Figure 1: The
method

THE ART OF THE WIRE

Mastering safety wiring

BY CAROL AND BRIAN CARPENTER

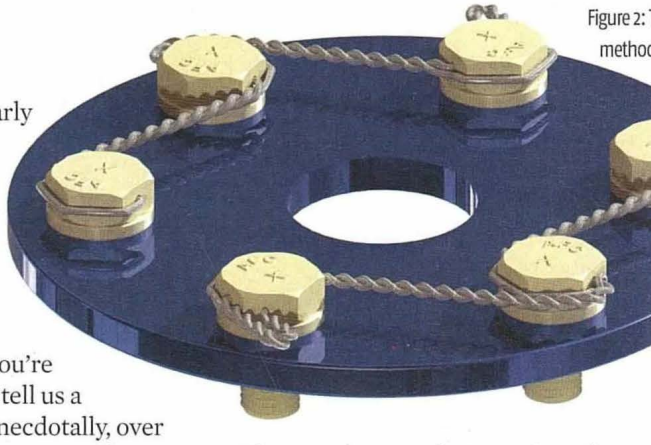

Figure 2:
method

ALTHOUGH THE PRACTICE of safety wire itself is not particularly difficult, the chasm between casual practice and precision execution could easily fit a Boeing 747. Even the participants in our repairman workshops with aviation backgrounds often require many hours of practice to master the basic do's and don'ts of safety wire. And practice, practice, practice is the only solution for developing efficiency and that "attention to detail" type of craftsmanship that is essential in an award-winning aircraft. Even if you're not looking to win the Lindy Award, details like safety wire tell us a lot about the mindset of the aircraft builder or mechanic. Anecdotally, over the years, we have seen a very strong, positive correlation between safety and aircraft reliability, and the builders who put the effort into the details.

More often than not, we see safety wire installations that in practice will probably work, but strictly speaking are done with poor execution. In researching for this article, we found more cases of improper safety wire procedures than we found examples of safety wire done correctly. By definition, safetying is "Securing by various means any nut, bolt, turnbuckle, etc. on the aircraft so that vibration will not cause it to loosen during operation." This runs contrary to the mindset that the safety wire is used to hold the part from falling off the aircraft after having come loose. Only proper technique can ensure that the fastener will not come loose during normal operation.

There are two techniques in safety w
ing; the first is the double twist. (Figure
2) This is the most commonly used meth
of safety wiring. The second, and less oft
used method, is the single-wire method.
(Figure 3) The primary downside to the
gle-wire method is that a failure of the w
will affect all of the fasteners simultane-
ously. When using the single-wire meth
use the largest safety wire consistent wi
the size of the hole in the fastener to be
safety wired. This would typically be us
on screws, bolts, and/or nuts in a clo
spaced or closed-geometrical p
tern, or in places that are
difficult to reach.

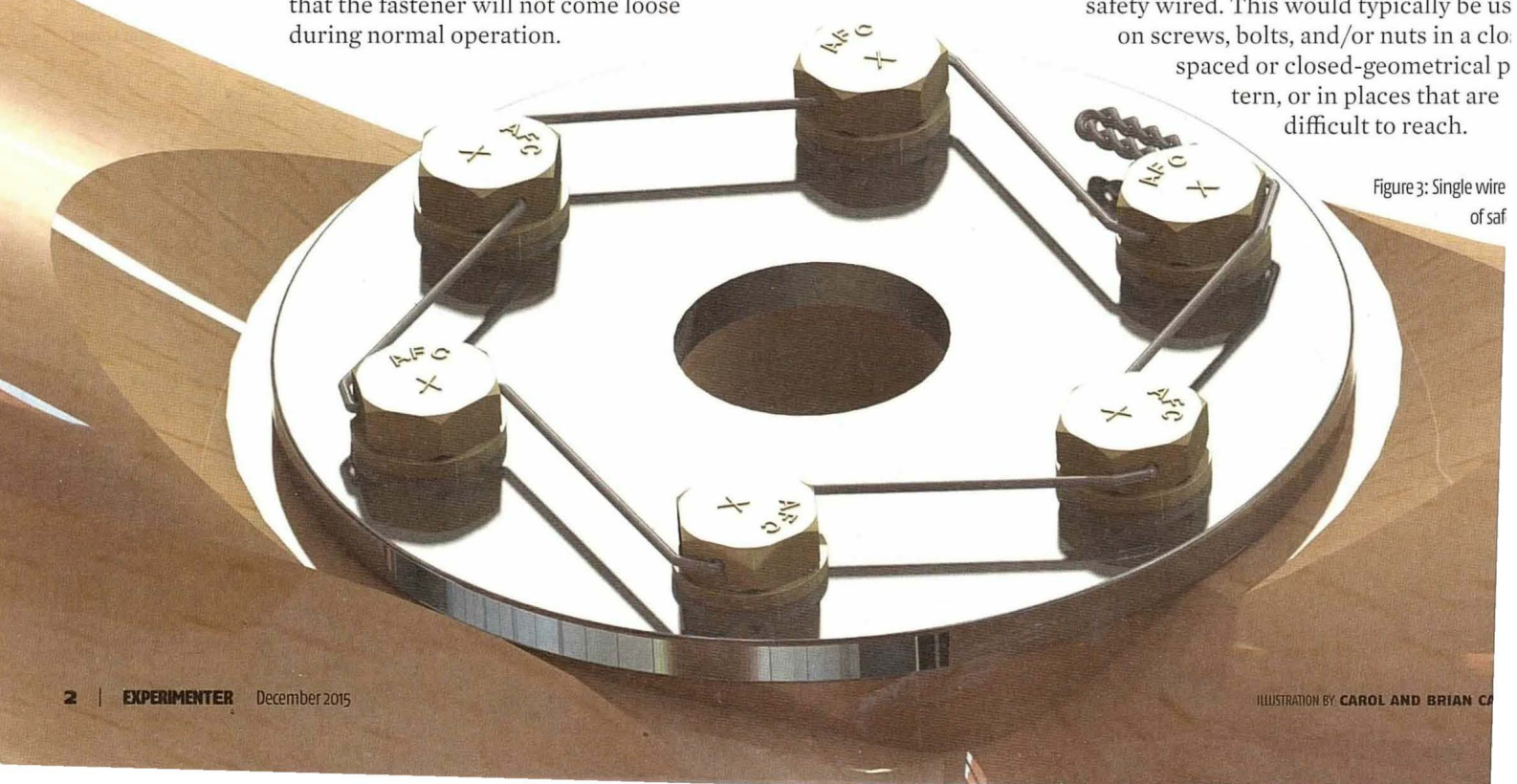

Figure 3: Single wire
of saf

ILLUSTRATION BY CAROL AND BRIAN CA

E BASIC RULES FOR SAFETY WIRE

fore beginning the safety wire procedure check, ensure that the fasteners have en properly torqued. The prime directive regarding safety wire is that it must installed in a manner that will prevent the tendency of the part to loosen. This cludes ensuring that the safety wire is routed in such a fashion as to tighten the stener. Remember "lefty loosy/righty tighty." (Figure 4) Upon initial inspection, e can generally identify that the safety wire has been installed with the correct ientation (tightening direction) by the telltale reverse S pattern of the safety re. Safety wire must be pulled taut when being twisted, and maintain a light nsion when secured. This serves the purpose of both preventing the part from osening as well as preventing failure of the safety wire due to rubbing or vibra-on. Although proper tension is of utmost importance, this is one area where you n't want to become overzealous. Safety wire must never be overstressed. Safety re will break under vibrations if twisted too tightly.

Do not reuse safety wire. Safety wire is cheap. Safety wire must t be nicked, kinked, or mutilated. This includes the damage at you do during the installation process. If you find at you messed up the safety wire during installation,

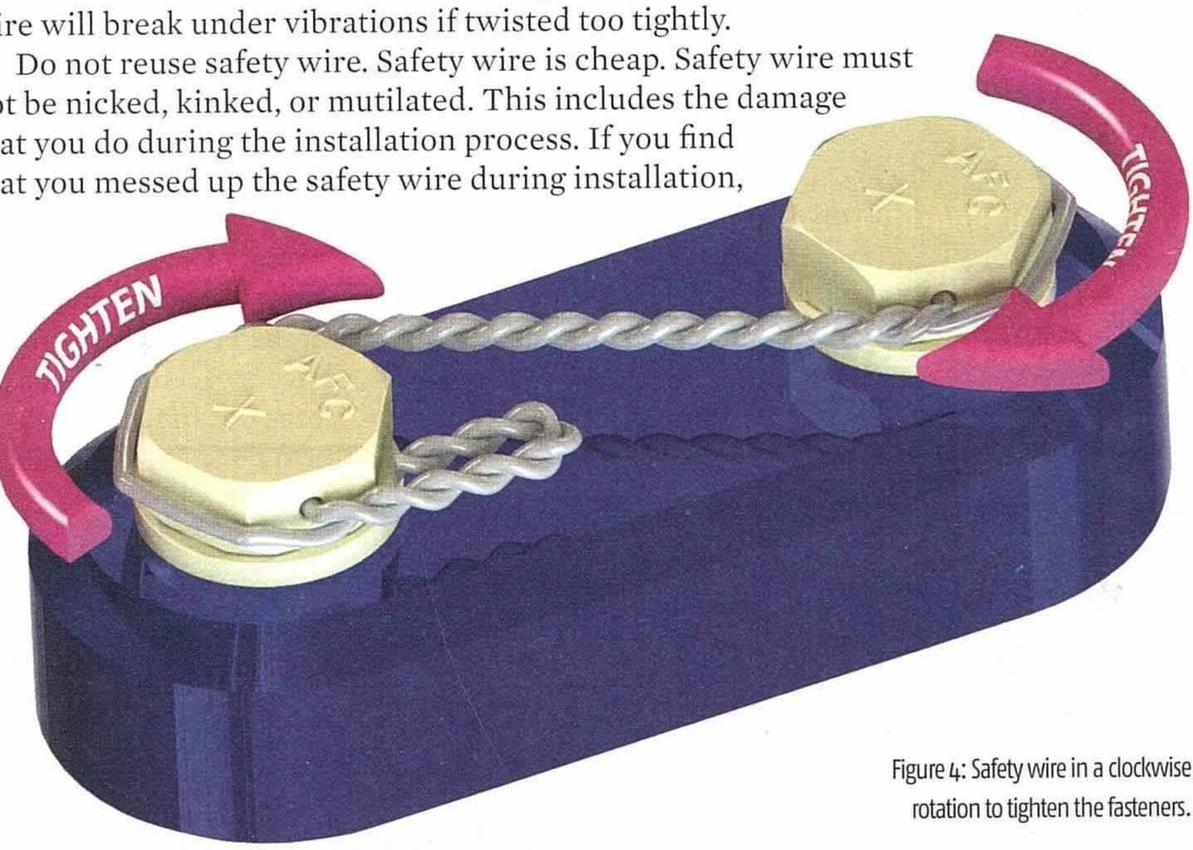

Figure 4: Safety wire in a clockwise rotation to tighten the fasteners.

mply cut it off and start over again. Remember, the only way to *not* have a pro-ssional-looking safety wire job is to give up and accept mediocrity before you chieve perfection.

Use the appropriate size of safety wire for the job at hand. If you own an air-ane, you should have at least the three following primary sizes of stainless steel fety wire in your toolbox. For small jobs use 0.020 inch—things like electrical

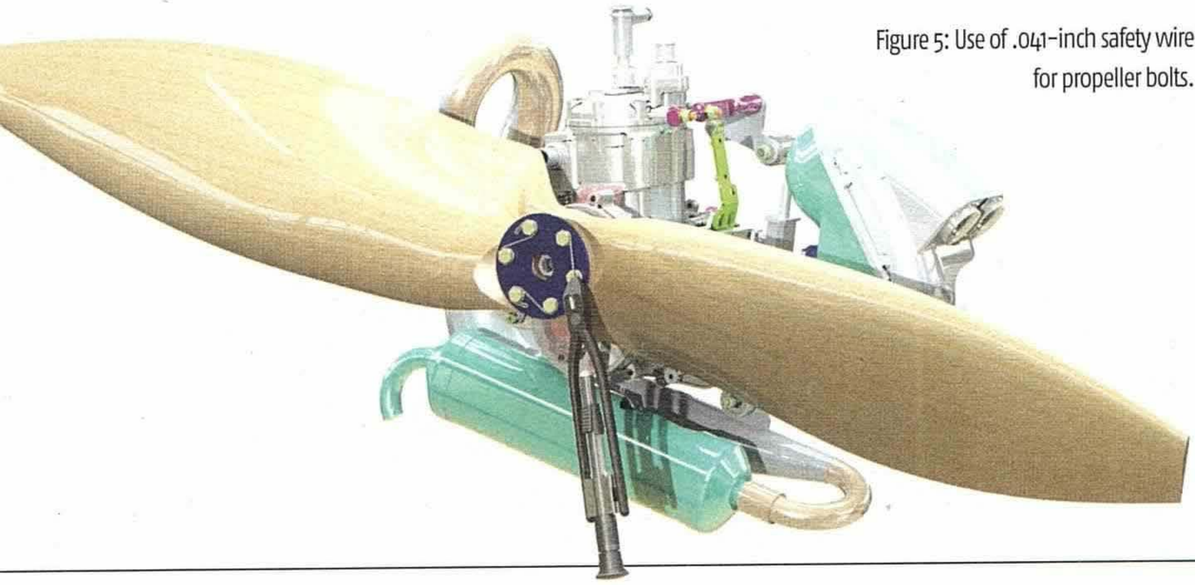

Figure 5: Use of .041-inch safety wire for propeller bolts.

cannon plugs and small accessories. The most common and widely used safety wire is 0.032 inch, and 0.041 inch is used for heavy-duty safety wiring on items like prop bolts, internal engine components, primary flight controls, and exhaust springs on Rotax engines.

The prime directive regarding safety wire is that it must be installed in a manner that will prevent the tendency of the part to loosen.

THE DOUBLE-TWIST METHOD

Step 1. Position the safety wire so that both of the non-twisted strands are pulling in the tightening direction. The single wire through the fastener and the loop around the perimeter should always be pulling in the tightening direction. The direction of twist is what determines to which side of the fastener the loop will naturally lie. This means that the first twist will always be a clockwise twist. The twist should begin precisely at the through hole in the fastener. This can be achieved by properly positioning the safety wire pliers approximately 75 to 80 degrees from the through hole in the fastener before pinching the wires to begin the twist.

Step 2. Position the safety wire pliers so that the twisting will not extend beyond the next insertion hole. Now twist the safety wire pliers to achieve six to eight twists per inch.

Step 3. Insert the single wire on the top of the twist through the bolt-through hole. Wrap the lower wire around the perimeter of the bolt head so that both wires are pulling the bolt in the tightening direction. Now reposition the safety wire pliers to achieve the 75 to 80 degree angle from the through hole and begin twisting once again. This time, however, you will need to be twisting in a counterclockwise direction, which will naturally tend to lay the loop around the perimeter of the bolt down against the base of the bolt head. The first twist will always be clockwise, and the last twist will always be counterclockwise. In addition, the twisted wire will always start exactly at an exit hole and always end the twist exactly at the hole of the next fastener. A twisted wire not starting or stopping at an insertion hole is a clue that the technique was done incorrectly.

Step 4. We now need to cut the wire to the proper length. Professional safety wire pliers typically have a set of rubber jaws located adjacent to the cutter. These jaws clamp the remaining safety wire during the cutting process so that the ends do not get lost inside the aircraft.

Step 5. Safety wire ends must be ›ent under and inward toward the ›art to avoid sharp or projecting ends hat might present a safety hazard. \C 43.13-1B (the FAA advisory circu-ar for acceptable methods and ›ractices) recommends a minimum ›f four to six complete turns for the :ut-off end. This is great if the ends lo not need to be bent more than a ew degrees.

Step 6. However, you will find a nuch cleaner product when you eave a longer tail when bending a tail 80 degrees back onto itself.

'IPS AND TRICKS

'irst hole cheat. On occasion you nay have a hole in the head of the 'astener that seems just impossible :o get access to for safety wiring. If t is the first fastener in the series to ›e safety wired, we can loosen that 'astener, install the safety wire, and :hen re-torque the fastener into its ›roper position. This, of course, can ›nly be done on the first fastener, ›ut still, it provides an option with difficult to reach fasteners.

Hardest first. This is also one of :he reasons that we start the safety wire in the most difficult position and work our way out to the easiest access fastener to finish up the final twist.

The "woop-dee-do" maneuver. This is a great trick for getting that twist tightened up. This involves twisting the safety wire pliers 90 degrees by hand while simultaneously making about a 2-inch circular motion with the tip of the safety wire pliers. This will force the twist to occur at the beginning of the twist near the exit hole rather than at the end of the twist where the wire pliers are located. Use this technique judiciously as overuse can easily overstress the wire.

Thin washers: Washers may be used to establish proper alignment. On occasion the safety wire holes just don't align in such a way that is conducive to proper safety wiring. A good way to