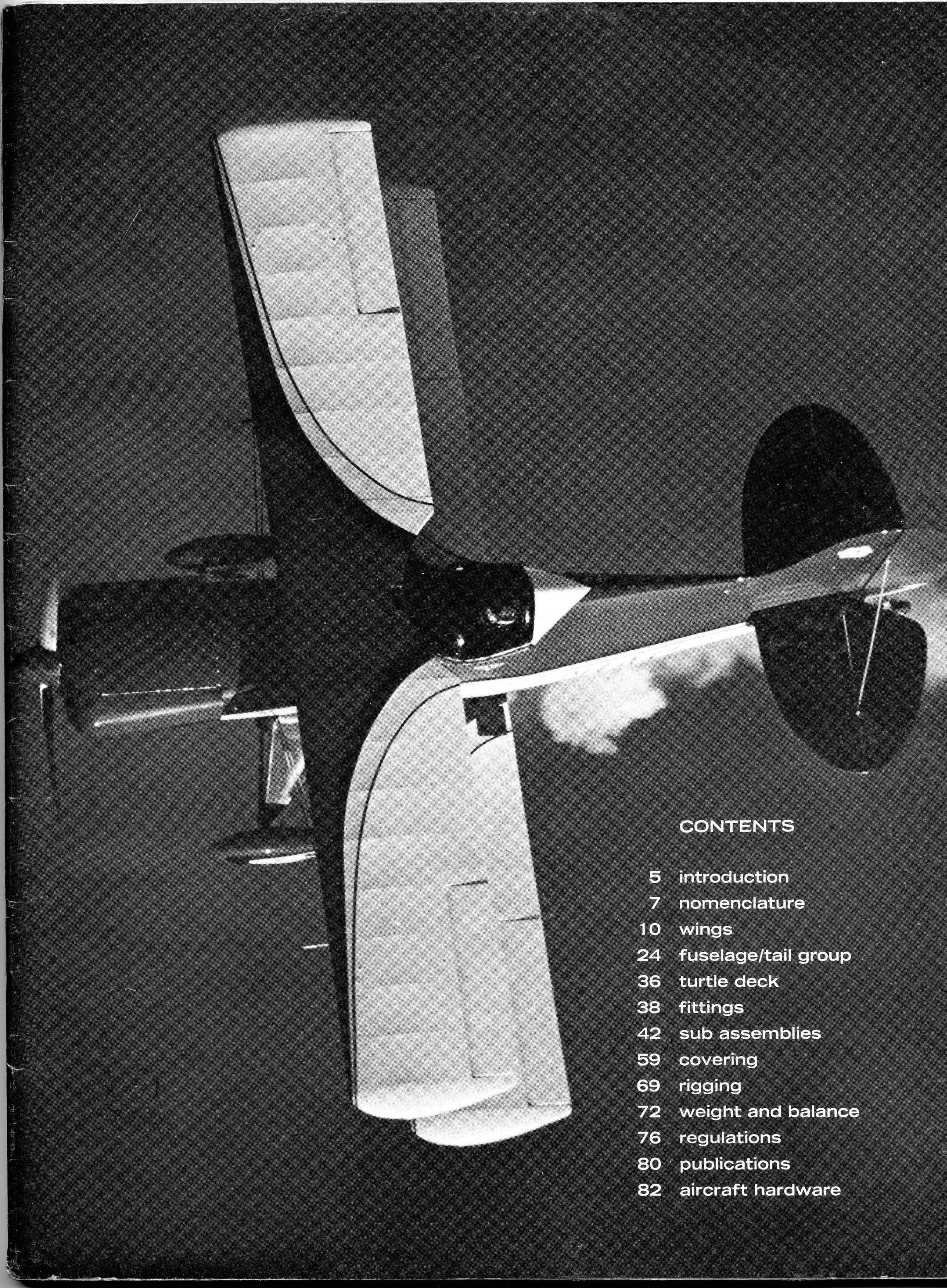
HOW TO BUILD THE acro SPORT

a custom airplane



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introduction

Looking for the ultimate in a home or school workshop project? Then perhaps building your own sporty little airplane might appeal to you. Impossible? Not at all.

Ever since the days of the Wright Brothers and Glenn Curtiss men have been fashioning good, serviceable airplanes in basements, garages and similar informal factories.

In the last ten years, more and more aviation enthusiasts and schools have been building their own — partly for the thrill of accomplishment and partly to provide themselves with an aircraft suitable for educational as well as recreational flying, since aircraft factories now turn out high priced executive machines.

For the industrial arts program, the light airplane, its construction, its many and varied attributes, can aid tremendously in the finding of oneself. Unlike the bread board, foot stool and such other projects, the building of an airplane offers variation of skills and above all appreciation of craftsmanship, a rapidly diminishing art in this fast growing world of today.

For the school it is not the purpose entirely to prepare young men or women for positions in aviation industry. But the many skills such as woodworking, welding, sheet metal, engine work, hydraulics, drafting and especially the team work of working together can help one find his or her place in our working society — whether it be in the trades or aviation itself.

For the individual aviation enthusiast working at home — whether in his basement, garage or attic — the self-education aspect of constructing a lightplane can only make our country richer — and his talents an asset.

Basically it is easy enough, for the materials used are light, handy and readily formed and there is a wealth of mechanical literature available in how-to-do aircraft work. Yet, the job is still a challenge. For workmanship must be excellent and all dimensions accurate. Mainly, it is a matter of being patient and methodical rather than of unusual manual dexterity.

Late 1976 saw more than 5,200 homebuilt airplanes flying and some 12,000 under various stages of construction. Safety of the amateur built aircraft is well recognized, for insurance can be obtained on most amateur built aircraft for the same rates offered to factory built aircraft.

This little biplane can be powered with popular light aircraft engines ranging from 85 to 180 horsepower class. With less power than that, takeoff climb as well as performance will be unsatisfactory. If the upper horsepower limit is exceeded, engine weight may unbalance this design and speed may over stress the structure.

Each amateur airplane building project costs a different sum and takes a different length of time — depending on the individual, his ability in finding material at favorable prices, and, of course, his working pace. Today, we have many suppliers of materials for the construction of light aircraft. EAA's house organ, SPORT AVIATION, lists the most reliable concerns.

If you work diligently nights and weekends, it could be flying inside of a year. If you take time out for a typical round of family and social activities, the project may take two to three years, but when it is all done the plane will prove to be the high point of your life and you will feel satisfaction is very much worth the effort.

For the high school project or Civil Air Patrol group, the completion of an airplane, one that students have constructed themselves, has been the highlight of their early lives. Having been privileged to test fly several aircraft constructed by high school students as part of their industrial arts education, I have always been thrilled by the enthusiasm of young men who, from tubing, wood and aluminum, have created something that suddenly came alive.

The educational plans given here have been thoughtfully worked out with emphasis on the growing interest and developing talents of our citizens through aircraft construction. A great amount of credit must be given to our EAA Air Museum Foundation and maintenance staff under the supervision of W. "Bill" Chomo in the successful completion of the prototype EAA Acro Sport and to Bill Blake for his excellent drawings. Yours truly has put a number of enjoyable hours in the air in this machine and was privileged to make the very first test flight.

I have found the prototype to be a pleasant airplane with flight characteristics suitable for the average licensed private pilot. Its roomy cockpit will provide comfort for the well over 200 pound and 6 footer pilot. Its wide landing gear provides ease on landing and ground handling. Its almost 20 foot wingspan provides more than adequate wing area and stall characteristics have proven excellent. A book could be written about building this airplane — the second best thing we can do is refer the prospective builder to literature which will supplement this article.

The Experimental Aircraft Association's publication list contains many manuals on wood working, metal, welding, hand tools, aircraft covering, engines, etc. For example, the Civil Aeronautics Manual 18 which explains approved methods of making structural detail such as splices in tubing and wood, stitching fabric to the framework, safety nuts and bolts, etc..

When working on the steel tubing of the fuselage and tail group, the manual on EAA Aircraft Welding will be invaluable. These are but a few of the manuals that the EAA Air Museum Foundation has made available.

The EAA member's monthly magazine, SPORT AVIATION, keeps the amateur aircraft builders posted on all phases of their educational endeavors and regularly features informative and technical articles.

It is essential that only aircraft grade materials be used in this plane. Non-aeronautical materials may resemble aircraft quality products superficially but there are great and important differences. Chrome-molybdenum steel tubing — known as 4130 among airmen — after a society of automotive engineers SAE specification number, is stronger than common mechanical steel tubing and is formulated to weld readily. It is manufactured to much higher standards in regard to uniformity of wall thickness, its absence of scratches and surface defects and straightness.

Nickel steel aircraft bolts, identified by AN* like mark forged on the heads, are much stronger than common bolts. They are machined more accurately and are individually inspected.

Aircraft spruce is cut from selected trees to meet high standards of grain uniformity and absence of defects and is kiln dried to lower moisture content in a way to increase its cell strength making it more dimensionally stable and to insure reliable gluing.

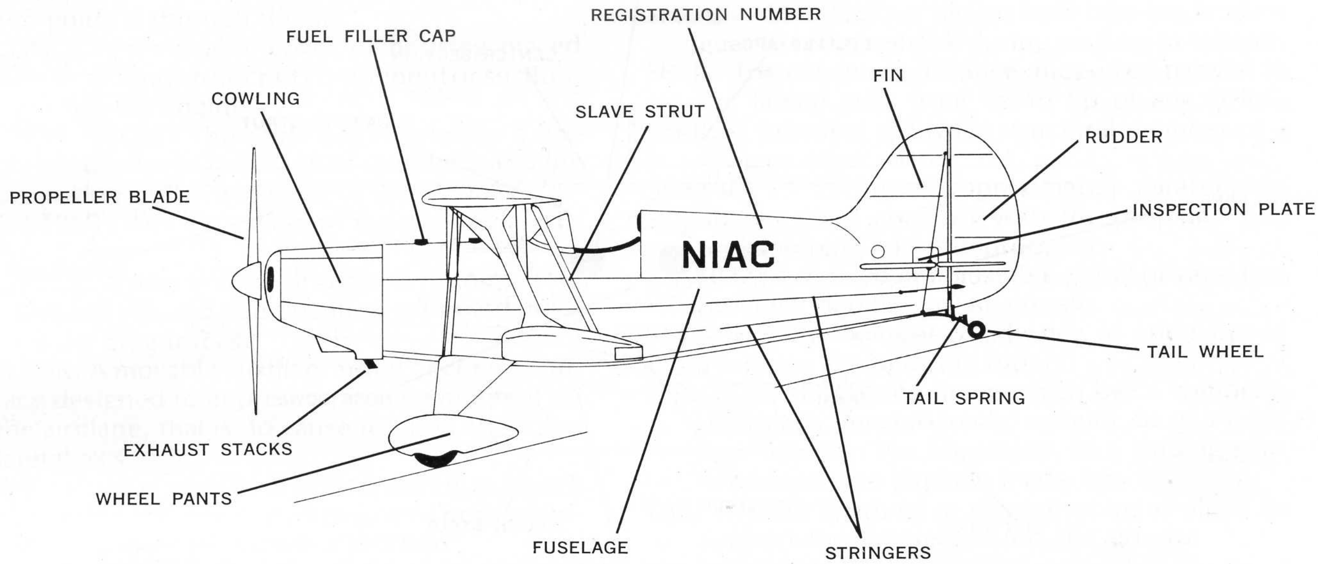
Cotton and linen aircraft fabric made of selected long fiber raw material specifically designed and woven to have high tear resistance to stretching under air pressure, is carefully cleaned of oil and wax to insure that the plastic like liquid called "dope" will adhere. It is woven with controlled tension so that the dope will penetrate the weave enough but not so much as to cause excessive tightening which might distort the framework.

Other synthetic fabrics such as Ceconite® Fiberglas® and Stits Polyfiber® covering processes are also acceptable. These are but examples of aircraft materials from everyday goods. Now you understand why only aviation supplies are to be trusted.

When starting your project, it is essential that you obtain an amateur built aircraft log book, available from EAA Headquarters. It will provide for documents, history of inspections and materials used during your construction period. When buying items, save purchase receipts to prove to the FAA Inspector that aircraft grade material has been used, and when you have decided definitely to build a plane, get in touch with your area's FAA Maintenance Agent. Any airport will know where to direct you. Notify FAA of your plans because amateur built planes in recent years have had a fine safety record and the educational sport is doing much to stimulate public air mindedness. The FAA approves of the activity and the reason for notifying local agents is so that the FAA will know what is going on and offer such friendly advice as an agency may deem necessary.

You are going to have to deal with the FAA before the project is completed — several times. So it pays to get acquainted early.

Paul H. Poberezny — Designer of the EAA Acro Sport



nomenclature

AILERON: One of a pair of movable control surfaces attached to the trailing edge of each wing tip, the purpose of which is to control the airplane in roll by creating unequal or opposing lifting forces on the opposite sides of the airplane.

AIRFOIL: Any surface, such as an airplane wing, aileron, or rudder, designed to obtain reaction from the air through which it moves.

ANGLE OF ATTACK: The angle at which an airfoil meets the airflow. It may also be described as the angle between the chord line of a wing and the relative wind.

ANGLE OF INCIDENCE: The acute angle between the chord of an airfoil and the horizontal axis of an airplane.

ANGLE OF STABILIZER SETTING: The same as the angle of incidence as applied to a vertical or horizontal stabilizer.

ANGLE OF WING SETTING: The same as the angle of incidence.

ANTIDRAG WIRE: A wire running from an inboard point near the trailing edge of a wing to an outboard point near the leading edge, designed to resist forces acting on the wing in the direction of flight.

ANTILIFT WIRE: Same as a landing wire.

CABANE: An arrangement of struts such as those used to support a wing above the fuselage of an airplane.

CAMBER: The curvature of the mean line of an airfoil or airfoil section from leading edge to trailing edge.

CENTER OF THRUST: A line coincident with the center line of the propeller shaft, about which the thrust forces are balanced.

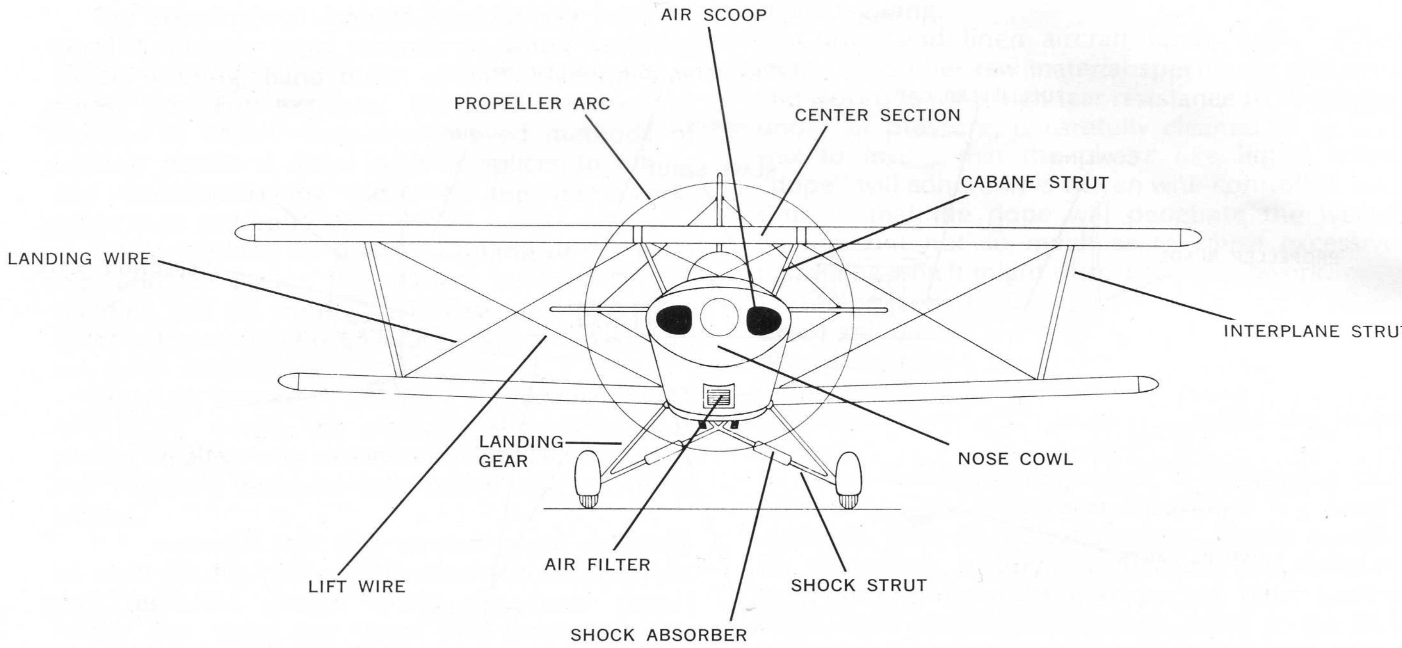
CENTER SECTION: The middle or central section of an airplane wing to which the outer wing panels are attached.

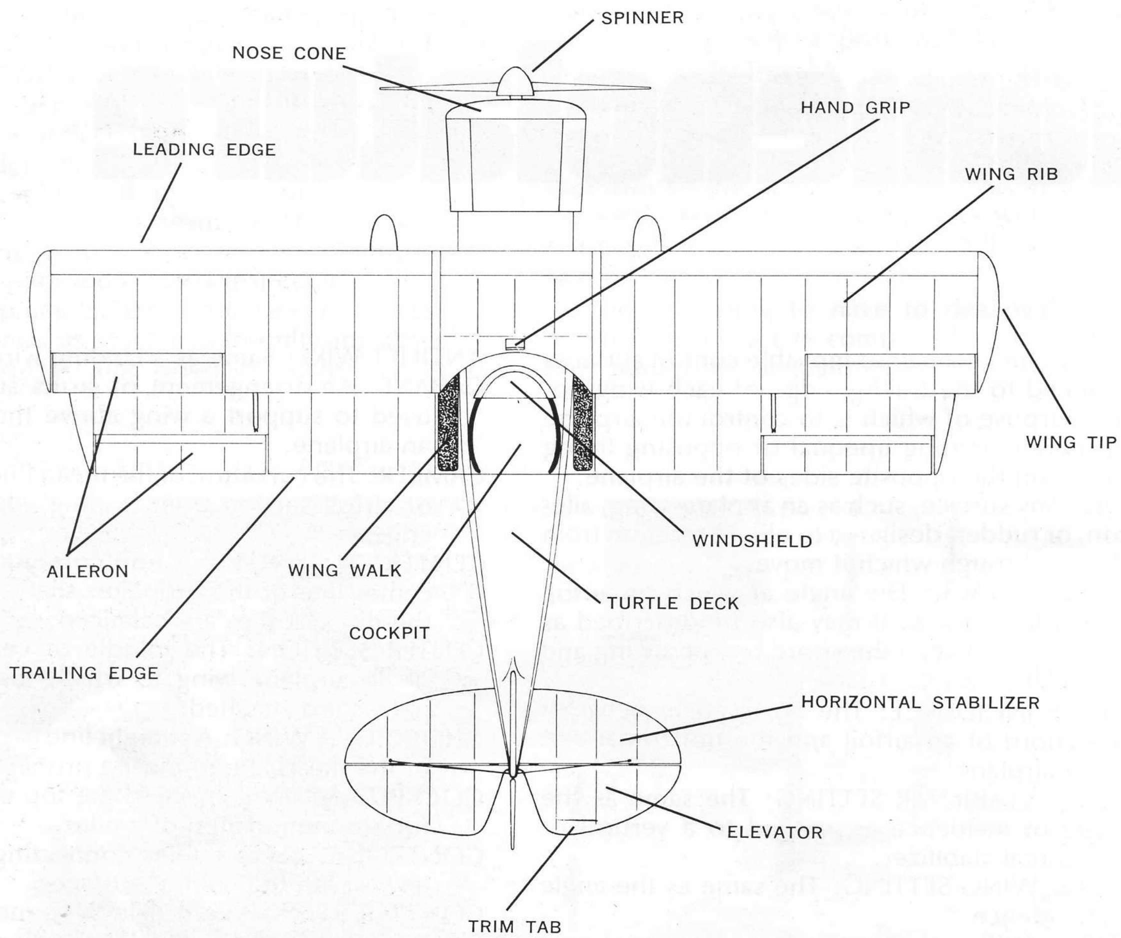
CHORD OF A WING: A straight line joining the ends of the mean line of a wing profile.

COCKPIT: An open space in the top of an airplane for accommodation of a pilot.

CONTROL CABLES: Cables connecting the control levers with the control surfaces.

CONTROL STICK: A vertical lever by means of which the pilot operates the longitudinal and lateral control surfaces of the airplane. The elevator is operated by a fore-and-aft movement of the stick, and the ailerons are moved by a sideways movement of the stick.


AIR SCOOP
PROPELLER ARC
CENTER SECTION
CABANE STRUT
LANDING WIRE
INTERPLANE STRUT
NOSE COWL
LANDING GEAR
AIR FILTER
LIFT WIRE
SHOCK STRUT
SHOCK ABSORBER


SPINNER
NOSE CONE
HAND GRIP
LEADING EDGE
WING RIB
WING TIP
WINDSHIELD
AILERON
WING WALK
TURTLE DECK
COCKPIT
TRAILING EDGE
HORIZONTAL STABILIZER
ELEVATOR
TRIM TAB

CONTROL SURFACE: A movable airfoil or surface, such as an aileron, elevator, or rudder, used to control the attitude or motion of an airplane and guide it through the air.

COWLING: A removable cover or housing placed over or around an aircraft component or section, especially an engine.

DIHEDRAL ANGLE: The acute angle between a line perpendicular to the plane of symmetry and the projection of the wing axis of the airplane.

DRAG STRUT: Any strut used to resist drag or anti-drag forces.

DRAG WIRE: A wire in wing structures, running from a forward inboard point to an aft outboard point to resist drag forces.

ELEVATOR: A movable auxiliary airfoil or control surface designed to impress a pitching moment on the airplane, that is, to cause rotation about the lateral axis.

FAIRING: A piece, part, or structure, having a smooth streamlined contour, used to cover a nonstreamlined object or to smooth a junction.

FIN: The vertical stabilizer.

FIREWALL: A fireproof or fire-resistant wall or bulkhead separating an engine from the rest of the aircraft structure to prevent the spreading of a fire from the engine compartment.

FUSELAGE: The main or central structure of an aircraft, elongated and appropriately streamlined, which carries the pilot and to which the wings are attached.

GAP: The distance between the chords of two superimposed airfoils.

HORIZONTAL STABILIZER: A stabilizer mounted horizontally on an airplane affording horizontal stability and to which the elevators are attached.

HORN: A short lever fastened to a control surface to which an operating cable or rod is attached.

INSPECTION DOOR: A small door used especially for inspection of the interior of an airplane.

INTERPLANE STRUT: A strut between two wings or other surfaces.

LANDING GEAR: The understructure which supports the weight of the airplane.

LANDING WIRES: Wires which brace the wings against the forces which are opposite to the normal direction of lift. These wires attach to the upper wing above the fuselage and to the lower wing near the outboard end.

LEADING EDGE: The foremost or front edge of an airfoil or a propeller blade.

LIFT WIRES: Wires which brace the wings against the forces of lift. They are also called flying wires.

LONGERON: A principal longitudinal (fore and aft) member of the framing of an airplane fuselage, continuous across a number of points of support.

PROPELLER BLADE: That portion of a propeller which cuts the air.

PROPELLER HUB: The part of the propeller that comes into contact with the shaft.

RUDDER: A hinged or movable auxiliary airfoil used to impress a yawing moment on the aircraft.

RUDDER PEDAL: Either one of a pair of cockpit pedals for operating a rudder or other directional control device.

SHOCK ABSORBER: A device built into the landing gear to reduce shock during landing or takeoff.

SPAN: The maximum distance, measured parallel to the lateral axis, from tip to tip of any airfoil.

SPAR: A principal spanwise structural member of a wing or other airfoil.

SPINNER: A fairing of approximately paraboloidal shape, fitted coaxially with the propeller hub and spinning with the propeller.

STABILIZER: A fixed or adjustable airfoil or vane that provides stability for an aircraft.

STAGGER: The amount of advance of one wing of a biplane ahead of the other.

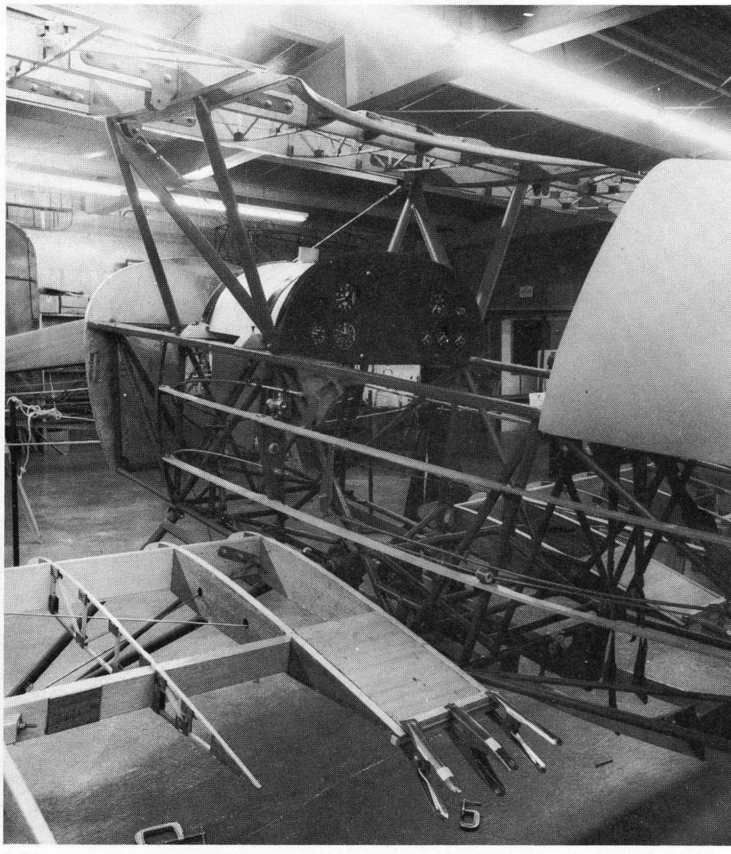
STRUTS: A supporting brace which bears compression loads, tension loads, or both, as in a fuselage between the longerons, in a landing gear to transmit the airplane loads, etc.

TAIL WHEEL: A wheel at the tail of an airplane to support the tail section on the ground. A tail wheel is usually steerable.

TRIM TAB: A tab attached to the trailing edge of an airfoil for the purpose of reducing the control force or trimming the airplane.

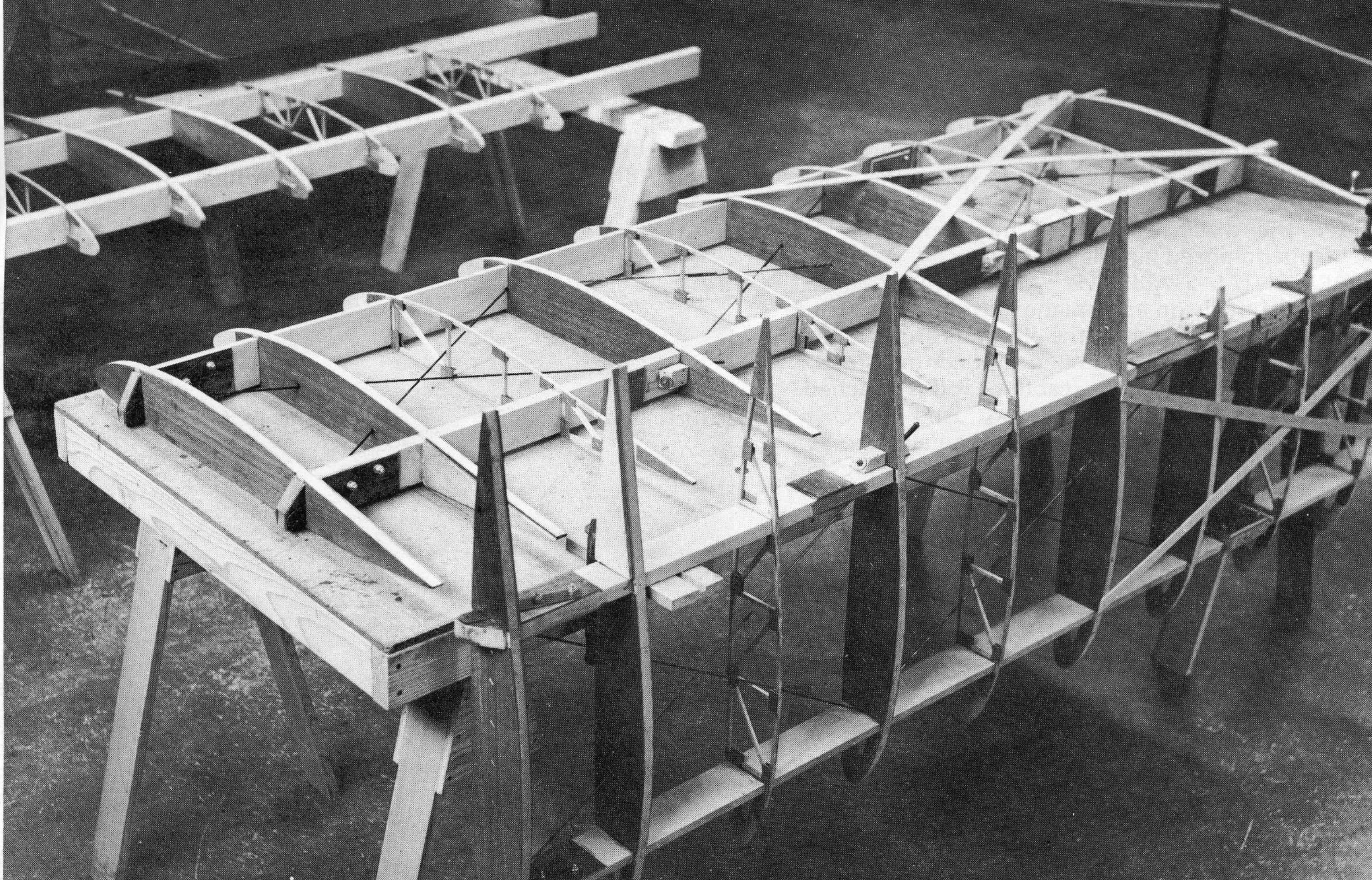
WING RIB: A chordwise member used to give the wing its shape and to transmit the load from the fabric or other covering to the spars.

WING TIP: The outermost extremity of a wing.



Note glue clamp holding wing walk plywood in position.

wings



Acro wing under construction.

It does not matter which component of a plane is built first. Many prefer to begin with the wings because a very modest investment in the materials will get you going. The drawings show how to make the wing rib jig which holds the several pieces in accurate relationship for the assembly. It is important that the outline of the rib section, called airfoil, be constructed accurately. The educational set of drawings available from EAA Air Museum Foundation include a full-sized detail rib and jig drawing and will insure accuracy and ease of working. Any deviation in the finished ribs over the plotted sections is quite apt to have a detrimental effect on performance and/or handling quality.

The airfoil selected for the EAA Acro Sport is the NACA M-6 which was developed in the wind tunnels and has had a long history of satisfactory performance in both amateur built and factory built aircraft.

If it is decided to make a wing rib first, select a piece of ¾″ plywood at least 40 inches long and wide enough so that the full size wing rib drawing can be placed on it. Many builders trace the full size rib drawing on to the wood building jig thus eliminating the need of wax at glue joints to prevent sticking to the paper.

Glue blocks of wood or excess wing rib material strategically along the curve, uprights and diagonals to hold the many rib pieces into proper position. These can be glued and nailed to the rib jig. The ribs are made out of ¼″ square spruce. You may purchase rib stock from a supply house or saw it out yourself from spruce boards. The plywood nose block is laid into position first. The upper and lower wing rib caps placed into position and the vertical and diagonal cap strips are cut to size and fitted into the jig. To save time it would be advisable to prepare one set and use that as a master, determine the number of each of the pieces and mass cut them, placing each into individual containers, numbering them so that a production line method can be established.

The plywood used for gussets is 1/16″ mahogany 3-ply material of aircraft grade which may have a light colored inner-ply of some wood such as birch. Aircraft plywood is made with special care to avoid hidden checks, splits and knots in the inner-plys and to perform the finished sandings so that both outer plys are of equal thickness thus producing a reliable stable material.

You will note in the wing rib sketch how the vertical and diagonal members are butted together. This is so the center line and hinge lines of force will all meet at one common point and achieve maximum rib strength. Gussets may be attached with Urea resin glues such as Weldwood or with resorcinol glue such as Elmer's Waterproof Glue. These brands are widely distributed and have proven satisfactory for airplanes. Other glues could be used but not until their suitability has been established. Follow mixing instructions carefully to get correct thicknesses.

Wood parts must lie flush and true. If spruce strips have been sanded — scrape areas to reglue. With a sharp edge of a piece of glass remove all sandpaper dust. Lightly scarify the surface of hard mahogany plywood to add adhesion. The tiny nails used to attach gussets add almost nothing to the joint strength and serve mainly to hold

To insure uniformity, wing ribs are built in a jig. All jigs necessary for construction of the Acro Sport are shown in the plans.

gussets in place and to create pressure. The adhesion of aircraft glues depends on pressures, not stickiness. Poorly fitting joints are those with inadequate pressures and will be pitted with pockets of glue which will be brittle and unreliable.

The use of a magnetized upholsterer's tack hammer to pick up and drive the tiny nails is ideal. Do not use substitute fasteners which could rust as rust spots lead to rotting which will weaken the slim wood strips.

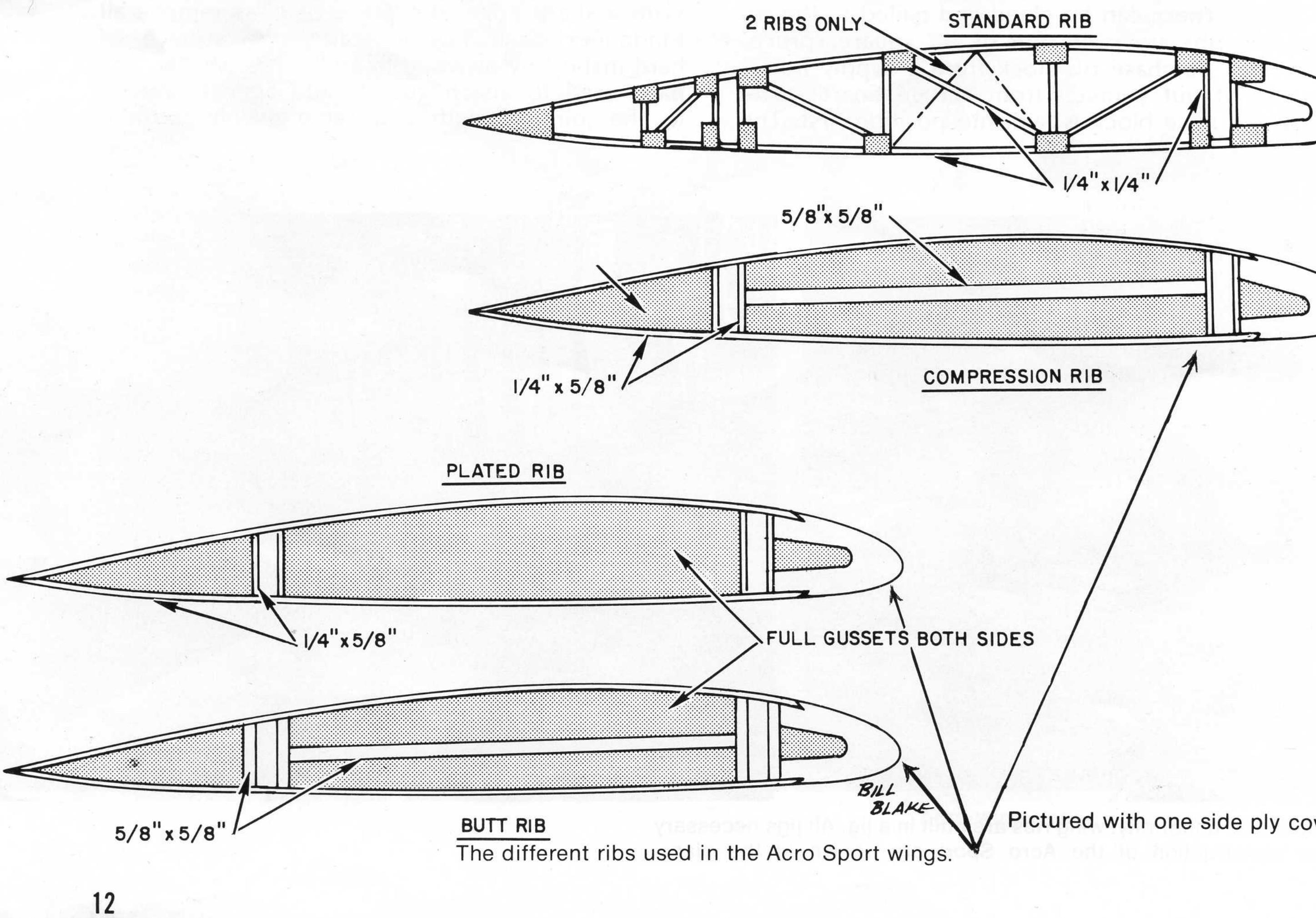
Apply all gussets to the upper side of the rib being careful not to split the cap strip when inserting the ½" aircraft quality nails. Remove the rib, turn it over and apply gussets to the other side. Go lightly on glue to avoid ooze droplets and so as to attain a craftsmanship quality.

Study the plans to see how many full ribs and how many aileron or shorter ribs to make and note also how the wing root ribs differ from others. When all wing ribs are finished, stack them together to see if all are alike. Cutting down on minor high spots on the cap strips of the stack pile with a sanding block is permissible provided, of course, that no cap strip is weakened. Many builders allow a little overhang of the wing rib gusset so that when the ribs are sanded the gusset is sanded down smoothly and fits flush with the upper and lower wing rib cap strip.

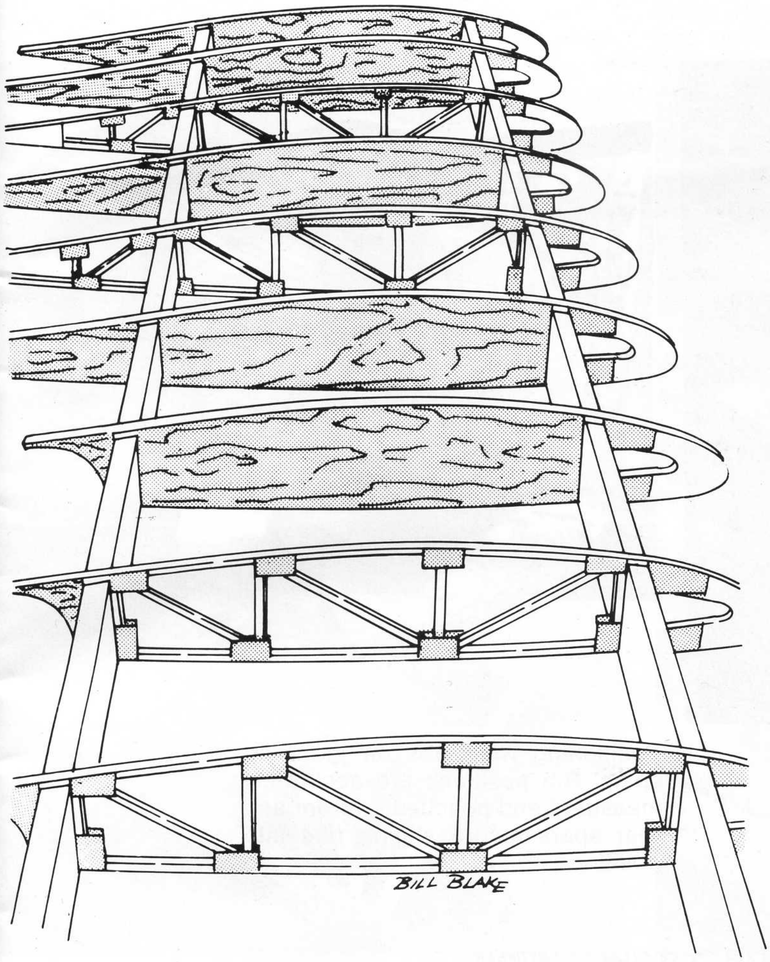
When preparing wing spars, great care in lay out and milling must be taken. Any firm supplyin aircraft spruce will usually saw and mill the roug stock to any specified thickness and width. The know the right cutters and speeds to use to get smooth finish. Many builders supply drawings an dimensions when ordering their spar stock. Then th material arrives ready for finishing touches. Remem ber, the wing spars are some of the most critica load carrying members in an airplane. It is recom mended that FAA certified Aircraft Grade Sitk Spruce be used. It is interesting to note that whe a wing spar is under bending loads or flight load there is compression on one edge and tension o the other. The neutral axis of a spar is the line wher there is neither compression or tension in the woo fibers and usually it is at the very middle or cente of the spar.

The birch plywood doublers that are glue on the spars keep bolts from pulling out along th grain of the spruce at the attach metal fittings — i such areas as where the outer wing struts attac and the metal wing fittings attach to the fuselage o the center section. These doublers or torsion plate must be firmly glued to the spar and can be secure either by nails or by clamps until the glue is dry Carpenters clamps are more than adequate and an surplus glue should be wiped off with a cloth befor it dries.

All bolt holes in spars must be as true an



The different ribs used in the Acro Sport wings.



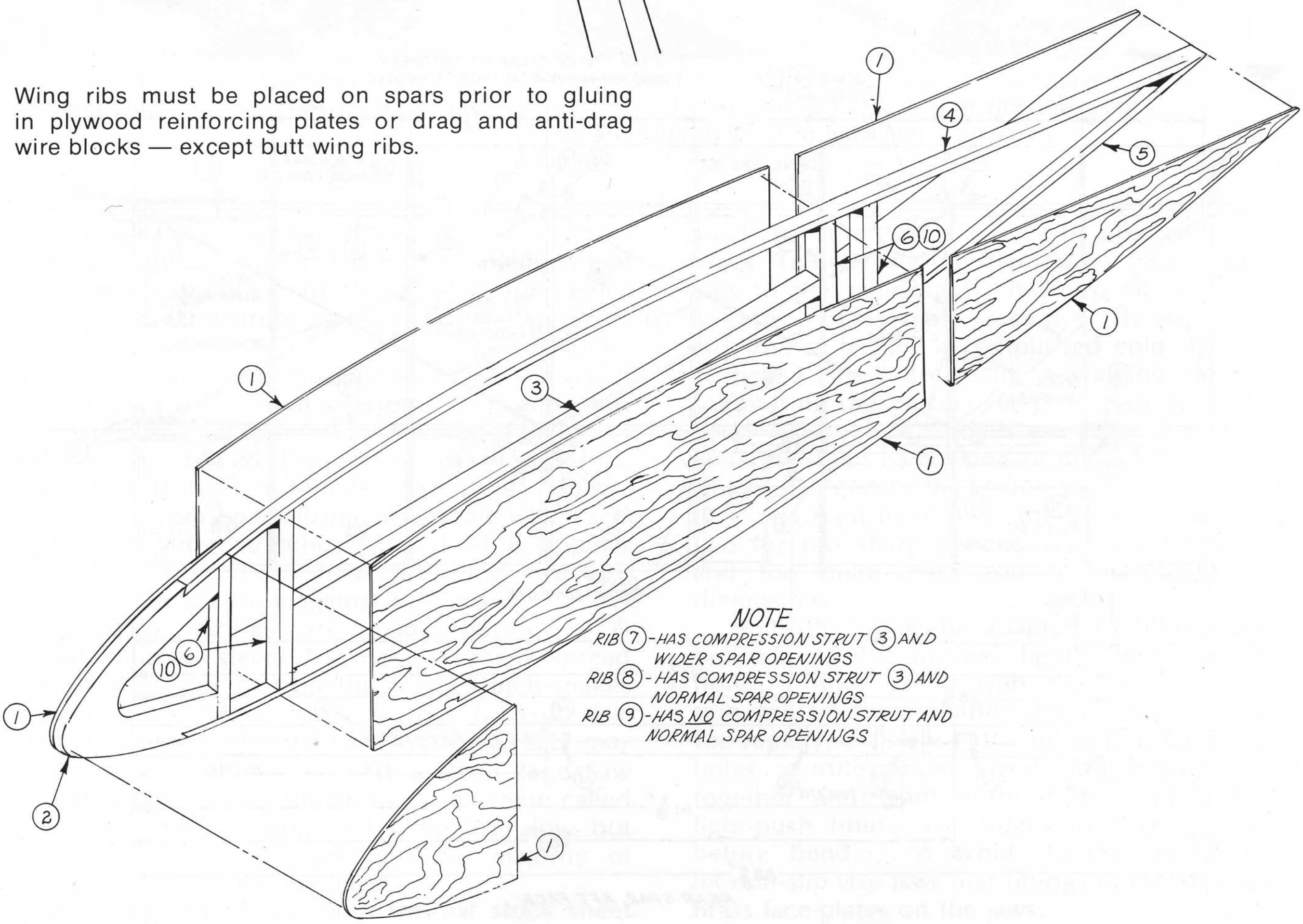
Wing ribs must be placed on spars prior to gluing in plywood reinforcing plates or drag and anti-drag wire blocks — except butt wing ribs.

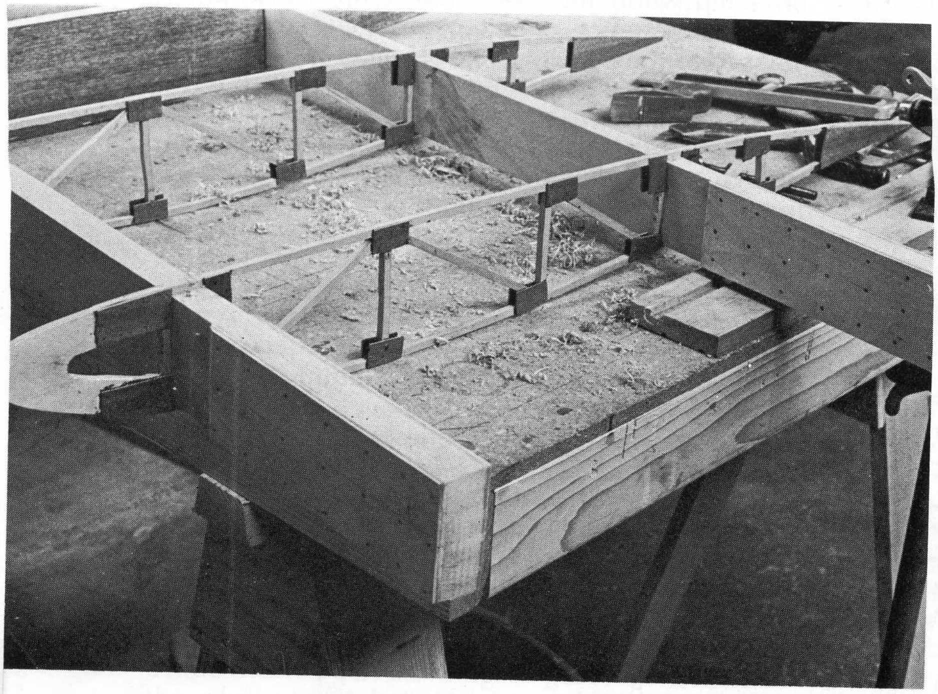
accurate as possible. One might consider practicing on scrap wood first. Do drilling on a drill press to attain accuracy. Don't use a hand drill. Spar holes and fitting holes must meet as perfectly as possible otherwise some bolts will do more work than others and crush or tear the wood. Rest the spar on a block of scrap wood and drill through into the scrap to avoid splintering the spar material when the drill breaks through. Run the drill at a high speed, make sure it is always sharp and feed it slowly to avoid tearing the wood fibers. Twist drills ground to a sharper point than is normal for boring metal make cleaner holes in wood. Boring patterns can be made from metal scrap stock and used to get accurate alignment in spacing in both spars and the steel wing fittings.

When boring right and left spars, take pain to get location and spacing of holes on each exactly alike so that when doing stalls the wing panels will be symmetrical and true, for if one wing panel was lower then the other, a greater lifting action would result causing the airplane to roll or turn.

The system of "X" wires in each of the wing panels, as noted on the drawings, are called drag and anti-drag wires and handle the fore and aft airloads on the wing system.

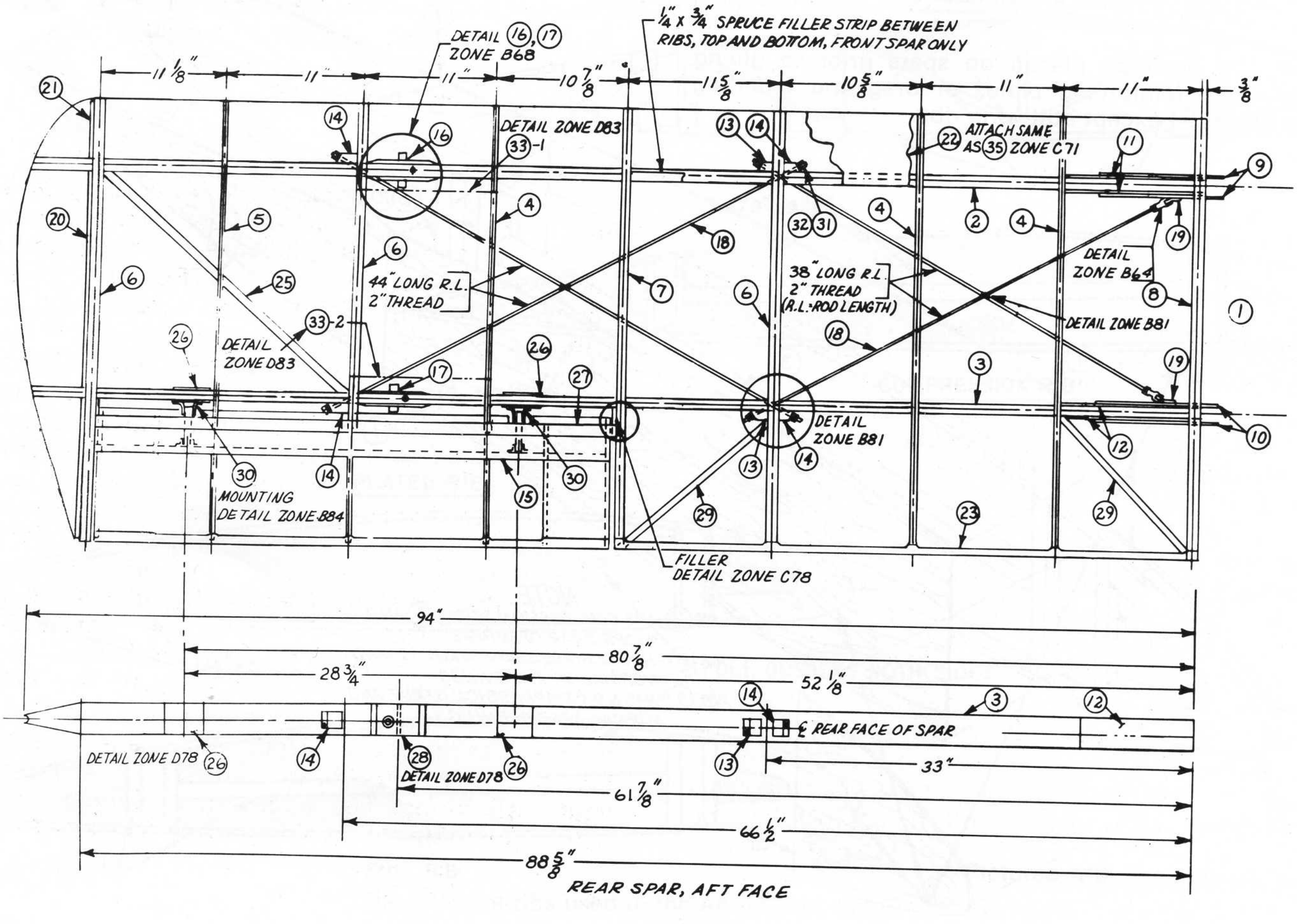
The compression struts fastened to the ribs are out of wood and are placed in areas where the drag wires go through the wing spars. Later



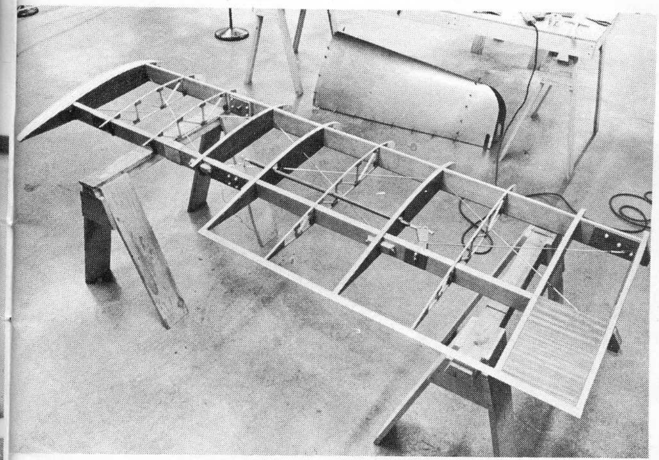


Acro wing under construction. Note plywood reinforcing plates glued and nailed into position. Wing ribs should be put on spar prior to gluing of plywood reinforcements on the spars.

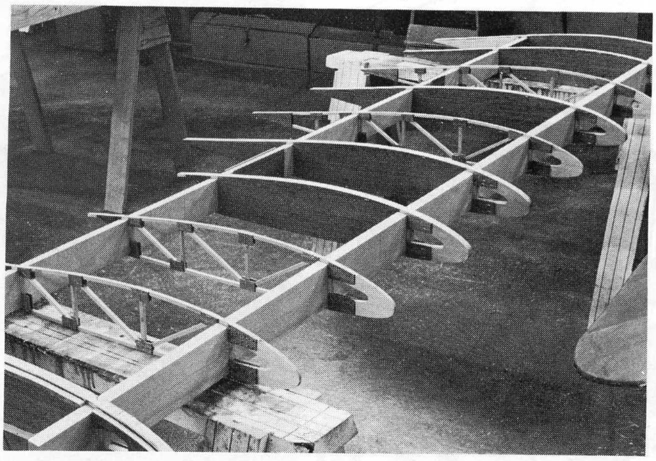
Positioning wing ribs on the wing spars. Rib positions are accurately measured and penciled on front and rear spars before sliding ribs into position.

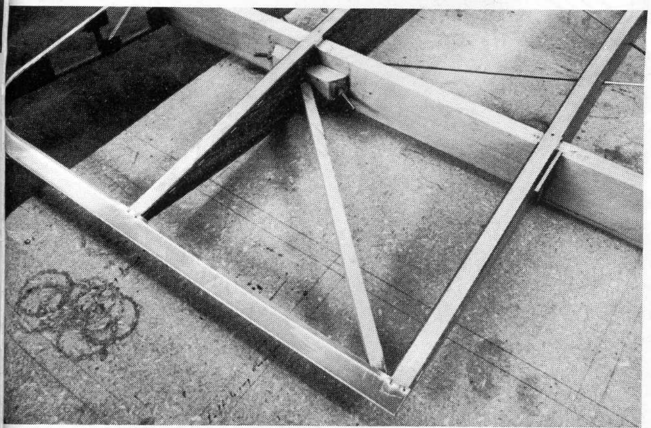


UPPER WING

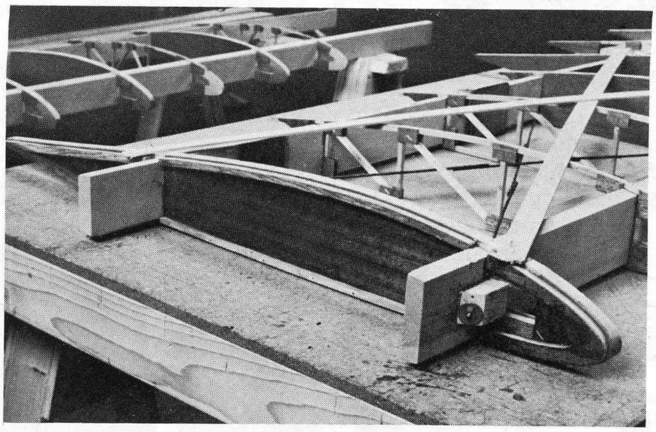


Wing ribs with compression ribs slid into position on the spruce wing spars.





Wing trailing edge attached top and bottom by ¼" aircraft nails.



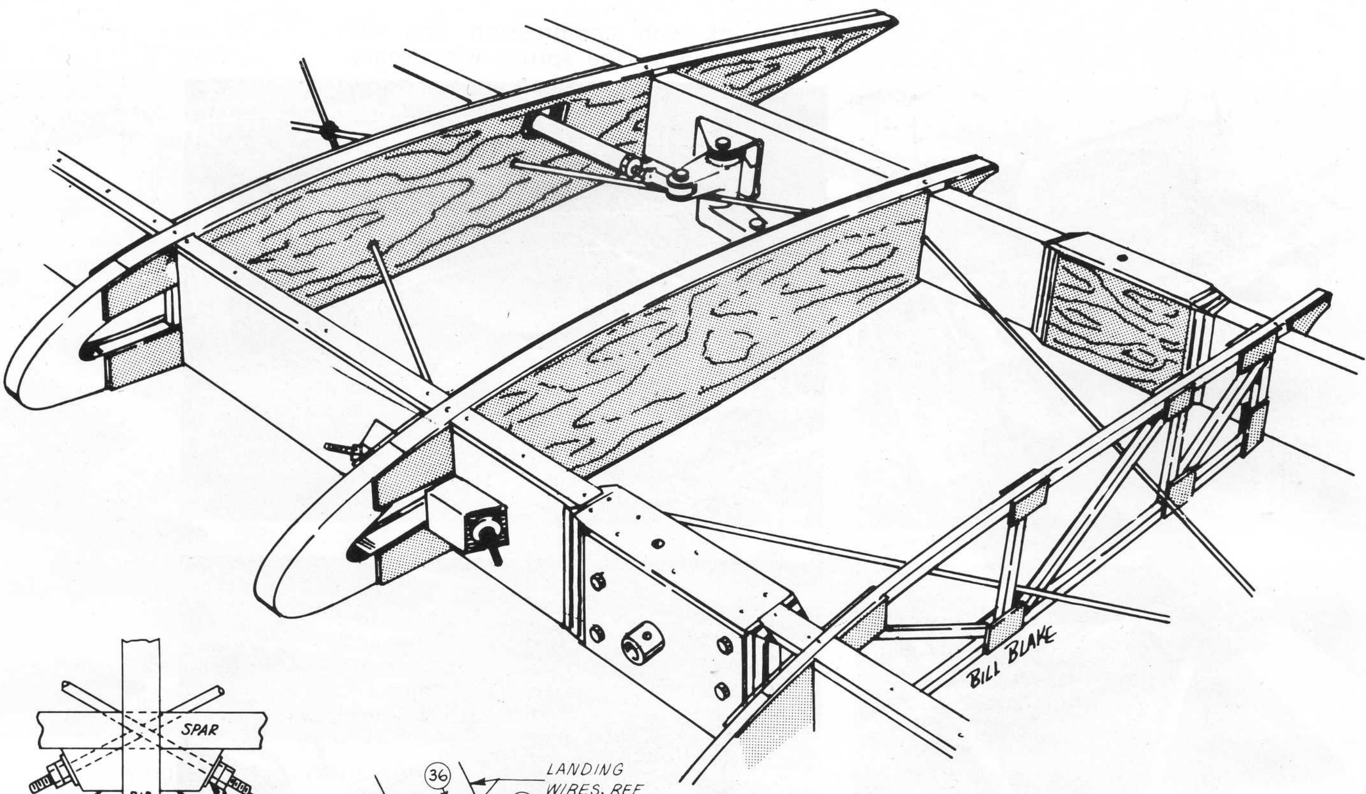
Wing tip prior to shaping spar ends and installing molded fiberglass tip. Strips across top of ribs are used to square wing by prior to installing drag wires.

these wires can be tightened and adjusted to square or trammel the wing so that perfect alignment of all fittings that attach to the fuselage or center section and wing struts are true. The trammel bar, which is made of two adjustable, pointed tools, is used to take accurate measurements between each bay of drag and anti-drag wires. Drag and anti-drag wires may be ordered to the proper length as well as streamlined flying wires from the Mac Whyte Company, 2906 14th Ave., Kenosha, Wisconsin. It is a firm specializing in aircraft wires and cable. The latter stretches when load is applied and will not serve to hold the wing structure in a rigid configuration against air loads.

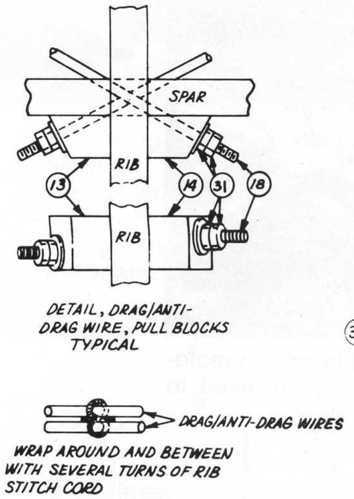
All wing fittings are made out of 4130 aircraft quality steel. To make fittings, spread machinist lay-out dye on the metal which makes scriber lines show up clearly. If you live near a commercial metal working shop, they may be able to cut fittings out with a Doall Band Saw or with a fast moving punch like a machine called a nibbler. Hack sawing and filing are slow but turn out very good work and the majority of homebuilders use this method.

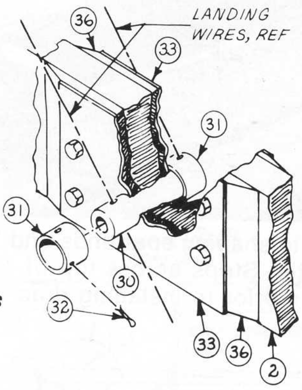
In laying out fittings onto the flat stock sheet steel, be sure that accuracy is adhered to at all times. Transferring the dimensions from the drawings to the appropriate thickness of sheet metal requires considerable accuracy. Bending where required is usually accomplished cold. If you try heating a small area with a welding torch and hammering the metal over progressively, a lumpy bend results. Small bends are made by clamping metal between hard wood or metal blocks, one of which is edged to the radius shown on the plans. It is important to observe the bending radii specified for too sharp a bend causes surface cracks and too mild ones lead to inaccurate fitting dimensions.

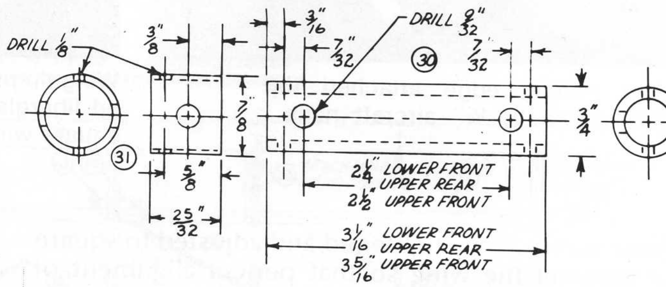
Bolts that must be adapted to fittings should be able to be pushed lightly into the fitting holes. If they go in with any looseness, vibration will let them shatter and elongate the holes too rapidly. Go slow — the finest practice is to drill holes a trifle under sized, put mating fittings together and ream both at once to a perfect light-push fitting. File edges to a smooth finish before bending to avoid starting cracks. Don't let non-slip vise jaws mar fittings or metal. Use soft brass face plates on the jaws.

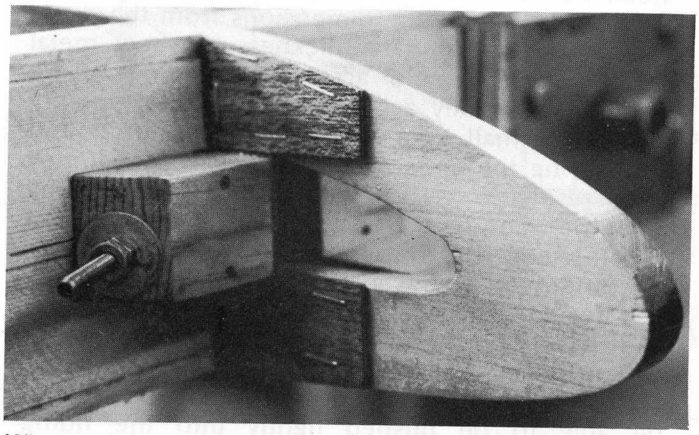


Lower wing of Acro Sport showing drag and anti-drag wires and blocks, aileron push pull tubes, short compression rib, and I wing strut attach point.

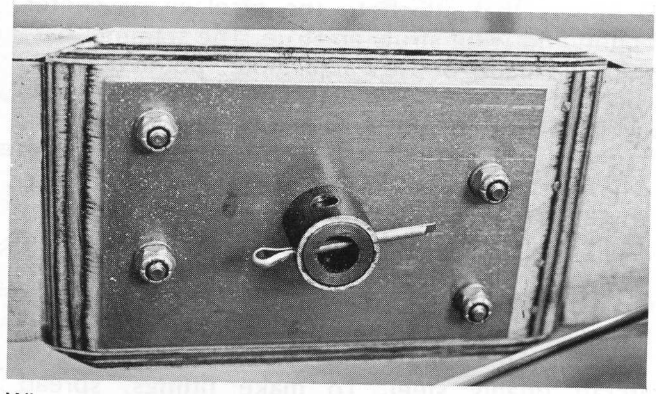




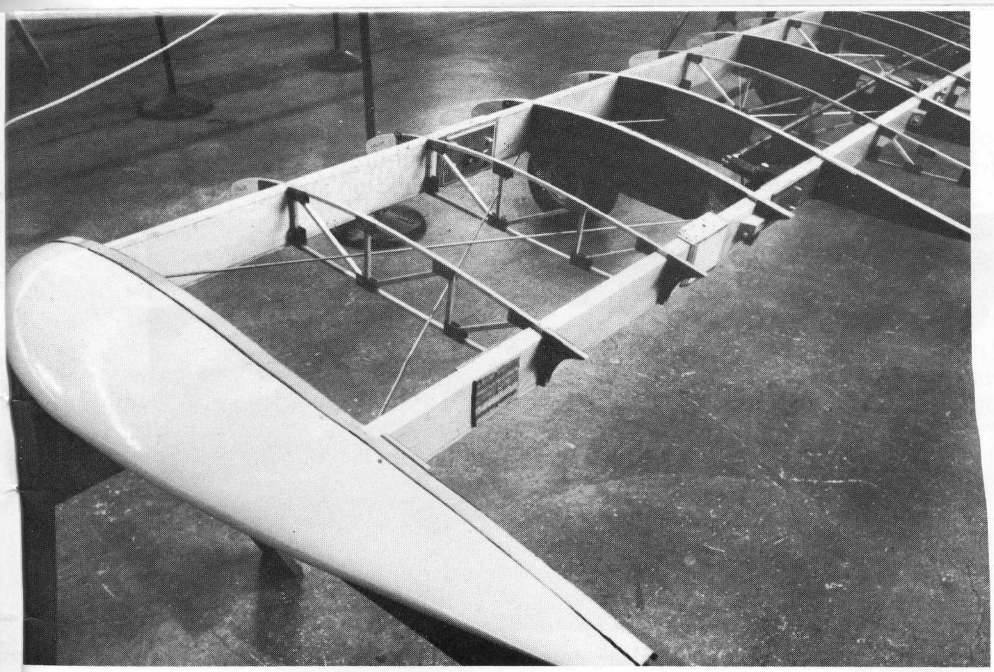




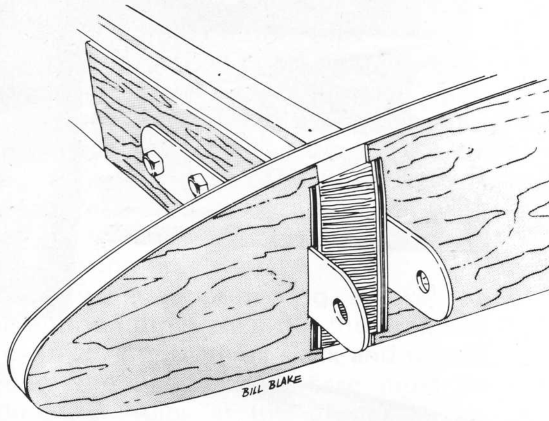
Wing anti-drag wire block, front of front spar. Hole for drag wires must be accurately drilled through block and spar.



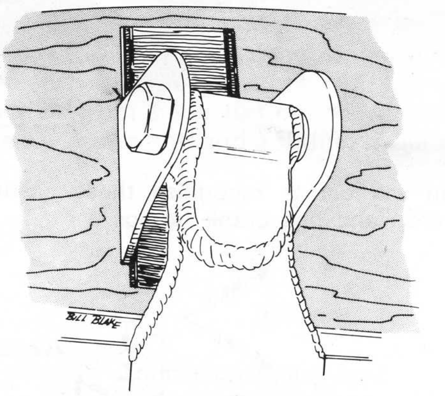
Wing spar outboard flying and landing wire fitting. This type of fitting of Pitts design will carry flying and landing wire loads.

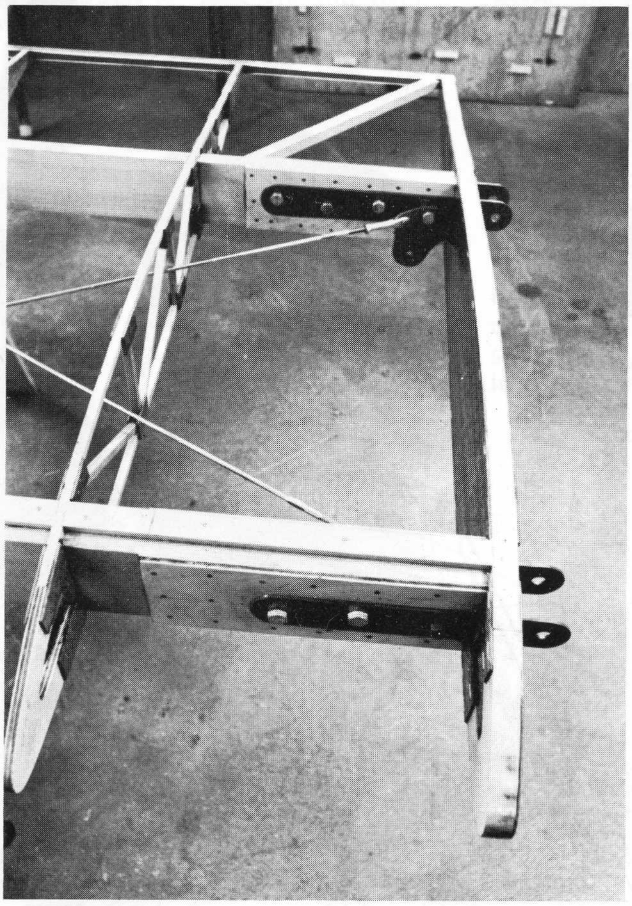


The fiber glass wing tip gives a smooth finish when the wing is covered. Aluminum trailing edge at aileron gap is next to be installed.



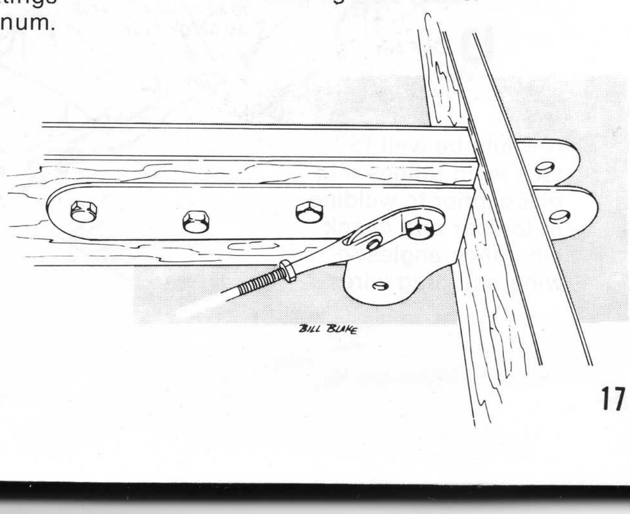
Upper front wing spar fitting showing plywood reinforcing plates. Note plywood is notched out to permit fitting of metal wing fittings.



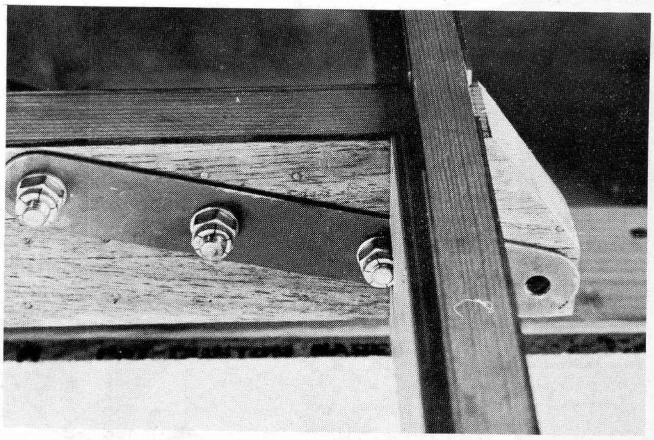


Right upper wing showing wing root fittings prior to covering leading edge with aluminum.

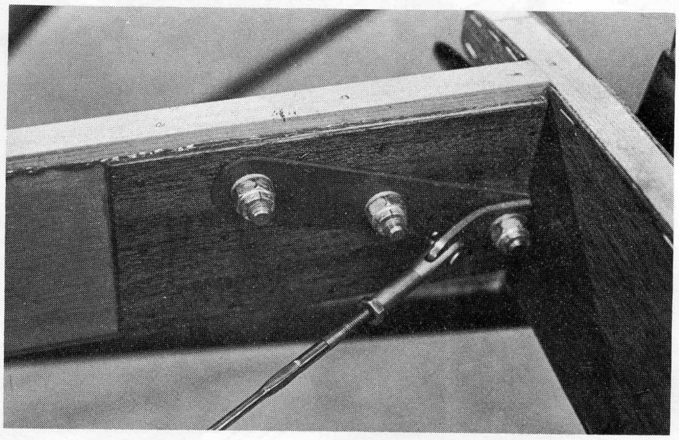
Upper right rear fitting showing drag wire attach method. Lower lug carries rear landing wire loads.

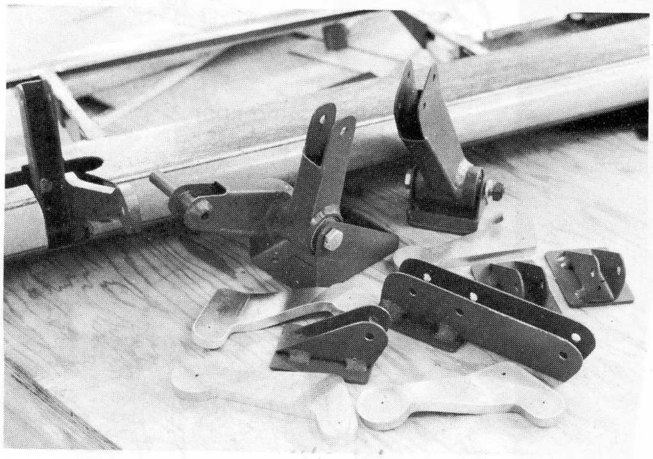


Lower wing to fuselage fitting. Do not over torque bolts as it can cause crushing of wood.

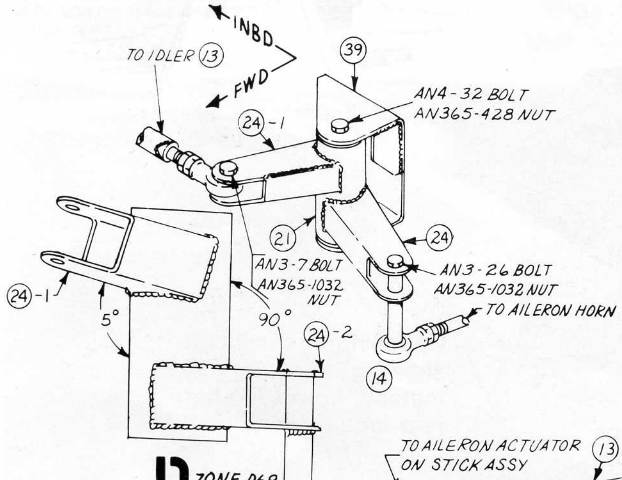


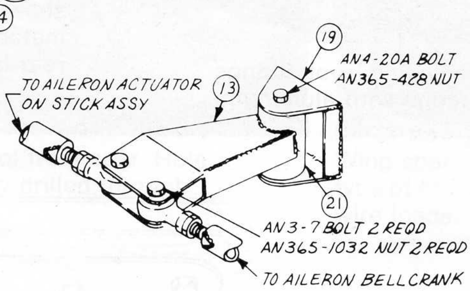
Upper wing root spar fitting and anti-drag wire. Note plywood re-inforcing plate glued on spar.



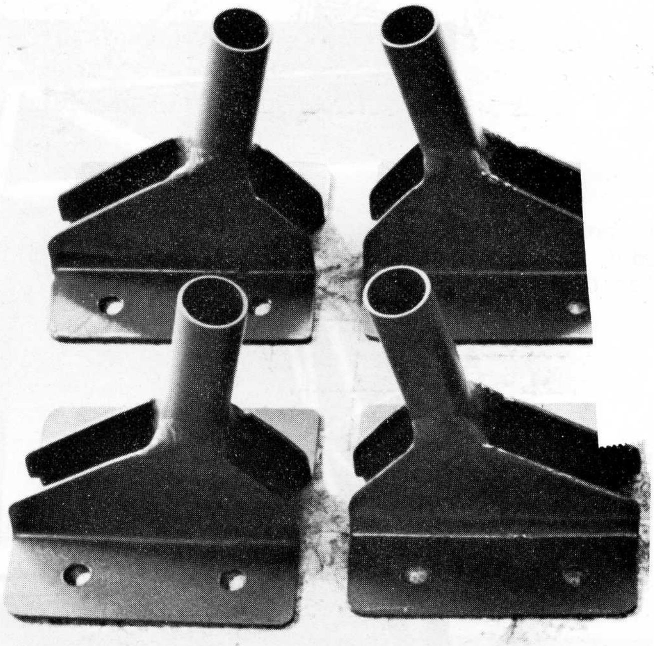


You will get to recognize these assorted aileron and bell crank fittings.

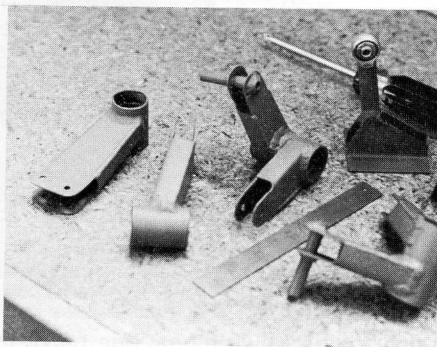




It would be well to tack weld fittings into place, prior to welding fit to spar and check clearance angles to wing anti-drag wires.



Rear wing spar to aileron fittings, less rod ends.



And there are more aileron fittings.

Take care not to run scriber lines across metal which will be part of a fitting. Don't chromium plate any fittings or struts because the usual processes suffuses steel with hydrogen ions and weakens it. When you do see chromed struts on aircraft, it is when special deionizing after the treatment has been used.

To begin assembling your wings, attach the wing strut fittings to the spars in accordance with the drawings. Great care should be given to slide the appropriate wing ribs into place prior to gluing the wing root or butt rib reinforcement plates to the spar. If these are installed the wing ribs between your "I" wing struts and the root fitting will not be able to slide onto the spars. Slide all ribs onto the spars after having pencil marked the spars with a tri-square to get the vertical ribs locating marks.

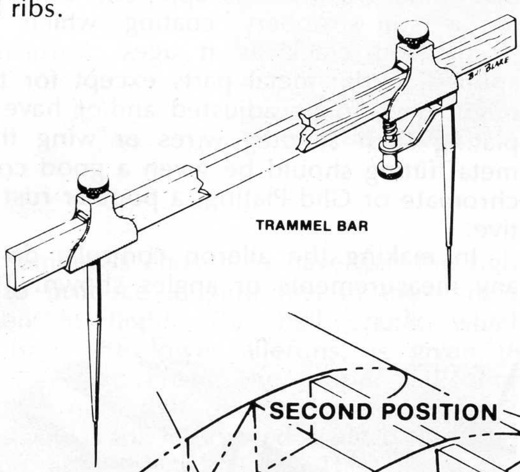
As can be seen from the plans, spar openings in ribs are made wide enough so ribs will slip over the spar doubler plates where needed. When ribs are in position suitable lengths of ¼" rib stock is cut to fit to fill up the space between the spars and ribs.

On the forward spar, the aluminum leading edge can be formed and fitted as wing construction progresses.

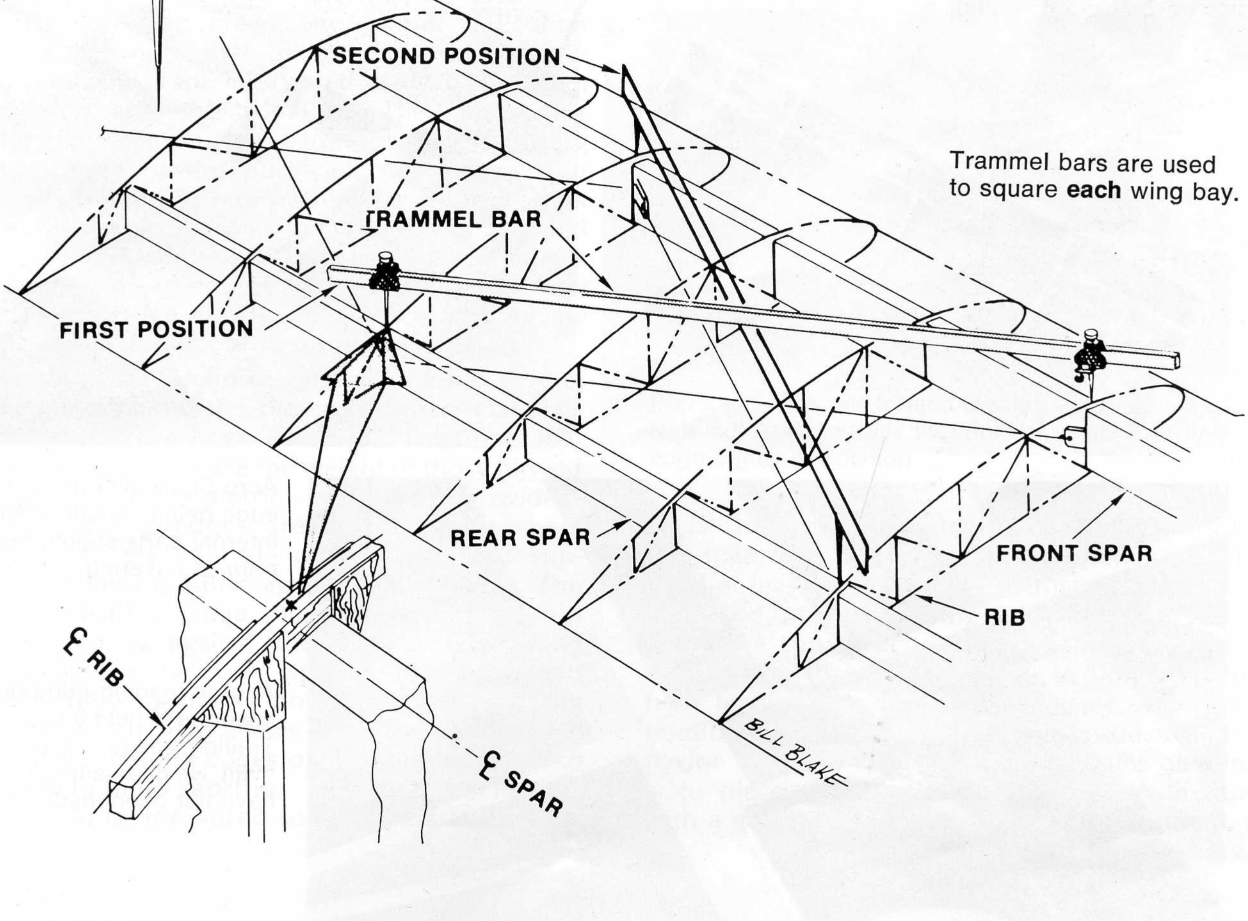
Upper and lower rib cap strips fit snuggly against the top and bottom of the spar surfaces and transmits air loads from the ribs to the spars, hence, the ribs need only be attached to the spars well enough to hold them into position. Glue each rib into place and two or three rust proof aircraft nails of ½" by 20 gauge through each rib vertical into the spar will do. Do not drive nails through the cap strips into the top or bottom of the surface of the spars for this will weaken the cap strips at a point of concentrated stresses. At a few places the wing rib vertical strips will have to be cut to make way for a wing and anti-drag wires.

With a basic wing supported to a level on horses, install all the fittings then put the drag and anti-drag wires in leaving them all slack and we are ready to square the wing. Great care must be used in drilling the holes at the proper angles through the wing spar and through the reinforcing block so that proper alignment of the drag wires is made.

On the top of the spars at every compression member, pencil a line to directly in the center of the wing rib. Then exactly in the center of the spar's top surface, make a clear dot by twirling a pencil on it. One can either purchase a set of trammel bars (see trammel illustration), or make one up out of a stiff rod, tube or stock with a fixed steel point (such as from a 5 & 10 Cent Store drafting compass head) at one end and a sliding lockable



TRAMMEL BAR



Trammel bars are used to square **each** wing bay.

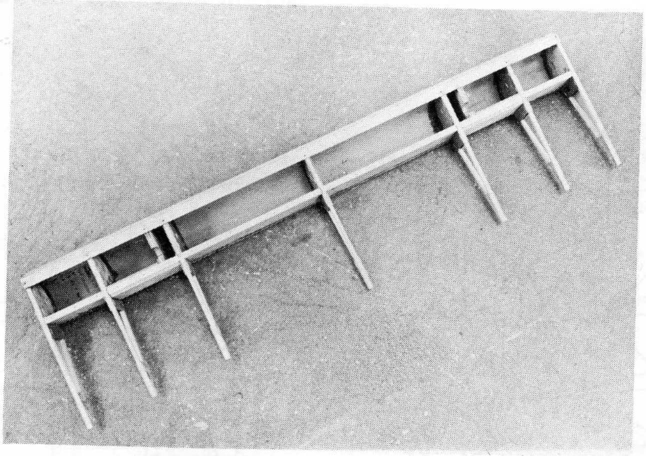
"Carrot top" Dorothy Aiksnoras applies 2 coats of clear spar varnish to all wooden parts.

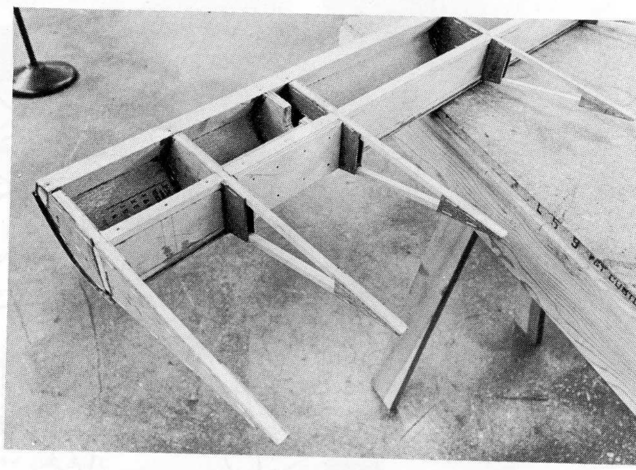
point near the other. The rod is a little longer t the longest wire.

Beginning at the inboard end of the wing pa lay the trammel point on the inboard pencil of one spar and run the trammel over one w diagonally to the other spar (the rear spar). S the point to meet with the dot there and t switch the trammel to the other wire to ch the distance between the dots. Gradually tigh the wires all of the time working to get identi distance between the sets of dots. Then m out to the next set of wires. By the time outboard set are straightened, the two w spars will be straight and true and the will be at a perfect right angle to the spar seen from overhead.

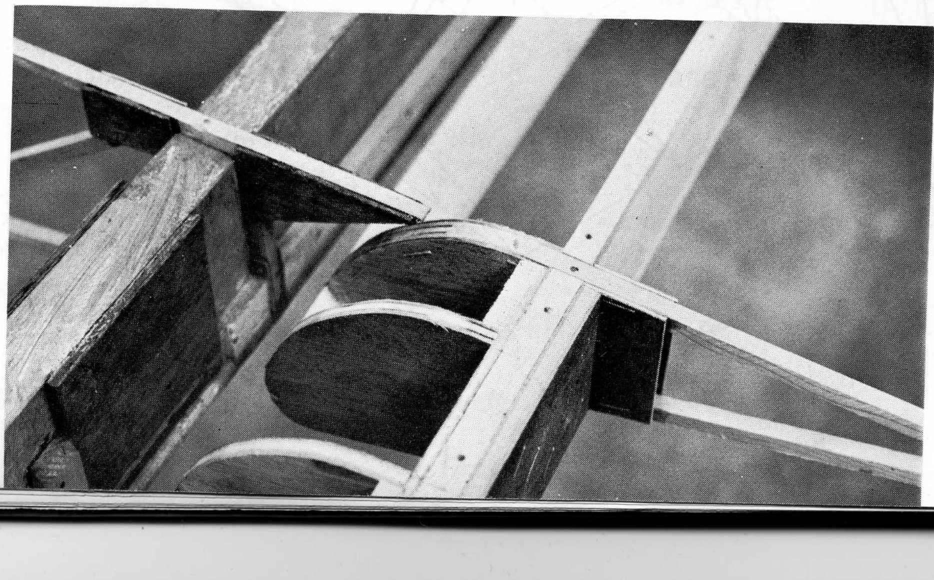
When all wing woodwork and basic structu is completed, give the complete wing frami spars and wing ribs two or more coats of cl spar varnish. The first coat should be somew thin to promote penetration. When done, the wo work should appear filled and covered enough that some glossiness is apparent. But don't bu up a soft, rubbery coating which will d shrink and crack as it ages. Varnish can applied to the metal parts except for those t might have to be adjusted and/or have cadmiu plating such as drag wires or wing fittings. metal fitting should be given a good coat of zi chromate or Glid Plating, a popular rust prevent tive.

In making the aileron controls, do not alt any measurements or angles shown. The leng



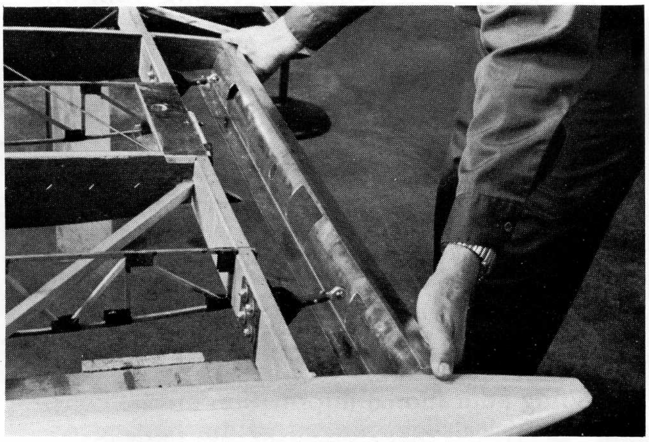


Acro Sport ailerons prior to t edge being installed. All woo internal parts should be varni prior to covering.

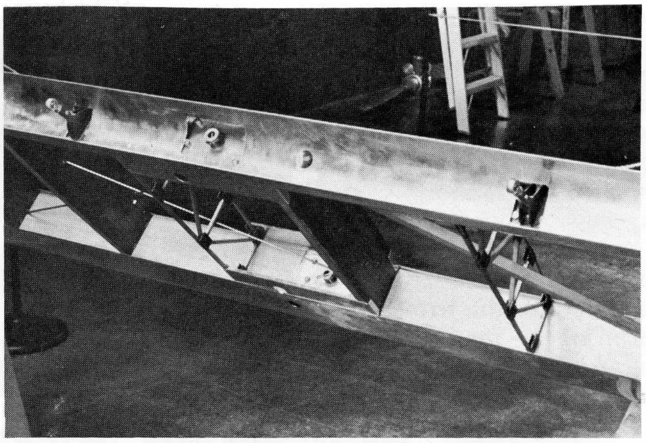


Aileron leading edge prior to covering is held into position. Trailing edge material on main wing or aileron hinges have not been installed.

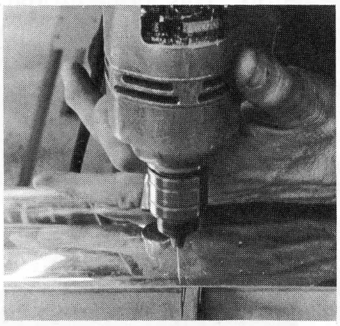
Installing wing aileron trailing edge.

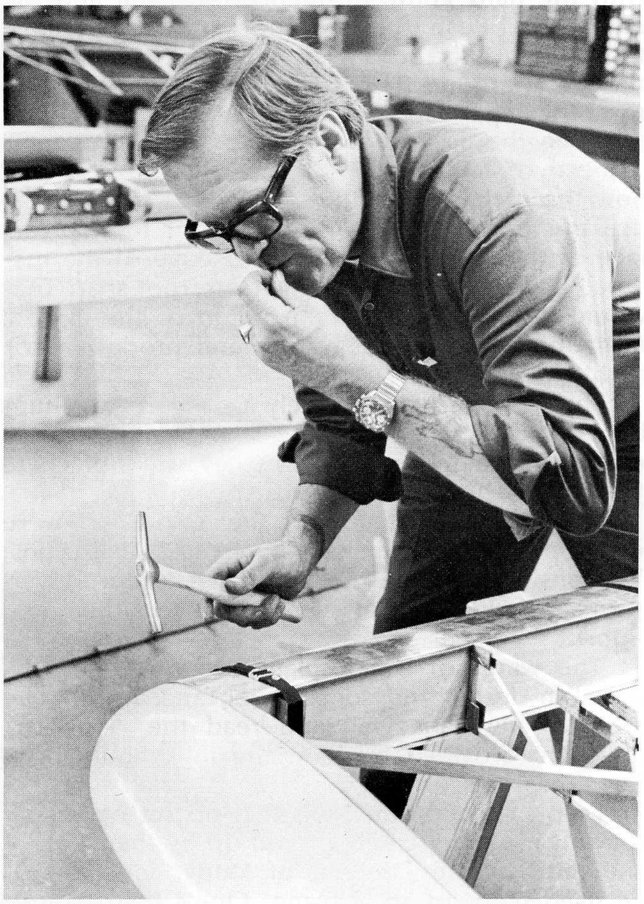


Curved aluminum fitted to short wing ribs on wing — note aileron fittings.



A fine drill is used to drill hole in aluminum prior to nailing.





Bob Ladd nails pre-formed leading edge in position. Note adjustable straps that hold aluminum leading edge tightly in position.

of each member is chosen to have just the right leverage to produce a good feel in the control stick when in flight. The bell crank, which operates both the lower ailerons, is given its particular angle to create the proper deflection and you will note that on the lower wings the idler type bell crank is located midway between the aileron and the root rib. This allows for smaller diameter push-pull tubes and less flexing or supporting of the push-pull tubes than if it were constructed in one piece. You will note that all aileron push-pull tubes are ballbearing actuated and are adjustable. Note that the aileron hinges are firmly attached to the rear wing spar having ballbearing attachments which adds to the lightness of aileron control on the Acro Sport.

Aileron construction generally follows that for the wings. Note the dimensions and materials shown in the drawings and avoid anything that would obviously increase the weight of those hinged members. A full size aileron jig drawing is provided.

Wing leading edges are covered with sheet aluminum to give a true airfoil shape and support the covering fabric against air pressure. The aluminum leading edge must be preformed and fitted accurately against the leading edge wing rib nose blocks. ¼" x ½" spruce strips are glued between the wing ribs — both on top and bottom of the front spar. This allows for a firm and smooth fitting of the trailing edges of the aluminum which are nailed to these capstrips. The aluminum leading edge should be measured so as to pass at least ¼" to ⅜" behind the capstrips on top and bottom of the spar. The aluminum should then be bent inward at least at a 33° angle so that when the fabric is placed upon the wing a sharp edge will not provide a cutting action against the fabric. I must remind you that it is desirable to hold the aluminum leading edge as closely and as uniformly as possible in the interest of good safe airfoil behavior in flight. One way to bend new aluminum is to place two planks on edge between horses with a gap of two inches or so between them. Lay the metal over the gap, place a length of iron pipe of suitable diameter on it and above the gap, press the pipe down forcing the metal to bend down between the planks. It will spring back some when pulled out but the leading edge radius will be there and just right. It is not necessary that the leading edge wing skins be in one piece. Two or even three pieces can be used, however, care should be taken that each section is overlapped by at least one inch — the overlaps being made at a wing rib.

I would again like to remind you that a ¼" x ½" spruce filler strip is nailed to top and bottom surfaces of the front spar as well as the top and bottom of the rear spar in the area of the aileron. Aircraft quality nails of ½" by 20 gauge are recommended.

Nail the aluminum to the spars bottom edge with the nails going through both metal and the filler strip. Push the metal down firmly against the leading edge wood nose rib blocks, wrapping the metal around these so it can be nailed to the top of the spar cap, smooth and free of ripples.

After the first section of metal is on, wrap a piece of fabric cloth around the wing to see how the metal affects the fabric surfaces. Try particularly to avoid a ridge running along the top surface of the wing at the rearward edge of the material which will be just behind the front spar. That would cause premature separation of the airflow from the wings upper surface and produce poor flight characteristics.

The trailing edge is merely a strip of aluminum bent to a V-shape on a break and with the raw edges turned inward so that they will not chafe the fabric. The bend also adds strength.

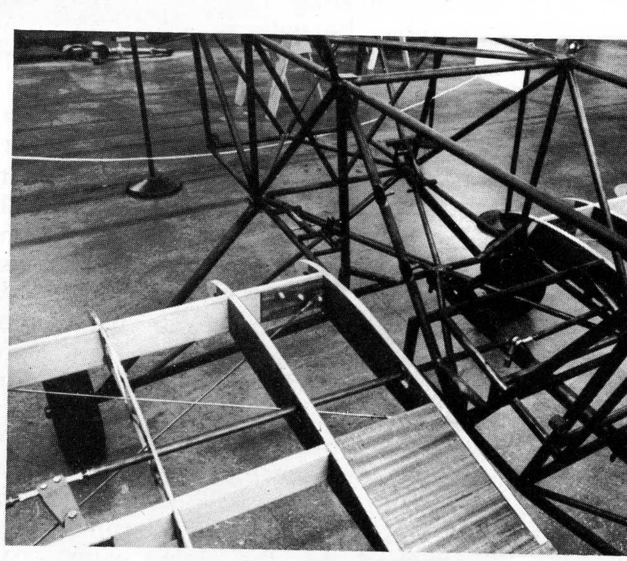
Fiber-glass wing tips for the Acro Sport were developed and furnished by Wag-Aero, Lyons, Wisconsin. Check SPORT AVIATION for advertisers offering similar wing tips for the Acro Sport.

The wings of this airplane are quite conventional in design and construction and if you have studied the plans well and read the "How-To" literature provided by EAA, the job should pose few difficulties.

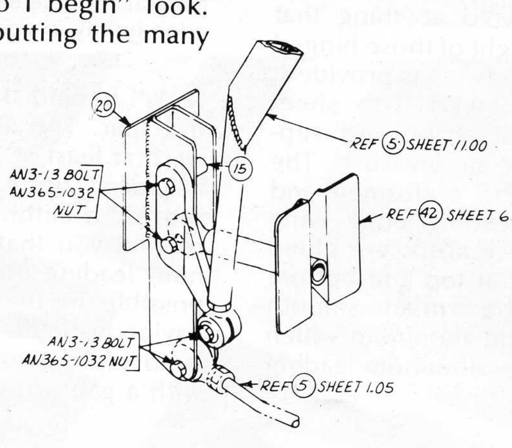
I would like to mention that no set of aircraft drawings can be readily picked up by the amateur and, without any degree of study, immediately be used to build an airplane. One's first glimpse at a good set of aircraft quality drawings may bring confusion and a "where do I begin" look. Self-education is a key factor in putting the many and varied details of aircraft drawings into t prospective positions, referencing from one s to the next, a cross check into manuals and e discussions with others.

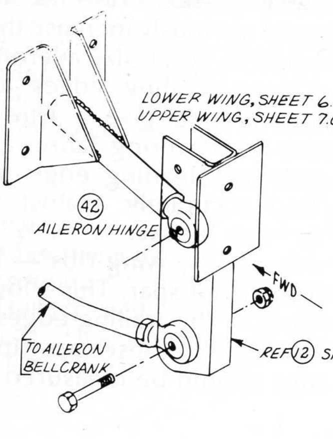
It always has been encouraging to see the r tion of an individual or group of individuals v after first looking at a set of aircraft drawi wonder "where do we begin" and then, spea with these people two or three weeks later, we encouraged to learn that the many bits and pi of information have been jelled into a progres program with an understanding of what it might to build an airplane.

We would like to state that the EAA Acro Sp is an effort in both self-education as well as p viding educational information on the construct of a typical light aircraft of the biplane config tion. This educational material can be used a homework shop project or for schools, provid the individual with the many and various tale and skills necessary in the design and construct of an aircraft of his own imagination. The E Acro Sport has been constructed to provide basis for this educational information and to deve one's own talent.

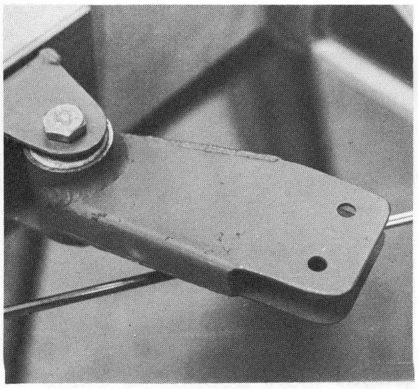


Lower wings temporarily fitted into position to ensure clearance of aileron torque tubes.

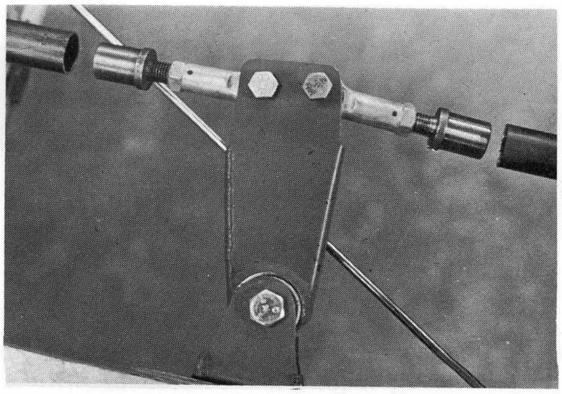




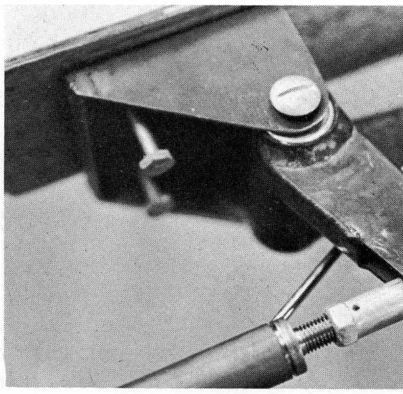
Aileron Idler. Insure angles permit proper clearance of wing anti-drag wires with bolts and nuts installed.

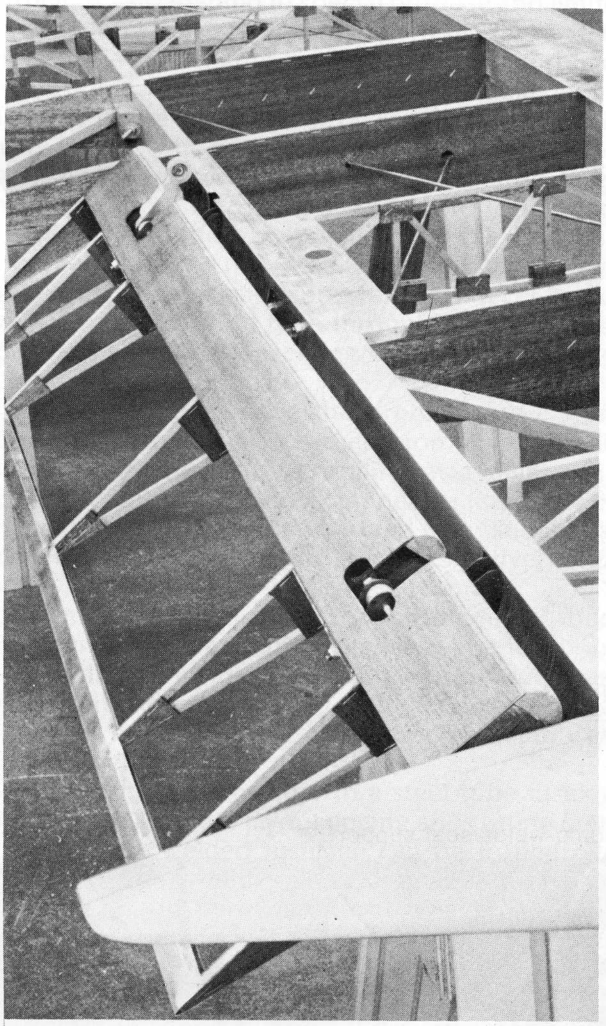


Aileron idler showing rod end bearings fitted into position, prior to welding to aileron push-pull tubes. A small fish mouth or V cut must be made in tube end prior to welding.

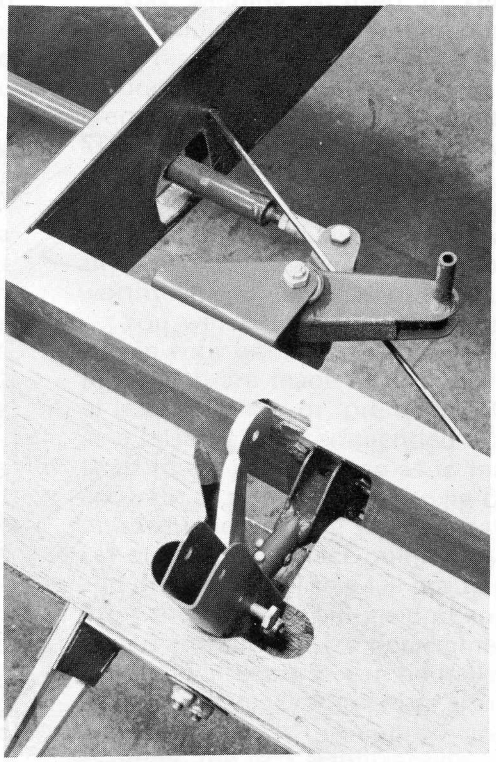


Aileron bell crank temporarily fitted into position to check final alignment and clearanc

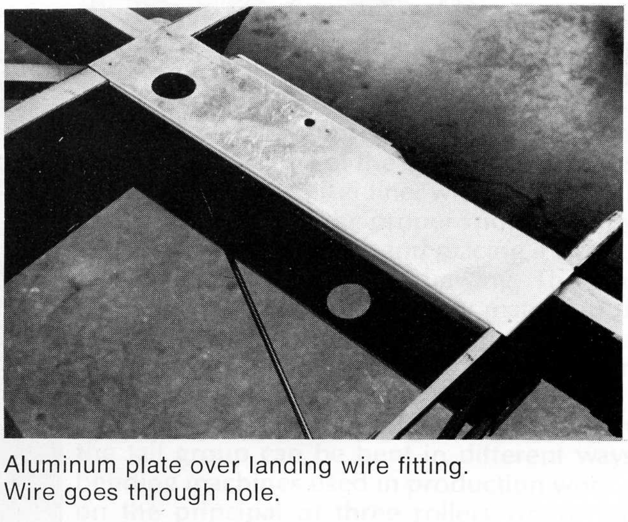




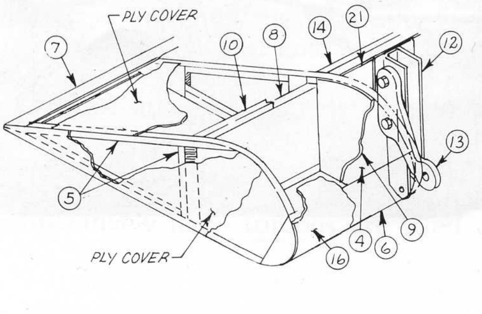
Aileron fitted into position. Note aluminum plate mounted between 2 ribs with hole which permits smooth fairing for installation of flying wires ahead of spar.



Aileron bellcrank assembly less inter-connect rod.

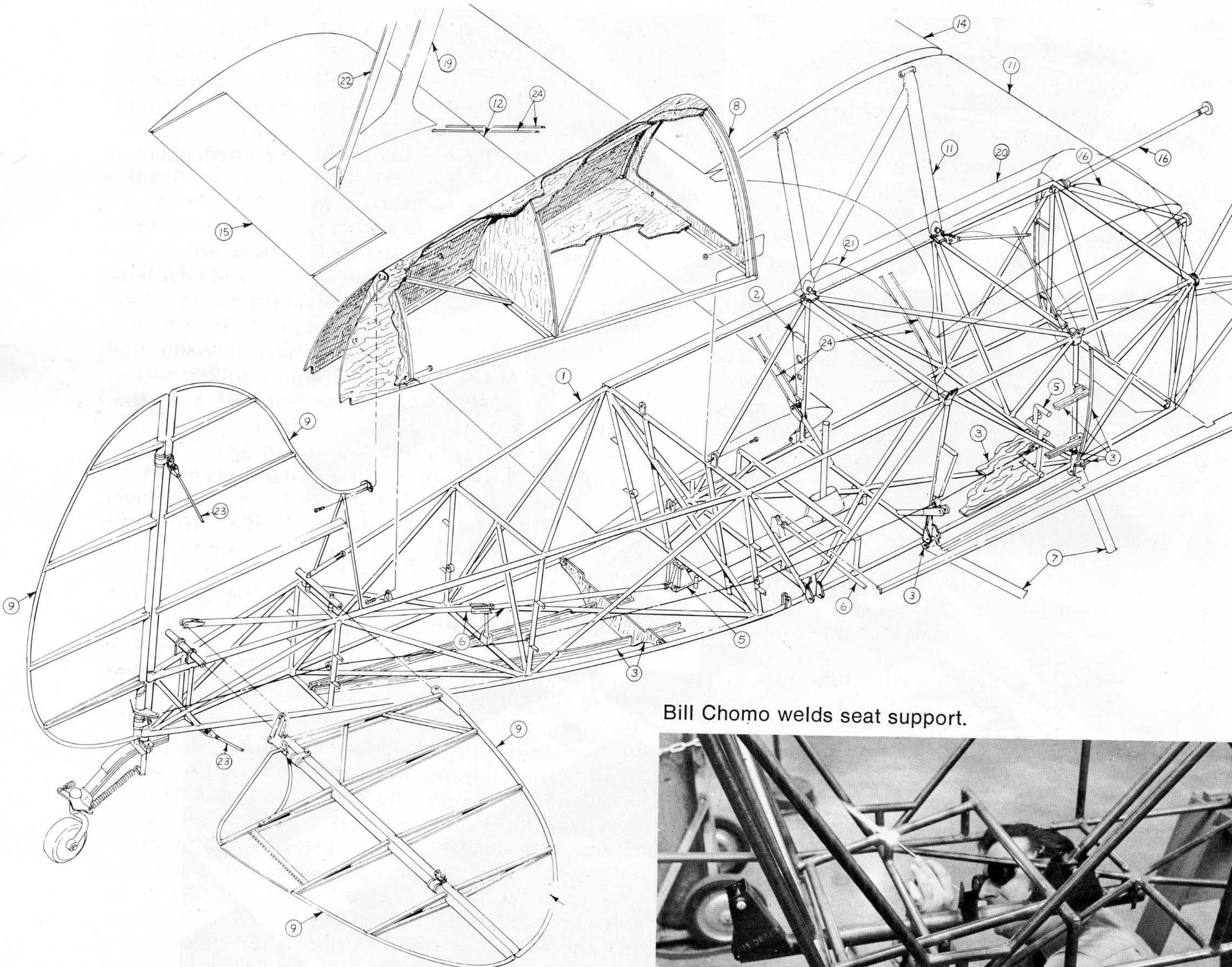


Aluminum plate over landing wire fitting. Wire goes through hole.

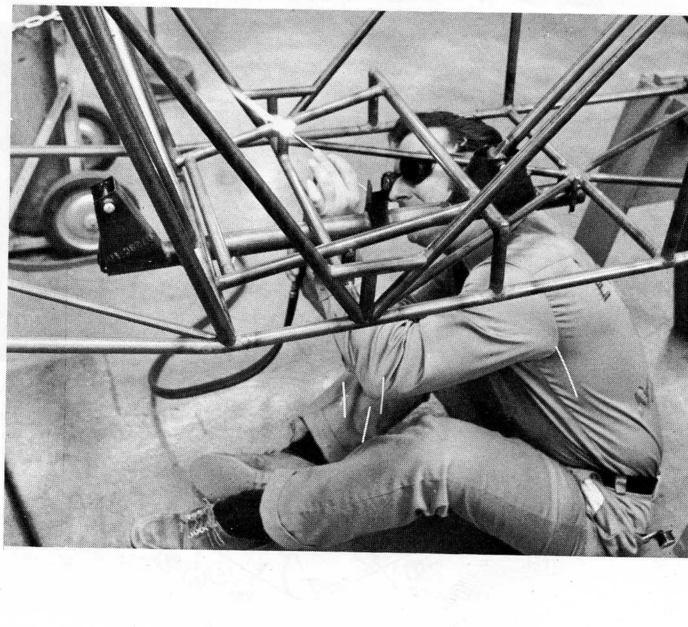


Aileron cut-away.

fuselage/ta



Bill Chomo welds seat support.



group

The fuselage and tail group of your sport biplane are made of welded steel tubing, a form of construction well adapted to special purpose and limited production airplanes. It is readily formed into an infinite variety of shapes with simple tools and hand work. Joints and fittings are simple to make and to attach and the result is a strong, durable safe structure. Probably its only disadvantage for the amateur is that a certain amount of skill is required in gas welding. The trick in gas welding is to learn to adjust the flame and manipulate the torch in such a way that while the thin walled tubing is always kept hot enough to make a secure weld, it is never heated so much as to burn a hole through it, and to manipulate the torch and welding rod so as to produce a uniform, smooth bead.

Some amateurs solve the problem by learning to weld either under the supervision of veteran airplane mechanics or by enrolling at a night trade school. With diligent practice one can learn to weld in a few weeks and we have found many individuals have learned to handle the torch in relatively short times in the same manner as a veteran.

A midway solution to the problem has been found by many amateurs. They learn in a few hours how to do tack welding — dabbing just enough weld metal onto joined parts to hold them securely in place. An entire fuselage or tail group assembly can be tack welded.

The real time-consumer in a steel tube fuselage is doing the accurate layout jigging and cutting metal to fit. A tack welded fuselage can be turned over to a more expert welder who can then do the skilled final welding in perhaps one or two days time. If you have joined an EAA Chapter, finding an expert welder should be easy. In fact, since the birth of EAA some 20 years ago, the availability of experienced welders in the U.S. and Canada has been greatly enhanced.

Most government licensed airplane mechanics do only a small amount of welding in everyday aircraft maintenance work and are glad to gain experience and practice involved in welding up a complete fuselage. Consequently, they may offer to do it in their spare time or give you guidance in what is considered quality welding.

Quite often we are asked if it is wise to take aircraft components in need of final welding to structural and machine shops. We would advise that most of these shops are accustomed to welding thick metals and comparatively large torches are used and they will need quite some practice on thin walled tubing to get the knack of it.

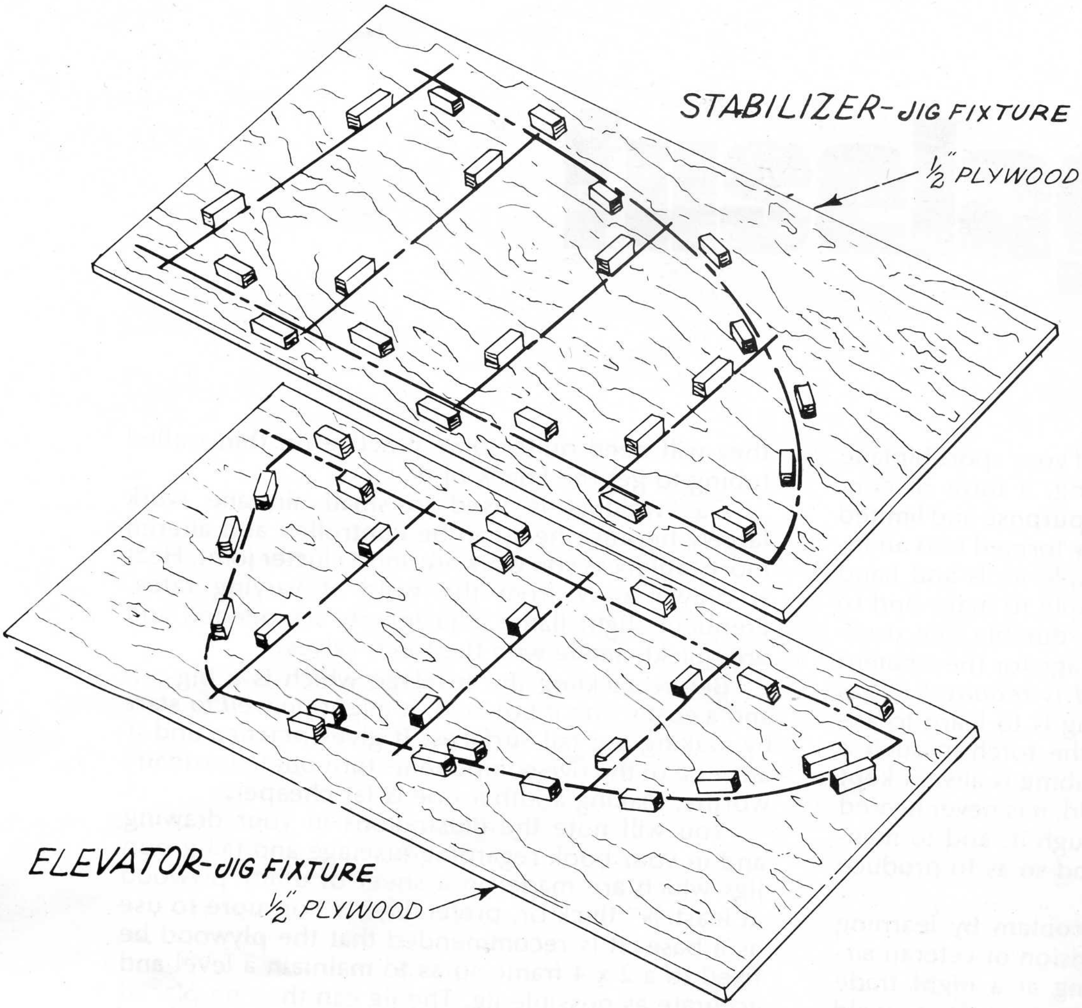
Gas welding is used in small airplane work largely because heat can be controlled and altered more rapidly as you work around a cluster joint. Heat is drawn away from the weld at varying rates. Frequent slight flame adjustments are needed and are quickly made with the torch valves.

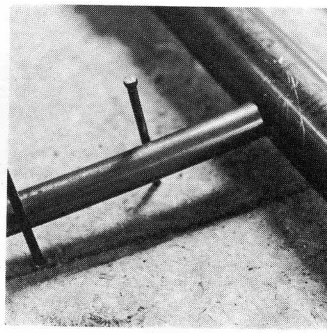
Before tackling the fuselage which is a big job and a costly one if botched, it might be well to start by making the tail surfaces. It gives practice and if any one of the five components turn out to be unairworthy, making another one is far cheaper.

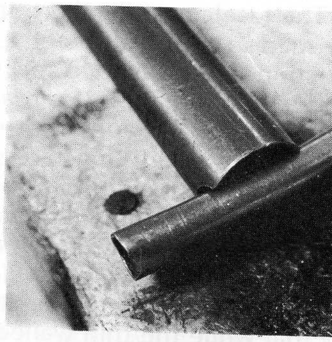
You will note the illustrations in your drawing and in your book regarding fuselage and tail group jigs which are made on a sheet of utility plywood at least ⅜" thick or, preferably, ½" or more to use as a base. It is recommended that the plywood be fixed to a 2 x 4 frame so as to maintain a level and accurate as possible jig. The jig can then be placed on sawhorses making sure it is flat, level and steady. Lay out the tail surface outlines by means of squares and draw up a full size tail group plan on the wood. After the full size tail group center lines are completed and tubing size determined, jig blocks of 1" square by at least 3" can be nailed into position allowing sufficient room either side of the center line for a snug fit of the appropriate size tubing. For example, the rear stabilizer spar or rudder post is a ¾" diameter tubing. Measurement of ⅜" on either side of the center line will give you the distance on either side of the center line and will measure out to the size of the appropriate tubing or ¾".

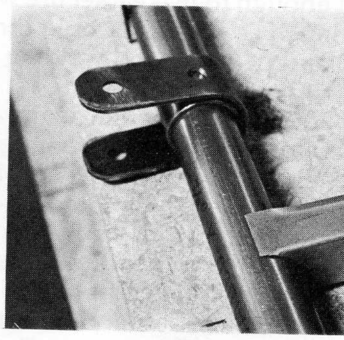
Some use the appropriate size tubing to establish accurate nailing of the blocks, placing the tubing directly over the center line, while others will obtain a piece of plastic of the proper width scribing a center line down the plastic and placing it over the center line of the full size jig drawing. The plastic enables one to easily and visually match up the centers and the outer edges of the plastic determining the appropriate distances from the center lines that the jig blocks must be attached to.

The tubing, leading edges and trailing edges of the tail group can be bent in different ways. Tube bending machines used in production work operate on the principal of three rollers where feeding a tube through results in it being bent into a circle. Expert workmen can adjust these rollers to get a variety of bend radii and with practice could turn out smoothly bent tubing of non-uniform radius. You



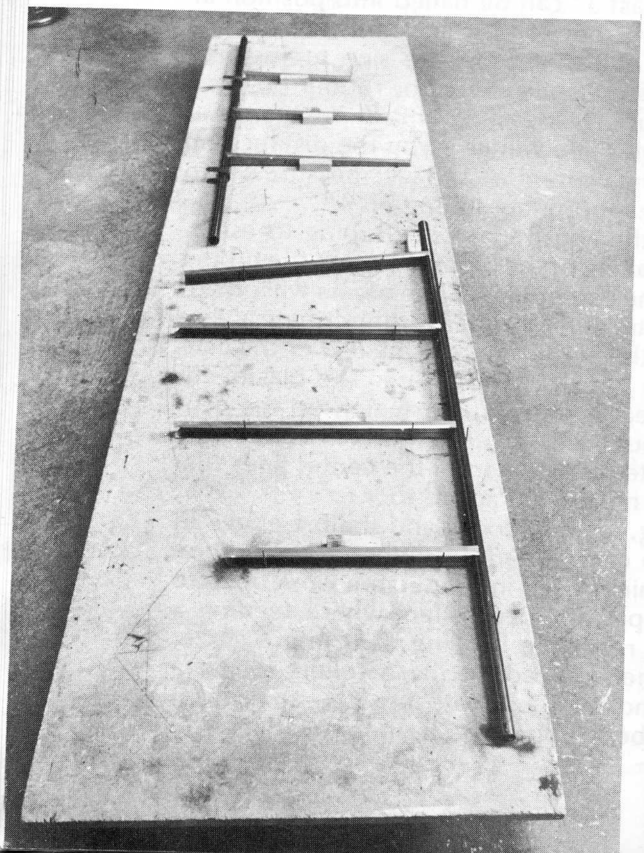


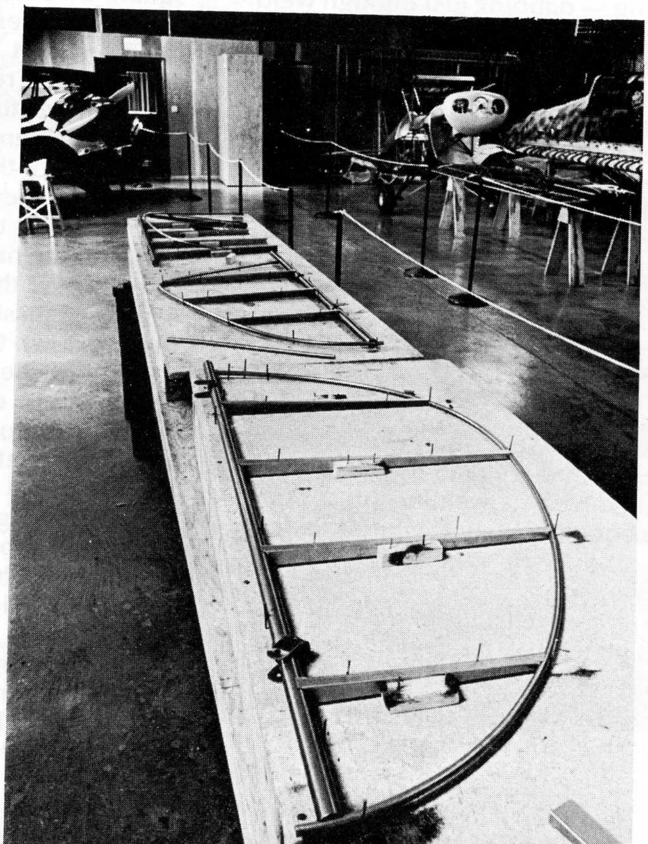




Elevator and stabilizer jigs with spar and ribs in place. Trailing edge to be formed and tack welded into place.

Wooden jigs are built to hold all components in place during welding. Control hinges must be slipped into position before tack welding.

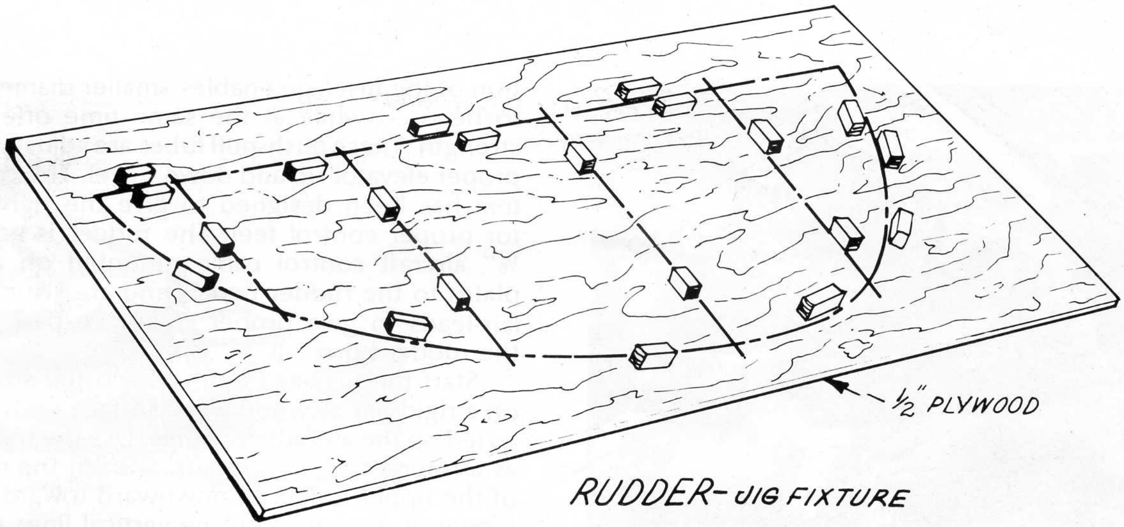




TOP — Elevator
edge tube is cen
spar prior to tack
welding into posi

CENTER — Eleva
trailing edge is fit
outboard end of e
spar tube. After ta
welding, heat and
end of spar tube f
with trailing edge
Excess material is
after completed w

BOTTOM — Ailero
fitted to rudder an
elevator tubes. Hi
must be slid on sp
prior to assembly.



RUDDER- JIG FIXTURE

can glue blocks to your plywood base along the outline and then bend the tubing around them — or full size tail group components can be laid out on ½" plywood and the tubing bent around the outer edges to the proper radius.

Some builders have grooved the plywood so as to get a better fit or attached the tubing to be bent at various points to hold it uniformly around the radius. It is recommended that when bending radii the extension of 8 to 10 inches be extended past the intial point to be bent so as to give greater leverage and make bending much easier. The extra length can always be cut off prior to attaching and welding to the tube elevator or stabilizer spars.

Heating by welding torch can also be used to aid ease of bending, however, care must be given so as not to concentrate heat in one particular area which could cause kinking or deformity. It is also possible to bend free hand, and many have been able to do a very fine job by using the back of a vise or a section of 6 or 8 inch pipe or even junked auto wheels or the corrugated parts of oil drums, old automobile brake drums, etc.

In making forming blocks remember that steel tubing will always spring back a little after being bent. This is overcome by blocking the tubing onto the work board securely right over the pencil lines.

After ribs and tubing are welded together, the bent leading edges and trailing edges will retain their desired shape.

After having gotten the desired smooth contour of both the leading and trailing edges of your tail group, check the bent tubing to be sure it is straight and not crooked in the edge view. If any variations are noted, lay it on a flat surface, place a hard wood block against the tubing and carefully hammer it into alignment.

The tapered ribs of the fin, stabilizer and rudder are bent on a metal worker's brake. Check your drawing for appropriate material as well as dimensions and bending radii. In bending metal always be careful that the radii are not sharp as this will have a tendency to tear or crack the metal. Bending can also be accomplished over your own hard wood blocks.

When jigging up these surfaces note that there is a size difference between front, center and rear edges of the tubes. You will have to shim up the slimmer ones toward the trailing edge as needed to get everything to lie flat and true prior to tack welding.

To prevent the wood from burning and smoking while welding on the plywood work base, place a square of sheet asbestos or sheet metal under the welding area.

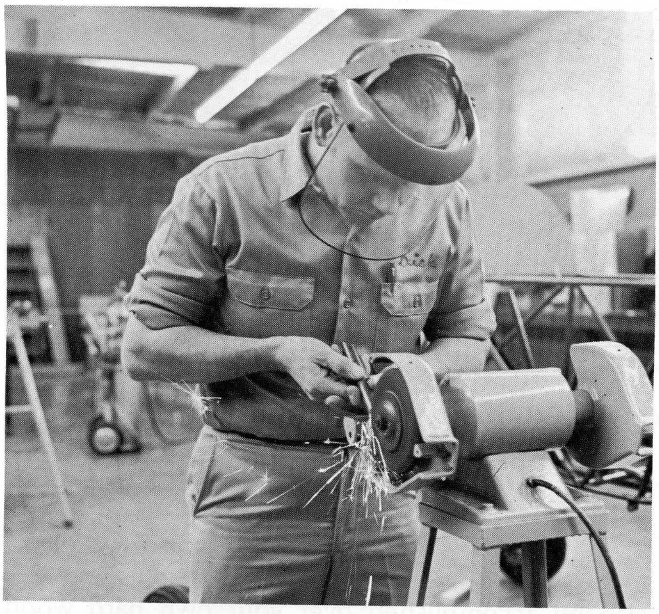
In fitting the stabilizer, elevator and aileron ribs into the jig, measurements from the center of the leading and trailing edges must be taken. A rat-tail file sized to the tubing that the ribs must fit will give a very form-fitting surface. For example, the stabilizer, elevator and rudder spars are of ¾" tubing. A ¾" rat-tail file will give you a ¾" half-round surface and a very snug and fine fit. Care should be given in not filing too much. Constant fitting and refitting can save ribs from the scrap heap.

When cutting 4130 aircraft steel tubing or sheet steel, use a high quality hack saw blade. Cheap ones will shed teeth after a few strokes. Use small-tooth blades because if the space between the tooth points is greater than the tube wall thickness, teeth will catch and break.

In fitting tubing for your tail group ribs a bench grinder can also be used to get the proper curves. And as said before, this in conjunction with a few round files, will enable the tubing to be shaped to fit snuggly against one another.

When fitting tubing avoid gaps of over 1/16" and if your filing and grinding puts feather edges on parts of a tube, file them off as they will burn prematurely as welding heat reaches them. A very important point is to tack weld all joints before making completed welds on any one joint.

When assembling your elevators and rudder, both the elevator and rudder hinges, straps and bearing guides must be slipped on to the spars prior to tack welding your ribs and other parts into posi-



Always wear safety shield or safety glasses when grinding metal fittings.

tion. After final welding of the tail group, it is recommended that the tail group be attached to the fuselage, jigged into proper position and elevator and stabilizer hinge points be brought into position and tack welded so as to gain the best possible accuracy and alignment.

It is recommended that throughout the aircraft, final welding be delayed until all major components such as tail group, landing gear, and other major fittings can be mated so as to maintain accuracy and ease of final fitting. Many a builder has found that when his parts, such as landing gear, fitted nicely to the fuselage when only tack welded that upon final welding attempts to reassemble it to the fuselage, was met with discouragement after finding that final welding changed measurements up to ¼″. Final welding of fitted parts must be jigged into position to maintain accurate dimensions and prevent contraction of the metals. Do not alter lengths or angles in the control surface forms or anywhere else in the control system.

The EAA Acro Sport is using a push-pull elevator control system. The idler mounted in the lower sec-

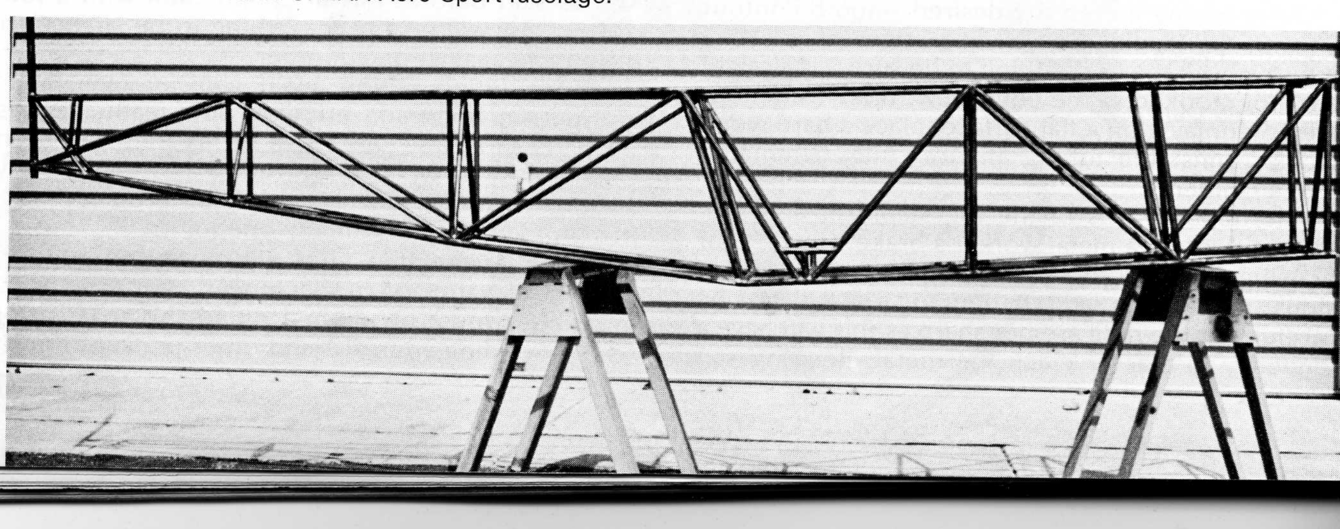
tion of the fuselage enables smaller diameter tub to be used while at the same time offering gr strength. These push-pull tubes are adjustable to g proper elevator up and down travel. The control s tem has been designed to give the right levera for proper control feel. The rudder is actuated ⅛″ aircraft control cable mounted on adjusta plates to the rudder pedals and are strung throu fair-leads to give proper clearance past tubing the rudder horn.

Start the fuselage by making a full size draw on a rigid flat plywood work surface such as is ill trated on the aircraft drawings. Use the top longer as a reference line, measuring from the center li of the upper longeron downward toward the lov longeron, complete all the vertical lines except t tail post. Then very carefully connect the lov longeron lines with the line that generally parall the upper longeron. The diagonals then can drawn in which will complete the full size fusela side drawing, Be very careful about measuremer and after a drawing is done, recheck all yo measurements and lines against your drawings. V would like to add that it has been a rare occasi that aircraft drawings of any type have been err free and great care must be taken to insure that a errors are caught prior to cutting tubing. Mistak are easy to correct now but not later.

Note that many fittings are not put on until aft the basic framework has been finished. You will no that your plans contain artist drawings of the fus lage side and upright jigs. The tubing is held in position in the same manner as your tail group, 1″ 1″ x 3″ blocks being nailed securely into place th appropriate distance on each side of the center lir for the appropriate size tubing. Asbestos and a piec of metal slipped under the tubing to be tack welde will prevent burning or scorching of your jig boar

When measuring for upright, diagonals ar cross pieces, measure from the center line of th top longeron to the center line of the lower or and cut the tubing to that length. A word of cautic — many builders have learned an expensive lesso by taking their measurements from the bottom sic of the upper longeron and the top side of the lowe longeron which does not allow material for form fi ting of the tubes with the appropriate size rat-ta file or grinding wheel. The ends must be shape

Side view of basic frame of EAA Acro Sport fuselage.



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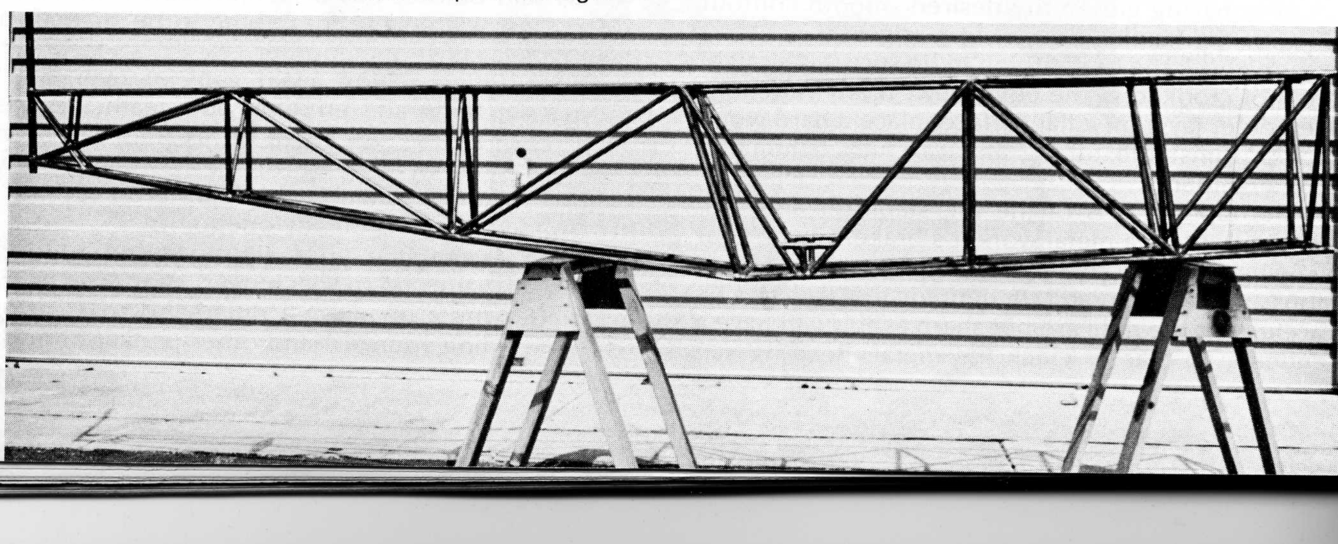
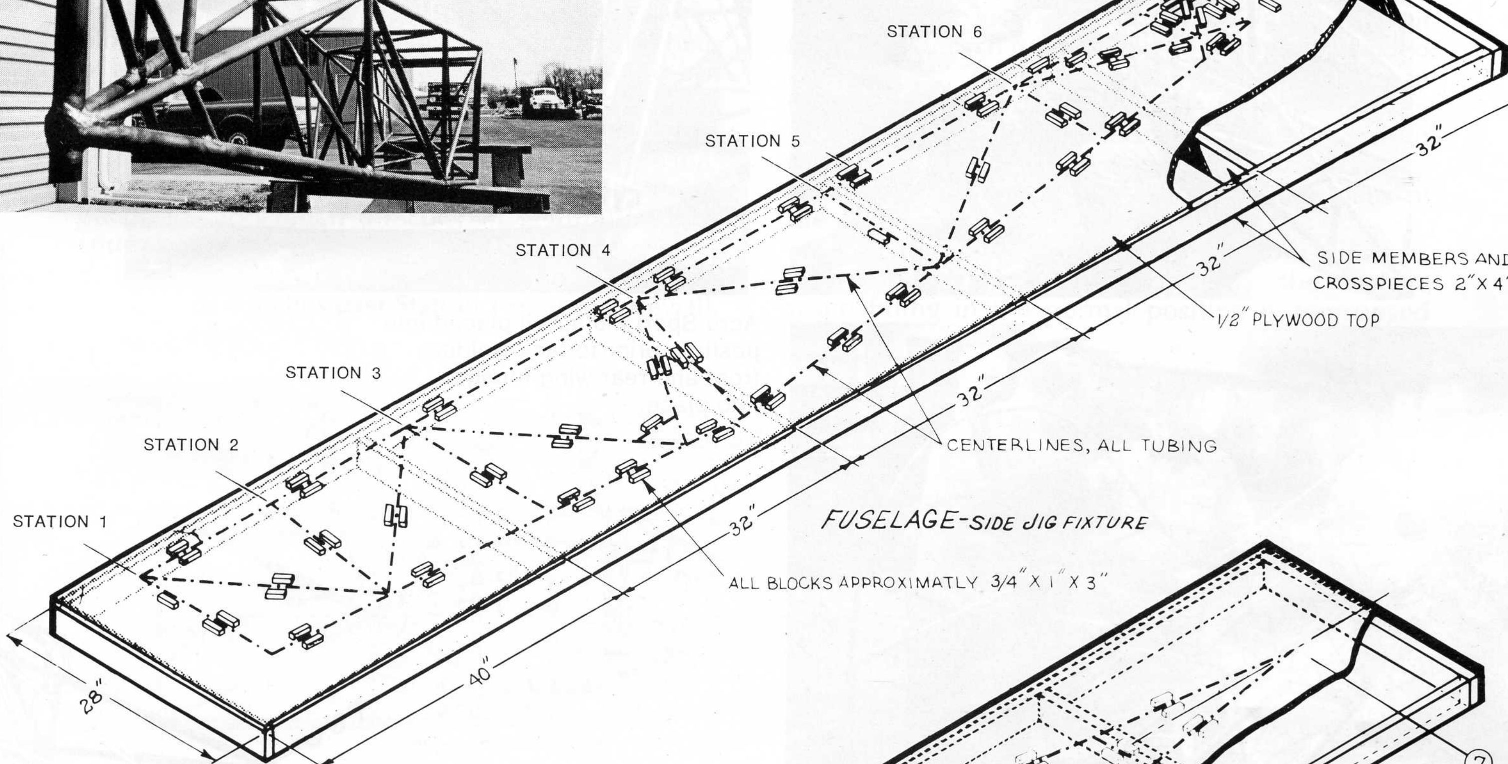
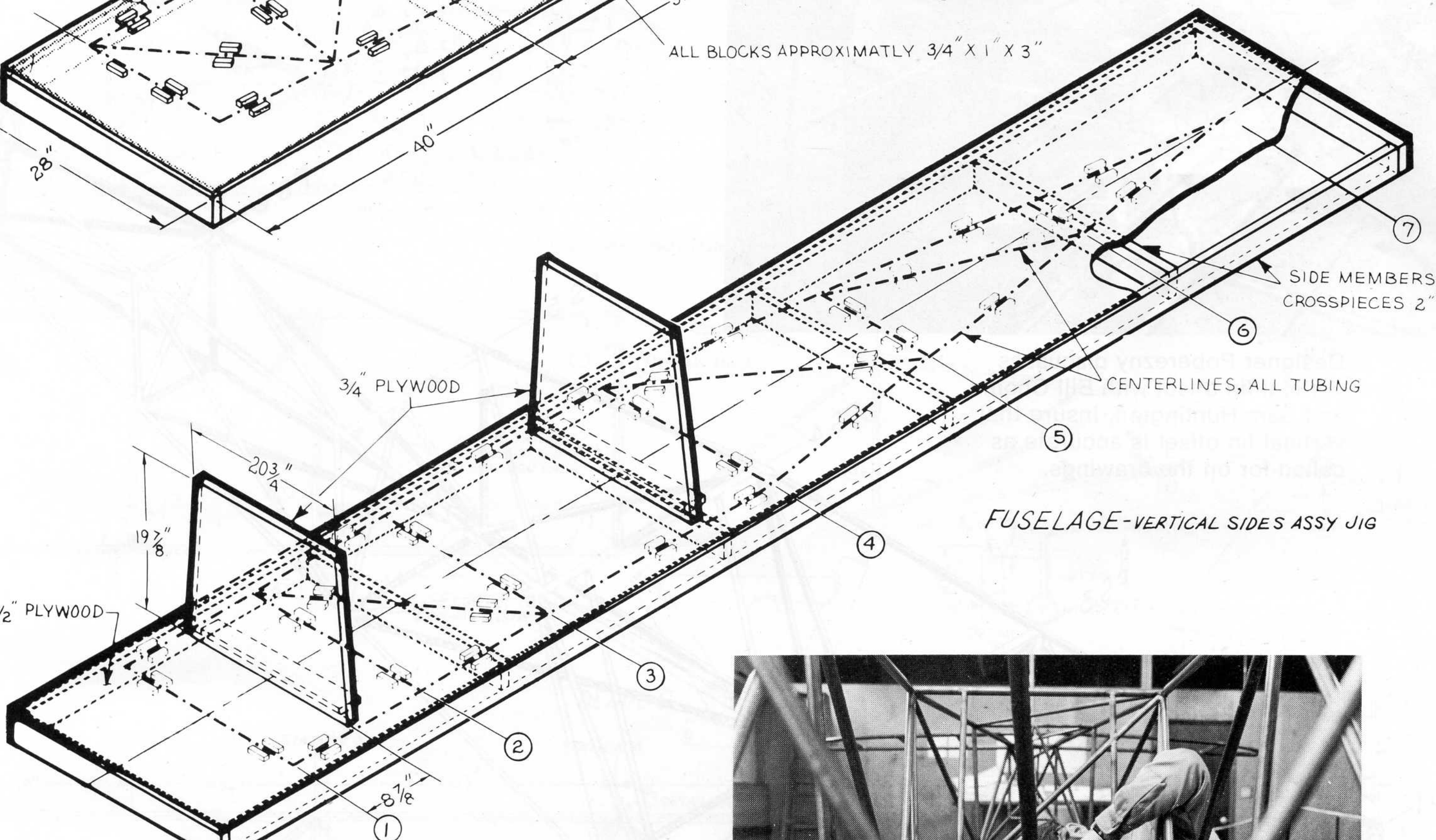


Fuselage tailpost must be vertical for proper rudder alignment.

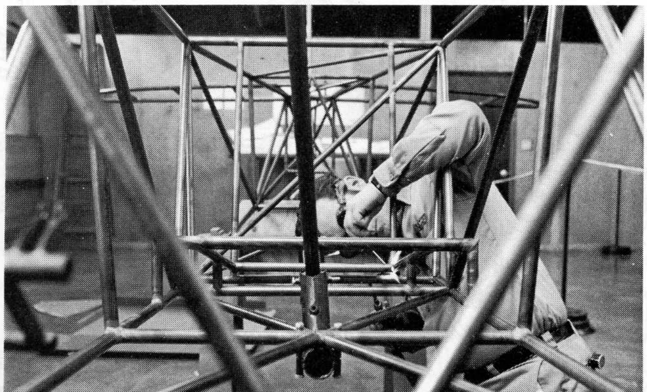


FUSELAGE-SIDE JIG FIXTURE

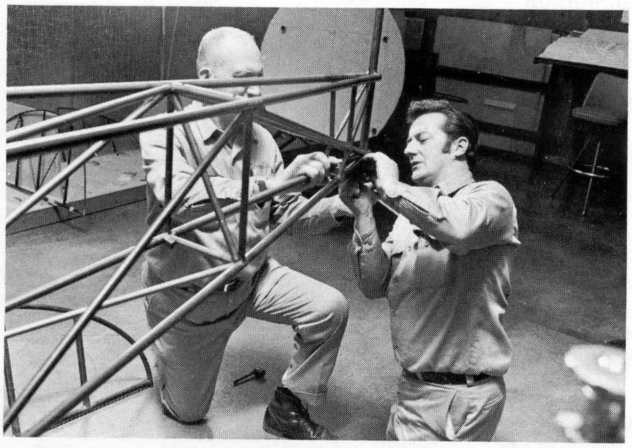


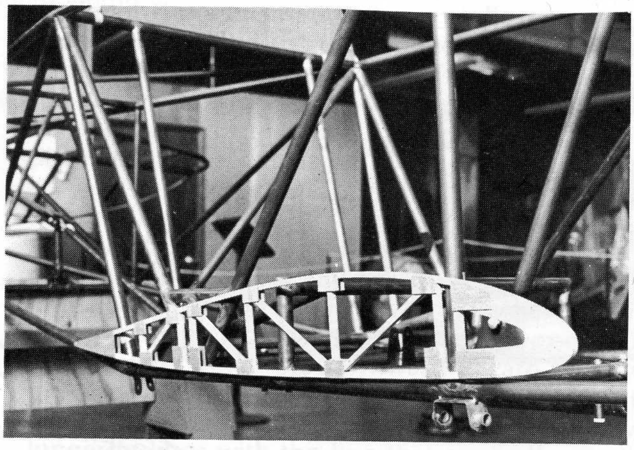
FUSELAGE-VERTICAL SIDES ASSY JIG

Looking from fuselage Station 1 rearward.

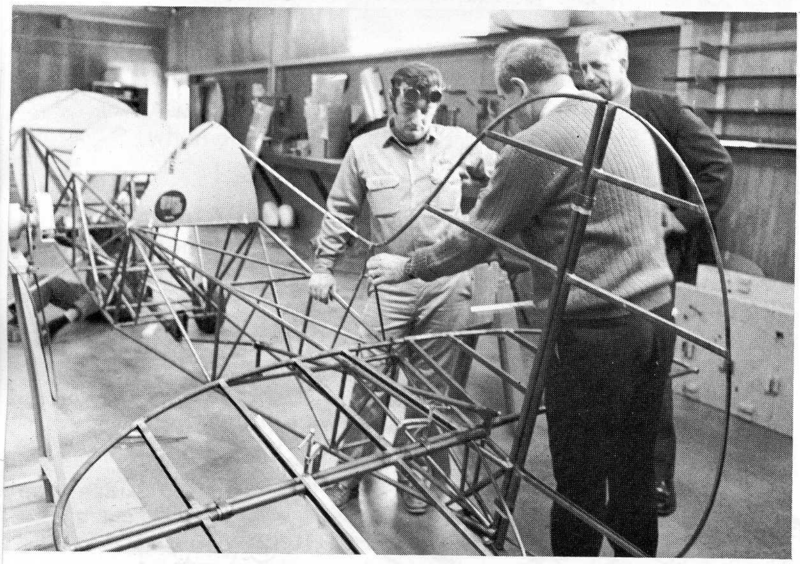


Fitting the fuselage and vertical fin tail post. Final alignment of rudder depends on accuracy of installation of this tube.

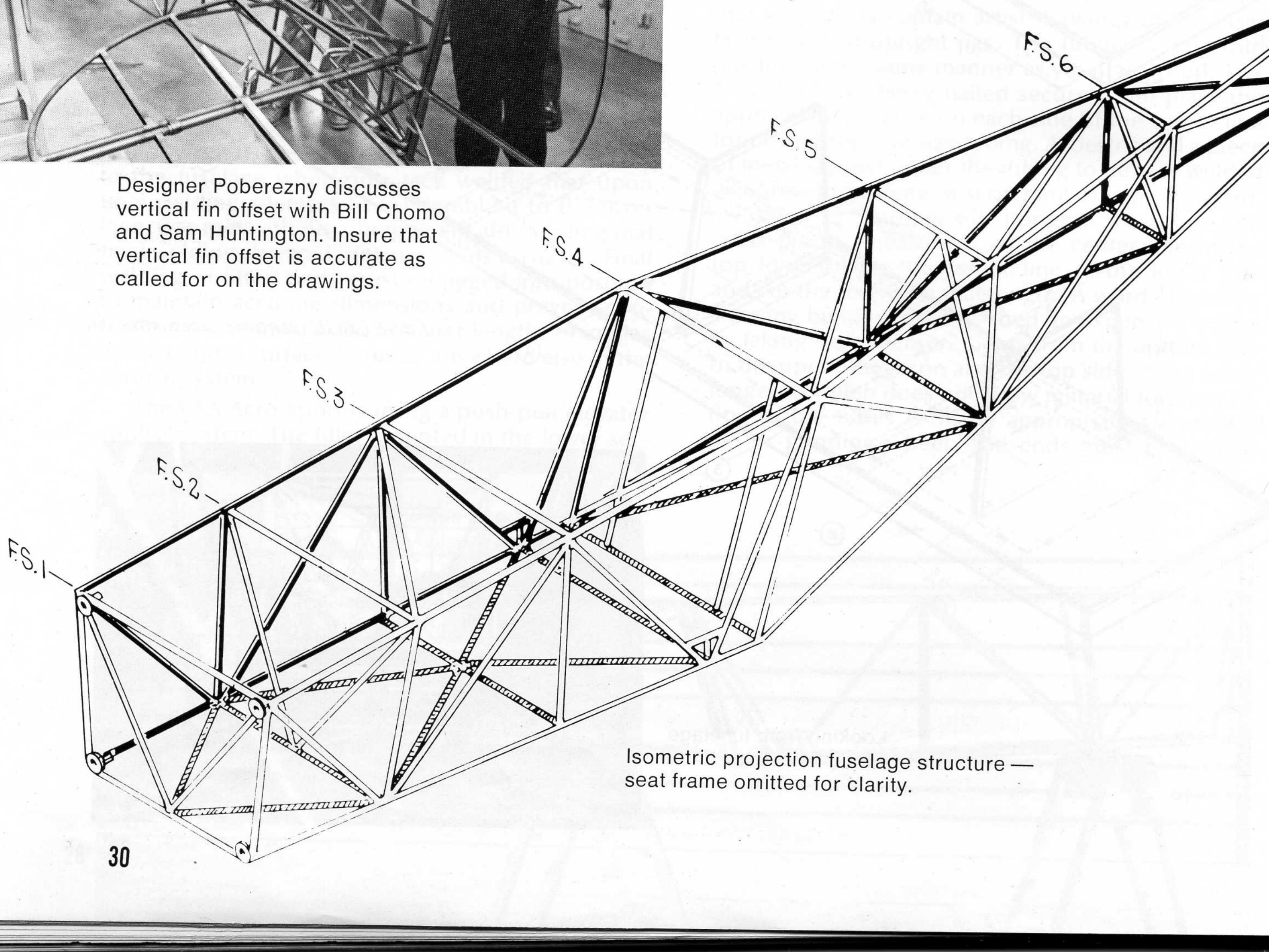




Acro Sport M6 airfoil placed into position prior to tack welding front and rear wing fittings into place.



Designer Poberezny discusses vertical fin offset with Bill Chomo and Sam Huntington. Insure that vertical fin offset is accurate as called for on the drawings.



Isometric projection fuselage structure — seat frame omitted for clarity.

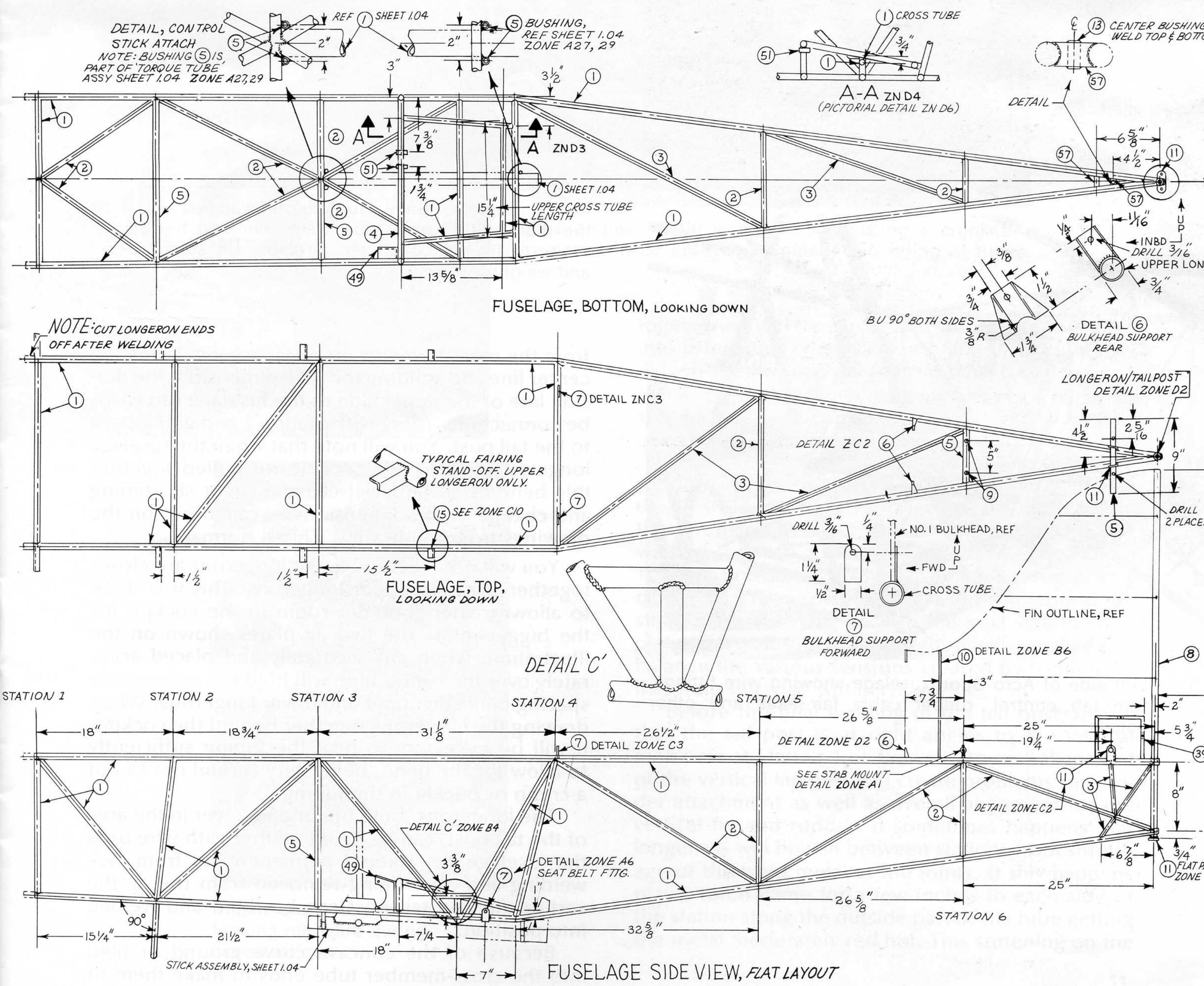
to fit nicely against the longeron and it is well to consider leaving a little play in the tubing as this small amount of play accommodates expansion during welding and thus prevents pushing the opposite longeron out of position when one end is being welded.

The lower fuselage longeron has a bend in it. To make this bend without harming the tubing, place the forward section in the fuselage jig between the blocks and with a heating torch and with the help of another aviation enthusiast, slowly apply heat in the area of the bend at the inside surface of the tube, heating it to almost a cherry red, making the bend very slowly so as to avoid putting a kink into it. This bend is not too sharp and one should not encounter too much difficulty in getting it to lay snuggly into the jig blocks.

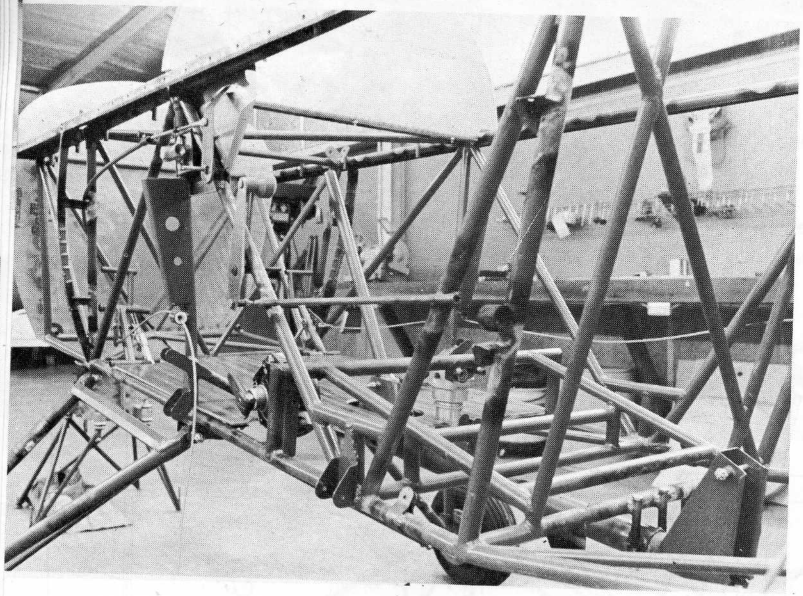
The upper and lower longerons should extend at least 3 or 4 inches past Station 1 or at the firewall. The same measurement should be maintained at the tail post. This additional tubing will allow for better welds and fitting and prevent welding burn-away when clusters are welded together at these key positions. After the fuselage is completely welded, the four pieces of tubing at Station 1 at the firewall can be cut off with a hack saw prior to fitting and welding in the fuselage engine mount attachments.

Build up a fuselage side on the jig leaving out the tail post. Each tube should be firmly tack welded into position. Do not attempt to weld any more than is needed to secure each tube. After both fuselage sides have been completed draw the top view of the fuselage on a flat plywood work surface or jig. A suitable and typical jig is shown in the plans of the Acro Sport.

A center line representing the thrust line is drawn on the jig board. The top side of the fuselage when fitting in the normal position is transposed



Airline captain, Sam Huntington watches Paul fi the rear landing gear tube. Sam later had the oppor tunity to fly the completed airplane. He stands 6' 5' and weighs 240 lbs.



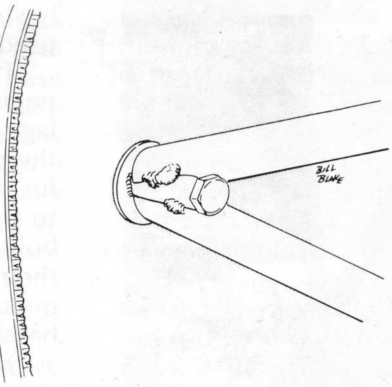
Left side of Acro Sport fuselage showing wire fittings, trim tab control, rudder cable fair-leads and other details.

from the measurements on your drawing. Using the center line and splitting the total dimension, the outside line of the upper side of the fuselage can easily be connected starting with Station 1 and going back to the tail post. You will note that when the fuselage longerons behind the cockpit are pulled together this bending inward will cause a slight shortening and change in the dimensions as called out on the drawings from a side view. This is normal.

You will note that the lower longerons are closer together than the upper longerons. This was done to allow greater shoulder room in the cockpit for the bigger pilot. The two jig plates shown on the illustration, when cut accurately and placed accurately over the center line, will hold the appropriate spacing between upper and lower longerons. When drawing the longerons together behind the cockpit, it will be necessary to heat the tubing sufficiently to allow for the bend, being very careful not to put a crimp or buckle in the tubing.

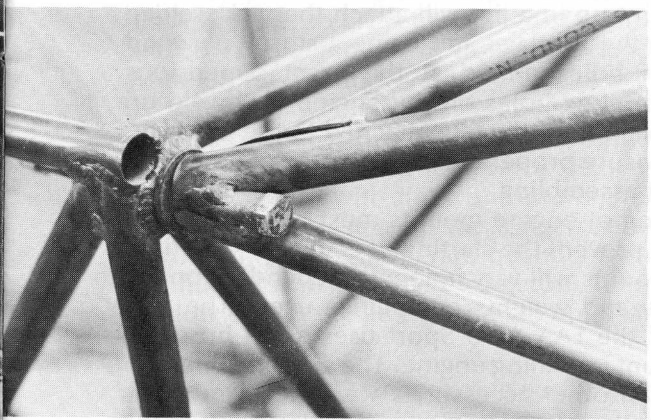
The longerons, both upper and lower in the area of the tail post, can be held together with wire until the fuselage has taken a permanent set from tack welding and after being removed from the jig the vertical fin and tail post can be fitted and welded into position.

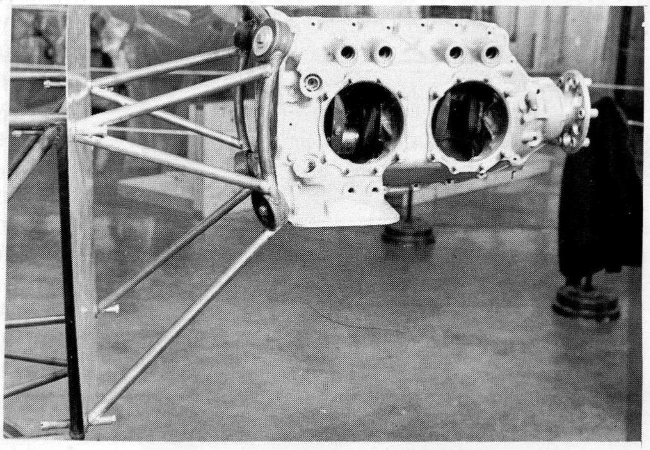
Because of the concave curve ground or filed into the cross-member tube ends to make them fit



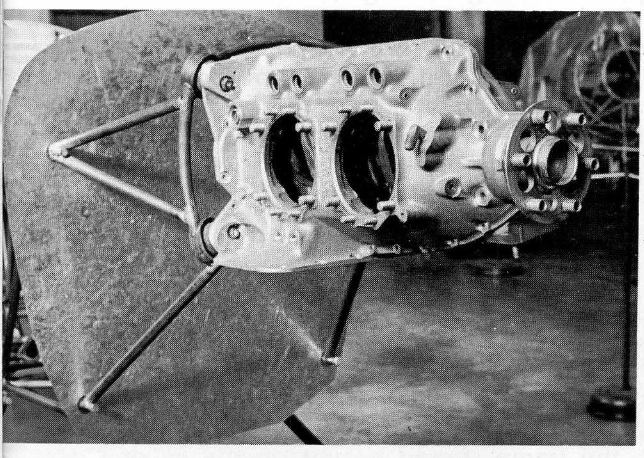
Engine mount tubing tack welded to bushing at fire wall. Final welding to be completed later. **Center points** must be maintained during final welding to insure proper fit.

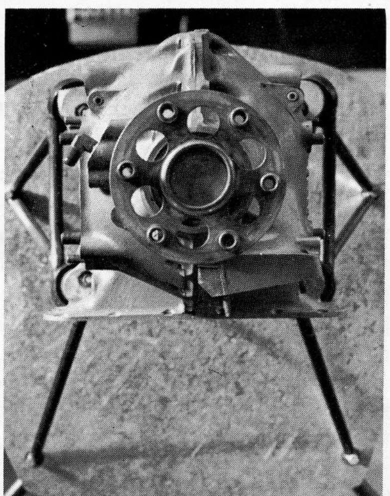
Engine mount bolted to fuselage at station one, firewall removed. Open end of longerons are closed to keep moisture out by welding small .035 metal discs over ends.





The engine mount was developed using a crankcase which allowed ease of alignment and fitting of tubes.



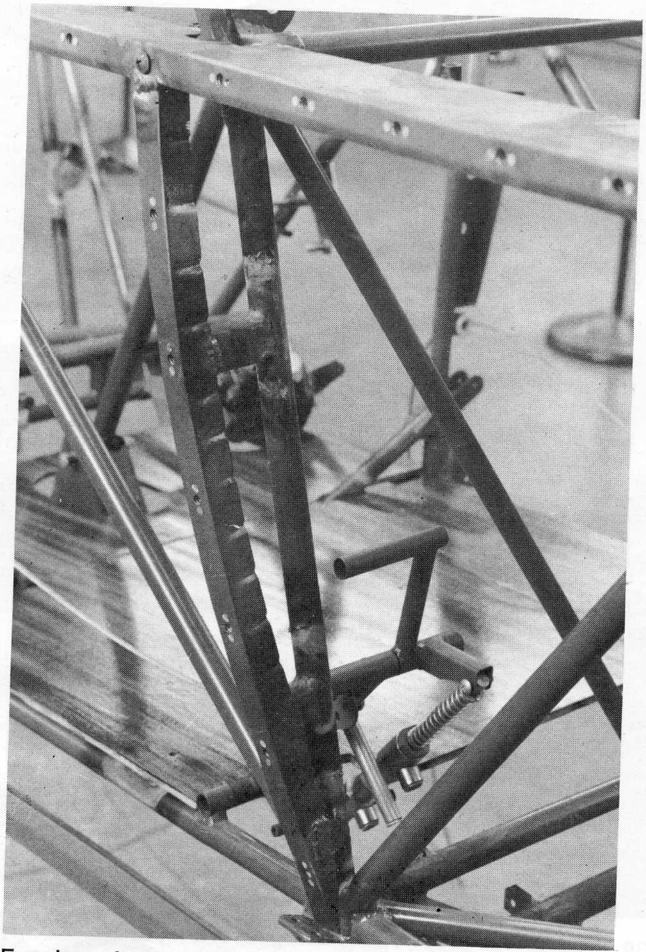


Engine crankcase and mount looking rearward during construction.

together, it will be quite hard to put the diagonals into place after cross tubes are done. So put in the diagonals as you progress from cross piece to cross piece. At each point the center lines of all tubes should meet at a common point to meet eccentric loads on the longerons.

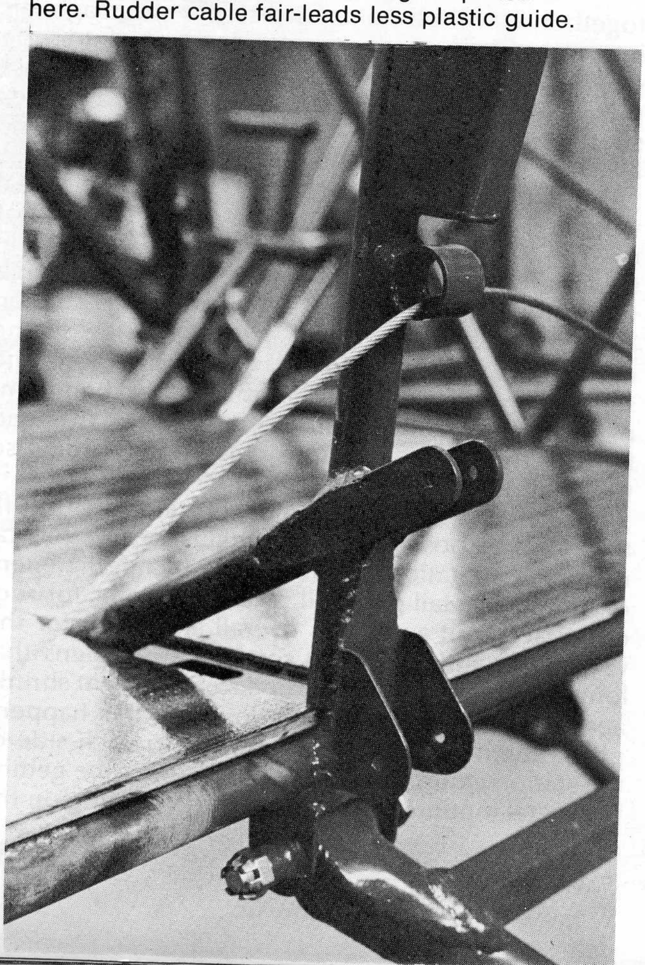
When the fuselage is all tacked together final welding can be done. A word of caution — do not do all welds along one longeron and then tackle the ones on the other side for this will result in a warped fuselage. One can either start from Station 1 at the firewall or at the tail post, starting at one cluster and then rotating to the next all around the station, then moving back to the next station completing all welds, etc. This method will equalize and balance the various tensions created by welding so that little warpage will occur.

Before the final welding of the tail post, insure that the tail post is at right angles to the vertical members at Station 1 or firewall. Any misalignment of the vertical tail post will create problems for rudder attachment as well as overall alignment for the vertical fin and rudder. It sometimes happens that longerons will bow in between stations from shrinkage of the weld metal at the joints. If this happens play a torch flame for a few inches to each side of the station along the outside part of the tube getting the metal moderately red hot. This softening on the



Fuselage former and front center section fittings, looking rearward.

Right front dual flying wire fittings depicted here. Rudder cable fair-leads less plastic guide.



outside will usually let the longeron spring true. Sometimes a rubber mallet used very cau ly so as not to bend, mar or flatten tubing c used to take care of minor bends.

The engine mount attaches to four fus engine mount fittings at the forward end of the lage. These must be located perfectly to mate the mount and must be placed accurately int fuselage so that when the engine mount is atta to the fuselage a perfect mating of the moun bolts occur. Many homebuilders, after tack we their mount up in a jig, will attach the tack we mount to the fuselage and using a sturdy plyw base with holes drilled at the exact dimens as the mounting holes on the engine, will wel the complete mount while attached to the fuse This will insure proper mating and ease of mou at time of assembling.

Welding of engine mounts must be of exce quality to prevent the starting of cracks by vibra Engine mounts will vary in length depending on type, size and weights of engines used. The totype of the EAA Acro Sport uses a 180 hp d focal mount Lycoming engine. The starter, gener and several other accessories were not used, lightening the basic engine weight. However, as EAA Acro Sport has a full inverted oil system fuel system as well as an air show smoke system, ferent weights and modifications for this purpose vary from those building an aircraft just for stra and level fun flying. A new weight and balance m be worked out for different weight and horsepo engines depending on the use of starters, s propellers, generators, batteries, etc. Due conside tion must be given this matter as a perfectly b anced aircraft insures safe and enjoyable flight.

During the work of welding up the basic fusela frame make liberal use of carpenter squares, leve plumb bobs and taut wires to keep things in tr alignment. While the fuselage will have to be tak off the plywood work base to get at the welds ne the wood, the frame should be left on the jig temporarily drilled into position as much as possib to hold it in alignment. The tack welds should generous enough so there is little chance of th pulling loose from warpage or strains as weldi progresses.

Many builders use wires — criss-crossing in X-manner between the top and bottom longero — to maintain exact centers until they are assur true alignment of the fuselage. Considerable ca should be used in making, bending, drilling ar welding the various fittings to obtain accuracy. all times be sure that 4130 fittings bent at 90° angl do not have tears or cracks in them. A magnifyin glass will be of great aid in determining quality your fittings.

The wing root fittings on the lower longeron for example, are designed so that when complete the wings will be held on at the proper angles fo good flight characteristics. If one fuselage win attach fitting was either lower or higher than th other, an aileron or rolling affect in flight would b noticeable.

Fittings for struts and wires are designed to transmit loads straight through with no bending forces arriving from eccentricity. Note that stops are provided to limit the range of motion of controls. These are important to safety. When control surfaces are moved too far in flight, the air loads can over stress the structure. Also there is a point in the motion of any control surface where its drag begins to greatly exceed its lift. Any more movement builds up so much drag that the plane responds badly. Stops are also necessary to prevent damage to control systems and controls being blown violently around by winds while on the ground.

When all welding has been done, it is a very wise step to coat the inside of the longerons with a rust preventative. One way to do it is to prop the fuselage up with the front end higher than the other. Before closing up the longerons on the forward end, pour a moderate quantity of rust proofing fluid down into each longeron. It will flow to the low end in the area of the tail post, far from the welding heat at the high end. Run a stick and cloth down each longeron to wipe out the fluid on the tubing near the weld to prevent smoking. Weld up the forward ends of the tubes and when the metal is thoroughly cool, rock the fuselage to distribute the fluid over all longeron interiors. Then drill small holes at the rear end of the longerons to allow the excess fluid to drain off, and seal the holes with self tapping or driven in screws. The entire exterior of the framework is sprayed with a zinc chromate or equivalent rust resisting primer.

The plans show coil return springs on the rudder pedals. They should be only stiff enough to keep the rudder pedals from falling backwards onto the floor. If they are too stiff they will induce a confusing feeling into the rudder control while in flight. It is vitally important to remember that the cables running from the rudder pedals to the rudder horn must not rub or touch any of the vertical or diagonal members of the fuselage. The cables are guided by fair leads, a plastic material mounted into pieces of tubing to insure long life and proper routing.

Fitting the two belly stringers into position. These are laminated and preformed according to drawings for proper curve.