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Airplane Engines

A Pilot-Friendly[®] Manual



*How to get the most performance, dependability,
and longevity from your engine.*

Replace Safety Wiring

Safety wire is a backup system. The most common use is on something that spins clockwise to tighten, like a nut. The item is tightened and then safety wire is attached, so the item can't turn counterclockwise. The wire doesn't hold the nut in place; it's there in case the nut rattles loose. The loose nut will at least stay in place until it can be tightened again.

There are some other uses of safety wire, such as holding an emergency fuel cutoff closed so it can't be pulled without enough force to break the wire, but you won't find those in your engine compartment.

Your job as a pilot/owner is twofold: Recognize broken or incorrect safety wiring whenever you're inspecting the engine compartment (page 86), and replace safety wiring you remove during routine maintenance such as changing the oil (page 98).

Find the Bad Wire

Even if you never intend to turn a wrench on your airplane, you should know good safety wire from bad. The first problem is simply that it's missing. There are some items that use other methods to stay in place. (See "Castle Nuts, Locknuts, and Jam Nuts" on page 93.) However, if you see a bolt with a small hole

through it and no wire, that's probably missing safety wire.

For wire that is in place, ensure it hasn't

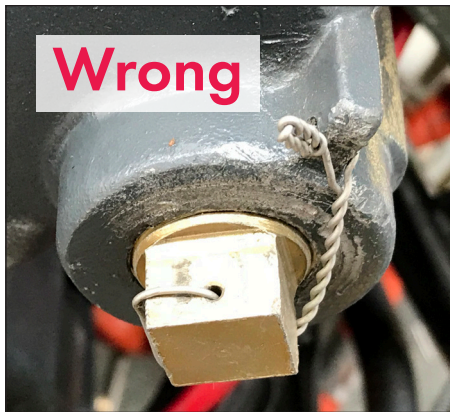


If you find missing safety wire, have a mechanic ensure the nut or bolt is still correctly tightened (torqued) before you replace the missing wire.

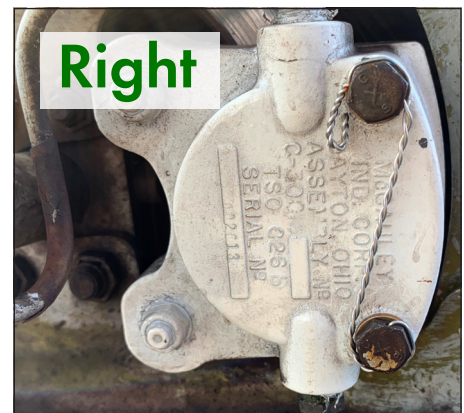
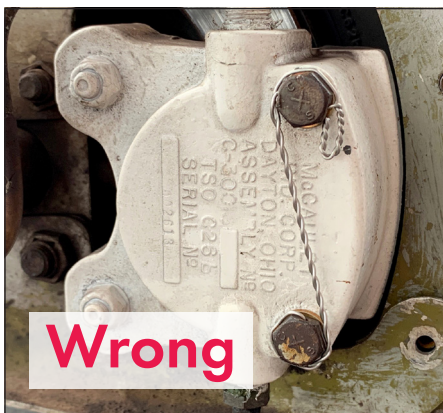
broken. Wiggle safety wire connections with your finger. Well-installed wire usually won't move at all, but so long as it can't flip over it's probably tight enough. A broken wire is usually obvious when you move it.

Believe it or not, safety wire is often installed backward. Look at the nut, bolt, or oil filter in question and visualize it unscrewing in the counterclockwise direction as viewed from the top (or lefty-loosey if you prefer). Does the wire prevent that motion? Does it lie flat on a surface curving away in the direction the bolt would tighten? Is the wire arcing away like an arrow saying "tighten this way"? If yes, then it's on the correct side.

Two bolts can be safety wired to each other, which creates a Z-shape. If it's an S-shape, it's backward. It's particularly important that this type of wiring lies flat and tight. If it can lift over the bolt, the



It's no surprise safety wire is most often backward on the bottom of an engine looking up, as with these drain plugs. Another common mistake is an S-shape between bolts instead of a Z-shape, as on these brakes.



wire path will get shorter and allow the bolt to move. Several bolts can be wired with a single strand in a manner such that each resists unscrewing. Technically, a single bolt could be wired to a post such that it can't move in either direction, but that's considered poor form as a bolt rarely lines up with its hole perfectly toward an anchor.

Safety wire should have six to eight turns per inch and the twisted direction should help hold the wire flat, but even a sloppy job will still accomplish the task so long as the item can't unscrew. Watch for wire that's rubbing up against another engine part as that can wear through the wire over time from vibration. Inspect any kinks in the wire, as that's where it's more likely to break.

Replace with Good Wire

The single best thing you can do to understand safety wiring is to watch someone skilled in the art do it in person. Creating functional safety wiring isn't difficult. Creating beautiful safety wiring takes practice.

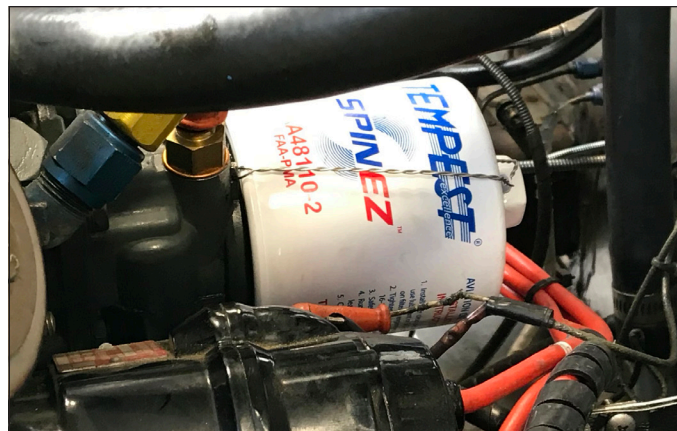
Technically, you can do the job with a pair of diagonal wire cutters (a.k.a. dykes or dikes) and a pair of needle nose pliers. However, a pair of safety wire pliers is worth the investment. These do the twisting for you and usually include a wire cutter. For personal use, get reversible 9-inch safety wire pliers. If you're in a shopping mood, duck bill pliers are also perfect for adding or removing a few twists manually. Wearing goggles is mandatory.

You'll also need a spool of safety wire. There are five wire sizes used in GA, but 32/1000 wire will probably be all you need for owner maintenance, including all the tasks covered in this manual.

Cut old safety wire at the single wire loops rather than through the twisted section. This should let you get the whole wire free without little pieces flying off into the engine compartment. Remove and discard.

If you're wiring a single nut or oil filter, you'll start the new wire at the anchor point that's probably on the engine or mounts rather than the nut. If you're wiring two bolts to each other, it's usually best to start with the point farthest away from you.

If you can't feed the wire right off the spool, cut a piece of wire slightly longer than twice the length of the final distance you'll use. Otherwise, feed the fresh wire from the spool through the first anchor point by putting it through the side of the hole farthest away



You can anchor safety wire to almost anything, if necessary. Sometimes the anchor point is beside—or even on—a bolt that holds an engine sensor, like oil temperature (above). Be sure you don't make contact with the wire and ground the sensor.

from you and continue to feed the wire through as you pull the cut end toward yourself. It can help to use needle nose pliers to grab the wire end, especially in cramped quarters.

Continue until you have the two wire lengths slightly longer than the final product. Be gentle and patient. You don't want the wire to loop on itself and kink. Believe it or not, it's also possible to break through the edge of an anchor point, bolt, or nut with the wire at the small drill hole. When you have enough, cut the wire from the spool.

Think about the route you'll want the wire to follow once it's lying flat and bend the far end of the wire toward you along that route. Pull both wire ends snug. This should make a nice bend at the far end of the anchor point. Cross the wires close to the anchor point. It can help to give them a manual twist or two in the direction you want, instead of just a crossing. Don't worry about it being tight. It's just to hold them in place for a moment.

Hold the two wire ends side by side and find the spot where you want the twisted portion to end. This is where the wire will enter the nut, bolt, or item you're safety wiring in place. Clamp and lock the safety wire pliers over both wires at this point.

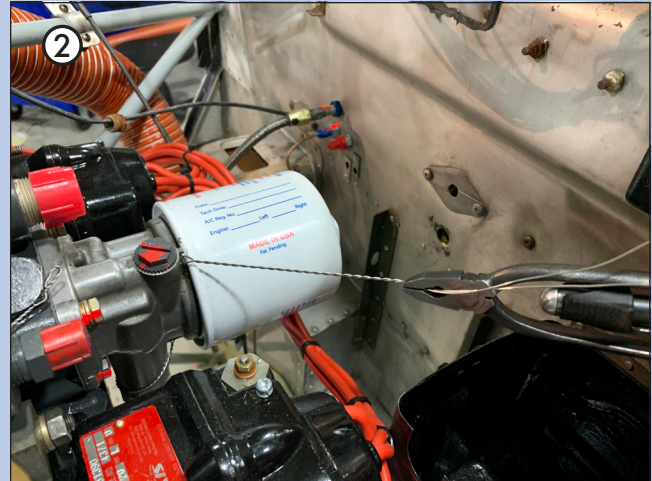
TIP

Before you cut wire you know you'll later replace, take a photo of the installed product so you can replicate it.

AN EXAMPLE SAFETY WIRE JOB: OIL FILTER



1 Loop the wire through the anchor hole farther from you, and measure a loop of wire several inches longer than the distance to the next anchor hole. Cut the wire from the spool.



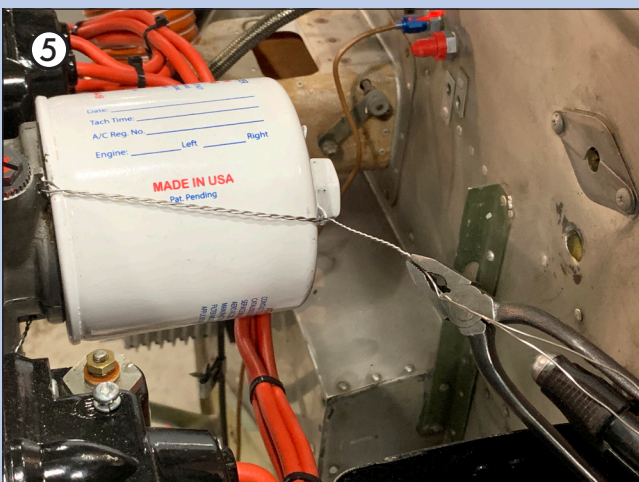
2 Twist the wires in the direction that will help hold the wire down along the path it will go. This is the direction that prevents the filter from unscrewing. Remember to pull gently as you twist.



3 Lay the twisted wire flat along that surface, and put one end through the second anchor hole.



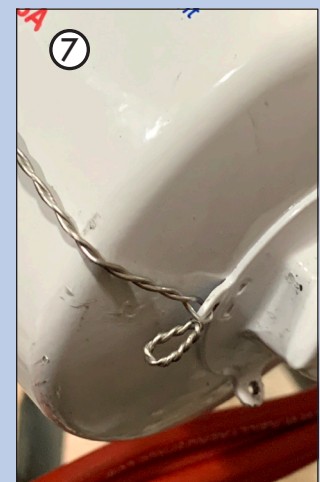
4 Manually make a few twists in the direction you want the next twist to lie flat.



5 Twist this pair an inch or so. It's best if this section is closer to 8 twists per inch, as it holds the wire twisted.

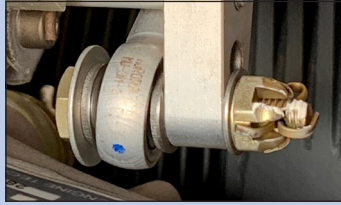


6 Snip the twisted wire, leaving a short tail that you can tuck out of the way under the wire or other metal.



CASTLE NUTS, LOCKNUTS, AND JAM NUTS

There are other common systems that ensure items can't move out of place.



Castle nuts are similar to safety wiring in that there's a hole through a bolt and six

grooves in the matching nut. A cotter pin goes through the hole and two of the slots, so the bolt can't unscrew more than a partial turn.

Locknuts come in many types. All have some mechanism, such as a nylon insert, that resist unscrewing, but don't actually prevent it.



Locknuts generally shouldn't be reused once they're removed.

Jam nuts are a nut tightened down against another nut or part to hold it in place. These are more common on flight controls in airplanes.



Locknuts and jam nuts often have a line of torque putty on them that will break if the nut moves.

If you see missing cotter pins from castle nuts, or broken torque putty lines, show it to a mechanic right away. And if you're putting on these nuts yourself, make sure they are set to the right torque. Every nut or bolt has a torque and these locking systems get installed with incorrect torque all the time.

Set the direction of your safety wire pliers so the twist will lay the wire down where you want as you twist. The safety wire pliers spin as you pull, which is important because you need tension on the wires as you twist them. If you twist the wires with a standard pair of pliers, it's important to pull as you twist. Hold the clamped part of the pliers loosely with one hand (so it can spin) and the knob with the other. Pull and it will twist. Grab the clamped part of the pliers tightly and push in on the knob to reset for another twist. Repeat until you have 6-8 twists per inch on the wire.

Check the length of the twisted portion. It should end just slightly short of where a single strand will go through the hole in the nut or bolt, wrapping around that nut or bolt counterclockwise to reach so any attempt to unscrew would pull the wire tighter. Feel free to add or remove a few twists with simple pliers to get the length right so one of the two ends can go through the hole. The duck bill pliers are perfect for this.

Feed a single strand of the wire through the hole and continue the other in the direction you were going around the bolt. Give them another twist together by hand where the two wires meet on the other side of the bolt. Then, clamp the safety wire pliers an inch

or more away from the bolt and twist in the direction that holds down the wire that went around the bolt rather than through it. This might be opposite your first twist, depending on which way you ran the wire.

Before releasing the pliers, cut the wire in the twisted portion you just made. That way, the pliers are still holding the extra wire ends you'll discard. The last step is using needle nose pliers to bend this clipped end (the tail) and tuck it away. That way it can't cut anyone or chafe items on the airplane. Bend it in the same direction as the twist to help hold everything together.

All of this is much easier to understand when you see it in motion. Dean Showalter's "Safety Wire Like A Pro" course covers just about everything with many examples. He also has a great point about the final product. "If you're not proud of your safety wiring, redo it."

Tools of the trade (from the upper right): Duck bill pliers, safety wire pliers, needle nose pliers, and diagonal cutters (dykes).

