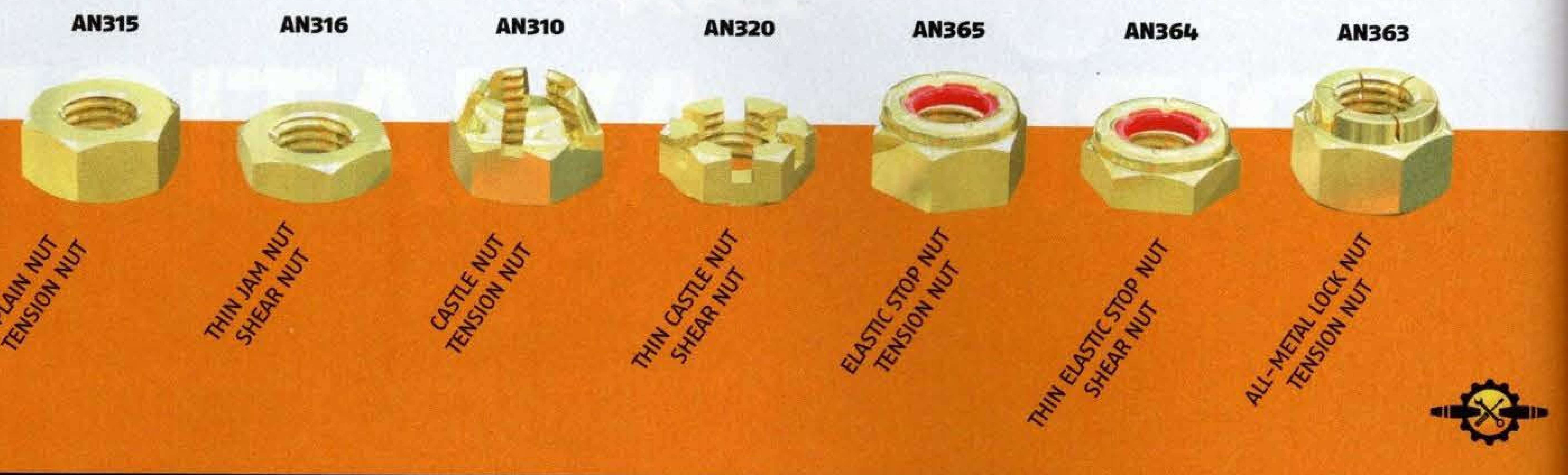

NUT BASICS

Most commonly used types in experimental aircraft

BY CAROL AND BRIAN CARPENTER

IN THE OCTOBER 2018 issue of *EAA Sport Aviation*, we had an article called "Bolt Basics." Although the article did not provide any groundbreaking revelations on bolts, it did spur a significant amount of praise for helping to simplify and clarify many of the confusing points about bolts and break down the conversation to the essentials for the experimental aircraft builder. With that premise in mind, let's examine the same for aircraft nuts. Like bolts, there are only a handful of types that make up the vast majority of nuts used on experimental aircraft (Figure 1). Although each of these nuts has a cross-reference to a military standard (MS) and national aerospace standard (NAS), we will be dealing with just the part numbers for the original Army-Navy standard (AN) for simplicity.

The AN315 plain nut (Figure 2) has no locking feature and, as a result, is almost always used in conjunction with some additional locking device. The most common locking device would be either a lock washer or a Loctite-type thread-locking product. Because the plain nut/lock washer combination is one of the least reliable locking systems, there is a list of areas where we would not use the combination, including flight critical primary or secondary structures, where failure would permit the opening of a joint to the airflow, where the nut is subject to frequent removal, or where the nut is subject to corrosive conditions. Additionally, when the nut is used with a lock washer against soft material, the use of a washer as a buffer is common practice. One of the more prolific uses of the AN315 or AN316 is on electrical wiring. Attaching a ring terminal to a switch, circuit breaker, or bus bar allows for the easy installation of the plain nut/lock washer in normally difficult to reach areas, with a reasonably secure system, considering the loads imposed on wiring.

Figure 1 (above):
Most common nuts for experimental aircraft.

Figure 2 (below):
AN315 plain nut.

Figure 3:
AN316 jam nut used as a lock nut, securing a rod end to a pushrod.

The AN316 jam nut or check nut is the thinner version of the AN315. You may also find it used in many of the same applications as its big brother, the AN315 plain nut, where the tension loads are minimal. In these cases, the same cautions and rules for its use apply. Although the AN316 is also a plain nut without a built-in locking device, it is, itself, often used as a locking device. The most common application here is as a lock nut to secure a rod end to a pushrod (Figure 3).

There are only a handful of nuts that make up the vast majority of nuts used on experimental aircraft.

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The AN310 castle nut (Figure 4) is used in conjunction with a cotter pin to provide a greater level of security in preventing the nut from backing off. The two primary applications for this combination are for nuts and bolts that are subject to rotation, and for applications where removal and re-installation of the nut are frequent. An example of this might include components of removable or folding wings. The AN320 castle nut is the thin version of the AN310 castle nut. This is a castle nut used when the bolt is loaded in shear and most commonly coupled with an NAS shear bolt that has a smaller cross section of threads suited specifically for shear-only applications.

Figure 4:
AN320 castle nut.

The elastic stop nut, nyloc nut, or fiber lock nut are all terms to describe the most prolific of all the nuts, the AN365. Most people are not aware that the term elastic stop nut is a trade name. You may have heard the term "esna nut," well, ESNA stands for Elastic Stop Nut Corporation of America. In 1934, Swedish immigrant and inventor Carl Swanstrom perfected a threaded fastener able to positively resist the loosening effect of vibration. He called the fastener an elastic stop nut because the nut remained stopped anywhere along the bolt threads. Although nylon didn't make its commercial debut until 1938, by the early '40s it had become the standard material for the self-locking nut insert. Today there are many manufacturers of nylon self-locking nuts, and the use of color to brand a product is common. If you see a red nylon locking insert, it is most likely from ESNA. Greer Stop Nut uses a green nylon insert (Figure 5).

For a fastener system to function properly, it is important that the bolt-nut combination retain its required torque. A fastener that is properly designed to carry its required load when properly torqued may fail from fatigue if it becomes loose and begins to rattle. The reliability of a load-carrying fastener depends not only on the strength of the nut and bolt but also on the ability of the system to remain in place and tight. The nylon insert's internal diameter is smaller than the bolt thread and the external diameter. The nylon forms a tight grip on the threads,

Figure 5:
AN365 elastic stop nuts.

preventing the nut from rotating even under severe shock and vibration. This friction that exists between the nylon and the bolt threads while the nut is being installed, but before it begins to seat, is referred to as prevailing torque. AC 43.13-1B, Table 7-2 lists the minimum prevailing torque for reuse of elastic stop nuts larger than 3/8 inch. The current wisdom for the smaller size nuts states that if a nut can be turned by your fingers, or if a nut moves easily with a wrench, it should be rejected. According to the ESNA manual, "Elastic stop nuts may be reused through more than 50 on-off application cycles."

However, this premise is only valid with new or relatively new nuts where the elastic properties of the nylon remain. The two major factors that reduce the ability of the elastic stop nut to perform are age and heat. Like a rubber band, it loses its elasticity over time. When replacing nuts that have been in service several years or have an unknown service life, it is standard practice to replace with new. The other variable is heat. The nylon insert is rated for 250 degrees Fahrenheit. When working in what we call firewall-forward applications, we normally opt for the AN363 all-metal lock nut (Figure 6) over the elastic stop nut for obvious reasons.

The AN363, like its counterpart the AN365 elastic stop nut, is also a self-locking nut and can also be reinstalled multiple times following the same minimum prevailing torque requirements for self-locking nuts. However, unlike the elastic stop nut, the all-metal lock nuts, because of their construction, tend to remove the CAD plating from the threads as they are removed and re-installed. Signs that the CAD plating has been compromised may warrant replacement of the bolt as well as the nut.

At first glance, it may appear that the all-metal lock nut is a superior nut when considering its self-locking feature. Although the all-metal locking nut has its area where it outperforms other nuts, primarily in high-temperature environments, the elastic stop nut's most important feature is often overlooked. It turns out that, through

Figure 6:
AN363 all-metal lock nut.

RELATIVE VIBRATION PERFORMANCE

ELASTIC STOP NUT		100
ALL-METAL LOCK NUT BEAM TYPE		53
ALL-METAL LOCK NUT DISTORTED TYPE		19
CASTLE NUT WITH COTTER PIN		8
CASTLE NUT WITH SPRING PIN		38
CASTLE NUT WITH LOCK WIRE		18
PLAIN NUT WITH SPRING LOCK WASHER		5
PLAIN NUT WITH TOOTHED LOCK WASHER		1
PLAIN NUT		1

Figure 7:
Relative vibration performance chart.

ILLUSTRATIONS COURTESY OF **CAROL AND BRIAN CARPENTER** extensive testing, the big advantage of the nylon insert is that it has been shown to act as a resonant vibration damper, reducing the vibrations present within the bolt that promote the loss of tension. There is a normal tendency of a fastener system to lose tension long before the nut begins to rotate. This is particularly prevalent in high vibration environments. This initial loss of tension can be the precursor to the nut losing enough tension to then allow the nut to rotate, thus reducing the tension even further and leading to subsequent failure.

Today there are many manufacturers of nylon self-locking nuts, and the use of color to brand a product is common.

The ESNA catalog shows a relative performance rating for different types of nuts and their ability to retain tension in these high vibration environments (Figure 7). In Figure 7, we see a re-creation and sampling of some of the test results. Not all applications require this high degree of attention to proper tension, but on those applications that do, it is critical that proper torque is applied during installation. These applications invariably involve the use of a tension-type nut. The distinction between the tension-type nuts and the shear-type nuts is readily observable by the nut height and number of threads. The thinner shear-type nuts are used in applications where they are not subject to significant tension loads. Using a shear nut in a tension application is a recipe for disaster. Likewise, torqueing a shear nut to the torque values used for a tension nut would certainly cause a failure of the nut. The reduced thickness and thread count necessitates a lower torque value when tightening. AC 43.13-1B, Table 7-1 is a good resource for standard torque values.

Remember that your manufacturer's manual is the bible. The standard torque value chart is used only when the manufacturer's data is not available. Although there are literally hundreds of different types of nuts, these that we have discussed in this column make up the vast majority used in experimental aircraft. It's a good idea to have some on hand for your next maintenance task. Not surprisingly, Aircraft Spruce and Specialty has a couple of kits that contain nuts with just the right assortment of sizes and types for the average aircraft owner builder. Who knew that a simple subject like aircraft nuts could be so interesting?

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