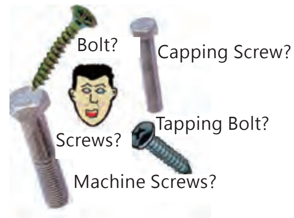
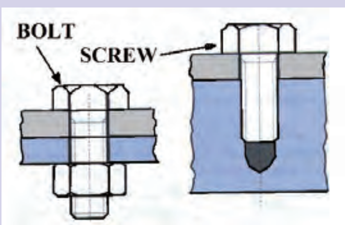
What is a **Machine Screw?**



by Thomas Doppke

Any discussion about machine screws usually starts an argument among fastener people about what is a screw vs what is a bolt. This controversy has been an on-going discussion since the earliest of days. Although there does not appear to be any reason for calling a fastener either a screw or a bolt, fastener engineers argue about many points even less important than this. One point that is often brought up is that some countries have trade restrictions and tariffs on parts. The naming of a fastener as a bolt or a screw may affect the import status. So what is a screw, a bolt, a machine screw?

To summarize some of the positions: one accepted definition of a screw is that it has spaced threads (threads are not adjacent, shoulder to shoulder, but are wound with a small space between them (commonly called a 'tapping screw') while bolt/machine threads are next to each other. For classification purposes the spaced tapping screw thread is called a "B" thread while the bolt thread (side by side) is classified as a "C" thread. There was an "A" thread used previously but it is now obsolete. The threads were a bit farther apart than the "B" thread now used. There is no special significance for these letters except to delineate the different threads. The currently most accepted definition is based upon functionality; a screw goes into a pre-tapped hole or cuts its own thread while a bolt is attached by the installation of its threaded end into a female threaded member (nut, et al). While this serves to delineate tapping screws from the rest of the group (tapping screws form their own threads). It leaves a lot of 'quasi- bolts' in limbo. One example that is common is the bolt that holds the differential ring gear in the rear axle assembly. Known as a ring screw here, the same part is called a bolt in other applications.



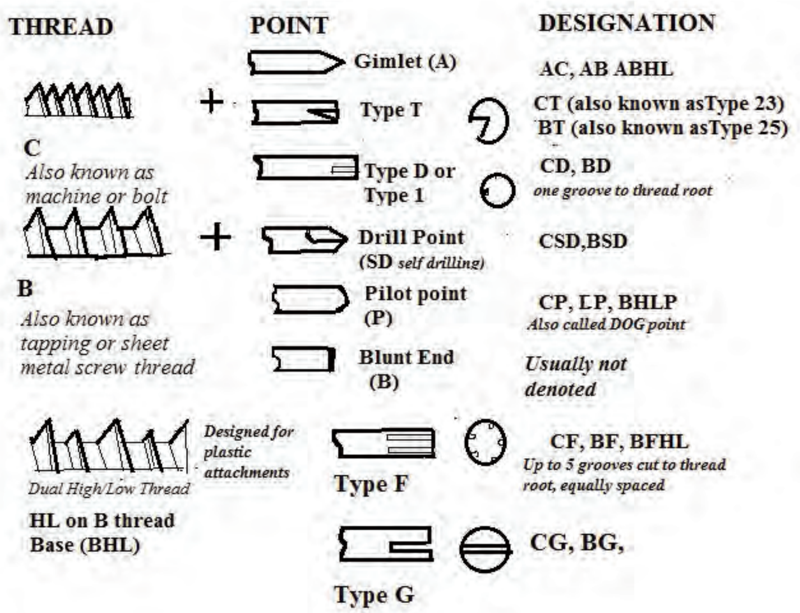
A third group of Muses maintains that a machine screw is a small diameter, lower hardness, adjacent thread fastener (C Thread), threaded to the head (or not!!?).

A quick trip to my local hardware store showed me a drawer of machine screws labeled tapping bolts and a drawer called machine screws which came with nuts. They both came in the same sizes except some showed grooves cut into the ends to assist insertion via tapping/cutting the substrate.

The best type to drop out this discussion is the spaced thread tapping screw, or sheet metal screw as it is sometimes known. Now we have the balance of parts to sort out. Many fasteners have unique ends which assist in their functioning. *(Fastener World Jan/Feb 2004 has an article on the different ends of bolts and screws)*

The A point works well into pilot holes and with B threads, acts as a starter point (it is the typical 'sheet metal tapping screw). Most of the variations on B threads are variations of what we are calling tapping screws and are here just for information's sake. The A point of a C thread assists in finding the internal thread hole during rapid speed assembly. The Type T points cuts a thread while being installed and the groove acts as a depository for the removed chips. Fine thread (C) and spaced thread (B) types are utilized in sheet metal as well as plastics and other softer materials. Types D, F, and G are variations of sheet metal cutting features for fine thread self-tapping screws, mostly derived, at the time, to circumvent patented features by other companies. They were intended to act as areas for chip collection when installed in plastics, etc. They do not perform this function very well, filling quickly with dross and contributing to hard driving. The grooves fill with the cut out material and hamper the tapping action they were supposed to initiate. In addition, what little tapping action they do generate only works with the smaller sizes, large diameters parts with these cutting features are about useless in thin metal and don't work at all in thick stock. While the patents have expired, the varieties are still available. Dog points and the several modifications currently being touted (mostly to length and roundness of the point), assist in correct starting of the screw into the threaded member to avoid cross threading in high speed assembly (See Cross Threading, Fastener World 142, Sept/Oct 2013). The self-drilling point is used to install a tapping screw where the location of the pilot hole is uncertain and/or is not always required. Each of these screw ends has their own proponents and we will skip that argument for now.

As stated above, many "C" threaded fasteners are modified with the addition of a feature to the end to allow the part to cut its own thread into some substrate, be it plastic, soft metal or what have you. With this feature (only a few are shown above), the part is a 'tapping screw' by definition. It supposedly cuts its own thread. Without this feature it should be assumed that the part would be called a bolt and assembled with a nut-like attachment. Unfortunately this is not the case. Small diameter parts without the feature are still called machine screws! Since they are incapable of cutting a thread without the cutting feature, they obviously must be nutted to function. Maybe the fact that they can be threaded into a pre-tapped hole somewhere makes the name justified? Which leads us to the next try at a definition.



Finally, the last definition which I think maybe the closest being the most correct is: Screws are turned by the head or head drive feature to install while bolts are held by the head while a nut (or internal threaded device) is turned on the other end. Let's see how this term divides the fasteners.

One group of fasteners commonly encountered is the self-thread rolling Type C thread forms manufactured by Taptite®, Reminc®, and approximately a dozen other patents. They roll their own threads into unthreaded holes. The thread form is some variation to an eccentrically formed or varied circumferential thread which causes the part, during installation, to roll the excess thread material into a thread to match the bolt rather than cut it out like the standard tapping thread parts do. The seat belt bolt is the prime example of this type. Called a bolt, is it a screw? By this definition it is a screw. Why is it called a 'bolt'? Best answer I ever got was the term "screw" didn't convey the idea of strength, toughness, etc. while the term 'bolt' sounded more Macho. Since the part is installed by turning the head of the part into the receiving hole, it is a screw!

Other parts considered-Socket head cap screws, usually with a hexagon drive recess, are installed by turning the head with a hexagon key- this meets the definition!

Hex head cap screws are listed in various Standards as bolts with typical dimensional characteristics but they vary somewhat from the products listed as in the Standards as 'Hex Bolts'. Hex bolts generally show a wider range for some dimensional characteristics and are somewhat coarser in construction. Hex bolts are used primarily for heavy construction product like bridges, building structures, highway steel works, and so on. They are cheaper and do not need to meet careful dimensional fits to attain their maximum strength. On the other hand, hex head cap screws are used about everywhere else; automotive, appliance, military, aircraft, marine, and so on. In most applications they are installed into nuts but may be torqued by turning the bolt head (does this make them a 'screw'?).

HOWEVER, for the purposes of this article I shall define the small diameter, adjacent thread (C) fastener, torqued into a tapped hole or nut device as a "machine screw" (our apologies to the Fastener Purists, but as the author its my prerogative).The characteristics of this part are: full threaded up to the head (for parts up to and including two inches [50.8mm]), small diameter (usually under 1/4 inch [6mm]), and made of a softer material (unheat-treated steel, copper, stainless steel, aluminum, etc.) than standard bolt/ screw. A machine screw appears to be very much like a small, soft bolt, driven by turning the head. Machine screws with a tapping feature, as mentioned above, are tapping screws and are not considered as 'true' machine screws by this definition. It may be noted that even with this narrow a classification I have found exceptions.

Exception one, we are faced with a contradiction to start with. Machine screws, in sales literature and standards, are listed as being sized from a number 0 to 3/8 inch in both fine and coarse threads and the equivalent diameters in metric sizes in many technical manuals and standards.

(A #0 screw has a major diameter of 0.060" [1.52mm] and the diameter increases by 0.013" [0.33mm] for each larger size. For example, a #10 screw is 0.060 + {10x0.013} which equals 0.190" [4.83mm]. –Ed)

The reason for this is not known? It seems logical to me that rather than use a 3/8 inch machine screw, with its added weight and space requirements, the use of a hardened, higher strength, smaller size bolt would be much more economical and better engineering.

Exception two. Machine screws are made to steel SAE Grade 1or 2 strength properties. Metric parts are to conform to Class 4.4 requirements. Again, the exceptions; machine screws are also available in brass, silicon bronze, stainless and aluminum. Aluminum screws are light, resist oxidation, are easy to manufacture and show good thermal and electrical conductivity. Brass parts are stronger than aluminum, are very conductive for electrical applications, resist corrosion fairly well and have low magnetic permeability. Copper screws are slightly weaker than brass parts but are wear resistant and highly conductive. Molybdenum screws are very strong, have a high melting point and are very expensive to manufacture. Stainless steel screws show a highly desirable cosmetic finish, and resists corrosion, especially around seawater. The 400 series can be hardened but will corrode slightly while the 300 series (Cr-Ni alloy) are corrosion resistant but are not hardenable. Titanium screws are very strong, hard, light weight and corrosion resistant. They are expensive but desirable for some applications (aircraft, motorcycles, eyeglasses, etc.).

These small machine screws are used in every small device, appliance, and gadget. You could probably reach your hand out now and touch several items that are held together with a small machine screw. Cell phone battery cover, access panel for electronics, the desk top fan, your eyeglasses, and so on. Machine screws are ideal where the screws must be removed and re-installed. Tapping screws wear out the holes and are generally good for only a few off-on cycles. Machine screws are made of low strength material so installation torques need to be carefully controlled to prevent strippage, an easy to happen occurrence when working with small diameters.

Since many applications do not require any appreciable strength, are made as cheaply as possible and are generally considered to be 'throw away', minimum use parts, little consideration is given to any assembly considerations beyond not breaking. Few small screw torques are ever tabled and tools settings are mainly 'guess work' trial and error derivations.

The following table lists some of the materials and recommended torques for their assembly. The values are approximate averages based upon metal strength.

Screw Size	Steel (55kpsi)	Brass (60kpsi)	Si Bronze (70kpsi)	Stainless	Aluminum (55kpsi)
#0	16 in.oz (0.113Nm)	11 in.oz (0.077Nm)	13 in.oz (0.092Nm)	14 in.oz (0.0989Nm)	8 in.oz (0.056Nm)
1	28 (0.198)	19 (0.134)	23 (0.162)	24 (0.169)	15 (0.106)
2	2.6 in.lbs (0.294Nm)	2.0 in.lbs (0.226Nm)	2.3 in.lbs (0.26Nm)	2.5 in.lbs (0.28Nm)	1.4 in.lbs (0.158Nm)
3	4.0 (0.45)	3.2 (0.36)	3.6 (0.41)	4 (0.45)	2.1 (0.24)
4	5.5 (0.62)	4.3 (0.48)	4.8 (0.54)	5.2 (0.59)	2.9 (0.33)
5	8 (0.90)	6.8 (0.77)	7.1 (0.80)	8 (0.90)	4.2 (0.47)
6	10 (1.13)	8 (0.90)	9 (1.02)	9.6 (1.08)	5.3 (0.60)
8	21 (2.37)	16 (1.81)	18 (2.03)	20 (2.26)	11 (1.24)
10	24 (2.71)	19 (2.15)	21 (2.37)	23 (2.60)	14 (1.58)
1/4	79 (8.92)	62 (7.00)	69 (7.79)	75 (8.47)	45 (5.08)

These values are for dry threads (unlubricated), tightened against similar materials on normal machined surfaces. For inch parts the average value given here may be increased slightly for coarse threads, and decreased slightly for fine threads. For metric parts the average value shown is approximately correct.

Exception three. The machine screws with thread cutting features (classified as tapping screws) must be made of hardened steel or case hardened to be able to cut the threads into the substrate. Definition: screws are of softer material. Regular machine screws are also found made of hardenable higher carbon steel, hardened stainless (Grade 400 series) and even some exotics such as titanium, molybdenum, and high nickel content alloys. On the plus side is the fact that some of these types of screws are installed by turning the head and driving into the substrate, meeting one of the defining points of the definition of a 'screw'. However, since they do not go into an internal, preformed thread they are not machine screws by my definition (unless they go into a nut!).

Head styles usually found (again a peek into the local hardware store bins) are slotted round head, slotted pan head, flat countersunk heads, hexagon washer heads and one or two special shapes truss head, with washers, pan heads, etc. Cross recesses and the six lobe recess and its several varieties are also popular. In fact, just about every drive mechanism is available on a screw.

Likewise, just about every finish is also available. The main drawback to some of the finishes is the fact that some coatings are so thick that they will interfere with the installation. This is true with the higher corrosion resistance coatings demanded for today's long term anti-rust requirements. Many of these are thick organics or metallic flake based paint coatings which quickly exceed the allowable limits of interference fits on the small diameter threads.

Finally, what is a machine screw? This article has attempted to define some conditions of a fastener that might allow it to be classified as a screw. A machine screw, a bolt, a tapping screw, a machine tapping screw; you can pick your definition but there will be some fastener guy who will disagree with you. Unless it involves some governmental agency who wants more money for a M8 screw than a M8 bolt, does it really matter? While I have attempted to define the term, even my efforts have met with confusion. I personally would like to call all the parts "externally threaded fasteners' but, alas I don't think that the term will catch on. An added note; I just saw an ad for coarse threaded lag screws called lag bolts.