INTRODUCTION

by

Luther D. Sunderland

The T-18 Newsletter began in the fall of 1964 as a result of several letters and a visit with Dick Cavin, 10529 Somerton Drive, Dallas, Texas 75229. Dick had essentially "kicked off" the T-18 Mutual Aid Society with his fine article in the September 1963 **Sport Aviation** magazine entitled "Reflections From Rockford" in which he told about building the T-18 fuselage in just 3 1/2 days at the EAA Fly-In at Rockford, Illinois. But we felt that there was a real need for a "house organ" to circulate to the T-18 builders. **Sport Aviation** was fine for reaching the general EAA membership, but the time lag was too great, and there was not the editorial freedom found 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 New York and Texas. This continued for the first five issues. Then family illness and work demands made it impossible for Dick to continue, so I published all subsequent issues up through number 44 in 1976. All articles in these Newsletters were written by me unless otherwise noted after the title. Then in December 1979, Dick retired from Braniff Airlines and resumed as editor, publishing the next 23 issues (by October 1986).

This volume contains a reprinted version of the first 44 issues of the **T-18 Newsletters**, which have been edited to omit material that is no longer applicable. Also, comments have been added occasionally with the notation (1986 Note:) to provide guidance to builders where we have since learned additional information that would shed further light on the particular subject under discussion.

Perhaps the reader is not familiar with the T-18 aircraft and you have obtained this book as a general reference to learn about fabrication of a riveted all-aluminum airframe. For anyone in this category who is not familiar with the design concept of the T-18/S-18, a brief historical sketch is included here.

In the early 1960s, the Experimental Aircraft Association sponsored a design contest intended to stimulate designers to develop aircraft that would be easy for the person with average home workshop skills to build, one that was safe for the low-time private pilot to fly, and one that could be converted for transport on the highway and kept in the family garage. The several finalists that were able to meet all contest requirements, including completion of flight tests for a prototype, were not notably good designs and are long forgotten, for all practical purposes. However, a design that was not completed in time for contest judging has proven to be the undisputed winner, for it dominated the display area at Oshkosh for years and is still a very popular homebuilt. It has captured a number of records for homebuilts, including the coveted first (and so far only) homebuilt to fly around the world and to the North Pole. This aircraft, of course, is the T-18, and its designer is the well-known aeronautical engineer, John Thorp. The T-18 was his 18th design. Some of his other designs were the Fletcher agricultural plane, the Thorp Sky Scooter, Piper Cherokee 135, Lockheed P-2V Neptune, and Wing Derringer.

When John Thorp established priorities on design criteria for the T-18, he placed construction simplicity higher than ease of conversion to highway configuration. The wing was constructed in four panels, each four feet wide, so standard-width aluminum sheets could be wrapped from trailing edge to trailing edge with no spanwise drag-producing joints. The 20' 10" wing could be detached in one piece when seven detented pins were removed. The main drawback was that it was a three-man operation that took about 20 minutes.

In 1974, at John Thorp's suggestion, I undertook the design of a wing that would be much easier to convert to highway configuration. Also, I widened the cabin by two inches to improve passenger comfort. For eleven years, I sold modification plans using the designation T-18CW for convertible wing with wide body. Then in 1985, after John Thorp took the T-18 plans off the market, I produced a complete set of new drawings for the entire aircraft. Since such extensive changes had been made to the original T-18 design, the model designation was changed to S-18. These construction drawings, along with complete detailed building instructions, are marketed by Sunderland Aircraft, 5 Griffin Drive, Apalachin, NY 13732.

The following sections, consisting mainly of reprints of articles from the first 44 issues of the **T-18 Newsletter**, not only give a detailed history of one of the most important homebuilt designs, but they also present much valuable information about how to build every part of an all-metal aircraft. How-to-do-it articles describe making fiberglas molds and parts, bubble canopies, plush upholstery, hand-formed ribs, no-fixture aircraft structures, etc. Also, advice is given on how to do weight-and-balance measurement and how to flight test an aircraft. This is a veritable gold mine of information that is of value to anyone building any type of aircraft.

The first twelve newsletters contained much material that has been outdated, so these have been condensed into a single section. The remaining newsletters have been placed in 32 separate sections.

EXCERPTS FROM T-18 NEWSLETTERS #1-12

Luther D. Sunderland

RIVETS: by Dick Cavin. Apparently some of the newcomers are a little confused about the use of Hi-Shear rivets and Pop rivets. Basically Hi-Shears are high shear strength steel rivets, with an aluminum retaining collar, that are used instead of AN bolts. They are lighter and in some other respects superior. They can be installed very easily, using only a hammer and a simple installation tool. It is perfectly acceptable to replace a number 10 (3/16-inch) Hi-Shear rivet with a 3/16-inch AN bolt of the proper length, a washer, and elastic stop nut if you have difficulty obtaining Hi-Shears.

Almost all aluminum rivets in the T-18 structure are 1/8 inch in diameter. With matched-hole tooling techniques, when the rivet holes are made around the edges of skins, frames, and ribs, they are punched with a hand punch that was originally invented by the Whitney Tool Company of Rockford, Illinois. The Whitney punch set (the #5 Jr.) is obtainable from the Whitney Tool Company or from industrial supply stores. (Other brand names are available in 1986 which are very similar, do the job, and cost less.) You should order extra #30 punches with and without the little "nib." Or you can easily make extra punches from drill rod on a lathe by copying the shape of the bought punch.

You cannot put a 1/8-inch rivet in a 1/8-inch hole. It takes a #30 hole. If you dimple the skin around a 1/8-inch hole, the hole will enlarge enough so that a 1/8-inch rivet <u>will</u> go in. Also, it is accepted practice to dimple the lighter gauge skin and countersink the thicker material (040). If you plan to flush rivet, you might want to get a set of dimple dies for the Whitney punch. They are needed for dimpling ribs and frames, but they do not do an acceptable job in external skins. (Make a hand dimpling tool for skin dimpling as described in a subsequent newsletter.)

USING TEMPLATES: by Dick Cavin. The T-18 is constructed without the use of jigs or fixtures through a process developed by John Thorp called matched-hole tooling. Once a hole pattern is laid out in a particular part, it is transferred to the mating part with a transfer template made of scrap aluminum. Here are some tips on the transferring (marking and drilling or punching) of holes by the use of templates.

The first thing the builder of a metal aircraft, using matched-hole-tooling techniques, needs to learn is how to properly transfer hole patterns with templates. Holes are transferred from templates with a hand duplicator punch. A hand duplicator punch is either the 1/8-inch nibbed male punch from a Whitney punch, or a similarly-shaped slightly longer tool that you can make yourself. It takes a little practice and skill, believe it or not, to properly use the 1/8-inch duplicator punch. Hold it between the thumb and middle finger and sort of wiggle it in the hole. Do not try to push it straight down into the hole, for this will not 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 the template. Absolutely do not drill through the template. Always use the punch that has a little center nib to transfer the hole centers. (Make sure that the nib is perfectly centered on the end of the punch. I bought a punch with a nib that was off center, so I had to true it up on the lathe.) Remove the template before you actually drill holes. Take care to keep your drill at 90 degrees to the sheet and, in the case of fuselage sides, drill both sides and transfer strip at one time. 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 WL 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 and clamped together. The hole pattern was then transferred with nibbed punch. Sounds complicated, but it really is not. 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 523-1 bottom skin extend forward to cover the main spar cutout to aid in aligning the 523-2 floor. Important! After alignment, drilling and clecoing, cut it out. To use rivet as a dowel through worksheet, put head on bottom, and secure on top with tiny C clamp or piece of masking tape.

DRILLING: Great care must be taken to prevent drift during drilling. It helps to first drill a 3/32 hole and then enlarge to 1/8. Also, if two centerlines (a vertical, a horizontal) are first drawn through the center punch mark, they can be observed during drilling. Keep drill vertical. Practice on some scrap aluminum.

SIDE SKIN SPLICE: If you decide not to purchase a long piece of rolled aluminum for the fuselage side skins, make a splice just aft of STA 179.2 (T-18), using a 0.032 strip 2.5 inches wide as a doubler. Four vertical rows of AN426 AD4 rivets are used. Rivet centers should be 0.25 inches from sheet edges. Rivet spacing is about one inch. Do not continue the doubler under the angle at WL 42. It is much better, however, to purchase a roll of skin material from Airparts Incorporated in Kansas City and make the skins in one piece.

Actually, in 1986 there is no need to use a splice in the side skins, for it is just as economical to purchase coiled aluminum in thicknesses up to 0.032 inches. Two side skins can be made from a 20-foot long piece four feet wide with the two 14-foot long skins overlapped.

FORM BLOCKS: by Dick Cavin. Have had a considerable number of you ask "From what material do I make form blocks?" I used a select grade of maple for all my small parts (ribs, etc.). I used 3/4-inch fir plywood for the fuselage bulkheads. I have heard of Beneflex (tooling masonite) being recommended, but know it is hard to find and very expensive. Some builders used wood chip composition board for fuselage frame forms. If you expect to make more than one airplane from the form blocks, glue a layer of 1/8-inch tempered masonite to the top surface. Actually, most any wood material will do for form blocks if it will not splinter badly. It is important to make all form blocks in duplicate, as you must always make a block-metal-block sandwich and clamp it together tightly while forming. Metal will creep from forming stress if not held tightly. The backup block need not be a complete duplicate but can be made from pieces of scrap wood 3/4 inches x 1 1/2 inches. Use two index pins or 1/4-inch bolts in each side of the form block. Put pins completely through the "sandwich" to both align parts and restrain them. Put them near a corner so the index holes can be punched rather than drilled in the metal part.

TOOLS: by Dick Cavin. I highly recommend another tool, the Mead Bandsander, which looks like a small band saw. It deburrs, sands, shapes, profiles, etc. It uses 1-inch x 42-inch belts that can be torn to 1/2 or 1/4 widths for small areas. It is used in every aircraft factory and is tremendous for sanding the edges of aluminum parts. Here is something else that will save you many hours of tedious labor. You can write Mead Specialties, Chicago, IL.

If you want to saw aluminum plate, Sears has a blade (both six inches and nine inches) that does a beautiful job. It is their Kremedge Non-Ferrous cutting blade. Carbide-tipped circular saw blades are available in 1986 very inexpensively. They will last almost indefinitely. If you have a band saw, get a skip-toothed 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: by Dick Cavin. You can make your own fittings of aluminum plate quite easily. Saw them oversize and sand or file down to a scribe line. An ordinary disk sander works fine. I used a rubber-backed five-inch one in areas that I could not get to with the sander, followed by sanding with the little Mead bandsander. If you turn the rotary files very fast, they will chatter. Take very light cuts, too. Final sanding is by hand using wet-or-dry sandpaper in progressively finer grades. Make all scratches parallel to the part edge, not perpendicular. 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. Before you get carried away, however, remember that all aluminum fittings must be sprayed with zinc chromate primer to prevent corrosion, so your nicely polished parts will not be visible for very long.

Actually you should always finish 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. Finish the edge of sheet parts to the extent that there are no visible scratches or nicks perpendicular to the sheet edge. This also applies to deburring holes. Always deburr holes before dimpling, as the forming stress of dimpling may possibly crack light skin. If this happens, you will have to drill it out and use an oversize rivet.

FORMING RIBS FOR THE T-18: by Dr. B. John Shinn.

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 thought that the cost of special tooling would be too high. Having things like ribs hydropress formed would also be too expensive.

But, then came the series of **Sport Aviation** articles on the T-18. John Thorp made it sound like an ordinary guy could make acceptable ribs himself with only a mallet, a bucking bar, and some wood form blocks. Besides that, he mentioned an alloy, 6061-T4, which could be formed without annealing. To me, all aircraft sheet aluminum had been 2024-T3, which required considerable care even in bending straight line corners, let alone compound curves. My interest mounted to the point that I was mentally stretch-forming ribs, so I decided I would 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."

Form Blocks: 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 has a fine-grained surface for non-bumpy layout, and does not split out under heavy pounding. Besides that, it comes in widths (6 inches to 9 inches) which are more manageable than large sheets of plywood. Thickness should be 3/4 inch to allow forming a good flange out to 5/8 inch. (1986 Note: Today 1986 builders might find solid birch hard to locate and very expensive, but most lumber yards have good quality 3/4-inch birch plywood that is used for making cabinet doors. This stands up quite well when used for rib form blocks. Also, it is quite difficult to find 6061-T4 aluminum sheet. Most suppliers have only T6, which can be used for ribs, but it is much more difficult to stretch form. Phil Tucker who bought Ken Knowles' Sport Aircraft Inc., 104 E. Avenue, K-4 Unit G, Lancaster, CA 93535 has T4 sheet, however.)

The complete airfoil template was laid out on 0.040-inch aluminum and 0.025 inch (the thickness of the rib material) was trimmed off the complete perimeter of the template. The airfoil coordinates given in the plans have the exact dimension of the main spar height. So, when a form block is made for a specific thickness rib (0.025, 0.032 or 0.040), then the appropriate thickness must be removed from the original airfoil contour to allow for the thickness of the rib material. Several 1/4-inch indexing holes were punched to align nose and center rib sections. The location of these locating holes is important for they must be reachable with the Whitney punch when there is a 7/8-inch wide flange on the rib blank. Put two of these holes along the lower side of the nose rib portion of the template so there is adequate distance from the bend line for the spar flange on the shortest rib.

This airfoil template was laid on top of two 3/4-inch birch boards and the indexing holes were drilled through the boards simultaneously. A couple of 1/4-inch 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, 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 band saw was the most practical. By carefully staying about 1/32 of an inch from the pencil line, with this cut I avoided excessive sanding time later.

The rough-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 undercut the form block to compensate for the spring back of the rib after forming. About four degrees was used for "straight" sections while a six-degree 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 angled undercut without over-shooting the mark.)

The edges of the form blocks were rounded to give the proper bend radius of 3/32 inch. 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.

Rib Blanks: For quick layout of the rib blanks, a 0.040 metal rib blank template was made for the nose ribs and another was made for 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 inch was used. By trimming this metal to the outer mark, a 7/8-inch 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 cutout at the front of the nose rib was made in this nose rib blank template per the 201 drawing. It is strongly recommended that the cutout 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. So, leave the rib blank at least 1/2 inch longer than the form block at the leading edge. When the excess is trimmed off after forming, it will remove most of the folded-back part of the flange.

Holes were also punched through this template for the corner relief (as indicated on the prints) for the 201-1, -3, and -4 nose ribs. The -1 and -2 were close enough alike to use the same relief holes.

Cutting Out Blanks: The 3' x 12' sheet of 6061-T4 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 the nose cutout.

For cutting up the sheet, I found that the 6061-T4 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 it was insignificant when compared to the stretching it was soon to undergo. The blanks were then placed under the rib-blank template, the locating holes were punched, and the nose cutout was scribed lightly on the blank but not cut. The flange around the very tip of the nose was trimmed to a 1/2-inch width to minimize wrinkles in this high-stretch area. The appropriate relief holes were also punched. The pile of rib blanks was then ready for the forming operation. Note that there are three different lengths for the 201 nose ribs and that left and right parts must be made.

Clamping: The metal blanks for the nose rib were inserted between the two rib form blocks and 1/4-inch bolts were pushed through those two locating holes in the nose section and meets with washers tightened. Both C clamps (2.5-inch throat) and a bench vise 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, I could push them over one way and then the other as forming progressed so that unscrewing them and saving them was not required.

Forming Tools: In forming my ribs I found that the following tools worked out best:

1. A medium-weight hammer with a modified hard-rubber head: The hard rubber head was sawed and filed to a wedge shape (about 60-degree 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, but it will make a much rougher finished rib flange since it makes many small dents that become work hardened and cannot easily be removed. Locating the correct hardness rubber-tipped mallet is one of the most important tasks in rib forming. Find the hardest plastic tip that still has enough compliance to be able to be dented by your thumbnail. This is extremely important.

2. A smooth bucking bar about 1" x 2" x 4".

3. Solder bars: Obtain two solder bars from a plumbing supply store. One is used as a "slapper" and the other is used as a "stomping" rod. The "stomping" 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.

Setting the Flange: 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 process. 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 back about 30 degrees. Because of the curves, this 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-degree angle. The bar is held vertically on the form block and since the rib blank is sloping back, when the pointed mallet head strikes the aluminum, it stretches the aluminum back into the recess. Make a stretching pass all around the top and the bottom to lock the blank in place and prevent it from being pulled out from between the form blocks and being distorted at the indexing pins.

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 6061-T4 sheet forms quite readily, and it is fun to watch the rib develop. The bucking bar is held behind the flange, and the hammer is aimed at the triangular gap formed between the bucking bar, the form block and the flange. Each pass of stretch forming is started at the nose and progressively moved toward the back. After each pass a rubber mallet is used to tap the flange back to a 60-degree slant to form a new triangular gap to stretch inward.

Eventually some radial wrinkles begin 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 bend the flange over farther than normal (45 degrees or flatter) and gently wipe out the base of the wrinkle with the plastic hammer. About three forming passes are needed to form out well beyond the 5/8-inch final flange dimension. On the third pass I use much heavier blows of the hammer to wipe the metal into the triangular gap. The bucking bar is actually held down behind the form block to allow the flange to be stretched to the full 3/4-inch width.

In the final forming operation is the only place that 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 severe spring back. I merely stretched the vertical flange so that it was out well beyond the 5/8-inch width and then trimmed it mostly off before slapping it down 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-inch depth gauge. It was made from a scrap piece of wood shaped like an "L". At a point 5/8 inch up from the inside corner I drilled a hole and pounded in a sharpened nail--just far enough so that about 1/8 inch of the point protruded from the wood. This was slid along the rib to scribe the flange before cutting.

Making Access Holes: Although the plans did not call for them, we felt that it would be a good idea to have holes in the ribs. Among other things they allow you to see inside and repair dents. Besides, the FAA inspector can see inside after the wing is all riveted so you do not have to wait to let him look before you "close it up".

Some holes were three inches in diameter and others were two inches. 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 two-inch thick oak. There was a set for two-inch holes and a set for three-inch holes. The male part of the two-inch set had a two-inch diameter plug with a 45-degree flared skirt. The mating part was a ring having two-inch ID with a 45-degree flare at one end. The lightning 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! A really professional looking rib.

1964 FLY-IN: by Dick Cavin. 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 feet per minute. With the 180 hp engine it loafs along at 180 with lots of power in reserve. John Thorp says that he will have the T-18 topping 200 mph when the cleanup program is done. He feels that the lighter GPU engine and prop combination will do almost as well. Visibility--very good. Comfort--average or better. Noise level--OK. Takeoff run--less than a Tailwind. In flight handling--superb. All in all, it is a real honest airplane from the time you fire up until you shut it off. In my opinion, a good 75-hour pilot could fly this airplane with no problems. All controls are responsive, but not sensitive. It is very well behaved on both take off and landing roll. I predict that it will be known as an outstandingly fine airplane in time to come. The only item that did not please me and the other boys that rode in it was the gear action on rough sod. It is much too stiff but was excellent on hard surface. Sod there was very rough.

Gear will be fine for crosswind work. Like most other high performance ships, this one will be at its best on hard-surfaced runways but it needs to be softened for sod. My hat is off to John for one more fine airplane design.

Metal Working: Here is an area that came under considerable discussion at the Fly-In. We recently experimented with testing Pop rivets versus ANs. 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 deburring prior to dimpling minimized this, but would not eliminate it completely. One good "fix" we found was to use a cloth buffing wheel with emery compound after dimpling, being careful not to overdrive rivets. John says the problem has always been around, but is not a serious thing, as the cracks do not spread. (Editor's Note: In 1986 we can verify this.)

Try this deburring tool: make a slotted pointed dowel to hold aluminum wool and use in a drill. We recently improved on this. Use a 1/8-inch diameter aluminum rod, tapered to a point on one end. Dip the point in epoxy glue and attach aluminum wool for overnight cure. It works well, but be sure to use only aluminum wool. Steel wool is verboten. It acts like cancer, triggering rapid corrosion.

Bulkheads: Our form blocks for fuselage frames were carefully cut with a 45-degree routing tool for the inner flanges. We have since learned that this was a mistake. A smoother job results if you do not bend to a restricting surface, but simply make the inside edge form block 90 degrees. (1976 Note: Bend all inner frame flanges 90 degrees except 45 degrees in corners. Exercise 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 3/4) with a slot cut in the bottom (the thickness of the metal) with about a 10-degree angle on the nose of this "tool". Lay the part on the bench with flanges up, slip the slot over the flange, and rebend the flange to the exact angle. Use scrap metal template to check the angle. Hold down (tightly) the rest of the bulkhead not being bent. Work up and down along the flange a few degrees at a time. Works great!

Here are a couple more ideas from Dick Fink: (1) Forget sheet metal grind drills--get a #1 Lathe center drill from Chicago Latrobe Tool (411 West Ontario Street, Chicago, IL). It has a starting nib and the body is 1/8-inch diameter, catalog number is 217-1. Their #2 drill is identical (catalog #217-2), but drills out to 3/16 inch, or 0.002 short of a #12 drill. (2) To figure bend allowance or "corner shrinkage" take a strip of required thickness exactly one-inch long and two inches wide. Scribe a line 1/2 inch from edge, parallel to one-inch side. Place in brake with correct radius bar. Bend up 90 degrees. Mike the two legs of the resultant angle. Subtract the original length of one inch and this is the amount the bend took up. Figure your bend allowance from this. For my setup h = 0.540 and the piece had a net gain of 0.080 inch for the 0.025 material.

QUESTIONS FOR JOHN THORP:

1. How can the O-290-G engine be modified to give higher horsepower?

   Answer: To soup up the O-290-G for higher horsepower, a crankshaft from an O-290-D, D2, or O-320 engine should be used. This gives the added strength required for higher horsepower. The sludge tubes in the O-290-G crankshaft are larger than in the other engines. Different pistons can be used to step up the horsepower. (Gs give 6.5:1 compression ratio, D2s give 7.0:1, D-2Bs give 7.5:1.)

2. Can a propeller be safely attached to the bare O-290-G crankshaft flange?

   Answer: No, not for a metal prop. The thin flange is not safe without a flange reinforcement.

3. How is the solid aluminum tail spring made?

   Answer: Make from 2024-T3, bend on an arbor press, then reheat treat. Heat to 960 degrees F and quench in cold water. (1986 Note: The spring is now a leaf spring made of spring steel.)

4. What exhaust system should be used?

   Answer: A crossover system is most efficient. Stainless is half as heavy as automotive exhaust tubing. Ball joints are essential. No mufflers are needed.

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

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 Company, West Medway, MA for a catalog. If you cannot find a local dealer who handles the rivets, order from United Shoe. Order Monel rivets with the steel shank. MD type are Monel domed, and MK are Monel flush.

Conventional AN 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 makes a clean square cut. Rivets cut with diagonal cutters cannot be driven properly. However, when a #30 hole is drilled through the overlapped flat jaws of a tool used for crimping electrical wire terminals, this makes an effective and inexpensive rivet cutter.

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 thinner than this dimension, 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 gauges 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-inch rivet will not fit in a 1/8-inch 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	1/4

Use the correct edge distance for all rivet holes, which is two rivet diameters from the center of the rivet to the nearest edge of the sheet (1/4 inch for 1/8 inch rivets).

If a hole is oversized or not round, the next size rivet should be used. Pop rivets should never be used in oversized holes but ANs can be expanded a reasonable amount to fill a sloppy hole. Flat-head rivets can be readily fattened up before inserting in the hole. Set rivet on a flat bucking bar and drive slightly with a rivet gun or hammer and drift punch to swell the shank. Round- or brazier-head rivets are are a bit more difficult to fatten and keep straight.

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 for 1/8-inch rivets is not recommended when the skin is less than 0.040-inch 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 center of 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. 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 3/4-inch diameter. Cut the shank equal to the rivet diameter and about 1/4-inch long to act as a guide. If this portion is too long, it will soon break off, for you must tilt the male die in the female die while dimpling to be able to take out unavoidable dishing around the dimple. The portion which forms the dimple should have the same angle and size as the rivet being used. Note that Pop rivets have a 120-degree head, while standard AN rivets usually have a 100-degree head. The female portion of the dimpler must be made in two parts. It should be rather heavy and of a convenient shape to fit in tight quarters and various locations required.

The best way to drive rivets is with a rivet gun unless the parts being riveted can be laid over a bucking bar on the work table. This requires a substantial supply of compressed air for power. When using a rivet gun, place the rivet set against the factory head and the bucking bar against the shank. Some builders have reported success in driving flush rivets backwards, with an old-fashioned 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 and backed by a solid structure. A rivet squeezer is ideal for rivets close to the sheet edge but is hardly worth the investment since so few rivets fall in this category. It is important that all tool surfaces which come in contact with the rivet be polished to remove all scratches, which set up stress risers in the rivet.

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 (and **S-18 Building Instructions**). Everything works fine just as the instructions specify. It is of considerable help in squaring up the fuselage during assembly if the #523-1 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-foot lengths of 3/4-inch 2024-T6 angle. Ken Knowles' Sport Aircraft Incorporated, Phil Tucker, 104 E. Avenue, K-4 Unit G, Lancaster, CA 93535 (805)949-2312 has these and all other extrusions for the T-18/S-18 (in 1986). It is feasible to use shorter lengths of extrusions and splice them.

In Part X, John states that the curvature should be put in the longerons before assembly. I found it very easy to bend the longerons to the proper curvature before riveting so the fuselage parts could all be assembled and drilled on the assembly.

For a bending jig, saw a 12-inch radius along the edge of a piece of a one-foot long 2 x 4, then make a saw cut along this same edge about 1/16-inch wide and one-inch deep. Nail this block to a table and nail another backup block about 1/4 inch away from the curved edge. By slipping one leg of the angle in the saw cut it is a simple matter to progressively bend the angle to any desired curvature. These angles are riveted to the skins while they were off the fuselage assembly. During hole transfer from the skin to the longerons, the longerons are held nearly flat. Then when they are put into the assembled fuselage, the skins will be drawn tightly against the longerons.

It is difficult to detect the lightly scribed fore and aft centerlines on the longerons for hole transfer but I found a simple cure. I sprayed a coating of zinc chromate on the longerons before scribing them. This makes the scribe lines show up. The -3 longerons should be cut off at a 30-degree angle to make sufficient clearance for the rudder. One leg of the 3/4 angles can be riveted to the side 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 the 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 centerline holes from the skin to the frame. 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 centerline holes are transferred.

Bending the flanges on the top skin was done very simply by bending it over the edge of a board that had 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 degrees, 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.

MAKING THE FIN: by Dr. B. John Shinn. In Part VI, "Building the T-18," November, 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 jig. 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 that the problem of supporting the fin skeleton (ribs and beams), as suggested in the article with its center plane held three inches above a table with clamps and blocks, had me scared. The problem gnawed at me for quite awhile and gradually the idea evolved that what I wanted was some way of holding the skeleton in rigid alignment while allowing me to fit and drill the skin simultaneously on both sides of the fin. But how? All of these things at once are not so compatible. Any rigid jig would have to come through one side or other of the skeleton to be supported. The only side that was not to be fitted with the skin was the back side--the beam. That is 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 10s (all as square 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 bolts, six inches long. Two large 1 1/4-inch 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 degrees 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 the right 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 will want to use rib blocks which support the ribs clear out to the front tips. (The 2 x 10s do not 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 10s, 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 1 1/4-inch 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 alignment 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 centerline 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.

From here on the job was just fun. Dimensions from the plans were used to lay out a fin skin that had about 1/4 inch to 3/8 inch excess on all sides. The fin skin was cut out and

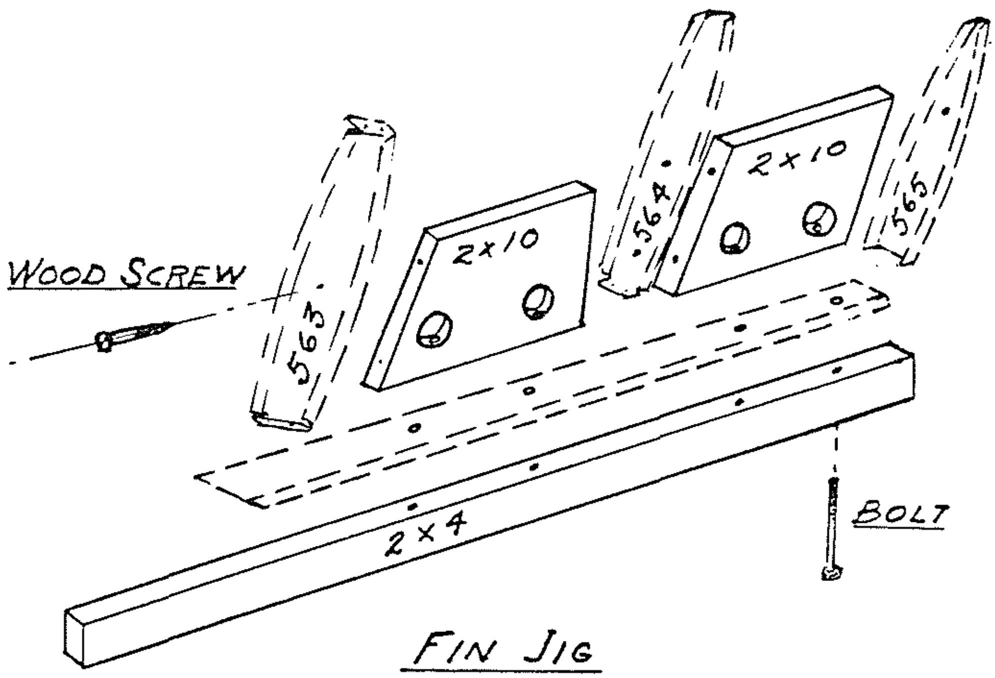


Figure 1

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 to get the sharp radius that fits the ribs! The 2 x 4 distributes the load so you will not get a "lumpy" bend. After several trials of bending, unclamping, fitting on the fin skeleton, reclamping, and really pushing down hard, you will decide it is 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 0.250 rivet-edge distance when you mark the centerline of the rivet pattern for each rib. Measure up the proper distance from the traced line and draw in the rivet pattern centerline. Drill a 1/16-inch 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 0.250 inches from their bottom edges (i.e., the rivet centerline). Reposition the skin over the skeleton, sliding it until the centerline on the rib shows through the 1/16-inch hole in the skin. Drill through the skin hole into the rib with the 1/16-inch 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 undersized hole is drilled at the rivet position closest to the fin beam. The skin is again fitted to 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 a. extending the undersized hole sideways with a file to meet the pencil line, or b. perhaps flexing the skeleton a little.) When you are satisfied with the hole alignment, connect the front and back holes with a pencil line on the skin. Mark off rivet positions and drill 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 centerline 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 cannot 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 punch over 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-inch 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 into the rivet hole already punched in the beam, and then squeeze. The rivet is pushed down through the die by the punch.

Where the overhang is too large for the Whitney punch, a long 1/8-inch 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 is 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. See the Fin Jig Drawing, Figure 1.

SHEET METAL MATERIAL LIST: This amount makes one T-18.

2024-T3 Alclad 0.025" x 4' x 12' 7 1/2 sheets
6061-T4 0.025" x 3' x 12' 1 sheet
    Ribs for wings, fin and stabilizer
2024-T3 Alclad 0.016" or 0.020" x 3' x 12'
    Ailerons, stabilizer tab and rudder
2024-T3 Alclad 0.032 x 4' x 12' sheet
    Frames, beams, canopy, engine baffles, inner wing skin, rear spars for wing and horizontal tail, fin beam, frames, and floor
2024-TO or 6061-T4 0.032 x 4' x 72"
    Frames and ribs

2024-TO or 6061-T4 0.040 x 4' x 24" 1/6 sheet
Ribs, fuel tank support etc.
2024-T3 0.040 x 4' x 12'
Main spar (enough for 3 airplanes)

HOW TO GET STARTED: by Luther D. Sunderland. Several persons have asked how they should get started on the T-18 if they have never before built a metal airplane. Well, I cannot 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-inch legs and made the 4' x 12' top from 3/4-inch thick chipboard. Do not expect good results with matched-hole tooling if you do your transferring on a piece of bent cardboard on the uneven workshop floor. Cover the chipboard with 1/8-inch tempered masonite. Allow the chipboard to extend 1 1/2 inches out from the frame to permit clamping of parts to the table edge for forming.

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

Whitney Junior Punch 1 extra #30 punch	Whitney Tool and Die Company Rockford, IL
Pop Riveter	Sears
Hand drill	Everywhere
Sheet metal shears (straight scissors type & right or left-handed aircraft type)	Everywhere
Scriber	Everywhere
Decimal scale (at least 18" long)	Sears
Six-foot tape	Everywhere
Several C clamps	Everywhere
Sheet metal clamps (look like clothespins)	Sears
Bucking bars	Junkyard, aircraft supply
Rivet set	Aircraft supply
Dimpling tools	Make
Hacksaw, files, etc.	Everywhere
Stanley Rasplane	Everywhere
Vise, large	Everywhere

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

Band saw	Air compressor	Milling machine
Saber saw	Drill press	Reamers, several sizes
Welder	Tube bender (hydraulic hickey)	Belt sander
Rivet gun		Buffing wheel
Spray gun		

DIMPLING: After much experimentation with various dimpling tools and techniques, we have discovered how to make dimples that 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 (3/4 inches or more) 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. See the Dimpler Drawing, Figure 2.

It is necessary to obtain the use of a lathe to make a dimpling set. Preferably, 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 7/8-inch diameter by two inches long or longer. One end is simply turned down to the exact dimensions of the rivet which will be used. The 1/8-inch projection representing the rivet shank should not be more than 0.2-inch long or it will break off after moderate usage. 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 the flange with a good grade of cloth duct tape. Adhesive tape will work well. At least a 1/2-inch 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-inch hole 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-inch radius seems to do the job. You will 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 degrees for AN rivets and 120 degrees for Pops), is to make removable inserts.

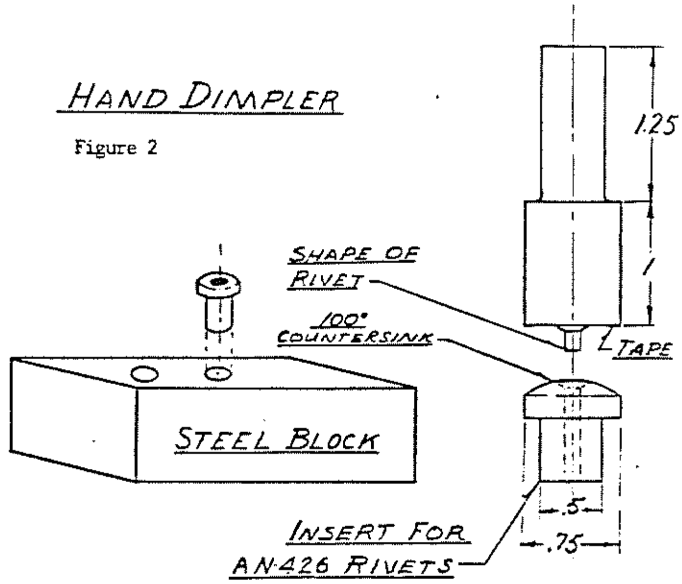


Figure 2

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 shave off high rivets.

When using the dimpling tool, support the sheet with blocks the same height as the female part of the dimpler's to keep it level. Hold the male die vertically while striking it. Then observe the finished dimple in bright light. Any unevenness in the dimple or distortion surrounding it will be clearly visible. If one side of the dimple needs more forming, tilt and strike again. The dimple should not have any dished region around it, but it also should not have any signs of pinching between male and female parts of the die outside of the dimple.

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 have 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 head of the particular rivet being driven.

The recess in the insert is made by using a drill that is ground 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 in a drill press or lathe. 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. The tool should contact the domed rivet head in the very center.

To drive the rivet by hand, place the factory head of a flush rivet down against the back-up block. Place the polished end of a drift punch against the shank of the rivet and strike the punch with a heavy hammer. I made a good drift punch from the 1/2-inch stem of a truck engine valve by grinding off the head. It is necessary to use a punch 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 punch, 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 times the rivet shank diameter, and the thickness of the shop head should be at least 1/2 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 the rivet set or bucking bar not being held properly in place and covering all of the rivet.
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 technique.

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-inch cross tube with a 1.25 x 0.082 tube. Cut this tube at the fuselage centerline and slide a six-inch piece of 1.5" x 0.120 tube over it. Bolt the splice together with four 5/16 bolts oriented vertically. Split the gear in two on the centerline at the apex of the triangle. 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 0.030 wall at both ends and the 1.25 tube from the lower end of the 1.5 tube down to 0.160 wall at the lower end. John has approved this modification for publication.

VISIT WITH THORP 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 175 at full throttle. This is a true airspeed of 182. 75% cruise would be at 165. John says it climbs at 1500 fpm solo and is a real hot rod.

Ralph's T-18 empty weight is 835 pounds plus canopy which adds about 20 pounds. 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.

John says that if 0.020-inch aileron skins are substituted for 0.0160 inch, aileron balance weights should be increased in weight by the same percentage.

Cabin Comfort: About the only disappointing feature I have found in all the T-18s 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-inch 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.

Canopy: The latest canopy drawing shows the top of the rear deck sliced off in the same plane as the canopy rails. (The original T-18 fuselage, being open cockpit, had a hump behind the seat.) 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 baggage access. In fact, he said a jump seat could be added for a small child.

Welding Landing Gear: Both Bill Warwick and Ralph Thenhaus welded up their own gear with regular oxy-acetylene torches. They used a lot of gas but claimed it was not bad after they got the joint heated up. With regular gas welding it is better to use a mild steel rod, such as Number 7, since it has less tendency to crack during cooling. All welded 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 that had to be rewelded usually at many points on each part due to cracks. This really sold me on the need for magnafluxing critical welded parts.

Welding Gas Tank: Ralph says he welded up his own aluminum gas tank with a torch and proper flux. He had never welded aluminum before but did not have any trouble. He also welded up his aluminum canopy frame. He did a really neat job filling in the flush Pop rivets with a two part epoxy filler available at auto supply stores. After painting you cannot even see where the rivets are located. The epoxy would not adhere without a primer being applied first.

FUSELAGE SKIN DOUBLER: Cracks have shown up on all of the three ships now flying at the forward upper corner of the main spar cutout in the fuselage side skins. This is caused by the fatigue stresses set up during taxing. John recommends that a 0.063-inch 2024-T3 doubler be added to all T-18s. The doubler can be put on the outside or inside. It extends up five rivet holes, down five holes, forward two holes and aft two holes from the upper front corner of the spar cutout. Connect the four extreme holes with straight lines and cut with 1/4-inch edge distance all around.

FLAPS: John has discovered on the Sky Scooter that 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 this on the Sky Skooter 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.

BRAKE PEDALS: 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.

FLOOR BOARDS: Clearance slots for the exhaust stacks have been cut in the floor boards for drag considerations. These should be made from 0.032 or 0.040 aluminum or 0.015 stainless.

PROGRESS REPORTS: John would like to hear from anyone who makes a first flight. The way it looks now, the next two ships to fly will be those belonging to Otto Zauner, Vineland, New Jersey and Bob Kaergaard, Glenn Ellyn, Illinois. I just talked with Bob on the phone and found that he had 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 seven or eight hours taxi time on the aircraft and then call the FAA so they could witness the first flight. When I got our Sky Coupe 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 did not 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 does not have an extra copy, you can get one by writing to United Shoe Machinery Corporation, Shelton, CT 06485. The T-18 is designed for use of the low-strength aluminum Pop rivets (150 pounds shear strength) except where the plans state, "no low strength rivets." Monel rivets are much stronger with 420 pounds shear strength. Regular AN rivets have a shear strength of only 375 pounds. However, Monel Pops or AN rivets are recommended.

I am using 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. 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 had been driven, sometimes the rivet will become loose. This indicates that a Pop rivet might work loose sooner. I have not observed this with AN rivets.

It might pay for you to contact your FAA agent before using Pop rivets since some of them do not like their use. 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 reskin 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 you start riveting. 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 built an air compressor from parts obtained from a local junkyard. I found a two cylinder refrigeration compressor which, when driven by a 1/3 hp washing machine motor, gives 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 gauge 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, do not 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 cannot be adjusted. You will 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's and passenger's knees may want to locate it in the center of the panel. Some of the newer radios will fit into this space with only a slight notch taken out of the tank (if the panel is moved aft 3 1/2 inches).

FUSELAGE: Someone asked what the note "spline curves" means on the fuselage skin prints. A spline is a draftman's tool made of flexible material and is used for drawing 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.

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

FILE SYSTEM: You will waste many hours looking for certain prints if you do not 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 rivets 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 that 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 required. In general, the larger the rivet, the heavier the bucking bar required. The only problem with too heavy a bar is the weight and difficulty getting 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 pretty well for the easy to get at 1/8-inch rivets on the T-18. Because some rivets are hard to get at it is necessary to have odd-shaped bucking bars--long bars, "Ls," 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. 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 that the bar does not rest on other parts--it will not only produce some tendency to rotate the bucking bar but will also mark 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 peen or mushroom out at the end rather than expand uniformly along the shank. You will also find that the rivet has a greater tendency 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 conclude that you should adjust the gun to set the rivet in just a few strokes (six 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 respect to the riveted surface with lots of force. If an adequate force is not 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 bursts and a firm grip will help here--the gun will not 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 the rubber mallet head depresses the skin surrounding the rivet. If you observe reflections on the skin around the rivet, you can readily learn to tell when the surface is "bumped" back flat again. No matter how careful you are during riveting, you will always find some local depression of the skin made by the rivet set on thin skins. Heavy bucking bars held with large force overcome this to a degree, but the metal, being flush with the rivet, is deflected with each blow of the rivet gun.

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

1965 FLY-IN: Those of us who were fortunate enough to attend the Rockford Fly-In had a chance to see two very fine T-18s, 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 was not able to attend, but his T-18 was flown there by Jack Park and Lee Hamlyn. Many of us were fortunate enough to get a ride in this ship. We passed a hat among the guys who had rides to help pay for gas. 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. I hated to leave before the forum but I was flying the Sky Coupe and the weatherman said that I would have a tough time getting home if I did not 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 where blind rivets are required.

(2) Some time ago I told you to make counter-balance weights (626) for the anti-servo tabs. John says they are not needed and should be eliminated.

(3) If full right rudder with 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 in the T-18, except to make a sharp turn while parking. It is a nuisance to back off rudder in order to apply brake for a sharp turn, 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 is not 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. The tubing for the gear costs $51 from Machinecraft (in 1965), and I used one set of welding tanks costing $8.52. The gear was really fun to build.

Here is 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-inch 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-inch doubler tubes and tapered them both in one evening. I tapered the lower end with a straight taper down to 0.030-inch wall and left a 1/8-inch full diameter ring at the end to prevent splitting. I tapered the upper end down to 0.080 inch. 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 stock could not be used. I just used the steady rest for support and clamped the other end in the chuck. Since I could not offset the steady rest with the tube clamped in the chuck, I had to cut the taper by hand. This does not sound like a very good idea but it worked out quite well. The 0.313 tube was tapered down to one inch OD.

Welding was done with a regular acetylene aircraft torch with a Number 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 screwed 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-inch Number 7 mild steel rod throughout.

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 after straightening the legs with a long chain and jack (bow and arrow style).

There has been much discussion about the stiffness of the T-18 gear. Everyone, including John Thorp, agrees that the gear should be softer for comfort in taxiing on rough ground. 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 fine. Callabie Wood's Tailwind legs worked loose where the mounting bolts went through the tubing. His A frame also bent since it was not heat treated. It is necessary to make the legs longer due to the extra deflection. Ron Zimmerman made his 3 1/2 inches longer. Do not use this approach unless you like the feel of squiggly Tailwind gear.

(2) Taper the existing legs as described above.

(3) Lengthen the existing inner tube 2 1/2 inches, with or without taper. I think this is the best solution since it is much more stable torsionally, easier to fabricate, and lighter.

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. Dick put no-skid material on the top of the tunnel, making it a convenient step. (Do not 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 am 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 two inches 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 inches toward the center of the cockpit. Do not mount anything under the panel between pilot's and passenger's knees.

Since the upholstery was applied directly inside of the side skins, it did not take away any valuable cockpit width at the seats. Although the corner of the tunnel cut into my hip, it was not too bad. I plan to round off my 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. (John has always been concerned about this arrangement because it increases the stresses on rib-skin rivets with ram-air pressure inside the wing.)

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, the tail 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 stall.

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 sets 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 do not worry about holding close tolerances except on the main pin hole. Drill through the corners to establish a nice radius, then saw to shape and file out scratches.

MANDATORY BULLETINS: The following bulletins are recommended on all T-18s (now part of the plans).

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 inch-thick 2024-T4 sheet.

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-inch rivets and to 528-2 with two rivets. Extend the 528-4 all the way to the dash. Make the 528-4 stiffener 12 inches 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 1/4-inch 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 1/4 inch to 5/16 inch.

MAIN GEAR: I was surprised to find that John's gear without wheels and axles weighs 48 to 49 pounds. My tapered gear as described in pages 29-30 weighs 37.5 pounds.

MAKING FIBERGLAS PARTS: 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 do not care about the appearance of the finished product, this is probably true. However, if you want a nice smooth finish, 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 nose cowling 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.

White gauging plaster works very well and costs abut $1.50 for a 50-pound bag. Mix it with nothing but water--no sand since it would make it difficult to shape. Do not add too much water or the plaster will become too soft.

To establish the rough shape of the finished part, it is advisable to build a framework from cardboard or plywood. For the wing tips, cut out spanwise formers from a 1/4-inch plywood, cut out a notch in each, and mount them on a 3/4" x 3" board which serves as a backbone. The more formers, the less guesswork in establishing the correct shape. Cut out a 1/4-inch 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 a 1/4-inch 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," that is 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 do not 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 lacquer on one pattern and found that if there were any pin holes in the wax, the resin would soak through and lift the lacquer. Then I tried ordinary waterbase latex wall paint and this worked perfectly. It dries quickly, fills holes well, and wet sands 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 would not 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 female mold can be made of either plaster or fiberglas. I used fiberglas to make it durable enough for reuse. 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 setup, 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 have not seen this operation performed, it would be wise to get a demonstration from someone who knows the ropes. It is 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. Stiffeners can be covered with glass cloth for added strength. A flange of about two inches 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 (poly vinyl alcohol) 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 the mold from the pattern. To mold the wing tip, do one half at a time. After the mold has been sanded, put on about five 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 10 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-inch plywood ribs run spanwise for a few inches in from tip.)

Do not let the part set up too hard before trimming or you will need a diamond-tipped saw. Make the other half of the tip in the same manner. The two halves are joined by first clamping the two doweled halves of the mold together at the flange, inserting the parts and then applying a 3-inch wide strip of resin-impregnated fiberglas cloth along the inside seam. First clean the area to be covered with resin reducer or the splice will not hold.

When building fiberglas parts for aircraft, a common fault is to make them too heavy by using fiberglas that is too thick, using too many layers or not working out excess resin. Your boat building friends are not used to thinking about weight so they will invariably advise you to make aircraft parts too heavy. George Rattray recommends that two layers of seven-ounce cloth be used for most applications on cowling, wheel pants, etc., with an extra layer applied in certain areas for reinforcement. Squeeze out absolutely as much resin as you can get out for maximum strength.

Although I described in some detail how to make a plaster pattern, I did not make my wing tip pattern quite this way. Instead, I borrowed a pair of tips which had been purchased from a commercial supplier. It was not possible to use them as a pattern because they were very wavy, but I did use them to make a female plaster mold, which I used to make a male plaster pattern. This pattern was then shaped down as I described, but it still took about two weeks to complete one pattern. An excellent space filler-upper for the center of the pattern is wadded up newspaper, which has been dipped in a thin plaster mix. This is extremely strong and, of course, cheaper and lighter than solid plaster.

Finding a reasonable source for fiberglas materials is not always easy. George Rattray, 3 Afton Road, Beloit, WI will supply everything at very reasonable prices. He also supplies finished parts. Herter's is another mail order supplier. Write Herter's, Waseca, MN for information.

T-18 NEWSLETTER #13   11-65

Luther D. Sunderland

SIX EASY STEPS TO METAL WORKING: After reviewing the comments on the T-18 Questionnaires, it became apparent that many more people would like basic information on working with metal than on building some of the more complex assemblies. A typical comment is: "This metal working business is new to me, and I cannot find anyone in the local EAA chapter who knows anything about it." Many do not even know how to do the simplest operations such as cut sheet metal. But this is no disgrace. I did not know the best way to cut aluminum or even how to properly buck a rivet when I started the T-18, and I had built a Sky Coupe and had been a chapter president for five years. So here are a few simple steps which everyone building a metal aircraft must learn.

1. **Layout:** In order to do a good job in laying out sheet metal parts it is essential that you have a smooth, flat work table. As a minimum, you need a 4' x 12' piece of 3/4-inch chipboard. Check the ends for squareness. If the sheet is true, you have a convenient, giant-size drafting table.

Lines can be drawn directly on aluminum sheet with a ballpoint pen or fine marker. When lead from a pencil becomes embedded in aluminum, it can cause corrosion. A pen is OK until you need to mark a line accurately for cutting. Then you must use a scriber. This is a pointed instrument that can be made of any good hardenable steel. But use it with extreme care. Do not ever scribe a line unless you are sure you want to cut along that line. Never leave a scribe mark in a finished part, for it acts just like a mark from a glass cutter on a piece of glass and invites cracking. If you scribe a line in the wrong place, you may have to scrap the part unless it can be sanded and buffed clean.

An absolute necessity for layout work is a decimal scale, preferably at least 18 inches long. This is marked in tenths and hundredths rather than eighths, sixteenths, etc. You should be able to work to an accuracy of 0.010" easily. An 18-inch draftsman's scale is marked off in 0.020" increments. It is a simple matter to estimate between these marks to get 0.010" accuracy. These scales are available from any drafting supply store.

Marking dye can be used on smaller parts to help show up the scribe marks, but it is not really necessary.

You will need a straightedge at least four feet long. For this you can scout around a sheet metal shop and find a piece of scrap steel about two inches wide and preferably at least 0.060" thick. Be sure to check both edges for straightness and mark any edge that is not perfectly straight. To do this, scribe a line and then flip the straightedge over and observe any departure from the scribed line. You will soon find that the edges of sheet aluminum are not always straight. **IMPORTANT!!** Check each sheet before using a sheet edge as a layout reference.

Perhaps the most confusing thing on the T-18 plans for the first-time builder is the dimensioning system, i.e., the use of WL, BL and STA instead of dimension lines and arrows. This is standard aircraft practice and has proven much superior to other means of dimensioning. To get a dimension, just subtract two numbers, so keep a pad and pencil handy (in 1986, a calculator). WL means water line--a vertical distance in inches from an arbitrary reference line. BL is butt line, a lateral (sideways) distance from the centerline of the fuselage, and STA is station, a distance measured aft of a reference point, usually somewhere out ahead of the nose. Many people get upset by the fact that dimensions are given out to four places. That does not mean you should work that accurately--unless you have good eyes, but at least all the numbers add up right. Just ignore what you cannot read on a scale.

2. **Cutting Aluminum:** Sheet aluminum of thicknesses below 0.040 inch can readily be cut with shears. Ordinary straight tin snips that look like scissors work alright for straight cuts, but you really should have a pair of right or left-hand, preferably both, aircraft sheet metal shears. These are the "double-jointed" type available everywhere. It is nearly impossible to cut sheet aluminum without somewhat deforming the edge of the cut. You can minimize this by helping to curl the metal away from the jaws of the shears with the left-hand and by **never** closing the jaws completely. If you close the shears completely, it makes a tiny crack at the tip of the shears. I always cut to within about 0.020 inch of the scribe line and then take the excess material off with a Stanley Surform rasplane--the small type (about six inches long), which can be held in the palm of the hand. Pull the raspplane rather than push it to prevent chatter. This tool gets my vote for the handiest tool in the shop. It is an absolute must.

If you have a table saw or a skill saw, get a fine-toothed blade used for cutting plywood. I use one to make all straight cuts in aluminum plate and angle. If the skill saw or saber saw are used for cutting sheet stock, lay a thin board on the metal and slide the saw on it or you will surely get bad scratches from the chips. Carbide-tipped circular saw blades are now fairly inexpensive. These blades are what supply houses use to cut aluminum plate because they last almost forever.

There is nothing quite so nice as a band saw for cutting out the heavy parts, and you will likely have to find a friend who has one if you do not. Some builders have simply enrolled in a night class at the local high school and used all the tools available there.

The fun has just begun when you have cut out a part with a saw. It then must be finished down to remove all visible surface scratches. I usually start with a coarse rasp or a belt sander, making all tool marks parallel rather than perpendicular to the edges. Then I scrape out the scratches with a scraper made from a file. Grind an old file smooth and grind one edge to about a 70-degree angle. After scraping, buff with fine emery cloth, again rubbed along the edge, not across it. If you want to invest a couple of bucks in an arbor, a cloth buffing wheel, and buffing compound from Sears, you can buff all parts to a mirror finish. This is very easy to do and insures that all the scratches are gone. It really catches the attention of the spectators too, for they will think you are the world's greatest craftsman when they see your nice shiny parts. Of course, the aluminum will eventually have to be corrosion proofed with alodine and zinc chromate, thus covering up all your polished parts.

If you have any doubt about how dangerous scratches are, it might interest you to know that Ernie Schweizer said they were considering using an aluminum alloy for the spring gear on their 1-30 sportplane. However, they rejected it because of the possibility of getting scratches in the legs which, they were afraid, would cause fatigue failures.

3. **Forming Simple Bends:** The easiest and best way to make straight bends is, of course, to use a sheet metal brake. In fact it is practically a necessity to use a brake of some sort for certain T-18 parts. The horizontal stabilizer rear spars, wing rear spars, fin beam and aileron and flap spars should be made on a brake for best results. Other parts can be formed simply with a rubber mallet, however. For these few parts it seems like a lot of trouble to build yourself a sheet metal brake rugged enough to be of any value, however some builders have had success building them. It is much easier to bend up these few parts on someone else's brake if at all possible. Heating and plumbing shops usually have an eight-foot brake.

Bend allowances are admittedly a little problem. If you cannot figure them out after reading the explanation in the building instructions, you can make up some test samples of the different thickness materials. I always do this anyway, for something usually does not come out just right on the average brake. The problem is that the run-of-the-mill sheet metal brake does not have radius shoes. To use a brake without various radius shoes, you must bend up one or more layers of scrap metal to use as a shoe. Just experiment until you obtain the proper radius. Never allow the brake to mark the finished part or to make a sharper bend than the plans indicate.

Forming straight bends with a mallet requires that the metal be clamped firmly between two blocks. A radius should be shaped on the inside block to prevent cracking. It is very important to use an adequate radius because 2024-T3 can be quite brittle. Use a rubber mallet to prevent denting the metal. Work the bend down slowly to minimize bowing. Since some bowing is unavoidable it should be straightened out.

4. **Straightening:** It is virtually impossible to form a bend with a mallet without getting some bowing. This can be taken out of frame and rib flanges (which will later be riveted) with a fluting pliars or a fluting tool that slips onto the jaws of vise grips. Crimp between the rivet holes.

5. **Making Holes:** A Whitney punch is a must for transferring all holes near sheet edges. A hand drill is used for all other holes in sheet stock. To transfer holes from templates, use a nibless Whitney punch for edge holes and transfer punch all other holes first with a nibbed punch and hammer, deepen with a center punch and then drill. Virtually every hole in a fitting that will receive a bolt must be drilled undersize and then reamed.

6. **Bending Skins:** To bend all leading edge radii, simply mark the centerline of the bend on the outside of the skin, fold over by hand and clamp the two trailing edges in the proper position with a board and C clamps. Lay another board near the bend and work the bend down by pressing on the board until C clamps can be slipped on. Screw down clamps and make proper adjustments to keep the bend in the proper position.

I have just discovered that inside flanges in fuselage frames can easily be bent down to almost 90 degrees without cracking. This gives a much stiffer frame than the 45-degree bend. The corner radius should not be bent down more than 45 degrees or the aluminum will crack. (The S-18 frames are made this way.)

POP RIVETS: Many builders want to know if Pop rivets are as good as ANs. In some ways they are far better and in some ways probably not as good. In any case, the monel pops are structurally sound, stronger than ANs, and a dickens of a lot easier to install--like about ten times easier. Since John Thorp recommends them, do not hesitate to use them. I personally think ANs make a smoother job and of course are much cheaper, but if all rivets are covered by epoxy filler, it makes no difference in appearance.

AFT TUNNEL: I just completed my aft tunnel, and it worked out fine. Instead of making a flat top I rounded it. For added strength, since it is used as a step, I made it in two pieces, one piece extends from the bottom fuselage skin up around the top and down the other side to the angle. The other piece is a mirror image, overlapping the first piece over the top between the two angles. This smooth tunnel feels much better on the hip than the square-cornered version, and it is stronger. (The square tunnel corners have been eliminated in the S-18.)

T-18 NEWSLETTER #14   12-09-65

Luther D. Sunderland

FLIGHT REPORT: Dick Cavin writes about some interesting flying in a T-18 at a recent southwestern Fly-In:

Yes, I really had a ball flying Ralph Thenhaus' ship at our Georgetown Fly-In. I hauled about 75-80 passengers, T-18 builders, etc. Even gave some dual. I think it flies great. His tail wheel setup makes it a little touchy on rudders on roll-out, but it has more rudder and brake than ever would be needed. Stalls nicely, too. Very hard to keep from putting tail wheel on first due to short main gear. Shot 3 wheel landings with bone-jarring results. Gear is no good for wheel landings, I believe, but I am satisfied with it as a landing gear on hard surface.

Jack Park, who helped fly Ralph Thenhaus' ship to Rockford, is nearing completion on his own ship. He writes:

The whole airframe is FAA checked and closed. The engine is on and cowled but lacks its mags, carb air box, exhaust stacks, and wiring. I have to do the "A-D" note modification to the fuel tank support structure. It is needed. I could watch the rivets and skin flex on Ralph's Bird 137RT during the trip to Rockford. I am using Hamlyn tips and a modified Hamlyn cowl on mine for the first flight. It looks like I might switch to the new Hamlyn cowl, which looks like my model, later. This new cowl was laid up by Merle Soule in Dallas and looks great. (1986 Note: This fiberglas nosebowl and bottom cowl piece is the one I use on N4782G and John Shinn used on N4784G. It is my preference for a cowling because it allows you to use nice big doors on each side for easy access and there is room on the nosebowl to place the oil cooler ahead of the left front cylinder. Note that the top and two side doors are made of 0.025 aluminum sheet.)

You can tell all T-18ers that they are in for some of the greatest cross-country flying they have ever had. That is my opinion, but I am sure Lee Hamlyn will go along with me. The T-18 really moves along, it is stable, relatively quiet, and can be as comfortable as the builder makes it.

SOME TIPS FROM MERLE SOULE: 3236 Camelot, Dallas, TX 75229. I received the latest T-18 Newsletter in the mail yesterday, and I want to express my thanks and also compliment you on a very well-written article on fiberglassing and mold making (pages 33-36). I have just completed the chore of making a T-18 cowl mold and the steps you outlined were almost identical to what I had done. I used styrofoam on the nose (donated by another T-18er), metal on the top and sides, and rulers on the bottom (for the compound curves). The styrofoam was sealed with thick latex house paint. After this was done the complete mold (except the metal) was covered with approximately a 1/16-inch layer of body putty--White Star, Bondo, Black Magic, etc., which is two-part and has to be mixed. This hardens in approximately 20-30 minutes. It then is filed with a Vixen file and graduated sanded to #400. Actually the latex barrier over the styrofoam is not necessary because of the short curing time of the body putty.

Everything is complete on my project except assembly of the wings, paint, upholstering, engine hookup, instrument hookup and installation of the canopy. I have a tentative completion date of June 1, 1966 but if my experience in building hot rods and show cars is any indication of broken schedules, first flight will be a little later than June 1. The interior will have contoured bucket seats upholstered in cream leather--full gyro panel, and initially, a Skycrafter radio with arcomni. The cowling will be of my own design with the nose and bottom made of fiberglass and the top and sides of metal. The fully polished chrome 150 O320 Lycoming will turn a 65-inch diameter 69-inch pitch prop. (1986 Note: This is not enough pitch or length for any T-18 engine.) Also a 35 amp Ford alternator will be used. Total cost of the airplane will be under $2500, but this requires a lot of scrounging. The paint scheme will be basically cream with a persimmon accentuating strip (transparent candy color).

Some suggestions that might help other T-18ers are as follows:

1. <u>Horizontal Tail Alignment</u>

   a. Scribe two lines 180 degrees apart fore and aft on tube
   b. Do same on top and bottom.
   c. Slide on the two mounting lugs plus the counterbalance arm.
   d. Attach to the 4130 fittings in the fuselage with bolts (ears are still loose).
   e. Check dimensions from WL 42 extrusions (top) to wing attach fittings on front carry-through bulkhead. If they match (which they should) lay a 12' or so length of pipe or angle on 2 x 4 (if straight) crosswise of the fuselage on top of WL 42 extrusions. (Editor's Note: This is not possible with the later fuselage design because the 3/4-inch angles are not exposed with the side skins now extending up to the canopy rails.)
   f. Make sure the lines on the HT tube are perpendicular and parallel to WL 42, drill 1 hole through the left ear and Pop rivet so it will not rotate.
   g. Pull up or push down on the right side of the tube to align with the pipe at WL 42 cockpit location. This

can be done very accurately by eye balling.

h. Hold the tube accurately in position and drill a hole through the right hand lug and Pop rivet.
i. Finish riveting lugs.
j. Caution: Check print for correct angle for the 510 horizontal tail mast fitting at BL 0. Do not make it perpendicular to the horizontal tail chord line like some people have mistakenly done.

The above method worked fine for me and aligned the HT to the airplane even though my 4130 fittings were slightly off. I used full ribs and matched-hole tooling on the horizontal tail as a trial. It worked fine except you can get as much as five degrees twist from the countersink holes.

Assemble as follows:

a. Using the fore and aft scribe lines on the horizontal tail tube, attach the nose and main ribs spaced as indicated on the print.
b. After the skins (L & R) are punched and bent, cleco the assembly together.
c. Remove horizontal tail from airplane.
d. Clamp the trailing edge between two pieces of angle iron the full length of the trailing edge.
e. Lay two straight edges on both ends of the horizontal tail and align by twisting the horizontal tail as necessary for alignment.
f. Sight down the leading edge and if OK, a few wisely spaced rivets will lock the skin in place.
g. A simple template can be made for accurately scribing the four lines on the horizontal tube tube. To make, scribe a vertical and horizontal line on a four-inch square piece of 0.025-inch aluminum, cut a two-inch hole out of the center.
h. To make sure the first scribe line on the horizontal tail tube is square, lay the tube and a piece of angle on a flat surface and scribe while clamped together.
i. To make certain horizontal tail ribs are attached accurately (nose and main alignment), make a wrap around of 0.025 for the beam and scribe a circle.

2. Vertical Fin Assembly:

a. Level the plane at WL 42 (cockpit area).
b. Attach vertical fin beam with cap screws making sure alignment is correct using a plumb bob.
c. Attach lower fin rib to vertical beam and forward mount bracket.
d. Attach other ribs to rear beam--make sure all have scribe lines for rivet holes.
e. Bend skin and cleco to bottom fin rib.
f. Attach a ruler to the top rib with the ruler sticking

forward about 30 inches attach a plumbob to intersect BL 0.

g. Twist fin accordingly and spot some holes and clecos in rear beam to lock in place.
h. Blind drill rest of holes, trim, and rivet in place.

Spotting some rivets to the rear trailing edge skin and beam locks the two in place and aligns right.

3. **Keying Bulkheads:** To simplify assembly after the bulkheads are made, key marks should be made on the bulkheads at BL 0 and WL 42. I used a fine wire drill and drilled through the form blocks at these points. Then I indexed with a wire brad lightly into the bulkhead while still on the form block when making the bulkhead transfer strips. I drilled through both side skins and the strips at the same time--the holes aligned perfectly at the assembly stage.

4. **Rigging Push Pull Tube to Stick and Horizontal Tail:**

a. Assemble wing and stick assembly in place.
b. With a protractor at the 4130 horizontal tail fittings scribe a line parallel to WL 42 intersecting the 4130 mounting holes for the horizontal tail lugs. Lay out lines radiating from the mounting holes at 5 degrees, 10 degrees, and 15 degrees up and the same amount down and fix into place.
c. Install horizontal tail with push pull tube attached to arm. At this point, the front tube fitting is not installed.
d. Move the horizontal tail leading edge five degrees down and fix into place.
e. Locate stick at 0 degrees fore and aft and fix into place.
f. Attach front push pull tube fitting to stick assembly and slide into untrimmed front portion of the tube.
g. After checking alignment of stick and horizontal tail, lock the fitting into place in the tube with a couple of rivets--remove tube and complete riveting.

Hope the above suggestions will be of some help. (Unfortunately, Merle's airplane got tied up in a legal suit and he had to sell it before it was finished.)

DEAR JOHN THORP:

1. How should the notches in the Lord mounts be positioned?

Answer: The notches in the Lord mounts should be disposed so that the mounting is stiffest in the vertical direction and softest in the torque direction. No one placement will do this, so it is probably best to set the notches vertically. This at least will provide maximum stiffness vertically.

2. What type of rivets are you using in your T-18?

Answer: I am using AN 426AD-4 and AN 470AD-4 rivets in my T-18. I will use Pops where I need blind attachments.

3. Should gyro instruments be mounted vertically in level flight rather than in the plane of the panel as shown in the plans?

Answer: DGs and horizons must have their faces vertical for satisfactory operation (drift and response rate). Most turn and bank indicators will work acceptably well tilted 15 degrees.

4. Is it alright to use lightening holes in the ribs?

Answer: The ribs were designed without lightening holes and they can tolerate some reduction in shear material, but I do not know how much. Lightening holes "weaken" faster than they "lighten" so I do not like them. Small holes can be tolerated for access etc., but not big lightening holes. (1986 note: Many T-18s have been built with three-inch access holes in the ribs and there has never been a problem. In fact they are extremely convenient for use during assembly and for rubbing out dents that might get made in the wing during service.

5. Should the horizontal tail balance weight be adjusted for perfect static balance?

Answer: No. The horizontal tail balance weight is a dynamic longitudinal stability augmenter. It reduces static longitudinal stability and provides proper feel forces to the stick in pitch. In smooth air the T-18 will fly better without the bob weight. In any case, its weight is not critical and static balance is not required (or desired).

6. Bob Kaergaard's rear spar cracked at the aileron hinge. What should be done about it?

Answer: I do not think that Bob Kaergaard's cracked rear spar is a design deficiency. A 3/32 radius on 0.032 for 100 degrees is pretty close to the forming limits and if it cracks it needs to be repaired. The crack is probably due to his bend radius being too small. You should add a doubler angle below the hinge stock.

7. What is the latest on props for the T-18?

Answer: Jack Park's prop now installed on Ralph Thenhaus' T-18 is 65 x 67. It was 65 x 65 and should be 65 x 69. It is a guessing game because the blanks from which they are made vary considerably. Diameter and pitch are most important but blade width (activity factor) and thickness have considerable influence.

8. Rivets along the inner wing leading edge of both Hanson's and Warwick's ships loosened. (ANs were used.) What should be done about this?

Answer: The leading edge rivets on the center wing (with two-inch spacing) are too few. I am adding six rivets to each leading edge rib both top and bottom on the center wing. I cut the rib rivet spacing too close at two inches. Although Thenhaus' wing has not loosened with Pop rivets, Dick Hanson's T-18 is 250 pounds (20%) over design weight and the cockpit vent system adds full dynamic pressure on the inside of the skin to the low pressure on the outside. Dick's wings have the added rivets now. (Rivet spacing was later reduced on the plans to one inch.)

9. It is possible to get a small amount of twist in a wing panel using matched-hole tooling with dimpled holes. Would it not be wise to use a simple fixture for holding the panels during riveting and checking for twist before riveting with a carpenter's level?

Answer: Yes. (This is covered in later Newsletters. See pages 52-53 and 64-65.)

MAKING A FIBERGLAS GAS TANK: by Don Carter, 2316 Donna Drive, Vestal, NY 13850. The following reasons led to my choice of fiberglas rather than aluminum:

1. Lack of aluminum welding capability.
2. Elimination of the fuel gauge (markings on the tank seen through a mirror on the forward tunnel could provide a highly reliable fuel gage.)
3. Recess in tank for radio and addition of sump would have been difficult modifications if aluminum were used.

My tank has a recess for the radio which is located in the lower center of the instrument panel. The instrument panel has been moved aft three inches at WL 42 and is perpendicular to the fuselage reference line. The recess is deep enough to accommodate the long radio 1 1/2 systems such as the Mark 12 and the KX 150.

Dreading the thought of building a form of wood and cardboard, which seems to be the more conventional home-builder's method, and also desiring the forms to be reusable by other T-18 builders, were the factors responsible for the technique which I developed for the fabrication of my tank. Basically, the tank is made of the three parts as called out for the aluminum assembly on the drawings (the two ends, and a wrap around skin). However, instead of joining the parts by butting, I left an additional 3/4-inch flange on the end pieces so that the skin could overlap. For a perfect fit the flange angles with respect to the ends should be something other than 90 degrees but with a little trimming a good fit was obtained. The end form blocks were made of two-inch thick pine and had the one-inch radius as called out on the drawing.

Before going any further I would like to discuss a little of the philosophy of the fabrication method. To avoid the probability of loose fibers on the inside of the tank, only cloth was used for the first two layers, and all inside surfaces were laid against the forming surface. Where both surfaces were inside the tank, as in the case of the baffles, the outer surface (as laid) and hole edges were coated with resin. It was also desirable, for the same reason, to make a female mold of the wooden form for the radio recess.

The skin was made by laying up a single layer of cloth on a Formica table top. The ends were made by applying two layers of cloth before removing them from the form blocks. The ends required rigidity, the skin flexibility. The skin was trimmed to the print dimensions but allowing one inch extra circumference for overlap. Be sure the overlap does not occur along an edge of the tank. The ends were trimmed and smoothed.

The circumference of each end was then measured by wrapping a piece of masking tape around it. The masking tape was then laid along the corresponding edge of the skin to determine the location of the overlap (skin is kept properly oriented for correct surface on inside). Locating holes were punched in the overlap at each end. The lap was then cemented with resin between two 2 x 4s with nails at the locating holes. When set the lap has rigidity, which explains why it cannot occur on a tank corner. The three pieces can now be assembled by punching holes and clecoing. If a sump and radio recess are desired, the appropriate forms can be made of wood. As mentioned, I made a female mold for the recess so that the molded surface would be inside the tank. If a one-shot deal, this would not be necessary if a coat of resin were applied after the part was laid up on a male mold. These parts required two layers of cloth again for rigidity. The sump and recess had one-inch radius corners and 3/4-inch flanges. Baffles can be made by laying up flat on a Formica top and cutting to desired shape. I put two in at BL 7.0. This helped stiffen the tank where the retaining straps go around it.

The sump and recess forms can now be positioned against the tank to locate the cutouts. After cutting, they can be assembled by locating holes and clecoing.

Fittings: My fittings were made by silver soldering brass automotive pipe fittings into three-inch diameter heavy brass shim stock which had a number of 1/4-inch holes for locking in the resin. Fittings can be applied before or after final assembly. I put my sump fitting with strainer and my flexible aerobatic fuel pickup line in before assembly. All other fittings (there were four including filler neck) were put in after assembly. Also before installing the fittings, they were coated with a two-part epoxy adhesive. Leaks have been known to occur between metal fittings and fiberglas because of the large differences in thermal expansion between the metals and the polyester resins. The epoxy will provide an interface between the two.

Assembly: The fiberglas parts were assembled using Pop rivets and an adhesive made of resin with enough filler powder added to increase the viscosity so that the mixture would not drip from a stick which had been dipped into the adhesive. I used a filler called CAB-O-SIL. With the ends removed, a bead of adhesive was applied to the tank end side of the baffles. A funnel-shaped applicator was made from a magazine page. The ends were next cemented in place by first placing the ends inside of the skin near the baffle. After applying the adhesive, the ends were carefully pushed out from the inside through the recess opening forcing the excess adhesive out ahead of it. Next the sump was installed from the inside.

The tank is now ready for final layup. Before applying more cloth, any fittings and filler neck left should be cemented in place. The number of layers of cloth, weight of the cloth, and the use of cloth or mat appear to be very debatable subjects. Since the strength of fiberglas assemblies can vary considerably, depending on amounts of resin and material selected, I will not recommend the number of layers for anyone's tank. I used a minimum of three layers. The third layer was mat except where my fuel quantity markings are located. In this area I kept all cloth for better light transmission.

I learned how to remove a part from a mold when it sticks fast. A hole was drilled in the center and air pressure applied using a rubber stopper with a hole as a seal. The part may come off with quite a bang, so do not get shook up.

Luther D. Sunderland

NEWS FROM THORP: Modified T-18s: Questions are often asked about the possibilities of 65 or 85 hp engines being used on T-18s. None are in the mill, to my knowledge, and Thorp strongly recommends against it. Also, some have considered increasing the span to 25 feet to reduce landing speed. He says that calculations indicate this would reduce the minimum speed 4 mph, but it would add about 25 pounds weight.

COMPLETING YOUR PROJECT: Another new year is starting, and you have probably resolved to get busy on your project and finish your airplane this year, so we will expect to hear a lot of progress reports coming in. If you are wondering just how long it is going to take you to complete your project, I have figured out a very simple way for you to estimate your completion date. It will take about 2,000 hours labor to complete a T-18. It took me about 2,200 hours to complete a Sky Coupe and all indications are that it will take about the same amount of time on the T-18. Now just figure out how many hours per week you spend on your project. If you are really serious about your project you will probably be spending about 20 hours per week or 80 hours per month on it. At this rate, you would be spending 1,000 hours per year and your project could be completed in two years. On the other hand, if your wife is really holding tight on the reins and will not let you spend much time in the workshop, you might be spending only about an hour a day or 30 hours per month. At this rate it will take you over 5 years to complete the project. Of course, the number of hours that it takes to complete a project is largely a function of the individual builder. It may take one individual twice as long as it takes another to do a given task, so, it might take some people 4,000 hours to complete a T-18. It is quite unlikely, however, that you could complete one in less than 1,000 hours.

If you have a nice roomy workshop in which to build your T-18, you should feel quite fortunate. There are those who are working under much less favorable conditions such as Ray Remy who is building his in a real city environment on Long Island. He tells me he has aluminum scattered all over his apartment and is cutting out parts in the living room. After his work sessions, he has to straighten everything up and put all his parts away. He is going to rent a garage to do the assembly work.

You will find that one of the biggest problems in your entire project, if you are a family man, is learning how to work the project into the family schedule. If your wife is agin you, you will have an uphill battle all the way. Those of us who have wives who cooperate are very fortunate. My 12-year-old daughter, Lisa, is even getting pretty good now on the bucking bar so I am beginning to get some help. Someone would probably do the homebuilders' movement a great service if they would write an article for **Sport Aviation** on "Family Relations and the Homebuilder".

FUEL TANKS: Last month we had a fine article by Don Carter on building fiberglas fuel tanks (pages 47-49). Following Don's instructions, I have just built my fuel tank. With the recess for the radio included, the tank will hold three quarts less than the standard tank. Don put an inverted system in his T-18. He obtained plans from Ray Stits for $15 for the inverted system. Ray included in the plans a number of alternate approaches to inverted systems. You can do aerobatics in your T-18 without an inverted system but, of course, it means that you cannot fly inverted for prolonged periods. Although I am looking forward to doing some aerobatics maneuvers, I have decided to not go to the extra weight and complexity of an inverted system. I am going to use a Volkswagen fuel gage although I am looking forward to the convenience of being able to visibly check the fuel level in the fiberglas tank, especially when the fuel gets down to a very low level. It might make those last few minutes when you are getting low on fuel a little more pleasant. (1986 Editor's Note: It has, several times!)

There are two problems that you should watch out for in building fiberglas tanks. First, you should make sure that you do not let the weight build up excessively. You can very easily double the weight of your tank with a few extra layers of cloth or mat. The second problem is that fuel tanks often leak. A leak may start at one point and follow a glass strand and come out eight inches away. Dick Cavin tells me that one way to eliminate this problem is to dump a cup of thin resin inside the tank after it is completed and tumble the tank thoroughly to coat the inside with a film of resin. Of course, one of the main advantages of a fiberglas tank is that it can be readily repaired in the aircraft. I once talked to someone who had a leak in a miniplane aluminum tank somewhere in Arizona on the way from California to Rockford. They were not very happy about the repairability of an aluminum tank at that point.

One way to determine whether your fiberglas tank is strong enough is to test it under pressure, not too much pressure of course. The tank should be installed in the fuselage and tested to 4 psi while filled with water. Dick also said that Bob Kaergaard's aluminum tank has become indented at the supports, so some builders are flush riveting a two-inch wide strip of 0.040 2024 to the support to give it a wider footprint.

PROGRESS REPORT: Many of you have written to me asking how much progress I have made on my project. According to my log book, I started working on the T-18 December 7, 1963. I now have all of my riveting completed with the exception of the top of the fuselage which I am leaving open for FAA inspection. I have cut down the top deck underneath the canopy and have installed the canopy rails. John Thorp said that it would be perfectly alright to cut a hole in the top deck for the installation of a jump seat in the baggage compartment. (See Figure 3.) However, when the plans came out they showed the canopy rails extending too far forward for this. But since the aft rails are about 1.5 inches longer than the front rails, I shortened them. Also I moved the rails inward about 0.5 inches and back 1.5 inches. This made sufficient space for a jump seat. I left at least three inches at the front and sides of the cutout and bent down a 0.5-inch flange around the hole for stiffness. The tunnel will be extended through the luggage compartment.

Jack Park just wrote to me that he thinks the bending of the skin on the flap was the hardest part of the whole project. I really do not think this was too bad, but I have a new candidate as the hardest thing to do in the whole project. I spent a complete day putting the flange on the top front skin where it joins the windshield. People had told me that you simply take a slotted stick and work it along the flange to bend it up, but I found that this was easier said than done. It would take a book to describe how I went about doing it but the best way to sum it up is that I "worried" the flange up, using every tool at my disposal. It finally turned out fairly smooth so I plan to put my windshield on the inside as have some of the other builders. (1986 Editor's Note: On a second project we put the windshield on the outside per the drawing, and it does not look bad.)

FLAPS: I discovered that the easiest way to bend the flap skin was to make the larger radius bend first and then put in the sharp leading edge bend. My only trouble with the flaps was that they ended up with a slight amount of twist. This was caused mainly because of my assembly technique using AN rivets. When using AN rivets it is necessary to hold the trailing edge apart while you rivet the skin to the spar. During this operation it is difficult to insure that there is no twist getting built in. Had I used Pop rivets I could have held the flap in perfect alignment while the entire assembly was Pop riveted. There is a way of getting around this problem however, using AN rivets. First, cleco the skin to the spar and also cleco the flap trailing edge; then, insert about a half dozen Pop rivets in the skin and spar to hold the assembly tightly. Pop rivets will hold the skin much more firmly than will clecos. Then open up the trailing edge and rivet the skin to the spar with AN rivets. After this is complete, if you do not want to leave the Pop rivets in the assembly, they can be drilled out. Do this while the trailing edge is still open. You can hold the Pop rivet from the inside with a pair of pliers while it is being drilled

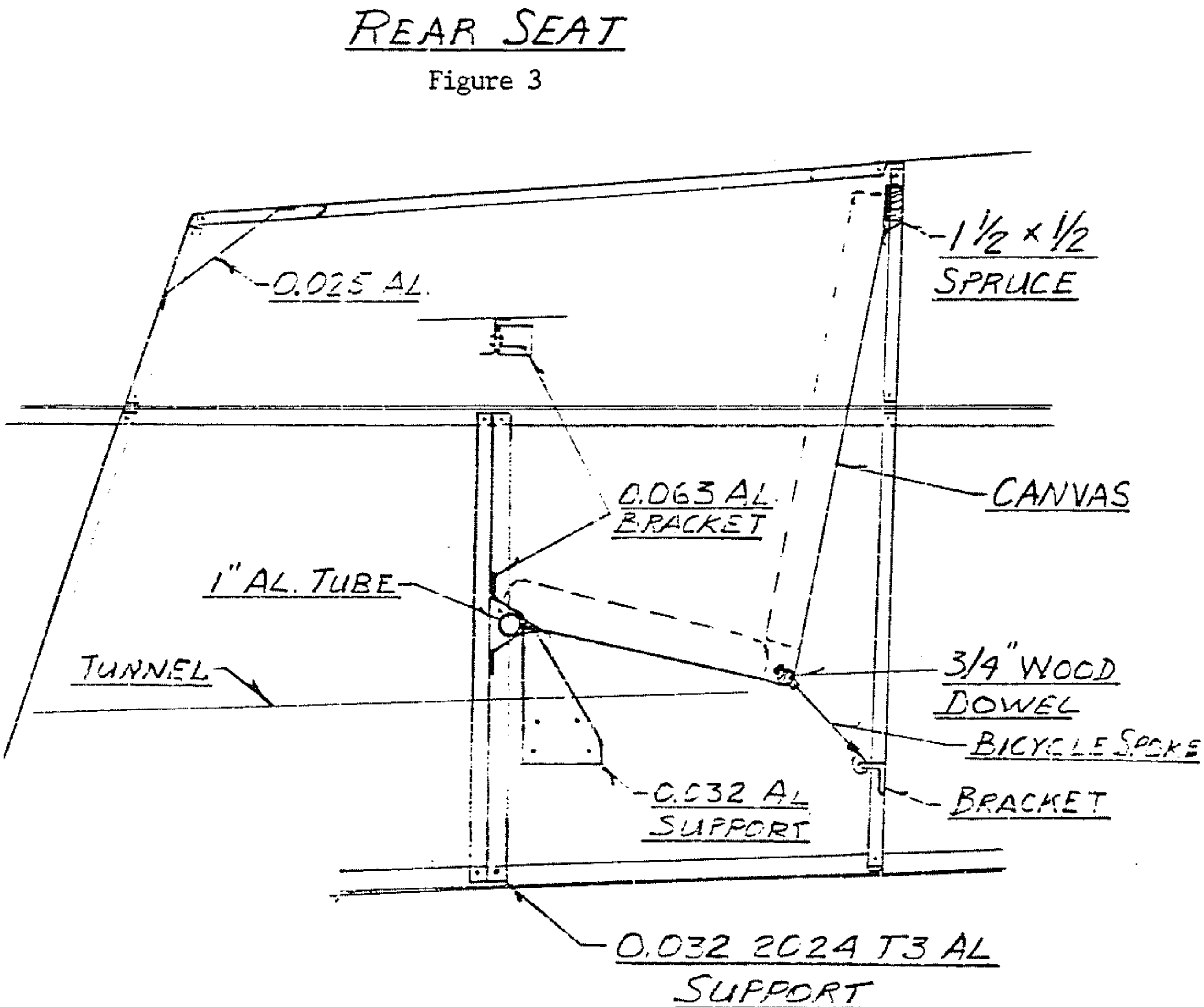

REAR SEAT
0.025 AL.
1 1/2 x 1/2
SPRUCE
CANVAS
0.063 AL.
BRACKET
1" AL. TUBE
TUNNEL
3/4" WOOD
DOWEL
BICYCLE SPOKE
BRACKET
0.032 AL
SUPPORT
0.032 2024 T3 AL
SUPPORT

Figure 3

out. It is quite difficult to drill out Pop rivets since they will invariably want to spin with the drill. With a little care they can be held with a sharp instrument from the outside however. (1986 Editor's Note: Part of the problem of twist is that the leading edge bend is not made perfectly straight. To insure a straight bend, first mark a line with a felt pen along the flap skin where the center of the bend radius will be located. Then make the large radius part of the bend. Next make the leading edge bend in a manner similar to that for the wing skin. Instead of clecoing the upper and lower sections of the skin together at the trailing edge, lay a 1 x 2 piece of wood over the upper skin and secure with C clamps along the edge of the work table. Adjust the relative positions of the skins to make the bend come out at the pen line. Since the S-18 flap sections are shorter than the T-18 flaps, bending their skins is much easier.)

EXHAUST SYSTEMS: I am presently welding up an exhaust system for the O-290-G engine. I was fortunate enough to find, at a local salvage yard, enough 1 3/4-inch stainless steel tubing already bent to make a complete crossover system as shown on the plans. Stainless steel is a little tricky to weld, but it can be welded if you allow some excess acetylene. You will find that it is easier to make puddle welds rather than a continuous bead. Whip the torch away slowly as the puddle cools to keep out the oxygen. I would recommend that you get an expert to show you how to weld stainless tubing.

Aluminum Sheet and Tubing Kits: (1986 Editor's Note: I used to order materials kits for builders through a local Alcoa distributor. Would you believe these prices?)

1 sheet 0.020 (or 0.016) 2024-T3 alclad 36 x 144
1 sheet 0.025, 6061-T4 36 x 144
9 sheets 0.025, 2024-T3 alclad 48 x 144
1 sheet 0.032, 2024-T3 alclad 48 x 144
1 sheet 0.032 6061-T4 48 x 144
36 ft (3 lengths) 3/4" x 0.035, 6061-T6 tubing
24 ft (2 lengths) 1/2" x 0.035, 2024-T3
12 ft (1 length) 1" x 0.035, 6061-T6
12 ft (1 length) 2 x 0.049, 2024-T3
1 sheet 0.040, 2024-T3 alclad, 48 x 144
1 sheet 0.040, 6061-T4, 48 x 144

Single kit price ea $305.00
5 kit quantity price ea $247.00

WINDSHIELDS: A windshield can be formed very easily if you can find a large enough oven to heat an 18 by 60-inch piece of plexiglass. The form is made of two plywood formers and a piece of 0.025 sheet aluminum. One former is the exact shape of the rollover bar windshield frame and the other is the shape of a section through the fuselage at the front edge of the windshield. These two formers are nailed to a wooden base, then they are covered with a piece of 0.025 aluminum, which is tacked in place. Make sure that the tack heads are countersunk and, preferrably, are located outside the outline of the windshield. The aluminum is then covered with ordinary outing flannel, which is tacked to the wooden framework fuzzy side up. Presto! You have a windshield form.

Now all you have to do is obtain an 18 x 60-inch piece of 0.125-inch thick plexiglas and an oven big enough for it. I found a local sign shop which uses a pizza oven for this purpose. He has a piece of 1/4-inch hardboard inserted in the oven with holes cut in it. The plexiglass is placed on this. Even though it is oriented horizontally, it caused no markoff on my windshield. If you get stuck for an oven, why not try the local pizza shop.

The oven is heated to 375 degrees F. This is the temperature at which Piper Aircraft had their oven set when we visited there, and I found it works fine. At least two people are needed to remove the plexiglass from the oven. Soft cotton gloves should be used. Simply drop the plexiglas over the mold and hold down the edges until it cools. Plexiglass has the nice quality that it will return to shape after being reheated. So if you have trouble, just put it back in the oven and start over. The windshield should not be trimmed to size until it is formed. If you do not follow these simple instructions you are likely to end up with a crazed windshield.

MORE ON COWLINGS: Since I am starting on a mold for my cowling, I asked Merle Soule of 3236 Camelot, Dallas, TX some questions about his. (See page 42.) He sent me some photos of it and it looks real neat.

1. Is your cowling all fiberglas?

   I made up a complete female mold and later gave it to Lee Hamlyn who is going into production on them. I made a complete fiberglas cowl since I had the mold, but the top and sides could easily be made of 0.025 2024-T3 since the male pattern was metal in these areas and they have simple curves. You will be able to buy the parts for nose and bottom.

2. What provisions are made for access?

   The cheeks are hinged for access, each at the top. The bottom row of Camlok fasteners is low enough on each cheek not to be too noticeable. All eight plugs are accessible. The cowl is set up for a 4-inch prop extension and will fit everything up to an O-320. A 180 hp, which is about 1.5 inches wider, will not fit since the present cowl fits very tightly on my 150.

3. Now that you have made your cowl, are there any changes you would recommend?

It would be difficult to make a cowl more streamlined unless you use a longer prop extension. As it is now, there is room for a crossover exhaust system, starter, and alternator.

Lee made a cowl from the molds I sent him, tried it on Jack Park's plane and it fit real well. Thorp said it was very similar to what he had in mind and he did not recommend any changes, so it ought to work.

DIMENSIONS: Does Butt Line (BL) mean something just below the Waist Line (WL)? Answer: Sometimes.

This month we welcome builders from serial numbers 350 through 400.

NEWS FROM THE QUESTIONNAIRES: Herman Rassler, 98 Constitution, Henderson, Nevada 89015. He has about everything up to the firewall completed and expects to fly in 1966 for a cost of $2300. He says: "I riveted the fuselage skins on in the flat and am very pleased with the tight skins. The only real problem I have had was in the layout of the rudder skin. I spent two nights trying to engineer it and still wound up an eighth inch off on one corner of the mockup. I moved the instrument panel back three inches aft of the bulkhead. This is easier to reach and does away with the center column by putting the radio in the panel."

Bill Davis, 206 Grady Place, Langollen, New Castle, Delaware. Bill tells how to grind the axle pads on the main gear. "The landing gear was tough for me. I would buy the next one. The FAA man said that dye check is OK to use on welded joints in lieu of magnaflux inspection. Metal Supply Company, "G" and Luzerne Street, Philadelphia, PA is a good place in this area to buy aluminum plate and sheet (also tubing). They will cut to any size you want. My Delta sander-grinder (same as a Meade Band Sander) has turned out to be indispensable. I used this to grind the axle pads on the main gear by blocking the gear up to the proper height on rollers (rest the gear on a large board and rest the board on rollers such as paint cans; rest the rollers on your table saw). One axle pad rests lightly on the sander grinder table (no roller here). The gear is then moved back and forth across the belt. A little cut and try is necessary to get the proper angle but it is not difficult and worked out fine.

T-18 NEWSLETTER #16 03-31-66

Luther D. Sunderland

CORROSION PREVENTION: by Kent Hugus (Sport Aero). Metal corrosion defined: The disintegration of a metal caused by the interaction of its surfaces with other substances in its environment.

Metals vary in susceptibility to corrosion. The least active metals are termed cathodic. An example is gold which has a solution potential of 0.0 in the electro-chemical series. Very active metals are termed anodic, such as magnesium which leads the solution potential parade with -1.66 volts. (2024 aluminum and steel stand -.68 and -.67 respectively).

Why solution potential ratings? Because corrosion is generally believed to be an electro-chemical activity. When metals are immersed in an electrolyte, such as dirty water, the difference in potential creates an electron flow from anodic to cathodic material. The metal particles on the anodic metal are transformed into ions which combine with non-metallic ions in the electrolyte and form corrosion products. These products are usually brittle, scaly, and weak.

A corrosion spot on a single metal may result from a casual electrolyte. The drop of electrolyte may vary in strength throughout its mass, creating a differential in potential from one area to another. Likewise the metal itself may vary in its composition with more alloying elements in one area than another, and you again have a potential differential.

What can be done about it?

1. **Keep it clean.** Dust is condensation nuclei for moisture and moisture is an electrolyte. Keep your metals covered. A plastic drop cloth is fine provided it is propped up to allow some air circulation. Finger prints may last forever if allowed to "set up." Work should be wiped with solvent after handling to remove prints. I use alcohol. Steel wool and crocus cloth both leave corrosive residue so do not use them on aluminum. Substitute good quality wet or dry #400 paper and aluminum wool. Mild corrosion may be removed with any of the good aluminum polishes available or with non-chlorinated Bon ami.

2. **Follow the drawings.** The use of zinc chromate for faying (contacting) surfaces and closed assemblies such as rod ends serves as an insulation. It also supplies a constant supply of chromate ions, the "good guys" in the corrosion battle. The anodizing called out for certain parts provides an oxide film which inhibits corrosion.

3. **Protect your workmanship.** Protective finish for aluminum should comprise the following, in order from inner to outer layer: a. Chemical film such as Alodine. b. Wash primer. c. Zinc chromate. d. Lacquer or enamel. If you are located in a corrosive atmosphere, it may be well to invest in an Alodine 1200 kit for treatment of heavier, bare aluminum parts. This is a two-part treatment which uses an acid cleaner followed with a protective film. To use the kit, a plastic bucket, nylon bristle brush, rubber gloves, and plenty of water are required.

TRIM SYSTEM: You have no doubt recently received the drawings for the trim system. My first impression was that it was quite complex but, now that I have completed mine, I cannot say that it was too bad. John says he went through a long process reducing it to an absolute minimum.

I ran into problems in making the trim system which might be of interest. It is absolutely necessary that there be no appreciable slop in the linkage from the screw jack to the surface. First, I had trouble cutting good tight-fitting threads. Then the jack screw bearing had a large amount of end play.

The tapped threads were no problem, but I had a few rejects on the jack screw. The screw can be made from an ordinary machine bolt, but do not try to use any of the original threads because there will be a necked down section between the new and old threads, making a sloppy fit. The original bolt should have an unthreaded portion longer than the finished threaded portion. To make the screw fit well, I had to open up the die and make successive passes, each time tightening it a small amount. The die holder would not allow the die to be opened far enough, so I had to hold the die in a lathe chuck. Then the threads were cleaned up and polished. The screw was then plated.

The bearing problem has been solved by John Thorp as described in the following letter:

"Yes, we ran into the bearing-end play problem on Dick Hanson's T-18. I have not yet found a more suitable bearing, so made the following fix:

1. Ground a 0.25 radius on a small portion of the head of the #704 jack screw.
2. Made a plug 3/4-inch diameter and approximately 0.06-inch thick, which is inserted between the head of 704 and the A-582 doubler.

The thickness of the bare 2024-T3 plug should be sufficient to take out all but a couple thousandths slop.

The 1/4 x 0.035 2024-T3 tube bent to route the shaft was used and works fine. The #701 system works well with the plug. The plug should be lubricated with lubriplate before assembly. The flex shafts have been found in machine tool surplus. (In 1986, most builders use a 90-degree gear head at the trim wheel and to instrument universal joints at the back.)

At long last I have an acceptable way of hooking up the flap control system. It should not take too long now to finish the drawngs."

FLOOR BOARDS: On page 24 we stated that the clearance slots for the exhaust stacks should be welded in place to seal up the cracks. John says that they need not be welded in place but the ducts themselves should have any cutouts in the flanges welded up. I made mine from stainless instead of 6061 aluminum. I silver-soldered the cutouts in the flange since this is much easier than welding stainless. John says that the slots are not absolutely necessary, but they bring the exhaust stacks out at a much more efficient angle and every little bit helps when it comes to reducing drag. Never bring the stacks out at 90 degrees to the slipstream but, if you are looking for a way to save time, omit the cut outs and exit exhaust tubes at as small an angle as possible. Flatten the tubes at the end slightly in the horizontal plane. (1986 Note: If you use 1/4-inch plywood floor boards, the floorboard skin can be made of 0.032 2024-T3.)

WING TIPS: John Tonzer has found a way to make very light fiberglas tips. He uses a thin layer of fiberglas and then fills them with polystyrene which is foamed into place with the tips in the mold. They look mighty strong and light weight. Thorp notes that this process should be done carefully since the foam has a lot of power if confined tightly while being foamed and might ruin a mold.

FIBERGLAS PARTS: Lee Hamlyn, who works for Volpar doing twin Beech conversions, took me out to see his fiberglas workshop. He does all of the fiberglas work in his garage. He had just completed a new set of wing tip molds which are nice and smooth. He showed me his new fiberglas cowling designed by Merle Soule. I now have one and it is a real beauty. I was anxious to see whether it would clear my alternator and exhaust system and it does. The cowling has the proper size inlet and outlet openings for good cooling of the 125 hp engine. Total inlet area should be 54 square inches and the outlet 10% more.

ASSEMBLING THE SPINNER: by Bob Kaergaard. I have been asked to describe how I assembled the spinner parts that I bought from John Tonzer, so here goes. First, I made a hole template by laying a piece of scrap 0.040" sheet aluminum under Drawing #640 and pin-punching the seven hole centers right from the drawing. These punch marks were carefully drilled with a #30 drill bit. The large hole in the center was cut using a fly cutter in a drill press duplicating the hole already in the #639 rear bulkhead. A word of caution about using the fly cutter--keep your hands away from the piece you are cutting! Clamp the piece you are working on to the drill press table over a piece of wood. Otherwise, if the cutter should "grab" the work, this piece becomes a "finger slicer" of the first magnitude--I know!

Next, the hole template was clamped to the #639 bulkhead, carefully aligning the two large holes. Then the six #30 holes in the template were drilled into the bulkhead. I did not have the proper size drill so, rather than buy one, I first enlarged the six #30 holes with a 1/4-inch bit and then, using a tapered pipe reamer in a carpenter's brace, I carefully enlarged each hole, stopping just short of the finished diameter. The holes were finished to size by using a fine half-round file and constantly checking for a nice snug fit on the driving lugs in the crankshaft flange. This may seem like a lot of unnecessary work, but to me this part of the job is the most important step of the entire thing for, if the rear bulkhead runs "out," the entire spinner will hop as it rotates.

The cutouts in the #641 shell were made using a template I made first of the prop shank profile. Probably no two props will be alike in this respect, so each builder will have to satisfy himself as to the fit. I ended up with about 1/16 inch between the prop and the shell. (It is important that the shell does not touch the prop or it will wear a dangerous groove.) With the cutouts made, I marked off the center hole location for the eight nut plates at the rear end of the shell. These eight holes were made with a #30 drill. Laying the rear bulkhead with the flange down on my table saw, (you should use a flat surface), I placed the shell over it. Slipping my left hand through one of the cutout holes and pressing down firmly, I drilled through one of the #30 holes in the shell while my Mrs. pressed down on the shell. The idea here was to align the rear edges of the bulkheads and shell as perfectly as possible. With the first hole drilled and clecoed, we repeated this process 180 degrees away and so on for the rest of the eight holes. At this point I thought it would be a good idea to mark the parts so that they will always go together the same way. A little dab of finger nail polish on the inside of each part did the job nicely.

The #642 front bulkhead prop bolt holes were drilled using the same hole template as before on the rear bulkhead and then the holes were drilled to finished size. Both bulkheads and the prop were bolted to the engine and the shell was slipped over this assembly and clecoed to the rear bulkhead. I then marked off the location of the eight screw holes for the front bulkhead and drilled the holes using a #30 bit. It would be wise before drilling to be sure that the holes will be in the proper place in the front bulkhead flange. If the thickness of your prop hub is more or less than the 3 1/2 inches shown on the spinner assembly drawing, this variation must be considered, otherwise, the front bulkhead will not fit the shell properly.

Now came disassembly. The 32 #30 holes were drilled to size using a #17 bit. To drill the nut plate rivet holes, place a nut plate over a hole and on the outside of the bulkhead flange, and run a short screw into the plate from the inside. A short screw will not mark the elastic stop material and is quicker to install and remove. With the nut plate thus held securely in position, I used a #40 bit and drilled the two rivet holes using the plate as a hole pattern. Counter-sinking and riveting completed the installation of the sixteen nut plates.

The shell can be dimpled by using a 509 screw as the male die and making a female die from a piece of scrap aluminum plate stock that has been properly countersunk. It takes a little experimenting to get the countersunk hole just right in order to get the proper dimple. I was in a big hurry to get my T-18 in the air last year, so I took the easy way out by just using the oval head AN 526 screws. Perhaps I will "clean up" the assembly and go to the AN 509 flat head screws Thorp calls for at some later date.

TAILWIND-TYPE GEAR: by Ron Zimmerman, 1915 McKinley Street, NE, Minneapolis, MN 55418. Ron designed Tailwind-type gear legs for his T-18 and got Thorp's approval before building the gear. Here is what he has to say about it:

"The main gear has a short "A" frame in which Tailwind-type springs plug in. It stands three inches higher than the "stock" gear and weighs three pounds less (including axles) than the "stock" gear (without axles). My guess is that the spring action should be about halfway between the stock T-18 and a Tailwind (due to the difference in angle of sweepback between the two planes).

"The tail spring is a round tapered spring (like Cessna 180) that moves the tail wheel back 7 3/8 inches from stock position. The tail spring attach points in the fuselage have been beefed up to take care of the leverage of the longer Scott tail wheel assembly. It should have less drag and a softer spring action.

"The main gear was designed to be 100% interchangeable with the "stock" gear. Sorry but it looks like there will be no flight or taxi tests of this gear until after Rockford."

VISIT WITH JOHN THORP: We asked John how much the tail spring could be softened and he said: "So it does not bend the rudder." Everyone feels that the solid aluminum tail spring is too stiff, but it is easy to soften it by whittling it down if you do not like it.

John found that you can get more horsepower from an O-290-G by replacing the valve seats with O-290-D2 type. The air filter and heat box could be made from fiberglas. The rear canopy rails can be shortened and moved inward and aft to make room for a cutout in the aft deck for a jump seat. The pitot and static tubes mounted on the fin of Thenhaus' and Hansen's ships provide accurate airspeed data. The pitot extends 16 1/2 inches and the static 14 1/2 inches above the fin. The two aluminum tubes are tack welded together for added strength.

RIVETING TIPS: 17S AN rivets, the ones with a dimple in the head, normally can be driven without being annealed. They do grow harder with age and after some period are too hard to use. Driving a rivet that is too hard causes four problems. (1) It is difficult to drive it straight. It wants to bend and results in a lop-sided shop head. (2) It must be driven harder and the extra energy in the gun may cause deformation in the parts being riveted. (3) The shop head may crack giving an unsafe rivet. The crack will show up along a diagonal shear line. All rivets should be carefully inspected for this. (4) The hard rivet will put a higher expanding force on the material being joined and cause it to crack. This is particularly true with dimpled sheets.

If you have been having any of the above problems, you can very easily solve them. Take all your rivets to a heat treat shop and have them reheat treated to the 17S condition. Then bring them home and store them in the freezer. You have a real surprise coming if you have not tried this. Riveting really becomes effortless with soft rivets. It makes driving ANs almost as much fun as using pops!

If you are a person who cannot admit a mistake you should not use AN rivets. Remember, if a rivet does not look quite right, drill it out. Do not even try to rivet without a hand drill by your side or you may tend to let some bad ones go.

Dimpling can easily start cracks. Carefully debur before dimpling and inspect every hole afterwards.

When driving a flush rivet located close to a heavy fitting or extrusion, it is nearly imossible to keep from deforming the metal at the edge of the heavy member. As an example, the rivets in the fuselage just above the 3/4 inch extrusion at WL 42 are very hard to drive. This can be solved by driving these rivets inside out where possible.

Rivets in side skins which attach the 601 frame are nearly impossible to buck after the wing fitting is riveted in place. Either rivet the fitting on later or machine down the flange on the fitting to allow bucking clearance. Bill Warwick said some of his rivets worked loose in this area. He attributed it to poor riveting due to the tight bucking space.

T-18 NEWSLETTER #17 06-03-66

Luther D. Sunderland

FAA AND POP RIVETS: Our district FAA office recently sent a letter to the chapters under its jurisdiction regarding Pop rivets manufactured by the Independent Nail Company. Here is what they said:

"This is to bring to your attention Pop rivets manufactured by the Independent Nail Company which have recently been found in the general aircraft supply market.

"Available Information indicates that there are two basic designs of Pop rivets; closed-end and open-end. Because the open-end type is open at the processed head end and, therefore, is susceptible to corrosion, we do not recommend it for aircraft use. The Pop type rivets (closed-end type) may be used for non-structural applications only. Additionally, Pop rivets do not comply with any MIL specifications, so that there are no guaranteed minimum shear strength and bearing strength values for the various combinations of rivet diameter versus sheet gauge thicknesses such as those presented in the Military Handbook MIL-HDBK-5.

"Pop rivets have been approved on aircraft for certain structural applications when approved as part of the type design. Such was the case of Aerofab, Inc., on the Lake Model LA-4. This approval, was on the basis of tests and special receiving Quality Control requirements by the T. C. holder! These rivets have been assigned part numbers. It follows therefore, that their unlimited use on amateur-built projects without tests could be dangerous especially in the area of primary structure."

I answered this, pointing out that Monel Pops are stronger than ANs in shear and asked for clarification. I received this reply:

> Our memorandum dated February 16, 1966 was forwarded for your information relative to the use of Pop rivets for structural application. The memo did not condemn these rivets but did caution home-builders regarding their use. The use of Pop rivets for structural application in amateur built aircraft should be substantiated by load test or data. Pop rivets meeting or exceeding shear and tensile strength specifications of solid AN rivets should be satisfactory for use in any area the AN rivet is acceptable.
>
> In our previous memorandum we were referring to corrosion resulting from moisture entering structure through the openings in the rivets. All such openings which expose internal structure to the elements must be sealed. The use of epoxy to seal the

rivet ends would be acceptable if the epoxy used has no corrosive effect on the rivet or structure.

If you use the rivets specified in the Thorp drawings you should have no difficulty obtaining FAA approval.

Thus, the FAA did not have their facts straight before they wrote their memo. Pop rivets should be corrosion proofed like any other part, they (Monel type) are stronger in shear than AN rivets, so can be used as structural fasteners in homebuilts.

LETTERS FROM THORP: Trim. The new trim system is working very well on Hanson and Thenhaus' T-18s. Jim Roberts took Dick Hanson's T-18 to 210 mph with the same margin over flutter that a part 3 airplane has. With two people, low fuel, and 92 pounds of baggage, Dick Hanson's T-18 is just about neutral in static longitudinal stability. Part of its problem is high pivot friction as the elevator hinge binds. Trim is adequate for all loading conditions and is most effective. The "bent" drive shaft works OK. The sloppy KS6L bearing static tests OK.

Flaps: The flap problems (forming skins) bother me. 0.020 skin would be good enough for the flaps, but I made them 0.025 so as to use up scraps rather than introduce a new material item. I suspect that rivet hole cracking is due to over driving of rivets. We have even encountered this on frames (0.025). I would not want to make all frames 0.032, so we need to see what it takes to not have cracks in 0.025. Careful deburring will help and possibly the rivets were old and hard. Anyway, I do not have a pat answer.

Propeller: I agree that a longer prop would be more efficient. We have used 65 and 66-inch diameters, but I do not know of any at 67. Since there are no special requirements for homebuilts we can ignore the 9-inch minimum ground clearance up to the point that we start digging up runways with props.

I show a 63-inch prop with a 3/4"/g stiff gear and 9-inch clearance. 67 inches will reduce the clearance to 7 inches. Your softer gear will reduce it still more. I do not know what we can get away with but I would not want to even try anything bigger than 67 inches. If you want to, it is your nickel.

I favor the low activity factor laminar profile Sensenich props. A 65-68 or 65-69 is about right for a T-18 with an unbeefed O-290-G engine. (1986 Note: When I gave Henry Rose the T-18 propeller design problem, I said that he could chose the most efficient length prop up to 70 inches length since we were all using 2 1/2 inches longer main gear. He chose 66 inches for the 125 to 160 hp W66LM wooden propeller, and 68 inches for the W68LY wooden propeller for efficiency reasons only.)

Rivets: To be meaningful, rivet tests should be according to ASTM specifications. I believe that this is a double shear set up to minimize tension influences.

I have already responded to the Eastern region FAA letter on Pop rivets for homebuilts. This is beyond their jurisdiction because there are no specific requirements for amateur built aircraft--strength or otherwise. What difference does rivet strength make? There are no specific loads that the structure must take.

I flew a Victa Airtourer in Vero Beach. It is an Australian commercial product. It is built entirely with open end "Pop" rivets, (probably Monel). It can have a standard category FAA license here because of the reciprocal agreement and in spite of "Pop" rivets. The Australian DOT is more stuffy than our FAA, but they licensed the Victa, "Pop" rivets and all. The FAA will have to buy it whether they like "Pop" rivets or not.

Kaergaard called to tell of having his bird in the air again complete with elevator trim. Three T-18s with the system report favorably on it. There was nothing wrong with Kaergaard's fuel tank. The padding slipped off the supports (non-standard). Lee Hamlyn is flying Ralph Thenhaus' T-18 with the prop shaft extension and Merle Soule's nose cowl which Lee plans to make. There are no new data, but all reports are favorable including looks. I have a set of horizontal tail parts which were to have been for my T-18 which I am going to donate to EAA at Rockford this year. It is still touch and go with my new Sky Scooter. We are counting on having it to fly to Rockford.

WING AND TAIL ALIGNMENT: by Bill Foote, Box 2050, Campbell River, B.C. I have noticed a number of references regarding alignment of the wing and horizontal tail during construction and have a couple of suggestions I would like to throw in for what they are worth.

If the surface upon which the wing is supported during construction is parallel, the wing will be free of twist when completed. One method I have used is two <u>rigid</u> sawhorses upon which are nailed 2 x 4s with the lower portion of the airfoil section cut out with the chord line parallel to the lower surface. Stops are placed at the forward and aft portions of the cutout to stop fore and aft wing movement during construction. The sawhorses are leveled using the chord lines of the airfoil--as laid out on the 2 x 4s--as references. One advantage of using sawhorses is that all portions of the wing are accessible for riveting with minimal movement of the wing. Some of the riveting must be done from underneath or sitting on the floor, but the results are worth a sore neck. Once the sawhorses are leveled and parallel they should not be moved. The legs can be nailed down or marks painted on the floor to insure that they have not been moved or, if moved, that they can be returned to their proper locations.

To check for twist during construction an "incidence board" is used. We lay out the upper ordinates of the airfoil and the chord line on a piece of 1/4-inch plywood. Lay out a line parallel to the chord line a convenient distance above it--say six inches, the airfoil section is cut out and the plywood cut so the upper edge is parallel to the chord line. 3/4-inch strips of wood are glued to the plywood along the top edge and also the forward and aft cutouts on both sides of the plywood.

Because the upper surface of the board is parallel to the chord line we can check for twist by placing the "incidence board" on the wing and a level on the top surface of the board. The position and direction of the level should be marked on the board to eliminate any errors.

The above method can be used on the horizontal tail equally well and by using a bubble protractor--available in any hardware store--it can be rigged with accuracy. The top of the "incidence board" is always parallel to the chord line regardless of the angle of the horizontal tail.

I have used the above method with great success when rebuilding damaged wings of manufactured aircraft without the use of jigs. The wing skins can be opened up on the upper side for riveting--the lower surface is best done first and then the top skin working from the spar aft--and because the wing is supported on the lower surfaces during both riveting sequences, no twist will occur. Once the wing is clecoed together and leveled on the sawhorses, there is no need for moving it during the riveting.

(Editor's Note: Due to waviness of skins, it is better to not make a "surface board" that has the complete airfoil shape. Instead, use a piece of wood that extends only from rear to main spar. Cut a taper on it so that its top surface will be level when the wing is mounted on saw horses. Locate two pins, pointed at both ends, in the wood so they will contact the upper surface of the wing at the front and rear spar locations. Use a carpenter's level to check for twist.

With my new S-18 wing having been assembled while being adjusted for straightness in this manner, the airplane trims in roll with the ailerons nicely streamlined. Still, the right wing drops first in a stall, so John Thorp said that I had to put on stall wedges. This, of course, completely solved the wing drop-off in a stall problem.)

LAYOUT: Lt. Paul Miller, 106 2nd Street West, FPO San Francisco, CA 96637. I have made copies of the full size prints with the use of a copy machine. I cut the outline allowing a quarter inch for shaky hands, then spray the back side with spray adhesive. I simply stick the layout on whatever metal I am using for the part. Rivet locations, break lines, etc. are all there without my having to draw a single line. If there is an error involved I am sure it is insignificant and would never approach normal drafting error. (Editor's Note: Caution. Never assume that a drawing is accurately drawn. Always check all dimensions before using a drawing as a template.)

An added benefit is that while the stock is covered by the layout, it is protected from handling and tooling scratches that never should have gotten there in the first place. Efficient layout is also possible because the layouts can be jockeyed from place to place easily to reduce wastage. I think this procedure will reduce my layout time 90% and eliminate much possibility for error. Where full size prints are not shown, I merely redraw the part and make a copy of it. It is much easier to draw on paper than on metal and it is less cumbersome. I make the Ozalid copy in case I foul up so I do not have to redraw the part, just recopy it. Using this procedure I never have to draw a part more than once, and I will still have a master set for further use when I am finished.

MAKING FITTINGS: B. C. Roemer, Manitowish Waters, WI 54545. To save time in laying out <u>full size</u> prints of fittings, etc.: 1. Blue plate. 2. Make a copy of print with copy machine. (I use a 3M dry photo copier.) 3. Cut out paper part, leaving about 1/16 inch around edge. 4. Position on plate and rough mark the cutout with a pencil. 5. Use #465 Scotch transfer tape (two-sided adhesive), 3/4-inch wide and overlay enough strips on plate to cover rough marks. 6. Place cutout on tape (be sure it is dead flat). Roll it on starting at one edge. 7. Dust with powder or flour to deaden excess exposed tape. 8. Prick punch all holes--should it be difficult to determine just where hole center is (because of multiple lines), use a knife and metal rule and mark the hole center cross lines. (Mark only within the hole itself.) Prick punch after paper is removed. 9. Drill all holes. 10. Band saw out, leaving a thin white line around drawing. 11. Band sand right to drawing. 12. Place part in pan of water. 13. Remove softened tape and template. 14. Break edges, deburr holes, polish edge, and the part complete. On the main beam wing fitting--drill one fitting with two holes--mating fitting with one--then dowl together (using drill and C clamps) and "match hole" drill remaining hole. Use 23/64-inch drill then ream to fit.

SHEET METAL BRAKE: Robert Hammer, Box 72, Monroe, OH 45050.

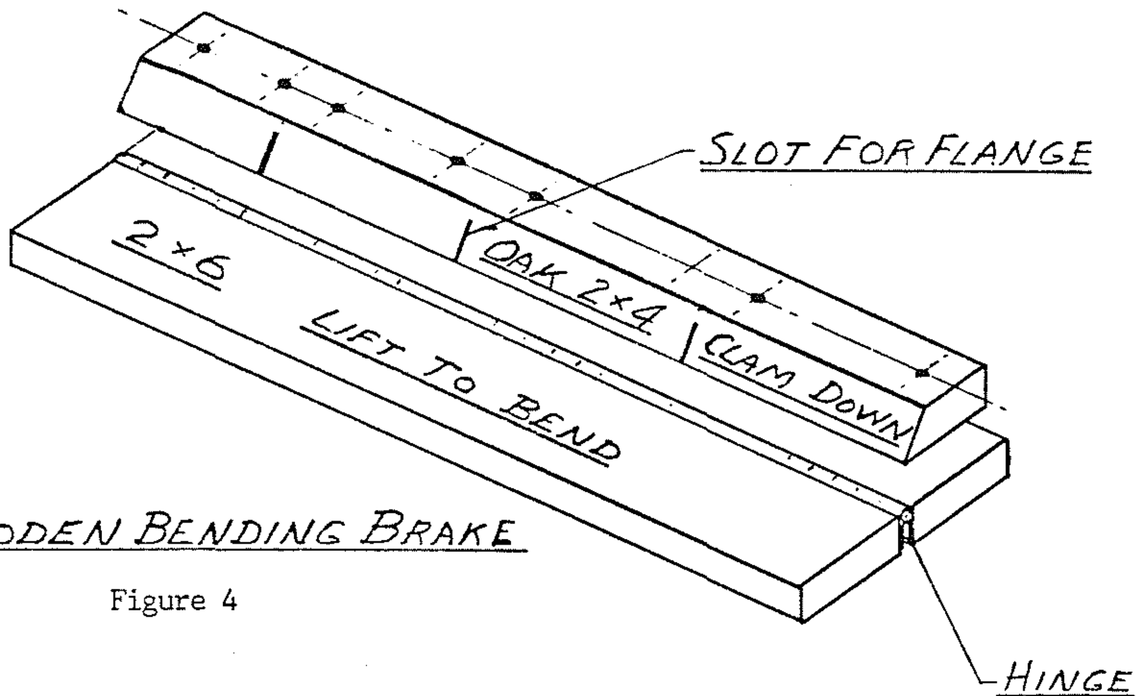
Enclosed is a sketch of a homemade brake which will produce a flange equal to any commercial brake. Mine cost between $5 and $6 and has proved extremely versatile. It works very nicely with 2024-T3 up through 0.040. The oak bar is chamfered, the edge radiused with a block and sandpaper, aligned on the 2 x 6s with the piano hinge already screwed on, drilled, and then cut into sections. The removing of a section allows you to form a flange which butts to a perpendicular flange. The lengths of the sections were chosen to give the best combination of lengths in increments of one inch when the flange to be formed has butting flanges on both ends. See Figure 4.

SEATS: There are two very important features required to make an airplane seat comfortable. First, the seat should support the hips and thighs over as large an area as possible. It should have an angle that parallels the thigh bone so contact is made nearly down to the knee. Second, the seat structure right under the spine should never be made of a hard material, such as a sheet of plywood, sheetmetal or fiberglas. The very best construction is zig zag springs covered by canvas, horsehair, and foam.

(1986 Note: Details of my seats are given in other Newsletters [see pages 82-83, 146, 246 for seat articles including sketches.] After 18 years of flying my T-18 and many others, I can say that I have not found a more comfortable seat than mine. The only thing uncomfortable about my T-18 is the width of the cabin, and my new widebody with two inches extra width solves that.)

ANODIZING: If anyone is interested in doing their own anodizing, it is easy. Just put the part in a weak solution of sulfuric or chrome acid (preferably chromic as any surface defect will show as a brown line). Around it place a piece of aluminum foil, TV dinner plate, etc., and connect it to the negative of a 2-4 volt DC source (battery, battery charger, etc.). Connect the part to be anodized to the plus side, use aluminum wire only, and apply current for 15 to 30 minutes. To check the finish, first rinse parts thoroughly, dry and check with an ohm meter or battery and light bulb, no current will flow across a good surface. The surface is porous and will take dyes nicely.

FIBERGLAS TIPS: Lt. Peter Beck, C/O 050 Materials Management, NNS & D.D. Co., Newport News VA 23607. I would pass on some comments about fiberglas tips. I started off with the tail tips since they were smaller and easier to handle. I used fine grade potter's clay, available in most any arts and crafts store, for the male master mold. I did this by using a chord section template, cut to include skin thickness, and then errected on it perpendicular templates from John's prints. This was then filled in roughly with odd blocks of wood to minimize the amount of clay used and the



WOODEN BENDING BRAKE

Figure 4

amount of possible shrinkage. The remainder is filled in with clay and is splined over at least three templates. Final dressing is quick and easy as it can be done with a sponge. It took me about five hours to produce a decent master. If one must work on this over a couple of evenings, it can be done OK by simply draping the work with a wet towel to keep the clay moist and inhibit shrinkage. Once the master is finished, female mold can be made as you describe. Since the clay master cannot stand the handling that a plaster master can, I cast the female mold from plaster in two pieces. One must keep the first few coats of plaster pretty wet and runny. This makes for fewer air bubbles and ensures that there will be enough water for proper hydration. If the plaster is too dry, it will draw water from the clay master, shrinking it, and producing ridges in the mold around the templates. Once the mold has been cast and built up, it can be covered with a hard paste wax after a light buffing with steel wool, and the fiberglas and resin can then be laid on. I have found that several good coats of paste wax, with care to buff out all ridges and buildups, does an admirable job of filling the very small holes.

BENDING STRAIGHT FLANGES: John Austin, 1101 South Eric, Monahans, TX 79756. In bending the flanges on the bulkheads, it is a simple operation to turn the flange over the form block by hammering on a 1" x 2" soft board to spread the impact over a greater area. Otherwise very light taps with the rubber hammer are necessary to prevent localized stretching, which results in a wavy flange. This technique gives a perfectly straight flange which can be joggled into recesses in the form block with a plastic wedge-shaped hammer. While this point is minor, it will help keep the skin smoother making for better air flow.

(Editor's Note: The unavoidable slight bend in frames after hand-forming flanges can easily be taken out with fluting pliars. A few flutes placed between rivet holes will straighten a frame perfectly.)

BENDING ANGLES: Larry Larcom, 173 N. Union Street, Delaware, OH 43015 (T-18 #194) made a set of rolls for bending the fuselage angles. Three junk bearings approximately two inches in diameter were bolted to a 1/4-inch steel plate. One bearing is adjustable to increase pressure on the angles. He says that compound curves can be put in as easily as curves in one plane. The angle takes one trip through the rolls for each plane of bend.

T-18 NEWSLETTER #18 08-22-66

Luther D. Sunderland

T-18 FORUM: On Tuesday, August 2, 1966, a T-18 Forum was held in the main meeting tent at the Fly-In. John Thorp gave a brief history of the T-18 and then answered questions from the audience. Here are a few of these questions and answers.

1. What is the story on tolerances for the various parts in the plans?

Answer: The only tolerances called out are those required for proper assembly. None of the tolerances given are for strength reasons. The drawing dimensions, which are carried out to four places, are not an indication that you are expected to work to four-place accuracy.

2. We have heard about some slop appearing in the horizontal tail pivot points. What is the story?

Answer: Slop in the horizontal tail pivot point is not a problem for flutter reasons. However, there is no slop permitted in the tab linkage. Excessive slop in the tab linkage could cause flutter. The loading on the horizontal tail bearings is very low so no wear should occur due to bearing loading. Bill Warwick's T-18 now has 470 hours on it, and it does have some slop in the horizontal tail but it does not appear to be increasing and has never caused any problem.

3. Center of gravity limits have not been called out in the T-18 plans. What should they be?

Answer: The theoretical neutral stability point is at 34% MAC. The N299V aircraft has demonstrated a neutral stability point at 31% with 94 pounds in the baggage compartment. This forward shift in the neutral stability point is apparently due to high friction in the horizontal tail bearings. The lower this friction, the more aft will be the neutral stability point. It would be better to use anti-friction bearings in this horizontal tail pivot but it would be advisable to enlarge the fitting slightly if they were used. The forward c.g. limit is 15% MAC.

4. What horsepower limits would you suggest for the T-18?

Answer: 125 hp is the minimum permissible and I would not recommend anything larger than a 180 hp Lycoming engine. Any one of the four-cylinder engines over 125 hp would be satisfactory.

5. When are more drawings coming out?

Answer: I have now published 171 drawings. It was not originally planned that this many drawings would be published, but the added expenditure has been made possible by the larger than expected volume of sales. 442 sets of plans have been sold. I am presently swamped with work connected with making a living and I do not know how soon additional drawings will be completed.

6. Could the T-18 be made into a single place design?

Answer: The T-18 design would not be appropriate for a single place or for more than a two-place aircraft. Please leave it as a two-place. I hear about people who talk about simply lengthening the fuselage and changing it to a four-place aircraft. This is not a safe thing to do and it would require a complete redesign. It is possible to go to as high as 1,600 pounds gross weight but remember that the design calculations for the 6-g aerobatic loading was based on a 1,250-pound limit. When you exceed this limit you do not have a fully aerobatic airplane.

7. What is the present estimate on performance?

Answer: Lee Hamlyn says he gets about 150 to 155 true airspeed cruise on Ralph Thenhaus' 125 hp airplane at 6.8 to 6.9 gallons per hour fuel consumption. Lee won the AC Spark Plug Rally at the Fly-In. Bob Kaergaard came in second.

8. What will flaps do?

Answer: They will reduce the landing speed 5 mph and significantly reduce landing roll, but the biggest help will be to increase the glide slope by 8 to 10 degrees. This will help the pilot judge his approach better.

9. What can a builder do if the FAA in his area does not like Pop rivets?

Answer: Under the present regulations the FAA cannot legally prevent you from using Pop rivets. If he gives you a hard time, I suggest that you go to his boss and his boss, etc. (Editor's Note: I had a discussion with Bill Stout from the FAA in Washington regarding this subject, and he confirmed that there is no specific requirements for homebuilt aircraft materials. They say we can use virtually anything we want to. However, the local inspector may place whatever restrictions he sees fit on your aircraft until it has been proven out.)

Lee Hamlyn reports that Ralph Thenhaus picked up 75 rpm with his new streamlined cowl and the prop extension. Apparently the prop extension gets the propeller out of the interference of the cowling and gives better efficiency.

QUESTIONS ASKED AT THE FLY-IN: While I was working on the T-18 wings at the Fly-In I naturally was asked many questions about the project.

Forming Ribs: The single item which seems to scare most people is the forming of wing ribs. People will apparently go to any extent imaginable to keep from trying to form a rib. They will notch them, crimp them, or pay extremely high prices for someone else to form them, but they are afraid to tackle the very simple job of forming them as described in the building instructions. I think forming the wing ribs is one of the simplest tasks of the whole T-18 project. Just get the right tools and give it a try. But first be sure to read T-18 Newsletters 1-12 pages 4-9, written by John Shinn, on how to form ribs. Just be sure to get a good bucking bar, the right hardness plastic-tipped mallet, and do not cut the nose of the rib to the exact size until after forming. If you cut the rib to the exact size at the nose you will surely run into trouble with a sharp kink at the bend line. It is completely unnecessary to form your ribs out of 2024-0 and then heat treat them.

Dimpling: Nearly everyone wants to know how to make dimples in sheet stock. I strongly recommend that you follow the advice given in Newsletter #8 and make the simple dimpling tool shown there. If you do not have the facilities to make this tool, you probably should not be building a T-18. Be sure to put a radius on the insert for the female die. Otherwise, the flange on the male die will invariably pinch the metal and cause a ring to show around the outside of the dimple.

The Whitney Company had a display at the Fly-In and they were pushing their combination dimpler and punch, which will punch and dimple in the same operation. I strongly recommend against using this tool for skins for two reasons. First, it is impossible to punch and dimple with this tool without causing very bad cracks and tears around the edge of the hole. Furthermore, I cannot imagine any holes in the T-18 which could be punched and dimpled at the same time using the type of matched-hole tooling which is described in the building instructions. The second reason why this tool is not good is because it does not produce a good-quality dimple. The male die does not have a flange and therefore does not hold the metal down firmly. About the only place you will find the Whitney punch dimpler of value is for dimpling frames and wing ribs.

Pop Rivets: There were the usual questions regarding the use of Pop rivets. Several reports have come in from certain FAA regions where the inspectors do not like Pop rivets. If anyone finds this to be the case, ask the inspector to show you in writing what his authority is for disapproving of Pop rivets. Since he has no legal authority for this, you should have no problems, but if he persists, get his objection in writing and send a copy to me.

Gas Tanks: Many people want to know about putting baffles or stiffeners in an aluminum gas tank. John insists that baffles are not needed in the T-18 gas tank for damping of the gasoline. Furthermore, the baffles make the tank much more susceptible to fatigue due to vibration. His experience is that a tank with baffles cannot be made to pass a shake test. Fiberglas tanks should have two baffles all around at the two mounting locations.

CONVERSION OF THE LYCOMING 0-290-G FOR THE T-18: By John Thorp (Based on a group discussion at the T-18 workshop during the 1966 EAA Fly-In, Rockford, IL; edited by J. N. Shinn).

Engine Background: The first engine of this Lycoming series was a 235 cubic-inch model. I believe it had a 4 3/8-inch bore with a 3 7/8-inch stroke. The next step was to go to a 4 7/8-inch bore with the same stroke, which gives 290 cubic inches. Lycoming felt that the shaft was a little light so they beefed it up. Thus the standard 0-290-D shaft used in the 0-290-D and D2 is stronger than the 0-235 shaft, which they put into the ground power engine, the 0-290-G. The next step was to bore it as much as they could, which brought it up to 5 1/8 inch and thus the 0-320. Except for provisions for a hydro-controlled propeller, there was no difference in the crankshaft between the standard 0-290 shaft of the 125-135 hp engines and the shaft they used in the 0-320 engine of 5 1/8-inch bore, which was first rated at 150 and then later at 160 hp. Since it was bored out twice, they could not make the bore any bigger, so as a next step they started increasing the stroke. They went 1/4 inch from 3 7/8 inch to 4 1/8 inch and this gave the 340 cubic inch engine. The 5 1/8-inch bore in the 4 1/8-inch stroke, gives 340 cubic inches. Now you can use the 340 cubic inch shaft with the 4 7/8-inch bore and you have 309 cubic inches. The next step (and the reason why there were not more 0-340s built), was that they said: "Well, let us see how big an engine we can make." As a matter of fact, Piper had an airplane that had to have it. The original Comanche was thought to have been capable of flying with the 150 hp engine and it did not work out. Since they had bored it as big as they could make it, they then stroked it as far as they could stroke it, which was another 1/4 inch, to 4 3/8-inch stroke. This is currently the biggest engine that they make in the four cylinder series. It has 5 1/8-inch bore and 4 3/8-inch stroke; this is the 0-360 (180 hp).

Part Interchangeability: The bulk of all the parts in this whole series of engines that I talked about are interchangeable. Some of them are strictly interchangeable without doing anything to them, others require a certain amount of modification. For example, you can put an O-360 crank in the GPU engine, O-360 cylinders on this engine, and O-360 pistons and rods, but you have to do a little bit of sculpturing in the case with a rotary file to get clearance for the bolts on the connecting rods. But this is exactly what Lycoming does. Everyone of the earlier O-360 engines had hand-sculptured cases. They were basically the same case, but they had to remove a little material in order to get rod clearance. (They have a new series of engines now which they call the wide deck engine, that I am excluding from this discussion because none of the power section parts will fit on the GPU engines.) I am talking about the O-360s used up to about a year and a half ago. But back then, you could mix up almost any combination of parts that you wanted. I put a set of inclined-valve cylinders off the O-435 (the engine that was used in the Navion and the Aerocommander), on a ground power engine and called it the O-290-G-Whiz because it was 290 cubic inch, but it was really a hotrod engine. Now the only real problem with that is that the O-435 has hydraulic lifters where the ground power engine is set up for mechanical lifters and the rocker arms for the O-435 cylinders give you no provisions for valve adjustments. So this problem was never completely satisfactorily solved. We did solve it by welding, etc. but we did not feel that this was too good. I am sure that there is a way that you can actually match up the rocker arms and have an O-290-G-Whiz if you want to. It would put out about 160 hp.

Crankshafts: There is a surplus crankshaft from the O-320 that is used in the Piper Twin Comanche. The shaft has lightning holes in it and because of propeller problems with a twin-engine plane it has been necessary to replace the shaft with one that has a heavier flange and no lightning holes. As a result there are shafts becoming available that are perfectly satisfactory for single engine airplanes that are much better than the standard O-235 shaft that is used in the ground power engine. This shaft is basically the shaft that is in the 150-160 Lycoming engines.

The best source I know is our engine repair stations that at the time of overhaul an AD note must be complied with, so the shafts should be available through them. You can use the GPU pistons, valves and all, but of course there is not any point in using this heavier shaft if you are going to stay with the standard GPU parts. This shaft is externally the same dimensions as the 235 shaft, so the compression ratio and displacement would be the same. The shaft that I talked about yesterday that does a lot of things at once is the shaft from the O-340. Now, unfortunately there were not many O-340 Lycomings made. The shaft can be be purchased new from Lycoming for around $500. This one shaft does a lot of things; it will increase the displacement from 290 cubic inch to 309 and will increase the compression ratio of the standard GPU pistons from 6.5 up to 8.1. As a result you will have an engine that is capable of putting out somewhere between 155-165 hp (depending on the rpm that you elect to run at) by only just changing the shaft. You have to use a minimum of 91 octane fuel. The shaft is structurally stronger even than the O-320 shaft and is quite adequate for any power that you can get from the engine, even with additional modifications such as the use of the big intake valves and seats, the big carburetor, and other hop-up items that can be incorporated in the engine.

Carburetors: It has been my experience that the MA-4 makes a very excellent carburetor for this engine. If you can find one from an L-5 (the O-435 190 hp Lycoming, 6-cylinder engine is used in the L-5), this carburetor may be used fairly successfully without any modifications or any work on it at all. It is a little bit rich but all this means that you start your leaning a little early. If you want to go to the next step above that, take the carburetor to a Marvel-Schebler Repair Station and have it set up for a 150 Lycoming; this works perfectly on this engine. It is about as good an arrangement as you can get. If you tell them you want to use it on an O-290-G, they are obligated to send you packing; so do not intimate that you are going to use it on anything but an O-320 engine. An MA-3 of course works fine.

Valves: The exhaust valves that are stock in the GPU are superior, in my opinion, to the exhaust valves that you buy from Lycoming for the O-290-D or D2 engine. The superiority is in what appears to be a higher heat-resistant steel and the provisions for the valve rotator caps. This valve is identical externally (except for the diameter of the stem) with the exhaust valves that are used in the later and more sophisticated Lycoming engines.

Piston Rings: An entirely satisfactory set of rings is the stock repair kit that is furnished with O-290-G, which uses a chrome top ring. The second compression ring and the oil ring are cast iron. These rings are good for somewhere between 500 to 600 hours before the oil consumption becomes excessive. The rings seat in easily; it makes an entirely satisfactory engine. If you want to have a 1000-hour to 1200-hour engine, then you should use all chrome rings and you can buy this as the stock set for the O-290-D.

Fuel Injection: I have had no experience with fuel injection on these engines and I have no recommendations about it. I can say this: I would not advise an amateur builder without considerable test facilities to try to adapt a fuel injection system from some other engine to the O-290-G engine. I know that it becomes a laboratory job and it is not something that the average homebuilder wants to become involved with. If it comes with the engine, then fine.

Magnetos: The S4LN-21 impulse coupling mag, which is the only magneto furnished on the ground power engine, is more readily available than the S4LN-20 which is normally used on the right-hand side of this engine as an O-290-D2 and the O-320, etc. The T-18 mount was designed to use either two S4LN-21s with the impulse coupling and the adaptor plate, or if you do use the stock S4LN-20 you have to sculpture out some back clearance on the mount and then you have to add a reinforcement on the front. Practically, it is easier to get the -21 magnetos and there is some virtue in having two impulse coupling magnetos. In two experiences (not with this engine, but the little old 145 Lycoming in the Scooter) I have had the mag with the impulse coupling go out and I was dead whereas if I had had two impulse coupling magnetos, I could have gotten the engine started, and there was still enough magneto function so that it would have been safe to have flown home. As it was I was "dead on my feet," I had to have an overhaul on the spot. In one case I had to make a bus trip down to Los Angeles to get the magneto overhauled and another bus trip to get it back on the airplane. So practically, the thing to do is to use the T-18 mount setup just the way it is and use two of the -21 magnetos.

Oil Cooler: It is not possible to use the O-290 engine in the summertime anyplace in the United States, without an oil cooler. A very satisfactory oil cooler for this is the Corvair oil cooler or one from a Volkswagen bus. If you buy one across the counter from a Chevrolet service agency, it will cost you somewhere around $20. But $20 against $120 or $180 (for an aircraft cooler) is a cheap oil cooler, and it is more effective than any other oil cooler that I know of. Or you can go to a junkyard too. The coolers are pressure-tested to pressure far in excess of anything that is needed for an airplane engine and I do have type certification of a Sky Scooter with a Corvair oil cooler on it. The FAA took a hard look at the thing and first they said, "Nothing doing," but I got Harrison to furnish me the testing, inspection, and qualification data for the cooler and then the FAA said: "Well this is better than the aircraft coolers and we will have to buy it."

Mounting the Cooler: You make an adapter block into which you can thread pipe fittings to connect Aeroquip hose and use two O-rings in the grooves in the cooler and just one bolt to hold it together. Preferably, it should be mounted in a position right ahead of #2 cylinder (the front cylinder on the left-hand side). The oil take-off is from the oil gallery (front right) and to keep from robbing the engine of too much oil, it is necessary to put a restrictor in this hole. Use a steel AN fitting with a 1/8 NPT that will screw into the gallery which will go to 1/4-inch hose. Use 1/4-inch hose which is adequate for this partial-flow setup. We braze up the hole in the 1/8 pipe end of the fitting and then drill it out 0.070 to 0.075. (Editor's Note: I had to enlarge the bleed hole even further to get adequate cooling, but pressure was still OK.)

Oil Filter: I am also recommending the use of the Corvair oil filter. (1986 Note: Since Corvair parts are no longer readily available, buy an oil cooler bracket from J. C. Whitney Company, 1917 South Archer Avenue, Chicago, IL 60616.) Take the oil through the cooler first and then the oil filter. The filter can be mounted on the firewall. These parts are extremely light; there is no problem in mounting them and they certainly do help the engine life. You go from the cooler to the oil filter and back to the sump. You can braze a brass fitting to a steel plate covering the fuel pump pad if no fuel pump is used.

It is not necessary to use a bypass on a partial flow system because of the oil congealing. In Canada you might need a bypass--if you do, then there is a standard set of parts that you can buy to bolt on to the back of the case to give you a bypass valve. In the United States, with the kind of weather we have here, there is no problem with a partial flow system. If the oil congeals the bypass system will shut itself off. With this system congealing does not interrupt any lubrication function; if it does congeal you just do not get any oil flow through the cooler and the oil will heat up and maybe it will start to flow, and it will congeal again. It pretty well takes care of itself. You do not need an oil cooler under conditions where it is cool enough for congealing to occur. In my opinion these engines would never wear out with the kind of use an amateur builder would have on a homebuilt airplane if it were not for dirt. In all the engines I have torn down, and particularly the ground power engines, I would say that 95 to 99% of the reasons for rejection of parts has been because something hard had gone through the engine. When the crankshafts are scoured and the bearings are ruined, it is due to dirt. The crankpins and the sludge pins are practically full. At this point, dirt is recirculating and engines do not last very long after that. So compare the dollars you pay for an automotive oil cooler against the price for a new crankshaft.

Oil Breathers: The breather modification is quite simple on the ground power engine because there is a boss on the inside of the casting already there that is just not machined. It is on the front left-hand corner of the case. I usually put a pilot drill through just by eyeball to see how close I am to the center of this boss. I then increase the bore just until I am on center and then drill it out for a 3/4 NTP, but then just use a standard plumber's 3/4 pipe tap and a 3/4 aluminum AN elbow. You may lose a little oil out this front breather. It is not enough to be critical on oil consumption, but it is enough to make the airplane dirty, so that on one installation that I worked on we ran the breather through an oil separator. (Editor's Note: If water vapor from a breather freezes, it might cause the crankshaft seal to blow out. Drill several 3/16-inch holes in the breather tube near the crankcase fitting to prevent blockage--top side of course.)

TEMPLATES: Those of you who choose to reproduce the prints and paste them to the plate stock to save layout time, should not forget to check every dimension very carefully. Several people have gotten into trouble with this procedure, especially for wing ribs. Blueprints have a strange habit of changing dimensions. For this reason, I maintain that use of a full-sized rib layout in homebuilt plans is totally useless except for rough checking your own layout.

T-18 NEWSLETTER #19   11-66

Luther D. Sunderland

WHAT RPM IS RED LINE? John Thorp tells an interesting story about how the 2600 rpm red line got established for light aircraft. After World War II, an SAE committee meeting was called to set standards for engines and propellers for light aircraft. Representatives from the various airframe, engine, and propeller manufacturing companies were present including John Thorp and Fred Weik of Piper. Mr. Weik stated that it looked like the propellers in post war airplanes would be in the 72 to 78-inch length range and that for the wooden props then in use, 2600 rpm would be a good maximum. So, since that time, most of the airplane manufacturers have specified 2600 rpm as the maximum. But this is not necessarily a hard and fast limit based upon engine or propeller design considerations.

The Hughes helicopter uses an O-360 Lycoming engine which cruises at 2950 rpm. John was involved in its design. The only problem which arose was that the valve mechanism had a shorter life, so they had specially hardened cam shafts and lifters installed. John thinks the O-290 series engines can be turned at cruise speeds up to 2800 rpm without adverse effects.

You have heard that propeller tip speeds cannot exceed the speed of sound and that this limits maximum rpm. The speed of sound at sea level is 1100 feet per second, but you should not attain tip speeds this high. A wooden propeller should not exceed 900 fps, and for a metal propeller 1050 fps. A 68-inch long propeller turning 3100 rpm has a tip speed of 1000 fps. The best maximum tip speed depends somewhat on blade pitch. So for T-18-length propellers, you can cruise at up to 2800 rpm.

How do you determine the 75% power point for your airplane? Power varies roughly as the cube root of rpm. So to determine the 75% power point, first determine the maximum level flight rpm for a given temperature and altitude. Your engine is delivering its maximum horsepower for that set of conditions, but you do not know what it is (or do not need to know). Now, reduce rpm by 10% and you are obtaining 75% of the original maximum power. If you assume a maximum of 2900, the 75% point is 2610 rpm.

BRAKE LINES: Brake lines running from the fuselage to the wheels should be made of 1/4-inch stainless steel rather than aluminum. The tubing should enter the fuselage through a 3/8-inch hole in the 3/4-inch angle about two inches aft of the firewall. The tubing should be protected by a one-inch piece of Teflon sleeving where it passes through the angle. The tubing should be connected to the master cylinder with a flexible hose having a generous loop to allow bending (not twisting).

CARBURETOR AIR SCOOPS: John Thorp gave me some pointers on air scoops. I am using a standard TriPacer type carb heat box and air filter and wanted to know how to shape the air inlet for it. Two things are important. First, the scoop should have a generous (at least one inch) lower lip extending forward of the filter to help deflect the air into it. This is especially important with filters that slope back sharply like mine. Second, the inlet hole in the air scoop should be only about half as large as the filter. This gives a diffusing action at the inlet and reduces the velocity of the air at the filter. Thus, less dirt particles enter the inlet since it is smaller, and since their velocity is lower at the filter, they will not penetrate as deeply.

CARBURETOR HEAT MUFFS: The drop in rpm experienced when carb heat is applied is due primarily to the restrictive action of the carb heat system rather than due to an increase in inlet air temperature. These passages are never really big enough, so make your heat muff and ducting as large as practical. To improve the heat transfer, wrap a steel spring tightly around the exhaust pipe inside the muff. The muff is made from two steel ends and an aluminum wrap-around jacket. Only one end needs to be welded to the exhaust pipe. If the other end is free to move, it will cause less stress on the muff during the dissimilar expansion and contraction of the steel and aluminum.

SOUNDPROOFING: It is important to filter out both low and high frequency noise, but no single sound-proofing material is available to cover the whole spectrum. So it is necessary to use two types. For high frequency filtering, use 3M acoustic tape which is aluminum backed. It comes in six-inch wide rolls. It is quite expensive and is available directly from the 3M company. The smallest size roll may do many airplanes, so a joint order with your friends will help. Put the six-inch tape on the inside of all cockpit skins including above the tank. A double cross layer should be used on the firewall and floor. Add a one-inch layer of spun glass insulation to this to filter out low frequencies. The firewall should have a double layer of the one-inch glass. Heating shops have an adhesive that will attach the skin and firewall.

OIL COOLERS: John is convinced that the oil cooler should be mounted in the cowling nose piece and directly attached to it. This will keep the oil temperature about 20 degrees lower than with the cooler mounted on the rear cylinder baffle. Also, the connecting hoses are much shorter. (Editor's Note: It will not work on the rear cylinder baffle.)

MORE ON ENGINES: Crankshafts. There have been some questions about the strength of the Ground Power Units (O-290-G) crankshafts. John Thorp says that there were some early reports of crankshaft flange failures. It is absolutely necessary to install a flange reinforcement that clamps around the O-290-crankshaft.

Carburetor Air Intake: Some T-18ers at the Rockford Fly-In asked about putting the intake for the carburetor up in the cylinder air inlet, so as to make a more streamlined, tighter fitting cowl, (One Piper model does this). John advises against this because the induction pressure drop will be too great and you will not be able to get full power. It is best to have as short a path as possible from the intake to the carburetor. Some airplanes (like the new Mooney) even go so far as to have an air filter bypass to use when flying up high where there is no dust and dirt. This gives the lowest possible pressure drop. John says that with his filter design using an automotive carburetor filter (for 283 Chevrolets) the pressure drop is so very low that a bypass would give no advantage.

Oil Pressure: Some GPU engines will provide too low a value of oil pressure even though all bearings, etc., are within tolerance. This is probably because the pressure relief mechanism is set too low. This can <u>not</u> be corrected by replacing the spring with a stronger one. The problem lies in the cage that the pressure relief ball seats in. In some of these cages the holes are larger than standard for aircraft. Remove the cage and replace it, and the pressure should fall in the correct range.

Exhaust System: Most builders have been having trouble getting stainless steel for exhaust systems.

A crossover exhaust system will give about 100 rpm increase because of the reduced exhaust back pressure. A crossover system has one front cylinder exhaust tied together with the opposite rear cylinder exhaust pipe.

Cowling Outlet Size: Be sure to have enough outlet area for best climb speed. Since the best climb for the T-18 is greater than 100 mph, an ejector type cooling system will give no advantages and is more complex. (At 100 mph at sea level the ram air provides about five inches of pressure.)

Static Pressure Port: John says that there is no point on the fuselage which will provide reliable static pressure throughout all flight conditions. If you want to have your pitot and static pressure probes mounted on the wing you will have to go about two chord lengths (100 inches) out to avoid fuselage proximity effects. If it is mounted under the wing it will read low, and then you will need to add a flare ahead of the static line to compensate correctly. The best place is to mount the pitot and static probes on the vertical fin (about 15 inches up). This gets the probes above the propwash for all flight conditions down to about 60 mph where it hits a drop off under power.

Rudder Bearings: Some people have suggested that nylon be used instead of Micarta for the rudder bearings. John Thorp says that Micarta (which he recommends) is a little harder to machine but nylon is harder to lubricate--you cannot load it up with graphite. Micarta is the best overall.

Welding: The question was raised about how you can tell if heliarc parts are good. John's comment: "If it is not cracked it is good, if it is, it is no good." The cracking occurs during the temperature stress during welding. To minimize this risk preheat (and sometimes post heat) is advisable. A torch (gas welding) provides good preheat and post heat. As a result there is less risk of cracking.

Use _low carbon_ steel welding rod (1/16-inch #7 mild steel) for _all_ welding techniques. High allow welding rods are more temperamental.

Engine Bearings: The bearings for the O-290-G and the O-290-D are the _same_ parts and have the same part numbers. Therefore, if you can buy bearings for the O-290-G you will save money.

Vacuum Pump: The O-290-G has an accessory pad for mounting a vacuum pump so that if the adapter and gear train are available you can have an engine-driven vacuum system.

Removing the Engine Flange: The flange on the front of the O-290-G can be removed by using a little elbow grease. Band saw off the upper lip with the case open and then drill 1/4-inch holes around the flange and knock if off. A little filing is then required to smooth up the job to professional standards. (Others have removed this flange while the engine was still together by drilling a series of holes all around.

MATERIAL SOURCE: Just spent an interesting visit at Spencer Aircraft, 8410 Dallas Avenue South, Seattle, Washington 98102. They are an aircraft surplus supply house that handles many goodies usable on homebuilts. They also give good discounts on new equipment. Examples: new vacuum pressure regulator for gyro instruments $12.50 (regular $25). Oil temp with 48" capillary $1.50 new. Gas tank strap cork covers $.50 each. Clecos $.12 each, Cleco Pliers $1. (1986 Note: Sorry folks, those prices are no longer available but Dick Baxter there will help homebuilders with hardware--prop bolts, etc.)

T-18 NEWSLETTER #20 01-01-67

Luther D. Sunderland

Here it is New Year's Day and time for all of us to resolve to get the ole bird flying this year. I have spent the holidays riveting the flange on the nose piece and doing all the other time-consuming cut-and-try jobs necessary to get the cowling made. I am also in the process of installing insulation, making seats, and forming the canopy.

SEATS: While sitting on an aluminum lawn chair, which I had bought to take to the Fly-In, I got a good idea for seat frames. A trip to the local discount store turned up a broken aluminum chair made of one-inch tubing, which I bought for $1. This provided exactly enough tubing for both T-18 seats. The chair seat bottom and back were both the same size and each made a bottom seat frame. The legs made the two seat back frames. Since the original chair frame was too wide, each piece was cut down to make a 16-inch wide frame. A splice was made with a four-inch long piece of one-inch tubing which was slit to allow it to be fitted inside the two pieces being joined. A few Pop rivets secured this splice and the two corner splices. (1986 Note: The new Cascade 701 aluminum soldering rod will do a great job on seat frames--eliminates Pop-rivet splices.)

This is a very easy-to-make ultra-light seat frame and I think it sure beats anything else, such as welding either aluminum or steel. Plywood should not be used if you want a comfortable, light-weight seat.

The bottom seat frames should have springs added. You can obtain zig-zag spring material from any upholstery shop or tear up an old chair. Use four springs running front to back. The springs can be secured with wrap around clips made of 0.015 stainless. These clips are secured to the top of the tubing in the frame with Pop rivets. The springs should bulge up about an inch above the frame. If they bulge up too much, you can crimp them to draw them down.

The springs do not need to be tied together with wire as in chairs. Just cover the springs with a very heavy grade of canvas and attach the springs to the canvas with hog rings. This is the way Cessna does it. The canvas is secured to the frames by folding it over 1/2-inch wide aluminum strips, wrapping around and Pop riveting to the frames. Now you are ready for the padding. I used a 1 1/2-inch layer of rubberized hair plus a four-inch layer of polyurethane foam. Pincore foam rubber can be used, but it weighs more and costs many times more and deteriorates quicker. With this amount of cushion, I just clear the canopy with my 6'2" height. My rounded and lowered tunnel does not bother me either.

I recommend that you make a bucket type sent for maximum comfort. Cement, with foam cement, a four-inch wide x one-inch-thick strip of polyfoam on each side of the cushion. The inner corners can be trimmed off to help shape it. The center portion of the cover is held down by small steel rods inserted through two loops sewed to the cover. In seats with thin padding, the foam is just slit part way through to make space for these rods. Then the rods are squeezed down and attached to the zig-zag springs with hog ringsor tied with heavy cord. (Corvair seats are made this way.) But with thick cushions the rods can be attached to the springs with strong cords. The center portion of the cover can be given a nice ribbed effect by sewing a piece of about 3/8-inch thick polyfoam between a thin backing cloth and the top cover. The cover can be stitched every two inches with the biggest size stitches possible to minimize weakening of the material.

Plastic upholstery material can be obtained at a fabric shop or auto seat cover shop. The best is Naugahide but it is also very expensive. The type with cloth backing should be used. The best grades use a foamlike plastic which is very pliable.

Ordinary sewing machines have a tough time with heavy plasticc, so you should use a heavy duty machine. In our area, it is possible to lease a heavy duty machine.

Backs of seats need not be padded so well. I am using canvas stretched over the frames with no springs. Over this I am using one-inch polyfoam with the sides built up similar to the bottom cushions. Even with this thin back cushion and my rudder pedals located as per the plans, my knees just barely clear the instrument panel. If you are over six feet, you do not have any extra leg room. John does not recommend a backpack parachute for this reason, so make the bottom seat cushion removable so you can use a seat type chute.

For the most comfort, the front of the seats should be raised about two inches. This distributes the support more evenly along your legs. If you cut a hole in the top deck aft of the seat, there is no need to have fold-down seat backs. This is by far the simplest arrangement.

COWLING: Supports for the cowling outlets (or gills) have usually been fabricated from 1/4-inch steel tubing with a one-inch strip of 4130 welded to it to form a flange. The support is riveted at the top and bottom of the gil to the 0.040 flange on the edge of the firewall. If you have some extra 3/4 x 3/4 aluminum angle, this will serve the purpose. Just trim off one leg of the angle, making it 3/4 x 3/8. Bend this to form the shape of the gill, then rivet this to your cowling door. Remember, the area of each outlet should be 10% bigger than the inlet, or about 27 square inches on each side, for minimum drag (0.35 sq in/hp).

If you use Lee Hamlyn's fiberglas nose and bottom cowling you will not have any clearance problems for there is plenty of room for an alternator and a crossover exhaust system. There is not much extra clearance over the top plugs but it appears to be adequate. Lee does really nice fiberglas work. (Aircraft Spruce & Specialty sells this cowling in 1986.)

One feature of this cowling is that it has nice big access doors, which make nearly everything on the engine accessible, without removing the cowling. The cut-outs are so large that the doors form a part of the load-bearing structure. Remember this when allocating fasteners.

CHROMATE APPLICATOR: If you do not want to have to clean a brush or spray gun every time you need to chromate a small part or faying surface, just keep a piece of polyfoam handy, tear off a small piece of it, and dip it in the chromate with a pair of pliers. It works better than a brush and does not need to be cleaned since it can be thrown away after use.

MARKING DYE: Lucius Bigelow, 17 Crescent Avenue, Sumter, SC 25190 sends this tip. Just paint your aluminum parts with ordinary shellac before scribing. After cutting, the shellac washes off with alcohol and the metal is not scratched.

CANOPIES: Bob Gaede was unable to produce canopies because of a lack of facilities, so I bought his plaster mold. I have spent nearly a month putting two layers of fiberglas over it, and am now ready to make a canopy. But I am not making any for sale. Hopefully canopies will be available very soon, however, for George Breitsprecher is tooling up to produce them with vacuum-forming equipment.

ANOTHER FIRST FLIGHT: Herman Rassler, T-18 #24 of 98 Constitution Avenue, Henderson, Nevada 89015, made his first flight in October, 1966, and already has 50 hours completed. With a 125-hp Lycoming turning a 65 x 68 Flotrop prop at 4000 feet, maximum rpm is 2950, and at 2800 he gets 172 mph average ground speed! At 10,000 feet it still climbs at 850 feet/minute. Stall is straight ahead, not tricky. He is very very happy. Watch for more details in the next Newsletter. (See pages 90-94.)

601 ASSEMBLY: There is not sufficient clearance between the fittings and the flange on the 601 bulkhead to permit riveting. Therefore, I recommend that the fittings be riveted to 601 after 601 has been riveted in place. If this riveting sequence is used, wait to install the 592 frame until after the 601 fittings have been installed. This might make the Hi-Shears impossible to install so just use bolts instead. Some people have had so much trouble riveting 601 that it bulged back slightly and made the wing difficult to install.

RIVETING: by B.C. Roemer, Manitowish Waters, WI. Past Newsletters have gleamed with good tips. One of my favorites was the heat treating of AN rivets. To me this is a must.

I ran into a problem in some tight-to-buck places. If the shop head deformed and the rivet had to be replaced, I drilled it out using a 1/16-inch pilot drill and then (for flush heads) a #25 drill. The head will spin off and you can punch the bucktail out (or work it out with pliers). Do not drill on through with the #25.

Now comes the problem: Dimpled holes are always larger than the rivet body to start with, so the rivet is loose in a normal hole. While seating, before the shop head forms, the body of rivet swells until it is stopped by the sheet holes. Most any rivet (especially hard ones) in dimpled holes, will enlarge the hole as it takes some force to stop the expansion of the rivet body.

If a 4-4 was the original rivet and you use another 4-4, so much of the length will be used up swelling to the enlarged sheet hole that you will not have enough rivet left to form a proper thickness shop head. So you should use a 4-5.

Now the problem of bucking a longer rivet in a loose "hard to get at" hole and not bending the stem, is a dandy. It is almost impossible with hard rivets.

I set up the Whitney punch into a squeeze riveter. Take a 4-5, drop the head in the base, and center the stem on the plunger. Squeeze slowly (you will expand the body) until you are about a -4 in length. If stem bends, discard, of course. Now you have a fat-bodied -4 that will fit nicely in the expanded holes. It will be long enough for a good head and it will drive straight as it fills the hole. (Need some nice tight dowels for dimpled holes? Squeeze yourself some the same way. Make them as tight as you need them.)

FORMING PARTS: Stu McGeary, 3517 Debolt, Cincinnati, OH 45244 has sent a sketch of a homemade press made for forming wing ribs and other parts. He uses a 5 to 10-ton jack pushing against an I beam in his basement. The form block is made of masonite. The metal is forced down around the form with a slab of rubber one-inch thick and 40 durometer hardness. Steel plates are placed between the jack and the rubber. It requires about two tons force to form 0.030 aluminum. This should work OK if you have a heavy house.

INSTRUMENT PANEL: Many questions are asked about the panel. I moved mine aft about three inches by making an additional frame from 0.025 2024-T3 (crimp the outer flange) which extends down to WL 42. Attach to the 3/4 angle with a bracket made of 0.063 bent to 90 degrees. I put the panel on the aft side of the frame. The gap around the panel can be covered with an overlay, or the panel can be made slightly larger to hide the gap. Make the panel perpendicular to WL 42. The top of this added frame should be in line with the top of the forward top fuselage skin or slightly lower. It does not look good to make it the same height above WL 42 as the top of the 603 dash.

HARDWARE: All-Aircraft Parts, 16673 Roscoe Boulevard, Van Nuys, CA 91406 now has all T-18 hardware and fiberglas cowlings. Send for price list. (This is the Hamlyn cowl.)

POP RIVETS: Many builders are having trouble finding the MK-440BS rivets at their local dealers. For some reason they have stopped stocking them. United Shoe wrote me a letter saying that anyone can order Pop rivets directly from the factory, Fastener Division, United Shoe Machinery Corporation, Shelton, CT 06485 in minimum orders of 500 of each type. The MK440s are $23.74 per thousand and all others are less. (These are old prices.)

DICK CAVIN: Just had a nice visit with Dick and saw his new round-back fuselage now being riveted. The aft fuselage will look something like a Sky Scooter with doors hinged up at top along fuselage center line and with aft windows. He is not selling plans. (1986 Note: Dick later sold this fuselage.) He tells me that the boys around Atlanta are really going great. They have rented a building and have a regular assembly line going with 38 ships underway. Gotta watch that Southern Air Force!! Sounds like they are mobilizing. (1986 Note: Like any cooperative building project, this one was short-lived. Only a couple of these greatly redesigned T-18s ever flew. Also, Dick sold his round-back fuselage after George Breitsprecher's canopies became available.)

T-18 NEWSLETTER #21 04-06-67

Luther D. Sunderland

PROPELLERS: Another source has dried up, but I have found a replacement. Sensenich now refuses to sell cut-down metal props less than 72 inches long. (1986 Note: See pages 260-261 for more on metal props.) They say that since they have not done complete testing on shorter props they will not risk their reputation on them. This is an item you should start looking for well in advance of your project completion since the prop shops do not get too many props suitable for cutting down. (1986 Note: Most people buy the W66LM [for O-290 through O-320] and W68LY [for O-360] wood props from Sensenich.)

FORMING RIBS: One builder had trouble getting the rib flange to lay down flat. It curled up slightly near the edge. The problem was that the blank was cut too small and as the flange was stretched back, there was not enough of a vertical portion to hold it down. Cut the blank about 7/8 inch larger than the form block to allow plenty for the flange. It should take only three or four passes to stretch the flange the complete width of the rib form block. At this point a vertical portion about 3/8-inch high will remain. Before slapping this down with a solder bar, trim most of it off with shears. Otherwise, the rib flange will be distorted while this excess is being slapped down. Do not forget to leave at least 1/2 inch extra at the nose of the nose ribs. Trim to size <u>after</u> forming or you will be sorry. Also, I have found that all flanges on ribs and fuselage frames occasionally have a habit of coming out a little short making the last rivet too close to the edge. This is especially true where joggles are involved. About the only way to correct a situation like this is to make a new part so I have developed a habit of making flanges a little too long (not wide) until after the rivet holes are drilled or punched. Be sure to come back and read this after you scrap your first fuselage frame for too little edge distance.

So many people have trouble forming the horizontal tail nose ribs because they try to stretch the flange all the way around the nose. This is not only unnecessary but nearly impossible without an intermediate annealing. Just trim off the flange at the nose similar to on the wing ribs. These ribs are duck soup to form.

T-18 IN SIX MONTHS: Publishing the Newsletter would have been abandoned long ago if it were not for the enjoyment I have had in associating with so many fine people through this endeavor. (I do not make any money and it certainly has held up progress on my own project.) But, people such as Irvin Faur, Box 236, Princeton, IA 52768 really make it worthwhile. He bought plans at the 1966 EAA Fly-In and, after a somewhat leisurely start last fall, just whipped out a T-18 in five months and flew it March 10, 1967!! He might have flown a month sooner but he was held up waiting for a canopy. His numerous progress report letters have been most enjoyable. I will include a few excerpts. This is the first ship to fly with a cut off hump under the canopy and it really looks nice. It has by far the cleanest nose since there is no carb air scoop. He used a Corvair air filter with the inlet in the nose piece just under the spinner. He used Lee Hamlyn's fiberglas cowl with a prop extension, a 160 hp engine, Pop rivets, no flaps and Pitts wheel pants. He put only two degrees dihedral in the wings instead of eight degrees for eye appeal only.

Irvin H. Faur, February 20, 1967: Just got the bird out of the basement yesterday. Painted it today in about 27 degrees to 35 degrees temp in the carport. Am waiting for a canopy and a windshield. It is ready to fly after inspection.

Irvin H. Faur, March 12, 1967: Well at last the T-18 has been in the air. Have made three landings only, and use more runway than a big jet. I got licensed on the 4th but had to wait for canopy. Finally got it about the 7th. Flew on the 10th. Anyhow, it just flies wonderful. So far seems like no heavy wing, nose, or tail, and of course in 35-degree temperatures it takes off very short. Sure surprised the watchers and really climbs -even with a 66" x 72" prop but indicates 150, and the fellows think it really moves. It is real quiet inside, two inches of aircraft insulation all around. Just a little goes a long way and very light on all controls. Just no fight no place.

Irvin H. Faur, March 23, 1967: About the canopy, since I have got six hours now I am getting so I look around some. Noticed today those sheet strips of aluminum we put around the lower edge of the bubble pull out about 1/2 inch from the fuselage when you get moving. Hope someone comes up with a bubble to fit soon. I am gradually getting more mph. Can turn 2900 now on the straight. Going to get the engine timed by an A & P soon. My airspeed is close, checked by timing over a two-mile stretch, and I have already indicated 180. That is sliding the ground underneath fast. Have used your seat deal and sure is very comfortable. Kaergaard saw it and is going to change to that also, so he said. Flew two hours today and not cramped at all. P.S. My wife finally made me start fishing again!

Irvin H. Faur, April 1, 1967: Am sure you get sick and tired of my raving on about the little T-18. Everyone tried to impress me with the need for flaps, and of course, I ignored them. But flaps are needed for sure to slow down the landing roll and to keep from using so much braking. That is absolutely my only fault with the little bird and flaps will be on mine in 1968. Have now flown my T-18 just over 180 mph on straight and level. This is not hogwash or a guess. That thing moves. There is no doubt by Rockford time I will be doing at least 190--same prop 66 x 72. Went to 100 octane fuel. Have the gear to cuff, and a few other details. Turned 2925 on this run. Noise level about normal, vibration T-18 about normal, speed fast. John says the dynafocal mount will further reduce vibration. Do not believe I have the vibration Bob Kaergaard has but, boy, his workmanship is really good.

GAS TANKS: Here is some advice on the filler neck. You will be disappointed if you use the filler neck as shown in the plans protruding through the top skin. It is a little extra work, but well worthwhile to use a shorter neck and an access door. With the internal gas cap you will need a drain for sloppy gas attendants. Lawrence Larcom, 137 North Union Street, Delaware, OH 43015 has some good ideas on tanks:

> Have a suggestion on the fuel tank mounting. Use automotive window channel tape which is available at automotive shops and comes in various thicknesses. It has a cloth backing and is very durable. I drilled small holes through the gas tank saddles, applied the bath tub sealer (available at plumbing shops). The sealer beads through and makes an anchor for the tape. Used a gas tank gauge and sender from a 190 XT Allis-Chalmer farm tractor, which fits the tank perfectly. The gauges are marked with a red line which is very convenient for aircraft application.

This tape and GE silicon adhesive really work well. I also used it for seal material in engine baffles. Rivet it to the aluminum baffles.. The gauge sounds fine too so now we have at least two to choose from, this and the VW type.

TIPS FROM AUSTRALIA: Peter Hodgens, 136 Curlewis, Bondi Beach, NSW, Sydney, Australia 2026 sends these tips along with a photo of his beautiful Emeraude:

1. To cut sheet alclad up to 0.025 for spars etc., place sheet on flat table and clamp straight edge along line, use a sharp knife as a cutting tool. Takes a bit of hard work but produces good clean straight edge.

2. To make male fiberglas spinner mold construct wood frame allowing 1/4 inch for plaster cover with burlap material tacked on, and then lay on 1/2 inch of plaster in one lot, first paint thin coat on burlap to stiffen it. Let plaster dry and then turn in lathe to required contour. Sandpaper finish, seal with two coats shellac, then use auto primer.

3. When making wing tip mold, etc., after preparing the male plaster mold including parting agents, draw a heavy soft pencil line at halfway point. Lay up fiberglas female mold

using clear resin, let set till firm and then cut to pencil line with Stanley trimming knife (line can be seen through layup). Do same with both female halves. When laying up finished wing tip halves in female mold, trim exactly to top edge with knife, join two halves by taping together with masking tape and two or three layers of cloth and resin inside.

4. To flip half template about centerline, make 1/4 inch wider and use two 1/8-inch holes on center line. I figure this is a better method than straight edges as John suggests.

HERMAN RASSLER FLIES: 98 Constitution, Henderson, Nevada, 89015, December 29, 1966. I just flew my bird October 19. It weighed in at 920 pounds with cg range of 18.5 to 31.5%. It has a Flotrop prop 65 x 68 to which I credit most of the good performance. The engine is an O-290-D2 with G jugs. All my minimum test altitudes here are above 4000. I get a maximum rpm of 2950 and at 2800 rpm a ground speed average of 172 mph. Rate of climb is 850 ft/min at 10,000. It is flush riveted with filler, has flaps with electric actuator, electric trim, crossover exhaust, full panel with gyros, no center console, 600 x 6 tires, canopy and side doors, 36-gallon gas tank, Falcon air filter and Corvair cooler. To say I am completely satisfied would be an understatement. It is a very honest bird. Plenty of burble on the stall and straight forward. The only thing I might not like is the sensitivity on trim. To equalize from solo to dual I had to trim ailerons to hold right for solo and left for dual. I am trying now to dream up a two position aileron trim. Any suggestions?

The only "fly in the ointment" is my operating restrictions. The 50 hours local was bad but now I am restricted to days only and avoid heavy air traffic, cities, towns, villages, and congested areas. I have sent in a letter of protest but as yet have had no answer.

HERMAN RASSLER, JANUARY 10, 1967: **Flaps.** My flap actuator works smooth and easy. The only prints I have are of the flaps themselves with a one-inch OD tube extending into the fuselage. I ran a 1" x 0.045 stainless steel tube all the way through and mounted a one-inch ID T-shaped fitting at centerline to which an actuator (surplus 24V, 6 3/4", $10.95) is rigidly attached to hold center. The bay from seat back to STA 119 is all luggage compartment, so I had to build a tunnel high and wide enough to clear the torque tube and rudder cables. The area under the tube is just right for an actuator and the tunnel reinforces STA 119 enough to anchor the other end of the actuator with an extension of about four inches added. The actuator has built-in limit switches to set the length of travel and the extension has adjustment threads to adjust location. I have not had too much time to test the flaps as my home port (Boulder City) has one gravel and one blacktop runway, both at 6% slopes. All landings are uphill (if it is not too windy to fly) and the T-18 flares for an instant and then stops so I never use the flaps at home. I have made landings at our dry lake so do have impressions but no definite figures as yet. It stalls 5 to 6 mph slower with full flaps. The roll is about 2/3 normal although it seems shorter. It will three-point but the flare is about as quick as at Boulder. Partial flaps (they stop at any variable) do not seem to have very much effect either landing or takeoff. My actual impression is that they make very good dive brakes or drag brakes which ever is the right word. I am glad I have them installed because they do help slow her down and recommend them for short fields. It takes about 2/3 power to maintain level flight with full flaps at 100 mph so that should give you some idea of the drag. The 24V motor runs at half speed but the power due to the gearing is much more than adequate. The same goes for the trim actuator although it is a small unit (1 pound 15 ounces). It just happened to be the right length to mount vertically behind the stabilator arm. At the top it is bolted to a crossover arm similar to Thorp's print to give one-inch travel and the bottom to an angle across the bottom longerons. It was a very simple installation but if that little motor ever quits it will be a major operation to repair it. The fellows should give some thought to an inspection plate in that section or a two-piece top cover. You just cannot see into that compartment and a good inspection will require removing fin and rudder. Christianson plans a regular round inspection plate on each side.

I got extra space for the fuel tank by moving the panel aft about five inches on top and three inches on the bottom. Made the tank of glass, just as wide as possible and as close to the instruments. Instead of a continuous curve from firewall to top aft I have a straight vertical line down for about six inches or seven inches. I have a Skycrafters radio which just clears the tank but with glass construction a dent would have given me another gallon if I had known for sure just what radio I was going to have. If anyone copies my panel layout tell them to group the instruments a little tighter vertically. My panel just does clear my long knees at times.

There is about 1/2 inch above and one inch between the flight instruments which could be worked out.

I used AN flush rivets and back drove them wherever possible. Riveted the side panels to the longerons in the flat and those panels are drum tight. The body filler is Martin Senour's "Payday" - a polyester filler applied to clean bare metal. I did not know the trick of using the rubber hammer to bring the rivet back up after driving so I still have slight depressions along the rivet lines but most people cannot see them. I used about four pounds of the Payday but at least half of it was waste due to it setting up to a crumbly consistency before I could get it spread. A fresh mix spread with a piece of 0.090 plastic sheet wiped on with very little sanding required. In fact, where it was back-riveted, I do not remember sanding at all. Sure makes an amateur rivet job something to be proud of.

I must have gotten my pitch numbers mixed in my last letter. The prop is marked Flotrop 7668-11 which means 11 inches cut off a 76 diameter to make a 65 diameter - 68 pitch. It comes from the factory as a 76xx-2 for a small Beechcraft. The cord length at about the center of the blade is 5 5/8 inches and at the tip is 4 1/4 inches. It looks to be more of a work horse than most of the blades I had checked before. Eventually I want to mount an extension and get more slope to the frontal area. My air intake may also be slightly small, although not as much undersize as the books say, and I could use a little more ram air for manifold pressure. The cowling ports are 1 1/2 times inlet plus 1/2-inch clearance all around the exhaust stacks. I tufted the air flow and it seems near perfect on the sides. The tufting on the canopy all lays flat and straight too. My big problem on that greenhouse was getting fresh air to the face and shoulder area. The windshield area is all high pressure so I have a Mickey Mouse trap door with the roll bar brace in the center and it diffuses the air perfectly with very little noise. I plan to unshroud the heaters and use those tubes for more air in the summer. (Nevada gets hot!) I used a 1/2-inch high-density fiberglas insulation around the fuel tank area and 3/4 inches under the carpets on the floor boards. The rest of the cockpit and baggage area is lined with 3/16 sponge rubber stair runner purchased from Wards. Everything is glued to the outside skins with air conditioning duct insulation glue. This glue is a yellow rubber-based stringy, sticky, about like rubber to metal cement, but much cheaper. Just slap it on thick, get the material on while it is still wet and take a bath in gasoline to clean up!

The noise level is about the same as a 172 really winding up. That is a real busy-sounding engine at the higher rpms. Mufflers might help some but with the crossover system and the heavy insulation on the floor, I do not seem to hear much exhaust. I would rather get some high frequency insulation for the firewall and cowling to cut down the prop noise. I have not located any around here yet. I have a buddy in Phoenix trying to get some there. I have the standard gear from Tublar Products with 15-600-6 tires. On normal runways I like the stiffness but on rough strips I think it could even be dangerous. I went into Furnace Creek at Death Valley which was rough surfaced and also alkali heaves - about four inches to six inches high and it was a real fight right down to taxi speeds. As short coupled as that bird is and with all that rudder, it is very easy to over control normally without being bounced around in the cockpit. The gear came from Tublar with toe-out which I corrected to neutral with skins. The toe-out was alright down to about 20-25 mph while the rudder had plenty of control but then it seemed to want to dart (maybe I should say drift) to the sides with more and more rudder jockeying to keep straight. The only sod we have around here is golf courses and football fields but gravel and dry lake beds are not any different than blacktop. You are busy but that is to be expected.

Now about that first flight. I will never do it again! After inspection on the morning of October 19, the inspector told me to take it around the pattern and then he would sign it off for test flying. I had done quite a bit of taxiing so had rudder under control, but other than a few gentle lift-offs without watching any instruments I had no experience with the other control movements. I took off, circled, lined up with the runway, made the transition from downhill to up, slowed down to 75 indicated, flew into the side of the hill, bounced, stick forward, bounced harder. After three progressive bounces I finally realized I was in trouble so I shoved the throttle in and went around. Next time around I slowed to 70, made every movement as easy as possible, finally touched and rolled to a normal stop. The inspector signed her off, so then I took her up again to see just what kind of a wild beast I had sired. Thorp said it should stall at 68 (which it does) but my airspeed said 35. I made the next landing approach at 45, flared at about 40 and had no problems until the final rollout with the toed-out gear. I figure I was trying to land at about 110. After trying a dozen ways of modifying the static system, I finally gave up and am now using cabin static which is 2 mph faster than ground speed with the vents closed, 3 slow with them open at 4000 feet. Maybe I have these figures reversed but there is not enough difference to worry about a fancy static system at these elevations. According to my figures standard sea level should also be close for indicated and true. While at Death Valley, I made a high speed run at sea level to see what max rpm would be. Thorp said it should be 3000 and for 75% start at 2700 sea level, add 25 per thousand feet to full throttle at 2900 at 8000. I developed 3025 at sea level with an indicated speed of 193, two people, half tank gas and no baggage. Maybe someone with a slide rule will say I am all wet! I find it hard to believe that top speed myself. Most of the flight was at low levels and 2700 or more rpms and fuel consumption was slightly over 10 gph so I must be pulling much power out of that engine. I am going to Phoenix this weekend and hope to make at least one way at over 10,000'. Should have better cross-country figures to add to the end of this note. I would recommend anyone testing this bird to stay up on the first flight and really get to know it before that first landing. Check that gear closely (for no toe-in) and make those tires very soft for the first few landings. My test pilot friend says his impression of it is about the same as military only faster response due to the light weight. The name "tiger" might be a little strong but it is no "pussycat." I made the crossover stack system out of standard auto pipes and U-bends. Tacked it in place right on the engine, removed to weld with x braces on the flanges to reduce warpage. After welding and light sandblasting, I used a 1/4 pint of heat resistant paint, sloshed it around inside (what a mess) and sprayed what was left on the outside. After air drying I cured the paint with a butane torch. Just let the flame blow up the stacks. There is no good point to support the rear lengths of the pipes. After about 15 hours they cracked at the 3 to 4 junction. I rewelded that and welded a sleeve brace over the joint. It is showing a little rust in that area, otherwise they show no sign of deterioration. (Editor's Note: We learned long ago that ball joints and spring supports on the stacks are an absolute must.)

The seat backs are one-inch foam on 1/4-inch plywood with an angle stiffener at the center side. The bottom cushion is three-inch coils with four-inch foam rubber on plywood base. They are heavy (11 pounds each) but very comfortable. I strapped myself into cruise position for three hours and read a book for testing. I did not want to suffer from TB (tired butt) on long trips. The cushion sets on a dustpan-shaped tray which swings up for storage below. Room for landing light, tools, tiedowns, and other standard equipment. Desert survival for here. FAA answered my protest of restrictions with a new operation limitation. The high density, cities, towns, etc. has been deleted and this substituted; flight tests are prohibited. Also they advised me that on the installation of a rotating beacon they will lift the day-only VFR. For once it payed to howl although I do not know what they mean by the flight test restriction because #4 says: Any major changes to this aircraft shall invalidate this certificate.

01/15/67 - Just returned from a semi-fly-in at Phoenix on the invitation of Roger Weselmann. He is an engineer at Bonanza Airlines. He explained the flap action, which had bothered me as a natural effect, nothing to bother with. He thinks most of the buffeting sounds are the quarter panels on the rear deck. They just cannot be made tight and he could see them vibrate at certain attitudes. (Editor's Note: The top panels can have a center angle rivetted in the flat which will stretch it into shape just like the sides. Mine are that way and very solid.) Just two rides in my bird sure built a fire under RW. I held her at 2800 both ways, burned 8.8 gph at 11,500 and 9.6 at 8,500 and got an average ground speed of 168 for the trip both ways.

O-290-G CONVERSION AND OVERHAUL: by Luther D. Sunderland. Although many words have already been written about converting the O-290-G for aircraft use, you might be interested in hearing of my experiences. I found the manuals and articles very informative, but they never seemed to cover all the little items you really need to know. First, in buying any used engine you must realize you are getting a pig-in-a-poke. Your engine might be brand new, one with a fresh major, or it might be a run-out. If you can inspect it before purchase, you can tell something about the condition, but you really will not know the whole story until it is completely disassembled. It is fairly common for the oil passages in the crankshaft to clog up, due to the dusty ground environment and cause the front main bearing to seize. This condition if severe, can be detected by discoloration of the case. Condition of cylinders can be determined by inspection through the spark plug holes. An engine which was recently overhauled will have visible circular hone marks and very little carbon deposits on the pistons. Vertical (longitudinal) scratches mean longer wear since overhaul. Condition of exhaust manifold gaskets also indicates time since new or overhaul. Drain out some oil and check for metal particles which are a danger sign if present. Of course check compression by pulling it through and check for damaged cooling fins. The best bet is to buy your engine from a reputable source who will check it for you, but as scarce as these engines are becoming, you cannot be too choosey.

Conversion is very simple.

1. Cut off the generator attachment flange by drilling a row of holes, breaking the flange off and filing smooth. This is a necessity for use with a standard ring gear and, in any case, is strongly recommended since it is a relatively simple way to save some weight.
2. The oil pan should be replaced with an aircraft type. It is possible to cut off the old one, plate up the back and use an external spider and intake tubes, but this does not allow a nice clean profile cowling.
3. Add a second mag and set of plugs.
4. The oil pressure relief valve may have to be replaced with a standard Lycoming part to get the oil pressure up to an acceptable level for aircraft use.

The big question you will ask is: Should I disassemble the engine completely or wait until next winter? If the engine shows signs of a recent overhaul, the latter will be especially tempting. However, complete disassembly is an absolute MUST! You see, the Air Force has probably been cooperating with the anti-poverty program (since Lycoming is in a depressed area) and therefore tried to wear out the engines as fast as possible by using a thick mixture of mud for break-in oil. If you think I am kidding, wait until you remove your sludge tubes from the crankshaft. Overhaul of the engine is not difficult if you obtain an O-290-G engine - overhaul manual from the government printing office, Washington, D.C. for $2.50. Even if you have an O-290D manual it is necessary to have the G also since dimensions and tolerances differ slightly on some critical parts, such as the crankshaft journals. The manuals show several special tools which are a must even for disassembly. First you need offset wrenches to remove the cylinder hold down nuts. These can easily be made in a shape similar to the pictures by cutting away the handle from a boxend wrench and welding on a bent-up steel rod extension. A somewhat simpler wrench could be made for disassembly, but for proper torquing after assembly, the torque wrench drive should be directly over the nut.

Tag all parts so the cylinders can be put back together with their original parts. If you are wondering whether or not you should use a GPU engine, remember that the O-290-G engine is nearly identical to the O-290-D certified engine, both use the same cylinders, rods, and pistons. The crankcase only differs in the generator flange which you cut off. The G crankshaft is the same except that it has larger oil passages to help prevent clogging in the more contaminated ground environment. The O-290-G engine is a real bargain so get one while they are still available.

T-18 NEWSLETTER #22   06-23-67

Luther D. Sunderland

RETRACTABLE GEAR MODEL: by Russell Basye, 4957 East Nevada, Fresno, CA 93700. I just finished riveting up my fuselage and I am pleased the way it turned out; skins are nice and tight. I was concerned about any twist as all the holes were dimpled, but it turned out square and level. Along the top quarter panels I doubled the amount of rivets to prevent gaps between rivets. I made a roller and bent about 3/32 inch down slightly along all the edges to make the joints hug (Figure 5). This worked out fine. I also made a big roller to form the windshield flange. I spent about a week making the roller but the results were worth it. The flange is nice and smooth without any tool marks. I am putting my windshield inside of the flange. I am using an aluminum windshield frame from Rudy Adler. Was thinking of using Teflon for canopy slides in place of ball bearings. At the side rails I put in a piece of 0.025 to receive upholstering. Also I put in a lock to hold canopy closed. It is a piece that pushes up just back of the ball bearings.

I heat treated my rivets and put them on dry ice. The ice man said the dry ice would last two or three days - it thawed out overnight!! I used the rivets anyway and they seemed to be softer than before heat treating. I have anodized all my parts at home. I was thinking of writing an article on the process I use. What I like about doing it at home is that I can anodize the part and install it without any waiting.

I used a rivet gun to form all my 6061 parts. It does not leave any hammer marks, your arm does not feel like it will drop off, and it is much faster. I could form a wing nose rib in 15 minutes. This includes trimming also. Use a 1.5-inch diameter x 3-inch long piece of birch sawed to a wedge shape. Drill a hole in the other end and insert a rivet set.

Use the rivet set with the birch just as you would a mallet. The rivet set should have square shoulders to prevent splitting the wood. The tip must be dressed occasionally. I use the fairly heavy gun. It takes a little practice but you can ruin a wing rib or two and be far ahead. For 0.040 wing ribs it takes about 80 pounds of air. By the time I got 1/4 of the way through, my wing ribs looked as if they were stamped out!

I am using a Grimes 12-volt retracting landing light motor for my flaps. I am using the cables just as they are with the motor mounted just above bottom skin with the mounting bracket riveted to the rear of the tunnel and the two cross 3/4 x 3/4 angles. The motor is small but powerful. You have to cut a lot of brass off to reduce weight but I think it

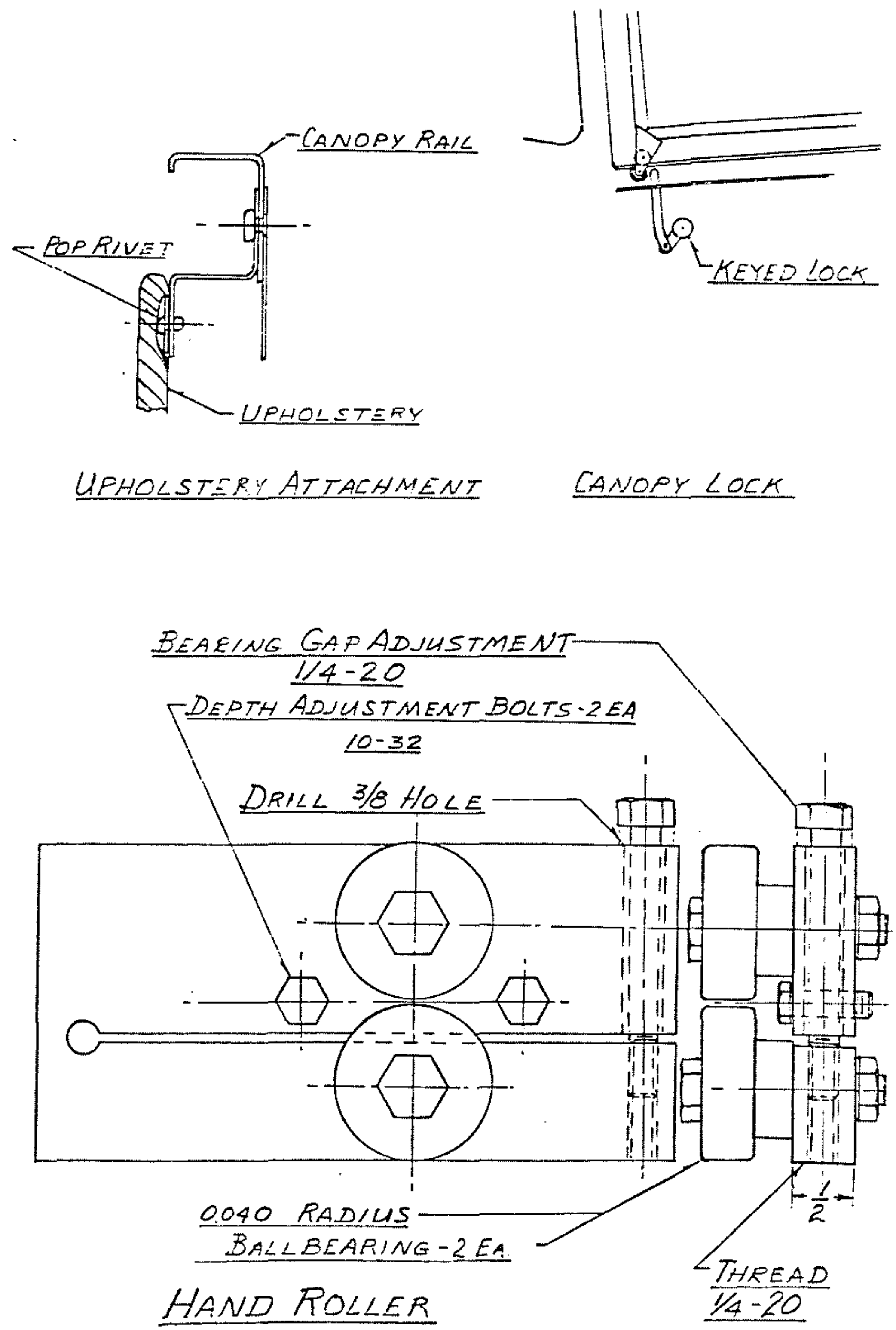

CANOPY RAIL
POP RIVET
UPHOLSTERY
KEYED LOCK
UPHOLSTERY ATTACHMENT
CANOPY LOCK
BEARING GAP ADJUSTMENT
1/4-20
DEPTH ADJUSTMENT BOLTS-2 EA
10-32
DRILL 3/8 HOLE
1/2
0.040 RADIUS
BALLBEARING-2 EA
THREAD
1/4-20
HAND ROLLER

Figure 5

will work fine. I am anxious to mount the wing on the fuselage to see how my retracting gear works. If it had not been for that silly retractable landing gear I would have been flying the T-18 a year ago! Having built a heavy Sky Coupe I have been weight watching all through this project--nipping off extra metal here and rounding corners there. I hope I have not picked up extra weight with the landing gear. (Editor's Note: After all that, Russ said that he did end up with a heavy T-18 which did not really perform well, even with the retractable gear. Figure 5 also shows details on a canopy lock and a method of attaching upholstery.)

Fuel System: I have two wing tanks of 13 gallons each mounted in the outer wing panels and a fuselage tank of 13 gallons, giving me 39 gallons total. The wing tanks are pumped with a Bendix fuel pump to the nose tank. From there gravity to the carb. All the tanks are fiberglas. I used fiberglas mat and cloth in the wing tanks and they came out 10 pounds each. The nose tank with four layers of cloth came out five pounds so--no more mat for me! It soaks up too much resin. My rudder pedals are pivoted from above as the nose wheel wipes out the floor mounting. The biggest problem was the toe brakes. I finally worked this out by a rod pulling down on a lever attached to the brake cylinder. To finish my T-18 I have the following to do: engine mount, engine installation, cowling, canopy, instrument panel, seats, wiring, upholstery, and a lot of odds and ends.

Tips: Use corrugated cardboard on the work table when working on aluminum sheets. The chips fall into the "valleys" and do not scratch the material. Use a layer of masking tape on flush rivet set when riveting dimpled rivet holes. This sets the thin outer edge of rivet down tight. Do not use on countersunk holes in 0.025 sheet. I really look forward to your Newsletters. You have been doing a lot of hard work building a T-18 and getting out the Newsletters.

FLIGHT REPORT: by Luther D. Sunderland. My trip to Seattle has been made complete with a stopover in Chicago and a little side trip to Moline, IL where Irvin Faur met me. We talked T-18 until 1:30 AM, which was rather late for Irvin who got up at 5:00 and emptied his fishing nets. He is a commercial fisherman on the Mississippi River. He just catches fish and his wife cleans, smokes, and sells them in a little roadside store. Too bad this is not a sporting magazine, for his story would make colorful reading.

After a tasty 7:00 AM breakfast of bacon and eggs we headed out to the airport to see his six-month wonder. Irvin was quite apologetic about his "hurry-up" workmanship, so I was prepared for the worst. But when he rolled back the hangar doors they uncovered a nice looking bird. Except for several little chipped spots in the paint and yet-unfinished upholstery, he had nothing to apologize for. Despite the subfreezing conditions for painting, the finish was not bad. The cowling fit nicely and I liked his method of installing the piano hinges. A 90-degree 3/4-inch flange was bent down on the door and on the fixed top skin. The hinge was riveted to these flanges with no rivets showing. This served the dual purpose of stiffening the hinge line and allowed the amount of exposed hinge to be adjusted as desired.

Since he had no way of getting his canopy frame heli-arced, he solved the problem by making joints and bearing attachments from 4130 and then slipping the aluminum tubing over these and Pop riveting. The rear bearing support cross tube was 5/8-inch 4130. There is more than one way to skin a cat and to avoid welding aluminum. The cockpit did not give my 6'2" frame much extra room but, with a very thin seat back and my hip pocket about two inches below the top of the standard square tunnel, I just cleared the canopy comfortably. If you are about 6' or over and have broad shoulders, I strongly recommend at least rounding off the tunnel and preferably lowering it an inch or more at the back, like I did. The side of the airplane pushes your shoulder one way and the tunnel pushes the other way and it is all most uncomfortable. His ship handled very nicely and had lots of zip. It climbed at 2,000 fpm up to about 4,000 feet. It was really quiet, and I was most impressed by the lack of any wind whistle around the windshield canopy seal. The reason was that he did not use a rubber seal. Instead, he just let the canopy underlap the 0.040 flange on the windshield. When the suction raised the canopy against the aluminum strip it made a good seal. Was interested to see how the two-degree dihedral worked out. There was no noticeable difference in riding qualities but it was impossible to pick up a wing with the rudder. When left rudder alone was used to pick up the right wing, the ship would have a rather severe tuck of the right wing, giving a negative dihedral effect. My recommendation would be to leave the dihedral as is in the plans. I discovered how Irvin built his airplane in less than six months. He just plain worked hard at it like he does everything. For example, he learned to fly and he got his private license in less than one month.

NEWS FROM JOHN THORP: I am sure sorry that Rassler lost his T-18, but am most thankful that he is able to rebuild it. We are going to lose more on first flights with inexperienced non-current pilots if we do not do something to reverse the trend. I am interested in your comments on Irvin Faur's T-18. I am not surprised that you cannot pick up a two-degree dihedral wing with the rudder. A T-18 out here is being built with four-degree dihedral. This might be OK, but I would not try less than 6 degrees. I had a letter from Bill Johnson about his wing-fuselage juncture. I doubt that he has reduced the drag any. We now have a Scooter-type stall warning spoiler on Dick Hanson's T-18 which provides adequate stall buffet warning. It is in the opposite direction to Bill Johnson's mod, and does not hurt performance. With flaps down, Dick's T-18 will fly at 60 mph indicated power on. I have just finished a stroker (1/4 inch) 308 GPU engine. It is necessary to use the O-340 rods as well as crank to get clearance. Also, it is necessary to machine 1/16 inch off the backside of the pistons to clear rods. This engine should put out 160 hp at 3000 rpm. We need a surplus source of O-340 rods and cranks.

I am furnishing flap control system details to all who need them (27) to date. Do not have time to make any additional T-18 drawings in the foreseeable future. Piper has been keeping me quite busy. Phillips of All-Aircraft Parts is retailing the T-18 seals and moldings--744, 1188, and 1439. Exhaust stacks should clear the fuselage skin. No exhaust gas should impinge on any airplane surface. The exhaust should come out nearly parallel to the direction of flight.

INFORMATION FROM JOHN THORP: For the prop shaft extension, the attaching hardware will vary with the engine. For the O-290-G you will need 6-AN6H-13A bolts and 6-AN960-616 washers. On the O-290-G it takes 6-AN6H-14A bolts and 6 or 12 AN960-616 washers. On the O-320 engines, many use 7/16-inch prop bolts so the engine side of the extension must be reamed to 7/16 inch and the bolts become AN7H-14A with AN960-716 washers. The prop side attaching hardware are AN-6A-46 bolts of appropriate length for the various hub thicknesses, AN365-624 nuts, AN960-616 washers. In removing the extension from the shaft use 2 3/8-inch bolts as jacks, otherwise both prop shaft and extension may be damaged.

WATCH THAT LINE BOY: Herman Rassler, 98 Constitution, Henderson, Nevada 89015. I do not know just how to start this letter but May 21st I added another chapter to T-18 history. Returning from a trip to Lake Tahoe, I stopped at Bishop to refuel, and the attendant left the oil plug off after checking the oil supply without my notice. I made an emergency landing at Lone Pine, California and overshot on the rather short runway. I applied power to make a go-around and got no response from the throttle. As there was a new ditch across the end of the runway, I tried to save as much speed as possible to jump the ditch. The gear hit the top of the far bank and this started the disintegration of #24. About twenty feet beyond the right wing hit a mound of earth and she started cart-wheeling and tumbling from tip to tip. After the dust settled, my wife and I crawled out of the wreckage with only minor scratches and bruises (for the damage done). The engine, gear, fuel tank, instrument panel, and floor boards were laying inverted about twenty feet beyond the mound and the tail cone with the wing attached by one rear spar bolt was another twenty feet away inverted and reversed. The roll bar with one attached channel still on it and the canopy were between the main parts. Both the shoulder belts and the high back on the tail cone share the credit for the minor injuries in this case. None of the panels survived with no damage but most of the tail cone and one horizontal tail panel are repairable. On any other bird it would be declared a total loss but to a homebuilder I can see plenty of fittings which can be salvaged by carefully removing rivets. The engine appears OK except for the crank and the engine mounts. Not a fin broke. That marvelous prop is just scratched and repairable. John Thorp called the next day to find out what happened and made the generous offer of any tooling I need to get her flying again and Lee Hamlyn has offered me another set of glass to help. Sure makes me proud to associate with people like that although I always have been one to go it alone. This time I think I will accept all the help I can get. Even the wife says she will help more this time. I do not think she ever really comprehended what I was building until it was nearly done. A few trips over areas where we had spent days driving convinced her we really had something that would go for us. Hope this has not spoiled your day, but be assured she will be rebuilt better than before.

#272 FLIES: William R. Johnson, 23321 106th Avenue, SE, Kent, Washington 98031. T-18 Serial #272, first flown April 29, 1967, has two modifications which make the Tiger act like a pussycat as far as ground handling and stalls are concerned. These modifications are swept forward wing root and a 4 1/2-inch landing gear extension. Although the wing root was modified to reduce parasitic drag, a major improvement in stall characteristics was also realized. Various conditions of power and flaps straight ahead and power off in turns have been tried. In each case a positive buffet occurs before stall followed by a pitchdown straight ahead as the stall is entered. Recovery is initiated by releasing back pressure. Altitude loss is about 50 feet. No tendency to roll was noticed. One pilot inadvertently stalled the ship about 10 feet off the runway, it just mushed in like an Ercoupe and bounced less than a foot. The landing gear change was necessitated by the desire to use a 72-inch constant speed propeller. This is nine inches more than the plans call for so after a stress check to assure it would work, the gear was built 4 1/2 inches longer than plans. The extension increases the tread by three inches and moves the contact point back about two inches (deflected). Ground handling is much like a Cessna 140. Both takeoff run and landing roll are reduced by the increased pitch attitude. The ship also lands nicely on the sod with 500-5 wheels. A disadvantage is the increased tendency to nose over at low speed when the brakes are applied. The forward cg limit must be moved back to STA 63 to allow a little safety for runup and taxi purposes; actually with the wing mod the plane flies well with the cg as far forward as STA 61. Some performance data was obtained at almost standard day conditions (OAT 17 degrees C, Alt. setting 29.96). With an actual weight of

1520 pounds the best rate of climb was 2,200 fpm at 100 mph. At altitude the TAS was 172 with power at 2,500 rpm. At an actual weight of 1300 pounds slow flight at 60 mph is possible with power and flaps. The wing modification was done by extending the root nose rib in the ratio of 2.75/2, and retaining the same leading edge radius. The new skin goes out to the second nose rib and back to the main spar caps picking up existing rivet locations. The control sticks have to be removed in order to remove and install the wing. Making the fillets in the form of removable fiberglas gloves would be an improvement if the ease of removing the wing is desired.

The minimum bend radii for our metals are listed in the following table. For handformed parts it should be slightly more. See Figure 6 for a flange bending diagram.

Minimum Bend Radii for Aluminum and 4130 Steel

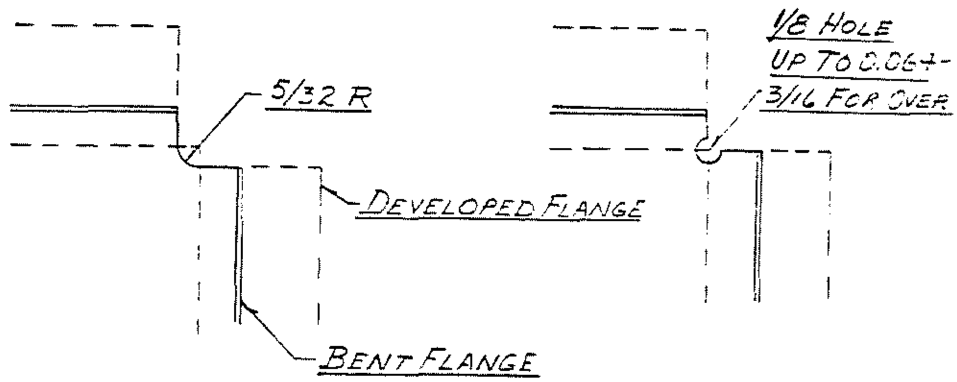
Thick	2024-0	2024-3	6061-T4	6061-T6	7075-0	7075-T6	4130 steel
.016	1/32	1/16			1/16	1/8	
.020	1/32	1/16			1/16	1/8	1/16
.025	1/16	1/16	1/32	1/16	1/16	1/8	1/16
.032	1/16	3/32	1/32	1/16	1/16	1/8	3/32
.040	1/16	3/32	1/16	3/32	1/16	3/16	1/8
.051	1/16	1/8	1/16	3/32	3/32	1/4	1/8
.064	3/32	5/32	3/32	1/8	3/32	5/16	1/8
.090	1/8	9/32	3/16	7/32	1/4	1/2	3/16
.125	3/16	7/16	1/4	9/32	11/12	3/4	1/4
.188	11/32	27/32	3/8	15/32	9/16	1 1/8	3/8
.250	15/32	1 1/4	1/2	5/8	3/4	1 1/2	1/2

TIDBITS: Jack Park reportedly flies upside down as much as the other way. John reports that Ron Lee's canopy stays closed even without the latch. Jack mounted rear of tail spring on rubber pad, and he rubber bushed bolt holes. It works nicely. John recommends also trimming the solid aluminum tail spring down about 1/8 inch each side and double tapering it. (We found that you must have a canopy latch.)

Just finished forming my canopy and am quite happy with it. It is the first one built to the lofting drawings and fits well. I will give all the details later.

FLY-IN: Just returned from the Paris Air Show and I can assure you that it is quite tame compared to your EAA International Fly-In.

Paul would like very much to see the EAA T-18 completed. What he needs is for someone to volunteer to take over the project for it could take 10 years if only worked on at the Fly-In. If you get a ride in a T-18, the owner will not want



TWO TYPES OF CORNERS

Figure 6

to take any money but a little donation for gas would certainly be in order. See you at the Fly-In! Let us have a T-18 Forum Friday. Check at T-18 tent. (1986 Note: The major airframe assemblies of the T-18 were built at various EAA Fly-Ins but no one finished the project, so EAA recently sold it.)

FIRST FLIGHTS: Lee Hamlyn is very concerned about the near crackups on first flights. He is writing an article for next issue. In the meantime, before that first flight or even taxi tests:

1. DO get practice wheel landings at 70 mph in something like a Swift or Luscombe.
2. DO check your airspeed indicator on another airplane or even an auto. Two have been off about 50 mph, nearly causing a catastrophe--and there were no static problems either.
3. DO fly around for an hour and practice stalls before first landing--especially if first takeoff is unintentional and even if illegal.
4. DO use some power on first landing.
5. DO check accurately your control stops for proper surface travel. Failure to observe each of the above has already nearly caused crashes on first flights.

T-18 FLY-IN: John wishes to thank the 175 T-18 builders who donated toward the plaque presented to him at the T-18 Chino Fly-In, June 25, 1967, which was organized by Ron Lee. The weather did not cooperate, but there were five T-18s there. John was very pleasantly surprised. When I visited him the next evening he and Kay were sitting in the living room reading over the names on the plaque.

Do not use the O-290-G baffle between the cylinders. The hold-down clip puts pressure on cylinder walls and causes noticeable wear. Copy a Lycoming 140 hp engine baffle, Part No. 72150.

T-18 NEWSLETTER #23 08-67

Luther D. Sunderland

ENGINE MOUNTS: What is a Dynafocaal mount? You have probably heard this term and wondered what it meant. A Dynafocal mount can be identified by the orientation of each rubber mount. Instead of laying in one plane as they do in the original T-18 mount, they are oriented such that the centerlines of all mounts aim through a common point. If this focal point is at the cg of the suspended mass, then the engine will rotate about this point during vibratory disturbances without translating. That is, it can rotate in any direction without shaking. Thus there is less resulting reaction on the airframe. It perhaps can be compared to a well-balanced car tire versus an out of balance one. Just how much better is the Dynafocal? The original T-18 mount is already very good with the Lord mounts which have quite a bit of rubber cushion compared to the old cone-shaped mounts. The best way to find out how good a Dynafocal mount is would be to see for yourself. The T-18s are now flying with the old and new mounts so I would appreciate hearing from anyone who has closely evaluated both. John designed a Dynafocal mount and can have an engine mount made to this design for $200.

FORMING AN INSTRUMENT PANEL OVERLAY: You have no doubt eyed with envy the fancy control panels on some homebuilts and factory jobs wishing you could turn out one half as nice looking. It really is not difficult if you know how. An overlay for your panel serves two functions, it provides a reflective surface for helping light the instruments and it also helps the appearance. The penalty is about a pound of extra weight. Now I am not one to go in for a lot of extra weight like electric motors to do things the pilot can do with a flick of the wrist but then we all have our weaknesses. There are two materials which you can readily use, namely, aluminum or Royalite. It is more difficult to obtain a source for Royalite. I obtained mine from a local plastics shop. The built-in textured Royalite is probably more durable than aluminum with a painted finish and looks just as nice.

The aluminum overlay is made by first cutting out holes in a piece of 0.025 or 0.032-thick 6061 sheet which match the instruments in the panel. The holes are then flared with a wooden plug form which must be turned out on a lathe. Just insert and strike with a mallet. A different size form is needed for each size instrument face. The finished overlay is then painted with crackle-finish black paint available in spray cans at most electrical supply houses. If you can locate the material, I highly recommend a Royalite overlay. Use a piece of Royalite 18" x 40" x 0.040 to 0.060 thick. Piper uses this material for their panels. Obtain two pieces of 1/4-inch thick hardboard or plywood. Clamp these two pieces together with Royalite between them and drill two 1/4-inch locating holes along the ends outside the outline of the panel. Place the instrument panel over the two pieces of hardboard and drill #30 holes through both of them at the center of each instrument. One piece will be used as the male mold and one as the female mold. Use a fly-cutter in a drill press to cut out of scrap 1/4-inch hardboard one disc for each different size opening in the overlay. The opening should be about the same diameter as the instrument glass. These discs will later be screwed to the male mold one at a time. Cut holes in the female mold which are 5/8 inch in diameter larger than the instrument cutouts. Screw one disc to the male mold. Place Royalite between the two halves of the mold and secure with 1/4-inch bolts through the locating holes.

Forming is accomplished with heat. Cover adjacent holes with scrap aluminum and heat the Royalite through the hole in the female mold with a heat lamp. When pliable, remove heat and press down on mold until Royalite hardens A more symmetrical shape will be obtained if a flat piece of wood is pressed down on the Royalite where the instrument cutout will be located. Cut out the center with a fly-cutter and presto! you have a nice 45-degree flanged hole. Repeat for each hole. Caution should be exercised to insure even heating of the Royalite or the flange will be uneven. Also, do not make an upside down overlay by mistake.

To bend the flange along the bottom, clamp Royalite to the edge of a table with clamps and a 1" x 2" piece of wood. Let the portion to be bent extend over the edge of the table. Clamp two more 1" x 2" pieces on both sides of the Royalite flange allowing about one inch exposed for the bend. Heat first. The overlay is mounted to the panel with screws and spacer. The upper edge of the overlay can be hidden behind padded upholstery covering an eyebrow sunshade over the panel.

TRIM INDICATOR: John says there is absolutely no need for a trim indicator on the T-18 since the stick force needed to overcome full trim is very light. It is safe to take off with trim in any position. He convinced the FAA to license the Sky Scooter without an indicator. As a matter of interest, one of the Blue Angels told me they fly all their performances with full nose down trim cranked in. If anything happens this causes them to dive away from formation. This means they must constantly fight a 60-pound force. The T-18 trim force is about 10 times less than this.

FIREWALL FITTINGS: It is good practice to use a regular AN-type bulkhead fitting where the fuel line passes through the firewall. We have all seen the various other cables, wires, and hoses crammed through one big grommet with lots of sealing putty piled on to keep out carbon monoxide. A very convenient firewall fitting can be made with a 1 1/2 x 3 1/2 x 0.2-inch piece of neoprene. Holes can be cut in it to pass the various cables. It is clamped over a slot cut in the firewall with two screws and an aluminum or stainless back-up plate. For convenience use plate nuts or Pop rivet nuts in the firewall. A 0.1-inch flange can be bent down on four sides of the plate for stiffness. If you have not discovered it yet, you need about 200 Number 3 Pop rivet nuts. You will need a Pop riveter that takes the next bigger size stems than 1/8-inch rivets have.

PANEL LAYOUT: Having just installed the various push-pull controls on my panel, I thought I would pass on a few tips. While building a plane, especially the first one, you usually could not care less about maintainability. "Just get her in the air" is your motto. But with very little extra thought you can make it easy to repair. For example, run everything over or around the fuel tank so the tank can be removed easily. If you do not like the throttle up high like shown on the plans, it can be mounted below the panel on a slotted angle bracket which allows it to be dropped for tank removal. Also, hook up everything on the panel so the panel can be removed without disconnecting anything in the engine compartment. I mounted my push-pull controls in slots cut along the top edge of the panel. My panel is mounted on the pilot's side of the extra bulkhead which is located 3 1/2 inches aft of the dash frame at WL 42. To remove the panel, just loosen the nuts on the controls and slip the panel out.

Make liberal use of plate nuts and Pop rivet nuts for anything that might need to be replaced such as starter solenoid mounting, etc. Push-pull control knobs must be tapped so they can be unscrewed to permit removal of the panel overlay.

BATTERY BOXES: Don Carter has designed a very fine fiberglas battery box. To make it, first lay a thin layer of glass mat on a sheet of aluminum or mylar and saturate (using a roller) with acid-resistant resin. After hard, cut out the various parts for the battery box according to the enclosed sketch. Sand a strip 1/4-inch wide on the smooth side of the parts along all edges. This makes the resin stick well. Then assemble the entire box using a good sticky tape like the cloth duct tape now available nearly everywhere. Face the smooth side of the parts inward with the tape on the outside. Mix up about 1/4 cup of acid-resistant resin with plenty of cabosil filler to make a paste to use as a cement. Just plain resin can be used, but it is difficult to get it to keep from running away. It can be thickened into a paste by adding a white fluffy filler and some cobalt, both available at a fiberglas shop. Apply a little fillet of the resin cement along all inside seams. Just wipe the seam with your finger to remove excess resin. As soon as this hardens, remove tape and you have a one-layer thick battery box. See Figure 7 for battery box layout.

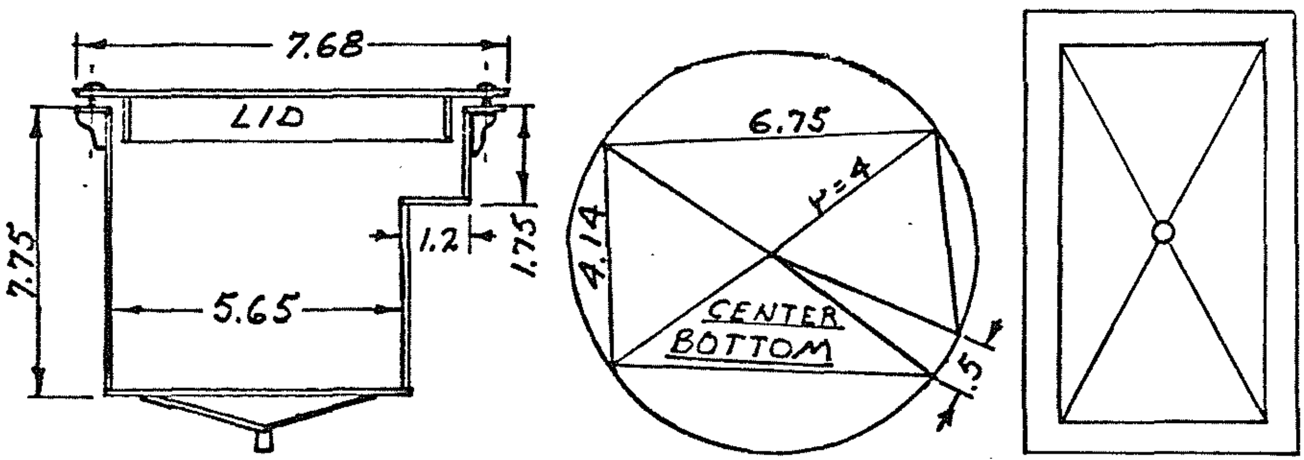
Cement four plate nuts under the lip for securing lid. Apply one or two layers of mate on the outside depending on the weight of the mat. Do not make it too heavy. Attachment brackets can be cemented on and covered with mat for reinforcement. A round drain tube can be made over a collapsible cardboard form and attached with cement. Now you have a box which will never corrode or leak. It is very easy to make. Extend the drain tube four or five inches out the bottom fuselage skin. I did not and when my battery box sprang a leak, it badly corroded the bottom skin before I discovered the problem.

FORMING A BUBBLE CANOPY: by Luther D. Sunderland. There has been a number of articles written on the subject of forming free-blown bubble canopies but there has been very little published on forming complex curved plexiglass canopies with shapes which do not permit fabrication by free blowing. It should be made clear that a free-blown canopy is superior from the standpoint of simplicity of tooling and optical clarity. However, there are few existing homebuilt designs which can use free-blown canopies without modification of the airframe. Schweizer was so concerned about canopy fabrication that for the three-place 2-32 sailplane they first designed a free-blown canopy and then designed the fuselage around it. If you want to know whether you can use a free-blown canopy, just cement toy balloon rubber to a model of your cockpit and inflate. The biggest problem will be bulges where you want flat spots.

Bill Johnson and Glen Moore have made free-blown canopies for the T-18 by blowing (or sucking) the bubble against a single degree curved surface located along the top of the form. This gives you considerable mark-off if you blow the bubble hard enough to give a smooth juncture at the windshield. The canopy Glen had at the 1967 Fly-In had no distortion but did not quite make a smooth transition with the windshield. It also cut the corners a little by the occupants' heads. But Glen will tell you that this type of canopy is not the easiest to make, for he tried for a long time before achieving success. He has a large oven and vacuum forming equipment.

There are several other techniques for forming plexiglass canopies which permit the formation of any desired contour. These are: 1. Hand stretching over a male mold; 2. Machine stretching over a male mold; 3. Snap back over male mold; 4. Pressure forming into a female mold. Of these, hand stretching is by far the easiest for the beginner so it will be described in the greatest detail.

In machine stretching, the sheet of plexiglass is clamped in



BATTERY BOX

Figure 7

a fixture around the perimeter and forced down over a male mold with a press. To facilitate clamping, the sheet may be clamped cold and the oven placed over the fixture and mold. The snap-back technique involves sucking a bubble, placing a mold under it, then letting the bubble come back against the mold. It gives the least mark-off of any except the free-blown technique because it applies the least force against the mold.

It is possible to vacuum or blow into a female mold but the biggest problem is attaching a padding material to the surface of the mold. Instead of padding, a special grease is coated on the bare mold. The mold must be very smooth and it must be heated.

Now for us average do-it-yourselfers, the hand stretching method is the simplest. All it takes is a mold, which anyone can make, an oven, and about five sets of hands.

The mold is made with plaster and fiberglas over a wooden framework. First cut out a 3/8-inch plywood base which is the size of the bottom face of the canopy less 1/4 inch on each edge. Now secure a two-inch wide strip of 1/4-inch plywood to the left and right sides allowing it to extend below the base 1 5/8 inches for a clamping flange. Now attach the base to a 2 x 4 frame so that it does not come closer than two inches to the inside edge of the base. This allows room for clamps on the plexiglass. For convenience, attach 2' legs to the frame and brace well.

Make a plywood bulkhead which is the exact size and shape as the side view of the canopy. From 3/8-inch plywood make three-inch deep ribs according to the canopy lofting drawings. Notch the bulkhead to receive these ribs and assemble with tacks and glue to the base. Firmly glue and screw a 1" x 1" strip to the last rib's aft edge for clamping the plexiglass before stretching.

Before applying the plaster, tack a heavy screen or wire mesh between all ribs and about 1 1/2 inches below the surface. The plaster is applied to this so start stirring mud. A final coat of finishing plaster is required to obtain a smooth surface. You will find it very difficult to get a smooth enough surface on the plaster. Also, it will crack before long so for best results apply two layers of fiberglass cloth and resin. Follow this with one coat of white Gelcoat and two coats of colored Gelcoat, preferably black. Sand between all coats. Wet sand for the final finish. The wet black surface readily shows up any waviness. If the surface does not feel wavy when you rub your hand over it, then you have arrived.

The mold is covered with soft outing flannel available at any fabric shop. It has a hard finish on one side and soft on the other. Stretch this over the mold fuzzy side out, wrap around and tack to the inside edge of the two-inch flange. The flannel does not come in wide enough rolls to make a one piece cover so it is necessary to make a seam down the centerline. Accurately locate this seam so it can be used as a reference for trimming.

A clamp is made from a 2 x 6 to hold the plexiglass along the mold centerline during forming. The canopy is made in two pieces to minimize the amount of stretching required and thus, the mark-off. The 2 x 6 is trimmed along one edge to conform to the canopy at the centerline. The first 10 inches at the front should not conform to the centerline contour. It must be given 1/2-inch clearance. During the stretching operation excess plexiglass material must be pulled through this opening by hand. Install 3/4-inch long round-head screws along the centerline of the curved edge of the 2 x 6 at about a 1 1/2-inch spacing. These act as teeth in the clamp to hold the plexiglass. These screws can be adjusted to give a perfect fit with the mold. The 2 x 6 should be hinged at the back to facilitate alignment during clamping. The two or three seconds saved by this hinge makes the difference between success and failure. For this hinge, use a bolt in an oversized hole to allow for vertical movement during clamping. An upright post is constructed at the rear of the mold to support the 2 x 6. The 2 x 6 should be about 1 foot longer than the mold. The centerline of the 2 x 6 should be adjustable at the hinge. It should be 1 inch to the left of center when forming the right half and vice versa. Thus, the screw heads do not deform the plexiglass at the centerline.

The plexiglass halves can both be cut from one 52" x 80" sheet. Allow three inches excess in width. Clamp with broadbill vise grip at the front edge and suspend in the oven. The material will try to curl around and touch itself in the oven, making a severe blemish, so clamp a stick along the front edge to prevent this. Make sure the clamps can be removed in one second. Heat the oven to 375 degrees F and let soak for several minutes. If the glass is heated to higher temperatures, it will be weakened.

You will need at least five persons to pull a T-18 canopy. Each should be wearing new cotton gloves turned inside out. You will need two large C clamps for clamping the front and back ends of the 2 x 6 and one small C clamp for clamping the outer aft edge of the glass to the 1" x 1" strip. You also need six broad-billed vise grips and five heavy spring clamps.

When the plexiglass comes out of the oven it is nearly as pliable as freshly rolled pie crust, but it does not stay that way for long. You have about 30 seconds to stretch it and get out all the wrinkles. Place it on the mold with at least two inches extending past the centerline. Adjust the position so that the outer edge does not extend too far below the mold to allow the spring clamps to be used for holding down the edge. Quickly clamp the glass at the aft outer corner with a C clamp to the 1" x 1" strip. Clamp the aft end of the 2 x 6 to the 1 x 1 strip, with a large clamp. Man #1 and #2 should install these two clamps. Man #3 should pull forward on the glass along the centerline while Man #4 clamps the front of the 2 x 6 to the front of the mold. Man #5 is pulling forward at the lower front corner while #1 and #2 start at the rear and clamp down the outer edge with spring clamps. By this time it will be cold so you will have to put it back in the oven and start over. After six trys, I got a good right half canopy. The left half canopy came out good on the first try.

The formed halves are placed back on the form one at a time and scribed for trimming. Now comes the delicate business of sawing and drilling plexiglass. The best way to cut it is on a table saw using a fairly fine tooth blade. But curved surfaces and shapes cannot readily be cut on a table saw. A band saw works well, especially if it can be slowed down. A high cutting speed causes the chips to melt and weld the glass together behind the blade. This can really cause trouble, especially if your blade freezes when the saw is stopped. If this happens when you are trimming your canopy, send someone for the tin snips because a new canopy is more expensive than a new blade.

Everyone will need to use a saber saw at some time on the plexiglass, at least when cutting out the material from the sheet stock. This is the trickiest part of the whole deal. No matter how careful you think you are, you will undoubtedly get some cracks. When cutting the blank from the sheet, leave the paper on but keep pealing it away from behind the saw to check for cracks. A crack here is not so expensive since you will be cutting the blank oversize. But on the finished canopy, there is no room for error. So, use the slowest running sabeersaw you can find. Borrow a variable speed type if you do not have one. Use a fairly fine tooth blade and go <u>easy</u>!

The halves are joined with regular plexiglass cement available from any plastics shop. This is a thick syrupy cement. Do not try acetone, etc. which just softens the plexiglass. Start by taping the two halves with a strip of tape down the center on the inside. (Use clear scotch tape to get a good seal.) If you leave a 1/16-inch gap between the halves, the cement will fill in better. To keep the cement from running away from the joint area, build up a trough as wide and as deep as the reinforcing tape using two rows of Scotch tape, each several layers high. Reinforcing tape approximately 1-inch wide will be cemented to both the inside and outside of the joint. Fiberglas tape is best if you can locate it, otherwise, dacron is alright. Now mix up some cement and apply to the joint. It is extremely difficult to get out all the air bubbles. Some people have extracted them with a hypodermic needle. If you get out all the bubbles, this joint is as strong (even without the tape) as the plexiglass sheet. We made a test sample with two pieces of plexiglass joined with the cement. After the cement hardens, sand off any rough spots and then cement the outside reinforcing tape in place. Cover with a strip of clear mylar or cellophane to help work out the air bubbles. Then remove the Scotch tape from the inside of the seam and repeat the process to apply the inside strip of tape.

When attaching plexiglass, it is necessary to use very large clearance holes for the screws to allow for the tremendous expansion with temperature variations.

Always dull the drill by grinding off the cutting edge. Try a number of samples before attempting the real thing. Above all, never drill plexiglass while any stress is being applied to the sheet because this is almost certain to result in a big crack.

WINDSHIELDS: Some people have bent their T-18 windshields in place without heat forming. The ones I have seen installed this way soon developed crazing. Maybe you will never attempt forming a canopy, but forming a windshield over a simple sheet aluminum form is real easy. Just make two plywood bulkheads the shape of a cross section of the windshield, nail to a frame and wrap sheet aluminum over them. Cover with outing flannel and you have a mold. Heat plexiglass to 340 degrees F, droop over the form and hold down edges until cool. Sounds simple after the canopy--and it really is!

CG LIMITS: Do not get the forward cg ahead of station 61. Most have been aft of STA 62. The limiting consideration is not elevator effectiveness but rather possibility of nosing over on the ground--especially with full tank and no passengers sitting on the ramp with gusts. Aft limit is 31% or STA 70.5. Empty weights vary from 750 to 1050 pounds. Keep that weight down if you want good performance.

1967 ROCKFORD FLY-IN: This year we assembled the center wing of the EAA T-18 during the Fly-In. This completes all of the main structural assemblies. Now someone must take over the job of completing the project. M-R Supply donated a one-piece bubble canopy for the project.

BENDING WING SKINS: John Thorp demonstrated how very simple it is to bend the leading edge contour on the wing skins. This is accomplished on a skin for a wing with flaps by first adding two inches to the rear edge of the bottom skin. The bottom rear spar holes are all duplicated exactly 1.7 inches behind the normal spar holes (for the T-18, not S-18). After the skin has been prepared for assembly in the flat, it is folded over and this extra row of holes is lined up with the row of holes for the top of the rear spar and a cleco is inserted in each hole. This clamps the top and bottom edges of the skin together in precise alignment so that when the skin is squashed down to form the leading edge bend, the bend location is exactly right. Caution should be exercised so that you do not get the wrong holes clecoed together like we did on one skin. This makes awfully expensive scrap. Also, orient the extra row of holes so they match in the folded positions.

Now get a four-foot long 2 x 4 and some newspapers. Lay the folded wing skin on a smooth surface and cover the top with newspapers to protect the skin from scratches. Place the 2 x 4 at the highest point on the skin; press down with your knees. As the skin begins to bend, progressively move the 2 x 4 toward the leading edge always keeping it horizontal. As the bend progresses the 2 x 4 will end up right over the bending edge. One person can bend a skin in just a few minutes. It is surprising how sharp the bend must be in order to fit the nose rib properly. Uncleco the skin and try a rib to determine whether the proper bend has been established. If the bend is not sharp enough the nose rib rivets will pull the skin down and cause unsightly depressions in the skin. Make a plexiglass template of the leading edge of the airfoil and bend the trim to fit.

As a general rule, to bend any skin just cleco two rows of holes together along the trailing edge. This location must be exactly the same distance from the leading edge "radius."

There were five T-18s at the Fly-In belonging to: Kaergaard, Faur, Wood, Zimmerman, and Johnson. Kaergaard had done a really fine job on his canopy installation but still had the open cowling. Faur's attracted quite a lot of attention due to the nice photo on the back of **Sport Aviation** which drew everyone's attention to the six-month building time. Johnson's ship was flown from Seattle by Cecil Hendricks. The extra long gear legs really made the ground ride much smoother and surprisingly did not block off over-the-nose visibility very much. The outer leg tube was tapered and the inner tube was untapered but 4 1/2 inches longer. Otherwise the gear was standard. I could not tell what effect the leading edge fillet had. It started to buffet at about the same speed as the others--perhaps several mph sooner. Otherwise the stall was about the same. I did not have time to make a meaningful comparison.

Ron Zimmerman did give me a most spectacular stall-control demonstration. After I gingerly did a couple of stalls he said: "Now watch this." He held the stick all the way back with the throttle almost closed and the airplane just shook like a scared rabbit while we mushed down for several thousand feet. Ron had perfect control with the ailerons, although he had to work fast to keep the wings level. I began to feel a bit uneasy when we got below 1,000 feet in this peculiar flight condition so suggested we move on. Ron did a very fine job on his T-18. The paint job was eye-catching and his workmanship professional. He used 100% Pop rivets. The fuselage did not have flush rivets and yet it looked exceptionally nice. His Tailwind-type gear legs were quite soft and John Thorp thought they were the best he had seen. They were a little softer than Johnson's, but both were fine. Ron found the cross tube in the canopy frame was too flexible so ran an extra vertical support from it up to the center tube. This cross tube should be made of 7/8 or 1 inch tubing. I beefed mine up with a bent-up aluminum channel Pop riveted to the cross tube along the bottom.

Wood also had Tailwind-type gear legs but he had two problems which kept him from doing any extra flying at Rockford. The bolts holding the legs in the A frame worked loose and the A frame got bent slightly in a hard landing. The A frame had not been heat treated. The bubble made by M-R Supply looked very nice. Was sorry I did not get to fly in his ship.

The T-18s must have made quite a hit this year because there are many new T-18 builders being added to the ranks every week.

T-18 NEWSLETTER #24   04-04-68

Luther D. Sunderland

YIPPEE!!! IT FINALLY FLEW!: by Luther D. Sunderland. On March 25, 1968 I had my final inspection and the FAA inspector could not find a single thing wrong. After the inspection, the inspector said that he liked the T-18 so much he thought he would build one. I spent most of the afternoon closing everything up and installing the gap covers.

Then the big moment came to start taxi tests. The day was warm and cloudless, very unusual for March, and there was not a breath of air moving. I had already spent several evenings doing low speed taxi tests and was beginning to get the feel for this very nimble little ship. I also had had the good fortune of spending about a half hour the previous week flying Bill Johnson's T-18 in Seattle, although I did not handle it on the ground. Bill had given me some good advice about handling the T-18. He said: "Do not try to pick the tail up until it is ready to fly. Use 1/2 flap on the first landing and 3-point it. This keeps the tail on the ground the maximum amount of time and thus gives better control."

But I was not ready to fly yet. I wanted to take it easy and not repeat some of the near catastrophes some of the other T-18ers have had on their first flight. John said that close calls are the rule rather than the exception and recommended a couple of hours in a T-6 or, as second choice, a Swift. Since we have no T-6s around, I got several hours in Paul Schriebmaier's Swift, shooting landings during the previous several weeks. Even with this experience and most of my recent flying done in tailwheel airplanes while towing gliders, I was still a bit apprehensive after hearing about how tricky a high-performance plane like the T-18 was on ground handling. So I taxied out resolved to spend a lot of time doing taxi tests before trying a flight.

One of the first big surprises was the complete lack of torque effect when full power was applied during taxiing. The offset in the engine is just right and makes right rudder on take-off unnecessary. (The 150-hp Swift pulled to the left so much that it was actually necessary to some times drag right brake on takeoff to keep it on the runway.)

On the first run I kept the tail on the ground and the speed below an indicated 50. The steering was very easy and responsive until power was cut, then it was a bit more difficult without the prop wash on the rudder, but still very quick on the response. On the second run I kept the tail down as well as the speed but a bump at the intersection bounced me into the air a few inches. I just held the nose steady and it settled back without any consequence or directional problem. This gave me more confidence, so I picked up the tail at about 50 on my next run but still kept the power way back. I was able to lift it off a few inches at a time and finally fly nearly the length of the runway with the wheels just kissing the pavement occasionally. After this I knew I was ready, but just for good measure I made a few more runs. Then I was ready to go.

Remembering the many first flights which ended up in trouble due to fuel starvation I decided to make one more test. I held the brake and applied full throttle for several minutes without any apparent hesitation. I figured this would be enough to get a fair amount of altitude. So with another mag check and carb heat check I was ready to go.

This time I gave her full power and left it on. In a very short distance I was indicating 50 so I applied a little forward pressure. Then it began to feel light so I lifted it off at just over 60 indicated. I held it down until it had a good solid feel and then let it have its rein; I already knew the airspeed was reading low so I did not trust it. The rate of climb was phenomenal--especially for an old J-3 and Sky Coupe pilot. By the time I got to the end of the runway and crossed the river I had a comfortable bit of space under my wheels. The rate of climb held steady at 1500 fpm. At 4500 I leveled off and started cranking in trim. There was just barely enough roll trim to hold up the left wing.

I was disappointed to find that the maximum rpm in level flight with my 67-68 prop was only 2450 and I could indicate only 140. I knew that one or both had to be off because my calibrated ear said I was going close to Mach 1.

Since the best check on airspeed is a stall, I did stalls both without and with half flaps. Just as I pulled up to do the first stall, I heard a cracking sound coming, I was sure, from the engine. It was only faint at first and I tried to ignore it. But it got worse with each stall and I began to wish I were on the ground. Then I felt a clunk on the side of the fuselage and I knew what was wrong. The little rubber molding along the wing-fuselage juncture had come loose and was slapping against the skin. Whew! What a relief.

Then I tried one more high speed run. Just as I got it really wound up the engine started to run rough. I quickly pulled on carb heat and reduced throttle and everything was fine. I was sure it was carburetor ice, but I decided I would rather be on the ground anyway.

On the approach I was surprised that the tail started to buffet when one notch of flaps was applied. It did not seem to be serious so I left the flaps down. I leveled off a few inches from the runway and held it there to bleed off speed. It touched down in a perfect three-point landing. The roll out kept me busy, but I had no trouble since all the taxiing had me pretty well accustomed to it. When I taxied up to the ramp I was a little weak, but managed to crawl out to let the spectators see the interior. I was relieved to see that the rubber molding had really been making the noise. No use trying to explain the feeling of satisfaction after a successful first flight. You will just have to hurry up and finish your bird and see for yourself.

Some contact cement took care of the molding, and I was pleased to find no buffeting with flaps down during the second flight. The gas tank breather tube stuck down below the fuselage about an inch and was originally cut off straight. I figured this might have caused a suction in the tank (like on a fly sprayer), which made the fuel flow too low, so after talking to John Thorp I cut off the tube at an angle so it would get ram air into it. Since then I have had no problem. Also, I covered the vent with a screen to keep out the mud wasps!

A check with a strobe light showed that my tach was reading 100 rpm low. On a later flight I found the airspeed was 30 mph low. I had checked the instrument before installing it, so I figured it was a plumbing problem. Sure enough, the pitot line was leaking. John told me how to make a simple leak check on the lines. Just slip a rubber hose over the pitot probe and pinch it off until the indicator reads 100 mph. Hold it, and if the indicated speed bleeds off you have a leak. The same check should be made on the static line.

I now have five hours on my ship and all the little bugs have been ironed out. I find it very easy to land three-point with full flaps. My tapered gear is just perfect. It is fine for sod strips also.

STALLS: John says he now has a perfect fix for taming down the stall. He tried a wing leading edge fillet at the fuselage juncture but claimed it did not do much good. Now he has added a spoiler to the leading edge of each wing about midway out the center wing. It is a 4-inch long 1/2 x 1/2 angle attached just above the chord line about at the stagnation point. This stalls the inner wing first and prevents the sudden dropoff on a wing experienced by most T-18s.

PAINTING AND FINISHING: A good paint job begins with the proper preparation of the surface.

In order to get paint to adhere to aluminum it is necessary to roughen up that nice mirror-like surface to give the primer something to cling to. Although zinc chromate provides a mild etching effect to aluminum, it is much safer to use a separate etching treatment. The military specification process is to first apply alodine and then zinc chromate.

The alodine process is quite simple. First you brush on an acid cleaner to get rid of all the oil and grease. After a few minutes you rinse with water and then brush on the alodine. After five more minutes you rinse again with water. The alodine not only etches the surface but also leaves a gold-colored oxide. The alodine alone gives good corrosion resistance.

Now you are ready for the zinc chromate primer. Zinc chromate makes an excellent primer because the chromate ions prevent the cancerous corrosion process from taking place. They fill the hole in the outer ring of electrons in the aluminum atoms, thus stabilizing the metal and preventing its combination with oxygen to form corrosion (aluminum oxide). The important thing to remember when applying the primer is that it should be applied with as thin a coat as possible while still covering the surface completely. You should be able to read the lettering on the aluminum through the primer. The primer needs to be only one atom thick to protect the aluminum. If it is too thick it may chip off since it is quite brittle. A good adhesion test for zinc chromate primer is to try to scrape it off with your fingernail after it has dried for several days. If it comes off, you did something wrong and had better start over. This will happen if the surface had oil or grease on it.

It is possible to obtain zinc chromate at a local paint store but it is unlikely that you will be able to get aircraft quality primer. Look on the label to see if it meets military specification requirements. To be on the safe side, you should order good primer from one of the aircraft supply houses. I once bought some at a Sherwin Williams store and it took overnight for it to dry. The aircraft type dries in a few minutes. You will need a gallon especially if you use it inside and out. Alclad aluminum is fairly corrosion resistant but since it takes little effort to prime the entire inside of the skins, I recommend it. To provide extra insurance that the paint and primer will not peel, some builders rub the entire metal surface lightly with number 400 wet-or-dry paper before doing anything else.

If you used Pop rivets, it will be necessary to first fill the holes in the rivet stems. The FAA in this district does not object to the use of Pop rivets, but they do require that they be properly sealed. If this is not done, water entering the holes soon rusts the steel mandrel and before long even the monel rivets begin to corrode. To seal the rivets, first put a drop of zinc chromate down each rivet to help make it corrosion and rust proof. The holes are then filled with a two-part epoxy auto body putty available at any auto supply store.

If you used flush Pop rivets you might want to cover the rivet heads and a small adjacent area with the putty. Use a piece of hard rubber for applying the putty. Be sure to spread it thin. With a little practice you can make it smooth enough to require practically no sanding. After it sets up, wet sand with #220 paper and a wooden block. Go over again with the putty until all recesses are filled. Care should be taken not to sand through the primer. After filling is complete, spray two or three coats of auto primer-surfacer over the areas around rivet heads. Use the lacquer type primer or it will take overnight to dry. It costs about $2 per quart and one quart is more than you need. It comes in red or grey. The grey is easiest to cover if you plan on using a light color paint. This primer wet sands nicely and permits you to really get a very smooth surface.

After the surface is washed and dried wipe thoroughly with a clean cloth to remove all dust. Then go over all surfaces with a tack cloth. This is a specially treated cloth, available at a paint store, which is used to remove all specs of dust and lint. Now you are ready to spray on the paint.

There are two enemies you need to guard against while painting--bugs and dust. If you spray out-of-doors, you are sure to get insects in the fresh paint so be certain to keep a pair of tweezers handy to pick them out. Wet down ceilings, walls, and floor of your spray booth to keep down dust. You need good ventilation, but a strong wind blowing in through an open window or door can bring in dirt and dust. Plenty of fluorescent lights are an absolute must in the paint booth so you can observe the surface for coverage.

There are two general types of paint to choose from, enamel or lacquer. Enamel is generally more durable, but it is much more difficult to apply and is nearly impossible to touch up without respraying an entire panel. Lacquer dries very rapidly so is not so likely to get blemishes due to dust. Enamel must be applied in a spray booth with exhaust ventilating fans and filters. Lacquer can be applied almost anywhere. Lacquer has the nice characteristic that permits you to sand and polish out dust specs and runs or make patches without respraying an entire wing or fuselage.

You have a choice of three types of enamel. The regular auto enamel is of good quality and always available in case you need to match it in the future for repairs. Aircraft quality enamel dries faster and is therefore not quite as tricky to apply. Many builders get excellent results with Imron. Good auto acrylic enamels are available which have the same qualities as lacquer. This is what our local body shop recommends and I have used with good results, especially when the hardener and a clear-finish coat are added.

If you have no experience with spray painting, be prepared for some surprises. Unless you are an expert, do not choose a metallic paint. It looks great but is exceedingly difficult to apply. Also, be certain to buy exactly the same type reducer (thinner) as is specified on the paint can. The wrong thinner may cause curdling of the paint. I learned all of the above the hard way--after redoing the aluminum parts on my Sky Coupe several times.

If you get a run in enamel either wash off the entire panel with thinner and start over, or wait about a week and then sand it out right down to the bare metal in the area of the run. Then repaint the whole panel. Do not apply masking tape over fresh paint in less than a week or the enamel may pull off when removing the tape.

Choosing a paint scheme is always a big problem. The paint scheme will either make or break your airplane's appearance. You can have perfect workmanship, but a lousy paint scheme can make the spectators turn up their noses. Here are some good general rules to follow.

1. Solid colors with no trim seldom are appealing.
2. Pin stripes make the scheme no matter what else you do. They are extra work but very eye-catching.
3. Do not clutter up the design with too many strips or it will look confusing.
4. The airplane is viewed most while sitting on the ground in that attitude.
5. Exhaust and oil streaks show up worst on a white fuselage bottom. Why not try a dark color there?
6. Wrinkles in the skin show up less with white paint. Black is the worst.
7. The T-18 fuselage is deepest at the aft edge of the canopy. Do not chose a paint design that accentuates the depth there. Cut it in two horizontally with different colors to make it look long and slender.

When applying masking tape before painting numbers or designs over existing coats, it is very important to rub the edge of the tape down very carefully. But, no matter how hard you rub, paint will still seep back under the tape. This can be prevented on a doped surface by first applying a little clear dope to seal the edges of the tape. With enamel this run-under can be alleviated in two ways. One way is to first spray on a light coat of the base paint to seal the tape. But then you must wait a long time for it to dry. Another way is to mist on a little clear enamel and let it get tacky. Do not make it a heavy enough coat to soak under the tape.

If some paint does seep under the tape, do not despair. I have found a way to fix it with only a little extra work. First you must pull off the tape at just the right time. Wait about one hour but not more than two. The enamel should be dry enough so it will not smear but still is slightly pliable. Extreme caution should be exercised in removing the tape or it will peal off the edges of the new paint. Do not pull straight out or cause the tape to bend through a large angle while removing it. The very best way is to grip the tape firmly and pull it as if you were trying to stretch it, using a back and forth sideways motion and keeping your hand near the surface. This causes the tape to shear loose from the enamel.

Now after the tape is removed, remove any paint that seeped under the tape by scraping with a piece of plastic. Use a piece about 2" x 2" and 0.030-inch thick like a plastic calendar you carry in your wallet. With a little practice you can slide the plastic toward the paint line and scrape off any unwanted enamel. The loose enamel will look like a burr along the new paint border. Do not try to remove it. Several days later, you can rub these burrs off with a wet cloth. The scraping operation will not mark the underneath layer of enamel if a flexible piece of plastic is used. Now you can see why you cannot let the tape on until the next day. The paint would be too dry to remove.

If you get specks of dirt in your enamel, let them dry 30 days before trying to rub them out with rubbing compound. Some people are using the new acrylic paint which can be rubbed out like lacquer.

WING RIBS: It is amazing to see the great amount of trouble people will go to in order to keep from trying to make ribs the simple way. There is nothing on the T-18 that is easier to make; you at least should have the courage to try. If you cannot make all the ribs in a couple of evenings, then you did not read and follow instructions.

BILL JOHNSON: Bill added generous fillets at the wing fuselage junction and at the same time reduced the exit area of the cowling cheeks. He says that these combined modifications increased speed 12 mph at 2200 rpm and 8 mph at 2600 rpm. The fairing started at the leading edge with no radius and built up to a two-inch radius at the main spar. The radius remained constant to the trailing edge and faded away against the fuselage. The fairing was made of fiberglas and secured to the fuselage with 12 Pop rivets. Be sure to seal the flap-fuselage gap.

He has a constant-speed prop with prop extension on a 160 hp engine. If there is enough interest, I can print his drawing of his prop extension. Top speed level flight is 189 mph with no wheel fairings. Cruise at 5000 feet, 2300 rpm, 22.5 inches MP is 168 mph TAS at 8.1 gallons per hour. Maximum climbout corrected to sea level standard day is 2800 fpm. Pullup from 200 mph gives 5,000 fpm for 2000 feet. Sounds exciting! When empty, his airplane needed something like nine pounds force on the tail to keep it from nosing over. He added 15 pounds of lead in the tail. With the 4 1/2 inch longer gear legs the wheels were moved back and the extra weight of the constant speed prop did not help any. Bill is building a new wing and putting retractable gear on his bird.

RIVET HEAT TREATMENT: John Thorp warns that AN rivets should not be returned to the completely soft condition by annealing but rather should be returned to the 17S hardness or else thrown away.

FORWARD TUNNEL: There are two modifications which should be made to the forward tunnel. First, the forward and aft edges should be cut off to facilitate installation. The present design is nearly impossible to install after the fuel tank is installed--especially if you have any upholstery on the firewall and a shutoff valve under the tank. I trimmed mine off horizontally straight forward of the rudder pedal cut out. Also, I moved the aft bottom corner forward about one inch. This missing metal cannot be viewed from the cockpit, so is not noticed.

Second, the trim wheel robs precious space from an already narrow space for your legs. It should be put on the tunnel centerline and a 90-degree gear head used instead of the flex shaft. If I had it to do over, I would also round off the forward tunnel as well as the aft tunnel so your leg does not rest against a sharp corner of the tunnel.

VACUUM REGULATORS: A directional gyro is a "must" instrument for cross country flying and is also an excellent safety instrument in case you accidentally get into a cloud. You cannot get into a graveyard spiral if you use a DG. A turn-bank is a good emergency device since it cannot tumble, but you will rarely use it. If you choose to use only one, install a DG. The best vacuum source is an engine-driven pump, but that is very expensive. An externally mounted 4-inch venturi will slow up a T-18 6 or 7 mph according to John Thorp. I used manifold pressure taken off all four primer ports for driving my DG and turn-bank. The directional gyro and horizontal both require four inches of vacuum while the turn and bank uses two inches. These regulators regulate to four inches and have a bleed through to an orifice to provide a two-inch source also. All gyros can be driven by one regulator.

CANOPY LOCK: Don Carter has installed a key-operated lock in the side of the fuselage just aft of the seat. It drives a plunger which comes up behind the roller. This location is convenient for it allows you to push forward on the rear edge of the canopy while turning the key to close it tightly. See Figure 5 on page 97 for a sketch of a keyed canopy lock.

SPINNERS: The plans specify that the spinner be heat treated to 6061-T4 condition. To minimize warping, heat treat before making the cut-outs. Spinner bulkheads will warp and do not need to be hardened anyway. I insert a metal disk to help prevent the spinner from warping. Do not use cad plated screws, for this will cause embrittlement of the aluminum around the hole, according to my heat treat man.

Here is an easy way to fit your spinner to the propeller.

1. Drill the six holes in the bulkheads for the prop attachment bolts. The most accurate way to do this is to first make a drill fixture.

2. Cut prop clearance holes in spinner. To do this, first make cardboard template to fit your prop. Then attach bulkheads and prop to prop extension. Cut and try until you have a nice fit leaving about 1/8-inch clearance. If you do not leave adequate clearance, the spinner may touch the prop and wear a groove in it. No need to mention the consequences of this. Note that the print has a screw hole directly under the trailing edge of the propeller. This requires a little projection of the spinner at this point. This little projection will cause you a great amount of headaches since it prevents the spinner from sliding straight over the prop. So cut it off. There is no need for it anyway. Just relocate the screw hole.

My front bulkhead would not fit into the spinner quite far enough so I had to persuade it a little. The center of the bulkhead had to be bulged forward about 1/8 inch. I sawed a hole, slightly smaller than the OD of the bulkhead, in a piece of 1/4-inch plywood. I placed the bulkhead over this hole, and with a short piece of 2 x 4 placed across the center of the bulkhead, I hammered on the 2 x 4 until the desired amount of reforming was obtained. It really was not difficult, but it had me worried for awhile.

3. Mark the spinner for the bulkhead attachment screws and drill #30 holes in spinner.

4. Draw a line around the forward bulkhead flange for screw location.

5. Slide spinner over prop and clamp to rear bulkhead flange with C clamps. Prop should be mounted on engine for this step. Erect a stick alongside the spinner so it nearly touches. With plugs out of engine, rotate prop to check for wobble of the spinner. It is important to first track the propeller so both blades pass a reference point within about 1/16 inch.

6. Adjust spinner for tracking and drill #30 holes in aft bulkhead for screws. Install clecos as you go.

7. Recheck tracking and drill screw holes in front bulkhead. Observe the pencil line on the front bulkhead to make sure it

is aligned properly before drilling. With this technique, you can make sure that your spinner will track within a few thousandths of an inch. Obviously, if you have a dial indicator, you can use it.

8. Redrill holes for Number 8 screws, remove bulkheads and install plate nuts.

Lee Hamlyn used flush screws for attaching his spinner but the holes worked oversize and he nearly lost his spinner. Since then he installed a new spinner with non-flush screws and has had no further trouble.

You might want to refer to pages 58-60 to see how Bob Kaergaard fitted his spinner.

SOUNDPROOFING: If you do not do anything else to soundproof your airplane, I strongly recommend that you use aluminum sticky-backed acoustic tape. This stuff is as expensive as pure gold, but it is worth more than gold in sound isolation effectiveness. A layer of it on the firewall makes the firewall sound like a piece of rubber when you tap on it. After you see how effective it is, you will probably use it on all cockpit interior skin surfaces. A diagonal or X on each panel does wonders but, a solid covering of tape is needed at least on the firewall and floor. Any automotive finisher's supply store has it in 3-inch x 20-yard rolls for $9. The 3M factory wants $50 per 6-inch x 60-yard roll.

A Bell engineer told me they had trouble with the large amount of sonic energy in the plane of the fans on the X-22 causing cracks in the structure. They found from one of their German engineers that the soundproofing they spray on VW firewalls is one of the most efficient materials known for this purpose. They tried this and had no more problems. Anyone know where to buy it? Polyurethane foam is light-weight and also does a good job. I am not too impressed with fiberglas. With a one-inch layer of fiberglas cemented on a panel of skin you can rub your hand over the outside of the skin and the sound seems just as loud as on a panel with no insulation. I think the fiberglass needs to be very fine and tightly packed to be effective.

Someone told me that an expert from Cessna told him that much of the noise in light planes comes from air leaking out of the cabin. If you have been in a T-18 whose canopy seal leaked, you will probably agree. John says that a canopy latch is not needed because if everything fits right, the suction on the canopy should hold it forward and seal it. However, I think a latch is necessary. (1986 Note: Ask Peter Beck who lost his canopy when his too-flimsey canopy latches failed.) Ron Zimmerman had no latch on his at Rockford. It had to be held forward while accelerating down the runway and then in flight it would not seal properly.

The S-18 plans have a simple latch that works well.

The canopy needs a better seal along the bottom. Lift on the canopy causes the frame to deflect sufficiently to raise the neoprene seal up off the deck. This can be alleviated by making a wedge-shaped hold-down which engages a fitting on the rear of the canopy frame as the canopy is closed. (See S-18 plans.) I made a different type of canopy seal. I upholstered the rear deck beneath the canopy with a 1/2-inch layer of polyurethane foam covered with plastic upholstery material. At the periphery, where it touched the canopy I left a large bulb about 7/8-inch in diameter in the plastic upholstery. This sucks out against the canopy, making a good seal around the bottom edge.

A 1/2-inch wide 0.025 strip is contact-cemented inside the folded plastic. The upholstery is secured with Pop rivets, up through the deck and this strip. I have not found a good way to seal along the forward rails. Any ideas?

ALUMINUM TYPES: One of the most popular questions among T-18 builders is "Can I substitute Type X for Type Y aluminum called for on the plans?" In most cases the question can be answered by referring to a handbook on the strength of aluminum materials. In general, if the material under consideration is stronger than that specified, it can be substituted safely. In fact, this is about the only substitution rule John Thorp will endorse. Certain parts are designed, however, with stiffness rather than strength being the limiting factor. Since 6061 and 2024 have the same modulus of elasticity (stiffness), John said that it is alright to use 6061 for the engine mount ring, but this is the only case he has permitted such a substitution.

A number of questions arise about the various hardness numbers. The following table will answer most of these questions. Make sure you do not substitute 6061 in such places as main spar caps, horizontal tail spar, or main spar fittings, for this could cause serious problems.

Aluminum Strength Table

TYPE	YIELD (psi)	ULTIMATE (psi)
5052-0	25,000	
2014-T6	55,000	63,000
2024-T3	42,000	64,000
2024-T6	50,000	64,000
6061-T4	16,000	30,000
6061-T6	35,000	42,000
7075-T6	60,000	77,000

The 16,000 versus 35,000 psi yield for 6061-T4 versus T6 explains why it is more difficult to form ribs from T6.

SPRING-STEEL LANDING GEAR DRAWINGS: Ron Zimmerman now has the drawings completed for the landing gear used on his T-18 #117-N18117 as seen at the 1967 Rockford Fly-In. The main gear uses a special shortened A frame into which round tapered spring-steel legs (Tailwind-type) plug in. It is 100% interchangeable with the #515 gear, so the installation hardware and engine mount require no change. The tail gear again uses a round tapered steel spring which extends the wheel more than seven inches farther back. The drawings are now available for $8 postpaid USA for both the main and tail gear from Zimco Plastics, 7714 Colfax Avenue South, Minneapolis, MN 55423. The cost of building this gear will be higher than the #515 gear. If you expect your gross weight to exceed 1450-1475 pounds, larger diameter springs must be used. This would require different mounting hardware and a modification of the engine mount.

RON ZIMMERMAN: 1915 McKinley Street, East, Minneapolis, MN 55418. Last October my T-18 was damaged while I was attempting an unscheduled landing on a road. The cause developed from poor judgement by the pilot followed by an electrical equipment failure. I was demonstrating the gliding characteristics to my passenger. An attempt was made to restart the engine with the starter. It turned through two compression strokes and ceased responding. When I realized the starter was hopeless (later found a poor connection inside the non-aircraft-motorcycle-battery), I dropped the nose to gain speed for an airstart. I was a little shy of enough speed when I ran out of sky.

I lined up with a road below without any traffic. Just before touching down the landing gear caught some unseen power lines. The contact with the wires was very gentle and I did not feel any stall.

The plane hit the ground just off the road with the wings level and about 5 degrees nose down. I estimate the speed at 50 mph. The main gear spring steel legs (Tailwind-type) bent back to where the wheels dented the wing skin and bent one nose rib. The tail came up as the plane bounced once, overturned, and came to a stop. Personal injury was taken care of with one Bandaid--thanks to luck and SHOULDER HARNESSES.

Most of the damage (and expense) was done from stopping bottom side up. The windshield, canopy and frame, fin, rudder were totaled. The fiberglas cowl and wing tips were broken. The wing now has two new rear spars, three nose and one center ribs, all new skin, and a repair on one outer main spar. The damage to the fuselage can be described as "widely scattered minor damage."

I used an aluminum windshield frame and it worked real well, keeping our heads off the ground and in place (thank you Rudy Adler). Its slight bends have been straightened and will be used again.

The spring steel landing gear legs were annealed, straightened, and rehardened. The modified A frame was OK except one spring socket hole was stretched a few thousandths out of round. All main gear parts passed Magnaflux inspection and will be used again. I am very satisfied with this gear.

My T-18 was 95% Pop riveted (Monel). A few AD rivets sheared off but NOT ONE POP RIVET FAILED. Some Pop rivets pulled out but because other parts ripped, broke, or pulled off. I am putting things back together with "Pops."

Wing skins were duplicated by flattening the L.E. radius and removing a few wrinkles from the "old" skins.

This incident proved to me (the hard way) that the T-18 is a very rugged design. The only thing wrong with it is that it is so good that one can become overconfident.

I should have it flying again this summer. Changes include relocated and larger cowl flaps, wing landing lights, and possibly Hoerner-type wing tips (sharp edge).

Here are some suggestions for using Pop rivets. Dip the Pop rivets into zinc chromate primer just before squeezing to reduce the possibility of electrolysis between dissimilar metals. This alone is worth the effort, but there are added benefits. If removal of the rivet is necessary, the chromate tends to keep the rivet from spinning while drilling out. Even more importantly, the wet chromate lubricates the mandrel so the rivet pulls up tighter before the mandrel "pops." Be sure to wipe off any excess chromate on the outside before it dries. The hole diameters should be kept within the rivet manufacturing tolerances (0.128 - 0.132 inch). Pops cannot expand to fill an oversize or untrue hole like a driven solid aluminum rivet can. It has been my experience that dimpling a 1/8-inch hole in 0.025 sheet results in a hole diameter of about 0.140 inch. All holes where I used flush head rivets started out 3/32-inch diameter. They were then dimpled and reamed on assembly to 0.128-inch diameter.

T-18 NEWSLETTER #25 07-11-68

Luther D. Sunderland

THE FIRST 20 HOURS: The longer I fly my T-18, the more I enjoy it. Although the first few hours are filled with much thrill and excitement, the newness and the few little bugs keep you from really feeling that enjoyment you get after you have flown enough to make the airplane seem like a part of you. Now that I have 20 hours on it I can say I am truly having fun. My T-18's performance is very encouraging, although I still do not have it checked out and calibrated. On a round trip to Ithaca, New York, one evening, a total distance of about 60 miles, I averaged a ground speed of 173 mph. Both legs of the trip were made within a half-hour so the wind did not have a chance to change. At 5,000 feet my maximum rpm was 2600, so I held 2400 the whole way, about 75% power. My maximum indicated airspeed was 174 or a true airspeed of 181. My airspeed indicator was accurately calibrated off the airplane and when installed it seems to check closely with the ground speed, although I have not made a close check. We do not have any measured courses around here, so it is not an easy task.

My first few hours were flown without the oil cooler connected. In 70-degree temperatures, the oil temperature got up to 2100 degrees but head temperatures were quite low. Now that I have my Corvair cooler and oil filter connected, the temperature stays about 20 degrees cooler. It still gets up to 210 on a long climb. The cooler is mounted on the baffle above and aft of the left rear cylinder. The oil pressure line comes off the port on top of the oil screen housing, goes to the filter mounted on the firewall, through the cooler and then back into a fitting which is silver soldered to the plate which covers the hole where the fuel pump is normally mounted. All connecting hoses are high-pressure type. The fitting on the oil screen housing was made of brass. to make the bled hole, it was silver soldered shut and then drilled out to 0.065 inch. If cooling is not sufficient, this hole can be enlarged. The only limitation is that pressure be maintained during idle, at least 15 or 20 psi. (The hole was later enlarged.)

I have now landed at three different private sod strips, two of which are mighty rough. My full flaps cut the ground roll nicely and there was no problem.

The use of full flaps makes landings much easier. Due to a river bordering our airport on three sides, there is usually a severe downdraft off the end of each runway. coming in low and flat without flaps, many times you must add power to get through this downdraft and then end up coming over the fence at a pretty good clip, making the flare and ground run rather long. But with full flaps I can come over the river at 500 feet, come down at a steep angle without being affected by the downdraft, land and turnoff at the cross runway about 1000 feet from the downwind end.

As I mentioned before, for the first few landings, I did only three-point landings to get my tail wheel on early for good ground control. I found, however, that these were not complete stall landings. When I got the feel of it a little more so I could hold it off until it started to shudder, the tail would hit first even with full flaps. One sunny day when a nice thermal was coming off the center of the runway, if I would make a perfect three-point landing it would roll awhile in that attitude and then balloon back up a few feet. So under those conditions I found it best to make wheel landings. There is no problem of directional control if you keep on your toes and do not start waving at spectators or enjoying the scenery until it stops rolling. But then what conventional gear airplane does not fall into that category? (Or should we tail draggers call ourselves "unconventional" now that we are probably outnumbered?)

My induction system seemed to be causing a little problem because, at wide open throttle, the highest RPM and the smoothest operation could be achieved when the carburetor heat butterfly valve was in the 1/2-open position. This position almost completely opens both the cool air and hot air ducts to the carburetor inlet. I solved this problem by removing the aircraft type filter and, during flight, using straight-in unfiltered air. On the ground I leave on carb heat, which brings in air through the automotive type filter.

I am quite happy with straight sticks. It is not necessary to bend the sticks unless a center console is used between the panel and the tunnel. For maximum comfort, I strongly recommend against hanging anything under the panel except the throttle. The throttle does fit very nicely under the panel and I think it is much handier there than when located at the top of the panel.

At an early date I got the idea that the rollover bar should be a bit higher for better visibility, so I made the rollover bar 3/4 inches higher than as shown in the plans. I am very happy with my visibility, and the performance does not seem to be too bad. I am not sure how strongly I would recommend it unless you are on the tall side, I can only say I am satisfied with mine.

The left exhaust stack cracked, was repaired with a big patch, and then cracked again. So now I have added a diagonal brace from one of the fuel pump attachment bolts (I do not use a fuel pump) down to the left stack just forward of the point where it exits the cowling. So far, this seems to have done the job (but it later broke off also until I installed ball joints.) My right stack has caused me no problems, apparently because the hose connection from the heat muff and the air box is so short that it helps support it. Make the stacks long enough to clear the bottom skin by nearly an inch to prevent exhaust streaks on the fuselage.

A number of people have ended up with fairly high friction in the horizontal tail pivot bearings. I also have some friction there although it does not bother me any. The reason is apparently not misalignment of the two fittings since the bolts slip in easily. Rather it is a slight binding between the 509 aluminum fittings and the 4130 steel fitting riveted to the frame. If you have not made your bushings yet, I suggest that they be made on the high side of the tolerance in length. Otherwise, just a build-up of paint on the fittings may cause interference. Friction in the tail bearings decreases longitudinal stability. The higher the friction, the more forward the aft cg limit must be moved.

I strongly recommend that you design your cowling attachments so the entire cowling can be removed without removing the prop. After 10 hours of operation I discovered that my alternator belt was a bit loose so I had to remove the prop to get the cowling off. Much to my surprise, the loose belt was caused by a crack in the alternator bracket, which could not be seen without removing the nosepiece. I also found it very necessary to retorque some of the nuts on the engine. After the first five hours of operation it would be wise to remove all cowling for a complete inspection.

The alternator attachment bracket was made of 0.093-inch 4130 and I thought it was rugged enough. Now I have added another reinforcement which is holding up all right. Alternator attachment brackets should be made of 0.125-inch 4130 or heavier. Make sure there is absolutely no flexure possible or the millions of cycles will soon cause a crack.

BILL JOHNSON: I have been in Seattle this week where I talked with Bill Johnson. He just added wheel pants to his T-18 and says it helped his cruise about 4 to 6 mph. He left for California in his ship to attend a couple of fly-ins. Sounds like a great way to spend a vacation.

IRVIN FAUR: The 200 hp fuel-injected engine is now installed and flying in Irvin's T-18. He says he cannot see much difference in speed over the 160, but the rate of climb and fuel consumption have gone up nicely. It will climb at 4000 feet per minute now instead of 2,000. Because the engine installation did not allow room for an exhaust system, he cut four holes in the bottom cowling and stuck short stacks out.

He made one other addition which he likes quite well. To keep out that hot Iowa sun, he painted the top of his canopy. I used to think I would like to cover the canopy with an opaque material for shade until I found how much fun it is looking down at the scenery through the top of my canopy.

PRIMING: Since my carburetor has an accelerator pump, I did not install a primer. This seems to be a wise decision because I have had no trouble starting the engine even in the coldest weather. It sure saved a lot of trouble not having to gather up parts and install the primer. Never pump raw fuel with the accelerator pump without the engine turning, however, for the gasoline can catch fire due to backfiring if it lays in the induction system.

MATERIAL SOURCES: Here is a list of sources for T-18 materials. If you know of other good sources, just let me know.

Canopies (one piece)	Glen Breitsprecher 18415 Second Avenue Seattle, WA 98148
Fiberglas Parts	All-Aircrafts Parts 16673 Roscoe Boulevard Van Nuys, CA 91406
	Aircraft Spruce and Specialty Box 424, Fullerton, CA 92632 (Get catalog, has everything!)
	Ken Knowles' Sport Aircraft Inc. Phil Tucker 104 E. Avenue K-4 Unit G Lancaster, CA 93535 (805)949-2312
	George Rattray Route 3, Afton Road Beloit, WI
Propellers	Sensenich Corporation Lancaster, PA
Cleco Fasteners	Spencer Aircraft 8410 Dallas Avenue Seattle, WA 98108
Ribs and Aluminum Rollover Bars	Ken Knowles' Sport Aircraft Inc.
Aluminum Kits and Extrusions	Ken Knowles' Sport Aircraft Inc.
Hardware, also Rubber Molding	All-Aircraft Parts 16673 Roscoe Boulevard Van Nuys, CA 91406

Hardware	Stits Aircraft Riverside, CA
	Spencer Aircraft 8410 Dallas Avenue Seattle, WA 98108
	B & F Oak Lawn, IL
Wheels & Brakes	Rosenhan 830 East 6400 South Midvale, Utah
Engine Mounts	Melvin Miles 16341 Mahogany Street Fountain Valley, Ca 92708
Prop Extensions	Ron Zimmerman 1915 McKinley Street NE Minneapolis, MN 55418
	Ken Brock 3087 West Ball Road Anaheim, CA 92804

BULLETINS: Two changes are being made. To increase the strength of the tie-in between the side skin and the 601 bulkhead, an 0.032 doubler will wrap around the outside of each corner at the ends of 601. This can and should be done on all T-18s.

Secondly, the horizontal tail main spar is being changed to decrease its thickness near the ends and increase the thickness near the center. Th spar will be made of 2" x 0.049" wall with a 34.84-inch long insert made from 2" x 0.125" wall turned down to fit inside the 0.049 tube. The heavy solid rib in the outer end of the 517 tab will be replaced with a bent-up 0.025 sheet rib. Also, the -2 locator should be riveted to the end of the 0.049 spar. The 506 tip should be made as lightweight as possible--especially if it is made of fiberglas. Use only two layers of cloth. These changes increase the strength of the horizontal tail by 50% and increase its natural frequency by lowering the mass near the tips and stiffening the center portion. Although design calculations show that the original design is strong enough for operation under red line speed, the changes will increase the safety margin. New drawings for these changes will be mailed out within several weeks.

MODIFICATION PROBLEMS: John Thorp's biggest problem is still the person who wants free advice on a do-it-yourself modification to the T-18. You can save yourself some money by not calling him about that subject because he will not approve modifications, period. If you had any idea of all the possible ramifications of the apparently most insignificant modifications, you would think twice before making any. For instance, what amateur designer would think that using fiberglas tail tips instead of metal could raise the moment of inertia and lower the natural frequency affecting flutter susceptibility?

ROLL TRIM: If your airplane needs some additional roll trim, instead of adding a trim tab, first try bending the entire trailing edge of each aileron slightly. Of course you bend them the same direction that a tab would be bent. It really works great.

JACK BRIGHTWELL FLIES #434: You think we have troubles. Jack Brightwell of Australia has his T-18 flying as of April 4, 1968 and has had some interesting experiences with the authorities. They made him use a certified prop which naturally was quite long. Then they required nine inches of prop clearance with one flat tire. After building three sets of gear he finally got into the air. How about a full report, Jack?

COWLING: John's all-metal cowling looks very nice. Believe it or not, only the nose of each cheek requires stretching and welding. Everything else is made of simple bend. Lee Hamlyn already made a copy of the nose pieces so he can furnish fiberglas copies of them. The cowling has one very important feature, it is designed to be taken off in sections without removing the prop. this is an absolute must. He plans to use no screws, only camlocks, etc. Drawings will eventually be made for the cowling.

HORIZONTAL TAIL: Several people have made mistakes in positioning the 510 fitting on the horizontal tail spar. Check it carefully. If you goof, do not drill a new set of holes.

COOLING: There are two sizes of Corvair oil coolers. One has about twice the cooling capacity of the other. The most common one is the small one. Use the big one for best results. I opened the bleed hole up to 0.090 inches but the oil temperature still got up to 210 degrees F in 90-degree outside air. I am going to try a larger hole to get the temperature under 200 degrees F on a hot day although the red line is 245 degrees F. The limiting item on the size of the bleed hole is not pressure at cruise rpm but rather pressure at idle. For best cooling, place the oil cooler in front of the left front cylinder.

OIL: In warm weather, use SAE 40 weight oil. If chrome rings are used, detergent oil can be used from the start. (The O-290-G ring set has a chrome top ring.) If standard rings are used, it may help to set the rings by using non-detergent oil for 25 hours.

BREAK-IN: John does not believe in a ground run-in for an aircraft engine. The dimensions of parts hardly change over many hours of operation. He simply assembles an engine, runs it enough to make sure it is working OK and then flies it at normal rpm.

SAFETYING: During a recent inspection of a beautiful homebuilt biplane in my capacity as FAA Designee, I came upon a surprising error. All the cotter pins were turned sideways. Upon checking through CAM 18, I found that it did not even tell how to install cotter pins. Since some of you might be in the dark about this, here are some pointers:

1. Use only properly plated cotter pins. Hardware store variety will rust.

2. Use the proper size for the hole.

3. Bend one half up and around the end of the bolt. Cut off so it just comes to the bolt centerline. Bend the other half down and cut off so it just touches the washer.

4. Never reuse cotter pins or safety wire.

Safety wire should be installed where cotter pins cannot be used to prevent threaded parts from unscrewing, such as on prop bolts or studs in the oil pan. The wire should be tightly twisted between bolts and installed so that if the bolt tries to come unscrewed it will put tension on the wire rather than compression. Do not use rough-jawed pliers to twist wire or it may become badly cut up. Either use a special tool or twist it by hand. Do not safety all prop bolts with one continuous length of wire. Use stainless steel wire.

Washers: All nuts must have washers under them. Since bolts come in 1/8-inch incremental lengths, it might be necessary to use two washers--but no more. Standard AN washers are 1/16-inch thick. Also the bolt should be long enough so that no threads bear against the material being joined.

Elastic or metal stop nuts are permitted on any bolt not transmitting a torque load. Make sure that at least one full thread is showing above the nut.

HARDWARE: Only AN hardware is permitted, so do not buy any bolts or nuts from a local hardware. Send to an established aircraft supply house. Good sources are: All-Aircraft, Spencer Aircraft, Stits and B & F. Ads appear for all of these in **Sport Aviation**.

MATERIAL SOURCES: Some time ago I received a letter from someone saying that he did not know where to buy materials and "of course the Newsletters were of no help." I was not aware that we did not have material sources listed in the back Newsletters. There is no charge for ads so if you want anything included, just let me know.

VISIT WITH THORP, 06-27-68: Stall Spoilers. My T-18 had a decided habit of dropping off on the right wing in a stall. There was plenty of warning first with lots of buffeting; however, I decided to try the stall spoilers John suggested. About the only effect they had was to raise the speed that buffeting occurred, but did not cure the wing drop-off. John says that since every T-18 seems to stall differently (it takes only a tiny amount of wing twist to cause one wing to stall first) it is necessary to experiment with the spoilers using tufts of yarn to indicate what is going on. Just masking tape two-inch long pieces of yarn to the wings in spanwise rows six inches apart with six-inch spacing. In normal flight these should all be laying down smoothly, but as the stall occurs they will reverse direction.

They should also be used on the fuselage, especially along the wing-fuselage juncture to determine whether there is a good enough seal. John has found a need for a seal there where the flap butts against the fuselage.

FLIGHT TESTS OVER: On June 21, 1968 I flew into Rochester Airport for my 50-hour inspection with 50:19 on my tach. I had really been putting on the time at a rate of one hour a day and, toward the end, over two hours. My wife says that I used up my whole year's gasoline allowance. They had assigned me a flight test area 1/2 degree x 1 degree in size but it did not quite include Rochester so they sent me a ferry permit to allow me to fly it in for inspection. I did not want to wait for their regular visit to our airport.

Will Tetrault gave the airframe a thorough inspection, the same as before first flight. When he crawled out he said: "This is the nicest airplane I have seen--but don't tell Cessna or Piper I said that." I am sure he was being extra generous since my workmanship is not all that good but it is nice to hear someone say anyway. He changed my restrictions to read "continental limits of the United States, aerobatics and night VFR flight are permitted."

On the subject of flight test time, he said there is no firm rule on flight test hours. He could release the restrictions at 35 if he wanted, but 50 hours is the general rule. It is up to the local inspector, your workmanship, and how well-proven is the design.

On the 105-mile return trip, I averaged 194 mph ground speed at 7500 feet. The ground wind speed was very low but it must have been helping me a bit at altitude.

J. P. FOY FLIES AND CANOPY FLIES OFF: J. P. Foy has come up with a real startling discovery. Listen to his report for a first: Chalk up serial #6 as having made its maiden voyage on June 17, 1968. Was beautiful, partly cloudy day, 74 degrees, and a very light breeze out of the south. I had racked up 4.5 hours of various taxi maneuvers including lots of high speed taxi runs. Ground handling of the T-18 is superior to the light aircraft that I have come in contact with. I have a Lycoming O-290-G with an O-320 oil pan and MA4-SPA carb. I seem to have plenty of power and turn close to 2600 rpm with a 65-65 prop, on takeoff. Have not any more figures to give you as yet on the performance because I was pretty busy just flying. On the third flight of the day, the canopy decided to leave the aircraft. No problem flying the aircraft, even with the cut down deck. You can imagine the open area. The only buffeting that was noticeable was on the final approach using half flaps and nose high attitude. Even then it was no problem. The canopy sails very nicely and did not even scratch the glass when it landed in an open plowed field. Evidently the canopy completely cleared the T-18, since the pitot tube on the vertical stabilizer was not bent. I do not know why the canopy came open but the forward rails are definitely too light. Also, a canopy latch would seem to be a must.

By the way, mine had left wing heaviness also and I plan to put a small tab on the aileron to correct the problem. Will write more when I get some figures!!

CANOPY RAILS: According to John Thorp, the forward canopy rails should be secured to the windshield frame with a tab and a Pop rivet. He said he opened Rudy Adler's canopy the other day in flight and there was no problem. He has the tab installed.

I used 0.050-inch stainless for the rails. I did this because I was afraid the lighter (0.040) rails would get bent by passengers crawling over them. The material was readily available at our junkyard. John says that I lucked out!!

CANOPY LATCH: If you have not installed a canopy latch that applies positive clamping pressure, I strongly recommend that you use one. When I release my latch, the wind noise nearly doubles. Other T-18s I have ridden in that did not have good latches had high wind noise due to the seal problem.

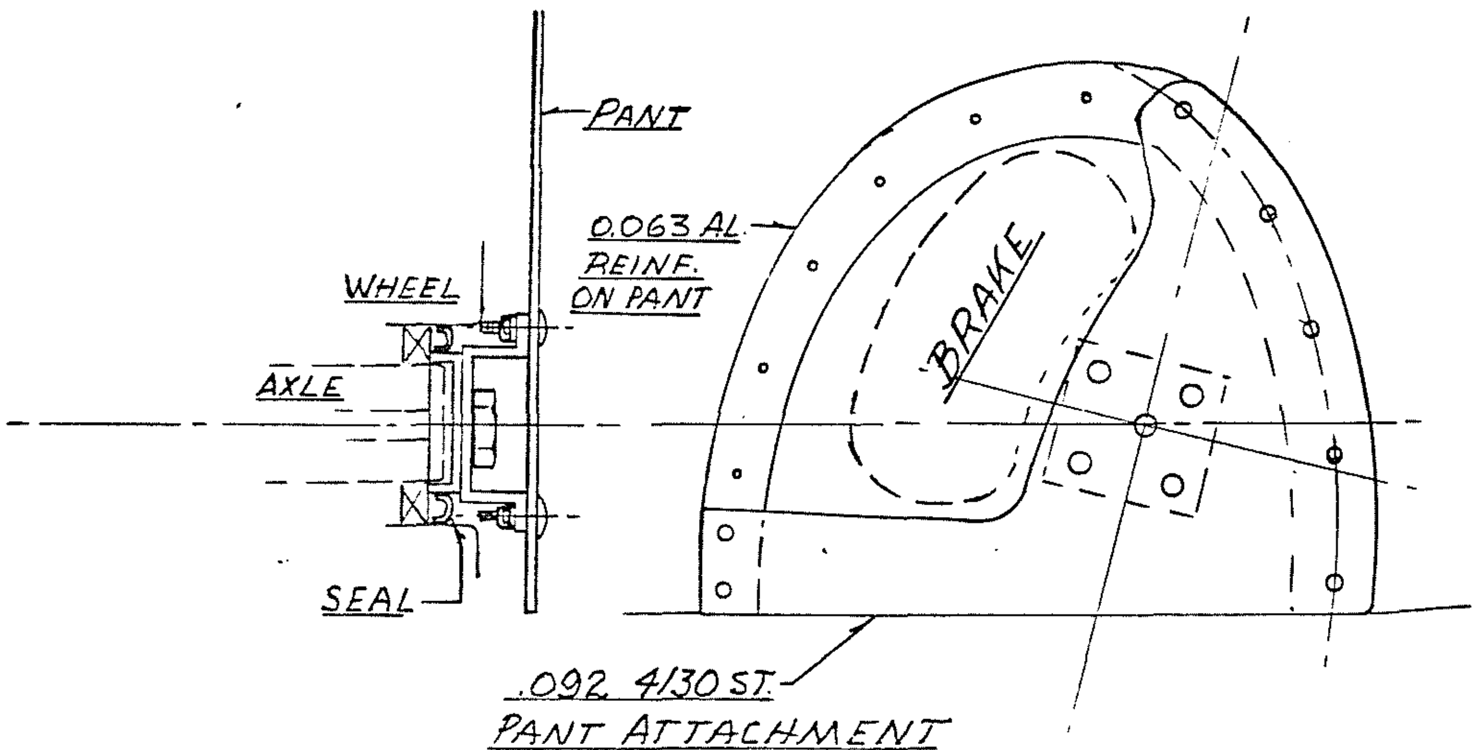
WHEEL PANTS: After much figuring I came up with a means for attaching my wheel pants, which seems to have worked out quite well. Since some people are having trouble keeping them attached, I thought I would pass on my design. First, I made my own pants, which fit quite snugly. This is important if you expect to gain any speed from them. If they significantly increase cross section area, then the drag will not be reduced. That is one reason John designed only a half pant. The other is ease of tire inspection. My pant is seven inches wide. This just clears the tire on the outside and is almost flush with the Cleveland brake unit on the inside. The brake unit protrudes a small amount through a clearance hole in the pant for better cooling of the brake.

To attach the pant to the end of the axle, I made a cup-shaped part with a flange as shown in Figure 8. Four plate nuts were attached to the flange to secure the pant. To obtain a seal, I took the wheel dimensions down to our bearing store and they found one that fit perfectly. A four-inch diameter disc of 0.063-inch aluminum was riveted and bonded to the inside of the pant for reinforcement. On the inside of the wheel I attached the pant with a bracket made of 0.093-inch 4130 steel. It also had nuts attached. It is shown in the accompanying sketch. The pant cut-out has a 1-inch wide 0.063-inch aluminum ring bonded and flush riveted for reinforcement. Make sure the clearance hole in the pant for the tire is not too large. The tighter the fit, the lower the drag.

VISIT TO LANCASTER, CALIFORNIA: Rudy Adler has his T-18 flying now. I went out to see it at Fox Field which sits in the desert just outside of Lancaster and not too far from the dry lake and Edwards AFB. The evening breeze was blowing at about 30 knots as I inspected it on the ramp. They tell me that is a daily occurrence. I was sure I would see the first T-18 fly while tethered, but only my camera case got airborne.

Rudy did a very nice job on his O-290-G powered model. It does not have the cutdown rear deck, but otherwise it is pretty standard. He did not finish off the airplane in its final paint scheme. Instead he just sprayed the bare exterior surface with a light coat of white lacquer. After the flight test period he plans to strip it all off and put on the final finish.

He has installed the automotive air filter about like shown on the new plans. He has put an elevated step on top of the tunnel between the seats. This keeps the shoes off the seats. John recently flew Rudy's T-18 and reports that it handles very nicely with a perfectly straight-ahead stall. With no electrical system or other extras, it is quite light.


PANT
0.063 AL.
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ON PANT
WHEEL
AXLE
SEAL
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.092 4130 ST.
PANT ATTACHMENT
Figure 8

Climb was an indicated 2100 fpm. With his 65 x 65 prop turning at 2800 rpm he maximum indicated speed at 6500 feet was 156 mph. These figures are all uncalibrated. The stall with full flaps was close to 40 so something must have been a little off. John opened the canopy in flight with no problem.

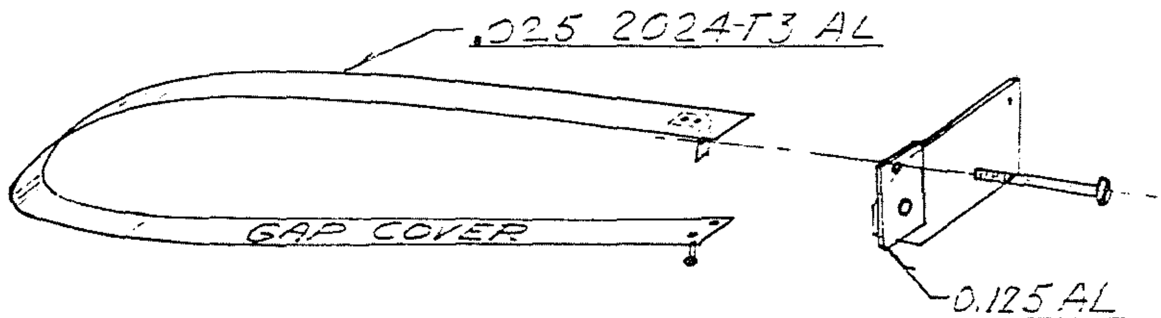
Then I went across town to see Lyle Fleming's 180 hp T-18 which he keeps in his front yard. It now has 70 hours on it with all restrictions lifted. It has the deck cutdown, gear leg fairings but no pants. With a fixed pitch prop, two radios and some extra tanks, the empty weight is 940 pounds. In addition to the standard tank, he put in three extra 6-gallon tanks. One is in the baggage compartment in front of the battery and there is one under each seat. The filler neck for these is through the side skin aft of the right seat. A 3/8-inch tube connects the three tanks. It takes too long to fill these extra tanks because fuel must drain from the aft tank into the underseat tanks through this small tube. An engine driven fuel pump takes fuel out of either the main tank or the auxiliary tanks as determined by a selector valve. All take offs are on the main tank. A bypass around the fuel pump has a check valve which permits fuel under gravity pressure to bypass the pump in case of failure.

He split the cover over the horizontal tail pivot bearings to permit inspection of the trim mechanism. If this is done, enough screws should be used to carry the shear stresses in that area.

Lyle came up with what appears to be an excellent means for attaching the gap covers between the wing panels. Each cover is attached with three screws. Two screws attach it to the bottom aft edge of the wing and the other applies tension to the top aft edge. This makes the tightest possible fit and prevents air leakage. I highly recommend it. See Figure 9.

He had some excitement on a trip crossing Idaho. The main bearing seal came out causing smoke in the cockpit. He landed on a highway for an inspection and found the oil level at six quarts and not losing anymore so he flew it to the local airport where they put in a new seal. They said that this happens quite often and that the oil level will not go down much below six quarts. After that, he modified the cowling so the nose piece could be removed without removing the prop. Another incident occurred while landing on his 5th flight. While straightening the rug around the rudder pedals with his foot, he accidentally got a parking brake locked. You can imagine what happened on touchdown. The resulting ground loop bent one gear leg so he replaced the gear. Now he has disconnected the parking brakes.

He has a 2500 dirt strip a short distance down his country



WING GAP COVER

Figure 9

road. He lands on it and just taxies up the road and parks in the front yard. Some guys have it made!! His canopy latch has a car door type handle in the center at the aft of the canopy. The sliding pin that it engages can be pulled with a cable operated from the cockpit to permit opening the canopy from the inside. The canopy latch can thus be closed or opened from the outside by turning the handle which also has a key lock operated from the inside by pulling the pin.

RED LINE: John says that to make the FAA happy he will have to keep the red line speed at 180 unless the tail mod is made. Then it will be raised to 200 and eventually 210. There is still no evidence that the original design is not strong enough even for 1,500 pounds gross.

TAKE-HOME FEATURE: John says that Stewart Schureman is the only one he knows about who removes his wings and keeps his T-18 at home. How about some information on how it works to keep a T-18 at home. (Editor's Note: This is what motivated the T-18C convertible wing and later the S-18.)

RIVETING: The methods of driving solid shank rivets may be classified into two types depending on whether the riveting equipment is portable or stationary. Since stationary riveting equipment is seldom used in airplane repair work, only portable equipment used in hand, pneumatic, and squeezer methods, is discussed here.

Before driving any rivets, be sure all holes line up perfectly, all shavings and burrs have been removed, and the parts to be riveted are fastened securely together. Two people, a "gunner" and a "bucker," usually work as a team when installing rivets. However, there are some jobs during which the riveter holds a bucking bar with one hand and operates a riveting gun with the other. When team riveting, an efficient signal system can be employed to develop the necessary teamwork. The code usually consists of tapping the bucking bar against the work; one tap may mean "not fully seated, hit it again'" two taps may mean "good rivet'" three taps may mean "bad rivet, remove and drive another," and so on.

Bucking: Selection of the appropriate bucking bar is one of the most important factors in bucking rivets. If the bar does not have the correct shape, it will deform the rivet head; if the bar is too light, it will not give the necessary bucking weight and the material may become bulged toward the shop head; and if the bar is too heavy, weight (and the bucking force) may cause the material to bulge away from the shop head. Weights of bucking bars may range from a few ounces to 8 or 10 pounds, depending upon the nature of the work. A bucking bar for 1/8-inch rivets should weigh three to four pounds.

Always hold the face of the bucking bar at right angles to the rivet shank. Failure to do this will cause the rivet shank to bend with the first blows of the rivet gun and the material to become marred with the final blows. The bucker must hold the bucking bar in place until the rivet is completely driven. If the bucking bar is removed while the gun is in operation, the rivet set may be driven through the material. Do not bear down too heavily on the shank of the rivet. Allow the weight of the bucking bar to do most of the work while your hands merely guide the bar and supply the necessary tension and rebound action.

Allow the bucking bar to vibrate in unison with the gun set. This process is called coordinated bucking. Coordinated bucking can be developed through pressure and stiffness applied at the wrists, and with experience, a high degree of deftness can be obtained. Should you fail to vibrate the bar at gun-set speed, you will cause the material to kink into a "depression."

Lack of proper vibrating action, the use of a bucking bar that is too light or too heavy, and failure to hold the bucking bar at right angles to the rivet will cause defective rivet heads. A rivet going "clubhead" can be corrected by rapidly moving the bucking bar across the rivet head in a direction opposite to the direction of clubhead travel. This corrective action can be accomplished only while the gun is in action and the rivet is partly driven. If a rivet shank bends at the beginning of the bucking operation, place the bar in the corrective position only long enough to straighten the shank.

Hand Driving: Under certain conditions, you may have to do all your aircraft riveting by hand driving. You may use either of two methods of hand riveting, depending upon the location and accessibility of the work. In the one method, you drive from the manufactured head-end of the rivet with a hand set and hammer, and buck the shank-end by use of a suitable bucking bar. In the other method, you drive from the shank-end of the rivet with a hand set and a hammer, and buck the manufactured head with a hand set held in a vise or a bottle bar (a special bucking bar recessed to hold a rivet set). This method is known as reverse riveting. It is commonly used in hand riveting but is not considered good practice in pneumatic riveting.

ENGINE MOUNTS: by Melvin O. Miles, 16341 Mahogany Street, Fountain Valley, CA 92708. I have purchased Jim Swick's T-18 engine mount jig and have made two mounts thus far. I am also making walking beams and rudder pedals. All parts have been approved by John Thorp. All parts are magnafluxed, inspected by an inspection agency and tagged, sand blasted, and painted with a protective coat. The mounts are for non-dynafocal mounted engines. Presently engine mounts and parts are on a first come, first serve basis with 60 to 90 days for delivery.

Present price list will be sent on request. The exception will be that I will not weld landing gears. Final exterior finish and tube oil or lionoil are left to the discretion of the builder for the internal preservation of the tubing.

I am a professional welder and A & P mechanic with 20 years experience. I am also building my own T-18 (slowly)--Serial No. 134.

WING FIT: Do not expect your wing and fuselage to mate properly unless you locate the 601 frame only after measuring the rear spar to front spar dimensions on the completed wing. A number of people are having trouble with tight fits--especially if they use Rudy Adler's ribs which were all made over one form block, making the 0.040 rib a little oversize.

BERNIE THALMAN FLIES: Bernard J. Thalman, 2912 Old Glenview Road, Wilmette, IL. Mark up one more T-18 that broke the bounds of earth. Yesterday, June 3, No. 86 made its maiden flight and it was great. After reading all the articles on how tricky the first flights are, I found just the opposite to be true. It tracks straight and is a pleasure on take offs and landings. Since there is only two hours flying time, I cannot quote any facts and figures, but it does fly nice. Those newsletters have been a great help. See you at Rockford.

ROCKFORD: If all goes well and the weather cooperates, I expect to have my T-18 at Rockford at least the last part of the week. John has donated some more parts so we have more work to do on the EAA T-18. Just got a letter from Paul who is anxious to get it completed.

WING REMOVAL: Just took my wing off and brought my ship home to do a little work on it before going to Rockford. With the aid of a little tool which I made to pull the main spar bal-loks (a sliding weight on a rod with a hook on the end), I was able to get everything ready and hooked up to the car in about 15 minutes with the help of one other guy. It surely is nice to be able to work on your airplane at home.

STALL SPOILERS: Have completed tuft tests to locate the stall spoilers. I covered the whole wing with yarn as shown in the August 68 issue of Airways magazine. I had to locate the spoilers just inboard of the gap covers. They work great. (Editor's Note 1986: It is mandatory that every T-18 with wing-drop stall characteristics have stall spoilers installed so the stall will be straight ahead. Failure to install spoilers in some cases has undoubtedly caused accidents.)

T-18 NEWSLETTER #26 01-10-69

Luther D. Sunderland

SHAPING PARTS: Howard Warren says that by clamping plate stock to the table of his radial arm saw and using a two-inch drum sander he has a handy surface grinder for shaping parts such as the tail spring.

WING RIBS: The idea of forming wing ribs still scares many people. In my opinion it is not worth the effort to use soft sheet and then heat treat. Pounding relief pockets in hard brittle 2024-T3 also does not make sense. Just try the easy way with 6061-T4 and follow directions. Use birch for the form blocks. Do not use a plastic mallet. Most good hardware stores have a mallet with screw-in heads. One is usually made of hard plastic and the other a hard softer plastic. Our discount store has them for less than #3. Cut a wedge shape on the end with the softer plastic.

TAIL SPRINGS: It looks as though even a 5/16-inch bolt is not strong enough for the front of the tail spring. Bernard Thalman had his break at the Fly-In with only a few hours on his ship and mine broke a week later while operating out of a rather rough sod strip. Fortunately, mine let go just as I was parking so it did not do too much damage to the rudder. I am replacing the 5/16-inch bolt with a 3/8-inch one and recommend this for everyone unless you like to build rudders. If you want to be extra safe, install the bolt inside out with the nut on the outside.

DIMPLING: At the Fly-In I talked with many people who still are going out of their way to ruin their dimples. It is so very easy to make nice dimples with no surrounding distortion. First, make a simple tool as disucssed on pages 20-21. If you do not have the availability of a lathe to make this little tool, you will not be able to make the T-18 anyway. Dimplers used in the Whitney punch are a necessity for inside surfaces such as ribs but do not do a smooth enough job for skins.

EAA AMATEUR BUILDERS' HANDBOOK: Every T-18 builder should obtain a copy of this handbook from EAA. It is a general reference for the homebuilder containing EAA forms and procedures for certification. It tells how to conduct a flight test, gives fuel system requirements, and many other necessary items of information.

LETTERS FROM JOHN THORP: Your spanwise stall pattern is normal, starting at the change of wing direction. I would prefer to have the pattern inboard to provide more aileron control at stall. A very small amount to twist will alter the pattern drastically, particularly if there is a little side slip introduced. Usually low wing airplanes have an induced root stall caused by a poor wing-fuselage juncture. High-wingers usually have a tip stall because the fuselage does not stall the root first. A little root stall is a good thing as it provides stall warning by shaking the tail. The T-18 wing stalls too close to the tip to suit me. I believe that the stall strip should be inboard of the wing break.

ROCKFORD 1968: Those of you who were at Rockford are undoubtedly all fired up and working hard on your own projects now. Lyle Fleming and I must have given 50 or more of you rides. We are sorry we could not get everybody up who wanted a ride but there were times when the traffic was so thick that we just could not fly. With three Breezies taking up passengers, there was nearly always one on the runway making it almost impossible to land. Anyway, the Fly-In was a real thrill again, especially with eight T-18s there. Each year the T-18 population has doubled so next year there will probably be 16. That is not too unlikely either because there is a large number ready to fly.

Callabie Wood again had his there. Jack Park and a friend flew in with his and Lee Hamlyn's. Bernard Thalman brought his recently completed open cockpit model. Irvin Faur brought his 200 hp constant-speed prop, fuel-injected conversion, although he did not do much flying in it. He says that no Midget Mustangs can catch him now. Lyle Fleming brought his 180 hp model and Len Anderson brought the 180 hp ship he bought from Ron Lee. Mine was the only 125 hp T-18 there.

The T-18 tent was kept busy with Bob Kaergaard directing the work of cutting down the fuselage deck for a canopy and building the flaps. John Thorp donated the parts.

The forum was held on Friday morning. First John told about the present status of various modifications and then gave an interesting talk on engines. Following this he asked each of the T-18 owners who had flown their ships to relate some of their experiences.

Two hundred sets of drawings had already been mailed out on the tail spar mod and fuselage mod at 601. The other 400 will be sent out soon.

IRVIN FAUR (04-26-68): Last year I had to turn too high an rpm to get any cruise and burnt to much gas. These constant speed props are costly and heavy but worth it. I can cruise 130 with 2100 and 15 inches manifold. That is just idling that 200 hp engine. Still have not full bored it in six hours. Am having vibration troubles yet. Still have one stack touching cowling.

Wish I had my old 160 back with the prop I have now. It is impossible to use crossover exhaust with the 200 and crossover is almost a must. It is so much quieter. I just hate these stacks on mine. I cannot give you any figures near accurate on mine. At sea level I do not believe I am a bit faster than the 160 was. But at 10,000 the only place I dared use some power (2400 and 20") it trued at 190. Will make a round trip flight at around ten soon and see what it will do at 2400 and 24". I figure 210, but figures are easy to write. I use the same ram air as Mooney and can pull quite a bit more manifold pressure than normal. So far have had no trouble propping the fuel injected engine. Starts right off. Just cannot use electric system with this heavy engine and prop either. I am fairly light overall at 860 empty, however. (Since then Irvin has observed the 180 red line so no more news.)

THORP ENGINE SYMPOSIUM: John gave an interesting talk at Rockford on the subject of power plant installation. The only way to get the full benefit from such an educational experience is to hear it first hand, but for those who were not so fortunate, here is a synopsis--quite brief because my shorthand is all long.

Propellers: Starting with the propeller, he pointed out that you will not get the best performance out of your engine unless you have just the right match of propeller, engine and airframe. Tip speeds no higher than 750 to 850 feet per second are preferred. Activity factor is important. A wide blade gives a high activity factor. For best performance it is desirable to have the largest diameter, lowest activity factor, lowest rpm and the best blade angle. It is not always possible to have all your desires, however, due to the limitation on blade length and the amount of available horsepower. The body shape behind the propeller is very important. A prop extension places the propeller further ahead of the front cylinders and thus by minimizing blocking of the propeller, it improves its efficiency. The cowling should be well faired to minimize the change in direction of the air flow.

Induction System: The induction system is extremely important. The Tri-Pacer type air filter gives a drop in manifold pressure and a corresponding loss in horsepower. Power is a function of the amount of air taken into the engine. When Lee Hamlyn changed to a new induction system with an automotive type air filter on his T-18, he picked up 15 mph airspeed.

Fuel Flow Check: Adequate fuel flow must be provided to the engine under the most nose-high climb attitude and low at fuel level. To check fuel flow, block the wheels up to simulate the maximum pitch attitude during climb and with one gallon of gasoline in the tank, run the engine at full takeoff power for three minutes. To determine the maximum pitch attitude, measure it in the air with a bubble protractor.

Cooling System: Cooling system baffles should be made of heavy enough aluminum to prevent cracking--0.032 or 0.040 is needed. Reinforcements made of stainless steel should be riveted on at rub and attachment points. Copy a good commercial design rather than trying an eyeball design which could be costly if it results in a ruined engine. Poor cooling causes rings and valves to go first. To make sure of the effectiveness of a new installation instrument the engine with cylinder head temperature gauges. These are worthless unless they are accurate, so have the gauge, exact length of wire to be used and the sensor all calibrated together.

Cylinder head temperatures should not exceed 500 degrees F but 400 is preferable with 350 maximum at cylinder base. Although the Lycoming manual states that oil temperature can go as high as 245 degrees F, a temperature between 190 and 200 is safer. Remember, outside air temperatures have a direct effect on engine temperatures so do the testing under the hottest expected conditions or you will get a surprise when summer comes. A properly shaped large spinner has considerable effect on engine cooling. The T-18 spinner is an example of a good spinner. To determine the size of the cooling system inlet use the formula area = 0.35 inches squared/hp. The exit area should be from 5 to 10% larger. For an O-290 engine developing 140 hp, the size of the inlet on one side would be 70 hp x 0.35 = 24.5 square inches. This is only a three inch by eight inch slot. Anything much larger means so much useless drag.

Cowling cooling air exits should be at one point (on each side) only. It does not work to take air out at two levels like at the bottom and on the sides. The exhaust stack clearance holes on the T-18 should be plugged up as much as possible since the main air exits on the cowling sides.

Cooling should be satisfactory if a pressure differential of five inches of water exists across the cooling system baffles. This is the amount of pressure existing in the pitot tube when the airspeed is 100 mph so to check your cooling system, use an airspeed indicator with the static line connected to the exit side of the engine compartment and the pitot line connected to the inlet side of the baffles.

Oil System: Both an oil filter and oil cooler should be used on an aircraft engine. To mount the oil filter, buy the standard Corvair adapter and cut off all the excess material. Tap the inlet and outlet holes in the casting for 1/4 pipe fittings. Make a bracket and mount to the firewall using high-pressure flexible hose for connections. The filter should be oriented so oil will not spill when filter is removed. The inlet to the filter can be from the 1/8-inch pipe outlet on top of the oil screen housing or from the oil passage at the base of the right front cylinder. A brass fitting can be used for this connection. It can be brazed shut and then drilled out to make a bleed hole to regulate flow through the cooler. Adjust the size of the hole between 1/16-inch and 1/8-inch diameter to obtain proper cooling. Make sure the oil pressure when hot and at idle RPM does not fall below minimum pressure for your engine.

A Corvair oil cooler works well with the O-290 engines. There are three sizes. Use the largest available. It is used on the supercharged models (Corsa) and the bus. Mount the cooler forward of the left front cylinder for best results. Lines should run from engine to filter to cooler and back to sump. If a fuel pump is not used, a brass fitting can be brazed to the plate covering the fuel pump opening to return oil to the sump. Use high pressure flexible 1/4-inch hose for connection. Remember that a broken oil line means an engine failure.

If a good automotive air filter and oil filter are used, your engine should never wear out. The oil should last 80 to 100 hours between changes. The design of an induction system to take advantage of the ram air effect can be beneficial for fast airplanes. Thirteen inches of water equals one inch of mercury. Since 100 mph ram air is equivalent to five inches of water, this is less than 1/2 inch of manifold pressure and not too significant. At 200 mph it becomes more significant, about 20 inches of water or nearly two inches MP. The carburetor air inlet should be little larger than the carburetor throat. This gives a diffusing action inside the inlet and slows down dust particles so they will not penetrate the air filter as far.

FORMING WING SKINS: To make forming the leading edge bend on wing skins a real snap, add 1.7 inches to the trailing edge of the bottom inner and outer wing skins. Then punch an extra row of rivet holes exactly 1.7 inches aft of the bottom row for the rear spar. To form the leading edge bend, fold the unbent skin over until the rivet holes for the <u>top rear</u> spar line up with this extra set of holes and cleco all holes. <u>DANGER.</u> Do not use the wrong row of holes! Place skin on a smooth surface. Pad a four-foot long 2 x 4 with folded newspaper to protect skin from scratches. Place 2 x 4 across skin spanwise at highest point and press down with body weight. As bend forms, move 2 x 4 forward and push down again. 2 x 4 should be located such that it is always level. Continue until a nose rib fits nicely after clecos are removed. If this procedure is followed, you cannot get the skin bent cockeyed. On the other hand, if you try forcing the skin down between the 2 x 4s with a pipe, do not be surprised if you end up using the pipe over the head of the guy who suggested it.

SEATS: Way back several years ago, I described my bucket seats (pages 82-83) but never managed to get a sketch included so see Figure 10.

The part shown is the seat bottom. The back is similar except that no springs are included and the foam is only two inches thick. This gives good leg room for a 6'2" person, but if you are short of stature you could stand to move the rudder pedals back an inch. This is preferable to get more clearance for the brake pedals. Do not do it if you are tall or you will be cramped--especially with a back pack chute. If you already have the rudder pedals located and are short, you could make the seat back thicker. The back is attached at the top with two Pop-rivet nuts placed in the tubular frame with screws coming up through the frame. This assumes that you have a hole cut in the deck under the canopy like I have. A third Pop-rivet nut is placed in the side of the tunnel and a screw is passed into it through a fitting at the bottom corner of the seat back.

The seat frames were made from a scrap lawn chairs. Splices were made with Pop rivets at three places--front center, and at the aft two corners.

To support the seat bottom at the forward edge and adjust it for proper leg support--something extremely important for comfort on long trips--I bent up a rectangular post about 1" x 2" by 2" high from 0.040 aluminum. Tabs were left at the top to permit Pop riveting it to the finished seat frame. Two were used on each seat.

Do not use foam rubber for aircraft seats. It is much too heavy. Instead use polyurethane foam, which is not only very light but also inexpensive. It can be cut with an electric knife or a ground sharp hacksaw blade in a saber saw.

CANOPY LATCH: Just noticed a picture in the January, 1969 issue of **Private Pilot**, page 20 showing the latch on the bubble canopy of the Waco Meteor. This is where I got the idea for the latch I installed on my canopy. I highly recommend this kind of latch in the top center. In addition it is necessary to have cams engage at the aft end of the rear canopy rails to lock the canopy down tightly. They engage the rear of the canopy as it slides forward to hold it down better in flight. My canopy is built according to the prints except that I added a stiffener to the cross piece holding the bearings and the rails are made of stiffer 0.050 stainless but the canopy still bulges up in flight leaving a very noisy and drafty crack all the way around the bottom. This is a drag producing leak that should be sealed well. Leaving a big bulb on the deck upholstery is alright if it is large enough to still touch the canopy after it bulges up and out about a quarter-inch.

CARB HEAT MUFFS: Bill Johnson says he has had good

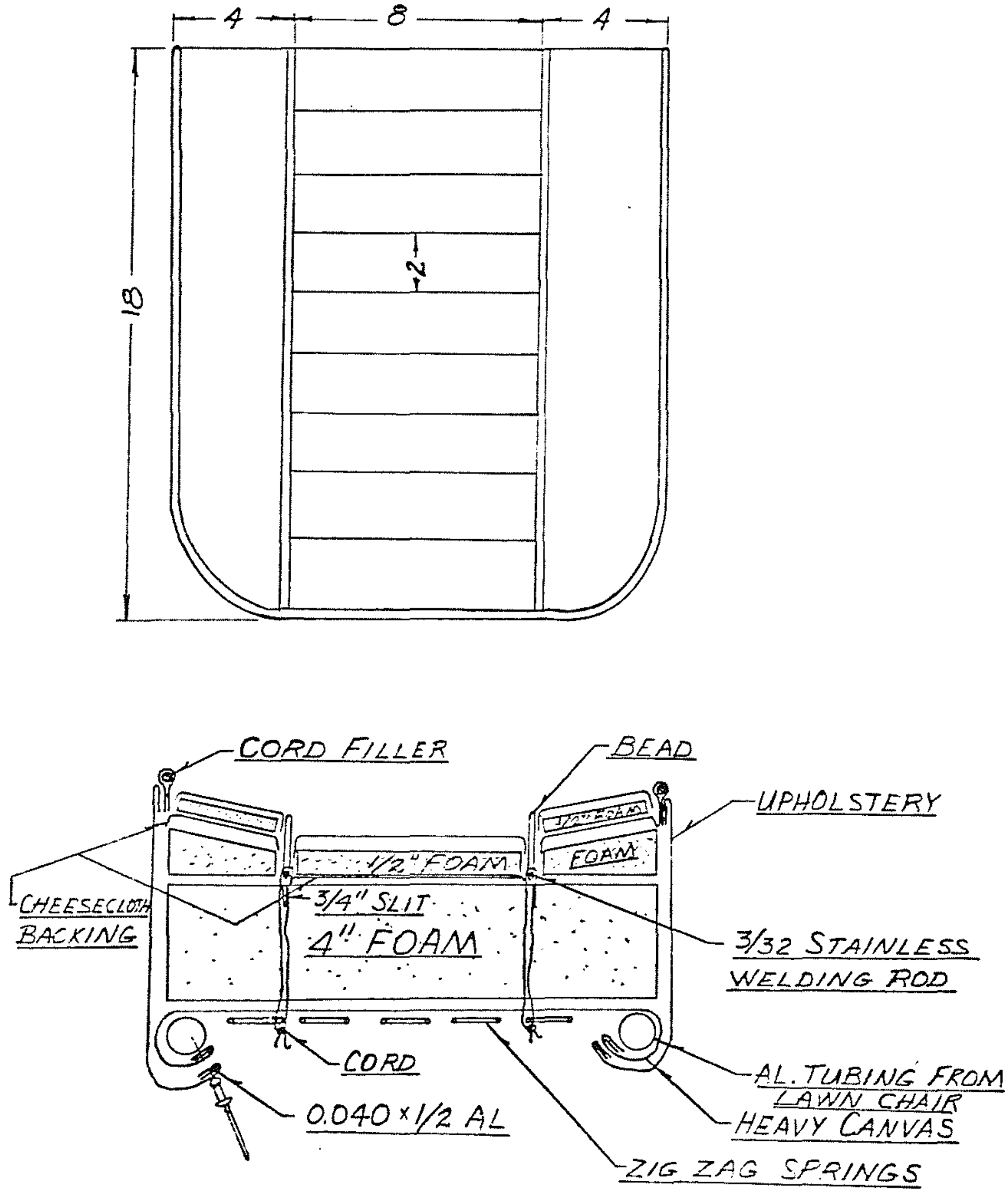


Figure 10 SEAT

experience with a very simple heat muff design. He just wrapped a screen door spring in a spiral around a straight section of exhaust stack and secured it with wire. Then he wrapped the aluminum muff tightly around this spring and clamped it in the conventional manner with screws along the side. The ends were left open for air inlet, and nothing was welded to the stack. This looks like a good arrangement. If you need to weld end caps for heat muffs to an exhaust stack, by all means, do not weld a continuous flange perpendicular to the exhaust tubing like some manufacturers do. A Super Cub exhaust system made this way used to crack every time it would be welded. Form the ends in a conical shape from 0.015 to 0.025 stainless. This shape does not cause such high locked up stresses during heating and cooling conditions and never cracks.

RETRACTABLE GEAR: Just saw Bill Johnson's drawings for his retractable gear modification. Gear legs made of double tubing like on the regular gear, will be pivoted in aluminum castings attached to the main spar. Wheels will swing into wells between main spar and rudder pedals. This requires a new inner wing and fuselage modification. The same extrusions are used for the inner wing but the web is beefed up and extra stiffeners are added in the wing walk area. He had mad new outer panels also because he wanted to try a new airfoil with less camber. For outer wing extrusions, he substituted three laminations of bent up 0.040. Each layer was of a different length to save weight. No bonding was used. He did not fabricate inner wing spar caps. Too much trouble. Bill is lucky because his wife, who is a draftsman at Boeing, is making all the drawings.

FUEL GAUGE: Bill Johnson says the 100 octane fuel must have attacked the seal in his VW fuel gauge float mechanism and it began to leak, so he replaced it with a Stewart Warner type. The 80 octane has not affected mine.

RIVNUT TOOL AND POP RIVETS: by Dick Walen. Make your own rivnut puller from an ordinary Pop rivet tool. Mine is a PGR 402 model made by United Shoe. Simply take 1 1/2-inch 8-32 bolt and turn down on a lathe so that it slips easily through the 5/32 tip, leaving about five or six threads on the end. File the keyhole with a small knife file. Screw the bolt into the rivnut and insert into the hole. When pulling, pull gently so as not to pull the threads up into the tip or they will strip. A few practice pulls and presto you have saved $32 on a Pop rivnut tool. Filling Pop rivets holes can be done quickly and easily. Buy a tube of GE or Dupont silicon rubber and squirt into the hollow rivets. Leave an ice cream top. Allow to cure for a day or two. Merely slice off with a razor blade and presto a smooth flush finish with no sanding required. (Editor's note: Do not get carried away with the use of silicon for sealing external cracks like I did for you will soon find paint will not stick to it.)

SPORT AVIATION: By now, most of you have seen the color picture of my T-18 in the December issue of **Sport Aviation.** I was hoping that it would make the cover, but then you cannot have everything. At least you readers no doubt agree that T-18s are more important than midget racers, Breezies and Bearcats, but then you too are probably prejudiced.

The photo was taken by Ed Aswad, our plant photographer. The landscape is typical of that in this area. The Susquehanna River flows from left to right through the center of the picture just back of the right wheel. The little town visible at the left is Owego, NY which is a few miles west of Endicott. If you cannot find Apalachin on the map it is four miles east of Endicott along the river. I fly out of Tri-Cities Airport at Endicott. If any of you want to see my airplane, drop in any time.

I have written an article for **Sport Aviation** about the tuft testing I did on my T-18. It includes a number of pictures and some performance data. It was supposed to accompany the color photo, but for some reason it did not work out that way and is being scheduled for the March issue.

ENGINE TOOLS: In case you want to go first class and obtain your own offset wrenches needed to torque the cylinder hold down nuts on Lycoming engines, they can be obtained through your Lycoming dealer. I innocently ordered the two required without first checking the price. You can imagine my surprise when I got them and discovered the list price for the 3/8 size, 1121-B is $25.80 and for the 1/2-inch size, 64952, is $9.65. If you want to save over $30 you can easily make your own from a couple of box end wrenches and some 1/2-inch solid steel bar stock. Use the sketch of the wrenches in the engine manual as a pattern if you cannot find a mechanic who will loan you one. First, heat the box end wrench and reform the handle to conform to the desired shape. While forming clamp the end in a vise so it will not lose its hardness. Then cut off the handle and weld on a piece of 1/2-inch bar stock. Form this to match the desired shape, cut to size and weld a large hex nut on the end to permit use with a standard socket. Since the weld is the weakest part, and it cannot be hardened there is probably no point in heat treating the wrench. The 1/2-inch shank should take the required 50-inch-pounds torque. You might use an alloy welding rod and heat treat the finished wrench.

RETRACTING THE T-18 MAIN LANDING GEAR: William R. Johnson, 23321 106th Avenue SE, Kent, Washington 98031. After a spring and summer family pacification program I have finally gotten back to work on the retractable main landing gear for the T-18. The new center wing section is about half complete. I also have a draftsman working part time on the layouts and detail drawings. With luck the plans should be ready for sale in about six months. I will not sell any until the modification is flight tested. Tricycle gear was considered but rejected because of the extra weight of the nose gear and the fact that there is no place to hide it. If it cannot be hidden, the extra weight is not worth while aerodynamically. For those who are interested in starting, here is a list of what can be done to get ready. The extensiveness of the changes preclude any salvage of the existing wing other than the aileron control linkage (flaps also if installed). The parts can be broken down into three categories: 1. Unchanged; 2. Minor modification; 3. Complete or major redesign. Parts from the first two categories can be made from existing drawings by use of the following information. Unless noted, quantities are the same as original.

1. **Unchanged Parts:** Fitting, Main Beam Attach, Dwg. No. 522; Rib Assembly, Center Wing BL 64, 125, Dwg. No. 536; Rib, Wing leading edge, Dwg. No. 544, (-2R & -2L 1 each, -4R & -4L 1 each); Stabilizer Modification, No. B502; Control Mounting, No. A566.

2. **Minor Modification:** Rib Center, Wing BL49.875, No. 535, Same as Dwg. but use 0.040 material. Main Beam Inner Wing, No. 537, (Do not drill any holes between wing BL 19.374 and BL 40. An extra thickness of 0.040 web 80" long in center of beam.) Rear Beam, Inner wing, No. 538. (Make -1 of 0.040 material. Make -3 of 0.188 plate. Otherwise same as dwg.)

3. **Complete or major redesign:** Dwg. Nos. 601, 515, 532, 533, 534R, and 580 require modification or complete replacement. Some additional new drawings will be required. Two rather complex castings will be required for the main gear bearings. All other parts will be similar to existing structure as far as complexity. If there is any reader who is a pattern maker of has an aluminum foundry connection, please let me know. (1986 Editor's Note: Bill is now deceased and I am not aware of anyone selling his plans.)

VISIT TO SAN FRANCISCO: Had a nice visit with James R. Shelton, 255 Heat Street, Milpitas, CA 95035 who works at the United Airlines Maintenance Shop at San Francisco. He has his fuselage nearly all riveted up and most of the parts made for the wings. He is doing a nice job on his riveting and spends quite a bit of time answering the questions of T-18 builders and prospective builders in that part of California. His ship will be made exactly according to the plans but he did not think the matched-hole tooling would work so he drilled the holes in the center wing skins from the inside out. He says he would not do that again because it is too much work. He has a 125 hp engine and will use either that or a 150 model.

ACCIDENT REPORT: As was announced in the November issue of

Sport Aviation a second fatal accident has occurred involving 180 hp T-18s. During the Southwest EAA Fly-In at Georgetown, Texas, a T-18 experienced what is believed to be flutter of the horizontal tail followed by failure of the spar at the 510 fitting. During the Fly-In, the pilot-builder was observed to make high speed passes across the field followed by abrupt pull-ups and zooms at extremely steep angles. The day before a passenger reported seeing between 210 and 220 on the indicator. A credible witness said that during the final pass, the tail was observed to flutter before it failed. The wing was bent down and separated and the fuselage struck the ground under full power.

Prior to the Fly-In, the builder had parked his airplane in his driveway and it had rolled down a hill tearing off the horizontal tail and associated fittings. Repairs were made and a new tail built, including the doubler tube. Three deviations from the plans were made. (1) The ribs were not riveted to the spar because he did not think it was necessary. (2) The 509 fitting was attached to the spar with a 1/4-inch bolt instead of rivets. (3) 5/32 rivet holes were also drilled but not used because the fitting had been positioned wrong. This is where the failure occurred. It is evident this accident would no doubt have been prevented if the red line speed had been observed and if the tail had been built to the plans.

Just had a talk with John Thorp on the phone to get the latest progress report on the testing program. He thinks they have identified the problem as being related to the bending frequency of balance weight arm. Everyone will be notified when tests are completed.

John expects that the program will allow the establishment of a red line speed of 210 mph. He expects however to recommend that all horizontal tails be modified to the new configuration. If you have not built your horizontal tail, I would recommend holding up until we receive word from John on any modification that might result from the test program. In the meantime, be sure to adhere to the present 180 red line which has been verified through tests as being safe.

HEAT TREAT FACILITY: Joe Martin of Saddlebrook, NJ and Lee Everle of Somerville, NJ say they found a shop which can heat treat the complete landing gear in one piece. It is Braddock Heat Treat Company, Bound Brook, NJ 08805 (215)356-2906.

EXHAUST STACKS: Someone at Rockford has some fancy looking red exhaust stacks. He said he simply used automotive stack material and then painted the finished stacks with exhaust pipe paint available in hot rod shops. Looks real fine and apparently does not burn off. Auto exhaust tubing is twice as heavy as 0.035 stainless, however.

CG MEASUREMENTS: One of the toughest problems in getting ready for a first flight is weighing the airplane and determining the cg. First is the matter of finding accurate scales with sufficient range. The airplane should have the tail raised to level the fuselage reference line, and scales should be placed under all three wheels at the same time. It is nearly impossible to get consistent readings if the airplane must be moved to place scales under different wheels. The reaction at the main wheels will be about 400 pounds, so single bathroom scales will not do the job. Try to rent or borrow platform scales. A poor substitute is two bathroom scales under each main wheel with a plank across them.

With the aircraft in a level attitude on the three scales, remove all extra articles and close the canopy. The fuel tank should be empty and oil should be full. Now, read all three scales. Drop a plumb bob from the leading edge of the wing and measure the distance from it to the center of each axle. This is extremely important in order to find the empty cg. The axle location may vary from station 53 to 55 depending on the length and amount of deflection of your gear. If the two axles are not at exactly the same station, just split the difference. Locations for the various reaction points are: Oil STA 23, fuel 48, main wheels 53 to 55, wing leading edge 55, passengers 87.6, baggage 111, and tail wheel 214. In the next Newsletter I will put in a set of sample cg calculations for my ship.

NEXT ISSUE: I will try my best to get out the next Newsletter sooner. Why don't you sit down right now and write some sort of article or little tip that might be of interest. And all you guys who are now flying, you have been getting a free ride for a long time reading Newsletters other people wrote, now how about sending in some news. I have not even heard a word from many of you since you have flown.

Don Carter who put the first 50 hours on his T-18 in record time during November and December has written a very interesting article on aerobatics and it will be in the next issue.

T-18 NEWSLETTER #27 1969

Luther D. Sunderland

TAIL MODIFICATIONS: The flight test and shake test programs are now completed and new prints are being mailed out as fast as possible. Four modifications are involved:

1. The tail spar is changed to include an outer full length tube of 0.049 and a shorter doubler tube inside.

2. Two of the balance weights are removed and new bullet-shaped weights are added externally to the tail tips.

3. A little 0.032-inch thick stainless stiffener is wrapped around the inside front corner of the tail tabs.

4. A stiffener is added to the balance weight arm.

BULLETIN: John Thorp urges all T-18 owners to make the Number 3 modification immediately. It had the most significant effect in raising the flutter speed. It simply stiffens the tab by tying in the inside rib with the leading edge and hinge. Note that it does not wrap around from top to bottom but rather from front to side. This is such a simple modification and so important that it should be done immediately.

John is recommending that all four modifications be made to all T-18s, even the 125 hp models, just in case someone forgets the 180 red line for unmodified models. The new red line for modified models is 210 mph.

TEST PROGRAM: John will probably be documenting the test program in a future article, but I know you are anxious to hear about it so here are a few details.

All tests were conducted on Dick Hansen's T-18 N299V. Shake tests, flight test instrumentation, and consulting engineering were subcontracted to Specialty Testing Services who drew upon some of the most expert talent available in the field of flutter analysis. Sensors were placed on the horizontal tail and balance arm and outputs were recorded in flight.

The procedure used was to make a modification and perform shake tests on the ground, which identified the bending frequencies of the various parts. Then flight tests were conducted by John Thorp to verify the predicted in-flight characteristics.

First, a new horizontal tail was built with the new two-piece spar. Test showed that at about 195 mph, the horizontal tail experienced a bending oscillation at 31 cycles per second with zero damping. This means that the oscillation reached a certain amplitude and got no larger. It was not actual flutter because flutter is defined as a divergent oscillation. That means it gets progressively larger until something gives. The condition was not detectable by the pilot, but showed up on the instrumentation.

The balance weight arm vibrated with a 16 cps-frequency. Figuring that this was coupling with the tail bending at twice the frequency, they added a stiffener to the balance weight arm. But tests revealed that this lowered the speed at which oscillations occurred.

Next, the three lead weights were removed completely and John flew up to 209 mph with no problems. Now, a word of explanation about the purpose of these weights. They were not intended to give static balance to the horizontal tail to raise the flutter speed but serve only to give the stick the proper force per "g" of pitch maneuver.

Since John felt that the balance weight was needed for good stick feel, he had to put the weights back on. The tests indicated that the weight was causing a flutter problem since there was considerable flexure between it and the tail tips. So, to get the weight more rigidly connected to the tail tips, the two side weights were removed from the balance arm and streamlined weights were added ahead of the tail leading edge at the outboard ribs. Flight tests were run up to 220 mph with this configuration, but they still were not out of the woods. A tail oscillation would still occur at 25 to 30 cps.

Next the little stainless steel stiffeners were added to the corners of the tail tabs and the frequency went way up, giving the biggest single improvement. Flight tests were then run up to 231 mph with perfect results. The damping from stick bumps was just as good at that speed as at 150 mph. John now thinks the tail would go all the way up to near sonic speed without flutter. However, his experts would not let him fly any faster because other surfaces, such as the fin, rudder and ailerons were not instrumented and there was no way to tell whether they were approaching flutter conditions. Since the FAA requires flight demonstration tests to be run at 10% above red line, that sets the red line at 210 mph. This is valid only for the flight-tested configuration which included all of the above listed four modifications.

Some people have asked whether a slab tail is more susceptible to flutter than a conventional tail. This is a fair question for the layman and, let us face it, almost everybody is a layman when it comes to flutter. The answer is a definite NO. Conventional tails have the same problem as slab tails and one can be made just as safe as the other. If you do not believe this, just take a look at all of the supersonic airplanes. Nearly all have slab tails.

So what conclusions can be drawn? What caused the two accidents? There has been no official announcement and we do not know for certain, however, there is evidence that they were caused by flutter of the horizontal tail. In one case there was strong evidence that the aircraft had flown much in excess of the 210 mph red line. In the other case there was evidence that not only had the aircraft been flown at high speed, but that the tail had not been built in compliance with the plans.

T-18 owners can now have the confidence that their airplane has been through perhaps the most extensive flutter test program of any homebuilt.

AEROBATICS IN MY T-18: Don Carter, 2316 Donna Drive, Vestal, NY 3850. The keynote of this article is "be prepared." It is important that both pilot and aircraft are properly readied for aerobatics. Another important consideration is that just as no two pilots have the same experience and capability, there are no two T-18s exactly alike. This is especially true of power plants and cg locations, both of which are significant factors in aerobatic performance. The reader therefore, should understand that the aerobatic performance to be discussed is not for all T-18s but only for Serial Number 96 with the conditions as specified. It is powered with a 125 hp O-290-G engine.

Is the Aircraft Prepared? The red line restriction should be considered in detail. The first question to be asked is "What is the accuracy of my airspeed systems?" John Thorp advises that the red line has a known 10% margin of safety. From what I have seen and heard about pitot-static systems of homebuilts, errors greater than 10% are not uncommon. Serial #96 was checked on a ground course and verified against a factory job that had a high confidence level.

The red line has additional significance because with a cruise CAS in the neighborhood of 150 mph, the red line represents only a small percentage increase. Since these T-18s are clean ships, that increase would invite exceeding the red line. That maneuver is conspicuous in its absence from those which #96 has performed.

Is the Pilot Prepared? It is never wise for a pilot inexperienced in aerobatics to experiment on his own. This is especially true in the "Tiger" for reasons outlined above. Therefore, if the T-18 pilot is not an experienced aerobatic pilot, he should buy himself some insurance in the form of a good course in aerobatics. Such courses are offered by many local flying schools.

Aerobatics in Number 96: Although I had handled a number of T-18s in flight and Lu Sunderland generously let me do some airwork and make four circuits around the field as preparation for my first flight, I did not appreciate the beautiful handling characteristics of the T-18 until I was on my own in #96. Although I have flown a number of aircraft from the WACO to F-51s and F-80s, I have never flown a sweeter handling aircraft than the T-18. This statement comes from a pilot who prefers a very responsive aircraft.

Number 96 began aerobatics with an empty weight of 730 pounds (bathroom scale accuracy) and a pilot weighing 175 pounds with chute. Depending on fuel, cg would vary between 20% and 22%. A GPU was up front. There is no tendency for either wing to consistently drop off in stall maneuvers.

Number 96's pilot has been through the formal aerobatic programs of

CPT (Civil Pilot Training) and Aviation Cadet training. In recent months he had made a number of aerobatic flights in an EAA Bipe. Therefore, both pilot and aircraft were reasonably prepared for aerobatics.

I will discuss the aerobatic maneuvers in the order that I progressed through them. In general, I started with the positive "G" maneuvers first. I would like to point out that my interest in aerobatics is generated by the desire to increase my skill in controlling my airplane and the pure enjoyment derived from them. I'm not a contest pilot nor am I even familiar with current standard techniques.

Barrel Rolls: I dive to 160 mph and pull nose up 5 to 10 degrees above the horizon at the same time banking about 20 degrees opposite to direction of roll. Then almost full aileron with lots of rudder with the roll and a little back pressure to keep you comfortably in your seat and hopefully the ball in the center. If the roll rate is relatively high, the nose will not deviate more than about 5 degrees during the roll. With full aileron, #96 will roll 180 degrees per second. I have done double and triple rolls by raising the nose proportionately higher at entry. I like this maneuver because it is comfortable, fast, and presents a real challenge in keeping it coordinated through recovery. One word of caution. Start with nose high, up to 30 degrees, on first attempts to avoid excessive speed in event you dish out. This roll could be entered at a slower speed but it would not be nearly as tight.

Loops: I enter my loops at 160 mph with full throttle. Because of the wide range of speed in this clean aircraft, back pressure will vary considerably if the loop is to be round. Use lots of it in the first quarter gradually letting off to a very light pressure as you go over the top. Remember that red line and throttle back in the third quarter. Biggest problems will probably be not enough back pressure in the beginning and too much going over the top. There is a natural tendency to pull too much back pressure at the top of the loop to hurry it up but this is at the point where the aircraft is going the slowest and a stall or even a snap roll can be induced. Remember to pull these Gs (2.5-3) in the beginning.

Immelmanns: Enter a tight loop at 170 mph using even more back pressure in the beginning so that enough speed to roll will be available at the top. Roll out at the top can be either barrel roll type or slow roll. For maximum comfort I like to barrel roll which should be started just before going over the top. Full aileron and lots of rudder for the roll with back pressure gradually increasing. Perhaps the more proper method is the half roll at the top. when reaching the top apply forward stick to keep the nose on the horizon. Immediately start the roll with aileron and rudder and add lots of top rudder as the wings go vertical decreasing as they approach level.

Spins: Spin entry is normal and recovery occurs immediately upon releasing back pressure and neutralizing rudder. Number 96's roll slows slightly about every half turn with forward cg. No difference in right and left spins. (1986 Note: Spin recovery depends on the specific airplane--cg location, wing twist, etc. John Thorp says that when the T-18 has the cg at the forward limit, it does not want to spin. But with the cg aft, the spin will tend to go flat. We have had one report with unknown cg location where a T-18W required full opposite rudder and full nose-down stick to effect deep spin recovery. Do not attempt spins in a particular airplane unless it has been through a spin test program with recovery accomplished after 1/2-turn progressive spin increments. Since few people are adequately equipped for conducting spin tests, I do not recommend spins in the S-18.)

Snap Rolls: As a precautionary measure to keep stick forces light, I have only performed snap rolls at 80 and 90 mph. I use stick full back and full rudder (no aileron). There is a slight hesitation as in a spin and roll rate is average (whatever that means). Recovery is instant with forward stick and opposite rudder.

Snap on Top of Loop: Enter at 170 mph and start snap about 10 degrees before reaching the top. Nose should be about 10 degrees down at recovery after 360 degrees of roll. Complete loop normally. Keep first half of loop tight as in an Immelmann.

Slow Rolls and Half Rolls: Start by vacuum cleaning the office. A tight seat belt and shoulder harness will also help keep you from standing on your head on the canopy. Start your slow roll, after a shallow dive to 160 mph, with your nose slightly above the horizon. Begin your roll with stick and rudder together. From then on your are completely uncoordinated trying to keep your nose on a point. Top rudder is maximum when the wings are vertical and forward stick maximum when on your back. I find that I need all the rudder I have and then some to keep the nose up. Except for lacking rudder, the Tiger rolls nicely. The only difference in the half roll is that all action is stopped on your back and then you go back to the way you came. If you get into trouble just apply full aileron and you will be right side up in jig time. Avoid recovering in a split S.

I wanted an inverted fuel system so I could keep the engine going when I rolled slowly. Number 96 has a poorman's inverted carburetor system and so I have to adjust the mixture when I go inverted. This makes things a little busy at this point.

Hammerhead Stall: If physical sensation is what you like, this is the maneuver for you. Dive to 160 mph, pull nose up as in a loop to vertical and hold her there until the airspeed approaches stall. Then apply full rudder and fall away. Your airplane will weather vane around to nose down vertically. Then quickly reduce power and recover to level flight.

Conclusion: The high performance and superb handling characteristics of the T-18 make it a fine aircraft for aerobatic flight. The light control pressures also reduce the fatigue factor. However, I am sure some of the pros would have some recommendations if the Tiger was to be used competitively. To date, I have only tested the inverted capability in slow rolls and sustained inverted flight. I have already messed up my T-18 by leaking a couple of quarts of oil while on my back. I will probably modify my lubrication system for inverted flight before pulling many more negative Gs.

I would like to conclude with the keynote "be prepared." I should not have to emphasize the significance of the red line. All pilots should observe it religiously. Below is a list of "be prepared" considerations.

1. Pilot should be experienced in aerobatics.
2. Aircraft should have accurate airspeed system.
3. CG should be forward for first flights.
4. Vacuum office for inverted flight.
5. Wear chute.
6. Practice opening canopy in flight to be prepared for emergency egress (rip pins are a necessity since the canopy is difficult to open in flight).
7. Have lots of air beneath you--like 7000 feet.
8. Get off airways to keep it legal.
9. Clear the area before each maneuver.
10. WATCH THAT RED LINE.

HOW TO TAXI: If you think this is a pretty silly subject, I assure you that you will not think so the first time you notice a gravel dent in the leading edge of your nice shiny new propeller. The fact of the matter is that practically nobody is using a 63-inch propeller. My metal prop, for instance, is 67 inches long and with a 68-inch pitch is just perfect for the O-290-G engine. It turns up 2750 maximum at 172 indicated. With a standard length gear, this puts the prop close enough to the ground to pick up loose gravel if you do not use some discretion in ground handling. Of course, it is not as bad as a typical tri-gear airplane, but it will still pick up gravel. Here are some suggestions which could save your prop.

1. Never apply high power while standing still or moving at low speed over gravel. If you have to taxi over loose gravel, get speed up before reaching it and either coast over it or hold reduced power. Do not stop and proceed slowly thinking this will be easy on the prop.

2. Choose run-up areas carefully. Even pavement usually has some loose gravel laying around, so avoid it. Try to find a patch of grass for run-ups on unpaved fields.

3. When stopping for parking, such as at the gas pump, try to avoid gravel also.

If you want to see how a propeller picks up debris, just watch an airplane running up over a dusty area. The swirl under the prop picks up debris just like a toronado. So, take heed.

CG CALCULATIONS: In Newsletter #26 (page 150) I made some comments about cg calculations and promised to include data for my T-18 in this issue. In order to assure accuracy, I reweighed my ship--this time with platform scales under both main wheels at the same time and a bathroom scale under the tail. Was I surprised at the difference over the previous measurements taken by first weighing one wheel and then the other with pairs of bathroom scales! Instead of getting an empty weight of 826 pounds without fuel or oil, it turned out to be 881. I knew the use of bathroom scales was not good but I had no idea how bad. It turned out that our local airport had two pairs of ordinary platform scales like we used to use on the farm to weigh grain. If you are not so fortunate, why not talk your EAA chapter into buying scales?

Be sure to accurately measure the stations for the main gear and tail wheel as referenced to the leading edge of the wing (STA 55). Use a plumb bob for these measurements.

The cg of a full tank is STA 50. When there is only a small amount in the tank, the cg of the fuel is forward of this point.

The following calculations are for my T-18. The table lists data on some others which have flown. Notice that I can take only 75 pounds in the baggage compartment with empty tank and not exceed the aft cg limit of Station 71. I have verified in flight that Station 71 is the neutral point, so do not plan to exceed it. If I could find room I would move my battery from the baggage compartment to the firewall. John Shinn has located his battery under the right front seat.

CG CALCULATIONS FOR N4782G

	Weight		Station		Moment	%C
Main Wheel	1019	x	54	=	55,026	
Tail Wheel	43	x	214	=	9,202	
	1062		60.4		64,228	
Fuel (27.5 gal)	165	x	50	=	-8,250	
Oil	16	x	28	=	- 448	
	181				-8,698	
Empty cg	881	x	63	=	55,530	
1 passenger	+170	x	85.5	=	+14,535	
Oil	+ 16	x	28	=	+ 448	
Fuel (27.5 gal)	165	x	50	=	+ 8,250	
Most forward cg	1232	x	63.93	=	78,763	17.8
2nd passenger	170	x	85.5	=	+14.535	
Baggage	75	x	109	=	+ 8,175	
Gross Wt. cg	1477	x	68.7	=	101,473	27.4

Fuel	-	135	x	50	=	8,250	
		----		-----	=	-------	
Most aft cg		1312		71		93,223	32
Fwd cg limit							15
Aft cg limit							32

T-18 WEIGHT AND BALANCE DATA

SN	OWNER	MAIN WHLS	TAIL	OIL	FUEL	IN. a	IN. b	EMPTY	CG AFT	STA FWD	WT GROSS
37	Thenhaus	817	36	16	0	1.25	160	60.5	68.7	62.6	1450
37	Hamlyn	866	45	16	0	1.25	160	61.65	69.7	63.2	1475
41	Hansen	951	43	16	0	1.13	160.25	60.8	69.8	62.5	1600
62	Ferko	815	43	8	0	1.75	161	1.32	70.2	62.9	1450
68	Schureman	767	29	16	0	1.5	161	59.6	70	62.1	1350
77	Sunderland	1019	43	16	165	1.0	160	63	71	63.9	1477
79	Kaergaard	672	42	16	0	1.75	160.75	62.7	71.7	62.9	1300
196	Anderson	990	55	16	42	1.38	161	62.6	70	62.9	1600
328	Martens	1051	48	16	0	1.38	161	60.65	69	62.3	1700
390	Grammer	940	43	16	0	1.75	162	60.34	69.2	62.25	1575

Comments:

37 Thenhaus - no canopy, O-290-G
37 Hamlyn - canopy, pants, new cowl
41 Hansen - constant speed prop 180 Lycoming
77 Sunderlnd - O-290-G
79 Kaergaard - no canopy, O-290-G
196 Anderson - 180 Lycoming
328 Martens - 180 Lycoming

a is distance in inches from wing leading edge to main wheel station.
b is distance from main wheel station to tail wheel station with fuselage level.

HOMEBUILT MAINTENANCE: Now that you have got your homebuilt aircraft flying after those seemingly endless months of toil and sacrifice, you can finally relax and enjoy flying again on all these nice sunny days instead of being cooped up in the workshop. Also, you can do some of those odd jobs around the house which you have been promising your wife you would do "just as soon as I get'er flying." Wow, what a great feeling. You can even take a little snooze after supper without feeling guilty. No longer do you go to work the next day with zinc chromate stains on your hands, cut fingers or burns from a hot welding rod. Yes, you can just fly to your heart's content or until the gas bill gets too big.

And just think how much money you are going to save on maintenance and annual inspections. Isn't it silly, all the rules the FAA has about maintenance on type certificated airplanes? Sure hope they do not get any idea like that about homebuilts. That would be ridiculous, since anyone who can build an entire airplane can surely keep it running. Besides, you are going to stay on the safe side and check it over good once in awhile.

Up to this point the picture is all roses, but it is all too easy to let human nature take over and give that ball-of-fire homebuilder a case of the "put offs." Since there is no absolute deadline on maintenance, it is easy to just relax and enjoy life and wait a little longer to do that preventative maintenance.

The disciplines and skills learned by the homebuilder are not necessarily those required by a good aircraft mechanic. Before a person can make a part from new materials he is forced to learn how to go about it, otherwise he will end up with scrap. Building an airplane is thus a mandatory learning process for the novice. He has nothing to lose but his time and money if he goofs--and even that is a very effective learning process. Maintenance, however, is another story. There is considerably more at stake than time and money if maintenance is not performed until it is forced upon us by a failure of some part. Much as we dislike being policed by the FAA, that is really the reason for all the emphasis on maintenance and inspections.

Currently, all preventive and actual maintenance on homebuilt aircraft can be performed by the owner with an annual recertification inspection performed by the FAA at least once a year (not as in 1986). Our FAA office does a good job on these inspections, but they emphasize that they are not meant to be a substitute for good periodic inspections. Just what should periodic inspections consist of and how often should they be made? This is where the average homebuilder should resume the learning process. To know when and what to do he should by all means study a book such as one which is intended to prepare a person for the A & P mechanics test. An example is the Zweng manual on this subject. If you cannot answer the sample questions that apply to your type of airplane, then you should do some studying.

Regarding inspections, the homebuilder should discipline himself to stick to a rigid, preplanned program. EAA chapters can help by devising such a program and take positive action to see that it is enforced. For insurance ask each aircraft owner to voluntarily submit his log books to a designated chapter representative once per year and thus show evidence that inspections are being performed.

Here are a few suggestions which might be of help in establishing your maintenance program:

1. Enter all maintenance actions in a log book.
2. During the first 25 hours, remove all cowling every five hours and thoroughly inspect the powerplant. If your cowling cannot easily be removed this often, including the nosepiece, without removing the propeller, then it is

not designed right.
3. Every 25 hours thereafter remove cowling, wash down compartment, and inspect engine mount for cracks, baffles, exhaust system, tightness of fittings and nuts, jugs, and check oil screen for metal particles.
4. Repack wheels every 100 hours and check plugs and points.

RON ZIMMERMAN: 1915 McKinley Street NE, Minneapolis, MN 55418. Back in October, 1964, I rode with Bill Hansen in his (N152A) new tri-gear Tailwind to Mississippi State University. We spent a week there while Sean Roberts ran some tests on the Tailwind. They recommended nylon yarn for tufting. The tufts need only be 2 1/2 - 3 inches long. They should be taped on in a staggered pattern--this reduces the possibility of the slight turbulence of one tuft affecting the ones downstream of it.

On the subject of stall characteristics of the T-18, I experienced a slight left wing heaviness both before and in a stall. The break was pretty much straight ahead. There was little or no warning (buffet before the stall). I tufted and experimented with stall strips to get more warning before the break. I tried to get the wing to stall sooner in the area of the wing walk so the tail would pick up the buffet for a warning.

After rebuilding my T-18 and reskinning the whole wing, my T-18 now stalls 10 mph lower with the same airspeed indicator (calibrated) and pitot-static. At first I would not believe it but the ailerons are not as responsive as before (in a stall) so it must be going slower.

Originally I flush riveted only the nose ribs and main beam. When I reskinned, I used flush rivets back to, but not including, the rear beam. Also originally, I bent the wing skin L.E. around a radiused piece of 3/4-inch plywood. This required much sweat, four-letter words (darn, etc.), and an extra set of hands. The second time around I used the method described in Newsletter #23, (1.7" dim). With this method it can be done alone in one-half the time, and during a church service. (Amen! Editor)

I do not think the extra flush rivets did much to reduce the stall speed, but I do think I got a better L.E. contour on the airfoil, which might be a big factor in the lower stall speed. I am not sure how close the airspeed indicator was calibrated before the rework, but it checked out very close after.

It is my personal opinion that the L.E. contour and uniformity has as much to do with stall habits as unwanted wing twist does. A little extra attention to these factors should be worthwhile. I have my horizontal tail off now to be updated.

FIREWALL FITTINGS: by Dick Walen. Want to save $$ on firewall bulkhead fittings? Make your own by brazing a flat washer to a pipe coupling. Drill firewall same as CD on pipe coupling. Drill three holes in flat washer, apply rubber cement to back side and Pop rivet to firewall. Chromate after assembly but before installation.

SANDER BELTS: For people using a Rockwell delta or Mead belt sanders with 1" x 42" sanding belts--make our own belts purchased (from local mill supply house). Rolls of 1" x 50 yd of Behr-Manning "handy-roll" metalite cloth or equivalent. Cost about $5.75 to $6 per roll depending on grit size.

Cut pieces at 45-degree angle, 42 1/2-inch long. Wet one end in warm water, scrape off 1/2-inch grit material (make up 6-8 belts at one time). Allow to dry then glue the lap joint with Elmers or white glue, hold in vise or clamp until dry. Make sure belt ends are aligned and do not use too much glue. This gives you 15 cent belts that work as well as the "ready made" ones costing 50 cents each.

VALVE PROBLEM: If you have not had a stuck valve on takeoff, you really have not lived. This happened to me during climb out recently. Fortunately, I was at 400-feet altitude and about at the end of the runway. I was able to just make it back and land across the other runway with only minor damage when I ran through the snow at the edge of the runway. Inspection of the engine revealed nothing wrong except that a piece of carbon had gotten under an exhaust valve. This kept the valve from seating properly and, with no heat sink for cooling, the valve got overheated and expanded in the guide. Even though the valve stem to guide clearance was within tolerances, the valve stuck open. This not only caused a power loss due to one less cylinder, but it also caused severe backfiring. This must happen when burning exhaust gas from the other cylinder is sucked in through the open exhaust valve at the same time the intake valve is open. Believe it or not, this makes a very noisy glider out of an airplane. John tells me that Bill Warwick had a similar close call when his 180 Lycoming-powered T-18 injested a nut from the induction system and this got lodged, jamming a valve open.

Changing Spark Plugs: John Thorp says that it is very common for carbon to get lodged under a valve when spark plugs are changed. Removal of the top plug can break loose chips of carbon which fall down past the valves. If a valve is open slightly, the chips will collect around the seat and when the valve closes it will smash and sometimes stick fast. Since the valve cannot touch the seat, it becomes very hot and may either stick or start to burn. John said this happened to him in three different types of engines until he figured out what was causing it. He thinks that 90% of the pitting of both exhaust and intake valve is caused by this.

Now he removes the bottom plugs first. Then before removing each top plug he brings the piston up on compression, thus insuring that the valves are closed. For added safety, blow air through both spark plug holes. John says that he has never had any burnt valves over the years since he began following this procedure. He has written to both Lycoming and Continental to bring this situation to their attention. You can be sure that I will always remove the bottom plugs first now that I am aware of this situation.

T-18 NEWSLETTER #28 09-14-69

Luther D. Sunderland

ROCKFORD 1969: Another exciting Fly-In has come and gone. With it came a new crop of T-18s, more exciting than ever. As far as I know there were ten T-18s in attendance.

Many of you were probably disappointed in not getting a ride. I do not know whether anyone else was giving rides, but I managed to take a few T-18 builders for rides during the three days I was there. If you have not flown at Rockford, you might not understand why many of us with fast airplanes are a little reluctant to do too much flying there. Threading your way through all the slow airplanes in the pattern is a rather tricky business. The runway traffic was handled in a much improved fashion however, with one side used for take-offs and the other side for landings. I never cease to be amazed that so many safe landings can be made with the average altitude at the turn from base to final of between 10 and 20 feet. This occurs so homebuilts can use one runway from the intersection while everyone else uses the other one.

Larry Larcom took me for a ride in his very nice 160 hp T-18. Larry does immaculate workmanship and has turned out by far the quietest T-18 I have been in. His airspeed system had not been calibrated, so I could not be sure how fast it would go. One thing that helped make it quiet was the use of fiberglas insulation throughout the aft fuselage. But more important was the good seal around the canopy. The canopy frame and rails were all standard except for a clamping latch at each of the two lower front corners. The deck under the canopy was upholstered and the upholstery was made oversize enough to press out against the canopy. The only disappointments were the poor forward visibility and the square tunnel jabbing my hip. In my T-18, I have very good over-the-nose visibility even in climbing attitude, but in his, I could not see anything but the instrument panel. I doubt if I could have raised the seat much because my hat already rubbed the canopy. I believe the difference is due to two things. First, my windshield frame is 3/4 inches higher than standard and Larry has a one piece canopy from M & R supply which does not bulge out according to the plans in the area over your head. Since it does not seem to hurt the speed any, I strongly recommend raising the windshield frame. Even if it is already built, you can add spacers.

Larry did a fine job of finishing his airplane. In order to get nice smooth wing skins he stretched them over the wing framework and then drilled everything in place. This extra effort paid off in very tight, smooth skins.

Hugh Grammer also did an exceptional job of workmanship. His interior was very tasteful and had that truly showroom appearance. I did not get a ride in it so I hope Hugh will give us a complete report for a future issue.

The weather people made such pessimistic predictions of the weekend weather situation along my return route that I decided to leave Thursday afternoon to get ahead of the front. So I missed the forum and only got a brief look at Russ Basye's beautiful tri-gear T-18 which arrived as I was leaving.

Three trophies were awarded to T-18 builders by John Thorp, as follows: (1) Russ Basye - Outstanding Workmanship; (2) Ron Zimmerman - Best Modification; (3) Lu Sunderland - Best T-18.

Ron Zimmerman did a remarkable job of rebuilding his ship. No one would know by looking at it that it had ever been scratched. This time he completely flush riveted the wings and was very careful to get nice smooth leading edge bends. He said that this greatly improved the stall characteristics.

Bill Johnson and his wife flew in from Seattle, having brought one of their children part way in their newly installed jump seat. Bill is presently machining parts for the retractable gear mod.

Al Neunteufel had his recently completed airplane there. He is very enthusiastic about the performance but after only a few hours is already talking about making some modifications to the cowling. After a fuel pump failure on take-off on his first flight, he says his church attendance has been very faithful.

Callbie Wood was there for just one day and then had to leave due to business. Dr. Cottingham was there in N299V.

Don Carter arrived Thursday with his daughter, Debbie, and camped right by his T-18. Don stirred up quite a bit of interest with his article on aerobatics in Newsletter #27 (pages 154-157) and gave some good advice on the subject at the T-18 Forum. This was that if you are not an expert at aerobatics, you should get some dual instruction before doing them. Even if you have had dual in slower airplanes, you should get some help from someone more experienced. Don has not yet solved an oil leakage problem in his Corvair supercharger so has not used it yet. He has not been successful in obtaining permission to use his T-18 for IFR flying but is still working on it since several Westcoast homebuilts have IFR approval.

LONGER LANDING GEAR: I have made a new main landing gear for my T-18. It has proven to be the best I have seen. Like Bill Johnson, I tapered only the outside 1.5-inch leg tubes to insure maximum torsional stiffness. A taper on the last few inches of the lower leg buys very little in simple bending deflection. I made a straight taper from the mid-point downward leaving a 0.030-inch wall thickness at the lower end. Then I left a 1.5-inch diameter by 0.125-inch ring at the very tip to prevent splitting. From the mid-point upward I made a straight taper down to 0.080-inch wall. This was left thicker to make it easier to weld. the inner 1.25-inch gear legs were simply made 2.5 inches longer, untapered. The cross tube was made of 1.25 inches by 0.080 wall thickness tubing. To facilitate heat treating and also simplify repair if one leg gets damaged, the gear was split down the middle. The cross tube was spliced with a 6-inch long piece of 1.5-inch diameter x 0.125-inch tubing and four 5/16-inch bolts. At the apex, the gear was split on the centerline and then welded after heat treatment. I used an oxy-acetylene torch to weld the gear. Do not try it unless you are a good welder. (1986 Editor's Note: This gear design is now standard for the S-18.)

If the 0.090 plate stock is permitted to extend about 1/4 inch outside of the weld at the apex, then when it is later welded, the main part of the fitting will not be heated enough to disturb the heat treat properties. The two halves need to be welded at the apex only to take vertical shearing stresses. (It keeps one leg from slipping vertically relative to the other.) This is a much better arrangement than the stub tube splice I previously used.

John Thorp says Merrill Jenkins is now building his gears 2.5 inches longer. John does not object to this modification, but does not recommend adding much more length because it sets the wheels too far back and you might nose over.

Why extra length, tapering and a lighter cross tube? They all make the gear softer. Why the split down the middle? To facilitate heat treating in a smaller oven.

More than likely, the legs will warp during heat treatment. Straightening is simple if you have a husky chain or cable and a jack. After assembling the two halves, just attach the chain or cable to the two ends of the bent leg. Insert a jack in the middle and start jacking. This makes a mighty powerful crossbow but works like a charm. I ruined my bumper jack trying it, but a hydraulic jack borrowed from the local gas station did the trick. Now, if the axle pads are not aligned exactly right, remember the sanding disc on a table saw as I described before. My first gear wore off my tires on the inside, so, on the new gear, I added one degree more camber. Make sure you do not have any toe-in since that is destabilizing and can cause ground loops.

My new gear has really tamed my Tiger. For some reason, it is much more stable on roll out. Instead of constantly having to use rudder and brakes to keep it rolling straight, I can almost sit back and relax. It is very noticeably softer on bumpy runways. When taxiing, it considerably reduces the stresses on the wing-fuselage attachments (which are much higher on the ground than in flight). In a three point attitude I can still see the ground 100 feet in front of the nose. This mod I strongly recommend.

CANOPIES: The article by Glen Breitspecher in **Sport Aviation** was well done and very interesting, especially to me since I also went down the route of forming canopies. His finished canopies are very fine and do conform precisely to the drawings. His story and the picture of the pile of scrapped canopies made me feel glad that I had gone the simpler route of making a two piece canopy over a male mold. For the novice, that is much easier and gives quite satisfactory results. Of the first half dozen canopies we scrapped only one when it slipped off the clamps into the oven.

THROTTLE CABLE FAILURE: A forced landing has been reported caused by throttle cable failure. After two hours on a new T-18, the pilot was unable to reduce power, so he came over the field and cut the engine with mixture control. On final, a Cessna got in his way, so he elected to turn and reapply power with mixture control. However, the engine would then produce no more than 1000 rpm, so he turned back to the field. Unable to reach the runway, he landed in 80-feet tall pine trees, fortunately without major damage or serious injury. Cause--loose throttle cable clamp. The T-18 slid down the pine trees, clipping off branches. Bent the spinner, engine mount and wing skins. It is flying again after wings were reskinned.

Do not depend on the FAA inspector to catch everything. Get one or more designees or chapter members to thoroughly go over everything before you fly. You will be surprised at the things they find.

While we are on the subject, do you have a fancy push button throttle control that you can twist for fine control? If it is like mine, there is no provision to safety the cable end, which screws into the fork at the carburetor. I drilled and safety wired mine to the fork.

Now, we should never again have forced landings or close calls due to the following reasons, right?

1. Loose throttle linkage
2. Loose oil filler cap
3. Loose crankshaft seal
4. Bad motorcycle battery
5. Injested nut through intake system
6. Bad airspeed indicator
7. Lost canopy

8. Ground loops
9. Broken non-standard tail spring
10. Loose bolt in brake
11. Fuel system failure or obstruction
12. Clogged fuel tank vent tube
13. Out of fuel

All of the above have caused accidents or near misses. Can you find any that could not have been prevented? All of them, of course. It is likely that the next one will fall into the same category. Better make this list part of your checklist.

OUNCE OF PREVENTION: By Lyle Fleming. Lyle just had a spectrographic oil analysis run and discovered warning signs. Disassembly of the engine revealed three broken rings. Ads for this type of service appear in the aviation magazines. Sounds like a good idea.

PROPELLERS: Does it necessarily make your T-18 go faster if you use a longer prop? No. If you decrease pitch and increase length, rate of climb will be increased, but not necessarily top speed. This is because, in the range of propeller blade angles we are using, propeller efficiency is nearly proportional to blade angle. The higher the pitch, the higher the efficiency. But it cannot be too long or the engine will not turn up enough rpm to get full horsepower. Of course, if a prop is too short, it loses efficiency. So, what is just right? It is hard to tell because of so many variables, but people have tried out about all possible combinations. (1986 Note: Henry Rose at Sensenich has designed optimum wooden propellers for 125 through 180 hp T-18s. For the 125 through 160 hp models he selected 66 inches [W-66LM series] and for the 180 hp, 68 inches [W-68LY series]).

It is, of course, difficult to get good comparative test data on propeller performance. Indicated airspeed is usually fairly inaccurate because of system errors.

Unless a recent calibration check was made, the tachometer can be off up to 10%. Different prop blade thicknesses and widths are used. Induction systems greatly affect power. Test data is not available under the same conditions. Airframe drag is greatly affected by finish, cooling system losses, leaks around canopy. Weights vary etc. But wouldn't it be nice to have the best available data on every T-18 all summarized in one table? I have published the small amount of data few people have supplied but this is not adequate. If all you guys who have flown your T-18s will cooperate and send in some data, I will publish a table in a future Newsletter. It should prove extremely valuable for both you and all those to come. Please sit down and fill out the attached form immediately or as soon as you can get the data.

For those of you who do not get a form, it includes spaces for serial number, N number, name, address, engine model, horsepower, propeller length, pitch, maximum level flight RPM at 2000 feet OAT, MP, maximum level flight RPM at 5000 feet OAT, maximum IAS and TAS at 2000 and 5000 feet, maximum rate of climb, aircraft weight during tests. Later, when you get your T-18 flying, why not send me this data. (1986 Editor's Note: The requested data never was forthcoming. It is not too late to send it to the Newsletter editor.)

RUNAWAY T-18: At least one T-18 has shaken the tail tiedown and made a very short first flight across the driveway and into a ditch at full throttle after the owner had hand propped it with no one in the cockpit. Fortunately, in this case the show was over in short order with only minor damage--such as ruined prop and wheel pants and a bent gear. Thank goodness he lived in the woods and his rambunctious bird could not get away. But let us make sure we do not have anymore close ones of that sort.

It is simple to prevent. DO NOT RUN ENGINE WITHOUT PILOT IN COCKPIT. Sounds familiar enough and the best of us probably have violated the rule and gotten away with it. But let's get some discipline--sign a pledge to obey this rule. Just put your "X" here____.

SAFETY FIRST: There have been too many close shaves on first flight. All of these could have been avoided. Before your first flight, why not talk to a T-18 pilot and let him advise you. A phone call can be made anywhere in the country for a couple of bucks and that is pretty cheap insurance. I will be glad to talk to anyone. I am usually home between 10 and 11 PM.

SEATS: Just received a set of plans in the mail from A. M. Wortz. 3655 W. 153 Place, Midlothian, IL 60145 for a T-18 seat. These plans are available from him for $3. It is the type described in a recent issue of **Sport Aviation.** It has an aluminum tubular frame with a basket weave within the frame for support of cushions. It gets quite narrow at the shoulders and comes up quite high. It can be adjusted in all directions except sideways. I have not seen one but Dick Cavin reports that it is very comfortable. It looks complicated to build and might crowd a tall person, but it looks like a well-designed seat.

SPRAY PAINTING: Unless you are a professional painter you are certain to forget this tip, but I will pass it on anyway. To keep from causing runs in your freshly sprayed paint, never try to spray a full cover coat on the first pass. The first coat should be very thin, so you can see through it. Just barely wet the surface. Let it stand for a few minutes until it gets tacky, then spray a full wet coat. The trick then is to hold the gun the right distance from the surface and keep it moving. If it gets too close, a run will result--too far away and the paint dries before it reaches the surface. Let up on the trigger at the end of a pass when you turn around to change direction.

ACRYLLIC ENAMEL: The trend these days is to use acryllic enamel in automotive finishing and many homebuilders have begun using it. Ordinary enamel not only has the disadvantage of being slow drying but also cannot be rubbed out like lacquer. If you get a run in it or a bug lands on the fresh paint, you must let it dry a couple days, sand it out and then repaint. The acryllic enamel handles just like lacquer. It dries immediately and can be rubbed out and polished. One word of caution. The instructions say that a second coat of acryllic cannot be put on between 24 and 72 hours after the first coat. Do not believe them!! I have tried a second coat at 20 hours and 80 hours with very sad results. So widen the safety margin on the sensitive period or the first coat will pucker up. The finish coat should be thinned quite alot or the surface will have an orange peel effect. To rub out overspray runs, or orange peel, use 400 wet or dry paper and then rubbing compound. Spray painting requires tons of patience, self-control, and quite a bit of knowledge for a good job.

AIR FILTERS: John is trying to find a source for the cellular type filter material which is commonly used in lawn mower engines. It looks like foam rubber. He had to change his filter in order to get it into his extra tight metal cowling. (1986 Note: Buy a motorcycle filter made of this foam. Be certain to restrain foam between a rugged screen. Two forced landings have been caused by foam being sucked into the carburetor.)

MANDATORY BULLETIN: If you sell your T-18, give the owner the plans and notify John Thorp of the change of ownership. Why is this so important? We very nearly had a serious accident in a case where a T-18 was sold but the new owner did not get the plans and knew nothing of the tail modification. One tail tab became fatigued at the root rib attachment rivets and the rib became detached in flight. The tab fluttered at 155 mph but the pilot got down safely. He knew nothing of the tail mod because he did not get the plans or T-18 Newsletters. The purchase of a set of plans licenses the owner to build one T-18 so, legally, you cannot keep the plans and build a second one anyway. And since an owner of a homebuilt needs the plans to make repairs, they should form a permanent part of the aircraft records.

OIL SEAL RETAINERS: If you want to buy some real cheap insurance, just install retainer to your crankshaft oil seal. Several T-18 owners have had problems with blown out oil seals. You will recall Lyle Fleming's forced landing in the middle of no where and Bill Warwick had two blown seals before he discovered a washer installed wrong in the breather. Lycoming now uses as standard equipment, on all engines, a split retainer ring which attaches to the front flange on the crankcase with four number 8 screws. It is very easy to make such a retainer if you cannot locate one. I strongly recommend that one be installed on all Lycoming engines. The flange on the O-290-G case is not any too wide, but there is ample material to drill and tap for four number six screws.

CRANKCASE BREATHERS: On engines with breathers on the aft case, be sure to follow the instructions in the overhaul manual when installing the washer in the breather assembly or it can cause a blockage. When installing a breather in an O-290-G engine, drill and tap the case on the upper forward left side of the case for a 3/4-inch pipe fitting. Be certain that the diameter at all points in the passage throughout fittings and tubing is at least 5/8 inches.

CONTINENTAL ENGINES: Question have been asked about the possibility of using Continental engines in the T-18. John says it would create cg problems but if you wanted to add lead in the tail it would work. One is flying; see Appendix.

ENGINE BAFFLES: Just had a look at John's latest Sky Scooter engine installation. I think the baffles are watertight! Except of course where the holes are supposed to be. Where a baffle touches the case, he seals the crack with silicone cement (metal seal, bathtub seal, etc.). He says it wastes energy to blow air through cracks.

ENGINE WRENCHES: I told John that my new $25 wrench would not get the cylinder hold-down nut by the oil pressure relief valve, so he showed me his wrench. It is a Sears Roebuck box end that has been heated and reformed to fit. He says he has always felt that the Lycoming manual specified torques on these bolts are not high enough.

CONNECTING ROD TORQUE BULLETIN: Lycoming has just published a bulletin on their engines raising the torque level on connecting rod nuts from 30 to 40-foot pounds.

GASKET CEMENT: John says he will not use the liquid so-called non-hardening gasket cement because it really does get brittle with age. He showed me a can of the stuff he uses. It is a paste and comes in a can which looks like car wax but you can also get it in a tube. It is called Tite-Seal. The company also makes the liquid type but the paste type is better.

FREQUENT QUESTIONS AND PROBLEM AREAS: Having visited, talked with, and answered letters from quite a number of T-18 builders, I can see that many of you are worrying about the very same things, so I will try to comment on the most frequently asked questions.

Matched-Hole Tooling: 1. Does matched-hole tooling really work? Yes. With the exception of the fin and the forward fuselage skin over the fuel tank, matched-hole tooling should be used exclusively. It works well and will save a tremendous amount of time. The alignment of the various components can be maintained with the same precision as could be achieved with complex jigs and fixtures. To get the fuselage completely square so the horizontal tail lines up with the center wing, use matched-hole tooling on the fuselage sides, bottom and top aft skins. With the center wing, or at least the center wing spar, in place and the horizontal tail in place, sight across both and square up the fuselage. Then the two 45-degree hip skins can be drilled in place. This locks up the fuselage so it is no longer flexible in torsion. If you do not first make this simple alignment check, do not expect the fin and horizontal tail to line up with the wing.

Flaps: Are flaps worthwhile? Absolutely yes. Not only do full flaps reduce stall speed about 5 mph but they also greatly increase the glide angle. This significantly cuts the landing roll and makes getting into small fields much easier. if you are in a big hurry to fly, you can skip the flaps and then add them later. But I believe it is much easier to install them when building the structure, especially the fuselage parts. you will probably just let them go and never get around to installing them.

Rib-Forming-Flaps and Horizontal Tail: How do you form the flap and horizontal tail nose ribs? Although I have made quite an issue about how easy it is to form ribs when you follow instructions, these small ribs are a slight exception. In order to form the flange around the nose as shown on the plans, it is necessary, I believe, to anneal that portion of the metal with a torch. I asked John about this and he said that it is not necessary to continue the flange around the nose. Instead, a small cutout can be made like in the nose ribs. Make it as small as possible to maintain strength.

Performance on 125 hp: Is performance adequate with 125 hp? In my opinion, the 125 hp engine is <u>the</u> engine for the T-18. Out of the eight T-18s at the Fly-In last summer, mine was the only one with a stock GPU. When people see the performance with the 125 they seem amazed. I have asked many T-18 builders across the country why they are putting big engines in their airplanes and they usually say that they got the idea that the 125 was not big enough for good performance. They are wrong.

Baggage Compartment: Is there enough baggage space with the hump cut off under the canopy? Yes, this even makes more space available when you also cut a hole in the top bulkhead like I did. When John changed the design and cut off the hump, he made a beautiful airplane out of a rather boxy looking one. Whereas chapter members used to make wise-cracks about the looks of the T-18, they now rave about it. You will be disappointed if you do not cut yours down. If you want to fly open cockpit (something mighty uncomfortable at T-18 speeds) just slide on a dummy head rest. Don Carter has flown his T-18 with the canopy simply removed.

Main Gear: What about the gear? Unless you are lucky enough to have a really big heat treat oven available, make the gear in two pieces as previously described. The standard gear is fine for hard surfaced runways but I think it is too stiff for comfort on rough sod strips. There are two ways to make it softer--lengthen and taper the legs. Either or both methods can be used. now do not get carried away adding length. Since the legs slant back, extending them moves the wheels back and they are not too far forward to begin with. Bill Johnson added 4 1/2 inches to his gear legs and with a 160 hp engine and constant speed prop he had to add lead in the tail to keep the empty airplane (with full tank) from nosing over on the ground. A third way to get a softer gear is to use Whitman type solid legs. Ron Zimmerman sells them or you can make your own. If you calculate the strength of a solid leg and a hollow one, you will find that the center 3/4 inch does not give you any appreciable strength. But Ron has compensated by saving weight in the A-frame. Do not use 600X6 wheels unless you are not interested in speed.

Pop Rivets: Are Pop rivets satisfactory? Yes. Use ANs if you are equipped, but if not, use Pops. There are no reported problems with them on the many T-18s that use them. Stainless steel and monel are acceptable but do not use the aluminum type. Use the type whose stems break inside, designated BS. It will not buy much increase in speed to use flush rivets except on the front half of the wings. you gain mostly in appearance by using all flush rivets. I used them and I am glad but it did make a few extra operations and took time. The actual dimpling time is insignificant but you have to take everything apart in order to dimple so you do not dare start riveting until you have all the holes drilled.

HEAT TREATING ALUMINUM: The following information taken from the Aircraft Mechanic's Pocket Manual should be of interest to all of you "tin benders." Only the alloy designations have changed. 24S is now 2024 and 17S is now 2017. Unless you are making some parts out of soft material and then heat treating them, your main interest may be in regard to AN rivets. The ones with the little dimple in the head are made of 2017 and normally can be driven as is. However, when they get too old, they become hard and may crack or at least expand dimpled holes too much. If a rivet rings when it is dropped on the floor, it is too hard and should be reheat treated to return them to the original 17S condition. If the rivets are put in a freezer immediately after heat treatment they will remain soft for some time. I cannot seem to find out how long they will last, but you will not have to worry for a number of months.

"Aluminum alloy heat treatment is a process which may be applied only to the structural aluminum alloys 17S and 24S. These alloys are held at a constant temperature for a sufficient length of time, depending upon the thickness and nature of the material. The temperature limits for 17S and A17S is from 930-950 degrees F. The temperature limits of 24S and A24S is from 910-930 degrees F. After the material has been held at this temperature for a sufficient length of time, it is quenched rapidly in cold water to retain its hardness. The natural aging of 17S and 24S material is 90% complete after 24 hours and fully complete in four days.

"It has been found advisable to form aluminum alloys within one-half hour after Solution Heat Treatment before the aging has progressed too far. During this period, the metal may be worked with ease and without danger of cracking. It has been found that the aging of 17S and 24S material may be retarded for as much as 24 hours if it is kept at, or below, a temperature of 32 degrees F. Aging can be retarded for longer periods if a lower temperature is maintained. in practice, an icebox containing dry ice is used to hold rivets, or small pieces of sheet, until the shop is ready to work them.

"24S has a relatively rapid rate of room temperature aging as compared to 17S. The rate of aging of 24S is not only greater but the material, immediately after quenching, develops greater strength than does 17S sheet, also less workability. For this reason it is necessary to work 24S more promptly after quenching than it is 17S, if comparable workability is to be achieved. While it might seem advantageous to use 17S rather than 24S to form sheet during the age-hardening period, practically all aircraft shops use only 24S in order to gain the higher allowable strength and to standardize sheet stock.

"Solution Heat treatment is usually done in a salt bath heated by gas, oil, or electricity, or in an electric furnace.

"The length of time that material must be soaked at the proper temperature depends upon the nature of the material, the thickness of the material and the type of heat-treating equipment available. Heavier material requires a longer soaking period.

"When various thicknesses are treated at one time, the soaking time necessary for the heaviest material should be used. The lighter material will not be injured by a moderately long soaking. This is not true of Alclad material, which must be heated as rapidly as possible and soaked for the shortest possible time. If this is not done, the alloying elements of the base material will diffuse through the pure aluminum coating and destroy the corrosion resistance. For this reason Alclad up to 0.019 gauge should not be reheat treated. 0.050 to 0.077 gauge should not be reheat treated more than one time and 0.078 to 0.125 gauge can be reheat treated any number of times without affecting them."

FORMING THE DASH: A number of builders have had trouble forming the dash. The common problem is getting cracks in the inner flange. This undoubtedly is due to the 90-degree bend on the flange. John says that it is not necessary to make the bend 90 degrees. I recommend that, on all fuselage frames including the dash, the inside flange should be bent about 45 degrees in the curved portions and 90 degrees in the straight portions. The form block should be cut out and radiused for 90-degree bends all around the inside edge, but when the frame is formed over it, just do not wipe the corners all the way down with the rubber mallet. The frames look much rougher if you try to form them over formblocks with 45-degree bevels cut into them.

John recommends that everybody now flying reread my article in the March 1969 **Sport Aviation** on tuft testing and then add the spoilers. A recent stall spin accident after an apparent engine failure emphasizes the need for these. They do not hurt the speed any and are mighty good insurance.

T-18 NEWSLETTER #29   12-08-69

Luther D. Sunderland

USING WING SKIN TEMPLATES: I have two sets of T-18 skin templates circulating around the country. One set is for fuselage only and the other set also includes inner and outer wing skins, horizontal tail and rudder. The donation for use of these is $3 for the fuselage only and $6 for the more complete set, in case you have used them and forgot to pay. Each user pays shipping to him. These templates were copied directly from John Thorp's original templates.

Many T-18s have been built from the fuselage templates with no problems to my knowledge. However, I have not heard any reports from anyone who has used the wing skin templates so do not know how they are working out. I am concerned that there may be a tolerance build-up problem if they are not used properly.

Here is a way to use the wing skin templates which will insure that all holes will line up.

1. Transfer all spar rivet holes in both outer and inner skins. Transfer wing walk rivet holes in inner skins.
2. Scribe around all outer edges of the templates.
3. Transfer and then punch only <u>one</u> complete row of rivet holes for <u>one</u> rib in the outer wing skin.
4. From this row of holes, a transfer strip can be punched directly from your wing skin.
5. Then use your new transfer strip to transfer all other rib rivet holes. The original templates could be used to mark, not drill, several rivet locations for the top and bottom of each rib just to help locate the transfer strip.
6. Make your rib tooling and transfer from the transfer strip to the master rib.

This procedure will work just as well as the one described in the Building Instructions. Using the skin templates will guarantee a good straight wing if you also take the few steps described in earlier newsletters on using a carpenter's level during final assembly of the panels.

Here are some tips on using the templates.

1. You must have a smooth, flat work surface. This means something like a new, unwarped piece of plywood, or better yet, chipboard or particle board. You can get by with a 4 x 8 sheet, but 4 x 12 is much better.
2. The templates are made of 0.025 sheet so must be handled with respect.
3. Never drill or punch through my templates. Use only a duplicator punch to mark through them by tapping with a mallet. This can be a punch out of the Whitney punch set or

one you made on a lathe. Why not drill through the templates? If you do not know this much, you definitely should not be building an airplane. Yet John Thorp tells me he often catches people drilling through his templates. But why not punch where possible since this can be done without enlarging the holes? Yes, it can be done if the nib is ground off a Whitney punch, but you can also slip up now and then and catch the template. You are certain to do this sometime. If each user does it just once, it would not take long to ruin the templates.

MATCHED-HOLE TOOLING: M. R. Yoder, 1047 Dolorita Avenue, Glendale, CA 91208. I just received Newsletter #28 and found it most interesting reading as were all the others. I would like to add a comment to yours about matched-hole tooling. Ed Henderson and I also had doubts about this type of construction, because all our past experience had been on massive jigs. After building the ailerons and flaps to test John's templates and our own rusty but not forgotten sheet metal skill, we started the wings, starting with the spars. Again we used John's templates and fabricated all parts for the center section and outer panels, and after completing these parts, with tongue in cheek we assembled the outer wing spars to the center section spar and were able to finger press 1/8-inch rivets into and through the #30 alignment holes for the spar-attach bolts. As you can see we are convinced matched-hole tooling works.

As for a progress report, we have completed to date both ailerons, both flaps, rudder, fin, landing gear, all wing spars, all ribs, wing skins laid out, cockpit flight controls and many miscellaneous goodies in the making.

PHOTOGRAPHING AIRPLANES: Did you ever notice how some photos of airplanes look like an amateur snapshot while others made with a comparable camera will look professional? One of the most important factors in photography is the **viewing angle.** A favorite view of amateurs is from about 45 degrees off the nose and six feet off the ground. For small homebuilts, and especially tail draggers, this makes a rather unbecoming picture. A good rule is to get down on the same level with the subject. Haven't you noticed that when a television camera takes a picture of a girl walking, they never view from a point level with the top of her head? They always get right down where the action and interest is. Still photos are the same. Just leaf through some back issues of **Sport Aviation** and see the difference **viewing angle** can make. Sure, all pictures should not be taken from directly off the wing tip at mid-height level, but the further you get from this position, the more distortion--unless you are trying to emphasize some particular feature.

If you include people in a photo that is primarily meant to be a picture of the airplane, get them out of the way--either inside, below, beside or behind it. If the airplane is only background, that is different, treat it as such and concentrate on the subject.

EXHAUST STACK CRACKS: After rewelding broken off or cracked exhaust stacks about a half dozen times, I called John to find out what to do. I had a crossover system with no slip joints. If you do not know what a crossover system is, it is one which uses two exhaust stacks, and exhaust from the right front cylinder is brought across in front of the oil pan, joined with that from the left front and existed through the left stack. Exhaust from the left rear is also taken around in front of the pan, joined with the right rear and exited in the right stack.

The problem is that when the engine is running, there is relative motion between cylinders. We have all learned that you cannot tie two cylinders on one side together with a solid cooling baffle or it will crack. The same thing applies to the exhaust system. The solution is to put a slip joint between each pair of cylinders just like on the Cherokee.

But how do you make a slip joint? John has a set of dies to make one on a press, but that does not help us. So I decided to weld up one. For material, I used one of the stainless shrouds that were around the short stacks on my GPU. By slitting one with the chrome blade on my table saw, I could form it neatly to fit tightly over the exhaust tube, making a sleeve. The sleeve was made 3 1/2 inches long and the slit was welded up. To keep from having any weld material run through the crack, I slipped the sleeve over a one-inch steel bar that was clamped horizontally in a vise. The tube was welded with the slit facing upward so that the tube contacted the bar just under the weld seam. Surprisingly enough, it did not make too much of a heat sink but did make a perfectly smooth inside seam. Now, cut the exhaust tube at the desired location and slip the sleeve on the downstream side of the cut. Overlap about 1/2 inch and weld. The gas should have to reverse direction in order to escape. Trim about 3/8 inch off the end of the tube which slips inside the sleeve for clearance. Presto, a slip joint which John says will end cracked exhaust problems. (1986 Note: I now have dies for stretch forming both slip joints and ball joints for T-18s.)

WELDING STAINLESS: Until now I have been getting all my welding of stainless done by heli-arc because I could not seem to make anything but a mess with gas. But after seeing a demonstration with gas--on top of not being able to get my heli-arc man when I needed him--I decided to learn or bust trying. Much to my surprise, it really is not too difficult.

First you need some flux and some 1/16-inch stainless welding rod both available at your welder's supply house. Clean the joint well with a steel brush and make sure the parts fit well with no big cracks. Coat the joint and the rod with flux. You will notice that at bout the time a nice puddle would be starting to form in ordinary steel, the area under the flame suddenly caves in and you have a nice hole. Lesson one: there is no visual indication of temperature such as with 4130. Then you melt some rod over the hole which for some reason wants to either cave in after the first, or make a rather obscene looking pile. The pile is stubborn and only gets bigger as you dab on more rod. Lesson two: you cannot shape the puddle with the flame in the normal way, in fact, it should not be puddled. So, how do you weld stainless? Let's try it again. Heat the weld area and apply a little rod before it caves in. About the time you think you have some rod flowing on, sparks fly and a bubble erupts from within, making a pop! and a real mess! Lesson number four: use a very carbonizing or reducing flame. Now, I thought this meant just a little bit more than the normal feather of excess acetylene normally used for welding 4130, but I discovered that my trouble was that I needed more excess acetylene. Then things started working better. Two other pointers should help. Normally, you weld 4130 easier if you progress up hill, but stainless welds easiest if you progress downhill. Also, I found it works best if you weld backwards with the rod held behind rather than ahead of the torch as it progresses. Point the torch toward the already formed bead. Apply rod sparingly. Keep the rod bathed with the reducing flame. (1986 Note: Since writing the above, I have learned to weld stainless with a #7 mild steel rod, a little excess acetylene and no flux. Cannot figure out why I was having so much trouble. The above pointers are still valid, however.)

CLECOS: A very popular question among T-18ers is "Where do I buy clecos?" To my knowledge, the surplus $.09 clecos are about all gone. So you will have to pay the new price. One place you can obtain them is: Spencer Aircraft, 8410 Dallas Avenue, Seattle, WA 98108. (The price is $.40 each in 1986.)

You will need at least 100. You might get by with 50, but you should get 100. It will be easy to sell them and recover most of this cost.

TAIL WHEEL STEERING SPRINGS: During the first 150 hours on my T-18, the springs on the tail gear became uncoupled at least a half dozen times. I tried several different weight springs and bent the ends in more, but still they became unhooked. I finally found a fix that really works, and makes ground handling much easier. I simply restricted the amount of stretch of each spring with an extension of the connecting chain. New chains were made a few inches longer than normal. The first link of the chain was hooked to one end of a spring and the same end of the spring was then hooked to the horn on the tail wheel. Then the chain was hooked to the other end of the spring in a link which permited the spring to stretch about an inch before taking up the slack in the chain. The chain then continued on to be hooked to rudder horn.

Since making this change, I have never had an unhooked spring and directional control is much improved. This along with the longer, softer main gear legs, has really made a world of difference in my T-18. I strongly recommend both. (1986 Note: Builders frequently ignore this advice. Try it. You will be greatly surprised at the results.)

TAXI TEST ON 336: by Dick Walen. I have started taxi tests on No. 336 and have found that it is a bit more than I can handle right now. I am not familiar with the tail wheel so I am checking out on a 125 hp Pacer. When I get her up to about 40 to 50 mph and reduce power I have fishtail problems. I am just not proficient enough to handle it yet.

The noise level is surprisingly low. The cockpit is fitted with styrofoam one inch all around with rolled and pleated upholstering. With the styrofoam filling the cavity between the angles, the upholstery is flush from the seats to the firewall. Here is some data on construction and equipment: three years, two months to build; $5000 total investment; O-290-D2, zero time certified engine; full IFR instruments; Alfa 200 Genave radio; prop from a 180 Cherokee adapted to fit extension 68-inch diameter 70-inch pitch. Weight 950 pounds. Engine will turn 2200 static, 29-inch MP with the tail tied down. (Editor's Note: The foregoing comments about Dick's taxi tests are not surprising for two reasons. First, the difficulty in maintaining directional control when the throttle is cut under 40 mph is typical. It is the only time a T-18 could be said to be even slightly hard to handle. Second, all of Dick's experience has been in nose-gear airplanes. For this reason I recommended that he find an experienced tail gear pilot to make the test flight. For making a first test flight in a new airplane, it is not good enough to just be able to handle an airplane. The pilot should be able to handle all the unexpected things which can occur without worrying about normal control of the aircraft.)

FUEL SYSTEMS: B. D. Ham, Route 3, Box 703, Orlando, FL 32811 sent a sketch of a fuel strainer made from a brass elbow into which a finger of copper screen was inserted and soldered. He said a friend had a forced landing in his all-metal Cougar when a moth got into the fuel tank and clogged the outlet because there was no outlet filter. This is a very common kind of problem. A strainer at this point is an absolute must. (See page 252 for more on fuel strainers.)

If you make your own strainer, do not restrict the hole in the fitting any. Drill out the hole in the end of the fitting that screws into the tank so, when the screen is inserted and soldered, the ID will be as large as original. Caution: Since items such as this cannot be easily visually inspected, make a sketch of your fuel system and show it to the FAA inspector before the final inspection. Here are a few tips:

1. Use no smaller than 3/8-inch fuel lines.
2. A flexible coupling must be used between fuselage and carburetor. Use only approved high-pressure fuel hose for this.
3. Make sure there are no low spots between tank and sediment bowl where water could lay and freeze.
4. Make provision for easy access to a quick drain on the bowl.
5. Different carburetor kits are used when a fuel pump is used. This is not easy to get the straight scoop on. Do not fly until you have checked with someone who really knows.
6. The fuel tank vent should have a screen to keep insects from building nests in it.
7. Install two fuel tank exits and two shutoff valves. One exit has a stand pipe that allows 1/2-hour fuel reserve as on the early Volkswagen. Then we will never lose a T-18 due to running out of fuel. Do not laugh--it will happen to you someday.

If you have been reading the aviation literature you will recognize that all of the above items have been involved in accidents or at least engine problems.

FUSELAGE FRAMES: People continue to have trouble bending up the fuselage frames. Common troubles are cracks at lower corners of the outer flanges and cracks in the inner flanges. Here are my recommendations.

1. Do not use a brake to bend up the outer flanges unless you are so good you do not need any advice.
2. Get a 4 x 8 sheet of chipboard (particle board) and saw out some forms. Be sure to make adequate bend radii. Also, areas to be joggled can be a little on the "deep" side due to springback. Make up a little sample and experiment to get the proper size joggle.
3. The inside flanges of all frames are shown on the original T-18 plans to be bent down 45 degrees. Do not, however, make a 45-degree bevel on the forms. Cut the form at 90 degrees.
4. Using a rubber mallet--the type where the mallet is one big piece of rubber stuck on a handle--bend the inside flange down. All straight sections should be bent down 90 degrees but the radiused corners should be bent down only 45 degrees.
5. Make absolutely sure that you first removed <u>all</u> scratches from the edges of the sheet material. The best way is to first draw file the edge after cutting and then with

sandpaper wrapped around a stick, rub parallel to the sheet edge until nicks and scratches not parallel with the edge are removed. Sloppiness with cleaning up sheet edges seems to be the most prevalent problems with novice tinbenders, yet they are so very easy to remedy. Do not forget the Stanley Surform rasplane for all straight edges.

7. Now for the $64,000 question. What do you do if you crack a frame? If you have spare material, you naturally can make a new part. However, it is perfectly acceptable to stop-drill or cut out the cracked material and put a splice over it using the same stock.

RUSS BASYE: (T-18 #72, N372RB). Sure sorry I missed you at Rockford, but I fully understand about weather. We ran into weather just west of Omaha and went back to Grand Island, Nebraska on the way to Rockford. I found where the T-18 leaks! At the rear of the canopy where the hip skins start. We averaged 184 mph (not counting return to Grand Isle) takeoff to touchdown going to Rockford, and 155 mph coming home.

In my opinion the T-18 is the nicest flying airplane I have ever been in. After about 20 hours I finally got the canopy sealed and with the sound-deadening material that was put in (aluminum foil tape and polyurethane foam) its noise level is about halfway between a 172 and a Bonanza, so it is real comfortable for cross-country flying. With 39 gallons of fuel it will go safely about 500 miles.

I have my pitot and static tubes halfway out the wing outer panel, underneath. It stalls when the indicator reads "0" mph. After fiddling with it for a couple of months, I am now in the process of installing the pitot on the fin as per plans. Otherwise I have had no problems--the retracting gear works fine, although I have to retract it under 85 mph or I cannot get it up. A wind tunnel would probably show me where the air loads are that keep it from going up. It is just the last few inches where it gets hard to pull up. (1986 Note: Russ' tires did not retract completely flush with wing skin and his performance was not better than a fixed gear T-18 with the same power.)

PERFORMANCE DATA QUESTIONNAIRES: I have received only six completed questionnaires that were mailed out with Newsletter #28. Out of the thirty-some already flown, this is a pretty poor score. I know that some of them are laid up for maintenance or modifications, but you other guys can obtain the necessary data. It will be of immense value to everyone, so please try to get the data and return the form as soon as possible. The weight and balance data has already been put to good use by many who are about to fly.

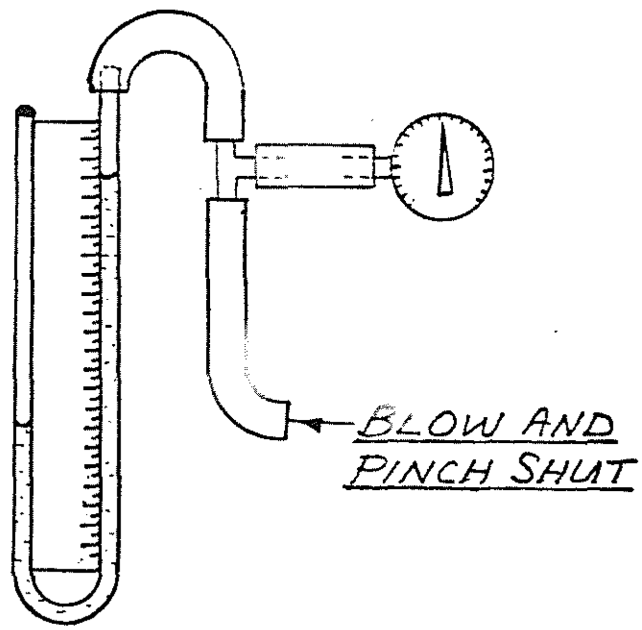
HERM RASSLER: (He is rebuilding after a forced landing when a dip stick came loose.) Think it is about time for a status report on the rebirth of #24. Have the wings, fin, ailerons, rudder down through prime, fuselage up to firewall except for wiring, instrument panel, and a few tunnel parts. Have most all of the parts rounded up to complete by late summer or early fall. Need cool weather for testing. Should be about 50 pounds lighter, 25 more horses, smoother and faster! I built twist into the wing roots. If anyone is interested, 1/16 inch off square (diagonally measured) will give approximately 1/4-degree twist.

Bought a Rattray T-18 nose cowl, the one in the winter **Sport Aviation** ads and at the Fly-In last summer. The work is beautiful but it will not fit over a Lycoming ring gear. Sent it back for refund and he sent one he has designed for a 180. Great big ugly thing (my opinion). Sent it back about two months ago. Now have nose and belly panel from Hamlyn.

Am enclosing a tester for checking airspeeds. You can make a manometer with clear tubing and a yardstick. See Figure 11. I think this is more accurate than flying alongside one of these factory spam cans.

According to the article I got it from, all airspeeds are off somewhere along the scale. Only some are worse than others. One could make up a correction card just like for the compass. This will not test the static system but I think teeing a manometer into it would also check for good static. Use food coloring to make water more visible. Blow up pressure and hold to check for leaks in the system. (Editor's Note: Bench checking of an airspeed system does not guarantee accuracy in flight. Getting a good static pressure source is a big problem. Note Russ Basye's comments. The only way to be sure of accuracy is a good calibration test over a measured course. The bench test should be run before first flight. Go back and read Herm's test flight report [pages 90-94] to see why. His is not an isolated case.)

JOGGLES: John Purvis, 2925 Marco Way, Carmichael, CA 95608. Perhaps others are dissatisfied with their efforts to achieve good 0.093 joggles in the 3/4 inch x 3/4 inch #580-14 stiffeners. My solution is too simple to be new but just in case--here goes. A 3/4-inch aluminum bar is shaped with a recess and with a backing plate of handy aluminum--say 1/4-inch thick--is clamped in a vise with the extrusion between. A punch is used to direct the energy of a hammer directly onto the standing leg of the extrusion. The left end of the bar is clamped in the vise, and the right end where the joggling takes place is relieved sufficiently to permit the standing leg to move downward. The relieving can be very slight. If relief is too extreme the standing leg will wander and produce a wavy result. The 3/4-inch bar is clamped and relieved on both sides so right and left parts



AIRSPEED INDICATOR CALIBRATOR

Figure 11

can be joggled. The dimensions do not appear to be critical and one bar will also set the 0.062 joggle just by using a lesser hammer blow. The punch should be used, because direct application of the hammer to the part will "ding" the part. My results have come out real "pro."

FUEL TANK STRAPS: by John Purvis. Perhaps another idea that is obvious--good results in bending the fuel tank straps to receive the bolts on each end have been achieved by placing two rods of 7/32-inch diameter vertically in a vise--with about 1/4 inch between them. The strap is then bent by inserting the strap between the rods about two inches, and smoothly pulling the long end around until sufficient bend is obtained. The strap is allowed to "unwind," and is continued back in that direction until the short end of the strap can be used to press against the long end of the strap and cause a bend, identical to that first placed in the short end, to be placed in the long end. It works real fast and results are excellent. If any imbalance exists between the two sides of the bend, one of the rods cn be placed in the loop and the strap clamped in the vise, and the loop tapped lightly to the appropriate side to created symmetry--holes are then drilled and waste trimmed off.

BILL JOHNSON'S PROGRESS: As you know, Bill is modifying his T-18 to install a retractable conventional gear. He has made an entirely new wing using a different airfoil with no camber, which he says is not needed with flaps. His gear is now mounted on the wing spar and the fuselage is about ready to button up. When he removed the wing and inspected the rivets around the ends of 601, he found the rivets loose. Although he had not made the wrap-around modification, he does not think it is adequate to distribute wing loads into the fuselage side skins. He has done a pretty thorough stress analysis of that area and says an additional doubler is needed to transmit loads from the B-580 doubler to the dash and side skin. A total of 12 rivets is needed between the B-580 and the new doubler. The doubler is a 15.5-inch long piece of 0.63 inch 2024-T3 bent up as an angle 2 inches x 0.6 inches. One is placed inside the dash at each lower corner. Except for the extra rivets in B-580, use the normal rivet spacing in the dash. Rivet spacing is 1/2-inch minimum in B-580.

Just got another letter from Bill: "While installing the new vertical stiffener at STA 70, I noticed another possible mechanism which could have some bearing on the 601 loose-rivet problem. Under g loads, the 601-2 clip transmits loads to the lower longeron, which will tend to rotate about a longitudinal axis and tend to move the center of the clip through a lateral distance. Note that during positive g this is inboard and during negative g, outboard of the static position. I am modifying the clip as shown to resist rotation."

JOGGLING ANGLES: by Malcolm Fowler.

1. This was how I solved the problem of those -10 brackets in the center section of the wing. Worked very well with no rejects. Make a hardwood block (maple or birch), two inches longer than bracket, band saw to profile making the angle sharper than called for to allow for spring back. Kerf through the center on bench saw. Insert flange in kerf and clamp tightly at high end, hold block as low as possible in vise to prevent block splitting then beat the 3/4-inch x 3/4-inch angle down.
2. Another quicky to joggle 3/4-inch x 3/4-inch angle as in forward fuselage modification. Place angle, not too tightly in soft-jawed vise, support horizontal flange with spacer slightly thicker than depth of joggle. Hold heavy block of steel on top of angle and hammer the unsupported end down.

DIMPLING AND RIVETING: Dave Hendrick, Star Route A, 1729C, Anchorage, Alaska 99501. For dimpling, chuck up your male die in a drill press and the female die in drill vise. Thus you do not spend time hunting the hole in the backup. Works well but is limited by depth of drill press throat. Another idea is the use of masking tape on face of rivet sets. Helps keep us amateurs from murdering rivet heads. Also, use tape to hold a line of rivets in place rather than install one at a time. Also use tape to keep components in position.

RIVET GUNS: Bert Nicholson, 3712 Riviere Place, North Vancouver, BC. I see that rivet guns at $39.75 is considered a good price. I purchased a Florida Air Hammer from US Industrial Tool and Supply, 13541 Aubury, Detroit, MI 48223 for $18.75 plus retainer spring and rivet sets at an additional $12. I bought the little regulator valve locally. This tool is listed in the US Industrail Tool and Supply Catalog #268.

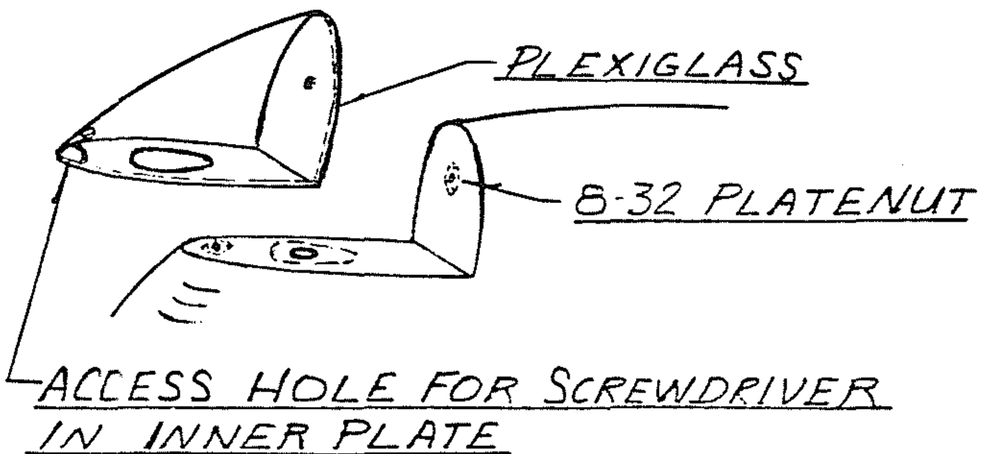
ANOTHER TRI-GEAR: R.L. Moore, 3327 Fenimon, Corina, CA 91722. I wish to thank you for publishing the T-18 Newsletter. It is informative as well as a source of inspiration fuel. When I start to lag on my project I reread some first flight reports. I have SN442 and, like many others, have made modifications. I do not claim to be an authority on aeronautical engineering but I do have an aircraft background. I am a retired (Navy) Chief Warrant Officer, and Aviation Maintenance Technician is my specialit. Retired 1960 after 21 years in Naval Aviation. I am presently involved in aviation as an Aircraft Division Manager of a small plant making aircraft structural parts. I am making a tri-gear (retractable). The drawings were completed prior to starting my project October 1967. I have rudder, fin, ailerons, flaps completed. The trailing edges were spot welded instead of being brazier head riveted as per plans. It makes a nice smooth surface. I used the 0.040

reinforcing strip as per plans with 426 AD3-5 rivets spaced approximately 12 inches for holding edges and strip until spot welding. First the holes were drilled, then the skin portions were dimpled (both sides) and then the strip countersunk to receive the dimplled skin. A rivet then was bucked until material filled dimple. Excess rivet then was milled off leaving a flush head both sides. The edges to be spot welded were etched, thoroughly neutralized then spot welded and finished off by dipping edge in zinc chromate primer. Some test strips were made and pull tests made which were quite satisfactory. I am presently skinning the outboard wing panels. Since I am using the D section of the leading edge for extra fuel, I have increased the number of rivets in the spar and skin as well as using epoxy at the joints for sealing and strength of skin to spar and nose ribs, beam web to spar caps. Interconnect between outboard leading edge and center wing leading edge is accomplished by beaded tubing fittings, hose and clamps.

The wing tanks will be filled at the wing tips--the nose ribs serving as slosh bulkheads. Three each one-inch lightening holes plus suitable 1/4-inch drain and air bleed holes were put in the nose ribs. I am presently working on the center wing. The modified spar is completed and am presently cutting and welding up the main gear fittings. To take the heavy shock loads of hard landings, I had to beef up the spar, using two upper spar caps with additional rear web making a box spar.

WING LIGHT COVERS: Here is the way I formed my plexiglass wing tip light covers. First, cover the fiberglas tip with outing flannel in the area where the light will be located. Heat a piece of plexiglass in the oven and stretch down over the fiberglas tip using broad-jawed pliars or clamps. This takes two people. Cut out the fiberglas as desired. Make two fiberglas bulkheads and cement into the tip. See Figure 12. Install light on bulkhead. Make two plexiglass bulkheads. Cement plexiglass cover and bulkheads together. Intall with two #8 screws into plate nuts located behind fiberglas bulkheads. The screw on rear bulkhead can be installed with a long screwdriver through a hole in the tip of the one plexiglass bulkhead.

PROPELLERS: Here's a letter from H. O. Beckett which might have been written before Sensenich decided they would no longer cut down props. The comments on harmonic modes should be of interest to everyone. "My engine is completed (O-320), and I bought a brand new Sensenich M74DM prop, cut down and repitched 67-68. I spoke to Mr. Rose, Chief Engineer, at the Sensenich. He stated that overspeeding the O-320 beyond 2750 rpm red line should in no way be harmful. However, he does state that there are several vibration ranges which are to be avoided in order to minimize chances of harmonic modes of the prop and engine. He says that each inch cut from the basic



WING LIGHT COVER

Figure 12

74-inch diameter prop will increase the 4th order (I believe) which occurs at approximately 2400-2500 rpm, by 100 rpm. He was not able to supply engineering data on the 67" x 68" or recommended cruising rpm. Mr. Rose says that operating on this harmonic could cause prop and/or shaft fatigue." (1986 Note: In-flight propeller vibration tests have accurately identified safe operating ranges for M74DM and 76EM Sensenich metal propellers.)

T-18 NEWSLETTER #30   05-70

Luther D. Sunderland

HORIZONTAL TAIL BULLETIN: John reminds all T-18 builders to complete the tail modification per the plans. When disassembling one tail to make the mod, they found loose rivets in the fittings. They were 1/8-inch Pop rivets. Of course, some were not long enough since it is not possible to get them long enough for this application. John says that the following is mandatory: Use only the AN 5/32 rivets specified for attaching the 510 horizontal tail fitting. Use no Pop rivets for this fitting. To buck them, use a seven-foot-long steel bar one inch or larger. It is also possible to use a shorter large diameter bar with a handle taped to it. Gravity does the job of holding it against the rivet. John is very concerned about the tail modifications and wants everybody to make them immediately.

HORIZONTAL TAIL TUBE MATERIAL: I was surprised to find how easy it was to get tail tube material. I just called my aluminum warehouse and they put me in contact with Mr. Weston at Tube Sales, 456 Nordhoff, Inglewood, NJ 07631 and he had a large supply. It comes only in 12-foot lengths. The 0.049 wall is $1.44/foot and the 0.120 is $2.61/foot. If you go in with other guys so there is no waste, it is about $17 per tail.

DICK WALEN FLIES: 2719 1/2 Powhattan, Toledo, OH 43606. March 14, 9:30 AM, ole 336 took to the air. Sure was beautiful. Had a qualified test pilot fly her. She indicates 130 at 2000 rpm and 155 at 2450. At present I have a roll problem. Right aileron pressure is needed to keep her from rolling to the left. I am trying to decide how much to lower the left wing trailing edge to correct this. Must be built in twist. Will send a detailed report when corrected. FAA said it was the nicest aircraft they had inspected in a long time. Sure makes me proud. Burst an oil line from firewall to pressure gauge on third flight. Had small orifice in firewall fitting so was able to get back before any damage was done. Advise builders to make sure of quality when installing hose and fittings. I took someone's word and it could have been disastrous. More later as soon as I have the information. (Engine is O-290-D2 135 hp with 68" x 70" pitch, 180 Cherokee prop adapted to prop extension.)

(03-31-70): More news--I have soloed my T-18 now and have six hours on it already. Lowered left trailing edge 1/4 inch and raised right trailing edge 1/4 inch and almost all rolling tendencies gone. Airspeed was checked against a Pacer and Tri-Pacer. Indicate 105 at 1700 to the Tri-Pacer's 120 indicated and 100 at 1600 to the Pacer's 112 indicated. At 4000 feet it will indicate 160 at 2500 rpm. At 2000 rpm it will indicate 130! I plan to cruise at 2450 or 2500 indicating 155 to 160. My airspeed indicator is slow compared to the planes I have checked it against so I do not know yet what it will true out to be. Hopefully 165 to 170 cruise, on 135 hp. Stalls are right now. The bottom just drops out with no warning or buffeting. I have not installed stall spoilers yet. I can get secondary stall by holding the stick back after she stalls the first time. No major problems to report. My engine breather outlet will have to be cocked more down into the slipstream as my belly is full of oil and it seems to be siphoning out--same on oil separator for vacuum pump. It is really a good feeling to go around all of those Cherokees, Muskateers and the like in my T-18. I am sure proud. I am glad I let a qualified person test my airplane as I do not think now I could have done it alone. By the way, I wheel land my T-18 all the time. I tried a stall landing and the tail hits first. A gust caught the left wing and put the right one on the runway before I knew what happened. Just skinned a little paint off and no other damage. I feel more comfortable in the flying attitude when the wheels touch. FAA permitted me to have a test pilot and he can ride with me anytime during the first 50 hours. My flight test area for the first 50 hours is 25 miles wide by about 40 miles long.

RIVETS: John Cragin, 34 Smith Street, Needham, MA 02192. Just a minor point, but an easy point of confusion and one that I recently investigated reference your aluminum alloy comments. The standard garden variety rivets with the dimpled head is the AD type A17S now called 2117, not 2017. Old 17S type D rivets with a raised dot are 2017. Enclosed is a copy of the pertinent page of my vintage **ANC-5 Strength of Metal Aircraft Elements**, now called **MIL Handbook No. 5.** This chart shows the designation equivalents. It is all academic though since the comments in this and earlier Newsletters still apply. Most handbooks do not mention reheat treat of 2117 so I called Alcoa here in Boston. The same rules apply for both 2017 and 2117, 940 plus and minus 10 degrees F for solution treatment. I guess we are all using AD rivets beyond the normal shelf life expectancy and hence the treatment is necessary. Chilling and cold storage should not be necessary with 2117 but quench is, just like 2017 and 2024. Check with your Alcoa office for their book **Riveting Alcoa Aluminum;** look at the rivet identification page similar to that in the Mech. Pocket Manual.

FORMING RIBS: Ed Rogers, P. O. Box 1767, Sioux City, IA 51102. Am starting construction on T-18, Serial Number 674, and have found Newsletters most helpful. Formed ribs with plastic hammer cut to chisel head. If wrinkles started to form--used birch block 2" x 2" x 4", with 60-degree angle face but hit with rubber hammer. After flange formed to full width of 3/4-inch birch form, used flat side of above birch block to smooth out flange by beating hard on it with hard rubber hammer. Worked better than solder bar. Rough cut ribs to full one-inch rough flange--bent surplus flange material after forming to about 45 degrees for ease of trimming--all flanges came out nice and smooth. Use electric metal cutting shears (Aircraft Components, Benton Harbor, MIchigan 49022) for trimming--it will be one of the most worked tools I have. Cut, formed, and trimmed all 16 nose ribs and 12 center wing ribs over Memorial Day Weekend. (Approximately 12 hours work.)

O-290-G PERFORMANCE: by Luther D. Sunderland, N4782G. While sitting here reading the material for this Newsletter, I decided that I had better get busy and take some good data on my T-18. Since today the wind is very calm, I figured it would be a good time for some speed runs. So I rolled out my bird and buzzed off. First I had to shoot a landing to see if I was as good as Springer Jones says he is getting, then headed for my measured course. (I never need brakes either unless I get to watching the scenery.) We are not so fortunate in this part of the country and have nothing measured to use for speed checks. I have located a six-mile course using topographical maps. I flew back and forth over this course four times and, using a stop watch marked in one second units, got the same readings every time, 150 mph at 2000 ft MSL, 56 degrees F, 2450 rpm and 1242 pounds. The wind was about 5 mph directly across course. Then I opened it up and made one run at full throttle, 2900 rpm, 2000 ft MSL and made it in two minutes even, averaging 180 mph. I even gained 200 feet to keep from exceeding red line. That is really moving!

O-290-G PERFORMANCE DATA ON MY SHIP, N4782G: by Luther D. Sunderland. Lycoming O-290-G, 125 hp, FP prop 68 long x 66 pitch; max static 2300, OAT 15 degrees C, 840' alt; max at 5000' 2950 rpm, IAS 178, OAT 5 degrees C; max at 2000', 2900 rpm, IAS 180, OAT 11 degrees C; airspeed was calibrated in lab and over measured course. Max TAS 187 mph at 2950 rpm, 1350 pounds, 5000', OAT 6 degrees C; oil temp at 70 degrees F is 190, at 90 degrees F is 210 degrees. Small Corvair cooler front of left front cylinder, max RC 1300; cruise 150 mph at 2500 rpm, 6.5 gpm; cost 2000, 3 1/2 years; empty 881 pounds.

O-360 PERFORMANCE DATA, SN587 N198SJ: Springer Jones, Route 1, Mitchell, Nebraska 69357. O-360-A2B 180 hp prop 70 x 81 fix pitch, static max 2200 at 42 degrees F and 3985' elev; max level at 6000', 2750 rpm, 172 IAS, +5 degrees C; at 10,000' 2500 rpm, 155 IAS, -10 degrees C; Airspeed calibrated measured course; max ground speed 192, 2750 rpm, 1600 pounds, 6000', +5 degrees C; Corvair cooler, max RC 1500 fpm; 9.5 gph at 180 cruise, 2450 rpm; cost $3500+ in 20 mo., first flight October 8, 1969; empty 898 pounds, forward cg 62.6 (15.2%), gross 67.5 (25%), empty 60.78 aft 69.8 (29.6%).

O-320 PERFORMANCE DATA, #329 N2721: Major Robert Pargin, 2720 Mossdale Drive, Nashville, TN 37217. O-320 150 hp prop

68 x 72 FP, static 2500 rpm, 59 degrees F, 540' elevation, max level at 5000', 2750 rpm, 160 IAS, +5 degrees C; at 2000', 2750 rpm 165 IAS +9 degrees C, no calibration, max ground speed 150 mph, 2500 rpm, 1350 pounds, 5000' +9 C; oil at 70 degrees OAT 195 degrees F at 2500 rpm, 90 degrees OAT 210 degrees F 2500 rpm, Corvair cooler, RC 1300 fpm at 1350 pounds, cruise 150 mph at 8000', 8 gph, 2500 rpm; cost $4000, 2000 man hours, first flight September 25, 1967, empty 860 pounds, cg measurements aft of leading edge fwd 7 inches, gross 10", empty 7", aft 10 inches.

O-290-D PERFORMANCE DATA #117 N18116: Ron Zimmerman, 1915 McKinley Street NE, Minneapolis, MN 55418. O-290-D2, 135 hp; prop 69 x 67 FP, static 2250 rpm, 58 degres F, 908' elev; max level 4000', 2750 rpm, 170 mph IAS, -4 degrees C, 24.8 mp; 6000', 2740 rpm, 164 IAS, -6 degrees C, 22.9 mp; 8000', 2700, 156, -10 degrees C, 21"; 10,000, 2675, 148, -13 degrees C, 19.2"; max ground speed 180 mph, 2775 rpm, 1350 pounds, 2000', -5 degrees C; largest Corvair cooler, fwd of left cyl; RC 1400 fpm; cruise 155 TAS, 7 gph, 2350 rpm, 21", $4000+, 3.5 years, first flight, July 10, 1967, empty 880 pounds, fwd cg 63.1 (16.2%), gross 68.2 (26.4%), empty 62.3 (14.6%), aft 70.5 (31% with 90-pound baggage and 8 gallons in tank).

O-320-A PERFORMANCE DATA, #301 N318W: Callabie Wood Jr., 1121 Forest Hills Road, Wilson, NC 27893. O-320-A, 150 hp, prop 70 x 70 fp, static 12300, 70 degrees F, 160' elev; max level, 5000', 2750 rpm, 175 IAS, 70 degrees F, 24" mp; 2000', 2950 rpm, 185 IAS, 70 degrees F, 27" mp, calibrated on measured course, max ground speed, 180 mph, 2800 rpm, 1450 pounds, 7500', 21" mp, 50 degrees F; oil at 70 degrees OAT 180 degrees F; cardinal cooler fwd of left cyl; RC 1200 fpm; cruise 150 TAS, 7 gpm, 2500 rpm, 17.5" mp at 7500'; $4000, 18 mo.; first flight May 6, 1967, empty 830 pounds.

FLYING DOCTOR: Dr. Richard Cottingham, M.D., Rural Route 2, East Highway 6 and 34, McCook, Nebraska, 69001. Have all pieces done on my own T-18 save horizontal tail for assembly. Wore out a Mooney Mite in about 350 hours last year and, since purchasing Dick Hanson's T-18 299V last June, could not be more enthusiastic about an airplane. Put 339 hours on 299V in 10 months, rain or shine, hitting six sod fields per week, two of these atrocious. Had 1200 hours when I bought 299V, all tricycle time. Only tail wheel qualified instructor in this area was about three seconds behind everything in the cockpit from the right seat--typically calling out "right rudder" when we were veering about 30 degrees right on the runway. I decided after two hours of this I would have to go it alone. Spent eight hours on a 6000-foot asphalt strip making taxi runs, eventually minor lift offs and back on, etc. Learned that it is better to not do this in Nebraska in July as I warped the right brake flange in the average 100-degree F heat during this time. Decided I was ready and flew it off and on a number of times after the eight hour runway priming. Since then, 299V has been subjected to daily punishment including the worst sod fields in the US, wild mid-summer cumulonimbi, 30-40 mph crosswind landings, oil burner route vortices from B-52s and has been stood at bay by a 1700-pound Hereford bull after a night landing (no landing light then). He had taken over a Kansas strip last fall.

At 240 hours of this, I noticed the tail springs drooping one day and forward edge of tail spring was down 3/4 from the fuselage. Disassembled the tail and found the 591 fitting completely fractured aft of the flange. 5/16-inch bolt, nut plate, OK. Further found fractures (several) in the 583 fitting on the 576 bulkhead--some were old and had been stop drilled. New fittings, doubler on the lower 1/2 of the 576 frame have held up well after another 100 hours of the same torture. I am hesitant to report this since I think it is directly due to the lousy fields (especially when frozen), poor landings, and probably fast taxiing over these.

If I have to drive to look after my practice in this area it amounts to 19 hours in the car a week. The T-18 has cut this to five hours. Routinely indicate 165-170 and G.S. averaging 190 mph at 11 GPH. (Need an EGT) 2400 RPM and 23" MP-- usually abaout 5000 ft MSL. It is a great airplane!

JOHN THORP: Rudy Adler is claiming 180 mph V max for his T-18 with GPU. This gives an "f" = D/q = 2.5 feet squared and a CD of 0.029. The L/D at 1400 and 103 mph is 11.5. This is all better than it is supposed to be but I cannot dispute it. Your 75% power cruise is about 2700 rpm at S.L. with an increase of about 25 rpm per 1000 ft to full throttle at 2900 at 8000 ft. (all density altitude).

John says he will not be able to be at Oshkosh this year. I probably will not be there either for I am taking the family on an auto trip to California about then.

After getting the above letter from John yesterday, today I thought I would see what my T-18 would do at the 2700 rpm cruise. While at 2000' and 2700 rpm, I indicated about 167 mph. OAT was 55 degrees F.

MAGNETO PROBLEM: For 180 hours I have been plagued by a problem which I have finally solved. When at full throttle, occasionally the engine would give a little jerk like it missed once. Thought it had to be carb but it was a bad mag. Hooray! Be certain to install magneto cooling air tubes on the rear baffles. Otherwise, magneto coils will have a short life.

T-18 NEWSLETTER #31 09-70

Luther D. Sunderland

OSHKOSH 1970: Everyone who attended the Fly-In at Oshkosh seemed to have the usual good time and was amazed that such an involved event could be moved to a new location so smoothly. There were 13 T-18s there this year belonging to: John Wallace, Springer Jones, Ed Baker, Jim Reed, Atlanta Chapter, Ron Zimmerman, Larry Larcom, Dick Walen, Al Neunteufel, Tom Miller, Lionel Ribodoux, Bernard Thalman, and Bob Goodwin. I managed to cut my camping trip to California short and spend a few days at Oshkosh but without my T-18. John Thorp was unable to attend and asked me to hold the engine and T-18 forums.

Georgia Modifications (John Wallace): This year's crop of T-18s brought some interesting variations. John Wallace had the first of the highly modified version being built by the Tiger Club from Lockheed, Marietta, Georgia. He says there are about seven more in that group still actively working on their projects. John got started just two years ago after all the changes had been made. He certainly built his airplane in short order but did not cut any corners for it had excellent workmanship. The most outstanding feature about it is that it is undoubtedly the quietest T-18 I have flown. I attribute this to the shape of the canopy, although it is just a guess. He has the firewall and floorboards well insulated, so engine and exhaust noises are almost undistinguishable, but there just is not any of the usual rushing air noise around the canopy. Many of the T-18s at Oshkosh had canopies so sealed that I nearly roasted, but none was as quiet as this. The canopy and windshield are a free-blown bubble without the flat area in the middle. I do not necessarily prefer the bubble because it cuts down on valuable head room on the sides, but it sure is quiet. The aft deck under the canopy was also modified making it parallel with the waterlines and with a hole giving baggage compartment access from the top somewhat like mine.

The fuselage forward of the wing had the lower corners rounded off. A smaller diameter spinner was used with a new shape cowling. Wing tips were the droop type. John said that he thought the tips improved low speed aileron control, but he had no direct comparison since he had not flown in another T-18. When I flew in it I slowed it down to stall speed and, sure enough, it did have good aileron control through stall. Of course, the standard model also has good control, except in the ones which drop off on one wing, so it is hard to say how much difference there really is. With a 150 hp engine, it would only indicate 170 mph, which is less than my 125 will do, so there is no way to tell whether the tips help speed or not. John and his wife are justifiably proud of their airplane and use it extensively for cross country flying.

Fixed Tri-Gear: The Atlanta EAA Chapter had a tricycle gear T-18 there with a totally different canopy. I did not get to talk with the pilot and did not see it fly so could only inspect it externally. The two main gear legs were of tapered round spring steel which came out at the forward corners of the fuselage where the standard gear comes out, but at a much different (swept back) angle. They were quite long. Could not see how the nose gear was anchored. The cockpit was partly covered and had side doors somewhat like an Emeraude.

Propeller Failure: Jim Reed had pictures of the propeller blade failure which caused the accident in Maryland. He said that the prop had been sent back to Sensenich once for straightening and then, after being bent a second time, had been straightened over a car bumper. For this reason, it would be difficult to draw meaningful conclusions from the incident. (1986 Editor's Note: This was a cut-down M74DM propeller on a 160 hp engine. Bob Dial's blade failure was on an identical installation.)

Award Winner: Dick Walen won the Russ Basye Memorial Award with his 135 hp model. It was completely flush riveted and the rivets were filled so well you could not tell where they were. He claimed the fastest speed for under 180 hp but had not calibrated his airspeed, 190 mph max indicated in hot weather and near 200 in cold weather. We went up and checked the airspeed over six miles of section lines, both directions. While indicating 180 we averaged 176, so it was fairly close. He has a 68 x 70 prop from a 76EMM blank. It will get 2800 rpm max. He has a Rattray cowling with exit on the bottom and closed sides. Its shape gave sufficient pitch-up moment to require changing the linkage in the trim system. He is now replacing his cowling with one which exits on the sides.

Canopy: Bob Goodwin found a way to keep his canopy down tight. He ran a large tube from the deck under the canopy to an outlet under the fuselage. This sucks air out of the cockpit and he says it keeps the canopy down in back. He suggests we publish a list of dos and don'ts for builders and is going to send in a list for a starter. For instance, he bought a 180 hp engine with oil cooler and one impulse mag, with a dynafocal engine mount. "Do plan to use a manifold pressure gauge and do plan to get checked out properly or have someone else test fly your T-18." On his 180 he can get 205 mph maximum.

Noise Suppression: After riding in a number of T-18s, I can give some pointers which might be of help.

Noise level varies greatly from one to another. Those with only a rug on the floorboards had the greatest amount of exhaust noise. Pack in lots of insulation and use an extra floorboard of light weight material. I used 1/4-inch Philippine mahogany. Firewall insulation is next in importance. Use tape on the firewall, then insulation and upholstery. Do not leave any holes for noise to get through. A tight canopy seal makes for low noise from air movement. Nearly everybody had a good seal, but this makes other problems.

Air Vent: No one seems to have solved the problem of getting a good supply of fresh air. I never realized how serious this problem was since my canopy leaks enough to make my cabin comfortable even in summer. But when I rode in others with a good seal, I found how uncomfortable it could be. So, put in a good fresh air source. Do not bring cool air through the engine compartment for it turns out to be hot air by the time it passes through the ducts. Callabie Wood just cut a hole in the center bottom windshield and put in a little door type vent. Do not expect to get air on the fuselage sides because of the engine cooling exits. I have not seen a real good arrangement yet. (1986 Note: The vent door at the rear of the canopy is the best arrangement, supplying plenty of air.)

Cabin Comfort: Those with radios slung under the panel are almost impossible for me to ride in, even as a passenger, unless the stick is removed. On some, I could not move the stick toward the center of the airplane even one degree with my knee in the way. I am 6' 2" so my knees just barely clear the bottom of the panel. A short person has no problem for his legs stretch out down low. If you expect to have anything but short passengers, do not hang anything under the panel.

My other big problem is with the tunnel. Unless I remove my wallet from my hip pocket, I hang up on the tunnel and cannot even slide down far enough to touch the seat, and it is not because I have a fat wallet since it usually contains little more than some T-18 pictures. With the tunnel rounded off it is much more comfortable.

Visibility: Over-the-nose visibility varies quite a bit. The worst ones are those with free blown canopies which do not conform to the plans and cut off head room. Then, even with a standard canopy, if the seat is not high enough, I cannot see over the instrument panel without stretching my neck. This is why I like the extra 3/4 inch on the windshield frame. With this, the T-18 has more than ample forward visibility, for it gets the windshield frame up out of your line of sight.

ENGINE FORUM - 1970: The engine forum had as participants Lock York, Aircraft Sales Manager for Continental Motors;

Dick Scheffler, Regional Service Managaer for Continental; Dick White, Franklin Sales and Service, and I acted as moderator.

Mr. York first gave a description of the new Tierra series of engines and how a manufacturer goes about certificating an engine. In case anyone was wondering why EAA has not developed a line of engines for the homebuilder, this new series is costing Continental about 25 million dollars. They will not be out until next year. The object of producing the new engine is to improve the horsepower to weight ratio and reduce costs. It has a two to one gear reduction to the propeller shaft, giving attendant benefits to both propeller and engine efficiency. It is particularly smooth running. Geared engines are normally rough in torsion, but the Tierra engines have eliminated the need for torsional dampers through the use of a quill shaft drive. It has a hydraulic drive coupling for high speeds and it locks up for low speed operation. Tension bolts hold the cylinder heads to the cylinders. They tried to design a standard exhaust system but the first seven applications took seven different exhaust systems. Heads are common for all engines and cylinders are interchangeable. It uses a new Bendix four-pole magneto due to the high crankshaft speeds. The four-pole mag turns at only half the speed of a two-pole mag. The number of cold starts has a far greater effect on engine life than does engine speed. The worst possible service is a ten minute run once a week.

Automobile engines get much less severe treatment than do aircraft engines. An auto engine spends its average life at less than 30% power while an aircraft engine runs at 75% power. A Cadillac running at 75% power would be travelling 128 mph. A 125,000-mile Cadillac would have wear and tear comparable to a Bonanza with 1000 hours. Red line is not critical on the O-200 engine. At one time they thought 3100 rpm was max due to valve float but it was raced at 3800 rpm with no problems.

The oil companies are planning to discontinue 80 octane gasoline soon and supply only the 100-octane lead-free type. Shell claims it will not hurt any engine. Continental now has an O-320 under test to determine if there are any detrimental affects other than cost. They warn that you should not advance the spark any with 100 octane. On automotive gasolines, here is the straight scoop. The problem with using automotive gasoline in airplanes is that aviation fuel vaporizes at no greater than seven pounds per square inch pressure whereas some automotive gasolines can vaporize at as high as 19 psi. They must have to use that along the Dead Sea since sea level pressure is 14.7 psi. Anyway, that it the explanation Lock York gave.

Dick Scheffler gave answers to the most frequently asked questions. If you have any question about overhaul manuals, parts manuals, etc., write to Continental Motors, for their free list of publications.

Can an alternator be substituted for a generator? Yes, an alternator is lighter and can be used on any engine down to the C-75. The Mooney Mite even used a generator on the C-65.

All pal nuts can be left off cylinder hold down bolts. Nuts will never come off under vibration without them.

Scores at top of cylinders are cold-start scores. They result from no oil at the top of the piston. Do not run an engine at 1800 rpm right away after starting. The cylinder becomes distorted at first due to the top being hotter. They are ground with the top smaller, to compensate for the temperature gradient. Until the engine becomes heated, the top ring might break due to the ring motion from cylinder taper. (cont. in next issue.)

PERFORMANCE ON 135 HP, #336: Dick Walen, 2719 1/2 Powhattn, Toledo, OH 43606. I do not have too much to report so I will try and relate some performance figures and statistics about my last long cross country--from Toledo Express Airport non-stop to Fulton Airport (New York) = 435 miles in two hours and 15 minutes = 193 mph GS and 19.3 gallons. Return trip, Fulton, NY to National Airport, Toledo = 411 miles took two hours and 45 minutes = 149 mph GS and 23.6 gallons. Total trip = 846 miles in five hours = 169 mph both ways and 8.6 gallons per hour at 2450 = 19.7 miles per gallon. All that on 135 hp. I sure am pleased.

George Rattray and I are working on a new streamlined cowl which should prove to be a little cleaner than the one I have now. It will have side outlets for air exhaust. We can clean up and flatten the belly of the cowl. I am looking for a DM hub prop, which is about 10 pounds lighter than mine and I want to go to about 72" or 74" of pitch. Most of my flying is cross-country and I think I can use the extra pitch. Now I can turn 2750 with 70" pitch in the hot summer and 2800 in the winter. I will sacrifice my climb, but I think it is worth it, don't you? Still have not got my oil problem solved yet. I think my separator from the vacuum pump is the culprit. Will run the line through the gear fairing and exhaust it at the wheel. I am getting tired of scrubbing the oil off the belly. Have 75 hours on her now and my landings are getting better--still a bounce now and then though. If I can help any fellow T-18 builder locally--Ohio, Michigan area, let me know. Be happy to fly in and give a ride on weekends.

STRONGER NOT BETTER: Many homebuilders seem to follow the same philosophy as the guy who wore both belt and suspenders to be double safe. They feel that if they can make a part stronger than is called for on the plans, they will do it. It is most discouraging to see the results of this practice. I first ran into this when I built the Sky Coupe. The fellow who helped make the fiberglas nose piece put four layers of cloth in it instead of the two that I had requested. I asked why and he said, "To make it stronger." This would no doubt be quite helpful if you planned to run into a lot of brick walls, but it sure did not help the rate-of-climb any. It seems that almost every modification anyone makes to a T-18 part is in this category.

Tonight I inspected a T-18 which had recently changed hands. The parts were 90% complete and assembly was 50% complete. The original builder had worked for about seven years and finally got discouraged and sold out. It was clear what had happened to discourage the builder. Most was a result of not following plans or building instructions. Here are some examples: Large gussets were added to the bottom corners of all fuselage frames. Then large amounts of epoxy were poured around each frame corner. The frame aft of the seat was made with a two-inch wide flange all around. The supports under the aft canopy rails were made to extend completely between two frames and had one-inch wide flanges. The frame back of the baggage compartment had a solid piece of 0.025 riveted across it with a jillion Pop rivets, completely closing off access to the aft fuselage. A number of 1" x 1" angles were riveted to this sheet and around the baggage compartment for supports and stiffeners. It seems I have spent more hours inside my tail than in the cockpit--looking for pitot leaks, troubleshooting omni co-ax cable, replacing tail springs, etc., so the tail certainly cannot be sealed off.

An angle was hung from the seat to the tail down the middle of the fuselage to support the pitot static tubes. An aluminum sheet cradle had been riveted between the fuel tank supports. Heavy coil spring seat frames had been built up from automotive parts. Without upholstery the back was about four inches thick. In addition to the heavy steel bottom seat frame, underneath it was a 3/4-inch plywood bottom. An A-frame for Zimmerman-type main gear had been arc welded (strictly illegal) and the welds had been built up by successive rewelds until the bead was as much as one-inch wide. The fuselage had been flush riveted with a mixture of Pop and AN rivets. There were a number of oversize brazier head Pop rivets around the top firewall flange. All rivet holes had been drilled and dimpled undersize to be drilled out later. This is a good safe procedure to prevent cracks, but it sure causes a lot of extra work and it is not necessary. (John says they are still flying airplanes which were built back in the 30s with 1/8-inch holes dimpled after drilling and there have been no problems with cracks.) This airplane would have been rugged enough but sure had a lot of extra pounds which added nothing to an already well-designed structure. Remember, in airplane design the name of the game is not to make it as strong as possible. Rather, it is to make it as light as possible with adequate strength. Once a part is strong enough, any further "beefing" is detrimental, for it throws off the cg and cuts down performance. Sure, 0.032 skins are stronger than 0.025, but who needs them? Or do you wear a belt and suspenders?

O-290-G ENGINE: by Luther D. Sunderland. Since the article on the O-290-G Lycoming engine appeared in the May 1970 issue of **Sport Aviation**, many builders have wondered if this engine is really safe to fly. Some have actually pulled them out of their airplanes. I have just had a long conversation with John Thorp about the points brought up in this article. He is an authoritative source on Lycoming engines, especially the O-290-G, having torn down 40 and rebuilt 20 of them. The article cast doubt on the camshaft, valves, pistons, propeller flange, and general airworthiness of the engine. Here is what John has to say on these subjects.

Camshafts: Figure A showed a picture of two camshafts, one with wide cams and one with narrow cams. The article said that the narrow O-290-G cam would not hold up and should be replaced with a wide one. The G engines used two different camshafts. The early engines used the 61527 cam. Only four of the 40 engines had this shaft. All the others had the 62772 shaft, which is the standard shaft for the O-290-D and O-235-C engines. Both of these shafts have narrow cams, but John only used the 62772 shaft since the obsolete 61527 shaft had been reported to give trouble. The 62772 shaft is a good shaft and has given no problem even when used in biplane racers turning up 3300 rpm. The only camshafts with wide lobes are the 70492 Hughes helicopter cam and the current 74167. Both of these are suitable for use <u>only</u> with hydraulic lifters and may be used in the O-290-D2, D2B, O-320 and O-360 engines. Caution!! With a little filing for clearance, these wide lobe camshafts can be made to fit into the O-290-G, but they should <u>not</u> be used. One person tried an O-320 shaft in his GPU with very bad results. It buckled a valve stem, buckled a pushrod and stretched a valve. The cams made for hydraulic lifters have a different shape and set up excessive stresses in the valve train if put in an engine with solid lifters. The part number is stamped somewhere along the shaft between the lobes, so you can check yours when you overhaul the engine.

Valves: The article advised the replacement of 3/8-inch stem exhaust valves with 1/2-inch stem valves. John never heard of a 3/8-inch valve being used in a GPU. The standard O-290-G valve is the 62386 which has a 13/32-inch stem. It is set up for valve rotator caps, has a solid stem and is a good valve. The overhaul instructions handbook T.O. 3862-40-13 lists this size valve as standard for the O-290-G1 and O-290-G4 engines. The O-290-D and D2 exhaust valve is #66531. It also has a 13/32-inch diameter stem that is solid. It differs from the 62386 in that it uses a 60009 retainer key. In the article, Figure C, Number 1 valve is a 66531 and Number 2 is a 62386 valve. 7/16-inch stem valves were used in the 150, 160, 170, and 180 horsepower engines. Some 150 horsepower engines used solid stem valves #69534, and the others used #71595 sodium filled valves. John has never found 7/16-inch valves in a GPU but has put this size in them by using the standard 69533 valve guide or by boring out the GPU guides to fit the 7/16-inch stems. He feels that the 7/16-inch stem exhaust valves, particularly the sodium-filled ones, will run virtually forever in a GPU. The 1/2-inch stem valves are used in engines with hydraulic lifters. They should not be used in the O-290-G engine because there would not be sufficient lubricating oil. The 74636 rocker shown in Figure D of the article differs from the 69444 rocker in that it has an oil jet that sprays on the valve stem but it cannot be used on the GPU with solid lifters as there is no provision for valve clearance adjustment. Some of the GPU engines come with valves which have been badly necked down under the heads. These naturally should be discarded.

Crankshaft: The O-290-G crankshaft is the standard O-235 shaft. It differs from the O-290-D shaft in two ways; the sludge tube passages are larger and the propeller flange is not as thick. Although the sludge tube passages are larger and this does give somewhat less strength in that area, it is not known to be a problem. The O-235 shaft has a propeller flange of 0.190-inch thickness. Starting with the O-290-D and going up to the O-360 180 hp engine, the flange is 0.260-inch thick.

Although there have been few problems with the G flange over the years, within the last year, there have been four cases reported of either cracks or complete flange failure when metal propellers were used. Two of these involved four-inch shaft extensions. For this reason, the propeller and ring gear should be removed periodically, at least at annual inspection, for a close examination of the flange for cracks. The cracks start at the jagged edges of the two 1032 tapped holes. These holes should be deburred and the screws should not be used.

Crankshaft Flange Reinforcement Bulletin: Take off the ring gear and inspect the flange before flying again. It is evident that the G shaft flange should be reinforced (especially since mine was one of the four). Figure 1 shows a flange support that I designed, which can be installed without disassembly of the engine. It not only will sufficiently stiffen the flange so it will be kept below the fatigue limit of the flange material, but even in the event of complete flange failure, it would prevent the propeller from separating from the airplane. Due to tolerance considerations, it is not possible to tightly clamp the split ring to the shaft. The epoxy is used only as a shim. Holes for the lugs must be precision bored for a press fit. The flange is counterbored because the lugs are only at maximum diameter for 0.25 inch and they need to be a press fit in both flanges. I am running a test on this reinforcement with frequent inspections. John concurs with this mod, although he feels it would not need to be quite as heavy. But then he never had one fail. This may be a belt and suspenders situation, but sometimes it is necessary if we do not have big enough hips. See Figure 18 on page 299a for more.

Metal Propeller Failures: A bigger problem to the homebuilder appears to be with propeller blade failures on metal propellers. Recently, two cases have been reported where homebuilts have lost about 16 inches from metal propeller blades. This, of course, is not exclusively a homebuilder's problem, for the factory jobs have their share of blade failures. Blade fatigue is less of a problem with lower compression engines like the O-290-G, but the only way to be sure that a propeller installation is safe is to run an in-flight vibration survey test for each different propeller length and pitch, engine horsepower, and engine mount combination. Such a test is very expensive and complicated and can be run only by someone who has all of the necessary equipment. Arrangements are being made to run such tests on a T-18. (More on this later.)

Piston Rings: Some O-290-G engines come equipped with four-ring pistons while others have three rings. Over the years, Lycoming has been unable to decide which they preferred and switched back and forth several times. For instance, the O-235-C has four-ring pistons so they are used in aircraft engines. John has always discarded the four-ring O-290-G pistons and used the three-ring ones, but some people have had success in simply leaving off the scraper ring.

The O-290-G engine is a fine, reliable powerplant for use in homebuilt aircraft if properly converted and maintained. If an oil filter, cooler, and a good air filter are installed, it will last more hours than most of us will ever fly. Good cooling is a must, however. Throw away all of the original cooling system baffles--including the ones between the cylinders--and copy a certified airplane installation like a Cherokee. Do not expect low oil consumption unless the valve stem to valve guide clearance is low. The G manual allows 0.008-inch clearance. Do not believe it. Replace the guides if there is more than 0.0035-inch clearance. Do not ever reuse piston rings once the cylinders have been removed because the rings will never return to the exact original position no matter how few hours they have on them. New rings will seat only if the cylinder walls have had the glaze well broken and non-detergent oil (no STP) are used for the first 25 hours. Never remove top spark plugs unless the piston is at top dead center, on the compression stroke. Cracked loose carbon may otherwise get under a valve seat, later burn itself fast and bye-bye valve. This advice was learned the hard way, through experience, so take all of it seriously.

If you are lucky enough to find a GPU, thoroughly overhaul it, treat it right, and enjoy many happy hours of flying.

BILL JOHNSON'S PROGRESS: I just had a visit with Bill Johnson and saw the parts for his retractable gear modification. It is coming along slowly, as anyone who has tried this type of project will tell you. Of course, Bill has the usual amount of distractions, for he is also building a cottage on the seashore. The fuselage is now completed except for the fairing around the wheels. The castings which pivot the main gear legs are machined and attached to the main spars. He is now adding all the little stiffeners and gussets to the center section to transmit the very high torsion stresses caused by the far-forward location of the wheels. To see the angle the gear leg makes with the ground, draw a line from a point about two inches forward of the center of the main spar to the center of the axle of the standard T-18. The wheels need to be this far forward to keep the aircraft from nosing over on the ground. The legs are made of the same tubing as the standard gear with a 1.25-inch tube inside a 1.5-inch tube. He hopes the bending of the leg will give adequate softness and thus he does not use clecos. He intends to sell plans and the two main gear castings after the design is flight tested. (1986 Note: Sorry, but plans are not available.)

PEDRO (PETE) D. GONZALES, #380: 1318 Server Drive, Colorado Springs, CO 80910. Tail section, wings, and fuselage are FAA approved. Need to close up stabilator on ends plus vibration tail mods. Have new tail spar installed. Fiberglas fuel tank and instrument panel are completed. Nothing made ahead of the firewall, except that I purchased the main gear. Have a 125 Lycoming from a Tripacer but will disassemble and balance and overhaul before using it. Have wheels and brake assembly from a Colt, which may be slightly heavy but will allow rough field landings. Axle presents a problem due to its larger diameter, which will make it hard to bolt to the purchased gear. Am now installing a new Omni antenna and the wiring in the fuselage so I can close it up. I have a Cardinal Lycoming 150 prop cut and twisted to 67 diameter, 67 pitch. A friend, Col. Rick Loeffler, is using it on his Pazmany which is on temporary airworthiness. He has an O-290-G and is getting 133 mph TAS at 8,000'. Field elevation at Meadow Lake is 6880 feet and he has no trouble getting airborne with himself and a 185-pound man (essential crew member).

There was some trouble with the trim for the servo-tab due to the unavailability of a satisfactory cable for the bends. Any cable I used would unravel somewhat in one direction. I discovered that a heavy duty truck speedometer cable of 0.177 diameter worked very satisfactorily, not only for the sharp bends but to carry all the way from the cockpit to the rear bulkhead A-576. This speedometer cable has the advantage of having each twist opposite to the preceding, therefore having no tendency to unravel. Using this cable, I was able to do away with terminal 719 by using a piece of 1/4-inch 4130 tubing drilled out with a 3/16 bit, which allowed the cable to slip in nicely for swaging while the OD of the tubing fit the 715-2 and 715-3 fittings exactly, minimizing the lathe work. I also drilled a 1/4-inch hole in tunnel 505 directly above the roll pin in front of the 715-3 fitting which allowed easy removal of the pin for removing the A-504 tunnel when access to the rudder cables at front is desired. The speedometer cable was purchased from the local International Harvester Truck Store at retail of 75 cents/foot. I purchased mine wholesale for 58 cents/foot. I did not like the sag of this cable between bulkheads so I purchased some low pressure 3/8-inch diameter nylon fuel line and used it for a housing from the rear of the tunnel 505 to the support bracket on bulkhead 574 (actually about 6 inches past bulkhead 574). Ten feet of this purchased at the local plastics outlet at 39 cents/foot was sufficient. NOTE: 13 feet of the 0.177 speedometer cable sufficed for my needs. Another possible tip. I had difficulty placing and removing the bolts that bolt the main spar to the bulkhead at station 70.0 so I drilled 1-inch holes in station 76.5 bulkhead so that a wrench, socket and extension could reach across to the bolt from under the seat--after removing the seat, of course. (1986 Note: Good idea. Another good solution is to not attach the fuselage spar cut-out gap cover to the center section but, rather, use a separate gap cover that is P-K screwed to the fuselage.)

BERNARD J. THALMAN, #86: 2912 Old Glenview Road, Wilmette, Illinois 60091. Number 86 flew open cockpit in 1968 for some 60 hours until it got too cold in November. I then brought it home complete with ten field mice, (those recessed tie-downs are great for mice.) to do a little work on it. The little work has only taken two years. It included installing a canopy (IAS without was 135), wheel pants (I am tired of washing the mud off.), cowling replaced, tip lights added, rear deck cut down, new seats, electric trim, radio, etc. I hope to have it back in the air soon.

The first trouble I ran into with the T-18 was the engine; the engine would go sour as the fuel got low or the speed increased. It turned out that the fuel tank vent was not turned into the airstream enough to pressurize the tank--same trouble as listed in an old Newsletter. I built the regular landing gear as per prints and found ground handling very nice. I did not heat treat the gear, and after one 5G landing the gear spread one inch. It has since been pulled back into shape with a Blackhawk tool and heat treated.

My electric trim is nothing more than a Grimmes light motor mounted on the second last bulkhead with a flat plate of 0.090 and the flex shaft moved to the motor spur gear. A fuel gauge sending unit and gauge act as a trim indicator. Idiot lights were installed on the oil and generator. It is one sure way of not leaving a master switch on.

Painting Tip: For nice sharp lines, use 3M low tack tape ("Paklon" Film Tape 682). Sign painters use it. It is great. No need to spray a coat of clear as with masking tape.

PLEXIGLASS DRILLING: by B. C. Roemer, Manitowish Waters, WI 54545. After reading all I could find on plexiglass, I did not see how to drill holes easily and safely. I sharpened drills all different ways, but had little success in keeping them from "grabbing". Here is the way to go: (1) Mask both sides of the hole line. (2) Lay out holes. (3) Heat the tip of a prick punch hot and hand push it into plexiglass to form a drill starting mark. (4) Drill 1/8-inch holes with regular drill using a very slow speed (use variable speed drill). Back the piece with wood--flat on flat, radius on curved. Always drill from outside inward on a curved part. (5) Enlarge the hole to 1/4 inch using slow speed and regular drill also backed as before. (6) Use a 3-flute, 1/2-inch counter bore with 1/4_inch pilot, slow speed and backed as before and you are done. The 3-flute will not grab and it is a scraping type cut. The backing wood must have a 1/4-inch pilot hole in it when using the counter bore.

I was unhappy with the prop from Anderson. They sent it UPS and it was all marked up--trailing edges nicked and had to be refinished. The rub? Well, you must send cash in advance and Anderson only insured it for $50 with UPS. I demanded a new prop but they just refinished the beat one. Moral of story--be sure to have supplies insured for full value especially when you send money in advance.

The building tip concerning heat treating spinners--you said to leave the rear bulkhead in when heat treating to minimize warpage of shell. Surprise! Rear bulkhead warped so badly I had to scrap it. (1986 Note: Sorry about that--mine did not. Pershing Larson does it for you now and John Tonzer.)

Our trip to California in July was just tremendous--the scenery was great, the many T-18s I flew even greater, but best of all were the many fine builders I met. I have decided that all T-18 builders are the finest people in the world.

Thanks for returning your questionnaire, for the generous contributions and the many nice comments about the Newsetter.

T-18 NEWSLETTER #32 02-71

Luther D. Sunderland

FLIGHT REPORT: Chris Fast, 507 Almar Avenue, Pacific Palisades, CA 90272. Reading T-18 Newsletter #31, I am reminded that I have thus far neglected to write to you regarding completion of my T-18. Sorry I missed you in July; would like to have shown it to you. Serial #262 was a five-year project and was test flown by Jack Park on August 15, 1970. I now have fifty-nine hours on it with virtually no problems at all, and the FAA lifted the restrictions on it last week. The O-290-G was built up by John Thorp and with 7:1 pistons turns a Sensenich 68/67 prop 3100 rpm. A 2500 rpm cruise produces a 150 miles per hour ground speed and the 3100 rpm gets a ground speed of approximately 176 miles per hour. It may do better after I install the gear fairings but I am happy with its performance. The big thrill to me is the way it climbs--1500 feet/minute at 100 miles/hour with two on board and 2000 feet/minute solo. It has Rudy Adler's wing root fairings so no tendency to "tuck under" with full 40-degree flaps. Stalls straight forward at 60 miles per hour, and 55 miles per hour with flaps. I have the drawings for the crankshaft flange reinforcement and hope to have it completed soon. Earl Ody tells me it does aerobatics very well but I will wait for the flange reinforcement before I take any lessons from him.

It has one of the first all-metal cowlings, developed by Jim Roberts from Thorp's drawings. It is a snug fit around the engine and I had problems getting exhaust clearances, but it is "clean" aerodynamically. I developed the banjo-type air filter from John's plans--it is a "free breather" and works well.

As for the seats, I bought a pair of seats and tracks out of a wrecked Cessna 150, cut them down and reupholstered them. They may be a little heavy but they are comfortable, and my wife and kids enjoy the seat track adjustments. Have not seen any that I would trade for them. And speaking of "belts and suspenders," I used 0.032 side skins on the fuselage and I would do it again. One test pilot recently told me that my bird is the only T-18 he has flown that did not make a "canning" noise when taxied. Sure it cost me seven pounds, but then my total weight empty came out at 862 pounds, so I am happy.

I would advise anyone building the T-18 to use reverse riveting (we call it the "bell bar" method at McDonnell-Douglas) on the fuselage for smooth contour. This method employs use of a broad-surfaced bucking bar on the outside surface while the rivet is upset with the standard riveting gun and tee-shaped set from inside. It is impossible to leave rivet depression marks on the outside surface with this procedure.

Another point I might mention concerns the paint job. For good bonding be sure to treat all surfaces to be painted with an aluminum etch. Follow this with zinc chromate primer (or FR primer if you can get it, it is catalyst mixed). Do not allow the primer to age before applying the finish coat. One to two hours is maximum. For best adhesion the finish coat should be a catalyst-mixed paint, preferably polyurethane. Synthetic enamel or lacquer will not bond sufficiently to stand a tape test. In closing, let me say how much I have appreciated the Newsletters; you have done an excellent job and it has helped us all. And speaking of help--who could build one of these little birds without it. These T-18ers are a grand group and it has been a rich experience working with them.

T-18 TO 747: by Luther D. Sunderland. If you were to ask the average T-18 pilot what his wildest dream would be regarding his flying accomplishments, he might have to admit that he would like to see how it feels to fly one of the really big ones, like a 747. Once a person has flown a T-18, he has some idea of how a nice hot fighter like the P-51 feels, but a 747, that is just beyond comprehension.

Well, this T-18 pilot had his wildest dream come true last week when he slid into the left seat of a Pan Am 747 and the instructor said, "It is all yours, do anything you like." This fantastic opportunity came when I put a new type of rate gyro, which is solid state (no rotating parts), into the autopilot of the 747 and we took it up on a combination crew training and test flight.

After the two captains were put through various exercises such as emergency descents after depressurization, stall recoveries and various types of landings--manual, automatic, and with flight director--the instructor put me in the left seat so I could check out autopilot operation with our new gyro installed. Much to my relief, everything went fine with the test. During this time, I flew around in the vicinity of Atlantic City where Pan Am usually goes to practice landings. Much to my surprise, the 747 has ideal handling characteristics, even with the gear down and 10 degrees of flaps. I was most surprised at the roll response. There was no big lag like you might expect, but the wing seemed to move just as fast as you turned the wheel. It was much better than many light airplanes I have flown. Of course, with the hydraulically boosted controls, the feel forces were ideal. The only unusual feature is the rather high detent force on the rudder pedals. Automatic turn coordination is supposed to keep the ball centered when you fly it manually, but it does not do to good a job and the ball hangs off slightly. When I tried centering it with rudder pressure, nothing happened. Then I discovered that it was necessary to really push the pedal to get it out of detent. But I soon decided there was really no need of rudder and just enjoyed myself doing steep turns and trying to get used to a strange panel.

Overall impression was that while in the pilot's seat, you did not get the feeling you were flying a large airplane. It was just as easy to fly as a light twin. The wings and engines are swept back completely out of view and you cannot even hear the engine noise. You do not really appreciate the size of the monster until you climb out of the seat, descend the spiral stairs and go for a stroll to the tail. All I could think of was, "Wow! What a miracle!"

The view from the cockpit, near or on the ground, was something else. While sitting on the huge concrete apron with nothing around as a reference, it did not seem too unusual until I spotted the tiny speck of a ground crewman three stories below. On takeoff you go charging down the runway during a very rapid acceleration and then instead of gradually taking off, you rise straight up in the air very rapidly during rotation, and finally the wheels come off. With an empty load, she really climbs. We held over 3,000 fpm. Landings were also a thrill for, besides being sure you could never get that much airplane on a tiny runway, the cockpit seems like it is 200 feet in the air during flare. It is a real relief when the wheels grease on much more smoothly than in most big jets.

When we pulled up to the passenger terminal at JFK, it seemed that we were parking a tall building, but the airplane was only half as tall as I felt when I walked away from the 747, looked back and asked myself, "Did I really fly that thing?"

CENTER CONSOLE: Just had a visit from #353, Casper Tootgoshin, 1011 Langs Avenue, West Bristol, PA 19007. He is trying to get his T-18 into the air and wanted to see how I had solved some of his problems. He has been within "about a month" of flying for nearly a year.

When he climbed into my cockpit, he commented on the amount of room it had. He said he had put in a center console below the instrument panel but was sorry now, for he does not have room to adequately move the stick for roll control. I asked him why he disregarded all my strong advice against this and he said that had seen some pictures of center consoles in **Sport Aviation** and thought they looked good. Also, he did not set the panel back like I recommended so did not have enough depth for his radio.

ENGINE BALANCING: When I replaced my crankshaft in my engine due to the flange failure, I had the main moving parts balanced at a local shop that specializes in balancing hot rod engines. This included shaft, pistons, and rods. To my amazement, the rods were really out of balance. The reason appeared to be that the rods were made from forgings with two different nu;mbers. This could have been the source of the engine vibration that caused the flange failure. So, be certain to have the O-290-G engine parts balanced. When I told John about this, he was not surprised. He said that before he balances rods he matches up a set with all the same forging numbers. Of course, if you have only one engine, you cannot do that. He said that rods in the G engines can differ in weight by as much as 7 to 10 grams. Continental balances their engine parts to 1/2 gram. The hot rod shops usually balance parts to 1/4 gram.

Rods are balanced by supporting the small end and weighing the large end on accurate scales. The bearing caps of three rods are ground off to match their respective rod weights with the lightest one. Then material is ground off the small end until all rods weigh within 1/4 gram of the same weight.

ROD BOLT TORQUING: The first connecting rod bolt which I tried torquing to 40 foot-pounds never made it. The highest torque reached was about 38 foot-pounds and then the bolt just kept on stretching and necked down under the head. I sent it to John who split it to inspect for flaws but found none. But again, I did not find out anything new. He said he ran into bad bolts before, one in an engine that had thrown a rod. He thinks they must have gotten a bad batch of bolts which were not heat treated properly. This is why he always torqued his bolts to 40 to 50 even before Lycoming raised the recommended value from 30 to 40 foot-pounds.

FOUR-PLACE SKY SCOOTER: Most of us have heard some mention about John Thorp's connection with the design of the Piper Cherokee, but few know the details.

It all started in 1942 when John designed the two-place Sky Scooter. This fine little airplane seemed to be at the wrong place at the wrong time, and although several attempts were made to get it into quantity production, it never made the grade. Only eight were built. Although none of the big boys would buy the design, Bill Piper came to John and asked him to make a four-place version of it. So, John did the basic design of the airplane that was to be the original Cherokee 135. He took the plans to Fred Weik, who was still a professor at Oklahoma A & M, and he approved them before John took them to Piper. Later several changes to the design were made and John disclaims any connection with them, but the Cherokee 135 was basically John's design. He also built landing gear parts for the first five airplanes in California.

LANDING GEAR: As I pointed out previously, if you have a suitable lathe available, you should turn down at least the outer 1.5-inch landing gear tubes to reduce weight and make the gear softer. This, of course, is not necessary for the gear is fine when made from straight tubes, especially if you add 2.5 inches to the center 1.25-inch tube at the lower end. Most people have trouble finding a suitable lathe. Ted Williams, 3254 Park Avenue, Mansfield, OH 44906 (#446) sent in a picture of his lathe set-up, which looks like a real fine idea. To extend his lathe bed, he built up from wooden blocks a support for the tail stock and bolted it to his sturdy work bench at a point which would allow the gear leg to be mounted between centers. He did not have a steady rest, so he made one by notching a 2 x 4 which was attached to the workbench at the end of the lathe bed. It certainly looks simple and permits even the long inner legs to be tapered on the smallest lathe.

While on this subject, you might like to hear a report on Don Carter's gear. He heard reports that the standard gear was a bit stiff for taxiing on rough ground so decided to soften it. After some rather exhaustive stress calculations, he convinced himself that he could eliminatae the outer 1.5-inch leg, taper (both up and down) the inner 1.25-inch leg, lengthen it by four inches and completely mount each leg independently in rubber. At the top, the two legs are separated and rubber washers are used between the leg and the 527 fuselage member. At the lower attach points it uses the standard rubber spacers but the cross member is only pinned at each end so it does not restrain the legs in bending or twisting.

After over 300 hours of service, how has it worked out? It is the softest T-18 gear I have seen. Due to the extra length and flexibility, during a full power run-up with only one person aboard, he tipped up and nicked his prop. Due to the twisting moment on the legs and the soft rubber suspension, the wheels toed considerably. This gave unusually fast deceleration, so he never needed brakes, but it was mighty hard on tires. The legs have gradually bent out and back taking a permanent set. While taxiing, they have a pronounced quiver about like on a Tailwind.

Don's experiment with the gear is interesting because it has demonstrated how far you can go in softening and lengthening it. Since the legs take a permanent set in normal use, it is evident that the outer tube is needed for strength. Torsional stiffness is also needed. If the legs are lengthened more than 2.5 to 3 inches, it moves the wheels back too far and you might nose over. (1986 Note: One gear leg failed near the engine mount attachment during taxiing fortunately. Don is now installing a gear built to my design.)

My recommendation is to build the gear as discussed in Newsletter 28 (pages 164-166). If you plan to operate out of really rough fields, you might shorten the lower end of the outer 1.5-inch tube by an inch or two.

TRIM SYSTEM: by R. L. Moore, 3327 Fennimore, Corvina, CA 91722. While installing the Elevator Trim Jack Assembly A-701, I became aware of what I consider a bad condition. I noticed a sloppy condition. That is, when alternating force applied to 703 torque arm a movement of approximately 1/4 inch was noted. After further investigation the cause was located in the Fafnir K56A bearing. The bore race of the bearing moves with 1/16-inch end-play. After checking new bearing supplies am convinced this is normal to this bearing. What concerns me is as the ships get more time on them the bearing blocks loosen up and the K56A loosens even more, the tabs become free to move from external excitement. I am currently planning on using an "unibal" type bearing. (1986 Note: I think we all had problems with end play in the trim jack screw. I remedied it by simply rounding off the end of the screw and putting in a shim to take out all the play. It has very little wear so should last a long time.

HORIZONTAL TAIL: by John P. Foy, 299 Edith Drive, West St. Paul, MN 55118. Last November the breather tube froze up on my bird and pushed out the front seal, which is no problem, except for the time spent taking it apart and putting it back together again. However, the worst winter in 88 years hit this state and I decided to put the tail mods in plus more engine baffling, straighten vertical tail, close down cheek openings, mount radio, etc. I am still at it and have no idea when I will get it finished. (1986 Note: This article was written March 17, 1969.)

While working on the horizontal tail mods, I worked up a method for alignment and assembly that should work on the wings just as well. I am assuming that the skins are bent and drilled and punched for rib rivet holes, and rear spar.

Cleco skin to all ribs and rear spar. Slip entire assembly over main spar. Block rear spar to level with main spar. Clamp a piece of angle, long enough to reach the entire length of the assembly, at the leading edge and trailing edge. Eyeball from rear spar and all around assembly. Mark centerline of main spar on the skins and clamp main spar to skins. Now drill rivet holes through skin into main spar and cleco as you go. This should give perfectly straight wing and tail components. The two outer wing panels can be done in exactly the same manner by placing them together side by side. After both sides of the main spars are done, the top skin can be unclecoed and opened up and the rib end rivet holes marked on the main spar. Then remove the skin assembly and drill the marked hole locations. The rib end holes must have been punched before the skin assembly has been placed on the main spar.

To align the horizontal tail assembly, slip mast and pivot fittings on tube spar, at premarked distances. Mount pivot fittings on fuselage. Wings must be mounted on fuselage for this method to work but it will insure that horizontal tail will be perfectly aligned with wings. Now use bubble level to block wheels to make sure that main wing is perfectly level. Set bubble level on main wing spar to check. Now use level to block horizontal tail tube level. Mark fittings and tube with locator line, using pencil. Check movement of horizontal tail tube by mounting mast (center) fitting to elevator tube. Make sure that tube clears fuselage longerons and has enough travel to give the full up and down range. The skin assembly could be clamped to the tube at this time to check the degrees of travel approximately. Drill one rivet hole in each fitting as a pilot hole while tube is blocked rigidly in place. Remove tube assembly from fuselage brackets. With fittings in place and clecoed, drill the rest of the rivet holes in the brackets on the drill press. Cleco brackets to tube. Mount tube on fuselage and slip horizontal skin assembly onto tube. Block tube in zero degrees, check skin assembly in zero degrees, tap end caps into place on tube. Now, unblock tube and hook up elevator push pull tube to center mast. Check skin travel against 0, 5 up, and 15 down marks on side of fuselage. This is the last chance to rectify any horizontal tail movement errors! Remember--five up is actually nose down control movement at the control stick. Do not get confused! Clamp skin in place and make locator marks at the edge of the skin where it meets the tube at the inboard edge. Remove the tube and clamp skin with angles, same as wings and drill skins and tube, clecoing as you go. Open top skin and mark, and drill rib rivet holes, after removing skin assembly. Clean up assembly and rivet.

EXHAUST SYSTEM: This summer when I was visiting at John's shop, I watched Vaughn Parker building exhaust systems. He had a stack of about 40 sets in process. Tubing bends had been made by Douglas Aircraft to John's specifications. He made his own slip joints and bought ball joints from Oliver Smith, 8329 1/2 Fontana, Downey, CA 90241. John says you need both slip joints and ball joints to prevent cracks. I agree, for I still got cracks, but at different places, after I added slip joints. The ball joints are the type used on Mooneys.

John's system is the crossover type, as shown in the plans. A slip joint is placed in both tubes directly in front of the oil pan. A ball joint is placed in each tube just aft of the Y where the two tubes join together. This leaves the last several feet of exhaust tube free to swivel. It is suspended from the cross tube on the landing gear with a flexible coupling. Some have used a piece of web-type brake lining for this, but I understand that it comes apart. The very best one I have seen is one Don Carter made from 3/32-inch stainless wire as shown in Figure 13.

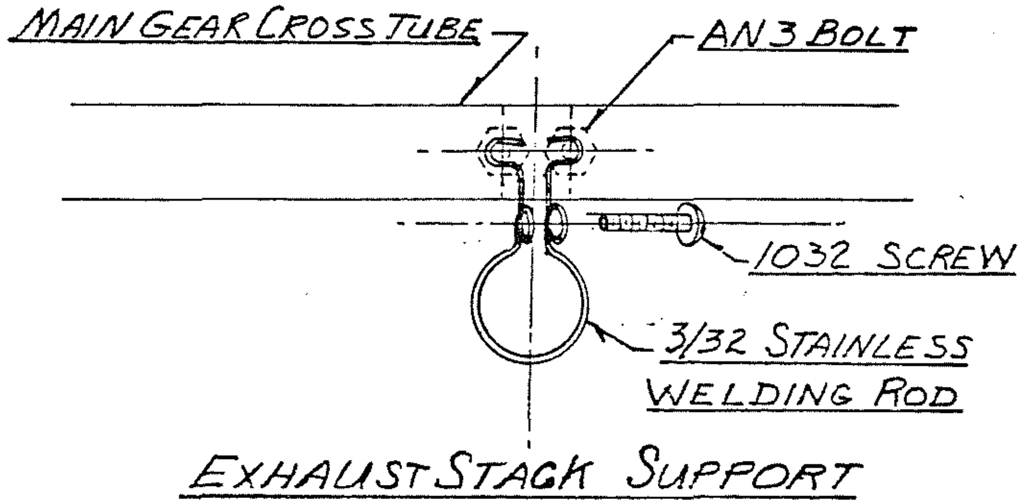

MAIN GEAR CROSS TUBE
AN3 BOLT
1032 SCREW
3/32 STAINLESS
WELDING ROD
EXHAUST STACK SUPPORT

Figure 13

John uses 1.75-inch OD 0.035-inch wall stainless tubing back to the ball joint. Then it flares out to two-inch OD and the ball joint and the remaining stack is two inches. He says that he flares out to two-inch tubing after the joint just to reduce the back pressure a little more, although it is not really necessary, especially for the lower horsepower engines.

BALL JOINTS AND SLIP JOINTS: After being unable to talk anyone into making the simple two-piece ball joints like Piper uses, I decided to make tooling and make them myself. So, I now have 30 sets of ball joints and slip joints made up from 1.75-inch OD stainless tubing. I will sell a complete set of two ball and two slip joints for $25.

PLEXIGLASS DRILLING: by B. J. Thalman, 2912 Old Glenview Road, Wilmette, IL 60091. After reading the last Newsletter, I noticed that people are still having trouble putting holes in plexiglass. Here is a tip that will take the work out of it. Drill a small pilot hole, 1/8 inch or so and open it up with a half inch reamer. A long one like Sears 9AT5479, it can be chucked in a half-inch drill, speed is not critical, just use light pressure. It cuts like butter.

I took my first long cross country in the Thorp into Wyoming. It averaged 150 GS going and 180 back with 7.5 GPH fuel consumption for 23.8 MPG. It is almost as good as my VW and twice the fun.

POP RIVETS FOR TRAILING EDGE: by W. F. (Bill) Terrell, R2 1501 Alena Road, Angleton, TX 77515. I am sending you a trailing edge test strip I have been working with. I drive the nail head out of the MD type Pop rivet, use the Whitney Jr. hand punch with a 9/32 punch, replace die with a 7/16 - 20 thread bolt with a flat end, then squeeze. (1986 Note: His test sample looks real fine. Both the shop head and factory head of the dome-type rivet end up looking about alike.)

CALIFORNIA T-18s: George Leider and Oliver Smith. We have been so busy in work and in working on the planes that we have not had time to perfect the ball joints that you wanted. We do have a few of the others if anyone would be interested in them.

We have 102 hours on our yellow T-18 (9279) and 60 hours on the red T-18 (04X) with no problems of any kind. Chris Fast's T-18 is right next to us at Chino and just had the time signed off. Ken Knowles just brought his out. They both have John Thorp's rebuilt engines. They seem to run real well.

Today we took off with our two T-18s and flew to Havaser and had lunch and flew back--about 450 miles round trip. We flew up and down the Colorado River with visibility about 60 miles. When we got back to Chino visibility was one mile, but we made it in OK.

MORE ON CRANKSHAFTS: by John Thorp. I still might use a new GPU shaft that I have and use the new D shaft for a biplane racer engine. At its weakest point other than the flange, the GPU (O-235) shaft is 88% as strong as the O-290, O-320 and O-340 shafts. If the O-340 shaft is strong enough as compared to the O-290, then the O-235 shaft is more than strong enough in the O-290.

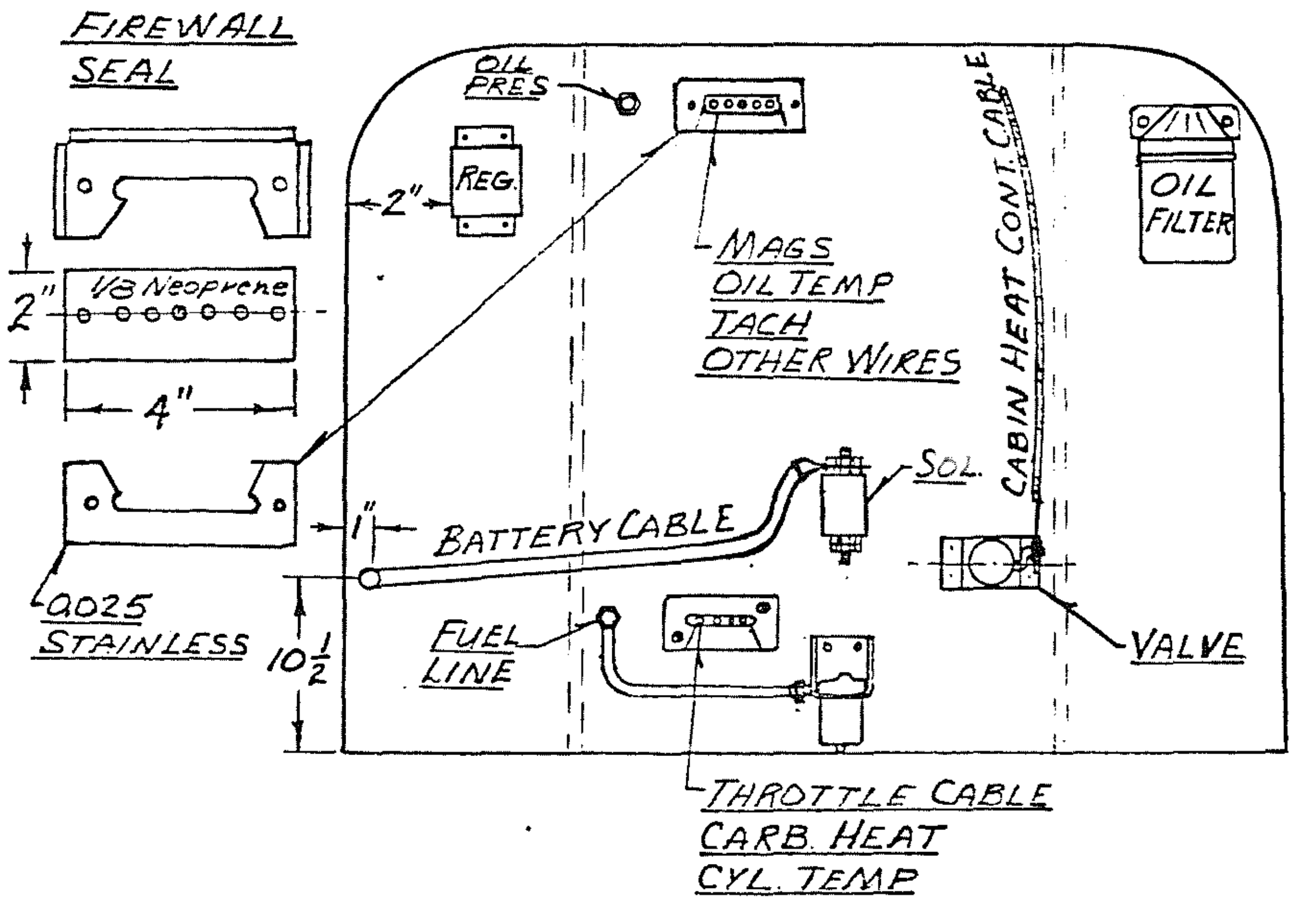
The spuds on the O-235 and O-290 shafts are 1/2 inches longer than on the O-320, O-340 and O-360. I feel that if the #1070 extensions were redesigned to bear the full length of the exposed part of the spud and fitted closely on the spud so as to minimize motion, there would be no way for bending to get into the GPU flange and our various beef-ups for the flange would be "belts and suspenders." However, I think that knowing you can get home even with a broken flange is worth a lot. You might want to close up the bore in the extension a thou. to $\frac{2.251}{2.250}$ diameter. The spud call out is $\frac{2.251}{2.250}$ diameter.

We have N299V back in my shop at 818 hours. Dr. Cottingham flew it 600 hours in 18 months. Vaughn and I are rebuilding it for another 600 hours of sod field use. For such use the tail gear is too stiff and I should redesign it. I probably will not have time now.

FIREWALL LAYOUT: by Luther D. Sunderland. Here is a sketch of my firewall layout which so many have had questions about. Hope you can figure it out. The homemade bulkhead seal for wires and cables seems to work OK and the FAA did not object. Sure saves on holes. See Figure 14.

Figure 14

FIREWALL ACCESSORIES



T-18 NEWSLETTER #33 05-71

L. D. Sunderland

DICK WALEN #336: Just a short line to pass along a few tips. Located inspection hole in floor between tunnel to inspect rudder pedal cables and connections. Saves pulling the tunnel to inspect. Also made hinged pieces on fuselage by aft vertical fin so that the rudder and fin do not have to be removed to inspect the horizontal tail fittings and trim linkage. The main tip regards building the new horizontal tail. How do I salvage all parts except old tube and transfer holes in skin to new tube so that everything lines up perfectly? First, drill rivets out of bottom of skins on airplane. Next with skin hanging down, use 90-degree drill adapter and drill front rib rivets off tube. Then drill the top row of rivets holding skin to tube and slide skins off tube. Remove tube from airplane and drill out rivets to remove three fittings. Take any thin white paper, preferably tracing paper, and wrap tightly around full length of old tube and tape so the paper tube cannot rotate around the metal tube. Transfer on each end with pencil the centerline of the tube for the top row of rivets on the paper. You can see the countersinks on the old tube through the tracing paper. Take a straight pin and prick punch the center of the countersinks. When finished remove securing tape and slide paper tube off and install on new tube. Align the centerlines and secure with tape. Center punch through the pin holes, remove paper and drill. When I installed my skins and ribs everything came out exact. It sounds like a lot of work but the whole operation from start to finish took one week. The first tail I built took me six weeks. Will give full report on new cowl at Oshkosh. George Rattray has really bent over backwards for us T-18ers. He has now the most beautiful T-18 cowl on the market. Wing tips and tail tips with no waviness. Just wait until you see my bird. (Cowl $145, tail group $25, fillets $35, wing tips $50)

FRED KRACHT FLIES #559: 31 Caron Port Crescent, Don Mills, Ontario, Canada. The first flight was made on August 23, 1970, and I can only say that there really are no words to describe the first flight of something that has taken two and a half years in the basement and garage to build. The only problem I had was a major one. The crankcase was vented in two places--at the front of the 290-D2 engine and on the rear case of the engine. Unfortunately enough, I got positive pressure on one vent and negative pressure on the other which in turn sucked out all the oil mist in short order causing the oil to empty completely and scoring two bearings, but everything is together again and well. (1986 Note: He now has only one breather.)

JACK HAGLE FLIES: 461 Melrose Lane, Crystal Lake, IL 60014. After some four years and nine months of intermittent toil I can announce that T-18 #347 flew successfully on April 30. I am fully satisfied with everything about it. I would sure hate to spend all that time and end up with a "dog." Performance is startling, even compared to the jets I fly regularly. It seems to take off short on less than full power. I have been very gentle with the power the first couple hours since it is a freshly majored engine. Promise to send in the performance sheet as soon as I get some good data. First flight was uneventful except for some crummy landings. I have an O-320 with constant speed prop and extension, standard gear from Jenkins, modified tail, cut down deck, etc. It is more or less standard Thorp. Tips: (1) For maintenance reasons, I put bolt and nut through sticks and socket so it is removable. (2) Also, I have a Harrison oil cooler that came with the engine. I mounted it vertically in front of the #2 cylinder. Oil temps have never exceeded 170 degrees. I think I will change it to a horizontal position in the same location so that the ends are not blocking any part of the cylinder head. It would then be in the front baffle for that cylinder. (3) I put an access plate underneath the right elevator to make it easier to install the nut and bolt on the elevator torque tube. (4) Someone probably has an ex-Apache engine and prop like I do. If the prop is bent and smashed, it is a lot better to find a Cessna 180 or 182 or Mooney or Comanche prop and put money into it. The Apache hub is a lot heavier with the feathering spring etc. than is needed. Sounds elementary but I just realized it a short while ago. I really like the performance with the constant speed prop. Last, I have an EGT gauge and I think the fuel savings will pay for it in just a short time. Really takes the guess out of leaning the engine. Newsletters have been invaluable.

QUESTION BOX:

1. The Franklin Sport Four looks like a very good buy. Do you think that a mount could be adapted to use it, and have you heard of anyone working on a mount?

Answer: Have not heard of anyone using it but someone probably will.

2. All fitting holes on the plans have the words "ream" and two figures for the size like 0.374/0.376. Do I need a special tool for this?

Answer: This means 0.375 with a tolerance of 0.001 inch. It is important that fittings have fairly good fits to reduce chucking and it is difficult to maintain this sort of tolerance with a drill. It is preferable to drill undersize and then finish to final dimension with a reamer. AN bolts are slightly undersize so do not aggravate the situation with oversize holes. Finish reaming can be done with a drill if the final cut is very light and the drill I sharpened precisely.

3. What about using Pop rivets on the 509 and A510-1 fittings?

Answer: 5/32-inch cadmium-plated steel rivets are available for this purpose. If your Pop rivet tool will not accept the 5/32-inch rivet stems, just drill out the hole. John said they found loose 1/8-inch Pop rivets in one tail being disassembled for modification, but this is not necessarily significant since it is not possible to buy 1/8-inch Pop rivets which are long enough for this application.

4. What is the best all-around prop for the T-18 with a GPU? I have seen all kinds in old Newsletters.

Answer: It is a bit like asking what is the prettiest kind of girl. Also, the measurements alone do not tell how much power can be delivered. Two props with the same length and pitch can have quite different characteristics. John says he has seen two Sensenich 74DM series props with identical length and pitch give much different rpm. I have two DM props which are 1/2 inch different in width. As to the "best" prop, it depends somewhat on your personal preference. The amount of horsepower you get out of your engine is almost directly a function of rpm--the faster, the more horsepower. But there are those who do not like high rpm because it does not "sound right." However, my personal opinion is that my present (76EM) prop is very nearly ideal. It is 68 inches (long) x 70 inches (pitch). I have also tried this 68-inch prop with a 66-inch pitch and a different prop which was 67 x 68. Max rpm for each was 2700, 2900 and 2750 respectively. I have not taken good data on the 70-inch pitch, but it will give 178 IAS max. Rate of climb is more than adequate for all three--over 1200 fpm. The 66-inch pitch naturally gave the highest rate. The nice part about the 70-inch pitch is that I can indicate 160 at 2500 rpm, which happens to be the rpm I like to cruise at. It is significant that no one has had any problems with longer props. (1986 Note: The W66LM-74 or -72 with plastic leading edge are the best wood props available for the 125 hp engine. My -74 pitch gives a max level flight rpm of 2650 at 185 IAS and about 1100 fpm climb. Use the -72 if you want better climb.)

5. Explain your seat belt and shoulder harness arrangement.

Answer: As you know, I have a big hole cut out of my rear deck for the rear seat. I like this arrangement even when a jump seat is not used, for it simplifies front seat construction since it does not need to be folded down to get access to the baggage compartment. To anchor the shoulder harness, I riveted a piece of 3/4-inch angle diagonally underneath each forward corner of the aft deck and secured the harness with a 3/16-inch bolt through this.

6. How do you buck rivets in the tail of the fuselage?

Answer: Find a small boy, otherwise plan ahead. Also, put in two access plates made of 0.032 2024-T3.

KEN KNOWLES FLIES: 27902 Alvarez Drive, Palos Verdes Peninsula, CA 90274. It has been a lot of fun building our T-18 N77KK. It took almost three years, with lots of help from my wife Jerry and our friends. Jack Middleton, our neighbor, was always there when he was needed, which was most every weekday night. Others who helped very much were Merrill Jenkins, Mel Eagles, Bill Warwick, Vaughn Parker, John Thorp, Chris Fast, Oliver Smith, George Leider, Cleon Burden, Chuck Borden, Micky at Nagles' Aircraft, Noel Hayward, and many others.

After the plane was finished we towed it tail first down the hill from our home in Palos Verdes to Torrance Airport--less wing, of course. After putting the wing on, Bill Warwick made a couple of taxi tests and everything checked out OK, but he said we should install a cylinder head temperature gauge. This we did. Then it was off with the wing again, and onto a trailer to Chino, the place where most homebuilts in this area fly off their 50 or 75 hours.

We had it ready to fly on Saturday, 10-17-70. But, by the time the fog cleared at Torrance Airport and we flew out to Chino in Bill Warwick's 182, the smog was not so good at Chino, but Bill Warwick said he would taxi N77KK a little. Well, his taxiing took him out to the runway, and down it just far enough to have it jump off the ground and fly off in the smog! He flew fast and slow, did stalls, etc. After two or three landings and take-offs he brought the plane back to the hangar and reported that it would fly hands off. What a happy time that was for us, and am I ever glad to have someone of Bill Warwick's T-18 experience to check out N77KK. The following weekend he checked ME out in it. Man, what a nice airplane to fly! John Thorp said after he had a ride in it that he will be happy if his flies as well. Thank you, John.

This T-18 has one of John's engines in it and 67/68 prop. The induction box is per John's drawings. At first it was not, but I had to change it. Man, what a difference it makes. My first under the cowl intake did not work out, but this new intake box of John's really makes this plane go. 1:35 from Las Vegas to Torrance with a little headwind. We were turning 2600 rpm at 8500'.

The following are some performance figures (no static used). At 500' top indicated speed is 200. (175/180) is my guess as to what it should be. At 500' and 2500 rpm it indicates 165. At 500' top rpm is 3000. Rate of climb at 110 mph, 2 people, 1400'/minute. Turns 2500 rpm. Weight is 859 pounds. Date of manufacture 10-07-70. 90% of 3000rpm = 2700 rpm for 75% power, 81% of 3000 = 2430 rpm for 60% power.

One way to cool the inside of your T-18 is to install a short tube approximately 1 1/2" diameter x 6" long in the fuselage just forward of the wing main beam, Cessna type. Use a 0.064 2024-T3 doubler and approximately 3/8-inch thick micarta block as a socket. Weld a cover on one end of the tube, then cut a hole in the side of tube approximately equal to diameter of tube. Hole should be oblong and about 1.0 inch from capped end of tube. Now slide open end of tube into socket which should have a slip fit hole in it. Cut a hole in leading edge of wing like Cessna does. This must be in first bay unless you have lightening holes in nose ribs. Put one on both sides of fuselage. If this is not enough cooling, Bill Warwick says that you make a small door with control to open and close at back of canopy near canopy frame centerline. The air pressure here will make the air flow up and around your shoulders. (1986 Note: This works great.)

We now have four T-18s flying out of Torrance Airport. Oliver Smith, George Leider, Chris Fast, and Ken Knowles. By July we should see Sandy Crists' T-18 finished and Bill Warwick should soon have his back with all the drawing changes added. I think Bill has over 800 hours on his T-18.

I think there will be four or five T-18s at Oshkosh this year from Torrance, CA.

Starting soon we are going to sell material marked per John Thorp's templates. Each rivet hole will be center punched. The trim scribed, bend lines marked all ready for the t-18 builder to trim, drill, deburr and bend up flanges as required. This will make it a lot easier to build a T-18? We are going to start with the fuselage and from there on to other T-18 parts.

POWERPLANT TIPS: by Luther D. Sunderland. In my last article, "More on the O-290-G" (February 1972 **Sport Aviation**) I briefly pointed out some ways to extend the life of an engine by properly installing and maintaining it. This article is intended to elaborate on these points as well as provide some additional information.

Virtually every time I have discovered a powerplant related problem since beginning publication of the T-18 Newsletter in 1964, I have subsequently found that John Thorp already knew about it and had long ago found a solution. Unfortunately there does not seem to be any practical way to instantly extract all the information someone has learned through 40 years of formal training and practical experience, but here are some of the things about engines which I have learned, largely through my association with John.

Cowling Design: A major reason the O-290-G engine has gotten some bad publicity is that it has been abused perhaps more than any other aircraft engine through improper overhaul, maintenance and installation. Of prime importance for good reliability and long life is the design of the cooling system. There is more to it than just hanging an engine out in the breeze or, on the other hand, wrapping a nice tight cowling around it with two big holes in front and one or more in back. Even if your gauge says the oil temperature is within the green range as stated in the engine manual, there can be hot spots which can ruin rings and valves. And, from the efficiency standpoint, on a clean airplane the cooling system losses can represent a high percentage of total drag, so just enough air should be permitted to flow through the cowling to adequately cool the engine.

There is a rule of thumb for determining the size of cooling system air inlets and outlets. For an airplane in the climb speed range of a T-18 (about 100 mph) the opening should have an area equal to 0.35 times the horsepower of the engine. For an O-290-G turning up to deliver 140 horsepower, the cooling air inlets should have a total area of 49 square inches. Anything extra just means loss of performance.

Location and size of the cooling air outlet is just as important as the inlet. The size needs to be only slightly larger than the inlet, say 10%, to allow for expansion of the heated air. Location and shape can greatly affect drag. One of the worst is the stalled flap type on the bottom cowl near the firewall. Hot air does not like to do down, especially into the high pressure field below the wing of a low wing airplane. The use of side outlets permits a more nataural flow with no high drag projections into the low pressure region over the wing. The very best are adjustable cowl flaps like Ron Zimmerman has on his T-18.

Now that we have the right amount of air flowing through the engine compartment, what do we do with it? One thing you do not do is try to cut corners and use the intercylinder baffles from an O-290-G. Not only do they provide inadequate direction to the air flow around the cylinders, but the little steel clips used to support the baffles are forced down between the jugs causing them to distort. Sometimes you can see uneven wear on the inside of the cylinders where these clips had pressed. The surest procedure is to precisely copy the baffle system of a proven commercial design like on a Bonanza. Be particularly careful to keep it tight so no air can get through except where it is supposed to go. John even seals up all cracks with GE silicone (bathtub seal, etc.) except where the baffle touches cooling fins.

Oil and Air Filters: For long life of any engine, it is important to keep the oil clean. The best way to keep contamination low is to first not let it into the engine. The automotive paper type filters can be adapted for aircraft use and they do a good job, but the old folded-screen type used on many light planes is virtually useless except for keeping out birds. John has recently found a source for the porous foam material (filtron) used in lawn mower air filters. It is made right in Van Nuys, near his home. Why don't you parts suppliers stock this material so everyone can have a first class filter?

Once the dirt gets inside the engine, then you must filter it out of the oil. If your engine is not equipped for a filter, it is quite simple to install one. Just remove one of the allen head pipe plugs from the oil journal at the upper right front of the crankcase or on the accessory housing and insert a brass fitting which has been brazed shut and then drilled out making a 0.100-inch orifice. (It can be changed later to get the right oil pressure and cooling.) Connect high pressure hose from this fitting to the oil filter. If you do not have an aircraft type filter, just buy an automotive aluminum casting from J. C. Whitney in Chicago to hold the filter to the firewall. From the filter connect to the oil cooler. Some people have objected to this series connection of cooler and filter, for when the filter clogs up the cooling is degraded. However, It seems to me like a good way to indicate when the filter is getting dirty. Anyway, I have not found it to be a problem.

There are three sizes of Corvair coolers. The smallest will provide adequate cooling for a 125 hp engine if it is mounted in the nose cowling so it receives unheated air. When I moved mine from the rear cylinder baffle to the nose cowling just under the left main air inlet, it lowered the oil temperature from about 215 to 205 degrees F. The next size Corvair cooler has the same external dimensions but gives 25% more cooling. The latest cooler gives another 50% more cooling. This largest one, used on the Spyder engine, is the best if you can obtain one. A new model VW is coming out with a cooler the size of the Spyder but with more efficient fins. When I changed from the smallest to the largest cooler it lowered oil temperature about 15 degrees F. High oil temperature is bad news for the oil. Although Lycoming lists the red line temperature at 240 degrees F, John likes to keep his oil temperature at around 200, just enough to drive off moisture.

Changing Spark Plugs: How could changing plugs cause a valve to stick? When plugs are removed, carbon gets broken loose. If an exhaust valve is partly open, carbon from the top plug may collect around the valve seat. Then when the engine is turned over, the valve will smash the carbon and cause it to stick to the valve. One of the two things will then occur. If the valve is held up so it cannot tough the seat to be cooled, it will become overheated, the stem will swell and the valve will stick open. Then when a fresh charge of fuel-air mixture is brought in it will be ignited with the intake valve open and a backfire will occur in the entire intake manifold causing almost total loss of power. This is no pipe dream for it is precisely what happened to my engine.

If the valve does not stick, the carbon will cause a hot spot and burn a hole in the valve or seat. John had this happen on three different Lycoming and Continental engines a short time after overhaul. He and an engine manufacturer's representative doped out what was happening. He changed the procedure for removing plugs to always remove the bottom plug first and bring the piston up on compression stroke before removing the top plug. In the many years since he adopted this practice he has never had a burnt or pitted valve. His attempts to get the engine manufacturers to redesign their engines so this could not have been unsuccessful because of the expense involved.

Oil Consumption: High oil consumption is a frequent problem with engines installed in homebuilts. This is caused by either poor ring seating or valve guide to stem clearance. Several sentences were inadvertently left out of my last article and the result could be the very opposite impression to the point I was trying to make about valve stem clearance. Following the sentence, "The G manual allows 0.008 in clearance." should have appeared, "Don't believe it. Replace the guides if there is more than 0.004 in clearance."

New Rings: When overhauling an O-290-G engine, it is best to use the chrome rings recommended in the Lycoming parts book. If the cylinders have been chrome plated, things must be done. First, it is necessary to break the glaze in the cylinders. If you do not have access to a special tool used for this purpose, take a piece of #220 wet-or-dry paper and, without making any vertical scratches really rough up the wall. It is a common practice to coat moving parts in an engine with STP when assembling them. Do not put STP on rings or cylinder walls because it will prevent ring seating. For the first 25 hours, or until oil consumption drops, do not use STP or detergent oil. When an engine is first started, it is not good to operate it at low power settings. It should be run on the ground only long enough to ascertain proper operation. John feels the best way to break in an engine is to fly it at normal cruise power. This puts high pressure on the rings and seats them quickly before glaze can form. Rings have special features which help them seat. The back side of the two top rings has a bevel on one corner. This unsymmetrical cross section causes the ring to twist and thus put higher pressure on the cylinder wall. Also, the front face of the ring is cut at an angle so it initially touches the cylinder along a very narrow band to speed up ring seating.

Engine Balancing: One subject regarding converting the O-290-G previously given very little publicity is the balancing of all moving parts. This is very important because although the G parts were originally balanced during overhaul they might have gotten mixed up. Some rods have been found to differ by as much as seven grams while Lycoming balances aircraft engine parts to within one half gram. You can balance rods and pistons yourself if you have an accurate scales which will measure to a fraction of a gram. First find the lightest piston, then machine off the skirt of other pistons to match it to within 1/2 gram. Then support the small end of a connecting rod and balance the large end by weighing on scale and matching three to the lightest. Then weigh total rod and remove material from large end until all rods weigh within 1/2 gram of the lightest rod.

T-18 NEWSLETTER #34   11-71

Luther D. Sunderland

NEW TAIL SPRING DRAWINGS: After thoroughly reworking N299V, now owned by Dr. Cottington in Nebraska, John decided that for rough field use the T-18 needed softer tail spring. So he designed an alternative spring made of two spring steel leaves. He put one on 299V and says it is a big improvement. I strongly recommend against using the original 3/4-inch aluminum spring. It is too stiff, even when tapered. I finally solved the problem by making the standard spring from 5/8-inch aluminum. It has worked just fine and is much softer.

LOW-ALTITUDE AEROBATICS: Now we have two more items to add to the list of things NOT to do with your airplane. One is, do not do a slow roll on take-off--even over a beach. Second, do not buzz a lake, for there might be power lines stretched across it. Two T-18s just ended "in the drink" because of the above. Fortunately, all four occupants got out.

T-18 IN JAPAN: A. L. Pitts of Tachikawa, Japan has about everything but the fuselage completed and is now working on the fuselage. Building an airplane in Japan leaves alot to be desired. When it comes to materials or aircraft parts, there is very little available locally. We rely mostly on stateside sources and the cooperation of many airline friends. It takes a good friend to hand carry two complete landing gear assemblies, along with his own baggage, through customs. If progress continues at the present rate, test flight will be August 72 at Seattle. Please find $2 for continuation of the Newsletters, which, I might add, have been a tremendous help in answering our many questions and an aid to construction where there is very limited homebuilt aircraft activity.

Doesn't this letter give some of you who think you have it rough a little encouragement? A number of T-18 builders have had their projects interrupted by tours in Viet Nam. Dick Cavin just told me of meeting Francis Richardson on one of his many trips to Viet Nam. He was very worried the next night to hear of a rocket attack on Francis' barracks. Fortunately, a steel folding chair leaning against his bunk stopped a piece of shrapnel and protected him. Francis is now back in the Unite States and has his T-18 about ready to fly.

ENGINES DATA: The horsepower and compression ratio of an engine has an important effect on the stresses induced in the propeller due to vibration. The compression ratios and other data on the Lycoming series of engines are shown below:

Engine	hp	Bore	Stroke	Comp ratio
O-235	115	4 3/8	3 7/8	6.5
O-290-G	125	4 7/8	3 7/8	6.5
O-290-D	125	4 7/8	3 7/8	6.5
O-290-D2, A	135	4 7/8	3 7/8	7.0
O-290-D2B, C	135	4 7/8	3 7/8	7.5
O-320	150	5 1/8	3 7/8	7.5
O-320	160	5 1/8	3 7/8	8.5
O-340		5 1/8	4 1/8	8.5
O-360	180	5 1/8	4 3/8	8.5

PROPELLERS: During the power cycle of a reciprocating engine, the propeller receives an impulse from the combustion followed by an opposite impulse due compression. One pulls the propeller and the other resists it alternately two times per revolution. At 2500 rpm, this occurs 5000 times per minute or 83 cycles per second. The larger the piston area and compression ratio, the larger are the power and compression impulses. If propellers of the same physical dimensions were to be put on all these engines, it is plain to see that the propeller blade stresses would be much higher in the higher horsepower engines. That is why the M76 props used on the O-360 have much heavier cross section.

Depending upon a propeller's geometry (thickness, width, length, pitch, and shape), at certain rpms the blade stresses will be higher than at others. This is basically because the propeller is like a very stiff spring and, when it is excited, it will vibrate at a certain fundamental frequency like a tuning fork. If the firing and compression impulses occur at the same frequency that the prop wants to normally vibrate, then the size, or amplitude, of the vibration will be much larger. Just like on a playground swing; if you lean forward and backward at the right rate, you will make it swing; if you lean forward and backward at the right rate, you will make it swing, but if you move at the wrong frequency or rhythm, it will not go.

On certificated aircraft, there must be a placard against operation at rpms where propeller blade stresses are too high, if indeed there is such an rpm within the operation range of a particular installation. But with homebuilts with unknown propeller, engine and engine mount characteristics it is difficult to determine the rpms to avoid. Two propeller blade failures have no occurred on T-18s, both with 68-inch long 74DM propellers. Both were on 160 hp engines. Consequently, John Thorp is getting very concerned about the need for a vibration survey. According to John, all propeller manufacturers have Dave Bierman, Vice President and Chief Engineer at Hartzel do all their vibration surveys and he is the only one in the US which the FAA recognizes as qualified to do this type of work. He has quoted a price to

John of $10,000 for each combination tested. A survey involves instrumenting a propeller with strain gauges and recording their outputs during actual flight.

PROPELLER TEST FUND: It is time we do something about getting a proper vibration survey performed. I feel that it would be worth $25 in peace of mind for everyone with a Lycoming engine on his homebuilt to know that his propeller is not going to come apart without warning. Just ask anyone who has had such a failure (if he is lucky enough to be around) and he will tell you that even $100 would be cheap.

So, the T-18 Mutual Aid Society is starting a special fund which will be used to finance a propeller vibration survey. This will be done first on a cut down M76 and then on an M74. We do not expect to raise 10 or 20 thousand dollars for this, but John thinks we can find a less expensive arrangement. I will keep records of all donations and if by some small chance we raise more money than is needed we could put it toward the legal fund. Perhaps you could pass the hat at your chapter meeting because this something that will benefit all FAAers. Make all checks payable to L. D. Sunderland and mark at the bottom "for test fund." Please do not put it off, for this is a very important project. The main thing is for everybody to participate or we will never raise enough money.

Since writing the above, I discovered that Bob Dial, who nearly lost 19 inches of his 74-DM cut down to 68 inches on his 160 hp O-320, is already making arrangements with Hartzel to start the tests on his T-18. Bob now has an M76, and it will be tested with two different prop extensions. Then Parker Miller will have his T-18 tested with a M74DM. So, the machinery is all set up. Let's do our part.

SPLIT NOSE PIECE: I finally got around to splitting my fiberglas cowling nose piece so it could be removed for inspection without removing the propeller. To do this, I simply sawed the nose piece in two right down the middle (in the vertical plane). Then I added a 3/4-inch lip made of fiberglas all along this parting line to which I attached plate nuts. To lay up the flange, I first fastened the two halves together by screwing on a two-inch wide strip of aluminum externally along the parting line. Holes were drilled and tapped in the fiberglas for number six screws which were used to secure the strips. The screws were short enough so they did not extend through the inside surface of the fiberglas when inserted from the outside. I covered one side where the fiberglas was not supposed to stick with a strip of mylar. Scotch tape would also work. After sanding the other half well to make the new resin adhere, I laid up a flange across the parting line using a strip of fiberglas mat.

This worked out quite well so that now I can remove the nose piece without removing the prop, and, just as importantly, I do not need to hunt up a small child to reach in and install the prop bolt nuts when I do need to remove the prop. I strongly recommend this feature. Caution! Be sure you can remove the nose piece half without first removing the top cowling. Mine just barely makes it.

TIE DOWNS: I keep my T-18 in a hangar and never have occasion to need tie downs except when I go to Oshkosh each year. I have not installed any because I could not find a good low-drag solution. George Leider has a good design. The tie down is made from a piece of aluminum angle--perhaps 1 x 1 x 0.090. It bolts on the bottom two #10 holes on the main spar fitting on the center section and extends out at the edge of the gap cover.

METAL TIPS: C. Tibbitts, 24 West Roanoke Street, Richmond, VA 23225. Credit goes to Charles Vogelsong, Chapter 122, Harrisburg who ran an excellent forum show at the East Coast Fly-In, Frederick, MD, September 25-27. He and others really knocked themselves out to do a good job in demonstrating the simplicity of working with metal. A tip I learned is to put masking tape along the lines where layout is to be drawn on aluminum...draw on the tape and after the holes are drilled, pull the tape off. The tape helps to prevent walking of drill bits, making scratches on the aluminum, and prevents marking the aluminum while bending flanges. If masking tape is left on for several months, it is difficult to remove.

Charlie also demonstrated how important it is to have metal shears sharp and in good condition. He had an old pair that he found by the road more than 20 years ago--duckbill type. He had sharpened them well and honed the edges. It was an enlightening experience to compare his old ones with some new ones of the same type that had been "almost" correctly sharpened and stoned. He showed that correct cutting technique was to not apply pressure to the metal--just let the shears support the metal.

ALUMINUM SOURCE IN EAST: Charles T. Vogelsong, Route 3, Dillsburg, PA 17019 (717)432-4589 has aluminum sheet and plate for pick-up at his place of business. Sufficient aluminum for a homebuilt aircraft can be transported in a standard automobile or station wagon by rolling the 0.020 and cutting the 0.040. Call or write for his price list.

SPORT AVIATION INFO REQUESTED: Jack Cox, EAA Sport Aviation Editor just wrote to me requesting that I urge all of you T-18ers to send information and photos to EAA on your projects. He says it is very difficult to obtain material. You probably feel that you are not qualified to write for such a professional-looking magazine and that is exactly why we have the T-18 Newsletter--to give us a less formal means for information exchange. However, do not let **Sport Aviation** scare you. It is your magazine as much as anyone's. It is more for the average guy builder than for the expert and the only way to keep it that way is to get contributions from you, the averagae guy. Pretty soon it will be so filled with special sections for the various categories that it will not be of any interest to the little guy who is trying to get educataed on how to build an airplane. Racing and antiques and who won what award does not help you make a part easier.

I think the T-18 will get its deserved attention as being the very finest homebuilt in its class if we will tell our story to others. Just read through the back NL and see how enthusiastic the T-18 owners are. Now, read through back issues of **Sport Aviation** and see what you find--a few notes about crashes, lawsuits, how hot a Tiger it is and how the tail flutter was solved. Even the Efficiency Contest article only had one sentence about Ron's T-18 winning it. The last issue had a nice article by Chris Fast, however.

One thing anyone can do is get a picture of his T-18 in **Sport Aviation.** If you are not a good photographer, you must know someone who is and he would be flattered to think his picture might be used in **Sport Aviation.** Just remember how NOT to take pictures. Aerial photos are the most difficult, for with most cameras you need to almost overlap wings with the photo ship or the subject aircraft will be just a "little speck," to quote Paul Poberezny. Telephoto lenses do not work well for aerial photos. Color is not true and motion is amplified.

So, if you cannot write, send a photo with some pertinent information. You guys who have flown, send in an article. Even you beginners should send in tips when you hit onto something good. Since so few people will take the time to write legibly, it is preferable to use a typewriter--always double spaced to help the editor. But if you cannot get it typed, handwritten script is acceptable. Do not use tiny note paper. Plain old lined notebook paper is better for handwritten material. They prefer 5 x 7 photos, either color or black and white but smaller size and transparencies are acceptable. If it is not in sharp focus, forget it. If you hope to make a cover, you must have professional quality.

You have been complaining about the antiques and Breezies getting all the coverage in **Sport Aviation.** So, if you want to see the T-18 get equal space with Breezy, get busy!

AUSTRALIAN PROJECT: There are now about 30 owners of T-18 plans in Australia, so I suggested that they organize their own mutual aid society since many of their problems are quite different than ours here in the US. Bert Oosterhoff, 15 Urana Street, Kilsyth 3137, Victoria, Australia (a displaced Dutchman) writes about homebuilding there. He says that most of those holding plans are inactive, but he might change the situation by supplying premarked skins and some of the more complicated sub-assemblies. I will send him a list of all Australian plans' holders so people can contact him to see if there is someone nearby who is building. He writes:

"I am not exactly a Newsletter producer, or even correct material for one. However, with my trade and flying experience, I am thinking of making up marking-off templates for all the parts of the T-18, mark off and drill and bend all the sheet, weld up engine mounts and undercarts, etc., in my small shop behind my house for first T-18 builders and later other aircraft. Because, the majority of ultra light aircraft association members here are frustrated would-be commemrcial pilots who cannot find a job, and who have no other training or trade, and are a bit apprhensive about the building of anything let alone a T-18 Thus, I will make the parts at cost price for any member of the Ultra Light Aircraft Association.

"Another difficulty that arises is, though we pay the same price for materials as you do in the USA, we get only $81 per 40 hour week, and that is tradesman wages, non-skilled or semi-skilled get only $55 to $65, in Australian money, about .15 cents more dollar than the US dollar. So you see that although there may seem to be a lot of aircraft started, in view of the prints sold here, the actual aircraft finished and flying would be no more than three or four. Also, any builder intending to build an aircraft in this country has to get each set of blueprints/workshop/and builder approved by the D.C.A. and he is then put on a list in the department H.Q. In due course, all members of the ULAA are notified by circular of that association every month." How about some flight reports?

HORIZONTAL TAIL FITTING ALIGNMENT: Care should be exercised when locating the 510-1 fitting on the horizontal tail tube. There must be a trap in the drawing for a number of people have read it wrong and ended up with the fitting at the wrong angle. Bill Warwick made his wrong on the first T-18 and they are still doing it. Better make a note on your drawing now before you forget it.

John says that before the first flight, you should check the horizontal tail:

1. Align the horizontal tail with the row of rivets along WL 42. The stick should be 7 1/2 degrees forward of a line perpendicular to WL 42.

2. The horizontal tail tab should be approximately streamlined at this point.

3. If not, bend the steel tube arm. DON'T change the length

of the aluminum links or it will change the kinematics of the linkage.

FLIGHT TESTING: Most builders are taking my advice and obtaining experienced pilots for initial flight tests. But then they are anxious to see for themselves and, too soon, jump in the right seat and go along. Regardless of whether or not this is permitted by the FAA, it is not wise to fly dual before the airplane has been thoroughly checked out. Before adding the second person, make progressive loading changes with sand bags in about 25-pound increments. There is no problem if everything is alright, but it is the unexpected that you must look out for.

B. D. Ham of Orlando, FL had trouble with his electric trim when he went along dual with his test pilot for the first time. He had installed an auto seat motor directly connected to the screw jack trim mechanism and it ran too fast. If you try something new like that, be sure to test it out on the ground.

MODIFICATIONS: As I have said many times, about the only way people get into serious trouble with building the T-18 is when they depart from the plans. I think that 95% of all modifications are bad and some downright dangerous. For instance, John says he has the most trouble with people trying to modify the ultra simple trim system with a complicated electric system. Next comes the flap system. I can assure you that if you do not follow the plans in these two areas, you will be making a big mistake. Here is an example I heard about: Instead of the standard flap handle, an emergency brake handle from a sports car was used. A single cable was run back through the tunnel, and it rubbed against the battery cable. Had this worn through, it could have burnt the cable through very easily. I ran my battery cable up the side along with all other wiring and think this is better because of possible interference.

TRIM FLEX SHAFT: John is using high pressure flexible hose in place of the flexible cable for the trim system. He thinks it will work out real well and solve the problem of finding a source for the flex cable. I think he said #601 hose.

FLAP BULLETIN: John says that on T-18s with a far forward cg loading, it is possible to get a phenomenon he calls "bunt" at a 40-degree flap setting and at speeds between 100 and 120 mph. He thinks this is caused by a horizontal tail stall due to high tail loading and bad airflow due to the tail getting into the wing wake. He says that while flying solo he can nearly always cause a pitch over in N299V (which has 180 hp and a constant speed prop--therefore a forward cg) and occasionally when dual. I have never experienced this, and cannot imagine what it is like, but then, my cg is pretty far back. John says that the solution is for all T-18s to have the flap travel limited to 30 degrees. Consider this a mandatory bulletin. John says this is a problem for T-18s with the cg far forward and probably explains why no one else has reported experiencing this phenomenon except several with O-360 engines and constant speed props.

GAS WELDING ALUMINUM: Lloyd Toll, Box 303, Hazen, Arkansas 72064 (Editor's Note: One of the most popular demonstrations at Oshkosh this year was the oxy-hydrogen aluminum welding demonstration conducted by Lloyd Toll. In just a few minutes time he could have a person with gas welding experience making fairly respectable welds in aluminum. The secret is the use of hydrogen, which burns clean, instead of acetylene. The tough part is getting the right amount of heat and adjusting for the right mixture since you cannot see a nice cone like with acetylene. Lloyd says he has welded up over half a dozen T-18 aluminum tanks and has not had a single problem with leaks. His technique makes the most beautiful, smooth bead you have ever seen. Here is how you do it, from the old pro himself):

The aluminum welding technique which I used in the demonstrations I gave at Oshkosh this year was the method used in the aircraft factories before and during World War II. Since Northrop's initial development of the heli-arc process in the 1940s, the oxy-hydrogen method seems to be a lost art.

Why heli-arc? Because it is easier to learn, no flux removal problem, works better on thick material (two inches or more), and more adaptable to automation.

Why oxy-hydrogen? Because of simplicity and low cost of equipment involved, and it actually does a better job on thin material (0.016 to 0.125).

Alloys generally used are 1100, 3003, 6061, and 5052. Rod used is 1100 and 4043 in 3/32 and 1/8-inch diameter. Flux used is Alcoa #22 (pink and #8 flux made by Antiborax Compound Company, Fort Wayne, Indiana. Use 1100 rod on 100 and 3003 material and 4043 on 6061 and 5052. The latter melt at lower temperatures. When welding a combination of the above material, use 4043 rod.

The equipment needed is an oxygen regulator with an adapter to fit hydrogen tanks and the left-hand hose fitting to accommodate your acetylene hose. Use your oxy-acetylene torch, but tips used for aluminum must be about twice as large. On 0.020 material, use an orifice diameter of 0.035; on 0.032 use 0.045; on 0.050 use 0.065. Unlike oxy-acetylene, you will have a wider range of heat adjustment on a given tip with no backfiring or popping. The flame adjustment either way from neutral can also be greater.

Flame adjustment will give you some problems. You cannot visually (as with oxy-acet) adjust the inner cone etc. Remember that an excess of hydrogen results in heating too wide an area too slowly, and too much oxygen concentrates too much heat in a small area and oxydizes metal to a degree which is indicated in finished weld bead showing little pits on the surface. If, in adjusting flame, you will direct it toward the fluxed area, it will intensify color and make the adjustment easier. While holding flame about two inches above fluxed metal, the yellow flame visible on the surface should be about the diameter of a quarter (0.75 inch).

Set both gauge pressures at about eight pounds. The actual amount of gas used is much less and is determined by torch valve adjustment. when completing weld, shut hydrogen valve off first to blow out hydrogen flame. Otherwise, hydrogen flame has a tendency to burn up in the torch. Not dangerous, but damaging to equipment. Flux is mxed in nonmetallic container to a creamy consistency. Apply flux to rod by rubbing on with small brush. No flux is required on base metal. Flux is removed from finished part by immersing part in cold acid for 10 minutes or 4 to 6 minutes in acid held at 150 degrees F. Technical sulfuric acid (93% H_2SO_4) (66B E) one gallon acid to 19 gallons water. Personally, I just wash it off with water and let it go at that and have had good results.

Material being butt welded does not have to be clean (as with heli-arc) and does not have to be vee'd out at joint to get 100% penetration on material up to 3/16-inch thick. The more curves, radii, angles and flanges you have in the part being welded, the less distortion you will have. A butt weld is as strong as any and easier to make.

Before any welding is begun, have the part all tacked together. Tacks should be as small as possible and about 1 inch apart. Closer on thin (0.016) and wider spaced on heavier (0.090).

A book, **Welding Alcoa Aluminum**, by Alcoa, Pittsburgh, PA, is free for the asking and will be very helpful.

The best welding lense to use is one that American Optical makes for glass blowers. I have forgotten the name of them. Cobalt blue is next best and sun glasses, a last resort. Much more could have been said on this subject, but I have been so busy on my T-18, which I intend to fly before Christmas, that I cannot get anything else on my mind right now.

O-360 PERFORMANCE ON N299V: John has been flying Dr. Cottingham's 180 hp T-18, which he rebuilt and put in all the latest mods. He says, "I have decided it is pretty much of a pussy cat instead of a tiger. (I have been saying that for years and thus never gave the name "Tiger" publicity since I did not think it appropriate.) It seems to cruise about 195 mph at 75% power and 8,000 feet (2400 rpm and 22.5")."

Luther D. Sunderland

TIPS FOR BEGINNERS: A neighbor is just getting a T-18 project started, so now I have an opportunity to relive the learning experiences of a beginner. He bought a project with many of the parts already made, but I think his experiences will give me some good ideas for how-to-do-it articles. For instance, today he called and asked if I would show him how to get started on an aileron. He had taken my suggestion and built a nice 4' x 12' table with chipboard nailed to a frame made from 2" x 4" lumber. The first time I went to clamp a template to some skin material to keep everything nice and smooth for transferring (punching) holes, I discovered he had made the frame exactly the size of the table top with no overhang. Thus it was not possible to clamp to the edge of the table. So, Lesson One, allow the table top to extend out over the frame on all sides about two inches. This gives room for clamping during transferring and various forming operations. I find that 4 x 12 sheets of chipboard are not always available so you can use one and one-half 4 x 8 sheets.

[1986 Note: After 22 years of heavy use and my son-in-law recently wet sanding T-18 wings and controls on it, I found it necessary to replace the chipboard on my table top. Since I could not find a piece of 4' x 12' x 3/4" chipboard like I bought in 1964, I used 1 1/2 sheets of 4'x 12' x 5/8" chipboard. To give me a nice smooth working surface, I glued a layer of 1/8-inch masonite on top. This gave me a total thickness of 3/4 inches, but, to my dismay, it soon sagged between the cross-members on the table frame. Since a perfectly level work surface is a necessity for matched-hole tooling, I am going to replace the top with 3/4-inch plywood or 3/4-inch chipboard (if I can find it) with a layer of 1/8-inch tempered masonite glued to the top. You do not want the table to be too thick (at least around the edge) or it will be difficult to C-clamp to when forming frames with wood forms and back-up blocks.]

He had cut out an aileron skin after marking it with a pencil. It was cut slightly oversize with a pair of right-handed aircraft-type sheet metal shears. The cut was made by completely closing the shear jaws, making little lateral cracks each time. I found a small pair of straight scissors-type shears hanging on the wall, so I showed him how easily a nice straight cut could be made with them. So, Lesson Two, do not try to make straight cuts with right or left-handed aircraft-type shears (double-jointed type). Use the ordinary straight type "tin snips." (1986 Note: Actually, the old scissors-type tin snips are now outdated and should not be used for making straight cuts in sheet aluminum. At Oshkosh this year I bought [for $20] a set of the new offset handle shears that are an absolute must. Once you learn that you do not hold the jaws at 90 degrees to the sheet while cutting, you can make beautifully smooth cuts without either burrs or a row of little kinks. Hold the shears so that the jaw surface is about in the same plane as the sheet being cut. I bought my shears from a booth run by T-18er Nick Seraphinoff, 11411 Sherman, Warren, MI 48089. The shears are called Robin V2A Shears and are made in Solingen, Germany. He said the brand new Stanley Surform hand plane chattered. They always do this until worn down a little, even when pulled rather than pushed. However, I showed how it could be kept from chattering by turning the plane to a slight angle. But with the rather broad pencil mark, it was difficult to make a straight edge. So, I showed him how to mark a cutting line with a scriber, then cut to within about 0.010 and trim to the scribe line with the Surform. Lesson three, mark all lines, which will be cut, with a scriber. Never scribe on a surface which will not be cut away, however. Someone might argue that it is not necessary to cut sheet metal edges anymore accurately than you can get with a pencil mark since the only critical dimension involved is to a rivet hole which is always 0.250 inches away from the edge. It is true that 0.025-inch error on this dimension would not matter that much, especially if you always made it on the high side. However, I find that it is always easier in the long run to work to accurate dimensions. The only precaution when using a scriber is to never scribe a line on metal which will not be cut away. If you have not yet discovered it, when 1/8-inch rivets are used, the distance from the edge of the metal to the center of the rivet is never less than 1/4 inch, or 0.250 inch. To figure the edge distance for any size rivet, simply multiply the rivet diameter by two. The most frequent problem with edge distance seems to occur at the corners of fuselage frames where they overlap the 3/4-inch angles. Frequently, the hole at the corner has come out too close to the edge and some builders have scrapped frames due to this problem. Scrapping is not necessary because a splice could be riveted to the frame corner, but most people do not like the idea of having a patch on their new airplane. There is an answer for this, i.e., if you use matched-hole techniques and put the holes in the frames before bending, you cannot have this problem. However, most of us start with the rivet pattern already in the skins which were made from templates. The frame hole patterns are then transferred after the frames are bent up and, although it should not happen, the hole sometimes comes out too close to the corner. Perhaps the skin pattern has a hole or two slightly off, so to be on the safe side, I would recommend checking everything out before you make your frames. Another possible variable is the shape of your frame joggle which could pull the corner in too far. To be on the safe side, you could leave a 1/16 inch extra on the frame corner and then trim it off after the frames are bent and holes are transferred. When transferring hole patterns to the sides of the fuselage frames, always reference everything to WL 42. Unfortunately, this is where the upper edge of the 3/4-inch angle is located and a clearance hole is cut in the frame there. The nearest sharp corner on the frame edge is just above this point at WL42.6, so use it as a reference for taking all vertical measurements. It was necessary to make a transfer strip to transfer the holes from the aileron spar to the aileron skin. I told him to be sure to label the template with a felt pen showing which edge was forward, up, etc. The template was clamped to the skin and we were ready to punch with a Number 30 nibless Whitney punch. Then I said to stop and check for proper orientation. Sure enough, the arrow labeled "forward" was pointing toward the trailing edge of the aileron. Lesson Four, before cutting, punching, or drilling anything, stop and recheck. Always assume you made some stupid mistake and try to find it. To keep from repeating the error during checking, measure from a different reference.

LANDING GEAR MATERIALS: I have just ordered material from Machine Craft, Troy Urbana Road, Troy, OH for several sets of main landing gears and decided you might like to have a material list for my gear modification as mentioned in Newsletter #28 (pages 164-166).

2 Inner legs each 1 1/4 x 0.313 x 58 inches 4130 tube
2 Outer legs each 1 1/2 x 0.120 x 32 inches 4130 tube
1 Cross member 1 1/4 x 0.083 x 28 inches 4130 tube
1 Piece 18 x 18 x 0.090 4130 plate
1 Piece 18 x 18 x 0.125 4130 plate
1 Piece 2.1 x 4.2 x 0.313 4130 plate
1 Piece 1/2 x 0.120 x 7 4130 tube
1 Piece 1 1/4 x 0.120 x 3 inches long 4130 tube
1 Piece 1 1/2 x 0.120 x 5 inches 4130 tube

PROPELLER INSTALLATION: If you want to have a nice smooth-running propeller, it is necessary for the shaft extension to run very true. You cannot be sure of this unless you check runout, after extension installation, with a dial indicator. This is very important and should be checked after every installation of the shaft extension. How much runout is permissible? The Lycoming overhaul manual specifies that the crankshaft pilot (stub end projecting forward of flange) must run true within 0.003 inches. It does not say whether this is plus or minus, or a total of 0.003. I assume it means total. So, if the pilot on the shaft extension runs true within 0.003 it should be satisfactory. The manual specifies a maximum runout of 0.005 inches at the propeller flange face. It says that if the runout, as measured on the flange face just outside the lugs, exceeds 0.018 inches, the shaft should be rejected and that the flange can be straightened if runout is less than 0.018 inches. John Thorp says that it is quite common for the propeller flange on O-290-G engines to be bent due to improper prying when the engine was removed from the generator. He straightens them by tapping with a lead mallet. He warns that it is possible to demagnetize the magnets in the magnetos by pounding on a crankshaft when installed in an engine. This has happened. The Lycoming manual recommends that if a flange has been straightened, the face should be reground and replated. To dial indicate your shaft, clamp a long bar to the push rod shroud tubes with two C clamps and then clamp the indicator to the bar. Another necessity for a smooth-running propeller is perfect tracking. After installing a brand new M76 cut down to 72 inches long and repitched to 64 inches, I had a very bad vibration even after making sure the prop extension ran true, balance was good, and the tip of the prop was tracked to within 0.010 inch. Upon checking tracking further up the blade, I found that it had considerable variation. I took it back to New England Propeller, Industrial Road, Windsor Locks, CT 06096. This is located at Bradley Field near Hartford. They confirmed that the front face was not right and worked on it. After this, I finally got a nice-smooth running installation. And, unless my airspeed indicator suddenly went crazy, I have picked up some airspeed with the new prop. At 2700 rpm, 2000 feet MSL and about 35 degrees F, today I could indicate about 183 mph. With me alone, I could climb at over 1500 fpm. Also, I sure like the extra weight in the nose, for it gives added longitudinal stability.

FUEL INJECTED ENGINES: Bob Dial, 5975 Wing Lake Road, Bloomfield Hills, Michigan 48013. Let's talk about using the IO-320-B1A engine in the T-18. I will list the advantages first:

1. Fuel feed is not sensitive to attitude. You can do light aerobatics without having the engine quit. Even without an inverted oil system, it is safe to run the engine for about 90 seconds inverted. This may not seem like a lot but it will be sufficient for everything short of all-out competition aerobatics.

2. Inherent Anti-icing. Because of the nature of the injected system there is nothing but pure air going through the injector pump. Therefore, there is no adiabatic expansion in a venturi such as with a carburetor and no ice formation. There is the possibility of ice accumulation at the air inlet for the filter but this is simply accommodated by the use of a calibrated, spring-loaded alternate air door which is automatically operated by the engine induction vacuum if the primary source becomes blocked by ice or for any other reason.

3. No requirement for an outside ram air box, thus a cleaner cowling. This is possible because the injector pump can have a large throat with an ideal air flow not compromised by the requirements for atomizing fuel, etc., that a carburetor has. This is not to say that high static air pressure at the throat of the injector pump is not desirable, it is, but the

power loss by not having high static pressure is not as critical as with a carburetor.

4. **Fuel Economy.** This is one of the really outstanding characteristics of an injected engine. At 75% power I burn from 8.5 to 9.5 gallons per hour. An O-320 carburetor engined T-18 that flies cross-country with me regularly burns about 10.5 to 11.5 gallons per hour. This has been proven with several other T-18s and I consistently burn less fuel. Usually after a three hour flight I will have about six gallons more fuel left than the other T-18. This is significant when you are flying cross-country and figure your reserves fairly close.

5. **Smoother running and cleaner burning.** The injected engine uses fuel more efficiently and it is noticeable at cruise and the engine has much less carbon buildup and less deposits in the oil; also, plug life is better.

Now, for the disadvantages:

1. **Installation.** Because the injector pump is mounted on the back of the oil pan, the engine requires a special engine mount. Earl Ody bought the mount from a commercial airplane that uses this engine and cut the ring gear off and used it to build up an engine mount. This is probably the way to go but these mounts are difficult to come by and they are very expensive. I built mine up from scratch and it is a lot of work. Also the induction pipes are located lower on the oil pan and this complicates the cowling and the exhaust system installation.

2. **Fuel System.** This engine requires an engine driven fuel pump and an electrically driven boost pump. You cannot start the engine without the electrically driven pump and the engine will not run if both pumps fail in flight. You must have at least one pump operating at all times. This simply means that the fuel system installation requires more care in the design and installation than with a carburetor since it is more critical.

3. **Cost.** This engine is generally used on more expensive airplanes than the O-320 so the cost for the engine and for repairs is considerably higher. Although it may appear to be nearly the same engine from external appearances, this is far from the truth. It has two impulse mags, different pistons, different induction system, different case, different cam, different starter, different ring gear, type, two dynafocal mounts, different valves, etc. Very few parts are interchangeable and since this is a late model engine, parts are expensive and sometimes hard to come by.

4. **Hard Starting.** Like all injected engines, the IO-320 requires a certain technique in starting and it can very

easily be flooded and end up not starting. Also they have a characteristic rough idle and they should be idled about 1000 rpm. This is not practical since the T-18 will almost be flying at these rpms.

5. Critical adjustment of the injector pump including a calibrated bench flow. If it gets out of whack, the overhaul price is around $400. It is not an item the average homebuilder is equipped to work on--it can be costly.

I am happy with my engine. It is stronger, smoother, more powerful and more reliable than the carburetor engine. But I would not recommend it for anyone else and if I had it to do over I would go with the carburetor engine. The disadvantages listed do not warrant the effort required to overcome them as compared to the advantages. If anyone is contemplating this installation, I would be happy to help in any way I can but if the initial choice is between the injected engine and the carburetor engine I would say choose the carburetor model unless all-out performance is the objective.

PROPELLER TESTS: by Bob Dial. Now, about the prop situation. I just talked to John and told him that I have arranged for Dave Biermann at Hartzell propeller to instrument my airplane and run complete flight tests to determine the best prop extension combination. These tests are quite complex and require considerable time and engineering. As of now, the situation is this--Hartzell has my EMM76 prop, Parker Miller's DM74 prop, my original 1071 extension, John's new 1072 extension and a new barrel type extension designed by Sensenich. I am negotiating to get the tests run using both props, (M74DM and EMM76) and all three extensions using my airplane and also using Parker Miller's airplane, if possible, since he has a very stock airplane using the O-320 carburetor engine and John's engine mount. This would give the most representative results and cover a great many of the airplanes now flying or under construction. Hartzell assures me that the test results would also cover the GPUs ad O-290 series. We are going to end up with specific model props cut to exact lengths and using extensions and prop bolts. The test results will only be valid if thee parameters are strictly adhered to. It looks like we may end up with a length of 68 inches on the DM74 and 71 inches on the EMM76. To change the performance for specific airplanes you will only be able to adjust the pitch, not the length. Let me caution you that these are only guesses at this point and the tests may show something entirely different. We are shooting for an S/N curve below 5000 psi in the first mode second order vibration regime which is the most dangerous one since it breaks props about 15-20 inches from the tip. We are also trying to get the second mode, sixth order vibration down since this is the mode that causes the prop to break three to six inches from the tip. This is much more common but not nearly as dangerous since the loss of three to six inches is not normally enough to cause the engine to come out of the airframe and the engine can be run at reduced power to get on the ground. The test equipment to be installed in the airplane weighs about three hundred pounds and is quite bulky. It consists of a 36V power supply, amplifiers, brush recorders, transducers, slip rings, sensors, and other equipment.

May I give a few observations about props? An incipient prop failure, (due to vibration fatigue), cannot be detected by any inspection method prior to flight. Stone nicks, gouges, etc., are obvious causes for not flying, but a prop can be in perfect visual condition and still fail.

The vibration modes which will fail a prop cannot be felt in flight.

Injected engines place less stress on props than carburetor engines.

High compression engines place higher stresses on prop than low compression engines.

The elastic stress failure on 2025 forged aluminum props is at about 100 million cycles. This is about 2400 rpm x 2 x 350 flight hours. The moment of truth on a new prop would then be about 300 - 500 hours. (1986 Note: Fatigue life in metal depends upon stress level.)

The most critical parameters are engine, prop extension, and propeller. The engine mount, compression ratio, airframe, aerodynamic exhaust system, cowling, etc., all have some bearing on the stresses on the prop but the big items are the ones mentioned.

All prop extensions, no matter how well designed or built, increase the stresses on the prop and the engine.

Prop extensions decrease the natural frequency of the crankshaft and the natural frequency of the prop. (That is what all the tests are about--how much?)

Clipping the prop increases the natural frequency of the prop.

Prop bolts are critical since, although they are under relatively low tension loads and are not under any torque loads, the engine oil heats the crankshaft, which in turn heats the prop extension and the prop hub. Over a few hours flight this heating is appreciable. If you do not think so, feel your prop hub after flight. Due to the large mass of the extension and the prop hub, there is considerable expansion of the metal. If the prop has been torqued on the high side of limits this expansion can easily exceed the bolt torque limits. (Refer to appropriate FAA and technical reports for further information.) The answer is use high-strength bolts made of 4137 steel or carpenter 416 stainless heat treated to 34-40 Rockwell, straightened, stress relieved, magnufluxed, cadmium plated, baked five hours at 300 degrees for hydrogen debrittlement. Use high strength nuts. Change prop bolts periodically.

OIL AND YOUR ENGINE: From Avoco Lycoming Flyer. There are two basic types of oil used in general aviation aircraft piston engines: (1) Straight mineral; (2) Ashless dispersant (AD). Most of these engines use straight mineral oil for "break-in" purposes with a new remanufactured, or overhauled engine; then the operators tend to switch over to AD after "break-in" has been accomplished, (exceptions are out TIO-541 series and TIGO-541 power plants which require only AD oil). Those engines using straight mineral oil beyond the normal break-in period, and later switched to AD, must watch their oil screens after each flight until clots of sludge no longer appear. Lycoming does not approve any additives to the oil. The modern FAA approved lubricants do not require additional additives.

Clean Engine Oil is essential to long engine life, and the full-flow oil filter is an added improvement over older methods of filtration. Generally, service experience has shown that the use of external oil filters can increase the time between oil changes provided filter elements are replaced at each oil change. However, operation in dusty areas, cold climates, and where infrequent flights with long idle periods are encountered, will require proportionately more frequent oil changes despite use of the oil filter. The oil filter element should be replaced after each fifty hours of engine operation, and it should be cut open in order to examine the material trapped in the filter for evidence of internal engine damage. In new or recentlyoverhauled engines, some small particles of metallic shavings might be found, but these are not dangerous.

The oil filter is more important to the high compression or higher power engine. Some of the aircraft manufacturers have had good success in the small, lower compression, four cylinder engines without using a full-flow filer. Generally speaking, these engines are also able to achieve their expected overhaul life, as long as oil was consistently changed, and operation and maintenance were accomplished in accordance with the airframe and engine manufacturers recommendations.

Pilots and mechanics should know what weight, type, and brand of oil is being used in the engine being serviced. At each oil change, this specific information should be recorded in the engine log book. Except as a temporary measure in an emergency, different oils should not be mixed. Indiscriminate mixing of oil has created a high oil consumption problem or clogged oil control rings and oil screens.

Oil consumption is a very important trend to monitor in an engine. The operator and maintenance people should know the general history of oil consumption during the life of the engine. It is typical of an engine during seating of new piston rings that oil consumption may be erratic or high, but after the rings are seated, generally within the first 25 to 50 hours, oil consumption should level off below the maximum limits established by the manufacturer. Later, during the life of the engine if there is a noticeable increase of oil consumption within a 25-hour period, this could be a possible danger signal and calls for an investigation. The oil screens and filter should be carefully observed for signs of metal. Maintenance personnel should take a compression check of the cylinders, preferably using differential pressure equipment, and also look inside the cylinders with a boroscope or gooseneck light to detect any unusual conditions.

PROP TEST SITUATION: Just talked to Mrs. Dial by phone. She reports that Bob talked to Hartzell this week and they have not been able to start the in-flight tests. He is to check back in several weeks. (Bob is a pilot for General Motors.) Received a letter from John Thorp today and he is within two weeks of flying his T-18, N18JT. Shake tests on his M76 prop cut down to 68 inches with 85-inch pitch show the first bending mode, second order is at 2800 rpm and second mode, sixth order at 2500 rpm. N299V, Dr. Cottingham's, with a constant speed prop, is much better with first mode, second order at 3050 and second mode sixth order at 2190. You should not operate at one of these modes. John is flying his T-18 with the 1072 extension and AN-8 bolts. He is not aware of a prop bolt failure problem due to hot propeller hubs. He says that any conclusions on props prior to the planned test program would be difficult to make and he is anxious to see it completed. If you have not sent in your contribution, please do so for we have a long way to g. EAA Chapter 361 from Tachikawa, Japan sent in $25. How about yours?

DEBURRING: W. Warnack, 189 Bayshore Drive, Baytown, TX 77520. I ran across an interesting approach to deburring. I have a small draftsman's electric eraser. By experimenting with different eraser rubber, I came up with one with just a little 'grit' in it. I can polish rivet holes very nicely by just touching the eraser in and around the hole. Very quick and easy once you locate the right eraser rubber. Have a question regarding the horizontal tail 509 mounting lug and spacer. Tolerances called out are very close and I doubt if I can ream out to 1/1000 accuracy. I understand that it is not intended anyway. My question is this: Is relative movement intended to occur between the 509 lug and the spacer, between the spacer and the 1/4-inch bolt, or both? Talked with Paul Stanley in Galveston. He expects to fly about Easter. Has all inspections completed except the final one before the test hop.

Answer: The fit between the 509 lug and the bushing is very important. This is the bearing for the horizontal tail. When the bolt is tightened, it clamps the spacer so it cannot turn, so all motion is between the steel spacer and the aluminum 509 lug. If you cannot ream accurately, you can certainly tailor the spacer OD to make a nice close fit in 509. My horizontal tail shows no signs of slop at the pivots after 552 hours.

FLIGHT REPORT ON N18TT: B. C. Roemer, Manitowish Waters, WI 54545. I now have 25 hours on it and am still trouble-shooting the airspeed indicator. The only mechanical problems were the brakes--not enough. We reworked them getting more leverage on the pedals and they are satisfactory now. As for flying, there just is not much around to top it. I have had my troubles with landings--strictly pilot fault although I have never ground looped or even had any indication of one. Ground control is very good. It wheel lands nicely if you keep the tail high enough, but you sure use up runway. Doing the test flying with the forward tunnel off and main spar uncovered, I had a problem that might be worth repeating. We have a mike that has a button on the back that slips up into a fork, which is located under panel center. I called into a grass field and tried to hang up the mike only had it backwards and could not get it to go in fork. You just do not look around under the panel while flying a T-18. It has a mind of its own when not watched. Anyway, I got the mike stuck a bit and went on in to land--gassed and took off--field is rough. After I used forward stick to get the tail up, I used back stick to lift off then forward stick to level off--only I had no forward stick--jammed. After cutting power and making an unimpressive landing (unless you were looking for thrills), I discovered the mike had fallen in the spar at the push pull tube point. Needless to say, I hung it in correctly and installed tunnel and cover plates, pronto. Cannot use full flaps--pressure and buffeting too high; restricted them to 30 degrees. My son, Peter, flew off the wing of a Bonanza who had a very accurate airspeed indicator. It read 195 and he had no trouble to go ahead of him on the O-360. We have no gear fairings or wheel pants yet and a fixed pitch 68-81 which sure seems a good combination. We cannot get over 2575 rpm so are not getting full hp. (Editor's Note: There is a really important lesson to be learned here since the outcome could have been much more serious. Accidents are almost always caused by more than one thing going wrong--sometimes three, as in this case. It started with his failure to install the tunnel cover. Next, he failed to hook the mike properly, and then Murphy took over from there. Not only did the mike fall in a way to jam the stick, but in just the right way so that it was not detected until the critical moment of lift-off. It is incredible that the professors teach their students that random, accidental processes like that made everything out of nothing. Obviously, professors who preach such foolishness never tried to do anything practical, such as build an airplane.)

BENDING EXHAUST TUBING: by Luther D. Sunderland. As you know, about the only part of the T-18 for which there has not been a good source of supply for raw materials has been the exhaust system. Finally, I have discovered how to make nice smooth bends in 1.75-stainless tubing. Someone will probably now say they knew how to do this all along, but if so, they sure kept it quiet. Here is how I went about it. First, it is necessary to have available a powered tubing bender. Since not everyone is fortunate enough to have one of these in his shop you might throw up your hands at this point, but take heart, all is not lost. Almost any area large enough to have a muffler specialty shop has one available. The local Mac's Muffler Shop here in Endicott will make bends for one dollar a bend and will tailor your bends to any desired angle. (No mail orders.) I am not aware of the different types of tubing benders which might be available but the one I used has an inner radius block with a semicircular groove in it. Two hydraulically actuated die blocks, also containing semi-circular grooves, trap the tube at the bend point. As the bend progresses, these outer blocks wrap right around the inner block. When I tried a 90-degree bend in a piece of 0.035-inch wall stainless, it wrinkled very badly on the inner radius. After discussing the situation with several other builders, we decided to fill a section of tubing with sand and weld plugs in the ends to plug it. But this did not work any better. Then, I made two aluminum plugs about 1.24 inches long, which fit snugly inside the tubing. Then I drilled two 1/4-inch holes for bolts through each plug and the tubing. In one plug end I drilled and tapped a hole for a 3/8-inch bolt. The hole passed all the way through the plug. With a plug installed in one end of a 16-inch long section of tubing, I filled the tube with clean white dry sand purchased from the local Agway store.

Then came the important part. I rested the tubing on the arbor of my grinder which acted as a nice vibrator. Within several minutes, the sand had settled down over one inch. Then I installed the plug in the other end, put in more sand through the 3/8-inch hole and screwed in a long bolt, which further compressed the sand. Off to the muffler shop with a little spare sand. Before putting the tubing in the bender, I removed the 3/8-inch bolt and looked in. Whatdayaknow, the sand had settled down more. After refilling, we made a perfect 90-degree bend with a 5-inch radius.

So, order 20 feet of tubing and have fun making your exhaust system. I think you could get by with about 8 bends. To make a mockup of your exhaust system, get some 1/4-inch rod, make four flanges from plate stock to fit into the exhaust ports, bend and weld up a complete system right on the engine. To check for clearances, make up some 1.75-inch discs from cardboard and slide them over the rod. It is better to do this with the engine mounted right on the airplane. If you are using a Hamlyn-type cowling, the tightest spots will be where the tubes curving down and inward from the attach points at the jugs pass the lower edge of the cowl cheeks. Few people are able to get more than a finger width of clearance there. That is all I have and it has not burnt a hole in the fiberglas. Do not forget to put in ball joints and slipjoints. Slip joints are directly in front of the oil pan and a ball joint is placed in each of the two outlet tubes just aft of the "Y" joint. If you put a heat muff on the outlet tube aft of the ball joint as I have, the stainless ends of the muff should be made cone-shaped. This design prevents cracking. The outlet tube may need to be bent downward just aft of the muff to get clearance between the muff and the bottom cowling.

See **Air Progress World's Great Aircraft** for my T-18 article.

BACK SEAT DETAILS: by Luther D. Sunderland. Many people have shown interest in my back seat installation. Since it has worked out very well and is simple and light weight, I will include a sketch. At least a half-dozen T-18s have a back seat and I recommend it if you have very small children (under 100 pounds). The only problem is rearward cg. With my wife and me in front and my 80-pound boy in back I cannot run the tank empty or pitch stability gets too low. I have not tried this loading with my new five-pound heavier M76 prop, but it should be much better. The seat is a canvas sling type supported at the top with 10-32 bolts through a strip of wood and at the front with a one-inch aluminum tube. The tube is supported on each end with 0.063 brackets riveted to 0.032 supports added between the 3/4-inch angle and the 1.125-inch angle. A notch is cut out of the top of one of the brackets to allow the tube to be slid to one side and lifted up at one end for removal. The quick-removal feature is an absolute must to permit access to the aft part of the fuselage. Support is provided for the center of the tube where it rests against a bracket riveted to the aft tunnel. A 3/4-inch hardwood dowel holds the canvas down in back and is secured by a couple of bicycle spokes whose nuts are countersunk into the wood. The spokes are secured to brackets riveted to 571 which also anchors the seat belt.

MANEUVERING SPEED: Don Carter finally got his T-18 approved for instrument flying. He needed to know the maneuvering speed for the T-18. John says it is 158 mph with 1270 pounds gross weight. This is the speed where you cannot exceed 6 g. CL max is 1.48.

WING ROOT FILLETS: Letter from Dewey Parks to Rudy Adler, 16716 Nearview Drive, Sangus, CA 91350. Thank you for your idea on the wing fillets. The installation was as simple as you said and the fit was perfect. As far as appearance is concerned they are a great improvement, but the real advantage shows up in the stall. With either half or full flaps and the ship completely stalled it just "mushed down" at a high rate of decent with no tendency to bunt or tuck under. There is adequate stall warning (rudder shake) at about 5 mph above stalling speed. This is better than stall strips on the leading edge of the wing. I flew my T-18 to Oshkosh last week and was surprised to find no other T-18 with your wing fillets. Someone is missing a good thing. The T-18 is pure pleasure, exceeding by far my expectations.

T-18 NEWSLETTER #36 03-06-72

Luther D. Sunderland

TUNNEL CRACKS AND PLEXIGLASS CUTTING: Lyle Fleming, Lancaster, CA 93534. Here are a couple of items for the T-18 Newsletter. I found during the last annual inspection that all four bolt holes in the top of the tunnel, where the quadrant for the flap bolts on, had a crack radiating out from each of the holes. I made up a saddle reinforcement piece of 0.063 over the top of the tunnel and extending down each side where I bolted it to the side of the tunnel. The plane had over 427 hours on it at that time.

One of the easiest and nicest ways to cut plexiglass that I have found is to use an abrasive cutoff wheel. The wheel is about 1/32-inch thick and melts its way leaving a smooth edge. If you ever have a chance to use it you will never try a router or band saw. The Norton Company makes a disc, part number A60 OBNA2, which should cost about a dollar. To make the mandrel take a 1/4-inch bolt and cut the head off. Braze on a large-area washer at the end of the treads. Install the cutting disc with another large area washer and nut. Using this with a 1/4 portable electric hand drill you can cut plexiglass with no problem. The electric drill has plenty of speed. However, do not stop in the middle of a cut without first removing the disc, or it might freeze in the plexiglass.

Now for a rundown on my T-18 N252F. It has over 427 hours on it. It has been tied down in the yard in front of my house for the last three years. The desert sun faded the paint and ruined my upholstery so I decided to repaint and reupholster it at the annual inspection time in April. This caused me to build a new horizontal tail assembly because I did not want to paint the old one then have to paint the new one when I got it done so I proceeded to make a new one with the weights inside the leading edge. New fairings were added to the wing roots (From Rudy Adler). Then I had to make a new canopy and canopy frame as the old canopy was crazed and cracked. This has caused me to be down all summer and miss the usual 11 or 12 fly-ins each summer.

TOM GAUTIER #493: 3775 Davidson Place, Boulder, CO 80303. I am a terrible correspondent, but not because I am unappreciative of your efforts in the T-18 cause. The Newsletters are so good I am awed, and the size of the stack is becoming monumental. My fuselage is about 80% complete. Tail feathers are essentially done. I have the main gear and tail spring done. I have bought Industrial Dynamics wheels and axles. They seem to be very good. Dean Cochran wishes he had some instead of his Goodyears. I also have a Gee Bee windshield and canopy but no work has been done on them yet. I bought a 160 hp Lycoming from Miller Aviation at San

Antonio. It was supposed to have been running nicely when it was pulled from an Apache, but it had 1200 hours since a 1200-hour overhaul, so I did not get as nice an engine for $1000 as had been reported in the Newsletter about a year and a half ago. It did come with all accessories, constant speed prop and spinner, but the prop blades proved to have cracks at the hub, and was otherwise worn out and virtually worthless. I have had the engine overhauled at Colorado Aero Tech (Jeffco Airport where the manager, Brad Davenport, is an EAAer and member of Chapter 43. They do not charge for labor, but the parts they put in (not including a crankshaft, which was not needed) came to $1489! This was not exactly the economical way to go, but I do wind up with a certified 2000-hour engine.

FLIGHT DATA ON #63: Steward Schureman, Granada Hills, CA. Initial rate of climb is 2500 fpm at 120 mph. Cruise at 700 feet is 150 mph at 2400 rpm; 180 mph top speed. Maximum level flight rpm is 2700. Gross weight is 1390 pounds, empty weight is 868 pounds. Engine is O-320-B, 160 hp with a Sensenich fixed-pitch prop. M76 EM68 x 74 model. Other than a cut down rear deck the ship is stock to prints.

I have been keeping my T-18 at home and have used a special trailer which was made by Rudy Adler and it works fine. It takes under an hour to load and unload with the help of two men, mainly for lifting the wing and mounting it both on the trailer and on the plane. I chickened out and used nuts and bolts instead of the ball lock pins as it is not that much trouble but gives me added peace of mind. Rudy's trailer is designed so that one man can load and unload but I usually have help and it goes much faster. I have my wing sitting on a metal box which has wheels attached and it acts as a dolly. I then wheel the wing into the garage leading edge down and it fits nicely on one side of the garage out of the way. I park the fuselage in the backyard under my patio cover which keeps it out of the elements and is close at hand to work on.

FLIGHT REPORT: by Nick Seraphinoff. I made the first flight in 426 on July 16, 1971. As of this letter, I have flown four hours. The ship is powered with a O-290-GH turning a 65 x 65 prop. I installed a O-290-D2 cam shaft in the engine. The shaft with the narrow cams gives me a little more valve lift, seems to work OK. There has been much said about the subject so I thought I would experiment. The ship flies very well, has a 1970 Rattray cowl, static rpm 2350, wide open level flight 2800 rpm, climbs approximately 1600 fpm. Speeds--110 mph at 2100 rpm. At 2000 feet altitude MSL 2500 rpm 20 inches manifold 130 mph--gauge readings only. Wide open level flight. I let the speed build up to 165 at 2800 rpm. The ship is all flush-riveted with most all screws countersunk. Will let you know more as I learn.

FLIGHT REPORT: Earl Ody, 219 Peacock Lane, Montebello, CA 90640. Flew my bird for the first time on 07-09-71 and it is great. If you put excerpts from this note in the next Newsletter, please give much credit on my behalf to George Leider, Phil Cline, Herb Weigle, and Bob Leider for much help. I am powered with a 160 hp fuel-injected Lycoming. You are doing a marvelous thing and I am happy to contribute $20 to the legal fund. If the fund comes up short let me know and I will send more.

FLIGHT REPORT: Floran Sullivan, 2418 Bush Avenue, St. Paul, MN 55119. On September 23, 1971 my T-18, N427, made its first flight. The first and second flights were flown by Ron Zimmerman. I made the third flight one week later after getting some fine instruction in Ron Zimmerman's T-18. It is sure a pleasure flying the T-18s. I started the T-18 in May 1966 and completed it September 23, 1971. The engine is a Lycoming O-290-G4 with an O-320 oil pan and an MA 4SPA carburetor, Corvair oil cooler mounted forward of #2 cylinder, automotive-type air filter system as per drawings and Thorp prop flange reinforcement. The prop is from a Tri-pacer and reworked by Maxwell to a 68-inch diameter and 66-inch pitch. My T-18 is built per prints except for the Ron Zimmerman landing gear which I think works great. In the trim system I used two universal joints and a short tube instead of the rear flex cable, and up front I used a radio compass 90-degree drive unit for a replacement of the flex cable. The aircraft is all flush riveted. I painted my T-18 with Dupont Deluxe enamel. The colors are white with green trim. I have anti-friction bearings in the horizontal tail pivots. A complete electrical system and basic instrument panel. My T-18 empty weight is 843 pounds. The engine turns 2500 rpm on take-off. Climbing at 110 IAS, the rate of climb is 2000 fpm with one person. At 2400 rpm, 20-inch MP, indicated airspeed is 145 mph, at 2600 rpm 22-inch MP indicated airspeed is 160 mph. In closing I would like to say how much I have appreciated the T-18 Newsletter; you have done an excellent job of helping us all. When I get some more information on flying performance I will fill out your questionnaire and mail it to you.

REAMING: Guenter Steuer, 9252 Christine Drive, Huntington Beach, CA 92646. When I purchased the first 3/8 bolts (outer wings to center wing) they were AN bolts and miked 0.371, which means a 0.373 reamer. but I have a 0.375 reamer only. So I bought NAS bolts. They miked 0.3735, OK, with a 0.375 reamer. Besides the NAS bolts have a much better finish. From then on I bought NAS stuff only.

PROPELLER BULLETIN: The propeller in-flight vibration survey has been concluded at Hartzell. Bob Dial's 160 hp T-18 was used for all of the tests. Twenty-three flights were made with three different props (M74 cut to 68 inches, M74 cut to 69 inches, and a M76 cut to 70 inches), and three different propeller hub extensions (1070, 1072, Thorp spool extension and a Sensenich-type bolt-through barrel extension). Hartzell is still writing the test report, but several conclusions have already become evident and should be brought to the attention of anyone using a cutdown Sensenich propeller. Cutdown M74 Sensenich propellers and light 1070 extensions should not be used on 160 hp Lycoming engines. They probably should not be used on the 150 hp O-320 engine either.

A full report on the tests with information extrapolated for the smaller engines and on the effect of pitch can be obtained from the Editor, T-18 Newsletter, 5 Griffin Drive, Apalachin, NY 13732 by sending a donation of $5 or more to help pay for these tests. Twenty-seven persons have donated $575 to date to help pay for them but we need to raise about an additional $1500. The report will reveal some surprising things about propeller extensions, engine timing, and cutdown props which should be of interest to all homebuilders. A Tailwind with an O-290-D2 engine was recently found to have a bad resonance point right in the middle of his operating range.

DECIMAL SCALES: I have discovered that some builders are trying to struggle along without a scale marked off in decimal units rather than fractions. This doubles your layout work. I use an 18-inch scale, from a drafting machine, marked off in 0.020-inch increments. This serves the purpose quite well and I recommend it if you cannot locate a decimal steel scale. If you do not have a drafting supply house, you can send $8.50 to Cahill and Larnard Company, 83 State Street, Binghamton, NY 13902 and they will mail you one. (Better call first for a new price.) I also have a steel scale marked in 0.010-inch increments, but it makes me dizzy trying to read it without a magnifying glass--and that would waste time. The 0.020-inch increment scale is much better.

BEGINNER'S CORNER:

1. How do I "fix" an extra 1/8-inch hole in exterior skin?

Answer: If the center of the erroneous hole is at least 1/4-inch away from another 1/8-inch hole, the hole can be plugged. Chamfer both sides of the hole, insert a punching made with a 1/8-inch Whitney punch and "rivet" in place with a hammer and bucking bar.

2. Will an air gun available at automotive stores (for chiselling off mufflers, etc.) work as a rivet gun? I do not think they would give adequate fine control for riveting. Anybody tried one?

3. What wall thickness is required for the aluminum

windshield frame?

Answer: 0.083 x 1 1/4 aluminum 2024.

THORP'S T-18: John says he missed on the weight estimate on his personal 180 hp T-18. He estimated 940 pounds but it weighed 938. But he hit the tail weight right on the button at 41 pounds. He now has over 50 hours on it and it is back home from Fox Field at Lancaster where he had to take it for flight testing. He is now installing a canopy latch, for the canopy would come open at speeds over 172 mph. His only other problem was a broken tachometer shaft. Vaughn Parker told me (confidentially) that the standard panel location does not leave much room for instruments and it is really tough to change instruments. No performance data is available yet.

CYLINDER HEAD TEMP GAUGE: by John Spranger. Buy the VW cylinder head temp gauge kit from J. C. Whitney($17.95). The probes have 1/8-inch pipe threads, but if you run a straight 3/8 die over the threads, they are a perfect fit for the Lycoming cylinder. It is electrically operated. Now you can check all of your cylinders any time.

FLIGHT REPORT: Clive Canning, 7 Hillside Crescent, Blackburn, Victoria 3130, Australia. It is with pleasure that I can advise you that my Thorp T-18 aircraft has now flown and in fact has completed the whole of the flight test schedule as required by our Department of Civil Aviation and has been issued with the necessary certificate of airworthiness. Construction time was two years, ten months. The assistance given by Mr. Thorp during the construction period highlights the character of the man and also his unbending enthusiasm for the amateur builder. It goes without question that the flying qualities of the T-18 are unequalled by any other aircraft that I have personally flown, and this includes a wide range of commercial aircraft manufactured by the well-known reputable organizations. For the purpose of your records I have enclosed a brief resume of the aircraft VII CMC on which I have now logged some 20 hours since its first flight on March 10th. You may be interested that during our first National Fly-In it was awarded the trophy presented by our U.L.A.A. for amateur constructed aircraft. I would also like to record that the T-18 Newsletters have always proved most interesting and certainly of great assistance during construction.

Initial Test Flight: Latrobe Valley Airfield. Engine: Lycoming O-320-E2A - 150 hp. Fixed-Pitch Propeller: Sensenich 74-inch Diameter - 60-inch Pitch. Performance: All at 1355 pounds. Stall clean 48 knots IAS. Stall full flap 43 knots IAS. Cruise 2450 rpm 130 knots TAS. Full throttle level flight sea level 153 knots TAS. Full throttle climb at 90 knots IAS 1800 fpm. Equipment: Engine driven dry vacuum pump providing suction for A/H and DG. Electric T and B - Electric auxiliary fuel pump. King KX 170 with K 211 B Indicator including Glide Slope. Bendix T12D ADF. Instrument lights, navigation light, landing light, rotating beacon.

Modifications: Undercarriage lengthened 4 1/2 inches to comply with propeller clearance needs of Department of Civil Aviation, Australia. Sump added to fuel tank to collect possible water contamination together with separate water drain pipe with fuel cock for external drainage aft of firewall (DCA requirement). Pitot-static source moved to underside of port wing (DCA requirement). Full length aileron hinges (my own modification). (Editor's Note: This is a fine flight report. If yours is not included somewhere in a back Newsletter, why not send me one? I see no mention was made of airspeed calibration. The high-speed figures may be fairly accurate, but the stall speeds probably reflect errors due to the under-wing location of the pitot tube. Some pitot-static tubes located there have given readings near zero at stall.

The full-length aileron hinge makes a good seal, but is not a good idea because of the potential for high binding friction. When I added two segments to the S-18 aileron hinge because of reported wear in T-18 hinges, John Thorp was upset. He said that he had gone to great pains to reduce the aileron control friction to a minimum and hated to see anyone put friction in the system unnecessarily. Since it is impossible to get perfect alignment between the mating halves of a piano hinge, there is inevitable binding in the hinge as it rotates and forces the two mating structures to bend by an amount equal to the misalignment. I am presently working on all-electric actuation systems for the next generation of composite-structure fighters. When maneuvering, their wings deflect with a 500-inch radius bend, so we must use only two hinge points per surface segment. This principle was vialated in one of our hottest new fighters with dire consequences.)

APPLYING NUMBERS: Robert Cumberford, Tuxedo Park, NY 10987. I had extremely good luck putting numbers on my Bolkow Junior using 3M Scotchbrite reflective tape, two inches wide. As this is the legal minimum stroke width for 12-inch high numbers, it was convenient. I laid out the angle of letters I wanted full size on drafting velumn, then just used scissors to cut off pieces of tape that would fit. I then taped those onto the velumn, and took the whole works to the airplane. Taping the whole assembly of layout, tape bits, etc., to the fuselage sides, I was able to use a water-based Flair pocket pen to mark the ends of letters. Then I just put the reflective tape bits on one at a time, peeling the back and sticking the tape down with a lubricant of household detergent and water. (3M gives instructions on the method with the tape, as well as supplying the squeegee). This material is used on airliners (and New York Telephone trucks, now) and will not be disturbed by high speed if properly applied. However, there is an Aircraft Edge Sealer, a kind of industrialized nail polish, that can take all risk out of the situation. I used it. The whole job--layout, installation, and burnishing down--took about four to five hours. I could do it more quickly now but others not used to graphic arts work might take a bit longer. There was almost no waste, which is good since the roll of tape cost $28. There should be plenty for several airplanes in one roll. I also used some on the l.e. of the stabilator and wing (gold tape on Corvette red-orange paint).

CANOPIES: Gee Bee, 18415, 2nd Avenue South, Seattle, WA 98148. Here is something you might mention in your next T-18 Newsletter. T-18 canopies are going up a little in price. The price of plex is going up again. I absorbed the last two price increases but just cannot afford to absorb any more. The new prices will be: canopy and windshield $150; canopy only $135; windshield only $20; shipping carton $13.50. Colors: clear, green, light gray. I will honor the old prices until August 1, 1972. Phone 206 CH2-0332 6:00 to 7:00 PM Pacific time. (Those were the good ole days folks.)

FUEL SYSTEM: by Luther D. Sunderland. After Jack Parks and several others reported that they got power interruptions with several gallons of fuel in the tank, John recommended that a fuel pump be put on all T-18s. However, many of us do not use pumps and have no problems, even with 180 hp engines. Before Bill Warwick flew the first T-18 he ran a full power test with the nose elevated and there was no problem using up all fuel in the tank.

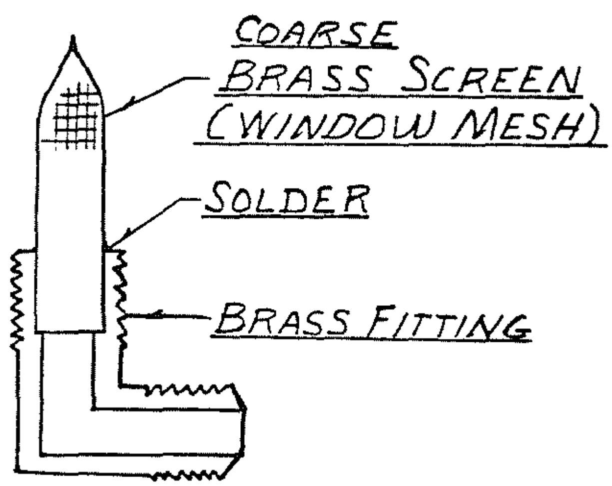
So, what could cause fuel flow problems in some T-18s? Three possibilities: vent clogged or creating negative pressure; clogged fuel strainer, or a wrong carburetor float valve. If the vent tube faces forward into the wind getting full ram air, the pressure increase is equivalent to that if the fuel level in the tank were 7.2 inches higher. On the other hand, if the vent tube faces aft, thus pulling a suction, it will be like lowering the fuel level. Depending on the amount of negative pressure differential, it could prevent fuel flow. What is wrong with facing the vent forward? It collects dirt. So it should have a screen to keep out contamination and perhaps more importantly, mud wasps. An alternate inlet should be made inside the fuselage just in case the main inlet becomes clogged. Drill a 1/16-inch hole in the tube for the alternate inlet inside the cabin.

My vent tube is made of 3/8-inch aluminum. It comes through the 0.040 floor board near the fuselage centerline and extends out about 1/2 inch. The end is cut off at a 45-degree angle with the opening facing foward. Peen the tip forward making a small pocket to insure getting positive ram pressure. Air in the vent tube is virtually stagnant except between the end and the alternate hole where water or dust will be purged by the airflow. I have purposely run my tank very low (it is fiberglas so I can observe the fuel level in flight) and I have been unable to cause the engine to even hesitate in a steep climb.

If a filter or tank strainer is clogged, the solution is obvious. Someone has already had engine failure because of not having a screen finger strainer in the outlet of the tank. If your airplane does not have one, ground it until you intall one. If you cannot find a shutoff valve with a finger strainer, you can make one easily as shown in Figure 15. The fitting which screws into the tank should be made of brass. Drill out the center hole about 0.080 oversize. Then make a two-inch long sleeve from brass or copper screen. The sleeve ID should be at least as large as the original ID of the fitting. To secure the screen until it can be soldered, bend several wires into hooks. Tin the end of the sleeve with solder, tin the fitting, insert the sleeve and solder in place. Inspect to ascertain that the sleeve ID is as large as the original fitting ID so there is no restriction, crimp the sleeve end and solder. If all homebuilders had done the above, there would be alot more nice shiny airplanes around. (1986 Note: The finger strainer screen should be made of coarse screen to keep out foreign particles large enough to clog the fittings and fuel line to the sediment bowl. The screen should not be very fine, like that in the sediment bowl. I found one made this way, but that can easily become clogged, requiring the disassembly of your fuel system. That is why you have a sediment bowl with a fine screen that can be easily inspected annually. Do not forget to remove and inspect it. The big problem is in finding brass screen. I cannot find a source. Anyone have any ideas?)

I have been told that carburetors have different float valves when designed for use with a fuel pump. Still have not been able to verify that but John Thorp tells me that there were some surplus carburetors available after the war which did not cause a problem because the engine would not even run without a fuel pump.

What are the disadvantages of a fuel pump? If your fuel system configuration is such that a pump is not required, then its use decreases powerplant reliability. (Al Neuntuffel says that his fuel pump failed on takeoff on his first flight. Luckily he made a safe landing back on the airport.) A pump by-pass with check valves can and should be added when a pump is used, but it all adds up to more things which can go wrong. A part can have no higher reliability than when it is not used.



FUEL TANK STRAINER

Figure 15

While on the subject of fuel systems, I have heard of two T-18s that have run out of fuel, one in rugged terrain resulted in a fatal accident. We do not need anymore of those, so why not try making an extra fuel stop if you do not have a one-hour reserve? Or better yet install two fuel tank outlets and two shutoff valves. This can give you a one-half-hour fuel reserve like on the old Volkswagen cars without fuel gauges.

T-18 NEWSLETTER #37 10-16-72

Luther D. Sunderland

OSHKOSH 72: There was a nice crop of new T-18s at the Fly-In this year in spite of a solid weather front stretching from the Atlantic coast to the Rockies which kept many from making the trip. Lloyd Toll and Dick Walen are to be congratulated on winning the T-18 awards and there are many others very deserving of commendation for the fine workmanship. It would really be worthwhile for every builder to make the trip to Oshkosh at least once before completing your T-18 so you can see how you should set your standards. Especially in the upholstery and exterior finishing areas, some people do a poor job and ruin an otherwise fine airplane's appearance.

There were several interesting variations which deserve comment. One was a further variation on the modification made by the Tiger Club from Marietta, Georgia. George Fugate N7199 put conventional dihedral in the wing. It is made the same as the standard wing except that the joint between inner and outer wing is overlapped and the main spar is spliced in the center at BL 0. It is one of the heaviest T-18s now flying with a weight over 1000 pounds, although I do not know how much is due to the wing modification. Tell us more about it, George.

A second new mod was Ron Zimmerman's wing tips. As a result of the test program at Mississippi State University, Ron thought he might get a slight improvement by changing tips. He said that there was slight inwash at the trailing edge of the tip which effectively reduced the effective span by the amount of total inwasy. He made new tips with the same planform but a large amount of camber at the outer edge somewhat like the Yankee tips. He reported disappointedly that they lowered the maximum speed, but they did cut stall speed by three to five mph. Later he reported that the loss in speed was due to a sticking carb heat valve and that he thought he actually gained 2 mph.

Bob Young had the most enviable control surface trailing edges. He did what many of us wondered about but did not do--make both sides of the surface from one piece with the trailing edge simply folded over. It must have worked, for there were no cracks. He also did a fantastic job of filling rivets to hide them. (1986 Note: I made my S-18 ailerons this way with beautiful results.)

TUFT TESTING THE T-18: Peter Garrison has been commissioned by **Flying Magazine** to write an article on tuft testing. For this John Thorp tufted his entire T-18 and had in-flight pictures taken from all angles. He says that the airflow is perfect except around wheel pants. Watch for the article.

LEN EDVINSON'S T-18: 2204 Camas Circle SE, Renton, WA 98055 (by Luther D. Sunderland). On a recent trip to Seattle, I visited Len and got a ride in his nice T-18 (150 hp). It is really a smooth one with every rivet filled on the external surfaces, making them quite invisible. The workmanship makes me want to build another T-18 to get a second chance. Len, a former Boeing engineer, is design engineer for a firm which sells laminated fiberglas fabrication equipment. The are designing an all-fiberglas powered sailplane a la Hummingbird that they hope to have at Oshkosh 73 and offer in kit form to homebuilders. Len made some interesting variations which are worth noting.

Fuel Tank: As you know, the standard T-18 fuel tank filler cap was made exposed for simplicity, but I strongly recommend enclosing it for it spoils the looks of a beautiful airplane and the extra door adds little work--probably less time than you would take hunting a molding. Also, hiding the cap allows you to use an alternate cap since the standard one is almost impossible to build. Some builders who enclosed the cap had a clearance problem with the door latch. Len solved this by hinging the door outward. (Editor's Note: This is not really necessary, however.) He used a combination of aluminum and fiberglas to make the tank. The ends were made of fiberglas like my tank, over male molds, but instead of making the center of fiberglas sheet, he used a sheet of aluminum. Tank ends had a strip of aluminum cemented inside the lip. Assembly was accomplished by wrapping the center sheet around the ends and securing with closed-end Pop rivets. An epoxy fuel tank sealant was first applied to seams. The filler neck and other fittings were attached in the same way. Sealant was then sloshed around inside and Len reports no sign of fuel leakage. The ends were made full-strength over the molds, so no additional layers are added on assembly as in the all glass process. (Do not forget reserve outlet when you make your tank.)

Oil Cooler: Len used the largest Corvair cooler but mounted it in an unusual location on the bottom side of the bottom cowl just forward of the firewall on BL 0. Air enters through a metal scoop, turns 90 degrees and flows up through the cooler. The scoop is hinged on the aft side to allow inlet adjustment. With a 3/4-inch opening, it gave adequate cooling. Although the scoop adds drag it works well.

Tail Spring: Although the Zimmerman-type round tail spring is probably the softest I have seen, Len's was very impressive also. It was a standard 3/4-inch spring with two inches extra length. His main gear was the same as mine (outer tubes tapered and inner legs 2 1/2 inches longer) but the ground ride was softer, probably due to the longer tail spring. My 5/8-inch spring is a big improvement but Len's is probably softer. The only disadvantage of the long spring is that it increases the moment on the fuselage attachment fittings. So far, this has not caused a problem however. I have not ridden in a T-18 with one of John's new steel leaf springs yet, but he says it is also softer. Whatever you do, do not use the old standard 3/4-inch aluminum tail sring. Len's steering springs were too soft, and I could hardly keep the airplane on the taxistrip. If you have ground handling problems with a T-18, it is probably due to these springs. Mark my word, if you do not hook these springs up like I suggest with an extra loop of chain and bend the hooks so they cannot come off, sooner or later you will ground loop. I did not get to takeoff or land Len's airplane because I had to hold my left leg up over the stick due to limited stick motion with the center console. T-18s with center consoles should be placarded against carrying passengers with stick installed if they are over about 5'11".

Pitot Tube: Len forgot to put holes in the fin ribs for the pressure tubes so he put a long probe on the wing. Usually, this results in bad airspeed readings around stall, but Len's looked pretty good there. At full throttle, it would indicate only about 145 mph, which was quite a bit low. If you have forgotten the holes in the fin ribs, I suggest you weld a drill bit to a long rod and go to work. It works, for that is what I did! It is worth it to get a good airspeed reading and to keep the pitot tube up where it will not bump into you when you are not looking.

PROPELLER VIBRATION TEST RIG: Dean Davis and Howard Henderson, 444 Bryan, Kirkwood, MO 63122. An attempt has been made to devise a method to vibration test propellers with the kind of equipment normally available to the ham radio hobbiest. We have used our test rig to identify the non-rotational resonant frequencies of a propeller. The prop is suspended on a bungee and driven by radio speaker coils.

The readout device is made from a small portable radio and a communications receiver. The transistor radio serves as a noise free source of frequency modulated signal, which can be picked up by a good general coverage receiver. The combination of the aluminum plate and propeller acts as an extension of the local oscillator capacitor of the transistor radio providing modulation. The speakers are used to drive the propeller. Best results were obtained with the fairly expensive ($15) flat response eight-inch diameter type but we got some data with $1.50 six-inch cheapies. (Editor's Note: The prop must be suspended on a bungee attached to the hub for this test to be valid. A complete discussion with equations for converting to rotating frequencies will appear in my article entitle "Propeller Fatigue" in the November 1972 **Sport Aviation**. It describes a mechanical shaker and strobe light test rig. It is too long to print here. Static tests are good indications, but are not as reliable as an in-flight survey.

NEW SENSENICH PROP TESTS: Henry Rose just informed me that Sensenich has completed vibration tests on the first new 76FM6-8-72 propeller and it has very good characteristics (it is 68 inches long). The first mode, second order is at 2789 rpm, the second mode, sixth order is at 2560 and the third mode, tenth order is at 2945. Since the in-flight tests showed that the stress level of the second mode, sixth order was below the fatigue limit level, the new propeller will have a green range up to the engine red line of 2700 rpm.

This propeller is now available new and can be ordered only direct from the factory for $290 (Sensenich Propeller Corporation, Box 1168, Lancaster, PA 17604). Specify engine model and horsepower. (1986 Note: When Sensenich started selling their 66LM and W68LM wooden props, they stopped selling this cut-down metal prop, but anyone can make his own by cutting down an M76 propeller. The tip is shaped by using the top blade surface contour and simply rotating it 180 degrees about the blade chord. In other words, when you look down on the blade tip planform, it should have the same shape as the upper surface of the blade tip when viewed from the end of the blade. Henry Rose has found that this gives the highest blade efficiency.)

Note that this propeller uses 3/8-inch attachment bolts but is as thick at the hub as a standard 76EM prop (which uses 1/2-inch bolts). This requires using some "persuasion" on the front spinner bulkhead to reform it if the spinner bulkheads were originally made for a 74DM prop. If you buy a spinner from B. Pershing Larson in Chicago, he will send the proper bulkheads pre-drilled to fit your specified propeller. The new propeller has a different hub thickness and bolt diameter combination than either the 74DM or 76EM. George Leider is buying the first one and will test it on his 150 T-18.

SENSENICH PROPELLER DESIGNATIONS: There is no doubt some confusion about Sensenich's propeller designations since they have changed recently. For instance, a 180 hp Cherokee propeller was designated M76EMM-0-60. The first M differentiates a metal from a wooden prop and has been dropped since only metal props are now in production. The 76 is the original length in inches. The E refers to the airfoil shape which has basically an elliptical camber over the front part. M specifies the flange type. Designations for the flanges are as follows: K - SAE1; M - SAE2; R - SAE3; C -ARP502 (Cont and Frank sport 4). The next M is no longer used and has now been changed to a number specifying bolt diameter in 16th of an inch (6 = 3/8 inch and 8 = 1/2 inch). Following the dash is a number indicating inches removed from original diameter, and after the next dash is the pitch in inches.

Serial numbers also tell a story. Forgings for Sensenich propellers were made by both Alcoa and Kaiser. The early blanks made by Alcoa have no prefix to the serial number. The 74DM props with no prefix have a larger hole in the center. Later blanks made by Kaiser have a K prefix. both have similar vibration characteristics however. Early model 76EM propellers have no suffix. They have a first mode second order and third mode, tenth order resonance at 2250 rpm. When these were reworked (and on all subsequent new 76EM propellers) the blade thickness was reduced 3% to lower this resonance to 2160 rpm and a K suffix was added to the serial number.

BILL COX FLIES: 419 Willow Lane, Baytown, TX 77520. I now have 26 hours on #182, 20 hours of which were open cockpit. Most of this flying was done at 115 to 120 mph. The only ill effect I could note was a slight buffet in the rudder. I believe the average light plane pilot can probably transition into the T-18 easier by leaving the canopy off the first few hours. Speed does not build up nearly so fast and it slows down easier. Also, when open cockpit I would land three-point very near stall speed. With the canopy, if I get too slow before touchdown, the tail wheel touches first and it will roll along before the main gear touches. I am still flying off a 2000' sod strip. I approach at 80 mph, and the ground roll with average 1200 to 1300 feet with little braking. Sunday evening it was cool and I made two landings to a full stop in 1000 feet, same 80 mph approach, power off, 30-degree flaps and generous use of brakes. I have Rosehan wheels and brakes on a standard gear. There is no tendency to nose up even on a full power run-up. These brakes will barely hold at full power. I still need to seal around the bottom of the canopy and fair the gear legs for a little more speed. At low altitude, cruise is 145 IAS, which is the same as a friend's 180 Cessna. Engine is O-290-D2 Lycoming, prop is Flottorp 67-67. All the following data was at 1280#, temperature 90 degrees F at 50 feet field elevation. Cruise at 8000 feet, 158 TAS (Density altitude 10,300), 2600 fpm 20 inches MP. Full bore at 200 feet, 2950 rpm, 170 IAS. Rate of climb at 110 mph 1400 fpm. Climb 50 feet to 8000 feet in 8 1/2 minutes. Power-off stall (clean) 62 mph, oil cooler is eight-plate Corvair in front and below left front cylinder oil temperature 210 F. (1979 Note: Bill is flying a new T-18C convertible wing this year.)

O-290-G CAMSHAFT: The July 1972 issue of the EAA Designee Bulletin warns about the use of O-290-D2 camshafts in O-290-G engines. It reports on telephone conversations with Lycoming factory personnel. "One conversation, in particular, with the engineer responsible for the valve train stressed the dire results of mixing the hydraulic cam into a solid lifter system. The valve dynamics of the two systems are not compatible."

This should sound vaguely familiar to you T-18 Newsletter readers since we have been warning against this for some time. The distressing thing is that people disregard our advice and often proudly tell about using a D2 cam and the engine has not come apart yet.

That article in **Sport Aviation** some time ago by the guy who advised people to use this cam has really caused problems. If you are using or converting a G engine, go back and read T-18 Newsletters #18 and #21 (pages 71-75, 94-96) Engine Coversion articles on this and take the advice seriously. To my knowledge the information in my articles is correct.

FUEL TANKS: There has been much talk about the porous material that can be put in fuel tanks to stop sloshing and for crash safety reasons. The FAA has just notified EAA of a hazard in its use:

Gentlemen:

> The following is furnished for amateur aircraft builders. We have received a Malfunction and Defect report on "Safoam" material, manufactured by Firestone Tire and Rubber Company, Akron, OH, which was used in a fuel tank to prevent fuel slosh and spraying in case of impact.
>
> The material had been installed for two years and was breaking down. It had become hard and brittle and was causing fuel stoppage problems. The aluminum tank containing the Safoam cellular material. The type of fuel carried in the affected tank was 80-octane gasoline.

Sincerely,
Paul E. Cannon
Chief, Flight Standards Division, GL-200

JOHN THORP'S T-18: On a recent flight test over a measured course at sea (ocean) level, John indicated 213 mph at 2850 rpm. His ground (sea) speed averaged out both ways at 209 mph, so he is very happy with the performance. His prop is 68 x 85 which has a first-mode resonance at 2875 rpm. Because Sensenich does not like to use props twisted to such a high pitch, John is considering going to the 72-inch light weight constant speed Hartzell prop used on other aircraft. Bill Eckel has one on his 180 T-18 and is averaging 195 on round trips.

METAL TOOLS AND RIVETS: USAYCO, Air World, 2121 Jericho Turnpike, Garden City, Long Island, NY 11040 is a complete source for all aircraft sheet metal tools and rivets. Send for a free catalog. Also, anyone in the New York City area can obtain sheet aluminum locally. 4 x 12 sheets of 2024-T3 x 0.025 alclad anodized are $12.50 in quantity of four or more and $15 single from: Joe Gertler, Raceway Equipment, 2630 Raymond Avenue, Bronx, New York 10461 (212)824-5796. (1986 Note: Can you believe what inflation did to us?)

WOODEN PROPELLERS: Just visited with Ted Hendrickson, Route 3, Box 103, Snohomish, WA 98290 and enquired about his ability to supply wooden propellers for large four-cylinder engines. He has made several for the slower pushers (Breezy and Volmer) with no problems. One which was made for Bob Hammer's 125 hp T-18 had too much pitch and was not flown very long. It was also too much for Len Edvinsen's 150 hp T-18. Ted is now cutting it down in both width and pitch. I will keep readers posted on progress. Ted made the three-blade prop which was on the Cessna 170 at Oshkosh this year.

You should see the neat glueing press he uses. The moveable part is activated by air pressure applied to a fire hose. The inflated hose applies perfectly even pressure.

NEW WOODEN PROPELLER DEVELOPMENT: As a result of Sensenich's recommending against twisting the 76EM blanks from the original 60-inch pitch to the approximately 85-inch pitch required for the O-360 engine, we are making arrangements to develop a new wooden propeller for the O-360 engine. It would not be economically feasible to have a new metal blank made since the tooling would cost about $30,000. Ted Hendrickson of Washington offered to build a wooden prop if someone would design one. When I asked John to design one, he said he was sitting there looking at the remains of a wooden propeller which had lasted just 20 minutes on a Sky Skooter. When it came apart it broke all but one member in the engine mount. He said, "This reminds me that I do not know how to design a wooden propeller."

So, I asked Henry Rose of Sensenich if he would develop a prop, and he agreed. John is sending him the specifications and he will quote a price for the developmental model. The prop will be tested on a 180 hp T-18. We will use money from the propeller test fund to pay for this development program. If this works out all right we will do the same for the O-320 and O-290 engines. He plans to use a very thin birch veneer for laminations which Air Force tests have shown are superior in strength and stability. (1979 Editor's Note: The wooden props work great, especially with a smooth plastic leading edge.)

PROPELLER FUND: To date we have collected a total of $962 for the propeller test fund. The Hartzell test costs amounted to only $671. After printing and mailing costs for the tests reports, there is a balance of $178.82. Effective immediately, test reports on the Hartzell tests can be obtained from the T-18 Newsletter editor for $2. Those of you who contributed to this project are to be congratulated for helping to make one of the most significant contributions to the safety of homebuilt aircraft since the EAA movement began. Not only do we now have two flight-tested metal propellers available for T-18s but, as a result of these tests, we convinced Sensenich to produce a new 68-inch diameter metal propeller for homebuilders. Also, as a result of all this, I was able to collect a lot of information on the subject of propeller fatigue, which I put into a long article that will be printed in the November issue of **Sport Aviation**. Dave Biermann, President of Hartzell, Henry Rose, Chief Engineer at Sensenich, and John Thorp all helped edit the article. It not only tells the results of the flight tests but also includes information on how to do static vibration tests on a propeller and a lot of other information which does not seem to be available anywhere except in the minds of two or three experts in the country.

WOODEN PROP: Sensenich is charging $500 to develop the new wooden prop and Dick Walen will test it on his new O-360 as a favor. If it works well, we will get wood prop designs for the smaller engines. So, how about donating to the cause? Thanks!

HAM OPERATORS: George Lange, 2605 Boston Avenue, Muskogee, OK 74401 would like to contact other builders who are ham radio operators.

SAVE ENERGY WITH A CROSSOVER EXHAUST SYSTEM: by Luther D. Sunderland. Why use a crossover exhaust system? The answer is very simple; to increase engine efficiency. You see, an engine has a big job on its hands not only in driving the load, but also in getting rid of all the hot exhaust gases. it must expend energy and thus do work to push the exhaust from the cylinder and exhaust system. Anything which obstructs or resists the flow of exhaust gases from the cylinders causes the engine to waste energy on garbage disposal.

The resistance to the outflow of exhaust gas is called back pressure. A fundamental rule of powerplant engineering states that the lower the back pressure, the higher the powerplant efficiency. When two consecutive firing cylinders port exhaust into a common pipe, like on many early light planes such as the J-3 Cub, the back pressure is high. Why? Because the two exhaust pressure pulses occur in the pipe close to one another. There is then a long period with no pulses while the other two cylinders are dumping gases into their respective stack. Engineers have found that, in a four-cylinder four-cycle engine, the highest engine efficiency results from manifolding the exhaust from pairs of cylinders such that the exhaust pulses are evenly spaced. If the firing order is 1-3-2-4 then 1 and 2 should share a common stack and 3 and 4 should share the other. The only "fly in the ointment" is that these pairs are on opposite sides of the engine, hence, the need for crossover tubes.

Strange as it may seem, this arrangement gives lower back pressure than individual stacks which port directly into the atmosphere.

According to John Thorp, noted aircraft designer, the potential engine efficiency increase which can be realized by using a crossover system is perhaps on the order of 7%. The shape of tubing bends, dimensions and internal smoothness of weld joints in a particular system will give some variation.

You may have heard from your automobile hotrod friends that the length of an exhaust tube can be cut so as to tune it for maximum efficiency. This is true if the tube can be made sufficiently long. Standing pressure waves are set up in the tube and the tube length can be adjusted to minimize the back pressure at the cylinder ports. This tuning on an auto is done using trial and error by starting with the longest tube practical (perhaps ten feet) and cutting it down until power output reaches a peak. since there usually is not sufficient flexibility in selecting the length of an aircraft exhaust stack--or the desire to suffer the penalties of an extra long one--tuning is not normally practical on an airplane exhaust system.

Design Durability: When two exhaust ports on opposite sides of an engine are connected by a long curved tube, which then extends another two or three feet past the resulting welded joint, it makes for a pretty shaky structure. If the entire tube connecting two cylinders is fabricated out of one solid weldment, it is almost certain to develop fatigue cracks within a very short time. First, the whole engine shakes in the engine mounts causing the stack to whip back and forth as much as a half-inch during starting and stopping, so the stack cannot be reinforced with a support attached to the airframe. The stacks usually project several feet beyond the engine, and attempts to support them with a brace attached to the engine usually result in broken supports within 10 or 15 hours due to vibration.

In addition to the motion of the entire engine structure, there is a surprising amount of motion of one cylinder head relative to the other. If you doubt this, observe what happens when someone connects a cooling baffle rigidly from one head to the other. It is just a matter of time before cracks develop in the baffle. The baffle must be constructed in a way that permits relative motion between the parts attached to each head. Exhaust stacks must be made with the same kind of feature. That is why the airplane manufacturers place slip joints in the tubing between cylinders.

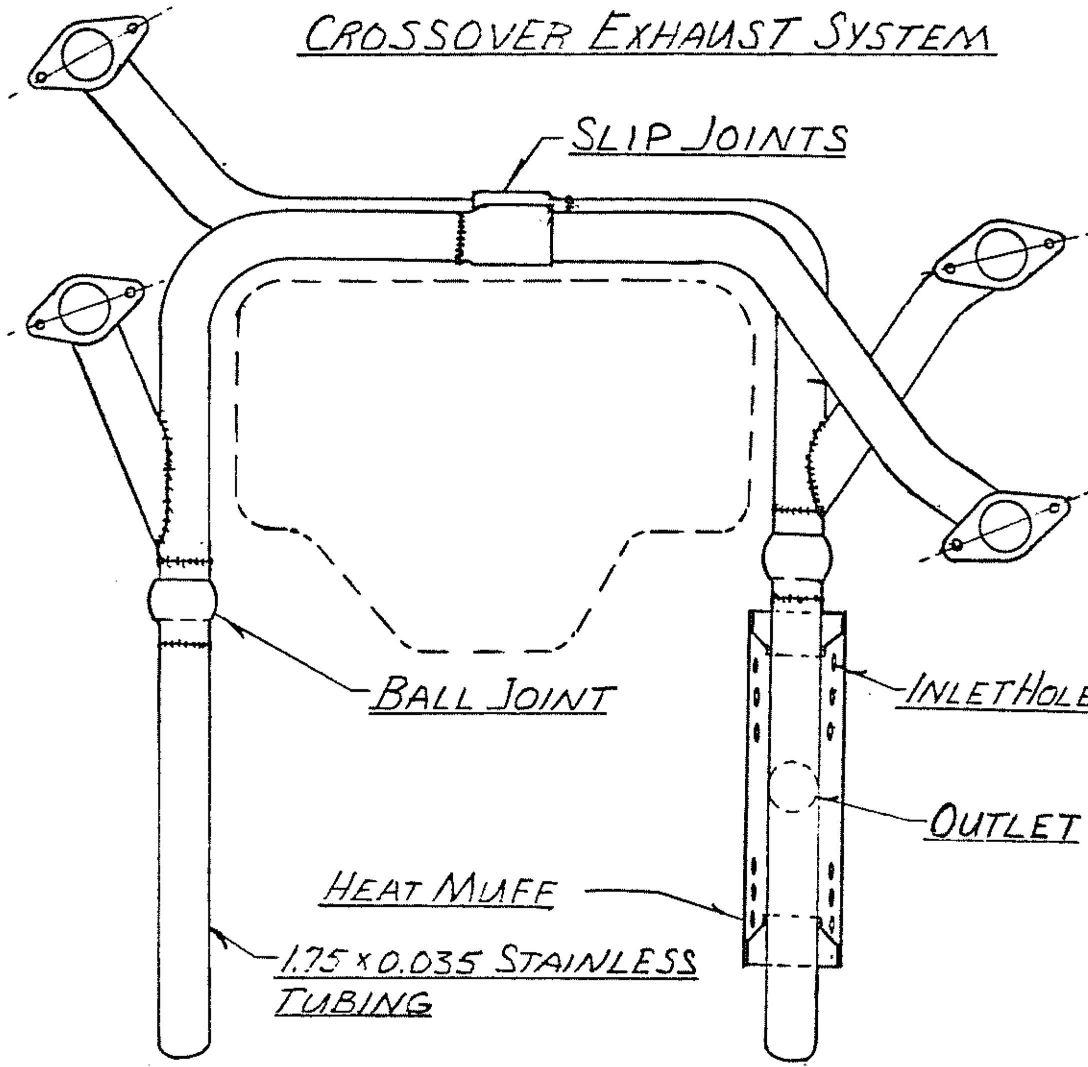
To solve the problems of supporting the long exhaust stack and raising its resonant frequency above the engine operating range, they break the stack aft of the Y-joint and insert a ball joint. Then, since the stack is free to swivel, it can be attached to the airframe with a flexible mount. Figure 16 shows a properly designed crossover exhaust system.

Before the author installed both slip joints and ball joints in the crossover exhaust system of his T-18, during the first one hundred hours the exhaust tubes and various supports cracked at least a half-dozen times. This experience has been repeated by other builders. Several times builders have proudly opened their cowlings to show me how they succeeded in keeping their crossover system together with various supports made of brake lining or tubing but had to turn away with a red face when they found them broken loose. Both ball joints and slip joints are an absolute necessity in crossover systems.

Fabrication: For the average homebuilder--or even the old-time expert--locating the proper materials and fabricating a crossover exhaust system may be the most difficult task encountered in building an airplane. If you are fortunate enough to have some extra money, a complete system can be purchased ready-made, but if you are the intrepid type who likes to make his own--and are hard up for money--here are some tips which will make your job easier.

Finding proper raw material is the first problem. There are three choices: use old tubing salvaged from other aircraft exhaust systems, buy new stainless tubing or use the ordinary automotive type. The latter is the least desirable from the standpoint of weight and durability but it is the cheapest, easiest to fabricate and most readily available. It comes in a minimum wall thickness of 0.065 inches while the stainless tubing used for aircraft exhaust systems is 0.035 inch thick. This means the automotive tubing is twice as heavy. It is made of this heavier wall thickness to facilitate bending without collapsing and creating wrinkles with the tubing benders found in muffler shops. These shops usually charge $1 per bend, so a system can be bent up to your specifications or mock-up without too much sweat. The simplest procedure is to have a single bend made in a number of short sections of tubing. These can later be cut to fit and welded in place on the engine. If you want to go to the trouble, make a mock-up from something convenient like 1/4-inch steel rod. A number of cardboard discs can be slid on to check for clearances throughout the system. Take the mock-up to the muffler shop and they might be able to bend the tubing in sections which will reduce the number of weld joints. You will find the mock-up a great time saver in any case when you try to figure out how to get all those tubes going the right direction without touching the oil pan or another tube or the cowling. Regarding durability, rust is not too much of a problem because builders have reported good results with the high-temperature paint available at automotive stores. The main reason for not using this tubing is the weight penalty.

Figure 16


CROSSOVER EXHAUST SYSTEM
SLIP JOINTS
BALL JOINT
INLET HOLES
OUTLET
HEAT MUFF
1.75 x 0.035 STAINLESS TUBING

The best exhaust tube material is stainless steel. Two types of stainless are available from most tube supply houses, 303 and 326. The 303 is about half as expensive as 326. Specifications advise that 303 stainless is subject to intergranular corrosion, which can cause cracking, when it is exposed to temperatures between 900 and 1,300 degrees F. 326 is resistant to that type of corrosion. Many builders have used 303 in aircraft exhaust systems without problems, however. One source for stainless tubing is Tube Sales, 175 Tubeway, Forest Park, Georgia 30050 (040)361-505. It comes in 1.5, 1.75, and 1.875 OD (for 65 to 90, 115 to 160, and 180 hp Lycomings respectively. Order 0.035 wall thickness.

Now for the 64-dollar question, how do you form the thin wall stainless? A trip to your friendly muffler shop will produce one badly wrinkled up piece of scrap. Fill a section of tubing with sand and weld caps on the ends and the same result will be obtained. After much experimentation, I hit onto the solution. Cut an 18-inch section of tubing. Machine two 1.5-inch long aluminum plugs. Insert a plug in each end of the tube and drill two 0.25-inch bolt holes through each plug and the tubing. In the end of one plug through-drill and tap a hole for a 5/16-inch coarse thread bolt. Now, install one plug with two bolts and fill the tube with dry sand. Hold the tube on something that vibrates a lot like a grinder that is slightly out of balance. After several minutes the sand will pack down an inch or two. When it stops packing down, install the other plug and fill completely full through the open hole. Install the 5/16-inch bolt and head for the muffler shop with some spare sand.

Just to make sure, when you arrive, remove the bolt and check the sand level. You will be surprised to find the level has lowered significantly due to the jiggling in the car, and more sand must be added. This is why it did not work to weld the plugs in the tube. Now, insert in the bender and presto! A nice bend with the desired radius and angle. A few more trips to the muffler shop and you will have enough bends to make up an entire exhaust system. Again, multiple bends can be made in one piece to reduce the number of trips.

When you try to drill the second tube for the bolt holes, you will discover that a drill jig is needed. One easy way to make this is to find or make a sleeve which just slips over the tube. Small holes can be put in the sleeve to act as locator holes. After the sleeve has been removed, they can be opened up with a clearance drill for the 0.25-inch bolts. The drill jig should obviously be made <u>before</u> the holes are drilled in the aluminum plugs.

Slip joints can be fairly easily made. Just machine a die block from any steel bar with a taper from the tube ID to slightly larger than the OD over a 0.5-inch area. Cut a piece of tubing 5 inches long being careful to make the ends square, and squeeze the die into it in a press. The proper die bevel angle and a sharp corner are necessary to get the tube to release from the die after forming. If it does stick, tap the side of the tube all around at the large end with a ball-peen hammer and it will fall off. The expanded sleeve should be about four inches long.

It does not take much force to expand the thin stainless tubing. A hydraulic jack pressing against a post and backed up by a beam in the basement will do nicely. Careful, do not tear the house down though. With this tool, you can easily make a drill jig sleeve for the tube bending operation.

Ball joints are a bit more difficult to make. Finding them unavailable, the author made tooling to form on a hydropress the type Piper uses. Anyone needing 1.75-inch ball joints and slip joints can obtain them from me. Ralph Bowles, RD, Danby, New York supplies the same type for 1.5-inch tubing.

Heat muffs can cause a problem if they are not properly designed. For instance, when the ends of the muff are made by welding flat discs onto the exhaust tube, they are sure to crack. A PA-11 we once had regularly developed cracks in the muff ends. The very best design is like the one used in the Aircoupe. The ends are formed like cones so the thermal gradients do not set up such high stresses. These ends can be formed with a solder bar over an aluminum die. Material can be 0.015-inch stainless which is formed around the die and riveted. The ends are then tack-welded to the stack with three or four short welds. The muff jacket is made of 0.025-inch thick 2024-T3 aluminum. If you do not know how to weld aluminum, hose fittings can easily be put together from 0.015-inch stainless sheet and silver solder. They are then riveted to the aluminum jacket. The inlet for the carb heat muff can simply be rows of holes punched around the end of the aluminum jacket. The total area of all inlet holes must exceed the area of the carburetor inlet. Outside air should be supplied as the inlet source for the cabin heat muff to insure that engine compartment fumes are kept out.

When all the pieces have been accumulated, you are ready to put the whole mess together. You will find a chrome cut-off wheel used in a table saw (available at Sears stores) will be of great assistance for cutting the steel tubing. It is extremely important to fit the stainless tubing very closely at all joints or you might cheat and fill up a gap greater than the required 1/16-inch maximum for 4130. You will find it highly desirable to keep all joints in stainless much less than 1/16 inch. To fit the tubing in place, it is best to mount the engine inverted on a bench with a mock-up of the section of cowling where the two stacks must exit. Place old exhaust stack gaskets under the flange fittings before bolting them in place.

The spring clamp mounts shown are bent up with a pair of pliers from one length of 3/32-inch stainless welding rod. They work out perfectly and are the ultimate in simplicity supporting the ends of the exhaust stacks while permitting them to move freely in any direction. These are an absolute must.

Stainless is most readily welded with a heli-arc machine, but if you do not have one available, do not fret because the old faithful oxy-acetylene rig can be used. Two gas welding techniques are feasible. With the proper flux and rod, stainless can be welded if a really generoua amount of excess acetylene is used. You will find it easier to weld down hill and progress in steps, like in puddle welding, although the bead may look more like a ghastly lump than a puddle. Be careful to keep the bead from sagging through or you will lose everything you gained in efficiency with the crossover system. A second technique involves the use of 308-15 flux-coated arc welding rod with the oxy-acetylene torch. This does a superb job. Of course, if you are a novice welder, better get some help from an expert.

T-18 NEWSLETTER #38 02-25-73

Luther D. Sunderland

NUMBER 100 FLIES!!: Dr. John Shinn, 835 John Anderson Drive, Ormond Beach, FL made the first flight of the 100th T-18 to fly, N4784G. On Christmas he towed it to the Daytona Beach Airport, but it was January 24 before the FAA inspected it and he could make the first flight. By that time he had ample time for taxi tests, for he had 2.5 hours taxi time before the first flight. He is very happy with his ship now that he has cleared up several minor things, such as a wing walk which came loose, making a nice spoiler, and low oil pressure caused by his parallel oil cooler and filter arrangement.

As you readers know, John helped edit the Newsletter for many years while he lived in New York. His T-18 is painted with the same paint scheme as mine and is also blue. His engine is an O-290-D2. More information later.

FUEL TANKS: W. R. Warnack, 189 Bayshore Drive, Baytown, TX 77520. I built a fiberglas tank about six months ago. It was filled with Safoam which was purchased from a surplus house. When the tank was completed, I filled it with water, pressure tested it with no leakage indicated, drained the water, removed it from the fuselage, and stored the tank in my attic with all the vents and the filler neck open--so as to allow it to dry out. Then came all the discussions about Safoam, and I decided that it probably was a built-in hazard. I brought the tank down from the attic last week, cut a hole in the top and began removing the Safoam. Could hardly believe it but the Safoam was still thoroughly soaked with water. After six months, this stuff still retained at least one-half gallon of water. I could actually squeeze out water readily as the Safoam was removed. Some deterioration was evident with small pieces beginning to crumble off, particularly around ink markings on the foam. I am convinced this stuff could be very bad news--particularly if water is allowed on it. It is out of my tank now, and I say good riddance.

WOODEN PROP: Sensenich was to have shipped the new wooden prop to Dick Walen a week ago, so there should be news on performance by next Newsletter. Since the last Newsletter Sensenich decided for non-technical reasons (advice from a lawyer) to not offer the 76EM-8-8 metal propeller for sale. It was mainly due to the added liability exposure for a relatively small potential market in the present consumer protection atmosphere. You might say Nader scores again. They are not concerned about wooden propellers since they have never heard of one failing due to fatigue.
Incidentally, Mr. Welch, who wrote a letter to **Sport Aviation** about my article, when confronted with this admitted that he

might have been observing stone damage in the VW prop.

It should be no particular problem since Sensenich is not selling the 68-inch long prop, because you can still obtain one. Just buy a 76EM propeller and have it cut to 68 inches and repitched at a good prop shop. My 70-inch long old model 76EM (no K after serial number) works fine with 65-inch pitch on my O-290-G, so 67-inch pitch should be about right for the 68-inch length. 74 inches should be good for the O-320. Bob Dial's 160 hp T-18 would turn up 2800 rpm in level flight with a 70-inch long 76EM with 73 inches pitch. Sensenich does not recommend twisting the 76EM blank to more than 74 inches pitch, hence the reason for developing the wooden prop for the O-360.

PROPELLER TEST REPORTS: I still have copies of the official report on the Hartzell flight tests. First come, first served. They are $2. Do not fly a cut-down prop until you read it.

PARTS LAYOUT: Jim Blythe, Apalachin, NY 13732. I would like to relate my experience in copying full-sized prints and glueing the copy to the material to be cut. It was not a desirable experience, as it led to scrapping some fittings. The dimensions were enlarged 0.100" and hole locations were offset even a greater amount. I now draw my own copies and find it far more satisfactory. (Editor's Note: The hazard in this practice is that any reproduction process can produce copies with dimensional errors, and changes in humidity can cause additional dimensional changes. Many copying machines such as Zerox use image projection which can give other than a 1:1 ratio-size copy depending on the machine's adjustment. If copies happen to come out right, after cementing, it is a way to save layout time. The real problem is in forgetting to check and recheck.

BUILDING TIPS: This would be a good time to talk about shop practices. If you have forgotten earlier advice given in the Newsletter, the most difficult task you will encounter in building a T-18 is measuring between two points, marking accurately and cutting or drilling in the right place. It seems so very elementary, yet failure in this operation is the reason for most builders' goofs. To prevent errors in measuring, it is a good idea to measure and mark, then before cutting chips measure again, if possible from a different reference or by looking at the scale in a different way. A common mistake is to view the scale up-side-down and count fractional parts in the wrong direction. It is always dangerous to read a scale when it is in the inverted position, but if you do, then turn it around and check the measurement with it right-side-up.

Many builders have problems because they try to get by without proper measuring scales. I feel it essential to have one decimal scale marked with 0.020-inch minimum divisions. It is hard to believe that these are so difficult to find in lengths greater than six inches. Despite appeals through the Newsletter, the only source I have found is the 18-inch drafting scale available at drafting supply houses. This is what I use and find it quite satisfactory. Anything shorter would be unsuitable. In addition, a six-foot steel tape (yoyo) is needed. It should be checked carefully with the 18-inch scale and if not accurate, compensation made.

FLUSH GAS CAP: Aviation Industries, 114 Bryant, Ojai, CA 93023 makes a flush gas cap with a 2.6-inch opening which fits the T-18 perfectly. It has a flange made of 6061 aluminum that may be welded, riveted, bolted, or molded to the tank. Satisfaction guaranteed or money back. Include $16.95 with order. Looks good.

WOODEN PROPELLER SOURCE: Leslie Trigg, formerly chief engineer with Sensenich operates a shop called Propeller Engineering Duplicating at P.O. Box 63, Manhattan Beach, CA. He will copy any propeller with his duplicating machine for around $175.

WORLD RECORD ATTEMPT: Don Taylor, Lt. Col. USAF Retired is planning a round-the-world flight as already announced in **Sport Aviation.** He is soliciting donations to help finance the trip. It will be a solo flight in T-18 #455.

#719 FLIES: Gayle LeCount, 301 East West Street, Georgetown, IL 61846. At last (October 28, 1972) #719 is done. It has taken 2 1/2 years but, thanks to people like you, it was a great experience to build it. I cannot say enough about how my 82-year-old grandmother has helped me. She has helped with every detail of the plane, including bucking more than 90% of the rivets. She is Mrs. Zoe Brown, 407 Mill Street, Georgetown, Il 61846. How about that! No wonder he finished it in two years.

WING HEAVINESS: John Foy, 3801 127th NE, Bellevue, WA 98005. I have just reread the Newsletters for about the fifth time and get more out of them each time. Although I have finished the T-18 long ago, I still appreciate the Newsletter and look forward to each issue. I am not sure that the Newsletters in the past have mentioned this, but I found out that some wing heaviness I had on my T-18 was due to aileron to wing gap. As soon as I covered the gap with cloth tape, the wing heaviness disappeared. The exact cause I am not sure of but suspect a slight uptilt on the edge of the wing, just ahead of the aileron. Since I have returned to the mainland from Hawaii, I have started on Jim Stewart's P-51D--the all-wood version, so that I can round out my building experience. (Editor's Note: See, you cannot keep a good man down.)

RIVETING AND BRAKE TIPS: Chris Fast (T-18 #260 N4354A) 507

Almar, Pacific Palisades, CA 90272.

1. Use an inflatable air mattress to lie on while riveting or working inside the fuselage aft of the cockpit in place of using boards or plywood. Advantages: (a) Distributes your weight evenly on fuselage structure. (b) Protects frame flanges and skin from damage. (c) Provides a much more comfortable "pad" for the torso. (Editor's Note: Be sure to use your wife's air mattress for you might put holes in yours.)

2. For an air-bubble free hydraulic brake system, the fluid should be pumped in from the wheel cylinder end. This can be done easily by cleaning out an oil can that has an integral pump and installing a rubber hose over the spout. Slide the other end over the wheel cylinder outlet and pump in the fluid.

My little "Fast-Craft" T-18 has 320 hours on it now and has been about as trouble-free as you can get. Broke a couple of outboard wheel pant brackets but that is about it for repairs. My M74 prop cut to 68 inches with 69-inch pitch trues out at 185 mph at 3000 rpm. But since John limits me to 2500 cruise rpm as a result of the vibration test, I cannot pull 75% power and it burns slightly less than 6 gallons per hour. My engine is a Thorp built GPU with 7:1 pistons and has the crankshaft flange beef-up. I purchased a new 76EM propeller and am having it cut to 68 inches and pitched to 71 inches. This should let me pull 75% power at 2500 rpm and cruise 160 or 165 mph.

ENGINE BALANCING: by John Austin. While reading the back Newsletters, I ran across engine balancing. Leon Davis, designer of the DA-2, said he balances them with a simple balance made of three pieces of safety wire and a strip of flat stock, 0.063" or so. Carefully lay out the center of the balance beam and hang rod assemblies until you get the lightest one. Grind the others until they all balance the same. Use the same on the pistons. Very crude but simple. (Editor's Note: Any time you are balancing anything, always reverse ends to eliminate effects of errors due to the measuring device.

AIR GUNS: Carlyle W. Dean Sr., #621, 2900 Perdue Aenue, Chester, VA 2381. I can answer the question with a definite "yes" asked in a past Newsletter, "Will an air gun available at automotive stores (for chiseling off mufflers, etc.) work as a rivet gun?" My air gun is a Sears Craftsman costing about $50. I bought the necessary rivet sets with the standard 0.401 shank, plugged them in and went to work. Although my fuselage, tail, ailerons, etc., are not perfect riveting jobs I do not feel that the gun is at fault. I would point out, however, that with the money required to purchase a new automotive store-type air gun, the builder could probably buy a rebuilt surplus gun. A gun manufactured for the purpose of driving aircraft rivets hits at a slower rate; also, the trigger allows more control over the hitting rate, which is very desirable.

SPEED INFO: B. C. Roemer, Manitowish Waters, WI 54545. We flew without pants at 3500 feet wide open down a road, noted rpm and air speed, landed, put on pants and reflew the same course. We gained about 4 mph and around 25 to 35 rpm. Tested the same as above with and without gear fairings and gained 10 mph and around 100 rpm. Very surprising.

At Oshkosh, I passed Al Neunteuffel's T-18 with constant speed prop and 180 hp engine with no contest. In fact, before we flew head to head, Al flew our ship and passed 19 airplanes on one fly-by, which caused the FAA to send out a messenger when he landed and imposed a speed limit on fly-bys for our airplane. We turn 2700 rpm and cruise over 200 (75% at 7500' with 180 hp and a fixed pitch propeller.

WISCONSIN MATERIAL SOURCE: Smith Supply Company, Aluminum and Aircraft Supplies, Rout 4, Brown Deer Lane, Janesville, WI 53545 (608)754-9500. Simon Smith informed me that he will supply T-18 sheet metal kits for $300 for one, $280 each for two, $240 each for three to five and $230 each for six or more. Add a $10 crating charge per kit. Kits will be shipped by truck collect. Wisconsin residents add 4% sales tax. He will also supply aluminum tubing. Sounds like you should talk a half-dozen friends into building a T-18 with you.

PERFORMANCE QUESTIONNAIRES: Many of you 900 and some builders have been more than generous with your compliments on the T-18 Newsletters and how helpful they were to you while you were building your ships. For some strange reason, once you get yours flying, however, you forget all about helping anyone else. There have now been exactly 100 T-18s that have been completed and made first flights, but I have just 19 completed data sheets in my file. We will make another try and include a data sheet with this issue. Please fill it out. Maybe some of you have been reluctant to send information because your data did not look as good as some of the others. Send it anyway. Maybe you will win the prize for honesty.

AIRSPEED CALIBRATION: It is hard to explain why, but most of us are just too lazy to check our airspeed system calibration. It is really quite easy to calibrate your system, especially if you own an automobile. Just check your odometer accurately by the markers along a highway, then find a stretch of straight highway five or ten miles long and measure off a course between two prominent landmarks like overpasses. Then wait for a calm day, preferably early in the morning around 6:00 AM before the wind has started to move, and go fly over this course back and forth many times. Use a stop watch if available, for a second or two can make quite a difference. Stabilize your speed well in advance and start the watch as the landmark passes underneath the leading edge of the wing. It is best to let altitude vary a little in order to control airspeed accurately. Be sure to record outside air temperature and altitude. Make three or four two-way passes at each airspeed tested, throw out any readings which look too far out and average the others. Make runs at 5 mph increments in the vicinity of your cruise speed. If you cannot get sea level, use 2,000.

If the system reads low, there may be leaks in the pitot line. To check for leaks, slip a piece of rubber hose over the pitot tube, pinch off the end and squeeze the tube until the airspeed indicator reads about 100 mph. Now hold it and see if the needle stays fixed or slowly moves toward zero. If there are leaks, seal them. If not, the airspeed readings can be adjusted with a little spoiler in front of the holes in the static tube. Just cut a 1/16-inch wide ring from rubber tubing and slip it over the static tube. By trial and error, find a location ahead or behind the static ports that will make the airspeed read correctly. The poorest procedure is to check against another aircraft.

PAINTING TIPS: Dr. B. John Shinn, 835 John Anderson Drive, Ormond Beach, FL. By the time most of us get around to the painting stage on our projects, we are pretty impatient and want to get it flying. But, a good paint job is really needed to make a success of any homebuilt project.

Paint Scheme: Not only must a color scheme and layout be selected which complements the particular airplane's lines, but, also the paint design should help de-emphasize any less attractive lines and contours. I think Lu Sunderland was very successful with his paint design on his T-18 N4782G. Take a look at the picture of his plane in the Thorp ad in **Sport Aviation**. The sets of stripes emphasize the beautiful nose and tail lines while hiding the rather thick afterbody of the fuselage. This thick section aft of the wing is hidden by the light blue bottom with dark blue pinstripe which runs parallel to the upper strips. It really accentuates the length of the airplane by slicing the thick section into several thin layers. It is also interesting to note the extensive use of white, especially on the turtledeck, wings, and tail. White paint has so much light reflected from the pigment that surface details are hard to discern. The ridges on the "hip roof" tail cone and any slight surface variations around rivets and even surface scratches are obscured by white paint. Perhaps most important of all is the fact that white makes for good visibility against all terrains except for snow.

One consideration often overlooked is the appearance of the paint scheme as viewed from distance. It should still retain its graceful, appealing lines. Too many homebuilders put on a few timid narrow stripes and designs which disappear when viewed from a distance leaving a plain looking plane. So, do not have a plain plane. Be bold in your design.

Paint Selection: The next problem after a paint design selection is to decide on the kind of paint you are going to use. As with all things, the better paints are going to cost more.

Lacquer: Lacquer has the desirable characteristic that it dries rather quickly and can be touched up without painting an entire panel. After dry, the overspray can be rubbed out with wet-or-dry paper and rubbing compound. The inexperienced painter may have trouble because of the rate of drying, because it is difficult to keep from getting overspray from one pass to the next. Few people use lacquer on aircraft although a body shop operator in our chapter used it on his Stinson, but that was before the new acrylic enamels.

Acrylic Enamel: Various brands of acrylic enamels are available. They are more durable than lacquers but possess the same quick-drying characteristic. Also, they can be spotted like lacquer and rubbed out without repainting an entire panel. In two hours Dupont's Centari acrylic enamel can be given a second coat or masked for trim. No warning is given regarding a sensitive period between 24 and 72 hours when it cannot be recoated but at least used to have this sensitive period when the old coat would raise up in tiny bubbles if covered with a fresh coat. As with regular enamel, it is recommended that different thinners be used for different ambient temperatures.

Amer-Flint: This is a two-part mix paint related to alkyds and urethanes by the American Lacquer Solvents Company, P. O. Box 11515, Tampa, FL 33610. It is used by Embry-Riddle Aeronautical University on their quality paint jobs on their fleet of Cessnas. It is also used by Volusia Aviation at Daytona, Florida who specialize in custom paint jobs. It has good resistance to sun fading and chalking. It has very good adhesion. Because it is a two-part mix, it has a finite pot life, but it is much longer (24 to 48 hours) than some of the more expensive urethanes (six to eight hours). One disadvantage is that you cannot add any "fish eye" killer to the paint as you can with regular enamel. This means your surfaces must be really free of grease. Wash your hands before handling parts to be painted. In addition to solid colors, Amer-Flint is available in metallic tints. I selected this paint to use and so far it is working out very well. A good feature of this paint is that any overspray can be glazed into a glossy surface by spraying the area with Amer-Flint thinner and it really works! (Editor's Note:

John says there is no guarantee that it won't run, however.)

Imron Polyurethane: Imron is a two-part mix polyurethane put out by DuPont. It only has a pot life of six to eight hours but has an excellent resistance to sun as proved by a year-long test exposed to Florida sun. It is tough and chip resistant and you can really spray it on heavy without runs. This is the paint recommended by Lamar Garrett of superior Aircraft Painting in Sanford, Florida. He has planes come there from all over the country to get his paint jobs. Even had a picture of a Riviera Amphibian with his paint job in Playboy magazine with a couple of females draped over the wings. He also painted my Luscombe Sedan which subsequently won the over 165 hp Classic Award at Oshkosh in 1971. (More painting tips from Lamar Garrett later.)

Alumigrip: This is perhaps the top of the line as far as aircraft finishes are concerned. It is a tough, durable polyurethane which resists that pesky hairline corrosion that can cause paint to come off rivets in hot climates. Ted Smith's Aero Star, Learjets and other big-name aircraft are painted with it. It was developed especially for painting aluminum airplanes.

Surface Preparation:

(1) **Washing.** Sheet aluminum as received from the factory has an oily substance on the surface and by the time you are done cutting, forming, and riveting it you will have a lot of oil fingerprints all over it. Paint just will not stick to it unless you clean it well before painting. This is especially true of the interior faying (mating) surfaces that we just tend to dab in a hurry with zinc chromate primer. To my dismay, I found that some of my primer just washed off with soap and water. Wiping the surface off with thinner is not the right way to clean grease! It only spreads the grease around in a very thin film and you will be sorry later when the paint peels off. I found out the hard way. A good wash down with a detergent and water is best. Do not let it dry or it will be too hard to rinse off.

Any markings put on the metal or fiberglas during construction with a felt pen must be removed with plenty of thinner or you will cry later when it bleeds through primer and paint. (Editor's Note: This is so important it should be put on a sign in your shop.)

Scrub with a brush or tough synthetic sponge making sure to clean around rivets etc. Rinse with clean water and rub the entire surface to make sure you dislodge all traces of emulsified grease and detergent.

(2) **Etch:** If you want a first class job, according to Lamar Garrett, you should now etch the surface. DuPont makes a good etch, 5717,S. Rub it on with a synthetic sponge or

scrub brush and wash it off after three to five minutes with lots of clean water. You must be careful not to get any etch inside the wings or fuselage where you cannot flush it out with lots of water or you can cause corrosion. I had a little trouble with it getting in around my retractable landing light on my wing and had a dickens of a time cleaning it off my spar later.

Many old pros do not etch but instead use zinc chromate primer with an etch. I visited Piper Aircraft at Vero Beach, FL and they do not use an etch. They do sand the surface lightly all over the plane, which is always a good idea for good paint adhesion. Use #400 wet-or-dry and use it with water. This gives the primer something to hang onto just as does the etching process. Even if you use an etch, it is good to sand first.

(3) **Alodine:** If you really want a first class job, use the Alodine process. The kit contains a cleaner which is applied and allowed to stand several minutes before being rinsed off. Then the alodine is brushed on and allowed to stand a few minutes. After it is rinsed off with water, the surface of the aluminum has a gold-tinted appearance. Alodine applies a mild etch. It is the standard military specification process treatment for anything the government buys. Zinc chromate is applied over alodine after the surface has dried after rinsing.

Wash Primer: Although many people do not bother to use it, wash primer is good for use over bare aluminum, old paint or fiberglas. It is a good idea to use it over filler primer too for extra good adhesion so paint will not peel in moist weather. it is a two-part mix with a very short pot life but is very easy to apply. Just mix the catalyst with the yellow wash primer, wait 15 minutes for aging and then spray it on in a full wet coat. After it sets on the surface a few minutes, it turns a little brown and a little transparent. Wait 45 minutes and rub the surface very lightly with a fine or worn out piece of sandpaper to knock off any dirt particles which have become dried in. You are now ready for putting on the zinc chromate primer.

Zinc Chromate Primer: Probably the most important thing to remember about this step is the fact that the zinc chromate primer is the undercoat for the final finish. If it comes out rough, you will not get a smooth top coat. Zinc chromate should be put on in a thin but wet layer to minimize overspray roughness. If it is not freshly opened, the primer should be strained before you put it in your gun. If you have not learned by now, everything but thinner should be strained before it goes into your spray gun. An old nylon stocking does a good job. Be sure to thin down the primer adequately or it will give an orange peel surface.

Many people cut the gun down at first to apply a thin mist coat and then when they go over it again with a regular full coat there is less likelihood of getting a run. Zinc chromate should be put on in a thin coat for best adhesion. it is supposed to be transparent after applied so do not expect to cover with it like other primers. In order for the chromate ions to do their job in stopping corrosion, they need to be only one molecule thick--which is mighty thin. Sand with #400 after two hours.

Tack Rag: An important item in any paint shop is a tack rag. It costs but $.39 and is a must for wiping off dust particles from the surface before applying primer or finish coats. Carefully wipe the whole area to be painted before spraying and then keep the tack rag in one hand to wipe off loose dried overspray and other dirt particles ahead of where you are going to spray. Do not think you can get by using an ordinary cloth for wiping off dust because it will leave tiny fibers and lint.

Filler or Sanding Primer: You may find filler quite useful in filling pin holes and imperfections in fiberglas and also filled areas when epoxy putty is used for filling rivets. I have seen it laid on thick over flush rivets for a smoother finish but advise against this as the metal might flex too much and cracks appear. I saw two absolutely beautifully finished planes develop this problem. The primer should be thinned to normal spraying consistency with lacquer thinner. when sprayed on, it dries fast and buildup in desired areas is easy to accomplish. Just spray it on heavy;, let it dry a little and spray on another coat. For best results on fiberglas pin holes spray on a light coat, let it dry a few seconds and smear it over and into the pin holes with your finger. Otherwise, you have to build up an awfully thick layer before the holes finally cover over. After a successful smear, apply the normal coat.

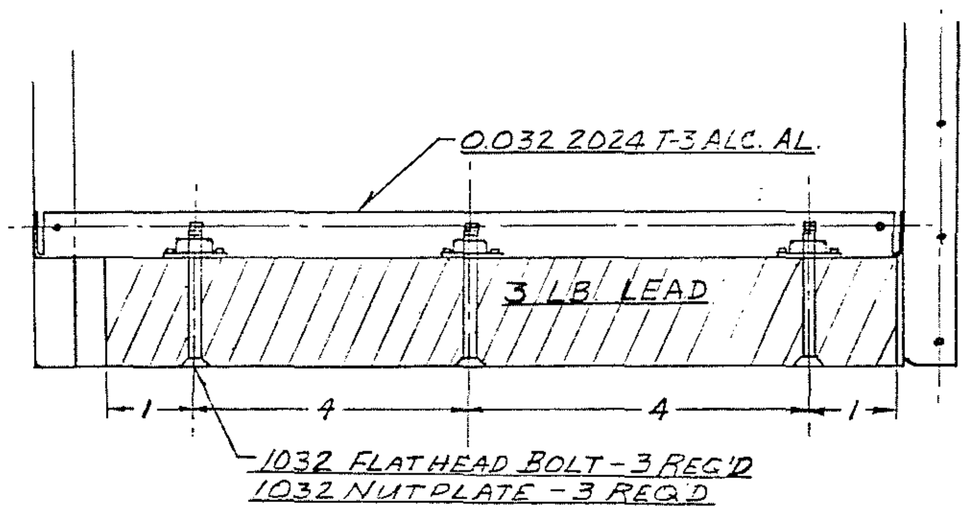
Sanding should be done with #200 wet-or-dry to smooth out the larger bumps and finish up with a finer paper (320 or 400). Cut the paper into quarters and wrap the paper around a block of wood about 2 1/2 inches wide which acts to put pressure on the high spots. After sanding, wash down with water and then wipe with enamel thinner, not lacquer thinner. This should be followed by a coat of wash primer, if used, in a manner described earlier to provide a good seal.

Finish Coat: In watching many old pros paint airplanes, I discovered an interesting thing. They usually paint the trim stripes and lettering on first. That is right, first. They paint the area of the trim and lettering with the proper color, being careful to get a smooth, non-orange peel surface. They tend to put on a light mist coat first, followed by a full wet finish coat. You will soon learn how important the thin mist coat is for it is the only way to prevent runs--the plague of any painter. Force yourself to let the first thin coat get tacky to the touch before spraying the full wet coat or you will get runs. The thin first coat when partly dry soaks up the full coat and holds it from running. When you get your first run, you will remember this and wish you had made a sign and hung it in your shop as a reminder. The full wet coat should be sprayed with long even passes with the gun held at a constant distance from the surface. Release the trigger at the end of each pass to avoid depositing a large quantity of paint during the turn-around motion. The proper distance to hold the gun from the surface can be easily determined by trial and error on a sample. If you get too close, it will cause too much build-up and a run while holding it too far away causes the paint to partially dry before it strikes the surface and an orange peel will result. Use what is called a cross-coat to insure even coverage, that is, first make passes in one direction and then immediately make passes 90 degrees to this.

After the first full coat has dried well, check the surface to see if it needs an additional coat. If it has too much orange peel, dirt particles or runs, it can be sanded lightly and another coat added. When satisfied with the finish, put on masking tape to cover up the paint in the shape of your trim and lettering. The main color is then sprayed over this first trim coat. By using this seemingly reverse procedure, you minimize the amount of masking required.

Masking: When ordinary masking tape is used to mask the edges of trim, the little crinkles in the tape allow paint to run back under the tape in little hairlike fingers making a sloppy looking job. This can be reduced somewhat if the edge of the tape is rubbed down well with the fingernail before painting. Especially, make sure the tape is rubbed down well where it crosses or joins another strip of tape. You might want to make a sign about this one too for the sharpness of trim stripes is one thing that makes the difference between a sharp paint job and just a mediocre one. If you use smooth plastic Electroplating Tape, 3M #470 you get better results. If masking tape is removed just as soon as the paint is dry to the touch, it will permit you to carefully scrape.

Cleanliness is the order in everything you do when painting if you hope to be successful. All of this may have sounded like a lot of bother but doing the job right can save a lot of grief and embarrassment later. Remember, it is a lot harder to remove the paint from a surface than to the the job right the first time. I ran into some grief with the wrong paint on painting a Luscombe 8F which I owned once. I painted on some gold trim and put the masking tape over it for the stripes and then the white main coat. When I pulled the masking tape off, the white also peeled off wherever there was gold beneath. In the messy job of removing the



INTERNAL TAIL WEIGHTS

Figure 17

paint right down to the bare metal again some thinner got under the masking paper covering the plexiglas window and it crazed. Plexiglas is very sensitive to such vapors and will craze much later after exposure when exposed to heat and sunlight. Good luck on your paint job. (Editor's Note: And do not be too surprised if you have to rub out some runs and do it over. It happens to the best of us. Remember to always spray on a thin coat first and let it dry seven to ten minutes to get tacky before spraying on a full cover coat. The under coat then absorbs some of the thinner and discourages runs.)

WIRING PANELS: by Bob Dial. Assemble and prewire all fuses, switches, controls, etc. to an extrusion or separate bent-up strip made to fit below the instrument panel. Use quick-disconnects and all wiring and controls can be removed in minutes.

T-18 NEWSLETTER #39 07-14-73

Luther D. Sunderland

OSHKOSH SCHEDULE: The T-18 Forum has been scheduled for Monday afternoon from 2:30 to 3:45. Could not get another time other than Saturday afternoon. At least you will have the previous weekend to get there. I am conducting a propeller forum on Thursday from 10:30 to 12:00. Henry Rose, Chief Engineer of Sensenich is helping me prepare a paper. John Thorp has indicated that he will not be able to attend unless his health improves. The metal workshop will be run by Bob Bushby this year where he will show a new VW powered all-metal design. Dick Walen said, "Now maybe we T-18ers can get some flying done."

THE PIPER LEGEND: A new book that all of you should find interesting reading is **Mr. Piper and His Cubs** by Devon Francis. Although it concentrates heavily on the economic and business aspects of Bill Piper's aviation career, it contains many interesting sidelights that affected the Piper design and hence all of the world's light aircraft, because Piper airplanes have so dominated the field during the formative years since the early 1930s. I got the feeling that Mr. Francis is not very close to grass roots aviation, although a distinguished aviation writer. At least he must not read **Sport Aviation** or the general aviation magazines for he spelled John's name Johnny Thorpe. It was also disappointing to find a book primarily about the J-3 Cub with a Super Cub picture on the cover. Anyway, I highly recommend it for reading--to fill in between the not too frequent T-18 Newsletters. John Thorp is mentioned three times for his significant contribution to the Piper designs. Not only did he invent the all-moving horizontal tail and do the initial design on the Cherokee 135, but also built the first few Cherokee landing gears and obtained FAA certification. He has also done other work for Piper from time to time.

The book should dispel any suspicions people might have that the reason we do not have a $2,000 airplane in every garage is that the big boys like Piper conspired to keep production quantities low to hold prices up. Some of the self-appointed experts writing in **Sport Aviation** have been known to make such accusations (like Jim Bede).

BILL JOHNSON'S RETRACTABLE PROGRESS: After many delays, including moving, Bill is about ready to fly again. Today when I spoke to him he said, "It is all ready to paint, but if I had it to do over I would do things differently. Everything seemed to get in the way of something else." Like Russ Basye, who made a tri-retractable T-18, Bill does not particularly recommend that other builders try it. Some of Bill's changes are: (1) Main wheels folded forward from wing main spar, tucked under pilot's and passenger's feet. (2)

Fuselage belly extended several inches to fair wheels. (3) Fin swept back and lengthened. (4) Different wing airfoil to minimize drag at higher cruise. (5) Hoerner wing tips made from sheet aluminum with simple bends.

BUILDING THE MAIN GEAR: by Luther D. Sunderland. Having just welded up a new main gear for Don Carter, like the one described in Newsletter 28, I thought I would set down some of the thoughts I had which might help someone making a gear for the first time. Now that I have made four main gear assemblies, I can say that they can be welded quite easily with an oxy-acetylene torch. Although, if you do not know how to weld, this is no place to learn. There is no need to use two torches if a big enough tip is used. The #5 tip works fine. Probably the toughest spot to get hot is where the inner leg is welded to the outer tube. spend several minutes pre-heating the upper end of the inner tube and it will weld with no trouble.

Here are the steps I went through to make the gear: (1) Taper 1.5-inch tubes. Instead of the 32 inches called out, I made this tube 31 inches long, 16 above the reference point and 15 below. This helps soften the gear a bit. My tube was 32 inches long but I left 1/2 inch on each end to grip with the dog while turning the taper. As was mentioned in the Newsletter, if the lathe bed is not long enough, the tail stock can be removed and mounted on a wooden platform nailed to the workbench. My 9-inch Logan lathe bed is just almost long enough to mount the 32-inch outer leg tubes between centers, so I extended it with two pieces of 3/4-inch thick aluminum plate. One piece I clamped across the ways with two C clamps. The other plate was bolted under this first plate and allowed to extend out past the bed 10 inches. I placed the tail stock on this and clamped it, positioned for the proper taper, with two C clamps. A steady rest was used in the middle. Had trouble with the steady-rest scratching the tube so padded the contact points with pieces of an old blanket. Crude but it worked fine. The upper end of the tube is tapered to 0.060-inch wall and the lower end to 0.030 inch with a 1/8-inch wide full diameter ring left on the end to prevent splitting. Polish and it is ready to cut to length and slip on the inner leg.

(2) Lay out gear outline on work table. A standard four-foot wide sheet of plywood can be used as a welding jig. I just laid out the gear on my work table. It works best if it is drawn crossways with the centerline of the bolt at the apex placed right at the edge of one side of the table. The ends of the legs (at axle pads) will extend off the other side for the lengthened gear, but this is quite convenient as you will see later. Draw the centerlines of all tubes then the outlines of all tubes and fittings. Fasten wooden blocks to the table on both sides of the inner legs near top and bottom to hold them in place. Bolt two 1-inch diameter x 1/2-inch

wooden discs to the tables to locate the -6 plates. If these bolts are allowed to extend about 2 inches above the work table they will serve as convenient index reference points.

(3) Cut inner legs at apex. Only one hacksaw cut need be made on the inner legs at the apex. The 1.25 x 0.313 tubes can be cut square 56 inches long. The upper end can be butted against the modified -9 fitting with the single cut made in the vertical plane on the gear centerline or 0.090 inch from the centerline if the gear is made in two pieces. I strongly recommend splitting the gear even if you have a giant heat treat facility available in case you damage one leg and need to replace it.

(4) Make -8 and -9 split fittings per Newsletter 28 (pages 164-166). Bend in vise with help of hammer and weld -8 and -9 together. Leave bolt hole 1/4-inch diameter at the time.

(5) Weld -8 and -9 fittings in place. First bolt a scrap 1/2-inch aluminum plate between fittings to hold in proper alignment. Slide piece of sheet metal under the fittings and tack to legs. Remove legs from table and weld each separately.

(6) Weld outer and inner tubes together.

(7) Cut and grind fit cross member. With the legs positioned on the able cut to length and grind the 1.25 x 0.082 cross tube to fit. Now, slide a 4-inch long x 1.5-inch splice tube over the cross tube, center and drill four 5/16-inch holes. It does not need to be 6 inches long as shown in Newsletter #28. Remove splice and saw crosstube in two on the gear centerline. Insert bolts and place in jig. Nail several wood blocks to hold crosstube in place. slide a piece of sheet steel under joints and tack weld crosstube in place.

(8) Weld -6 fittings on wooden locator discs, slide sheet steel under fittings and tack -6 fittings to outer tubes at two places. Turn gear over and tack other side. Heat outer edges of -6 fitting and bend down around outer leg with hammer. Slide 1/8-inch steel plate between crosstube and -6 fitting with edge of plate on crosstube centerline. Heat -6 fitting and bend down to touch crosstube. Weld -6 fittings four places complete. The most difficult spot to get hot is where the -6 fitting crosses the weld between the crosstube and leg. If you can cross this point you have it made.

(9) Cut lower ends of legs to fit. Place gear back in jig. Legs may have warped slightly. Do not straighten yet, just force into position between blocks. The lower ends of the 1.25-inch legs will stick out from the side of the table several inches. Note that a camber has been increased to 3 degrees. This seems to work out well for my tires are now wearing evenly. To help mark correct angle, take two pieces

of scrap aluminum about 1 inch x 12 inches x 0.060 or thicker, drill a #30 hole at midpoint and rivet. Set the angle between the two pieces at three degrees with a protractor. Using edge of the table as a reference mark 1.25-inch legs for cut at pads. Be sure both legs are cut the same length as measured from the reference point at the apex. Now have fun with the hacksaw. It really does not take hours to make a cut although it seems like it. It took me 20 minutes per leg.

(10) Attach axle pads. First tack weld the four bushings to the pads, then grind clearance notches in the legs. For this use a grinding wheel chucked in your hand drill. Finish off with rat-tail file. To locate pads accurately for welding, clamp a long straight angle across the two legs just above the pads. Position angle parallel to bushing holes in -1 fittings. Tack weld pads at one place and using the angle as a reference adjust for zero toe-in and 3 degrees camber. Tack several other places and recheck. The axle pads can be ground to proper alignment after heat treating, but it is far easier if the initial alignment is fairly good.

(11) Weld -7 engine mount fittings in place. To position for tacking, cut 1.5-inch long spacer from a piece of scrap tubing having ID in excess of 0.25 inches. Bolt fittings and spacer together. If centerlines of fitting holes are marked on table, the fittings can be positioned with the help of a square. Tack, remove gear from table and weld.

(12) Heat treat to 190,000 psi.

(13) Reassemble and check for warpage. If legs have warped, they can be straightened with a heavy chain and jack a la bow and arrow. I ruined a bumper jack doing this and had to borrow a hydraulic jack from a gas station--four-wheel type with handle. If pads are no longer aligned properly --three-degree camber and zero-degree toe-in (some toe-out is OK), grind on table saw or make a tapered shim from aluminum. Some points to remember about welding. If the tip is too small, the gas velocity will be too high and tend to blow the puddle away. Use a bigger tip, or, if the tip is almost big enough for a tough spot, whip the torch away and the puddle will rush back and fill the hole before solidifying. This is called "puddle welding" and is acceptable but should not be used for any great distance. 1/16-inch number 7 copper-coated steel road is best for all aircraft welding even on the T-18 main gear. Rig up a way to hold the gear in various positions so it will not slip while welding. I had a hole on my knee for some time where I got branded. Happy soft landings!

ENGINE BOOK: From Avco Flyer. One of the finest basic engine books we have seen in recent years has been compiled by the Flight Standards Service of the FAA, and entitled

"Airframe and Powerplant Mechanics Powerplant Handbook." Although it provides basic engine information for the mechanic, pilots will find it easy to read and quite helpful. It is listed as AC 65-12, and is for sale by the superintendent of Documents, US Government Printing Office, Washington, DC, Price $3.75.

SCRATCH REMOVER: by Al Lurie, Peoria, IL. Since sheet metal seems to pick up scratches if you look cross-eyed at it, I found a reasonably quick way to remove most of them. Start with the Norton Company Bear-Tex #668 (green color 6" x 9 1/2" pad) and finish up with Bear-Tex ultra fine #635 (gray color). Cost is about $.50 to $.70 each. It should outlast sandpaper of the same size by 50 to 100 times--or more. Try it, you'll like it.

DECIMAL SCALES: At last I have smoked out some sources for a steel rule marked off in 10ths and 100ths. One source is National Gauge and Tool, 6728 San Fernando Road, Glendale, CA 91201 (213)243-1666. In their last catalog they offered a set containing a 6-inch, 12-inch, 18-inch, and 24-inch satin chrome Sheffield Chesterman Rule for $16.50. All you really need is the 18-inch or 24-inch rule. (I built my T-18 with only an 18-inch draftsman's scale.) They sell them separately also. The CF967F 18-inch Chesterman rule is $8.45 and the 24-inch Chesterman rule is $11.35 (quoted June 1973). The LS Starrett Company, Athol, MA 01331 also has scales available through distributors--$11.95 for 18-inch and $17.25 for 24-inch (C303SR). I do not recommend scales marked in 0.010-inch increments because they are too difficult to read. A scale with 0.020-inch increments is adequate and preferable

DESIGN MODIFICATION: by Luther D. Sunderland. The subject of modifications to the standard plans is always open for discussion since almost everyone thinks he must put at least a few of his own ideas into his airplane. As you Newsletter readers know, there are some modifications which your editor and John Thorp frown on, but there are some which have met with less disfavor. John's position is that he will not actually approve any non-standard design change because of the legal ramifications. He has not opposed certain minor changes which some builders have made if they do not adversely affect structural integrity or flight safety. Some of the modifications in this category are as follows: (1) Enclosing fuel cap with door. (2) Moving instrument panel aft. (3) Rounding tunnel between seats. (4) Lengthening main gear 2.5 inches and splitting for heat treat simplification. (5) Raising roll-over bar 3/4 inch. (6) Lowering throttle knob to bottom of panel. (7) Softening tail spring. (8) Changing wing gap cover securing means. (9) Moving rudder pedals aft for brake pedal clearance (for short pilots and passengers only). (10) Adding jump seat or top access to baggage compartment. (11) Adding fuel tanks.

Then there is one yet unaccomplished change which would probably meet with everyone's approval, including John's. This would be adding a couple inches width to the cockpit. The only real difficulty in doing this would be the drafting involved in changing the prints.

TAIL MODIFICATION: by Luther D. Sunderland. Many builders who already had their horizontal tails built before the modification bulletin have hesitated to make the change because of the work involved. I was one of those who simply chose to stick with the 180 mph red line rather than change the spar. After 300 hours, I noticed that the 1/8-inch Pop rivets attaching one 509 lug were working loose, so I decided to replace them with the 5/32 AN rivets and at the same time modify the spar. I already had the two new spar tubes, but the flying weather was just too good for me to take my T-18 out of service for any length of time. When I came to dismantling the horizontal tail, I could not quite bring myself to drilling out all those rivets and starting with a new tube so I decided to look for another solution. I got a piece of two-inch OD x 0.156-inch wall aluminum. A 24-inch length of this fit nicely between the chuck and a center in the tailstock of my nine-inch lathe. It turned quite easily to fit into my original spar, leaving a 0.070-inch wall. Only the rivets on one side of the tail had to be drilled out. The penalty was about one extra pound in the tail, which did not help my cg any--it was already too far aft--but I have the consolation that it is much stronger. Bill Johnson built his tail this way. As expected, John Thorp commented that the standard mod is lighter.

Riveting was absolutely no problem. I found a piece of steel bar 1.25-inch diameter x 2 feet, slid on and taped a six-inch long piece of scrap 1.5-inch steel tubing left over from the landing gear, taped a yardstick to the end for positioning and I had a perfect bucking bar. The tail was laid across the backs of two chairs and I started driving away with the rivet gun. (Pop rivets were used to attach ribs to the spar.) The weight of the bar is adequate to buck even the 5/32 rivets when they are driven from underneath. The big question of course is how can you tell when the rivet is driven properly? With a flashlight you can inspect each rivet as you go, but before long you can tell just how long to drive a rivet with this bucking bar arrangement to get it to come out right. Be sure to corrosion proof everything before assembly. A piece of foam tied to a stick does a good job applying zinc chromate to the inside of tubes. Slide the inside tube in place while the chromate is still wet to eliminate the possibility of clearance problems. Be sure also, to apply chromate under the fittings. When I removed the fittings I was shocked to find that I had forgotten to do this, but fortunately I had always kept my bird hangared and there was no corrosion. With this simpler way of making the spar mod, those builders with tails already built will find the job less forbidding. One source of 2024-T3 OD x 0.156-inch wall tubing is Tube Sales, 456 Nordhoff, Englewood, NJ 07631 (201)567-4400. They will supply six feet for $25 (their minimum order) and this will make three pieces. The inner tube can be shorter since the outer tube is heavier. You can also get any kind of aluminum or steel tubing from them.

TOOL SOURCE: Bob Cumberford, 24620 Les Eyzies, France. I have the Fourth Edition of the Starrett catalog, which shows many other items which would be extremely useful in aircraft construction, and I would recommend every T-18 builder obtain one early in his project. There are branch offices and warehouses in Los Angeles, Chicago, and Springfield, NJ. I do not have a price list, but the tools are expensive. I think they are worth the money. The company bills itself "World's Greatest Toolmakers," and I for one will not argue. I consider the Newsletters the equal of any single book in my library.

WELDING TIPS: by Luther D. Sunderland. Many builders wish to learn to weld steel tubing so they can do their own welding on the T-18. This may not be too practical if you have never welded since there is not enough welding required to really give a novice welder adequate practice to get proficient. Furthermore, most of the welding is in fairly critical parts. But, if you are learning to weld or have not done aircraft welding, here are some pointers which usually will not be found in the welding books. Welding aircraft tubing is not like welding farm machinery so even if you have done non-aircraft welding, take serious note of the following: (1) never weld over weld material. The FAA is very particular about this. (2) Use only #7 copper coated mild steel rod 1/16-inch diameter. (3) Check all rods on grinding wheel before using. A fellow chapter member check 100 rods and found two which were bronze but looked the same as #7. The welding supply had goofed. When he had unknowingly touched one of these rods to a cluster at a wing fitting on his Skybolt, it just sputtered and left a 1-inch long crack in the tubing. He had to use a finger patch to repair it. (4) Never leave undercuts. An undercut is caused when sufficient filler rod is not used and the base material is melted away leaving a thinner cross section at the edge of the bead. The FAA is also very particular about undercuts, for they naturally weaken the joint. Check every weld carefully for undercuts and pin holes. (5) Pin holes are verboten. They are caused by sudden removal of the flame from a puddle allowing it to cool too rapidly. The flame should be whipped back and forth from side to side as it is retracted from a finished weld to allow the puddle to cool slowly. (6) Sufficient heat should be used to insure penetration of the base metal. Good penetration is indicated by a bead which is faired in smoothly with the base metal.

(7) Before you begin welding on your airplane, make a sample joint using several sizes and thicknesses of 4130 tubing. Send it or show it to the FAA inspector for his approval.

BILL COX FLIES: 419 Willow Lane, Baytown, TX 77520. Serial #182 has flown after three years and 2400 hours labor. It is built very close to the plans. So far all flights have been open cockpit. It is cutdown, I checked with John on this and he said OK. I have not seen any data on this configuration so I will send what I have. After all the tales I had heard about the T-18, I did not know if I could fly it after it was built. I have 275 hours, with 200 in taildraggers. In the past two years I flew 75 hours in a Piper Clipper. A friend flew the first flight on June 26. I have flown it ten hours since then and it is a great bird. Ground handling does not seem over sensitive to me. I think some of the guys are trying to go from a Cessna 150 to the T-18. Empty weight with canopy is 902#. Power is Lycoming O-290-D2 with full electric. Fuselage is insulated with polyurethane foam. cowl is from Hamlyn. Prop is FIC Flotrop 67 x 67. This is a little beefier prop than a 74DM. Static rpm 2350. Without canopy 145 mph at 2000, feet 2700 rpm. At 1300, 95 degrees F at sea level rate of climb at 100 mph is 1400 fpm. Cruise 125 at 2400. Stall 63 mph. Air speed has been calibrated and I believe these numbers are real close. Rate of sink at 100 mph no flap is 1100 fpm. Stalls are abrupt, but no problem. Power off I have no warning. Power on, the airspeed begins to oscillate at about 70. this is due to the pitot being in the prop wash at high angles of attack. Spins both right and left have been done up to three turns. Recovery is normal and very quick. Test flying to date has been from a 2000' strip. Approach is made at 80 to 85 with 30 degrees flap. I carry a little power to the fence, then power off to land. I would not make a habit of flying from less than 2000' since it normally takes 1500 to 1800 feet of sod for landing, without excessive braking. I will be moving to a 4000' strip and using the canopy soon. When I get some new numbers I will write again.

BEGINNERS' CORNER: James Blyth, Apalachin, NY. **Spar Fabrication:** I would like to discuss some of my learning experiences in getting started on the T-18 since those mentioned in Newsletter 35 (pages 232-233). You know what? I have not learned yet! Recently Lu and I got together for what I thought was going to be the assembly of an outer wing panel but instead ended with me making all new main beams and rear beams. Why? I went my own way and did not follow instructions. I used a pair of dividers to step off my hole locations in the beam webs and the caps. Problem was I simply set in a dimension on the dividers and stepped off the whole length of the web and cap. This puts in holes that interfere with rib locations. So I learned to follow the print and step off only the areas within the rib locations. Also the overall depth of the main beam was off. One beam was way over-sized, and the other was bowed nearly 0.1 inch. The reason was that I simply did not locate my web and cap pieces properly, and make constant dimension checks during the location of hose first few critical hole locations. The bowed beam was caused by the aluminum angles, which, although expensive, were not straight. So caution! Assume nothing is straight, square, or flat. First lesson learned. Lu had told me about buying two 12-inch tri-squares and using both heads together, set at the desired dimension of the beam to use as a gauge. During main beam assembly, two heads clamped on one rule at the precise depth of the main beam can be slid down the beam to keep a check on the dimension. When you purchase your tri-squares get a fairly good grade and check them with another fixed square that will probably be hanging nearby. Avoid the $ .98 square. Lu is still chuckling about my $.98 wonder (off about two degrees) that has since taken up residence in the junkyard.

Bending Flanges: I have had success bending parts though, and I would like to pass along my methods, for what they are worth. For the sake of discussion, I am using print #557, aileron beam. Cut out the 49.25 x 3.671-inch blank square one side and with the end as true as possible. Using a hard pencil, establish a reference line 2.369 inches in from the squared edge. Using this line as a basis for all further measurements, establish the areas to be in the bend radius. Once the bend areas are established, draw a line right down the center of them. This line is what you sight in on when the part is set up in the brake. Now, to establish the 0.090 radius, I used a two-inch wide 50-inch long strip of 0.040 dead soft aluminum. I bent this in the brake first to form a sort of shoe for the brake. The part is then put in the brake with the shoe. You then sight down that centerline and clamp up the part in the brake. Caution! Be absolutely positive the shoe has not slipped down on the brake. It can also become bowed so it should be checked for proper seating during clamping operation. Now bend the part, checking it against the print for proper deflection, and you should be home free. I have checked my bends with a radius gauge and they are very nearly perfect. For those of you who are having trouble finding a large enough brake, try plumbing and heating outfits, and take some T-18 photos with you, they are magic! People just seem to go out of their way to help when they see what you are building.

(Editor's Note: Never bend <u>any</u> part on a brake without first making a test bend from scrap of the same thickness. You can forget all about figuring bend allowances and proceed by trial and error until you discover where to locate the part in the brake with the particular radius block or shoe you have made. It is much less time consuming and, in the end, usually necessary anyway after you scrap a part. Because of problems most builders seem to have getting the rear wing beams formed exactly right, I <u>do not</u> recommend punching the holes in the beam before bending. You can still use matched-hole techniques, just transfer punch the holes along the edge of the beam after forming. The rib attach holes can be marked but check after bending before drilling. It is quite common for the angle extrusions to be bowed. This is a problem when they are bowed along both legs.)

AVIATION SHEET METAL SHEARS: If you cannot locate a source for snips, according to Popular Mechanics you can order right or left-handed aviation snips from Channel Locals Inc., Meadville, PA 16335 for $5.40. I have one pair of left-handed snips and they are all that is needed. As you hold them in the right hand, the right jaw is on top. The straight ones are not good for anything. Use only the old-fashioned scissors type for straight cuts--a fairly large size, not the 8-inch or 10-inch variety. I do not think I could build an airplane without both of these snips. if you have the wrong kind, you will probably get discouraged and quit.

BUILDING OUTER WING PANELS: by Luther D. Sunderland. A recent experience helping Jim Blyth with his outer wing panels alerted me to some possible pitfalls which everyone should know about. Here are some dos and don'ts. Do follow directions explicitly, especially those given in Newsletter #35. One thing which caused Jim to scrap his spars was that he got mixed up laying out only half a rivet pattern and then flipping the template. Due to the many complaints about this, I therefore recommend that no half templates be made. When there is a straight row of rivets across a four-foot sheet, lay out the whole rivet pattern. It does not take that much more time and there is less chance of getting mixed up. Counting all the hole patterns in the T-18, you could not save more than a few minutes by making half templates, but you could surely lose hours by the resulting mistakes. Always mark templates and parts in large letters with a felt pen to show which side faces UP (or SKY), which side faces DOWN (or GROUND), which side is toward RIGHT WING TIP, which side faces FORWARD (or PROPELLER) and which side faces BACK (or TAIL). With those labels you can still transfer a hole pattern wrong--especially if you have spectators bothering you--but it is far less likely. Do not use labels which can be interpreted two ways. You cannot get along without a large carpenter's square (24-inch size) and a small combination square (12 inches long with adjustable head). Check both carefully for squareness. To do this, draw line perpendicular to the straight edge of a sheet, flip the square and draw another line on top of the first. If both lines do not coincide, the square is not. I found it handy to have two of the 12-inch squares with removable heads so I could put both heads on one square and use it to slide along my main spars to adjust the angles for the right separation. Remember, extrusions (and sheet edges) are rarely straight.

Ends of aluminum sheets do not always come exactly square.

When you goof up on a part, usually you will save time if you just start over and do it right. Much as you might hate to waste the time, almost any part can be made over in an hour or so but you have to live with the airplane for years. You cannot get along without a pair of micrometer calipers. Most discount stores have them for several dollars. You really should have a good set which measure to 0.001 inch, but you can get by with cheap ones which you can sharpen and use to mark reference lines from the edge of a sheet. They can be set accurately by holding them up to your steel scale. You should not make scribe lines in material which will form a finished part, but a tiny light mark in the alclad will not hurt anything, especially if it is material which will be cut away.

To make outer wing main spars, first make the web per Thorp's instructions. Then transfer holes into one angle, making sure the angle is held exactly straight. To transfer into the second spar cap angle, place two heads on a combination square exactly 5.933 inches apart. Use this as a guide to position the angle until a rivet hole is located along side of each of the four ribs. Drill these four #30 holes, place rivets in them for dowels and transfer the other holes. Now you know the spar is exactly the right width along its entire length.

To transfer the rib attachment holes from the spars to the ribs, I prefer to first position the ribs on the spar and hold in position with the wrap-around transfer strip. A rivet hole centerline should be marked on the rib flange with a pencil. Starting with just the nose rib in place, carefully position the nose rib to be flush with top and bottom spar caps. Then transfer through the spar onto the rib flange. Make only one hole in each rib, cleco in place and check across all ribs with a straight edge. If an adjustment is needed, it can be made by cheating a little on the one hole. Then the other three holes will at least be exactly right. Usually there is no problem. If a rivet hole has been elongated, an additional hole can be made or an oversized rivet used. AN rivets expand and fill slightly oversize holes but Pop rivets do not. Incidentally, you will find wing assembly much simplified if you use Pop rivets to attach ribs to the spars. I used Pops and they worked great.

MY BUILDING EXPERIENCES: M. B. Mantooth, 4109 Barnsley Lane, Olney, MD 20832. I thought that it was about time that one former beginner jotted down a few words for the other newcomers. I have just finished my landing gear, motor mount, and rudder pedals which are the end in a series including ailerons, flaps, outer wings, inner wings, tail, fin, and rudder in that order. I like the order in which I proceeded. The flaps may be a bit difficult to tackle so early in the game, but it you ruin some material on them you have not wasted nearly as much as on your wings or some other component. And they provide an excellent training ground for alignment procedures. When I received that stack of drawings a year ago, I almost went into mind lock. The two big questions are: how do you proceed with any pattern, and where does all of this material come from. The Newsletters will help with the material and in addition you can subscribe to **Trade-A-Plane**, Crossville, TN. In regard to the drawings, I sat down and made a complete list by number, title and next assembly. I then designated these assemblies as groups and then listed the drawings numerically for each group. When I ended up I had a master list that told me in which of 14 groups a drawing was located and 14 groups of drawings arranged numerically for the components themselves. You just cannot overlook a drawing with this scheme. The horizontal tail gave me more trouble than any other part if you disregard the labor involved in working with 4130 steel. But this was my fault since I was off in the scribe line on the tubing. Lesson: make sure that this line is true. I really sweated over that. I used, with some minor changes, John Shinn's ideas in making the fin and this turned out to be fairly easy. I can see how you can get into trouble if you are over-confident but I see no reason to fear any more than any other part. In retrospect I would suggest making the outer and inner wing main beams before any assembly is started. this will make it easier to mate them together. You may be accurate enough that you will not have to match the holes, but I am not. I enjoyed making the landing gear despite the difficulty of 4130 steel. I used one of the metal cutting blades on my radial arm saw to whack it off at the right angle. Kinda hard on those blades, though I made it in two pieces and Drever Heat Treat, Inc. Rouinwood Road, Baltimore, MD stress relieved it and treated it for $25. That is a good price, but he cannot handle gears that are much longer than three inches over specs. Builders in that area should check before shipping to him. And speaking of 4130 steel, in order to conserve your energies use about 50 strokes per minute. Otherwise you just burn up blades and yourself. I am installing dual brakes on #844 (I am thinking of calling it Band-Aid--You will find out why). This is not difficult to do. It consists of a Gerdes A-110 master cylinder in series with an A-049 which has the reservoir. These are a little longer than the specified Scott, so appropriate changes must be made in the pedal operator. Aircraft Spruce and Specialty, Box 424, Fullerton, CA have the hookup in their catalog. I am a little apprehensive about the forthcoming cowling. Sure hate to buy one but I may have to. Wish some one would write a good article on that. Good luck on your project.

ENGINE MOUNTS: All-Aircraft Parts, 16673 Roscoe Boulevard, Van Nuys, CA 91406 has the rubber mounts for the T-18. They are not made by Lord, but are interchangeable and the same price, $3 each. They also have T-18 hardware and the canopy seal. Someone asked if a heavier mount is needed for the bigger engines. John Thorp says that his mounts shown in the plans are suitable for all Lycoming engines up to 180 hp. John builds a dynafocal mount for sale and Merrill Jenkins builds one copied after a Piper mount.

CONTROL PANEL OVERLAY: Previously I explained how easy it was to form a panel overlay and make your panel look as professional as one of Piper's. I highly recommend this to dress up your cockpit. Many people have had a problem finding Royalite or other thermosetting plastic. I have contacted a local plastic supplier and he has agreed to sell partial sheets of Kydex Plastic which is just like Royalite but not made by U.S. Rubber. They will mail you a 32-inch x 48-inch piece of 0.060-inch black plastic for $15. Address is: Binghamton Plate Glass Company, 362 State Street, Binghamton, NY 13902.

WING PROFILE: Ted Strange, 237 Leon Avenue, Kelowna, B.C., Canada. I have a buddy who is also building a T-18 and we paid to have the wing profile cut out with a laser beam to give faithful reproduction. It cost us $64 to receive two mirror images cut out from 3/4-inch maple plywood.

ELTs: The deadline is getting close so we all have to do something soon. Here is what B. C. Roemer, Manitowish Waters, WI 54545 has to say on the subject, "I bought one from EAA. I mounted it on my canopy cross piece. This was an exercise in making a neat installation which certainly was stupid. Every time I closed or opened the canopy, it triggered. So, do not install on the canopy. Next, I bolted it to the deck upright, right in back of the pilot. Full of confidence, I taxied on our grass field to flight test it--and triggered it twice just taxiing and once landing. (I thought the landing was one of my better ones, at that). As stiff as the T-18 gear is, I just do not know where to put it so I am going to block the hammer to keep it from triggering except on a 10 g blow. (It is set for 5, I believe.) Be sure you can get at it to turn it off if it goes on accidentally. And when first testing the installation, be sure to keep your radio tuned to 121.5 and in the "com" position. You will know when it triggers. Flew to Florida Christmas time. Over 1200 miles, 5.5 hours flying time, about 220 mph average at 9500 feet, 2500 rpm (about 55%). Had a tail wind all the way. Coming back, is another story. (2 1/2 days). B.C. has challenged any T-18ers to a race. He says so far he has had only a BD-4 for a taker but will not lower himself to race with Jim. He expects someone will be faster but hopes to induce others to build clean ships.

FOLDING WING T-18: by Luther D. Sunderland. One of the dreams which many of us have always had is to own an airplane that could be readily taken home and stored in the garage.

The T-18 concept falls short of this in one respect--it cannot readily be prepared for road transport by one person. Anyone who has removed and replaced the wing a few times will tell you that it is a three-man operation with one of the three adept at gymnastics (standing on his head in close quarters) and capable of giving directions in a very cool manner (my family helpers usually are not on speaking terms for a day afterward). Only one T-18 is regularly kept at home. Even those who would not bother taking their airplane home between every flight would like to be able to take it home for maintenance or would welcome the cost reduction of sharing haangar. I have been talking with John Thorp about this for some time. He has decided to design a folding wing if there is enough interest. So I am going to include a questionnaire which I hope everyone will fill out and return. With a seven-foot center section the wings could be pivoted just ahead of the rear spar and still clear the horizontal tail. It is necessary to keep the folded width under eight feet to meet road limits and fit through a standard eight-foot garage door. The design goal is for one person to be able to prepare the T-18 for road transport or for flight in less than five minutes. It would be of interest to know how many current owners of T-18 plans would purchase plans for the folding wing. No price has been set but I would guess it would be $25 or more since a large portion of the drawings would be affected. Even if you would not plan to buy the new drawings, it would be of value to have your opinion on such a design feature. I will pass the forms onto John. He solicits any and all ideas. Help play a part in aviation history.

1986 Postscript: The questionnaires revealed that there was a great amount of interest in a folding wing design for the T-18. But John became physically unable to do the design, so he suggested that I do it. This resulted in the T-18C convertible wing and later the S-18. A total of 382 sets of T-18C plans were sold before they were taken off the market as a separate modification to the basic T-18 design.

Luther D. Sunderland

FOLDING WING SURVEY: The survey showed an overwhelmingly high percentage of persons responding favorably to a folding wing design. Actually, only 75 forms were returned, but that is about par for the course. Only one of these indicated that they did not favor the idea. John Thorp feels the survey was akin to asking people if they would accept a free $20 bill, but he is convinced a folding wing would be a desirable feature. It is not a simple matter of moving the wing break in and folding the wing. There are complications of breaking the flaps and taking the increased bending moment at the joint.

In any case, John says he is likely not able to take on the job of doing all the necessary redesign work due to health and work load problems combined. So your editor has undertaken the job of making drawings for the folding wing design. John is doing all stress calculations on structural parts. The wing will pivot at the rear spar on a pull-out tube and swing back along the fuselage. Two levers will be actuated to extract the two main spar fitting pins and one ball-lok will release the sliding tube at the rear spar fitting. No other actions are required before folding the wing. The break will be made at Butt Line 45, the dihedral starting at that point. If there is someone with a fair amount of experience who would like to build the prototype and could work just from preliminary sketches, contact me. i will have time to do any design work though if I have to answer a lot of mail on this subject, so I will keep you all posted on progress via the newsletter. Please try to have patience. The fuselage is not affected so if you plan to build a folding wing, just work on everything else but the wing.

RIVET GUNS: I see B & F Aircraft Supply, 6141 West 95th Street, Oak Lawn, IL 60459 (312)433-3220 has a good selection of rivet guns in their catalog which they will send you for $1. A 3x size gun is $45 used and a new 3-M-401 is $47.50. Either would probably work fine for T-18 building. Their No. 5 Jr. Whitney punch is $17 in metal box. Clecos are $34 per 100. Ouch!

P-51 OR T-18? Perhaps you saw the sharp picture of Bob Dawson's T-18 in **Sport Aviation** and thought it looked more like a P-51 (N45Z). The color photo he sent me sure looks great and I hope it performs as well as it looks. So far, he has sent no data. He said, "I used to get upset when I read in the Newsletter that someone flew his plane and did not say how fast it went etc. Now I understand. I will send performance and other particulars as soon as I can." It is narrowed to a single place about 28 inches wide at the cockpit. The main gear attaches to the spar and retracts into the wing. Tailwheel retracts also. A 150 hp engine is installed and equipped with a constant speed prop, inverted fuel system with pressure carb and inverted oil system. An auxiliary fuel tank is installed behind the seat. He says it is an exciting airplane. Now where is the data, Bob? He lives at 211 Savoy, Sugar Land, TX 77478.

FIRST-HAND PROP EXPERIENCE: Frank Boehulein, 6206 Timberline, Independence, OH 44131, T-18 #576. Your prop experience coupled with your forum at Oshkosh on the wooden props certainly points me in that direction. A recent experience by one of our chapter members also reinforces my tendency towards the wood prop.

Perhaps you do or do not remember the Ilse that was at Oshkosh last year. It is a high wing Cougar-looking four-place airplane with distinguishing full plexiglass doors and swept forward fiberglas wings. It was built by Rudy Segrist and is quite a performer. At any rate, he and his wife Ilse were on a return flight to Cleveland from San Bernadino, CA when his prop let go approximately eight inches from the hub. It just about tore the engine from the mount before he got shut down. They were at 8,500 feet and fortunately he remembered an abandoned mining strip they had passed over shortly before so he headed for it. He did not think he was going to make it and his last transmission to the FSS was that he was going into the trees. At this point he remembered he had dumped the flaps and quickly retracted them and got enough lift back to skim over the trees to plop it down on the airstrip smack dab in the middle of a hippy commune. They got out, looked at the airplane and found the cowling was gone, two feet of prop, and the 180 hp engine was hanging there by the two lower engine mount tubes.

Ilse, to say the least, was glad to be spared her life. The ride down in the crippled plane frightened her to death but the ride to town on the back of a hippy chopper really scared the -- out of her. They called FSS, told them they were OK and in fours hours had the airplane on a trailer on their way home. The young people could not do enough for them--helped them get a trailer, take the plane apart and load it for the trip home. Happy Ending!

A not so happy ending is the Mike Simkanan story. He crashed in his T-18 a week before Oshkosh at Akron, OH. A subsequent autopsy showed that he died of a heart attack. We have lost a fine individual and a fine T-18.

MATERIAL SOURCE: Airparts Inc., 1430 South 334d Street, Kansas City, KS 66106 sent me a catalog which has all sorts of goodies in it, such as rolled sheet aluminum, metal countersinks for $1.50, dimpling dies, rivets, bolts, etc. (1986 Note: This is still a good source for aluminum sheet.)

BUILDING EXPERIENCES: John Austin, 1101 South Eric, Monahans, TX 79756. I just received Newsletter #39 and am returning your questionnaire. We live in a small town and hangar rent is only $15 per month so not a big problem now, but many metropolitan areas have rent $50 to $60 which is another reason John Doe is not flying. The Newsletter has been invaluable to me and I sure want to thank you for your patience. I am about to take T-18 #630 to the airport. I started building in December 1965 with Larry Larcom and Curtis Whipps at Delaware, OH. Larry finished #194 at Delaware about three years ago. He has a beautiful machine, which now has over 400 hours on it. It takes about 45 minutes to go from his home in central Ohio to a cottage on middle Bass Island in Lake Erie. He really loves his T-18.

After starting my project, I moved to Huntington, West Virginia and most of my three years there were spent on small assemblies, going to night school to an adult education class where I made T-18 fittings. This was really great as they had all the power equipment and know-how needed. Also, since I furnished my own material, they were quite willing for me to deviate from their standard course of instruction. Actually I taught the class several new things due to the quality of the drawings, reference system etc. Everyone was quite interested in the project.

Just after I clecoed up the fuselage and was going to start riveting, I was transferred to west Texas. I am in the oil well service business. I am closing up the cowl, installing wheel pants, painting and upholstering now. I have a stock GPU, Delco alternator, Corvair cooler, filter, 283 Chevy air cleaner element and cut down deck with hole for jump seat. The gear is also extended and tapered. I had low oil pressure on the GPU but fixed that with a new spring (standard). Bought a 182 instrument cluster from Bob Kelley in Wichita and had a terrible time with it. Had tach, MP, two fuel oil pressure and temperature. The fuel and oil pressure had electrical inputs, others were mechanical. The Cessna sending unit for the oil pressure was $27, so I shopped around and found an equivalent automotive unit for $7. It took me about two months of bench work to get these gauges to work, partly due to lack of information. I installed it in my panel, which made a big hole 5 inches x 8 inches or so but lots of data in a small space. Then after about a year I started my engine, and neither the oil pressure nor fuel gauge would work. Replaced the OP with a mechanical unit cut out of its case so it would mount in the cluster and replaced fuel gauge with a new SW unit. Leon Davis, builder of the DA-2, told me earlier I would be ahead to scrap that cluster and start over but I did not believe him. I guess he was speaking from experience. I was disappointed in the length of time it took to get an answer from Pershing Larsen on my spinner order. (Editor's Note:

His spinner maker has moved out of the area and is not taking any more orders. He is referring all orders to George Rattray who makes them for $50 I believe.)

I know there are many homebuilders traveling around the country. If anyone will stop by Monahans, Texas and give me a call, they will have a hospitable welcome.

PLANNING A PROJECT: Bill McKinley, 315 Harvard, Liberal, Kansas 67901 (316)624-7382. Received plans in June. John is very prompt. I have been gone on charity work since them. My wife, Irene, said the Mooney plans I ordered 3 January 73 finally got here July 21. The first thing I did was to sort the drawings, make a list (drawing number, name next assembly) then from the list I made flow charts in production sequence and arranged plans in this sequence. The back Newsletters--thanks to you all--came and Irene sent them to me (250 miles away). Reading the Newsletters told me I should reread and footnote each comment on structure and procedure. That is what I am doing now. The Mooney is a pile of little bitty pieces. It has info I want but I do not think I will build it. The T-18 has a real set of plans compared to some others I have seen. May I ask any T-18er flying through Liberal (real good old Army training field) to stop, and let me see their bird in exchange for a steak dinner.

PERFORMANCE: I am sorry to say that only 30 people have filled out and returned T-18 Performance Questionnaires out of the 106 or so that have flown. And many of those returned did not contain airspeed data. I have decided the reason is that some people are ashamed to admit their ships' performance. Since several of the 125 hp models have claimed speeds in the high 170s or 180s, it is understandable when a 150 hp owner who cannot go that fast would not feel like publishing his data. Frankly, I cannot figure out why some T-18s go so much faster than others, especially when the slower ones often have superior finishes. For one thing, I never believe airspeed readings if not checked accurately over a measured course. If we did have data measured accurately, it would be quite helpful for it might help determine what a builder should or should not do.

One way to check your airspeed system is to check a straight stretch of highway between two prominent landmarks at least five miles apart. Auto odometers can be checked readily by the mile markers along highways. Make many flight runs early in the morning when there is no wind and average the results. If you are lucky, you may find a straight stretch of highway five miles long. In my area, I was not so fortunate and I have to use a six-mile course from the point of an island in the Susquehanna River to a highway intersection as measured from a topographical map.

I am not sure how accurate these maps are. It is quite important to precisely measure your course, for a 1% error can mean almost 2 mph. Also, you need a stop watch which measures in fractions of a second for a one second error on a six-mile course can also mean almost a 2 mph error. Be sure to figure speed by the formula:

$$\text{Speed (mph)} = \frac{\text{Distance (miles)} \times 3600}{\text{Time (seconds)}}$$

As an example, I made my six-mile course in both directions in a total of 240 seconds.

$$\text{Speed} = \frac{12 \text{ miles} \times 3600 \text{ second/hour}}{240 \text{ seconds}} = 180$$

When checking the maximum speed, pick an altitude and establish it a mile ahead of the starting gate, then hold that altitude as accurately as possible, at least making sure you go through the finish gate at precisely the selected altitude. As you pass the gates, lean against your shoulder harness to obtain a fixed body position and sight down past the leading edge of the wing on your side of the aircraft. When checking intermediate airspeed indicator readings, do not worry too much about holding constant altitude. Pick a power setting that will hold a constant altitude at the selected airspeed, then vary pitch attitude to hold the indicated airspeed within one or two mph. Be sure to note fractions of a second. If there is a crosswind, you can minimize the effect by holding the course heading and allowing the airplane to drift.

KITS: Ken Knowles' Sport Aircraft Inc., 104 East Avenue, K-4 Unit G, Lancaster, CA 93535 (805)949-2312 has pre-marked kits available for the T-18 with many hardware items also (1986 address).

T-18 PARTS: Ken Brock, 3087 West Ball Road, Anaheim, CA 92804 (of Gyrocopter fame) has a T-18 parts catalog available. Examples of his parts are 905 driving lug $1.25, 612 main beam fittings $22 pair, steel bushings 554, 594 etc. $1.25 each, canopy rails $9 pair etc.

INTERNAL TAIL WEIGHTS: Many people have expressed interest in the design for enclosed horizontal tail weights. It is shown in Figure 17. It takes three pounds of lead on each side 1.2-inch deep by 10-inch long. An extra 0.032 2024-T3 beam backs it up and extends between the two outer nose ribs.

Dimple leading edge skin for 10-32 countersunk screws. The 0.032 backup is bent up as a channel and joggled to fit inside rib. File off edges of screw head if dimple is not deep enough. Bend up a trough-shaped form and pour in lead. Do not get lead any hotter than necessary as it will warp making it difficult to fit.

CARB HEAT BOX: Chris Fast, Pacific Palisades, CA. Your neoprene canopy seal sounds like a winner and I will give it a try. Incidentally, I own the tooling that makes John's carb intake box and also the turned plate to lay up the silicone rubber seal. This is the banjo box that fits the O-290, 320 etc.--not the long scoop.

MOLDINGS: by Luther D. Sunderland. On my initial test flight I discovered that the U-shaped rubber molding or the inner wing skin did not work out too well. It cannot make a good seal with the fuselage and still provide clearance to permit wing installation without interference. Subsequently, I found some white molding which I cemented to the fuselage leaving a nice fillet for the wing to simply seat up against.

QUESTIONS:

1. Merrill Jenkins wrote me that I would need a heavier mount for the O-320 160 hp engine. How much etc?

Answer: John says the plan's mount is good for 180 hp.

2. I have never been able to successfully grind the little nib on a sheet metal grind drill and have not found anyone else who could.

Answer: Neither have I.

3. Have not been able to come up with the 3/4-inch micarta rod for flap hinges.

Answer: I never could figure why John did not use mild steel there also. I asked him but forgot the answer.

NORM SPILLMAN FLIES: Serial #257. You are right, It is hard to describe the feeling of a first flight in one you built yourself. Had my final inspection at 10:00 AM on the 10th of May and the inspector, Mr. Graither of the Kansas City area, treated me just great. Ended up with four discrepancies from the inspection; needed mark on tachometer; placard master switch; arrow marked for stabilator trim, up, down; deviation card on compass. He was very complimentary about my bird and even went to the point of getting his boss to come look at a T-18. This was done while I was in the process of "buttoning up everything." Got it all closed, then came the hardest part for me.

I had made arrangements for a test pilot because of the good advice coming from the Newsletter. I had taxied for four hours prior to the tenth, but did not feel I should make the first flight because I have not been flying regularly these last few months. So came the hard part, helping my test pilot adjust shoulder harness, then watching the little bird taxi out, make one taxi run the full length of the runway just off the surface, turn around, taxi back, final check, apply power, roll very short distance in the 14 knot wind, tail up, plenty of speed, then make a gentle takeoff. The left wing dipped slightly, came up and he climbed out of the pattern. Sure was a long 90 minutes waiting for him to re-enter the pattern. He finally came in on a long final with no flaps, greased it on with a nice three-point. He said I would not have a bit of trouble with it, but I decided to wait till the wind quit blowing--sometimes quite a rare event in Kansas.

Well, Friday morning I got up around 5:00 AM, looked out and found not a breath of wind. Told my wife I was going to the airport and she and my son went along. Rolled the airplane out, taxied to the active, requested a high speed taxi check, started down the runway, increased to full power, tail up, relaxed on the forward pressure on the stick and suddenly found myself in the air six or eight feet. Called the tower and told them "I just changed my mind, wanted a go-around." Came around on final indicating about 95, cut power over the end of the runway and as it started settling out I eased back on the stick, touched down three-point. Rolled out with no braking. It all went so well, I taxied back and ended up shooting five takeoffs and landings. Since that time, it has been raining and the wind blowing hard.

Now I will give you a little data. I am using a 67-68 prop which turns 2100 static and only 2425 maximum level flight indicating 140 mph. It indicates only 59 mph in the stall with no flaps so I have got to do some calibrating. It stalls real good and just keeps hanging in there, then very little warning and falls through dropping off on the right wing a bit.

After 178 hours, Norm filled out his questionnaire and said he had only one small problem, an exhaust stack flange cracked at 53 hours. Engine 0-290-G; cost $3700; time to build 6.5 years; max speed 170 mph at 2000 feet; cg, most forward 63.52 - 17%, most aft 71.2 - 32.4%; empty 63; empty weight 900; no modifications; wheel pants; gear fairings; cuffs and flush rivets.

PROPELLER FLANGE REINFORCEMENTS: Roy Sweatman, 7016 Belle Road, Harbor Creek, PA 16421. As soon as I got back from Oshkosh, I ordered material to fabricate the clamp-around type crankshaft flange reinforcements as pictured in your article in November **Sport Aviation.** It has arrived and I now have reinforcements in production. I am forming a corporation called Air Tech Inc. to produce these and other machined parts. (Editor's Note: Roy made several samples which he brought to Oshkosh. They were cadmium plated and looked fine. He was asking $45 each for them. They were made to my design, as shown in Figure 18.)

NEW WOODEN PROP: by Luther D. Sunderland. I am now testing a new Sensenich wooden prop, W66LM76 on my O-290-G T-18 and it is too good to be true. Performance exceeds that of the metal propeller I have been using. Although I balanced both the metal prop and the wood one in-flight with a dynamic balancer, the wood prop is unbelievably smooth in comparison except at idle. It weighs only 14.1 pounds--19 pounds lighter than my M76. Sensenich inspected Dick Walen's W68LY80 after 70 hours and it was perfect. The W66LM props have a standard-size flange so take the standard prop extension but use 5 3/8-inch bolts. It is for the 125 thru 160 hp engines and costs $170 the last I heard. Just tell Sensenich the hp engine and they will select a proper pitch. (1986 Note: The 76-inch pitch was too much for my O-290-G, so I changed to a 74-inch pitch. It is an excellent cruise prop. If you operate from a short field, however, you should get a 72-inch pitch in your W66LM prop. The 76-inch pitch is fine for a 150 hp O-320 and 76 or 78 for a 160.)

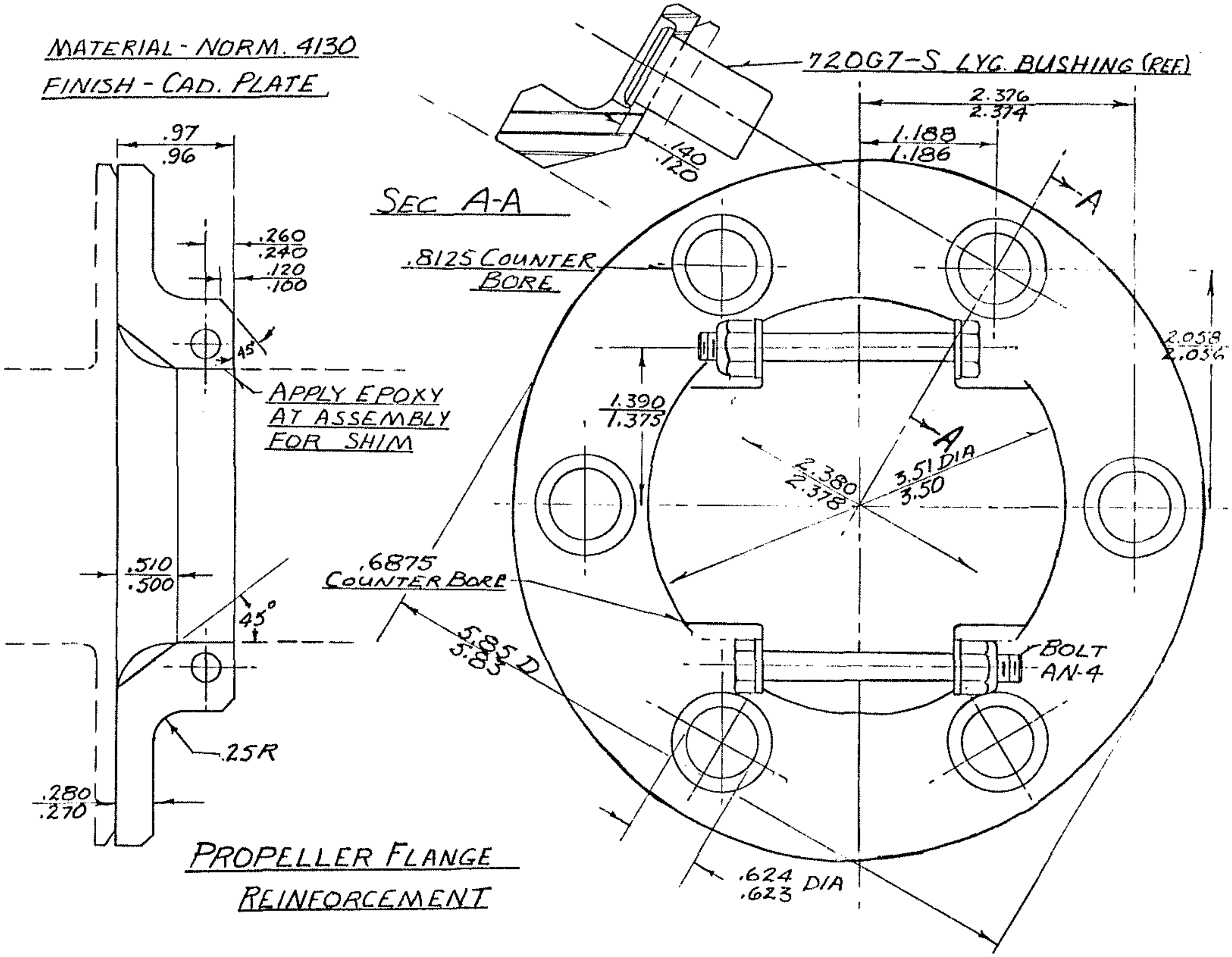

MATERIAL - NORM. 4130
FINISH - CAD. PLATE
.97
.96
.260
.240
.120
.100
45°
APPLY EPOXY
AT ASSEMBLY
FOR SHIM
.510
.500
45°
.25R
.280
.270
PROPELLER FLANGE
REINFORCEMENT
720G7-S LYC. BUSHING (REF.)
.140
.120
SEC A-A
.8125 COUNTER
BORE
2.376
2.374
1.188
1.186
A
2.058
2.056
1.390
1.375
A
3.51 DIA
3.50
2.380
2.378
.6875
COUNTER BORE
5.85 D
5.83
BOLT
AN-4
.624
.623 DIA

Figure 18

T-18 NEWSLETTER #41   07-01-74

Luther D. Sunderland

FOLDING WING PROJECT: I have completed a sufficient number of drawings for the T-18 Folding Wing to permit a prototype to be built. John Thorp stress-analyzed the joint and spar, and a prototype being built by Ken Knowles will be tested before plans will be made available. Ken plans to be at Oshkosh (in his own T-18) and bring a set of pictures which he took while building the new wing. Today he told me that he had completed most of the parts and is starting assembly. It will not be completed before Oshkosh, in all probability.

There are very few completely interchangeable parts between the standard and folding wing, but the center section spar is the same (except that the new one is shorter). Ailerons have been shortened and flaps lengthened to help lower minimum speed a bit. If all works as well as planned, the folding operation should be a one man job.

WHEEL PANTS: B. C. Roemer says he cannot get at his tire valves without removing the wheel pants, so he cut a one-inch hole in the side of the pant for access. He then got two long plastic valve extenders from a service station, forced them into one another, glued them together and spun onto the valve. Then he removed the extender and installed a snap plug in the hole. I lucked out and can reach mine from the bottom. John Thorp would probably say he does not have any problem with his half-pant design!

SERVICE TIPS: B. C. Roemer sends this list of service items he has found necessary in the first 400 hours. You other owners should also send in any items you may have.

1. Two 1/2-inch rubber washers on landing gear failed. Replaced with belting type.
2. Oil cooler bracket, carb heat valve, carb heat box and mixture control wire all failed or cracked.
3. All rivets from skin to horizontal tail tube had to be replaced, were Pops and he replaced with cherry structural type. Also a number of Pops in leading edge wing ribs were replaced.
4. Horizontal tail tabs next to rudder are flexing with air loads and need strengthening. (Editor's Note: This is a very important point and relates to the flutter modification. My observation is that an 0.020-thick tab is much stiffer.)

It has not been previously reported that so many rivets have come loose. Usually, the only cracks in paint around rivet heads occur in the main spar to skin rivets near the fuselage, but they have never seemed to really get loose.

John Shinn reports that everyone should frequently check alternator brackets for cracks. It is absolutely essential that the nose piece be easily removable without removing the propeller.

TAIL SPRING ATTACHMENTS: Bill Johnson just had a failure of the front attachment point for his tail spring. The bracket cracked off right through the bolt hole and the two rivet holes for attaching the plate nut. He also found cracks in the aft attachment fitting near the two 1/4-inch bolt holes. It would be wise for the two fittings to be inspected immediately. The 591 bracket was made of 0.092 as recommended. Bill says that since the brackets are difficult to inspect, you should be on guard for another clue. (An access panel is needed for the last fuselage bay.) He had a loud rumbling noise during taxiing but assumed it to be sloppy tail wheel bushings. After repair, it was gone. Bill beefed up the 591 bracket by making a new one from two layers of 0.063 plus a radiused washer of 0.125 steel. The nutplate was deleted. An 0.063 steel doubler was installed over the 583 bracket. The ends were made long enough to tie into the lower longerons to pick up side loads. 1/4-inch bolts were replaced by 5/16-inch bolts. Total time on the airframe was 220 hours. About 300 landings were made on mostly rough runways.

MORE ON BILL JOHNSON'S RETRACTABLE T-18: Bill has sent me some additional information, for inclusion in the Newsletter, which was not in the article he sent to **Sport Aviation**. "My first speed check with gear up gave a cruise speed of 190 TAS at 6,500 feet. The center gear doors had not been installed, and the left flap was stuck down 1.24 inches. A considerable amount of cross control was necessary to maintain straight and level flight. After some rework to get the flap to fair, installation of the center gear doors and changing the rigging of the outboard panels to minimize some twist, the second speed check was made. The speed at 73% cruise power and 7,500 feet was 203 mph TAS. Top speed in level flight is about 225 mph TAS (on 160 hp).

The handling of the airplane is greatly improved. Directional stability in flight is noticeably different. The airplane will hold the heading once trimmed out quite well. On a recent 70 mile flight, I made only one heading correction of about five degrees. The main gear tread is about eight inches wider than with the fixed gear. This plus the larger fin and rudder make ground handling very easy.

NACA data indicated that the airfoil change should cause an increase in stall speed of two or three mph. A pleasant surprise was instead a three mph reduction in stall speed with flaps, and no measurable change with no flaps. This effect may be due mainly to the Hoerner tips. However, the aerodynamic twist which was built into the root section between Buttock Lines 21.0 and 38.5 may also be contributory. An unexpected problem occurred during preliminary flight tests with the gear retracted. Blast from the exhaust pipes pressurized the wheel wells so that the gear stopped eight inches short of the full up position. The problem was isolated by taking some inflight movies. The gear would retract only when the throttle was closed so the exhaust pipes were modified so that the outlets are now about six inches outboard of the original positions. Now, at full power the gear can be completely retracted. Relocation of the exhaust pipes resulted in a 12 mph speed increase with the gear down at 70% power. I do not understand why, but the effect may be due to circulation effects in the wheel wells. It would be interesting to see if the exhaust pipe relocation would have an effect on a fixed gear T-18.

A problem with this very clean configuration is that it exceeds the present red line, so I am conducting a flutter investigation. The analytical characteristics of the wing structure will be calculated using a digital computer. This will be followed by a static shake test and an inflight test with strain gauge instrumentation. Sufficient data will be obtained to determine gust response and damping characteristics of the structure. I hope to establish a red line of at least 250 mph at 2000 feet altitude. If not, the analytical program will show what needs to be done, as well as what the red line IAS should be."

FIRST FLIGHTS: **Max Pendergrast**, 1611 SW 26th Street, Fort Lauderdale, FL (#419). He made the following modifications: Wet leading edge of the wing, using Fuller O'Brian sloshing material (12.5 gallons per LE section, 50 gallons total), full 74-inch constant speed prop from a Mooney, 2.5 inches longer landing gear, 0.032 in lieu of 0.025 on wing and fuselage. The entire plane was flush riveted or counter sunk. Low profile rivets on 0.032 or counter sunk on anything under 0.032. All riveting was one inch apart. Also, some modifying was done on the cowling. The little jewel flew on April 9, 1974 and about the only statistics I can give you now it that it was light at 60 and airborne at 65 indicated. It is quiet enough to carry on a conversation without raising your voice too much.

He does not say, but it is probably powered by an O-360 engine. Empty weight is probably the highest yet, 1,117 pounds. Forward cg is 68.2 and aft cg is 71. Max sent a list of installed equipment that is just too long to print. No, it does not have a restroom, ladies.

Worthy R. Warnack, 189 Bayshore Drive, Baytown, TX 77520 (SN 772). He flew March 16, 1974. It took him 3 3/4 years to complete and $4,000+. It has an O-320 swinging a Hartzell HC-C2YK-1 of 70 inches length. Modifications include: Round back, roll bar 3/4-inch higher, canopy 3 inches higher, right pedal moved to clear tank support, tunnel rounded, dash set back 3 1/2 inches, canopy similar to Derringer, mounted on three arms, moves up and back. The larger headroom is comfortable but the added cross section cancels out cleaner back. It is neither the fastest nor slowest T-18. It has fantastic climb out (2,000 fpm), no upholstery yet so it is loud. I have taped on stall strips and have decided to install them permanently. They do wonders for the stall--give a nice warning. Four inches of 3/4-inch aluminum bent to a sharp angle mounted midway out the center wing on each side works fine.

My goal was to cruise 150 mph in comfort and I think this has been surpassed easily. The plane is a dream to fly (as all T-18s seem to be). I cannot claim any real advantage for the round back other than esthetics. My plane is very stable at high cruise, maybe because of the smooth flow aft of the cockpit--I do not know. I sacrificed a lot of visibility and the construction of the canopy was a major project in itself. Earlier T-18 experience pretty well proved that a constant speed prop adds climb performance, but little speed. My plane is no exception. But I really do enjoy the lower RPM (1900 - 2000) performance--much quieter and vibration free.

This airplane was completed in my garage, which is located in a flood prone area on the coast. During construction, I evacuated N2WW three times due to storm threats. The last time, my shop was flooded with 3 1/2 feet of water during tropical storm Delia. Fortunately my ship was evacuated earlier. I am moving next month.

Ron Kuyoth, Jr., 6128 Secor Road, Toledo, OH 43613 (#716). Finally after four years and two months, #716, N8RK, went to the airport February 25, 1974. The FAA, out of Vandalia, Ohio, made their inspection on the 21st of February. The plane was still in the garage, wings removed, awaiting its trip to the airport. I had called FAA the previous week after being informed that there was at least a three week wait on inspections. When they called and said they would be here on the 21st, I explained to him that the plane was disassembled, but he agreed to inspect it anyway. He was very formal and did his job without much comment. Then he went out to the airport and inspected Max Dauer's Teenie Two which was built in my garage along side the Thorp. The buddy system worked well as we were able to share ideas, help each other, and then there is always someone to praise and encourage you. Both planes were approved!

The trip to the airport was uneventful and after assembly, there in 20-degree weather, taxied it down to the active. I made a few high-speed taxies with it and found that it handled beautifully. After checking things over for the first flight, they changed runways so had to taxi to the new runway. Made a final check of everything, pulled out onto the runway, gave it full power and after a short roll was off. It climbed right out and I made three trips around the airport. My final approach speed was 110 mph because I was not certain the airspeed was correct. I found after the flare that the airplane floated about half the length of the runway since the speed was so high but proceeded on to make a three-point landing.

The plane had a slight tendency to roll to the left and the pitch trim was not adequate in the forward direction. Bob Dial and Parker Miller advised me to bend the trim arms a bit and this cured the pitch trim problem. Now, for the roll problem, several other owners have had this problem. I went to great lengths to build my wing without twist. I jigged the center wing onto the fuselage, the main spar bolted to the fuselage, the rear spars bolted to the fuselage and all the ribs on the spars. I put redheads into the concrete floor of my garage, bolted 2 x 4s onto the A frame and bolted the A frame right to the floor using all threaded rods. On the outside of the wing, I riveted an angle on the rib with a hole in the bottom of it and put an all-threaded rod through the angle into the redhead in the floor. I leveled the main spar and rear spars and jam nutted them together with an all-threaded rod. Both main and rear spars were perfectly in line and absolutely could not move. I had the holes in the skins, center lines on the ribs and stretched the skins over the wings while still in the jig and stretched them tight with truck inner tubes. Transferred my holes onto the ribs and clecoed it together. I cannot see how there could possibly be any twist with this method.

There is slight twist in my outer panels but the way it is twisted, I expected the plane to have a tendency to roll to the right, but just the opposite happened. Would like any suggestions on correction of this problem. I have heard of guys lowering their left wing slightly and raising the right at the fitting. (Editor's Note: I am glad to hear that someone else had this problem even when they went to all the trouble to jig up the wing. I just built mine with matched-hole tooling and checked it with a big level before riveting. To cure the left wing heaviness, I just massaged the aileron, as John calls it. That means bending the trailing edge a bit (up on the left aileron and down on the right of course for left wing heavy. This gives the appearance of flying with the left aileron drooped a bit, but it does not seem to slow me down any.)

I have an O-320-D2B, 160 hp engine with a 180 EM hub, which I purchased from Anderson Propeller Company. The prop was never damaged but I had it cut to a 70-inch length. The pitch is 74 inches. Since my landing gear is 2 1/2 inches longer, I still have 9 inches clearance in level attitude. I do not have performance data yet after only three hours. It was a long four years, but in my opinion the wait was worth it. It think the T-18 is one of the finest homebuilts ever designed. See you at Oshkosh. N8RK's weight is 885 pounds.

DON PHELPS' N8786 Flies in Less Than Six Months: John Thorp reported that on February 10, 1974 he and Kay flew out to Chino airport to see Bill Warwick fly the 110th T-18 to take to the air. It was built by Don Phelps in a time that would almost rival Irvin Faur--less than six months. He bought the plans July 20, 1973! In addition, 10 more T-18s flew in to see the event: (1) Bill Warwick, (2) Ken Knowles, (3) Ollie Smith, (4) George Leider, (5) Earl Odie, (6) Chuck Borden, (7) Lyle Fleming, (8) Don Taylor, (9) Howard Culbertson and John. All 11 ships were lined up for pictures and Kodak rally made out. Now let's see a good shot get sent to Jack Cox for **Sport Aviation** you guys!

Paul Stanley: 2012 29th Street, Galveston, TX 77550 (#671). Paul flew for the first time September 17, 1973. The only problem after the first three hours was a heavy left wing and a weak mag. (Does everyone have a heavy left wing?) He took 4 1/2 years to build it, has an O-290-G, no electrical system and weighs only 752 pounds. (Wow, that is really light, but I still would not want to hand prop a big Lycoming.)

PAINT AND PRIMER: Several months ago I got to see Bill Lawson's T-18 while in Seattle. His paint job was so outstanding that I asked him to send me information on it. Bill will try to make Oshkosh so you may see for yourself. He used 3815 zinc chromate metal-etching primer. He found that combining one gallon of the primer with two gallons of its catalyst (3816) is enough to do both sides of all the aluminum for the T-18. It is made by Fuller O'Brien Corporation, South San Francisco, CA 94080. Instructions say "mix only as much as can be used in 8 to 12 hours as the mixture will gel after a time." He used DuPont Imron polyurethane enamel for the finish coats. Grumman uses it on the Yankee. Bill lives at 2419 SW 150th, Seattle, WA 98166.

CUTTING PLEXIGLASS: Doug Hilton, 1608 NE 120th, Portland, Oregon. Doug bought an abrasive disk from Gee Bee that cuts plexi like butter with a 3/8-inch variable speed drill.

MATERIALS: Dick Baxter of Spencer Aircraft, 8410 Dallas Avenue South, Seattle, WA 98108 (206)763-0210 says he will send a materials list of homebuilders' supplies to anyone requesting it. He has all sorts of hardware--especially PROP BOLTS for the new wooden props which are 5 3/8 inches thick.

KEN KNOWLES' SPORT AIRCRAFT: 104 East Avenue, K-4 Unit G, Lancaster, CA 93535 (805)949-2312 (1986 address) has just about every raw material for the T-18. Today, I asked him if he was having trouble getting materials and he said he was, but at present he had everything. As mentioned earlier, Ken is putting his 30 years in the aircraft business to good use, for he has offered to build the prototype T-18 Folding Wing. He will supply a price list upon request. Ken has beautiful Tie Tacs of the T-18.

YOUNGEST T-18 PILOT: I hear that George Leider's 16-year old son soloed his T-18 with only 20 hours total time. Both George and his brother had low time when they first flew the T-18.

FIBERGLAS PARTS: Leopold Perlaky, 6301 Somerset Road, Riverdale, MD 20840. He says he has fabricated a nice set of molds for fiberglas wing tips, nose bowl and tail tips. He is willing to supply a few sets of these parts to other T-18 builders if he does not have to bother with packing and shipping. In other words, they must be picked up in the suburbs of Washington, D.C. He has about 10 years experience in fiberglas fabrication, mainly in boats and associated parts.

T-18 CENTERFOLD FROM PLAY-AVIATION: When I saw the centerfold of John Shinn's beautiful T-18 in the February issue of **Sport Aviation**, I thought it would be nice enough to frame, especially if it did not have the crease down the middle. So I obtained 400 copies of this nice color photograph from the printers of **Sport Aviation**, assuming that many of you would like to have a copy also. They are printed on the same paper stock as the magazine. I have ordered mailing tubes for them so they can be mailed without being creased. You may obtain one by sending me $2 for the first copy and $1 for extra copies.

WOODEN PROPELLER TEST PROGRAM: We have tested four different propellers on four T-18s as a part of a formal test program for Sensenich. Each prop was first made with brass leading edge and tipping and then the brass was removed and replaced with a smooth plastic (with the exception of the W66LM76 which had only plastic). Tests were run on my 0-290-G, John Shinn's 0-290-D2 (135 hp), Bob Daniels' 0-320-E2A (150 hp), and Dick Walen's 0-360 (180 hp). I do not have all the data collected yet, but here is a brief summary. More later.

PRELIMINARY DATA

Propeller	Tipping	Engine	Max Static rpm	Max rpm at 7,500'
W66LM74	Brass	0-290-G	1975	2550
W66LM74	Plastic	0-290-G	2075	2625
W66LM76	Plastic	0-290-G	2025	2525
W66LM76	Plastic	0-290-D2	2100	2725
W66LM76	Plastic	0-320-E2A	2200 ?	2800
W68LY80	Brass	0-360	2000	2800
W68LY80	Plastic	0-360	2150	2700

W68LY82	Brass	0-360	1950	2700
W68LY82	Plastic	0-360		

The most important piece of information is rpm at 7500 feet at full throttle. Rated rpm for the 0-290-G engine is 2600, so the 74-inch pitch in plastic is about right for that engine. Rate of climb is not quite as high as with my metal props. It is about 1,000 instead of 1200 fpm loaded. It is quite noticeable in the 90-degree weather we have been having this week. But I like my cruise at low rpm. The significant thing is that changing to the plastic tipping increased rpm about 100. And if you look at T-18 Airspeed vs RPM Controlled by throttle curves, you will see that a 100 rpm increase gives nearly a 10 mph increase in speed. Dick Walen and I both realized over 5 mph increase in speed when changing from brass to plastic tipping on the same propellers. The only strange thing about it is that on the 0-360, the higher-drag brass leading edge and tipping gave a higher rpm, even though the airspeed was lower. The W68LY82 has not been flown with both types of tipping yet so we do not know whether it will do the same. Just talked to John Shinn and found that the 2725 rpm for the 0-290-D2 was for 3,000 feet, and at 7,500 feet the maximum rpm was around 2650. His engine is rated for continuous operation at 2600 rpm, however, he thinks he should have a 74-inch pitch. It is strictly a matter of preference. That engine could use either a 74-inch or 76-inch pitch prop. He says he also misses his "show-off" high rate of climb. John has thus ordered a W66LM74 prop. He figures his maximum speed is 184 mph with the 76-inch pitch. This is about four or five mph faster than the metal M74DM-4-68, data taken on the same day within a one-hour period.

Bob Daniels from way out in Oregon, does high altitude photography work. He tested the same W66LM76 on his 150 hp T-18 and reported a 5 mph increase over the metal prop he had been using, (195 mph vs 190 for the metal). He checked this out over a 7.5-mile measured course. The metal prop is 68 inches long x 75 inches pitch. The wood prop is also much smoother but will not climb quite as fast as the metal one.

Dick Walen favors the 80-inch pitch on his 180 hp T-18. He really raves about the wood props and gets around 210 to 213 mph with them. Maybe the plastic will help the 82-inch.

I did not list true airspeeds in the table because no direct comparison has been made of the various test aircrafts' airspeed systems. About the only way meaningful data can be deduced from airspeed readings is for readings to be made on the same system within a few minutes of one another. I developed a leak in my pitot line between tests of the 76-inch pitch and 74-inch pitch props and had to recalibrate the system. Both of them were checked against the metal prop on the same day and both were faster than the metal one. At 5,000 feet altitude, full throttle, I can cover my six-mile measured course in two minutes average with the 74-inch pitch plastic-tipped prop.

Conclusions: Use of the plastic tipping gives a 5 to 10 mph increase, so I would recommend ordering it unless you expect rough service in rain. Sensenich has been quite cautious about converting to plastic because of the durability question. Ray Hegy and Ted Hendricks used nothing but the plastic and report that it is very durable and easy to repair. John Shinn flew through some rain with the W66LM76 and the clear polyurethane peeled off the plastic, but it did not hurt the plastic. Sensenich had failed to use the proper primer on the plastic. Since then it has been recoated and has held up OK although it probably has not had a good rain test yet. Those of you who purchased props with the brass tipping can change it over very easily. Just remove the brass, remove 3/8 inch from the leading edge of the wood, remove 1/16-inch layer of wood under area where brass covered, apply Sears Roebuck boat two-part polyester to the leading edge and tip filling in all rivet holes and sand down. Then apply a polyurethane finish. Balance on knife edges by adding or removing plastic before coating, then check again after finish coat is applied. I discovered how Sensenich gets such a fantastic finish on their propellers. They soak the bare birch propeller in the polyurethane (which has been thinned down well) for about 20 minutes. Then they just spray on the polyurethane and air dry. (1986 Note: After extensive tests of many plastics, they dropped the boat polyester and now use a more flexible material for the leading edge, which resists rain erosion.)

BOB DIAL GETS INSTRUMENT APPROVAL: Bob had been unable to get his T-18 approved for instrument flight, so he decided to bring the matter to a head. He obtained a copy of Dick Walen's instrument waiver and sent it to Washington. Dick figured he would be up the creek and probably lose his approval in the process. But, Bob got a favorable ruling from the FAA in Washington, saying that his aircraft simply had to comply with FAR Part 91 to obtain the instrument waiver. So, if anyone has trouble with their local FAA, you can write to Washington for help. But just make sure you have an aircraft which is worthy of the waiver. There are now so many T-18s with this waiver that I have lost track of the number, far more than any other type homebuilt.

TRIM SYSTEM FLEX COUPLING: John Thorp says that Aeroquip 601 fuel line hose works very well as a replacement for the flexible steel cable in the trim system.

WING ATTACH BOLT ACCESS: Recently John had occasion to remove his center section (after a connecting rod bolt broke) and he discovered what a number of people have been saying for some time, namely, that you have to be double jointed to get the wing attachment bolts removed. So, John is changing the plans to show an access hole for a socket wrench behind each main spar attach bolt in the 592 bulkhead.

PREPARING SHEET METAL: Robert Clayton, 1783 Harvard Avenue, Salt Lake City, Utah 84108. As a new builder, I have more questions than helpful hints, but I do have one thing that might be of help regarding washing down sheet metal to get rid of the coating. Basic H from the Shaklee people is a terrific organic cleaner, highly concentrated, that will do a better job safer than any soap or detergent. It has anti-magnetic properties in that it reduces the tendency for a surface to build a static charge and attract more dirt. It is fantastic for washing planes. It was the only cleaner to go to the moon on all Apollo flights. There will be no residue.

MATERIALS: Received a listing from Airparts Inc., 1143 South 33rd Street, Kansas City, Kansas 66106 which shows they carry all thicknesses of 2024-T3 sheet, rivets, bolts and all sorts of other goodies.

TUNED EXHAUST: Rick Keller, #332 has written an article on calculating the length of tuned exhaust stacks, but it is too long to print here. For anyone interested in picking up some extra power in this manner, it may interest you to know the required length--10' 6" stacks, two side by side. It will be interesting to see if the pluses win over the minuses in this setup. Rick lives at 3284 Bayside, San Diego, CA 92109.

FLIGHT RECORD: If anyone knows of a T-18 which has flown but has not been listed in the Newsletters, please have the owner notify John Thorp, for he keeps the master list of first flights and assigns numbers. John just notified me that the third Eckel brother has bought a set of T-18 plans, SN1000. Gene Eckel had his T-18 at Oshkosh last year. In total number of plans sold, the T-18 has not broken any records. Some homebuilts have had plans sales in the tens of thousands. There are few which can rival the T-18 in total number of aircraft completed and flown, however. The BD-5 has been threatening to eclipse the T-18 by the thousands since 1968, but it still has a long way to go to even catch up. (I hear the BD-5 with a Japanese water cooled snowmobile engine and a flexidyne coupling to the prop shaft has been virtually free of burnt pistons, drive shaft problems and mixture problems which have plagued the Hirth engine model.)

SN374 FLIES: Carl Hoots' flight report. I started building in January, 1966 and my first flight for N18CH was May 18, 1974. No mods except flush gas cap. 180 hp engine with a light-weight Hartzell constant speed prop. Empty weight is 951 pounds. Performance is spectacular. By the time you get the throttle back you are at pattern altitude, over 2000 fpm.

My exhaust system is made from old aircraft pipes with two-inch tail pipes. I anchored my crossover exhaust with a triangle of braces down from the back of the engine to each pipe and joined them together. This combination is guaranteed to break a pipe every hour. (Editor's Note: Amen! See back Newsletters for a description of ball joints and a flexible attachment clamp which is guaranteed to <u>not</u> crack.)

T-18 NEWSLETTER #42 04-75

Luther D. Sunderland

T-18C WING PLANS: At long last I have completed the detailed drawings for the new convertible wing. The T-18 with this configuration wing has been designated the T-18C. The C stands for "convertible." I elected to use this designation rather than F for "folding" because, when the wing is converted to highway configuration, it does not just fold up like a Corsair, but rather is rotated and swung back along the fuselage. And although I have designed systems for two of our swing-wing military airplanes, the F-111 and B-1, I never really liked the term "swing-wing."

Those of you who have never designed an airplane might not realize how much work is involved. This project has used up just about every bit of spare time for the last year, so I have not had much time to put out a Newsletter.

If you have not noticed the ad in **Sport Aviation**, the price of the plans is $35 for 38 drawings and building instructions. The original T-18 drawings are referenced for some details, but just about every drawing associated with the wing was redrawn. The only change to the fuselage, and this is optional, is the elimination of the fuselage gap cover from the wing center section. The gap cover under the main spar can be attached to the fuselage instead of the main spar. Anyone who has ever tried to attach the wing to the fuselage with AN bolts will tell you that you need a triple-jointed arm. Of course, there is no problem if Ball-Locks are used. Sealing the cracks around the center-wing gap cover in the fuselage has also been a bit of a problem.

The T-18C wing uses basically the same center wing as the standard wing out to BL 40. Thus, the same materials can be used for the center wing, including the main spar materials. The skin has been changed to 0.032 for the center wing, but John has already been recommending that, especially for the higher horsepower engines.

The outer wing has been changed more significantly. The main spar has a 0.032-thick web and the extrusions are 1.25 x 1.25 x 0.125 angle with a short piece of 1.125 x 1.125 x 0.125 angle used as a doubler. Main spar fittings are 4130 steel. So, if you already have materials for the wing and want to build a new one, you perhaps can sell some of the main spar materials. Some builders already have the wing completed and expect to change. We should therefore see some wing panels advertised in the Newsletter before long. Ken Knowles is stocking up on all materials needed for the new wing.

Much effort was directed toward the design of the joint to permit one person to convert the wing quickly, easily and especially to make it fool-proof. The design originally included a lever-type pin extractor for each main spar pin. This was finally abandoned because of the building complexity involved. So, two tools are now required for wing conversion, a screw driver and a special pin extractor which is just a sliding weight on a rod. A built-in latch captures the main spar pins and this cannot be left unlatched if the gap cover is in place. The gap cover has been simplified by using wing skin overlap up to the main spar--no separate piece--and a small D-section forward of the spar. This D-section cannot be slid into place unless the spar pins are completely seated and the latch is secured. A single captive screw at the leading edge secures the D-section gap cover in place. The status of this screw can be observed from the cockpit. A single detented pin (Ball-Lock) secures the rear spar joint. To convert a wing from flight to highway configuration, it is simply necessary to: (1) Unscrew the screw in the D-section gap cover and remove cover. (2) Extract two main spar pins. (3) Remove detented pin in rear spar fitting. (4) Grasping wing tip, rotate leading edge up slightly, pull wing panel out, then swing back and rotate leading edge up.

It is recommended that the T-18C be transported on a trailer rather than on the main gear, especially if it is to be towed any great distance. Tire wear is too great on those little tires as it is, there is too much chance of damage, and as Molt Taylor says, an airplane structure just is not meant to be a trailer. Plans for a trailer have not been included, but any low trailer could be adapted. Three channels for the three wheels could be built along with a securing means. If two wing cradles are built onto the trailer, they could be hinged down until the airplane is pulled onto the trailer with a winch. This allows them to clear the horizontal tail. Then they could be pinned in place and wing conversion accomplished right on the trailer.

John Thorp has performed a stress analysis on the T-18C wing using 1480 pounds as the design gross weight. The wing was designed for the same design load factors (6 and 9 gs positive) as the standard wing, but I am not advertising it as aerobatic. Due to uncontrolled factors, such as workmanship and substitution of materials, it is up to the individual builder if he elects to verify a safe operating envelope through static loading tests on the ground. The T-18 is such a clean airplane that it is easy for an inexperienced pilot to build up excessive speed in aerobatic maneuvers. For this reason, John is not pushing it for aerobatics. You will see why in a subsequent article.

LANDING LIGHT INSTALLATION: Norm Buehler, Route 3, Box 106, Scott City, Kansas 67871. Norm asked me if it was safe to cut a hole in the leading edge of the center wing to install a landing light. I suggested he engage John's services and here are the results: "I have installed landing lights in the first bay (near BL 60) of the leading edge of the center wing. Since the wing torsion from the outer wing panel has been picked up by the rear spar fitting, there is very little stress in the leading edge skin at this point. In the center of the center wing leading edge, the shear stress due to torsion is relatively high. However, if the hole is not too large and if you reinforce the cutout with a doubler of at least 0.040 x 1.5, the structure will be OK. Functionally, the landing light in the outer position has been a notable success."

TEMPLATES: The T-18 skin templates have finally worn out. There has not been too much demand lately since some suppliers have begun marking sheets with hole patterns. So, unless somebody wants to start up a template service, you will have to make your own.

WING PROFILE LAYOUT: by Luther D. Sunderland. Recent questions from a builder about airfoil contour layout indicate a need for some instructions on this subject. Drawing 547 gives the coordinates of the upper wing surface and lower wing surface in both percent of chord and in inches. To lay out the curves, first set up two reference lines, one horizontal line over 50 inches long and the other a vertical line crossing the horizontal near the left side of your paper.

Station measurements are taken as horizontal distances in inches to the right of the vertical reference line. Ordinates are vertical distances from the horizontal reference lines. Positive distances (to the upper surface) are above the reference line. Just ignore the percent numbers for they are not needed. NACA data is always expressed in percent of chord, but John has already converted to inches.

To make the layout, first draw the line on which the center of the leading edge radius is located. Start this line at the intersection of the two reference lines and slope it up to the right. The slope is given as 0.1685. Draw the line through the intersection of the reference lines which we will call point two, and a second point, which we will call point C located 10 inches to the right and 1.685 inches above the horizontal reference line.

The leading edge radius is given as 0.5435 inches. Set a compass at this length and draw the leading edge radius arc with the center at point C. Note that the leading edge of the circle extends slightly to the left of the vertical reference line, but all stations are measured to the right of point O. (1986 Note: The new GAW series of NASA airfoils, including my LDS-4-212, have all leading edge coordinates defined and use no L.E. radius since the curve is actually exponential there.)

Now, lay out all station points along the horizontal reference line using point O as home base. Draw vertical lines through each station point extending about five inches above and below the reference line. Then lay out the ordinates for upper and lower surfaces on these lines. Draw a smooth curve through all points. For this layout, as for all T-18 layout work, you need at least an 18-inch-long scale marked off in 0.020-inch minimum increments. (Drafting supply stores have them.) The wing profile laid out according to drawing 547 (and 108 for S-18) is for the outside of the skin. So, to make everything come out right, you should make the master rib form block smaller by the thickness of the skin and the tooling rib, (0.025 top 0.025 bottom). Center rib form blocks for 0.032 and 0.040 ribs should be made smaller accordingly, but Rudy Adler says he uses all the same size form blocks and everything seems to fit alright.

ALUMINUM HEAT TREATMENT: Questions are sometimes asked about the substitution of T3 for T4 in 2024 alloy aluminum. There is only a slight difference between the strength of T3 and T4. T3 is solution heat-treated and then cold worked while T4 is solution heat-treated and naturally aged to a stable condition. Generally, sheet and thinner sections come in T3 while sections over 0.060 are T4. Ken Knowles tells me that plate and extrusions are only available in T3511 rather than T4 and this is suitable.

WOODEN PROPELLERS: Just received a letter from Al Wedge, Vice President of Sensenich, and he reports that they have sold a number of wooden propellers with both plastic and brass tipping. But I see they are still putting out information recommending pitches that in my estimation are too steep. Perhaps they have now changed their bulletin, but if not, here are my suggestions: On W66LM props, 160 hp - 78 inches, 150 hp - 76 inches, 135 hp - 74 inches, 125 hp - 72 inches or 74 inches. I have a 74-inch pitch prop with plastic tipping and like it fine for a good low rpm cruise, but it does not climb too well, that is, it will not do over 1000 fpm with a full load. Someone operating from a small field would probably prefer a 72-inch pitch.

I really have not received many reports on the new props so you folks who have them should write in and let me know of your experiences. Bob Daniels of Eugene, Oregon tested the first W66LM on his 160 hp T-18 after John Shinn had tested it on his 135 and I had tested it on my 125 hp T-18. This prop had 76 inches pitch. It was too much pitch for both the 125 and 135 engines. Bob reported that it equalled his metal prop in top speed but did not get quite the rate of climb. At 7500 feet altitude, he obtained 195 mph as checked over a 7.5-mile measured course. After 17.5 hours on the 160 hp engine, a piece of the plastic leading edge came off this propeller. All other propellers made by Sensenich with plastic tipping have had the plastic wrapped around the leading edge rather than just bonded on the very front portion and there have been no further reported problems. Some have had the finish peel off the plastic in rain. Ford Hendricks says that this will happen to any propeller in rain, but if you just throttle back to about 2000 rpm you can go right through rain. So far, this has worked with mine and I have lost only one small piece of black paint near the tip, about the size of a dime.

HEAT TREATING ALUMINUM ALLOYS: (Info supplied by Dr. Jeff Shinn, a mechanical engineer and John Shinn's brother.) It is possible to change 6061-T4 aluminum alloy to the T6 condition by a heat-aging process called precipitation hardening. This is just a fancy name for heating at 350 degrees F for eight hours. Room temperature-aged 6061-T4 has a yield strength of about 22,000 psi. After eight hours at 350 degrees F, the yield strength increases to about 37,000 psi - a factor of 1.7. It sounds like a good way to gain some strength. There has been no indication, however, that the present T4 ribs are not adequate.

BAND SAW: James Borg, 1332 Jersey Avenue South, St. Louis Park, Minnesota 55426. James says he built the band saw shown in September 1973 **Sport Aviation**. It works great and he highly recommends it. These are the kinds of tips which are helpful to new builders. Send more!

REGIONAL MUTUAL AID GROUPS: Frequently I get letters requesting the names of builders in their area. My trouble is that I have no idea where Polecat, TN is near and to sort out all the builders in Tennessee would take an hour. (Just try reading through 1000 names and addresses sometime.) What we need is a regional coordinator for each state or metropolitan area. If you would like to serve in this capacity, please send me your name and permanent address. I will list all coordinators in the Newsletter and I will send each one a list of builders. Then local builders can contact their nearest coordinator. So, let's have some volunteers. I am quite sure that you will be amply rewarded through your contacts with other builders.

HOWARD GINN REPORTS: 44140 North Gillan Avenue, Lancaster, CA 93534. Howard sent in performance data on his 150 hp T-18. He has a 68" long x 75" pitch prop (metal I assume) which gives a max static rpm of 2000 and a max level flight rpm of 2700 at 2500 feet. He reports max speed of 176 without gear fairings or pants. Using a Corvair (large) oil cooler, the max oil temp is 200 degrees F. Construction cost was $4000. Empty weight is 894. Most forward cg is STA 63.7, gross cg is 68.4, empty cg is 62.7 and most aft cg is 70.7. "Since the first flight on June 22, 1974, I have flown just over 100 hours and have no problems except a terrible gas bill.

The total lack of problems is a direct result of closely following the excellent advice in the T-18 Newsletters. You have my sincere thanks and appreciation for your many months and years of devoted effort. Enjoyed your fine article on the folding wing and look forward to starting construction on one of my own. I agree that it is a "dream come true!"

(Editor's Note: I appreciate receiving flight data so it can be included in the Newsletter and of course it always helps to know that the Newsletter has been of assistance. Thanks to all you who have been so generous with your donations and comments.)

CORRESPONDENCE: I am always glad to answer questions from builders, but the mail load is really getting heavy. It would be of great assistance if you would enclose a self-addressed, stamped envelope when you expect a reply. Also, list all questions by number on a separate sheet of paper with space provided for an answer. That way I will not miss answering any. If you ever fail to get a reply within a reasonable amount of time, please write again for your letter might have become lost. My wife Marilyn handles most of the clerical work. She requests that you always use your plans number and that Canadian builders not send personal checks. The bank tells us that they are going to start charging a couple dollars each to cash out-of-the-country checks. (1986: They now charge $7 per check.) I can usually get currency changed OK. Money orders are OK, as are checks for US funds. If you buy someone's plans and do not know the number, look on a copy of an old T-18 Newsletter and the plans number will appear before the name on the label.

CHANGE OF ADDRESS: If you move, send us a change of address for the post office will not forward mail after about a month. After each mailing we get about 50 returned.

ALTITUDE RECORD? Pete Roemer flew his dad's 180 hp T-18 to what may be a altitude record for a non-turbo powered T-18. He went to an absolute ceiling of 26,100 feet in one hour and twenty-five minutes. Now he not only claims the world's FASTEST T-18 but also the HIGHEST. The rat of climb was impressive: at 10,000 feet - 1400 fpm, 15,000 - 695 fpm, 20,000 - 380 fpm, 25,000 - 50 fpm. Took 22 minutes 48 seconds to climb to 20,000 feet.

BELT SANDER: Roger Weselmann, 4054 Suburban Drive, Waterloo, IA 50702. My favorite tool is a one-inch belt sander from Wards. Cost $18 plus motor. Absolutely indispensable because I hate filing. It is much preferred over a grinding wheel. I even use it to sharpen drills. Think the plans are great and the Newsletters are the best idea since sliced bread.

Tip: Especially on good parts, I apply masking tape where lines etc. will go. Lay out lines, holes, etc. on masking tape and start over. Leave masking tape on when drilling. Seems as though the tape cuts down on drill wander. With a good drill center punching is not necessary, except for highly accurate locations.

Also, I have added a 0.025 bent-up angle down top centerline of the fuselage from the canopy to the fin. Reason: Other T-18s really vibrate in this area. (Editor's Note: Good idea. Many of us have done this.) Tip on flaring tubing. Many people buy automotive flaring tools for tubing and use them with AN fittings. This will not work because AN fittings are 37 degrees and automotive are 45 degrees. Also, aircraft and automotive air disconnects are not interchangeable. Why can't these things be standardized? Maybe it will straighten things out when we go metric. (Editor's Note: This will just add a third to help confuse us for the next hundred years!)

A. O. CHELLIS FLIES: 12 Henry Street, Bridgeport, Tasmania 7254, Australia. Received a nice picture of VH-AKC powered by an O-320-A2B swinging a 74" x 61" pitch prop. It first flew February 21, 1972 and was the fourth T-18 to fly in Australia.

O-290-G WITH WOODEN PROP: William Oliver, 2369 Phillips, Beakley, Michigan 48072 has a Sensenich W66LM74 on his O-290-G, no gear fairings or wheel pants. He gets 2625 rpm at 2,000 maximum and indicates 165 mph at 72 degrees F. Empty weight is 928. No flush rivets. Most forward cg - 62.1, most aft cg - 69.5. "I like the wood prop both for performance and peace of mind. My wife and I recently flew from Pontiac, Michigan to Salina, Utah and back--the longest and best trip I have ever made in an airplane. Averaged over 160 mph and 20 miles per gallon. At 14,000 it will turn 2450, indicating 125 to 128 mph."

TAIL SPRINGS: A number of people have had the front bolt in the tail spring break, including your editor. This is so common that I figure we should have two bolts there, one padded with a rubber washer. Then when one breaks, the other one would catch it. The Citabria used for towing gliders at our local airport could sure use this trick for they are always repairing a bent rudder when the front bolt breaks. John replied on this subject as follows: "The front bolt in the tail spring has been called out as 3/8 inch since February 22, 1969 (A-590). I have not been told of a 3/8-inch bolt failing. (Mine was 5/16). On June 20, 1971, I put out drawing A-862 for the heavy duty steel leaf tail spring. This also uses a 3/8-inch front bolt and I have not heard of any front bolt failures with the steel spring which is noticeably softer than the aluminum spring. At the moment, I would advise all T-18 builders to install the A-862 tail wheel spring."

SHOCK TEST: Howard Warren, Flint, Michigan reports that he washed out his T-18. He was making an approach in bad weather when he struck a utility pole and went into a steel utility building. His son received a broken nose and few cuts and he got away with two broken ankles and broken wrist. Following this accident, two of his friends who were quite far along building wooden airplanes switched to T-18s.

LOAD TEST: Chuck Borden took someone from the local airport who knew how to do aerobatics for a ride in his T-18. When Chuck was in the middle of a barrel roll inverted at 160 mph. his passenger for some reason yanked back on the stick. The result was a split S at very high speed and the g-meter registered over 6 gs. Weight was over 1400 pounds. Wrinkles occurred in the center wing skin and in the fuselage sides at the dash. The center wing was reskinned and it was found that there was no permanent set in the spar except that the inner wing main beam web (0.040) became wrinkled. Thus, we have added 3/4 x 3/4 x 0.062 aluminum angles vertically on the front face of the beam in the T-18C wing. Two angles are equally spaced between the ribs in the center wing and are attached to the beam with five 1/8-inch rivets. It would be a good idea if stiffeners were added to the standard T-18 inner wing also, even though design loads were exceeded in this incident.

HOWARD HENDERSON FLIES: 444 Bryan, Kirkwood, Missouri 63122. I flew the first flight on SN600 October 21 after carefully heeding the advice of others to do lots of taxiing. It is slightly left wing heavy, but otherwise trims out OK. I selected a first flight day with a steady 15 mph breeze almost down the runway. For the landing, I set up a long approach at 90 mph with half flaps, cut the throttle at the end of the runway and proceeded to hold it about a foot off the runway for a three point, which caused a little bounce. The rollout was easy because of my taxi experience. Engine is a 150 hp and the prop is a 74DM, 68 x 68 purchased before the prop requirements were well understood. Ground vibration tests (suspended on shock cord) showed a first mode resonance of 2750 rpm so am placarding the tach at 2600. I will get another prop after my test period. The gear is double tapered, both inner and outer tubing and two inches longer. It feels fine to me. Am using special foam soundproofing supplied by "Sound Coat" and two Pazmany mufflers, so as soon as I figure out how to seal the canopy, it should be fairly quiet. Have a large Corvair oil cooler and my oil temp never got over 160 degrees F.

LUBRICATION: The T-18 drawings specify Lubriplate for lubrication of all bushings, bearings, etc. John now recommends one of the dry lubricants such as graphite or Electrofilm. I have specified Moly-Kote on the T-18C wing. It is also a dry lube. After 1000 hours, John disassembled N299V and bushings were still adequately lubricated (with dry lube). Oil and grease tend to collect dirt which is abrasive.

TRIM WHEEL: Lyle Trusty, 43 Conklin Street, Farmingdale, NY 11735 sent a report on his 150 hp T-18 with Hartzell Constant Speed prop. It weighs 950 pounds empty and has a top indicated airspeed of 170 at 3700 feet, climb is 1700 fpm. Building time was 22 months. He has sent a sketch of his trim wheel installation which is located near the center of the tunnel rather than on the side. The side-mounted trim wheel is especially bad for someone of my stature (6'3") because the edge of the trim wheel is the only thing my right leg has to lean against. Lyle mounted the 716-1 wheel and 721 hub in a slot in the top of the tunnel and on a 1/4-inch shaft. The shaft is mounted in the 722 bearing on the left side and in a gearbox on the right. He used bevel gears from a Terry drill adapter mounted in a frame made from 3/4-inch plate, hollowed out. Anyone else have a good solution with available parts?

T-18 NEWSLETTER #43   07-06-75

Luther D. Sunderland

REGIONAL T-18 COORDINATORS: A good response was received to the request for regional coordinators. The latest list of T-18 plans' owners will be mailed to each coordinator, except of course for the many blanks representing persons who moved without sending in a change of address. Builders can contact the nearest coordinator for information on other nearby builders and on local material sources. Most coordinators have sufficient experience to assist new builders with answer to their questions. This initial listing reveals areas not covered, so if your area needs a coordinator, why not volunteer? If I have missed listing anyone who wrote in, please write again for it is easy to place letters in the wrong file.

No.	Region	Name	Address
1	NJ	Elmer Hyman, 36 Center Street, Midland Park, NJ 07432	
2	PA	Grover Rahiser, Jr., 517 Van Buren Street, Evans City, PA 16033	
3	GA	Conrad H. Hagle, 90 Martin Point Court, Roswell, GA 30075	
4	FL	Tom Daniels, 335 Okaloosa Drive, Winter Haven, FL 33880	
5	OH	Lewis Cunningham, 8180 Deepwood Boulevard, Building H, Apartment 12, Mentor, OH 44060	
6	MI	William Beswick, Jr., 7144 Heatherwood Drive, Jenison, MI 49428	
7	WI	B. C. Roemer, Manitowish Waters, WI 54545	
8	MN	James A. Borg, 2451 115th Avenue NW, Coon Rapids, MN 55433	
9	AR	Lloyd Toll, Box 303, Hazen, Arkansas 72064	
10	NE	N. L. Nate Eastman, Box 83, Kimball, NE 69145	
11	TX	Richard Cavin, 10529 Somerton, Dallas, TX 75229	
12	NM	Vic J. Plath, 6109 Natalie NE, Albuquerque, NM 87110	
13	WA	Cecil Hendricks, Seattle, WA 98188	
14	CA	Paul A. Harris, P.O. Box 7304, Menlo Park, CA 94025	

#844 FLIES: M. B. Mantooth, 4109 Barnsley Lane, Olney, MD 20832. First flight was June 7, 1975 but do not have any data since the canopy is off. No problems as far as I know except the oil temperature went up too much. Airspeed indicator really goes to pot about 85 just above stall. Hope it does better with the canopy on.

#200 FLIES: Jerry Ewing, Box 307 East Jordan, MI 49828. After three and a half years, serial number 200 took to the sky on May 11, Mother's Day. I had read in the past

Newsletters about first flights, how to taxi and how to fly. I taxied for about an hour and it felt so good on the ground that I knew it would fly. I used an airport 35 miles away with 7500-foot long runways made of blacktop. I took off, climbed to 3000 feet and leveled off. It handled just like an old airplane, for everything was perfect. Did slow flight and came back to the airport and landed. By that time all of Chapter 510 was there. I told them I was going back to East Jordan with a 3000-foot long sod strip. Am flying almost every day trying to get 50 hours before Oshkosh. Weight empty - 894 pounds. Engine - 320 150 hp. Prop - 68-63 metal. I will be going to a wood propeller. Static - 2200 rpm. Max level is 2750 rpm at 2000 feet. Max indicated is 165. Have gear fairings and pants. I am using a Corvair oil cooler and oil temperature never gets over 180 degrees F. Cost to build was $5700 with full panel and 360 channel radio. Thanks a lot for a very fine job on the Newsletters. It was a great help.

WOODEN PROPS: Lloyd Toll just reported that after some recent flying in 90-degree temperature weather, he is convinced he needs less pitch in his wooden prop. He has a metal tipped Sensenich with 78-inch pitch and is going to replace it with a 76-inch pitch prop. His engine is the 150 hp O-320. For some reason, Sensenich is still sending out pitch information based on their early estimates before any tests were flown. The 150 hp engines need 76 inches pitch and the 160 hp engines need 78-inch. Lloyd will sell his 78-inch pitch W68LM-68 prop for 10% off original price.

At the last report, Sensenich had sold 80 wooden props of which about 30 had been ordered with plastic tipping. Just talked to Henry Rose and he reports that the only cases where the plastic tipping eroded involved aircraft which were being flown in IFR conditions of heavy rain. He said that Sensenich has now changed their literature on pitch recommendations and it is consistent with what I have been suggesting. Here it is:

O-290-G	W66LM72	125 hp
O-290-D2	W66LM74	135 hp
O-320	W66LM76	150 hp
O-320	W66LM78	160 hp
O-360	W68LY80	180 hp

Dick Walen had used both an 80 and 82-inch pitch wood prop on his O-360 and he has now switched back to the 80-inch pitch, preferring the higher rate of climb in hot weather.

George Rattray finally sold all of his super expensive prop extensions which Sensenich had designed for the W68LY wooden props. (This is the only wooden prop which takes the larger than standard SAE four size flange.) Now he is making and selling the spool type prop extension which I designed and which John Thorp now will sell you on request ($2 I believe, for Drawing A-126). Do not have the exact price, but I hear it is less than $100 from Rattray.

METAL PROP SURVEY: I am happy to report that there have been no further incidents with cut-down metal props since the Hartzell in-flight vibrations tests. Since a large percentage of T-18 builders already have metal propellers and do not want to incur the expense of another propeller, it would be of special interest and value if we could obtain service information on the cut-down metal props that are now or have been in service. If you have used a cut-down metal prop on a T-18, please fill out the questionnaire at the end of this Newsletter. Results of the survey will be published in the next issue and also sent to Sensenich.

The value of metal in a propeller became evident recently when my W66LM74 began to run a bit rough. I took it off and checked the balance, finding that it was 1.75 grams out of balance. No wonder it felt rough! There must be a quarter of a cup of water running around in there. Otherwise, I am quite happy with it.

BALANCING A PROPELLER: To balance a propeller, it is necessary to get a good tight mandrel through the hub and level parallel bars. The mandrel can be made in the form of two aluminum plugs inserted from either side. Or it can be made of a wooden plug with a 1/2-inch or larger pin through the center to provide a good smooth rolling surface. To obtain best results, the parallel bars should be mounted on two long pedestals to permit the prop to be rotated to any position, but it will suffice if they are just high enough to permit the prop to be oriented horizontally. I use my table saw top which I level up by placing shims under the legs and checking with a good carpenter's level. Then I place two 3-inch long pieces of scrap main spar extruded angle on two one-inch high steel blocks. I cleaned off the edge of the extrusion with a file to get a smooth straight surface. To compensate for a slight non-level condition of the parallel bars, always check balance with the prop pointed in first one direction and then the other. Happiness if very definitely a smooth running propeller.

MY J-3 FLIES AGAIN: Happiness is also flying a Cub low and slow. After spending 10 years standing on its nose beside my T-18, my J-3 just took to the air last weekend with a shiny new rebuild job and overhauled engine. After three or four evenings of flying, I filled it up with a whole eight gallons of gas. With a 34-inch pitch climb prop, that 65 hp Lycoming engine really stands it on its tail on climbout. The only problem was a rough running prop, but after I took it off and balanced it, now it runs as smooth as a sewing machine, instead of a threshing machine. But after getting used to the T-18, the J-3's ability to roll seems infinitely slow.

One thing I can say for sure, if you learn to land a T-18, landing a Cub is a snap!

198 MPH ON 135 HP: John Shinn just received the results of last year's efficiency contest at Oshkosh. His maximum speed was 198 mph and minimum speed was 68 mph. He has great hopes for this year because they only clocked him on one of the three high speed passes because on the first two he was a bit too high for their viewing mechanism. He had the lowest IAS on the pass which they clocked. Now perhaps people will believe my 180 mph on 125 hp.

This year, let us get more T-18s in the efficiency contest. The rating formula appears to be designed to favor airplanes with low minimum speeds, so do not expect to win first place. It is an excellent way to get comparative performance data with other T-18s to point up which design modifications or construction details produce the best results. Those of you still pondering the selection of a powerplant should note the very narrow speed differential between the 180 hp models and the 135 hp on John Shinn's beauty.

NEWSLETTER POLICY: For you new members of the club, you may obtain copies of back issues of the previous 42 Newsletters plus future issues by sending me a donation of $12. The T-18 Newsletter is financed by donations from builders and by donation of my time.

OSHKOSH FORUMS: Two forums of interest to T-18 builders will be presented. On Friday morning, 9:00 to 10:15 in forums tent #2 I will give a paper on the application of propellers which Henry Rose, chief engineer at Sensenich is helping to prepare. Then on Saturday morning from 10:30 to 12:00 in forums tent #2-A we will conduct the T-18 Forum. This year we have been given prime time, so a good number of people should be able to attend. See you there.

T-18 INFORMATION STAND: Benjie Roemer is making good progress on plans to maintain a T-18 information stand and have all the T-18s parked in one area. Pilots should contact him upon arrival to donate some time.

CONVERTIBLE T-18C WING PLANS: A total of 36 sets of T-18C wing plans have been shipped to builders around the world. I will have a few sets along at Oshkosh if you have not obtained a set and will be there. The price is $35 for 38 drawings. To avoid some of the liability problems which have plagued John Thorp, all purchasers must sign a purchase agreement somewhat similar to that used by Pitts.

Ken Knowles will have his T-18C there again but I doubt if anyone else will have one completed. If anyone has parts completed, why not bring them to display?

WATCH OUT FOR 4130, CONDITION A: Some suppliers are substitution 4130 Condition A for Condition N plate stock. Unless it is to be heat treated, it is only 2/3 as strong.

BENDING SHEET METAL: Bob Clayton, 1783 Harvard Avenue, Salt Lake City, UT 84108 writes that he would like to see a rather detailed explanation and procedure for making proper bends in sheet metal correlating with reference points and dimensions on the drawings--something like John Shinn's articles on ribs and riveting. Until someone comes up with such an article, perhaps the following comments will be of some help:

If the novice needs advice in the area of bending sheet aluminum, he probably also does not have access to a sheet metal bending brake. Without such a brake, it is almost useless to accurately compute setback, which is the distance from the vertex of the mold lines intersection to the point where the bend begins. Even with a commercial brake found in the average heating and plumbing sheet metal shop, there is usually no selection of bend radius shoes. so again, it is not a simple matter to theoretically figure setback. If you wish to take that route, get a good sheet metal book and use the tables in it to determine setback. Otherwise, here is a simple and foolproof way to make your bends:

Figure bend allowances for making templates according to the example and equations found in Part IX of Building the T-18 by John Thorp. Now cut out some two-inch square pieces of scrap aluminum of the same thickness as the part being formed. Bend samples in whatever brake you are using, make adjustments and add shoes until the proper bend radius is obtained. Remember, if the bend is too sharp, the material may form cracks. Now, experiment with the samples until a flange of 0.625 inches is obtained (or whatever the flange should be). Observe the amount of setback used and use this for all bends with this thickness material with this set of shoes and with the brake adjusted in this manner. My experience is that if you do it any other way, you will end up scrapping some parts and doing it this way anyway.

If you cannot locate a bending brake, contact your local high school and see if night classes are available in sheet metal. Many builders have been allowed to make their T-18 parts in such classes and in some cases they were permitted to use the T-18 as an instructional project.

If builders need more help in this area of forming straight bends, let me know. Also, if you have found some tricks which might help others, let me know.

CADMIUM PLATING SOURCES: The main spar joint fittings in the T-18C wing are made of 4130 which is heat treated to 150,000 psi and cad plated for corrosion resistance. Bill Huff who is now on assignment in Iran writes that his home town of

Amarillo, Texas does not have a plating facility, and he wants to know where he can find one when he returns home. This is where the regional coordinators can be of assistance. For instance, Dick Cavin can give you the name and address of shops in Dallas. But, from what I remember about distances in Texas, Dallas is only a little bit closer to Amarillo than Iran.

HYDROGEN EMBRITTLEMENT RELIEF AFTER CADMIUM PLATING: Bob Todd, 427 NW Overlook Drive, Vancouver, WN 98665 heard about hydrogen embrittlement in 4130 cad plated parts so he wrote to the FAA office in Seattle and asked them some questions about it. Here is a portion of their answer:

> ...essentially, hydrogen embrittlement is a phenomena where free hydrogen in metal draws to it, from the atmosphere, other hydrogen molecules. This action results in cracking of the part as the atmospheric hydrogen "elbows" its way into the microstructure of the metal and forces the structure apart. To preclude this occurrence, it is common to bake parts after cad plating or other types of plating to ensure that all hydrogen in the metal is removed. The Federal Specification regarding cadmium plating is QQ-P-416C. Note in paragraph 3.2.8 that it is appropriate to bake a part for three hours or more after plating.

The following is a quote from paragraph 3.2.8:

> Embrittlement relief. Unless otherwise specified or stated in the end product specifications, all steel parts having a hardness of Rockwell C40 and higher shall be baked at a minimum of 375 plus or minus 25 degrees F (191 + - 14 C) for three hours or more, within four hours after plating to provide hydrogen embrittlement relief.

The above note is included on T-18C Drawing #231. Any plating shop worth their salt will be quite familiar with this procedure.

DRILLING HOLES IN PLEXIGLASS: Elmer Hymen, 36 Center Street, Midland Park, NJ 0732. I have tried lots of ways to drill large holes in plexiglass and had lots of cracks. Now what I do is drill a small hole 1/8-inch diameter using a standard 1850 rpm electric drill. Use a rate that lets the bit do the work. Then I have a reamer that is tapered from 1/8-inch to 1/2-inch. I feed this in the hole with a slow speed drill stopping at the right size and that is it. I find that this method works quite well with no cracks so far. I tried it on some scrap pieces first to see how rough I could get and it works real good! The same procedure works for making large holes in aluminum sheet also.

BATTERY CABLE ROUTING: Elmer Hymen asked how he might route the cables forward from the battery. It is probably possible to run them through an aluminum tube mounted in the tunnel in such a way that it does not interfere with push-tube or cables, but I ran mine up the side of the fuselage over the wing cut-out. I simply drilled holes in frames and put in grommets. One which I saw that routed cables through the tunnel had them rubbing the tube.

FUEL TANK CONSTRUCTION: Bill Johnson warns that builders who make fiberglass ends for fuel tanks and join them to an aluminum sheet center portion with Pop rivets might be asking for trouble. Even though one uses epoxy tank sealant, a reliable bond cannot be achieved unless the metal is chromic acid or phosphoric acid anodized. All of the other surface prep systems break down in the presence of water. It is my personal opinion that the entire tank should be made of fiberglass as described in previous Newsletters. So far, mine constructed in this fashion has not leaked a drop.

T-18 NEWSLETTER #44   04-13-76

Luther D. Sunderland

T-18 NEWSLETTER POLICY: No, we have not gone out of existence, even though the Newsletters are few and far between. The existing back issues seem to contain about everything a builder needs to know to build a T-18, so there is not a pressing need for more. If anything, there is already too much material for builders to read and remember because most of the questions I get in almost every mail have been adequately answered in the Newsletter. We will publish future issues only when something comes up which needs publishing.

On the subject of mail, my wife Marilyn has been taking most of the load and it uses up much of the morning every day. This seems to be an endless job, so please try to follow these rules when you have questions or need back issues:

1. Always include a stamped, self-addressed envelope (Unless you are from outside the United States). About one out of 10 now do this.

2. List all questions on a separate sheet of paper with space for answers.

3. Your best chance of reaching me by phone is between 10:00 PM and 11:00 PM (607)625-3084.

4. Read your back Newsletters first to try to get answers.

5. Contact your nearest Regional Coordinator (Newsletter #43) or other experienced builders whose addresses are listed in other Newsletters. The builders who have flown are a bunch of nice guys who do not mind helping others.

MOST FREQUENTLY ASKED QUESTIONS:

1. Are Pop rivets satisfactory, safe, and approved?

   Answer: Yes. They have stood up for about 10 years now with no more problems than AN rivets.

2. Should flush rivets be used?

   Answer: On the wings and tail surfaces, yes. It is just a matter of appearance on the fuselage, for little performance improvement will be realized with flush rivets there.

3. Should rivets be filled with body putty?

   Answer: Yes, on the wings and tail. The two-part putty sold in auto supply stores has worked out well. It seems unavoidable to get little circular cracks around some rivet heads on the main wing spar but they never seem to become a problem.

4. Where can I obtain materials?

   Answer: Write to Ken Knowles' Sport Aircraft Inc., 104 E. Avenue, K-4 Unit G, Lancaster, CA 93535 or Merrill Jenkins, 2413 Moreton Street, Torrance, CA 90505 for catalogs. They have about everything except canopies which can be obtained from GB. All-Aircraft Parts sells cowlings made to the shape on my T-18, Ken Knowles' Sport Aircraft and Rattray both have nice cowlings also. Dewberry makes machined parts.

5. Where can I get prop bolts?

   Answer: Spencer Aircraft, Dallas Avenue, Seattle has any length AN bolt. See my May 1975 **Sport Aviation** article to figure dash numbers.

6. Which propeller do you recommend?

   Answer: The Sensenich wooden props listed in Newsletter 43 have been performing and holding up well. For best performance, get the plastic tipping, but if you expect to fly in much rain, get the brass tipping. My W66DM74 makes me awfully happy during cruise, but I miss those skyrocket climbs. Wouldn't want to try to get out of real short strips with it. (1986 Note: Only plastic tipping is available today.)

7. How can I get more width in the cockpit?

   Answer: I have drawn up the necessary changes to add two inches more width to the fuselage. Several fuselages are being constructed to this configuration. Drawings will be for sale for $10 consisting of one new drawing and a list of changes to 29 others. We are looking for someone who could assemble a fuselage in rather short order to check everything out first. The wing has remained unchanged except for fittings. In order to keep the same fuselage side curves which John carefully had designed to minimize drag, the side skins were simply moved apart two inches and the tail extended five inches. The extra length was added between the canopy and fin. Everything aft of the fin leading edge was unchanged except the bottom trim line on two frames. How much the performance will be affected, we have not been able to estimate, but it should be minimal. John Shinn and I do not go any slower with our 3/4-inch higher canopies, so maybe the same thing will happen here. One thing is certain, we of bigger stature will have plenty of shoulder room. (1986 Note: The S-18 plans contain these features.)

EXHAUST SYSTEM BALL AND SLIP JOINTS: As you know, it is necessary to install both slip joints and ball joints in an exhaust system to prevent cracking. If you are building your own, I still have these available to fit 1.75-inch tubing. Two ball joints and two slip joints are $18. This also includes detailed instructions on how to make perfect wrinkleless bends in stainless tubing.

EXHAUST SYSTEM PARTS: Dean Cockran, 255 Hemlock Street, Broomfield, CO 80020 supplies all the bends and parts cut ready to weld for T-18 exhaust systems. He found it uneconomical to supply welded systems. Write for latest prices.

T-18 COFFEE CUPS: Ken Knowles sells nice coffee cups with a picture of his T-18 glazed on the side. A good conversation piece, but you had better get two for your helper will want one also. I see the picture has the "new look" wing. Looks sharp. Ken also has nice three-dimensional T-18 tie tacs.

DIMPLE CRACK QUESTION: John Walton, 5726 Boyce Springs Drive, Houston, TX 77066. In my test piece, it appears that I am getting small cracks adjacent to the rivet after it is upset. These are mentioned a lot in the Newsletters, with various polishing ideas to smooth the hole prior to setting the dimple (and/or rivet?). I have tried several of these, but the small cracks are still there--(they are not there _before_ the rivet is upset.) Answer: The best way to prevent cracks around dimples is to deburr before riveting and then use new soft rivets. Rivets harden with age. Once before, I recommended solution annealing of hard rivets to make them soft again. This means heat treating them to the original 17S state, which is not dead soft. Nearly every T-18 has some tiny cracks around dimples. They have been flying for years with no problems!

Question Two: How do you bend the joggle in 580-3 3/4-inch angle longeron at the horizontal tail fitting? Answer: With great difficulty. After you have tried to make the joggle as best you can, just forget it even if the fitting is not completely recessed. The slight bulge in the side skin is not noticeable. I have been getting most of my materials from Ken Knowles. He deserves some notice for being prompt on deliveries--even for the little orders. J.W.

SUN 'N FUN FLY-IN: Bill Satler won the best metal aircraft award with his beautiful T-18. Bill says that the secret of making a nice airplane is practice. This was his third T-18. One of the novel features incorporated in this aircraft is the electric trim. He uses a headlight door motor from a 1967 Camaro. It is a standard GM-Delco part. The motor is mounted with the output shaft pointed aft on the frame at Station 191.75. The motor is on the forward side of the frame. Two universal joints and a short piece of tubing connect the motor with the trim screw. The nylon universal joints fit 1/4-inch tubing and are available from any radio supply house. He installed limit switches to prevent a stuck trim switch from applying continuous current to the motor. Bill reports ideal operation, 15 seconds for full travel. The limit switches are actuated by a hose clamp that is clamped to the 1/2-inch 703 trim torque tube. This system appears to be an ideal arrangement with little if any complexity.

DRILLING HOLES IN PLEXIGLASS: E. S. Arvidson, 8918 Birch Avenue, Morton Crove, IL 60053. I just received your Newsletter and see there are still problems with drilling holes in plastic. I have not had any problem with cracking. I use a solid shank wood spade, for the small holes a 1/4-inch solid shank wood spade. Do not use changeable heads. I would never use a twist drill, they heat and build up material and crack one in ten times, but wood spade and 1/4-inch high speed drill motor, full bore will give you a clean hole without cracking. Try it on scrap, it really works. On cutting my canopy, being one of the older ones, I trimmed on the band saw and finished with 1/4-inch drill motor and two-inch sanding disc. Do not be afraid to cut it, just do not twist it. Do everything high speed.

HOWARD HENDERSON FLIES SN600: 444 Bryon, Kirkwood, MO 63122. Enclosed is a copy of my summary of the performance of SN600. The equivalent flat plate area is 2.8 square feet as compared to approximately 2.4 to 2.5 for Roemer's or Thorp's. The data assumes a propeller efficiency of 85% and a gross weight of 1300 pounds. My static source is located on the fuselage side at STA 149 and WL 38 and produces only a 3-mph error at cruise. Possibly locating it four or five inches more to the front would produce even less error.

I am using a M74DM 68-76 propeller and do not have wheel pants. If any ham operators would like to talk to me join in on the EAA net (WOZJR).

(Editor's Note: Howard sent graphs of airplane performance that will not be reproduced here. The range curve at 7500 feet shows a maximum at 123 mph TAS. Maximum duration is under 100 mph. Range computation assumes six gallons reserve. He obtains 190 mph TAS.)

NOISE REDUCTION KIT: Ken Knowles has just arranged with a professional noise reduction expert to obtain ready-made noise reduction kits for the T-18. There are two separate kits, one which makes a complete liner for the cockpit forward of the seat back and the second just for the baggage compartment. The liner is composed of a fiberglass mat sewed inside a fiber glass screen. It is cemented inside the fuselage skin including the floor. Weight of kit #1 is 16 pounds which seems a bit heavy, but acoustic engineers claim that it takes mass to make effective sound insulation. Price of Kit #1 is $69.95 and Kit #2 is $25.20.

OTHER MATERIALS: Ken Knowles presently sells T-18C steel main spar fittings only in prefabricated form. They are already heat treated and plated. The complete set is $160. For those builders who have machining facilities, Ken will make 4130 plate stock available from his next wholesale purchase. I have not checked with Merle Jenkins but I assume he also supplies plate stock. Builders report that they have been unsuccessful in locating 3/8-inch 4130 plate from other suppliers. Price of the T-18 coffee cups in $3 each. Either a gold or silver tie tac is #.95. each.

ALLAN CHIVERS FLIES SN287: 45108 11 Street West, Lancaster, CA 93534. The following data applies to T-18 N18AL: Engine 0-320-E2D 150 hp, propeller M76EM-8-76, max rpm static 2050, OAT 70 degree F at 2785 feet altitude, max level flight at 5000 feet 178 mph IAS at 2700 rpm, OAT 5 degrees C, max ground speed 190 mph at 1300 pounds weight. Airspeed was calibrated over measured course. Oil temperature 83 degrees C at 70 degrees OAT. Oil cooler is a Corvair type mounted forward of the left front cylinder. Max rate of climb is 1250 fpm. Construction cost is $4000 in eight years. First flight 21 December 1975. Empty weight 947 pounds. Most forward cg at STA 63.0. Most aft cg 69.96. Empty cg 60.32. Gross weight cg 67.3.

C-GRAF #644 FLIES: R. A. Froebel, 54 Cumber Avenue, West Hill, Ontario, M1E1T3. I first flew my Thorp on September 28, 1975. That day was also my oldest son's birthday and my youngest son won $100 in the Olympic Lottery. Good things seem to happen in bunches. There is really no way to describe a first flight on an aircraft that you have constructed yourself so I will not try. I purchased the plans from John late in the fall of 1968 and then working on and off again, my three sons (Eric 14, Mike 15, and Peter 17) and I finished it late in August. I estimate that it required about 4 1/2 years of steady part-time work since there were several long periods when we did not even look at it. As far as cost goes I do not know. I have yet to add up all the bills. It has got to be more than $6000. If we had some spare money we would spend it on parts. If we did not have it we did not spend. It is essentially a stock Thorp with a good smattering of stock 1966 Mooney Mark 21. We bought a wreck and salvaged many, many parts from it including a full panel, radio and engine.

Basic Details of T-18 #644: Engine: Lycoming 0-360-A1D 180 hp (carb: MA4-5); Propeller: Sensenich wood 68LY82. More on this later; landing gear: Jenkins, 2 1/2 inches longer;

tail gear: Thorp steel spring made by local auto spring shop, $8; cowl: John Thorp. All snap-locked together and to the fuselage; engine mount: Dynafocal, John Thorp. Mounts: Lord from the Mooney, reversed; canopy: Gee Bee, clear; spinner, tips and wheel pants: Rattray; radio: Narco Mk 12A 90 channel plus 100 nav channels; panel: full, vac. & elec. driven, plus fuel press, man, press, g-meter, vac gauge and volt meter. Also cylinder head temperature; miscellaneous: remote ELT with panel switch, rotating beacon, Alumigrip paint done by my sons and I; mufflers both sides with muffs for cabin heat; carb heat off cross-over exhaust pipes; air intake highly modified Thorp with 360 cubic-inch 300 hp auto air filter. Hot air also filtered; small access door right center fuselage for battery and ground-power plug, snap-lock fastened (booster battery a must below -10 degrees); pitot-static right wing 18 inches ahead of leading edge; VOR antenna inside canopy works well saves eyes; fully upholstered including indoor-outdoor rug on the floor, all panels including floor and firewall deadened with sticky lead tape (8-10 pounds) before upholstering. All AN flush riveted except key structural elements front sides of fuselage.

Weight and Balance Data from C-GRAF #644: Empty weight: 950 pounds; empty cg STA 63.52; most forward cg pilot, full fuel STA 64.68; most rearward cg pilot, pass, zero fuel plus 64 pounds of baggage STA 71.00. Now to bring things up to date. We finished the thing late in August, had big launching party on September 13 and hauled it out to the airport the next day. (Oshawa Airport, 20 miles east of Toronto.) We assembled it, checked everything over for the third time, did some taxiing and waited for the MOT inspector to come and give us the go ahead. He came finally, pointed out a few little things he did not like which we were able to correct in an hour or so and then we got our flight permit for the first 50 hours: no passengers, no aerobatics, day VFR only and 25 nm radius from the airport. Next I had to wait for the proper day. Oshawa is a controlled and rather busy place most of the time. I did not want to have to talk to the tower or look out for Cessna 150s so that meant an early morning flight. Meanwhile we did some more high speed taxiing. Bad shimmy in the tail wheel. Tightening up the friction screw fixed that. Finally got up at 0500 hours on September 28 and looked outside. It was clear, temperature 10 C and you could see a million miles--the sun was just coming up to the horizon and not a breath of wind. Told my wife that this was the morning she went back to sleep and I went to the airport. We did not tell the boys. Got to the airport and it was just me, C-GRAF and a bunch of seagulls (just a couple of miles north of Lake Ontario). Just looking at her for the umpteenth time I knew she would fly. Another couple of high speed runs, lifted it off a couple of times and it did not seem to have any bad tricks. One more run to clean off the seagulls from Oshawa's (3500') runway and away we went. Absolutely indescribable--we were at circuit altitude before we were ready to turn downwind. Kept climbing to 4000' still directly over the airport. At 4000' we very carefully turned off the electric fuel boost pump and the engine pump carried the fuel just fine, though at 3.8 instead of 6.0 psi. All the temperatures and pressures were just fine and she was flying at about 125 indicated at about 2000 rpm and 19 inches. Next for some slow flight and stalls. Stalls in an exceedingly nose-high attitude at about 60 indicated without flaps, rapid right wing drop and fall through recovered in about 400' that first time. G-meter tell tale read -0.5. Did a couple more stalls, no flaps and same results but recovered in about 300'. Now it was time to land it. I figured that if anyone ever stalls this airplane below 500' he has had it so I decided to approach at 90 mph with power about 1300-1400 rpm. (Editor's Note: To cure the right wing drop off he simply needed to add a four-inch stall spoiler three feet out each center section.) No problems, crossed the button at 85 indicated, power off and eventually hit tail first. No problem controlling it. I stopped and took off again more to convince myself that I had really built an airplane and that it was flying than for any other reason. Landed again uneventfully but not well, tied it down and went home for breakfast. It was 0730.

Later the whole family came out and we flew it again with many witnesses. We had 50 hours on it by November 29, 1975 including a climb test which the MOT requires before they will give you the final flight permit. The climb test has to be at full gross with the density altitude reduced to standard day conditions. I decided to make this a careful full load handling check as well as the climb test so we started out by loading in 50 pounds of scrap iron, flying it and then 50 more pounds of scrap and so on up to 225 pounds. No problems at all though she handles somewhat differently. Finally the climb test at full gross. According to the MOT requirements I had to be able to climb at least 1210 feet in three minutes. My measured climb in three minutes was 3800 feet. Took all the paper work into the MOT last week and got my final flight permit without restrictions. I can now go anywhere in Canada, VFR and no aerobatics, and carry passengers. The test period was completely uneventful except for a sheared vacuum pump drive (new pump required).

The longer gear makes the airplanes a little softer on the ground and gives more prop clearance. The steel tail gear makes all the difference in the world. I have flown Fred Kracht's Thorp CF-YEI a lot and early on we had the aluminum tail spring on it. When I got my steel one made up we got two and changed Fred's as well. That aluminum one should be banned. In my opinion it is part of the problem why people have trouble on roll out in the Thorp. I have the large Maule tail wheel on mine and that helps too as the tire is pneumatic and quite soft. I went to the large tail wheel because of the large engine. However I did not need it for that reason. I have only one complaint about the plane and I am not sure if it is my piloting or the plane itself. I find it very hard to three-point land well. The tail wheel almost hits first with a resounding thump of the front wheels shortly thereafter. I have pretty well given up three-point landings and now do almost all wheel landings which are relatively easy. If I can ever find a really good tail wheel instructor I am going to ask him to come up with me and we will try some three pointers. (Editor's Note: Try using full flaps. Makes a world of difference.)

I do not have much performance data yet. Partly because I have not had the time yet to lay out a really good measured course and partly because I am not sure how good my airspeed indicator is particularly at the top end. I compared it with the local Citabria one day and it appeared to be about 7 or 8 mph low but that is not much of a check. The maximum speed that I have been able to get on the deck (500' indicated) is about 180. At this speed the control forces are exceedingly high (much higher than in CF-YEI) so I think that I might be going a little faster. I have not taken it faster than 195 in a dive for this reason. I did one altitude cruise check on a leg about 125 miles long. For this leg, which I flew at 10,500 indicated, I had an IAS of 137 which gave me a TAS of 176 mph at 2300 rpm and 18 inches. At this power setting I was fully leaned out and my fuel consumption was 6.5 gallons (imperial) per hour.

Now for that propeller. It is the standard Sensenich with metal edges 68LY82. I believe it is slightly too much prop for this engine. At a density altitude of 50 feet, 29 inches (on my manifold pressure gauge) the max rpm that I can get static is 1950-2000. This is less than 50% power. I believe this checks out because it takes me abut 700 to 800' to get airborne, paved runway, zero wind. By lift off 75-80 mph the rpm is up to about 2250. I get max rate of climb at about 110 indicated (1600-1700 fpm with just me) but the rpm will not go above 2350. I have to get above 6000 feet to get 2700 rpm at full throttle. On the deck full power the best rpm is about 2550-2600. At 1000' my best climb would appear to be about 105 indicated and the rate of climb is just over 900 fpm. I am in a bit of a quandary as to what to do about this propeller. As a cruise machine it has got to be the cats whiskers. However, she is not going to be much good for short field work or high altitude fields especially at full gross.

The engine came from the wrecked Mooney. It had only 1100 hours total time on it so I thought that I would simply pull it out, check the crank and stick it in the Thorp. One of the cylinders had some broken fins which I thought I could get welded. Oh how wrong one can be. I put a dial indicator on the front flange of the crank it was off about 13 thou, not bad considering that the Mooney went through a ditch and live at Stellar Airpark, a community of houses on a private airport. We have taxi ways to the back of our houses and most have planeports or hangers on our own lots. I started the T-18 December 1966 and it took nine years. I worked pretty fast the first two years or so. Then I got involved in building houses (after my normal working hours). I am on my fifth house now. I do not think I would have finished it at all without the Newsletters. It seems someone already solved all my problems before I got to them. I have read them probably twenty times over.

S-18 MATERIALS LIST: by L. D. Sunderland (Nov. 1986)

I have just begun construction of an S-18 fuselage and have made a rough layout of all sheet metal parts to determine the amount of each type of aluminum sheet required for the entire airframe. The following list of sheet metal materials should be of assistance to those just getting started on an S-18 project. It should be noted that this list is preliminary and it requires some overlapping of parts to conserve material. For example, if one side skin is laid out with WL42 parallel to the long sheet edge and with the top of the skin against the sheet edge, then a second side skin can also be cut out of the first 19 feet of a four-foot wide roll of 0.025 2024-T3 alclad sheet. Air-Parts from Kansas City sells sheet in any length rolls, so the side skins won't have to be spliced. I bought rolls of 0.025 in 40-foot lengths for convenience in shipping. To get the bend out of the sheet material, just roll it up in the opposite direction and squeeze tightly.

S-18 Sheet Aluminum Material List for Complete S-18

0.025 2024-T3	95 feet x 4 feet wide roll
0.025 6061-T4	10 feet x 4 feet wide
0.032 2024-T3	26 feet x 4 feet wide
0.032 6061-T4	2.5 feet x 4 feet