All About Rivets...

And fixing your riveting problems

JACK DUECK, TECHNICAL COUNSELOR

RIVETED CONNECTIONS REPRESENT 80 to 90 percent of aircraft structural fastenings in a metal aircraft. Consequently, rivets and riveting will occupy much of your time while building an amateur-built sheet metal aircraft. This article looks at the common AN solid rivets we use almost exclusively in our solid rivet applications.

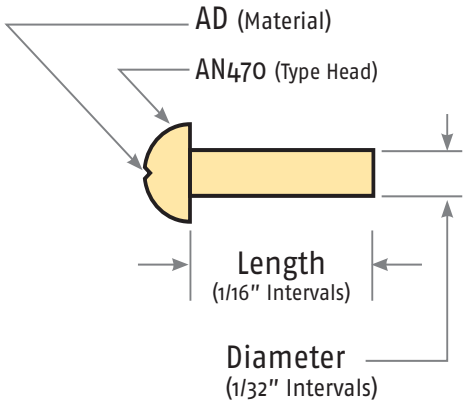
WHY RIVETS?

Aluminum alloys in connections don't easily lend themselves to connection methods such as gluing, welding, or other bonding methods; therefore, rivets offer the most attractive fastening device. Rivets are light (2117-T4 aluminum alloy), strong (26,000 pounds per square inch [psi] in shear and 38,000 psi in tensile strength), corrosion-resistant (aluminum alloy), and easily formed or set (although a degree of skill and care is required in the setting operation), and a group of properly set rivets presents a pleasing appearance.

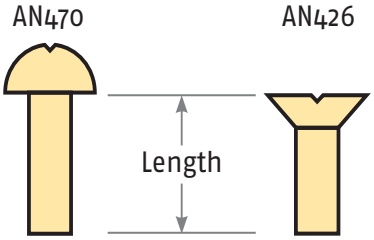
Rivets are identified with a standard nomenclature by which we can immediately recognize the rivet. In the designation AN470AD4-5:

- The letters AN tell us that the rivet is manufactured to the Army and Navy specification;
- The number 470 designates a universal (or semi-round) head;
- AD tells us that the rivet material is of 2117-T4 alloy;
- The 4 conveys that the rivet diameter is 4/32 inch (or 1/8 inch);
- And finally, the -5 shows that the rivet shank is 5/16 inch in length.

SOLID RIVETS



RIVET HEAD SHAPES



PHOTOGRAPHY BY **BRADY LANE**

Similarly, if we consider the designation AN426AD3-8, the number 426 indicates a flush head, the number 3 indicates this rivet has a diameter of 3/32 inch, and the -8 tells us that the rivet length is 8/16 inch (or 1/2 inch).

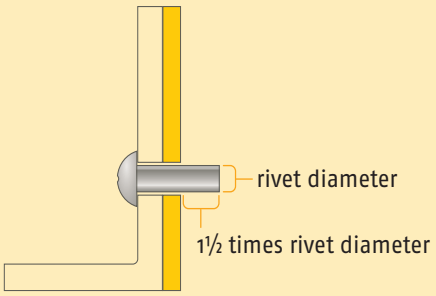
SETTING SOLID RIVETS

Solid rivets are set or formed by applying a series of hammer blows to the factory manufactured head of the rivet while holding a bucking bar (or a mass of metal) to the shop end of the rivet. (This is the mushroomed head created on the backside of the rivet... sometimes called the field head.) During these blows the rivet first swells to fill up the hole surrounding it, and then the rivet shank deforms and balloons out to form the field or shop head. (A variation of setting a rivet includes a "back riveting" procedure in which the hammer blows are directed at the rivet shank, and the bucking bar is held against the factory head.) A rivet gun is used to apply the hammer action.

In the series of sketches below, the rivet is placed into the prepared hole in the material connection. Next the rivet gun (with the appropriate rivet set) is placed and held firmly against the rivet factory head. The bucking bar is placed against the rivet shank. And then the rivet gun is triggered to hammer or shape the rivet.

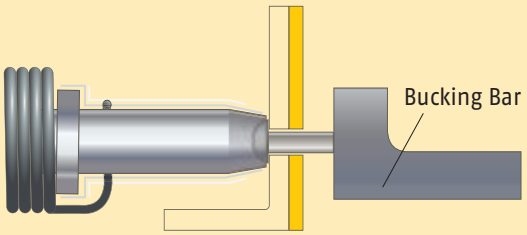
RIVET SETTINGS

1



Note how the hole is slightly larger than the rivet and the rivet extends through the material 1.5 times the rivet diameter.

2



The rivet gun with rivet set is placed firmly against the factory head of the rivet. The bucking bar is held lightly to the shop head of the rivet.

ILLUSTRATIONS BY **GARY COX**

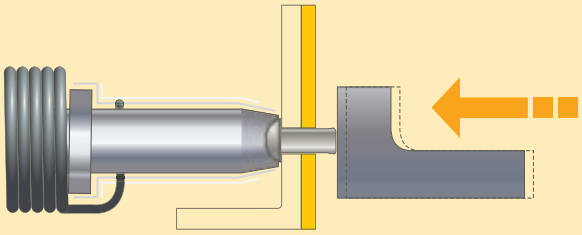
RIVET	MATERIAL CODE	HEAD MARKING	ALLOY	ULTIMATE STRESS
	A	Plain	1100	16,000 psi
	AD	Dimpled	2117	38,000 psi

The operation is simple, but it takes some time and patience to get to the craftsman stage in setting rivets. Initially, just trigger the gun lightly to allow a few taps to start the setting process. This initial light action will swell the rivet shank to the dimensions of the hole and will start the setting or ballooning action of the shank end. Once these light taps have set the stage, increase the trigger pressure to complete the setting process.

EXPERIENCE WILL TEACH YOU TO OBSERVE THE FOLLOWING:

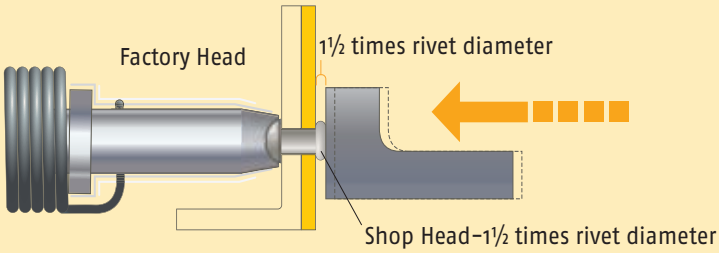
- Always clamp your work pieces so they don't move during the process. If necessary, have a helper hold the material while you do the riveting. (If you're working on a larger component, such as an aircraft wing, the mass of the component will suffice to prevent the work from moving, and you can work from one side while your helper works on the opposite side.)
- Hold the rivet gun and set firmly against the factory head, not letting it come away from the rivet.
- Bring the bucking bar up to the work as you're operating the gun. The gun should be fixed; the bucking bar moves with the rivet shank toward the work material as it is set.
- Make sure that you're in the most favorable body stance for the operation. If

3



A few taps of the rivet gun locks the rivet in place. Note how the rivet has swelled to fill the hole and the length has decreased slightly.

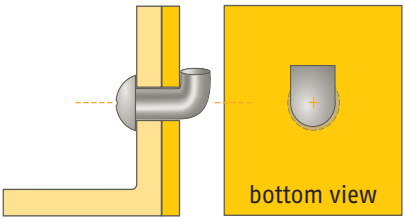
4



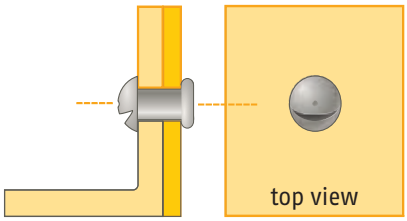
A short burst of the rivet gun sets the rivet. Notice that the shop head of the rivet has deformed concentrically around the shank and now has a diameter of 1.5 times the rivet diameter. Also note the height of the shop head of the rivet has reduced from 1.5 to 0.5 diameter.

DEFECTIVE RIVETS

"DUMPED" RIVET

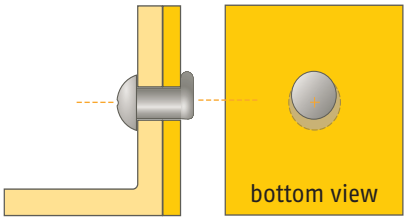


"SMILEY" RIVET



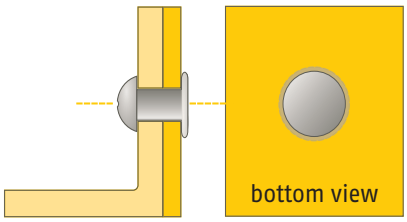
Although this rivet has been driven to the correct dimensions, the rivet gun was allowed to come off the rivet head during setting with the result of the smiley. The degrading of the factory head is sufficient to necessitate this rivet be replaced.

NON-CONCENTRIC SETTING

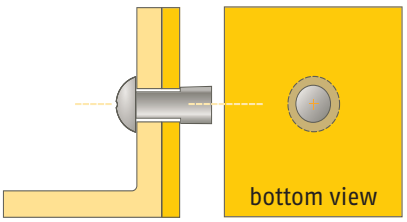


Rivet shop head has been driven non-concentric

OVER-DRIVEN RIVET



UNDER-DRIVEN RIVET



ILLUSTRATIONS BY GARY COX

you are leaning or over reaching, your grasp of the gun and its situational stability will be degraded.

- Practice! To develop riveting skills, set up a practice regime of setting 20 rivets in a piece of scrap material for 10 days in a row. You will be amazed at the skill that you'll develop.

- Finally, inspect every rivet after it is set. Use a rivet gauge and critique your own work.

DEFECTIVE RIVETS

When are rivets good and when should they be replaced? Here are five common riveting errors.

DUMPED RIVETS The length of the rivet is important. If the shank portion of the rivet extending through the material (before setting) is more than 1.5 times the rivet diameter, the tendency will be for the rivet to "dump." In the sketch, the rivet stem has not ballooned concentrically, but has bent or dumped over. If the hole in the material is substantially larger than the rivet diameter, there will also be a tendency for the rivet to dump.

A dumped rivet should always be replaced. The shop head does not give the rivet the strength required by the design.

NON-CONCENTRIC SETTING If the bucking bar is improperly applied to the center of the rivet and has allowed the rivet to be driven over to one side of its centerline, the narrow part of the shop head will not offer the strength to the connection. In the sketch you can see that although the shop head is formed correctly, it is not centered on the shank of the rivet.

A non-concentric rivet is very much like a dumped rivet in that it does not provide the design strength to the connection. Like the dumped rivet, it should also be replaced.

SMILEY RIVETS When driving a universa1 (round-headed) rivet, if the rivet gun is allowed to come away from the factory head of the rivet, it will hit the rivet off-center in its next hit. This will cut into the rivet head, leaving the telltale "smiley face." You will need to assess if the damage to the rivet head is severe enough and ugly enough to justify replacement.

Assessing the rivet's strength calls for a subjective evaluation. Ask yourself, how much does the damage to the rivet factory head degrade its strength? Obviously, if the smiley cut is minor and does not cut into the head seriously, you may decide that it's okay. However, if the head is seriously cut and the rivet is obviously degraded, it should be replaced.

OVERDRIVEN RIVETS If you overdrive a rivet, you will exceed the driven shop diameter as well as reduce the height of the shop head. An overdriven rivet degrades the connection strength somewhat, but the greater danger is a distortion of the thinner plates of the material joint with overdriving. Besides, it's ugly!

The question of whether to replace an overdriven rivet is also a subjective one. The strength of this defective rivet is slightly degraded, and the decision would rest upon your ability to replace it with a properly driven rivet. In many instances a replacement rivet is more difficult to drive properly than an original one. So it's your call. Suffice it to say that if the rivet is acceptable in appearance, it is probably better to leave it alone than to replace it.

UNDERDRIVEN RIVETS: Underdriven rivets substantially reduce the connection strength. The good news is that an underdriven rivet can easily be corrected by some additional setting.

RIVET GAUGE: A rivet gauge is a useful tool to check the quality of your driven rivet.

You can easily make a rivet gauge. Use a scrap of metal of thickness approximately equal to one-half the rivet diameter. Drill a hole of 1.5 times the rivet diameter and shape the scrap as shown. The gauge should just fit over the driven shop head, and the rivet head should be flush with the top of the gauge.

REMOVING DEFECTIVE RIVETS

To remove a defective rivet, follow these steps:

REMOVING A RIVET – STEP BY STEP

Drill Rivet Head

Pry Off Head

Insert Pin Punch

Drive Out Rivet Shank

PHOTOGRAPHY BY **JACK DUECK**

- Drill a hole (same size as the original) into the head of the rivet, using the rivet dimple to help locate the center. Drill only through the head (either universal or flush).
- Insert a pin punch into the hole and pry off the head.
- Support the material on the back side, and using the pin punch, drive the remaining rivet shank out.
- Replace the rivet with the same size and type of the original rivet, provided that the hole has not been enlarged.

I find that this works about 50 percent of the time. If there has been any swelling of the rivet between the materials of the joint, or if the hole has not been drilled precisely in the center of the rivet, this will be impossible. The only solution is to drill right through the rivet and contend with a larger hole.

SUMMARY OF A RIVETING EXPERIENCE

- Drill and prepare a correct diameter hole into the materials to be joined.
- Insert a rivet and look (or check with a gauge) that the appropriate 1.5 times the diameter extends through the material.
- Clamp or hold the material so that it is held firmly.
- Initiate the setting operation with the gun held firmly against the factory head of the rivet, the bucking bar brought lightly to the rivet shank or shop head, and trigger the gun for a few taps to help swell the rivet.
- Add trigger pressure, bringing the bucking bar toward the material as the rivet is being set.
- If riveting a connection with a thin material, be careful not to overdrive the rivet, distorting the material.
- Inspect and check your rivet to see if it passes your critical standard. EAA

For more information on riveting, order Jack Dueck's book, *Sheet Metal Building Basics*, at *www.ShopEAA.com*, or call 800-564-6322 (outside USA and Canada call 920-426-5912).