FASTENERS

Fasteners literally hold our boats and their engines together, so let's explore the subject and debunk some of the falsehoods along the way. First, let's explore the theory behind some of our typical fasteners. Screws, bolts, rivets and in some cases, nails are what are generally referred to as fasteners. We will cover screws and bolts since they are the most common fasteners.

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Fig. 1 – The wood screw on the left shows a defined shoulder while the sheet metal screw has threads over its entire length, and on the right, the drywall screw shows a coarse pitch thread.

Let's begin with wood screws. The most popular wood screws for our boats come in three materials; brass, bronze, and stainless steel, with polished or chrome plated variants often used for trim pieces. The bulk of the structural screws used to hold the frames and sides in place are bronze because of its superior resistance to galvanic corrosion since they are in contact with water. Generally, wood screws come in a range of diameters from a #2 at 3/32" dia. to a #14 at ¼" dia. and lengths ranging from ¼ inch to over 3 inches. The heads of the wood screws come in many different basic drive configurations. See Fig. 2.

Fig. 2 – Various screw head configurations shown L to R the slotted screw, Reed & Prince, Phillips, square, modified square, and finally the Torx or star. While still used, the slotted head screw has been relegated to period correct restoration work. The other configurations have evolved due to their ability to speed production while reducing unintended disengagement. The square and Torx varieties have become popular as mechanical drivers have provided not only secure engagement but also increasingly more torque capability.

Stainless Steel Fasteners

Depending on the application and the alloy, most stainless-steel screws are generally not recommended for use in wooden boats because they do not offer the corrosion resistance, resulting in brittle fasteners. If you are inclined to utilize Stainless fasteners, make sure they are made from a premium alloy such as 316 and are not in direct contact with the water.

Drywall screws

Drywall screws made from steel are plentiful, cheap, and extremely easy to use, but should NEVER be used other than for temporary fastening and fixturing during the build or repair process. Think of them as sheet metal screws for wood.

Sheet metal screws

To the untrained eye, sheet metal screws appear to be very similar to wood screws, however sheet metal screws have slightly broader thread spacing since they are designed to join two pieces of sheet metal. Because of their similar appearance they are often mistakenly used for joining wood. The easily distinguished feature for a sheet metal screw are the threads on a sheet metal screw which run the entire length of the fastener as opposed to the wood screw which has a plain shoulder on the top 1/3 of the fastener.

Factoid

A screw develops its holding power by clamping two adjacent bodies together, thus creating a bond which resists lateral or longitudinal movement. When joining two pieces of sheet metal together, it is customary to drill a larger pilot hole in the unthreaded part allowing for ease in assembly. If the joint will be used to contain a liquid such as on an engine valve cover, a gasket or seal is used in the joint. Because sheet metal is thin, the sheet metal screws incorporate thread over the entire length of the fastener.

Wood screws as used in our boats are typically in or near liquid, and for the fastener to function properly a precise diameter hole is drilled in the top portion while a smaller hole is drilled in the bottom portion of the two pieces allowing for thread to be formed when the screw is installed. When the screw is installed, it draws the two pieces together while the smooth slightly tapered shoulder of the screw wedges into the top board creating a watertight seal. See Fig. 3.

Knowing this, it becomes apparent how important it is to use the proper size pilot holes for properly installing wood screws since you will not only be ensuring the integrity of the clamping load but also the watertight sealing attributes of the fastener. If you join two pieces of wood together using a sheet metal screw with a common size pilot hole in both pieces of wood, the screw will tighten up, but it will not draw the pieces together and provide any additional clamping load since the two pieces are held in their original vertical positions by the common thread.

Fig. 3 – Special drills used for installing wood screws. The unique profiled shape creates a proper tapered hole with a countersink for the screw head thus ensuring good thread formation and maximum clamping load capability. Correctly adjusted, they take the guesswork out of drilling screw holes.

Fig.4 – Perhaps the handiest gadget I have used in a long time, this driver from Milwaukee Tools which accepts a variety of hex replaceable bits. It incorporates a sliding sleeve which slides over the head of the screw to guide and support and align the screw while it is being installed or removed. ***It prevents the driver from slipping out and ruining your varnish job!***

Bolts, studs, & nuts

The fastener shown in Fig. 5 on the right is typically referred to as a bolt, but by definition it is a screw when

PHILLIPS VS REED & PRINCE

In 1873, a British engineer John Frearson invented what today has come to be known as the Reed & Prince screw, manufactured in Worchester, MA by the company of the same name. Reed & Prince was founded by Edgar Reed in 1886 in a small shop on Tainter Street in Worcester, Massachusetts as a manufacturer of tacks, nails and brads. Frearson's invention solved the problem of traditional screw drivers slipping out of slotted screws and damaging the surrounding area.

In 1908 P.L. Robertson invented the square drive screw which saw it first use on the Ford Model T. See Fig 2. He was followed by Henry Phillips who invented the Phillips head screw in 1936. Phillips Manufacturing came up with a cross type of screw drive system similar to the Reed & Prince but with subtly different configuration designed to ease engagement and thus speed up production. The Phillips version was quickly adapted by General Motors for use on the 1937 Cadillac and remains in wide use today. However, in use it is much easier for the driver to jump or "cam out" of the Phillips screw than out of the Reed & Prince, leaving users to decide which is more appealing, the slower positivity of the Reed & Prince or the speed of the Phillips. The wide market has in large part adopted the Phillips style, hence the Reed & Prince screws, while still available, have become a specialty item. Interestingly, the square drive system pioneered by Robertson has made a comeback with the advent of powered drivers which enable greater torque transfer.

With the advent of battery powered screw drivers starting in the '70s, slotted screws were quickly abandoned in favor of the Phillips screws. In response to the increased torque available from the cordless drivers, more positive drive systems were needed. Soon the square head reappeared followed by the Torx™, otherwise known as the star drive.

used alone. It is only considered to be a bolt if it is used in conjunction with a nut. If the fastener is threaded at both ends it is called a stud. Studs function as screws and are used to allow assembly in some designs. A screw, stud, or bolt is used to hold two parts together by developing what is called clamping load. Think of tightening a screw which is used to attach your exhaust manifold to the cylinder head. As you tighten the screw, it advances into the cylinder head and soon applies clamping load to the manifold. The amount of clamping load is typically measured as a function of torque necessary to tighten the screw. Good practice requires sufficient clamping load to prevent the fastener from loosening during its life cycle. The part shape and duty cycle loads determine the clamping load necessary to properly attach the manifold to the head. Once the overall clamping load is established, the diameter, location, and total number of screws can be determined.

DUTY CYCLE VS LIFE CYCLE

A life cycle describes the conditions the fastener sees starting when it is a finished part and ends when it is recycled at the end of its life. Loads encountered during assembly, manufacturing, quality checks and day to day use are all included in the life cycle. Duty cycle are loads and conditions encountered repeatedly but only during normal use. The loads and atmospheric conditions encompass the extremes.

Fig. 6 – Shown here is a 4" fastener, where the length of a fastener is measured from the bottom of the head to the end of the threaded portion. Good practice suggests that an installed fastener should have at least three threads sticking out of the nut when properly installed, since the first three threads are usually smaller to aid starting and are therefore non load bearing.

Thread Pitch

Thread pitch is the number of threads within a given standard length. In the US, the Imperial system, which is based on the inch, is commonly used. For each diameter in the imperial system there are usually two different thread pitches: UNC-Unified National Course and UNF-Unified National Fine. Perhaps the most common imperial fastener has a UNC 3/8-16 thread. 3/8 designates the major or shank diameter of the bolt as 3/8 of an inch, while 16 indicates that there are 16 threads per inch. A similar size metric bolt might have a designation of 10 x 1.5 mm indicating that it had a 10 mm diameter (.394 inch) and a pitch of 1.5 mm per thread, which works out to be 16.93 threads per inch.

Fig. 7 – A thread gage available in either Metric or Imperial is used to determine the thread pitch.

Nuts

Next let's look at the various styles of nuts starting with what is aptly referred to as a plain nut. These come in various thread designations and in most cases have a preferred mounting face. Nuts are used when both nut and bolt can be accessed for tightening and loosening during assembly. Once assembled, preventing a fastener from loosening becomes critical. Over the years several innovative solutions have been devised and implemented to provide this locking or retaining capability. For many years, the simple lock washer was used to prevent loosening. Today, the nylock nut, a generic trade name describing a nut with a stiff nylon or plastic insert imbedded in the top edge which deforms and grips the threads has become the more popular alternative to effectively lessen the chance of loosening.

In areas where heat is a factor, crimped or locking thread nuts have carefully distorted threads which effectively engage with the male threads of the bolt to create an interference fit, thus hopefully preventing any loosening. Like the nylon insert nuts, distorted thread nuts should be considered a one-time application to remain effective. Once used, they should be discarded and replaced with new nuts since they no longer retain their primary locking capability.

Fig. 8 – An assortment of nuts ranging L to R: a plain nut, a nylock nut, crimped or locking thread nut and finally, a standard flange nut designed to spread the load.

Fig. 9 – An assembled castellated nut with a cotter pin.

Castellated nuts

Castellated nuts get their name because they resemble the turret on a medieval castle. They are used in conjunction with a matching bolt with a cross-hole strategically located in the thread area. Once tightened, the nut is advanced until the notch in the nut lines up with the hole in the bolt into which a cotter pin is inserted and folded over, thus retaining it. The cotter pin effectively prevents rotation in either direction, making it a popular retaining solution for nuts which, are not designed to be fully tightened, such as axle hub nuts.

Fig. 10 – Two castellated lock nuts illustrating the difference between aircraft style on the left to automotive on the right. The tangs on the aircraft nut have been subtly machined to remove the excess material to save weight.

Washers

Washers come in all sizes and shapes depending on the intended purpose and space available where they serve to provide a smooth, hard surface to support the head of the bolt and nut while spreading the load. Some variants offer some retention capabilities by preventing the nut from backing off. For years, tiny spring washers and star washers have been religiously used to prevent loosening, but studies show they do not generate enough restraining torque to prevent loosening, hence, they are no longer used, having been replaced by locking nuts, adhesive, and mechanical methods such as safety wire and cotter keys.

Fig. 11 – Washers come in all sizes and configurations determined by the installed environment and space available. They are used to provide a solid base to spread the load and prevent wear during installation and use.

Fig. 12 – The lowly spring washer. Widely used but marginally effective and prone to break.

Fig. 13 – Safety wire used to prevent the prop shaft grub screw from loosening

Safety wire

Safety wire is sometimes used to prevent screws from backing out. To use safety wire, each fastener must have a small diameter cross-hole drilled in the head and once tightened, thin stainless-steel wire is threaded through one or more screws, twisted and fastened to an adjacent point to prevent loosening.

In part 2 of this article, we will discuss the factors which go into the selection, design, and application of fasteners.

Above, we covered the various fasteners found in one of our boats. Now we will explore how the proper fasteners are determined and designed.

Configuration

To better quantify fasteners, let's look at the various general properties that define a typical screw. First and most obvious is the major diameter followed by the length. Next is the thread pitch, either coarse or fine. Separate metric or fractional designations determine functionally similar fasteners. Prior to 1960 Metric fasteners were found primarily in products from non-English speaking countries while Fractional or Imperial thread fasteners were used in the English-speaking countries. The American auto industry started adopting metric fasteners in the 70's. Largely dictated by economics, most of today's automobiles have a mixture of Imperial and Metric fasteners. Material determines the overall strength within a given diameter designation.

Metric vs Imperial

There is a great deal of confusion regarding the attributes of both Metric and Imperial versions. There is no fundamental functional difference between a Metric or Imperial fastener, however some specialty fastener suppliers offer their technology in only Metric or only Imperial. For example, spark plugs use only metric threads in the base. The Metric and Imperial fasteners are sized according to the shoulder diameter or major diameter of the threads. The thread pitch is measured in the imperial fasteners by the number of complete turns the threads make within an inch while the Metric threads are designated by the distance in millimeters the screw would advance in one full revolution.

Design

For parts attached by screws, the load and safety factor drive the initial decisions. Once the load is established, the number and location of the fasteners is determined. Using higher strength fasteners permits fewer fasteners, thus reducing not only parts but also holes to drill and tap as well as less assembly effort and lower inventories. Today, low strength fasteners have been relegated to patio furniture and yard ornaments. Once the specific application has been determined, the basic properties such

SAFETY FACTOR

Every well-designed fastener should have a safety factor. The safety factor is determined by the duty cycle and the tolerance for risk or failure. If human life and limb is involved the safety factor is usually at least double the basic strength and durability requirements. Put another way, the fasteners attaching the transmission to the engine have a far greater safety factor than those for the air vents. If a vent fell off, chances are good that all aboard would survive and arrive alive. However, if the transmission suddenly broke free of its mounts and began to flail around in the bilge, it could be disastrous.

as strength and physical dimensions are determined and then the final choices such as head configuration, finish, and safety considerations can be made. Today most of the fasteners have a hex head, while the remainder have an assortment of head styles designated to address various assembly or clearance issues. When selecting a fastener system during the design process, the first thing to consider are the load requirements, followed by the space available and finally the safety factor. Let's look at the design choices for two common parts; a deck mounted air vent and a bow-eye to see how the fasteners are determined. Obviously, the screws mounting a vent casting need a far lower safety rating than the single stud which attaches the bow eye.

The vent shape typically lends itself to three fasteners located on the bottom which will allow the vent to remain properly attached while hiding the fasteners. Since it has three points, it can be mounted on an irregular or non-flat surface without rocking. The vent sees virtually no loads, hence, the fasteners merely keep the vent attached to the deck. Unlike a handrail, there is no human interaction with a vent, so the safety factor can be something slightly over 1.0.

Designers must consider three primary factors in their initial design selection. For example, the bow eye sees a variety of loads. The duty cycle describes how the part functions under normal conditions and defines the amount of load as well as the applied direction. Durability determines the reasonable life expectancy, and the worst-case scenario determines the highest load and number of cycles a fastener might reasonably see during extended use.

The vent might see its highest wind load while on a trailer at 70 mph, or perhaps a brief spike load from a mooring line caught on the vent during docking. The bow eye will see some tremendous shock loads when being towed by another boat or when anchored during a storm. Since antique boaters tend to store their boats rather than anchor them during a storm, bow eyes on our boats typically see their greatest sustained load when the boat is being pulled onto the trailer using a winch. If the fastener holding the eye were to fail, it could cause the winch strap to recoil and potentially injure the winch operator.

The designers and engineers must make some choices along the way. In the beginning, designers determine how the finished product should look and function to be aesthetically appealing. The final design factors involve manufacturing and assembly or installation. Once those details are determined, the engineers are left to determine how to accomplish the design goals while still providing a safe and durable part within the budget constraints.

The obvious solution to avoid failure would be to select more and larger fasteners than needed, thus ensuring zero chance of failure. We see especially high safety factors especially in bridges or skyscrapers. However, in many applications weight becomes a more significant factor than cost. Aircraft design requires perhaps the most demanding choice of fasteners. Weight is second only to safety. As a result, airplanes are filled with thousands of very intricate and expensive high strength fasteners. Because of the many lives involved, not only must the plane be safe while carrying its payload, but it must also get off the ground.

Strength

Most individual fasteners come in various strengths. The tensile strength of a given fastener depends on the material used, thus allowing low strength, economical fasteners to be used in non-critical applications such as access panels, while the screws attaching a lifting hook are much higher strength. The tiny fasteners mounting the nameplate to the dash are made from low strength thus inexpensive material, while the engine's connecting rod bolts are carefully manufactured from high strength material. The available fastener space on a connecting rod is small but the loads are extremely high as is the penalty for failure. The connecting rod fasteners must endure literally millions of cycles during its life cycle.

Fig. 1 – The strength of the alloy used in a standard Imperial fastener is typically indicated by the number of markings shown on the head. A low strength one without marking as shown on the left. The grade 5 with three marks is in the center while the strongest is the grade 8 with 6 marks on the right.

Strength of materials

When choosing fasteners, it helps to understand how the overall load carrying capability of a fastener is calculated. The strength of a given material varies depending on the alloy and its manufacturing process. Steel typically used in fasteners can have strength ranging from 60,000 psi to 150,000 psi.

Fig. 2 – Material strength of Metric bolts is determined by the numerical rating indicated on the head of the fastener. Shown are fasteners with strength designations ranging from 4.8 through 12.9. 4.8 would be suitable for a screen door hinge while a 12.9 might be found on an aircraft landing gear assembly.

TENSILE STRENGTH

is a term used to define the ultimate strength of a given material. Imagine for the moment a 12" piece of round steel bar measuring 1.125" diameter which has a cross sectional area of 1 sq. inch. If you were to pull on both ends of the bar, it would stretch minutely until just before it reached what is called its elastic limit. If the stretch continued and surpassed the yield point it would remain in its stretched form when the load was removed. Therefore, the rated strength for the given material is the force per unit area required to achieve the stretch just shy of the elastic limit. If the load does not exceed the elastic limit of the material, permanent deformation or yield does not occur. To obtain the rated tensile strength, simply divide the force generated by the area in inches. Since our square bar has a cross sectional area of 1 square inch and the force required to reach the elastic limit was 85,000 lbs., our material strength would be 85,000 pounds per square inch (psi).

Basic fastener sizing

Let's do the math to learn just how much weight a certain size bolt made from a given alloy could theoretically lift. Assume that we will use a 3/8 diameter grade 5 bolt loaded axially (lengthwise). The cross-sectional area of the bolt is .110 sq. inches. If we use our 85,000 psi material, the bolt could theoretically lift 9388 lbs. Just to be on the safe side, engineers use Proof Load which is 85-90% of tensile strength to cover any inconsistencies. Therefore, it is safe to assume that our grade 5 material 3/8-16 bolt could lift 7979 lbs. If it was torqued to its recommended torque of 30 Ft. Lbs. it would generate 4940 lbs. of clamping load. Most threaded fasteners are designed to carry loads significantly lower than their rated proof loads to account for safety factors and other variables found in materials and manufacturing.

Load application

The direction in which a load is applied to a fastener during its duty cycle becomes a significant determinant in fastener choice. Shown below are several ways a load is applied to a fastener. The most typical is in tension, where an axial load is literally applied to the fastener along the longitudinal axis. Our lifting eye fastener would be an example of this type of loading. On the other hand, the bolt holding the bow cleat is loaded at right angles to the axis and is said to be in single shear. The bolt or pin holding the trailer hitch into the receiver on a class three hitch is said to be in double shear since the load is shared equally between two diameters of the same fastener, thus effectively reducing the fastener load by half, while eliminating the cocking or bending load.

Anerobic adhesives

Anerobic adhesives self-activate in the absence of air. This principle was utilized by the LocTite brand and offers an easy-to-use solution for fastener retention. In liquid form they are applied to the threads of the bolt prior to installing the nut. Once the nut is installed, the mating threads of both the nut and bolt are simultaneously covered and no longer exposed to air. Then, through the magic of anerobic chemistry the adhesive hardens. This

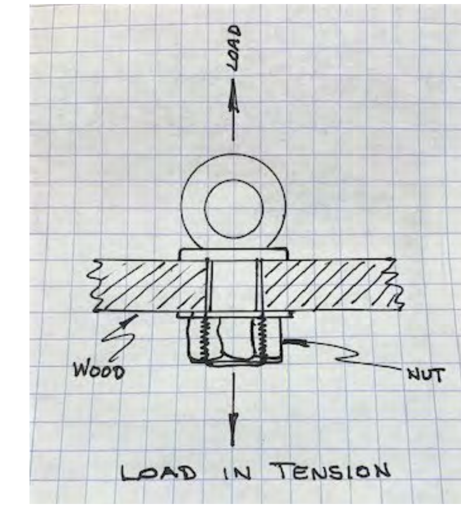

Fig.3A – The lifting eye is loaded in tension.

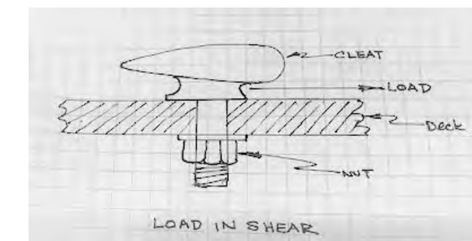

Fig. 3B – The cleat is loaded at 90 degrees to the fastener axis thus making it loaded in shear.

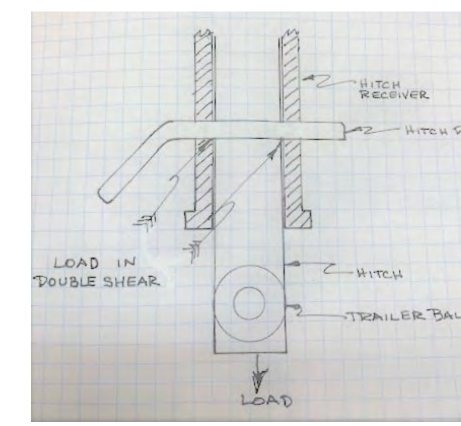

Fig. 4 – A common example of double shear loading occurs between the hitch receiver attached to the tow vehicle and the hitch. The hitch pin is in double shear since twice the area is loaded, thus reducing the effective load on the pin by half.

line of products performs quite well *If you follow the application directions.* The proper product must be selected for your particular application and both male and female threads must be carefully cleaned using the recommended cleaner. Note: Often to successfully

Fig. 5 – Perhaps the best-known name in anerobics is LocTite, and #272 is its most common product.

Fig. 6 – Stretch Gage used to measure rod screw stretch

Fig. 7 – Go-no-go thread gages used to inspect and rank threads within a given size range.

Fig. 8 – A torque wrench was the preferred method of establishing proper clamping load in fasteners until just recently when the torque-angle method has emerged as the preferred method for the newest class of fasteners.

remove these fasteners, heat must be applied.

Assembly

Over the years assembly methods involving fasteners have progressed from what some refer to as using the universal German torque spec. "guden-tight" to the use of the torque wrench, to todays computerized "smart wrenches" used in major manufacturing plants. Let's explore some of the basics surrounding this new technology.

Torque to yield fasteners

Today, all modern engines and machinery utilize fasteners designed to be stretched until they reach a clamping load in excess of the greatest sustained load the joint will encounter, plus an adequate safety margin. By knowing the precise loads encountered, engineers can determine the number and size of the fasteners needed to ensure a reliable joint. In applications where a fail-safe joint is required, a variety of mechanical methods such as cotter pins or lock nuts are employed to ensure the fasteners do not back off and lose clamping load.

Stretch vs Twist

Traditionally we always used a torque wrench to apply a measured tightening torque on critical fasteners to develop the correct clamping load. However as fastening technology evolved, we realized that method did not always produce the desired results. Today, most critical fasteners utilize stretch to determine clamping load. When the fastener is tightened, it stretches over its entire loaded length. This incremental increase is called the stretch. Once the proper amount of stretch is defined, the question becomes: how to measure the stretch?

On a simple bolt and nut, measuring the overall length increase is straightforward. However, measuring the stretch of a screw where one end is no longer accessible presents a problem. The simple solution is to use the torque angle method. Knowing the stretch, we need to obtain the desired clamping load; we start with thread pitch, and calculate the required angle.

For example, if we need .007 " of stretch and we are using a 3/8-24 fine thread screw. We know that it takes 24 turns to move the screw one inch, therefore it moves 1/24 of an inch or .041" per revolution. If we divide our stretch of .007 by the distance of a complete revolution, . 007/.041= .166 we get the portion of a circle. Multiplying that .166 times 360 degrees we get 60 degrees of twist to obtain .007' of stretch. At this point, you might say OK why not just use the tried and true torque wrench? Here's why: Supppose the internal threads were slightly small and the threads on the fastener were on the high end of the spec. It would result in a very tight fit. That tight fit would cause the torque wrench to reach the limit BEFORE the stretch had been achieved thus allowing an out of spec clamping load even though the torque wrench indicated sufficient load.

Torque-angle Method

Today, state of the art fastener application is accomplished by "smart wrenches" which apply torque to preload the fastener then advance a predetermined number of degrees to induce the proper amount of stretch. All of the individual torques for the critical fasteners are then logged in the records for that particular engine. In the event of a failure or question, the records can be retrieved to confirm the proper assembly. In some critical cases, such as connecting rod bolts, where both ends of the fastener are readily accessible when assembled, the stretch is measured and can be easily achieved. The torque angle method however is the only method for blind fasteners where both ends are not available.

Using this method, a cylinder head is installed on a current engine using cap screws with the threads coated by a carefully selected lubricant. Even though the threaded portions of the fasteners have the same size and pitch designation, not all threads are identically sized, so some threaded fits may be slightly tight while others may be slightly loose. The best way to ensure all the fasteners develop equal clamping loads is to install the fasteners and carefully pre-tighten them in the correct sequence using a minimum torque. Once that is done, a common wrench using a special angle gage, see Fig. 9, is used to turn the fastener a specified number of degrees, regardless of the effort to do so. By using this method, each fastener is stretched a very precise amount, thus producing nearly identical load at each joint.

Fig. 9 – A torque-angle meter which when installed between a wrench handle and socket will indicate the angular travel.

Lubrication

To ensure proper torque, most critical fasteners such as connecting rod bolts are engineered to be assembled using a specific lubricant. Some plated fasteners such as cylinder head screws rely on the soft plating to provide lubrication. It is critical to use the recommended lube since the wrong lubricant will cause the fastener to yield or break due to too much load or not apply enough clamping load thus causing a secondary failure.

Fig. 10 – This array of rod bolts displays the quality and unique design features of a dedicated specialty fastener. These critical fasteners are designed to be installed using the stretch method to ensure proper clamping load is established and maintained.

Threading

When restoring a threaded fastener, use the correct tap or die and run it in the hole or over the threads, being careful to start it without cross threading it. It is good practice to use a bottoming tap followed by removal of the metal debris left in blind holes typically found in castings. Special taps called thread chasers are available to recondition and clean out common pre-existing internal threads

POINTERS

To ensure proper assembly of threaded fasteners, take the following steps:

1. Make sure the threads both internal and external are clean. You should be able to run the fasteners by using your fingers unless it is a locking nut.
2. If the threads are damaged, either run a tap or die over them to repair them, or if severely damaged, simply replace the fastener.
3. Use only the recommended lubricant on the threads.
4. Use an accurate torque wrench and follow the manufacturer's recommended torque.
5. If you are torquing up a gasketed part, ensure the two mating surfaces are flat and without burrs.
6. In the case of a cylinder head, oil pan, or manifolds, follow the torque sequence to ensure the gasket is spread out evenly and not crimped.
7. It never hurts to come back after the gasket has had a chance to relax or after the engine has run and retorque the parts.
8. Never reuse locking nuts.

HAPPY BOATING!