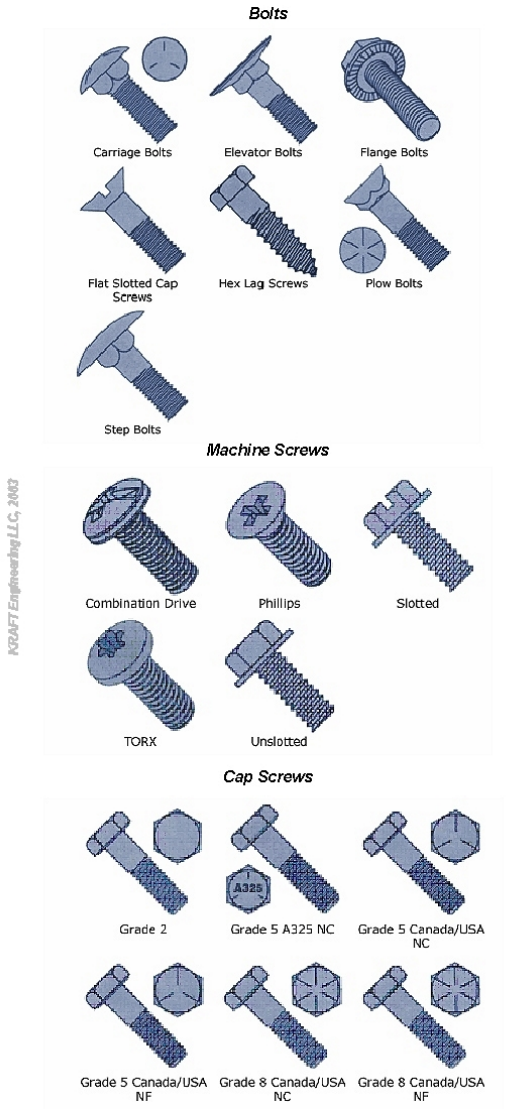
This is the first in a series of articles regarding fasteners. Over the coming months we will discuss bolts, screws, nuts, washers, specialty fasteners and their applications.

This month our discussion turns to bolts and screws. The purpose of this article is to provide a cursory overview of the common nomenclature, grades and classes, identification of both SAE Inch and ISO / DIN Metric bolts and screws and a short overview of screw threads.

Common nomenclature



Typical Screw and Bolt Configurations

Generally speaking, we tend to use incorrect terminology when discussing fasteners. This can cause problems when we head down to Joe's Fastener Supply to purchase a particular fastener for some project that we are working on. Generally speaking, most supply houses serve the technical community and are versed in the "geek speak" of the industry. Often times we go to the counter of the fastener store with a certain idea of what we want in our mind. However, the counterperson makes several trips back and forth to the stock room to get that particular item that we are trying to describe. We'll try to make the trips back and forth to a minimum and allow you to get in and out of the store quicker, or where

there are no counterpersons to help, the ability to search quickly for what you need. That in mind, here are a couple of definitions:

Screw: A fastener designed to clamp two components together by the fastener mating to a threaded hole or other preformed hole. The first component having a clearance hole through it for passage of the screw and the second component having a threaded hole in it to accept the screw and being tightened or released by torque applied to the head of the screw. A commonly misidentified item is a “Cylinder Head Bolt”. Oddly enough in that example, the term “Head Bolt” is so commonly used that it has now become the vernacular, but the technical fact is that it is a Hex Head Cap Screw.

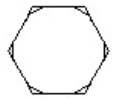
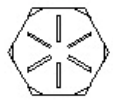
Bolt: A fastener designed to clamp two components together by the fastener passing through the components and mating with a corresponding nut to hold the assembly together. The entire set of components has a clearance hole through them to allow passage of the bolt. The bolt is then secured with a nut and torqued in place to retain the assembly. Either the bolt or the nut can be retained statically during assembly to apply clamping pressure to the assembly.

A diagram is provided to help determine typical bolt and screw configurations.

Grades and classes / identification

Grades and Classes of fasteners are one of the most misquoted and misunderstood areas of this type of hardware. We are including the term “Class” in this discussion because it pertains to ISO / DIN Metric hardware. “Class” is the equivalent term of “Grade” in the Metric world. For example, an SAE Grade 8 bolt has a minimum tensile strength of 150,000 psi (the point at which the material must withstand breaking) and a 130,000 psi minimum yield strength (the point at which the material must withstand permanent deformation.) Those combinations of factors along with material alloy composition and heat treatment compose the structural make up of a fastener. Consequently, an ISO / DIN Class 10.9 is roughly the equivalent of an SAE Grade 8. Below is a printable chart defining the identification techniques, basic physical makeup and tensile strengths of the different SAE Grades and ISO / DIN Classes:

Grade Markings and Properties

Identification Markings (Fasteners may also have manufacturer I.D. markings)	Specification	Material	Nominal Size Range (inches)	Mechanical Properties		
				Proof Load (psi)	Minimum Yield Strength (psi)	Minimum Tensile Strength (psi)
SAE Inch						
 No Markings	Grade 2	Low or Medium Carbon Steel	1/4 thru 3/4	55,000	57,000	74,000
			Over 3/4 thru 1-1/2	33,000	36,000	60,000
 3 Radial Lines	Grade 5	Medium Carbon Steel, Quenched and Tempered	1/4 thru 1	85,000	92,000	120,000
			Over 1 thru 1-1/2	74,000	81,000	105,000
 6 Radial Lines	Grade 8	Medium Carbon Alloy Steel, Quenched and Tempered	1/4 thru 1-1/2	120,000	130,000	150,000
Stainless markings vary. most stainless steel is non-magnetic	18.8 Stainless and A-2 Metric	Steel alloy with 17-19% Chromium and 8-13% Nickel	1/4 thru 5/8		80,000 – 90,000	100,000 – 125,000
			3/4 thru 1		45,000 – 70,000	100,000
			Above 1			80,000 – 90,000
ISO / DIN Metric						
 8.8	Class 8.8	Medium Carbon Steel, Quenched and Tempered	All Sizes thru 1-1/2	85,000	92,000	120,000
 10.9	Class 10.9	Alloy Steel, Quenched and Tempered	All Sizes thru 1-1/2	120,000	130,000	150,000

Tensile Strength: The maximum load in tension (pulling apart or shearing which a material can withstand before breaking or fracturing.

Yield Strength: The maximum load at which a material exhibits a specific permanent deformation

Proof Load: An axial tensile load which the product must withstand without evidence of any permanent set.

U.S. Thread Chart

Diameter of Bolt	Coarse Thread "UNC" Threads Per Inch	Fine Thread "UNF" Threads Per Inch	Diameter of Bolt	Coarse Thread "UNC" Threads Per Inch	Fine Thread "UNF" Threads Per Inch
No. 2	56	-	7/8	9	14
No. 3	48	-	1	8	14
No. 4	40	-	1-1/8	7	12
No. 5	40	-	1-1/4	7	12
No. 6	32	-	1-1/2	6	12
No. 8	32	-	-	-	-
No. 10	24	32	-	-	-
No. 12	24	-	-	-	-
1/4	20	28	-	-	-
5/16	18	24	-	-	-
3/8	16	24	-	-	-
7/16	14	20	-	-	-
1/2	13	20	-	-	-
9/16	12	18	-	-	-
5/8	11	18	-	-	-
3/4	10	16	-	-	-

This chart lists the coarse thread and fine thread for each diameter bolt and machine screws.

Metric Thread Pitch

Bolt Diameter	Standard Thread Pitch (mm)	Fine Thread Pitch (mm)	Extra Fine Thread Pitch (mm)
4mm	0.70	-	-
5mm	0.80	-	-
6mm	1.00	-	-
7mm	1.00	-	-
8mm	1.25	1.00	-
10mm	1.50	1.25	1.00
12mm	1.75	1.50	1.25
14mm	2.00	1.50	-
16mm	2.00	-	-
18mm	2.50	-	-
20mm	2.50	-	-
24mm	3.00	-	-

Size Identification: Metric bolts are written down as an 'M' followed by 3 numbers. For example M10x1.25x35 The first number is the diameter, the second the thread pitch, and the third the length all in millimeters. The example is therefore a 10mm diameter fine thread bolt 35mm long.

Thread pitch: The distance from one thread to the next, measured down the length of the fastener.

Understanding the nomenclature of a thread is important in determining which type of fastener you are going to purchase. Determining factors are Major Diameter (either expressed in a number or fractional size) and threads per inch / MM. For brevity, we'll discuss only common helical "V" threads since it the most common thread form. Simply, a "V" thread is a form in the shape of a "V" that forms an angle of 60 degrees to the complimenting surface of the thread form. For a good visual aid in understanding this concept, go to your store of fasteners in your garage, pick out the largest bolt / screw you have and examine the profile of the thread. You will see that it does indeed have the basic shape of a "V", likely with a flat surface at the top (crest) and the bottom (root) of the thread form. You will also notice that it spirals (helix). These are the factors that make an external fastener thread, when mated to an internal thread, an effective means of fastening two objects together.

First, some definitions:

- Major Diameter: The diameter of the major size of the cylinder. i.e. a ¼" thread is nominally .250.
- Pitch Diameter: The functional diameter of all of the thread form dynamics, including perfect pitch, lead and flank angles, and having a specified length of engagement.
- Thread per Inch / MM: The cumulative number of threads per unit of measure, i.e. a .375 X 24 thread has 24 threads per inch of screw thread.

As a guide, see the chart depicting common SAE Inch and ISO / DIN Metric Sizes.

Gauging Thread Size

In the manufacturing world, threads are precisely measured using a combination of expensive and sometimes not commonly available measuring tools. For the common home garage, I would suggest the purchase of a varying degree of nuts, screws and bolts, of as many different sizes as you think you may need. Next, buy a simple plastic container, such as a fishing lure case and marking the applicable compartment with the thread size of the fastener. Using these bolts and screws for only this purpose is an inexpensive way for the "Garage Shop Guy" to have a readily available set of standards on hand. Following are some helpful charts for determining common sizes and the clearances required for tapping and drilling:

NUMBER SIZE CAP SCREWS

TAP DRILL AND CLEARANCE DRILL SIZES

Screw Size		Threads Per Inch		Drill Sizes	
No.	O.D.	N.C.	N.F.	TAP	CLEAR
0	.060		80	3/64	#51
1	.073	64		#53	#47
1	.073		72	#53	#47
2	.086	56		#50	#42
2	.086		64	#50	#42
3	.099	48		#47	#37
3	.099		56	#46	#37
4	.112	40		#43	#31
4	.112		48	3/32	#31
5	.125	40		#38	#29
5	.125		44	#37	#29
6	.138	32		#36	#27
6	.138		40	#33	#27
8	.164	32		#29	#18
8	.164		36	#29	#18
10	.190	24		#26	#9
10	.190		32	#21	#9
12	.216	24		#16	#2
12	.216		28	#15	#2

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FRACTIONAL SIZE CAP SCREWS

TAP DRILL AND CLEARANCE DRILL SIZES

Screw Size		Threads Per Inch		Drill Sizes	
No.	O.D.	N.C.	N.F.	TAP	CLEAR
1/4	.250	20		#7	17/64
1/4	.250		28	#3	17/64
5/16	.312	18		F	21/64
5/16	.312		24	I	21/64
3/8	.375	16		5/16	25/64
3/8	.375		24	Q	25/64
7/16	.437	14		U	29/64
7/16	.437		20	25/64	29/64
1/2	.500	13		27/64	33/64
1/2	.500		20	29/64	33/64
9/16	.562	12		31/64	37/64
9/16	.562		18	33/64	37/64
5/8	.625	11		17/32	41/64
5/8	.625		18	37/64	41/64
3/4	.750	10		21/32	49/64
3/4	.750		16	11/16	49/64
7/8	.875	9		49/64	57/64
7/8	.875		14	13/16	57/64
1	1.000	8		7/8	1 1/4
1	1.000		14	15/16	1 1/4

: Tap Drill Sizes shown give approximately 75% depth of threa

When we get to the forthcoming article regarding applications, we will delve more into why these different types, shapes, configurations and grades of fasteners are important and where they should and should not be used on our automotive based projects. Keep your bookmarks tuned to this section!