TASK SHEET

Propeller Installation

Text and photographs by Steve D'Antonio

TOOLS and MATERIALS:

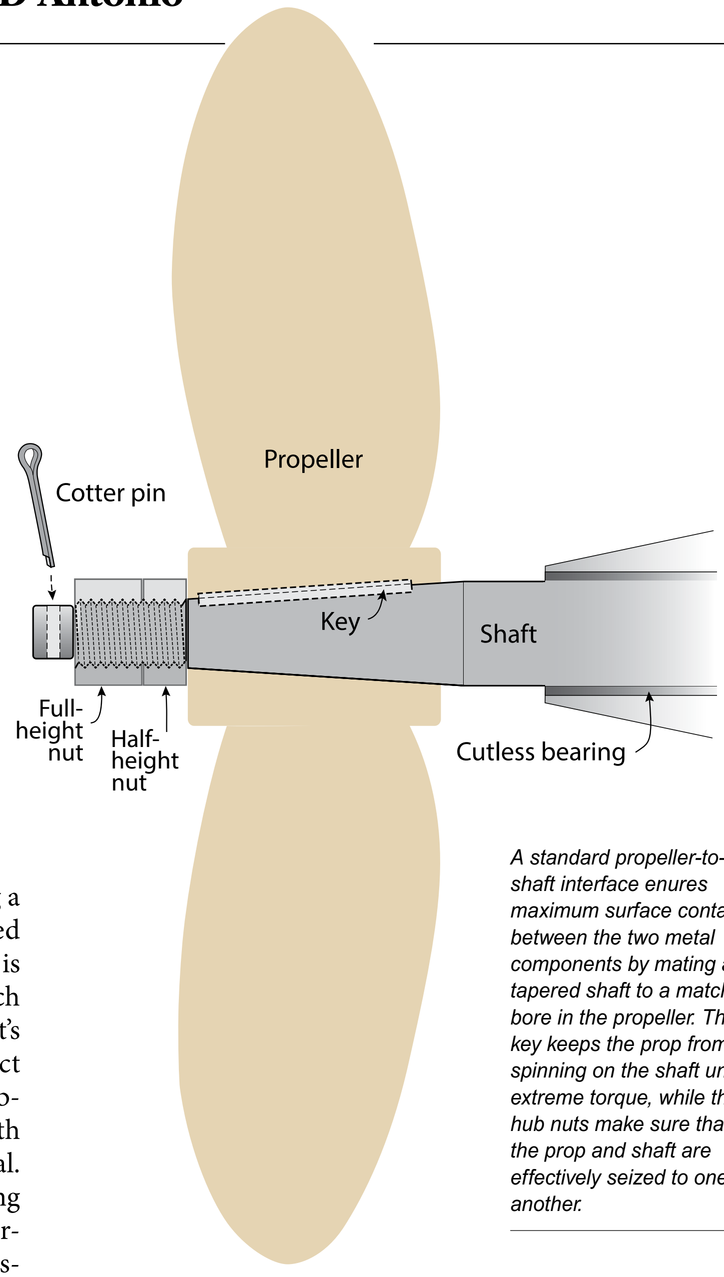
- smooth-jaw wrench (not a pipe wrench) large enough to fit prop nuts
- block of wood
- awl
- Prussian Blue or machinist's dye
- valve-grinding compound
- lightweight lubricating oil

PARTS:

- Replacement propeller nuts are necessary if the originals are damaged. To avoid galling, nuts should be manganese bronze rather than stainless steel.

ABYC STANDARD:

- P-6 Propeller Shafting Systems



A standard propeller-to-shaft interface enures maximum surface contact between the two metal components by mating a tapered shaft to a matching bore in the propeller. The key keeps the prop from spinning on the shaft under extreme torque, while the hub nuts make sure that the prop and shaft are effectively seized to one another.

INTRODUCTION:

I can't overstate the importance of correctly fitting a propeller to its shaft. The beauty of the tapered engagement between these solid metal components is it ensures that they remain firmly attached to each other; some might say they are seized or stuck. That's exactly what you're looking for. With the correct tools, removal rarely presents a problem, while problems nearly always arise when an installer, often with good intentions, tries to ease or aid a future removal. These ill-advised attempts usually involve applying grease or anti-seize compound to the shaft taper during propeller installation. When incompressible viscous materials are placed at the interface between the otherwise tight-fitting taper and bore, the frequent result is a hydrolock that prevents full engagement of the propeller and the shaft. The gap and resulting movement between the propeller and shaft during operation, and the lubricant migrating out of the interface, lead to damaged propeller bores and shaft tapers, sheared keys, and loose or lost propellers. Applying anything on a shaft taper other than a very light coating of liquid lubricant is a recipe for failure and a violation of most propeller manufacturers' installation recommendations.

Conversely, I have found properly engaged prop/shaft tapers in service with loose or even missing nuts, yet the props remain firmly attached to the shaft. While service technicians sometimes lament the difficulty of prop removal, the goal of the taper arrangement is to intentionally seize the prop to the shaft. A loose-fitting prop causes vibration, loss of propulsion, poor fuel economy, and possible catastrophic failure, up to and including propeller loss. All these faults can be avoided by taking the following steps.

PROCEDURE:

1. Inspect the prop shaft taper or aft end, as well as the propeller bore (the cone-shaped hole in the center of the propeller) for dents, scoring, corrosion, and defects of any kind. It's important these surfaces are clean and free of irregularities. Be sure to inspect the keyways (the rectangular troughs) in both the shaft and prop, as well as the rectangular key, for similar issues. The key should fit into the propeller and shaft keyways with only slight effort. If it's too loose, it will rock, allowing the propeller to move independently of the shaft. If it's too tight, the propeller can bind while being installed, which will lead to a balance and vibration problem.

2. The first time a propeller is mated with a shaft—or when you are unsure whether the following process has been carried out—the surfaces should be lapped to ensure a proper fit. Lapping is essentially custom-fitting a prop to a shaft, using an abrasive compound designed for installation of intake and exhaust valves in engine cylinder heads. Apply machinist's dye, or Prussian Blue, to the shaft taper, allow it to dry, and then apply lapping compound, which has the consistency of wet sand.

3. Place the propeller onto the shaft taper, and install one prop nut so that it is nearly touching the prop hub.

4. Rotate the prop by hand 180° in either direction 10 to 12 times while pushing it onto the taper. This grinds away some of the material in the prop bore, establishing a custom fit.

5. Remove the prop and wash off the lapping compound (it is water soluble). The dye that remains indicates the level of engagement achieved by the lapping process. Ideally, 85%–90% of the shaft taper should be dye-free, exposing the silver shaft material beneath. If this level of fit has not been achieved, repeat the process until you attain 85%–90% engagement.

6. When lapping is complete, thoroughly wash all the compound from the taper and propeller bore. Then place the propeller onto the shaft as far as it will go, *without the key installed.*

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7. Using a sharp awl, scribe a line in the shaft at the point where the forward section of the propeller hub ends.

8. Remove the prop, install the key, then apply a *light* coating of liquid lubricant to the shaft taper and key (light spray lubricant or motor oil will work). Only a few drops of light machine oil are required; don't overdo it. The purpose of the lube is only to reduce the likelihood of binding as the propeller is installed over the shaft, *not* to aid in propeller removal in the future. *Do not* use grease, anti-seize, or any other high-viscosity lubricants

9. The next step is the final installation of the propeller onto the propeller shaft. Push the propeller into place in line with the key, and then install the *large*, full-height nut using a *smooth-jawed* hex wrench. Do not use a pipe wrench, which is deigned to grip round surfaces by biting into them with hardened, serrated teeth—the last thing you want to use on a hex nut. If the nuts are stainless steel, there's potential for galling, which occurs between highly loaded threads, especially those of the same material and doubly so for stainless steel. It happens when fasteners are tightened and heat is generated causing micro-welding, transferring material from one thread to the other, damaging both in the process. It can be prevented by lightly lubricating the threads. For the most part, bronze nuts are self-lubricating and thus immune to this phenomenon, which makes them preferable to stainless steel. Now the prop can be held in place by wedging a sturdy block of wood between a propeller blade and the vessel's hull. While this method appears crude, it's well accepted and prescribed by industry experts and propeller manufacturers.

10. After the large nut is tightened, inspect the forward end of the propeller hub to ensure that it has reached or passed the line you scribed in the shaft earlier. If it has, you can be assured that the key and taper are not causing any binding.

11. Remove the large nut and install the smaller, half-height nut, tighten it, and then reinstall and tighten the large nut. While this may seem counterintuitive or needlessly complicated, ABYC, the Society of Automotive Engineers, the USCG, and others call for this small-nut-first approach. Here's why: When the first nut is installed and tightened, it carries the entire load. When the second nut is installed, much of the load is transferred to it, and logic dictates that the nut with the most threads should carry the bulk of the load. Installing the large nut first initially draws the shaft fully onto the taper using the maximum number of threads. Switching it for the half-height nut (sometimes known as a jam nut) means the large nut will still carry the majority of the load in service.

12. Finally, install a stainless steel, not brass, cotter pin large enough to fit tightly in the hole in the end of the shaft (undersize cotter pins move excessively and wear).

Following these propeller installation guidelines will ensure that the prop stays put until there's reason to remove it. PBB

About the Author: *For many years a full-service yard manager, Steve now works with boatbuilders and owners and others in the industry as Steve D'Antonio Marine Consulting. He is an ABYC-certified Master Technician and sits on that organization's Engine and Powertrain, Electrical, and Hull Piping Project Technical Committees. He is also technical editor of* Professional BoatBuilder.