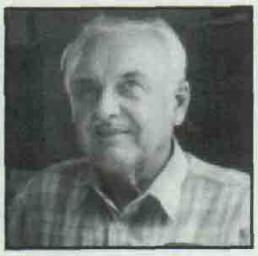
SPORTPLANE BUILDER

Tony Bingelis



STRETCH-FORMING PLEXIGLAS PARTS

You haven't earned your homebuilder stripes until you have tried your hand in stretch-forming Plexiglas (or, for that matter, any other brand of transparent acrylic plastic.) I assure you it is an interesting and worthwhile undertaking because it gives you the opportunity to fabricate small custom made plastic parts not otherwise available for your particular project. Two typical needs come to mind. Specially contoured landing light lenses, and Plexiglas wing tip nav/strobe light lenses.

Some years back, while building my Falco, I decided to build Hoerner-type wing tips into my wings. I never did like the ordinary rounded add-on wing tips so common today.

A Hoerner tip is easy to recognize. The same upper airfoil section shape of the wing is maintained all the way to and including the wing tip. This feature permitted me to skin the outer portion of the upper wing surface all the way to the tip with the same sheet of plywood. The result was a nice clean wing sans the usual joint for an add-on wing tip. The bottom skin was then fitted and bent up to blend into the upper airfoil shape at the tip end creating a sharp edged saber-like wing tip.

This modified Hoerner wing tip looked nice and was reputed to increase the effective span (more lift), and gently dissipate the wing tip vortex while effecting a reduction in drag. All that sounded mighty nice but it was not until months later when I decided to cover the wing tip navigation and strobe lights, a la "pheasant under glass" style, that I suddenly realized I had created a problem for myself.

Either I would have to leave the navigation and strobe lights exposed to the slipstream and reshape the cut-out area to streamline the installation area somewhat, or I would have to fabricate my own plastic wing tip lenses.

As you might surmise, it would have been much easier had I followed the plans and purchased a set of the stock Falco wing tip plastic lenses produced for the standard wing tip . . . but I didn't, so herein lies the tale.

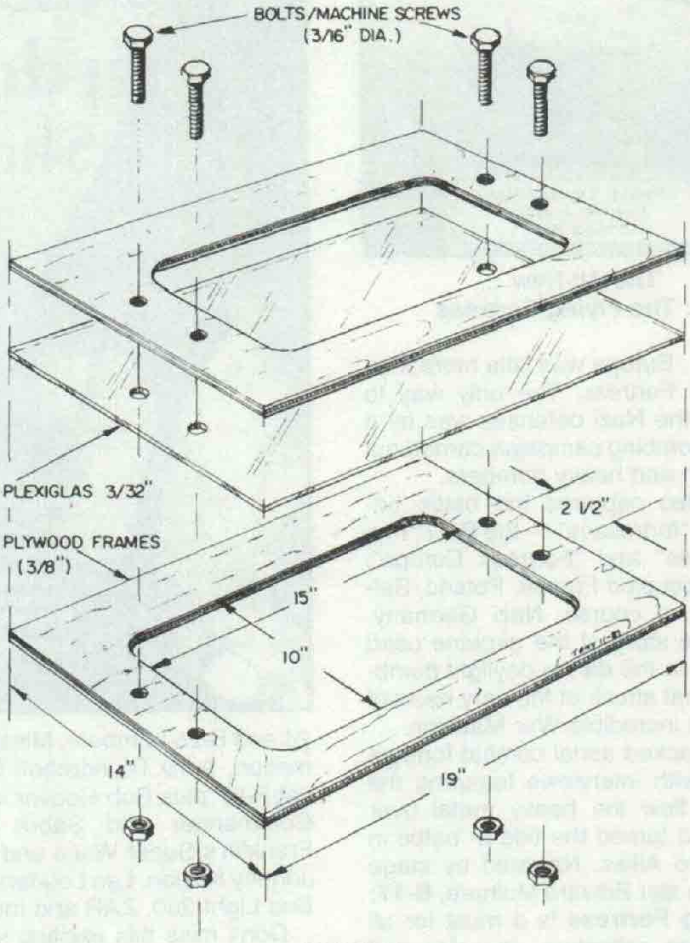


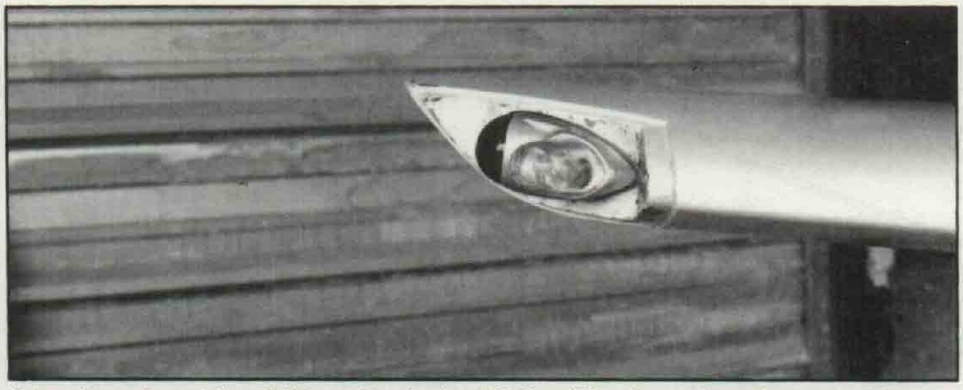
FIGURE 1.

PLEXIGLAS STRETCHING FRAME DETAILS

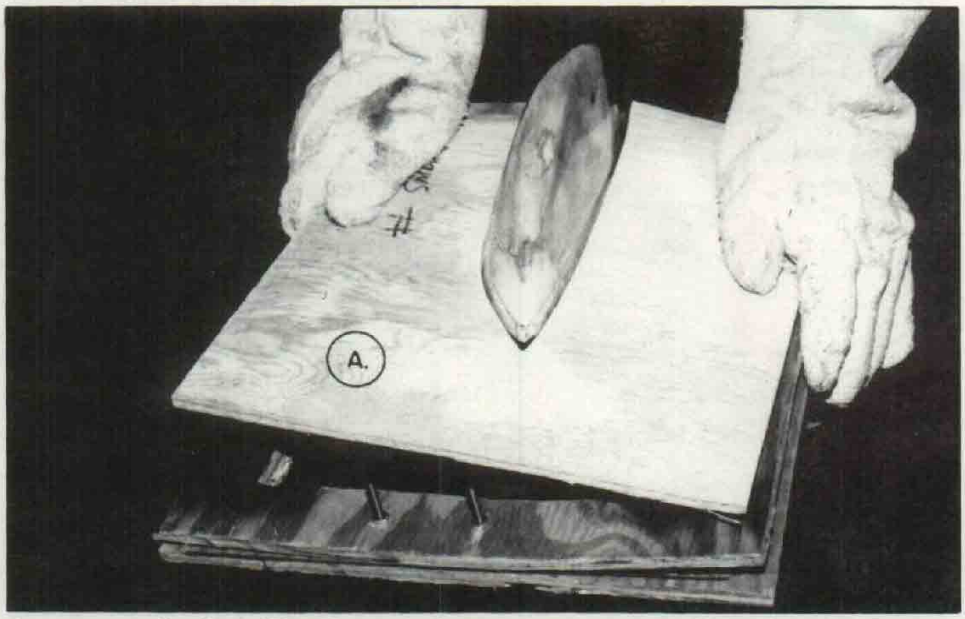
The Lexan Fiasco

Why not make the wing tip lenses out of Lexan? Well, I tried to do just that. After all, Lexan is a remarkably tough plastic that can even be bent 90 degrees in a metal bending brake without cracking. But, alas, it is not as versatile a material as I assumed it to be. Admittedly, it does have unusual qualities, but some peculiar trait surfaced and stubbornly resisted my attempts to stretch-form it over a male mold.

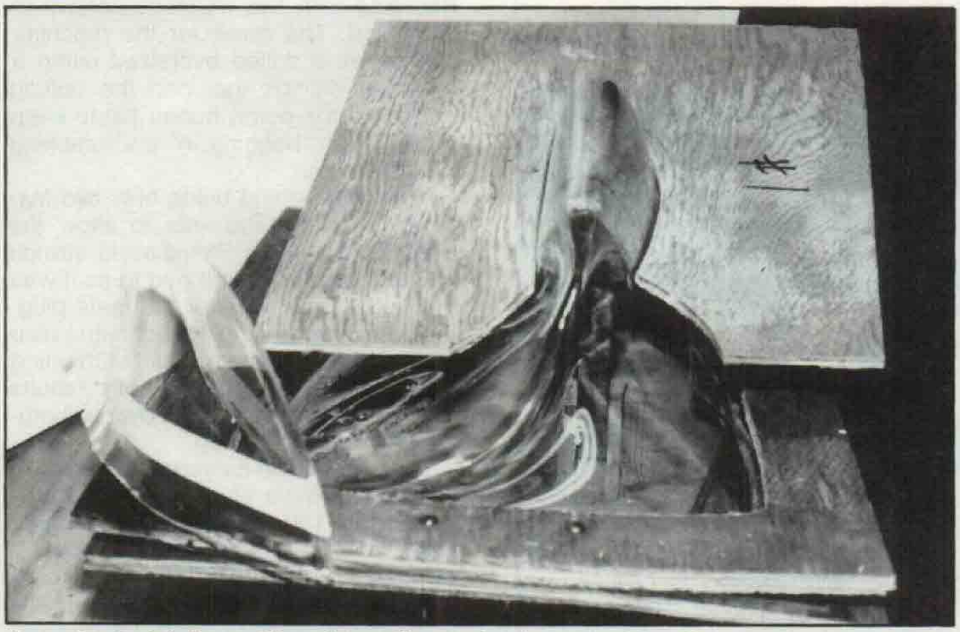
I thought I had done it right. I put a large piece of Lexan in the oven and heated it to about 350 degrees F. Then, quickly, I stretched it down over my prepared male plug . . . that is, I **tried** to stretch it down over the wood plug. Gad, what a sight! That semi-formed piece looked like some sort of solidified plasma from outer space infused with milky bubbles and other indescribable art forms. My first (and last) attempt to stretch-form a set of clear light lenses



A head-on view of the right nav/strobe installation. The sharp tip makes stretching the Plexiglas to conform a real challenge but it was done several times successfully.



As soon as the Stretching Frame is forced down over the Male Plug, the Contour Restraining Template (A) is also quickly forced down over the stretch-formed Plexiglas. Note the heavy gloves.



A newly stretch-formed lens is cooling under the restraining Contour Template. In the foreground is another lens masked with masking tape to aid the final trimming with a Dremel tool. The cut-out area in the plywood is to relieve the pressure on the Plexiglas where the end of the Male Plug is cut square.

from Lexan was a total failure. Right there and then, I decided that the Falco looked good enough in spite of its exposed nav/strobe lights.

NOTE: I was told later — much later — that I should have conditioned the Lexan by preheating it to remove the moisture before attempting to form it. That could be, but I was no longer interested in trying to stretch-form the stuff. The only thing I know about it first hand is that it does bend good in a bending brake, and that a guy could easily bend a nice one-piece angular windshield from Lexan — if he had a nice open cockpit job that needed one.

Two Years Later

Time does fly, doesn't it? For at least two years, my longtime EAA friend, Seth Hancock, had been trying to convince me that it was a disgrace to fly that Falco without wing tip lenses covering the nav/strobe lights. However, I was not at all swayed until one day he offered to take me by the hand and help me stretch-form a couple of wing tip light lenses from Plexiglas. That did it . . . I finally saw the light (ugh!).

It was not long after that day that Seth showed up at my garage workshop with Plexiglas, plywood frames, and welders gloves in hand and said, "Now, let's do it."

It was so easy. But like most everything else involved in building an airplane, the preparations took the longest. The actual stretch-forming of the Plexiglas was quick and anti-climatic. Here is what was involved.

Making the Male Plugs

Naturally, two forming blocks (or male plugs) had to be carved, one for the right wing tip and another for the left. Of course, if you have to make a landing light lens to grace the pointed nose of a VariEze or Long-EZ, all you'd need would be one forming block. (You could, in that case, use a propeller spinner as a male plug and not even have to make a special forming block.)

I believe the best type of forming block, for manually stretch-forming Plexiglas, is a wooden one. However, you could make yours of a polyester, or epoxy glass reinforced lay-up if you prefer.

Obviously, the male plug surfaces must be smoothly finished to prevent irregularities being embossed into the formed Plexiglas.

The makers of Plexiglas (as do most manufacturers of other brands of acrylics) recommend that the surfaces of the male plugs or wood forms be covered with a soft cotton flannel cloth, velvet or billiard felt. We found that to be unnecessary and stretched the

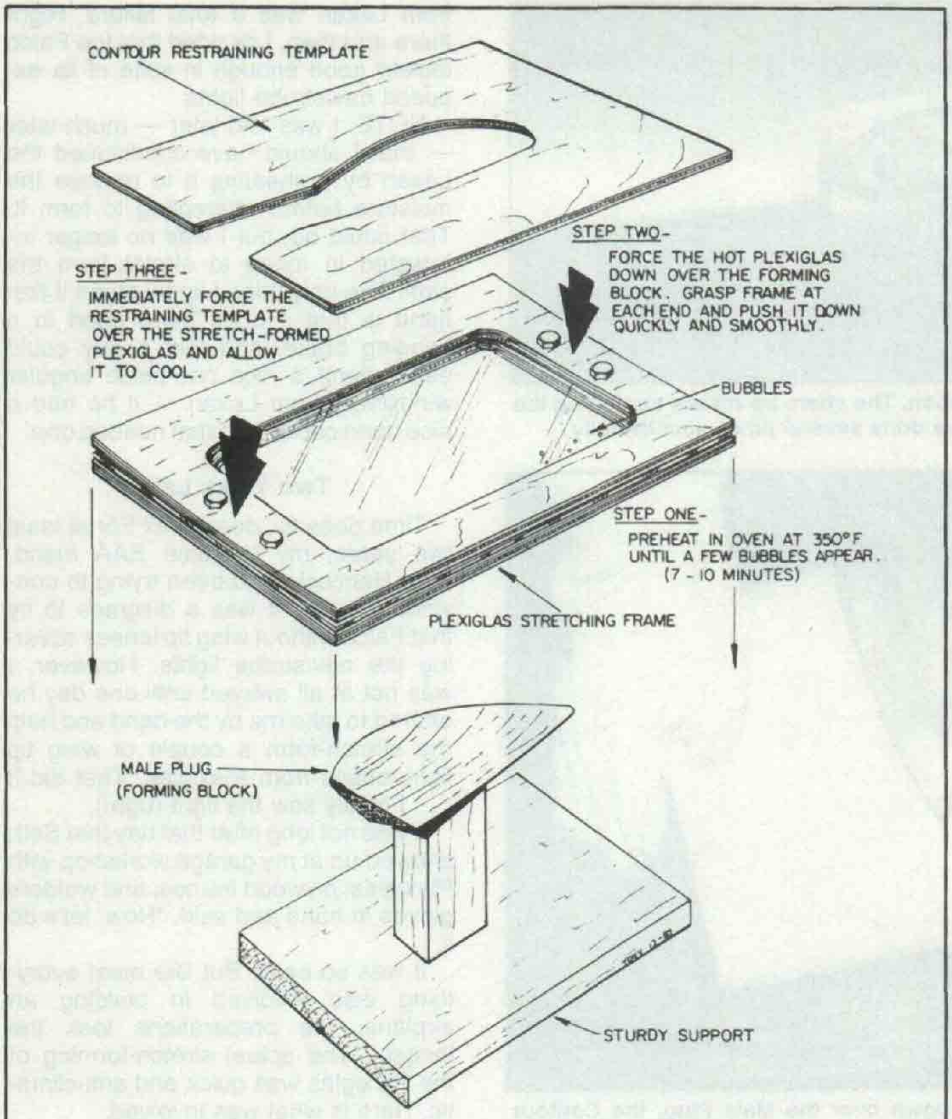
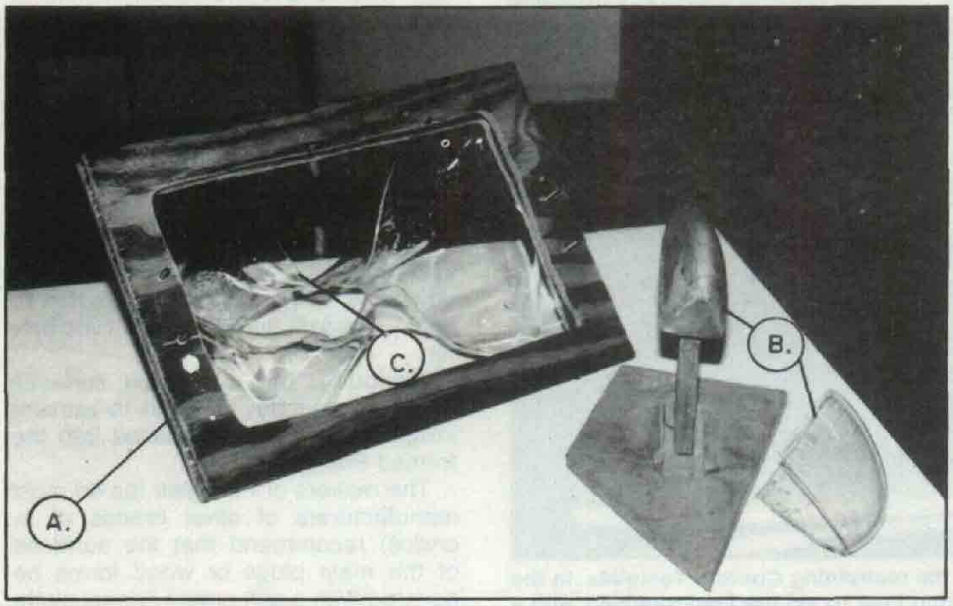


FIGURE 2.

STRETCH-FORMING PLEXIGLAS



Here we have the participants. The Stretching Frame (A): the wood Male Plug (B): and the trimmed Lens. Still in the Stretching Frame (C) is the distorted Plexiglas remnant.

Plexiglas directly over the smooth (dust free) male mold.

Incidentally, my forming blocks were made years ago. During the wing's construction, blocks of wood were lightly glued into the cut-out areas in the wing tips intended for the nav/strobe lights. These were then carved and shaped to the correct three-dimensional wing tip contour before I installed the plywood wing skins. This procedure enabled me to accurately duplicate the complex wing tip shape in the male lens plugs. Later I separated the male plugs from the wing tips and glued extra pieces of wood on the ends to provide a one inch extension of the plug's shape beyond that portion that was to be formed. This, in effect, enlarged the male plug to provide the necessary extra edge for attaching the Plexiglas covers to the wing tips.

Finally, I scored trim lines on the surface of the forming block to aid in accurately trimming the lens after it was formed. CAUTION — Be sure your scribed trim line includes that extra margin needed for attaching the covers.

Making A Plexiglas Stretching Frame

We found that a modified manual "plug-and-frame" stretch-forming method was effective for us — that is, it worked the very first time in spite of the severe compound curves that made up the male plugs.

First, two window-like frames were cut from 3/8" plywood (that's all we had) so that a piece of 3/32" thick Plexiglas could be sandwiched between them. These frames were then secured to the Plexiglas with two machine screws in each end. The holes for the machine screws were drilled oversized using a modified drill bit that had the cutting edges (at the point) honed flat to keep the bit from "hogging in" and cracking the Plexiglas.

The idea behind using only two fasteners in each end was to allow the heated rubber-like Plexiglas to stretch in whatever direction it had to as it was being pulled down over the male plug. This minimum clamping technique also seems to reduce the amount of thinning in the Plexiglas that normally results when you stretch the sheet over a sharply contoured male plug.

Each of the two carved wooden forming blocks (male plugs) measured 10" long by 2-1/4" high by 3-1/4" deep. Seth's instinct served him well when he decided to make the plywood stretching frame 14" by 19", with a 10" by 15" window cut into each of them. As it turned out that was just what we needed. Studying the illustration should clarify what all these words mean.

Making A Contour Restraining Template

After that hot pliant Plexiglas has been stretched down over the male form it will tend to pull away from the bottom edges of the form. This pull-away-tendency can be controlled by quickly forcing a plywood template down over the stretched Plexiglas while it is still hot and plastic.

We also cut this Contour Restraining Template from 3/8" plywood. Its cutout opening must duplicate the shape of the male plug, with an additional clearance all around equal to the thickness of the Plexiglas (3/32").

Doing It

Here's what you'll need. In addition to the pre-cut Plexiglas piece (we cut ours to 12" by 19"), you will need a Stretching Frame in which the Plexiglas will be sandwiched, and a Restraining Template. Of course, you will need the use of the household oven which, hopefully, has a window in the door through which you can peek. You will also need a pair of heavy welders gloves for handling that hot plywood Stretching Frame when you pull it out of the oven. Although the Plexiglas stretch-forming act is simple, you will need a helper who can quickly slip (force) that Restraining Template down over the hot stretch-formed Plexiglas.

Ready? Place the Plexiglas/plywood sandwich in the oven, supporting it on a couple of short 2 by 4's. This is necessary because the Plexiglas will sag slightly when it gets hot and may contact the hot metal bottom of the oven. If this is allowed to happen, the Plexiglas piece will be burned (curdled) and ruined. Also, as a precaution, you might slip a cookie sheet (ask your wife or girl friend what that is) under the Plexiglas frame to help diffuse the heat. You must avoid an uneven heating of the Plexiglas to be assured of reliable results.

A 3" abrasive disc is being used to liberate the stretch-formed lense. This is the safest way to cut it loose as heat is generated along the line of cut making the Plexiglas less brittle and less prone to crack or break.

Next, turn on the oven (and the oven light so you can see what's happening) and set the thermostat for 350 degrees F.

In about 5 to 7 minutes the Plexiglas will begin to get rubbery and you may notice that it is starting to sag very slightly.

That means get ready to act quickly. The first sure sign that the Plexiglas is hot enough to be stretch-formed is when you see a few bubbles begin to appear in the Plexiglas near the edge of the plywood frame. Do not delay any longer. Open the oven and grasp the plywood Stretching Frame at each end (use those gloves!) and quickly poise the hot Plexiglas/plywood sandwich over the male plug. Then smoothly and positively force the frame down until it is at or slightly below the bottom level of the male plug. Your helper should then, just as quickly, force the plywood template down over the stretched Plexiglas causing it to hug the plug in all areas.

After a few minutes, both of you can relax, turn loose of the plywood devices and allow the Plexiglas to cool gradually to room temperature.

The newly formed Plexiglas part can then be cut away from its parent piece with a 3" abrasive disc chucked in an electric drill. Work slowly and carefully. You don't want to crack that new Plexiglas lens.

After the Plexiglas part has been liberated, you can slip it back over the male plug for its final trimming. A Dre-

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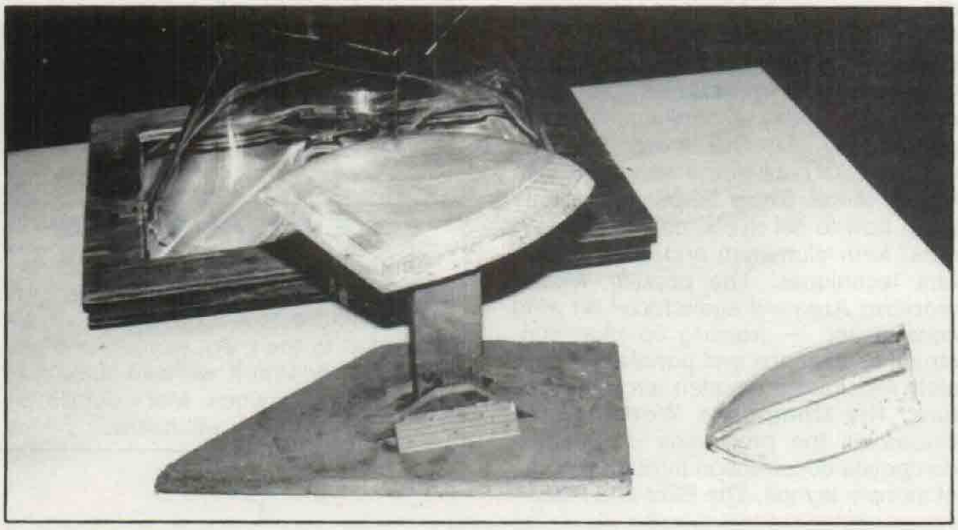
The Male Plug mounted on a stand is in the background and beside it is the trimmed wing tip light lens. Note how large the window frame is for the size of the lens stretch-formed.



A better view of the support stand for the Male Plug. Shape of the base chipboard has no significance . . . it was all I had. The stand is essential as considerable downward force must be exerted to stretch the Plexiglas over that form.

after you have performed the leaning procedure, as defined in the owners manual, do you really know if the engine is operating at peak EGT (Exhaust Gas Temperature). Jim said that this is not the place where you really want to be.

First, let me explain. Jim remarked: "Aircooled aircraft engines use fuel, not only for combustion, but also for cooling." The cooling fuel, or extra fuel, reduces the combustion temperature and, therefore, keeps the cylinders from running too hot.

Now that we have understood all of that, and it is firmly placed in our minds, the next time you lean your engine it should be somewhere below or on the rich side of peak EGT. However, without an EGT gage installed in your plane, it's only an estimate.

Jim suggests a leaning method which I have used since learning about it. It works like this. For carburated engines not equipped with an EGT gage, prior to leaning the mixture, shut off one magneto, and then lean to a point where roughness occurs or the rpm drops off. Then at this point, return to dual magneto operation and your engine should be running smoothly and the EGT will be approximately 75 degrees rich of peak EGT. I have personally found this method of learning works well in my Cessna 172.

Again, I wish to thank Jim Vitte for his valuable contributions to this article. Jim's experience in both corporate and general aviation has made him truly an expert in both fields. By the way, Jim owns a Cessna 182 which is parked at Palwaukee Airport in Wheeling, IL.

If you wish to contact the author for additional information, please write Harold Holmes, Department of Safety Studies Injury Research Laboratory, University of Wisconsin-Whitewater, Whitewater, WI 53190.

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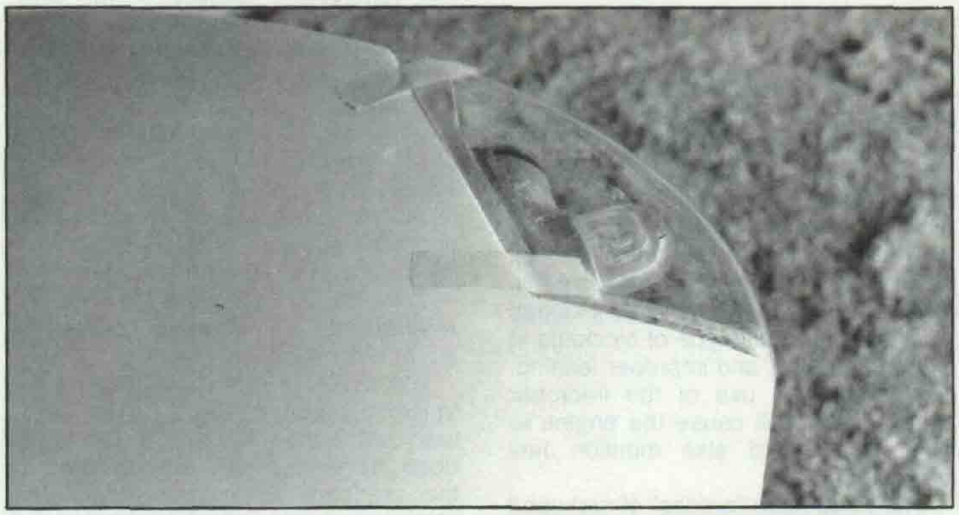
mel tool fitted with one of its fine tooth saw blades works beautifully.

The final smooth trimming is done by rubbing the cut edges over a full sheet of medium coarse alumninum oxide sandpaper laid on a smooth hard surface. If you prefer, you can get almost the same results by using a hand held sanding block.

While you are at it, why not make an extra pair of wing tip light lenses — just in case . . .

If you wish to contact the author for additional information, please write to Tony Bingelis, 8509 Greenflint Lane, Austin, TX 78759.



The new wing tip light lense being checked for fit after trimming with a Dremel saw blade and sanding block. Masking tape is most helpful here.

EAA Membership Honor Roll

This month we continue our recognition of persons who have qualified for the EAA Membership Honor Roll. When you receive your new or renewal EAA Membership Card, the reverse side of the attached form will contain an application with which you can sign up a new member. Fill in your new member's name, enclose a check or money order and return to EAA Headquarters and you will be recognized on this page in SPORT AVIATION — and there is no limit to how many times you may be so honored here.

Introduce your friends to the wonderful world of EAA . . . and be recognized for your effort. The following list contains names received through January 10.

PABLO DEPETRIS
Cordoba, Argentina

NORMAN PAUL ISLER
Brockport, NY

PHILLIP L. CACIOPPO
Elk Grove Village, IL

LEE INGALLS
Baldwinsville, NY

DON C. HILL
Lane Mills, IA

RON C. ERICKSON
Ramsey, MN

GARY D. ROLIN
Mariemont, OH

ROBERT D. SPIER
Kennebunkport, ME

CHARLES L. ELLIOTT III
Middleburg, FL

JOHN M. NICHOLS
Kennesaw, GA

ISMAEL FORES
Tortosa, Spain

BOB VANDALL III
Brookville, OH

JAMES O. LITTLE
Evansville, IN

RAY WINKEL
Milwaukee, WI

RAYMOND EISSLER
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E. R. TELICZAN
Baldwin, MI

CALVIN LUKASAVITZ
Milwaukee, WI

STEPHEN WILLIAMS
Robinhood, ME

RAFAEL TABOADA MARIN
Puebla, Mexico

JOHN DIRDAL
Halsen, Norway

RICHARD WALLRATH
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JEFF SONNER
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HARRY DENHAM
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BRIETZKE, VALDIR
Santo Andre, Brazil

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