EXCERPTS FROM T-18 NEWSLETTERS 1-12

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INTRODUCTION: The T-18 Newsletter began in the fall of 1964 as a result of several letters and a visit with Dick Cavin in Dallas. Dick had essentially "kicked off" the T-18 Mutual Aid Society with his fine article in the 1963 SPORT AVIATION entitled "Reflections From Rockford" in which he told about building the T-18 fuselage in just 3-1/2 days. But we felt that there was a real need for a "house organ" to circulate to the T-18 builders. SPORT AVIATION is fine for reaching the general EAA body but the time lag is too great and you don't have the editorial freedom that you have in an informal newsletter. So, Dick and I agreed to publish a newsletter for the exclusive use of T-18 builders with the editing and publishing being done alternately in NY and Texas. This continued for the first five issues. Then family illness and work demands made it impossible for Dick to continue so I have published all subsequent issues, now numbering 44 (in 1976).

The first issues were published with strictly volunteer help but recently it has been necessary to hire the typing done. The materials and postage costs have been paid for by donations from T-18 builders now numbering over 1200. Articles and tips have been obtained from the builders and through personal interviews which I have been able to make while on company business trips.

Since the master stencils for the first 12 issues are no longer usable, new stencils have been cut using excerpts from these issues. Much of the material has been omitted since it no longer is applicable.

<u>RIVETS</u>: Apparently some of the newcomers are a little confused about the use of Hi-Shear rivets and Pop rivets. Basically Hi-Shears are used instead of bolts, as they are lighter and in some other respects, superior. They can be installed very easily, using only a hammer and the little installation tool. The Whitney punch set, the #5 Jr. is obtainable from the Whitney Tool Co., Rockford, Ill. You should order extra #30 punches, with and without the little "nib". Again, for the beginner, you cannot put a 1/8" rivet in a 1/8" hole. It takes a #30 hole. If you dimple the skin around a 1/8" hole, the hole will enlarge enough that a 1/8" rivet <u>will</u> go in. Incidentally, it is accepted practice to dimple the lighter gauge skin and countersink the thicker material (040). If you plan to flush rivet, you may want to get a set of dimple dies for the Whitney punch. They are needed for dimpling ribs and frames but do not do an acceptable job in external skins. (Make a dimpling tool as described on page 16).

<u>USING TEMPLATES</u>: It takes a little practice and skill, believe it or not, to properly use the Whitney duplicator punch. Hold it between the thumb and middle finger and sort of rock it in the hole. Don't try to push it straight down into the hole. Won't work. Tap the punch with a hammer, not too hard. Be sure the punch is in the hole before tapping, so as to avoid damage to template. Absolutely do not punch or drill through the template. Always use the punch with the little center nib to transfer the hole centers, then remove template

from worksheet before you actually punch out or drill holes. Place template from worksheet before you actually punch out or drill holes. Place your transfer strips underneath bulkhead rivet lines before you drill or punch holes. Take care to keep your drill at 90° to sheet and in case of fuselage sides, drill both sides and transfer strip at one time. Make a simple little steady rest for your drill, using scrap wood, so you can keep drill vertical. To transfer the hole pattern from the skins to the bulkheads the important thing is to VERY accurately locate a starting point. We cannot transfer hole patterns at points where bulkheads are joggled, as this would cause mismatch. I chose the first rivet hole above W.L. 42 as my "anchor" hole. On my form blocks, I drilled a tiny hole at this point. I tapped a wire brad lightly through this hole, making a tiny mark on frames. On a penciled rivet hole center line, I punched the rivet hole. Next, a rivet dowel was used and skin transfer strip and frame were pinned together. The hole pattern was then transferred with nibbed punch. Sounds complicated, but it really isn't. Transfer strips should be labeled as to "up" or "out", etc. and extreme care should be used so that transfer strips are always turned the same way. THINK.

Leave the "spare pocket" area of the bottom sheet in for alignment of forward floor. Important! After alignment, drilling, clecoing, cut it out. To use rivet as a dowel through worksheet, put head on bottom, and secure on top with Tiny C clamp.

These templates are a real privilege. Please show your appreciatio by taking painstaking care of them. Take care of them not as your very own, but more like they belonged to your boss. When shipping, coil them carefully, tie or tape securely and either put in small crate or wrap several layers of cardboard around them and see that edges are protected against rough handling. I would like to be informed of condition you receive templates.

<u>SIDE SKIN SPLICE:</u> If you decide not to purchase one of the extra large sheets that make 2 fuselage sides, make your splice just aft of Sta. 179.2007, using either an .032 or .040 strip, 2.5" wide as a doubler. Four rows of AN426 AD 4 rivets are used. Rivet centers should be .25" from sheet edges. Rivet spacing is about one inch. Do not continue the doubler under the angle at WL42.

<u>FORM BLOCKS:</u> Have had a considerable number of you ask "What material do I use to make form blocks out of?" I used a select grade of maple for all my small parts (ribs, etc.). I used 3/4" fir plywood for the fuselage bulkheads. I have heard of Boneflex being recommended, but also know it is hard to find and very expensive. Some builders used a wood chip composition board for fuselage frame forms and were pleased with it. Actually, most anything will do if it won't splinter badly. And of course, most of you know that it is important to make all form blocks in duplicate, as you must ALWAYS have a clamp to hold your block-metal-block sandwich together tightly while forming. Metal will creep from forming stress if not tight. Also use index pins like

clevis pins or small bolts. Put pins completely through the "sandwich" These index, or tooling pins are important, as they serve to both align parts and restrain them. Put them near a corner so the index holes can be punched rather than drilled.

TOOLS: I would like to highly recommend another tool that I have. It is the Mead Bandsander. I call it indispensable - almost a must for a metal aircraft builder. It looks like a small band saw and it de-burrs, sand, shapes, profiles, etc. Uses 1" x 42" belts that can be torn to ½ or ¼ widths for small areas. It is used in every aircraft factory and is tremendous for sanding the edges of aluminum parts. Here's something else that will save you many hours of tedious labor. You can write Mead Specialties, Chicago, Ill. They are priced at $37.95 for the industrial model with ball bearings and $27.95 for the home workshop model with oilite bearings. Van White, 1512 6th St., Lubbock, Texas has a dealership for them.

If you want to saw aluminum, Sears has a blade (both 6" and 9") that does a beautiful job (about $5.). It is their Kremedge Non-Ferrous cutting blade. If you have a bandsaw, get a skip-tooth blade for best results, although you can use ordinary wood cutting blades if you use a wax or grease stick to lubricate them and keep the teeth from clogging.

MAKING FITTINGS: You can make your own fittings of aluminum plate quite easily. Saw them oversize and sand or file down to your scribe line. An ordinary disk sander works fine. I used a rubber-backed 5" one in areas that I couldn't get to with sander, followed by sanding with the little Mead bandsander. If you turn the rotary files very fast they won't chatter. Take very light cuts, too. Final sanding is by hand using wet-or-dry sandpaper in progressively finer grades. Sprinkle a little Bon-Ami on the sandpaper. This (or toothpaste) makes a fine light abrasive. If you want to get fancy and do real first class work, buff your fittings with a cloth buffing wheel, using emery buffing compound, working down to tripoli or jeweler's rouge for a true mirror finish that rivals chrome plate in brilliance. Actually you should always finish ANY aluminum edge to as fine a finish as possible, so as to eliminate starting places for cracks. This gets very important on thin sheet parts (ribs, etc.) that do more flexing. ALWAYS finish the edge of sheet parts to the extent that there are no visible scratches or nicks. This also applies to deburring holes. Always deburr holes before dimpling, as the forming stress of dimpling may possibly crack light skin. If this happems you'll have to drill it out and use an oversize rivet.

FORMING RIBS FOR THE T-18

by

Dr. B. John Shinn

A. INTRODUCTION - I had always looked at formed metal ribs, bulkheads, etc. with a sort of envious awe. I dreamed of building my own all metal plane, but obviously the cost of special tooling would be too high and having things like ribs hydropress formed would also be too expensive.

But, then came the series of SPORT AVIATION articles on the T-18. Mr. Thorp made it sound like an ordinary guy could make acceptable ribs himself with only a soft hammer, a bucking bar and some wood form block Besides that he mentioned an alloy, 6061T4, which could be formed without annealing. To me, all aircraft sheet aluminum had been 24ST (2024T4) which required considerable care even in bending straight line corners let alone compound curves. The interest mounted to the point that I was mentally stretching ribs with ease. I decided I'd just have to build the T-18.

Although the article in SPORT AVIATION ("Building the T-18" - Part 3, July 14, 1962) was well written I feel that a look at my rib forming experiences might be helpful to those who are also now "tin benders".

B. <u>FORM BLOCKS</u> - After reading Part 3 in Thorp's articles, checking prices on form block material (maple, birch, birch plywood, tempered masonite, etc.) I decided on birch. It is relatively low in price, has a fine grained surface for non-bumpy layout, and does not split out under heavy pounding like plywood. Besides that, it comes in widths (6" to 9") which are more manageable than large sheets of plywood. (Thickness should be 3/4" or greater to allow forming a good flange out to 5/8".)

The complete airfoil template was laid out on .040" aluminum and .025" (The thickness of the rib material) was trimmed off the complete perimeter of the template. Several ¼" indexing holes were punched to align nose and center rib sections. This airfoil template was laid on top of two smooth 3/4" birch boards and the indexing holes were drilled through boards simultaneously. A couple of ¼" metal dowel pins held the template on one board for the layout marking. A sharp knife was used to trace around the template. Then a pencil (preferably carpenter's) sharpened to a fine wedge shape was traced lightly through the knife groove. This made an accurate layout line which was easy to saw along. The template was "flopped" over, doweled, and traced by knife and pencil on the other piece of birch for the "opposite hand" rib.

For the sawing process it was discovered that the bandsaw was the most practical. By carefully staying about 1/32 of an inch wide with this cut it was possible to avoid excessive sanding time later.

The roughed cut form blocks were then sanded to the center of the knife groove outline. A sanding disc mounted in a table saw works well for this. The disc was tilted so that it undercuts the form block to compensate for the spring back of the rib after forming. About 3° was used for "straight" sections while a 5° tilt was used for the more highly curved nose of the rib. (It is important to note that it is much easier to make this spring back allowance with the initial sanding than it is to first sand to the line perpendicularly and then try to add the 3° to 5° undercut without over-shooting the mark.)

The edges of the form blocks were rounded to give the proper bend radius of 3/32". It was found that a small Stanley "surform" file made quick work of this with only a minor amount of sandpapering to smooth it out.

C. <u>RIB BLANKS</u> - For quick layout of the rib blanks a .040 metal rib blank template was made for the nose ribs and the center section ribs. (For the rest of this article we will concentrate on the nose rib fabrication since it is the more difficult). The airfoil template was laid on a piece of scrap aluminum and traced around for the nose rib section. A pair of dividers set for 7/8" was used. (Dick Cavin's idea of using a 3/4" radius washer for marking sounds better). By trimming this metal to the outer mark a 7/8" flange was left all around this nose rib blank. This blank was again placed under the airfoil section and the indexing (locating) holes punched through. The cut-out at the front of the nose rib was made in this nose rib bank template. It is strongly recommended that the cut-out in the actual ribs be made only after the rib has been formed. If it is made before forming it is almost impossible to prevent sharp double-back creases at the front edges of the nose rib.

Holes were also punched through this template for the corner relief (as indicated on the prints) for the -1, -3, and -4 nose ribs. The -1 and -2 were close enough alike to use the same relief holes.

D. <u>CUTTING OUT BLANKS</u> - The 3' x 12' sheet of 6061T4 was unrolled on a rug in the family room (to prevent scratches) and a few quick trial and error layouts with the rib blank templates produced the most economical layout. A "grease pencil" was used for this since it has enough contrast to be visible and is easily wiped off when desired. Since the ribs were to be trimmed after forming and generous flanges were allowed it was not necessary to make precision layout marks--- just a quick trace around the rib blank with the grease pencil was all. Again, do not mark in the nose cut out.

For cutting up the sheet people have used a skill saw, a sheet metal shear, and other such approaches. I found that the 6061T4 sheet was cut up with least waste and least scratching by using a regular pair of straight sheet metal shears. The two sides of the sheared piece were spread apart (by one hand and one foot) so the shears did not bind. This resulted in a slight curvature of the new blank but this was insignificant when compared to the stretching it was soon to undergo. The blanks were then placed under the rib-blank template and the locating holes were punched, and the nose cut was scribed lightly on the blank but not cut out. The flange around the very tip of the nose was trimmed to a ½" width to minimize wrinkles in this high stretch area. The appropriate relief holes were also punched.

The pile of rib blanks was ready for the forming operation.

E. <u>CLAMPING</u> - The metal blanks for the nose rib were inserted between the two rib form blocks and ¼" dowels were pushed through those two locating holes in the nose section. Both "C" clamps (2½" throat) and a bench vice were used to hold the form blocks together. The screw end of the "C" clamp was pointed away from the working side of the form block to give plenty of room to maneuver. By placing these "C" clamps near the edges it was possible to push them over one way and then the other as forming progressed so that unscrewing them and moving them was not required.

F. <u>FORMING TOOLS</u> - In forming my ribs I found that the following tools worked out best. A medium weight hammer with a modified hard rubber head. (Sears sells one for about $2.50 which has replaceable heads - one plastic and one rubber head). The hard rubber head was sawed and filed to a wedge shape (about 60° angle). This hard rubber hammer not only is more durable - no chipping, etc., but it also distributed the force of the blow over a larger area so it does not make sharp dents like the plastic hammer does. Many builders have had trouble finding a hammer with the proper hardness head. A hardwood hammer can be made as a substitute. Maple about 2 x 2 x 6 pointed on one end works fairly well.

A smooth bucking bar about 1½" to 2" thick, 3" to 5" long and 2" to 2½" thick. Too small a bucking bar makes marks in the metal where it stretches over the ends of the bar. This will result in dents and ripples since these marks work harden the metal so that it is harder than the adjacent metal. Too large a bucking bar is naturally unwieldly

Two solder bars. One is used as a "slapper" and the other is used as a "stomping" rod. The "stompping"bar is hand held and used end on. It tends to flare out at the end under use and this will cause dents if it is inadvertently used as a slapper. The stomper is used for the more severe stretching jobs such as around the sharp radius of the rib nose, etc.

G. <u>SETTING THE FLANGE</u> - I found that I ended up with the smoothest rib when I formed the rib as gradually as possible. That is, I tried to avoid sharp kinks, dents, and bends in the forming porcess. Each sharp dent work hardens the metal to a much harder state than the metal around it. These "hard" spots are difficult to smooth out when they are in the middle of soft areas.

The first operation is to bend or push back by hand the protruding flange. The flange is bent about 30°, and because of the curves, causes some general warping of the flange. The metal is set at the bend radius of the form blocks by light blows with the wedge shaped hard rubber hammer. The flange is backed up by the bucking bar and the hammer is swung to strike downward at about a 45° angle. After the rib had been set all around the top and the bottom the indexing pins were removed. I found that if they are left in the holes in the form block they may become elongated when the "heavy" pounding takes place (one form block will slip a little with respect to the other even though the rib stays fast to its formblock.)

For the remainder of forming I tried to keep in mind that Thorp said the idea was to stretch the metal - not bend it. The 6061T4 forms quite readily and it is fun to watch the rib develop. The bucking bar was held behind the flange, and the hammer was aimed at the triangular gap formed between the bucking bar, the form block and the flange. Each pass of stretch forming was started at the nose and was progressively moved toward the back. After each pass a rubber mallet was used to tap the flange back to a 60° slant to form a new triangle gap to stretch inward.

Eventually some radial wrinkles began to appear. If not taken care of early they quickly develop into sharp work hardened creases which are almost impossible to beat down. To remove them I bent the flange over farther than normal (45° or flatter) and gently wiped out the base of the wrinkle with the rubber hammer. About three forming passes are needed to form out well beyond the 5/8" final flange dimension. On the third pass I used much heavier blows of the hammer to wipe the metal into the triangle gap. The bucking bar was actually overlapped down on the form block to allow the full 3/4" width to be stretched.

The final forming operation is the only place I differed at all from Thorp's practice. I felt that I got better flanges if I did not try to slap down the remaining vertical flange. When I tried to do it I found that the already formed portion of the flange would tend to jack up away from the form block giving the appearance of severe spring back.. I merely stretched the vertical flange so that it was out well beyond the 5/8" width and slapped down the wrinkles in the horizontal flange with the "slapper"solder bar.

The rib was then trimmed with aircraft metal shears to the desired width. Since there were quite a number of ribs in the wings and tail, I made a 5/8" depth gage. It was made from a scrap piece of the form block (birch) material with a right angle notch cut about 1" deep. At 5/8" up from the bottom of the notch cutout I drilled a hole and pounded in a sharpened nail - just far enough so that about 1/8" of the point protruded from the side of the notch.

H. <u>MAKING ACCESS HOLES</u> - Although the plans did not call for them, we felt that it would be a good idea to have holes in the ribs. It allows you to see inside and repair dents among other things. Besides, the FAA man can see inside after the wing is all riveted so you don't have to wait to let him look before you "close it up".

Some holes were 3" in diameter and others were 2". We made them with chassis punches. The "hole saws" from Sears could be used instead but they do not leave quite as clean a hole. The most important thing is to clean the burrs off the inside of these holes and then emery them to a smooth finish. Otherwise, a crack may result when the flaring process is undertaken - we found out the hard way.

The "flaring tools" were made on a lathe from 2" oak. There was a set for 2" holes and a set for 3" holes. The male part of the 2" set had a 2" dia. plug with a 45° flared skirt. The mating part was a ring 2" ID with a 45° flare at one end. (See NL #23) The lightening holes were flared by inserting the plug through the rib hole into the ring. The plug was then given several "hard licks" with a rubber mallet. Presto! there is a really professional looking rib.

<u>1964 FLY-IN - DICK CAVIN</u>

This issue is being written just after the Fly-In and we'll try to fill you in on the big question. To answer it in one word - terrific!

The T-18 looks great and it flies just like it looks. Its climb rate and angle (at 120 IAS) is spectacular. Somewhere around 2000' per min. With the 180 hp engine it loafs along at 180 with lots of power in reserve. John Thorp comes right out and makes the flat statement that he will have the T-18 topping 200 mph when the clean up program is done. He feels that the lighter GPU engine and prop combination will do almost as well, too. Visibility - very good. Comfort - average or better. Noise level - ok. Takeoff run - less than a Tailwind. In flight handling - superb. All in all, it's a real honest airplane from the time you fire up till you shut it off. In my opinion, a good 75 hr pilot could fly this airplane with no problems. All controls are responsive, but not sensitive. It's very well behaved on both T/O and landing roll. Once again I'll predict that it will be known as an outstandingly fine airplane in time to come. The only item that didn't please me and the other boys that rode in it was the gear action on rough sod. It's much too stiff with tires this size, but was excellent on hard surface. Sod there was very rough and there is a difference in 3 mph taxi speed and 50-60 mph. Gear will be fine for x-wind work. Like most other high performance ships, this one will be at its best on hard surfaced runways. My hat's off to John for one more fine airplane design.

<u>METAL WORKING - Dick Cavin</u> - Here's an area that came under considerable discussion at the Fly-In. We recently were experimenting with testing Pop rivets vs. AN's. In the process of checking how well each swelled up in the hole we made the discovery that there was a very considerable amount of radial cracking of skin, due to dimpling and swelling of the rivet. Naturally this shook us up a little. We found that careful de-burring prior to dimpling minimized this, but would not eliminate it. One good "fix" we found was to use a cloth buffing wheel with emery compound after dimpling, being careful not to over-drive rivets. John says the problem has always been around, but is not a serious thing, as the cracks don't spread often. (Note: In 1976 we can verify this.)

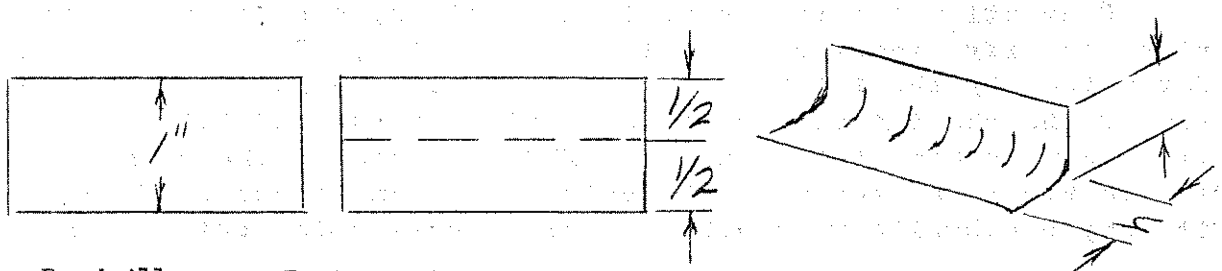
Try this deburring tool - a slotted dowel to hold aluminum wool - used in a drill. We recently improved on this. Use a 1/8" dia. aluminum rod, tapered to a point on one end. Dip the point in epoxy glue (local hdw. store) and attach aluminum wool for overnite cure. It works well but be sure to use only aluminum wool. Steel wool is verboten. It acts like cancer, triggering rapid corrosion.

<u>Bulkheads</u> - Our form blocks for fuselage frames were carefully cut with a 45° routing tool for the inner flanges. We have since learned that a smoother job results if you don't bend to a restricting surface, but simply make form block 90°. (1976 Note: Bend all inner frame flanges 90° except in corners. Excercise extreme caution to prevent cracking in corners. Strike with a wiping action with rubber mallet.)

When bending fuselage bulkhead flanges, I decided that I could never get an accurate angle on the flange on the form block alone. After forming I used a hardwood block (about 6 x 2 x 1) with a slot cut in bottom (the thickness of the metal) with about a 10° angle on the nose of this "tool". Lay the part on the bench, flanges up, slip the slot over the flange, rebend the flange to the exact angle, using scrap metal template to check the angle. Hold down (tightly) the rest of the bulkhead not being bent, working up and down the flange a few degrees at a time. Works great!

Al O'Brien recently wrote about his method of using Rollpins for indexing and part duplicating to eliminate "slop" around indexing holes in templates and form blocks. He says Rollpins (which are tubular pins with slot running full length, forming cylindrical spring) are excellen His method; (1) Make template of part (2) clamp template to piece of stock (3) Scribe outline of part, center punch (use duplicator punch all hole centers (4) Remove template from stock, clamp stock to second piece of stock, drill one hole .094/.097 dia., through both pieces (5) Drive .094 Rollpins in hole. Repeat until all holes drilled and pinned. (6) Finish part to outline shape, knock out Rollpins, open holes to final size. (7) Break all sharp edges and prime. Rollpins available from any elastic stop nut dealers. Al makes his templates of .064 T-3 (never use anything but aluminum for templates, as expansion coefficient difference between unlike metals makes them unusable).

If you use 12' lengths of the small extrusion, make the splice halfway between bulkheads #573 and 574. First of all file the sharp corner of the ext'n so it will nest to the inner radius of the other. The filler piece should be of sufficient length so that it picks up at least 3 rivets (of the present rivet spacing) on each side of the splice and preferably 4. Drop other rivets in halfway between the present ones, but alternately stagger them from ½ to 1 dia. from the present center line. Don't leave 90° corners at the ends of the splice piece - smoothly taper to 2nd rivet from each end. (Here is an excellent place to use rivets plus adhesive.) Here's a couple more gems from Dick Fink (1) forget sheet metal grind drills - get a #1 Lathe center drill from Chicago Latrobe Tool (411 W. Ontario St., Chicago 10, Ill.) ($1.25). It has a starting nib and body is 1/8" dia. Catalog # is 217-1. Their #2 drill is identical (Cat. #217-2), but drills out to 3/16", or .002 short of a #12 drill. (2) See sketch. To figure bend allowance or "corner shrinkage" take a strip of req'd thickness exactly 1" long and 2" wide. Scribe a line ½" from edge, parallel to 1" side. Place in brake with correct radius bar. bend up 90°. Mike the two legs of the resultant angle. Subtract the original length of 1" and this is the amount the bend took up. Figure your bend allowance from this. For my set up h= .540 and the piece had a net gain of .080" for the .025 material.



Bend Allowance Test Sample

QUESTIONS FOR JOHN THORP

1. How can the 0-290G engine be modified to give higher horsepower?
   "To soup up the 0-290G for higher horsepower, a crankshaft from an 0-290D, D2, or 0-320 engine should be used. This gives the added strength required for the higher horsepower. The sludge tubes in the 0290-G crankshaft are larger than in the other engines. Different pistons can be used to step up the horsepower. (D-2's give 7.0:1 compression ratio, D-2B's give 7.5:1).

2. Can a propeller be safely attached to the bare 0-290G crankshaft flange?
   "No, not for a metal prop. The thin flange is not safe without a flange reinforcement. (See NL 31 for dwg.)"

3. How is the tailwheel spring made?
   "Make from 2024-T3, bend on an arbor press, then re-heat treat. heat to 960°F and quench in cold water."

4. What exhaust system should be used?
   "A crossover system is most efficient. There should be adequate space for mufflers, one on each side. Due to the high cost of stainless tubing you might use regular automobile exhaust tubing available everywhere in various shapes and sizes. The completed systems can be porcelinized for added life. This service is available in the larger metropolitan areas." Note: Stainless is half as heavy. Ball joints are essential.

John says that he doesn't approve of adding a lot of extras to the T-18 to weight it down. The predicted high performance will be degraded when the gross weight increases. "But even so the limit load factor is +5.0 at 1500 pounds." "The beam is designed close for limit L.F. of 6.0 at 1250 lbs gross. Bill Warwicks T-18 grosses at 1450 lbs and Earl Love's, 1500 lbs.

RIVETING - Here are a few essentials which everyone should know before doing any riveting on aircraft parts. Get a book on aircraft riveting and read it. Talk to other people with experience in this type of work.

Types and Sizes: If you are using pop rivets, write to United Shoe Machine Co., West Medway, Mass. for a catalog. If you can't find a local dealer who handles the rivets, order from United Shoe. Order monel rivets with the steel shank.

Conventional rivets come in many sizes, shapes and materials. The plans specify diameter so that is no problem. Length of the rivet is determined by the thickness of the materials being joined. Take the sum of the sheet thicknesses being riveted and add 1.5 rivet diameters. Since rivets come in lengths of 1/16 inch steps, the nearest standard length rivet greater than the calculated sum is used. You will find it very worthwhile to purchase a rivet cutter for cutting extra long rivets to the right length. This tool is not only easy and fast to operate, but it also makes a clean square cut. Rivets cut with diagonal cutters cannot be driven properly. The size and shape of the driven head tells the inspector the story of whether or not the proper length rivet was used and how well it was driven. The driven head (the one you form) should be at least 1.5 times the rivet shank diameter when the proper length rivet is used. The thickness of the driven head should be at least one half the rivet shank diameter. If you overdrive a rivet and the driven head is larger in diameter and thinner than these dimensions, you had better drill it out because the inspector will make you remove it later when it is more unaccessible.

. It is a good idea to make go-no-go gages out of sheet metal for the most common sizes of rivets. Show the FAA inspector that your rivets have been checked in this manner and he will have more confidence in your work.

You will soon learn that a 1/8" rivet won't fit in a 1/8" hole. Use the drill or Whitney punch sizes as follows:

Drill Size	Rivet	Drill Size	Rivet
#50	1/16"	#20	5/32
#40	3/32	#10	3/16
#30	1/8	17/64"	¼

Use the correct edge distance which is two rivet diameters from the center of the rivet to the nearest edge of the sheet. (¼" for 1/8" rivets).

If a hole is oversize or not round, the next size rivet should be used. PoP rivets should never be used in oversized holes but AN's can be expanded a reasonable amount. Especially flat head rivets can be readily fattened up before inserting in the hole.

Round head rivets can be used where they are not exposed to the slipstream. It appears that most T-18 builders are willing to go to the little extra work necessary to use flush rivets on all external surfaces. This requires dimpling the skin. Counter-sinking is not recommended when the skin is less than 0.050" thick.

Except where hi-shear rivets are specified, most of you will want to use A17S-T rivets which can be driven without heat treating. These rivets have a small dimple in the head. Rivets with raised markings must be heat treated before driving.

Dimpling tools can be purchased for hand dimpling, or for use in a Whitney punch or rivet squeezer. However, if you have a lathe available or know someone who has one, you will find it a simple matter to make one. For the male part, make from a steel rod of almost any diameter larger than the rivet head. Cut the shank equal to the rivet diameter and about ½" long to act as a guide. The portion which forms the dimple should have the same angle as the rivet being used. Note that pop rivets have a 120° head, while standard rivets usually have a 100° head. The female portion of the dimpler should be rather heavy and of a convenient shape to fit in tight quarters. Several female parts can be made to fit the various location required.

The best way to drive rivets is with a rivet gun. This requires a substantial supply of compressed air for power. When using a rivet gun, the rivet set is placed against the factory head, and the bucking bar against the shank. Some builders have reported success in driving flush rivets backwards with a flatiron used for a bucking bar and held against the factory head. This procedure has the obvious disadvantage of driving the rivet back out of the hole if the flatiron is not held firmly in place. Driving rivets by hand is accomplished in the same way with the rivet set placed against the shank end of the rivet to receive the blows of the hammer and the bucking bar held against the factory head. A rivet squeezer is ideal for rivets close to the sheet edge. It is important that all tool surfaces which come in contact with the rivet be polished to remove all scratches to avoid setting up stress risers in the rivet.

BUILDING INSTRUCTIONS: Step-by-step building instructions for the T-18 originally printed in 1962 through 1965 Sport Aviation are all consolidated in the EAA manual, "Metal Aircraft Building Techniques" available from EAA Hq. for $3.00 (1976 price).

BUILDING THE FUSELAGE - Here are a few tips that might help other builders in building the fuselage. Follow parts 9 and 10 of Thorp's BUILDING THE T-18 articles. Everything works fine just as the instructions specify. It is of considerable help in squaring up the fuselage during assembly if the #523-I bottom skin is laid out with enough excess metal to extend across the main spar cutout and overlap the 523-2 floor. This permits the two bottom skins to be clecoed together for better alignment.

Some people have found it difficult to obtain 16 ft. lengths of 3/4 in. angle. Merrill Jenkins, Harbor City, CA and SPORT AERO have these. They also have all other extrusions for the T-18. It is feasible to use shorter lengths of extrusions and splice them. You can also save about $15. on the side skins byyobtaining two 4 x 12 ft. sheets and making a flush splice between station 159 and 179. Use a piece of .032 or .040 material for doubler backing. I highly recommend a simple lap splice on frame 573. It looks even better than a flush splice because there are less rivets. Add one extra row of rivets with about 1.5" spacing.

In Part X, John states that the curvature should be put in the longerons before assembly. He has since found that the longeronscan be riveted to the skins in the flat condition before being assembled. They are then bent to shape as the skins are clecoed in place on the fuselage. This ensures that the skins are drawn tightly against the longerons since some waviness will occur if the longerons are bent and holes are tansferred on assembly. I was skeptical of this procedure and found it very easy to bend the longerons to the proper curvature with a jig made by Don Carter.

For a bending jig he sawed a 12 in. radius along the edge of a piece of 2 x 4, one foot long, then made a saw cut along this same edge about 1/16" wide and over one inch deep. He then nailed this block to a table and nailed another back-up block about ¼" away from the curved edge. By slipping one leg of the angle in the saw cut it was a simple matter to progressively bend the angle to any desired curvature. These angles were riveted to the skins, while they were off the fuselage assembly. During hole transfer from the skin to the longerons, the longerons were held nearly flat. Then when they were put into the assembled fuselage, the skins were drawn tightly against the longerons. It was difficult to detect the lightly scribed fore and aft center lines on the longerons for hole transfer until I found a simple cure. I sprayed a coating of zinc chromate on the longerons before scribing them. This made the scribe lines show up. The -3 longerons should be cut off at a 30° angle to make sufficient clearance for rudder. The 3/4 angles can be riveted to the skins before final assembly. To get skin tight while riveting, spring angles to give them less curvature. When bent to proper curvature they draw skins tight.

You should have no trouble with the matched hole tooling technique on the fuselage except possibly on the top rear skin. When the skin is mated with the fuselage frames any slight misalignment will cause "oil cans" in this skin. Since other builders have experienced this problem I chose to take a slightly different approach in transferring the holes from the skin to the frames. I first drilled all of the holes in the skin except along the side flanges. Before bending the flanges down I transferred the top center line holes from the skin to the frames. With these center holes located I then used transfer strips to locate the remaining holes. It is important to remove any twist in the fuselage before the center line holes are transferred.

Bending the flanges on the top skin was done very simply by bending it over the edge of a board with the curvature of the top skin sawed along the edge. I bent up some small test samples first to determine where to place the skin relative to the edge of the board. After the flange was bent down to 45°, I marked the location of each rivet hole and then, using a homemade crimping tool, put one crimp between each rivet hole to draw the skin down to meet the fuselage frames. The 580-1 "hip" skins were made in a similar fashion. Care should be taken not to extend the crimp very far into the flange or it will be visible after assembly.

<u>MAKING THE FIN</u> - Dr. B. John Shinn -- In Part VI, BUILDING THE T-18, Nov, 1962 SPORT AVIATION, Thorp said, "When the fin is done you are the master of the T-18 project. No other component is harder to make." But, when the time came for me to make the fin, I was definitely not yet ready to make the hardest component on the T-18. I was, of course, spoiled at this point by the relatively easy assembly of the matched hole techniques which were used on the wing panels and stabilizer. They are rectangular in principal view and lend themselves readily to this approach. Not so with the eye-pleasing but trapezoidal fin. To get around this problem I have figured out a way to make a very simple fin jog. With it I found that the job of building the fin turned out to be easy, fast and a lot of fun.

I must admit the problem of supporting the skeleton (ribs and beams) assembly of the fin, as suggested in the article, (so that its center plane was held 3 inches above a table by lots of clamps and blocks), had me a little concerned. The problem gnawed at me for quite a while and gradually the idea evolved that what I wanted was some way of holding the skeleton in rigid alignment which would allow me to fit and drill the skin simultaneously and symmetrically on both sides over the skeleton. But how? All of these things at once aren't so compatible. Any rigid jig would have to come through one side or another of the skeleton to be supported. But, the only side that wasn't to be fitted with the skin was the backside -- the beam. That's it! a jig that fits through some holes in the beam! Now all I had to do was figure out how. Since it had to be cheap and relatively easy to make, I ruled out metal welding, etc. Thus wood was used: 2 x 10's (all as squard and true as possible). The basic idea was to clamp the rear fin beam between two blocks of wood to which the ribs could be screwed and held in rigid alignment. The clamps and the blocks could not protrude beyond the width of the ribs. Figure 1 shows the basic idea of the jig.

The main jig spar made of a 2 x 4 is placed behind the 566-1 fin beam and two large blocks of 2 x 10 are clamped edgewise over the 566-1 fin beam. The clamping is done with four, 3/8-16 bolts, 6" long. Two large 1-1/4" holes in each block provide a place for the nuts of the 3/8 bolts. (My Sears Craftsman Powercraft wood bits were used to make these holes.) Washers are placed under the heads of the bolts as needed to keep from "running out of threads." The blocks are cut at exactly 8° off perpendicular (as shown on the fin assembly print) at the right position for the ribs to be clamped to them.

The 2 x 4 can be clamped in a vise to hold the jig assembly during the entire skin fitting operation. The ribs are "clamped" by long wood screws going into the end of the blocks. (Washers under the screw head will help distribute the load on the rib a little better.) The bottom rib is screwed to the bottom edge of one block while the middle and top ribs are screwed to the other block. If the blocks do not come out at just theright position, keep trimming them until they do. If you go too far, shims can be made of scrap aluminum, masonite, or thin plywood, depending on the thickness required.

If you want a really first-class jig, then you'll want to use rib blocks which support the ribs clear out to the front tips. (The 2 x 10's don't go the whole way to the tips and the ribs could be forced out of alignment if proper care is not exercised during the fitting of the fin skin.) These rib blocks are screwed to the 2 x 10's which have been trimmed so that the blocks will hold the ribs in the proper place.

Before the ribs are screwed in place, they are "clecoed" to the fin beam through the rivet holes and are "C" clamped to the blocks. A "C" clamp grasping between the 1¼" nut hole and the end of the block will do the job. The ribs are then lightly tapped into alignment before screwing to the blocks. The aligmment can be done by: (1) sighting to a line, (2) using a flexible straight edge, and (3) laying the jig assembly on a flat plate (table) supported so that the center line is parallel to the surface. This last technique uses some wedges made from scrap wood) which can be tapped for proper positioning. As a check, I used all three techniques. (Don Carter went a step farther and assembled the jig and fin beam on his fuselage so he knew the bottom rib was at the right position.)

From here on the job was just fun. Dimensions from the plans were used to lay out a fin skin that had about ¼" to 3/8" excess on all sides. The fin skin was cut out and then was bent by: (1) Bowing the skin so that the trailing edges could be clamped together between two boards, and (2) squeezing the skin together by using a cloth wrapped 2 x 4 to push down on the skin as it lay on a table. You really have to lay on it go get the sharp radius that fits the ribs! The 2 x 4 distributes the load so you won't get a "lumpy" bend. After several trials of bending, unclamping, fitting on the fin skeleton reclamping, and really pushing down hard you'll decide its a good fit.

The skin is then held and clamped down in position on one side of the skeleton while the other side is lifted up like a flap so you can reach in and trace on the skin along the bottom edges of the ribs with a pencil. Observe the gap between rib and pencil line. This much must be added to the .250 rivet edge distance when you mark the center line of the rivet pattern for each rib. Measure up the proper distance from the traced line and draw in the rivet pattern center line. Drill a 1/16" hole at the foremost rivet position that you can with the drill you are using. (This will be from the inside of the fin skin, of course.) Now mark all ribs with pencil at .250 inches from their bottom edges (i.e., the rivet center line). Reposition the skin over the skeleton sliding it until the center line on the rib shows through the 1/16" hole in the skin. Drill through the skin hole into the rib with the 1/16" drill while holding the skin firmly by hand on the rib leading edge. Both holes (rib and skin) can now be drilled out to a size 30 and a cleco inserted. The pencil lines are rechecked for shifting, etc. The skin is removed and an undersize hole is drilled at the rivet position closest to the fin beam. The skin is again fit on the skeleton and clamped with the front cleco. The back rivet hole is checked for alignment with the pencil line on the rib. If it is close enough, then proceed. (Otherwise, check for reasons and decide on either (1) extending the undersized hole sideways with a file meet the pencil line, or (2) perhaps flexing the skeleton a little.) When you're satisfied with the hole alignment, connect the front and back holes with a pencil line. Mark off rivet positions and drill small pilot holes. Then ream out with a #30 drill, putting clecos in as you go.

By removing all but the top cleco this side can be pulled up like a flap so that the opposite side ribs can be traced along to determine the rivet line. Repeat for all ribs. Be sure to put clecos in as you drill. This prevents bulges and warping. You may now trim the skin to size. The only thing left is putting in the rivet holes for the fin beams (front and rear).

The little front beam can be clecoed in position on the bottom rib. By opening up one side of the skin you can reach in and push up firmly on the top end of the front beam. While holding it in position you can sight up along it edgewise from the bottom and draw a rivet center line for the straight position. Check by several resightings and drill a hole. Check edge distance on the beam and proceed with other straight line holes accordingly. To get the holes along the curved portion, remove the front beam and make a transfer template on the beam. Include holes to be drilled as well as those already in place. Reinstall the front fin beam and cleco the template on the skin and drill the remaining holes.

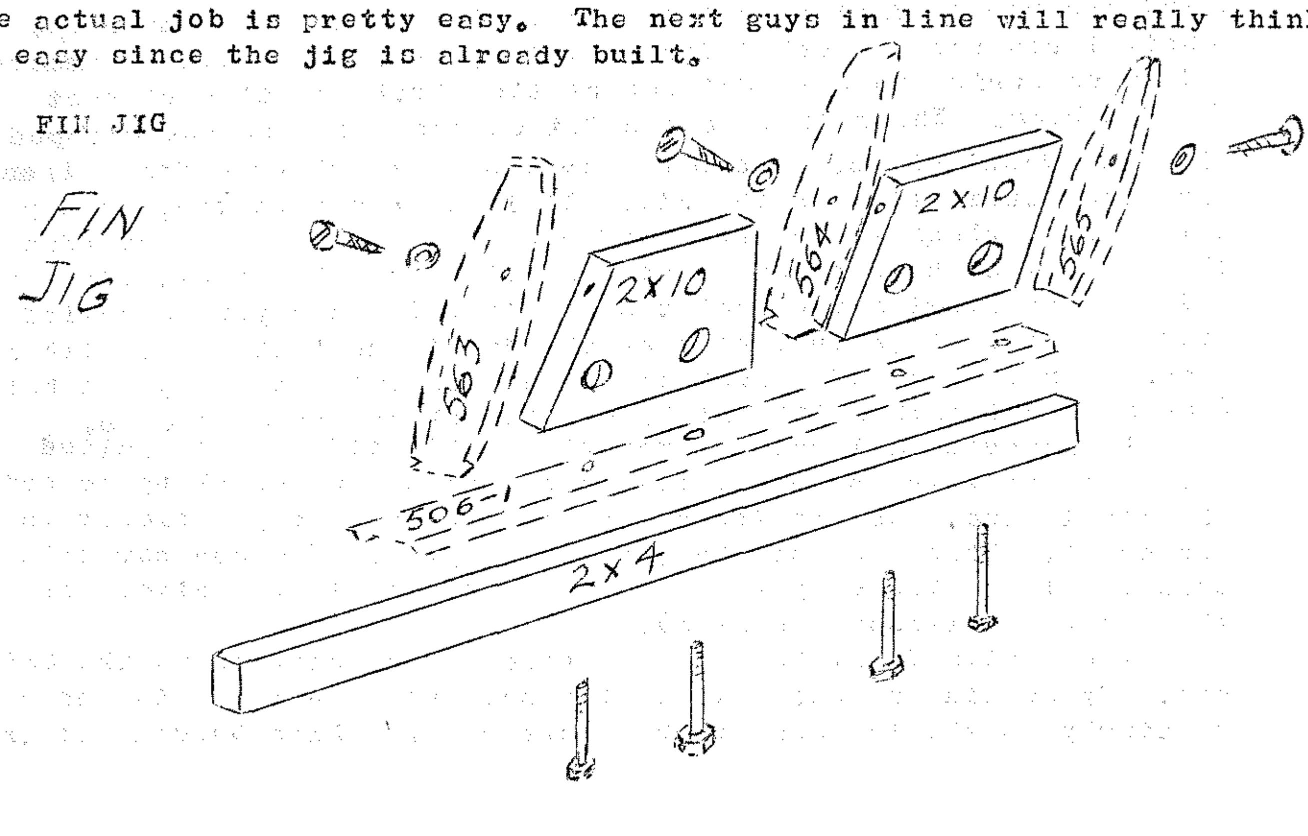
If the rear fin beam was not punched before fitting the skin, then the same procedures as described above can be used. If it is already punched, then it is necessary to transfer the holes to the skin. At the top, where the overhang of the skin is not too great, the Whitney punch can be used to punch through directly. At first it would seem the hole is on the wrong piece to do this, since you can't get the punch inside the channel of the beam to index on the hole. This problem can be circumvented by a neat little trick we learned. Slide the punchover the two thicknesses of metal (skin and spar) with the die on the spar side and the punch on the skin side. Then push a long 1/8" rivet up through the die of the Whitney punch and hold it in place lightly against the underside of the beam. Slide the Whitney punch around until the rivet drops in the rivet hole already punched in the beam, and then squeeze. The rivet is pushed down through the die by the punch and the plug from the new hole.

Where the overhang is too large for the Whitney punch, a long 1/8" transfer punch can be used. Push it through the holes in both flanges of the fin beam, lifting first one skin as a flap and then the other.

With a great deal of care you could drill through this hole in the beam, but it's tricky and you might enlarge them. The fin is ready for riveting!!

While the description of how to do the fin may seem pretty involved the actual job is pretty easy. The next guys in line will really think it easy since the jig is already built.

FIN JIG



Sheet Metal Material List

2024-T3 Alclad .025" x 4' x 12' 7½ sheets

Sheet Number	Use
1	Outer wing skin 82" plus 2 fus. frames
2	Outer wing skin 82" plus forward upper skin
3	Inboard wing skin 90" (includes flap junction) plus fin skin.
4	Inboard wing skin 90" plus 2 fus. frames
5	Top fuselage skin & deck plus bottom fus. skin
6	Fuselage side skin and "hip" skin
7	Fuselage side skin and "hip" skin
8	Two stabilizer skins plus spare

Note: Sheets 6 and 7 can be replaced by one 5' x 15' sheet eliminating splice but costs about $10. more. Sheet 2 makes a close fit on the upper skin. The other half of 8 would be better for the upper front skin.

6061-T4 .025" x 3' x 12' 1 sheet

Ribs for wings, fin and stab.

2024-T3 Alclad .016" or .020" x 3' x 12' 2 sheets

1	Ailerons, stab tab and rudder
2	Flaps (half sheet approx.)

2024-T3 Alclad .032 x 4' x 12' sheet

Frames, beams, canopy, engine baffles

2024-TO or 6061-T4 .032 x 4' x 72" ½ sheet

Frames and ribs

2024-TO or 6061-T4 .040 x 4' x 24" 1/6 sheet

Ribs, fuel tank support etc.

2024-T3 .040 x 4' x 12' 1 sheet

Main spar, floor (enough for 3 airplanes)

HOW TO GET STARTED - Several persons have asked how they should get started on the T-18 if they have never before built a metal airplane. Well, I can't say that it makes much difference having seen projects started in various ways. One of the first things you should do, regardless of the part that you choose to build first, is obtain a few necessary tools and equipment. First, you will need a nice smooth work table. For this I built a simple framework with six 38" legs and bought a 4' x 12' piece of 3/4" thick chipboard for less than $10. to form a perfect table top. Don't expect good results with matched hole tooling if you do your transferring on a piece of bent cardboard on the uneven workshop floor.

The next thing is to start accumulating tools. Here is a list of essential tools, their cost and sources:

Whitney Junior Punch	$12.50	Whitney Tool and Die Co.
1 extra #30 punch	.50	Rockford, Illinois
Pop Riveter	3.50	Sears
Hand drill		Everywhere
Sheet Metal shears (straight and right or left-handed)		Everywhere
Scriber		Everywhere
Decimal scale (at least 18" long		Sears
6 foot tape		Everywhere
Several C clamps		Everywhere
Sheet metal clamps (look like clothespins)	.40	Sears
Bucking Bars		Junk yard
Rivet Set		Junk yard
Dimpling Tools		Make
Hacksaw, files, etc.		Everywhere
Stanley Sureform raspplane		Everywhere
Vise		Everywhere

In addition, these tools should b available at least on a loan basis or are optional for convenience.

Band saw	Air Compressor	Milling Machine
Sabre saw	Drill Press	Reamers, several sizes
Welder	Lathe	
Rivet Gun	Tube bender (hydraulic hickey)	Belt Sander
Spray Gun		Buffing wheel

<u>DIMPLING</u> - After much experimentation with various dimpling tools and techniques, we have discovered how to make dimples which give a nice smooth finished job. Common dimpling problems are: (1) the area surrounding the dimple becomes recessed; (2) the dimpler scars the metal surrounding the dimple, or (3) the depth of the dimple is incorrect. The first two problems can be solved with proper shaping of the dimpling tools. The face of the female part should be dome shaped so the flange on the male tool cannot pinch the metal and cause an indented ring. It is necessary to have a generous flange on the male tool* to force the surrounding metal down perfectly flat. Since there is some variation from one batch of rivets to the next, the best way to make sure the dimple has the proper depth for a flush fit is to make a test sample.

*(3/4" or more)

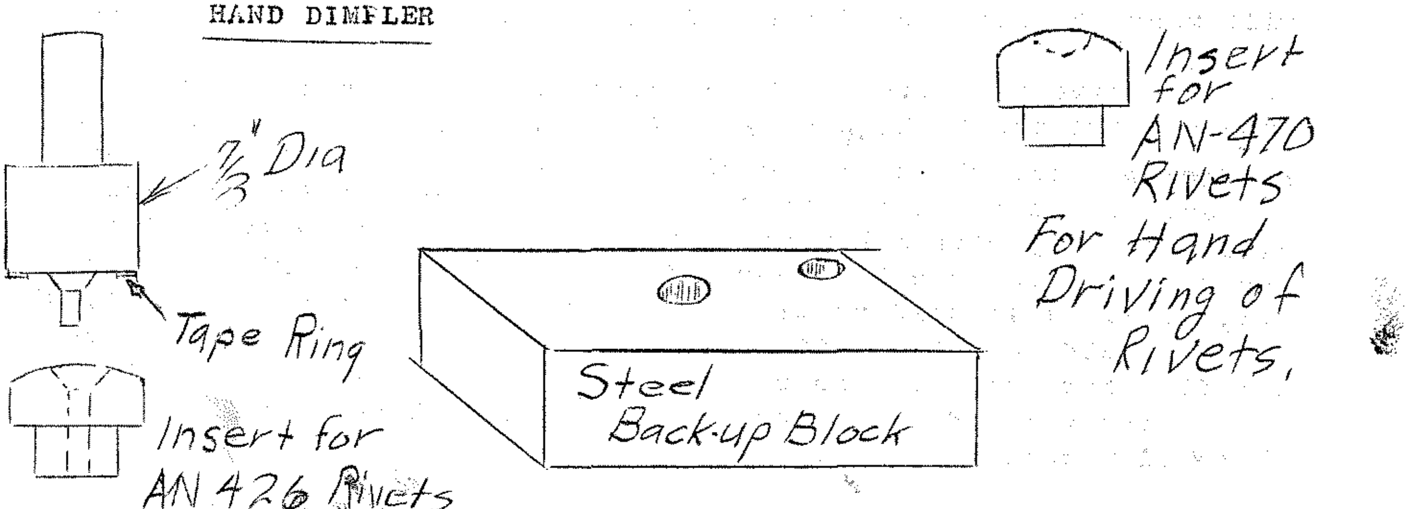
It is necessary to obtain the use of a lathe to make a dimpling set. It is preferable to use a steel which can be hardened, but I have made some from only mild steel and they seem to be holding up well.

The male part is made from bar stock at least 7/8" diameter by 2" long or longer. One end is simply turned down to the exact dimensions of the rivet which will be used. The face of the flange should be perfectly flat with the outer corner rounded. Polish to prevent marking the material being dimpled. The only way we have been able to completely prevent marking the aluminum with the flange on the male tool is to cover it with a good grade of cloth tape. Adhesive tape will work well. At least a ½" hole should be made in the center of the tape so it does not affect the dimensions of the dimple. If the tool is not made with a flange extending well beyond the rivet head die, the area surrounding the dimple will be deformed and the surface smoothness will be disappointing. If a lathe is not available, a tape-covered hammer and a rivet can be used as a substitute for the male part of the die.

The female part of the die can be made by drilling a 1/8" hole in a in a piece of steel and countersinking until the rivet to be used fits perfectly flush in the hole. To prevent marking the aluminum with the flange on the male die, it is absolutely necessary to make the face of the female part dome-shaped. Approximately a 3/4" radius seems to do the job. You'll be able to make dimples that are almost as smooth as countersinks with this tool.

A very convenient way to save material on the female part if dies for rivets with several different angled heads are to be used (100° for AN rivets and 120° for Pops), is to make removable inserts as shown in the figure below.

HAND DIMPLER



Inserts can also be made to fit round and brazer head rivets for use in hand driving rivets without a gun.

Remember that it is important to polish all dimpling tools and rivet sets to prevent putting stress-rising scratches on rivets or the parts being joined.

The ideally installed flush rivet should be perfectly flush with the outer surface. Since it is not possible to be perfect in all cases, it is better to be a little low than high. That is, it is better to over-dimple rather than under-dimple, since it is easier to fill in a recess with putty than to sand down a high rivet. Professionals have rivet shavers to shaveoff high rivets.

DRIVING RIVETS - Even if you plan to use Pop rivets you will probably want to use AN rivets in areas where it is convenient to drive them by hand on the bench. The main spar is a good example. Also, it is much cheaper to use AN rivets. I've never seen the subject of hand driving rivets covered in a textbook, so if you are new at the sheet-metal business, you are probably wondering how to go about it.

The secret is to use a good heavy backup block - the heavier the better. I use a two-foot long piece of railroad rail on which I have a spot polished where I place the head of the flat-head rivets for driving. To drive round and brazer head rivets, I place the previously described 2" x 2" x 3" steel block on top of the rail with the appropriate insert to fit the particular rivet being driven.

The recess in the insert is made by grinding a drill with a radius on the end to approximately match the shape of the rivet head. Polishing is accomplished with a piece of emery cloth forced into the recess with a rounded wooden stick while the insert or stick is spun. It is important to make the radius of the recess slightly larger than the radius of the rivet head or the edge of the tool will mark the rivet head and deform the head in the wrong direction.

To drive the rivet by hand, place the factory head of the rivet down against the back-up block. Place the polished end of the rivet set against the shank of the rivet and strike the set with a heavy hammer. It is necessary to use a rivet set rather than strike the rivet directly with a hammer in order to keep from driving the rivet crooked. Forces can be transmitted only along the axis of the rivet set, so if it is held vertically the rivet will drive straight. The rivet should be driven with as few blows as possible for best results. The finished shop head should be a minimum diameter of 1.5 the rivet shank diameter and the thickness of the shop head should be ½ the shank diameter.

If you have any question about the finished rivet you had better drill it out before the inspector sees it. Here are reasons for rejecting a rivet:

1. Shop head off center to the point where the hole is visible.
2. Shop head too thin or too small in diameter.
3. Either head marked by rivet set or bucking bar not being held in place.
4. Slanted shop head.

By sighting down a row of rivets, it is possible to tell how well they were driven. A nice straight row of shop heads indicates consistent riveting techniques.

LANDING GEAR - Since very few heat treat facilities are able to handle the gear in one piece, I am making mine in two pieces. Simply replace the 1.5" tube with a 1.25 x .082 cross tube. Cut this tube at the fuselage centerline and slide a 6" piece of 1.5" x .120 tube over it. Bolt the splice together with four 5/16 bolts oriented vertically. Instead of welding one leg at the apex of the triangle, weld in a 1" piece of 1.5 x .120, insert the gear leg and secure with 2 bolts. To make the gear softer, cut a taper from the cross piece down to the axle on each leg. Taper the 1.5 tube down to .020 wall and the 1.25 tube from the end of the 1.5 tube down to .160 wall. John has approved this modification for publication. (See dwg in NL 28).

VISIT WITH TECRI AND THENHAUS, May 19, 1965 -
Performance With 125 Engine - Ralph Thenhaus now has 75 hours on his ship. It has a canopy installed which is practically identical to the one shown in the latest prints. In fact, he says that Dave Gengenbach used his canopy as a reference when making the canopy drawings for John. With the canopy and a 125 hp engine John reports that the ship will do an indicated 165 at full throttle. This is a true airspeed of 172 which isn't bad at all. 75% cruise would be at 155. Furthermore, Ralph says he has checked his airspeed against other aircraft and he is indicating about 10 mph slow. John says it climbs at 1500 fpm solo and is a real hot rod which doesn't have to apologize for anything.

Ralph's T-18 empty weight is 835 lbs plus canopy which adds about 20 lbs. It has a full electrical system and a radio. Stall speed is 68 mph and landing speed is somewhat higher to minimize sink rate at touchdown.

Everyone who has flown the T-18 without a canopy says that it is too turbulent and that everyone should have a canopy even from the beginning.

The ships flying don't use the 626 balance weights on the anti-servo tabs. John says that if 0.020 aileron skins are substituted for 0.016, the aileron balance weights should be increased in weight by the same percentage.

About the only disappointing feature I have found in all the T-18's is the limited space due to cockpit equipment location. All have radio consoles mounted between the pilot's and passenger's knees. With this obstruction I cannot get more than 3/4" stick motion toward the center of the aircraft. Also, the aft tunnel cuts into the seat space making it uncomfortably tight; so, I plan to round off the corners of the tunnel and not waste any seat width with the upholstery panels.

The latest canopy drawing shows the top of the rear deck sliced off in the same plane as the canopy rails. This cuts down on baggage space but looks much better. John says it will be perfectly alright to cut a hole in the skin underneath the canopy for a baggage access door. In fact, he said a jump seat could be added for a small child.

Both Bill Warwick and Ralph Thenhaus welded up their own gear with regular acetylene torches. They used a lot of gas but claim it wasn't bad after they got the joint heated up. John says that regular arc welding would be suitable if a low carbon rod were used and the joint were pre-heated with a torch to alleviate localized cooling stresses. With regular gas welding it is better to use a mild steel rod, like No. 6, since it has less tendency to crack during cooling. All welded up 4130 steel parts should be magnafluxed, especially engine mounts and landing gear. On a recent tour through the Piper Aircraft factory I found that they magnaflux these parts. I saw a large stack of gear and engine mounts which had to be re-welded usually at many points on each part due to cracks. This really sold me on the need for magnafluxing critical welded parts.

Ralph says he welded up his own aluminum gas tank with a torch and proper flux. He had never welded aluminum before but didn't have any trouble. He also welded up his aluminum canopy frame. He did a real neat job filling in the flush pop rivets with a two part epoxy available at auto supply stores. After painting you can't even see where the rivets are located. The epoxy wouldn't adhere without a primer being applied first.

<u>Fuselage Skin Doubler</u> - Cracks have shown up on all of the three ships now flying at the forward upper corner of the main spar cut-out in the fuselage side skins. This is caused by the fatigue stresses set up during taxiing. John had recommended that a 0.063" 2024T3 doubler be added to all T-18s. The doubler can be put on the outside or inside. It extends up 5 rivet holes, down 5 holes, forward 2 holes and aft 2 holes from the upper front corner of the spar cut-out. Connect the four extreme holes with straight lines and cut with $\frac{1}{4}$" edge distance all around.

<u>Flaps</u> - John has discovered on the SkySkooter, the flap is more efficient if the rear edge of the wing butting against the flap is not faired smoothly to fit the leading edge contour of the flap. (He would change to this on the SkySkooter if it were possible without FAA complications.) The best arrangement is just as shown on the drawings. It is necessary to cement a rubber seal along the rear spar to provide a good seal when the flaps are up.

<u>Brake Pedals</u> - The pedals are designed without sufficient clearance to permit simultaneous application of full rudder and brake. If you are short, you can move the pedals aft, otherwise, clearance can be made in the tank support.

<u>Floor Boards</u> - Clearance slots for the exhaust stacks have been cut in the floor boards for drag considerations. These should be cut from 0.040 aluminum or .015 stainless.

Progress Reports - John would like to hear from anyone who expects to make a first flight in the near future. The way it looks now, the next two ships to fly will be those belonging to Otto Zauner, Vineland, NJ, and Bob Kaergaard, Glenn Ellyn, Ill. I just talked with Bob on the phone and found that he has had the final inspection and is nearly ready to go. To speed things up, he is using an open cowling and no canopy for the first flight. The rest will come later. To give you an idea of the variation in requirements between FAA agents, Bob was told to get about 7 or 8 hours taxi time on the aircraft and then call the FAA so they can witness the first flight. When I got my SkyCoupe licensed the FAA did not require witnessing the first flight. Bob is making prop extensions and may have them available for sale later.

I spent a very interesting day with John and Ralph yesterday. Due to a mixup in plans, I didn't get a ride in Ralph's T-18 but did get to look it over. It had the restrictions removed today. John is busily working on final FAA certification of the turbo-prop twin Beech conversion. When that is over, in several weeks, he hopes to finish up the T-18 drawings and then get to work on his ship which has been sitting in a partially completed state gathering dust for a long time.

POP RIVETS - A number of people have asked questions about pop rivets. Your dealer has a catalog which tells the size rivet for various grip lengths. If he doesn't have an extra copy, it will cost you only a 13 cent stamp to get one from United Shoe Machinery Corp., Shelton, Conn., 06485. The T-18 is designed for use of the low-strength aluminum pop rivets (150 lbs shear strength) except where the plans state, "no low strength rivets". The price of aluminum pop rivets at our local distributor is about $12. per thousand while monel pops are $17 to $20 per thousand. Monel rivets are much stronger 420 lbs shear strength. Regular AN rivets have a shear strength of only 375 lbs.

I am using only the monel pop rivets. I tried several countersunk head aluminum pops the other day and was very disappointed with the finished head. The head turned partially inside out so the supposedly flat head was dome-shaped.

I never use pop rivets anywhere it is easy to hand drive a rivet on the bench--such as in the webs of wing spars. There I use AN rivets and drive them with a hammer and rivet set. I personally feel that pop rivets may become loose quicker than an AN rivet even though they are stronger. I've had this happen. When drilling out rivets, the pop rivet will start to spin almost immediately. Also, if you try to flatten the aluminum surrounding a flush pop rivet by tapping it with a hammer after the rivet has been driven, sometimes the rivet will become loose. This indicates that a pop rivet might work loose sooner. I've not observed this type of thing with AN rivets.

It might pay for you to contact your FAA agent before using pop rivets since some of them don't permit their use (for instance, one in the Albany, NY area). John Thorp tells me that the FAA cannot legally stop you from using them however, but they can give you a hard time.

I feel that you are less apt to end up with twist in a wing or control surface if it is assembled with pop rivets. And twist is a major problem to look out for. Ralph Thenhaus had to re-skin his center wing because of built-in twist and Bill Warwick thinks his wing drop-off in a stall may be caused by twist. With pop rivets, you can get an assembly all clecoed together and checked for straightness before starting to rivet. When using AN rivets, you rivet up one piece at a time with at least a portion opened up for bucking. This process is certainly more conducive to getting a twisted assembly.

AIR COMPRESSORS - I recently fixed up an air compressor from parts obtained from a local junk yard. I found a two cylinder refrigeration compressor which, when driven by a 1/3 hp washing machine motor gives me more than enough air (up to 125 psi) to keep a rivet gun going as fast as I can work it. The compressor, tank and mounting base cost me only $3. If you are lucky enough to find a compressor pump, you might want to put a rig together. Sears sells a regulator and gage set. Of course, you cannot use the compressor from a hermetically sealed unit found in all modern refrigerators. You need the separate compressor that looks like a little gasoline engine. To get sufficient volume, get one with two cylinders. Also, don't use the type with the intake through the crankcase as this will get too much oil in the lines. If the intake is along the side of the cylinder with a drain to the crankcase, plug up this drain to keep the oil out of the air lines. Otherwise, no modification is necessary on the compressor pump. An automatic shutoff switch is not necessary for the average usage. Just plug it in and let it run as long as you are using air. However, a pressure relief valve is a must for safety. I bought one from a local air compressor dealer for about $2. It can be adjusted for any pressure. I believe the Sears models can't be adjusted. You'll also need a pressure regulator and two gages.

GAS TANKS AND RADIOS - Those of you who do not like the idea of having a bulky radio console hanging under the panel between the pilot and passenger's knees may want to locate it in the upper center of the panel. Some of the newer radios will fit into this space with only a slight notch taken out of the tank.

FUSELAGE - Someone asked what "spline curves"means on the fuselage skin prints. A spline is a draftsman's tool made of flexible material and is used for drawing in contour lines. When you lay out the skins, first locate the points at the frame locations, then take a long flexible piece of material -- wood is fine -- and anchor or have helpers hold it to the points at the frames. Carefully mark along the spline with a pencil.

DRAWINGS - Some people are confused and perplexed that dimensions aren't always given directly with lines and arrows in the familiar fashion. The use of stations, water lines, and butt lines is accepted aircraft practice and is as simple to understand and use as a,b,c. Stations (STA) are given in inches measured from some arbitrary reference point usually somewhere in front of the ship's nose. Water lines (WL) are vertical distances in inches and butt lines (BL) are lateral distances measured from the fuselage center line. Reasons for using this system are many and obvious. Drawings are much less confusing without all the extra lines and numbers and it is easier for the designer to keep everything correct. You will find few sets of plans as accurate as the T-18 plans.

FILE SYSTEM -
You will waste many hours looking for certain prints if you don't sit down and make a complete list of all the drawings and their numbers. Then just file the prints in order and it only takes a few seconds to scan the list for the desired print and then locate it. It is wise to classify prints by component and underline the numbers on the list according to a color code. All horizontal tail prints could be red, wings - blue, etc.

RIVETING TIPS -- By Dr. John Shinn - In riveting up my tail surfaces I have rediscovered a few important tips on riveting procedures.

(1) Rivet length is very important, especially on thin sheet metal. If they are too short they will not leave an adequately thick shop head and will not cover over the underside edge of dimples. If the rivet is too long it will be difficult to drive straight, it bends over one way or the other with the slightest misalignment. If the "too long" rivet is hammered down to acceptable head thickness it will take a very large number of large blows. The expansion necessary to do this "over"setting operation will be so high in many cases that the pressure of the expanding rivet will rip the hole in the metal. A further disadvantage of hammering down a rivet which is too long is that the distortion of the skin is greater.

(2) Bucking bars are critical as to weight, shape and the holding forces. In general the larger the rivet the heavier the bucking bar required. The only problem with too heavy a bar is the weight and ability to get into tight places. When a bar of sufficient weight is held squarely on a rivet it has a good "solid" feel in response to blows from the rivet gun. Bucking bars of the size of the hand-held "bumping" bars used by auto body men work prett well for the easy to get at 1/8" rivets on the T-18. Because some rivets are hard to get at it is necessary to have odd shaped bucking bars -- long bars, "L's", offsets, etc. The important thing is to get as much mass as possible in line with the rivet

being bucked. A bar with a small joggle (for reaching inside a part) works well if it is backed up by a large mass on the bar outside. If the mass is offset too much from the rivet centerline however, you will find that the bar rotates slightly in the riveting process, and a bent rivet will result every time unless the bar is held a slight amount in the opposite direction to counteract this tendency to bend over the rivet. The holding forces on the bucking bar are equally as important as the weight. Even a heavy bar will not produce good results if it is not held squarely on the rivet with a positive force. Make sure the bar does not rest on other parts -- it will not only producesome tendencies to rotate the bucking bar but will also mess up other rivets and parts unexpectedly.

Perhaps the most important thing in riveting is to keep enough pressure applied on the rivet gun and the bucking bar. Before pulling the trigger the rivet should be "Squeezed" in place between the rivet set and the gun and the bucking bar on the other side of the metal being riveted. As the rivet begins to expand during the setting process the pressure on the bucking bar should be increased as much as practical. This will prevent the gun from denting in a low area in the skin around the rivet. This added pressure is especially important in working with light bucking bars and light sheet metal.

(3) Gun settings are important too. If the resulting hammering force is too low the rivet will take a great number of hits to set it and it will tend to pean or mushroom out at the end rather than expand uniformly along the shank. You will also find that the rivet has a greater tendancy to bend, and that the skin takes more of a beating so that dents are more prevalent. One further disadvantage is that the bucking bar "dances" around for a longer time and is more likely to slip off the rivet or end up at the wrong angle.

Therefore, I concluded that you should adjust the gun to set the rivet in just a few strokes (6 or so)and fire the gun in short bursts. Observe the rivet between bursts for any necessary corrective action. Then apply plenty of force to both the gun and bucking bar for the succeeding bursts. The screw on the handle of the gun adjusts gun speed and force. Screwing it in reduces the effective air supply. I found I could do most of my riveting with a line air pressure of about 50 psi. For the long rivets on the inner wing spar a pressure of 80 to 100 psi seemed better. The gun will work down to about 35 psi if necessary.

(4) Flush riveting requires that the gun be held very squarely with reppect to the riveted surface with lots of force. If an adequate force isn't used you will find that the gun will tend to dance off the rivet and dent the adjacent metal. Again, plenty of pressure on the bucking bar side is a must. I find that the Good Lord made a pretty good universal joint in the form of a man's wrist. As a result it takes a little talent and practice to one-handedly

hold a medium or long length rivet gun without slipping. Short ...ts and a firm grip will help here -- the gun won't slip so much between trigger squeezes.

(5) Bumping out the flush rivets is a trick we learned from John Thorp. After you set each countersunk rivet keep the bucking bar in place and lightly strike the rivet area with a large rubber mallet. The bucking bar pushes out on the rivet and rubber mallet head depresses the skin surrounding the rivet. If you observe reflections on this skin around the rivet you can readily learn to tell when the surface is "bumped" back flat again. No matter how careful you are you will always find some local depression of the skin by the rivet set on thin skins. Heavy bucking bars hold with large force overcome this to a degree but thin metal, being flush with the rivet, is deflected with each blow of the rivet gun. (One way to avoid this is to use shallow countersinks or dimples and then shave the excess rivet head off when done.) This is a lot of work and with a little care the "regular" way does almost as well.

This about sums up my thoughts. Always use the correct length rivets and hold the gun and bucking bar squarely and firmly.

FLY-IN - Thoses of us who were fortunate enough to attend the Rockford Fly-In had a chanceto see two very fine T-18's, the second and third models to be completed. Dick Hansen's 180 hp ship (N299V built by Earl Love) has had a new paint job since the June cover picture for SPORT AVIATION was taken. This really is a beautiful aircraft in every respect. It was flown to Rockford by Jim Roberts.

Ralph Thenhaus wasn't able to attend but his T-18 was flown there by Jack Park and Lee Hamlin. Many of us were fortunate enough to get a free ride in this ship. We passed a hat among the guys who had rides to help pay for gas. If you had a ride and missed the hat, you might want to send a little donation to Ralph Thenhaus, 6536 Colbath, Van Nuys, CA. This was my first ride in a 125 hp model and I was very much impressed. The canopy was quite tight and the noise level below many good factory aircraft.

The Fly-In gave everyone an opportunity to talk to other T-18ers from all over the country. If you picked up any helpful ideas, send them in and we'll print them. I hated to leave before the forum but I was flying my SkyCoupe and the weatherman said I'd have a tough time getting home if I didn't leave before the bad weather moved in.

Here are some things I picked up at the 1965 Fly-In:

1. John Thorp no longer recommends the use of aluminum type pop rivets. Their shear strength is fine but tension is poor. He is using monel pops exclusively.
2. Sometime ago I told you to make counter-balance weights (626) for the anti-servo tabs. John says they are not needed & should be eliminated.

3. If full right rudder and simultaneous full right brake capability is desired, do not cut a clearance notch in the tank cradle. Instead, slice off the side of the right rudder pedal for clearance. Pilots confirm John's contention that full brake and rudder are not needed under any circumstances in the T-18, however.

Landing Gear - During my first week of vacation before the Fly-In, I made my main gear and the engine mount. So, the part I feared most is completed. I made the gear in two pieces, to facilitate heat treating. To give you an idea of the magnitude of this problem, the local heat treat shop says that there isn't a shop anywhere in this part of the country which could handle the complete gear. Merrill Miller found a shop in Detroit which heat treated his for $86. including shipping. I'm getting mine done free since the two piece gear fits the local oven. The tubing for the gear costs $51 from Machinecraft and I used one set of welding tanks costing $8.52. The gear was really fun to build.

Here's how I went about it: First I cut up the "tubing"? into the proper lengths with a hacksaw. (This is a simple task, but undoubtedly a stiff test of your endurance.) Then, because I was fortunate enough to find a fellow chapter member having a 36" bed lathe with a steady rest, I decided to taper the gear. John recommends a taper if you have the equipment. I made aluminum plugs for the ends of the 1.5"doubler tubes and tapered them both in one evening. I tapered the lower end with a straight taper down to 0.025" wall and tapered the upper end down to 0.080". I was afraid to go to a thinner wall at the upper end since I planned to use acetylene for welding instead of heliarc and it would be tough welding anything too thin to the 0.313" tube. Then I spent one whole day cutting the taper on the lower end of the 0.313 tubes. This was more of a problem than for the outer tube. Because of the extra long length a tail sock couldn't be used. I just used the steady rest for support and clamped the other end in the chuck. Since I wouldn't offset the steady rest with the tube clamped in the chuck, I had to cut the taper by hand. This doesn't sound like a very good idea but it worked out quite well. The 0.313" tube was tapered down to 1. OD.

Welding was accomplished with a regular acetylene aircraft torch with a No. 5 tip. For a fixture I took a 4' x 4' piece of plywood and sketched on it the various parts of the gear. Then I nailed a piece of wood in place to simulate the 526 attachment point. Several blocks were nailed on each side of the gear legs to hold them in place. I tacked all of the members in place and then removed the assembly for final welding. Welding was accomplished by first heating the area to be welded to a red color. I used 1/16" No. 7 mild steel rod.

Merrill Miller reports that his gear warped during heat treating so the axle attachments were not properly aligned. Rather than having them ground--an expensive job for the average guy--he just turned out wedge-shaped shims on a lathe and adjusted them to true-up the axles. I ground my pads to the correct angle with a sanding disc on a table saw.

There has been much discussion about the stiffness of the T-18 gear. Everyone including John Thorp agrees that the gear could be a bit softer for comfort in taxiing. There are three ways to make it softer:

1. Several persons have cut off the gear at the cross member and plugged in tailwind type legs turned out of solid stock. Ron Zimmerman made his this way (after John Thorp did a stress analysis for him) and it rides real fine. Callibie Woods tailwind legs worked loose where the mounting bolts went through the tubing. His A frame also bent since it wasn't heat treated. It is necessary to make the legs longer due to the extra deflection. Ron Zimmerman made his $3\frac{1}{2}$" longer.

2. Taper the existing legs and make the cross member lighter as described above.

3. Lengthen the existing inner tube 3 or 4 inches, with or without taper. I think this is the best solution since it can give identical spring constant and strength to the tailwind type while being easier to fabricate and much lighter. The extra steel necessary to fill up the hole in the tubing buys you virtually no strength, just extra weight.

Tips - Several people have sent in this one. For a cheap dimpling tool, take the mandrel (stem) out of a countersunk type pop rivet and re-insert it backwards. This rivet can then be pulled into a countersunk block of 3/8" aluminum to form dimples. I personally wouldn't recommend this for outside surfaces except in emergencies because it doesn't produce a nice smooth job. The area around the dimple becomes deformed - concaved. You will make a serious mistake if you don't try the very simple tool we described in the May 17 newsletter.

How it feels to fly a T-18 - Dick Hansen was gracious enough to give me a demonstration ride in his 180 hp T-18 today. I had a number of questions about the flight characteristics of the T-18 so he let me get the answers myself.

Getting into his ship is no problem because the canopy slides well back to give plenty of space between it and the windshield. Also, the side door is very convenient since it reduces the height of the step. He had no-skid material on the top of the tunnel, making it a convenient step. (Don't clutter up the top of the tunnel with gadgets to prevent using it for a step because using it in this way permits easy entry and exit without stepping on the seat cushions.)

The seat arrangement was comfortable although I could have used more leg room - I'm 6'2". The rudder pedals had been moved aft to provide brake pedal clearance at the fuel tank support. To compensate for this, the seat back had been moved back about 2" behind the 598 frame. Even so, my legs were doubled up so my knees were above the top of the stick. The stick had an offset bend which moved it about an inch closer to the outside of the cockpit. This is a good idea for it centered the stick better between my legs. However, with the radio console between our knees, I could move the stick only about 3/4" toward the center of the cockpit.

Since the upholstery was applied directly inside of the side skins, it didn't take away any valuable cockpit width at the seats. Although the corner of the tunnel cut into my hip it wasn't too bad. I still plan to round off my aft tunnel because of this.

One thing the homebuilder usually forgets about is passenger comfort, especially when it comes to fresh air vents. On the ground we taxied in real comfort with the canopy open. But when we pulled it shut for take-off it got hot mighty fast under that California sun. Then when we started moving I discovered how effective were the air vents Dick had installed. The vents were located on both sides of the fuselage near the floor, just forward of the main spar. Intakes were from holes just under the leading edge radius of the wings about one foot inboard of the junction of the inner and outer wing panels.

Dick made the take-off by lifting the tail off slightly after we got up to a pretty good speed and then easing the main wheels off at about 80. After we had climbed out of the smog, I took over and proceeded to do a series of turns. All normal flight maneuvers could be done with two fingers on the stick and not enough rudder to even mention.

Indicated cruise speed was 160 mph at 6,500 feet. This is about 182 true.

Having heard rumors that the T-18's stall is tricky, I asked Dick about it. He said, "No, I think it handles as well or better than most factory jobs in a stall, just watch." So he pulled on the carb heat and cut the throttle. When the needle read 70, it started to buffet and this increased until the speed dropped to 65. Then the left wing dropped and Dick picked it up with aileron and kept whipping the stick around to keep the wings level until the nose dropped and he let it pick up speed. I was surprised at the effectiveness of the ailerons all the way through.

When we made our approach, Dick came over the fence at about 85 and greased it right on, touching down at just under 80. He then seemed to do quite a bit of fancy work with the rudder to keep it rolling straight. He let me finish the roll out and taxi back to the ramp. He has brakes on both set of pedals.

I asked Dick how small a field the average guy could operate a T-18 out of and he replied "2500 feet at first, 2000 after you get the feel of it." With flaps he thinks it should cut down on the runway requirements.

Wing Fittings - Some people have complained about the amount of machine work connected with the inner wing (602) fittings. John says these were purposely designed to be made on a drill press and band saw. They are way over-designed so don't worry about holding close tolerances except on themain pin hole. Drill through the corners to establish a nice radius, then saw to shape and file out the scratches.

Mandatory Bulletins - The following bulletins are recommended on all T-18's

1. Fuselage Skin Stiffener - Add a stiffener to the side skin at the upper front corner of the main spar cut out. Material is 0.063" thick 2024 T4 sheet. See sketch.

2. Fuel Tank Support - It is necessary to provide a stress carry-through from the 528 tank support to the dash. This can be accomplished by making an angle bracket from 0.063" extrusion or bent up from sheet stock. Attach to the dash with two 1/8" rivets and to 528-2 with two rivets. Extend the 528-4 all the way to the dash. Make the 528-4 stiffener 12" long.

3. Tail Spring Attachment - Two failures have occurred at the front tail spring attachment point. In one case, the 591 bracket cracked from fatigue and the other was a broken ¼" attachment bolt. Change the 591 to one with the same dimensions made from 0.090 4130 stock and change the bolt and plate nut from ¼" to 5/16".

Main Gear - I was surprised to find that John's gear without wheels and axles weighs 48 to 49 pounds. My gear as described in NL#11 weighs 37.5 pounds.

Making Fiberglas Tips - Fiberglas parts can be molded in one of two ways, with a male mold or a female mold. At first glance, the novice might think that it is much easier to use a male mold since it eliminates one step in the process. If you don't care about the appearance of the finished product, this is probably true. However, if you want a nice smooth finished product, it will take considerably longer to finish off a part made on a male mold than to make a female mold. I have never seen a finished part made on a male mold which looked really smooth although it might be possible with enough effort. So, when I made my fiberglas wing tips for the T-18 I used a female mold.

The first step with any fiberglas molding process and by far the most time consuming, is to make a pattern of the part. There are a number of ways to go about making a pattern and the builder will usually select the one which best suits his circumstances. The pattern can be made from soft wood, styrofoam, balsa, or plaster. I chose plaster for the wing tips since it is very inexpensive and yet fairly easy to shape. We have made patterns for nose cowlings, wheel pants and tail tips from soft pine but this really takes a lot of whittling - about one month for a SkyCoupe nosecowling for instance.

If styrofoam is used, it must be coated with a material which will seal it from the resin. Otherwise the resin will destroy it. The cost of styrofoam in this area is completely prohibitive.

White gauging plaster works very well and costs about $1.50 for a 50 lb bag. Mix it with <u>nothing but water</u> - no sand since it would make it difficult to shape. Don't add too much water or the plaster will become too soft.

To establish the rough shape ofthe finished part, it is advisable to build a framework from cardboard or plywood. For the wing tips, cut out spanwise formers from a ¼" plywood, cut out a notch in each and mount them on a 1" x 3" board which serves as a backbone. The more formers, the less guesswork in establishing the correct shape. Cut out a ¼" plywood rib conforming to the wing profile and attach the skeleton to it. Set this framework on a piece of aluminum or waxed paper and slap on the plaster. The formers should be slightly smaller than the finished wing tip dimension so they can be covered with about ¼" layer of plaster. Sanding and finishing a surface composed of materials of different hardness is very difficult.

The handiest tool I have found for shaping plaster is a body rasp, called a "Vixen", used in auto body shops. It is slightly flexible and the cutting surfaces are in the shape of smooth semi-circles. It cleans very easily and makes no scratches. I consider it a must for shaping plaster. Very little finish sanding is required. If plaster is allowed to cure for about a week it files better.

The bare plaster pattern will undoubtedly be filled with many air holes. Filling them in with plaster is not as simple a job as you might think for the plaster block sucks the water out of the wet plaster so fast that it crumbles before you get it smoothed up. Try to fill in the largest holes but don't be too worried about the smaller ones. I wasted a lot of time carefully filling the holes with red lead body putty but this caused me other problems and I had to remove it.

The plaster must be finished off with a material impervious to resin. We tried laquer on one pattern and found that if there were any pin holes in the wax, the resin would soak through and lift the laquer. Then I tried ordinary water-base latex wall paint and this worked perfectly. It dries quickly, fills holes well, and wets sand very easily. I sprayed it on to get an even coat. I found that if it started to run I could just spray the run (while still wet) with plain water and it would disappear. About the only problem I had was that the latex paint just wouldn't stick to the putty I had used. I strongly recommend this type of paint for sealing a one-shot type of pattern. It is important that the pattern be finished very smoothly for its finish will determine the finish on the final part.

The pattern is then covered with several coats of a hard wax. Johnson's floor wax is ok. I recommend making a split mold for the wing tip, otherwise the trailing edge must be made too thick. To make a split mold, the top and bottom half must be made separately. The dividing line is formed by cutting a hole the shape of the wing tip plan form in a piece of aluminum and building a crude wooden framework to support the aluminum at the desired parting line on the pattern.

The mold can be made of either plaster or fiberglass. I used fiberglass to make it durable enough for re-use. The pattern and parting flange are not absolutely necessary but it facilitates separation. Wax alone works fairly well. Then one-half of the mold is laid up.

To get a decent finish, it is <u>necessary</u> to use gelcoat resin for the first coat. Gelcoat does not get air bubbles like regular resin. Brush a coat of gelcoat on and let it stand until set-up, preferably overnight. I rushed it once and found that the next coat of resin raised the gelcoat in places.

Next cut out glass cloth or mat, brush on a coat of resin and apply the fiberglas to the wet resin. Now if you haven't seen this operation performed, it would be wise to get a demonstration from someone who knows the ropes. It is really quite simple, but it is really messy to learn the hard way. Put on two or three layers of heavy fiberglas and then cut out some cardboard "egg crate" stiffeners and apply to the mold with resin to make the mold as rigid as possible. Stiffness can be covered with glass cloth for added strength. A flange of about 2" should be made at the parting line.

After the mold has set-up, turn it over and remove the aluminum parting line form. Apply wax and PVA to the pattern and parting flange. Then lay up the second half of the mold like the first. After it has set up a little prying will then separate mold from pattern.

To mold the wing tip, do one half at a time. After the mold has been sanded, put on about 5 polished coats of hard paste wax. Then follow with PVA sprayed on very very lightly. If it starts to pile up in globules wash off with water and start over. Then apply gelcoat and two layers of 7 to 10 ounce glass cloth. While the resin is still rather soft, trim at the parting line with a razor blade. (Note 20 years later. My tips held up fairly well, but people do like to squeeze them. Might help to cement in several reinforcements after they are joined, like 1/8" plywood ribs run spanwise for a few inches in from tip.)

Materials List - John Thorp has not made a materials list for the T-18, but Ken Knowles has a catalog which acts as a fairly complete materials list. Ken Knowles Sport Aircraft, Inc, 27902 Alvarez Dr, Rancho Palos Verdes, CA 90274. Merrill Jenkins, 2413 Moreton St, Torrance, CA 90505 also has a free catalog. In 1976, these are the two main sources for T-18 materials.