# Screw

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*http://en.wikipedia.org/wiki/Screw#Tamper-resistant\_screws*

This article is about the fastener. For other uses, see [Screw (disambiguation)](http://en.wikipedia.org/wiki/Screw_%28disambiguation%29).

Screws come in a variety of shapes and sizes for different purposes. [U.S. quarter coin](http://en.wikipedia.org/wiki/Quarter_%28U.S._coin%29) (diameter 24 mm) shown for scale.

A **screw**, or **bolt**, is a type of [fastener](http://en.wikipedia.org/wiki/Fastener) characterized by a [helical](http://en.wikipedia.org/wiki/Helix) ridge, known as an *external thread* or just [*thread*](http://en.wikipedia.org/wiki/Screw_thread), wrapped around a cylinder. Some screw threads are designed to mate with a complementary thread, known as an *internal thread*, often in the form of a [nut](http://en.wikipedia.org/wiki/Nut_%28hardware%29) or an object that has the internal thread formed into it. Other screw threads are designed to cut a helical groove in a softer material as the screw is inserted. The most common uses of screws are to hold objects together and to position objects.

Often screws have a *head*, which is a specially formed section on one end of the screw that allows it to be turned, or *driven*. Common tools for driving screws include [screwdrivers](http://en.wikipedia.org/wiki/Screwdriver) and [wrenches](http://en.wikipedia.org/wiki/Wrench). The head is usually larger than the body of the screw, which keeps the screw from being driven deeper than the length of the screw and to provide a [*bearing surface*](http://en.wikipedia.org/wiki/Bearing_surface). There are exceptions; for instance, carriage bolts have a domed head that is not designed to be driven; [set screws](http://en.wikipedia.org/wiki/Set_screw) have a head smaller than the outer diameter of the screw; J-bolts have a J-shaped head which is not designed to be driven, but rather is usually sunk into concrete allowing it to be used as an anchor bolt. The cylindrical portion of the screw from the underside of the head to the tip is known as the *shank*; it may be fully threaded or partially threaded.[[1]](http://en.wikipedia.org/wiki/Screw#cite_note-0)

The majority of screws are tightened by [clockwise](http://en.wikipedia.org/wiki/Clockwise_and_counterclockwise) rotation, which is termed a *right-hand thread*. Screws with left-hand threads are used in exceptional cases. For example, when the screw will be subject to anticlockwise forces (which would work to undo a right-hand thread), a left-hand-threaded screw would be an appropriate choice. The left side [pedal](http://en.wikipedia.org/wiki/Bicycle_pedal#Attachment) of a [bicycle](http://en.wikipedia.org/wiki/Bicycle) has a left-hand thread.

# Differentiation between bolt and screw



A carriage bolt with square nut

A structural bolt with a nut and washer

There is no universally accepted distinction between a screw and a bolt. The [*Machinery's Handbook*](http://en.wikipedia.org/wiki/Machinery%27s_Handbook) describes the distinction as follows:

A bolt is an externally threaded fastener designed for insertion through holes in assembled parts, and is normally intended to be tightened or released by torquing a nut. A screw is an externally threaded fastener capable of being inserted into holes in assembled parts, of mating with a preformed internal thread or forming its own thread, and of being tightened or released by torquing the head. An externally threaded fastener which is prevented from being turned during assembly and which can be tightened or released only by torquing a nut is a bolt. (Example: round head bolts, track bolts, plow bolts.) An externally threaded fastener that has thread form which prohibits assembly with a nut having a straight thread of multiple pitch length is a screw. (Example: wood screws, tapping screws.)[[2]](http://en.wikipedia.org/wiki/Screw#cite_note-1)

This distinction is consistent with [ASME B18.2.1](http://en.wikipedia.org/w/index.php?title=ASME_B18.2.1&action=edit&redlink=1) and some dictionary definitions for *screw*[[3]](http://en.wikipedia.org/wiki/Screw%22%20%5Cl%20%22cite_note-2)[[4]](http://en.wikipedia.org/wiki/Screw#cite_note-3) and *bolt*.[[5]](http://en.wikipedia.org/wiki/Screw#cite_note-4)[[6]](http://en.wikipedia.org/wiki/Screw#cite_note-5)[[7]](http://en.wikipedia.org/wiki/Screw#cite_note-6)

The issue of what is a screw and what is a bolt is not completely resolved with *Machinery's Handbook* distinction, however, because of confounding terms, the ambiguous nature of some parts of the distinction, and usage variations. Some of these issues are discussed below:

### Machine screws

ASME standards specify a variety of "Machine Screws"[[8]](http://en.wikipedia.org/wiki/Screw#cite_note-7) in diameters ranging up to 0.75 in (19.05 mm). These fasteners are often used with nuts as well as often driven into tapped holes. They might be considered a screw or a bolt based on the *Machinery's Handbook* distinction. In practice, they tend to be mostly available in smaller sizes and the smaller sizes are referred to as screws or less ambiguously as machine screws, although some kinds of machine screws can be referred to as [stove bolts](http://en.wikipedia.org/wiki/Screw#stove_bolt).

### Hex cap screws

ASME standard B18.2.1 -1996 specifies Hex Cap Screws that range in size from 0.25–3 in (6.35–76.20 mm) in [diameter](http://en.wikipedia.org/wiki/Diameter). These fasteners are very similar to hex bolts. They differ mostly in that they are manufactured to tighter tolerances than the corresponding bolts. The *Machinery's Handbook* refers parenthetically to these fasteners as "Finished Hex Bolts".[[9]](http://en.wikipedia.org/wiki/Screw#cite_note-8) Reasonably, these fasteners might be referred to as bolts but based on the US government document, Distinguishing Bolts from Screws, the US government might classify them as screws because of the tighter tolerance.[[10]](http://en.wikipedia.org/wiki/Screw#cite_note-9) In 1991 responding to an influx of counterfeit fasteners Congress passed PL 101-592[[11]](http://en.wikipedia.org/wiki/Screw#cite_note-10) "Fastener Quality Act" This resulted in the rewriting of specifications by the ASME B18 committee. B18.2.1 [[12]](http://en.wikipedia.org/wiki/Screw#cite_note-11) was re-written and as a result they eliminated the "Finished Hex Bolts" and renamed them the "Hex Cap Screw".

### Lug bolts & head bolts

These terms refer to fasteners that are designed to be threaded into a tapped hole that is in part of the assembly and so based on the *Machinery's Handbook* distinction they would be screws. Here common terms are at variance with *Machinery's Handbook* distinction.[[13]](http://en.wikipedia.org/wiki/Screw#cite_note-12)[[14]](http://en.wikipedia.org/wiki/Screw#cite_note-13)

### Lag bolt

Lag bolts : These are clearly screws based on the *Machinery's Handbook* distinction. The term has been replaced by "Lag Screw" in the *Machinery's Handbook*[[15]](http://en.wikipedia.org/wiki/Screw%22%20%5Cl%20%22cite_note-14)

### Government standards

The [US government](http://en.wikipedia.org/wiki/US_government) made an effort to formalize the difference between a bolt and a screw because different [tariffs](http://en.wikipedia.org/wiki/Tariffs) apply to each. The document seems to have no significant effect on common usage and does not eliminate the ambiguous nature of the distinction between screws and bolts for some threaded fasteners.[[16]](http://en.wikipedia.org/wiki/Screw#cite_note-15)

### Historical issue

Old [USS](http://en.wikipedia.org/wiki/United_States_Standard) and [SAE](http://en.wikipedia.org/wiki/Society_of_Automotive_Engineers) standards defined cap screws as fasteners with shanks that were threaded to the head and bolts as fasteners with shanks that were partially unthreaded.[[17]](http://en.wikipedia.org/wiki/Screw#cite_note-dyke-16) This is now an obsolete distinction.

### Controlled vocabulary versus natural language

The distinctions delineated above are enforced in the [controlled vocabulary](http://en.wikipedia.org/wiki/Controlled_vocabulary) of [standards organizations](http://en.wikipedia.org/wiki/Standards_organization). Nevertheless, there are sometimes differences between the controlled vocabulary and the [natural-language](http://en.wikipedia.org/wiki/Natural_language) usage of the words among machinists, auto mechanics, and other workers. These differences reflect linguistic evolution shaped by the [changing of technology over centuries](http://en.wikipedia.org/wiki/History_of_technology). The words *bolt* and *screw* have both existed since before today's modern mix of fastener types existed, and the natural usage of those words has evolved [retronymously](http://en.wikipedia.org/wiki/Retronym) in response to the technological change. (That is, the use of words as names for objects changes as the objects themselves change.) Nonthreaded fasteners predominated in fastening technology until the advent of practical, inexpensive screw-cutting in the early 19th century. The basic meaning of the word *screw* has long involved the idea of a helical screw thread, but the Archimedes screw and the screw [gimlet](http://en.wikipedia.org/wiki/Gimlet_%28tool%29) (like a corkscrew) preceded the fastener.

The word *bolt* is also a very old word, and it was used for centuries to refer to metal rods that passed through the substrate to be fastened on the other side, often via nonthreaded means (clinching, forge welding, pinning, wedging, etc.). The connection of this sense to the sense of a door bolt or the [crossbow](http://en.wikipedia.org/wiki/Crossbow) bolt is apparent. In the 19th century, bolts fastened via screw threads were often called *screw bolts* in contradistinction to [*clench bolts*](http://en.wikipedia.org/wiki/Clinker_%28boat_building%29#Fastening_the_centre-line_structure).

In common usage, the distinction is often that screws are smaller than bolts, and that screws are generally tapered and bolts are not. This distinction is not rigorous.

Other distinctions

Bolts have been defined as headed fasteners having external threads that meet an exacting, uniform bolt thread specification (such as [M, MJ](http://en.wikipedia.org/wiki/Metric_thread), [UN, UNR, and UNJ](http://en.wikipedia.org/wiki/Unified_thread)) such that they can accept a nontapered nut. Screws are then defined as headed, externally threaded fasteners that do not meet the above definition of bolts.[*[citation needed](http://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed%22%20%5Co%20%22Wikipedia%3ACitation%20needed)*] These definitions of screw and bolt eliminate the ambiguity of the *Machinery's handbook* distinction. And it is for that reason, perhaps, that some people favor them. However, they are neither compliant with common usage of the two words nor are they compliant with formal specifications.

### http://upload.wikimedia.org/wikipedia/commons/thumb/f/fe/Wood_screw.jpg/170px-Wood_screw.jpgTypes of screws and bolts

Threaded fasteners either have a tapered shank or a non-tapered shank. Fasteners with tapered shanks are designed to either be driven into a substrate directly or into a pilot hole in a substrate. Mating threads are formed in the substrate as these fasteners are driven in. Fasteners with a non-tapered shank are designed to mate with a nut or to be driven into a tapped hole.

### Fasteners with a tapered shank (self-threading screws)

A Phillips wood screw being driven into a board with a driver.



#### Wood screw-

A **wood screw** is defined as a male screw made of a metal with a slotted head and sharp point. A wood screw is commonly furnished with a flat, round or oval-head. A wood screw generally has an unthreaded shank below the head. It is designed to attach two pieces of wood together.

#### Twinfast screw

A Twinfast screw : is a type of wood screw with two threads (i.e. a [lead](http://en.wikipedia.org/wiki/Lead_%28engineering%29) of 2), so that it can be driven twice as fast.[[18]](http://en.wikipedia.org/wiki/Screw#cite_note-17)

#### Coach screw (UK) or lag screw/bolt (US)

Coach screw or lag screw/bolt[[19]](http://en.wikipedia.org/wiki/Screw%22%20%5Cl%20%22cite_note-18) is similar to a wood screw except that it is generally much larger running to lengths up to 15 in (381 mm) with diameters from 0.25–0.5 in (6.35–12.70 mm) in commonly available (hardware store) sizes (not counting larger mining and civil engineering lags and lag bolts) and it generally has a hexagonal drive head. Lag bolts are designed for securely fastening heavy timbers ([post and beams](http://en.wikipedia.org/wiki/Post_and_beam), timber railway trestles and bridges) to one another, or to fasten wood to masonry or concrete.

Lag bolts are usually used with an expanding insert called a lag in masonry or concrete walls, the lag manufactured with a hard metal jacket that bites into the sides of the drilled hole, and the inner metal in the lag being a softer alloy of lead, or zinc alloyed with soft iron. The coarse thread of a lag bolt and lag mesh and deform slightly making a secure near water tight anti-corroding mechanically strong fastening.

#### Sheet metal screw

A Sheet metal screw (self-tapping screw, thread cutting screws) has sharp threads that cut into a material such as sheet metal, plastic or wood. They are sometimes notched at the tip to aid in chip removal during thread cutting. The shank is usually threaded up to the head. Sheet metal screws make excellent fasteners for attaching metal hardware to wood because the fully threaded shank provides good retention in wood.

#### Concrete screw

A concrete screw is a stainless or carbon steel screw for fastening wood, metal, or other materials into concrete or masonry. Concrete screws are commonly blue in color, with or without corrosion coating.[[20]](http://en.wikipedia.org/wiki/Screw#cite_note-19) They may either have a Phillips flat head or a slotted hex washer head. Heads sizes range from 0.1875 to 0.375 in (4.763 to 9.525 mm) and lengths from 1.25 to 5 in (32 to 127 mm).

Typically an installer uses a [hammer drill](http://en.wikipedia.org/wiki/Hammer_drill) to make a pilot hole for each concrete screw.

In the United States, concrete screws are commonly called *Tapcons* which refers to the brand name created from the definition of "an anchor that taps its own threads into concrete." Other commercial names for the fastener are *masonry screw*, *confast screw*, *blue screw*, *self-tapping screw*, and *Titen*.

#### Drywall screw

A drywall screw is a specialized screw with a bugle head that is designed to attach drywall to wood or metal studs, however it is a versatile construction fastener with many uses. The diameter of drywall screw threads is larger than the shaft diameter.

#### Particle board screw (chipboard screw)

A particle board screw is similar to a drywall screw except that it has a thinner shaft and provides better resistance to pull-out in particle board, while offset against a lower shear strength. The threads on particle board screws are asymmetrical.

#### Deck screw

A deck screw is similar to drywall screw except that it has improved corrosion resistance and is generally supplied in a larger gauge. Most deck screws have a type-17 (auger type) thread cutting tip for installation into decking materials.

#### Double ended screw (dowel screw)

A double ended screw (dowel screw) is similar to a wood screw but with two pointed ends and no head, used for making hidden joints between two pieces of wood.

#### Screw eye (eye screw)

A screw eye (eye screw) is a screw with a looped head. Larger ones are sometimes call lag eye screws. Designed to be used as attachment point, particularly for something that is hung from it.

#### Mirror screws

Mirror screws are flat head wood screws with a tapped hole in the head, which is designed to receive a separate screw-in chrome-plated cover. They are usually used to mount mirrors.

#### Thread rolling screws

Thread rolling screws have a lobed (usually triangular) cross-section. They form threads in a pre-drilled hole in the mating workpiece by pushing the material outward during installation.

#### Self-drilling screw (Teks screw)

A self-drilling screw is similar to a sheet metal screw, but it has a drill-shaped point to cut through the substrate to eliminate the need for drilling a pilot hole. Designed for use in soft steel or other metals. The points are numbered from 1 through 5, the larger the number, the thicker metal it can go through without a pilot hole. A 5 point can drill a 0.5 in (12.7 mm) of steel, for example.

### Fasteners with a non-tapered shank

#### Breakaway bolt

A Breakaway bolt is a bolt with a hollow threaded shank, which is designed to break away upon impact. Typically used to fasten fire hydrants, so they will *break away* when hit by a car. Also used in aircraft to reduce weight.

#### Cap screw

The term *cap screw* refers to many different things at different times and places. Currently, it most narrowly refers to a style of head (see the gallery below). More broadly, and more commonly, it refers to the group of screws: shoulder screws, hex heads, counter-sunk heads, button heads, and fillister heads. In the US, cap screws are defined by ASME B18.6.2 and ASME B18.3.[[21]](http://en.wikipedia.org/wiki/Screw#cite_note-20)[[22]](http://en.wikipedia.org/wiki/Screw#cite_note-21) In the past, the term *cap screw*, in general, referred to screws that were supposed to be used in applications where a nut was not used, however the characteristics that differentiated it from a bolt vary over time. In 1910, Anthony defined it as screw with a hex head that was thicker than a bolt head, but the distance across the flats was less than a bolt's.[[23]](http://en.wikipedia.org/wiki/Screw#cite_note-22) In 1913, Woolley and Meredith defined them like Anthony, but gave the following dimensions: hex head cap screws up to and including 7⁄16 inches (11.1125 mm) have a head that is 3⁄16 inches (4.7625 mm) larger than the shank diameter; screws greater than 1⁄2 inches (12.7 mm) in diameter have a head that is 1⁄4 inches (6.35 mm) larger than the shank. Square head cap screws up to and including 3⁄4 inches (19.05 mm) have a head 1⁄8 inches (3.175 mm) larger than the shank; screws larger than 3⁄4 inches (19.05 mm) have a head 1⁄4 inches (6.35 mm) larger than the shank.[[24]](http://en.wikipedia.org/wiki/Screw#cite_note-23) In 1919, Dyke defined them as screws that are threaded all the way to the head.[[17]](http://en.wikipedia.org/wiki/Screw#cite_note-dyke-16)





Cap screws (wide definition)

#### Hex cap screw

A hex cap screw is a cap screw with a hexagonal head, designed to be driven by a wrench (spanner). An ASME B18.2.1 compliant cap screw has somewhat tighter tolerances than a hex bolt for the head height and the shank length. The nature of the tolerance difference allows an ASME B18.2.1 hex cap screw to always fit where a hex bolt is installed but a hex bolt could be slightly too large to be used where a hex cap screw is designed in.

#### Hex bolt

At times the term *hex bolt* is used interchangeably with *hex cap screw*. An ASME B18.2.1 compliant hex bolt is built to different tolerances than a hex cap screw.

#### Socket cap screw

A socket cap screw, also known as a *socket head cap screw*, *socket screw* or *Allen bolt*, this is a type of cap screw with a hexagonal recessed drive. The most common types in use have a cylindrical head whose diameter is [nominally](http://en.wikipedia.org/wiki/Real_versus_nominal_value) 1.5 times (1960 series design) that of the screw shank ([major](http://en.wikipedia.org/wiki/Major_diameter)) diameter. [Counterbored](http://en.wikipedia.org/wiki/Counterboring) holes in parts allow the screw head to be flush with the surface or recessed. Other head designs include *button* head and *flat* head, the latter designed to be seated into [countersunk](http://en.wikipedia.org/wiki/Countersink) holes. A [hex key](http://en.wikipedia.org/wiki/Hex_key) (sometimes referred to as an *Allen wrench* or *Allen key*) or [*hex driver*](http://en.wikipedia.org/wiki/Hex_driver) is required to tighten or loosen a socket screw. Socket screws are commonly used in assemblies that do not provide sufficient clearance for a conventional wrench or [socket](http://en.wikipedia.org/wiki/Socket_wrench).

#### Machine screw

A machine screw is generally a smaller fastener (less than 1⁄4 inches (6.35 mm) in diameter) threaded the entire length of its shank that usually has a recessed drive type (slotted, Phillips, etc.). Machine screws are also made with socket heads (see above), in which case they may be referred to as socket head machine screws.

#### Self-tapping machine screw

A self-tapping machine screw is similar to a machine screw except the lower part of the shank is designed to cut threads as the screw is driven into an untapped hole. The advantage of this screw type over a self-tapping screw is that, if the screw is reinstalled, new threads are not cut as the screw is driven.

#### Set screw

A [set screw](http://en.wikipedia.org/wiki/Set_screw) (grub screw) is generally a headless screw but can be any screw used to fix a rotating part to a shaft. The set screw is driven through a threaded hole in the rotating part until it is tight against the shaft. The most often used type is the socket set screw, which is tightened or loosened with a hex key.

#### Set bolt

A set bolt (tap bolt) is a bolt that is threaded all the way to the head. An ASME B18.2.1 compliant set/tap bolt has the same tolerances as an ASME B18.2.1 compliant hex cap screw.

#### Stud

Studs ([threaded rods](http://en.wikipedia.org/wiki/Threaded_rod)) are head-less screws. They may be threaded at both ends and unthreaded in the middle or completely threaded; the latter is usually referred to as a threaded rod, especially when it has a large aspect ratio (that is, quite long compared to diameter). Completely threaded round stock is available in [bar stock](http://en.wikipedia.org/wiki/Bar_stock) form and is then usually referred to as "all-thread".

#### Eye bolt

An eye bolt is a bolt with a looped head.

#### Toggle bolt

A toggle bolt is a bolt with a special nut known as a wing. It is designed to be used where there is no access to side of the material where the nut is located. Usually the wing is spring loaded and expands after being inserted into the hole.

#### Carriage bolt

A carriage bolt (coach bolt) has a domed or countersunk head, and the shank is topped by a short square section under the head. The square section grips into the part being fixed (typically wood), preventing the bolt from turning when the nut is tightened. A rib neck carriage bolt has several longitudinal ribs instead of the square section, to grip into a metal part being fixed.

#### Elevator bolt

An elevator bolt is a bolt similar to a carriage bolt, except the head is thin and flat. There are many variations. Some do not have a square base, but rather triangular sections of the flat head are folded down to form "fangs" that cut into wood and hold it secure.[[25]](http://en.wikipedia.org/wiki/Screw#cite_note-24)

#### Stove bolt

A stove bolt is a type of machine screw that has a round or flat head and is threaded to the head. They are usually made of low grade steel, have a slot or Phillips drive, and are used to join sheet metal parts using a hex or square nut.[[26]](http://en.wikipedia.org/wiki/Screw#cite_note-25)

#### Shoulder screw

A shoulder screw (stripper bolt) differs from machine screws in that the shank is [ground](http://en.wikipedia.org/wiki/Grinding_%28abrasive_cutting%29) to a precise diameter, known as the *shoulder*, and the threaded portion is smaller in diameter than the shoulder. Shoulder bolt specifications call out the shoulder diameter, shoulder length, and threaded diameter; the threaded length is fixed, based on the threaded diameter, and usually quite short. It is usually used for revolving joints in [mechanisms](http://en.wikipedia.org/wiki/Mechanism_%28engineering%29) and [linkages](http://en.wikipedia.org/wiki/Linkage_%28mechanical%29); when used as a guide for the [stripper plate](http://en.wikipedia.org/wiki/Stripper_plate) in a [die](http://en.wikipedia.org/wiki/Die_%28manufacturing%29) set its called a stripper bolt.

#### Thumb screw

A thumb screw is a threaded fastener designed to be twisted into a tapped hole by hand without the use of tools.

####  Security screw

A security screw is similar to a standard screw except that once inserted it cannot be easily removed.

#### Tension control bolt

A tension control bolt (TC bolt) is a heavy duty bolt used in steel frame construction. The head is usually domed and is not designed to be driven. The end of the shank has a spline on it which is engaged by a special power wrench which prevents the bolt from turning while the nut is tightened.

#### Plow bolt

A plow bolt is bolt similar to a carriage bolt, except the head is flat or concave, and the underside of the head is a cone designed to fit in a countersunk recess. There are many variations, with some not using a square base, but rather a key, a locking slot, or other means. The recess in the mating part must be designed to accept the particular plow bolt.[[27]](http://en.wikipedia.org/wiki/Screw#cite_note-26)[[28]](http://en.wikipedia.org/wiki/Screw#cite_note-27)[[29]](http://en.wikipedia.org/wiki/Screw#cite_note-28)

#### Spring bolt

A spring bolt is a bolt which must be pulled back and which is brought back into place by the spring when the pressure is released. Spring bolts are used in [Rubik's Snakes](http://en.wikipedia.org/wiki/Rubik%27s_Snake), for example, the wedges of which are pulled apart slightly when twisted and are pulled back together by the spring bolt when shifted back into position.

### Other threaded fasteners

#### Superbolt, or multi-jackbolt tensioner

A superbolt, or [multi-jackbolt tensioner](http://en.wikipedia.org/wiki/Multi-jackbolt_tensioner) is an alternative type of fastener that retrofits or replaces existing nuts, bolts, or studs. Tension in the bolt is developed by torquing individual jackbolts, which are threaded through the body of the nut and push against a hardened washer. Because of this, the amount of torque required to achieve a given preload is reduced. Installation and removal of any size tensioner is achieved with hand tools, which can be advantageous when dealing with large diameter bolting applications.

#### Hanger screw

A hanger screw is a headless fastener that has machine screw threads on one end and self-tapping threads on the other designed to be driven into wood or another soft substrate. Often used for mounting legs on tables.

### Materials

Screws and bolts are made from a wide range of materials, with [steel](http://en.wikipedia.org/wiki/Steel) being perhaps the most common, in many varieties. Where great resistance to weather or corrosion is required, stainless steel, [titanium](http://en.wikipedia.org/wiki/Titanium), [brass](http://en.wikipedia.org/wiki/Brass) (steel screws can discolor oak and other woods), [bronze](http://en.wikipedia.org/wiki/Bronze), monel or silicon bronze may be used, or a coating such as brass, [zinc](http://en.wikipedia.org/wiki/Zinc) or [chromium](http://en.wikipedia.org/wiki/Chromium) applied. Electrolytic action from dissimilar metals can be prevented with [aluminium](http://en.wikipedia.org/wiki/Aluminium) screws for double-glazing tracks, for example. Some types of plastic, such as [nylon](http://en.wikipedia.org/wiki/Nylon) or [polytetrafluoroethylene](http://en.wikipedia.org/wiki/Polytetrafluoroethylene) (PTFE), can be threaded and used for fastening requiring moderate strength and great resistance to corrosion or for the purpose of electrical [insulation](http://en.wikipedia.org/wiki/Electrical_insulation).

### Bolted joints



Rusty hexagonal bolt heads

Main article: [Bolted joint](http://en.wikipedia.org/wiki/Bolted_joint)

The [American Institute of Steel Construction](http://en.wikipedia.org/wiki/American_Institute_of_Steel_Construction) ([AISC](http://en.wikipedia.org/wiki/AISC)) 13th Edition Steel Design Manual section 16.1 chapter J-3 specifies the requirements for bolted structural connections. Structural bolts replaced rivets due to decreasing cost and increasing strength of structural bolts in the 20th century. Connections are formed with two types of joints: slip-critical connections and bearing connections. In slip-critical connections, movement of the connected parts is a serviceability condition and bolts are tightened to a minimum required pretension. Slip is prevented through friction of the "faying" surface, that is the plane of shear for the bolt and where two members make contact. Because friction is proportional to the normal force, connections must be sized with bolts numerous and large enough to provide the required load capacity. However, this greatly decreases the shear capacity of each bolt in the connection. The second type and more common connection is a bearing connection. In this type of connection the bolts carry the load through shear and are only tightened to a "snug-fit." These connections require fewer bolts than slip-critical connections and therefore are a less expensive alternative. Slip-critical connections are more common on flange plates for beam and column splices and moment critical connections. Bearing type connections are used in light weight structures and in member connections where slip is not important and prevention of structural failure is the design constraint. Common bearing type connections include: shear tabs, beam supports, gusset plates in trusses.

### Mechanical classifications

The numbers stamped on the head of the bolt are referred to the grade of the bolt used in certain application with the strength of a bolt. High-strength steel bolts usually have a hexagonal head with an [ISO](http://en.wikipedia.org/wiki/International_Organization_for_Standardization) strength rating (called *property class*) stamped on the head. And the absence of marking/number indicates a lower grade bolt with low strength. The property classes most often used are 5.8, 8.8, and 10.9. The number before the point is the [tensile ultimate strength](http://en.wikipedia.org/wiki/Tensile_strength) in [MPa](http://en.wikipedia.org/wiki/Megapascal) divided by 100. The number after the point is 10 times the ratio of tensile yield strength to tensile ultimate strength. For example, a property class 5.8 bolt has a nominal (minimum) tensile ultimate strength of 500 MPa, and a tensile yield strength of 0.8 times tensile ultimate strength or 0.8(500) = 400 MPa.

Tensile ultimate strength is the stress at which the bolt fails. Tensile yield strength is the stress at which the bolt will receive a permanent set (an elongation from which it will not recover when the force is removed) of 0.2 % [offset strain](http://en.wikipedia.org/wiki/Yield_strength#Definition). When elongating a fastener prior to reaching the yield point, the fastener is said to be operating in the elastic region; whereas elongation beyond the yield point is referred to as operating in the plastic region, since the fastener has suffered permanent plastic deformation.

Mild steel bolts have property class 4.6. High-strength steel bolts have property class 8.8 or above.

The same type of screw or bolt can be made in many different grades of material. For critical high-tensile-strength applications, low-grade bolts may fail, resulting in damage or injury. On SAE-standard bolts, a distinctive pattern of marking is impressed on the heads to allow inspection and validation of the strength of the bolt. However, low-cost [counterfeit](http://en.wikipedia.org/wiki/Counterfeit) fasteners may be found with actual strength far less than indicated by the markings. Such inferior fasteners are a danger to life and property when used in aircraft, automobiles, heavy trucks, and similar critical applications.

### Inch

[SAE J429](http://en.wikipedia.org/w/index.php?title=SAE_J429&action=edit&redlink=1) defines the bolt grades for inch-system sized bolts and screws. It defines them by *grade*, which ranges from 0 to 8, with 8 being the strongest. Higher grades do not exist within the specification.[[30]](http://en.wikipedia.org/wiki/Screw#cite_note-siu-29)[[31]](http://en.wikipedia.org/wiki/Screw#cite_note-30) SAE grades 5 and 8 are the most common.

| **[**[**show**](http://en.wikipedia.org/wiki/Screw)**]Head markings and properties for inch-system hex-head cap screws**[**[32]**](http://en.wikipedia.org/wiki/Screw#cite_note-boltdepot-31) |
| --- |
| **Head marking** | **Grade, material, and condition** | **Nominal size range (in)** | **Proof strength ([ksi](http://en.wikipedia.org/wiki/Ksi_%28unit%29%22%20%5Cl%20%22ksi%22%20%5Co%20%22Ksi%20%28unit%29)/MPa)** | **Yield strength, min. (ksi/MPa)** | **Tensile strength, min. (ksi/MPa)** | **Core hardness (**[**Rockwell**](http://en.wikipedia.org/wiki/Rockwell_scale)**)** |
| Hex cap screw-no markings.svg | **SAE Grade 0**[[30]](http://en.wikipedia.org/wiki/Screw#cite_note-siu-29) | Strength and hardness is not specified |
| **SAE grade 1****ASTM A307**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Low carbon steel | 1⁄4–1-1⁄2 | 33/230 |  | 60/410 | B70–100 |
| **ASTM A307 - Grade B**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Low or medium carbon steel | 1⁄4–4 |  |  | 60/410 minimum100/690 maximum | B69–95 |
| **SAE grade 2**Low or medium carbon steel | 1⁄4–3⁄4 | 55/380 | 57/390 | 74/510 | B80–100[[34]](http://en.wikipedia.org/wiki/Screw#cite_note-johndeere-33) |
| Greater than 3⁄4 | 33/230 | 36/250 | 60/410 | B70–100[[34]](http://en.wikipedia.org/wiki/Screw#cite_note-johndeere-33) |
| **SAE grade 4**[[35]](http://en.wikipedia.org/wiki/Screw#cite_note-american-34)Medium carbon steel; cold worked | 1⁄4–1-1⁄2 |  | 100/690 | 115/790 |  |
| Hex cap screw-grade 3.svg | **SAE grade 3**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Medium carbon steel; cold worked | 1⁄4–1 | 85/590 |  | 100/690 | B70–100 |
| Hex cap screw-grade 5.svg | **SAE grade 5**Medium carbon steel; quench and tempered | 1⁄4–1 (inc.) | 85/590 | 92/630 | 120/830 | C25–34[[34]](http://en.wikipedia.org/wiki/Screw#cite_note-johndeere-33) |
| 1–1-1⁄2 | 74/510 | 81/560 | 105/720 | C19–30[[34]](http://en.wikipedia.org/wiki/Screw#cite_note-johndeere-33) |
| **ASTM A449 - Type 1**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Medium carbon steel; quench and tempered | 1–1-1⁄2 (inc.) | 74/510 |  | 105/720 | C19–30 |
| 1-1⁄2–3 | 55/380 |  | 90/620 | [Brinell](http://en.wikipedia.org/wiki/Brinell_scale) 183–235 |
| Hex cap screw-grade 5.1.svg | **SAE grade 5.1**[[36]](http://en.wikipedia.org/wiki/Screw#cite_note-itp-35)Low or medium carbon steel; quench and tempered | No. 6–1⁄2 | 85/590 |  | 120/830 | C25–40 |
| Hex cap screw-grade 5.2.svg | **SAE grade 5.2**[[36]](http://en.wikipedia.org/wiki/Screw#cite_note-itp-35)Low carbon martensitic steel; quench and tempered | 1⁄4–1 | 85/590 |  | 120/830 | C26–36 |
| **ASTM A449 - Type 2**[[36]](http://en.wikipedia.org/wiki/Screw#cite_note-itp-35)Low carbon martensitic steel; quench and tempered | C25–34 |
| Hex cap screw-ASTM A325.svgorHex cap screw-ASTM A325 lines.svg | [**ASTM A325**](http://en.wikipedia.org/wiki/ASTM_A325) **- Type 1**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Medium carbon steel; quench and tempered | 1⁄2–1 (inc.) | 85/590 | 92/630[[35]](http://en.wikipedia.org/wiki/Screw#cite_note-american-34) | 120/830 | C24–35 |
| 1–1-1⁄2 | 74/510 | 82/570[[35]](http://en.wikipedia.org/wiki/Screw#cite_note-american-34) | 105/720 | C19–31 |
| Hex cap screw-ASTM A325 type 3.svg[[37]](http://en.wikipedia.org/wiki/Screw#cite_note-crnote-36) | **ASTM A325 - Type 3**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Atmospheric corrosion resistant steel; quench and tempered | 1⁄2–1 | 85/590 | 92/630[[35]](http://en.wikipedia.org/wiki/Screw#cite_note-american-34) | 120/830 | C24–35 |
| 1–1-1⁄2 | 74/510 | 82/570[[35]](http://en.wikipedia.org/wiki/Screw#cite_note-american-34) | 105/720 | C19–31 |
| Hex cap screw-ASTM A354 grade BC.svg | [**ASTM A354**](http://en.wikipedia.org/wiki/ASTM_A354) **- Grade BC**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Medium carbon alloy steel; quench and tempered | 1⁄4–2-1⁄2 (inc.) | 105/720 | 109/750[[35]](http://en.wikipedia.org/wiki/Screw#cite_note-american-34) | 125/860 | C26–36 |
| 2-1⁄2–4 | 95/660 | 99/680[[35]](http://en.wikipedia.org/wiki/Screw#cite_note-american-34) | 115/790 | C22–33 |
| Hex cap screw-grade 7.svg | **SAE grade 7**Medium carbon alloy steel; quench and tempered | 1⁄4–1-1⁄2 | 105/720 | 115/790 | 133/920 |  |
| Hex cap screw-grade 8.svg | **SAE grade 8**Medium carbon alloy steel; quench and tempered | 1⁄4–1-1⁄2 | 120/830 | 130/900 | 150/1,000 | C32–38[[34]](http://en.wikipedia.org/wiki/Screw#cite_note-johndeere-33) |
| Hex cap screw-ASTM A354 grade BD lines.svg | **ASTM A354 - Grade BD**[[38]](http://en.wikipedia.org/wiki/Screw#cite_note-Fastenal-37) | 1⁄4–2-1⁄2 (inc.) | 120/830 | 130/900[[38]](http://en.wikipedia.org/wiki/Screw#cite_note-Fastenal-37) | 150/1,000 | C33–39 |
| Hex cap screw-ASTM A354 grade BD.svg | 2-1⁄2–4 | 105/720 | 115/790[[38]](http://en.wikipedia.org/wiki/Screw#cite_note-Fastenal-37) | 140/970 | C31–39 |
| Hex cap screw-grade 8.2.svg | **SAE grade 8.2**[[34]](http://en.wikipedia.org/wiki/Screw#cite_note-johndeere-33)Medium carbon boron martensitic steel; fully kilned, fine grain, quench and tempered | 1⁄4–1 | 120/830 |  | 150/1,000 | C33–39 |
| Hex cap screw-ASTM A490.svg | [**ASTM A490**](http://en.wikipedia.org/wiki/ASTM_A490) **- Type 1**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Medium carbon alloy steel; quench and tempered | 1⁄2–1-1⁄2 | 120/830 | 130/900[[35]](http://en.wikipedia.org/wiki/Screw#cite_note-american-34) | 150/1,000 minimum170/1,200 maximum | C33–38 |
| Hex cap screw-ASTM A490 type 3.svg[[37]](http://en.wikipedia.org/wiki/Screw#cite_note-crnote-36) | **ASTM A490 - Type 3**[[33]](http://en.wikipedia.org/wiki/Screw#cite_note-fastspec-32)Atmospheric corrosion resistant steel; quench and tempered |
|  | **18-8 Stainless**Stainless steel with 17–19% chromium and 8–13% nickel | 1⁄4–5⁄8 (inc.) |  | 40/280 minimum80/550 – 90/620 typical | 100/690 – 125/860 typical |  |
| 5⁄8–1 (inc.) |  | 40/280 minimum45/310 – 70/480 typical | 100/690 typical |  |
| Over 1 | 80/550 – 90/620 typical |  |

### Metric

The international standard for metric screws is defined by [ISO 898](http://en.wikipedia.org/wiki/ISO_898), specifically ISO 898-1. [SAE J1199](http://en.wikipedia.org/w/index.php?title=SAE_J1199&action=edit&redlink=1) and [ASTM F568M](http://en.wikipedia.org/wiki/ASTM_F568M) are two North American metric standards that closely mimic the ISO standard. In case of inch sizes the grade is dictated by the number of radial shapes plus a value of two. Inch-system bolts use integer values to indicate grades but metric bolts use numbers with one decimal. The two North American standards use the same property class markings as defined by ISO 898.[[39]](http://en.wikipedia.org/wiki/Screw#cite_note-38) The ASTM standard only includes the following property classes from the ISO standard: 4.6, 4.8, 5.8, 8.8, 9.8, 10.9, and 12.9; it also includes two extra property classes: 8.8.3 and 10.9.3.[[40]](http://en.wikipedia.org/wiki/Screw#cite_note-F568M-39) ASTM property classes are to be stamped on the top of screws and it is preferred that the marking is raised.[[41]](http://en.wikipedia.org/wiki/Screw#cite_note-metrichandbook-40)

| **[**[**show**](http://en.wikipedia.org/wiki/Screw)**]Head markings and properties for metric hex-head cap screws**[**[41]**](http://en.wikipedia.org/wiki/Screw#cite_note-metrichandbook-40) |
| --- |
| **Head marking** | **Grade, material, and condition** | **Nominal size range (mm)** | **Proof strength (MPa/ksi)** | **Yield strength, min. (MPa/ksi)** | **Tensile strength, min. (MPa/ksi)** | **Core hardness (**[**Rockwell**](http://en.wikipedia.org/wiki/Rockwell_scale)**)** |
| Hex cap screw-class 3.6.svg | **Class 3.6**[[42]](http://en.wikipedia.org/wiki/Screw#cite_note-41) | 1.6–36 | 180/26 | 190/28 | 330/48 | B52–95 |
| Hex cap screw-class 4.6.svg | **Class 4.6**Low or medium carbon steel | 5–100 | 225/32.6 | 240/35 | 400/58 | B67–95 |
| Hex cap screw-class 4.8.svg | **Class 4.8**Low or medium carbon steel; fully or partially annealed | 1.6–16 | 310/45 | 340/49 | 420/61 | B71–95 |
| Hex cap screw-class 5.8.svg | **Class 5.8**Low or medium carbon steel; cold worked | 5–24 | 380/55 | 420/61 | 520/75 | B82–95 |
| Hex cap screw-class 8.8.svg | **Class 8.8**[[32]](http://en.wikipedia.org/wiki/Screw#cite_note-boltdepot-31)Medium carbon steel; quench and tempered | Under 16 (inc.) | 580/84 | 640/93 | 800/120 |  |
| 17–72 | 600/87 | 660/96 | 830/120 | C23–34 |
| Hex cap screw-class 8.8 line.svg | **Class 8.8 low carbon**Low carbon boron steel; quench and tempered |
| Hex cap screw-class 8.8.3.svg | **Class 8.8.3**[[40]](http://en.wikipedia.org/wiki/Screw#cite_note-F568M-39)Atmospheric corrosion resistant steel; quench and tempered |
| Hex cap screw-ASTM A325M 8S.svg | [**ASTM A325M**](http://en.wikipedia.org/wiki/ASTM_A325M) **- Type 1**[[43]](http://en.wikipedia.org/wiki/Screw#cite_note-uiowa-42)[[44]](http://en.wikipedia.org/wiki/Screw#cite_note-astm_a325m-43)Medium carbon steel; quench and tempered | 12–36 |
| Hex cap screw-ASTM A325M 8S3.svg | **ASTM A325M - Type 3**[[43]](http://en.wikipedia.org/wiki/Screw#cite_note-uiowa-42)[[44]](http://en.wikipedia.org/wiki/Screw#cite_note-astm_a325m-43)Atmospheric corrosion resistant steel; quench and tempered |
| Hex cap screw-class 9.8.svg | **Class 9.8**Medium carbon steel; quench and tempered | 1.6–16 | 650/94 | 720/104 | 900/130 | C27–36 |
| Hex cap screw-class 9.8 line.svg | **Class 9.8 low carbon**Low carbon boron steel; quench and tempered |
| Hex cap screw-class 10.9.svg | **Class 10.9**Alloy steel; quench and tempered | 5–100 | 830/120 | 940/136 | 1,040/151 | C33–39 |
| Hex cap screw-class 10.9 line.svg | **Class 10.9 low carbon**Low carbon boron steel; quench and tempered |
| Hex cap screw-class 10.9.3.svg | **Class 10.9.3**[[40]](http://en.wikipedia.org/wiki/Screw#cite_note-F568M-39)Atmospheric corrosion resistant steel; quench and tempered |
| Hex cap screw-ASTM A490M 10S.svg | [**ASTM A490M**](http://en.wikipedia.org/wiki/ASTM_A490M) **- Type 1**[[43]](http://en.wikipedia.org/wiki/Screw#cite_note-uiowa-42)[[45]](http://en.wikipedia.org/wiki/Screw#cite_note-astm_a490m-44)Alloy steel; quench and tempered | 12–36 |
| Hex cap screw-ASTM A490M 10S3.svg | **ASTM A490M - Type 3**[[43]](http://en.wikipedia.org/wiki/Screw#cite_note-uiowa-42)[[45]](http://en.wikipedia.org/wiki/Screw#cite_note-astm_a490m-44)Atmospheric corrosion resistant steel; quench and tempered |
| Hex cap screw-class 12.9.svg | **Class 12.9**Alloy steel; quench and tempered | 1.6–100 | 970/141 | 1,100/160 | 1,220/177 | C38–44 |
| Hex cap screw-A2.svg | **A2**[[32]](http://en.wikipedia.org/wiki/Screw#cite_note-boltdepot-31)Stainless steel with 17–19% chromium and 8–13% nickel | Up to 20 |  | 210/30 minimum450/65 typical | 500/73 minimum700/100 typical |  |
| **ISO 3506-1 A2-50**[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)]304 stainless steel-class 50 (annealed) |  |  | 210/30 | 500/73 |  |
| **ISO 3506-1 A2-70**[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)]304 stainless steel-class 70 (cold worked) |  |  | 450/65 | 700/100 |  |
| **ISO 3506-1 A2-80**[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)]304 stainless steel-class 80 |  |  | 600/87 | 800/120 |  |

### Screw head shapes



(a) pan, (b) button, (c) round, (d) truss, (e) flat (countersunk), (f) oval

Combination flanged-hex/Phillips-head screw used in computers

Pan head

A low disc with [chamfered](http://en.wikipedia.org/wiki/Chamfer) outer edge

Button or dome head

Cylindrical with a rounded top

Round head

A dome-shaped head used for decoration.[[46]](http://en.wikipedia.org/wiki/Screw#cite_note-mitchell-45)

Truss head

Lower-profile dome designed to prevent tampering

Countersunk or flat head

Conical, with flat outer face and tapering inner face allowing it to sink into the material. The *angle* of the screw is measured as the [full angle](http://en.wikipedia.org/w/index.php?title=Full_angle&action=edit&redlink=1) of the cone.

Oval or raised head

A decorative screw head with a countersunk bottom and rounded top.[[46]](http://en.wikipedia.org/wiki/Screw%22%20%5Cl%20%22cite_note-mitchell-45)

Bugle head

Similar to countersunk, but there is a smooth progression from the shank to the angle of the head, similar to the bell of a [bugle](http://en.wikipedia.org/wiki/Bugle_%28instrument%29)

Cheese head

Disc with cylindrical outer edge, height approximately half the head diameter

Fillister head

Cylindrical, but with a slightly convex top surface. Height to diameter ratio is larger than cheese head.

Flanged head

A flanged head can be any of the above head styles with the addition of an integrated flange at the base of the head. This eliminates the need for a [flat washer](http://en.wikipedia.org/wiki/Flat_washer).

Some varieties of screw are manufactured with a break-away head, which snaps off when adequate torque is applied. This prevents tampering and also provides an easily inspectable joint to guarantee proper assembly. An example of this is the shear bolts used on vehicle [steering columns](http://en.wikipedia.org/wiki/Steering_column), to secure the [ignition switch](http://en.wikipedia.org/wiki/Ignition_switch).

### Types of screw drives

| **Part of the series on** |
| --- |
| [**Screw drive**](http://en.wikipedia.org/wiki/Screw_drive) **types** |
| Screw Head - Slotted.svg | [Slot](http://en.wikipedia.org/wiki/Slot_drive) (flat) |
| Screw Head - Phillips.svg | [Phillips](http://en.wikipedia.org/wiki/Phillips_drive)PH |
| Screw Head - Pozidrive.svg | [Pozidriv](http://en.wikipedia.org/wiki/Pozidriv) (SupaDriv)PZ |
| Screw Head - Square External.svg | [Square](http://en.wikipedia.org/wiki/External_square_drive) |
| Screw Head - Robertson.svg | [Robertson](http://en.wikipedia.org/wiki/Robertson_screwdriver) (square) |
| Screw Head - Hex External.svg | [Hex](http://en.wikipedia.org/wiki/Hex_drive) |
| Screw Head - Hex Socket.svg | [Hex socket](http://en.wikipedia.org/wiki/Hex_key) (Allen) |
| Screw Head - Torx.svg | [Torx](http://en.wikipedia.org/wiki/Torx)T & TX |
| Screw Head - Torx Tamperproof.svg | [Security Torx](http://en.wikipedia.org/wiki/Torx#Variants)TR |
| Screw Head - Tri-wing.svg | [Tri-Wing](http://en.wikipedia.org/wiki/Tri-Wing) |
| Screw Head - Torq-set.svg | [Torq-set](http://en.wikipedia.org/wiki/Torq-set) |
| Screw Head - Spanner.svg | [Spanner head](http://en.wikipedia.org/wiki/Screw#Spanner)(Snake-eye) |
| Screw Head - Triple Square.svg | [Triple square](http://en.wikipedia.org/wiki/Triple_square)XZN |
| Screw Head - Polydrive.svg | [Polydrive](http://en.wikipedia.org/wiki/Polydrive) |
| Screw Head - One-way Clutch.svg | [One-way](http://en.wikipedia.org/wiki/One-way_screw) |
| Screw Head - Spline.svg | [Spline drive](http://en.wikipedia.org/wiki/Spline_drive) |
| Screw Head - Double Hex.svg | [Double hex](http://en.wikipedia.org/wiki/Double_hex) |
| Screw Head - Bristol.svg | [Bristol](http://en.wikipedia.org/wiki/Bristol_wrench) |
| Pentalobular.svg | [Pentalobular](http://en.wikipedia.org/wiki/Pentalobular_screw) |
| **This box:** [**view**](http://en.wikipedia.org/wiki/Template%3AScrew_drives) **·** [**talk**](http://en.wikipedia.org/wiki/Template_talk%3AScrew_drives) **·** [**edit**](http://en.wikipedia.org/w/index.php?title=Template:Screw_drives&action=edit) |

Modern screws employ a wide variety of drive designs, each requiring a different kind of tool to drive in or extract them. The most common screw drives are the slotted and Phillips; hex, Robertson, and torx are also common in some applications. Some types of drive are intended for automatic assembly in mass-production of such items as automobiles. More exotic screw drive types may be used in situations where tampering is undesirable, such as in electronic appliances that should not be serviced by the home repair person.

### Tools



An electric driver screws a self-tapping phillips head screw into wood

The hand tool used to drive in most screws is called a *screwdriver*. A power tool that does the same job is a *power screwdriver*; [power drills](http://en.wikipedia.org/wiki/Power_drill) may also be used with screw-driving attachments. Where the holding power of the screwed joint is critical, torque-measuring and *torque-limiting screwdrivers* are used to ensure sufficient but not excessive force is developed by the screw. The hand tool for driving hex head threaded fasteners is a *spanner* (UK usage) or *wrench* (US usage).

### Thread standards

There are many systems for specifying the dimensions of screws, but in much of the world the [ISO metric screw thread](http://en.wikipedia.org/wiki/ISO_metric_screw_thread) preferred series has displaced the many older systems. Other relatively common systems include the [British Standard Whitworth](http://en.wikipedia.org/wiki/British_Standard_Whitworth), [BA system (British Association)](http://en.wikipedia.org/wiki/British_Association_screw_threads), and the [Unified Thread Standard](http://en.wikipedia.org/wiki/Unified_Thread_Standard).

### ISO metric screw thread

Main article: [ISO metric screw thread](http://en.wikipedia.org/wiki/ISO_metric_screw_thread)

The basic principles of the ISO metric screw thread are defined in [international standard](http://en.wikipedia.org/wiki/International_standard) [ISO 68-1](http://en.wikipedia.org/wiki/ISO_68-1) and preferred combinations of diameter and pitch are listed in ISO 261. The smaller subset of diameter and pitch combinations commonly used in screws, nuts and bolts is given in [ISO 262](http://en.wikipedia.org/wiki/ISO_262). The most commonly used pitch value for each diameter is the *coarse pitch*. For some diameters, one or two additional *fine pitch* variants are also specified, for special applications such as threads in thin-walled pipes. ISO metric screw threads are designated by the letter **M** followed by the major diameter of the thread in millimeters (e.g., *M8*). If the thread does not use the normal *coarse pitch* (e.g., 1.25 mm in the case of M8), then the pitch in millimeters is also appended with a [multiplication sign](http://en.wikipedia.org/wiki/Multiplication_sign) (e.g. "M8×1" if the screw thread has an outer diameter of 8 mm and advances by 1 mm per 360° rotation).

The nominal diameter of a metric screw is the outer diameter of the thread. The tapped hole (or nut) into which the screw fits, has an internal diameter which is the size of the screw minus the pitch of the thread. Thus, an M6 screw, which has a pitch of 1 mm, is made by threading a 6 mm shank, and the nut or threaded hole is made by tapping threads into a hole of 5 mm diameter (6 mm - 1 mm).

Metric [hexagon](http://en.wikipedia.org/wiki/Hexagon) bolts, screws and nuts are specified, for example, in [British Standard](http://en.wikipedia.org/wiki/British_Standard) BS 4190 (general purpose screws) and BS 3692 (precision screws). The following table lists the relationship given in these standards between the thread size and the maximal width across the hexagonal flats (wrench size):

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ISO metric thread** | M 1.6 | M2 | M 2.5 | M3 | M4 | M5 | M6 | M8 | M10 | M12 | M16 | M20 | M24 | M30 | M36 | M42 | M48 | M56 | M64 |
| **Wrench size (mm)** | 3.2 | 4 | 5 | 5.5 | 7 | 8 | 10 | 13 | 17 | 19 | 24 | 30 | 36 | 46 | 55 | 65 | 75 | 85 | 95 |

In addition, the following non-preferred intermediate sizes are specified:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ISO metric thread** | M7 | M14 | M18 | M22 | M27 | M33 | M39 | M45 | M52 | M60 | M68 |
| **Wrench size (mm)** | 11 | 22 | 27 | 32 | 41 | 50 | 60 | 70 | 80 | 90 | 100 |

### Whitworth

Main article: [British Standard Whitworth](http://en.wikipedia.org/wiki/British_Standard_Whitworth)

The first person to create a standard (in about 1841) was the [English](http://en.wikipedia.org/wiki/England) [engineer](http://en.wikipedia.org/wiki/Engineer) Sir [Joseph Whitworth](http://en.wikipedia.org/wiki/Joseph_Whitworth). Whitworth screw sizes are still used, both for repairing old machinery and where a coarser thread than the metric fastener thread is required. Whitworth became *British Standard Whitworth*, abbreviated to BSW (BS 84:1956) and the *British Standard Fine* (BSF) thread was introduced in 1908 because the Whitworth thread was too coarse for some applications. The thread angle was 55° and a depth and pitch of thread that varied with the diameter of the thread (i.e., the bigger the bolt, the coarser the thread). The spanner size is determined by the size of the bolt, not the distance between the flats.

The most common use of a Whitworth pitch nowadays is in all UK [scaffolding](http://en.wikipedia.org/wiki/Scaffolding). Additionally, the standard photographic [tripod](http://en.wikipedia.org/wiki/Tripod_%28photography%29) thread, which for small cameras is 1/4" Whitworth (20 tpi) and for medium/large format cameras is 3/8" Whitworth (16 tpi). It is also used for microphone stands and their appropriate clips, again in both sizes, along with "thread adapters" to allow the smaller size to attach to items requiring the larger thread.

### British Association screw thread

Main article: [British Association screw threads](http://en.wikipedia.org/wiki/British_Association_screw_threads)

A later standard established in the [United Kingdom](http://en.wikipedia.org/wiki/United_Kingdom) was the British Association (BA) screw threads, named after the British Association for Advancement of Science. Screws were described as "2BA", "4BA" etc., the odd numbers being rarely used, except in equipment made prior to the 1970s for telephone exchanges in the UK. This equipment made extensive use of odd-numbered BA screws, in order—it may be suspected—to reduce theft. BA threads are specified by British Standard BS 93:1951 "Specification for British Association (B.A.) screw threads with tolerances for sizes 0 B.A. to 16 B.A."

While not related to ISO metric screws, the sizes were actually defined in metric terms, a 0BA thread having a 6 mm diameter and 1 mm pitch. Other threads in the BA series are related to 0BA in a geometric series with the common factors 0.9 and 1.2. For example, a 4BA thread has pitch  mm (0.65mm) and diameter  mm (3.62mm). Although 0BA has the same diameter and pitch as ISO M6, the threads have different forms and are not compatible.

BA threads are still common in some niche applications. Certain types of fine machinery, such as moving-coil meters and clocks, tend to have BA threads wherever they are manufactured. BA sizes were also used extensively in aircraft, especially those manufactured in the United Kingdom. BA sizing is still used in railway signalling, mainly for the termination of electrical equipment and cabling.

BA threads are extensively used in Model Engineering where the smaller hex head sizes make scale fastenings easier to represent. As a result many UK Model Engineering suppliers still carry stocks of BA fasteners up to typically 8BA and 10BA. 5BA is also commonly used as it can be threaded onto 1/8 rod.

### Unified Thread Standard

Main article: [Unified Thread Standard](http://en.wikipedia.org/wiki/Unified_Thread_Standard)

The Unified Thread Standard (UTS) is most commonly used in the United States of America, but is also extensively used in [Canada](http://en.wikipedia.org/wiki/Canada) and occasionally in other countries. The size of a UTS screw is described using the following format: **X-Y**, where **X** is the nominal size (the hole or slot size in standard manufacturing practice through which the shaft of the screw can easily be pushed) and **Y** is the [threads per inch](http://en.wikipedia.org/wiki/Threads_per_inch) (TPI). For sizes 1⁄4 inch and larger the size is given as a fraction; for sizes less than this an [integer](http://en.wikipedia.org/wiki/Integer) is used, ranging from 0 to 16. For most size screws there are multiple TPI available, with the most common being designated a Unified Coarse Thread (UNC or UN) and Unified Fine Thread (UNF or UF).

## Manufacture – a schematic of the heading process



There are three steps in manufacturing a screw: *heading*, *thread rolling*, and *coating*. Screws are normally made from [wire](http://en.wikipedia.org/wiki/Wire), which is supplied in large coils, or round [bar stock](http://en.wikipedia.org/wiki/Bar_stock) for larger screws.

The wire or rod is then cut to the proper length for the type of screw being made; this workpiece is known as a *blank*. It is then [cold headed](http://en.wikipedia.org/wiki/Heading_%28metalworking%29), which is a [cold working](http://en.wikipedia.org/wiki/Cold_working) process. Heading produces the *head* of the screw. The shape of the die in the machine dictates what features are pressed into the screw head; for example a flat head screw uses a flat die. For more complicated shapes two heading processes are required to get all of the features into the screw head. This production method is used because heading has a very high production rate, and produces virtually no waste material. Slotted head screws require an extra step to cut the slot in the head; this is done on a *slotting machine*. These machines are essentially stripped down milling machines designed to process as many blanks as possible.

The blanks are then polished[*[citation needed](http://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed%22%20%5Co%20%22Wikipedia%3ACitation%20needed)*] again prior to threading. The threads are usually produced via [thread rolling](http://en.wikipedia.org/wiki/Thread_rolling), however some are [cut](http://en.wikipedia.org/wiki/Thread_cutting). The workpiece is then [tumble finished](http://en.wikipedia.org/wiki/Tumble_finishing) with wood and leather media to do final cleaning and polishing.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)] For most screws a coating, such as [hot-dip galvanizing](http://en.wikipedia.org/wiki/Hot-dip_galvanizing) or [blackening](http://en.wikipedia.org/wiki/Blackening), is applied to prevent corrosion.

Different bolt sections

### History

A [lathe](http://en.wikipedia.org/wiki/Lathe_%28metal%29) of 1871, equipped with [leadscrew](http://en.wikipedia.org/wiki/Leadscrew) and change gears for single-point screw-cutting.

A [Brown & Sharpe](http://en.wikipedia.org/wiki/Brown_%26_Sharpe) single-[spindle](http://en.wikipedia.org/wiki/Spindle_%28tool%29) screw machine.

While a recent hypothesis attributes the [Archimedes' screw](http://en.wikipedia.org/wiki/Archimedes%27_screw) to [Sennacherib](http://en.wikipedia.org/wiki/Sennacherib), King of [Assyria](http://en.wikipedia.org/wiki/Assyria), archaeological finds and pictorial evidence only appear in the [Hellenistic period](http://en.wikipedia.org/wiki/Hellenistic_period) and the standard view holds the device to be a [Greek](http://en.wikipedia.org/wiki/Ancient_Greece) invention, most probably by the 3rd century BC polymath [Archimedes](http://en.wikipedia.org/wiki/Archimedes) himself.[[47]](http://en.wikipedia.org/wiki/Screw#cite_note-46)[[*dubious*](http://en.wikipedia.org/wiki/Wikipedia%3ADisputed_statement) *–* [*discuss*](http://en.wikipedia.org/wiki/Talk%3AScrew#Dubious)]

The screw was later described by the [Greek mathematician](http://en.wikipedia.org/wiki/Greek_mathematics) [Archytas of Tarentum](http://en.wikipedia.org/wiki/Archytas_of_Tarentum) (428 – 350 BC). By the 1st century BC, wooden screws were commonly used throughout the [Mediterranean](http://en.wikipedia.org/wiki/Mediterranean) world in devices such as [oil](http://en.wikipedia.org/wiki/Vegetable_oil) and [wine](http://en.wikipedia.org/wiki/Wine) presses. Metal screws used as fasteners did not appear in Europe until the 15th century.[[48]](http://en.wikipedia.org/wiki/Screw#cite_note-MFA-47)[[*dubious*](http://en.wikipedia.org/wiki/Wikipedia%3ADisputed_statement) *–* [*discuss*](http://en.wikipedia.org/wiki/Talk%3AScrew#Dubious)]

In 1744, the flat-bladed bit for the carpenter's brace was invented, the precursor to the first simple screwdriver. Handheld screwdrivers first appeared after 1800.

Prior to the mid-19th century, [cotter pins](http://en.wikipedia.org/wiki/Split_pin) or [pin bolts](http://en.wikipedia.org/wiki/Clinker_%28boat_building%29#Fastening_the_centre-line_structure), and "clinch bolts" (now called [rivets](http://en.wikipedia.org/wiki/Rivet#Types)), were used in shipbuilding.

The metal screw did not become a common fastener until [machine tools](http://en.wikipedia.org/wiki/Machine_tool) for [mass production](http://en.wikipedia.org/wiki/Mass_production) were developed at the end of the 18th century. In the 1770s, English instrument maker [Jesse Ramsden](http://en.wikipedia.org/wiki/Jesse_Ramsden) (1735–1800) invented the first satisfactory [screw-cutting lathe](http://en.wikipedia.org/wiki/Screw-cutting_lathe). The British engineer [Henry Maudslay](http://en.wikipedia.org/wiki/Henry_Maudslay) (1771–1831) patented a screw-cutting lathe in 1797; a similar device was patented by [David Wilkinson](http://en.wikipedia.org/wiki/David_Wilkinson_%28machinist%29) in the United States in 1798. These developments caused great increase in the use of threaded fasteners. [Standardization of threadforms](http://en.wikipedia.org/wiki/Screw_thread#History_of_standardization) began almost immediately, but it was not quickly completed; it has been an evolving process ever since.

The development of the [turret lathe](http://en.wikipedia.org/wiki/Turret_lathe) (1840s) and of the [screw machine](http://en.wikipedia.org/wiki/Screw_machine_%28automatic_lathe%29) (1870s) drastically reduced the unit cost of threaded fasteners by increasingly automating the machine tool control. This cost reduction spurred ever greater use of screws.

Throughout the 19th century, the most commonly used forms of screw head (drive) were simple internal-wrenching slots and external-wrenching squares and hexagons. These were easy to [machine](http://en.wikipedia.org/wiki/Machining) and served most applications adequately. The 20th century saw the development of many other types of drive. In 1908, Canadian [P. L. Robertson](http://en.wikipedia.org/wiki/P._L._Robertson) invented the internal-wrenching square drive. The internal-wrenching hexagon drive (hex socket) shortly followed in 1911. In the early 1930s, the Phillips-head screw was invented by [Henry F. Phillips](http://en.wikipedia.org/wiki/Henry_F._Phillips).

Threadform standardization further improved in the late 1940s, when the ISO metric screw thread and the Unified Thread Standard were defined.

### Other fastening methods

Alternative fastening methods are [nails](http://en.wikipedia.org/wiki/Nail_%28fastener%29), [rivets](http://en.wikipedia.org/wiki/Rivet), [roll pins](http://en.wikipedia.org/wiki/Roll_pin), [pinned shafts](http://en.wikipedia.org/wiki/Clinker_%28boat_building%29#Fastening_the_centre-line_structure), [welding](http://en.wikipedia.org/wiki/Welding), [soldering](http://en.wikipedia.org/wiki/Solder), [brazing](http://en.wikipedia.org/wiki/Brazing), and [gluing](http://en.wikipedia.org/wiki/Gluing) (including [taping](http://en.wikipedia.org/wiki/Adhesive_tape)), and clinch fastening.

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