

Piano Hinges

How and where to use 'em

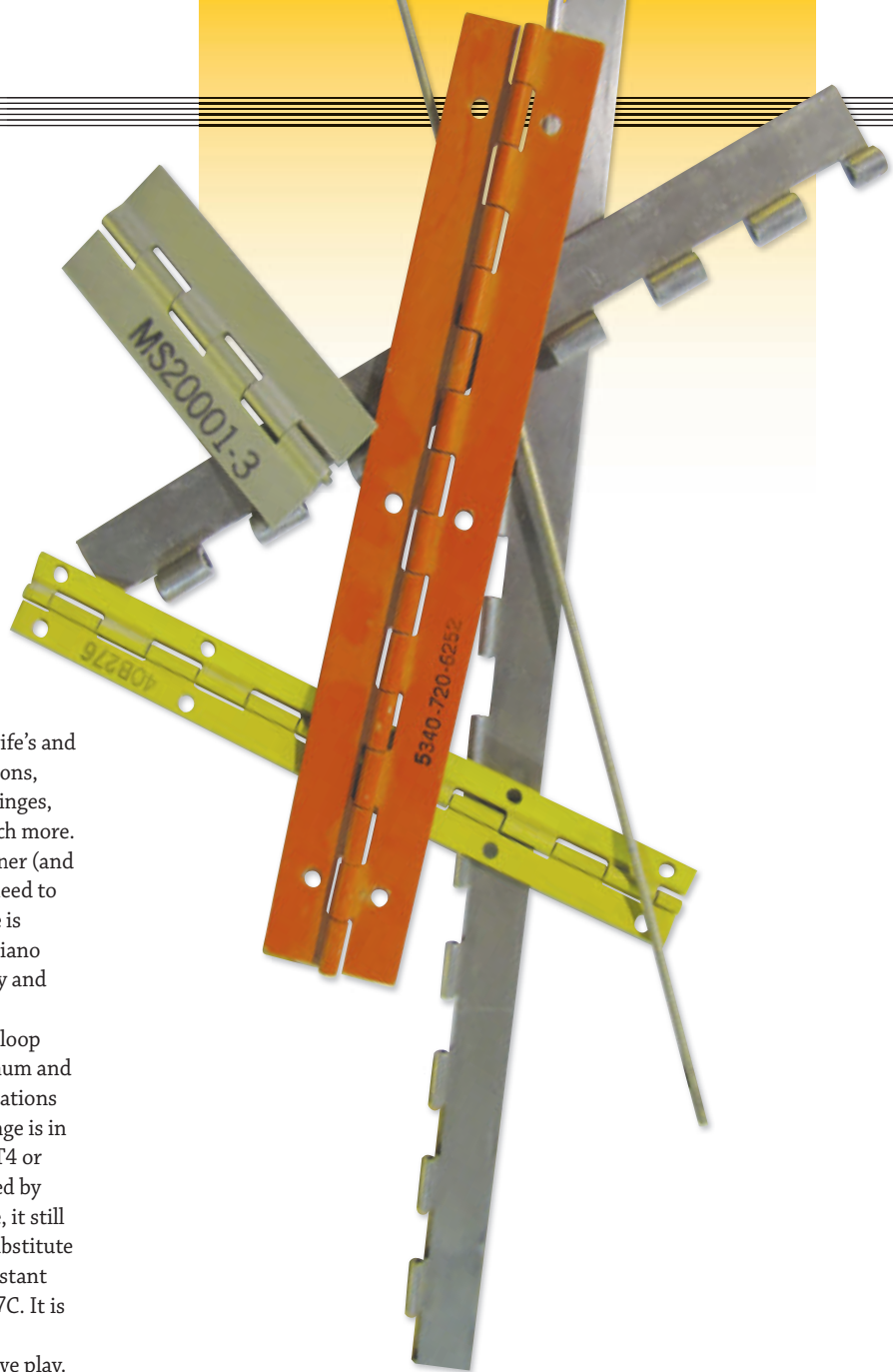
JACK DUECK

THE PIANO HINGE HAS many uses in amateur-built aircraft. On my wife's and my RV-4 and RV-9A we have used piano hinges in numerous applications, including cowlings connectors, oil access doors, flap hinges, trim-tab hinges, canopy hinges, seat-back hinges, hinge-pin safetying devices, and much more.

The piano hinge can be used in two ways: as a hinge and as a fastener (and sometimes as both). If you use this versatile product as a hinge, you need to keep a fairly straight hinge line. Over a long expanse, where the hinge is bound to flex (as on an aileron), it is best to use separate sections of piano hinge. If used as a fastener, the hinge line can bend quite substantially and still work well as a quick disconnect device.

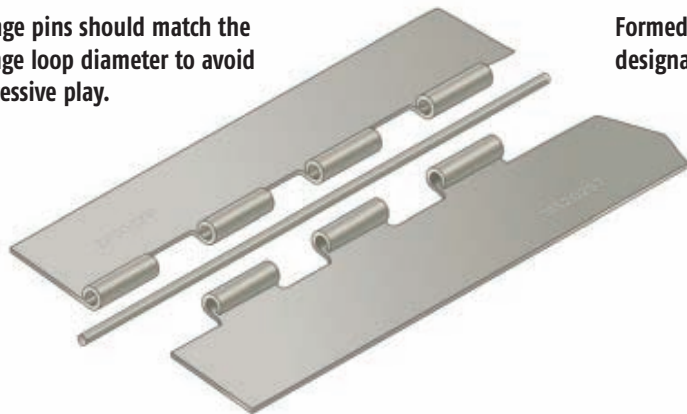
Piano hinges come in two types. The most common is the formed loop and is designated as Mil Spec MS20257. The other is extruded aluminum and is designated as MS20001. This hinge is stronger and is used in applications where high strength is necessary. One application of this stronger hinge is in the V-tail section on the Sonex Waix. It is composed of either 2024-T4 or 7075-T6511; both are strong aluminum alloys and have been hardened by heat treatment. While the formed loop (MS20257) is the weaker type, it still finds many applications in our aircraft. However, you should never substitute this hinge if the stronger extruded hinge is specified. A corrosion-resistant stainless steel piano hinge is also available under the call-up of AN257C. It is substantially heavier and consequently not often used.

Hinge pins should match the hinge loop diameter to avoid excessive play.



FORMED AND EXTRUDED PIANO HINGE

Hinge pins should match the hinge loop diameter to avoid excessive play.



Formed loop piano hinge
designated by MIL Spec MS20257



Extruded aluminum piano hinge
designated by MIL Spec MS20001

PROTRUDED OR CONCEALED PIANO HINGE

APPLICATIONS

Hinges can be installed with the loops protruding (or exposed) or concealed, depending on the application. When used as cowl fasteners they are normally concealed. On many hinge applications such as on a trim tab, you would see them installed protruding, allowing easier inspection of the hinge and hinge pin.

Piano hinges are installed using procedures common to homebuilding. Fit the first half to one component, drill the rivet holes, de-bur, fasten with a Cleco, and so on. Then, when you're satisfied with the fit, rivet and fasten the hinge to the component. When fitting the second half, make sure the two components are properly aligned, with the hinge pin installed, held, or jiggled to remain in place. Next, drill the holes in the second half using Clecos to fix the components as you go along. I like to drill the holes in the hinge pieces first so that I can drill to the component on assembly. When attaching the piano hinge to a component, don't crowd the component against the hinge loops. If you do, you may find that the two component halves rub together at the hinge line when the hinge is pinned to its other half. A little space will give you a better result.

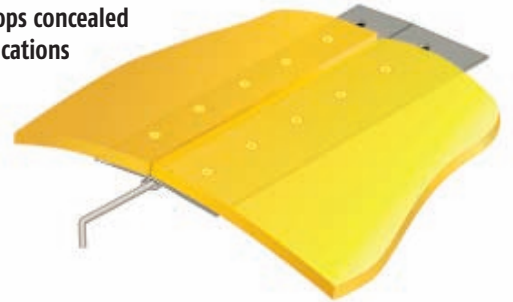
COWLING APPLICATIONS

One of the most common and popular uses of a piano hinge is as a connecting or fastening device for cowl components. On our RVs the cowls are composed of two halves—an upper and a lower half. A piano hinge fastens these halves together, and the cowl is then fastened to the airframe with

Hinge loops protruding
flat applications



Hinge loops concealed
flat applications



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another piano hinge. In this application the piano hinge provides a useful, quick, and solid structural connection.

The RV cowlings were designed to use the piano hinge as a fastener, and consequently, we chose to use this method. The piano hinge provides a uniformly distributed load throughout the cowling, whereas a series of Dzus fasteners provides point loads to the cowlings, and the cowlings would most likely have to be strengthened to accommodate this design change.

It is important to make sure you have trimmed and fitted the cowl halves together to provide a fit that is without stress, coming together tightly and correctly. Spend additional time trimming and fitting until the two components fit together without the need of any pressures or forces to make things fit. The piano hinge should be there only to connect the components, not to force them into shape.

We like to fasten our hinge halves to the cowling (or for that matter any fiberglass components) with a lay-up of glass cloth and epoxy resin (an idea from the ski industry, where steel components are bonded to fiberglass skis), as well as with rivets. When we have the cowl fitting properly and have prepared both the cowl and the piano hinge, drilled and de-burred for rivets, we further prepare the cowl by roughing up the area that will contact the hinge half. We also drill a series of 1/4-inch holes in the hinge as shown in the sketch. This provides more surface contact for the resin to hold onto. Next, we rough up the hinge half to help bond the resin.

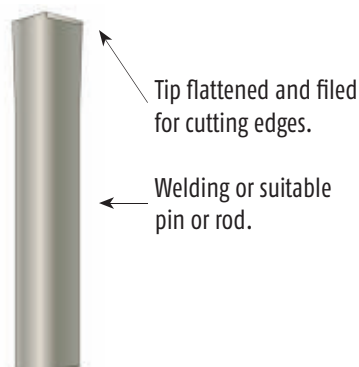
INSTALLING A PIANO HINGE ONTO A COWLING

We lay a strip of fiberglass between the hinge and the cowl and then place Clecos in each hole to hold the assembly together tightly while riveting the components together. Use the AN426A "soft" rivets; they will not crush the cowl material when you squeeze them. Available from Aircraft Spruce & Specialty, these rivets have about one-half of the tensile

strength (16,000 psi) of the common AN426AD rivets (38,000 psi). Do all of this before the resin cures. Be sure to use only as much resin as necessary, since it will find its way into the hinge loops, making it difficult to insert the hinge pin.

ROD FORMED INTO A LONG DRILL BIT

When the resin has cured, clean out the areas where excess resin has formed to allow the cowl halves to fit together without interference. Shape one end of a length of 1/8-inch copper coated welding rod into a drill bit by pounding the end flat and then filing the cutting edges as shown in the sketch. Insert this long "drill bit" into a slow-turning drill and use it to clean out any resin that has collected inside the hinge loops. When all cleaning is done, insert a hinge pin into the loops and closely check to see how each loop aligns with the pin. Using a pair of pliers, adjust any loop as necessary.



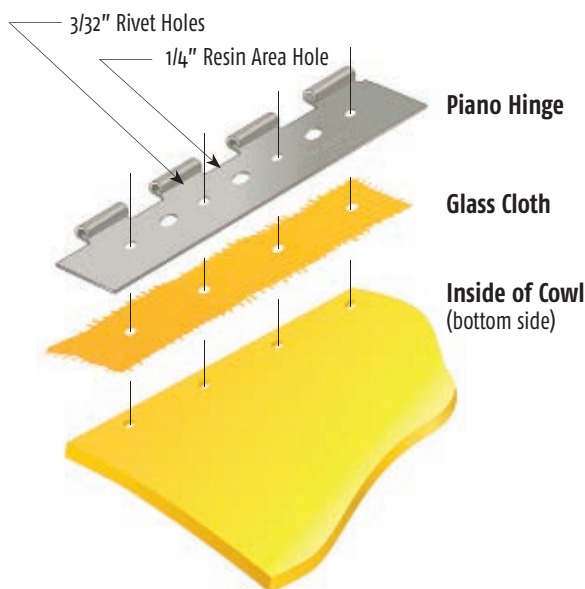
Now fit the cowl halves together and insert the pin. It is common to find resistance to inserting the pin the first several times. You may need a pair of pliers spaced about 1 or 2 inches in front of the cowling to insert the pin a few inches at a time. If you grind a bullet head to your piano hinge pin, it will be easier to insert. With time, the fit will loosen and the pin can be inserted with relative ease. Remember, you want a firm fit at all times. A loose fitting cowling will quickly wear or fatigue through vibration.

When we have completed the cowl installation, we change the hinge pin to a stainless steel pin for long life and wear resistance.

SAFETYING HINGE PINS

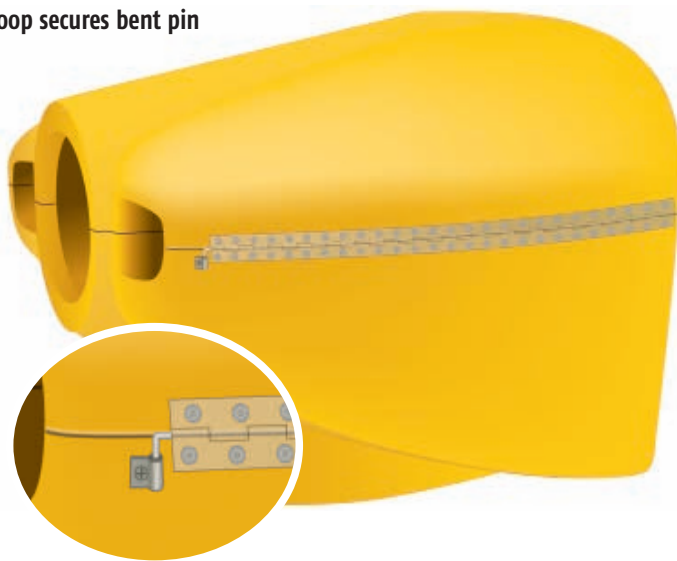
On our RV-9A the piano hinge that fits the top cowl to the aircraft ahead of the instrument panel has a tendency to migrate from vibrations. To prevent this from happening, we installed a bar behind which the pin is locked. This works quite well, but it adds difficulty in removing and installing the pin and cowling. (I once had an in-flight engine fire caused by a bird's nest, and after an emergency off-field landing, I spent an agonizing time undoing the

COWLING INSTALLATION



HINGE LOOP AS SAFETY DEVICE

Hinge loop secures bent pin

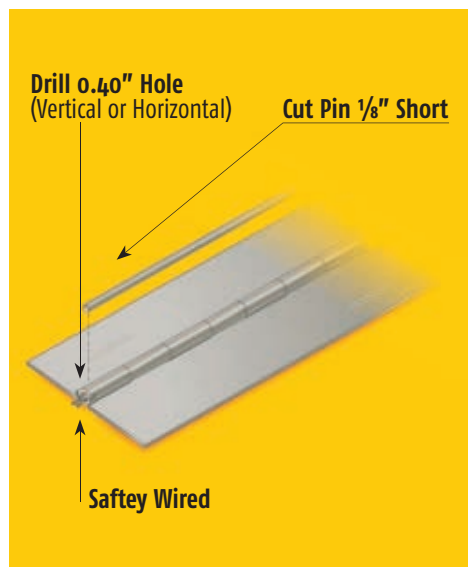




cowl to get at the fire; all the time watching the paint on the cowl blister as I worked feverishly on the cowl fasteners.)

I have also heard of a cowl hinge pin working its way forward and cutting through a wooden prop in flight. Not a happy thought! Several methods have been used to ensure this will not happen. A simple method is to bend a 90-degree end to the hinge pin and then insert this end into a hinge loop that is in turn fastened to a nut-plate mounted on the inside of the cowl. When bending the hinge pin, use heat to bring the pin to a cherry color before bending it so that you don't introduce a bending crack into the hardened hinge pin.

SAFETY WIRED PIANO HINGE



A method we used on our RV-9A is to weld a formed steel plate to the front end of the hinge pin. This plate has two holes for No. 6 screws, one to fasten to an upper cowl nut-plate and the lower one to fasten to the lower cowl nut-plate. This seems to work well and has the advantage of adding a secure fastening system to the front opening between the two cowl halves.

Another method is to cut the hinge pin about 1/8-inch shorter than the hinge and drill a No. 40 hole in the loop near the end of the hinge. This can then be safetied with safety wire as shown in the sketch below.

WORN PIANO HINGES

One of the first signs of a worn piano hinge will be the fatiguing of several loops. This may be accompanied or followed by "smoking" rivets. The hinge will fatigue across the loops.

This is the result of vibrations and will almost always also cause loosening of the rivets holding the hinge. Loose rivets show a halo around the outside of the rivet factory head. This halo is simply an accumulation of the materials that are being worn away around the rivet as well as material from the rivet. It looks like a dirty smudge that can be wiped away with a cloth, only to return again under use.

On my RV-4, I had built a hinge support doubler for my oil access hinge, out of 0.032-inch 2024-T3 Alclad. Within a couple of hundred hours of flight time, both the doubler and the hinge loops had fatigued. I replaced the doubler with one made out of 0.063-inch 4130 steel plate, and the mass increase in this doubler solved the problem.

Hinge pins are also subject to wear, especially if the pin is kept in a fixed position such as when it is safetied in a manner that does not allow it to turn.

Test your applications for wear as part of the preflight inspection. When you encounter this problem, deal with it promptly. It is most likely caused by excess play in hinges and accelerated by engine and airframe vibration. Replace hinge pins if they show signs of wear or if they become loose, giving excess play to the parts. Replace the entire hinge if fatigue of the loops has occurred.

With care and proper installation, a piano hinge provides an excellent hinge or connection, giving hours of secure flight. *EAA*

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