

We have come a long way in engineering terms in the rail industry, from steam trains to spring-reliant electric systems. But how does the suspension system work?

UK RAILWAYS

In the UK, most trains use bogies to carry and guide the vehicle along the tracks. Designing a bogie suspension system is a complicated matter, which has been developed and improved over the years. Early on, it was recognised that the space between the body of the train and the wheel needed a 'cushion' in order to reduce vibrations felt inside the carriages. This has usually consisted of a leaf steel spring mounted on the axles. Over time, this has progressed into a bogie system with a more sophisticated suspension.

PRIMARY SUSPENSION SYSTEM

There are two main types of suspension systems used in trains, both of which are involved with springs. The primary suspension consists mainly of a standard spring damper system which supports the structural suspension of the carriage and entire train. These damper systems are present in every bogie existing between the axle box and the bogie.

DASHPOT ARRANGEMENT

The primary suspension component in a bogie is through a dashpot arrangement, which comprises of a cylinder piston. The lower spring seat acts as a cylinder, and the axle box guide serves as a piston. The bogie bolster, or support, is the central section of the area; this carries most of the weight of the coach. The bogie pivots around using the pin which is centred and uses parts of the secondary suspension system, typically coil springs and a spring plank.

Dashpots can also be found in door closers to prevent them from slamming shut, in shock absorbers in cars' hydraulic cylinders, in aircraft carrier decks, in relays, in electrical switch gears and so much more.

BOGIE STRUCTURE

The bogie of a train is the undercarriage and usually has four to six wheels pivoted beneath the end of the vehicle. It is like a low truck or trolley underneath the train. The bogie is the generic way in which most railway vehicles work. It is divided into the frame, the bolster, the pivot pin, the wheel assembly, roller bearing, the brake beams, brake block, brake levers and brake cylinders; all of which are vital parts to the structure of the bogie.

SPRINGS IN THE BOGIE

Whilst passengers don't notice the bogie, this is still an essential element of safe railway operations, as it supports the railcar body, allows the train to run smoothly both on straight and on curved tracks, ensuring a comfortable journey, amongst other things.

The primary springs link the axlebox to the bogie frame; a secondary spring system connects this frame to the train. Typically, the types of springs found in bogies are steel leaf or coil designs, and you can also find rubber and air springs. They reduce forces and vibrations and help to prevent derailment.

The primary suspension is between the axle box and the bogie and consists of springs and dampers. It is a constant necessity for all classes of rolling stock, including wagons. Different classes of carriages are provided with different bogie designs; however, they can differ from the eight springs per bogie (classed on each bogie being a three-wheel set). They are all provided with either inner springs or balanced with inner springs along with friction dampers.

SECONDARY
SECONDARY SYSTEM

The secondary suspension connects the body of the car with the bogie and aids comfort of passengers by isolating the vehicle from vibrations transmitted from the track. Commonly part of secondary suspensions, the air spring works to reduce lower frequency range accelerations in the body of the train. The role of the secondary suspension is mainly to act as a pneumatic suspension and is even used in freight trains.

BOLSTER SUPPORT

The arrangement of this secondary suspension system is through the bolster springs. The bogie bolster or support is not structurally attached to the bogie frame; however, it is connected through the anchor link (the tubular structure with cylindrical ends). The anchor link is fixed to the bolster and the bogie frame with the assistance of brackets. Both ends of the anchor link then act as a hinge which allows movement of the bolster when the train is in action.

LOWER
SPRING BEAM

Lower spring beams support the bolster springs. This lower spring beam is a structure made up of steel plates, and the location is marked by circular grooves in the centre of the support. The lower spring beam is also a free-floating structure but is attached to the bogie frame by the outside, with the assistance of a steel hanger. These are traditionally called the BSS Hanger (Bogie Secondary Suspension Hanger).

EQUALISING
STAY ROD

The inside section of the lower spring beam is connected to the bogie bolster but gets a little help from an equalising stay rod. This rod is Y shaped and made from steel sheets and tubes. It is also hinged from both ends with the lower spring beam, along with the bogie bolster. They are all connected by a pin. The use of springs in railway and train systems are vital for both the smoothness and functionality of the train and the comfort of passengers.

PROSTHETICS

The field of medical prosthetics has advanced in leaps and bounds. Progress in engineering and manufacturing has allowed artificial limbs and joints to change the lives of millions of people around the world, but we're still not done.

Manufacturers of medical prosthetics continue to push boundaries, creating limbs that are not just better, but that combine aesthetics with functionality; the advanced prosthetics we see today contain small components, such as springs, that allow them to act almost like a natural limb.

Below, we take a look at medical prosthetics and how springs can facilitate the development of ground-breaking technology in the industry.

HISTORY OF PROSTHETICS

1000 BC

Prosthetic technology has been around for millennia; prosthetics date back to approximately 3,000 years ago in Egypt, where archaeologists discovered a carved wooden toe with a piece of leather that could be fitted onto a foot.

800 BC

One of the earliest mentions of a prosthetic comes from Herodotus, a Greek historian who told the story of a man who cut off his foot to escape his Spartan captors and had it replaced with a wooden limb.

1500'S

In the 16th century, Ambroise Paré, an innovative French battlefield surgeon, created the first functional mechanical limb, which was a hand with flexible fingers that worked by catches and springs.

1800'S - 1900'S

The 19th century saw the creation of articulated prosthetic limbs. While prosthetic limbs have existed for a long time, they rose in popularity in the UK after World War I, after approximately 41,000 British soldiers needed amputations.

THE TECHNOLOGY OF TODAY

According to Which-50: “11 million children and adults globally face a life without a hand, arm, foot, or leg due to war, diabetes, cancer and trauma.” It’s therefore more important than ever to carry on research that is fundamental to the advancement of prosthetic technology.

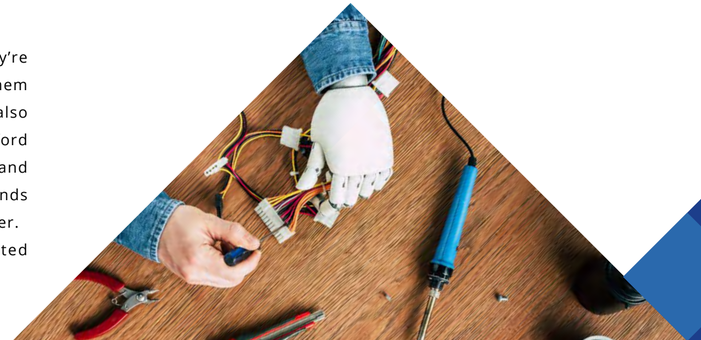
So far, this research has led to significant progress. Businesses like Next Step Bionics & Prosthetics provide the most progressive technology in the industry by working directly with manufacturers. The company offers products such as the BiOM Ankle System from iWalk, a prosthetic designed to improve mobility via propulsion technology while reducing stress on the body.

3D-printed prosthetics are also becoming more common. They’re not as cost-prohibitive as other high-end prosthetics, making them sustainable and easy to tailor to different individuals. They’re also heavily used in developing countries where most citizens can’t afford expensive medical prosthetics. LimbForge have been creating and printing 3D models of arms, elbows, forearms, wrists and hands from a plastic material which can be easily adapted to the wearer. UK-based company Open Bionics is also creating 3D-printed limbs for the NHS, which can allow amputees to write, walk and shake hands again. Not only are they aesthetically desirable, but they’re also cost-effective.

The brain will be key to developing even more complex prosthetics that increasingly resemble natural limbs. Cathy Hutchinson, a quadriplegic 58-year-old woman, was able to lift a bottle to her mouth to drink after researchers at Brown University connected a robotic arm to Hutchinson’s neural network. In 2012, Zac Vawter climbed up the 103 floors of the Willis Tower in Chicago by walking up the stairs while wearing a prosthetic leg connected to his brain.

While myoelectric limbs, which convert muscle movements to electric signals, have become a lot more common in the past few years, thought-controlled prosthetics may very well be the future of medical prosthetics. They’re capable of offering the closest approximation to natural limbs, especially in regard to functionality.

Prosthetics are not just limited to limbs, however. Researchers have already been able to replace specific organs in the body with artificial ones, like the pancreas. This has the possibility to become a widespread treatment for type 1 diabetes (or even the prominent method) after a successful trial where 29 patients were given an artificial pancreas.



AUTOMATION

Despite the healthy growth of many industries in the UK, the manufacturing sector remains an integral part of the UK's economy and a significant contributor to our country's growth. The scope of manufacturing is changing, however, with an increasing number of companies turning to automation in their production.

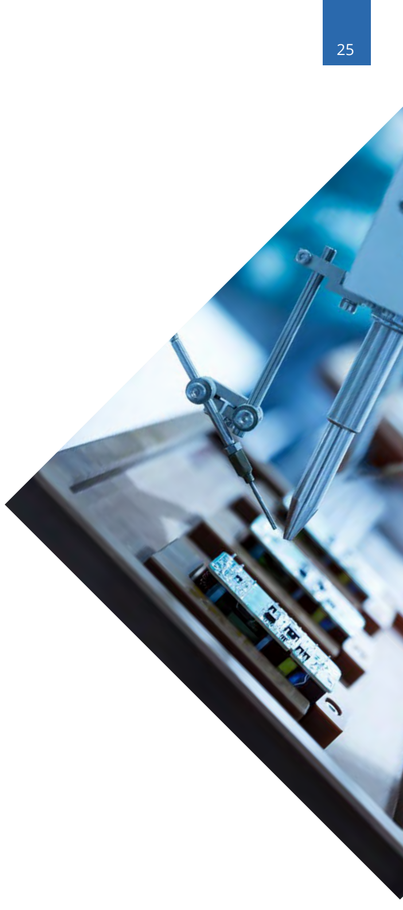
This suggests that despite manufacturing being one of the most highly automated industries, there is still huge potential for further change. As a result, many predict both the pace and coverage of automation will increase in future years.

Automation is associated with a variety of benefits, and springs continue to play an important role in the process that continues to advance the way we manufacture.

WHAT IS AUTOMATION?

Automation is when a process within a company is developed to become automatic with the aid of a specifically designed machine. Automation technology monitors and controls the production of products, executing tasks that were previously performed by humans.

Independence is a key aspect of automation, as software must be able to operate on its own without periodic interference. Automation is also being used in several areas outside of manufacturing, including transport, defence and IT; a commonality in every industry is that control systems are able to operate equipment and applications autonomously.



BENEFITS OF AUTOMATION

Many companies are opting for automated machines for a variety of reasons, each of which enhances the profitability of operations. One considerable incentive for companies in adopting automation is its cost-effectiveness. Machines may often represent a sizeable initial investment, but over time, the cost of operating the technology is relatively low in comparison to labour. Spreading the fixed cost over a large number of units produced, combined with lower variable costs, makes automation the cost-effective option in the long run.

Automated machinery not only tends to be cheaper; it's also significantly less prone to making errors that humans would usually make Reducing mistakes can speed up the manufacturing process and simultaneously improve production quality, which is a leading reason why more companies are opting for automated machines.

Fewer errors often correlate to greater output levels as well as improved quality. More output can be produced with the same or even fewer inputs, leading to an overall increase in productivityIt was way back in the early days of Formula 1 that the sport first began to use disc brakes to stop cars from high speeds safely consistently. Now almost every car that's currently in production (including commercial automobiles) utilises disc brakes, and they are far more durable and effective than 'drum' style brakes that used to be the norm.

The disc brakes used in F1 cars feature rotating discs that are attached to the wheels and then squeezed between the brake pads, slowing the vehicle down or bringing it to a stop.

SPRINGS IN AUTOMATION

With today's technological advances, potato processing plants rely heavily on automated machinery to meet the ever-growing demand for potato-based products.

In the production process, the potatoes are fed through various machines to the sorting stage. It is during this stage that springs are utilised; the potatoes are fed into a compartment that monitors the weight. Once the desired weight is achieved, the potatoes are dropped through a hatch separating them into desired amounts.

Springs are used in providing enough force to prevent the trap doors from opening whenever the slightest bit of pressure is exerted. With tension springs holding the door in place until the desired weight is achieved, the automated machinery ensures that the same amount consistently is weighed out and distributed.

FUTURE OF AUTOMATION

Automation is already a prominent manufacturing process, and it is set to continue growing in popularity over the coming decades due to advances in Artificial Intelligence (AI).

Factories can currently be run by just a small team of individuals with the majority of operations performed by automated machinery. However, some predict that in the not too distant future, factories will be 100% automated due to continued advancements in AI technology. The predicted progress in AI may allow manufacturing machinery to comprehend complex goals. However, it is perhaps slightly unrealistic to suggest 100% automation, as even the most finely-tuned machines will require human correction and maintenance.

Plummeting robotics prices could act as the catalyst for even greater use of automation in manufacturing. Costs have fallen as robotics production has expanded and, as robotics manufacturing shifts to developing countries, robots are likely to become cheaper still. In addition, people with the necessary skills required to design and operate automated manufacturing systems are becoming more widely available. Robots and robotics engineers are no longer prohibitively expensive, and if costs continue to decrease as predicted, this will only lead to further automation in manufacturing.

As well as their increased affordability, the quality of robotics will undoubtedly improve as technologies continue to advance. AI will enable automated machinery to cope with a greater degree of task-to-task variability while responding to changes in their environment. Robots are already incredibly accurate, but their precision will certainly advance in the coming years, which may increase their use in carrying out delicate tasks and almost certainly will make them more ubiquitous in manufacturing.

SPRINGS IN TOYS

It’s fair to say that springs and pressings are used in a whole host of applications and products. From the more obvious industries, such as manufacturing and the automotive sector, to the less obvious, including the fashion industry.

Another sector that is lesser-thought about, however, is the toy industry. At first thought, this may seem an unlikely area for springs to pop up. But spring-loaded toys have a rather long and dynamic history, with springs being used in children’s toys as far back as the 16th century

THE SLINKY

No list of children’s toys, including spring technology, would be complete without mentioning the iconic slinky! The idea for this iconic toy was born in 1943 when a naval engineer accidentally pushed a tension spring off of his desk. By the Slinky’s official release, two years later, all 44 units had sold in a matter of minutes.

JACK IN THE BOX

Before the invention of television or video games, the ‘Jack in the box’ was one of the most popular children’s’ toy, dating right back to the 16th century! This simple toy consists of a spring pushed down inside a box, held by a catch on the lid. When the catch is released, the force of spring causes the lid to burst open, allowing a clown figure to pop out.

TRAMPOLINES

Coiled springs are to thank for our childhood favourite: the trampoline. The trampoline mat is held taut and given elasticity through several springs that connect the fabric to the frame and store potential energy. With the growing popularity of the trampoline industry, the fun of trampolining does not have to be a distant childhood memory, but a fun activity for all ages.

PIN BALL MACHINE

Earlier versions of the pinball machine involved the player using a wooden cue stick to shoot a ball onto the playfield. Now they utilise spring-loaded knobs, or ‘plungers’, instead. Once pulled back and released, these springs will send a ball flying around the playfield through an array of potential hazards.

ELECTRONICS

Springs can be found in a whole host of electronic products; from top of the range TVs to the latest and greatest virtual reality devices, springs are probably present.

But whether you're TV mad or an avid watch collector, we can guarantee that there is going to be some sort of spring or wire form inside of almost all electrical products, with many products even relying on springs to operate normally.

But what devices can you find these components in and what do they do?

SMART PHONES

Whether you're an Apple fan or an Android user, do you know what all these phones have in common? Wire forms and springs.

Whenever your phone is on vibrate mode, the small motor which makes the phone vibrate has a tiny (but very important) spring inside which helps it do its job. Not only this but any button or compartment which pops out, clicks or pushes in, will most likely have a spring to help it move!

Wire forms are also inside your phone's mechanisms, whether it be clipping parts together, decorative panelling or contact clips – they are all important!

VR HEADSETS

At the top of the tech-ladder is the highly talked about Virtual Reality Headset. While not a new concept, they have recently been released on the market for consumer purchase and are getting more popular by the week. Chances are that many lucky people around the world received the gift of VR this festive season.

No matter what make or model you were lucky enough to receive, they all use springs.

In some models, there is a mechanism designed to hold a variety of smartphones using a spring-loaded clamp. This secure structure means there is zero chance your new smartphone will fall out the contraption. New VR headset patents are even making use of more springs and spring-loaded grommet systems.

DSLR CAMERAS

Many people are consistently taking up the fantastic hobby of photography, and yet again, this could not be possible without the help of the trusty spring. Yes, that's right, wire forms and springs are a crucial component to the smooth running of any DSLR, wind up, disposable, and even the top of the range Red camera – they all utilise them. Whatever camera you may have received for Christmas, the shutter mechanism in this device makes use of the humble spring.

When you hit the shutter, the shutter cocks and the camera's mirror then flips up. Electromagnets hold each of the curtains in place until the camera is ready to release, then the springs do the rest! It essentially all relies on the hinge to open the curtains, which is powered by spring-loaded levers.

VEHICLE MANUFACTURING

High-quality transmissions are vital for vehicles to run properly, and high-quality coil springs are needed for transmissions. Also known as helical springs, coil springs store energy and release it, absorb shock, or maintain forces between contacting surfaces. These springs are essential within the automotive industry, as they are fundamental in objects such as transmissions. Transmissions are one of the most important elements of a vehicle, as they aid in driving power from the engine to the wheels.

As the bases of suspension systems, coil springs are preferred in terms of space, weight, durability, and easiness of manufacture. As lightweight components, they offer a lot of power regarding the use of less metal to hold larger weights. Additionally, coil springs are typically made from steel, ensuring that they are self-preserving and durable.

THE IMPORTANCE OF SPRING DURABILITY

A spring's ability to not lose force or shorten under a given force is what relates to its durability. To ensure a spring is durable, the material's stress cannot be greater than the strength permitted by the material. When metal has a load applied to it, it has to deflect elastically first and then plastically if the load is high enough.

After the metal returns to its previous shape after unloading, elastic deflection occurs. Plastic deflection involves a permanent deformation in which the metal is unable to return to its previous shape. In durable springs, the elastic part of the deformation is utilised to receive the deflection. The stress and temperature also play a key part in the durability of a spring, alongside relaxation/creep and fatigue.

INCREASED PERFORMANCE

Performance is determined by a vehicle's transmission, and coil springs allow for the highest possible force requirements and reliability. A varied number of parameters determine coil springs' dynamic performance, such as the spring body diameter, the wire diameter, and the number of coils. A change in a parameter can make a big difference in the springs' dynamic performance and, subsequently, in a vehicle's handling characteristics and ride.

Coil springs offer increased performance for vehicle manufacturing through precise manufacturing. They can be made up of silicon, carbon, chromium, and manganese, amongst others, with its exact composition depending on the amount of pressure the springs need to withstand. These springs are required to withstand massive amounts of weight with shock absorbers, which allow for trucks to transport heavy loads. Coil springs permit weights exceeding the original capacity by absorbing the weight and springing back any resistance.

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