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COPING WITH DRILLED HOLES

Ancient oriental lore has it that Man is not perfect (nothing is said of Woman), nor can he create or produce anything that will be perfect - only the Gods are perfect. Hence, artisans and craftsmen of old, fearful of making the Gods angry, deliberately flawed any of their beautiful creations that turned out to be perfect.

Perhaps that same latent fear has filtered through the cosmic dust of the ages and has settled over us impacting our own western culture. Now that I think of it, maybe that's why some of my best work appears to be flawed. Could it be that I, too, instinctively fear incurring the wrath of the deities of old with my perfect workmanship? Other less informed builders fearlessly forge on with their projects in search of perfection.

Perfect workmanship is not really necessary but good craftsmanship is - if you want to build a beautiful and safe airplane.

Good workmanship often eludes us, not so much because we lack the skill and know-how, but more often because we fail to study a particular plans detail, or fail to re-read and follow the instructions.

Instead, we plow on and, when we can, hurry the completion of those simple but repetitious tasks . . . just to get them out of the way. That's when we are most apt to goof.

Consequently, we are ever so often jolted out of our complacency when we see - with chagrin - that we have just drilled an unnecessary hole, or maybe drilled one in a bad location. Then, just as often as not, we add to our problems by committing more blunders. Things like forgetting to drill one of the holes before starting to rivet, or failing to notice one has not been dimpled. And how about the embarrassing discovery that you have carelessly countersunk several holes too deeply.

When you look back at what you have done, you realize most of the problems encountered could have been avoided . . . and that "good enough" is not the same as "good" or "excellent."

I could go on and on, describing other self-induced problems everyone can and should avoid . . . as a matter of fact, I will.

The Right Hole In The Right Place

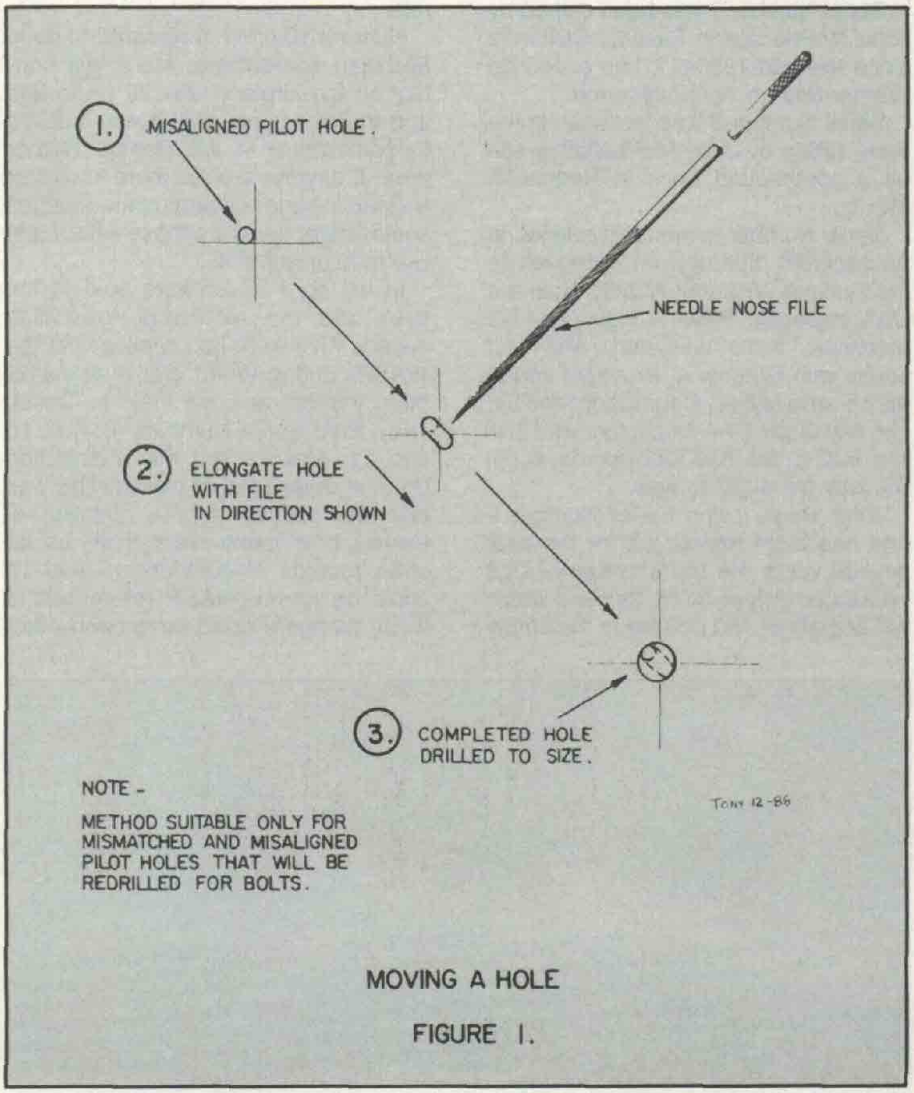
That is easier said than done. In the RV-6, as in any metal project, you will have to drill thousands of holes, and deburr and dimple (or countersink) them before you can do any riveting.

You will, therefore, have thousands of opportunities to drill a bad hole now and then. Just what do you think the odds are for any builder to drill all those countless holes perfectly placed and perfectly round? I don't know, but if each bad hole were a lottery winner, there'd be countless new millionaires gambolling out of workshops every weekend.

How's Your Hole Drilling Technique?

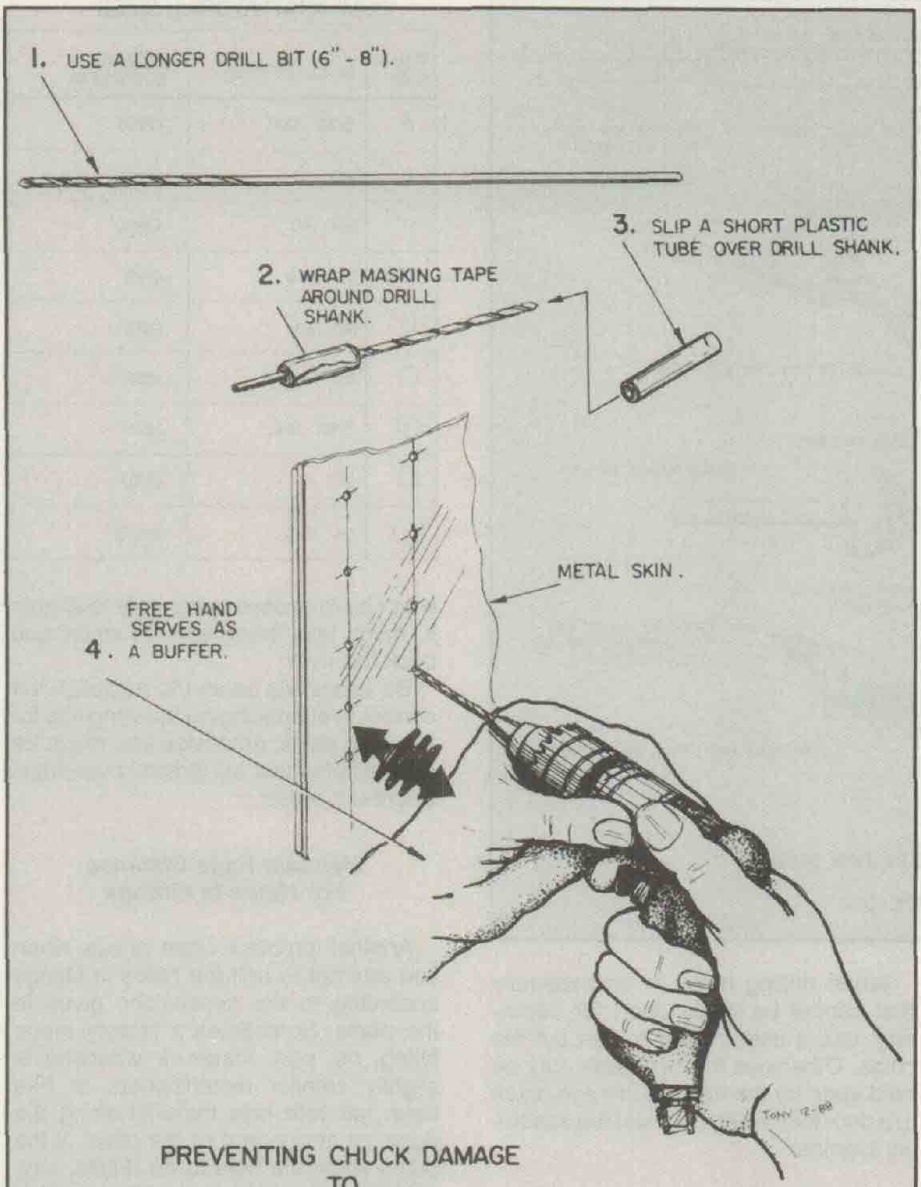
What can you do to improve your hole drilling averages?

First, be sure you have the correct



MOVING A HOLE

FIGURE 1.



PREVENTING CHUCK DAMAGE TO METAL SURFACES

FIGURE 2.

size bit (new or freshly sharpened) chucked in the drill. This is important because it is so easy to goof. A careful craftsman will check the drill size with a drill gauge before he chucks it. For example, you cannot, otherwise, distinguish a No. 40 bit from the slightly smaller No. 41.

When you are engrossed in what you are doing and have had to switch - a number of times - from a No. 30 bit (for 1/8" rivets) to a No. 40 bit (for 3/32" rivets), you may not notice that the larger drill bit is still in the drill. Should you pick up the drill and unwittingly start drilling a 1/8" hole when it should have been, like all the others, a smaller, 3/32" diameter hole, you have a problem. You are stuck with that larger hole and will have to install a larger diameter rivet . . . and that could lead to other complications involving dimpling, or machine countersinking.

Always Start With A Pilot Hole

The safest practice, in the long run, is to drill ALL holes, initially, with a small bit (3/32", No. 40 or No. 41), and Cleco or clamp the parts to maintain alignment as you progress. Later, if necessary, you can redrill whatever holes require it to the correct larger diameters with the added assurance that your holes will be perfectly aligned.

If the initial matching pilot holes are slightly misaligned, you will still have a chance to correct the misalignment with a small needlenose file - but only if you had the foresight to start with a small pilot hole (see Figure 1).

How To Start A Hole

Drilling nice round holes in thin aluminum skins (.016"-.025") requires extra care, especially if you won't take the time to center-punch mark each hole location with an automatic punch. (Drill bits are prone to walk, and will spin across the skin leaving an ugly trail permanently etched into the metal.)

How do the following drilling techniques compare with your own drilling style?

1. Start by pressing the point of the drill firmly against the metal, but be sure to hold the drill perfectly perpendicular to the surface. Squeeze the trigger lightly. If all is going well, and the drill point stays on the mark, complete drilling the hole.

2. Another less risky way to start drilling a hole is to press the drill point against the mark, and turn the chuck by hand a half turn or so before squeezing the trigger.

In either case, do not push on the drill too hard because, at the moment the bit starts to break through the metal, the lips of the drill bit (especially in light aluminum skins) will have a tendency to grab on the thin edges remaining around the hole and cause the drill to tilt suddenly.

This sudden uncontrolled lurching of the drill bit will surely cause the hole to become irregular, enlarged or elongated. But there can be another complication, too.

Preventing Drill Chuck Damage

The standard small No. 40 and No. 30 drill bits are rather short, something less than 3 inches long. So, drilling those countless rivet holes in your nice shining aluminum skins with one of these short bits invites the risk that you may, inadvertently, allow the drill chuck to grind against the aluminum when the drill bit breaks through.

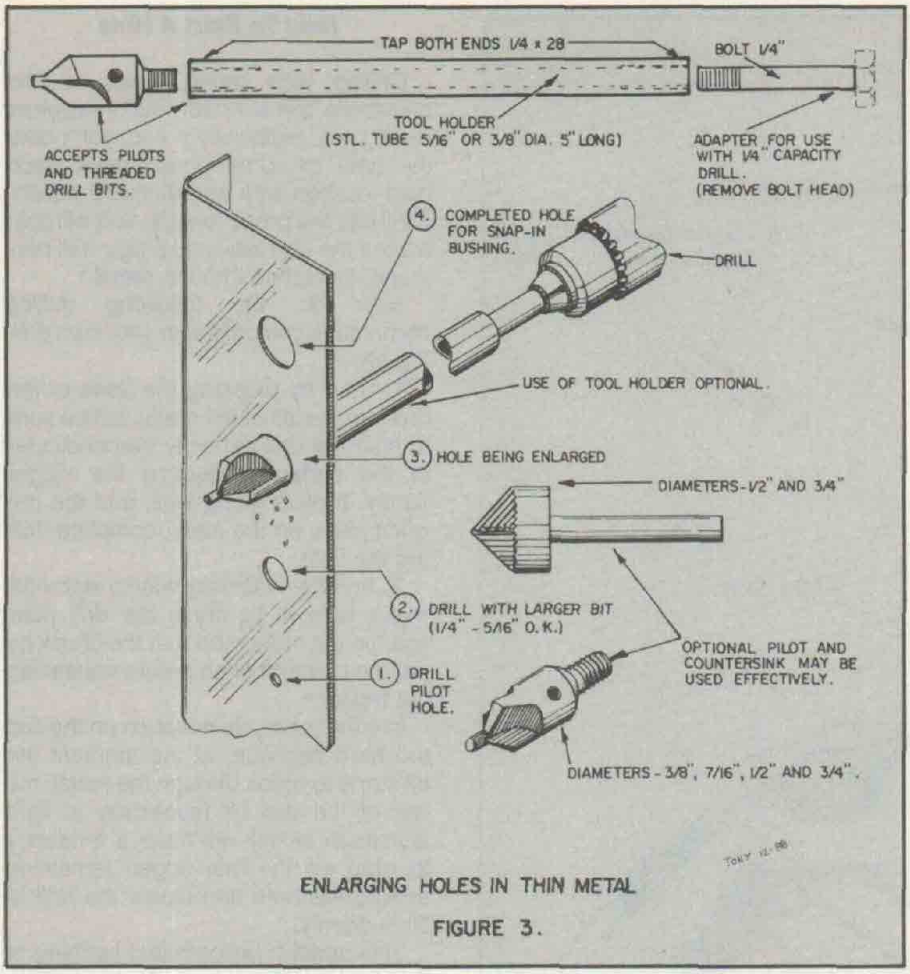
You can avoid this sort of skin damage by somehow preventing the chuck from hitting the metal skin (see Figure 2).

1. One way is by grasping the front end of the drill with your free hand and using it as a buffer.

2. Another way is to use a longer drill bit (6-8" long) . . . it will give you more time to react.

3. And still a third way - slip a plastic sleeve (tube) over the shank of your short drill bit, or wrap the bit shank with several turns of masking tape to form a protective sleeve. I like this way best. It is simple and effective.

You could also wrap the shank of your special No. 41 bit with a turn of masking tape to distinguish it from the regular No. 40 drill.



ENLARGING HOLES IN THIN METAL

FIGURE 3.

About Deburring . . .

Deburring all holes is essential to good workmanship. It is tedious and a most disliked chore. In addition to removing the very obvious burrs that interfere with the fit of the rivets and the proper mating of metal parts, there is another good reason for deburring each hole. By lightly chamfering (deburring) the hole, its sharp jagged edges are removed, reducing the possibility of stress cracks originating around the hole.

A hole can be drilled cleaner and easier in 2024 T3 sheet than in the softer 6061 T6 metal. The 6061 T6 aluminum is so much softer that the drill bit pushes out a lot of metal on the back side when it breaks through.

A sharp bit helps reduce this tendency, as does a reduction in pressure on the drill bit just as it is on the verge of breaking through. You can sense when this is about to happen if you are concentrating on what you are doing and are normally sensitive to mechanical symptoms.

The removal of burrs from around a hole in 6061 T6 requires a greater pressure on the deburring tool and, therefore, there may be a tendency to overdo it. That is to say, don't remove so much metal that you begin to countersink the hole.

When drilling holes in an assembly that cannot be taken apart for deburring, use a chip chaser to fish out the chips. Otherwise the two parts may be held apart by the metal burrs and result in a poor joint when you rivet the assembly together.

Rivet Hole Layout Patterns Help But . . .

Do not "blindly" drill your aluminum skins following dimensions and spacing for the rivet layout provided with the plans. You will find you often have to make small deviations in the rivet spacing in order to avoid riveting difficulties later.

Always check the suggested rivet spacing shown in the plans against the dimensions of your own structure. Be sure there will be no interference (angles, nuts, bolt heads, etc.) behind any of the proposed rivet hole locations. Also assure yourself that no rivet hole will fall too close to the edge of a rib or part.

You can normally space rivets closer than the spacing recommended, if necessary, but don't exceed that designated nominal spacing. All of these things are important to ascertain beforehand - or you may learn that you won't have access to the hole to dimple it, much less being able to insert and buck the rivet.

Be especially careful to establish the correct rivet spacing on the wing ribs for the wing skins, otherwise you might be drilling holes that fall directly over flutes or cut-out areas.

COMPARATIVE DRILL SIZES

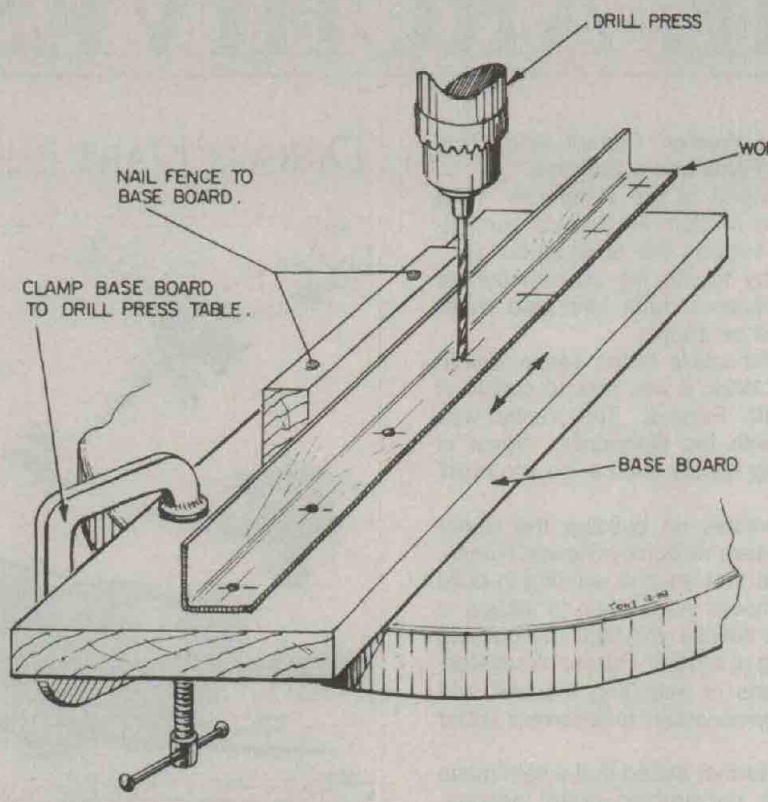
VISUAL SIZE	DRILL BIT SIZE	DECIMAL EQUIVALENT
o	3/32" DIA.	.0938"
o	NO. 41	.0960"
o	NO. 40	.0980"
O	1/8" DIA.	.1250"
O	NO. 30	.1285"
O	NO. 19	.1660"
O	3/16" DIA.	.1875"
O	NO. 12	.1890"
O	1/4" DIA.	.2500"

Maintain Edge Distance For Holes In Fittings

Another problem often arises when you attempt to drill the holes in fittings according to the dimensions given in the plans. Sometimes a factory made fitting, rib, part, flange or whatever is slightly smaller dimensioned, or has been left with less material along the edge, or at one end or the other. If the plans show the hole to be drilled, say, 1/4" from the edge in the drawing, the recommended spacing hole in your particular fitting or part may actually cause it to fall only 3/16" from one of its edges . . . sometimes less. So, be alert to this difficulty. Also, be sure that the hole, as drilled, will allow sufficient access for installing the nut after the bolt is inserted. This tricky situation is particularly applicable to the installation of aileron hinge brackets. If you have to, the only thing you can do is to move the hole locations inboard slightly to maintain an acceptable edge distance.

Drilling Holes In Close Quarters

In areas of difficult access, due to the closeness of adjacent structural parts, about the only way you can drill a hole is with a 90 degree angle drill. It is very difficult to build a metal airplane without having an angle drill. However, sometimes an alternate solution to the problem may even be better.



HOLE ALIGNMENT JIG

FIGURE 4.

In some close quarters, a long 12" drill bit chucked in your drill will allow you to drill closer to a corner or flange than may be possible with your 90 degree angle drill. The long bit can be easily flexed with your fingers to place the point of the drill bit (and the drilled hole) exactly where you need it. Naturally, center-punch the hole location first, if you can.

The next time you have a problem hole to drill, think of using a long bit as a possible solution.

What To Do About Bad Holes?

The odds are such that you will drill a bad hole now and then. And where will it usually be? You guessed it . . . on the top surface where it would be highly visible.

What can you do when you accidentally drill a hole where there is nothing at all behind the metal skin? In other words, the hole is simply not needed. Just go ahead and install a rivet anyway. Nobody will know that it is not doing anything and it probably won't even be noticed. Anyway, that is a better fix than trying to fill the hole with Bondo or some other filler.

Once in awhile a 1/8" domed rivet head is so badly damaged by the rivet gun that you can't tell where the center of the rivet is. Drilling out such a rivet invariably results in a botched job. The hole becomes so enlarged that a replacement rivet fits too loosely and will not carry its required load. The usual fix is to install the rivet anyway. Then, if the structure permits, drill a new hole on either side, halfway between the poor rivet and the next one. That added rivet should help to better distribute the load.

Dimpling Considerations

When the holes for 3/32" rivets are intended to be dimpled, switch from the normally used No. 40 drill bit to the next size smaller No. 41 bit because the dimpling process enlarges the holes slightly. A better rivet fit will be assured with the undersized No. 41 bit.

What if you did use the regular No. 40 bit instead of the smaller No. 41 drill for holes that had to be dimpled? Or what if one of your holes has become slightly enlarged after drilling out a bad rivet. Don't despair. The solid 3/32" rivets used will normally expand and fill the holes adequately . . . provided you use the correct rivet length.

However, do not count on a pop rivet to do the same. It will not expand to fill a sloppy hole and, therefore, its gearing strength will remain rather low. About all that pop rivet will have going for it will be the clamping pressure produced by its pulled/upset end . . . and that's really about all that will be keeping the parts together.

Drilling Large Holes

By large holes I mean any hole larger than 5/16" in diameter. You will find such holes to be easier to drill if you first drill a small pilot hole for the larger bit. A good pilot hole is one that will be slightly larger than the large drill bit's tip (point) you intend to use. Normally, either a 3/32" or a 1/8" drill bit works good for drilling pilot holes.

As a rule, you would turn the drill fast for small holes and much slower for larger holes.

Avoid enlarging any hole size in small increments, especially in steel. This is hard on the drill bit because trying to run a larger drill into a hole that is only slightly undersize imposes all of the cutting force on the extreme outer edges of the lips and flutes. In other words, it is better to go immediately to the final size drill bit from the start rather than incrementally switching to larger and larger bits.

Most builders agree that it is always difficult to drill a large perfectly round hole in thin aluminum sheet. Although it is helpful to hold a block of wood behind to stabilize the drill bit's point as it breaks through, there is a better way.

Try this method of drilling the larger 3/8", 7/16", 1/2" or 3/4" holes you'll need for the installation of snap-in bushings and grommets.

First, drill a pilot hole and then enlarge that hole with a bigger bit, say one 5/16" in diameter. Next, chuck one of your pilot cutters or countersink tools in your drill and use it to drill and ream the hole to the diameter of the countersink tool selected.

The hole will be (gasp!) perfect (see Figure 3).

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