

Thermal Interference Fit Stud, version 2

By R. G. Sparber

Follow up information has been added at the end of this article.

I wanted to lock a piece of 1/4-20 threaded rod into an aluminum knob I made. I tried Loctite™ red plus numerous other methods to secure the rod. In all cases, it took less than 10 inch-pounds of torque to loosen the rod. It also took time for the chemical methods to cure. For Loctite, that is 24 hours at 70°.

The method presented here uses thermal interference to lock the stud. What I found interesting about this trick is that no precision machining is needed.



I used a USA made 1/4-20 x 3/4" bolt for my testing.

The knob was made from a piece of scrap 6061 aluminum. It is 1" in diameter and about 1" long.

I first drilled about 1/2" deep and then tapped with a spiral tap as deep as possible. All chips were removed with a piece of pipe cleaner. No effort was made to degrease the hole.



Take a close look at a typical $\frac{1}{4}$ -20 spiral tap. The thread starts out very shallow near the point and tapers up to full depth before you are in $\frac{1}{4}$ ". If you wanted the thread to be usable through the entire hole, the tap would have to extend about $\frac{1}{4}$ " out the other side. If the hole was blind, a bottoming tap would get you closer but a few threads would still be too shallow to accept the bolt.



If you thread a $\frac{1}{4}$ -20 bolt into a blind hole tapped $\frac{1}{4}$ -20, it will present an increasing resistance as it reaches the shallower thread. You can tighten down until the bolt starts to fail, yet will easily come right out when you unscrew it.

So the trick is how to get the bolt in deeper so it won't come out even with a torque able to cause failure.

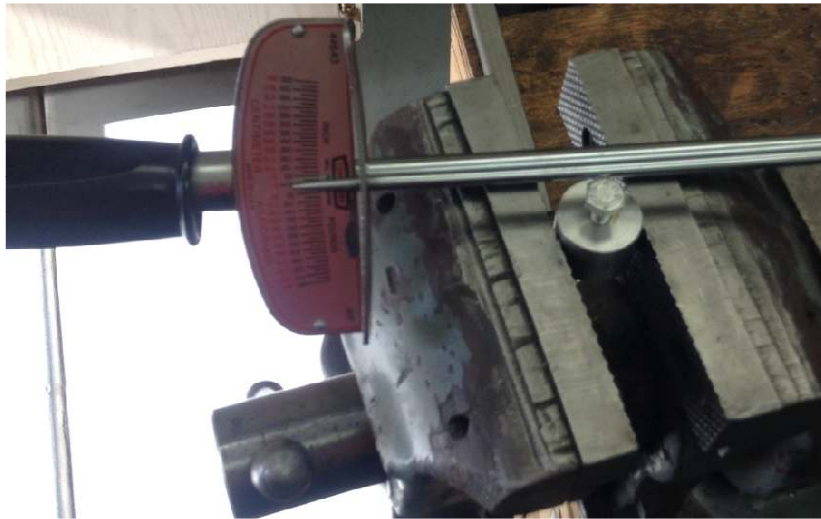


One answer is to heat the knob with a torch. This will cause the threaded hole to expand. I used a MAPP™ gas torch and shot the flame directly into the hole for 20 seconds.

I then grabbed the knob with pliers and drove the bolt in with my impact screwdriver.

The assembly was then dunked into a cup of cold water.

So how well did the bolt hold in the knob?



I clamped the knob into my bench vise and brought out my torque wrench.



At about 75 inch-pounds, the wrench started to turn. It was the bolt in failure. The bolt never turned in the knob.



I have run this test twice and both times the bolt failed before the joint.



Although I thought it was permanent, by applying the torch to the knob for 20 seconds I was able to easily unscrew the failed bolt.

Follow Up Information

I received a lot of good suggestions on alternate ways to lock in the bolt:

Rick...here's a trick that Medical Instrument techs use:

On the male threaded end...peen (or drive-punch) a small divot in the ***back*** end of the threads; that is, where it engages when the two parts are almost put together. Then thread them together, and give 'em an "oomph" on the last thread of the tightening. They will hold, but can be disassembled later, if necessary; and they won't tear up your threads on the way through.

Paul DeLisle

The above comments, formed from my experience as a Biomedical Equipment Technician; are my opinion only and do not necessarily reflect the views or protocols of my employer...but my dog thinks I'm awesome...

Rick:

Other tricks that might work: peening the ball with a center punch right at the threads, epoxy and a heat gun or heat lamp, a small dowel or roll pin, a small jamb nut...

Richard Marchi

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(author unknown but the idea is really cool):

Another thermal fit my father introduced me to when I was a kid is for something that has to rotate but never come out.

A hole is bored with the bottom of the hole turned larger...like an O-ring groove all the way to the bottom.

The shaft is made with a groove that matches the narrow part of the hole.

Heat the part that was bored while chilling the shaft.

Insert and let cool/heat. As it's all the same material you'll never get it back out but it will turn freely.

If you wanted a REALLY tight fit, but would have the danger back again, you could heat the knob AND freeze the bolt. But since it is already tight enough to break the bolt there isn't any reason to double down.

On the other hand, on larger diameter bolts you might find the failure torque on the bolt was high enough to require you to double down.

Jim Isbell

TheFreeRepublicAt.WordPress.com

(I did test this idea and found that because the steel does not shrink when frozen as much as the aluminum expands when heated, the hold is not as great)

My 2 cents to the original question. My approach is always kind of obvious, the same as you see in many knobs - set screw in the knob with small indent drilled in the rod threading. I do not know is it acceptable for particular application and what torque it can hold. So far, I used it adapting the adjustable handle to the tool post and tail stock lock.

Gennady

Rick:

Interesting enough I independently invented this about a month ago. Well, sorta kinda. No heat, but Red Loctite and over tightening the all-thread into the hole. I may have even ground an eyeballed taper to the beginning of the all-thread for more contact. So far it has held very well.

Now, just for the sake of over-thinking and hi-teching this to conclusion, if there was any doubt, you could use a GL1 tap [one expected to cut small] and then really capture the threaded rod after heating and cooling. FYI, the Hanson brand taps I've been buying at ACE Hardware have all been cutting small and have to be chased with a more major brand.

L8r,

L.H. Garlinghouse

I also received many perceptive and helpful comments on this article. This section presents experiments that addressed these comments.

Rick

Interesting test. Now try it with a high quality SHCS vs the common 'box store' fastener.

JR Williams

While I agree, I am dubious on the testing. Could the vise clamping have deformed the aluminum enough to aid in the grip on the bolt?

It would be more convincing if the test piece were held in a way that eliminated any outside crush force to the test piece. Say a couple of vertical bolts into a backer block that is held in the vise.

Ron Thompson

I addressed both of these concerns in the same experiment:



You can see that none of the clamping force is applied to the bolt. The bolt is a high quality button head screw. I was able to develop 75 inch-pounds of torque before the bolt started to turn. It did not fail.

So it looks like the thermal interference grip resists a torque under 75 inch-pounds providing the bolt does not fail first.

... heating the common aluminum alloys above 400F will permanently lower their tensile strength, so be careful. (Prolonged time-at-temperature above 250F will also weaken it.)

KL

(so noted)

Jam nuts work for that too, and you don't need a torch.

Brian Lamb



The nut was tightened with an 8" wrench. I then put my torque wrench on the button head screw and it started to rotate with a torque of less than 10 inch-pounds. The nut did not move.

Acknowledgments

Thanks to "doc" on the Atlas/Craftsman Yahoo site who suggested trying a thermal fit.

Thanks to all those sighted above for their comments and insights.

I welcome your comments and questions.

If you wish to be contacted each time I publish an article, email me with just "Article Alias" in the subject line.

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