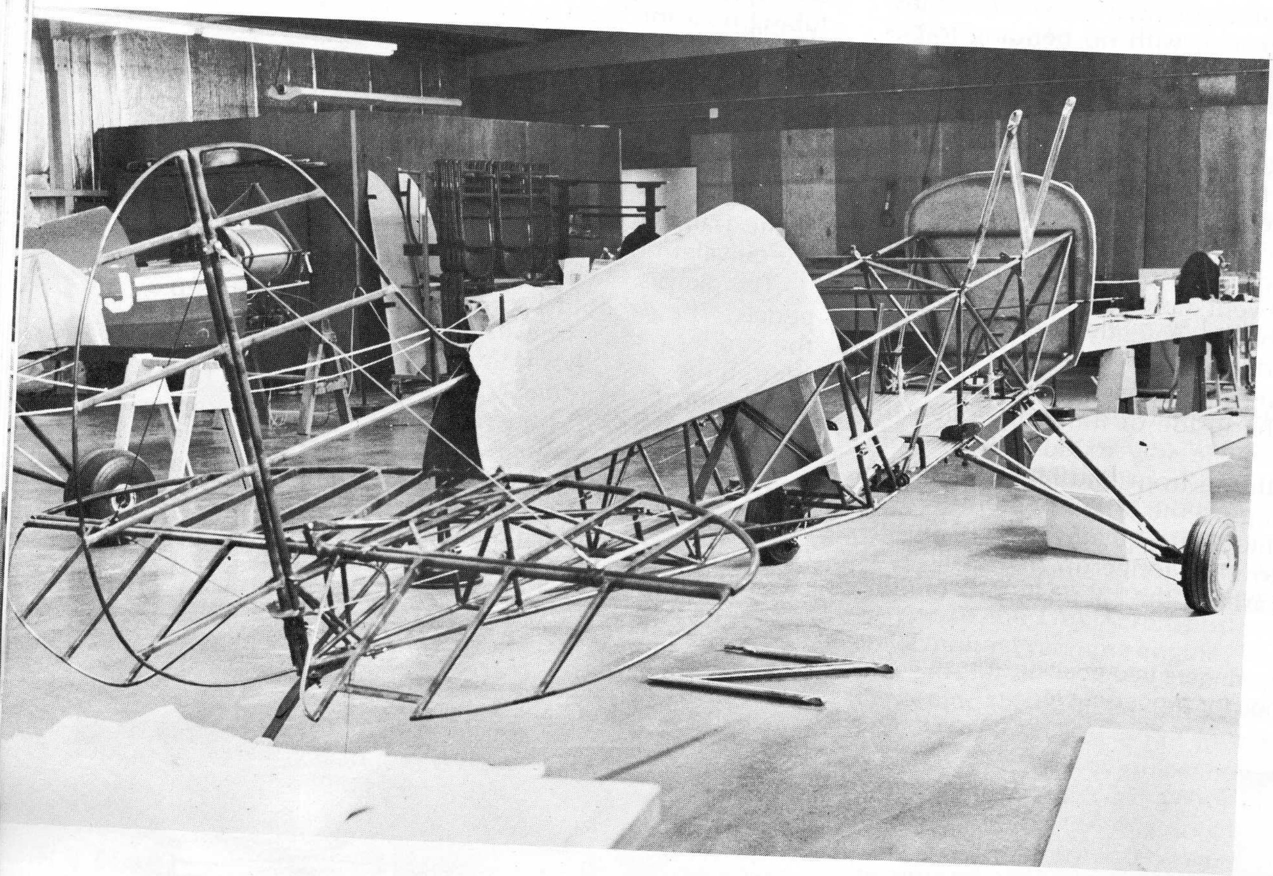
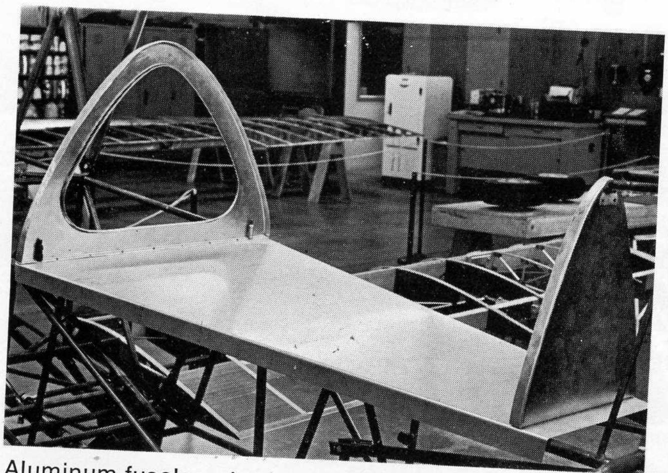
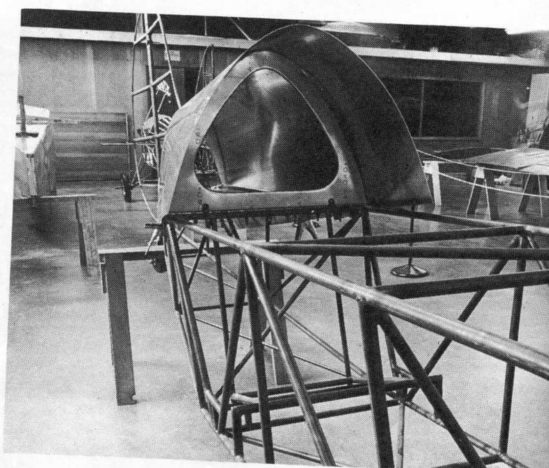


The Acro was devel
using both the plyw
metal turtle deck. H
shown the plywood
The plywood is soak
with water at the sha
radius (top) and ther
by straps around the
bulkheads to form ar
Care should be taker
to split the plywood.

turtle dec



Aluminum fuselage turtle deck prior to covering and riveting.

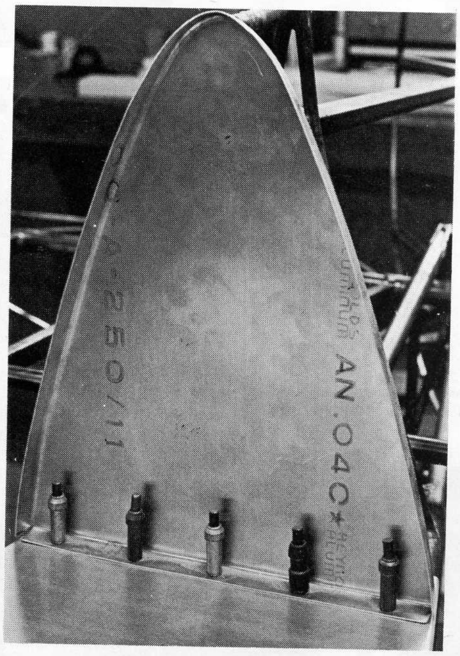


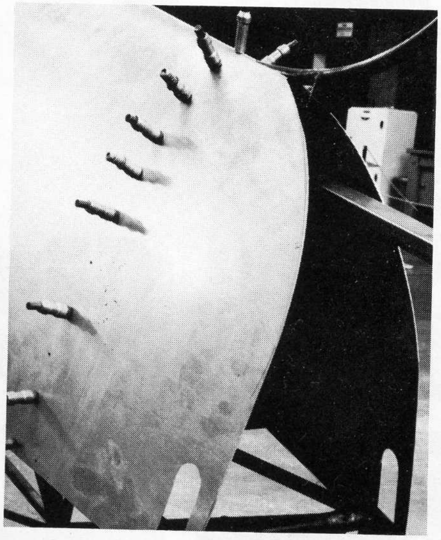
Aluminum turtledeck with wrap around sheet metal being formed into position.

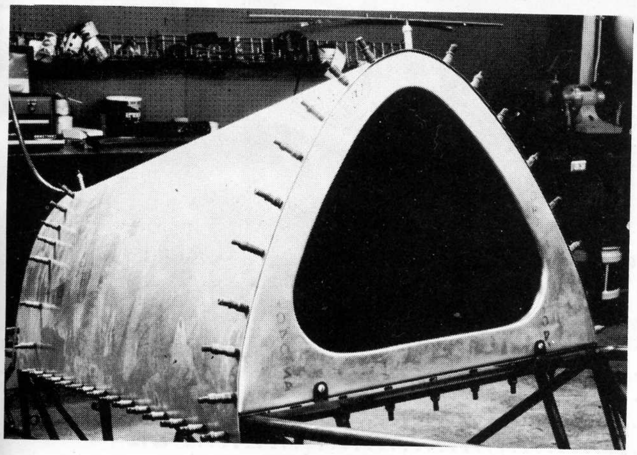
Koston Photo

The prototype Acro Sport is covered with Grade A fabric, although other materials may be used according to manufacturer's instructions. The Acro Sport final finish was done by Earl J. McEntire of Aircraft Paint, Smith Field, Ft. Wayne, Ind., who also arranged upholstery through Ted's Upholstery Service there.

Rear aluminum turtle deck former held into place with sheet metal fasteners prior to riveting.



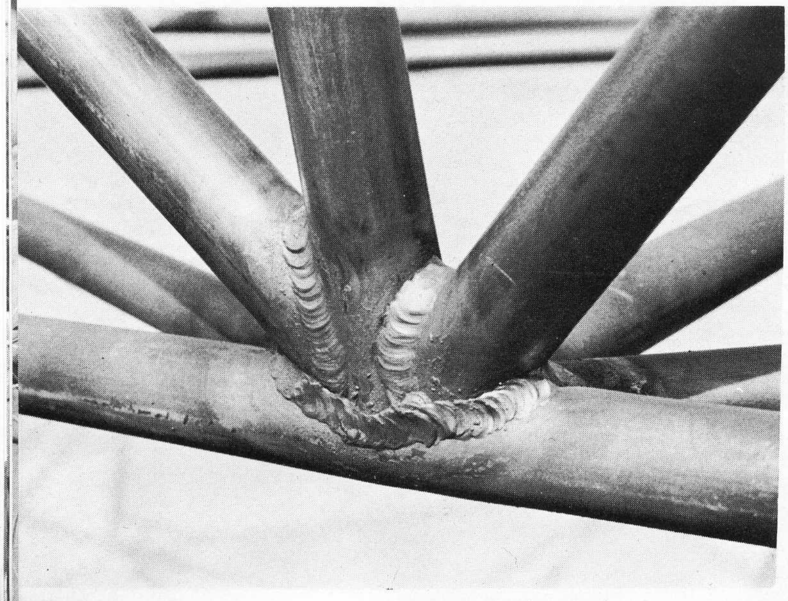




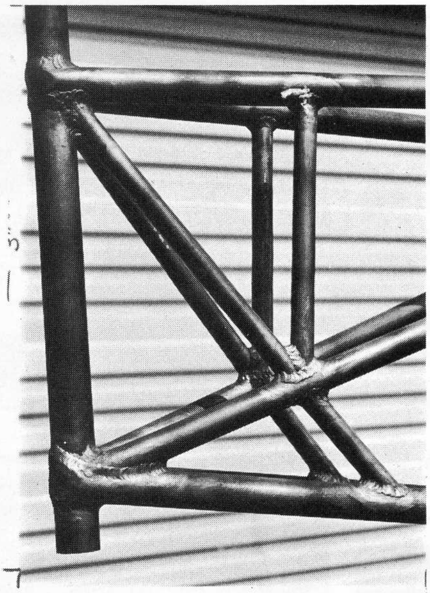
The aft portion of the turtle deck is faired into the vertical fin to give smooth fabric lines when covered. This is the metal version.

"Cleco's" (sheet metal fasteners) hold the aluminum into place prior to riveting. Note large baggage space.

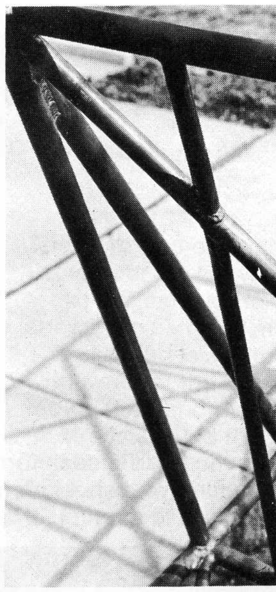
Typical fuselage weld prior to being wire brushed.

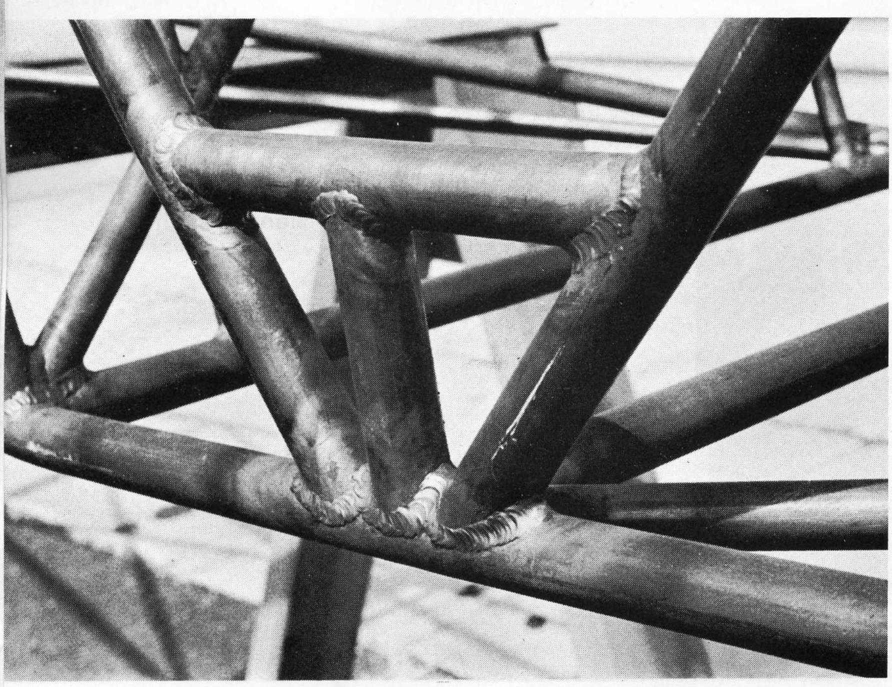


Tail post and tail spring trussing.



Seat back and more we





Rear wing strut fitting and second seat belt tube.

fittings

Minimum Inside Bend Radius:
4130 "N" Steel

Thickness	Min. Inside Bend Radius
.025	.06
.032	.09
.049-.050	.16
.063-.065	.19
.090	.28
.25	.38

Aluminum 1100-0

.050	.06

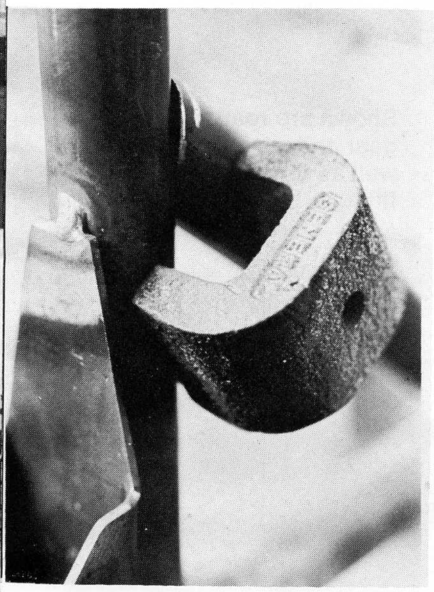
Aluminum 2024Ts

Thickness	Min. Inside Bend Radius
.020	.06
.025	.09
.032	.12
.040	.16
.063	.22
.090	.38
.250	1.12

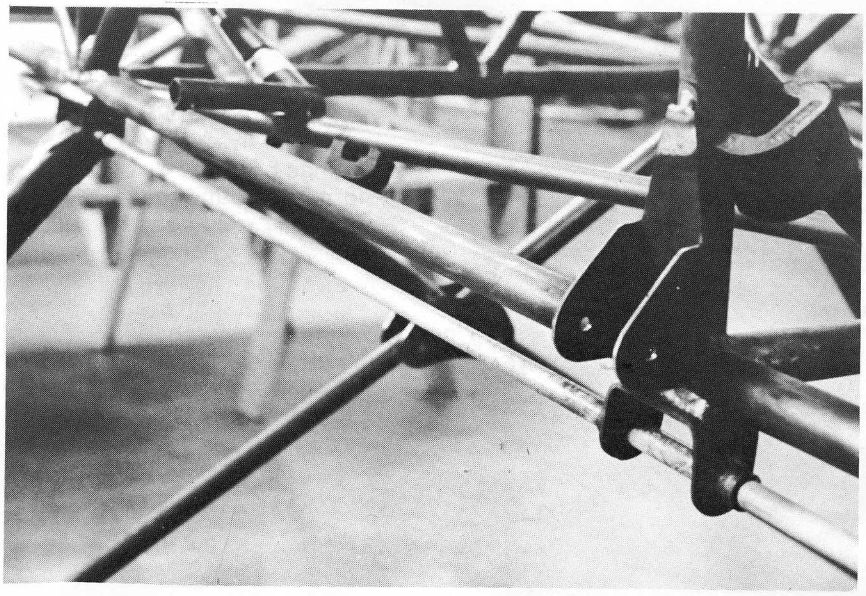
Aluminum 6061-T3

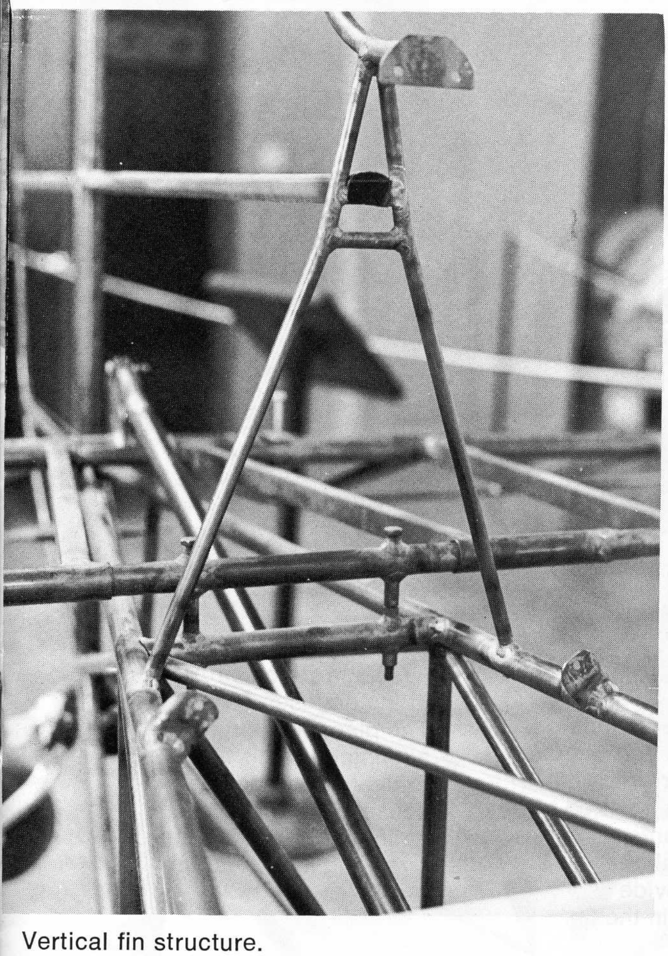
.063	.12

Magnet used to hold tubing
into position while tack welding.

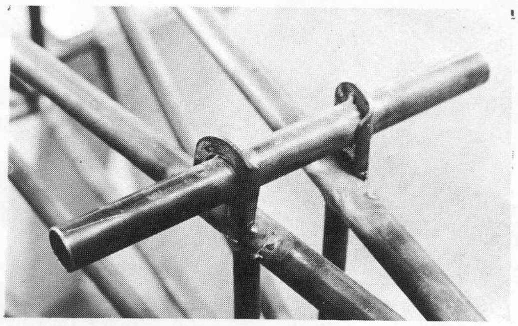


Note drill rod used for landing gear fitting alignment.

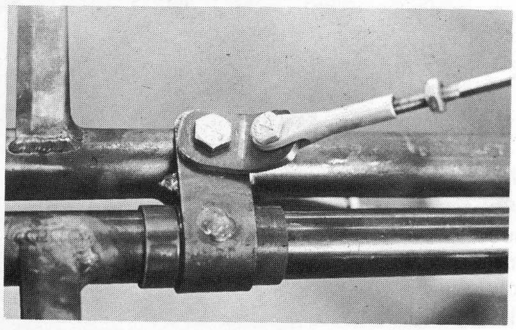




Vertical fin structure.



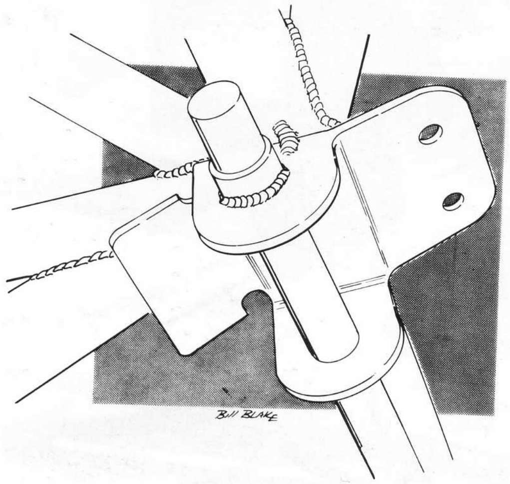
Rear stabilizer-fuselage
attach fitting.



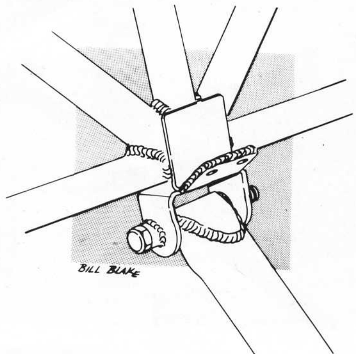
Elevator-stabilizer
hinge attach fitting. Note tail
brace lug and wire attachment.

Rudder horn and
cable temporarily
placed into position.

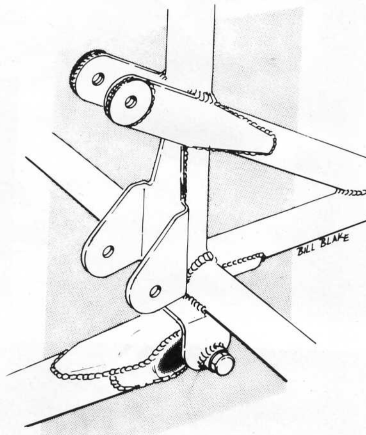
The front and rear landing gear fitting is shown tacked into position. Note the drill rod which passes through both front and rear fittings to provide proper alignment during welding.

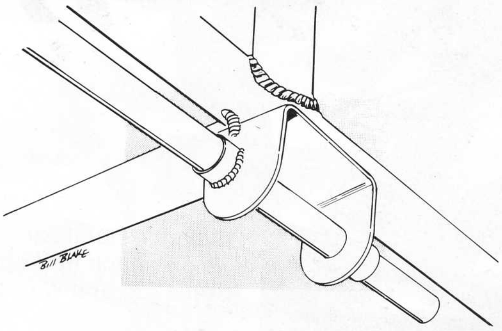


Join and fit landing gear and flying wire fittings prior to forming around the tube and welding.

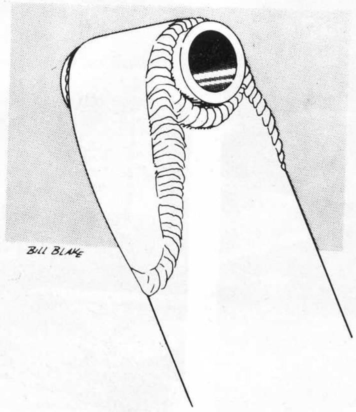


Shown are rear landing gear and wing fittings, as well as rear flying wire fittings.

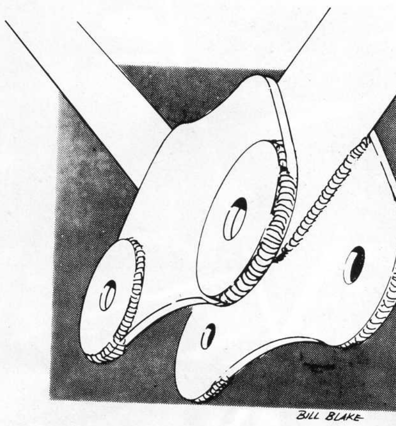




Drill rod used to align front and rear landing gear fittings while tacking into position.

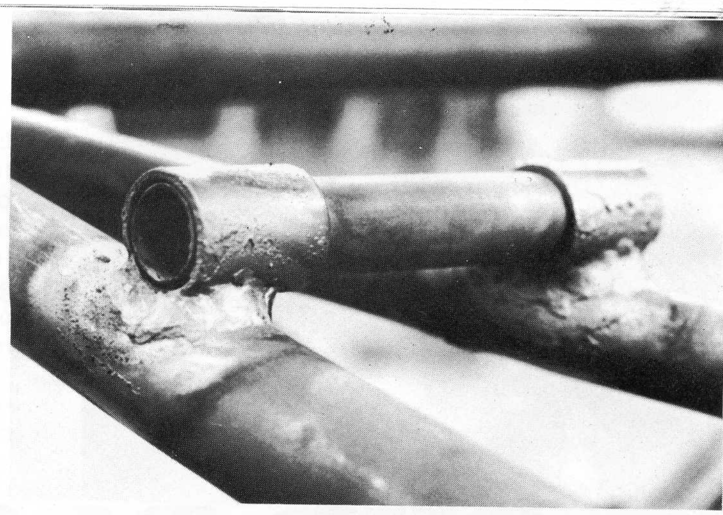


Upper end of front landing gear strut. This end should be completed prior to lower end being jig fitted to axle. A bolt mounted vertically through the bushing will provide accuracy while in the jig.

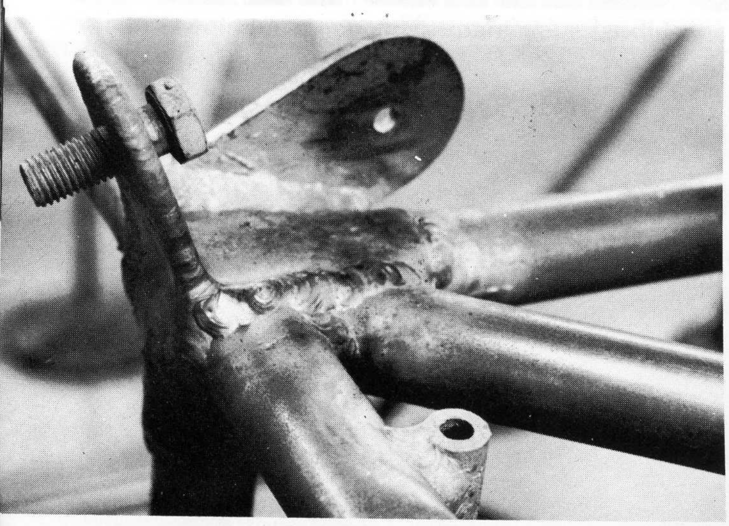


Fuselage shock strut fitting on fuselage cabane. The placement and alignment of this fitting is critical. Discrepancy will cause difference in landing gear shock strut position or a wing low condition.

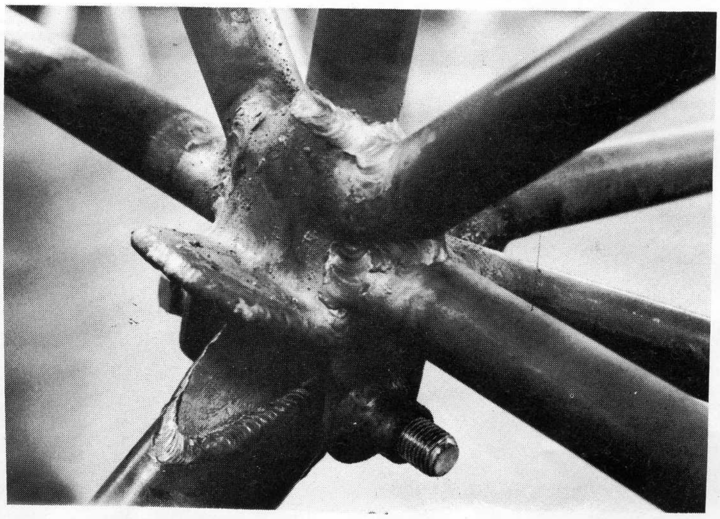
Rudder pedal bushings are welded to lower fuselage tubing.

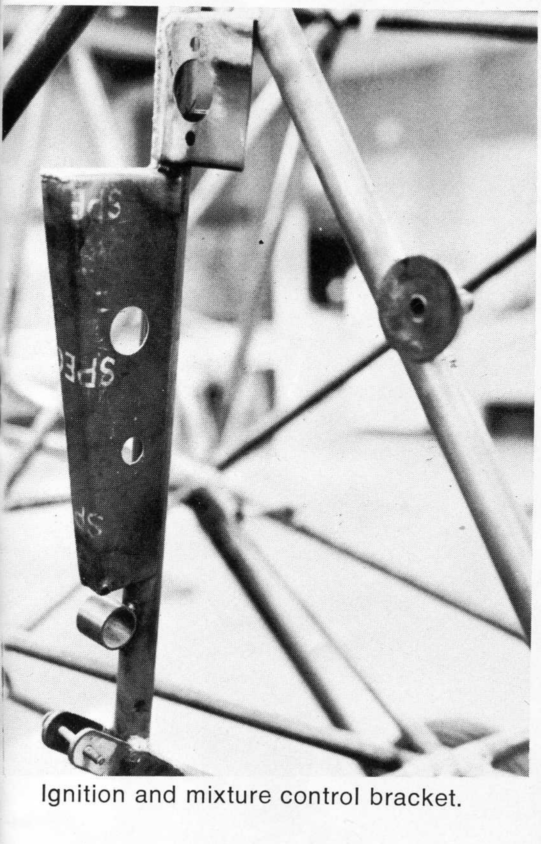


Viewed from above, center section fuselage strut fitting, "with bolt", center section roll wires attach lug. Bushing in foreground is smoke oil tank hold down strap attachment.

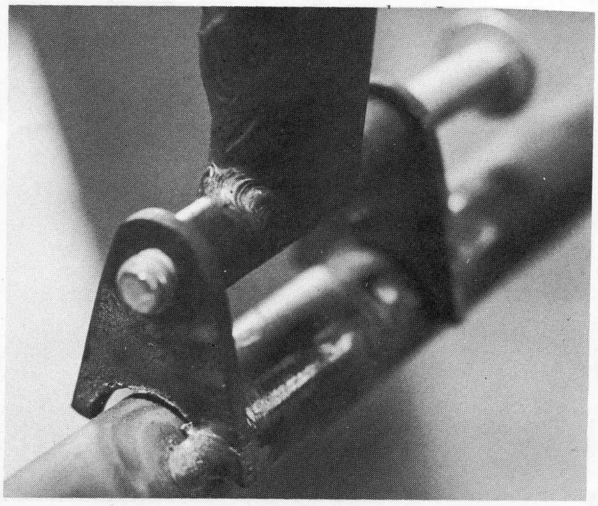


Front landing gear and double flying wires fitting offers sturdiness.

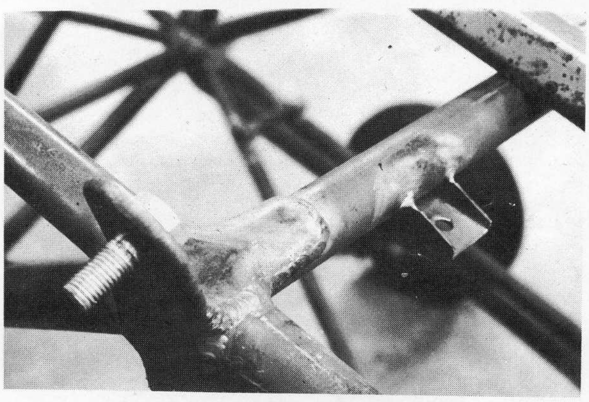




Ignition and mixture control bracket.



Elevator idler arm attach lugs, tacked into position.

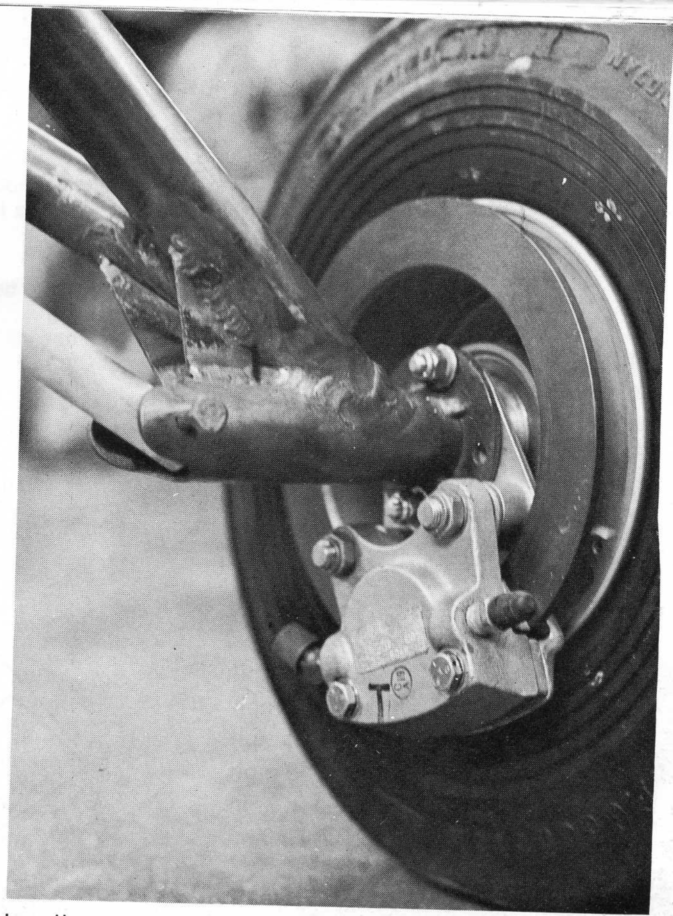


Rear left center section fuselage strut attach fitting.

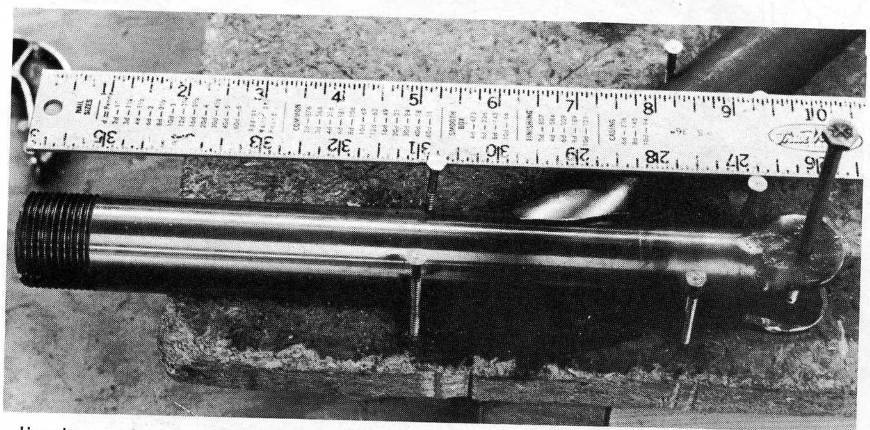
sub assemblies

The Acro Sport landing gear is made up of steel tubing very similar to the Piper J-3 or other light aircraft, using a shock absorber strut attached to the inside end of the axle and a fitting on the cabane strut just below the fuselage. Perfect wheel alignment is essential in an aircraft to avoid tire scuffing and insure good handling on the runway. It is also imperative that the fuselage be perfectly square at the areas of front and rear landing gear fittings; that the cabane below the fuselage and fittings attached to the cabane are in perfect alignment so that when your landing gear is attached, as well as shock strut, perfect alignment is maintained. If your fuselage bay is not square or one of your fittings or shock struts short or long, it will show up in a wing low condition. As a suggestion, it would be wise to attach all fittings to the fuselage, and after final welding begin to prepare your landing gear. It would be wise to cut the front leg of your landing gear, install the upper end fitting and wrap around strap. In making the full size jig, fit your axle and front landing gear strut into position so as to establish the proper angle. It will take filing and perfect fitting to attach the front strut to the landing gear axle. After tack welding the landing gear leg into position, fit and attach the upper end of the landing gear leg to the fuselage, blocking the aircraft into position so that a perfect alignment can be had without any weight resting on the landing gear — blocking the axle into the position it would normally be if the wheel and tire were in place.

Your next step will be to prepare the rear landing gear strut, cutting it a little longer than normal and getting the right angle and fit at the axle and front tube area. Then, as per drawing, fit and tack weld the bushing in so that it fits properly at the rear landing gear fitting. It is imperative that one only tack weld all the tubing into place so that you have the flexibility of heating and repositioning. It should be noted that welding can cause a great deal of stress and moving of tubing and this technique of fitting the landing gear to the fuselage fittings is the same as using them as a jig. After all of the fittings have been tacked into posi-



Landing gear axle and brake assembly. 5:00 x 5 wheels are shown. Reinforcing straps on axle at shock strut attach have yet to be welded on.

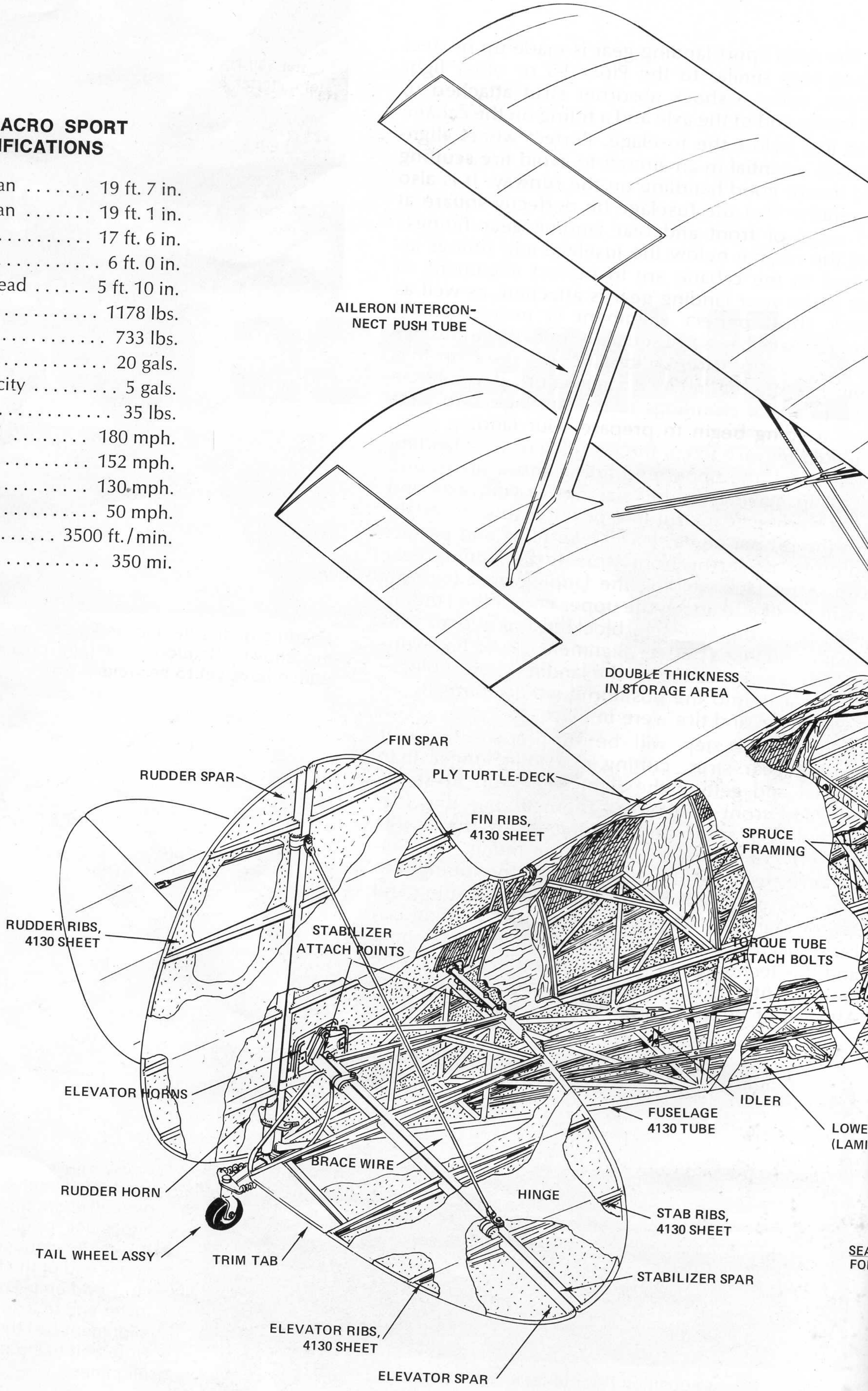


Jigging axle into position prior to tack welding.

The wheel axle and front landing gear strut are fitted and jigged into place prior to tack welding. It is recommended that the upper end of the front landing strut be completed before fitting lower end to axle. Perfect alignment can then be made. Note bolt being used for alignment.

180 HP ACRO SPORT SPECIFICATIONS

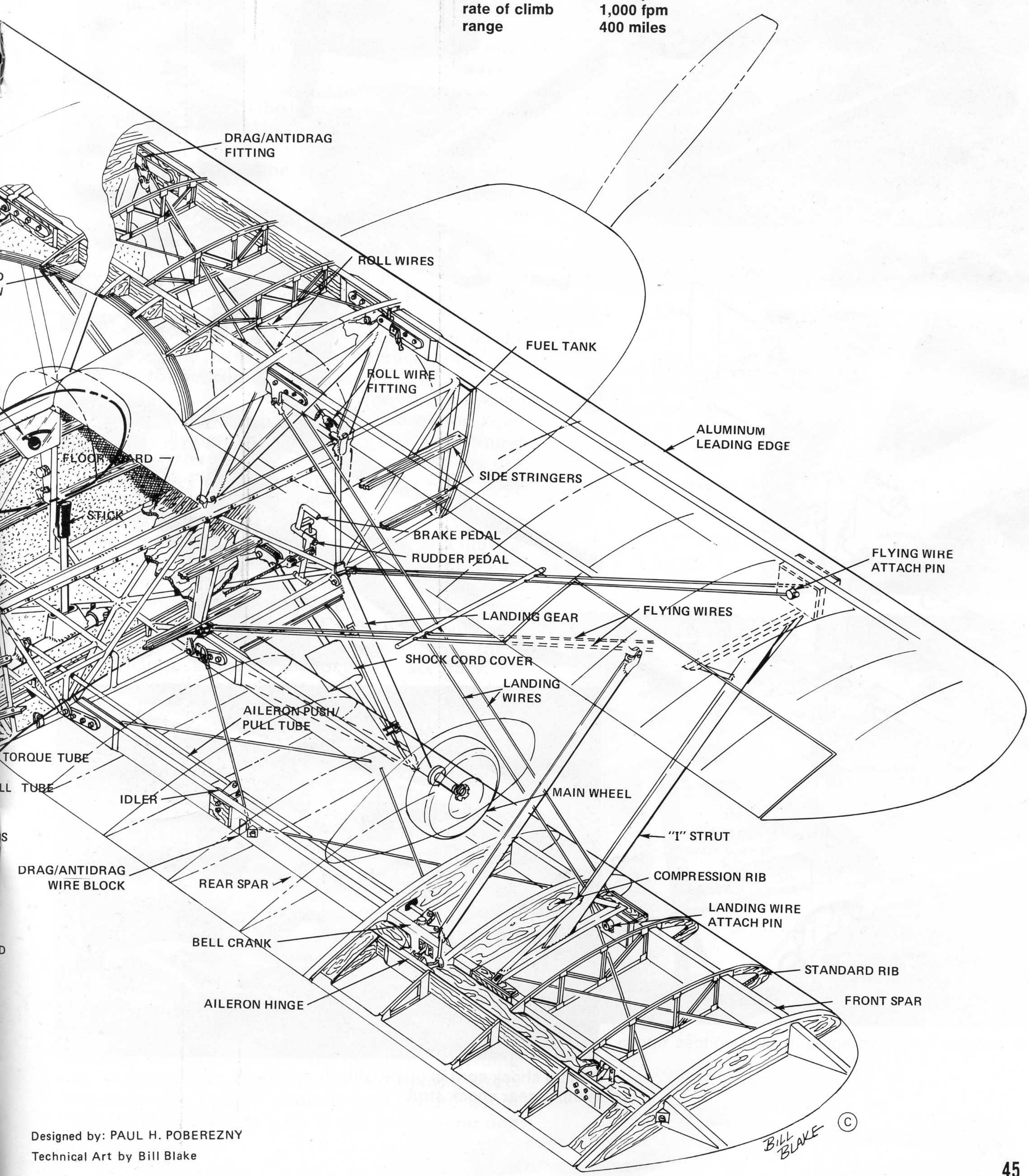
Upper Wing Span	19 ft. 7 in.
Lower Wing Span	19 ft. 1 in.
Length	17 ft. 6 in.
Height	6 ft. 0 in.
Landing Gear Tread	5 ft. 10 in.
Gross Weight	1178 lbs.
Empty Weight	733 lbs.
Fuel Capacity	20 gals.
Smoke Oil Capacity	5 gals.
Baggage	35 lbs.
Maximum Speed	180 mph.
Top Speed	152 mph.
Cruising Speed	130 mph.
Stalling Speed	50 mph.
Rate of Climb	3500 ft./min.
Range	350 mi.



EAA
ACRO-SPOR

O-200 Teledyne Continental 100 HP includes electrical system, starter & battery.

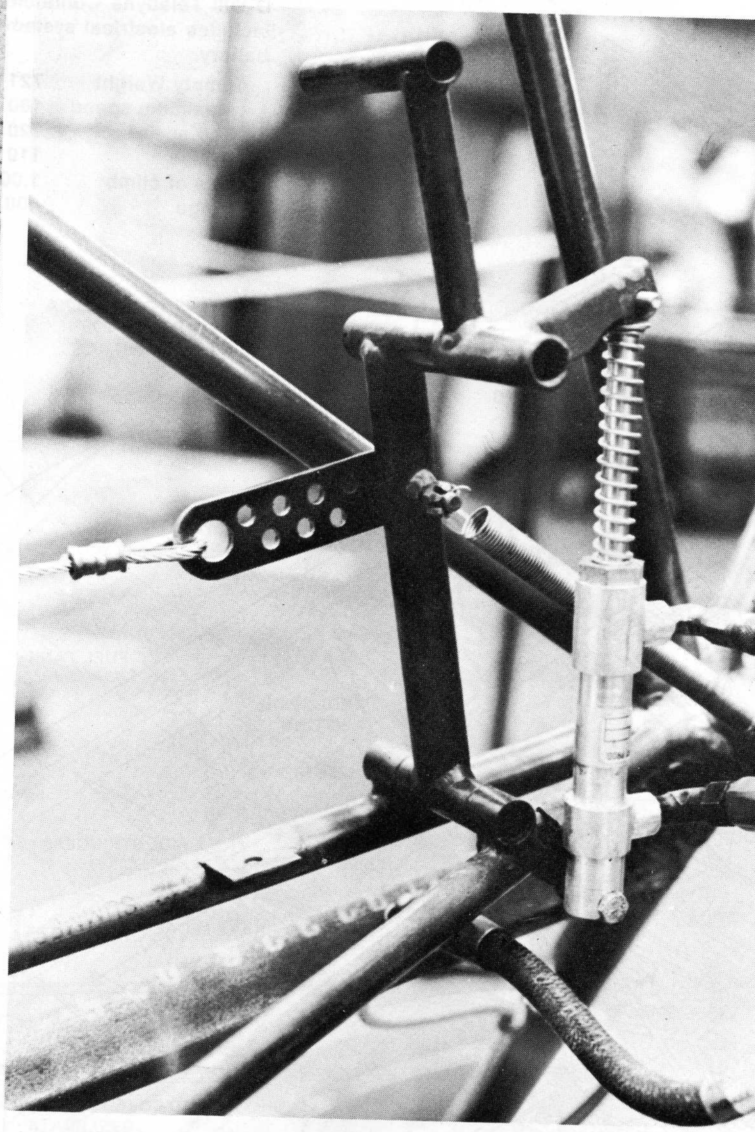
Empty Weight	721 lbs.
Maximum speed	180 mph
Top speed	120 mph
Cruise	110 mph
rate of climb	1,000 fpm
range	400 miles

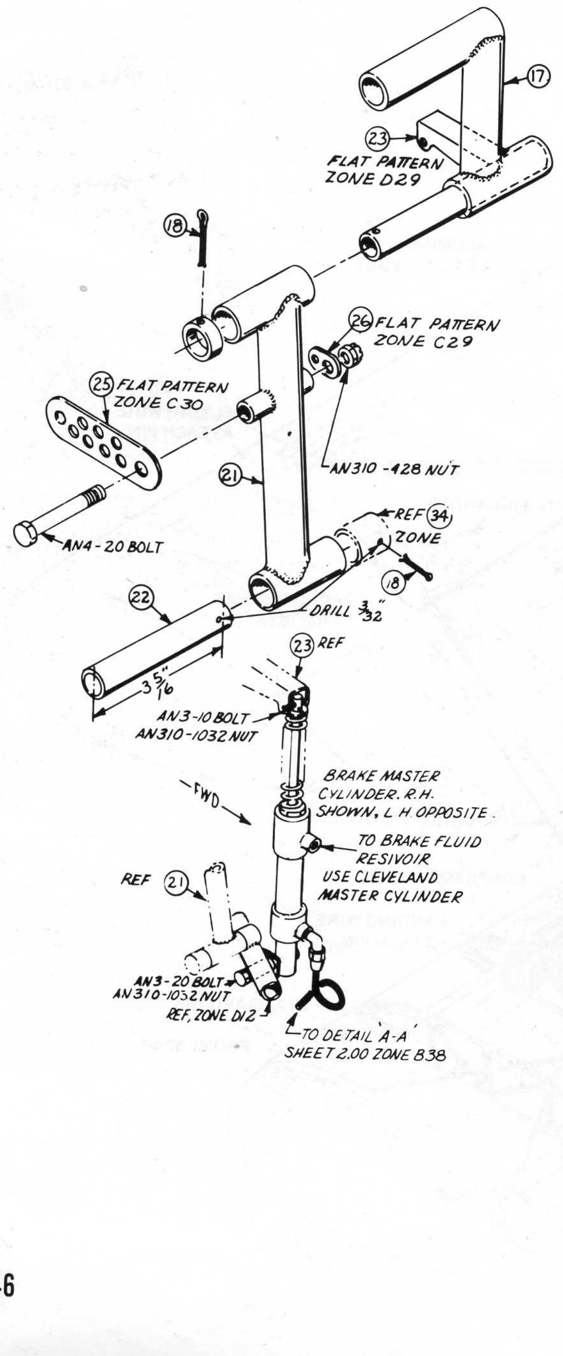


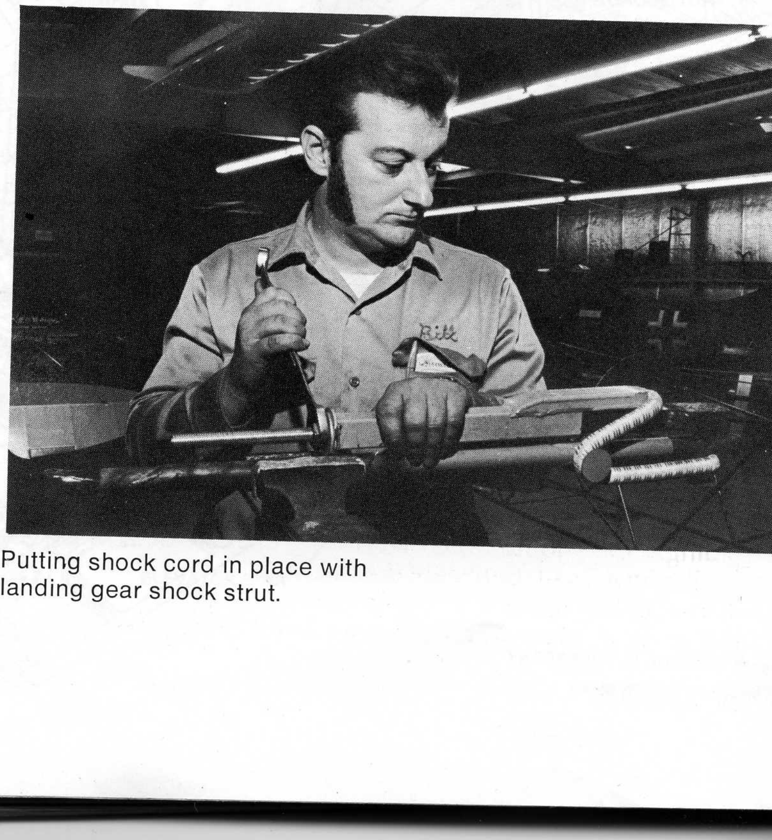
Designed by: PAUL H. POBEREZNY
Technical Art by Bill Blake

Rudder and brake pedal assembly.

Rudder and brake pedal with individual hydraulic brake cylinders are shown — note rudder cable with holes in attach fitting for rudder pedal adjustment — complete unit is of Pitts design.







Putting shock cord in place with landing gear shock strut.

tion securely, the cross section of fairing between the front and rear tubes of the landing gear near the upper fittings should be cut and fitted, and welded into position. This will not allow the spacing to differ so that later on when welding is completed, the heat will not distort or create variances in tolerance.

As per the drawings, lugs to hold fuel-vent lines (if inverted fuel system is used), and hydraulic lines are put into position.

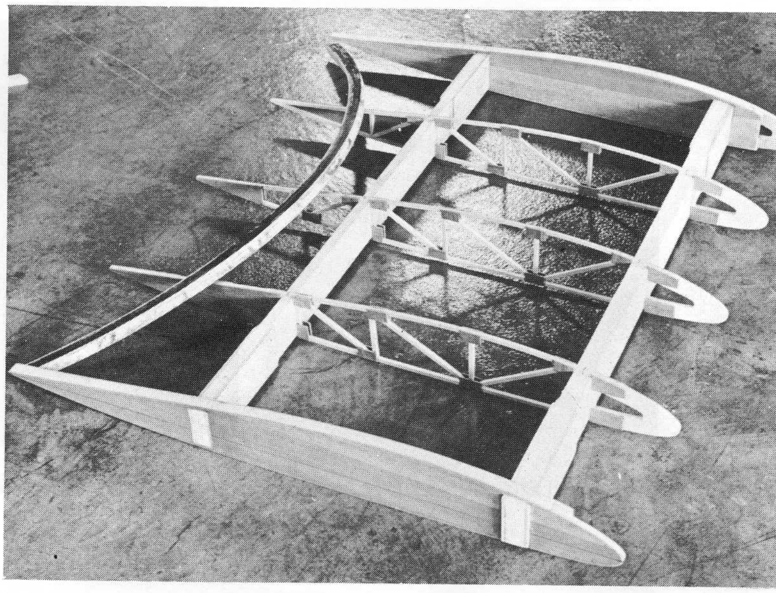
You will note that it will be a little bit more difficult in welding the lighter tubing to the heavy axle wall; great care should be taken so that the heat is distributed to the heavier walls and the lighter tubing is not burned away. It is advisable that the lower end of the shock struts and fittings going into the inboard side of the axles not be permanently welded until such time as the full weight of the airplane is on the gear. It is recognized that there will be variances in constructing the Acro Sport — no two being alike and small errors in dimensions can create fitting problems. This problem is even common when aircraft are built from the same jigs.

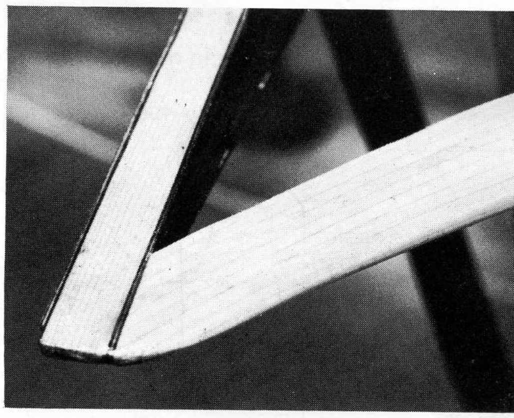
The brake attach washer must be welded into place as accurately as possible as called for on the drawings. The washer must be vertical, or ninety degrees to the axle so as to insure a true fit of the brake assembly to the wheel. The shock system on the Acro Sport is basically as used on the Piper J-3. In the flying of the Acro Sport we have found the shock system to be very adequate and the use of standard Piper Shock cords makes for easy availability and easy installation.

Regarding center section struts and outer "I" wing struts, we feel that the drawings and illustrations in the drawings of the Acro Sport are very adequate and if time is taken to study, they present a satisfactory picture for assembly. We would recommend, in this case, that all four wing panels be constructed as well as the center section. These items being used for jigs and for greater accuracy.

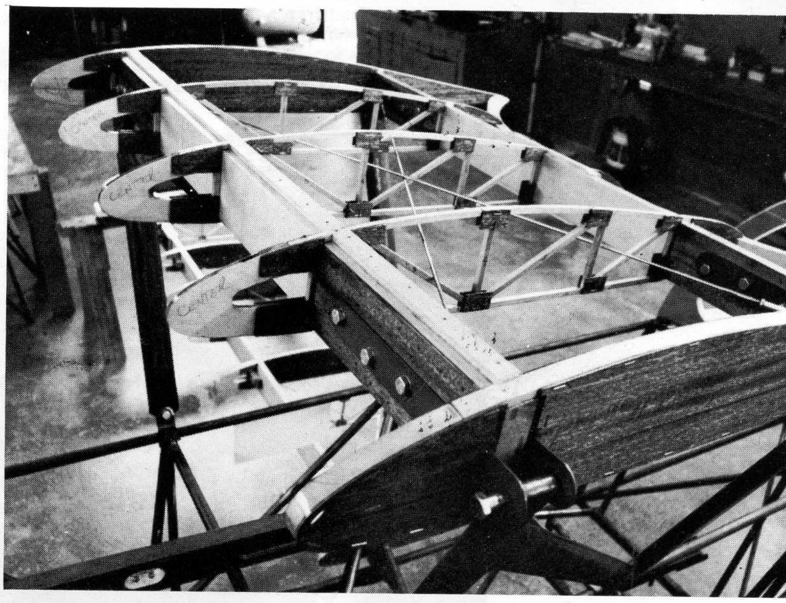
Many who have built biplanes have made a plywood jig box, resting the jig box on the top longerons in the proper location on the fuselage, so that the center section is accurately placed into position in accordance with dimensions shown on the drawings. With the center section in accurate position, front and rear struts are cut to length, fittings welded on the end and the N or diagonal struts are tacked into position, using the fuselage center section lugs on the top of the longeron and the center section strut fittings as the jig. The angle or the end of the strut is tacked into position while the jig box holds the proper dimension for angle of incidence. The center section struts can also be laid out in full size on a piece of plywood, making sure that accuracy of the drawings are followed. Again, I would like to stress that all work should be tack welded, final measurements taken to insure accuracy prior to final welding. One should note that during final welding the diagonal strut between the two upright struts will cause the upright struts to pull inward if not held firmly in place in a jig. If this is not done one

Center section wing ribs slipped on spars. Center section bow laid into position prior to cutting off of trailing edge ribs.



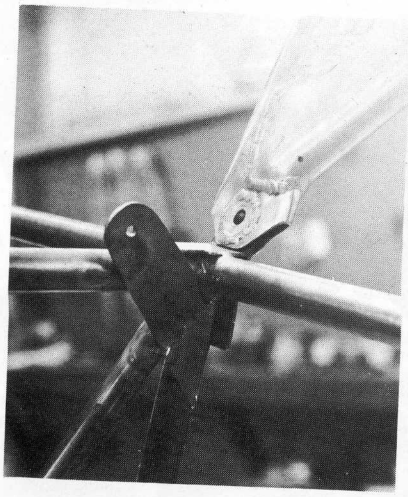


Trailing edge of center section bow attached to butt rib prior to gluing re-inforcing block into triangle.

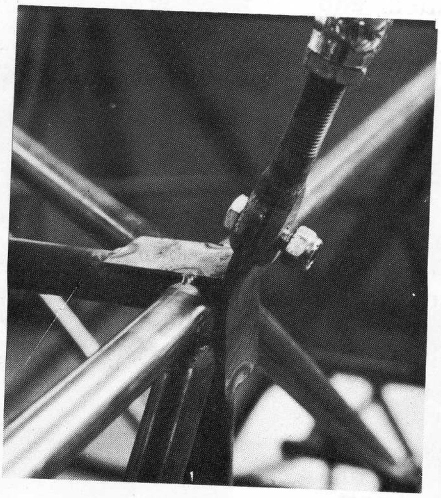


Wing center section held in place by center section struts.

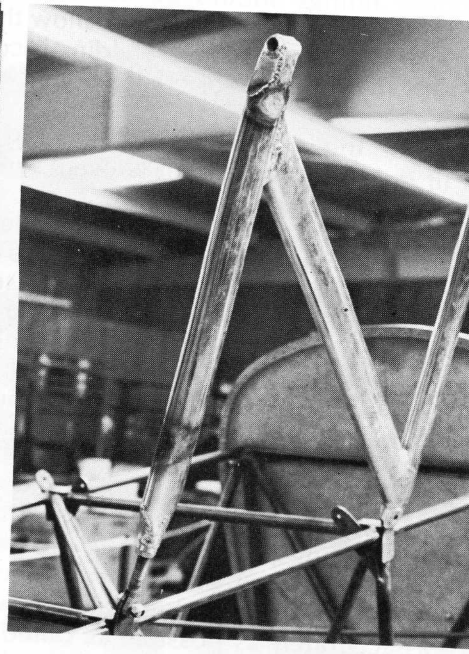
Center section roll wire attach fitting.



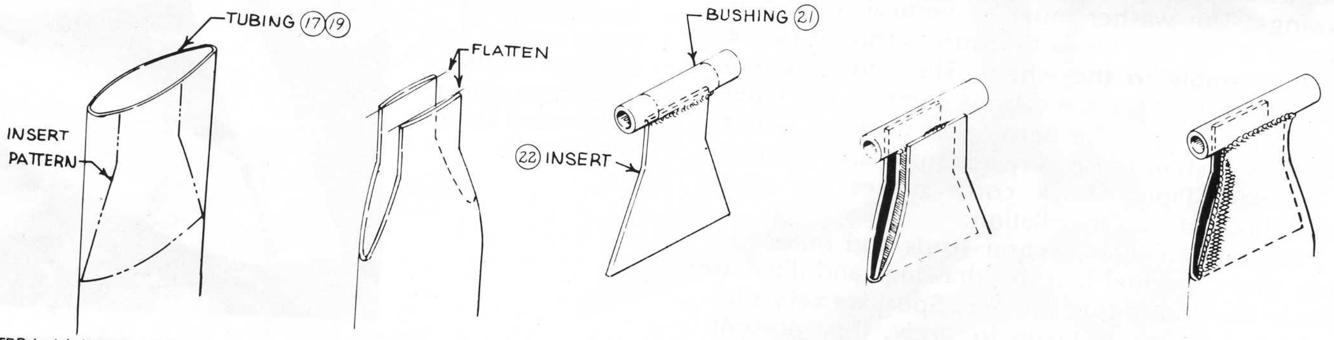
Rear fuselage center section attach fitting tacked into place, prior to heating, pre-forming and final welding.



Center section end strut placed into position.



CABANE STRUT ENDS, UPPER



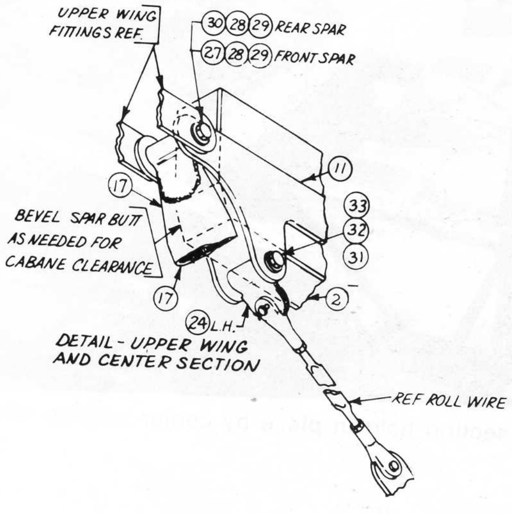
STEP 1. LAYOUT INSERT PATTERN ON STIFF PAPER AND TRACE ON TO TUBING.

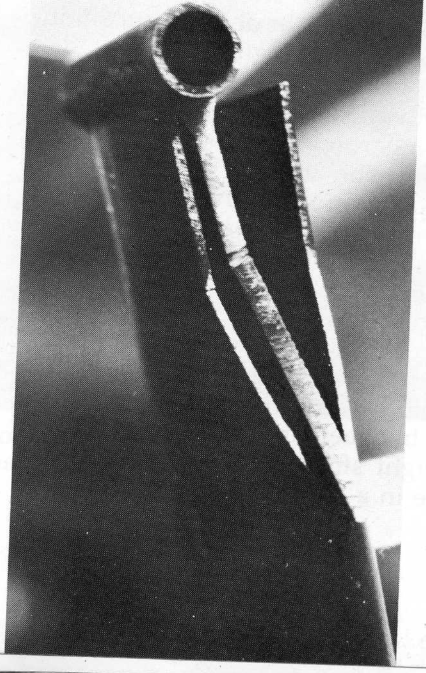
STEP 2. CUT OUT WITH HACKSAW AS SHOWN. FLATTEN TOP EDGES TO MATCH SIDES OF BUSHING.

STEP 3. CUT INSERT TO SHAPE AND WELD TO BUSHING. LEAVE BUSHING EXTRA LONG.

STEP 4. PLACE INSERT IN CUTOUT AND TACK WELD BUSHING TO SIDES. WELD INSERT IN PLACE

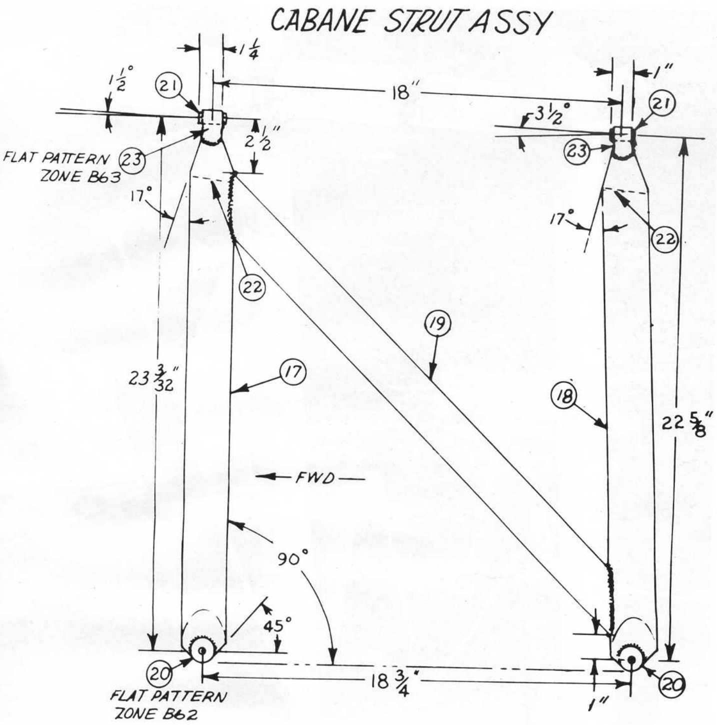
STEP 5. HEAT SHADE OF TUBING CHERRY GENTLY FOLD EDGE OVER TO MEET INS JOINT AND REPEAT OSITE SIDE AND R STRUT.

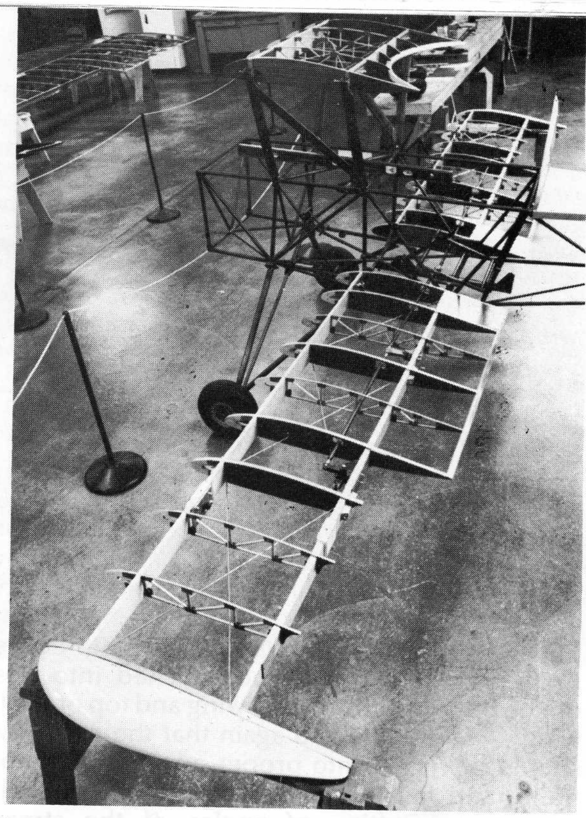




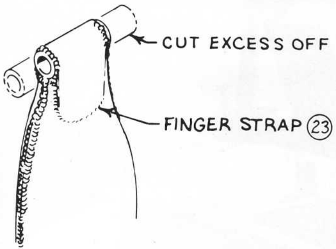
Top end of center section end strut.

Welding ce section enc

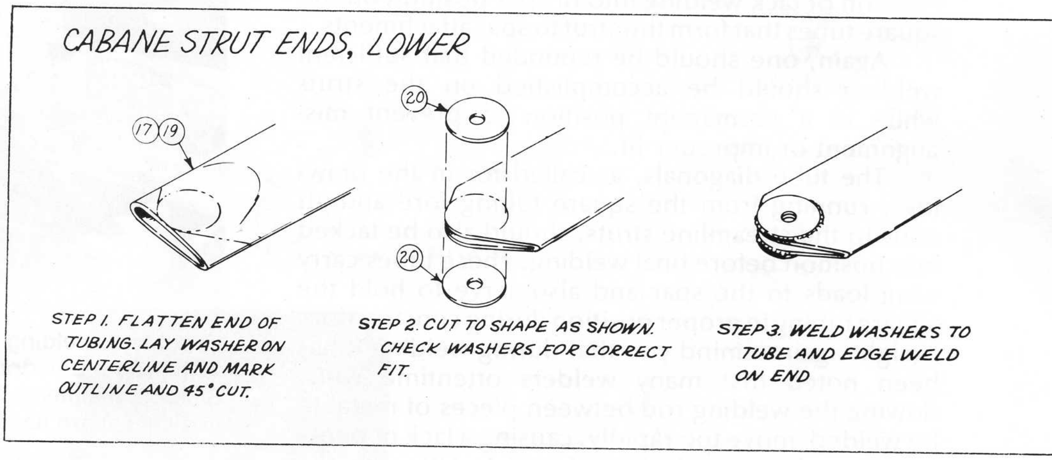


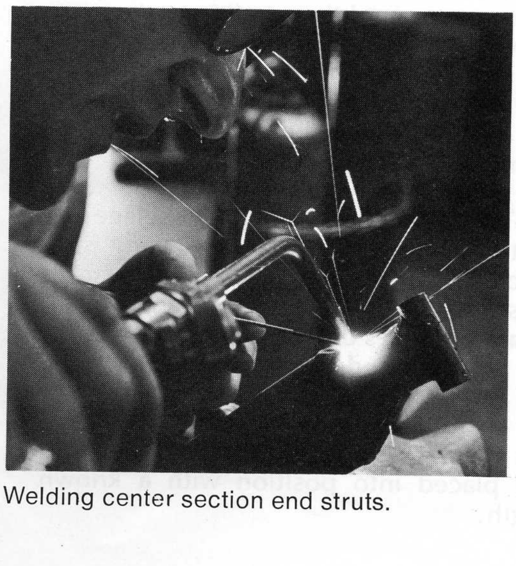


Lower wings and center section placed into position for alignment prior to final welding of fittings.



STEP 6. CUT OUT AND SHAPE FINGER STRAP, BEND OVER BUSHING AND WELD IN PLACE. FINISH WELD AROUND AND UNDER BUSHING. CUT BUSHING OFF TO CORRECT LENGTH.





Welding center section end struts.

will find that attaching the struts to the fuselage or center section will not be possible due to warpage or heat shrinking from final welding.

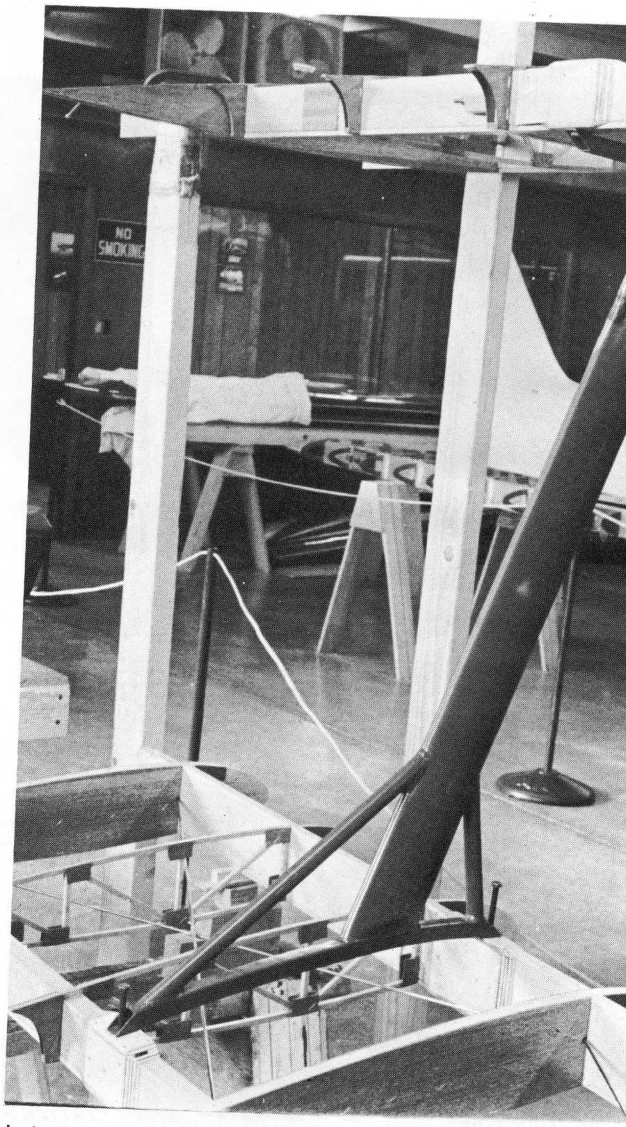
Upon completing the center section struts, attach a lower and upper wing panel into position, providing the correct amount of dihedral in the lower wing panels and no dihedral in the upper wing panels. Per drawing cut your main streamline tubing to size at the proper angle and the two pieces of square tubing for your two outer "I" wing struts.

The "I" strut carries loads fore and aft on front and rear spars equally. You will note the square tubing called for in the drawing should be curved sufficiently to follow the bottom airfoil line on the upper wing, and top airfoil line on the lower wing. These slight curves will permit clearance between the strut and fabric. It is recommended that the upper and lower square tubing that is to be welded to the streamline strut be attached into position on the bottom of the upper wing and top of the lower wing — reminding you again that the aircraft wings should be jigged into proper position prior to final fitting and tack welding. This procedure will permit proper cutting of angles of the streamline tube, filing, fitting and tapering inward of the top and bottom portions of the streamline tube in preparation of tack welding into proper position on the square tubes that form the strut to spar attachments.

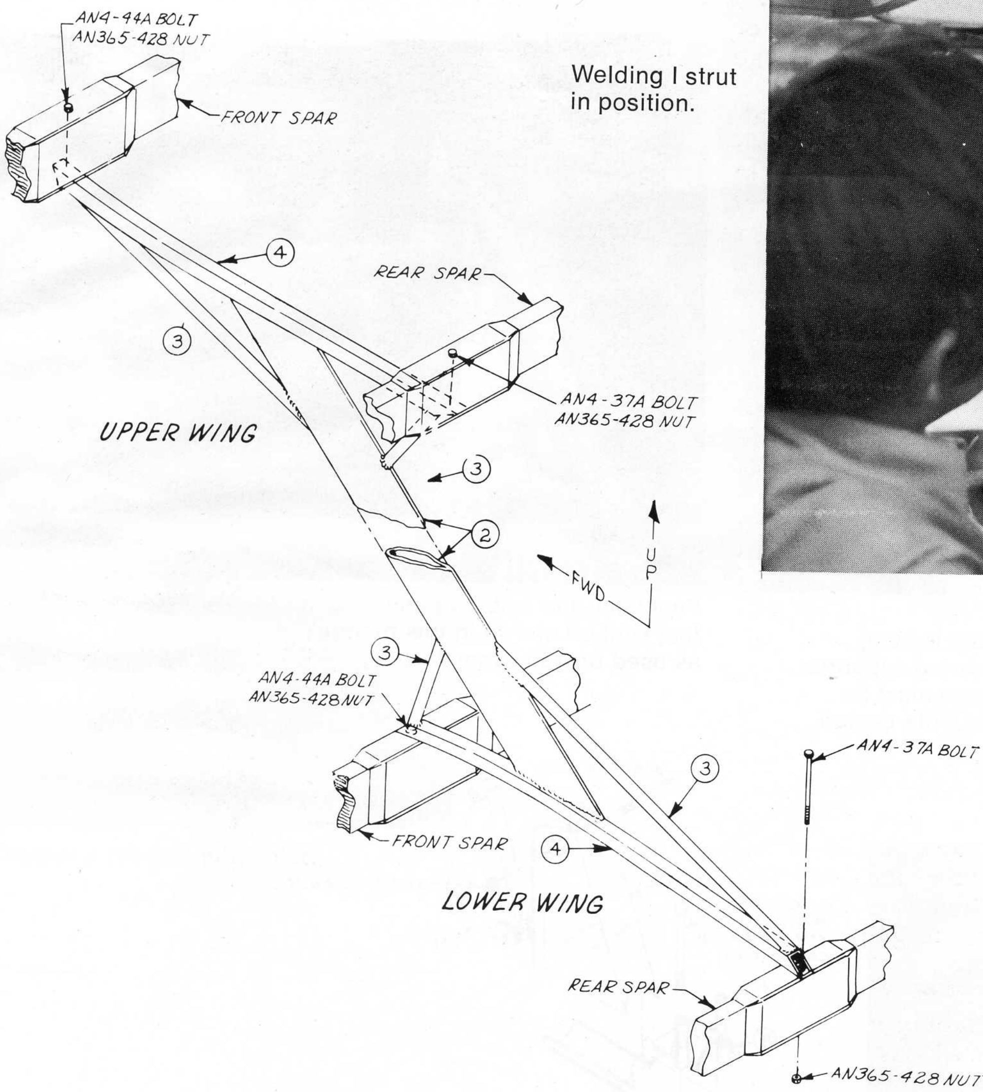
Again, one should be reminded that sufficient welding should be accomplished on the struts while in a permanent position to prevent misalignment or improper fit.

The tube diagonals, as called for in the drawings, running from the square tubing fore and aft ends to the streamline struts, should also be tacked into position before final welding. These tubes carry wing loads to the spar and also serve to hold the square tubing in proper position during construction. I might again remind you that during welding it has been noted that many welders oftentime while flowing the welding rod between pieces of metal to be welded, move too rapidly, causing a lack of penetration and proper fusion of metal. Although the outward appearance of the weld may look professional, if insufficient time is allowed to heat both metals into a wet or puddle condition, the poor penetration will result. It is better to weld slowly, patiently and with good penetration of both metals and welding rod rather than rapidly with the impression that one has a good bead going.

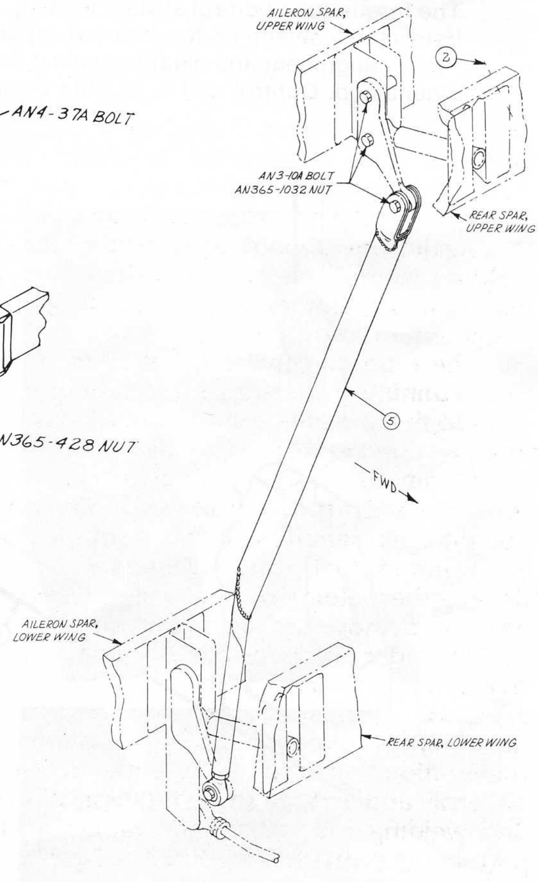
The streamlined wires which form an "X" between upper and lower wings, and the roll wires between the center section and the fuselage are vitally important. They are the prime wing supporting members. Without them the wing structures would collapse. **Do not substitute stranded aircraft cable for streamline wires or tie rods. Cables stretch under loads and if used would allow wing assemblies to distort in flight.** It is also recommended that wires other than those called out in the drawings not be used as each wire has been selected and placed into position with a known tensile strength.



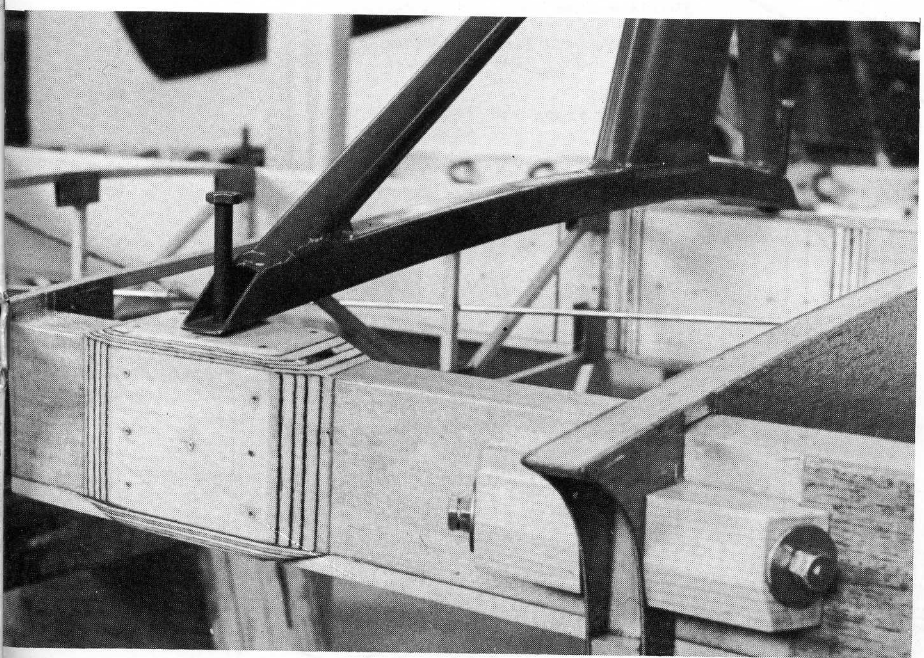
I strut tack welding into position. Wings are mounted with proper dihedral, 2° lower wing, 0° upper wing. Small adjustments for wing wash in or wash out (wing heaviness) are used for adjustment.



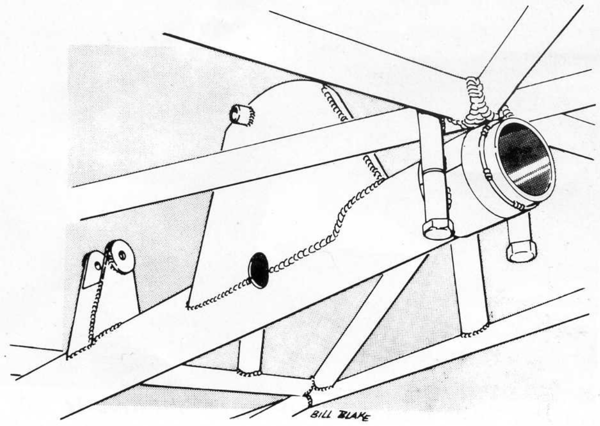
Welding I strut in position.



Jury — or slave strut — assembly details.

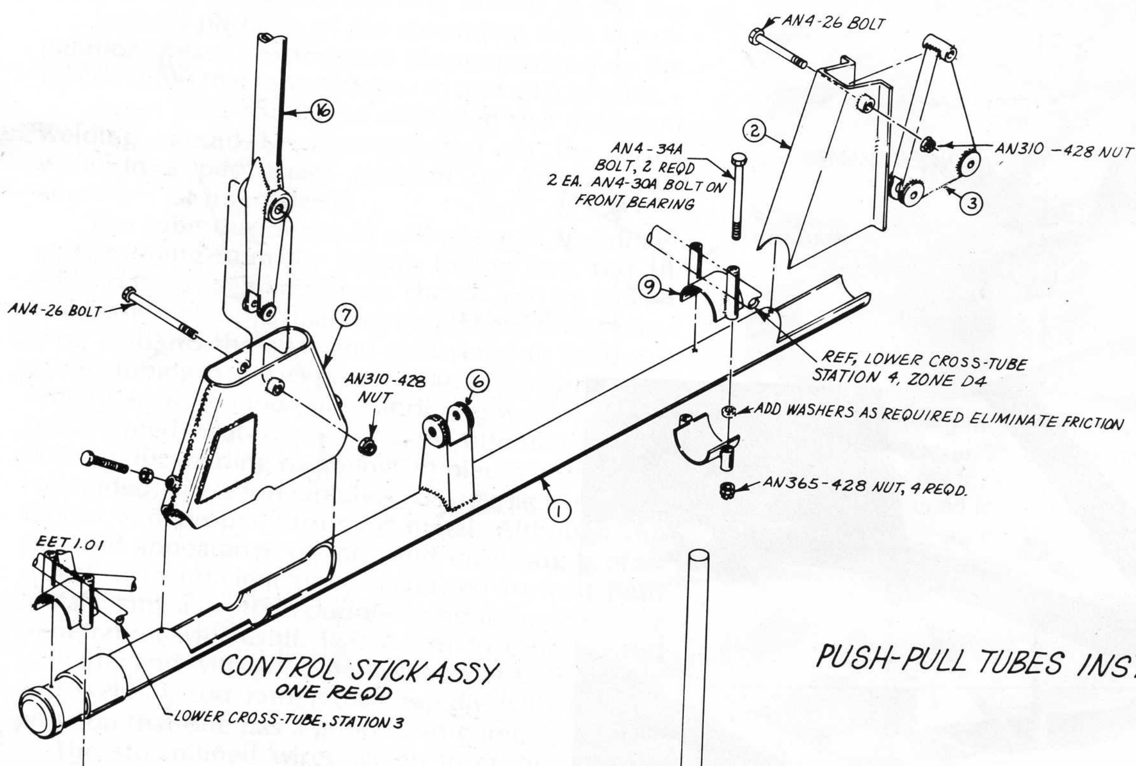


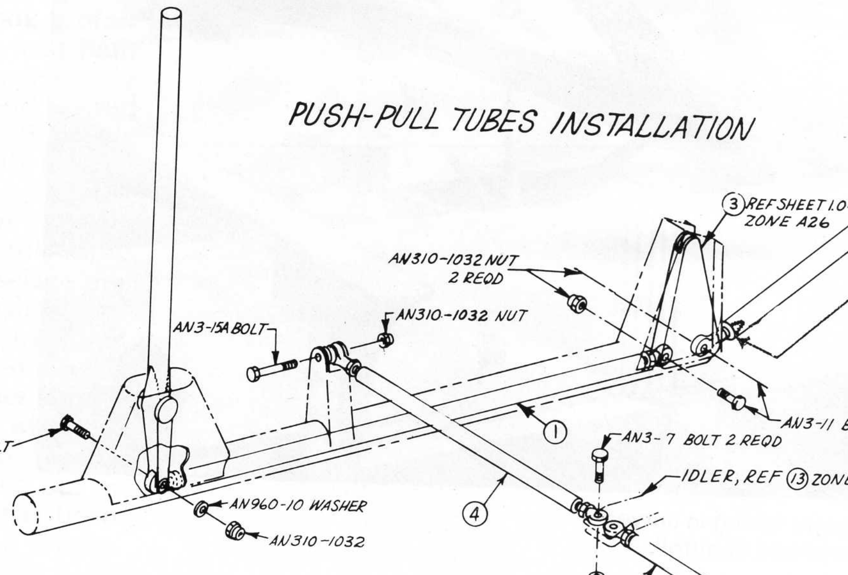
Note square tubing is curved to follow shape of airfoil.

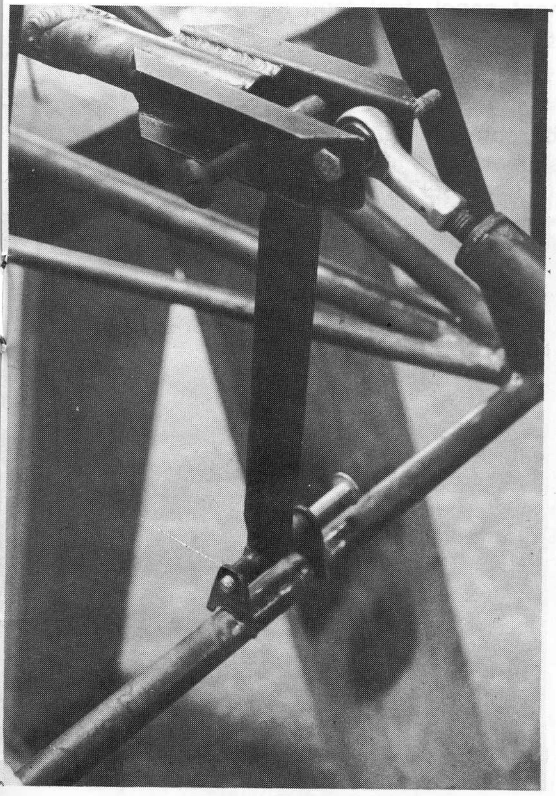


The torque tube control system is hung below the fuselage on two bearing supports. Proper alignment and clearance must be maintained. Control unit is of Pitts design.

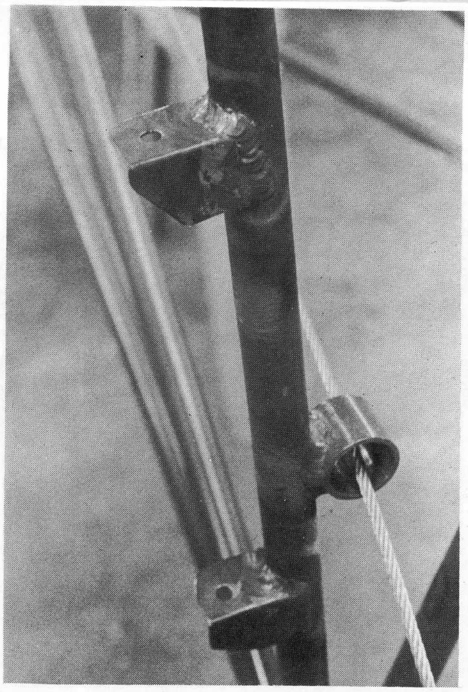
Fuel filter and wobble pump and fuel shut off shown in this picture as used on 180 Lycoming.



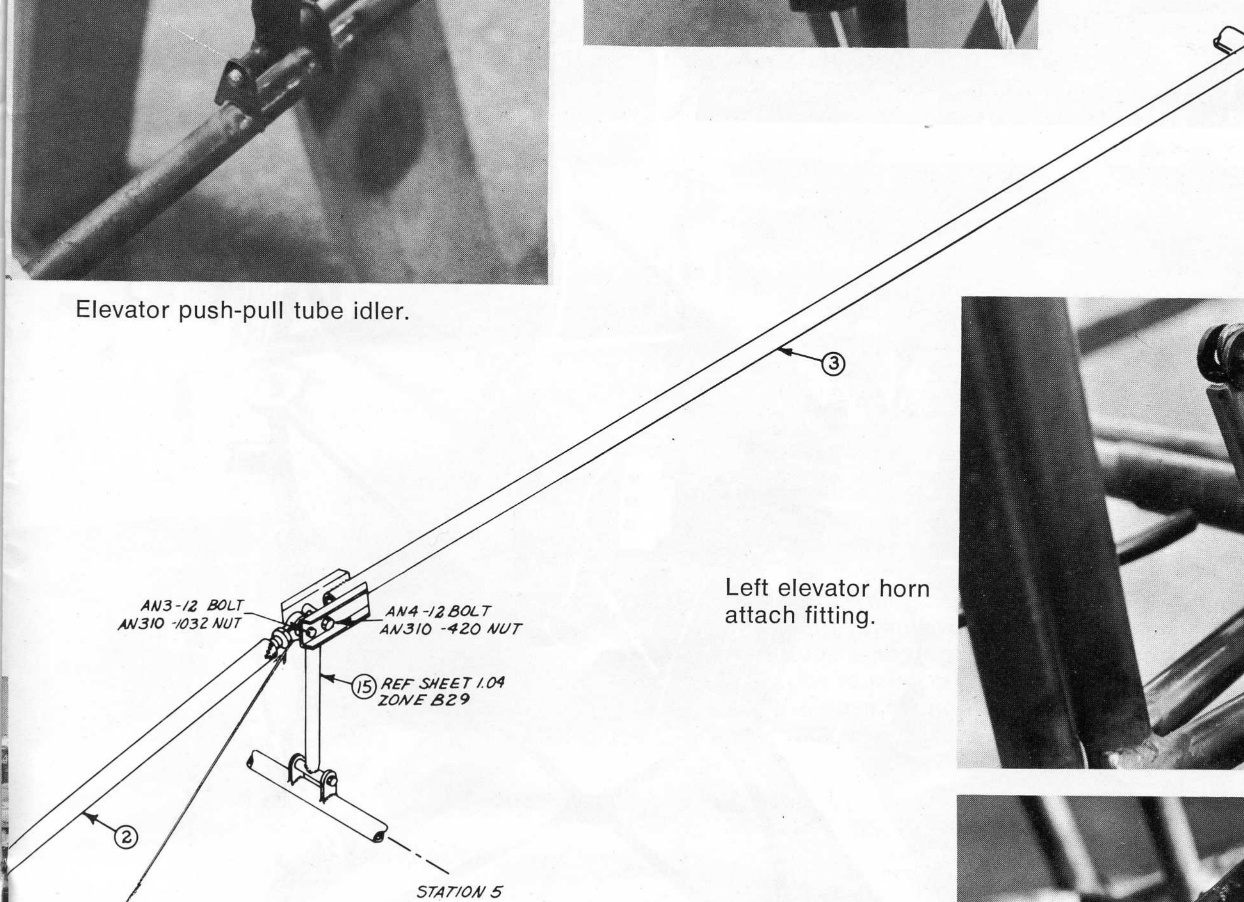




Elevator push-pull tube idler.

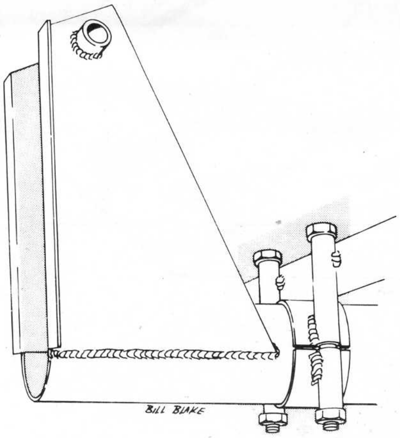


Rubber cable guides are welded to fuselage sides.

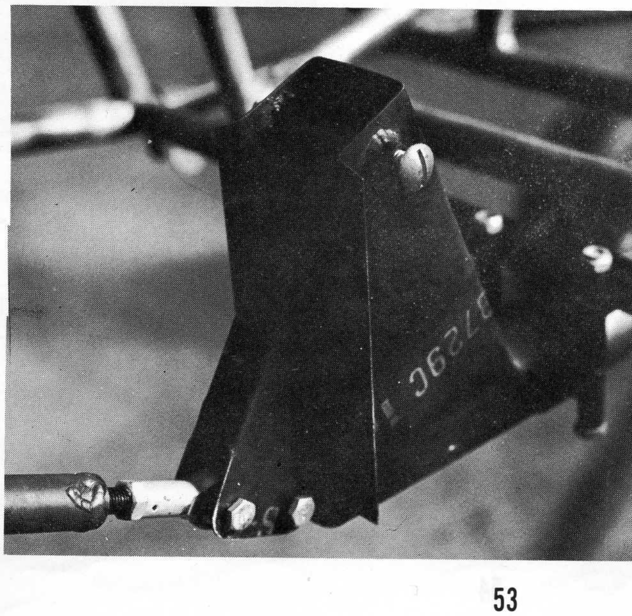


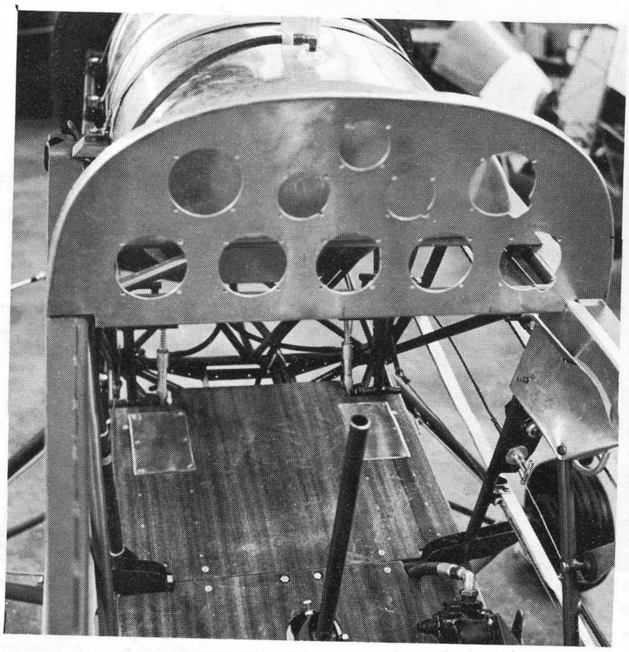
These 2 bearings must be REB3N2.

Left elevator horn attach fitting.



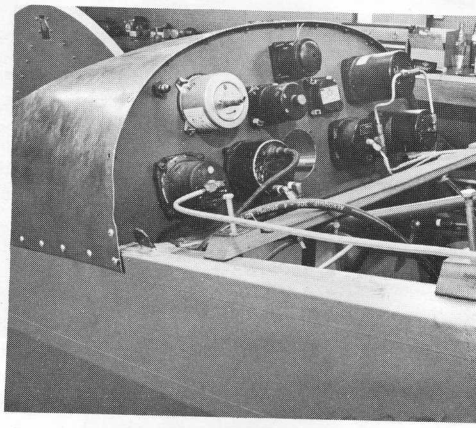
Elevator push-pull tube.

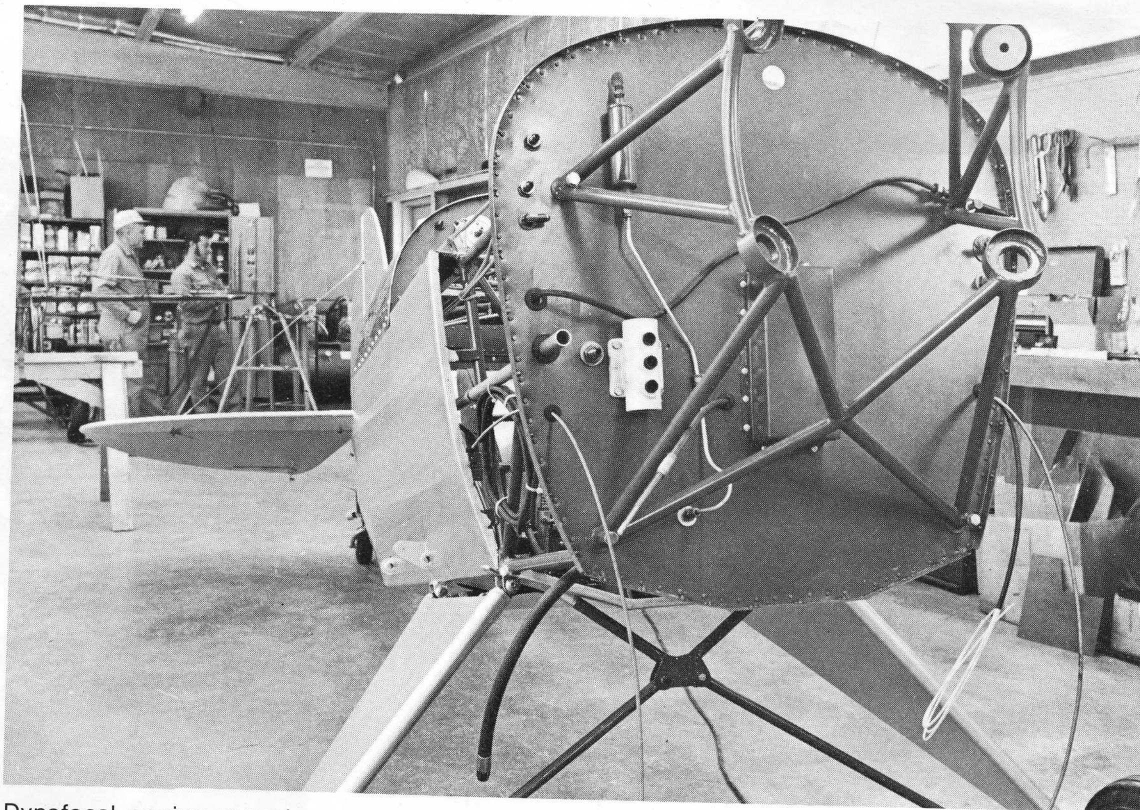




Instrument panel, fuel tank and contro
pear here.

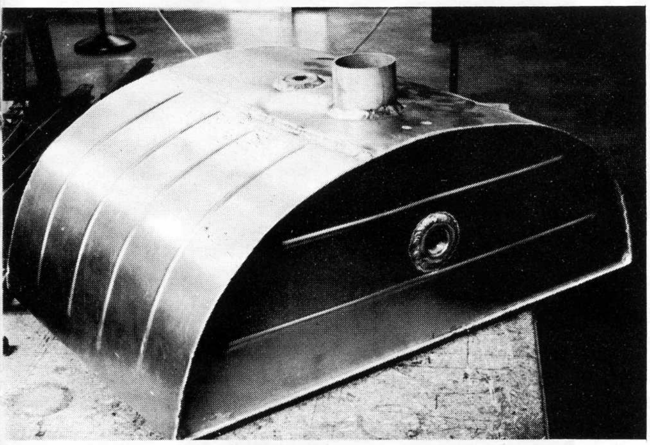
Plenty of room behind instrument panel.
Wood supports and felt provide base for s
oil or auxiliary fuel tank.



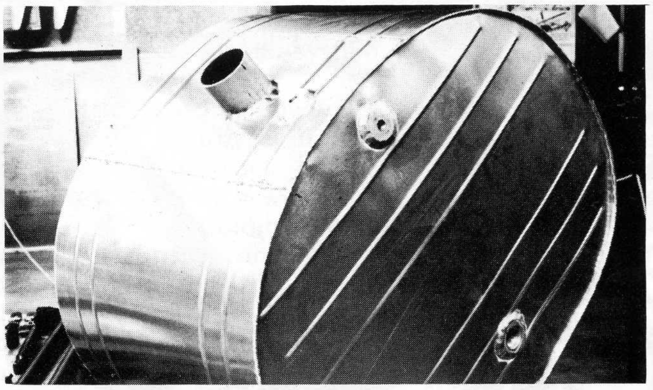


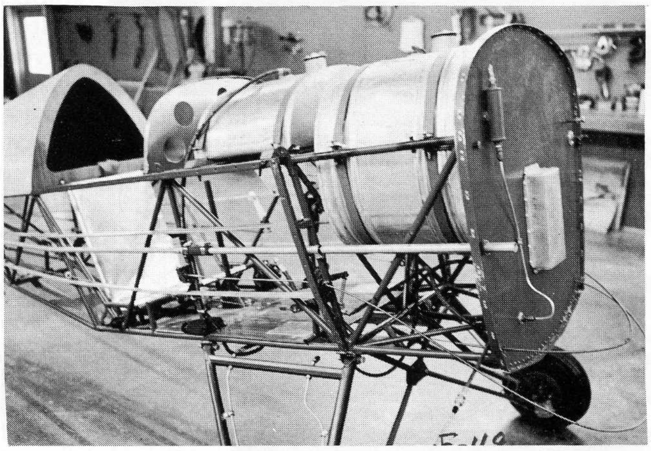
Dynafocal engine mount for the Lycoming 180 H.P. engine is shown here. A slightly different mount is used for the Teledyne Continental 0-200, 100 H.P. engine.

Smoke oil tank can be converted to auxiliary fuel tank — tank holds approximately 6 gallons.



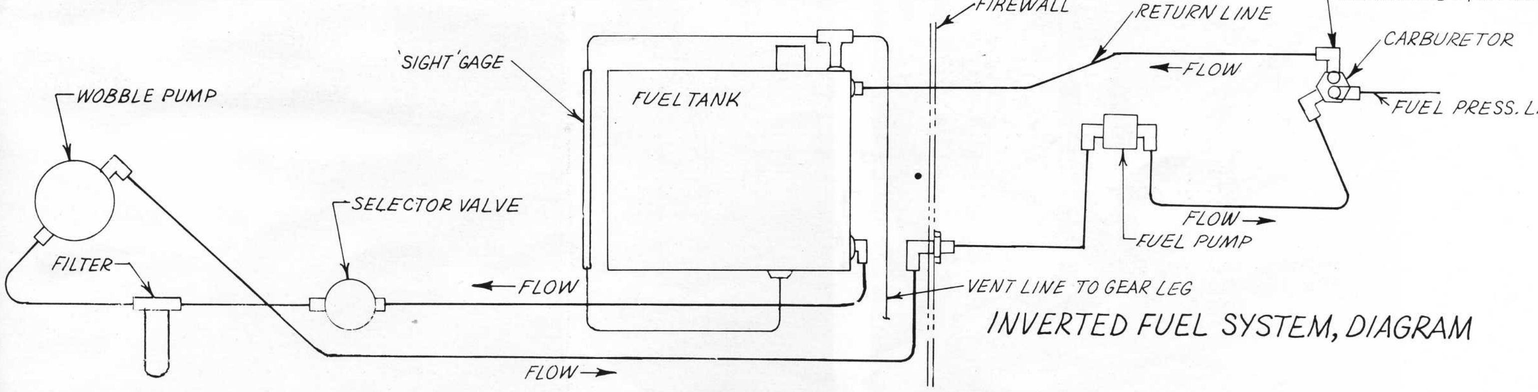
The Acro Sport fuel tank holds 20 gallons of fuel. Note reinforcing ribs pressed into aluminum to add rigidity and strength.



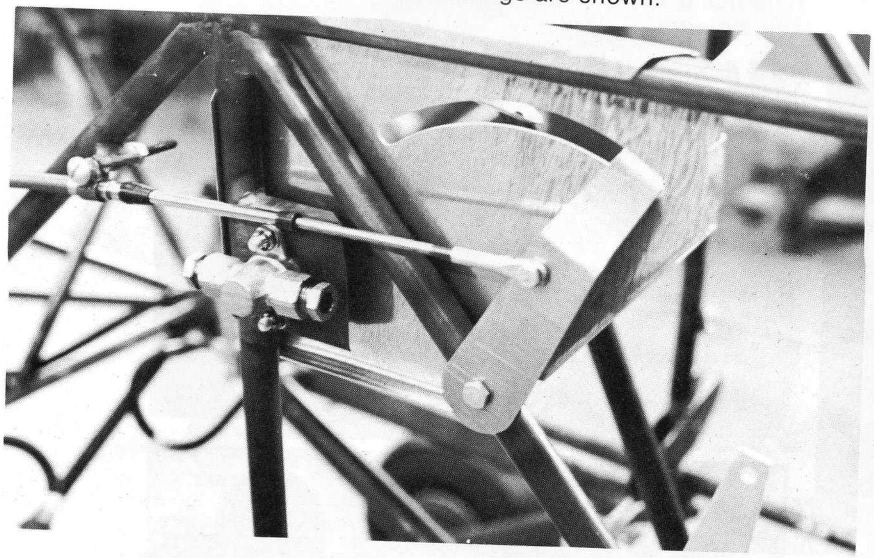


Fuel and smoke oil tanks in place on Acro Sport N1AC. Wheel brake hydraulic reservoir is located on front of fire wall. Tube along right side of fuselage is aerobatic breather tube to keep oil off fuselage belly. Lower wing fittings have been changed on later aircraft.

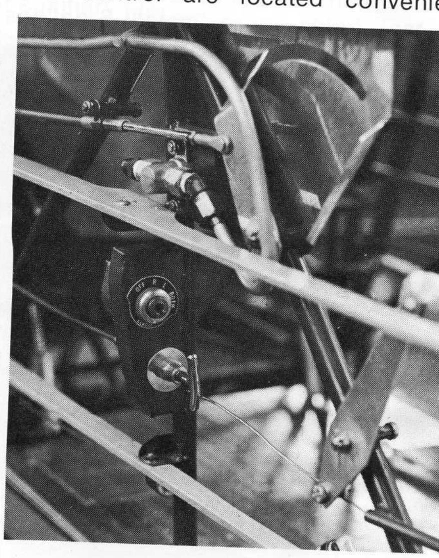
INVERTED FUEL SYSTEM, DIAGRAM

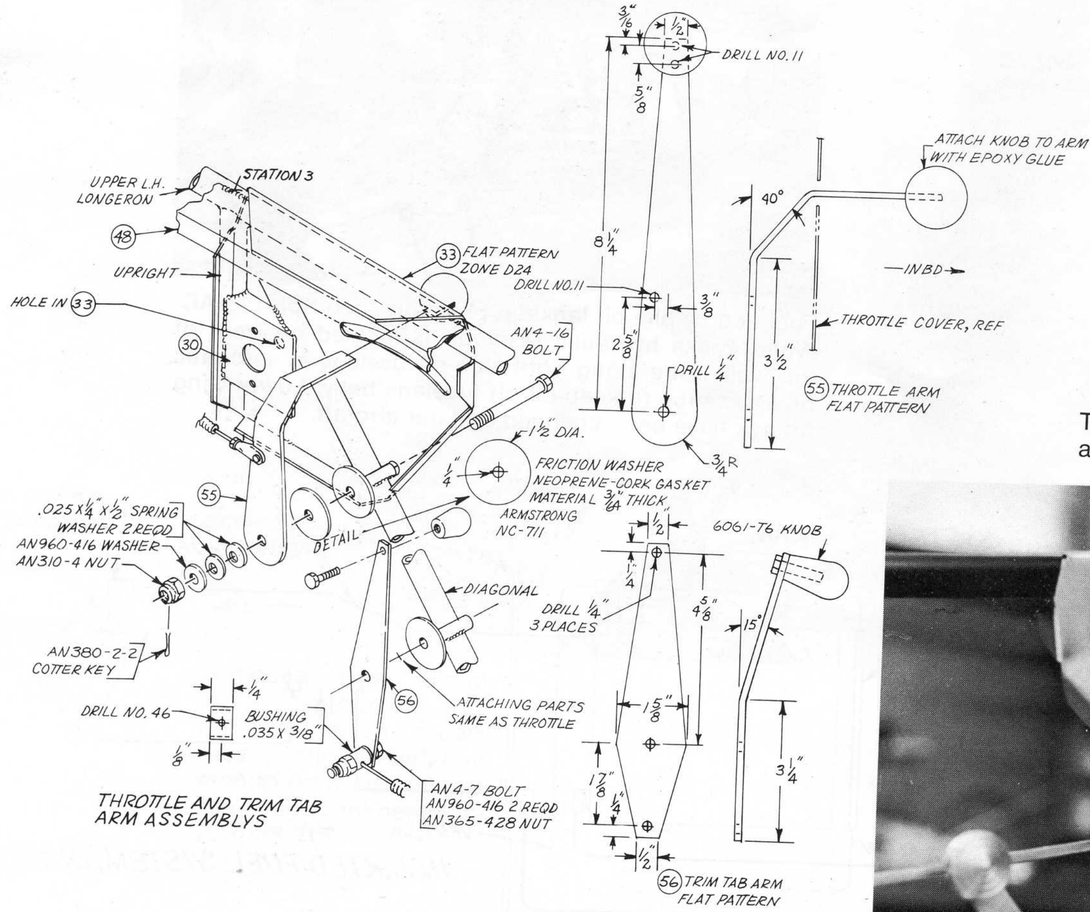


Engine throttle and smoke oil on-off fittings are shown.

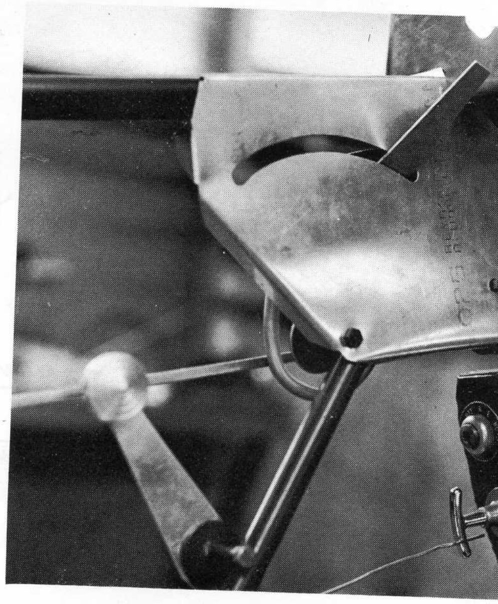


Trim tab lever, ignition switch and
ture control are located convenie





Throttle, trim tab, ignitior
and mixture controls.

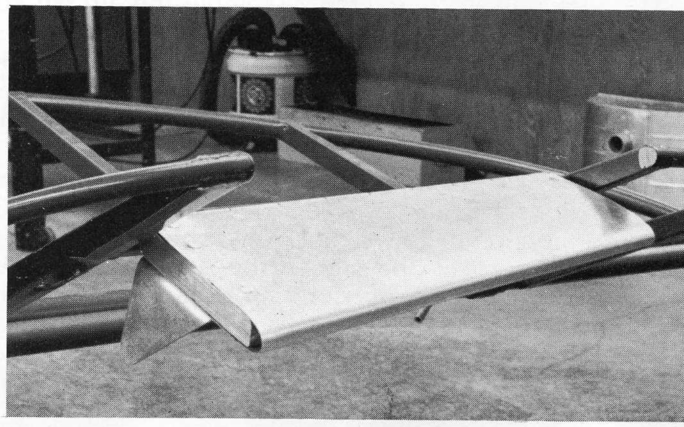


Building an airplane requires one to seek additional information as well as availing oneself of the publications from the Experimental Aircraft Association. It is possible, through self education, to construct a very successful aircraft. Federal Air Regulations require any airplane to be equipped with at least an air speed indicator, an altimeter, tachometer, oil and temperature guage and, depending on the engine, fuel and oil pressure gauges. Also, a single compass. Serviceable instruments of this type are fairly easy to find through the pages of SPORT AVIATION magazine.

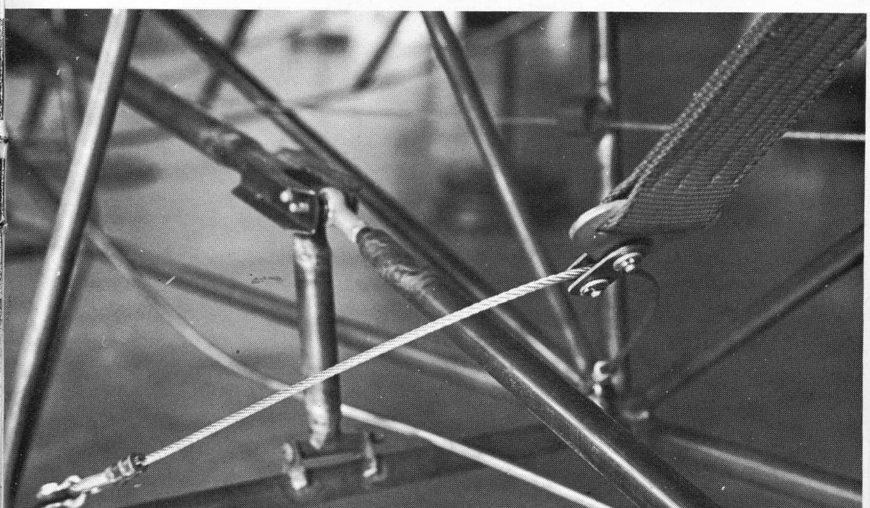
Where instrument lines, ignition wires, and fuel tubes pass through the airplane's fire wall, make the fire wall holes oversize and use snug fitting rubber grommets to prevent fire wall metal from chafing or cutting the lines. Do not put humps in fuel lines which could cause vapor locks at high altitudes or in hot weather, or during bending decrease the size of the line. It is realized that many who will construct the Acro Sport will vary considerably from drawings, using different fuel lines, fuel systems, different engines, etc. However, when doing this, each installation must insure proper fuel flow from the tank to the carburetor. The engine weights may vary, which must be considered in planning weight and balance, and different lengths of engine mounts must be considered so as changes provide reasonable flight characteristics of the airplane due to weight. Fuel tank outlet and strainers should be attached in such a manner that the engine will not be starved for gas while climbing, or with a low fuel quantity level in different attitudes. You must also insure that a large quantity of water cannot accumulate in the fuel system and not be properly drained. The tanks should, if possible, have a drain cock located at its very lowest point when the plane is a rest on the ground. Tubes should be provided to lead drained fuel down and clear of the cowling or fuselage. The outlets of these drains must remain clear of exhaust stack ends. A rubber gasket is recommended around the fuel filler neck so that fuel overflowing from the tank, while servicing, will not drain into the fuselage. It is recommended that before the forward part of the fuselage is closed in by cowling, the fuel tank be filled with fuel and that points of leakage be noted. If the engine is to have an engine primer, shoot a bit of fuel into the intake pipe, noting that there are no leaks in the primer system.

The dimensions called for in the drawing regarding cowling have been taken from the original prototype. It is realized that any inaccuracy during construction, even of one eighth or one quarter of an inch would adversely affect fitting of the cowl. It would be wise to use the dimensions as called for in the drawings, allowing at least a quarter to three

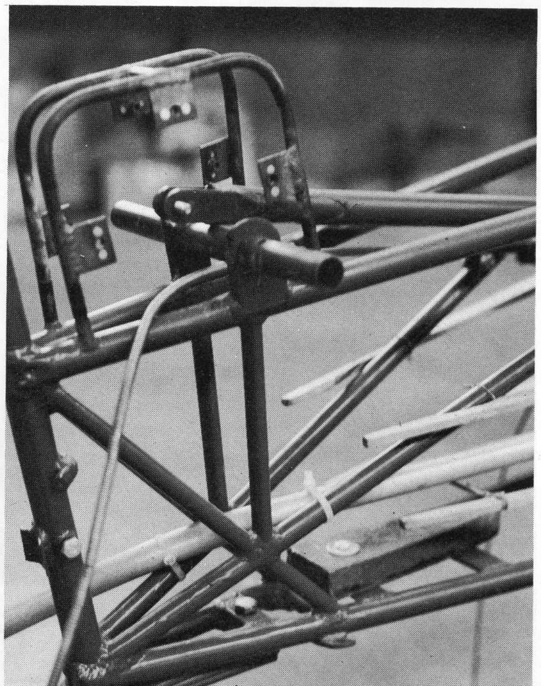
Trim tab mounted on right elevator. Servo tab mounted on left elevator.



Shoulder harness attach lugs and cable.



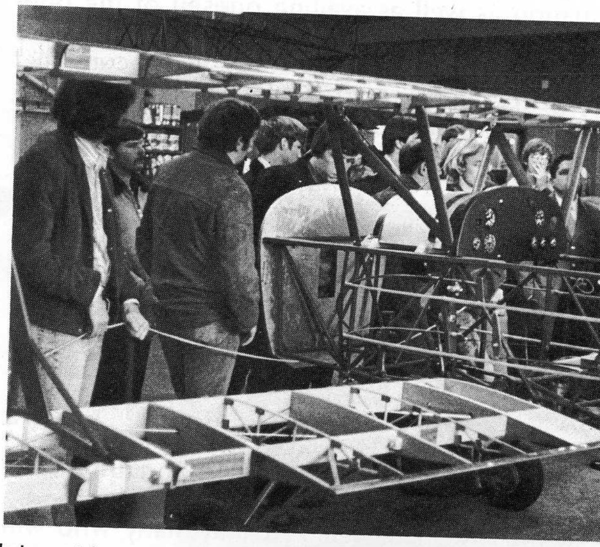
Inspection door at elevator. Push pull tube attach.



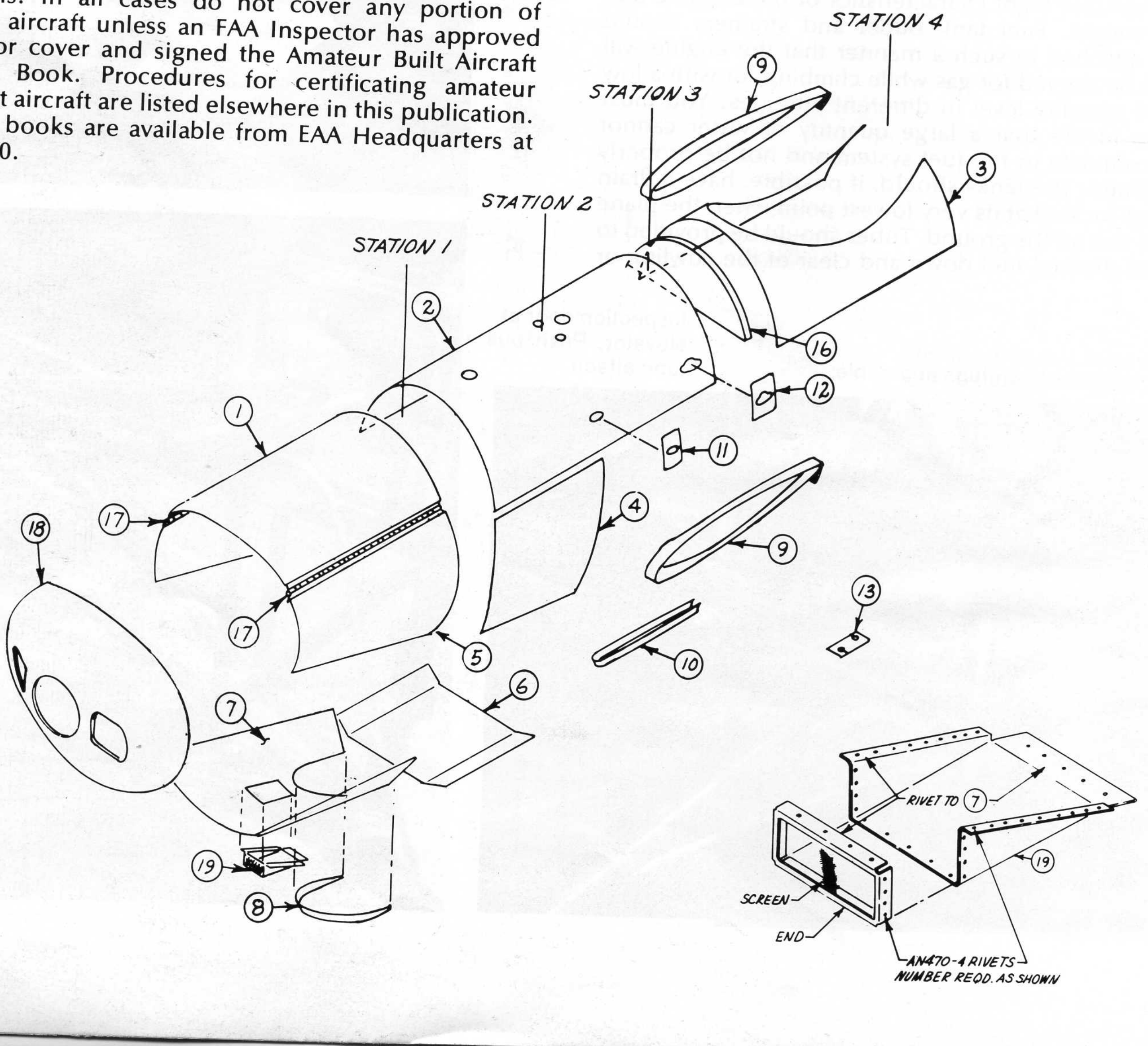
eighths inch overlap on each end, or better, for final fitting. It is always easier to cut off than add on. It is recommended that an enclosed cowl be installed on the airplane as called for in the drawing, to provide adequate and proper aerodynamic flight characteristics of the airplane.

It must be remembered that dependable operation of an air-cooled engine requires ample and free circulation of air. The closer your cowling and its internal baffles come to duplicating production airplane parts, the better. The cowling must be carefully and securely installed, because if it becomes loose in flight it can wrap itself around the propeller hub or upset air flow around the wings or tail group. The cowling has been so designed that no pockets exist which could catch dripping fuel and lead to dangerous fire hazards. Access to the oil dip stick is easily accomplished through the opening of one of the cowl cheeks.

When the entire framework of the uncovered aircraft is completed, assemble the aircraft so that the proper inspection of the design, materials and construction can be accomplished by either an EAA Designee or an FAA maintenance or engineering inspector. As the framework construction approaches completion, make arrangements some weeks in advance with the FAA for final inspections. In all cases do not cover any portion of the aircraft unless an FAA Inspector has approved it for cover and signed the Amateur Built Aircraft Log Book. Procedures for certificating amateur built aircraft are listed elsewhere in this publication. Log books are available from EAA Headquarters at $1.00.



Interest by school groups in the Acro Sport is great.



covering

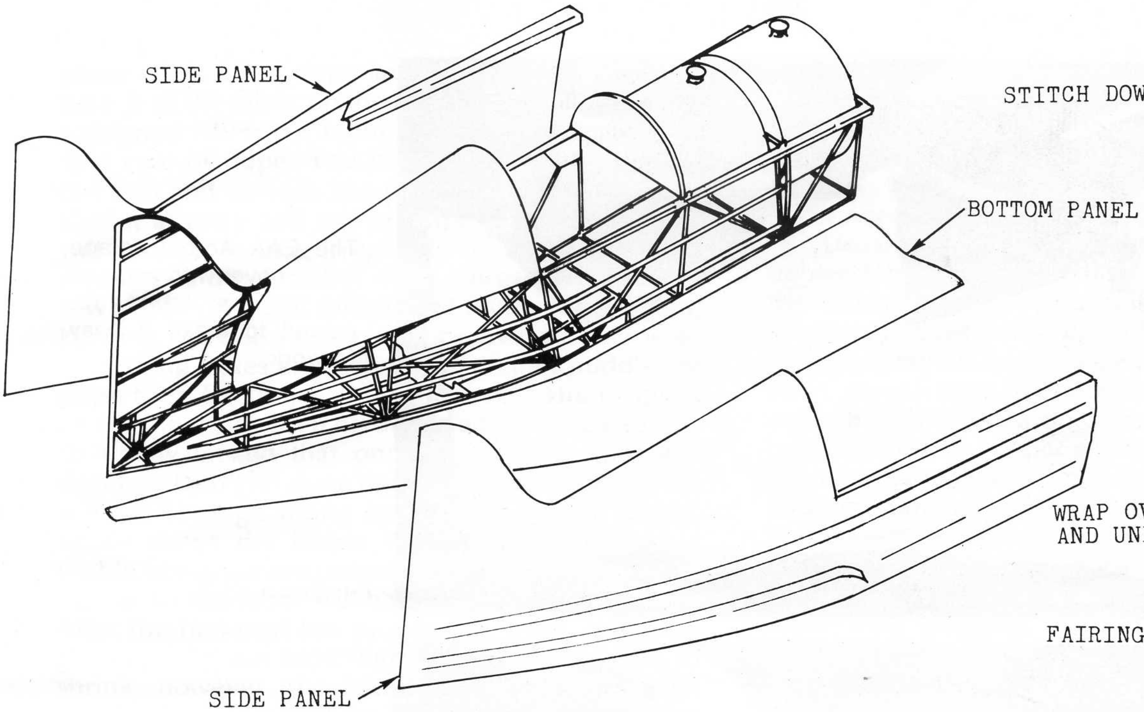
COVERING THE EAA ACRO SPORT

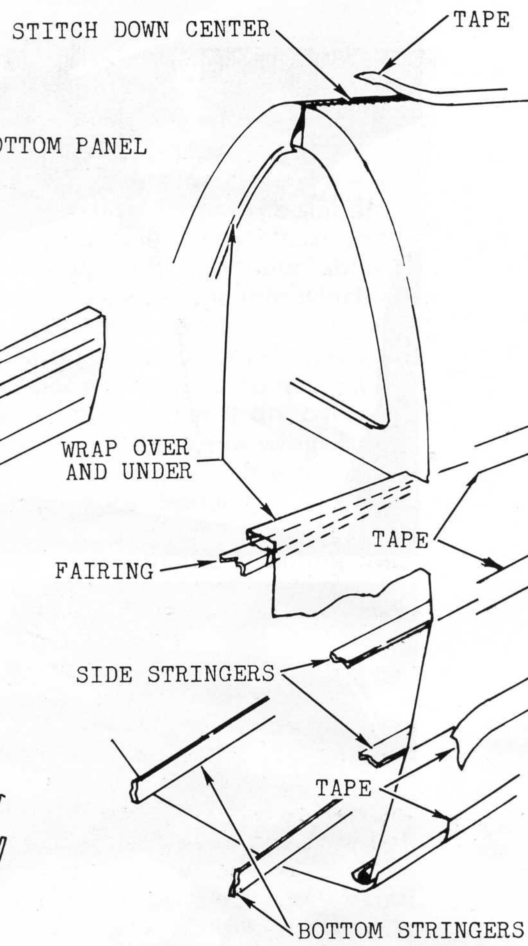
The prototype EAA Acro Sport was covered using grade A cotton aircraft cloth, however, imported linen aircraft cloth or a synthetic fabric such as Ceconite, Razorback, etc. could be used. Grade A cotton aircraft fabric is certainly entirely airworthy and reasonably durable for an airplane of this small size. The Acro Sport is so small that chances are that it can be kept out of the weather in some hangar corner most of the time. Sunlight is the worst enemy of aircraft fabric, for eventually it makes the finishes both hard and brittle. If your ship is to be hangared, grade A cloth may last ten or fifteen years easily. If it is kept outdoors all year around, it could last five or six years before needing to be replaced.

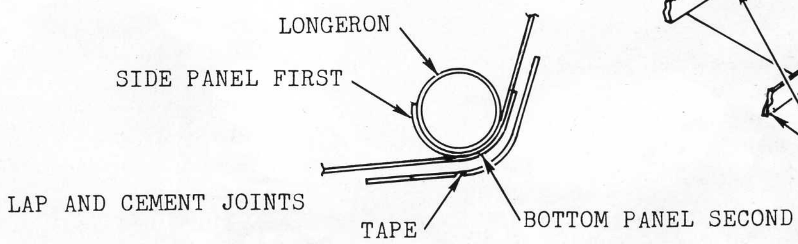
In general, you will find it easiest to get reliable literature and local advice on the use of grade A cotton through publications of the Experimental Aircraft Association or by writing to some of the advertisers listing **their** covering products in the Association's house organ, SPORT AVIATION. If desired, an extremely handsome finish can be put on by using plenty of dope and polishing the final job with rubbing compound. Dope, so called because as formulated long ago its fumes made workmen groggy, is available in two types — nitrate and butyrate. The latter is more expensive but is more durable and has a greater fire resistance. Doping should be done in a well ventilated place with no open flames or sparks present. Use good brushes with tight bristles. If bristles come out and are allowed to remain in the finish, they will cause cracks later. A two inch brush is handy for small work such as putting tape into place on edges of wing ribs, stringers, and trailing edges. A five inch brush will allow this fast drying material to be spread on rapidly and with ease over large surfaces. Each wing rib is a girder designed to take loads in a vertical plane. It is quite flexible in a horizontal plane, and when fabric is put on, it can bend a little so that the rib's spacing seems irregular through the fabric. Therefore, an aircraft type reinforcing tape, available from fabric suppliers, is run diagonally from rib to rib, midway between the spars very much like a diagonal bridging used with floor joists. It is wrapped once around each cap strip at the top of the wing rib or the bottom. This keeps the ribs in alignment while the fabric is being put on and the finish job shows straight, evenly spaced ribs through the fabric. Prior to covering, go over the complete framework looking for and correcting sharp edges which could chafe or cut the fabric.

The aluminum leading edge oftentime is installed in two or three pieces. If this is the case, where they join or overlap, affix a strip of painter's masking tape. The cap strips and the edges of wooden stringers on the fuselage should have their sharp edges broken with light sanding prior to varnishing. Raw metal edges in the elevator ribs and on wing fitting edge strips should be turned down sligh It should also be noted that during doping tha any dope is permitted to drop inside of the fusela tail group or wing, a boil or blister will show p manently. Putting fabric on a plane is a job full mysteries. But, actually, once the idea is graspec can be easily and satisfactorily accomplished. all airplanes the cloth is applied with its long dime sion parallel to the wing, the reason being the lationship of weave to stretching and teari characteristics. If the fabric area on the bottom sides of the fuselage is so many feet long, you unr that length with 6 to 8 inches of margin from a r of fabric and apply it lengthwise. But, in coverin wings, it is wrong to unroll cloth and lay it span wi from end of the wing; then its weave would be right angles to the air flow. Instead, any require number of strips are sewn together, edge to edge, make a single sheet large enough to wrap arour the wing. Depending on the width of fabric selectec whether it be thirty six, forty two or sixty inch wic material, it will determine how many panels on

Smooth, easy strokes are used in applying dope. Keep dope from thickening by adding a bit of thinner.

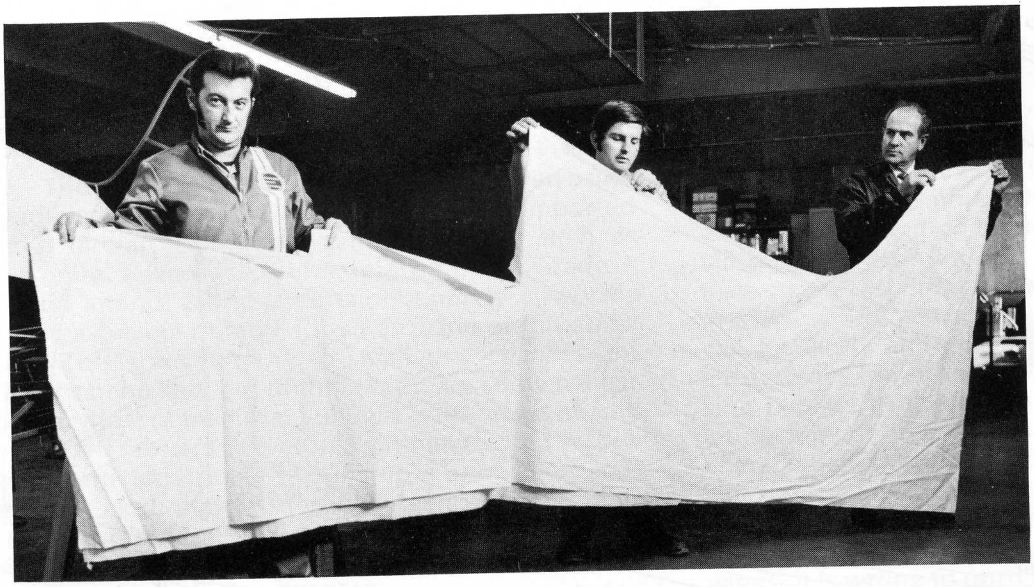






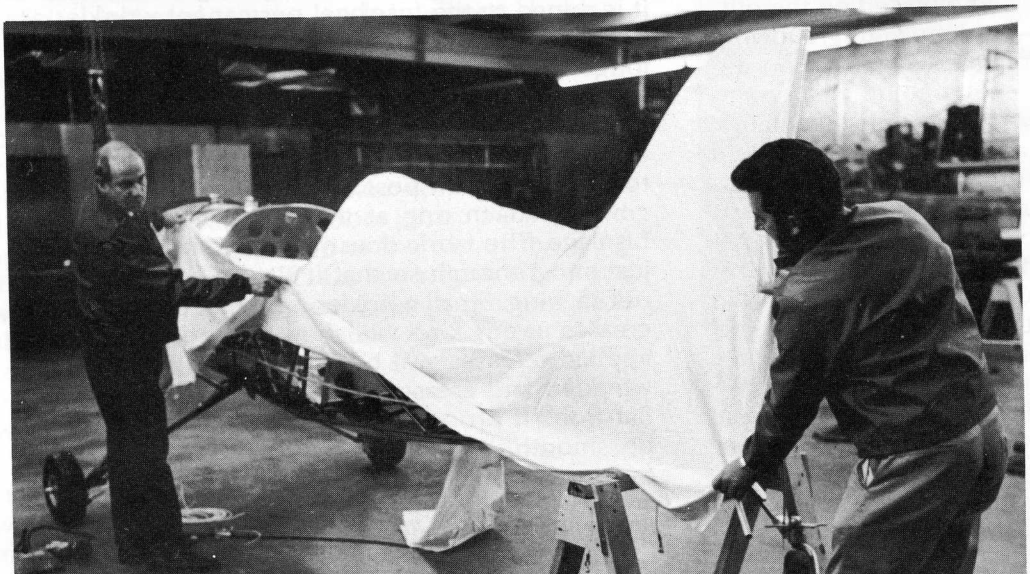
must sew together to make a large envelope. Procedures are called out in Civil Aeronautics Manual 18, available from EAA, on the methods of sewing fabric together. A pillow slip arrangement for the wings is made after the pieces are sewn together. The pillow slip, with the seams being placed on the outside, is pinned at the edge — not too tightly, allowing sufficient sag so that when water is rubbed on the fabric after being put into position and all wrinkles are out, the dope coats will not shrink the fabric to a degree that it will cause wing warpage. You will note that there are several photographs in this manual showing the covering of the fuselage. Two sixty inch wide grade A pieces of fabric were cut to proper lengths, pinned together at the top of the vertical fin, held into a square position and pinned down the leading edge of the vertical fin and up the turtle deck. Excess material was cut off, following the curvature of the vertical fin and turtle deck. Excess fabric in the area of the turtle deck headrest and top longerons is cut away as well as the excess material from the bottom longerons. With the excess material gone, it becomes much easier to sew the seams in accordance with CAM 18, down the vertical fin and turtle deck. Upon completion of the sewing, the excess material is cut away, allowing approximately a quarter inch material from the seam. The envelope is then turned inside out and fitted over the fin, turtle deck and around the upper longerons. Again, excess material is cut away from the longeron. Always keep in mind that the fabric must remain squared off to the basic fuselage, so that when it is doped to the fuselage, permanent wrinkles are not built in. It is best to attach the fabric to the top longerons in cockpit forward area, then to the bottom longerons, wrapping the fabric almost completely around the tubing. Any wrinkles then can be pulled out by pulling fore and aft when one dopes the fabric to the vertical fin post. Then make the fairing and cowling attach ring at the forward section of the fuselage. The fabric doesn't have to be drawn tight, just snug enough so that it sits on the frame without sagging. Small wrinkles are of little concern, but creases of any kind will show up and once dope is applied, creases will not come out. If the cloth is wrinkled and creased, iron it smooth with a warm flat iron. If properly shipped and stored it should be smooth, anyway. When all edges around the frame, the longerons, tailpost and forward cowling are dry, use a sponge with clean pure water and brush lightly over the complete fuselage.

You will note it will tighten up and all wrinkles will be gone. If water in your area is full of minerals, use distilled water because impurities left on the air-



The EAA Acro fuselage fabric cover with some of the excess fabric re-moved to make it easy to work.

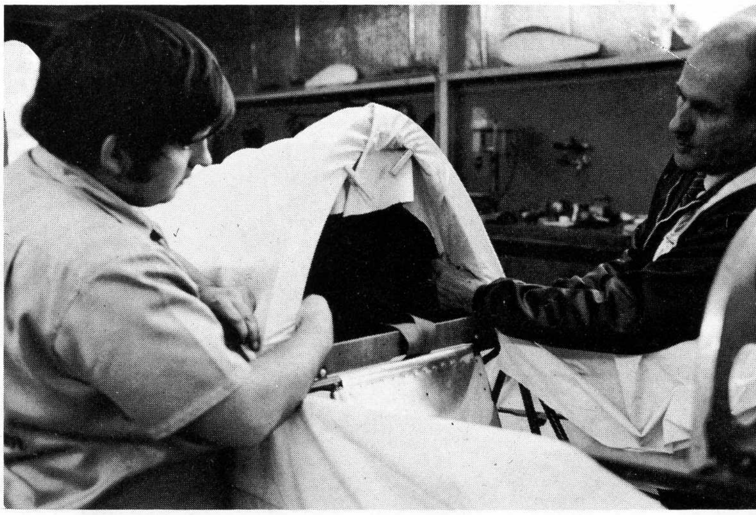
Aligning fabric for fuse-lage cover, a dope proo primer should be spraye on all metal surfaces be-fore covering.



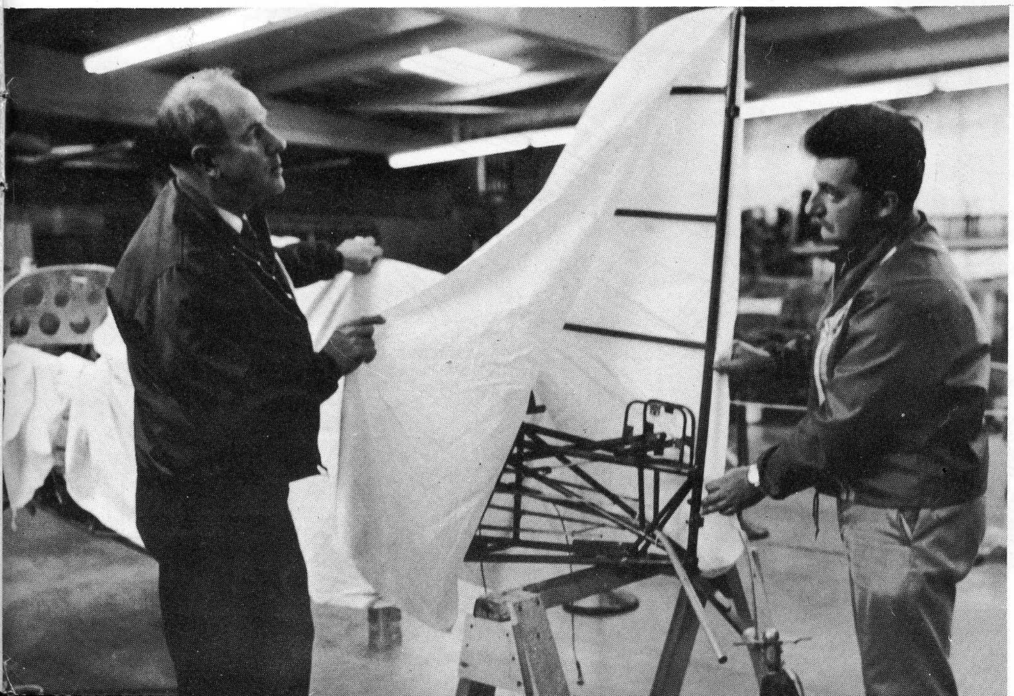
The fuselage cover fitted over the vertical fi plane fabric affect dope adhesion and absorb moisture. If all the fabric on the fuselage is properly water tightened when the fabric has dried, brush on the first coat of dope. You cannot simply brush dope out thin and smooth like paint . . . it begins to dry almost at once and any attempt at brushing it out will cause it to drag irregularly on the brush. Take a generous brush full of dope, spread it out with a few good firm quick strokes and fill the brush again, keeping wet dope going right on to drying dope so everything mixes and adheres. Don't let puddles of dope form for they will leak through. The droplets on the inner side then harden and the fabric weave is so ridigly locked that one day a brittle spot will develop. Don't let dope drop on the inside of fabric, such as through fitting holes or at cockpit edges. When drops dry inside they shrink and make a visible bump on the outside surface. When the first coat is dry the fabric will have a limp puckered look. After the first coat has thoroughly dried, apply the second. You will note that the fabric will begin to shrink, however, the fabric will take on a rough finish. This is created by the drying dope. Letting the fabric dry, you can then apply the pinked tape to all edges and seams. Apply dope for a few feet along the edge desired and then lay the tape down, push it down into the dope with a brush and apply more dope over it. When dry, go over the rough edges of the tape very lightly with fine abrasive sand paper, to smooth the projections. Then apply another coat of dope. An important tip is don't let long periods of time, such as several weeks, elapse between coats of clear dope. If you do, the last coat will then be quite dry and hard, and the next one won't bond so well. This leads to poor tightening and eventual peeling. Overnight waits, or a wait of a couple of days are all right, but try to schedule the fabric work so that when the doping begins it can be carried right through to completion. After the second coat of dope and each succeeding one, lightly sand paper the surface to cut the fuzz and tiny bubbles.

When sanding your fuselage stringers or wing ribs and other hard spots in the covering, be **extremely** careful not to let the sandpaper **cut** the fabric. After the third or fourth coat of clear dope, affix any plastic inspection rings to the fabric in areas called out for in need of entrance to controls, etc.

Usually four or five coats of clear dope will tighten fabric. The cloth should feel quite smooth to the touch, but not really completely glossy in appearance. After sanding with very fine abrasive papers, spray on a coat of clear dope into which has been mixed very fine powdered aluminum. Add enough of it to get a fluid that obviously has good bonding power, yet not so much as to make a stiff dry mix that will spray poorly. Let it dry overnight and then sand all over the fuselage or wings or tailgroup with No. 280 wet sandpaper such as the wet or dry used by auto body shops. Water acts as a lubricant without scratching thus keeping the abrasive paper from clogging. Wipe off the resulting mud with a small window cleaner, rubber blade or with a wet, lint free cloth. It is recommended that at least

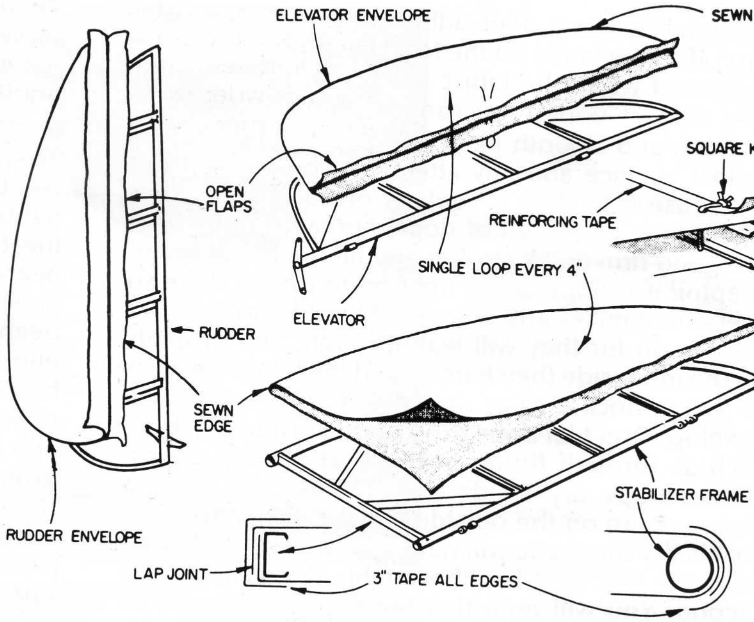


Fuselage slip cover sewed and being fitted around baggage door, excess material is cut away for ease of working.

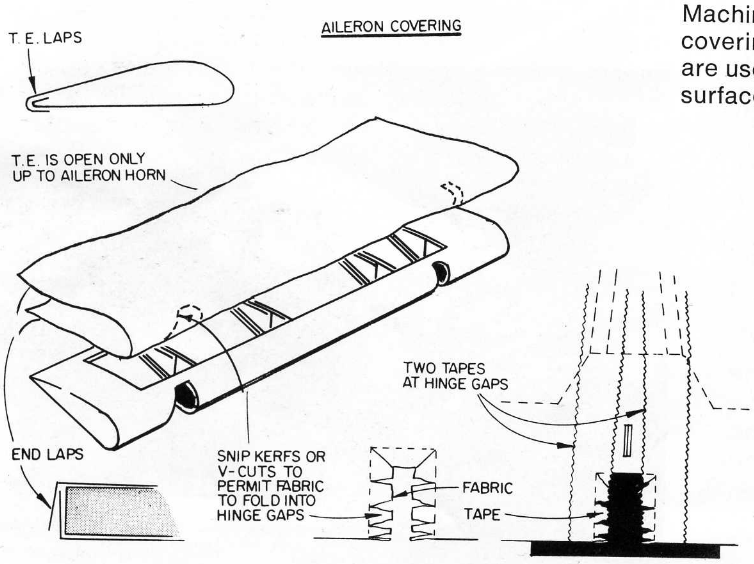


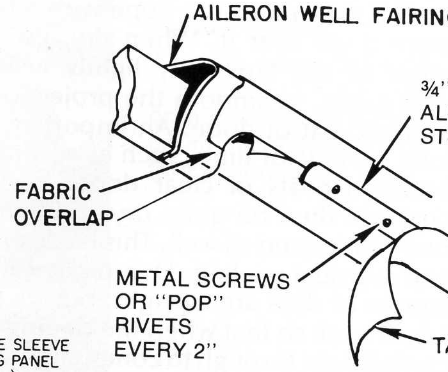
The fuselage slip cover is fitted to the fuselage. Cover is made from two 60'' pieces. The bottom of the fuselage is covered separately.

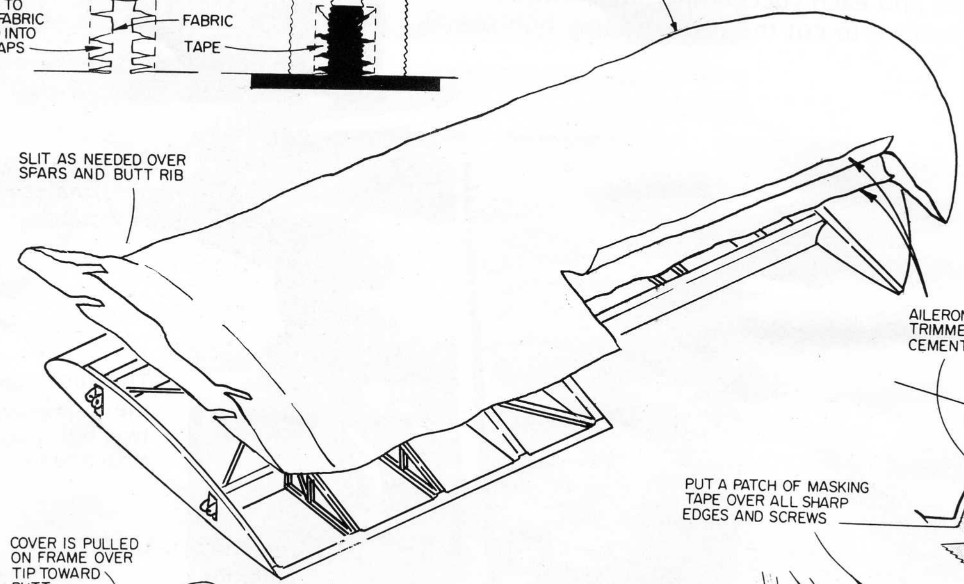
Fuselage fabric is doped to upper longerons, fabric cement is also used. Fabric is wrapped well under the longeron.

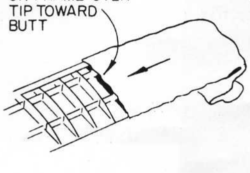


Machine sewed covering envelopes are used for control surfaces.

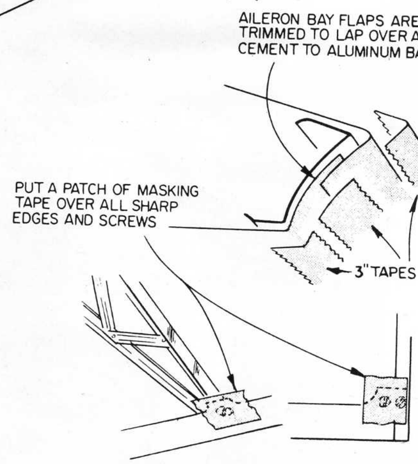






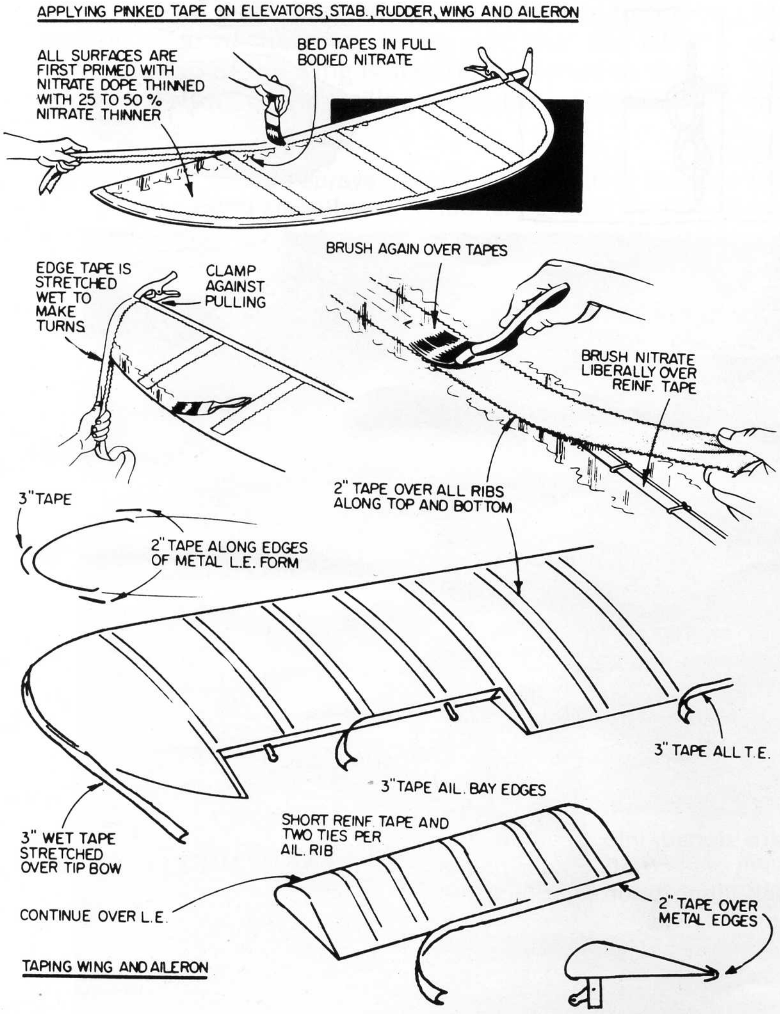


Wing slip covers are sewed according to FAA Procedures, turned inside out and slipped over wing panel and doped into position.



four, possibly five coats of silver dope be applied to all fabric, wet sanding between each coat to provide fill and smoothness. The cloth should feel quite smooth to the touch, the aluminum powder in the dope filling all the pores and giving a metallic appearance. Sanding invariably shows up thin places in the silver coat. Spray on another coat and repeat the sanding if needed. The purpose of silver dope is to block out sunrays from reaching the clear dope and the fabric, thus greatly prolonging the life of the covering job. Out in the sun look inside the fuselage — sunlight will be seen through the cloth to some degree, but at least it should be nearly uniform in intensity, indicating uniform silver dope coverage. It is best that no light penetrate the silver at all. The design of one's paint scheme is very important with as much work and effort as goes into an aircraft, its final appearance is very important to the builder. Final coat of pigmented dopes are applied and we would suggest using a manufacturer's manual on doping as a guide in this particular case. If not enough thinner is used in dope, it will spray on dry and produce a rough or orange peel effect. Remember, dope begins to dry immediately upon contact with air, and the mist from a spray gun is no exception. You will find that thinning of twenty five to fifty percent is commonly needed to get good spraying. The speed of a spray gun movement, distance of the nozzle from the surface, and dope consistency all affect the matter of avoiding runs. Temperature is very important. A temperature of seventy five or eighty degrees Fahrenheit being desirable. Humidity should be as low as possible. Spraying dope is easy enough, yet the chances of pulling a boner on one's first trial is very high. If possible, have an experienced friend help you out. One might even consider preparing several panels out of wood, stretching fabric across them, and applying your clear, your silver and pigment for practice. A total of four or five coats of pigmented dope will produce an attractive durable finish. If there is any roughness in the first pigmented coat, wet sand it lightly with 320 wet sandpaper. If dope is properly mixed, the gun working right and the air dust-free, the next coat should need no sanding. The final coat is thinned as much as possible without making it run, so that it will flow on smooth and dry with a nice gloss. Invariably some spray dust is in the air and will settle on the work and make it look dull and dusty. However, with a good suction fan, proper ventilation, this can be brought to a minimum. It is advisable to wait at least a month or six weeks before going over dope surfaces with an auto body cleaner or followed by waxing. If the aircraft is constructed in your home, your family will probably object to the strong smell of dope and make you do some of your doping out in the garage in warm weather. If the air is humid you may encounter

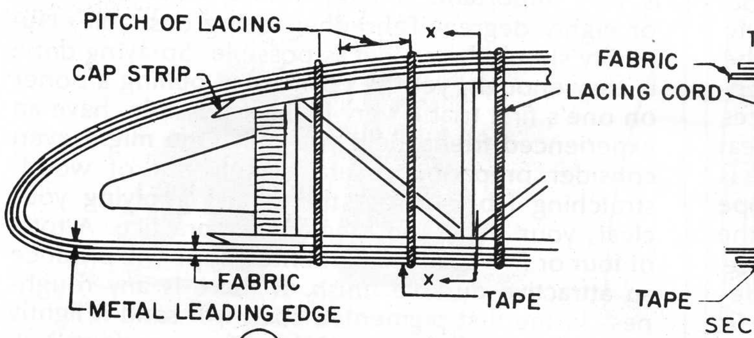
APPLYING PINKED TAPE ON ELEVATORS, STAB., RUDDER, WING AND AILERON



TAPING WING AND AILERON

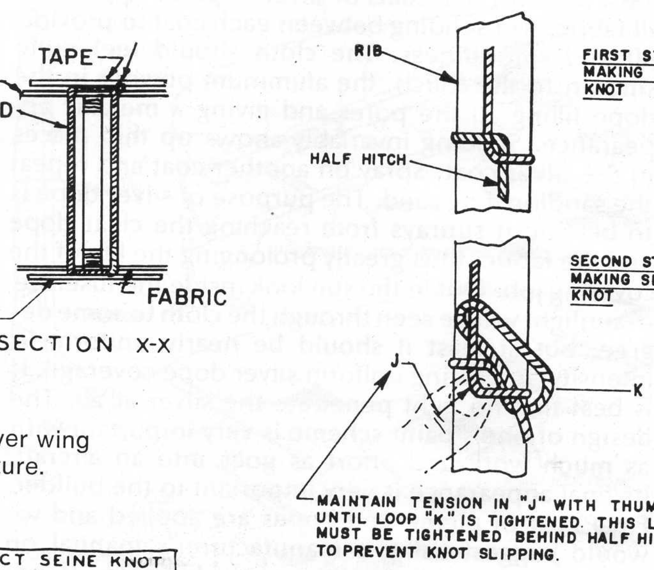
Pinked tape is used to cover ribs and leading and trailing edges.

Applying re-inforcing tape and pinked tape to wings and controls.

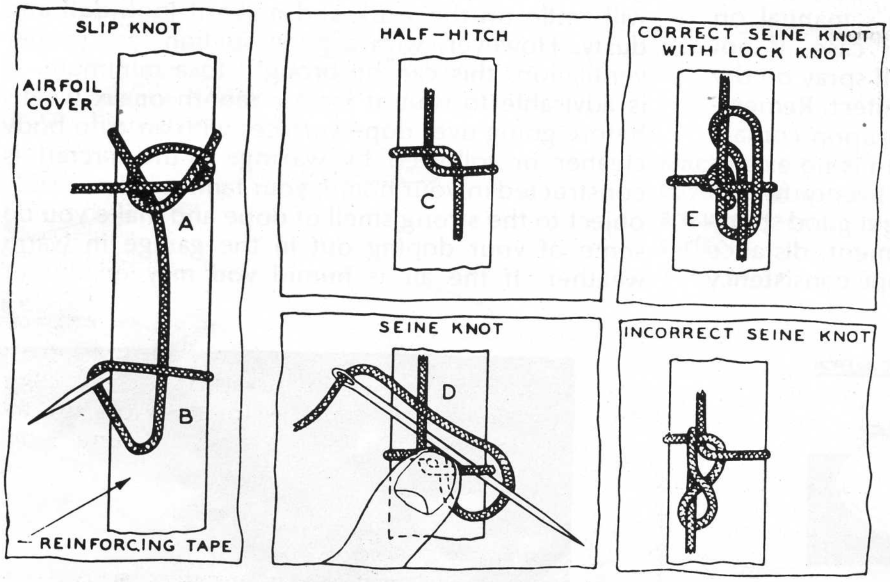


① WING RIB LACING

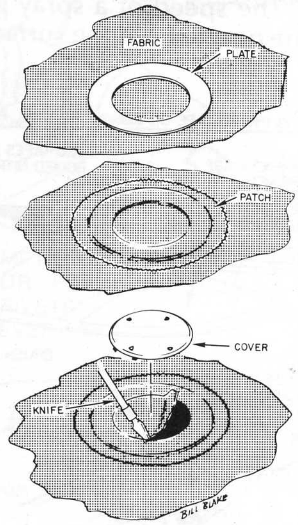
After placing the appropriate size re-inforcing tape over wing or control surface ribs, the fabric is laced to the structure.



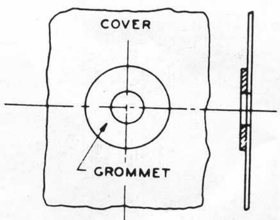
HOW TO TIE THE SEINE KNOT



② RIB LACING KNOTS

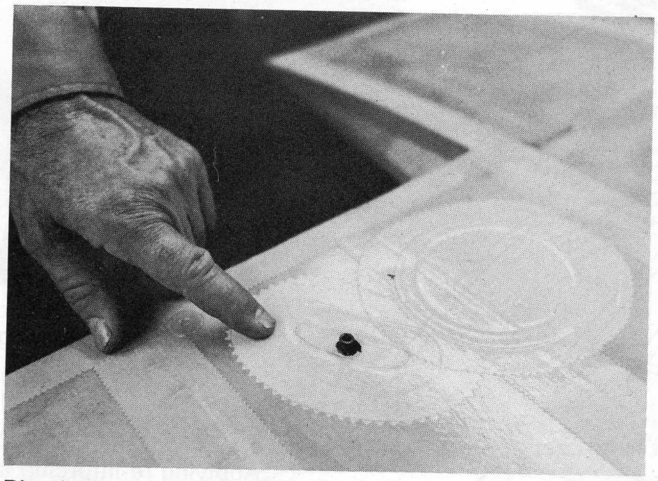


Round fabric patch is placed over plastic inspection grommets to prevent coming loose in flight.

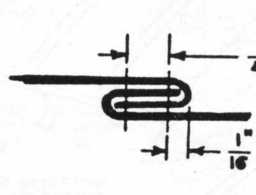


① PLASTIC GROMMET

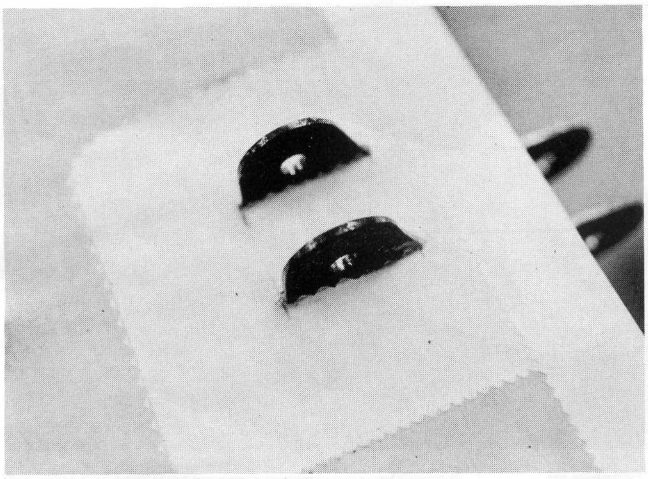
Plastic grommets are used to drain water. See page 68 for placement.



Plastic inspection rings are doped into position and covered with fabric to prevent peeling off. Finger points to aileron control bell crank fitting prior to cutting the fabric from the slot in which it moves.



FRENCH FELL SEAM

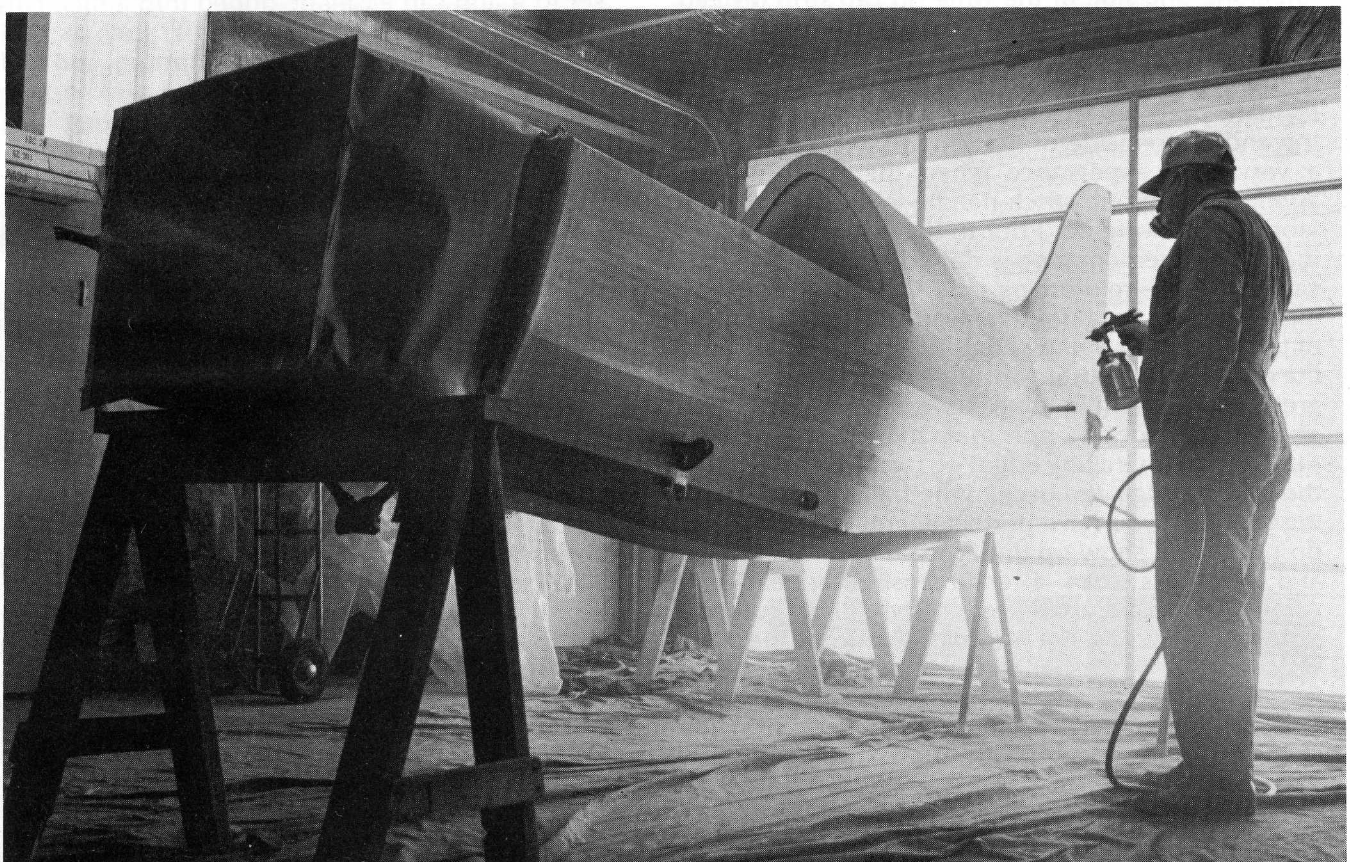


Fabric patch cut with pinking shears reinforces wing fitting fabric. Note pinked tape along edge.

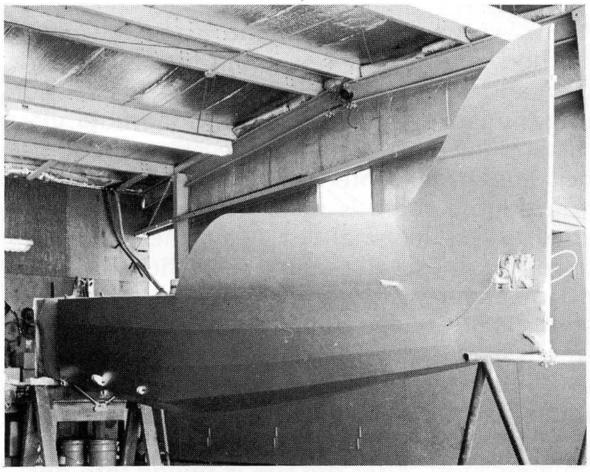
"blushing". This is rapid drying of the dope giving a whitish appearance. If you experience blushing use a retarder which is especially designed to reduce rapid drying in dope. This liquid slows down the rate of drying considerably and is of great help.

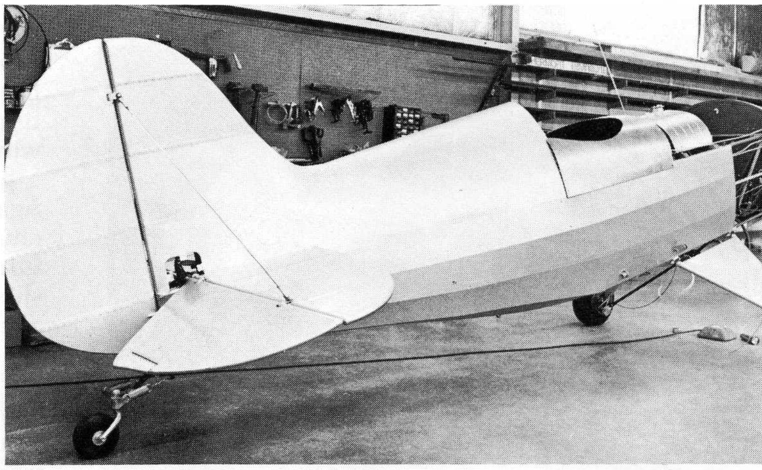
Regarding covering wings, we mentioned sewing the fabric strips together to form a blanket for each wing panel. The "French fell" seam is used to sew the strips together. Two methods of attaching fabric can be used. One is doping the fabric to the trailing edge of the wing, being sure that the fabric at the top of the wing is securely fastened to the top and bottom of the trailing edge. Excess material is cut off. We would recommend using the pillow slip method, and that is sewing all pieces of fabric together and when the pillow slip is inside out, bringing the fabric into place around the fiber glass wing tip and the metal trailing edge. It is good to use a pencil line at all center points to aid in sewing. Again, a double stitch is made on the sewing machine, all excess material cut away, the pillow slip turned inside out so all seams are in the inside and slipped over the wing panel. The area where the aileron fits is not sewed but glued with dope or fabric cement to the aluminum in the aileron section. It is recommended that three quarter inch strips of aluminum be sheet metal screwed to the inside curvature of the aileron fairing, to prevent the fabric from pulling away. After the slip is pulled into position, it can be pulled at the root or butt end of the wing rib to take out wrinkles and doped to the butt end of the rib. When all panels and center sections are covered, water again is used to take out any wrinkles prior to putting on the first coats of dope as spelled out and used in covering the fuselage. After the second coat of dope, rib stitching must be done. This is a manner of lacing the fabric to the ribs from the upper surface to the lower and back again. It keeps air suction from lifting fabric away from the ribs. If that happens, the airfoil would be changed considerably. It is recommended that the rib stitching be spaced one inch apart in the slipstream directly behind the propeller. This holds true for the elevators and stabilizer, as well as the rudder and fin, and two inches apart outside the propeller tips. The Civil Aeronautics Manual 18 on aircraft maintenance describes how the rib stitching is ac-

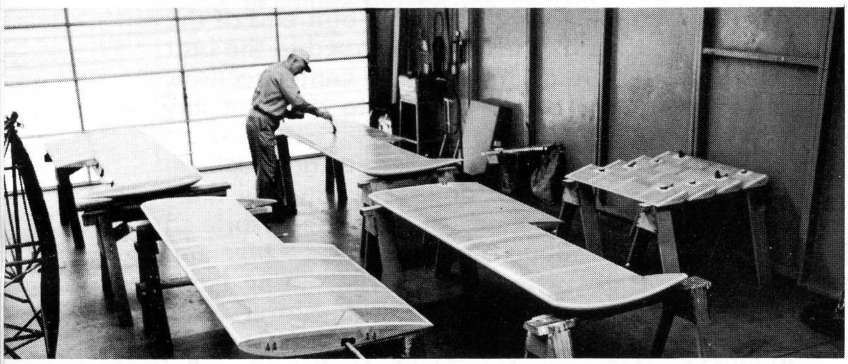
Charlie sprays second coat of silver on Acro fuselage. First coat was wet sanded to add smoothness to fabric. Forward section of fuselage masked to keep out silver dust.



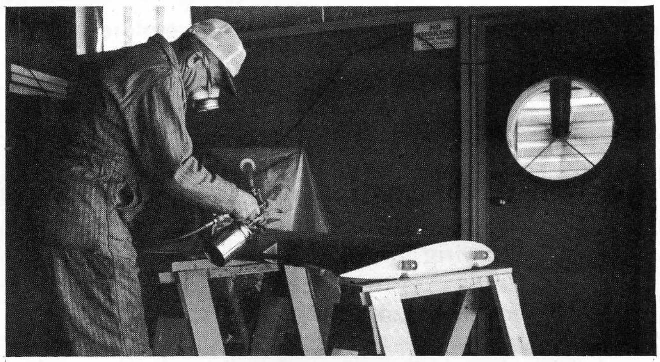
EAA Acro Sport fuselage after final coat of silver.







The wing panels and ailerons receive their final coat of clear dope prior to being sprayed silver. Note that all wing ribs and edges are covered with pinked tape.



Spraying silver to the center section.

complished. The rib cord that is used is a special, very strong aircraft grade which is treated with bee's wax for smooth working and water resistance. The knots that hold the fabric into place are usually run along one side of the wing rib cap strip instead of on top of it, and each knot is pushed down with the thumb so it does not show above the surface of the fabric. It is recommended that a ruler be used to mark the one and two inch spacings along the top and bottom side of the wing rib. This makes for a very neat appearance when the paint tape is applied. A long rib stitch needle is used to sew the fabric to the wing rib. Prior to rib stitching a quarter inch reinforcement tape is doped over the wing rib cap strips, the reinforcing tape is attached over the wood, behind the aluminum leading edge and ahead of the aluminum trailing edge. This helps in keeping the rib cord from cutting through the fabric and gives greater strength in holding fabric in place. When the rib stitching is done, apply the pinked tape over each rib. Start at the trailing edge, go forward and around the leading edge and back to the trailing edge, making sure that you have perfect alignment, for if you do not, it will show up underneath your final finish and give less than a craftmanship appearance. After all tapes are applied to the wing ribs, run one strip of tape along the leading edge from the wing root around to the trailing edge of the wing tip. It is recommended that the leading edge tape be doped firmly into place along the leading edge up to the fiber glass wing tip. The pinked tape when wetted with water and pulled tightly around the wing tip is held in place with a clothespin until it is dry. Upon drying you will find that the fabric has a curved set to it and can easily be doped into a nice curved and well fitted position. All edges, such as trailing edge of the aileron area, top and bottom, and trailing edge of the wing ribs should have pinked tape as well as the butt rib on the end board wing rib that attaches to the fuselage. Also between both the center section and the upper wing panels. All pinked tape is two inches wide and it should be mentioned that where the "French fell" seams are used to sew the fabric together in sheets on the wings, tape should be placed over these areas, at the same time the pinked tape is put over the wing ribs. This will protect the sewing and provide a smooth finish. Doping and finishing of the wings will continue the same as with the fuselage. Put inspection rings on the lower surfaces where drag and anti-drag wires attach to the spars, as well as where bell cranks or any moving fittings that are bolted into place are located, so that future inspections can be easily made. Drain grommets, little plastic circles with a hole in them, should be placed on each side of the trailing edge of each wing rib, just ahead of the aluminum. Upon final coats of dope, the little holes cut out. This allows moisture or any water that may accumulate in the wing to drain properly.

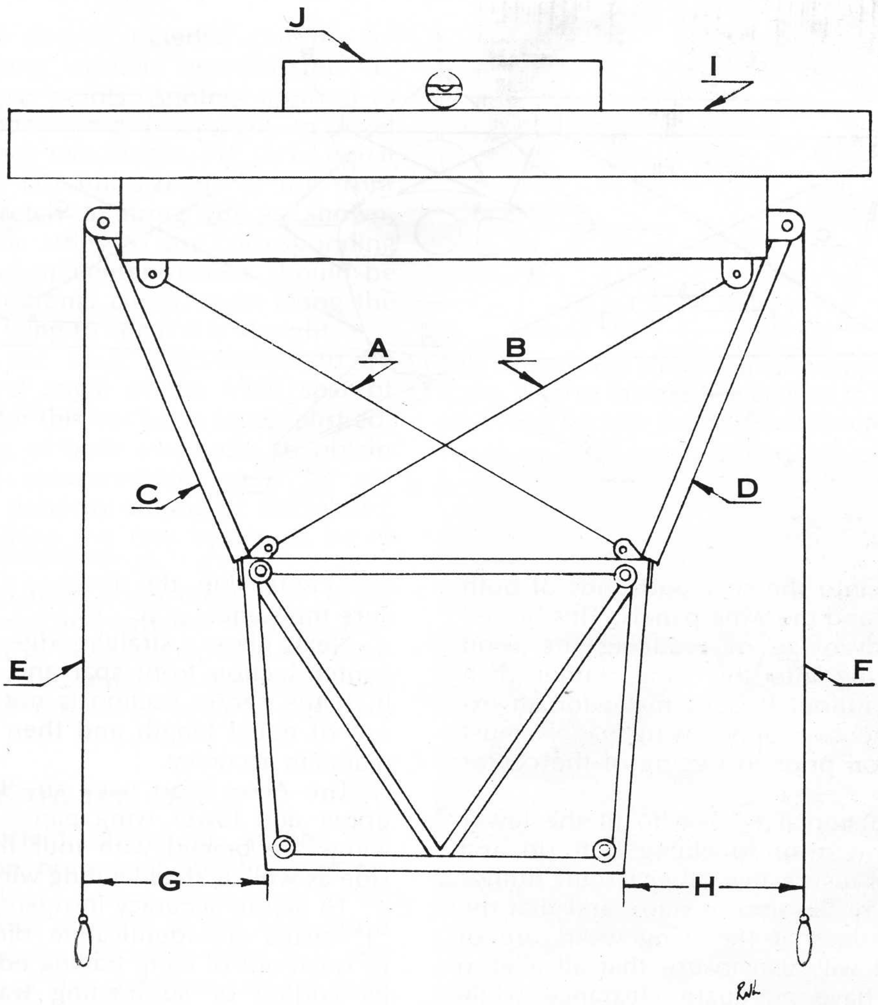


FIG. 1

For the best flight characteristics of any airplane, it is extremely important that all planes, — wings, center section, vertical fin and horizontal stabilizer — be in perfect alignment to the path of flight.

An improperly rigged aircraft can be a hazard, especially so on its first flight. It could cause excessive use of control at the time when a pilot needs his attention on completing a safe and successful first flight.

For example; if the trailing edge of the lower right wing extend downward an inch more than the left, the increased angle of attack would cause the wing to come up and turn the airplane to the left. This then would cause the pilot to apply the control stick to the right, dropping the left aileron to counteract this unwanted lift, and also applying right rudder to maintain direction. The pressures on the controls can be excessive depending both on forward speed and the degree of misalignment.

The Acro Sport has been designed with a center section, four wing panels, two uppers, and two lowers, a left and right horizontal stabilizer, and a fixed vertical fin.

The center section "N" struts, as they are known, are constructed of steel tubing and hold the center section into position. It is important that extremely accurate dimensions — as called out in the assembly drawings — be maintained and that both center section struts are perfectly matched, as well as the fuselage attach fittings and bolt hole dimensions.

All wing-to-fuselage and center section spar fittings must also maintain accuracy to insure perfect and equal alignment. For example; the center section and the two upper outer wing panels should be placed on a jig board, and center section spar wing bolts slipped into position to insure mating and alignment of the four bolts thru all attach fittings. The Acro Sport has been designed in such a manner that the upper ends

rigging

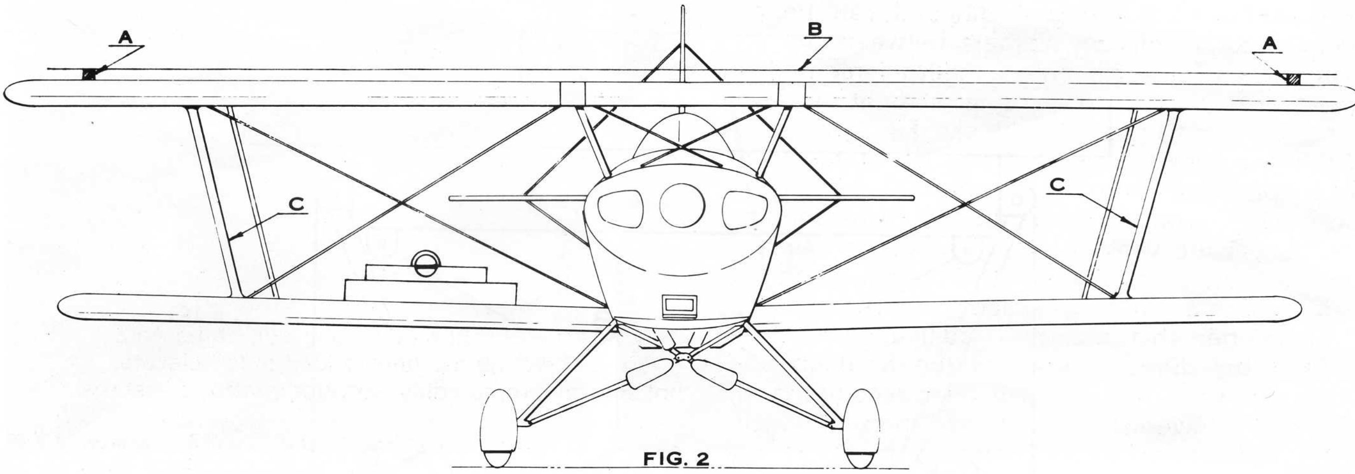


FIG. 2

of the cabanes fit into the spar butt ends of both the center section and the wing panels. This buried fitting has the advantage of reducing the wind drag load by fairing into the wing, rather than an extra external fitting. It does make for an extra problem as the two upper wing panels must be put into position prior to rigging of the center section.

During construction it is wise to fit the lower wings into position prior to gluing butt rib and covering. This will insure that all spar butt fittings and bolts will easily slip into position and that the inboard trailing edges at the wing walks are of equal distance. It will also insure that all aileron push-pull tubes have adequate clearance while passing through the compression and standard wing ribs in full travel each direction. The aileron bell cranks inside of the lower wings must maintain adequate clearance so that the bolts and nuts adequately clear the drag and anti-drag wires.

RIGGING THE CENTER SECTION

The tools needed to rig the Acro center section consists of plumb bobs and lines, steel tape, a spirit level, straight-edge and a various assortment of wrenches.

The first step in rigging is to position the center section so that the longitudinal center line of the section is directly above the center of the fuselage. To accomplish this, the attached center section roll wires (A) and (B) in Fig. 1 must be adjusted until they measure (trammel) the same distance from clevis pin to pin.

If the length of wire (A) is greater than that of wire (B), loosen wire (B) and tighten wire (A). If your fuselage and strut attach fittings are in alignment, when wires (A) and (B) are adjusted to equal length, the center section will then be in proper position to check the accuracy of the work drop plumb lines (E) and (F) from the upper center section front spar fittings. Measure the horizontal distance of these lines from some structure of the fuselage. If the airplane is level laterally and the center section is centered over the fuselage center line, the distance (G) and (H) will mea sure the same.

Next, place a straight-edge (I) directly over th center section front spar and place a level (J) o it. If the center section is not level the struts ar not of equal length and then must be altered t maintain accuracy.

The Acro Sport uses an "I" strut to hold th upper and lower wing panels into position. Th wings are braced with four flying wires on eac side as well as dual landing wires.

To insure accuracy in rigging, be sure that bot "I" struts are identical in dimension as wash-i or wash-out of wing trailing edges is accomplishe by adding or subtracting washers between th strut, fittings, and the wing spars. This will cop with any wing heaviness problems.

The lower wings can be put into position, a well as the outer wing "I" strut. The flying an landing wires can also be put into positio while rigging the center section. Upper wing must be on for center section alignment.

After all center section wing strut bolts an roll wire lock nuts have been tightened an checked, the rigging of the center section can b considered complete.

RIGGING WINGS

When rigging the Acro Sport, all flying wire should be loose and the lower wings rigged firs for dihedral. The front spar of the wing can b used as the wing reference line, therefore, th angle of dihedral 2 degrees for the Acro Spor can be measured by placing a straight-edg along the top of the front spar, holding a leve protractor on the top of this and adjusting an reading the instrument as illustrated in Fig. 2.

Tightening the landing wires increases the di- hedral and loosening the landing wires decrease dihedral. After the dihedral of 2 degrees ha been established in the lower wings, the uppe wings should be rigged for 0 degrees dihedral. I your "I" struts have been made accurately an both are matched, small adjustments for wash-i or wash-out and 0 degree dihedral can be accomplished by placing washers between the "I" strut and all four spar points. Another method to insure that the upper wing is straight or level transversely is to place two blocks, Fig. 2, of equal dimension over the last full size rib at the front wing spar, and stretch a string (B) as shown, the distance from the string to any corresponding portions of the wing or center section should be the same. As an additional check, sight along the leading edge of the wing to see if it is straight.

Remember that the basic adjustments to be made is the dihedral angle of the front spar of each lower wing. After this has been accomplished, raising and lowering of both rear spars to obtain equal and uniform measurements must be accomplished. This is done by adding or decreasing washers between either the rear upper or lower rear wing spars.

After adjustments have been made, the flying wires can be tightened and safetied with the lock nuts. A wood dowel of ¾" notched out appropriately, depending on the angle of the wires, can be installed to hold the wires against excessive vibration.

RIGGING THE TAIL GROUP

The most important alignment in the tail group is that of the horizontal stabilizer, in relationship to the wings. Before attempting to rig this surface, the lateral position of the Acro Sport should again be checked to make sure it is still level. The rear spar of the stabilizer can be used for a leveling position. This can be measured by placing a straight-edge and spirit level directly on the stabilizer spar.

The vertical fin is designed to be at 90° to the plane of the stabilizer. Therefore, the alignment of the vertical fin and the horizontal stabilizer have to proceed at the same time. This tail group is braced by adjustable streamline wires as shown in Fig. 3. A common method of procedure is to adjust wires (A) and (B) so that they trammel (measure) the same length from pin to pin.

Next, the wires (C) and (D) are adjusted so that they are at the proper tension and that they trammel the same length from pin to pin.

If the vertical fin rudder post has been installed accurately, if all wires are equal and the horizontal stabilizer rear spar is in level plane, the tail group, the brace wires, and lock nuts can be given their final tightening.

A plumb level can be held against the tail post to insure accuracy, or a plumb bob can be suspended from the top of the vertical fin post to visually inspect its position with reference to the center line of the tubing. The rudder must be removed to accomplish this.

This view clearly shows the tail group of the Acro Sport. A servo tab has been added to left elevator, not shown here, to adjust elevator control pressures.

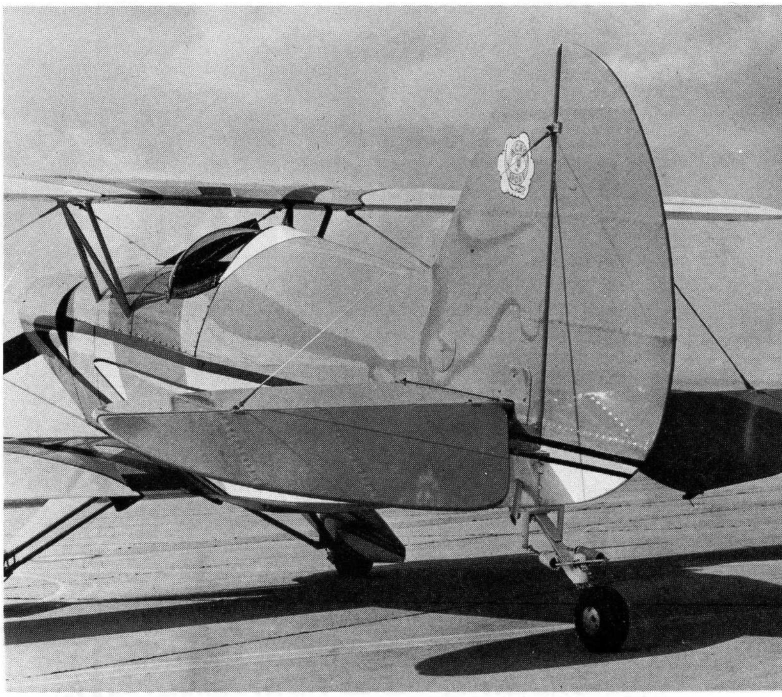
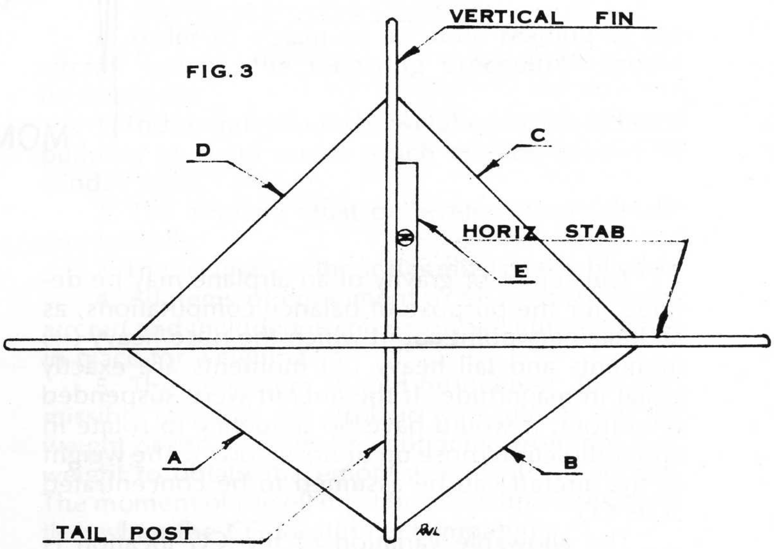
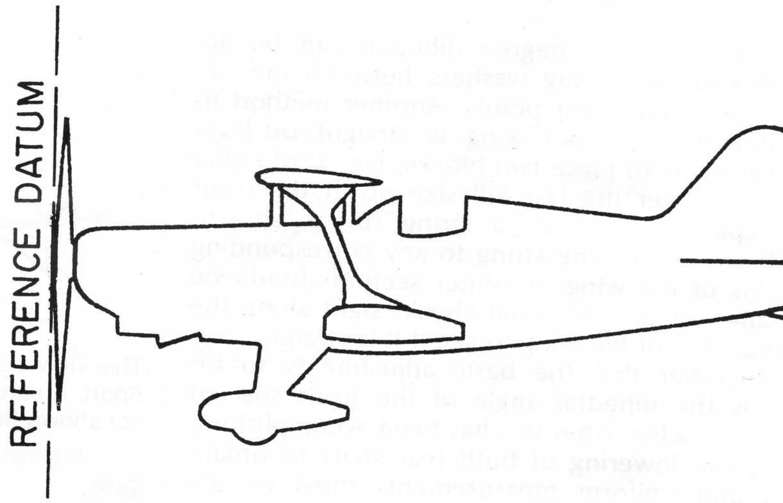
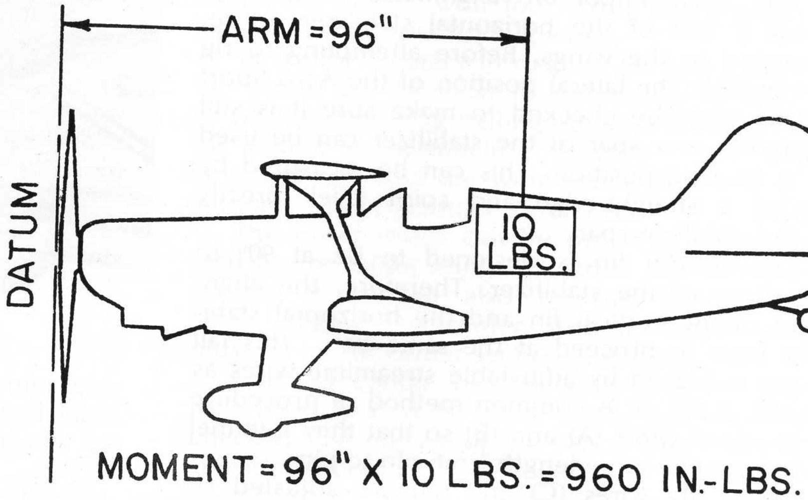


FIG. 3





weight & balance

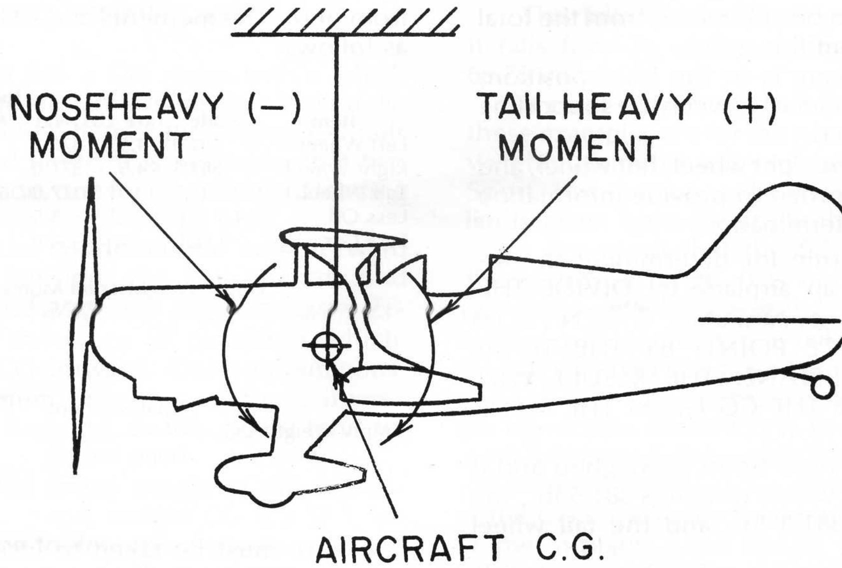


The center of gravity of an airplane may be defined, for the purpose of balance computations, as an imaginary point about which the nose heavy (−) moments and tail heavy (+) moments are exactly equal in magnitude. If the aircraft were suspended therefrom, it would have no tendency to rotate in either direction (nose up or nose down). The weight of the aircraft can be assumed to be concentrated at its CG.

The allowable variation of the CG location is called the CG range. Since CG limits constitute the range of movement that the airplane CG can have without making the airplane unstable or unsafe to fly, the CG of the loaded airplane must be within these limits at takeoff, in the air, and on landing.

The datum line, or simply datum, is a plane o line in a plane used as a reference in order to sho relative locations of objects. In computations fo weight and balance the reference datum is vertica and is located at the nose of the airplane as in ou case for convenience. As stated previously, all clock wise moments are positive and counterclockwise mo ments are negative. When the datum is located a the nose of the airplane, all moments must be posi tive and a nose-heavy moment is negative. If th airplane were suspended at its nose, it is obviou that the tail would be downward; hence all mo ments are tail heavy or positive.

It is very important to determine the exac location of the datum line before starting to solv



the weight and balance problem.

The moment arm, or merely the arm, is the horizontal distance in inches to the CG of an item measured aft of the datum. With the datum at the nose of the airplane, all measurements are aft and therefore positive.

The moment is the product of the weight and the arm. Thus, the moment of an item about the datum is obtained by multiplying the weight of the item by its horizontal distance from the datum. Moment is manifest as a tendency to cause rotation of the aircraft about its CG.

Before proceeding with the method of computing weight and balance, a thorough understanding of these terms is necessary:

EMPTY WEIGHT: The empty weight of an aircraft includes the weight of the airplane, powerplant, equipment which has a fixed location and is normally carried in the airplane, fixed ballast, and any other parts or equipment which are required during flight and are installed in the airplane. Fuel and oil are drained and only residual fuel and oil is included in the empty weight.

MAXIMUM WEIGHT: Maximum weight is the maximum authorized takeoff weight of the aircraft and its contents.

USEFUL LOAD: Useful load is the empty weight subtracted from the maximum authorized takeoff weight for the aircraft. This load includes pilot, maximum oil, maximum fuel and baggage.

WEIGHT CHECK: A weight check consists of checking the sum of the weights of all items of useful load against the allowable useful load of the aircraft.

EMPTY-WEIGHT CG: The empty-weight CG is the center of gravity of an aircraft in its empty condition.

OPERATING CG: The operating CG is the center of gravity of an aircraft in its loaded or operating condition.

WEIGHING POINT: The weighing points of an airplane are the points by which the airplane is supported at the time it is weighed. In this case, the landing gear and tail wheel are the weighing points.

TARE: Tare is the weight of the equipment necessary for weighing the airplane (such as chocks, blocks, etc.) which is included in the scale readings but is not a part of the actual weight of the airplane. Tare must be subtracted from the scale readings in order to obtain the actual weight of the airplane.

LEVELING MEANS: Leveling means are the reference points used for leveling the aircraft. In this case it is the top of the top fuselage longerons in the cockpit.

DETERMINATION OF EMPTY WEIGHT CENTER OF GRAVITY LOCATION

In order to obtain an accurate reading of the aircraft weight, the following procedures should be followed:

1. The aircraft should be weighed inside a closed building to avoid errors which may be caused by wind.
2. The airplane must be leveled longitudinally and laterally.
3. The accuracy of the scales must be established.
4. All items of equipment to be installed in the aircraft and included in the empty weight should be in place for weighing.
5. The oil system should be drained. It is permissible to weigh the airplane with full oil, but the weight of the oil must be subtracted from the total weight to obtain the empty weight of the aircraft. The moment of the oil must be taken into consideration when the CG location is computed.
6. The fuel tank should be empty, or the fuel in the tank will have to be condisered during CG location computation.
7. The weight of thc tare should be recorded, either before or after weighing the airplane, and the

tare weight should then be subtracted from the total weight as obtained from the scales.

8. When the airplane is in the level position, the exact horizontal distance between the supporting points must be recorded.

9. The weights of the right wheel, left wheel, and tail wheel must be recorded to provide information needed for the CG determination.

The fundamental rule for determining the location of the CG for an airplane is: DIVIDE THE TOTAL MOMENT OF AN AIRPLANE (TAKEN FROM A SPECIFIC REFERENCE POINT) BY THE TOTAL WEIGHT OF THE AIRPLANE. THE RESULT WILL BE THE DISTANCE OF THE CG FROM THE REFERENCE POINT.

In the figure, the Acro Sport is weighed and it is found that the right wheel weight is 381.5 lb., the left wheel weight is 381.0 lb., and the tail wheel weight is 24.5 lb.

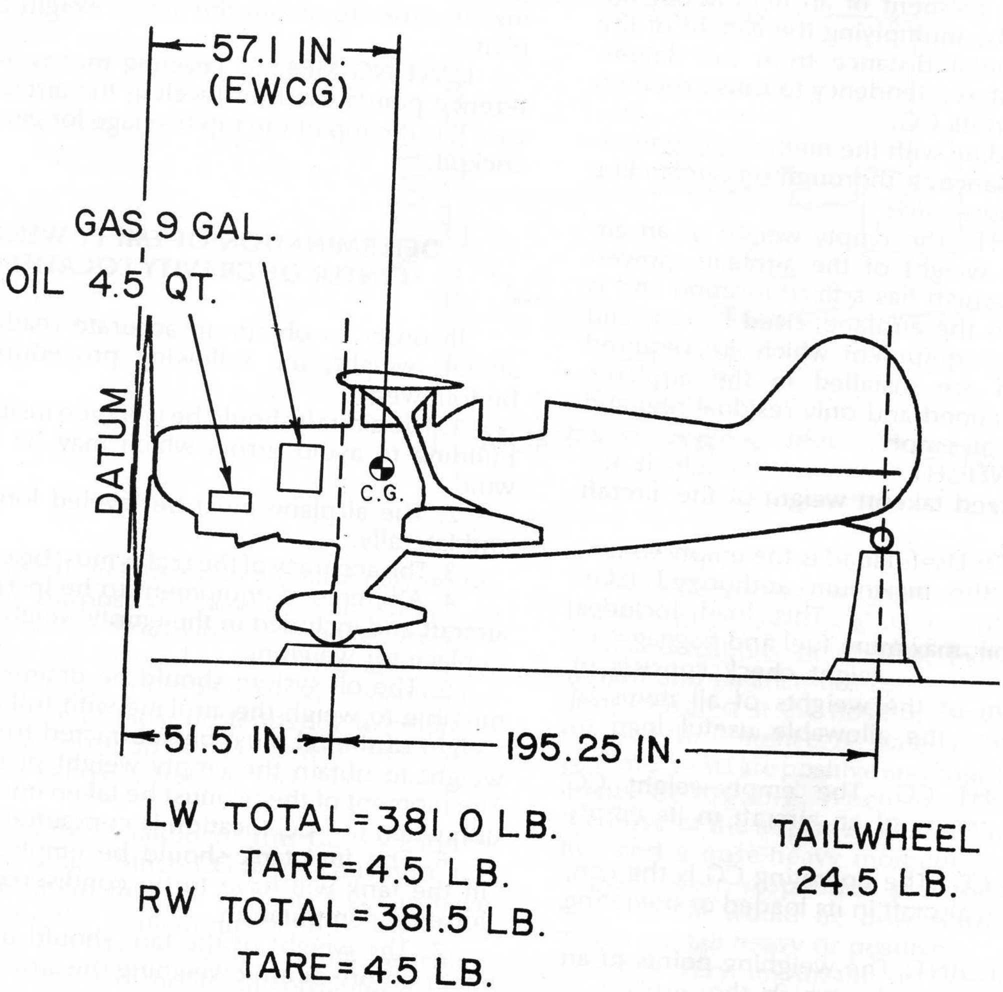
These weights, with the location of the weighing points, give us the information we need to find the location of the CG. The weight of the blocks that are used on the scales must be removed as tare.

We establish the datum line on the front face of the propeller hub. All moments will be determined from here. The moments and CG location are found as follows:

Item	Scale	Tare	Lbs. Net	Inches Arm	In. Lbs. Moment
Left Wheel	381.0	4.5	376.5	51.5	19,389.75
Right Wheel	381.5	4.5	377.0	51.5	19,415.50
Tail Wheel	24.5		377.0	195.25	4,783.63
Less Oil	4.5 Qt.		-8.5	23.0	-195.50
Less Gas	9 Gal.		-54.0	47.0	-2,538.00
Empty Weight Total Moment					40,855.38 in. lb

$$\text{Empty Weight CG} = \frac{\text{Total Moment}}{\text{Empty Weight}} = \frac{40,855.38}{715.5} = 57.1 \text{ inches}$$

Care must be taken to insure that the proper sign is applied to each quantity expressed in a weight and balance computation. All moments are positive (+) in this instance, since the datum is at the nose. The weight of an airplane is always positive. Also, the weight of any item installed in the airplane is positive. The weight of any item removed from the airplane is negative (-). According to the rules of algebra, the product of numbers with like signs is positive, the product of numbers with unlike signs is negative.



LOADING THE AIRPLANE

The Acro Sport has a CG range within which the CG must lie if the aircraft is to be operated safely. In order to determine whether the loaded CG falls within the approved limits, it is necessary that two computations be made, one for most forward loading and one for most rearward loading.

To determine the conditions for most forward loading, we must consider the fuel quantity and arm, oil quantity and arm, and pilot and arm. Except for the pilot, these are all quantities which tend to move the CG forward. Our computations must include maximum quantities of these items. We do not include baggage, as this would tend to move the CG aft.

Assuming that the empty weight of the airplane is 715.5 lb. and the empty weight CG is +57.1, we can load the airplane to determine whether the forward CG is within limits with maximum forward loading.

Unit weights have been established for weight and balance purposes. Gasoline is taken as 6 lb. per U. S. gallon, lubricating oil is 7.5 lb. per U. S. gallon, and 170 lb. is usually allowed for the pilot. Of course, exceptional pilot weights should be taken into consideration.

ITEM	WEIGHT	ARM	MOMENT
Aircraft EW	715.5	57.1	40,855.38
Oil (8 Qt.)	15.2	23.0	349.60
Pilot	170.0	93.5	15,895.00
Smoke Oil (5 Gal.)	32.5	65.0	2,112.50
Fuel (20 Gal.)	120.0	47.0	5,640.00
Baggage	——	——	——
TOTALS	1,053.2	——	64,852.48

$$\text{Most Forward CG} = \frac{\text{Total Moment}}{\text{Total Weight}} = \frac{64{,}852.48}{1{,}053.2} = 61.57 \text{ inches}$$

This falls within the allowable CG range, as it falls aft of the most forward CG limit of 60.0 inches.

To check the airplane for rearward CG limit, we must use a maximum of all weights to the rear of the CG limit and a minimum of all weights forward of the rearward CG limit. Now the problem is arranged as follows:

ITEM	WEIGHT	ARM	MOMENT
Aircraft EW	715.5	57.1	40,855.38
Oil (8 Qt.)	15.2	23.0	349.60
Pilot	170.0	93.5	15,895.00
Smoke Oil (5 Gal.)	——	——	——
Fuel (20 Gal.)	——	——	——
Baggage	25.0	119.0	2,975.00
TOTALS	925.7	——	60,074.98

$$\text{Most Rearward CG} = \frac{\text{Total Moment}}{\text{Total Weight}} = \frac{60{,}074.98}{925.7} = 64.98 \text{ inches}$$

This falls within the allowable CG range, since it falls forward of the most rearward CG limit of 66.75 inches.

It must be pointed out that the figures used in these examples are for the Acro Sport prototype. The weights and arms will vary for each individual Acro Sport, but the forwardmost and rearwardmost CG **limits** given here are applicable to **all** Acro Sports.

In the event that the CG does not fall within the approved range, it is necessary to correct the condition with ballast. It is highly unlikely that the builder will encounter a tail-heavy condition, so we will consider the nose-heavy condition.

The first step necessary in the computation for the correction of the CG is to determine what moment is necessary to provide the required correction. The moment necessary for correction is the distance of the CG outside the limit multiplied by the weight of the airplane. Lead ballast may be fixed in the tail just forward of the tail spring mount. To determine the weight required the moment necessary is divided by the arm of the intended location of the ballast.

During the lifetime of the airplane, it may be desirable to change the type of equipment which is installed. In every case of such a change it is necessary to figure the effect on weight and balance.

aircraft hardware

Since aircraft hardware is manufactured and inspected in accordance with rigid specifications, only genuine aircraft hardware may be used in the construction of this aircraft. Although the hardware used in the Acro Sport is specified on the plans, the builder should be generally familiar with all types and their applications.

BOLTS

Aircraft bolts are either general purpose AN (Army-Navy) bolts, or NAS (National Aircraft Standard) internal wrenching or close-tolerance bolts.

AN type bolts may be made of cadmium-plated alloy steel, corrosion resistant steel, or aluminum alloy. AN bolts are identified by the coded markings on the bolt-heads. These markings generally denote the bolt manufacturer, the material of which the bolt is made and whether the bolt is a standard AN type or a special purpose bolt. AN standard steel bolts are marked with either a raised dash or asterisk, corrosion resistant steel is indicated by a single raised dash, and AN aluminum alloy bolts are marked with two raised dashes. The strength and dimensions of AN bolts are specified by Army/Navy Aeronautical Standards.

Special purpose bolts include high-strength, low-strength and close-tolerance types. Such bolts are usually inspected by magnetic, fluorescent, or equivalent inspection methods. Typical markings include "SPEC" (usually highly heat treated), the manufacturer's part number stamped on the head, or plain heads (low strength). Close-tolerance NAS bolts are marked with either a raised or recessed triangle. The material markings for NAS bolts are the same as for AN bolts, except that they may be either raised or recessed. Bolts inspected magnetically or by fluorescent means are identified by means of colored lacquer or a distinctive type head marking.

Hex-head aircraft bolts are the all-purpos structural bolts used for general applications in volving tension or shear loads. The basic specifi cations for aircraft bolts are AN 3 through AN 20 AN 3 bolts are 3/16 inch in diameter, AN 4 bolts are 1/4 inch in diameter, AN 5 bolts are 5/16 inch in diameter, etc. The first number indicates the diameter of the bolt in sixteenths of an inch. The dash number which follows indicates the length o the bolt. The lengths of AN bolts increase by 1/8 inch increments. An AN 3-4 bolt is 1/2 inch long an AN 3-5 bolt is 5/8 inch long, etc. A 1 inch long bolt is designated as AN 3-10. An AN 3-11 bolt is 1 1/8 inches long, an AN 3-12 bolt is 1 1/4 inches long, and so on up to 2 inches, which is designated as AN 3-20. The next longest is AN 3-21, etc.

Close tolerance bolts are used in applications where the bolted joint is subjected to severe load reversals and vibrations. They are designed by AN-173 through AN-186 (Hex-head) and NAS-80 through NAS-86 (100° countersunk).

NAS internal wrenching bolts are designated under the numbers NAS 144 through NAS 158 and NAS 495. These are extra-strength bolts for use in applications where high tension and shear loads are developed. An internal wrenching bolt of more recent design and even greater strength than the NAS bolt is the MS 20004 through MS 20024. The MS (Military Standard) — series bolt is of very high strength and requires special washers and nuts for proper installation.

Clevis bolts are designated AN 21 through AN 36. These bolts are made from cadmium plated alloy steel. Clevis bolts are generally used for applications where shear is the principal stress.

The AN-73 drilled head bolt is similar to the standard hex-head bolt, but has a deeper head which is drilled to receive wire for safetying. The AN-3 and AN-73 series of bolts are interchangeable for all practical purposes from the standpoint of tension and shear strengths.

In general, the length of the grip (threaded portion) of a bolt should equal the thickness of the material through which it passes. However, a bolt with a slightly greater grip length may be used provided washers are placed under the nut or bolt head.

Many boltholes, particularly those in primary fittings, have close tolerances. Generally, it is permissable to use the first lettered drill size larger than the normal bolt diameter, except where the AN hexagon bolts are used in light-drive fit (reamed) applications and where NAS close-tolerance bolts or AN clevis bolts are used. Bolt holes are to be normal to the surface involved to provide full bearing surface for the bolthead and nut, and not be oversized or elongated.

The importance of the correct application of torque when tightening nuts and bolts cannot be overemphasized. Undertorque can result in unnecessary wear of nuts and bolts as well as the parts they are holding together. When insufficient pressures are applied, uneven loads will be transmitted throughout the assembly which may result in excessive wear or premature failure due to fatigue. Overtorque can be equally damaging because of bolt or nut failure from overstressing the threaded areas.

SCREWS

In general, screws have lower material strength and a looser thread fit than bolts. Screw heads are formed to engage a screwdriver, and the shank is threaded along its entire length without a clearly defined grip. Screws are usually made of carbon steel rather than the alloy steel used for AN bolts. Certain high-strength screws require the use of alloy steel. However, several types of structural screws are available that differ from standard structural bolts only in the type of head.

The material is equivalent and a definite grip is provided. The AN-525 washerhead screws, the AN-509 100° countersunk structural screws and the NAS-204 through NAS-235 are such parts. The material markings are the same as those used on standard AN bolts.

Structural screws are designated NAS-204 through NAS-235 and AN-509 through AN-525. This type of screw, when made of alloy steel such as SAE 4130 and heat treated from 125,000 psi may be used for structural assembly in shear applications similar to structural bolts.

The AN-504 and AN-506 self-tapping screws are used for attaching minor removeable parts such as nameplates. AN-530 and AN-531 self-tapping screws are used in blind applications for the temporary attachment of sheet metal for riveting and the permanent assembly of non-structural items. The AN-535 is a plain head self-tapping screw used in the attachments of nameplates or in sealing drainholes in the corrosion proofing of the tubular structures, and is not intended to be removed after installation. Self-tapping screws must never be used to replace standard screws, nuts, bolts, or rivets in the structure.

Plain and threaded taper pins, AN-385 and AN-386, are used in joints which carry shear loads and where the absence of play is essential. The flathead pin, or clevis pin, (MS-20392), is used in conjunction with tie rod terminals and in secondary controls which are not subject to continuous operation.

NUTS

Self locking nuts are used to provide tight connections which will not shake loose under severe vibration. There are two types currently in use, the all-metal type and the fiber or nylon lock type. Self locking nuts may not be used at points which subject either the nut or bolt to rotation. They may be used with antifriction bearings and control pulleys provided the inner race of the bearing is clamped to the supporting structure by the nut and bolt. Nuts must be attached to the structure in a positive manner to eliminate rotation or misalignment when tightening the bolts or screws.

All-metal locknuts either have threads in the locking insert that are out of phase with the load — carrying section, or a saw cut insert with a pinched-in thread. The locking action of the all-metal nut depends upon the resiliency of the metal when the locking section and load-carrying section are engaged by screw threads.

Fiber or nylon locknuts are made with an unthreaded fiber locking insert held securely in place. The insert has a smaller diameter than the nut, and when a bolt or screw enters it taps into the insert, producing a locking action. After the nut has been tightened, bolts and screws with rounded or chamfered ends should extend at least the full round or chamfer through the nut. Flat end bolts and screws should extend at least 1/32 inch through the nut. Locknuts may not be re-used if they can be run up finger tight. Bolts 5/16 inch diameter and over with cotter pin holes may be used with self-locking nuts but only if free from burrs around the holes. Bolts with damaged threads and rough ends are not acceptable. Self-locking nut bases are made in a variety of forms for riveting and welding to aircraft structures or parts.

The aircraft castle nut (AN-310) is used with drilled shank AN hex-head bolts, clevis bolts, drilled head bolts or studs. It is designed to accommodate a cotter pin or lockwire as a means for safetying.

The plain nut (AN-315 and AN-335) has limited use on aircraft and requires an auxiliary locking device such as a checknut or lockwasher.

Light hex nuts (AN-340 and AN-345) are used in miscellaneous applications and must be locked by an auxiliary device.

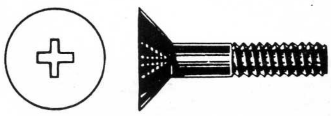
The checknut (AN-316) is used as a locking device for plain nuts, screws, threaded rod ends, and other devices.

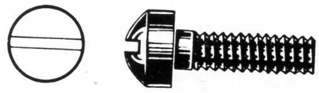
The castellated shear nut (AN-320) is designed for use with clevis bolts and threaded taper pins which are normally subjected to shearing stresses only.

Wing nuts (AN-350) are intended for use on hose clamps, battery connections, etc. where the desired tightness is ordinarily obtained by the use of the fingers or hand tools.

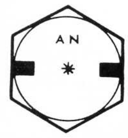
Sheet spring nuts are used with standard and sheet metal self-tapping screws in non-structural applications. They may be used to support hose clamps, conduit clamps, electrical equipment, access doors, and the like.

Two types of internal or external wrenching nuts are available. Both are of the self-locking type, are heat treated, and are capable of carrying the high-strength bolt-tension load.


Structural screw.

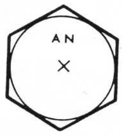

Fillister head screw.


Self tapping screw.

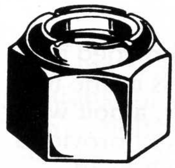


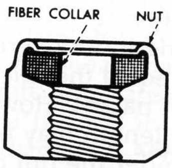
24ST aluminum alloy b

NAS phosphor-bronze b

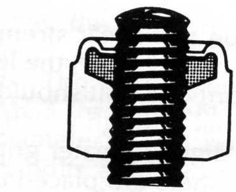


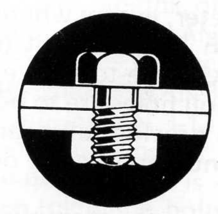
AN steel bolt.

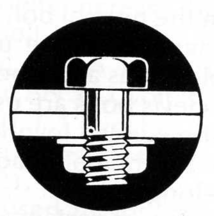

Elastic stop nut.

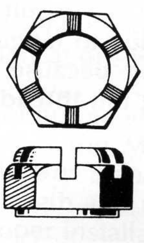


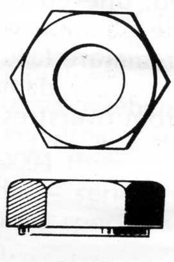
Fiber collar is not tapped.

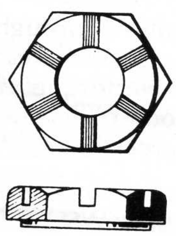

Bolt taps fiber collar as it passes through it


Bolt and grip length too short.


Bolt grip length correct.


Castle nut.


Plain nut.


AN castellated shear nut.

WASHERS

There are three types of washers used in aircraft structure. They are plain washers, lockwashers, and special washers.

Plain washers for use under hex nuts and for spacing are covered by AN specifications 960 and 970. Washers provide a smooth bearing surface, act as a shim and adjust holes in bolts. Plain washers are used under lockwashers to prevent damage to surfaces. The AN 960 flat washer is a general-purpose washer and is used for all normal installations requiring washers. Standard washers with an inside diameter for Nos. 2 through 8 screws are made .032 inches thick, sizes 10 through 5/8 inch are made .063 inches thick, and sizes for a 3/4 inch bolt are larger and are made .090 inches thick. AN 960 washers are also made in a light (thin) series.

The AN-970 washer has a large outside diameter and is designed for use with wood or other soft materials.

Lock washers are used to prevent the turning of nuts and may be used for limited applications in aircraft. They are designated AN-935 and AN-936 and are used with machine screws or bolts whenever the self-locking or castellated type of nut is not applicable. They should not be used as fastenings to primary or secondary structures or where they are subject to frequent removal.

Special washers are necessary for particular applications where plain flat washers will not suffice. Ball-seat and socket washers, AN-950 and AN-955, are used in special applications where the bolt is installed at an angle to the surface or where perfect alignment with the surface is required at all times. These washers are used together to provide the required angle between the surface and the nut.

Special washers for use with NAS internal wrenching bolts are the NAS-143 and the MS-20002 washers. The type C washer is countersunk to seat the bolt-head shank radius, and a plain type washer is used under the nut.

COTTER PINS

There are two types of cotter pins. These are AN-380 and AN-381. The AN-380 is a cadmium plated, low-carbon steel cotter pin used for safetying nuts, bolts, screws, and other pins and in various other applications where safetying is necessary. The AN-381 cotter pin is made for corrosion resistant, nonmagnetic steel and is used in safetying applications where these features are desired.

Standard aircraft rivets are designated by AN numbers as follows:

AN-420 90° countersunk head
AN-425 78° countersunk head
AN-426 100° countersunk head
AN-430 Roundhead rivet
AN-435 Roundhead rivet
AN-441 Flathead rivet
AN-442 Flathead rivet
AN-455 Brazier-head rivet
AN-456 Modified brazier head
AN-470 Universal-head rivet

Rivet sizes and materials are indicated by the numbers and letters following the basic AN number. For example, AN-470-AD-3-4 indicates a universal head rivet made of 2117 aluminum alloy (AD), 3/32 inches in diameter and 4/16 inches in length. The first dash number designates the diameter in thirty-seconds of an inch, and the second dash number indicates the length of the rivet in sixteenths of an inch. The letters indicate the type of materials from which the rivet is made. A, B, D, AD, and DD indicate different types of aluminum alloys, C indicates copper, F indicates stainless steel, and M indicates monel metal. The materials are also indicated by markings on the heads of the rivets.

TURNBUCKLES

Turnbuckles are commonly used for adjusting the tension of control cables. A standard turnbuckle consists of a barrel and two steel ends, one with a right-hand thread and the other with a left-hand thread. When the barrel is rotated the ends move together or apart.

Turnbuckles are supplied with several different types of ends. Some of these are the cable eye, the fork, the pin eye, and the swage fitting. The barrel of the turnbuckle is made of brass and is grooved around one end to indicate the left-hand thread.

When a turnbuckle is tightened, not more than three threads may show outside the barrel at each end. The turnbuckle must also be properly satetied.

Turnbuckle parts are designated by AN numbers as follows:

AN-155 Standard barrel
AN-161 Fork
AN-170 Cable eye
AN-165 Pin eye
AN-669 Swaging terminal

CABLE FITTINGS

Cable fittings are needed to connect a cable to control arms, other fittings, turnbuckles, etc. When it is necessary to attach a cable to a turnbuckle or other device and swageable fittings are not available, the AN 100 cable thimble is used. A method for splicing the cable around a thimble or bushing is the Nicopress swaged-sleeve method. The Nicopress sleeve is made of copper and is swaged (pressed) on the cable by means of a special tool.