Noisy Garage

- **Diagnosing Noisy Garage Door Operation**
  Diagnosing Noisy Garage Door Operation Fixing Doors That Ride Off Track Resolving Sensor Misalignment Errors Interpreting Opener LED Blink Codes Addressing Slow or Jerky Door Movement Eliminating Mid Travel Door Reversal Quieting Squeaky Rollers with Proper Lubrication Identifying Cable Fraying and Safety Risks Correcting Uneven Door Closing Gaps Resetting Remote Controls After Power Outage Detecting Spring Fatigue Before Failure Occurs Choosing When to Call a Professional for Repairs
- **Setting Up Z Wave Connectivity for Your Garage Door**
  Setting Up Z Wave Connectivity for Your Garage Door Linking Garage Doors to Apple HomeKit Scenes Voice Control Tips with Google Home Assistants Using Amazon Alexa Routines for Door Automation Security Considerations for Cloud Based Door Access Updating Firmware on Smart Garage Controllers Troubleshooting WiFi Signal Issues in the Garage Integrating Door Status into Home Security Dashboards Battery Backup Management for Connected Openers IFTTT Recipes to Automate Garage Door Functions Data Privacy Practices for Smart Garage Devices Future Trends in Connected Garage Door Technology
- **About Us**

essay explores the importance of data privacy practices for smart garage devices, discussing both the potential risks and the measures necessary to protect user data.

First and foremost, understanding what data these devices collect is crucial. Smart garage devices often gather information such as user location when accessing the app, times when the garage door is opened or closed, video footage from surveillance cameras, and sometimes even audio if voice commands are used. This data can provide insights into a homeowners daily routine, which if mishandled or accessed by unauthorized parties, could lead to serious privacy invasions or security breaches.

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The primary concern with collecting such detailed personal data revolves around where it is stored and how it is protected. Many of these devices connect to cloud services for remote access functionality. Herein lies a significant vulnerability; cloud storage systems are prime targets for cyber-attacks. Companies must therefore employ stringent encryption methods both in transit and at rest to safeguard this sensitive information. For instance, end-to-end encryption ensures that only the device owner can decrypt and view their data.

Moreover, transparency in how companies handle consumer data is non-negotiable. Users should be clearly informed about what data is being collected, why it is necessary, how it will be used, and with whom it might be shared. Consent should not just be a one-time checkbox during setup but an ongoing process where users can opt-in or out based on updated policies or features.

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Another vital aspect of data privacy practices involves user control over their data. Smart garage device manufacturers should provide easy-to-use interfaces where users can manage their privacy settings. Features like deleting old footage automatically after a certain period unless manually saved by the user can prevent unnecessary long-term storage of personal activities.

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Regular software updates are also paramount in maintaining privacy standards. These updates often include patches for newly discovered vulnerabilities which could otherwise expose user data to hackers. Companies must commit to providing timely updates and users must be encouraged to install them promptly.

In addition to technical safeguards, theres a need for regulatory oversight tailored specifically for IoT (Internet of Things) devices like smart garage systems. Regulations akin to GDPR in Europe or CCPA in California set standards that compel companies to prioritize consumer privacy or face substantial penalties.

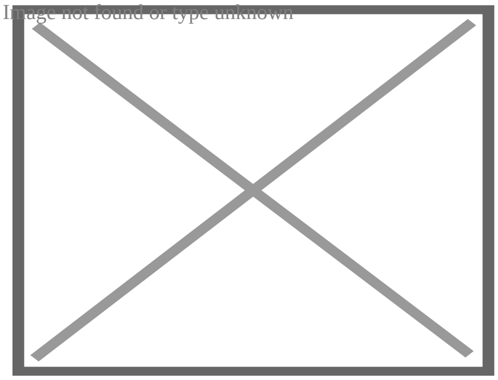
Finally, fostering consumer awareness about privacy settings and potential risks associated with smart home technologies cannot be overstated. Educational campaigns by manufacturers or independent bodies can empower users to make informed decisions about their digital footprint within their homes.

In conclusion, while smart garage devices enhance our lifestyle by offering unparalleled control over our homes security from anywhere in the world, they simultaneously pose significant privacy challenges due to the nature of the data they handle. Robust data privacy practices are not just beneficial but essential for protecting users from potential misuse of their information. By adopting comprehensive encryption strategies, maintaining transparency with consumers about data usage, allowing ample control over personal information, ensuring regular security updates, adhering to regulations, and educating users on privacy matters - we pave the way towards safer use of technology in our everyday lives without compromising on convenience or peace of mind.

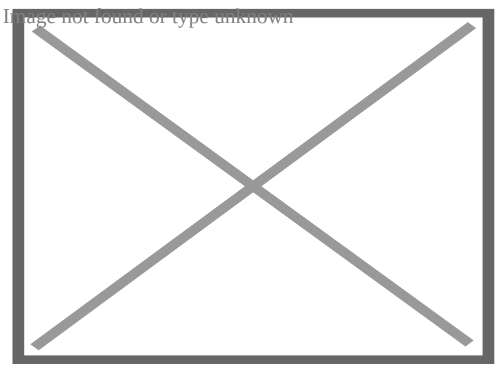
IFTTT Recipes to Automate Garage Door Functions

About Maintenance

"Repair" and "repairman" redirect here. For home repair, see Home repair.
For the Wikipedia administrative page, see Wikipedia:Maintenance.
For other topics about maintenance, see Maintenance (disambiguation).



A tractor being mechanically repaired in Werneuchen, 1966



Field repair of aircraft engine (1915–1916)

The technical meaning of **maintenance** involves functional checks, servicing, repairing or replacing of necessary devices, equipment, machinery, building infrastructure and supporting utilities in industrial, business, and residential installations.[1][2] Terms such as "predictive" or "planned" maintenance describe various cost-effective practices aimed at keeping equipment operational; these activities occur either before[3] or after a potential failure.

Definitions

[edit]

Maintenance functions can be defined as **maintenance, repair and overhaul** (**MRO**), and MRO is also used for **maintenance, repair and operations**.[4] Over time, the terminology of maintenance and MRO has begun to become standardized. The United States Department of Defense uses the following definitions:[5]

- Any activity—such as tests, measurements, replacements, adjustments, and repairs—intended to retain or restore a functional unit in or to a specified state in which the unit can perform its required functions.[5]
- All action taken to retain material in a serviceable condition or to restore it to serviceability. It includes inspections, testing, servicing, classification as to serviceability, repair, rebuilding, and reclamation.[5]
- All supply and repair action taken to keep a force in condition to carry out its mission.[5]

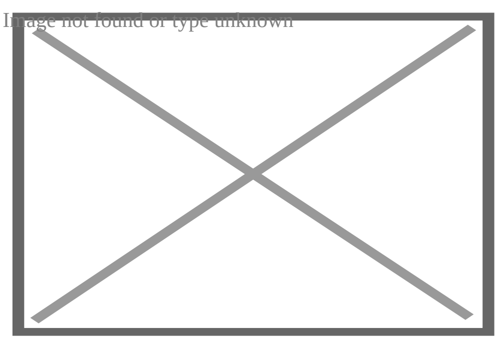
- The routine recurring work required to keep a facility (plant, building, structure, ground facility, utility system, or other real property) in such condition that it may be continuously used, at its original or designed capacity and efficiency for its intended purpose.[5]

Maintenance is strictly connected to the utilization stage of the product or technical system, in which the concept of maintainability must be included. In this scenario, maintainability is considered as the ability of an item, under stated conditions of use, to be retained in or restored to a state in which it can perform its required functions, using prescribed procedures and resources.[6]

In some domains like aircraft maintenance, terms *maintenance, repair and overhaul*[7] also include inspection, rebuilding, alteration and the supply of spare parts, accessories, raw materials, adhesives, sealants, coatings and consumables for aircraft maintenance at the utilization stage. In international civil aviation maintenance means:

- The performance of tasks required to ensure the continuing airworthiness of an aircraft, including any one or combination of overhaul, inspection, replacement, defect rectification, and the embodiment of a modification or a repair.[8]

This definition covers all activities for which aviation regulations require issuance of a maintenance release document (aircraft certificate of return to service – CRS).



Road repair

Types

[edit]

The marine and air transportation,[9] offshore structures,[10] industrial plant and facility management industries depend on *maintenance, repair and overhaul* (MRO) including scheduled or preventive paint maintenance programmes to maintain and restore coatings applied to steel in environments subject to attack from erosion, corrosion and environmental pollution.[10]

The basic types of maintenance falling under MRO include:

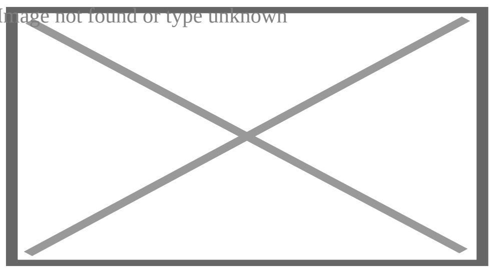
- Preventive maintenance, where equipment is checked and serviced in a planned manner (in a scheduled points in time or continuously)

- Corrective maintenance, where equipment is repaired or replaced after wear, malfunction or break down
- Reinforcement[11]

Architectural conservation employs MRO to preserve, rehabilitate, restore, or reconstruct historical structures with stone, brick, glass, metal, and wood which match the original constituent materials where possible, or with suitable polymer technologies when not.[12]

Preventive maintenance

[edit]



C-130J Hercules preventive cleaning at Keesler Air Force Base, Mississippi after a period of operation over the Gulf of Mexico (salt and moisture which lead to active corrosion require regular cleaning)

Preventive maintenance (**PM**) is "a routine for periodically inspecting" with the goal of "noticing small problems and fixing them before major ones develop."[13] Ideally, "nothing breaks down."[14]

The main goal behind PM is for the equipment to make it from one planned service to the next planned service without any failures caused by fatigue, extreme fluctuation in temperature(such as heat waves[15]) during seasonal changes, neglect, or normal wear (preventable items), which Planned Maintenance and Condition Based Maintenance help to achieve by replacing worn components before they actually fail. Maintenance activities include partial or complete overhauls at specified periods, oil changes, lubrication, minor adjustments, and so on. In addition, workers can record equipment deterioration so they know to replace or repair worn parts before they cause system failure.

The New York Times gave an example of "machinery that is not lubricated on schedule" that functions "until a bearing burns out." Preventive maintenance contracts are generally a fixed cost, whereas improper maintenance introduces a variable cost: replacement of major equipment.[13]

Main objective of PM are:

1. Enhance capital equipment productive life.

2. Reduce critical equipment breakdown.
3. Minimize production loss due to equipment failures.

Preventive maintenance or **preventative[16] maintenance** (**PM**) has the following meanings:

- The care and servicing by personnel for the purpose of maintaining equipment in satisfactory operating condition by providing for systematic inspection, detection, and correction of incipient failures either before they occur or before they develop into major defects.
- The work carried out on equipment in order to avoid its breakdown or malfunction. It is a regular and routine action taken on equipment in order to prevent its breakdown.[17]
- Maintenance, including tests, measurements, adjustments, parts replacement, and cleaning, performed specifically to prevent faults from occurring.

Other terms and abbreviations related to PM are:

- scheduled maintenance[18]
- planned maintenance,[19] which may include scheduled downtime for equipment replacement
- planned preventive maintenance (PPM) is another name for PM[20]
- breakdown maintenance:[20] fixing things only when they break. This is also known as "a reactive maintenance strategy"[21] and may involve "consequential damage."[22]

Planned maintenance

[edit]
"Routine maintenance" redirects here. For the album by Aaron West and the Roaring Twenties, see Routine Maintenance (album).

Planned preventive maintenance (PPM), more commonly referred to as simply **planned maintenance** (**PM**) or **scheduled maintenance**, is any variety of scheduled maintenance to an object or item of equipment. Specifically, planned maintenance is a scheduled service visit carried out by a competent and suitable agent, to ensure that an item of equipment is operating correctly and to therefore avoid any unscheduled breakdown and downtime.[23]

The key factor as to when and why this work is being done is timing, and involves a service, resource or facility being unavailable.[18][19] By contrast, condition-based maintenance is not directly based on equipment age.

Planned maintenance is preplanned, and can be date-based, based on equipment running hours, or on distance travelled.

Parts that have scheduled maintenance at fixed intervals, usually due to wearout or a fixed shelf life, are sometimes known as time-change interval, or TCI items.

Predictive maintenance

[edit]
Main article: Predictive maintenance

Predictive maintenance techniques are designed to help determine the condition of in-service equipment in order to estimate when maintenance should be performed. This approach promises cost savings over routine or time-based preventive maintenance, because tasks are performed only when warranted. Thus, it is regarded as condition-based maintenance carried out as suggested by estimations of the degradation state of an item. The main promise of predictive maintenance is to allow convenient scheduling of corrective maintenance, and to prevent unexpected equipment failures.[3] This maintenance strategy uses sensors to monitor key parameters within a machine or system, and uses this data in conjunction with analysed historical trends to continuously evaluate the system health and predict a breakdown before it happens.[24] This strategy allows maintenance to be performed more efficiently, since more up-to-date data is obtained about how close the product is to failure.[25]

Predictive replacement is the replacement of an item that is still functioning properly.[26] Usually it is a tax-benefit based [*citation needed*] replacement policy whereby expensive equipment or batches of individually inexpensive supply items are removed and donated on a predicted/fixed shelf life schedule. These items are given to tax-exempt institutions.[27][*citation needed*

Condition-based maintenance

[edit]

Condition-based maintenance (**CBM**), shortly described, is maintenance when need arises. Albeit chronologically much older, It is considered one section or practice inside the broader and newer predictive maintenance field, where new AI technologies and connectivity abilities are put to action and where the acronym CBM is more often used to describe 'condition Based Monitoring' rather than the maintenance itself. CBM maintenance is performed after one or more indicators show that equipment is going to fail or that equipment performance is deteriorating.

This concept is applicable to mission-critical systems that incorporate active redundancy and fault reporting. It is also applicable to non-mission critical systems that lack redundancy and fault reporting.

Condition-based maintenance was introduced to try to maintain the correct equipment at the right time. CBM is based on using real-time data to prioritize and optimize maintenance resources. Observing the state of the system is known as condition monitoring. Such a system will determine the equipment's health, and act only when maintenance is actually necessary. Developments in recent years have allowed extensive instrumentation of equipment, and together with better tools for analyzing condition data, the maintenance personnel of today is more than ever able to decide what is the right time to perform maintenance on some piece of equipment. Ideally, condition-based maintenance will allow the maintenance personnel to do only the right things, minimizing spare parts cost, system downtime and time spent on maintenance.

Challenges

[edit]

Despite its usefulness of equipment, there are several challenges to the use of CBM. First and most important of all, the initial cost of CBM can be high. It requires improved instrumentation of the equipment. Often the cost of sufficient instruments can be quite large, especially on equipment that is already installed. Wireless systems have reduced the initial cost. Therefore, it is important for the installer to decide the importance of the investment before adding CBM to all equipment. A result of this cost is that the first generation of CBM in the oil and gas industry has only focused on vibration in heavy rotating equipment.

Secondly, introducing CBM will invoke a major change in how maintenance is performed, and potentially to the whole maintenance organization in a company. Organizational changes are in general difficult.

Also, the technical side of it is not always as simple. Even if some types of equipment can easily be observed by measuring simple values such as vibration (displacement, velocity or acceleration), temperature or pressure, it is not trivial to turn this measured data into actionable knowledge about the health of the equipment.

Value potential

[edit]

As systems get more costly, and instrumentation and information systems tend to become cheaper and more reliable, CBM becomes an important tool for running a plant or factory in an optimal manner. Better operations will lead to lower production cost and lower use of resources. And lower use of resources may be one of the most important differentiators in a future where environmental issues become more important by the day.

Another scenario where value can be created is by monitoring the health of a car motor. Rather than changing parts at predefined intervals, the car itself can tell you when something needs to be changed based on cheap and simple instrumentation.

It is Department of Defense policy that condition-based maintenance (CBM) be *"implemented to improve maintenance agility and responsiveness, increase operational availability, and reduce* *life cycle total ownership costs".*[28]

Advantages and disadvantages

[edit]

CBM has some advantages over planned maintenance:

- Improved system reliability
- Decreased maintenance costs
- Decreased number of maintenance operations causes a reduction of human error influences

Its disadvantages are:

- High installation costs, for minor equipment items often more than the value of the equipment
- Unpredictable maintenance periods cause costs to be divided unequally.
- Increased number of parts (the CBM installation itself) that need maintenance and checking.

Today, due to its costs, CBM is not used for less important parts of machinery despite obvious advantages. However it can be found everywhere where increased safety is required, and in future will be applied even more widely.[29][30]

Corrective maintenance

[edit]
Main article: Corrective maintenance

Corrective maintenance is a type of maintenance used for equipment after equipment break down or malfunction is often most expensive – not only can worn equipment damage other parts and cause multiple damage, but consequential repair and replacement costs and loss of revenues due to down time during overhaul can be significant. Rebuilding and resurfacing of equipment and infrastructure damaged by erosion and corrosion as part of corrective or preventive maintenance programmes involves conventional processes such as welding and metal flame spraying, as well as engineered solutions with thermoset polymeric materials.[31]

See also

[edit]

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Look up ***repair*** or ***revamping*** in Wiktionary, the free dictionary.

- Active redundancy – Design concept
- Aircraft maintenance – Performance of tasks which maintain an aircraft's airworthiness
- Aircraft maintenance checks – Periodic scheduled inspection performed on aircraft to keep it airworthy
- Auto maintenance – Periodic maintenance of motor vehicles
- Bicycle maintenance – tools specifically for working on bicycles
- Bus garage – Storage and maintenance facility
- Darning – Sewing technique for repairing holes or worn areas in fabric or knitting using needle and thread
- Department of Defense Dictionary of Military and Associated Terms
- Design for repair – Procedure and discipline in various fields
- Fault reporting – Maintenance concept
- Intelligent maintenance system – System that uses collected data from machinerys
- Kludge – Unmaintainable solution
- Logistics center – hub for logistics
- Maintainability – Ease of maintaining a functioning product or service
- Motive power depot – Rail yard for cleaning, repairing and maintaining locomotives
- Operational availability – Measurement of the actual versus predicted uptime of a system
- Operational maintenance – Basic maintenance done by operators of the equipment
- Predictive maintenance – Method to predict when equipment should be maintained
- Product lifecycle – Duration of processing of products from inception, to engineering, design & manufacture
- Prognostics – prediction of the time at which a system or a component will malfunction
- RAMS – Engineering characterization of a product or system
- Reliability centered maintenance – Concept of maintenance planning
- Reliability engineering – Sub-discipline of systems engineering that emphasizes dependability
- Repair shop
- Remanufacturing – Rebuilding of product to original manufactured product using combo of reused and new parts
- Right to repair – Legal right and movement
- Total productive maintenance – Maintenance management methodology
- Value-driven maintenance

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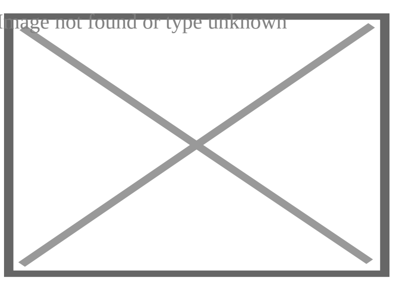
About Spring (device)



Helical coil springs designed for tension

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A heavy-duty coil spring designed for compression and tension

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The English longbow – a simple but very powerful spring made of yew, measuring 2 m (6 ft 7 in) long, with a 470 N (105 lbf) draw weight, with each limb functionally a cantilever spring.

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Force (F) vs extension (s).[*citation needed*] Spring characteristics: (1) progressive, (2) linear, (3) degressive, (4) almost constant, (5) progressive with knee

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A machined spring incorporates several features into one piece of bar stock

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Military booby trap firing device from USSR (normally connected to a tripwire) showing spring-loaded firing pin

A **spring** is a device consisting of an elastic but largely rigid material (typically metal) bent or molded into a form (especially a coil) that can return into shape after being compressed or extended.[1] Springs can store energy when compressed. In everyday use, the term most often refers to coil springs, but there are many different spring designs. Modern springs are typically manufactured from spring steel. An example of a non-metallic spring is the bow, made traditionally of flexible yew wood, which when drawn stores energy to propel an arrow.

When a conventional spring, without stiffness variability features, is compressed or stretched from its resting position, it exerts an opposing force approximately proportional to its change in length (this approximation breaks down for larger deflections). The *rate* or *spring constant* of a spring is the change in the force it exerts, divided by the change in deflection of the spring. That is, it is the gradient of the force versus deflection curve. An extension or compression spring's rate is expressed in units of force divided by distance, for example or N/m or lbf/in. A torsion spring is a spring that works by twisting; when it is twisted about its axis by an angle, it produces a torque proportional to the angle. A torsion spring's rate is in units of torque divided by angle, such as N·m/rad or ft·lbf/degree. The inverse of spring rate is compliance, that is: if a spring has a rate of 10 N/mm, it has a compliance of 0.1 mm/N. The stiffness (or rate) of springs in parallel is additive, as is the compliance of springs in series.

Springs are made from a variety of elastic materials, the most common being spring steel. Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after manufacture. Some non-ferrous metals are also used, including phosphor bronze and titanium for parts requiring corrosion resistance, and low-resistance beryllium copper for springs carrying electric current.

History

[edit]

Simple non-coiled springs have been used throughout human history, e.g. the bow (and arrow). In the Bronze Age more sophisticated spring devices were used, as shown by the spread of tweezers in many cultures. Ctesibius of Alexandria developed a method for making springs out of an alloy of bronze with an increased proportion of tin, hardened by hammering after it was cast.

Coiled springs appeared early in the 15th century,[2] in door locks.[3] The first spring powered-clocks appeared in that century[3][4][5] and evolved into the first large watches by the 16th century.

In 1676 British physicist Robert Hooke postulated Hooke's law, which states that the force a spring exerts is proportional to its extension.

On March 8, 1850, John Evans, Founder of John Evans' Sons, Incorporated, opened his business in New Haven, Connecticut, manufacturing flat springs for carriages and other vehicles, as well as the machinery to manufacture the springs. Evans was a Welsh blacksmith and springmaker who emigrated to the United States in 1847, John Evans' Sons became "America's oldest springmaker" which continues to operate today.[6]

Types

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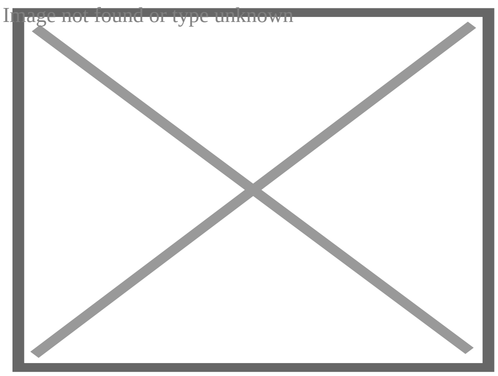
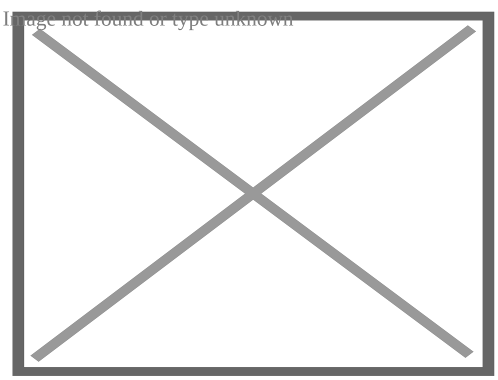
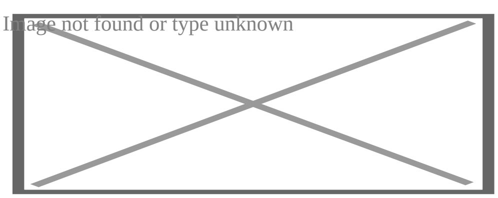


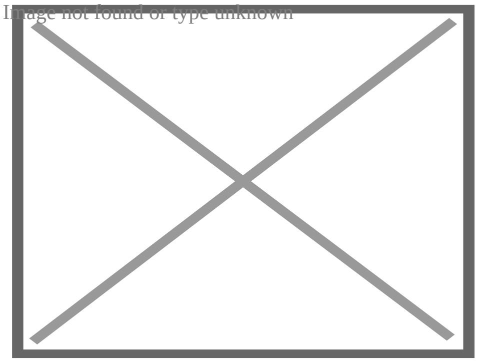
A spiral torsion spring, or hairspring, in an alarm clock.



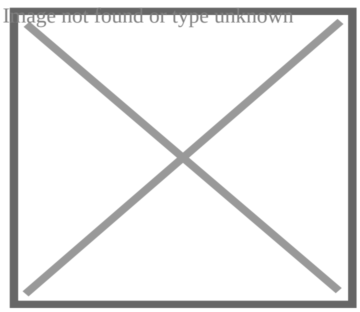
Battery contacts often have a variable spring



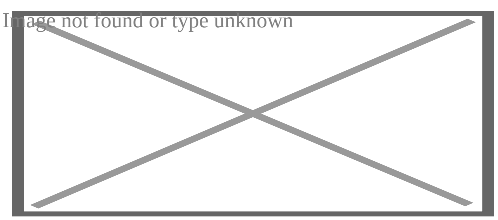
A volute spring. Under compression the coils slide over each other, so affording longer travel.



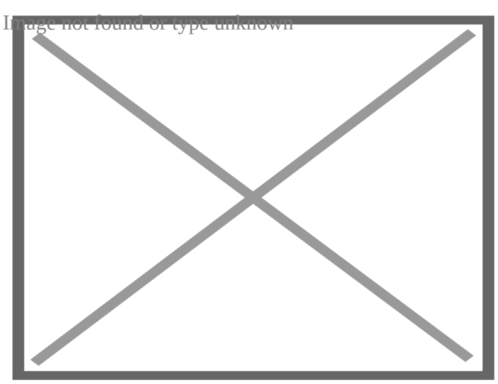
Vertical volute springs of Stuart tank



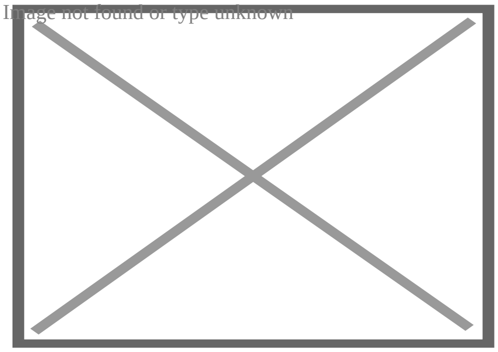
Selection of various arc springs and arc spring systems (systems consisting of inner and outer arc springs).



Tension springs in a folded line reverberation device.



A torsion bar twisted under load



Leaf spring on a truck

Classification

[edit]

Springs can be classified depending on how the load force is applied to them:

Tension/extension spring
: The spring is designed to operate with a tension load, so the spring stretches as the load is applied to it.

Compression spring
: Designed to operate with a compression load, so the spring gets shorter as the load is applied to it.

Torsion spring
: Unlike the above types in which the load is an axial force, the load applied to a torsion spring is a torque or twisting force, and the end of the spring rotates through an angle as the load is applied.

Constant spring
: Supported load remains the same throughout deflection cycle[7]

Variable spring
: Resistance of the coil to load varies during compression[8]

Variable stiffness spring
: Resistance of the coil to load can be dynamically varied for example by the control system, some types of these springs also vary their length thereby providing actuation capability as well [9]

They can also be classified based on their shape:

Flat spring
: Made of a flat spring steel.

Machined spring
: Manufactured by machining bar stock with a lathe and/or milling operation rather than a coiling operation. Since it is machined, the spring may incorporate features in addition to

the elastic element. Machined springs can be made in the typical load cases of compression/extension, torsion, etc.

Serpentine spring
: A zig-zag of thick wire, often used in modern upholstery/furniture.

Garter spring
: A coiled steel spring that is connected at each end to create a circular shape.

Common types

[edit]

The most common types of spring are:

Cantilever spring
: A flat spring fixed only at one end like a cantilever, while the free-hanging end takes the load.

Coil spring
: Also known as a helical spring. A spring (made by winding a wire around a cylinder) is of two types:

  - *Tension* or *extension springs* are designed to become longer under load. Their turns (loops) are normally touching in the unloaded position, and they have a hook, eye or some other means of attachment at each end.
  - *Compression springs* are designed to become shorter when loaded. Their turns (loops) are not touching in the unloaded position, and they need no attachment points.
  - *Hollow tubing springs* can be either extension springs or compression springs. Hollow tubing is filled with oil and the means of changing hydrostatic pressure inside the tubing such as a membrane or miniature piston etc. to harden or relax the spring, much like it happens with water pressure inside a garden hose. Alternatively tubing's cross-section is chosen of a shape that it changes its area when tubing is subjected to torsional deformation: change of the cross-section area translates into change of tubing's inside volume and the flow of oil in/out of the spring that can be controlled by valve thereby controlling stiffness. There are many other designs of springs of hollow tubing which can change stiffness with any desired frequency, change stiffness by a multiple or move like a linear actuator in addition to its spring qualities.

Arc spring
: A pre-curved or arc-shaped helical compression spring, which is able to transmit a torque around an axis.

Volute spring
: A compression coil spring in the form of a cone so that under compression the coils are not forced against each other, thus permitting longer travel.

Balance spring

Also known as a hairspring. A delicate spiral spring used in watches, galvanometers, and places where electricity must be carried to partially rotating devices such as steering wheels without hindering the rotation.

Leaf spring

A flat spring used in vehicle suspensions, electrical switches, and bows.

V-spring

Used in antique firearm mechanisms such as the wheellock, flintlock and percussion cap locks. Also door-lock spring, as used in antique door latch mechanisms.[10]

Other types

[edit]

Other types include:

Belleville washer

A disc shaped spring commonly used to apply tension to a bolt (and also in the initiation mechanism of pressure-activated landmines)

Constant-force spring

A tightly rolled ribbon that exerts a nearly constant force as it is unrolled

Gas spring

A volume of compressed gas.

Ideal spring

An idealised perfect spring with no weight, mass, damping losses, or limits, a concept used in physics. The force an ideal spring would exert is exactly proportional to its extension or compression.[11]

Mainspring

A spiral ribbon-shaped spring used as a power store of clockwork mechanisms: watches, clocks, music boxes, windup toys, and mechanically powered flashlights

Negator spring

A thin metal band slightly concave in cross-section. When coiled it adopts a flat cross-section but when unrolled it returns to its former curve, thus producing a constant force throughout the displacement and *negating* any tendency to re-wind. The most common application is the retracting steel tape rule.[12]

Progressive rate coil springs

A coil spring with a variable rate, usually achieved by having unequal distance between turns so that as the spring is compressed one or more coils rests against its neighbour.

Rubber band

A tension spring where energy is stored by stretching the material.

Spring washer

Used to apply a constant tensile force along the axis of a fastener.

Torsion spring

Any spring designed to be twisted rather than compressed or extended.[13] Used in torsion bar vehicle suspension systems.

Wave spring

various types of spring made compact by using waves to give a spring effect.

Main article: Wave spring

Physics

[edit]

Hooke's law

[edit]

Main article: Hooke's law

An ideal spring acts in accordance with Hooke's law, which states that the force with which the spring pushes back is linearly proportional to the distance from its equilibrium length:

$$\displaystyle F=-kx$$

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where

- $\displaystyle x$ Image not found or type unknown is the displacement vector – the distance from its equilibrium length.
- $\displaystyle F$ Image not found or type unknown is the resulting force vector – the magnitude and direction of the restoring force the spring exerts
- $\displaystyle k$ Image not found or type unknown is the **spring constant** or **force constant** of the spring, a constant that depends on the spring's material and construction. The negative sign indicates that the force the spring exerts is in the opposite direction from its displacement

Most real springs approximately follow Hooke's law if not stretched or compressed beyond their elastic limit.

Coil springs and other common springs typically obey Hooke's law. There are useful springs that don't: springs based on beam bending can for example produce forces that vary nonlinearly with displacement.

If made with constant pitch (wire thickness), conical springs have a variable rate. However, a conical spring can be made to have a constant rate by creating the spring with a variable pitch. A larger pitch in the larger-diameter coils and a smaller pitch in the smaller-diameter coils forces the spring to collapse or extend all the coils at the same rate when deformed.

Simple harmonic motion

[edit]
Main article: Harmonic oscillator

Since force is equal to mass, *m*, times acceleration, *a*, the force equation for a spring obeying Hooke's law looks like:

$$\displaystyle F=ma\quad \Rightarrow \quad -kx=ma.\,$$

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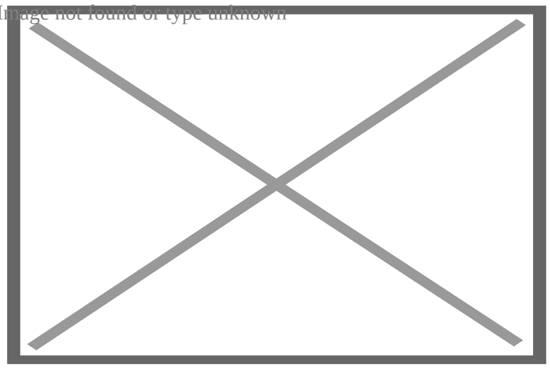

The displacement, *x*, as a function of time. The amount of time that passes between peaks is called the period.

The mass of the spring is small in comparison to the mass of the attached mass and is ignored. Since acceleration is simply the second derivative of x with respect to time,

$$\displaystyle -kx=m\frac{d^2x}{dt^2}.\,$$

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This is a second order linear differential equation for the displacement $\displaystyle x$ Image not found or type unknown as a function of time. Rearranging:

$$\displaystyle \frac{d^2x}{dt^2}+\frac{k}{m}x=0,\,$$

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the solution of which is the sum of a sine and cosine:

$$\displaystyle x(t)=A\sin \left(t\sqrt{\frac{k}{m}}\right)+B\cos \left(t\sqrt{\frac{k}{m}}\right).\,$$

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$\displaystyle A$ Image not found or type unknown and $\displaystyle B$ Image not found or type unknown are arbitrary constants that may be found by considering the initial displacement and velocity of the mass. The graph of this function with $\displaystyle B=0$ Image not found or type unknown (zero initial position with some positive initial velocity) is displayed in the image on the right.

Energy dynamics

[edit]

In simple harmonic motion of a spring-mass system, energy will fluctuate between kinetic energy and potential energy, but the total energy of the system remains the same. A spring that obeys Hooke's law with spring constant *k* will have a total system energy *E* of:[14]

$$\displaystyle E=\left(\frac 12\right)kA^2$$

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Here, A is the amplitude of the wave-like motion that is produced by the oscillating behavior of the spring.

The potential energy *U* of such a system can be determined through the spring constant *k* and its displacement *x*:[14]

$$\displaystyle U=\left(\frac 12\right)kx^2$$

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The kinetic energy *K* of an object in simple harmonic motion can be found using the mass of the attached object *m* and the velocity at which the object oscillates *v*:[14]

$$\displaystyle K=\left(\frac 12\right)mv^2$$

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Since there is no energy loss in such a system, energy is always conserved and thus:[14]

$$\displaystyle E=K+U$$

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Frequency & period

[edit]

The angular frequency ? of an object in simple harmonic motion, given in radians per second, is found using the spring constant *k* and the mass of the oscillating object *m*[15]*:*

$$\displaystyle \omega =\sqrt \frac km$$

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The period *T*, the amount of time for the spring-mass system to complete one full cycle, of such harmonic motion is given by:[16]

$$T=\frac{2\pi}{\omega}=2\pi\sqrt{\frac{m}{k}}$$

Image not found or type unknown [14]

The frequency *f*, the number of oscillations per unit time, of something in simple harmonic motion is found by taking the inverse of the period:[14]

$$f=\frac{1}{T}=\frac{\omega}{2\pi}=\frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Image not found or type unknown [14]

Theory

[edit]

In classical physics, a spring can be seen as a device that stores potential energy, specifically elastic potential energy, by straining the bonds between the atoms of an elastic material.

Hooke's law of elasticity states that the extension of an elastic rod (its distended length minus its relaxed length) is linearly proportional to its tension, the force used to stretch it. Similarly, the contraction (negative extension) is proportional to the compression (negative tension).

This law actually holds only approximately, and only when the deformation (extension or contraction) is small compared to the rod's overall length. For deformations beyond the elastic limit, atomic bonds get broken or rearranged, and a spring may snap, buckle, or permanently deform. Many materials have no clearly defined elastic limit, and Hooke's law can not be meaningfully applied to these materials. Moreover, for the superelastic materials, the linear relationship between force and displacement is appropriate only in the low-strain region.

Hooke's law is a mathematical consequence of the fact that the potential energy of the rod is a minimum when it has its relaxed length. Any smooth function of one variable approximates a quadratic function when examined near enough to its minimum point as can be seen by examining the Taylor series. Therefore, the force – which is the derivative of energy with respect to displacement – approximates a linear function.

The force of a fully compressed spring is:

$$F_{max}=\frac{Ed^4(L-nd)}{16(1+\nu)(D-d)^3n}$$

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where

E – Young's modulus

- d – spring wire diameter
- L – free length of spring
- n – number of active windings
- Image not found or type unknown $\displaystyle \nu$ – Poisson ratio
- D – spring outer diameter.

Zero-length springs

[edit]

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Simplified LaCoste suspension using a zero-length spring

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Spring length *L* vs force *F* graph of ordinary (+), zero-length (0) and negative-length (?) springs with the same minimum length L_0 and spring constant

Zero-length spring is a term for a specially designed coil spring that would exert zero force if it had zero length. That is, in a line graph of the spring's force versus its length, the line passes through the origin. A real coil spring will not contract to zero length because at some point the coils touch each other. "Length" here is defined as the distance between the axes of the pivots at each end of the spring, regardless of any inelastic portion in-between.

Zero-length springs are made by manufacturing a coil spring with built-in tension (A twist is introduced into the wire as it is coiled during manufacture; this works because a coiled spring *unwinds* as it stretches), so if it *could* contract further, the equilibrium point of the spring, the point at which its restoring force is zero, occurs at a length of zero. In practice, the manufacture of springs is typically not accurate enough to produce springs with tension consistent enough for applications that use zero length springs, so they are made by combining a *negative length* spring, made with even more tension so its equilibrium point would be at a *negative* length, with a piece of inelastic material of the proper length so the zero force point would occur at zero length.

A zero-length spring can be attached to a mass on a hinged boom in such a way that the force on the mass is almost exactly balanced by the vertical component of the force from the spring, whatever the position of the boom. This creates a horizontal pendulum with very long oscillation period. Long-period pendulums enable seismometers to sense the slowest waves from earthquakes. The LaCoste suspension with zero-length springs is also used in gravimeters because it is very sensitive to changes in gravity. Springs for closing doors are often made to have roughly zero length, so that they exert force even when the door is almost closed, so they can hold it closed firmly.

Uses

[edit]

- Airsoft gun
- Aerospace
- Retractable ballpoint pens
- Buckling spring keyboards
- Clockwork clocks, watches, and other things
- Firearms
- Forward or aft spring, a method of mooring a vessel to a shore fixture
- Gravimeters
- Industrial Equipment
- Jewelry: Clasp mechanisms
- Most folding knives, and switchblades
- Lock mechanisms: Key-recognition and for coordinating the movements of various parts of the lock.
- Spring mattresses
- Medical Devices[17]
- Pogo Stick
- Pop-open devices: CD players, tape recorders, toasters, etc.
- Spring reverb
- Toys; the Slinky toy is just a spring
- Trampoline
- Upholstery coil springs
- Vehicle suspension, Leaf springs

See also

[edit]

- Shock absorber
- Slinky, helical spring toy

- Volute spring

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External links

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Wikimedia Commons has media related to ***Spring (device)***.

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Machines

Classical simple machines	Inclined plane Lever Pulley Screw Wedge Wheel and axle

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About Crown Point, Indiana

Crown Point is a city in and the area seat of Lake Area, Indiana, United States. The populace was 34,884 per the 2023 American Neighborhood Survey. The city was included in 1868. On

October 31, 1834, Solon Robinson and his family members came to be the first inhabitants to an area that later came to be Crown Point. As a result of its place, Crown Factor is called the "Center of Lake County". The city is surrounded by Merrillville to the north, Winfield to the east, Cedar Lake to the southwest, St. John to the west, and unincorporated Schererville to the northwest. The southerly and southwestern parts of Crown Point surround some unincorporated locations of Lake County.
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