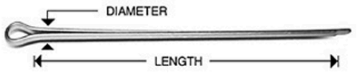
# Cotter Pins

*Michael Adams*

Cotter Pins – Part Number MS24665 - are used to secure bolts, screws, nuts, and pins. Some cotter pins are made of low-carbon steel (Formerly AN380), while others consist of stainless steel (Formerly AN381), and thus are more resistant to corrosion or where heat-resisting qualities are desired, such as forward of firewall. Use stainless steel cotter pins in locations where nonmagnetic material is required. Regardless of shape or material, use all cotter pins for the same general purpose - safetying.

Most Cotter Pins have uneven-prongs; the length measurement is to the end of the shorter prong.




Cotter pin installation is shown in Figure 1. Castellated nuts are used with bolts that have been drilled for cotter pins. The cotter pin should fit neatly into the hole, with very little side play.

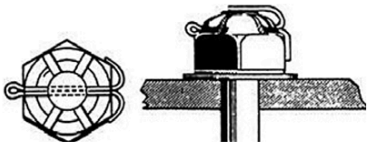


**Fig. 1**
**(Alternate method) (Preferred method)**

The following general rules apply to cotter pin safetying.

Do not bend the prong over the bolt end beyond the bolt diameter. (Cut it off if necessary as this end may interfere with other structure – Reference Fig. 5. This will also save excessive lacerations and scaring on your hands!)

Do not bend the prong down against the surface of the washer. (Again, cut it off if necessary. Reference Fig. 3)

Do not extend the prongs outward from the sides of the nut if you use the optional wraparound method.

Bend all prongs over a reasonable radius. Sharp angled bends invite breakage.

Tap the prongs lightly with a mallet to bend them.

Install cotter pins in rotating parts such as propellers, rotor heads, and the like, with head in direction of rotation.

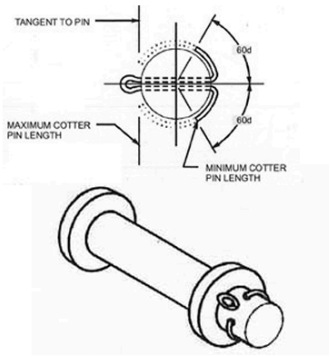
Install cotter pins in stationary bolts with heads up or facing forward whenever possible. When installing a cotter pin in a stationary bolt in a moving control (such as elevator control push rod end to elevator, carburetor mixture control rod end to carburetor mixture arm, etc.) the head of the cotter pin should be up or facing forward throughout the range of that control as much as possible.

**Fig. 2 (Correct Cotter Pin Installation)**

**Fig 3**

When safetying a clevis pin, install the cotter pin with the axis of the eye parallel to the shank of the clevis pin or rod end. Bend the prongs around the shank of the clevis pin or rod end, as shown in figure 4.

**Fig. 4**




The cotter pin installation shown in Figure 5 is a photo is of an aileron trim tab pushrod attach bolt. This is incorrect, as the bent prongs were not cut to the proper length and due to this had caused holes to be worn through the leading edge of the trim tab.

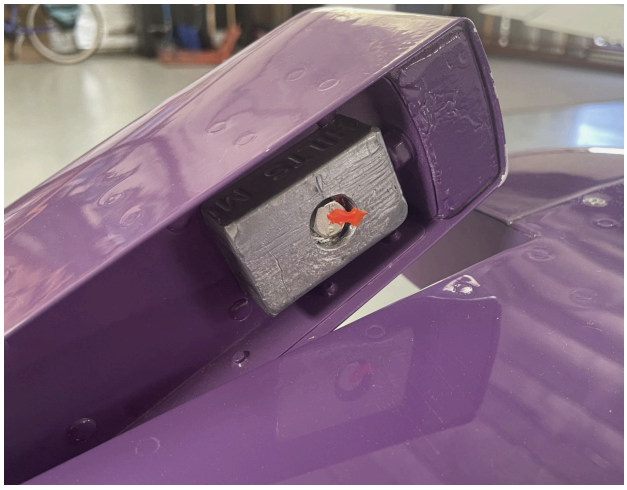
**Fig. 5**

*Related References:*
*FAA Advisory Circular – AC 43.13-1B (Section 6)*
*Standard Aircraft Handbook – Sixth Edition.*

A **torque stripe**, also known as a torque seal, is a visual indicator used to detect movement, changes, or tampering in parts that have been set to the proper tension or torque. Here's how it works:

1. Application: When assembling machinery or airplanes, builders and mechanics tighten nuts and bolts according to engineering specifications. Afterward, the person applies a thin lacquer stripe across each bolt or nut using a torque sealant.
2. Visual Detection: Once the torque stripe dries in place, it creates a seal. This is a visual indicator seal, not a structural locking seal.
3. Builder completion aid: We touch hundreds of fasteners when building our projects. Oftentimes with life interruptions, or simply time for a break. Here is an opportunity to set your standard that Unmarked fasteners are Incomplete and Marked fasteners are torqued and Complete, no further attention needed. And if that fastener needs to be removed because of some other rework required, simply scrape off the original seal and reapply.
4. Communication tool throughout  the lifetime of your project:
    a. Shows you the builder your progress.
    b. Shows your Technical Counselor the fastener is torqued.
    c. Shows your DAR the fastener is complete and good workmanship.
    d. Shows the faster status at each conditional inspection and preflight.
5. Easily available at Auto supply stores, Aircraft part suppliers and Amazon in your favorite color. I use Orange or Yellow, very easy to see and will get black on exhaust components.

Here are a few examples from my RV6 that I can easily verify the condition on every Pre-Flight.



Elevator Horn Counterweight bolt head

Rudder Jam Nut and Bolt Assembly

Aileron Hinge Bolt Assembly

Tail Wheel Parts

**Blind Rivets:**

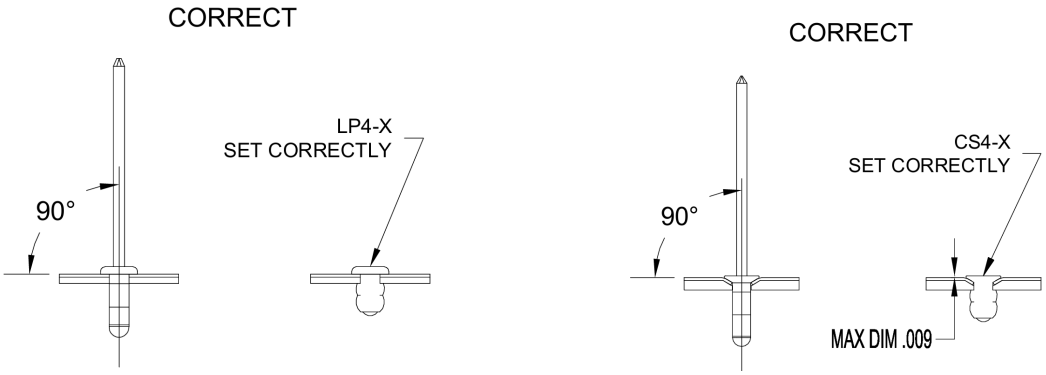
Blind rivet use has become very popular with kit manufacturers, Rans, Vans, Sport Performance Aviation Panther and Sonex are recent projects I have seen as a Tech Counselor.

What is the workmanship standard for a Blind Rivet? I call this the Accept-Reject Criteria. AC 43.13 and the Aviation Mechanics Handbook leaves this under defined.

Van's Aircraft has a fantastic builder resource called Section 5. This is a comprehensive "How-to" document covering all the aspects of building an airplane.

PLEASE download this, it is great down time reading and will answer so many questions as you build. Simply search for Van's Aircraft Section 5 and you will find a pdf version available to show on your shop big screen. And of course your particular plans govern your project and may have an equivalent document so use it.

Blind Rivet Accept Criteria:(any other condition is Reject, start over)

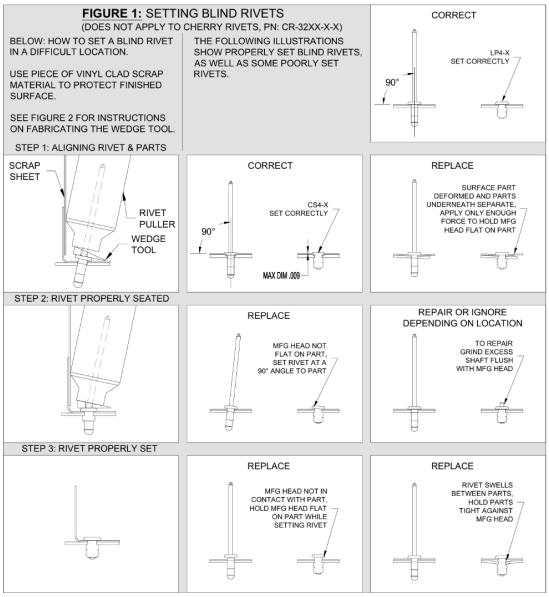


Here is an excerpt from Section 5:



**5.4 (continued)**

**METHODS FOR SETTING RIVETS**






**FABRICATING THE WEDGE TOOL**

The wedge tool provides assistance when blind riveting in locations where it is not possible to align the tool and the rivet. The wedge tool(s) will be placed between the rivet and the riveting tool enabling the riveting tool to pull the rivet from an angle, yet still achieve a properly seated manufactured head.

Step 1: Cut a length of VA-140 Trailing Edge to the length shown in Figure 2, centered on a .094 hole.

Step 2: Remove the hatched area from the length of VA-140 Trailing Edge as shown in Figure 2.

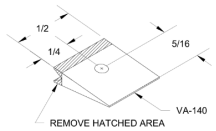


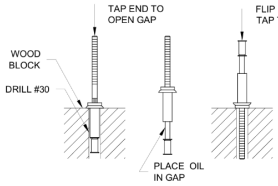

**FIGURE 2:** WEDGE TOOL FABRICATION

**CCR-246SS-3-2**

CCR-246SS-3-2 blind rivets that are specified in many locations should not be considered a replacement for 3/32" AN426 rivets that are being used in structural applications. They are acceptable for installation of nutplates or in other low load locations. When installing the CCR blind rivet it is normal for the stem to pull entirely out of the rivet.

**CHERRY RIVET LUBRICATION**

CherryMAX rivets may experience some loss of factory lubrication resulting in premature mandrel breakage. Restore lubrication by first drilling a #30 hole into a wood block, making the hole deeper than the length of the rivet. Insert the rivet, then tap the mandrel to expose a gap as shown in Figure 3. Place a drop of oil or spray lubricant in the gap then tap the opposite end to close up the gap.




VIDEO

**FIGURE 3:** LUBRICATING CHERRYMAX RIVETS



**5.4 (continued)**

**CHERRYMAX RIVET INSTALLATION**

CHERRYMAX CR32XX style blind rivets are aircraft grade fasteners of high strength but only if properly installed.

**NOTE: To achieve maximum rated strength use only the manufacturer's recommended method of installation. The *CHERRYMAX Process Manual* was the source of information for Tables 1, 2 and Figures 3, 4 and may be viewed and/or downloaded at: http://www.cherryaerospace.com/files/pdf/catalog/CA-1015.pdf**

**KEY POINTS TO REMEMBER:**

**RIVET SIZE**

Rivets must be accurately sized for each application. Proper grip length selection is critical. Only use the rivet lengths called out in the builders manual.

**RIVET HOLE**

Rivets require close tolerance holes in parts where they are being installed. See Table 1.

**TOOLS**

CHERRYMAX rivets require a greater stem pull force than common blind rivets but can still be installed with most common blind rivet installation tools. Though the PRP-26A tool recommended for RV-12 construction is not compatible with CHERRYMAX rivets neither is an expensive Cherry brand tool required.

**ALIGNMENT**

Unlike other blind rivets used in RV construction the CHERRYMAX stem cannot be pulled at an angle relative to the rivet axis. If stem is not pulled straight (parallel) to rivet hole axis premature stem breakage can occur resulting in a rivet that has not fully formed or locked.

**DRIVING ANVIL**

This small washer like device located above the manufactured head is a critical component of the installation process and **must not be removed**. It will detach on its own after the stem breaks. See Figure 1.

| RIVET DIAMETER | DRILL SIZE | HOLE SIZE | |
|---|---|---|---|
| | | MIN. | MAX. |
| - 4 (1/8")[3.2mm] | #30 | 0.129[3.3mm] | 0.132[3.4mm] |

**TABLE 1:**

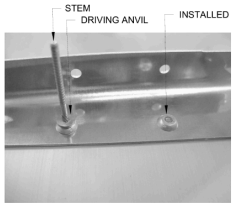



**FIGURE 1:** MANUFACTURED HEAD

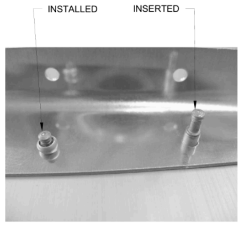



**FIGURE 2:** SHOP (BLIND) HEAD

**PROPER INSTALLATION**

Step 1: Verify tool and CHERRYMAX rivet compatibility by performing a test on an easily removed rivet, in the event that removal becomes necessary. For removal see the ***CHERRYMAX Process Manual*** mentioned earlier.

Step 2: Verify correct rivet grip length. The grip range of all CHERRYMAX rivets is in increments of 1/16"[1.6mm], with the last dash number indicating maximum grip length in 16ths (CRXXXX-X-MAX GRIP LENGTH). Example: -5 grip rivet has a grip range of 1/4"(.250)[6.4mm] to 5/16"(.313)[7.9mm].

Step 3: Insert rivet in hole and verify manufactured head fits square and flush to material surface. See Figure 1.

Step 4: Slip tool over rivet stem.

Step 5: Operate tool while taking care to not lean tool or bend rivet stem while doing so. Continue to pull rivet stem until it snaps free as shown in Figure 1.

Step 6: Inspect rivet to confirm proper installation per the following criteria:

Nearly flush surface due to stem fracture at top of manufactured head. See Figures 1 and 3.

Typical fastener flushness acceptance criteria is shown in Figure 3 and listed in Table 2. Locking collar is to be flush with top surface of rivet head. Collar flash permissible is .020 max. Stem flushness shall be as indicated.

Base of manufactured head should be tight against surface of material being riveted. See Figure 1.

Stem will not be pulled fully into rivet body at shop head end, but rivet body should have formed (closed up) around stem. See Figures 2 and 4 for acceptable blind head formations.

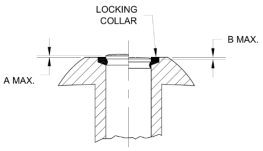



**FIGURE 3:** FLUSHNESS
(RIVET CROSS SECTION - NOT TO SCALE)

| RIVET DIAMETER | A MAX. | B MAX. |
|---|---|---|
| - 4 (1/8") [3.2mm] | .010 [.25mm] | .015 [.38mm] |

**TABLE 2:**

TYPICAL MIN. GRIP | IRREGULAR FORMATION MIN. GRIP | TYPICAL MAX. GRIP

**FIGURE 4:**
ACCEPTABLE BLIND HEAD FORMATIONS

Why use primer between steel parts and aluminum?

Because the Dissimilar Metal Alloys generate a Galvanic Couple, an Anode and Cathode, causing corrosion. I have included a cheat sheet I used in my early mechanical design career when I designed infrared night vision systems for the Navy A7 carrier fleet.

Galvanic series of selected metals in Seawater from MIL-STD-889

A galvanic series is a listing of metal and alloys based on their order and tendency to corrode independently, in particular electrolyte solution of other environments.

Galvanic series relations are useful as a guide for selecting metals to be joined. The closer one metal is to another in the series, the higher in the series alloy represents the anode, and will corrode preferentially in the environment.

Metals widely separated in the galvanic series must be protected when they are joined, A small anode area relative to the cathode area should be avoided, irrespective of the metals involved.

## GALVANIC SERIES OF SELECTED METALS IN SEAWATER
## FROM MIL-STD-889

ACTIVE (Anodic)

Magnesium (Mg)
Mg Alloy AZ-31B
Mg Alloy hk-31A
Zinc (hot-dip,die cast or pltd)
Beryllium (hot pressed)
Aluminum (Al) 7072 cl. on 7075
Al alloy 2014-T3
Al alloy 1160-H14
Al alloy 7079-T6
Cadium (plated)
Uranium
Al alloy 218 (die cast)
Al alloy 5052-0
Al alloy 5052-H12
Al alloy 5456-0, H353
Al alloy 5052-H32
Al alloy 1100-0
Al alloy 3003-H25
Al alloy 6061-T6
Al alloy A360 (die cast)
Al alloy 7075-T6
Al alloy 1160-H14
Al alloy 6061-0
Indium
Al alloy 2014-0
Al alloy 2024-T4
Al alloy 5052-H16
Tin (plated)
Stainless steel 430 (active)
Lead
Steel 1010
Iron, cast
Stainless steel 410 (active)
Copper (plated,cast or wrought)
Nickel (plated)
Chromium (plated)
Tantalum
AM350 (active)
Stainless steel 310 (active)
Stainless steel 301 (active)
Stainless steel 304 (active)
Stainless steel 430 (passive)
Stainless steel 410 (passive)
Stainless steel 17-7PH(active)
Tungsten
Niobium (Columbium) 1% Zr
Brass, yellow, 268
Uranium 8Zr Mo.
Brass, Naval, 464
Yellow brass
Muntz metal 280
Brass (plated)
Nickel-Silver (18% Ni)
Stainless steel 316L (active)
Bronze 220
Copper 110
Red brass
Stainless steel 347 (active)
Molybdenum, Comm. pure
Copper-Nickel 715
Admiralty brass
Stainless steel 202 (active)
Bronze, phosphor 534 (B-1)
Monel 400
Stainless steel 201 (active)
Carpenter 20 (active)
Stainless steel 321 (active)
Stainless steel 316 (active)
Stainless steel 309 (passive)
Stainless steel 17-7PH(passive)
Silicone Bronze 655
Stainless steel 304 (passive)
Stainless steel 301 (passive)
Stainless steel 321 (passive)
Stainless steel 201 (passive)
Stainless steel 286 (active)
Stainless steel 316L (passive)
AM355 (active)
Stainless steel 202 (passive)
Carpenter 20 (passive)
AM355 (passive)
A286 (passive)
Titanium 5Al, 2.5 Sn.
Titanium 13V, 11Cr,3Al(annealed)
Titanium 6Al, 4V(treated & aged)
Titanium 6Al, 4V(annealed)
Titanium 8 Mn
Titanium 13V,11Cr,3Al(treated & aged )
AM350 (passive)
Silver
Gold
Graphite

NOBLE (Less Active-Cathodic)