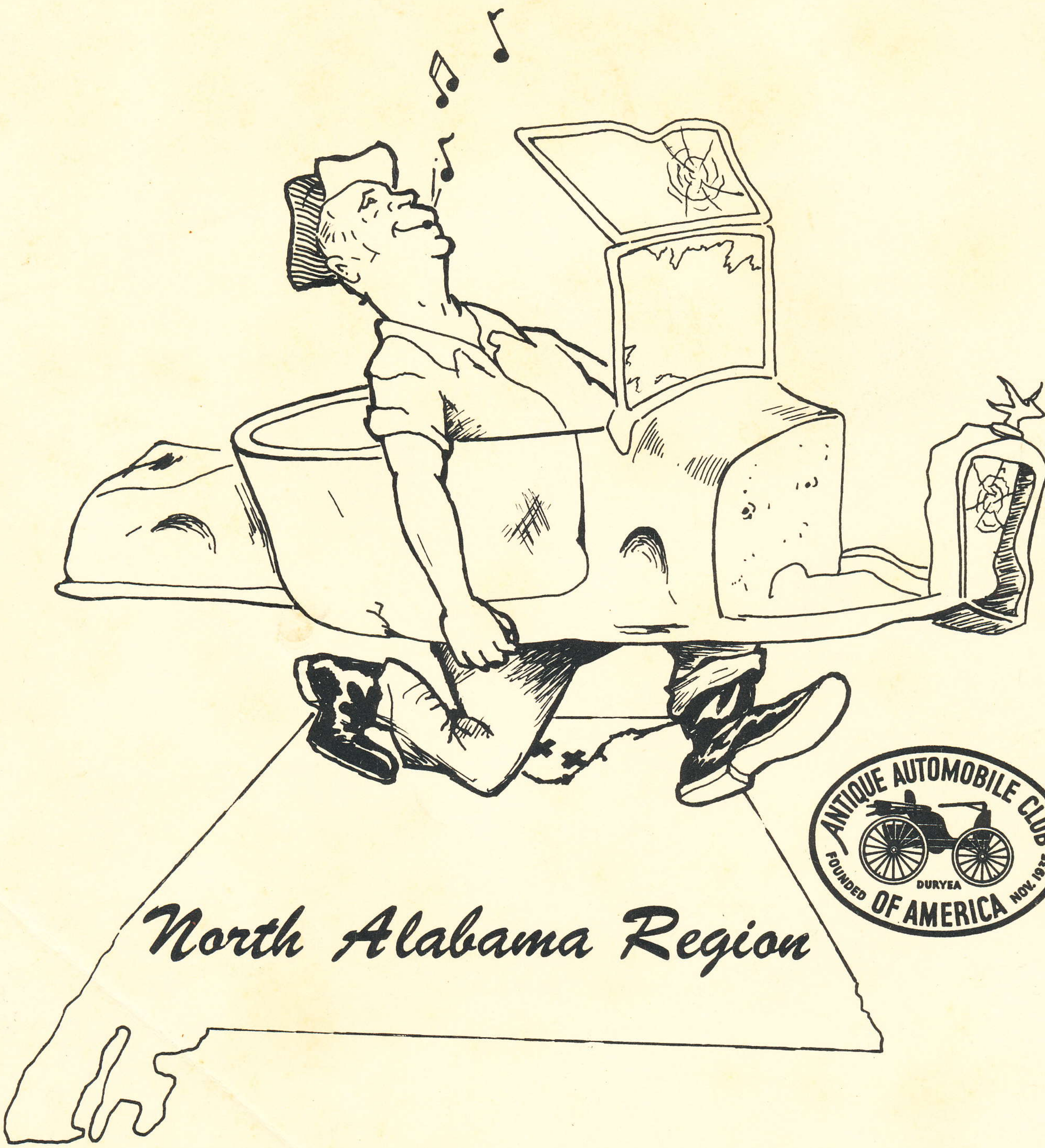
SPOKE FOLKS



ANTIQUE AUTOMOBILE CLUB OF AMERICA
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ANTIQUE AUTOMOBILE CLUB OF AMERICA

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Rod & Custom Magazine - May 1974
Fasteners
Torque Wrenches
Rod & Custom Magazine - July 1970
Frozen Fasteners

Meeting Notice: 25 April 1965 - 6:00 PM - Pot Luck Supper

Place: Big Spring Community Center - Across from Municipal Building Fire Station

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EVERYONE BRING WHAT THEY LIKE AND UTENSILS TO EAT WITH

Show Notice: 13-15 June - North Alabama Chapter, Studebaker Drivers Club, Inc., Rt. 1, Box 14B, Decatur, AL 35601. At Alabama Space & Rocket Center/Motel 6. All Studebaker, Packard, Pierce Arrow, and related drivers in AACA invited to attend.

FASTNERS

Do you buy nuts 'n' bolts that simply get the job done, or the kind you'd bet your life on . . . which is really what you're doing.

If you're asking yourself what fasteners are, don't feel left out; join the gang. What the fastener industry terms fastners we call nuts and bolts, and that's the way it's been for a long time. We also refer to bolts as capscrews, due to their head design. Actually, a fastener can be a rivet or any other mechanical device used to hold two or more objects in fixed relationship to one another, but throughout this article, our meaning of the word will be related solely to those goodies we call nuts and bolts.

Since you're an interested auto enthusiast, you've probably had more occasion to handle fasteners than the average person. If such is the case, then you can recall how some fasteners are of plain steel, just gray in color, while others are either zinc- or cadmium-plated to a silver color. Also, some are dull black, and others gold irridited. Again, you must have noticed that the heads of some capscrews are plain, while others have a series of lines and possibly a letter, number, or even name embossed on them. If you don't know the significance of these colors and markings, then it is best that you stick with us, as these "signs" tell just how strong any one particular fastener is.

If the head on a capscrew has no markings, it is a Grade 2 fastener, made of low carbon steel, and is not plated. If the head has three lines embossed on its surface, it is a Grade 5 fastener, made of medium carbon steel, and it may be zinc- or cadmium-plated for corrosion resistance, or it may be black (the result of heat treating). If the head of the fastener features five lines, it is a Grade 7 fastener, made of medium carbon alloy steel, and it's plated. The next fastener in line is the Grade 8, with six lines on its head. It too is a midium carbon alloy steel, with plating present. Premier (brand) fasteners have a unit that is somewhat better than the renown Grade 8; it's called the Supertanium fastener. It has eight lines on the head. Lamson & Sessions also have a fastener that is superior to the Grade 8. It is their Lamalloy L9, the strongest now available. These L9 fasteners are gold irridited and have nine lines on their heads. The gold irridite plating acts as a sealer and supposedly works better than zinc.

As you may have suspected, Grade 2 is the weakest of all fasteners, while the Lamalloy L9 is the strongest. We are sure you are aware of what the different Grade markings and colors mean now, but let's go a little further along and discover why so many different grades are necessary.

The Society of Automotive Engineers, or SAE, has established grade and material markings for use on capscrews that show they have met specified standards for minimum strength and chemical composition. These markings are the lines on the heads of the capscrews we've just discussed. The accompanying chart illustrates these head markings. Minimum tensile strength requirements have been established for each grade, so that users are assured that all capscrews of a certain grade, regardless of manufacturer, will meet at least the minimum specified strength level.

Grade 2 fasteners, the lowest category, must meet a minimum spec of 74,000 psi for bolt size 1/4-inch through 3/4-inch, and 60,000 psi from 3/4-inch through 1-1/2-inch. This means that a bar of Grade 2 steel that is 1-1/4-inch in idameter (or of 1-square-inch cross section area), will be able to withstand at least 60,000 psi pressure without breaking. Too often charts or figures given on a specific grade of fastener play up the minimum tensile strength factor. If a Grade 2 bar of 1-square-inch area can withstand 60,000 psi pressure, it is only reasonable that a lowly 1/2-inch capscrew of the same material will NOT be that strong, yet the minimum tensile strength figure is always played up. In fact, we find that a 1/2-inch Grade 2 capscrew has a minimum tensile strenght of 11,050 psi. A 1-1/2-inch Grade 2 capscrew, on the other hand, has a minimum tensile strength of 86,950 psi, because its area is larger than that 1-square-inch bar used in determining the minimum strength factor.

As you move up through the grade numbers, the strength of the fasteners increases as the chemical content of the steel used is improved. The stronger the steel, the stronger the fastener, and the higher the grade number to designate this.

Take two fasteners of equal diameter, and the one with the higher grade number will be the stronger. Again, naturally, if you have two fasteners of different diameters, but of the same grade number, the larger of the two is always the stronger. The reason we have so many fasteners to choose from, grade-wise, is the need for them. It would be foolish to produce only high-quality, super-strong fasteners, where the job at hand requires a low-strength fastener to attach a coil bracket on the manifold or firewall. Likewise, to expect a low-strength fastener to hold a main cap on a supercharged engine would be idiotic.

From what we have covered so far, it is clear that better grades of steel are used in the higher grade (number) fasteners. What determines the grade a fastener will be in is the metallurgical content, degree of cold working and heat treating of the steel involved. Heat treating is especially important as there is a definite relationship between hardness and strength. Two other qualities play an important part in fastener strength. They are ductility and brittleness. Ductility refers to a material's ability to be drawn or elongated. A bolt made of a soft steel (measured by the amount of force it takes to make an indentation in its surface) is more ductile-- and has a lower tensile strength--than a hard one. A bolt, on the other hand, may have a very high ultimate tensile strength, but lack fatigue resistance and ability to absorb shock loadings due to its brittleness. These two qualities must be balanced off to give the proper combination for the particular application.

You have probably noticed that in the Grade chart, the higher the grade number of a given capscrew size, the more torque that must be applied to properly secure it. Because the steel used in the higher grades is stronger, it takes more pressure to properly elongate (stretch) it, something that must be done if the fastener is to do the job right. If a nut and capscrew are merely tightened to a point where they are snug, and if they are employed where any vibrations are present or the materials being clamped are alternately heating and cooling, the joint will likely come loose. By torquing the fasteners to their recommended specs, they elongate a specific amount, which permits the threads to take "a set" against one another. Even where lock nuts are utilized, if the capscrew and nut aren't torqued properly, and they are used where stresses are involved, say on a connecting rod cap, the capscrews or bolts will ultimately break due to the permissible give, or play, in the rod cap joint. At the other extreme, if the fastener is over-torqued (too much pressure is applied), then you're in for much more trouble.

Every fastener must elongate somewhat if it is to do its job. When loosened, due to its ductility, the fastener will return to its original shape. When you apply too much force in tightening any fastener, it stretches to a point where the metal breaks down and begins to stretch, finally breaking. Presented herein are a couple of photos showing graphic examples of this. The single capscrew with nut is a Grade 8 unit, of 1-1/8-inch diameter. This particular capscrew has a tensile strength of about 145,000 pounds, and if the threads are dry when assembled, it requires 1440 foot-pounds of torque to properly tighten it. Approximately 2900 foot-pounds of pressure was applied to break this fastener. This would be the equivalent of a 150-pound man riding the end of a 20-foot bar, applying leverage to that socket.

Reference was just made to dry threads, so let's clarify this statement. If threads are dirty, you will find it hard to install a nut onto a capscrew, or screw a bolt into a threaded hole, such as a cylinder block. So you clean the threads with a good solvent (preferably Loctite Clean 'n' Prime), and in the case of a cylinder block, you may even clean the threads up with a bottoming tap to remove any rust or scale. Now, with everything in top shape, you can start assembling things. But, because the threaded parts are clean, they are also dry, and a lot of friction will be encountered as things go together.

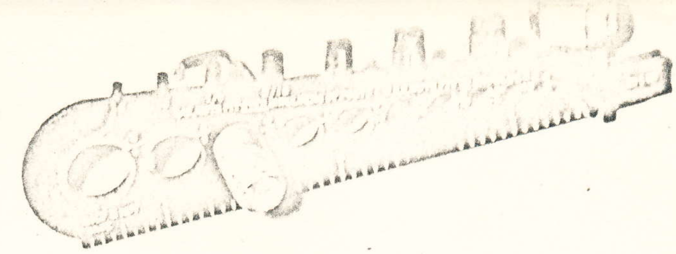
You can take a dozen clean fasteners of identical size, torque them to the same spec, say 50 foot-pounds, and it will be safe to say no two will be applying the clamp load on the parts being secured. This is because of friction encountered through dry threads. If a good thread lubricant is utilized, such as Never-seez, Molykote, Fel-Pro C-5, graphite and oil, or something similar, then we won't encounter this undesirable friction, providing of course that the threads are clean and undamaged. Engine oil as a thread lubricant is not recommended, but if you do use it, you should increase torque applied over figures given for lubricated threads. This explains why we have presented two columns for torque specs in one of the charts: one for dry threads, one for lubricated threads. You will also notice all fastener sizes given are for both coarse standard and fine (SAE) threads. The SAE, or fine-threaded, fasteners can be torqued down tighter than their coarse brethren.

This brings us to another small point that bears mentioning. You will normally find that capscrews which must be run down into cast iron (such as main cap and head bolts) are almost always of the coarse-thread type. This is because the goove depth of coarse-thread screws is deeper than that found on fine-thread capscrews. Since the cast iron is softer than the steel bolts being used, the joint is made stronger by the fact that coarse-thread screws cut deeper into the cast iron than fine-thread screws. Where a nut is used on a capscrew, the SAE or fine thread is stronger because the minor, or root, diameter at the thread is greater, leaving more material in the capscrew.

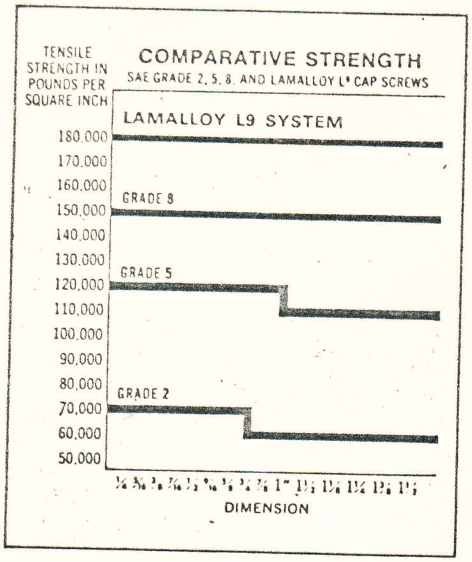
So far, our conversation has dealt essentially with capscrews, but we can't forget nuts and washers. There are many types of nuts that we as antique car enthusiasts come into contact with. The most common type is the standard hex nut that requires lock washers, followed by a nut that is referred to as a lock nut. Generally speaking, most of these lock nuts feature small slits about the top, with the metal crimped inward, providing tension against the threads. The SPS Flex-Lok nut is of this type. Other lock nuts we occasionally encounter are the Nylong lock nuts, with a Nylon ring inserted in the top groove of the nut; the Lamson & Sessions Stover lock nut which has its top crimped on two sides, producing an oval shape when viewed from above; and the Cone-lock nut, with the top crimped on three sides procucing a triangle when viewed from the top. All of these methods are employed for one purpose, and that is to aid in preventing the nut from backing off after torquing.

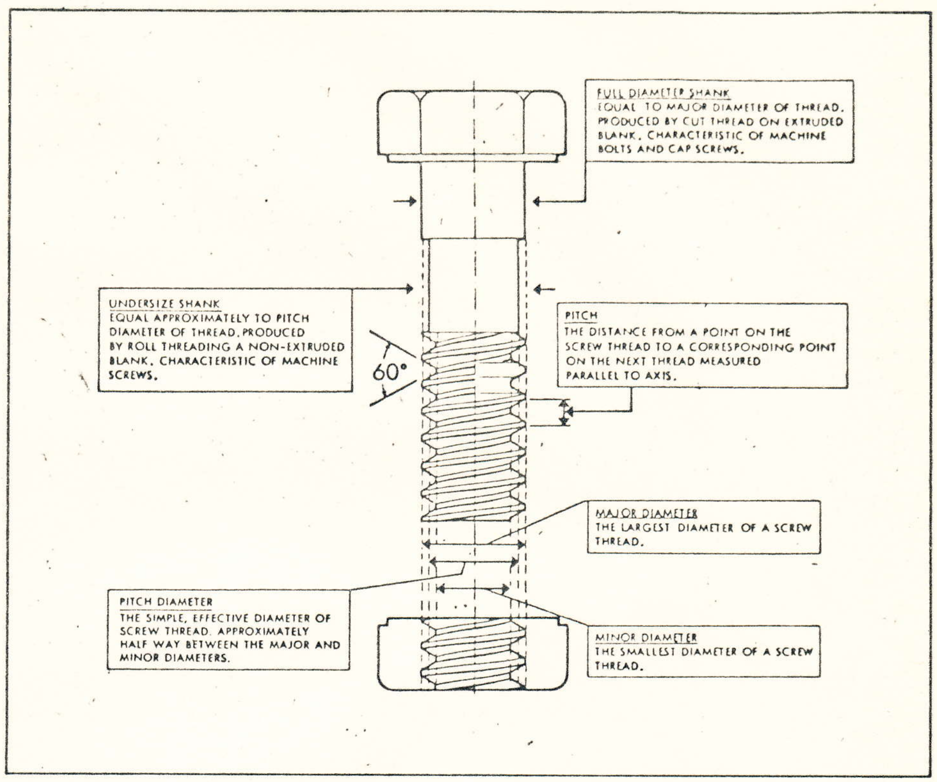
You will find that few car builders who take pride in their work rely on standard nuts and lock washers for any job. Whether you're talking about regular split-lock washers or internal or external tooth (star) washers, the same feeling applies. The reasons are that these washers damage the surfaces of the parts being clamped and tend to lose their elasticity, or ability to hold the parts being fastened.

Even some flat washers have their failings, though they are recommended under capscrews for most applications. If you use a Grade 8 capscrew and nut, and soft steel washers, the washers will either dish in or break. It



If you do much chassis work, you may find one of these plastic nut and bolt gauges handy. If you aren't sure of the size of a fastener, grab your gauge. You can try any dealer who handles a lot of fasteners. They should have some.





GRADE/TENSILE STRENGTH/TORQUE COMPARISON

Grade of Bolt / Min. Tensile Strength (psi)			SAE 2 74,000		SAE 5 120,000		SAE 7 133,000		SAE 8 150,000		LAMALLOY 9 180,000	U.S. Regular	
Grade Markings on Head													
U.S. Standard Bolt Diameter (ins.)	Threads per inch	Decimal Equivalent	TORQUE (ft.-lbs.) Dry	Lub.	Dry	Lub.	Dry	Lub.	Dry	Lub.	With L-9 Washers	Bolt Head	Nut
1/4	20	.250	66*	20*	8	75*	10	8	12	9	12	3/8	7/16
1/4	28	.250	76*	56*	10	86*	12	9	14	10	15	3/8	7/16
5/16	18	.3125	11	8	17	13	21	16	25	18	26	1/2	9/16
5/16	24	.3125	12	9	19	14	24	18	25	20	26	1/2	9/16
3/8	16	.375	20	15	30	23	40	30	45	35	36	9/16	5/8
3/8	24	.375	23	17	35	25	45	30	50	35	38	9/16	5/8
7/16	14	.4375	32	24	50	35	60	45	70	55	61	5/8	3/4
7/16	20	.4375	36	27	55	40	70	50	80	60	67	5/8	3/4
1/2	13	.500	50	35	75	55	95	70	110	80	105	3/4	13/16
1/2	20	.500	55	40	90	65	100	80	120	90	110	3/4	13/16
9/16	12	.5625	70	55	110	80	135	100	150	110	155	7/8	7/8
9/16	18	.5625	80	60	120	90	150	110	170	130	175	7/8	7/8
5/8	11	.625	100	75	150	110	190	140	220	170	215	15/16	1
5/8	18	.625	110	85	180	130	210	160	240	180	250	15/16	1
3/4	10	.750	175	130	260	200	320	240	380	280	340	1 1/8	1 1/8
3/4	16	.750	200	150	300	220	360	280	420	320	380	1 1/8	1 1/8
7/8	9	.875	170	125	430	320	520	400	600	460	540	1 15/16	1 1/8
7/8	14	.875	180	140	470	360	580	440	660	500	600	1 15/16	1 1/8
1	8	1.000	250	190	640	480	800	600	900	680	820	1 1/2	1 1/2
1	12	1.000	270	210	710	530	860	660	1000	740		1 1/2	1 1/2

*These torque values are expressed in *in.-lbs.*

is recommended that you use washers of the same quality as the fasteners being used. This advice also pertains to nuts. They should be of the same grade or quality as the capscrews. Otherwise they too will either break or strip. The Nylon-insert lock nuts may be used a minimum of 15 times, or 15 reuse cycles, before being discarded. The Nylon begins to lose its grip at about this period. They also have a temperature limit, which is 250° F. Above that--you're in trouble. The heat limit for plated nuts is 450° F, after which the plating fails and you're in trouble again due to other factors.

So whatever you do when building that auto or shop equipment, choose the right fastener for the job, and you'll have a machine that will stay together and be safer to operate. One can't ask for much more than that.

TORQUE WRENCHES

If you have already read the accompanying article on fasteners, then you are somewhat aware of the torque specifications of different fasteners and that a torque wrench should be utilized if a fastener is to be secured properly. It can also be assumed that most, if not all, of our club members do a reasonable percentage of the work on their own cars, yet I know from personal experience that many car builders don't possess a torque wrench. And this is something that amazes me to this day. It's hard to understand how a guy will spend months, probably years, searching for hard-to-find parts, then steadily build a car from scratch with painstaking care, and when it's finished not be able to tell you for sure if all fasteners concerned are torqued properly. Usually when talk about cars swings over to using a torque wrench, some people tend to think they are used only on engines, but this is untrue. Every fastener on a car should be torqued down to specific ratings if that car is to stay together. After considering why a lot of guys don't buy or use a torque wrench, I've come to the conclusion that many of them either don't understand how to use a torque wrench, or they "haven't the time" to consult a torque specification chart. Assuming these are the only two reasons a guy wouldn't use a torque wrench, we'll also assume that the former group may be interested in learning how to use these measuring devices.

Torque wrenches are used to measure the amount of resistance to turning in any specific fastener. Different fasteners require that different amounts of torque be applied to them if they are to perform as designed. But let's discover exactly what torque is first, and then we'll get into some of the tools designed to measure it.

Torque is twist. Here's a graphic example: You hold one end of a long metal band, say a tape measure, and a friend holds the other end. You rotate your end to left or right. The result is that the tape begins to twist. This is because you are applying torque. If that tape were of a heavier gauge, it would require more torque to twist it. Right? So when you tighten a head bolt to a specified number of foot-pounds of pressure (torque), you are also applying a controlled rotational torque to that bolt. The more you twist the bolt, the tighter it gets.

Torque wrenches come in many different sizes and types, but they all produce the same results. Torque is based on a simple formula . . . . DISTANCE x FORCE = TORQUE. Torque can be measured in pounds, ounces or grams, depending on the wrench you happen to have in your hands. Of course, the size and grade of fastener you are going to measure will dictate which wrench you employ. If it is a small fastener with a maximum torque spec of 24 inch-pounds, you would be foolish to try to measure out 2 foot-pounds (the equivalent) with a foot-pound wrench.

Going back to the formula, let's assume that the handle length (distance) of a torque wrench is 12 inches. With the socket plug held rigid and 10 pounds of weight (Force) applied to the handle grip, we find that we have 120 inch-pounds of Torque being applied. This torque figure is arrived at by multiplying the amount of force in feet by the handle distance, or length, in inches. Because we said the handle was 12 inches long, and the weight 10 pounds, we have 120 inch-pounds. However, if we referred to the handle as being 1 foot long, we would have 10 foot-pounds of torque being applied.

A majority of torque wrenches are designed with a maximum allowable inaccuracy of only plus or minus 2 percent of the full scale reading. The reason you want the most accurate measuring instrument you can afford is simple: You want to measure torque accurately. If the wrench you select is inaccurate, you would probably do just as well without it. As an example of how minimal 2 percent accuracy is, we'll use a 100-foot-pound capacity torque wrench in the next example. At the full reading of 100 foot-pounds, if this particular wrench were off 2 percent, our actual reading could be as much as 102 foot-pounds, or only 98 foot-pounds. With this same wrench, at 50 foot-pounds on the scale, the actual reading could be as much as 51 foot-pounds or as low as 49 foot-pounds. Carrying this example one step further, we would find the error (plus or minus) at 25 foot-pounds to be only 1/2 pound either way, which is very negligible.

One should always try to hold a torque wrench at a 90 degree angle from the object being tightened. Apply force evenly, never with short, hard pulls. Where the need is present to use an extension between the torque wrench and the socket, be that much more careful in supporting the head of the torque wrench with your free hand. Because of the angles involved, you must apply as much force to the head of the wrench as you do to the handle, if you are to prevent the socket from rocking off the head of the nut or bolt. It's also important that you hold the handle grip properly. If you hold your hand too far forward or rearward on the grip, you are changing the amount or torque actually being applied to that fastener. No matter what the reading says on the wrench, unless the handle has a built-in pivot point, the torque you're applying would be more or less than that which is indicated.

Torque wrenches come in different styles. Two common ones are the round beam and tapered beam types. Both of these beam types bend as torque is applied to a fastener. A pointer attached to the head of the wrench maintains the straight and narrow, pointing out the number of inch-pounds or foot-pounds of torque being applied on a scale attached to the handle. These torque-indicating wrenches are simple and easy to use. If you aren't too careful about how you use, or abouse, this wrench, and the pointer gets bent, you can easily straighten it, getting it back on zero, making sure it doesn't rub against the calibrated scale, but is floating. Of course, if you don't take care of your tools, you probably wouldn't own a torque wrench, anyway.

Another torque wrench is the encased beam type, with the measuring element inside the handle and a dial near the handle to show you the amount of torque being applied. A third, the micrometer type--with the amount of torque desired being preset in the handle before the wrench is put to use--is popular with many engine builders as it saves valuable time. Most of the micrometer-type wrenches give an audible click when the preset torque reading is reached. The operator doesn't have to keep his eye on a calibrated plate (there isn't one on these wrenches). Some of these models also have a ratcheting head which, again, greatly speeds up work. Finally, some of these micrometer-type wrenches release automatically when you reach your preset torque setting.

Without getting too deeply involved in this subject (which means we'll pass when it comes to recommending one design over another), all we can say in closing is that torque wrenches are precision tools and should be handled as such. They are a must in the tool chest of anyone who does a lot of work on engines, transmissions and rearends. They should be in the tool boxes of anyone who does much work on his chassis, too. When these wrenches are used in conjunction with the right fasteners, you'll have a machine that will stay together and be safer to operate. One can't ask for much more than that.

FREEING FROZEN FASTENERS

Vintage Tin? Great. Trouble is, it's always held together by about fifty pounds of vintage nuts and bolts covered with an almost equal quantity of vintage rust and corrosion. Obviously, if that Overland Bluebird touring car you've just acquired to form the basis of a highly polished antique, you've got to get it apart with a minimum of incidental damage and destruction.

As High-Flying Hunkins the human cannon ball used to say, the first time's the worst time. After you've had the experience of stripping-down one automotive relic things are likely to be a bit easier on your second effort if for no other reason than you know what to expect. Anyone who sets about building an antique with the idea that it's going to come apart and go together like a plastic model is in for a really big surprise. What's guaranteed to send even strong men weeping on their way to the looney bin is when their ordinary "brute force" approach to taking things apart results in the breakage of some irreplaceable piece of machinery.

The key to salvaging important parts intact is in thoroughly analyzing the entire situation before you attempt any disassembly work at all. Three factors are of greatest importance: (1) What are the materials used in the parts and in the fasteners holding them together? (2) What conditions are likely to be locking the fasteners in place? (3) What is the best no-slip way of gripping and applying force to the fasteners in question?

Iron, steel, brass, aluminum, and zinc or white metal castings constitute the large majority of all automotive parts. Techniques that may free the threads of a steel screw threaded into a cast iron part may have just the opposite effect if the screw is of brass or aluminum due to different expansion rates. Additionally, a brass screw in a steel part is a whole different snooker game from a steel screw in a brass part. Also, the corrosion which affects ferrous metals (rust) is different from that which forms on parts and fasteners made from other metals.

If the fastener has no washer beneath it or if there is a split-type lock washer it may be held in place by extreme internal tensions in addition to a locking layer of corrosion. Cutting away the washer with a cold chisel may therefore help in the case of exceptionally stubborn bolts. If there are exposed bolt threads extending through a nut or beyond the part into which the fastener is threaded, dirt and corrosion in that area may be hindering removal of the bolt more than the presence of internal corrosion. This is always a distinct possibility on bolts that pass through spring hangers or other once-lubricated assemblies. Clean off the exposed threads with a wire brush or thread chaser, apply penetrating oil, and they'll usually come right out. Try the brute force approach and you're only likely to get somewhere you don't want to go.

How you grip the fastener is highly important. Pipe wrneches, adjustable wrenches, and vise grips invariably do more damage than good, often making it impossible to ever get the fastener out intact. Use metric wrenches on cars having metric fasteners. The U. S. "equivalent" size is always a compromise. Some early car makers used non-standard hex and square sizes. Metric tools will sometimes fit these better than U. S. Sizes. Occasionally you can locate some of the original tools supplied by the car maker, and these can be lifesavers for certain special jobs. Six-point socket wrenches are superior to the 12-point variety for poping frozen fasteners free after years of neglect, and any kind of box or socket wrench is better than an ordinary open-end "spanner."

If a fastener is accidentally broken or damaged by your efforts, you must decide the best manner of extracting the threaded portion remaining in the hole. If the fastener itself is "standard hardware," you may choose to cut, break, burn, or grind it off and replace it with a new screw or bolt upon reassembly. In some cases the old bolts will have become so weakened by metal fatigue or internal crystalization that they will break off when merely struck solidly with a hammer!

If time permits, all fasteners on your piece of vintage tin should be given a daily socking with "Liquid Wrench" or some other good rust-dissolving penetrant. Keep this treatment up for five days or a week, wire-brushing away any loose rust around the exposed parts of the fastener. Copper polishing cleanser, made for keeping the bottoms of kitchen pans bright, can be obtained at any supermarket. Apply this stuff with an old toothbrush and a little warm water to dissolve the corrosion that forms around brass screws threaded into brass parts.

After the fasteners have been saturated as thoroughly as possible with penetrating oil, tap them and the metal surrounding them repeatedly with a hammer. This will set up vibrations that help break up solid rust and aids the flow of the penetrant into the threads. Select a good, properly-fitting tool and apply "exploratory pressure." If the fastener does not turn, continue the penetrating oil/hammering routine a bit longer before trying again. Should it become possible to turn the fastener even slightly, add more penetrating oil and alternately loosen and thighten the fastener to help work the lubricant deep into the threads.

If hammering doesn't help, heating usually will. A propane torch is the safest bet since it is not so likely to overheat the metal parts to a point that might cause permanent damage. Alternate heating and cooling will cause the parts and their fasteners to expand and contract, breaking the rust bond between them. Continued oiling and hammering may be used in addition to the heating/cooling cycle until the fastener can be worked free with a wrench.

If someone else has already failed at removing the fastener, or if your own efforts have gotten too brutal, the head of the bolt may become so rounded or broken that it is no longer possible to grip it in the normal way. Keep up with the oil/hammering/heating, but seek a means of getting a better grip on things. If the corners of the hex have been only slightly rounded off (by a poorly-fitting wrench or a 12-pointer with too much force applied), you can restore its corners by striking a deep "dimple" into each angle of the hex with a center punch. Use a 6-point socket after this operation.

When bolt or screw heads have become completely reformed, try drilling a hold through what remains of the head. Insert a steel pin through the drilled head so that it can be gripped with a wrench. This works especially well on soft brass bolts that tend to "crunch up" if vise grips are used.

Bolts with broken-off heads can often be removed using extractors. Once the head is gone it is actually easier to get penetrating oil down into the threads, and by drilling completely through the remaining threaded part of the bolt, penetrating oil can be gotten to the very bottom of the bolt as well. Drilling the length of bolts that are still intact for the sake of filling the lower part of the hole with penetrating oil is an occasionally-used trick.

Several important points must be observed for successful extractor work. First, always use the drill size indicated on the extractor. It will make the hole diameter that allows the best possible grip. Next use an extractor that is small enough to leave at least 1/16" of metal around the hole drilled in the fastener, but large enough to provide the greatest possible grip area. Finally, make sure the hole you drill is dead center in the broken bolt. This will prevent local deformation of the threads as the extractor is driven in and will permit a more efficient use of twisting force.

Do not hammer the extractor into the drilled bolt with great force. This would only tend to expand the threads and cause them to seize even more tightly in the hole. Because of this possibility, extractors may not be the best choice for broken screws that are made from soft metals. In such cases you may find that slotting the bolt shank's end for the insertion of a screwdriver will offer a greater chance of success than is likely with an extractor. This is especially true if the diameter of the threads is too small to permit adequate room for drilling.

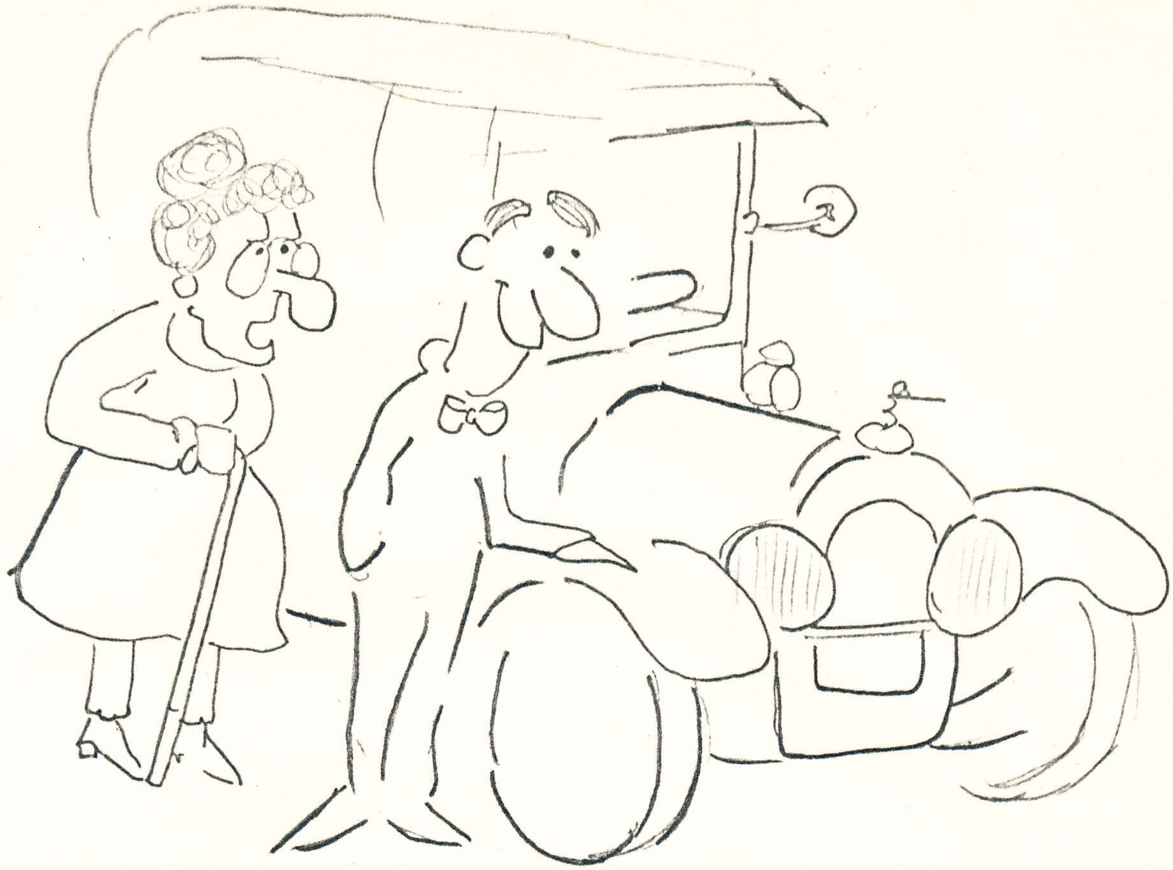
Make a slotting tool by grinding away all but two or three teeth from the end of an old fine-tooth hacksaw blade. Wrap some tape around it for a handle and use it as shown in the photos. Make sure the screwdriver you use accurately fits the slot you have cut into the broken screw end. Goodfitting screwdrivers are vital to removing any frozen fasteners having a slotted or special head.

Bolts that hold two sheet metal sections together or hold sheet metal parts onto the frame or other heavier pieces of metal require special care. Any cutting of fasteners, or hammering to get stubborn one free, may deform or tear holes in the sheet metal parts you are trying hardest to preserve. In cases like these it is usually best to grind the heads off the screws or bolts to separate the sheet metal parts from their mountings.

Various small abrasive stones and wheels are available which are well suited to the above work. An electric hand drill and a bit of patience is all that is required to use them for cutting away old rust-locked fasteners with a minimum of damage to the surrounding metal panels.

If it proves to be impossible to remove a bolt or screw that is threaded into a casting, forging, or other heavy metal part, you'll have to drill it out and tap the hole for slightly larger threads. Choose a thread size that is about 1/16" greater in diameter than the original, and has the same number of threads per inch if possible. A 5/16"-24 thread will, therefore, be the best replacement for a 1/4"-24, since the pitch of the threads is the same (24 per inch). If any of the original threads remain after drilling out the broken bolt they will be deepened rather than cross-cut.

Work carefully and follow the hints outlined above and you'll end up with more top-grade vintage tin in your shop than the guy who does everything with a cutting torch and a crow bar. If restoration is your game you'll be able to save most of the original nuts and bolts that are so necessary for a truly detailed p piece of work. The successful freeing of frozen fasteners is far more aresult of patience, know-how, and the right tools than it is of hurrying, hammering, and brute force. Spare the care and you'll spoil the car.



SOMTHING TELLS ME, YOU MARRIED ME FOR MY CAR.

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