



The Cozy

PLANS SECTION I

NOVEMBER 1983 - FIRST EDITION

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Printed in the U.S.A.

High Flight

*Oh, I have slipped the surly bonds of earth,
And danced the skies on laughter-silvered wings;
Sunward I've climbed and joined the tumbling mirth
of sun-split clouds — and done a hundred things
You have not dreamed of — wheeled and soared and swung
High in the sunlit silence. Hovering there,
I've chased the shouting wind along and flung
My eager craft through footless halls of air.
Up, up the long delirious, burning blue
I've topped the wind-swept heights with easy grace
Where never lark, or even eagle, flew;
And, while with silent, lifting mind I've trod
The high untrespassed sanctity of space,
Put out my hand, and touched the face of God.*

John Gillespie Magee, Jr.

GENERAL

COZY documentation is available in the sections shown below. Section I consists of this book, plus an appendix of twenty 17-1/2 x 22-1/2 in. drawings. The contents of all sections are as follows:

SECTION I. MANUFACTURING

MANUAL. This section covers the basic airframe. It includes education on composite materials and construction, plans and construction manual for the basic airframe.

SECTION IA. MANUFACTURING

MANUAL. This section covers firewall and accessories, control system, roll/pitch trim system, canopy and turtle back, electrical system, covers/fairings/consols/NACA flush scoop, finishing and upholstery.

SECTION II. ENGINE INSTALLATION. This section will cover installation of the O-235 Lycoming engine, including baffling, engine controls, exhaust, carb heat muff and box, engine instruments, prop, spinner, cowl, and induction.

SECTION III. OWNERS MANUAL. This section will be the flight and maintenance manual. It will include normal and emergency procedures, weight and balance, check lists, detailed flying qualities, descriptions, operating limitations, performance charts, maiden flight test procedures, pilot checkout procedures, and record keeping requirements.

NOTE. Sections I, IA, II, and a subscription to the 'Cozy Newsletter' starting with issue No. 4 (January 1984) are required to build a Cozy. The Owners Manual is required before flying your Cozy.

WARNING. These plans are obsolete unless updated by newsletters 4 and on. Do not fail to do this, as it is possible that MANDATORY flight safety improvements may occur.

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C213-7 VORTICONS

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CHAPTER 1

DESCRIPTION/INTRODUCTION.

DESCRIPTION. The COZY is a high performance, homebuilt aircraft. It is a side-by-side modification of the Long EZ, for more pleasureable cross-country travel. Although roomy enough to accommodate persons as tall as 6 ft. 4 in., it is restricted to 340 total lbs. in the front seat, for c.g. considerations. It has a large back seat, intended by the designer for luggage. Its canard configuration was designed not only for performance, but to provide improved flying qualities and safety as compared to the conventional tractor light plane design (see Owners Manual for complete details on flying qualities and performance). The Cozy uses the NASA - developed winglet system, and modern airfoils.

Its high-lift canard wing has full-span flaps which double as elevator and landing flap. Its rear wing has conventional ailerons mounted inboard for control system simplicity and low adverse yaw. The aircraft has a drag device, called a *landing brake*, to dirty it up, allowing use of runways as short as 2,000 ft., with appropriate pilot skill. The glide angle at idle power without the landing brake deployed is only 3.7 degrees. Thus, the brake is *required* to provide the normal descent control of conventional and less efficient aircraft.

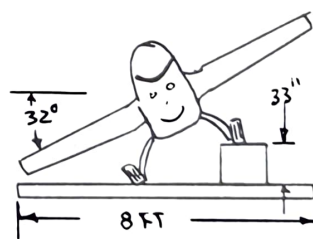
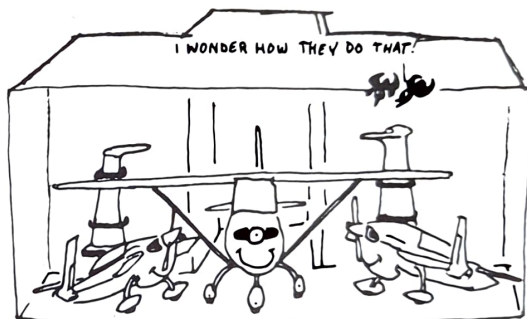
Yaw control and main-wheel brake systems are combined, to further result in major simplification and improved flying qualities. The pilot has simple, one-piece rudder pedals to control rudder and wheel-brake functions. A cable is run from each pedal to its rudder with a spring returning the rudder to a sealed neutral position. The outward camber of the winglet's rudder is such that the rudder brakeout force is increased with airspeed. This allows pleasantly low rudder forces at low speed where rudder is needed and higher initial forces at high speed where there is no requirement for rudder control. The rudder pedals are narrow enough to allow the pilot to tilt his feet and move them in front of the pedals so he can stretch out and relax his feet forward during cruise. The rudder cable moves a belcrank at the firewall such that after full rudder is reached, further motion of the rudder pedal actuates its respective wheel-brake master cylinder. This system is less complex than the coupled rudder and toebrake system found in conventional aircraft. Also, it results in less brake wear since it is impossible to apply brake in a given direction without already using full rudder power. An adjustable bungee system provides pitch trim, adjusted by a lever on the center console. Roll trim is via bungee adjustment to the aileron controls.

The main landing gear is a one-piece, molded, unidirectional fiberglass strut extending from one axle to the other. The one-piece design eliminates the excessive leverage loads found in conventional two-piece gear legs. This allows a much lighter structural attachment at the fuselage. The gear and attachment have successfully undergone drop test to FAR -23 criteria. The gear strut is molded in an airfoil shape. The strut is designed to enter at the top of the wheel pant, rather than at the side, to reduce interference drag. The cruise penalty due to the main gear being fixed, is only 6 knots. Thus, the increase in empty weight, increased cost, and increased maintenance of a retractable main gear is not justified.

The nose landing gear is a fiberglass strut, molded to the outside contour of the fuselage. The strut fits into a groove in the fuselage, thus a door is not required. The gear is retracted/extended by simple worm-drive mechanism. The gear is retracted on the ground after the pilot gets out to allow the aircraft to park with its nose down, resting on a rubber bumper. Kneeled parking is used for several reasons. The aircraft is not as susceptible to upset from high surface winds when parked on its nose, the propeller is raised to a convenient height for hand starting, and the nose bumper provides a chock so that chocking the wheels is not required for hand starting. Refer to the Owners Manual for inflight and ground operation of the nose gear and for de cEDURE.

The fuel system consists of two, 26-gallon glass/foam/glass-composite fuel tanks, which form wing strakes along the sides. The wing tanks have sumps to provide fuel in all attitudes. Unuseable fuel is very small. Gauging is provided by directly reading the fuel's coloration in a translucent portion of the tank in the back seat. See Chapter 21 for fuel system details. See Owners Manual for its operation.

Each wing and the canard are easily removed to allow compact storage or trailering. Refer to the Owners Manual for specific procedures for disassembly. While, in some cases trailering is the only solution to the crowded airport situation, we feel that the work required to completely disassemble, tie down on a trailer, etc., defeats the high utility of the airplane and results in the pilot not flying enough to stay proficient. We recommend the system shown in the sketch, where only one wing is removed and the airplane is hanged on a noninterference basis with a high wing aircraft. Assembly/disassembly time during this method is only about 15 minutes.



Trailering at road-towing width limitation of 8 feet requires a 33 in. high block under a wheel to tilt the airplane.

The composite structure of your COZY provides some important advantages over conventional metal, wood, or fabric construction. It has been tested to loads far in excess of those required for FAA certification. Fatigue margins are higher. Contour is maintained under load, the structure does not 'oil can', buckle or distort. It provides excellent insulation and damps noise. It has no hidden joints, no water traps, and is far less susceptible to corrosion. It is easier to repair. It is not susceptible to thermal stress due to temperature changes. Properly protected from UV (see Chapter 25), it has a very long life.

INTRODUCTION

This manufacturing manual has been specifically designed to educate you in the construction materials, their use, and to guide you through each step of assembly in the most efficient manner possible. It is our intent to drastically reduce the non-completion rate (estimated at 80 percent) common to homebuilt aircraft. With that in mind, we have:

1. Preceded the plans with an education chapter intended to thoroughly acquaint you with the tools and materials and how to use them.
2. Laid out the plans in a detailed, step-by-step format to answer the question of 'what do I do next?'
3. Provided all appropriate information to each step adjacent to the words. Due to binding requirements, the larger drawings are grouped together in an appendix.
4. Provided full-size templates where required, to avoid the work and confusion associated with scaling up drawings.
5. Set up distributors to provide all materials and the hard to find tools.
6. Identified the difficult to build items, and made them available (prefabricated and ready to install) from competent manufacturers/distributors.
7. Set up our newsletter, The Cozy Newsletter, as a continuing plans updating/correcting system. 'The Cozy Newsletter' may occasionally have changes of a mandatory nature as well as distributing builder tips and other useful information, and a subscription is mandatory for all Cozy builders.

Building Sequence.

The nature of the type of Cozy structure requires that a part be left alone to cure for a longer period of time than that required to build it. Thus, you will find that when following the step-by-step order, you will often find yourself out of work, waiting for a cure. In most cases you can skip to another chapter and build another part while waiting. With a little planning and familiarity with the entire manual, you should be able to use all your time productively. An old builder friend, who had built 8 airplanes in his lifetime, once gave me some good advice. 'If you are going to build an airplane', he said, 'make sure you do something on it each day, if only 15 minutes.' That was good advice, and if you follow it, you will make steady progress.

Building Time.

Note that many steps include an estimate of the number of man-hours required and the number of people required. This information was compiled from our experience building N2NP and 22CZ, and also a proof of plans model. We estimate these times would total 1,000 hours for Section I. This does not include (1) studying the plans and rounding up required tools and materials in preparation for a chapter, (2) cleaning up your shop, (3) standing around waiting for things to cure, (4) discussing your workmanship with friends that stopped by to help. Many of you will find that through efficient work practice, you can consistently beat the time estimates on most of the steps.

Others may find that they are spending as much as twice the time estimates. If you are spending considerably more time than that shown, go back and study all the details in the education chapter. Most slow work is due either to over-cautious work habits as a result of being unsure of workmanship, or ignorance of the correct way of doing things.

Questions.

Please follow the following procedure if you do not understand something and need an answer. First of all, do not be concerned if you do not understand everything the first time you read through the plans. Many things that may not be obvious just reading the drawings, will be obvious when you have that portion of the airplane in front of you or have built a similar part in a previous chapter. Also, we will be able to help you better if you are looking at that portion of your airplane. So, do not ask for clarification until you are really working in that chapter. We have found through our own experience that the majority of questions the homebuilder asks are already answered somewhere in the plans. We have made considerable effort in the COZY manual to make the information visible. If you do not understand something, study the words in the step, study the sketches and all related sections/views/photos, then look through the fullsize drawings that show that portion of the airplane. Check the overview and parts list. If it's a methods-type question, re-read the



education chapter for clarification. If the answer is still not found, it may be that that item is covered in detail in another chapter (there is some necessary overlap). Remember, items related to Section II (throttle control, oil pressure gauge, etc.) are covered only in that section. It is possible that a question related to the operation of a part of the airplane or its maintenance is answered in your Owners Manual. Also, check your back issues of 'The Cozy Newsletter' (No. 4 on) for plans updates or clarifications. Okay, you have checked everything and you are still stumped. You can do one of three things.

1. Ask a friend. Often a description of an item is unclear to one individual and clear to another. Get to know other Cozy, Long EZ, Varieze builders in your area and join your local EAA chapter. Helping each other is a part of the system.
2. Write to Co-Z Development, leaving room on the paper under each question for our answer. **Include a self-addressed, stamped envelope and include your aircraft serial number.** We do our best to answer all such questions within two days of receipt. We cannot answer questions regarding the application of non-recommended materials or regarding non-approved modifications. **Co-Z Development, 2182 N. Payne Ave., St. Paul, MN 55117.**
3. Call Co-Z (612) 776-1145 after normal working hours. During working hours I will be at the office, earning a living.

Also, let us know if you have found a better way of doing something. If we agree, we'll publish it in the newsletter so that all builders can benefit. If it is not a good idea, we'll tell you why. **if you include a self-addressed, stamped envelope.**



LICENSING AGREEMENT

In consideration of payment for the COZY Manufacturing Manual, you will be granted a license to build one aircraft from these plans and instructions. Upon execution of the licensing agreement printed below, you will be assigned a serial number, which is required by the FAA for registration of your aircraft.

The COZY Manufacturing Manual is Copyrighted, and may not be copied or reproduced, in part or in total, except as necessary for the manufacture of your aircraft.

Co-Z Development is a licensee of the Rutan Aircraft Factory, and holds an exclusive license for the single engine, side-by-side modification of the Long EZ, which has been named the COZY. In consideration of royalties paid by Co-Z Develop-

ment to Rutan Aircraft Factory, Co-Z Development has been granted permission to use Long EZ design and technology, where applicable, and to republish those portions of the Long EZ design and manufacturing instructions which apply also to the COZY.

The licensing agreement printed below is in agreement with FAA policy governing the design and manufacture of homebuilt aircraft. It is important for you to recognize that no matter how good the design and how detailed the instructions, and how many inspections by the FAA, you and only you can accept the responsibility for the manufacture of a safe aircraft and its operation in a safe manner.

The agreement has been printed in duplicate. Please execute both copies and send to Co-Z Development. The first copy will be returned to you with the serial number you have been assigned.

He is responsible for the quality control on all parts, all construction, and the conduct of his flight tests. While Co-Z Development is not the manufacturer of your aircraft, we do, through these plans and services, provide you with information about how our COZY was built and how we feel is the best way for you to build a safe, reliable airplane. We do encourage you to build the airplane as shown on the plans because we have found that our airplane provides us with reliability and safety, and any problems that we experience with our aircraft are documented and reported in 'The Cozy Newsletter'. We have gone to a considerable effort in developing the design, the structure, and the systems, and proving their adequacy with appropriate tests.

If you modify the airplane and then ask us if your modification will work, we cannot give you an answer without conducting the appropriate tests and totally qualifying the modification. This would obviously be quite expensive. Our concern then, is that if your modification is not successful, and causes an incident or accident, this would be attributed to our design, the COZY. Because of this, we must insist that if you modify the airplane with any major change (such as an aerodynamic change, primary structural change, or using a non-approved engine installation), you call your airplane a different name, rather than a COZY. If you make a major change, you must consider yourself involved in basic aircraft design and development, an extremely risky business. As such it is not fair to us to be associated with any results of your development. We state this, not to discourage inventiveness and progress, but to release any connection of your new development efforts with our proven design.

We are particularly concerned about the trend among the amateur builder to use high performance homebuilt airplanes, as flying test beds for brand new, unproven engine developments. Initial flight testing of a new powerplant, even though it is 'well proven' in a car, snowmobile, motorcycle, test stand, etc., is an extremely risky operation. These tests should be done on an airplane like a Piper Cub, Aeronca Champ, etc., for two reasons. (1) The slow flying, light wing loading types are much more forgiving for forced landings in the trees and (2) the accident you may have is not just another statistic, it is a **homebuilt** accident, the results of which can have an effect on the overall regulations governing the building and flying of amateur-built aircraft. The U.S.A. has the most lenient regulations for homebuilts of any country in the world and we can keep those regulations if we, through caution, common sense, and self-policing, retain our excellent safety record.

So, if you have a strong desire to try your idea of a turbo-injected rotary watzit or your geared-razzle dazzle, good, do it, but first put it in a Piper Cub (FAA will apply appropriate restrictions during your tests), fly it 1000 hours, keep strict maintenance/failure records, get the right attitude toward reliability for an aircraft powerplant and then, when you're convinced it is good, install it in a homebuilt aircraft. In this way, maybe we can finally get a good, low-cost powerplant without giving EAA a bad name and without forcing tighter restrictions on the operation of homebuilt aircraft.

followed by a single letter, or numbers followed by two letters. They are preceded by the letter 'N'. (For example, N2NP, N22CZ, etc.) Be sure to give them your second and third choice, in case the number you want is already taken. Sent \$10 to reserve your special number. Address: FAA Aircraft Registry, Box 25082, Oklahoma City, OK 73125. Do not register your aircraft yet, you don't need to pay registration fees, property taxes, etc., until your airplane is ready to fly.

3. When you are ready for inspection, contact your local FAA office. Be sure you have an airframe log book (available from a distributor) so that FAA can make an inspection entry.

4. To prepare for your final inspection, be sure you have the 'N' number painted. It must be at least 3 in. high and in block letters with contrasting colors. The 'EXPERIMENTAL' sign (2 in. high letters) on the canopy frame, the ID plate and passenger warning plate mounted (available from a distributor), and have an airframe log book and an engine log book. Before final inspection, fill out an application for registration (FAA form No. AC8050-1), a notarized affidavit that you built the airplane from parts that you bought yourself, and include \$5 registration fee. Send those three things to the FAA Registry, Box 25082, Oklahoma City, OK 73125.

5. After you have made a final inspection of your aircraft, run the engine, conducted low speed taxi tests, etc., (see Owners Manual), contact your local FAA office and tell them you are ready to fly. They will have you fill out an application for airworthiness (form No. 8130-6), inspect your airplane, and issue you an airworthiness certificate and a list of operating limitations, that will restrict you to an unpopulated area for your initial test period (40 hours). When you have completed your initial test period, contact FAA to get your operating limitations amended so you can fly outside your test area.

Note: FAA procedures may change. Check with them for their current requirements.

CHAPTER 2

BILL OF MATERIALS

This chapter is a listing of the materials and components which are required to build a COZY. The parts are categorized by type for your convenience when ordering. The parts are also categorized by plans chapter to assist you in locating them during construction.

Co-Z Development maintains a close liaison with the distributors listed to assure proper materials specification and quality control. The distributors listed here are the only approved sources for materials. Do not make substitutions for the structural materials shown. The indicated materials were selected, developed, tested, and optimized for ease of construction and structural integrity. Co-Z cannot provide assistance in the application of substitute materials. Each authorized distributor has a catalog or descriptive price list of the materials and components that they provide. The catalogs often cover a range of items beyond the basic requirements shown in this B.O.M. and serve as a very handy reference. Those distributors who charge for their catalogs will refund the catalog charge with your first order.

RUTAN AIRCRAFT FACTORY INC.
Bldg. 13, Airport.
Mojave, CA 93501.
(805) 824-2645

- (1) MG-1L Main gear strut 22-lb. S-glass

(1) NG-1L Nose gear strut 2.8 lb. S-glass
- ORDER FROM
TASIL RESEARCH
CR 5-1

KEN BROCK MANUFACTURING, INC.
11852 Western Ave.
Stanton, CA 90680
(714) 898-4366

CUSTOM PREFAB PARTS	CHAPTER
(2) LMGA assembly	5
(1) Step	8
(2) AX 5 Main gear axle 1-1/4 in.dia. (with spacers and nuts)	9
(2) CLT Lift tab	10
(7) CS2 Formed hinge with bushing	11
(9) CS3 Bracket	11
(4) CS9 Plug	11
(2) CS10 Lead weight	11
(2) CS11 Lead weight	11
(2) CS12 Belhorn with bushing	11
(1) PTB Belcrank	11
(2) CN1 Alum. bushing	12
(2) CN2 Steel bushing	12
(1) Worm/drive retract incl. crank	13
(1) LST Shock strut	13
(1) NG6 Casting	13
(1) NG3 Bracket	13
(1) NG4 Bracket	13
(1) NG6 Ass'y, incl.NG7 and NG23	13
(2) NG8 Plates	13
(1) NG401A Lower nose gear ass'y with tire,tube, friction, bolts, etc.	13
(1) CZRPL1 & 2, & CZRPR1 & 2	13
(2) CS13 Steel bushings	13
(2) CS15 Belcrank with bearing	15
(4) CS71 Brackets	15
(2) CS72 Pulley brackets (2 pcs.ea.)	15
(2) CS75 Steel bushings	15
(2) BA Brake arms	15
(12) LWA9 Aluminum bushings	19
(2) A2 Brackets	19
(4) A5 Brackets	19
(2) CS301 Stl. belhorn (1 left,1 right)	20
(2) FT-18 Fuel cap assembly	21
(1) EFP Electric Fuel Pump	21

Note: Brock also has available the individual parts for all assemblies listed.

AIRCRAFT SPRUCE AND SPECIALTY.
P.O.Box 424.
Fullerton, CA 92632.
(714) 870-7551

OR

WICKS AIRCRAFT SUPPLY.
410 Pine Street.
Highland, IL 62249
(618) 654-7447

CUSTOM PREFAB PARTS

- (1) SC Strut Cover (fiberglass)

(1) NB Nosegear Box (fiberglass)

(3) Seat Belt/Harness Assembly (E6000L22-14)

(2) (2)SB Glass Sump Blisters

INSTRUMENTS

- (1) Airspeed, kts or mph AS-DS-VE/LE

(1) Altitude, Sensitive ALT-1

(1) Compass C2300

(-) Engine - There are many options, order to suit

TOOLS

- (2) pcs.template plywood 1.5mm x 2 x 4 ft.

(1) bx 200 latex gloves & liners (0502 & 0501)

(1) jar Ply No.9 Gell Skin Protector

(1) pt Epo Cleanse, eqoxy hand cleaner

(1) Organic respirator face mask & filter

(10) Disposable filter masks (06985)

(2) 6-in. long rubber squeegee

(200) 8 oz. unwaxed epoxy cups No.8SN1

(100) 4 oz. unwaxed catalyst cups (444)

(100) 1 in. bristle brushes (150WPS-1)

(100) 2 in. bristle brushes (150WPS-2)

(1) pr scissors, Weiss model 20W

(1) Wood straight edge 1 x 4 x 72 in.

(1) Decimal tape measure, Stanley
No. 61-112

(1) bx 400 wood mixing sticks

(1) Disston Abrader No. 401C

(1) 5/8 counterbore with 1/4in. pilot & 10
in.shank

(4) rolls peel ply, 1 in.x 50 yd.

(4) rolls peel ply, 2 in.x 50 yd.

(1) roll safety wire, .041 x 25 ft.

(1) roll safety wire, .035 x 25 ft.

Note: Aircraft Spruce and Wicks catalogs list a large variety of composite-working tools.

THE FOLLOWING AIRFRAME KIT IS AVAILABLE FROM
EITHER OF THE TWO DISTRIBUTORS LISTED:

AIRCRAFT SPRUCE & SPECIALTY
P.O. BOX 424
FULLERTON, CA 92632
Telephone (714) 870-7551

WICKS AIRCRAFT SUPPLY
410 PINE STREET,
HIGHLAND, IL 62249
Telephone (618) 654-7447

CATALOG \$4 - REFUNDED WITH FIRST ORDER

NOTE: CR 8-3
CR 8-3(2) DRAIN VALVES, SAF-AIR CAV 110 OR CURTIS CCA 1510
CR 12-3(2) MS 20 71-BID UNIVERSALS

BASIC AIRFRAME KIT

SCREWS, C/S:

- (9) AN509-10R7 (MS24694S49)
- (2) AN509-10R8 (MS24694S50)
- (2) AN509-10R10 (MS24694S52)
- (6) AN509-10R12 (MS24694S54)
- (12) AN509-10R14 (MS24694S56)
- (4) AN509-10R28 (MS24694S70)
- (2) AN509-416R14 (MS24694S101)
- (2) AN509-416R18 (MS24694S105)
- (10) AN509-8R8 (MS24694S5)

SCREWS, B/H:

- (2) AN526-832R14
- (27) AN525-10R8
- (20) AN525-10R10
- (6) AN525-416R16

NUTS:

- (85) MS21042-3
- (72) MS21042-4
- (2) AN316-6
- (2) AN364-832 (MS20364-832)
- (1) AN365-524 (MS20365-524)
- (2) AN363-624
- (6) AN363-820

WASHERS:

- (90) AN960-10L
- (20) AN960-10
- (120) AN960-416L
- (4) AN960-616
- (10) AN960-816L
- (12) AN960-816
- (6) AN960-1016
- (2) AN970-3
- (11) AN970-4
- (2) AN970-5

NUT PLATES:

- (10) K1000-08 (MS21047-08)
- (22) K1000-3 (MS21047-3)
- (9) K1000-4 (MS21047-4)
- (2) MK1000-3 (MS21069-L3)
- (4) MK1000-4 (MS21069-L4)

COTTER PINS:

- (4) AN380-2-3 (MS24665-134)

RIVETS:

- (65) AN426AD3-3 (MS20426AD3-3)
- (50) AN426AD3-4 (MS20426AD3-4)
- (12) AN470AD4-5 (MS20470AD4-5)

PIPING AND CONDUITS:

- (4) No. 269-P 03 x 02 Brass Elbow
- (1) No. 0715-153 Polyethylene Tee
- (2) No. 0700-153 Polyethylene Adaptor
- (1) B44-3 Tygon Tubing .375 OD x .25 ID x 4 ft.
- (1) SK8201-3/16 Nylaflo Tubing .187 OD x .025 W x 60 ft.
- (1) AN815-6D Union
- (2) AN816-6D Nipple
- (8) AN818-6D Nut Coupling
- (8) AN819-6D Sleeve Coupling (MS20819-6D)
- (3) AN822-6D Elbow (MS20822-6D)
- (2) AN822-6-2 Steel Elbow (MS20822-6-2)

WHEELS/BRAKES/TIRES:

- (1) Set Cleveland 500 x 5 Wheels & Brakes *ALSO: ORDER 2 3/16" SPACERS*
- (2) 500 x 5 McCreary Tires, 6-ply rated *FLAM PROOF*
- (2) 500 x 5 McCreary Tubes
- (2) Rosenhan Master Brake Cylinders

MISCELLANEOUS: → 2 BID UNIVERSAL TUNING CR 5-1

- (2) RE4M6 or MM-6 with insert Rodend
- (2) AN210-2A Pulley
- (1) 970-F 0.04 x 32 x 34 in Fiber Frax
- (1) MS20001-P6 Hinge 72 in. long
- (1) MS20001-P6 Hinge 12 in. long
- (1) .35 OD x .05 wire x 30 in. tension spring
- (2) MS21919-DG11 Clamps
- (1) Gascolator, all metal with drain
- (1) 108HD-04 Fuel Valve

ELECTRICAL:

Due to various options, study Chapter 22
and order materials (aircraft grade) to suit.

Note: This list is complete only if you purchase all available
prefab parts. If you decide to build a prefab part, refer to its
drawing and order material and hardware as required. Do
obtain catalogs from all distributors. They contain photos of
available parts and a considerable amount of information on
hardware, components and use of them.

EPOXY:

- (1) qt. kit No.9935 5-min
- (13) gal Safe-T-Poxy II (2184/2410)
(RAES & RAEF are optional, but may cause
allergic reaction for some.)

RIGID FOAM:

- (2) pcs. Urethane (2 lb.) 1 x 24 x 48 in.
- (4) pcs. Urethane (2 lb.) 2 x 24 x 48 in.
- (5) pcs. Styrofoam (2 lb.) 7 x 14 x 41 in.
- (10) pcs. Styrofoam (2 lb.) 7 x 14 x 64 in.
- (5) pcs. Clark (18 lb.) 0.2 x 12 x 48 in.
- (1) pc. Clark (6 lb.) 0.25 x 24 x 48 in.
- (2) pc. PVC H100 (6 lb.) 0.25 x 34 x 37 in.
- (1) pc. PVC H100 (6 lb.) 1.0 x 6 x 10 in.
- (12) pcs. PVC H45 (3 lb.) 0.35 x 34 x 47 in.
- (5) pcs. PVC H45 (3 lb.) 0.75 x 26 x 47 in.

FIBERGLASS:

- (1) Roll (180 yds.) UND Tape 3 in. wide
- (160) yds. UND Cloth 0.009 x 38 in. (7715)
- (80) yds. BID Cloth 0.013 x 38 in. (7725)

FILLER MATERIAL:

- (2) lbs. Flocked cotton
- (4) gal. B23, 500 glass microballons

WOOD:

- (6) pcs. 0.25 x 1 x 105 in. Sitka Spruce
- (2) pcs. 0.4 x 0.7 x 60 in. Sitka Spruce
- (2) pcs. 0.7 x 0.7 x 105 in. Triangular Spruce
- (1) pc. 0.7 x 0.7 x 48 in. Triangular Spruce
- (1) pc. 0.7 x 1 x 30 in. Sitka Spruce
- (1) pc. 0.7 x 2 x 24 in. Sitka Spruce
- (1) pc. 0.75 x 1 x 10 in. Sitka Spruce
- (1) pc. 1 x 1 x 66 in. Sitka Spruce
- (1) pc. 1 x 2 x 14 in. Sitka Spruce
- (1) pc. 0.25 x 24 x 48 in. Birch 5-ply

EXTRUSIONS:

- (1) 6061T6 90 deg angle .25 x 2 x 2 x 24 in.
- (1) 2024T3 90 deg angle .125 x 1 x 1 x 60 in.
- (1) 2024T3 90 deg angle .125 x 1.5 x 1.5 x 6 in.

SHEET METAL:

- (1) 2024T3 90 deg angle .063 x 1.25 x 1.25 x 4 in.
- (1) 2024T3 0.125 x 2 x 60 in. alum. ext.
- (1) 2024T3 0.25 x 2 x 30 in. alum. ext.
- (1) 2024T3 0.016 x 34 x 36 in. alum.
- (1) 6061-0 0.020 x 20 x 24 in. soft alum.
- (1) 2024T3 0.063 x 6 x 8 in.
- (1) 2024T3 0.125 x 3 x 7 in.

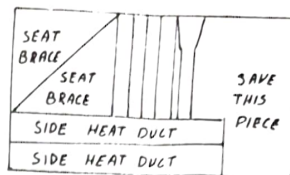
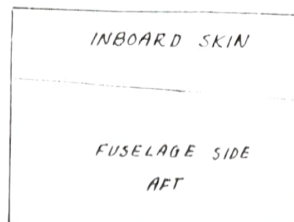
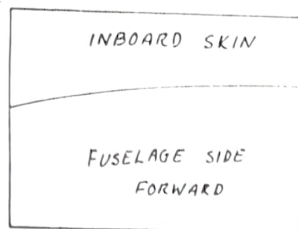
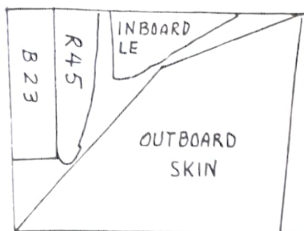
METAL TUBING AND ROD:

- (2) 6061T6 1.25 OD x 0.035 W x 62 in.
- (1) 6061T6 1.25 OD x 0.035 W x 32 in.
- (1) 6061T6 1.0 OD x 0.035 W x 10 in.
- (1) 6061T6 0.75 OD x 0.058 W x 18 in.
- (1) 6061T6 0.375 OD x 0.065 W x 6 in.
- (1) 1100-0 0.375 OD x 0.035 W x 25 ft.
- (1) 1100-0 0.25 OD x 0.035 W x 14 ft.
- (1) 4130N steel 0.625 OD x 0.058 W x 2 ft.
- (4) CR steel rod 0.375 OD x 3 ft.
- (1) Hard steel piano wire 3/32 OD x 12 in.

AIRFRAME BOLTS:

- (14) AN3-6A
- (6) AN3-7A
- (CR-83) 6421 AN3-10A
- (2) AN3-13A
- (2) AN3-14A
- (CR-8-3) 4421 AN3-15A
- (2) AN3-20A
- (4) AN4-5A
- (6) AN4-7A
- (7) AN4-10A
- (2) AN4-11A
- (2) AN4-13A
- (9) AN4-15A
- (12) AN4-16A
- (4) AN4-17A
- (8) AN4-22A
- (4) AN4-24A
- (4) AN4-25A
- (2) AN4-41A
- (1) AN5-41A
- (2) AN6-80A

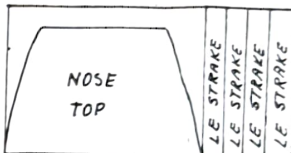
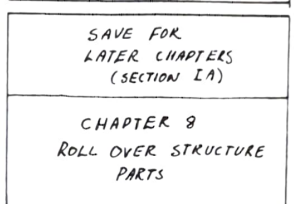
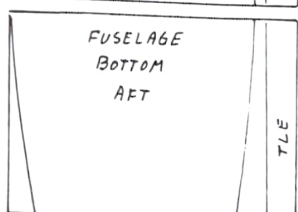
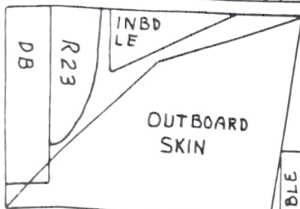
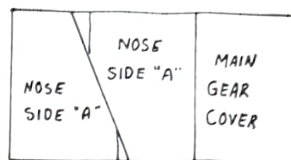
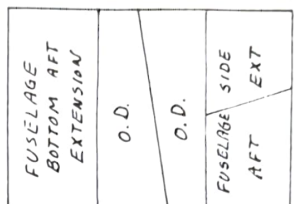
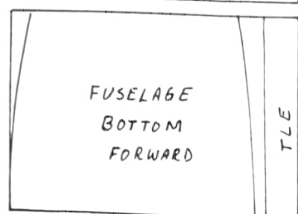
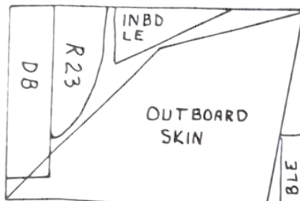
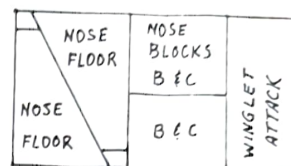
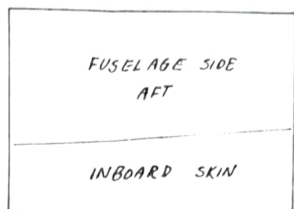
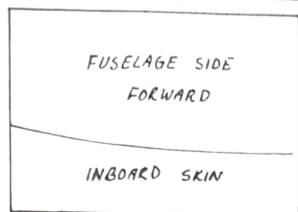
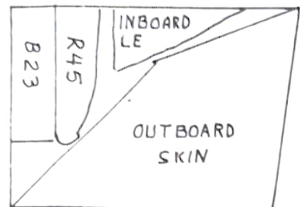
FOAM PARTS LAYOUT



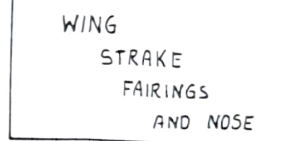
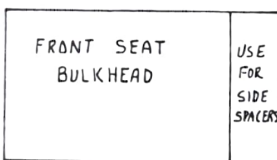
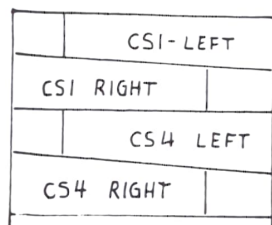
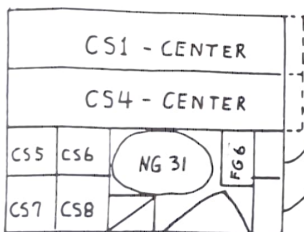
1 PC. 24" x 48" x 1/4" THICK

4.5# CLARK (WHITE)

5616 CR 14-4



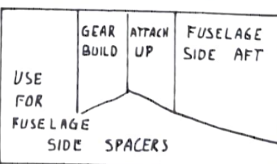
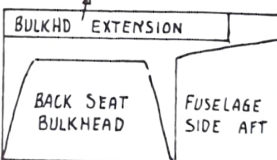
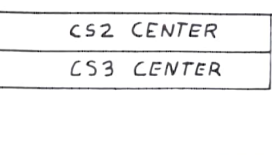
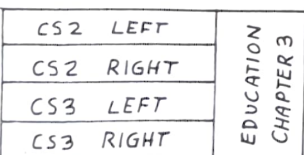
12 PCS. 34" x 47" x .35" THICK H45 PVC FOAM (PINK/TAN)



4 PCS. 24" x 48" x 2" THICK

URETHANE (TAN / GREEN)

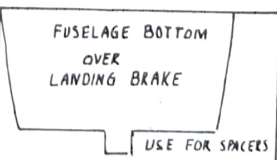
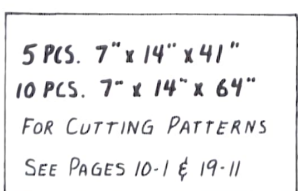
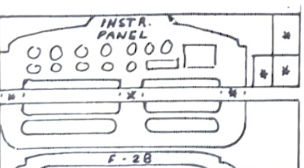
2 PCS. 34" x 37" x 1/4" THICK PVC (PINK/TAN)



1 PC. 6" x 10" x 1.0" THICK

R100 PVC (RED)

2 PCS. 24" x 48" x 1" THICK URETHANE (TAN / GREEN)



5 PCS. 7" x 14" x 41"

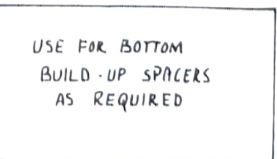
10 PCS. 7" x 14" x 64"

FOR CUTTING PATTERNS

SEE PAGES 10-1 & 19-11

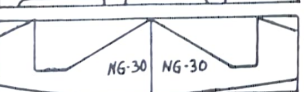
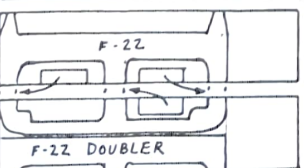
STYROFOAM BLOCKS

(BLUE / WHITE)



5 PCS. 26" x 47" x 3/4" THICK

PVC (PINK / TAN)



5 PCS. 12" x 48" x 0.2" THICK

CLARK (WHITE)

MATERIALS LIST BY CHAPTER

The materials listed here are the same as those included in the Bill Of Material summary. They are arranged by chapter in the manufacturing manual rather than by distributor. This list does not include tools, filler materials, (flox, microspheres) or jiggig materials. You will find this list handy to assure you have all appropriate parts before starting a major job, and will help you keep track of hardware.

Chapter 3: Education		
Prefab:	None	
Hardware:	None	
Glass:	(1.1)	yd. BID
	(0.1)	yd. UND
Epoxy:	(0.1)	gal.
Foam:	(1)	board ft. Urethane (tan)
Chapter 4: Fuselage Bulkheads		
Prefab:	None	
Hardware:	(6)	AN509-10R12 Screws
Glass:	(8)	yds. BID
	(5)	yds. UND
Epoxy:	(0.8)	gal.
Foam:	(12)	sq. ft. 3/4 in. thick H45 PVC
	(12)	sq. ft. 0.2 in. thick 18 lb. Clark
Wood:	(1)	pc. 24 x 48 x 1/4 in. birch plywood
Metal:	(1)	pc. 34 x 36 x 0.016 in. 2024T3 Alum.
Misc:	(1)	pc. 34 x 32 x 0.04 in.970-F Fiberfrax
Chapter 5: Fuselage Sides		
Prefab:	(2)	LMGA Assembly
Hardware:	(2)	AN6-80A Bolts
	(4)	AN4-16A Bolts
	(4)	AN4-17A Bolts
	(4)	AN4-24A Bolts
	(4)	AN4-25A Bolts
	(4)	AN960-616 Washers
	(32)	AN960-416L Washers
	(16)	MS21042-4 Nuts
Glass:	(2)	AN363-624 Nuts
	(9)	yd. UND
	(3)	yd. BID
Epoxy:	(0.8)	gal.
Foam:	(36)	sq. ft. 3/8 in.thick H45 PVC
	(12)	sq. ft. 3/4 in.thick H45 PVC
Wood:	(6)	pcs. 0.25 x 1 x 105 in. Spruce
	(2)	pcs. 0.7 x 0.7 x 105 in.Triangular
	(1)	pc. 0.7 x 0.7 x 48 in.Triangular
	(2)	pcs. 0.4 x 0.7 x 60 in. Spruce
	(1)	pc. 0.7 x 2.0 x 24 in. Spruce
	(1)	pc. 0.75 x 1 x 10 in. Spruce
	(1)	pc. 1 x 1 x 60 in. Spruce
	(1)	pc. 0.7 x 1 x 30 in. Spruce
Metal:	(24)	in. 0.25 x 2 x 2 in. 6061T6 Angle
Chapter 6: Fuselage Assembly		
Prefab:	(1)	NB Nosewheel Box Cover
Hardware:	(2)	MS21069-L3 Nutplates
	(4)	MS20426AD3-3 Rivets
	(2)	MS24694-552 Screws
Glass:	(10)	yds. BID
	(1)	yd. UND
Epoxy:	(0.8)	gal.
Foam:	(30)	sq.ft. 3/8 in. H45 PVC
	(12)	sq. ft. 3/4 in. H45 PVC
	(8)	sq. ft. 1/4 in. 4.5 lb. Clark
Metal:	(4)	sq. in. 0.0625 in.thick 2024T3 Alum.
	(4)	in. 3/8 x 0.065 in. wall 6061T6 Tube
Wood:		Scraps from firewall
Misc:	(1)	10811D-1/4 in. Fuel Selector Valve WEATHER HEAD 6749
Chapter 7: Fuselage Exterior		
Glass:	(17)	yds. UND
Epoxy:	(1.1)	gal.
Chapter 8: Roll Over Structure and Seat Belts		
Prefab:	(1)	Step
	(3)	Seat Belt/Shoulder Harness Ass'y
Hardware:	(6)	AN525-416R16 Screws
	(2)	AN509-416R18 Screws
	(2)	AN509-416R14 Screws
	(4)	AN4-5A Bolts
	(2)	AN4-10A Bolts
	(16)	AN960-416L Washers
	(2)	AN970-4 Washers
	(16)	MS21042-4 Nuts
	(4)	MS21069-L4 Nutplates
	(8)	MS20426AD3-3 Rivets
Glass:	(3.5)	yds. BID
	(0.5)	yd. UND
Epoxy:	(0.2)	gal.
Foam:	(7)	sq. ft. 3/8 in. H45 PVC
Metal:	(8)	in. 1/8 x 1 x 1 in. 2024T3 Alum.
	(16)	angle
		sq. in. 0.063 2024T3 Alum.
Wood:		Scraps from firewall

Chapter 9: Main Landing Gear and Landing Brake		
Prefab:	(1)	MG1-L 'S' Glass Main Gear Strut
	(1)	Set Cleveland 500 x 5 Wheels/Brakes
	(2)	Cleveland Axles, Spacers & Nuts
	(2)	McCreary Tires, 500 x 5, 6-ply rated
	(2)	McCreary Tubes, 500 x 5
Hardware:	(8)	AN4-22A Bolts
	(3)	AN525-10R8 Screws
	(10)	AN525-10R10 Screws
	(8)	AN960-416L Washers
	(13)	AN960-10L Washers
	(8)	MS21042-3 Nuts
	(8)	MS21042-4 Nuts
	(2)	90 deg.Nyloseal No. 269P Brass Fittings
Glass:	(5)	yds. BID
	(10)	yds. UND
Epoxy:	(0.8)	gal.
Metal:	(16)	sq. in. 0.063 2024T3 Alum.
	(5)	sq. in. 1/4 in. 2024T3 Alum.
	(4)	in. 0.063 x 1-1/4 x 1-1/4 in 2024T3 Alum. angle
Wood:		Scraps 1/4 in. plywood from firewall
Misc:	(12)	ft. 3/16 x 0.025 Nylaflo tubing
	(10)	in. MS20001-P6 Alum. Hinge
Chapter 10: Canard Construction		
Prefab:	(2)	CLT, Canard Lift Tabs
Hardware:	(6)	AN4-7A Bolts
	(6)	AN960-416L Washers
	(6)	K1000-4 Nutplates
	(12)	AN426AD3-4 Rivets
Glass:	(20)	yds. UND
	(4)	yds. BID
Epoxy:	(1.1)	gal.
Foam:	(2)	Part of 7 x 14 x 41 Styrofoam
	(2)	Part of 7 x 14 x 64 Styrofoam
	(60)	sq. in. 1 in.thick R100 PVC
Metal:	(9)	sq. in. 1/8 in. 2024T3 Alum.
Chapter 11: Elevators		
Prefab:	(7)	CS2 Hinges with Bushings
	(9)	CS3 Brackets
	(4)	CS9 Plugs
	(2)	CS10 Lead Weights
	(2)	CS11 Lead Weights
	(2)	CS12 Belcranks with Bushings
	(1)	PTB Belcrank
Hardware:	(7)	AN525-10R10 Screws
	(2)	AN3-6A Bolts
	(4)	AN3-15A Bolts
	(4)	AN3-14A Bolts
	(9)	AN509-10R7 Screws
	(4)	AN509-10R14 Screws
	(22)	AN960-10L Washers
	(28)	MS21042-3 Nuts
	(2)	AN470AD4-5 Rivets
Glass:	(3)	yds. UND
Epoxy:	(0.1)	gal.
Foam:	(2)	Part of 7 x 14 x 64 Blocks Styrofoam
Metal:	(2)	62 in. x 1-1/4 x .035 W 6061T6 Al. Tube
	(1)	32 in. x 1-1/4 x .035 W 6061T6 Al. Tube
Chapter 12: Canard Installation		
Prefab:	(2)	CN1 Alum. Bushing
	(2)	CN2 Steel Bushing
Hardware:	(2)	AN4-13A Bolts
	(2)	AN3-20A Bolts
	(2)	AN960-416L Washers
	(2)	AN970-4 Washers
	(2)	K1000-4 Nutplates
	(4)	AN426AD3-3 Rivets
Glass:		Scraps BID
Epoxy:	(0.1)	gal.

Chapter 13: Nose and Nose Gear

Prefab:	(1)	NG1-L 'S' Glass Strut
	(1)	SC Fiberglass Strut Cover
	(1)	Worm Drive Retraction Ass'y
	(1)	LST Shock Strut
	(1)	NG3 Bracket
	(1)	NG4 Bracket
	(1)	NG6 Assembly
	(1)	NG8 Plates
	(1)	NG401A Castoring Nosegear Ass'y
	(2)	CS13 Bushings
Hardware:	(1)	ea CZRPL1 & 2, & CZRPR1 & 2
	(3)	AN525-10R10 Screws
	(2)	AN526-832R14 Screws
	(8)	AN509-10R14 Screws
	(4)	AN509-10R28 Screws
	(3)	AN4-10A Bolts
	(1)	AN4-15A Bolts
	(2)	AN4-41A Bolts
	(1)	AN5-41A Bolts
	(2)	AN3-6A Bolts
	(2)	AN3-7A Bolts
	(2)	AN3-10A Bolts
	(2)	K1000-3 Nutplates
	(2)	AN364-832 Nuts
	(21)	MS21042-3 Nuts
	(6)	MS21042-4 Nuts
	(1)	AN365-524 Nut
	(2)	AN316-6 Nuts
	(16)	AN960-10 Washers
	(2)	AN970-3 Washers
	(7)	AN970-4 Washers
Glass:	(2)	AN970-5 Washers
	(4)	AN426AD3-3 Rivets
	(10)	AN509-8R8 Screws
	(10)	K1000-08 Nutplates
	(20)	AN426AD3-4 Rivets
	(10)	yds. BID
	(8)	gal.
	(14)	sq. ft. 2 in. Thick Urethane
	(4.5)	sq. ft. 0.2 in thick 18 lb. Clark
	(1)	2.5 x 3 x 1/8 in. 2024T3 Alum.
Metal:	(4)	ft. 1/4 in. ODx.035 W 1100-0 Al. tube
	(24)	in. 5/8 in. ODx.058 W 4130 Stl. tube
Misc:	(4)	ft. 3/8 in. ODx 1/4 in. ID Tygon tube
	(1)	0715-153 tee
	(2)	0700-153 adaptors
	(2)	MM-6 rods with bushings or RE4M6

Chapter 14: Centersection Spar

Hardware:	(8)	AN4-15A Bolts
	(8)	AN4-16A Bolts
	(32)	AN960-416L Washers
	(16)	MS21042-4 Nuts
Glass:	(11)	yds. UND
	(8)	yds. BID
	(50)	yds. 3 in. wide UND Tape
Epoxy:	(2)	gal.
	(10)	sq. ft. 1/4 in. thick H100 PVC
Foam:	(10)	sq. ft. 1 in. thick Urethane
	(36)	in. 1/8 x 1 x 1 in. 2024T3 Al. Angle
	(30)	in. 1/8 x 2 in. 2024T3 Al. Bar
	(12)	in. 1/4 x 2 in. 2024T3 Al. Bar
Wood:	(14)	in. 1 x 2 in. Spruce
	(6)	in. 1 x 1 in. Spruce

Chapter 15: Firewall and Accessories

Prefab:	(2)	CS15 Belcrank with bearing
	(4)	CS71 Brackets
	(2)	CS72 Brackets
	(2)	CS75 Bushings
	(2)	BA Brake Arms
	(10)	AN3-6A Bolts
Hardware:	(4)	AN3-7A Bolts
	(2)	AN509-10R8 Screws
	(2)	AN4-10A Bolts
	(2)	AN4-11A Bolts
	(34)	AN960-10L Washers
	(18)	AN960-416L Washers
	(22)	MS21042-3 Nuts
	(4)	MS21042-4 Nuts
	(4)	AN380-2-3 Cotter Pins
	(2)	AN210-2A pulleys
Misc:	(2)	Rosenhan Master Brake Cylinders
	(2)	Nyloseal No. 269-P Elbows
Metal:	(6)	1/8 x 1 x 1-1/2 in. 2024T3 extr. Al. angle

Chapter 16: Control System

Materials: See Section 1A

Chapter 17: Pitch Trim and Roll Trim

Materials: See Section 1A

Chapter 18: Canopy

Materials: See Section 1A

Chapter 19: Wings and Ailerons

Prefab:	(12)	LWA9 Bushings
	(2)	A2 Brackets
	(4)	A5 Brackets
Hardware:	(12)	AN960-816 Washers
	(10)	AN960-816L Washers
	(6)	AN363-820 Nuts
	(14)	AN525-10R8 Screws
	(14)	AN960-10L Washers
	(14)	K1000-3 Nutplates
	(28)	AN426AD3-3 Rivets
	(70)	yds. 3 in. wide UND tape
	(56)	yds. UND
	(9)	yds. BID
Foam:	(10)	7 x 14 x 64 in. Styrofoam Blocks
	(4)	7 x 14 x 41 in. Styrofoam Blocks
Epoxy:	(4)	gal.
Metal:	(1)	3 x 10 x 0.016 in. 2024T3 Al.
	(24)	in. 1/8 x 2 in. 2024T3 Al. Bar
	(12)	in. 1/4 x 2 in. 2024T3 Al. Bar
	(18)	in. 3/4 x .058 W 6061T6 Al. Tube
Misc:	(3)	ft. MS20001-P6 Hinge
	(4)	3 ft. x 3/8 in. dia. cold rolled steel
	(25)	ft. 3/16 OD x .025 W Nylaflo tube

Chapter 20: Winglets and Rudder

Prefab:	(2)	CS301 Steel Belhorn
Hardware:	(10)	AN525-10R8 Screws
	(6)	AN960-10L Washers
	(4)	MS21042-3 Nuts
	(6)	K1000-3 Nutplates
	(12)	AN426AD3-3 Rivets
Glass:	(10)	yds. UND
	(6)	yds. BID
Epoxy:	(1)	gal.
Metal:	(10)	in. 1 in. x .035 W 6061T6 Al. Tube
	(16)	in. MS20001-P6 Hinge
	(2)	4 x .35 x .05 steel springs
	(10)	in. 3/32 in. steel piano wire

Chapter 21: Strake (Fuel and Baggage) - C-2 8-3 REQUIRE 2 DRAIN VALVES

Prefab:	(2)	SB Glass sump blisters
	(2)	FT 18 Fuel Cap Assembly
	(2)	3/8 OD x 3/16 ID x .7 in. spacer
Hardware:	(2)	AN3-13A Bolts
	(2)	MS21042-3 Nuts
	(2)	MS21919-DG11 Clamps
	(2)	AN816-6D Nipple
	(8)	AN818-6D Nut Coupling
	(8)	AN819-6D Sleeve Coupling
	(3)	AN822-6D Elbow
	(1)	AN815-6D Union
	(2)	AN822-6-2 Steel Elbow
Glass:	(14)	yds. UND
	(9)	yds. BID
Epoxy:	(1.7)	gal.
Foam:	(70)	sq. ft. 3/8 in. thick H45 PVC
	(2)	sq. in. 1/8 in. 2024T3 Alum.
Metal:	(25)	ft. 3/8 in. OD x .035 W 1100-0 Al. Tube
	(10)	ft. 1/4 in. OD x .035 W 1100-0 Al. Tube
Misc:	(1)	Gascolator, all metal
	(1)	EFP Electric Fuel Pump

Chapter 22: Electrical

Note: Due to the various options, this bill of materials does not include electrical items. Order to suit (but use aircraft grade materials).

Chapter 23: Engine Installation

Prefab:	(1)	CZCT Cowling, Top
	(1)	CZCB Cowling, Bottom
Glass:	(3)	yds. BID
Epoxy:	(.2)	gal.
Metal:	(1)	pc. 20 x 24 x .020 6061-0 soft Al.

Chapter 24: Covers, Fairings, & Consoles

Materials: See Section 1A

Chapter 25: Finishing

Materials: See Section 1A

Chapter 26: Upholstery

Materials: See Section 1A

C2 5-1 Misc. ADD 2 BID UNIVERSAL JOINTS.

CHAPTER 3

EDUCATION

DON'T SKIP THIS SECTION. Every hour you spend in this preparation section will save you five when you really start building your aircraft.

GENERAL

In this section you won't build any part of your airplane. What you will do is learn how to build your airplane the right way. This construction technique is radically different from anything you've done before (including building boats, surfboards, airplanes, and go-carts), and you should assume there is only one correct way to do it. We've discovered lots and lots of wrong ways of doing things and have written the plans to keep you from repeating our mistakes. We insist that you do things our way. If you have a better idea, suggest it to us, we'll test, and if it really is a better idea we'll publish details in the **COZY NEWSLETTER**.

This section will teach you all of the techniques required to build your airplane, show you what special tools you need and how to use them. The educational samples that you will build in this section are designed to give you experience and confidence in all of the techniques that you will use in the construction of your airplane. The steps in construction of each sample are arranged in sequence (as are the steps in construction of the actual aircraft parts) and you should follow the sequence without skipping any steps. You will learn the basic glass layup technique used throughout the aircraft, special corner treatments, foam shaping/cutting, and joining methods. A summary of these techniques is provided on a separate sheet for you to tack up on your shop wall.

TOOLS

There are certain tools which are necessary to complete the aircraft. Three lists of tools are provided here. The first is the absolute bare minimum required, sacrificing efficiency; the second is a recommended list for the best compromise of cost and work efficiency; the third is a list for the Cadillac of shops where ease of construction is more important than money. The non-common items are stocked by the COZY distributors.

1. Basic Required Tools

Common household butcher knife
Coping saw
1/4 in. drive socket set
Small open-end wrenches
Sandpaper 36-grit and 320-grit, carborundum Aloxite
Fastcut (50 sheets), also 220-grit and 320-grit wet or dry silicon carbide (20 sheets each)
Disston Abrader No. 401-C - Tool for carving fiberglass.
5/8 in. conterbore with 1/4 in. pilot; 10-inch long shank
12 in. long, 1/4 in. dia. drill bit.
Peel-Ply
2 in. dia. drill sander (coarse) for 1/4 in. drill
Pliers
1 in. putty knife
Hacksaw
Blade & Phillips screwdriver
Box of single-edge razor blades
24 in. and 48 in. carpenter's level
Carpenter's square
Felt marking pens
3-ft. straightedge
200 eight-oz. paper cups (Lily 85N1)
50 3-oz. paper cups (unwaxed)
12-ft. decimal steel tape (Stanley No. 61-112)
1/4 in. drill with No. 30, No. 3, No. 10, 1/4in., No. 3, 15/64in., No. 12, and No. 21 bits
No. 10-32 and 1/4-28 taps
Roll of grey duct tape
1 in. & 2 in. paint brushes (100 each)
6 in. plastic or rubber squeegees
Scissors
Wire brush
Pop rivet puller
Homemade balance for ratioing epoxy
Wall thermometer 50-100 degrees F
1/4 in. hand drill
Approximately 150 lbs. weights in 5 or 10 lb. pieces

2. Recommended Tools (in addition to those above)

Dremel-type miniature high-speed hand grinder with saw and router bits
6 in. to 9 in. disc-type hand sander
Set of 1/4 in., 1/2 in. & 1 in. chisels (wood)
Small set of X-Acto knives
1/2 in. dia. 100 degree counter sink (piloted)
6 in. machinist steel ruler
X-Acto razor saw

Box of wood tongue depressors to mix epoxy
6-ft. straightedge
Cheap holesaw set or flycutter
3/8 in. variable-speed hand drill
12 in. long drill bits - No. 10 & 1/4 in.
Hand broom/brush
Large commercial 12 in. scissors (Wiss No. 20W)
Sabersaw
Bench-mounted belt sander
Stanley surform plane
Square & half round file
Several 6 in. C-clamps
Vacuum cleaner (shop type)
10 in. 18 tooth/inch handsaw

3. For the First Class Shop (in addition to those above)

Drill press
18-inch bandsaw
Vernier Caliper
Epoxy ratio pump (Michael Engineering dispenser)
90 degree drill adapter
Air compressor with blow nozzle
Orbital sander
3/8 in. & 1/2 in. spotface
Drill sets No. 1 to No. 60 and 1/16 - 1/2 (1/64 incr.)

4. Items Used Only Occasionally & Can Be Borrowed

Nicopress sleeve tool
1 dozen 1/8 in. Clecos
Hotwire voltage control

The following tools are ones you make:

Sanding Blocks

These are required in many areas during construction and for finishing. You may also use a 'soft block,' which is a block of the blue styrofoam wrapped with sandpaper.

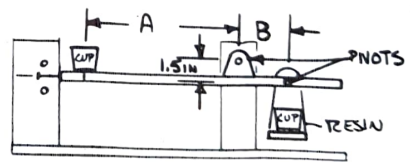
A lot of elbow grease is saved if you replace the sandpaper often.

Long Straightedge

This is not absolutely required, but is quite handy when jiggling or checking the straightness of flying surfaces. It is merely a 6-ft. or 8-ft. 1x3 or 1x4 piece of lumber that is hand-selected to be 'eyeball straight.' You can get it one of two ways: (1) Order it from Aircraft Spruce or Wicks—they plane them perfect from dry lumber. (2) Sort through the lumber (dry fir or redwood) at your local lumber yard until you find one that looks straight when you eyeball it from one end. Mark it and hang it on the wall so it doesn't end up as part of a shelf!

Epoxy Balance

Devices which automatically ratio the correct amount of resin and hardener and dispense it with the pull of a lever are available from COZY distributors for approximately \$130. These save time and epoxy. You can ratio the epoxy the way we did in building the prototype by building the following simple balance:



Balance Dimensions

	A inch	B inch	Parts Hardner for 100 parts Resin
RAE System	13.7	3	22
SAF-T-Poxy	13.95	6	43

Cut out the 5-step instructions and glue to your balance--don't skip steps! Follow each step exactly every time you mix epoxy:

1. Place both empty cups as shown (wet the hardener cup).
2. Adjust ballast weight to level mark.
3. Fill resin cup with desired amount of resin--1 to 6 oz.
4. Add hardener to hardener cup to balance scale on level mark.
5. Pour the hardener into the resin cup and mix.

RATIO BALANCE FOR RESIN/HARDENER

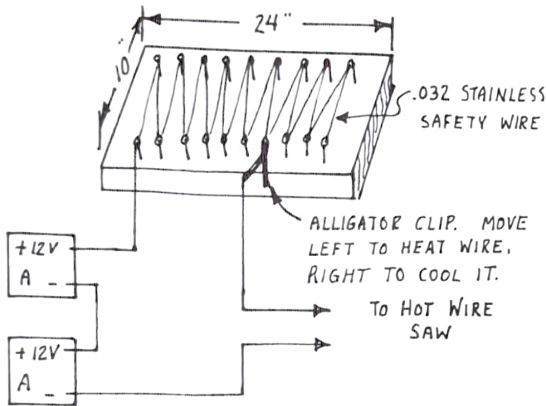
1. Place both empty cups as shown (wet the hardener cup).
 2. Adjust ballast weight to level mark.
 3. Fill resin cup with desired amount of resin--1 to 6 oz.
 4. Add hardener to hardener cup to balance scale on level mark.
 5. Pour the hardener into the resin cup and mix.
- Cut the instructions out and glue them to your balance.

A quick check of your home-made balance can be made by putting an empty resin cup at the resin location, an empty hardener cup at the hardener location, moving the sliding weight until the arm balances between its two stops, and then putting 100 nails in the resin cup and 22 nails (all the same size) in the hardener cup (for the RAE System). If your dimensions are correct, the arm should balance in the same place. If your dimensions are slightly off, mark a new location for the hardener cup so the arm balances correctly.

Hot Wire Cutter

You will need a hot wire cutter to carve all the foam cores for the canard, winglets, and wings. Refer to sketch.

The Variable Voltage control can be obtained from a COZY distributor, or you can substitute any controllable power supply to include the 14 to 20-volt range with at least 4 amp capability. An alternative is to borrow two 12-V battery chargers or auto batteries and lash up the following device.



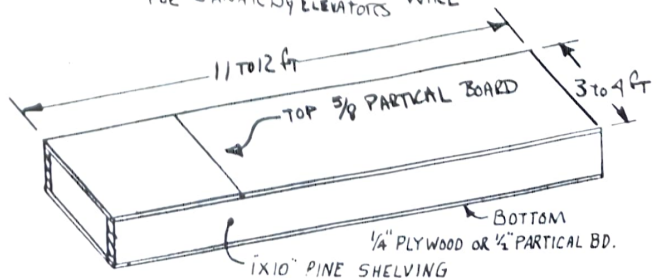
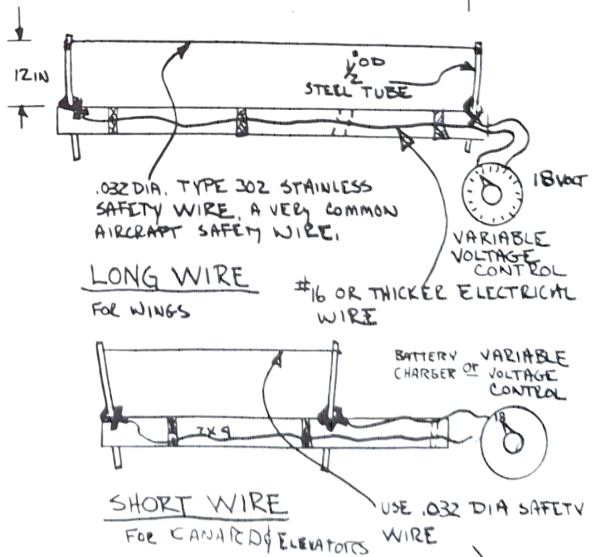
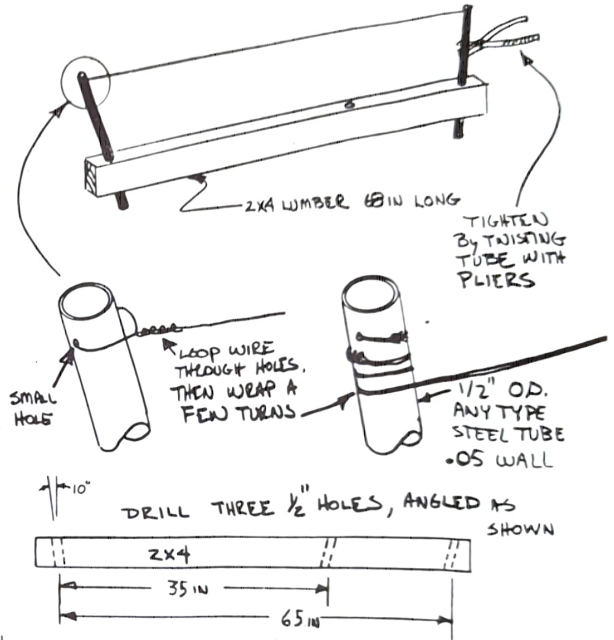
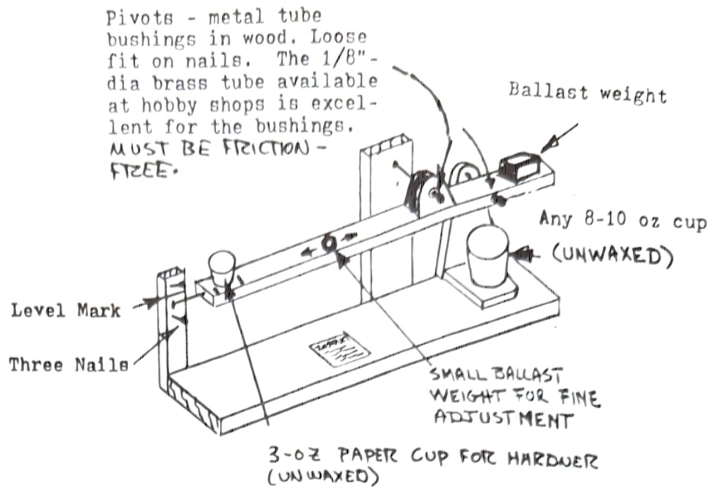
The (A) blocks represent either a battery or a 12-V DC battery charger with 4-amp capability.

The cutter should only be used on the blue or white styrofoam. A hazardous gas is emitted if you try to cut urethane.

You can substitute .025 nichrome wire which can be run at a lower current (about 2 amp) but nichrome wire is difficult to find. Adjust the current to obtain a wire temperature which will allow the wire to cut the foam at a rate of one inch every four to six seconds when pulled with a light load (less than 1/2 pound). This can be checked with a small scrap of foam. If temperature is correct, foam will have a smooth hairy surface. A cratered surface means too much heat. If the wire is too cold, the cutter will have to be forced hard, causing the wire to lag. Lag should not exceed 1/2 inch over the top and bottom of the wing and not over 1/8 inch around the leading edge. If the wire is too hot, it will burn away too much foam, making the part too small and will result in ruts in the foam if the wire is inadvertently stopped during cutting. The wire should be tightened until the wire starts to yield. Check this by tightening the wire while plunking it listening to the sound. The pitch will increase until the wire yields.

Jig Table

You will need a table to jig and build the wings and canard. It should be at least 3 ft. by 11 ft. Any larger than 4 ft. by 12 ft. will just get in the way. Use a little care in making a flat, untwisted surface. The following is a sketch of the one we made and it works fine. The box design makes it stiff in torsion. Set it up with the top 35 to 39 inches above the floor. Don't get carried away with surface finish, since you are going to be gluing blocks to it with Bondo and chiseling them off several times.



MATERIALS

The materials, processes, and terminology used in the construction of your **COZY** are new to homebuilding. This section is devoted to familiarizing you with the language, materials, and techniques used in these plans. This information is basic to the construction of your airplane. You should study this section and be sure that you understand all of it before continuing.

There are five basic materials that you will be working with: Fiberglass cloth, epoxy, microspheres, flox, and foam. Each material, its properties, and uses will be discussed in detail. Basic processes using these materials will also be discussed.

Glass

The most basic structural material in your **COZY** is glass cloth. Glass cloth is available commercially in hundreds of different weights, weaves, strengths, and working properties. The use of glass in aircraft structures, particularly structural sandwich composites, is a recent development. Very few of the commercially available glass cloth types are compatible with aircraft requirements for high strength and light weight. Even fewer are suitable for the hand-layup techniques developed by RAF for the homebuilder. The glass cloth used in the Long-EZ and **COZY** has been specifically selected for the optimum combination of workability, strength, and weight.

The glass cloth in your **Cozy** carries primary loads, and its correct application is of vital importance. Even though doing your glass work correctly is important, this doesn't mean that it is difficult; in fact it's *VariEze*!

Two types of glass cloth are used, a bi-directional cloth (**RA5277BID**), and a unidirectional cloth (**RA5177UND**). (Use the full part number for ordering your cloth, but for simplicity, the plans will use only the **BID** or **UND** designations.) **BID** cloth has half of the fibers woven parallel to the selvage edge of the cloth and the other half at right angles to the selvage, giving the cloth the same strength in both directions. The selvage is the woven edge of a bolt of fabric as shown in the accompanying sketch.

UND cloth has 95% of the glass volume woven parallel to the selvage giving exceptional strength in that direction and very little at right angles to it.

BID is generally used as pieces which are cut at a 45-degree angle to the selvage and laid into contours with very little effort. **BID** is often applied at 45-degree orientation to obtain a desired torsional or shear stiffness. **UND** is used in areas where the primary loads are in one direction, and maximum efficiency is required, such as the wing skins and spar caps.

Multiple layers of glass cloth are laminated together to form the aircraft structure. Each layer of cloth is called a ply and this term will be used throughout the plans.

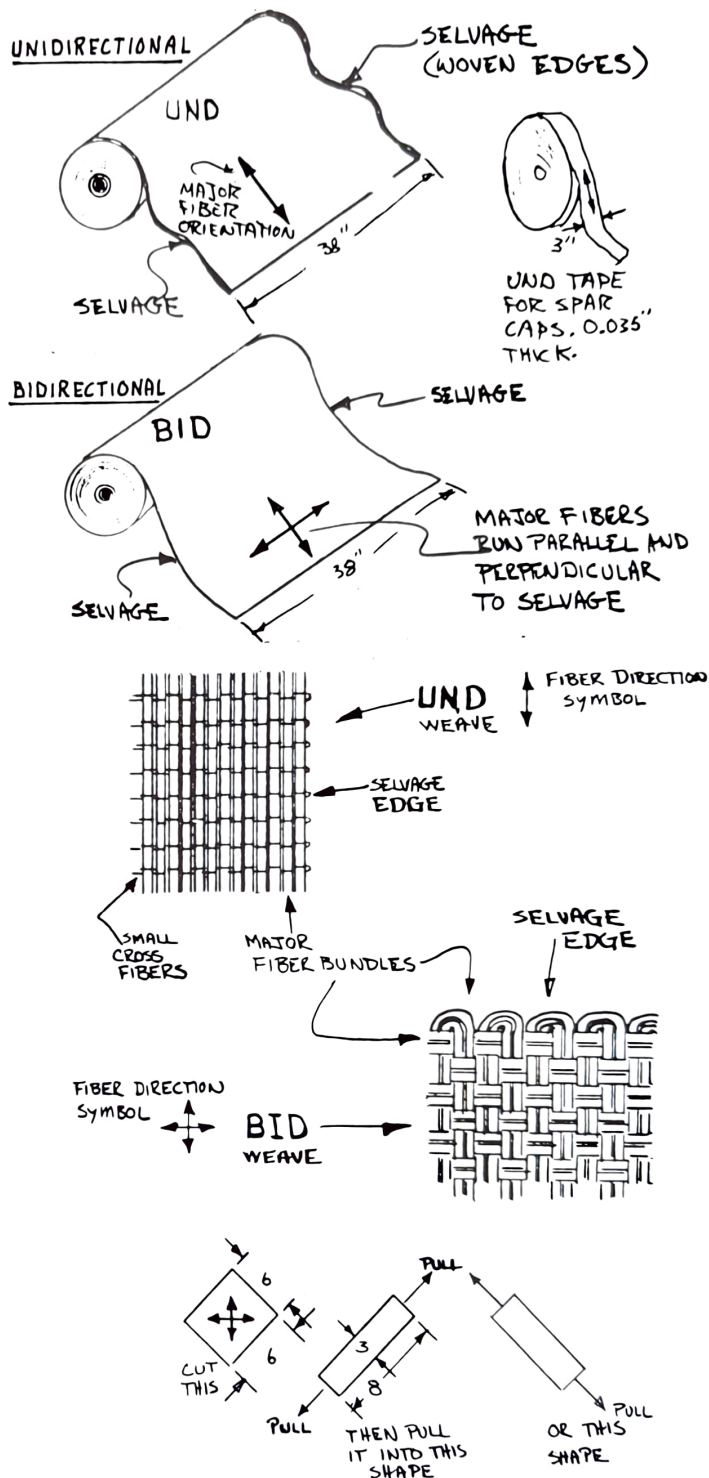
Marking and cutting the plies of glass cloth is a job that you will repeat often in the construction of your **COZY**. Glass cloth should be stored, marked and cut in a clean area with clean hands and clean tools. Glass contaminated with dirt, grease, or epoxy should not be used. A clean, smooth surface is needed for marking and cutting. The area used for storing and cutting glass cloth should be separated from the aircraft assembly area because it will be exposed to foam dust, epoxy, and other things which can contaminate the cloth. You will need a good sharp pair of scissors, a felt-tipped marker, a fairly straight board, and a tape measure for marking and cutting. The small amount of ink from marking and numbering plies has no detrimental effects on the glass cloth.

In each step the size, type, and fiber orientation of each ply is given. Take the list to your glass cutting table, roll out a length of the appropriate cloth, straighten the selvage, mark all of the plies, and cut them.

Now is a good time to stop reading long enough to go and cut a square ply of **BID** and see how easy it is to change its shape by pulling and pushing on the edges as shown in the sketches. cut a square with the fibers running at 45 degrees and pull on the edges to shape the piece.

It helps if you make fairly straight cuts but don't worry if your cut is within 1/2 inch of your mark. As you cut **BID** it may change shape, just as the square ply that you are experimenting with does when you pull on one edge. Plies that distort when cut are easily put back into shape by pulling on an edge. Rolling or folding cut plies will help keep them clean and make it easier to maintain their shape. If several plies are called for, it may help to number them before cutting. Save your clean scraps and make an effort to use them for smaller pieces. If the cloth is spotted with epoxy, throw it away.

When cutting long strips or large pieces of 45 degree **BID**, always roll or fold it so it keeps its shape when handled.



When it's applied it can be set on one end of the part and rolled onto it. If you pick up each end, it will distort and not fit the part properly.

The fiber orientation called for in each materials list is important and shouldn't be ignored. **UND** is characterized by the major fiber bundles running parallel to the selvage and being much larger than the small cross fibers which run at right angles to the selvage. In **BID** the cross fibers are the same size as those running parallel to the selvage, giving **BID** an even checker board appearance. **BID** is commonly used for plies cut at 45 degrees to the selvage. Your tailor would call this a bias cut. The 45 degree cut makes it easy to work wrinkles out of a ply locally, without having to chase it to the far edge. The 45 degree cut also makes it possible to make a ply slightly longer than originally cut by pulling on the ends or wider by pulling the sides. The 45 degree orientation isn't critical; you don't need to measure it. Your eyeball of a rough diagonal (45 degrees $\pm$ 10 degrees) is adequate when either cutting or laying up the cloth.

Epoxy

In recent years the term epoxy has become a household word. Unfortunately epoxy is a general term for a vast number of specialized resin/hardener systems, the same as aluminum is a general term for a whole family of specialized metal alloys. Just as the aluminum in the spar of a high performance aircraft is vastly different from the aluminum pots and pans in the kitchen, the epoxy in your COZY is vastly different from the hardware store variety.

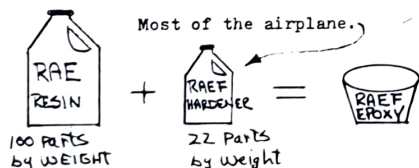
Epoxy is the adhesive matrix that keeps the plies of load-carrying glass cloth together. Epoxy alone is weak and heavy. It is important to use it properly so that the full benefits of its adhesive capability are obtained without unnecessary weight. A large portion of your education in composite structural work will be spent learning how to get the full strength of an epoxy/glass mixture with the minimum weight. This section will discuss the terminology and techniques for working with epoxy resin and its hardener.

An epoxy system is made up of a resin and a hardener tailored to produce a variety of physical and working properties. The mixing of resin with its hardener causes a chemical reaction called curing, which changes the two liquids into a solid. Different epoxy systems produce a wide variety of solids ranging from extremely hard to very flexible. Epoxy systems also vary greatly in their working properties, some are very thick, slow pouring liquids and others are like water. Some epoxy systems allow hours of working time and others harden almost as fast as they are mixed. A single type of resin is sometimes used with a variety of hardeners to obtain a number of different characteristics. In short, there is no universal epoxy system; each has its own specific purpose and while it may be the best for one application, it could be the worst possible in another use.

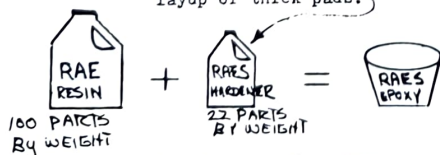
The RAE-type epoxy systems used in the construction of your COZY are tailored for the best combination of workability and strength, as well as to protect the foam core from heat damage and solvent attack. These systems are also low in toxicity (SPI-2) to minimize epoxy rash. These epoxies are not similar to the common types normally marketed for fiberglass laminating. Three different systems are used in the COZY for three different types of work: a slow curing system, a fast curing system, and a 5-minute system. The very fast curing (5-min.) system is used much like clecos are used in sheet metal construction (or clamps in woodwork) for temporary positioning. Five-minute is also used in some areas where high strength is not required, but where a fast cure will aid assembly.

As an epoxy system cures, it generates heat and in some areas, the heat buildup of a medium or fast curing epoxy system is unacceptable. Where this is a potential problem, a slow curing system is used. Slow cure epoxy is always used with styrofoam, where heat can melt the foam away and ruin the joint. In other areas where heat buildup isn't a problem and a faster cure is desirable, a fast curing system is used. Both the fast and slow cure epoxies will cure to a firm structure at room temperature within one day. Complete cure takes 14 days.

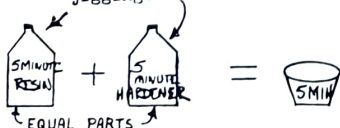
The RAF epoxy systems are called **RAES** (for slow curing), **RAEF** (fast curing), and **5-MIN.** Both the **RAES** and **RAEF** hardener use the same RAE resin.



Any place where exotherm can cause damage - Bonding large foam blocks or layup of thick pads.



Any foam bonding where parts are small & the fast cure allows the next step to be done soon. Also used as a temporary joint for jiggling.



Note: If working conditions are hot (85° to 90°F), **RAES** can be used where **RAEF** is called out. While this practice is allowable, the best results are obtained working between 70 and 80°F with the specified epoxy.

The working and strength characteristics of an epoxy system are dependent on the resin, the hardener, and on the amount of each in a given mixture. Epoxy systems are engineered for a specific ratio of resin and hardener. It is quite important that the proper mixture be obtained. An accurate balance or ratio pump must be used to accomplish this. A drawing of an inexpensive ratio balance is included in these plans. The mix ratio accuracy is particularly important with **RAEF** & **RAES**. The 5-MIN can be adequately ratioed by merely pouring a blob of part A in a cup and adding a blob of part B that looks the same volume before mixing. Never eyeball estimate, **RAEF** or **RAES**, always carefully use the balance or pump.

Epoxy resin and hardener are mixed in small batches, usually 6 ounces or less, even in the largest layup. The reason for small batches is that, in large batches, as the hardening reaction progresses, heat is generated which speeds the reaction, which causes even more heat, which ends up in a fast reaction called an exotherm. An exotherm will cause the cup of epoxy to get hot and begin to thicken rapidly. If this occurs, throw it away and mix a new batch. The small volume batch avoids the exotherm. For a large layup, you will mix many small batches rather than a few large ones. With this method you can spend many hours on a large layup using epoxy that has a working life of only a few minutes. If the epoxy is spread thin as in a layup its curing heat will quickly dissipate and it will remain only a few degrees above room temperature. However, in a thick buildup or cup, the low surface area to mass ratio will cause the epoxy to retain its heat, increasing its temperature. This results in a faster cure causing more heat. This unstable reaction is called an exotherm. Exotherm temperatures can easily exceed the maximum allowable for foam (200 degrees F) and damage the foam-to-glass bond. This is why the slow epoxy system is used in joining foam cores as exotherm is impossible as long as epoxy joint thickness is less than 1/8 in.

Unwaxed paper cups are used for mixing and ratioing resin and hardener. Convenient 8-oz. cups for resin are available from COZY distributors. The hardener cups are the 3-oz. unwaxed bathroom paper cups available at any grocery store. Don't use waxed cups; the wax will contaminate your epoxy.

If you are using the homebuilt balance, follow this procedure. Place the resin (8 oz.) cup on the right cradle. The resin cup can be either a new clean cup, one with a little uncured epoxy left in the bottom, or a clean cup from a previous layup with hard epoxy in the bottom (smooth, not lumpy). Now, take a clean 3-oz. hardener cup—pour a splash of hardener into it then scrape the hardener back into the container. This gives the hardener a wet surface, so its remaining hardener will not be counted in the balancing. Now, place the wet hardener cup on the scale, check that it swings freely and balance it perfectly by moving the small weight. Epoxy is then poured into the 8 oz. cup (6 oz. or less). Hardener is then poured into the 3-oz. cup at the other end of the balance until the arm is level. When ready to mix, pour the hardener into the resin cup and mix completely. If you have the ratio pump, you simply put one cup under the spout, pump out the amount that you want and mix.

Mixing is done by stirring with a stick, being careful not to spill any. If you spill part of an unmixed cup, the ratio of resin and hardener may be inaccurate and it shouldn't be used. Mix each cup for at least two minutes. You should spend 80% of your mixing time stirring the cup and 20% scraping the sides to assure complete mixing. **Do not** mix with a brush. The bistles can soak up the hardener, changing the ratio. Use a tongue depressor or wood stick.

The working temperature has a substantial effect on the pot life and cure time. Very hot conditions will cause the cure to speed up. In cold working conditions the cure will be delayed and if it is cold enough, epoxy may not cure at all. Working temperatures must be between 65 degrees and 95 degrees F. A range of 75 to 85 degrees F is best. Be sure to get a wall thermometer (approx. \$1.50 at any general store) to check the temperature of your work area. At 75 degrees F, 5-min. must be used within four minutes, **RAEF** must be used within 20 minutes and **RAES** must be used within 50 minutes.

Cold epoxy results in increased time required to do a layup, since it takes longer to wet and to squeegee the cloth. A layup at 65 degrees may take almost twice the time as at 75 degrees F. On most layups (except for joining foam cores) its best to have 70 to 80 degrees F room temperature and 80 to 90 degrees F epoxy. Resin and hardener can be kept warmer than room temperature by keeping it in a cabinet with a small light bulb on. **DO NOT** store your resin or hardener on a cold floor if you plan to use it within the next several hours.

If you let your shop get cold between working periods, keep some resin and hardener in the warmest place of your house for use on the next layup.

Save your mixing cups, as they can be used as a quality check of your epoxy. After a day or two take a sharp knife point or scribe and scratch the surface of epoxy in the cured cup. If the epoxy is cured properly, the scribe will make a white scratch mark. If the epoxy hasn't cured the scribe will make a dull ridge, indicating a soft surface. If this occurs, the epoxy is not cured either due to inadequate time or temperature, or bad mixing or bad epoxy.

SAFE-T-POXY: THE NEW LOW-TOXICITY EPOXY SYSTEM

In 1979 a new epoxy system was introduced that can be used in place of the RAEF and RAES epoxy. This new system essentially eliminates irritation problems experienced by a few with normal epoxies. **SAFE-T-POXY** has good physical strength, less water absorption and slightly better resistance to aromatic fuels. Due to its different curing characteristics, **SAFE-T-POXY** is less exothermic and can be used in place of both RAEF and RAES, i.e., in all cases where 'epoxy' is called out in the plans. **SAFE-T-POXY** uses a different mix ratio (43 pts hardener to 100 pts resin). If you are using Safe-T-Poxy, consideration should be given to two areas:

(1) When mixing micro balloons with Safe-T-Poxy, **only 3M B23, 500 glass balloons** (available from distributors), should be used. If you use Quartz Q-cell balloons, due to alkalinity, the cure will be delayed, depending on temperature as much as two or three days. Although it does ultimately cure, and is structurally sound, this much delay, particularly in finishing, is not acceptable.

(2) The Safe-T-Poxy has a higher viscosity than the previous resins, thus requiring a higher working temperature to use, especially on the larger layups. The high viscosity was selected for the Safe-T-Poxy to eliminate the tendency of the previous material to bleed-out (inducing air in the layup during cure).

If you are building in a cold garage in the winter you can still use the new Safe-T-Poxy if you take the following precautions:

(1) Warm the resin and hardener evenly to 85-90 degrees F prior to mixing. Do not try to hurry this. We use a light bulb under the ratio pump 3-4 hours prior to use, or keep your resin jugs in a cabinet with a light bulb inside.

(2) It's important to have everything thoroughly warm prior to starting to work. This also cannot be rushed. It takes time to get the parts (wings, foam blocks, etc.) up to a stable temperature throughout. If you are starting from a very cold garage, the warming process could take 4 hours or more. Don't think just because the air is warm that all the material is warm.

(3) Use an electric hair dryer to warm the area as you work, being careful not to over heat the part or epoxy. When, due to cool temperatures, a part is slow to wet out, a few quick passes with a hair dryer will greatly speed the layup time. Do not use a hair dryer to heat a cup of epoxy. This can give local hot spots and ruin your pot life. What shop temperature is satisfactory? That has a lot to do with the size of the job. Small jobs can be worked as low as 65 degrees F, but the working time will be excessive. It will also be more difficult to remove excess epoxy, resulting in a heavier part. On large layups like the fuselage, wings, etc., where there is a lot of epoxy to drag around, 77 degrees F should be considered the minimum. That's epoxy prewarmed to 85-90 degrees F and all parts, glass, foam, tools, table, etc., to 77 degrees F for 4 hours, and then go to work. Those temperatures are minimums. Add 5 to 10 degrees and your working time will be greatly reduced and parts built will be lighter.

For these reasons, many prefer to use the original **RAES** and **RAEF** epoxies for most of their layups, and **Safe-T-Poxy** only for the gas tank layups. If you experience no skin irritation, this is perfectly O.K., and you will still have a good airplane.

Microspheres

Microspheres are a very light filler or thickening material used in a mixture with epoxy. Micro, as the mixture is called, is used to fill voids and low areas, to glue foam blocks together, and as a bond between foams and glass skins. Several different types of microspheres and microballoons are available commercially. The quartz-type supplied by COZY distributors is lighter and cheaper than most common types. Microballoons must be kept dry. If moisture is present it will make them lumpy. Bake them at 250 degrees F, then sift with a flour sifter to remove lumps. Keep the microballoon container covered.

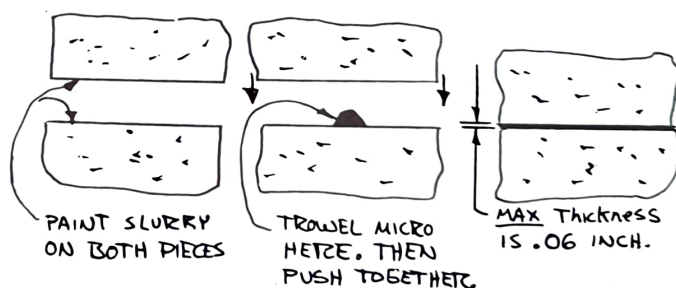
Micro is used in three consistencies: a '**slurry**' which is a one-to-one by volume mix of epoxy and microspheres, '**wet micro**' which is about two-to-four parts microspheres by volume to one part epoxy, and '**dry micro**' which is a mix of epoxy and enough microspheres to obtain a paste which will not sag or run (about five parts-to-one by volume). In all three, microspheres are added to completely mixed epoxy.

You do not have to accurately mix the microspheres; just dump them in until the desired consistency is obtained. **Micro slurry** is used to **paint or squeeze over foams** before glass cloth is applied over them. Slurry is almost the same viscosity as the pure epoxy and is runny enough to apply with a brush. However, the easiest way to apply slurry is to pour it onto the surface and spread it out evenly using a squeegee. When skinning **urethane foam** use a **full thick coat of slurry**. Inadequate slurry on urethane can result in a poor skin bond. **Wet micro** is used to **join foam blocks** and, while it is still thin enough to sag and run (like thick honey). **Dry micro** is used to fill **low spots and voids** and is mixed so that it is a dry paste that won't sag at all. In all three micro types, you don't measure, just add microspheres until the desired consistency is obtained. Use micro only as specifically shown--never use micro between glass layers.

JOINING FOAM BLOCKS WITH MICROSPHERES/EPOXY

Always use the following method to join foam blocks. This is extremely important. **Always use RAES or SAF-T-POXY.**

1. Check that the foam blocks fit closely together. If there are voids over 1/16 inch, sand to fit, or fill the void with a sliver of foam.
2. Paint a light coat of micro slurry on both surfaces. If joining foam to fiberglass paint pure mixed epoxy (no microspheres) on the fiberglass surface and micro slurry on the foam surface.
3. Refer to the sketch and trowel wet or dry micro in the center of the joint. Thus, when joined the micro is pushed outward expelling (rather than trapping) air. If the fit is excellent use wet micro. If it is open enough and vertical such that epoxy may run out, use dry micro.
4. Push the two pieces together, wiggling each to move the micro toward the surfaces. Be sure the micro is not thicker than 0.1 inch at any place, to avoid exotherm. Wipe off any excess. Do not be concerned if the micro does not completely reach the surface. That void can be filled immediately before skinning the part.



Flox

Flox is a mixture of cotton fiber (flocked cotton) and epoxy. The mixture is used in structural joints and in areas where a very hard durable buildup is required. Flox is mixed much the same as dry micro, but only about two parts flox to one part epoxy is required. Mix in just enough flox to make the mixture stand up. If '**wet flox**' is called out, mix it so it will sag or run.

When using flox to bond a metal part be sure to sand the metal dull with 220-grit sandpaper and paint pure mixed epoxy (no flox) on the metal part.

BONDO

Throughout these plans the term '**Bondo**' is used as a general term for automotive, polyester body filler. Bondo is used for holding jig blocks in place and other temporary fastening jobs. We use it because it hardens in a very short time and can be chipped or sanded off without damaging the fiberglass. Bondo is usually a dull gray color until a colored hardener is mixed with it. The color of the mixture is used to judge how fast it will set. The more hardener you add, the brighter the color of the mixture gets, and the faster it hardens. This simple guide works up to a point where so much hardener is added that the mixture never hardens. Follow the general directions on the Bondo can for fast setting Bondo. Mixing is done on a scrap piece of cardboard or

plywood (or almost anything) using a hard squeegee or putty knife. A blob of Bondo is scooped out of the can and dropped on the mixing board. A small amount of hardener is squeezed out onto the blob and then you mix to an even color. You will mix the blob for about one minute. You will then have two to three minutes to apply it before it hardens.

Be sure to clean the board and putty knife off before the Bondo is completely hard. MEK will clean Bondo off your putty knife and squeegee if it isn't completely hardened.

F o a m

Four different types of rigid, closed-cell foam are used in your COZY (and several densities). A low density (2 lb./ft³), light blue or white **styrofoam** is used as the foam core of the wings, winglets, elevators and canard. The styrofoam is exceptional for **smooth hotwire cutting of airfoil shapes**. The large cell type used provides better protection from delamination than the more commonly used insulation-grade styrofoams.

Low density 2 lb./ft³ green (or light tan) **urethane foam** is used only in non-structural areas, where its **ease of carving** is important (nose and canopy). Urethane foam is fantastically easy to carve and contour. The urethane used is U-Thane 210 or equivalent.

PolyVinylChloride, or PVC foam in low, medium and high densities is used extensively. The dark blue color 3 lb./ft³ type R45 is used in the fuselage and fuel tanks. It has **excellent compressive strength and is completely fuel compatible**. The light red color, 6 lb./ft³ type R100 PVC is used in the center section spar and canard inserts. Dark red color, 16 lb./ft³, type R250 is used in bulkheads. Quite recently an **alternate PVC** has been approved. It is higher quality, and slightly less expensive. It is called **Divinycell**, and is a **buff or pink** color. It is available in the same thicknesses and densities, and is an exact replacement for the original PVC foams.

Clark foam is a white, **polyester-urethane foam** which has some unique qualities. It has properties somewhere between urethane and PVC. Its peel strength and toughness is better than urethane. It is available in thin sheets of different densities and compressive strength. It can be more easily bent and formed than PVC, and it is less expensive than PVC. It is used in some bulkheads and miscellaneous fuselage parts.

Do not substitute other foams than those called out in the plans, or purchase foams from sources other than COZY distributors! Other styrofoams are available, but don't have as good a peel strength. Of course, white, expanded polystyrene used for insulation is completely unsatisfactory. There are other urethane foams available, but their physical properties are not as good as U-Thane 210.

All four types of foams, PVC, urethane, polyester-urethane and polystyrene are manufactured in a wide variety of flexibilities, densities and cell sizes. Getting the wrong material for your airplane can result in more work and/or degraded structural integrity. **Sun damages foam. Keep it covered!**

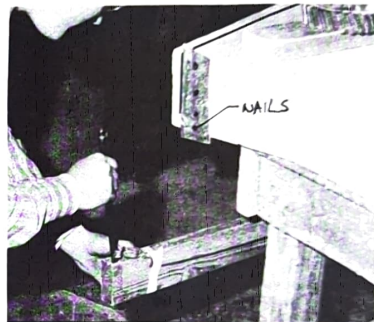
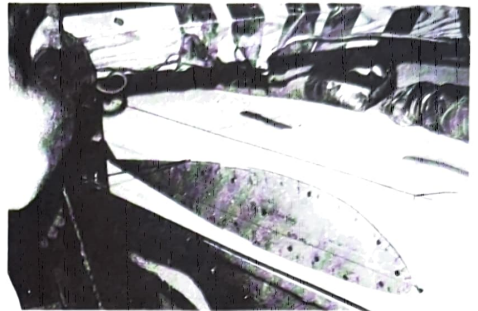
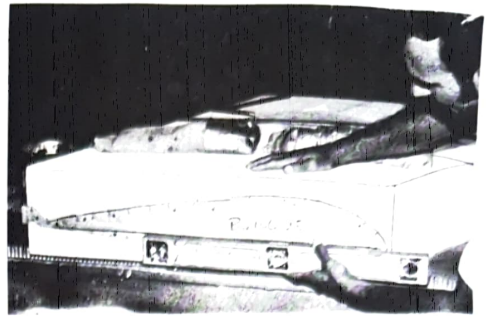
HOT WIRE CUTTING

The airfoil-shaped surfaces of your **COZY** are formed by hot wire cutting the blue styrofoam of 2 lb./ft³ density. The hot wire process gives airfoils that are true to contour, tapered, properly twisted, and swept with a minimum of effort and the simplest of tools. The details for making your hot wire saw were shown earlier in this chapter.

The **hot wire saw** is a piece of stainless steel safety wire, stretched tight between two pieces of tubing. The wire gets hot when an electrical current passes through it and this thin, hot wire burns through the foam. By making smooth steady passes, the hot wire gives a smooth, even surface. The foam offers little resistance to the hot wire's passage. To get a smooth accurate cut, a **template** is required. Templates are made from thin plywood, sheet metal, masonite or formica. A variable voltage control is used to supply the electrical current that heats the wire.

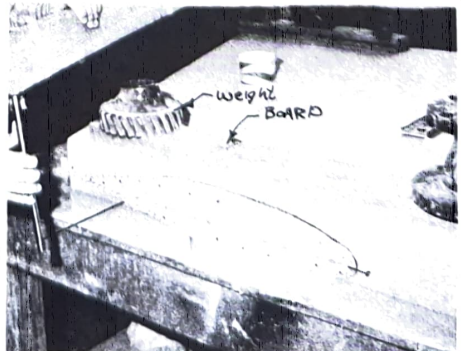
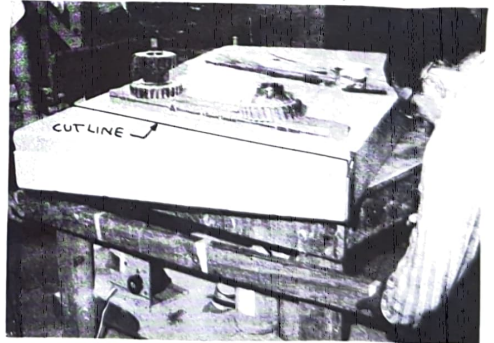
The blue foam used in your flying surfaces was selected for a combination of reasons and its hot wire cutting ability was one of them. Other types of foams are readily hot wire cut, but some (white expanded polystyrene) have poor physical properties and others (urethane) give off poisonous gases when hot wire cut. **Use only the recommended materials!**

Hot wire templates can be made from 1/16 to 1/8 inch plywood, formica, or masonite or 0.032 to 0.064 sheet metal. It is important to have smooth edges on the templates. A rough edge may cause the wire to hang up and burn into the foam being cut. The size, shape, and orientation of the two templates is varied to taper and twist the foam core as required. The planform (span and sweep) is set by squaring up the foam block before the templates are used. In general, the trailing edge of the wing is the reference; a 'trim line' on the templates is lined up on the trailing edge.

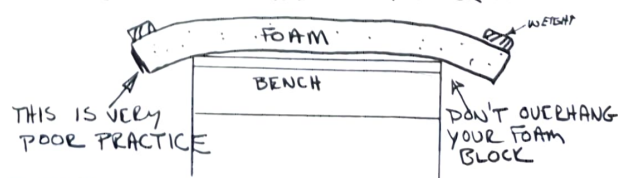


CUTTING
STRAIGHT
DOWN
ALONG
TEMPLATE
WITH
HOTWIRE

NOTE The diagonal CUT being MADE by correctly POSITIONING the VERTICAL Templates AND PASSING the hotwire downward along them



A WELL SUPPORTED FOAM BLOCK



Full-size template drawings are provided in the plans. To make your templates, just glue the template drawings to a piece of plywood or sheet metal and trim to the contours shown. There are a number of markings on each template which aid in the alignment and cutting of the foam core.

→ NOTE C2 10-2

Each template has a **waterline (W.L.)** marked on it which is used to align the twist of the foam core. Each template's waterline is leveled using a carpenter's bubble level. This assures that the relative twist at each template is correct. The template is then nailed to the foam block to obtain the correct planform; a foam trim line is provided near the trailing edge of each template which is lined up on the foam edge before cutting.

Each rib template has **numbered marks** running from the trailing edge around the leading edge and back to the trailing edge. These are called **talking numbers**. When the foam cores are cut into their airfoil shape, the talking numbers are used to assure that each end of the hot wire is co-ordinated to obtain the correctly tapered airfoil. The person calling the numbers should be at the largest template. A typical cut would sound like this: 'Resting on the tab 1/4 inch from the foam, moving forward, entering foam now—one, half, two, half, . . . , 34, half, 35, half, 36, coming out of the foam and pausing on the tab, the wire's out.' As the cut is made, the person on the small rib follows the numbers, passing over them as he hears them called out. Pause marks are indicated in places where it is necessary to pause for a couple of seconds and let the hot wire's center lag catch up with the ends.

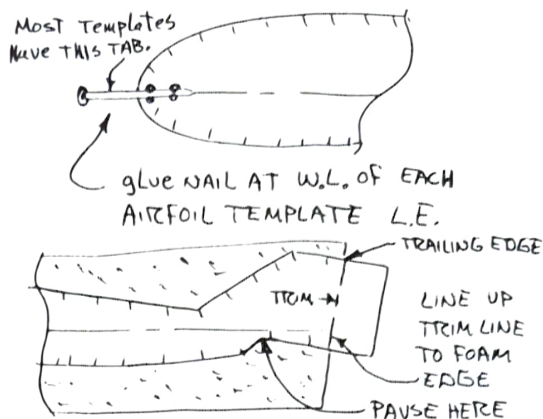
Preparing a foam block for an airfoil cut is begun by trimming the rectangular foam block to the basic dimensions for the correct planform. These 'trim' cuts are made using two straightedged trim templates. The templates are held against the foam by nails through the template into the foam. Enough nails should be used to hold the template firm so that it won't move when the hot wire is held against it.

Each template has symbols for the general location of holes for the nails. 4D (four penny) nails are good for this use. The holes in the templates should be a close fit for the nails. Be careful not to angle the nails so that the hot wire can catch on them! Some rib templates are used several times, for both inboard and outboard, thus you may have to transfer the talking numbers, pause marks, trim line, and waterline to the opposite side of the template.

The use of the hot wire saw is a simple thing if your equipment is set up properly. Proper wire tension and wire temperature should be maintained for good cutting. The wire tension should be tightened after the wire is hot by twisting one tube with a pair of pliers. The wire should be as tight as possible. The wire should be hot enough to cut one inch of foam in four to six seconds without having to force the wire. A wire that is too hot will burn the foam away excessively. To cool an over-heated wire, simply turn your voltage control to a lower voltage setting. If you use a battery charger, you will have to add length to the wire. To warm up a cool wire, just increase the voltage setting or, with the charger, shorten the wire. Although the foam offers only mild resistance to the hot wire, a long cut will cause the middle of your wire to lag behind the ends. Wire lag can cause problems in tight curves like the leading edge of an airfoil. To reduce lag there, the cutting speed is reduced to about one inch in 8 to 10 seconds. The airfoil templates have notations in the areas where reduced speed cutting is necessary and pause marks where it is necessary to allow the lag to catch up completely.

The most common hot wire error is wire lag which causes a bow in the leading edge. The following method solves this problem and thus we recommend you use it for cutting the canard, wings and winglets. Instead of making one cut all around, glue nails on the templates at the waterline at the leading edge as shown. Now, cut the core in two passes: one from the leading edge up over the top to the trailing edge, the other from the leading edge (under the nail) down under the bottom to the trailing edge. The thin 'flash' of foam left on the leading edge due to the thickness of the nails is easily removed with your butcher knife. The result is a perfectly straight leading edge. Care must be taken to assure that both ends simultaneously approach the template at the leading edge.

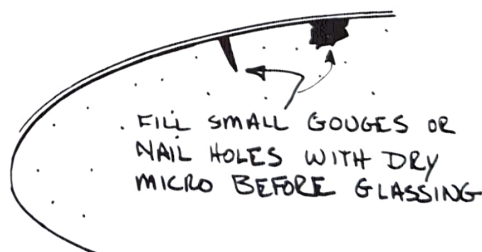
Use the following vocal commands: 'wire is moving toward the nail, now resting on the nail 1/2 inch from the template, moving up x (talking number), y (talking number) . . .'. When approaching the trailing edge overlap notch (see sketch) slow down and pause 3 seconds in the notch to assure a full, sharp, accurate surface for the skin overlap. See Chapters 10, 19, and 20 for clarification of the trailing edge overlap.



The hot wire should be guided around the templates with light pressures. Pushing too hard against the template may move them or flex the foam block which results in an under cut foam core. The correct set-up is just as important as using the correct tools and materials. Foam is a fairly flexible material and an improper set-up can cause deflection. The foam block should be well supported at each end, so that it doesn't sag and doesn't move around while being cut.

You need clearance for the hot wire cutter to pass by the table and the weights used to hold the foam steady. Foam is manufactured in sizes that are often too small to get a solid core from a single block. It is necessary to use two foam blocks to get the size required for the wing cores. These blocks have to be joined using an epoxy/microsphere mixture. The hot wire won't cut through the micro joint, so all of the hot wire cutting is done with the blocks temporarily joined. Nails or blobs of 5-min epoxy are used for temporary foam joints, but the hot wire won't cut through these either. Thus they have to be placed carefully so that the wire doesn't have to pass through them.

Don't be overly concerned if you don't make perfect foam cuts! Ridges on the foam core from inadvertently lifting the hot wire off the templates are easily faired in with a sanding block. A less-than-perfect leading edge can be blended in by sanding after the foam core is assembled. Gouges in the foam can be smoothed and filled with dry micro to contour after applying the glass skins. The foam is too expensive to throw away because of a minor gouge.



A finished foam core may warp out of shape after it is removed from the original block. This is due to internal stresses in the foam from the manufacturing process, and is no cause for concern.

A warped core is simply weighted into the jig blocks and shimmed straight. Once the skin has been installed, the foam is held firmly in position.

URETHANE FOAM SHAPING

One of the real treats in the construction of your COZY will be shaping and contouring urethane foam. Urethane is a delightful material that shapes with ease using only simple tools. A butcher knife, old wire brush, sandpaper, and scraps of the foam itself are the basic urethane working tools. A vacuum cleaner is convenient to have handy since working urethane produces a large quantity of foam dust. The knife is used to rough cut the foam to size. The knife needs to be kept reasonably sharp; a sander or file is an adequate knife sharpener since it's a frequent task and a razor edge isn't necessary. Coarse grit sandpaper (36 grit) glued to a board is used for rough shaping outside contours.

Inside contours or 'dishing' is done by using a ragged old wire brush to rough out the bulk of the foam and following up with a scrap foam piece to smooth the surface. The foam scrap conforms to the shape of the surface resulting in a very smooth contour.

Outside contours are roughed out with a sanding block and finished using a foam scrap. Dry micro and flox are used to fill voids and pot fasteners in a number of places. All foam shaping should be finished before any micro filling is done, because the filler is much harder than the foam and this makes smooth contouring very difficult. Your best carving template is your eyeball; an occasional check on the depth of a contour is about the only measurement necessary.

Keep your shop swept reasonably well. The **foam dust can contaminate your glass cloth and your lungs. Use a dust respirator mask while carving urethane.** Try not to aggravate the better half by leaving a green foam dust trail into the house.

GLASS LAYUP

The glass layup techniques used in your **COZY** have been specifically developed to minimize the difficulty that glass workers have traditionally endured. Most of the layups that you will do will be on a flat horizontal surface without the molds, vacuum bags, and other special equipment that are common in glass work. The layups that you do will all cure at room temperature; no ovens or special heating is required. If you have suffered through a project that requires you to build more molds and tools than airplane components, then you are in for a real treat.

The techniques that you will use are VariEze, but they still need to be done correctly. 90% of the work that you will do is covered in the next few paragraphs, so **make sure that you read and understand this section very well.** If you learn these basics, your airplane will be VariEze indeed. If you skip over this information, you will probably end up Vari frustrated.

Step 1. Personal Preparation

Before you get started with a layup, plan ahead. Some major layups take several hours and before getting your hands in the epoxy, it's a good idea to make a pit stop at the restroom.

Do not start a large layup if tired. Get some rest and do it when fresh. It's best to have three people for any large layup, two laminators and one person to mix epoxy. Be sure the shop is clean before you start.

Take the recommended health precautions (discussed later in detail) using gloves or barrier skin cream. Get your grubby, old clothes on or at least a shop apron. Make sure that your tools are clean from the last layup and ready to use. Your working area should be between 65 degrees F and 95 degrees F. Below 70 degrees F the epoxy is thicker making it more difficult to wet the cloth. Above 85 degrees F, the possibility of an exotherm is greater.

Step 2. Cut Fiberglass Cloth

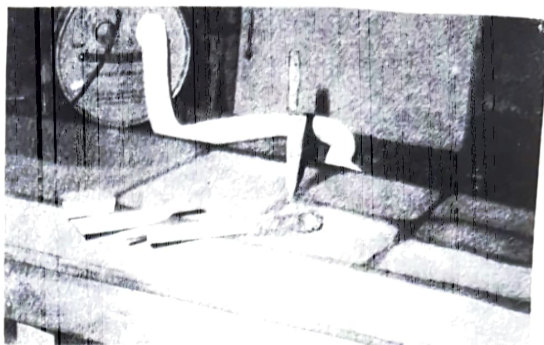
The fine points of glass cutting have been covered earlier. Remember that there isn't any requirement to cut accurate dimensions. Cloth dimensions are given well oversize. You scissor trim them as you go, while laying the cloth up. It is a good idea to keep two pair of scissors; one clean and in the glass storage area, and one in the shop that gets epoxy on it. After cutting, roll or fold the material; keep it clean and handy for the layup.

Step 3. Prepare Surface

The only difference between layups over different materials is in surface preparation. The layup over foam will be covered here since you will be doing more of it, and other surface preparations will be covered separately.

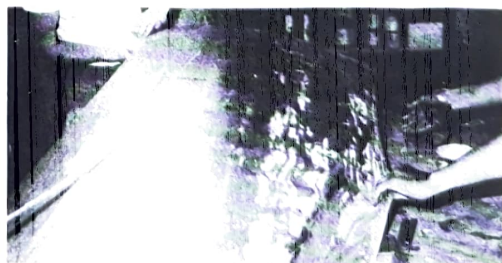
The foam surface is prepared by leveling uneven areas with a sanding block and brushing or vacuuming any dust off the surface. Use **vacuum** to remove dust.

Now is the time to accurately check that the foam core is the correct size, shape and contour. Refer to the section views of the part—be sure your core looks exactly like that on the section view. Lay a 12-inch straightedge spanwise on all critical areas of the flying surfaces and be sure you don't have any high or low places or joggles. Measure any areas that involve fiberglass buildups to check for correct depth. **Build up is 0.009 inch per ply for UND and 0.013 inch per ply for BID.**



Step 4. Mix Epoxy and Paint Surface

Mix epoxy only when needed, not before. Epoxy, micro and flox may be needed at various stages, so you may need several cups. If you are laying up over cured fiberglass, paint a liberal coat of epoxy on the surface. When laying up over Styrofoam, Urethane, PVC, or Clark foam, squeeze a coat of Micro slurry on the surface, before laying on the first ply. The slurry can be poured on the foam and spread thin with a squeegee or it can be brushed on with a brush. Then, fill any dings or gouges in the foam core with dry micro.



Step 5. Lay On The Cloth

Lay on the cloth in the specified orientation. Pull the edges to straighten the cloth out and to remove wrinkles. Maximum strength and stiffness is obtained if the fibers are not wavy or wrinkled. If the cloth is to be applied around and into a sharp corner, you will find the job easier to do if the fiber orientation is at 45 degrees to the corner. Don't get depressed if the layup looks like a hopeless mess at this point. Press on with patience and things will work out fine. To remove wrinkles, study the direction of fibers, follow the fibers to the outer edge of the cloth and pull on the outside edge. Pushing a wrinkle off the part is incorrect. Once the part is free of wrinkles use a squeegee and make light passes from the center outwards to smooth the cloth.

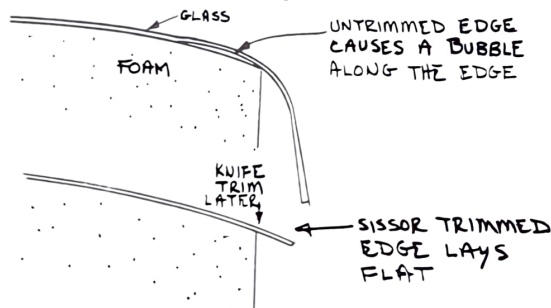
Step 6. Wet Out the Cloth

Wet out the cloth by brushing on a thin coat of epoxy. Do not use micro between plies of cloth. Extra epoxy will not be necessary if there is enough epoxy under the cloth to be brought to the surface. This is done by 'stippling,' which involves a vertical stabbing motion of a paint brush over the cloth. This brings excess epoxy up from below to wet out the cloth, resulting in a weight savings as compared to adding more epoxy on top. **REMEMBER,** epoxy adds no strength beyond what is needed to wet out the white color of the cloth and fill air voids; any further addition of epoxy is only **dead weight.** Where multiple plies are required, the first plies may be laid up wet and the excess resin brought up by squeegeeing and stippling to help wet out the middle plies. To do this, pour epoxy onto the part and move it around the surface with a squeegee. Your work will go much faster if you make the layup too wet, then remove excess epoxy with many light passes with the squeegee. Do not squeegee too hard, as this can starve the surface of micro and introduce air. Continue to inspect for air (tiny white flecks or bubbles) and stipple or squeegee in more epoxy to remove the air. A handy squeegee can be cut from the flexible plastic found on a coffee can lid. The final plies are ambitiously stippled and additional epoxy is applied sparingly. **When in doubt—stipple it out, or squeegee.**



As you wet out each ply, scissor trim to within 1/2 in. of any overhang (trailing edge, etc.). This 1/2 in. will be knife trimmed after the layup cures. If an overhanging ply isn't trimmed, it lifts the edge up and makes a bubble.

After scissor trimming, restipple the edges to be sure there are no voids. Wet the cloth beyond the trim line at least 1/4 in. to allow easy knife trimming later.



Step 7. Squeegeeing

Squeegee out excess epoxy. This involves drawing a plastic or rubber squeegee over the layup as shown. Excellent rubber squeegees are available from your COZY distributors. Plastic squeegees (scrapers) are available at any paint store. If excess epoxy exists, it will be pushed off the edge of the piece. **Remember, excess epoxy is much better on the floor than on the airplane.** It is possible to squeegee too hard and make the layup too dry. If this occurs, the surface will appear white, indicating the presence of air. If this occurs, wet the cloth by painting on a little epoxy and stippling it down onto the layup. The best quality layup is obtained if each layer of a multilayer layup is squeegeed. The excess epoxy which is pushed off the edge can be recovered and returned into the cup. This is easily done by catching the epoxy on the squeegee and scraping it on the side of the cup.

The finished layup should appear smooth and green so that the weave of the cloth is clearly visible, but not so dry that any area appears white in color. If you've done an excellent job, the weight of the resin will be about 1/2 of the weight of cloth used.

To check if there is too much epoxy in the layup, pull a squeegee across the surface, stopping before you reach the edge. Lift the squeegee up and look for a large 'ridge' of epoxy where the squeegee stopped. The ridge under the top ply indicates that the layup is too wet and you should spend time with the squeegee to remove epoxy off to the sides.

Don't hesitate to use your brush on an area after squeegeeing. Some places are not suited to the use of a squeegee and the dry brush must be used to expel the excess epoxy. On a given layup, about 1/2 of your time should be spent squeegeeing.

Step 8. General Inspection

After you have finished the layup, take a few minutes and give it a good general inspection from trapped air, dry glass, excess epoxy, and delamination. It is much easier to correct these things while the layup is wet than to repair the cured layup. Also, have someone else inspect it, usually a different person can find air flecks or bubbles that are missed by one inspector. Carry a good light around for the inspection. Glance the light off the surface at various angles to look for airflecks. If any air is visible, stipple it out. **Be sure the overlaps on the edges are perfect.** If, due to a sharp corner etc., you have a problem eliminating an air bubble, use one of the following two methods: (1) Lift the cloth up off the foam, trowel some wet micro into the troublesome area, add more epoxy as you stipple the cloth back down. (2) Add excess epoxy over the bubble, cover the surface with Saran wrap (thin plastic wrap) then push firmly outwards to force the air out to the sides. The Saran wrap will seal the surface to keep air from being drawn in. This method will force the cloth to stay down even around a sharp corner.

Step 9. Preliminary Contour Fill

Certain areas, like over the spar and along the trailing edge (see cross-section views) require a dry micro fill. It is preferred to apply this fill within 2-3 hours of finishing the fiberglass layup. However, where the micro filler obscures the structure underneath, like over the spar cap, FAA inspection should be completed before dry micro filling. Areas like the trailing edge where the structure can be inspected from the other side should be filled while the layup is still tacky (within three hours of the layup). If you wait until the layup cures, you will have to sand the fiberglass surface to a dull finish before applying the micro. So, mix up a 'dry' micro mix and trowel it into low areas while the layup is still wet, and save the work of sanding where feasible.

Step 10. Cleanup

Brushes can be used two to four times if after each layup they are washed with soap and water. Wipe excess epoxy off with a paper towel. Wet the brush and work soap into all fibers by mashing it into a bar of soap (Lava brand is best). Rinse with hot water and repeat 3 times. Be sure they are dry before next use. We generally use a cheap brush (approximately \$2.00 to \$4.00 per dozen) and discard after two or three layups. Clean squeegees the same way.

If you use skin barrier cream (Ply No. 9), the epoxy and cream will wash off easily with soap and water. When you get epoxy on unprotected skin, Epo-cleanse is used to remove the epoxy. Both of these products are available through COZY distributors and are listed in the bill of materials. Once you are sure your skin is clean, wash again thoroughly with soap and water, even if your hands were protected with plastic gloves. If you get epoxy on tools or metal parts, clean them with acetone or MEK before the epoxy cures.

The only good way to protect your clothing is not to get epoxy on anything that you care for. Use a shop apron and don't make layups in good clothing. A surplus flight suit or other cheap coveralls are a good investment.

You may feel that layups are real messy work after your first experience with them. However, after you've done several, you will have learned not to wipe your hands on your clothing (keep a roll of paper towels handy), not to scratch your ears, eyes, etc., during the layup. If your tools and work area are clean and organized well and you are disciplined with the epoxy, the job can be a lot less messy than working with other materials.

Step 11. Knife Trim

When a layup is wet, you can only scissor trim to within about 1/4 in. without disrupting the fibers in the ply. An easy clean trim can be obtained by waiting three to five hours after the layup. At this time, the laminate is firm enough to support the cloth from fraying, yet soft enough to cut easily with a sharp knife. This 'knife trim' stage is the optimum time for edge trimming with ease and accuracy. Take a sharp, single-edge razor blade or X-Acto knife and trim the edges with a motion downward toward the edge. Experience will help you determine the correct time in the curing cycle for optimum knife trimming.

In the plans when 'knife trim' is called for, this assumes the three to four hour wait, even though not specifically stated. Don't fall apart if you miss the knife trim stage and have to trim the fully cured glass. If you wait until the layup is completely set, then saw, dremel, bandsaw, saber saw, etc. Smooth the edge with the Disston Abrader. When trimming a cured edge, be careful of the 'needles' (sharp protrusions of glass-frayed edges supported with epoxy).

The needles can be avoided by returning three hours after the layup to make the knife trim. **Knife trim time varies with temperature:** about six hours at 60 degrees and one hour at 90 degrees.

Other Surfaces

Surface preparation (step 3 of the basic glass layup) varies with the material that you are laying up over. The layup over foam was covered in detail in step 3. To prepare a cured glass surface for layup, the cured surface must be sanded to a completely dull finish with 36 to 60-grit sandpaper. If any of the glossy surface remains, an incomplete bond results which is weak. Better yet, use peel ply as described later. Micro slurry should not be applied to glass surfaces being bonded, this weakens the joint. Wood requires no special preparation for bonding but should be free of grease, oil, paints, and varnish. Sand wood surfaces with 36-grit sandpaper before layup. Metal bonding is not relied upon for strength but metal surfaces should be free of oil and grease and, except for bolts, nuts, and other fasteners, metal surfaces should be dulled by sanding with 220-grit sandpaper, and coated with epoxy before setting in place. Cured micro surfaces should be sanded dull but be careful not to obliterate surrounding foam surfaces while doing it. In practice, you may be glassing over several types of material in the same layup and you will be using most of these surface preparation techniques together.

QUALITY CONTROL CRITERIA

One of the unique features of the glass-foam-glass composite construction technique is your ability to visually inspect the structure from the outside. The transparency of the glass/epoxy material enables you to see all the way through the skins and even through the spar caps. Defects in the layup take four basic forms: **resin lean areas, delaminations, wrinkles or bumps in the fibers, and damage due to sanding structure away in finishing.** Resin lean areas are white in appearance due to incomplete wetting of the glass cloth with epoxy during the layup.

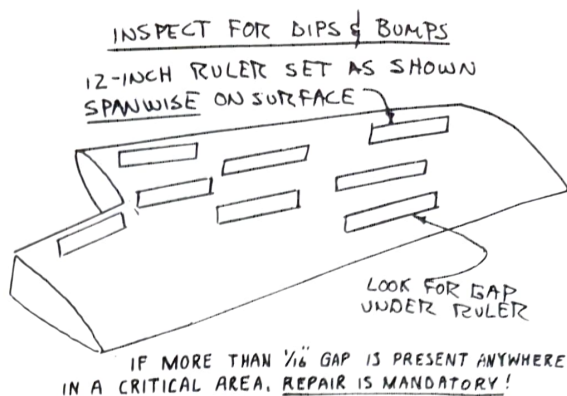
Dryness Criteria. Pick any 6 in. x 6 in. square in the layup in the critical area. Assess carefully if any evidence of air in the layup is present (white flecks, bubbles, air at the foam face). If the dryness evidence is more than 10% of the area, the part **MUST** be rejected. Reject or repair any evidence of dryness or voids in the trailing edge or leading edge overlaps. Better yet, do an adequate inspection with good light before cure when it's easy to fix. If in doubt on overlaps, be sure to stipple in enough epoxy.

Delaminations in a new layup may be due to small air bubbles trapped between plies during the layup. The areas look like air bubbles and are distinctly visible even deep in a cured layup. Small delaminations, or bubbles up to 2-inch diameter, may be filled with epoxy by drilling a small hole into the bubble and filling the void with epoxy.

When making a layup, do not be concerned if the brush occasionally sheds a few bristles-these do not need to be removed. If the bristle count exceeds about 10 per square foot, change your brush and remove bristles.

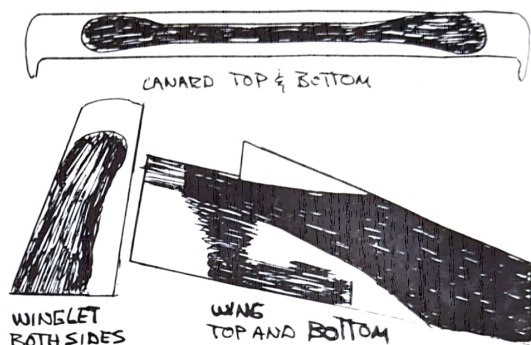
Occasional **sanding through** the weave in the first skin ply is not grounds for scrapping the part. Care should be exercised in areas, such as the skin joints not to weaken the structure in pursuit of an optimum finish. (Refer to Chapter 25 for details). An excess of resin (wet) will make your airplane heavy and does weaken the layup, but usually not enough to reject the part for strength reason.

Bump/Joggle/Dip Criteria. The best way to check this is to lay a 12-inch straightedge on the part spanwise. Move it all over the surface in the critical areas. If you can see 1/16 in. gap in any area, the part must be repaired. It is best to repair or beef up lumpy areas even if they meet this criteria. Better yet, do a good job in core preparation and use your squeegee well in the layup to avoid the lumps in the first place.

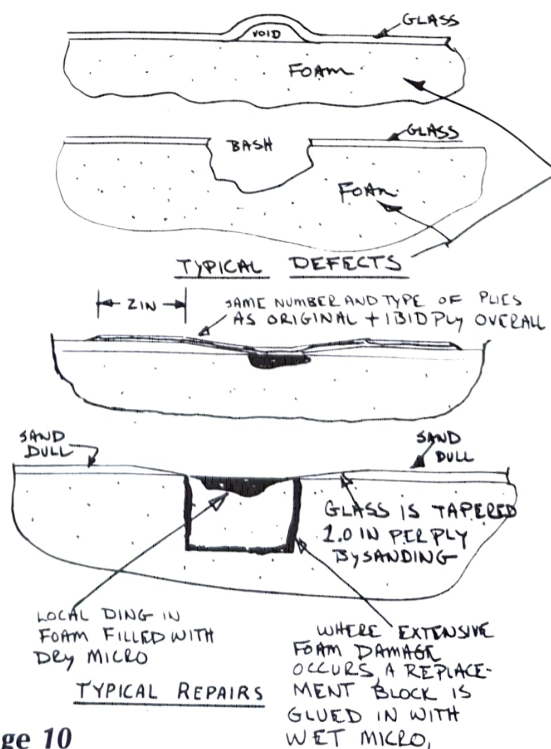


The following is a listing of the 'critical areas', the portions of the COZY that **must** meet all the inspection criteria:

1. Center section spar--entire outside skin and spar caps.
2. All portions of the fuselage within 10 in. of the engine mounts and canard lift tab attachments.
3. All control surfaces.
4. All flying surfaces in the shaded areas shown plus all overlaps at L.E. & T.E.



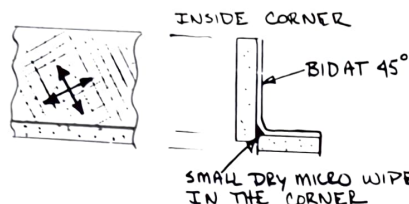
Major wrinkles or bumps along more than 2 in. of chord are cause for rejection in the wings, canard and winglets, particularly on the top (compression side). This does not mean you have to reject the whole wing--anything can be repaired by following the basic rule: Remove the rejected or damaged area and fair back the area at a slope of 1 in. per ply with a sanding block in all directions. By watching the grain you will be able to count the plies while sanding. Be sure the surface is completely dull and layup the same plies as you removed, plus one more ply of BID over the entire patch. This will restore full strength to the removed area. Use this method to repair any area damaged for any reason--inadvertent sanding through plies during finishing, taxiing a wing into a hanger, etc.



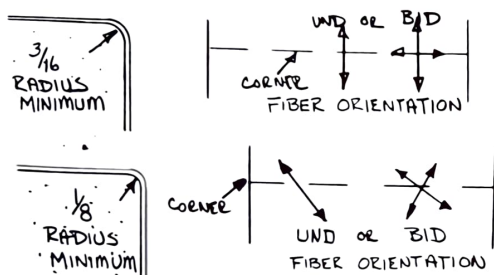
CORNER TREATMENTS

A variety of structural corners are employed in the construction of your COZY. There are two basic types of corners: One where the glass fibers are continuous around the corner, and the other where a structural filler is used and glass is bonded to the filler. The corner with the glass fibers running completely around it is used where maximum strength is required.

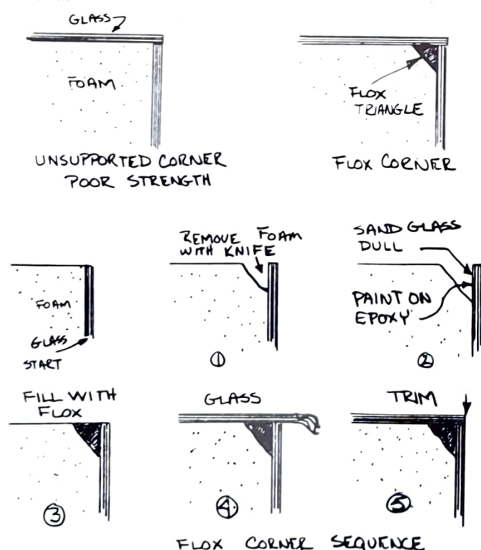
Inside corners can be laid up quite abrupt and only a very slight wipe of dry micro is needed to get the glass to lay into it. BID cut at 45 degrees is used on this type of corner.



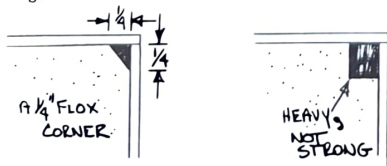
Outside corners require a radiused edge. Where the glass fibers run directly around the corner a minimum radius of 3/16 inch is required. Where the fibers run at an angle to the radius, only a 1/8 inch radius is needed.



In some areas a sharp corner is desirable and maximum strength isn't required. In these areas a flox corner is used. A simple unsupported glass corner has very poor strength. To strengthen this corner, a triangle of flox is used to bond the glass plies together. The flox corner is done just before one glass surface is applied for a wet bond to one surface. The other glass surface has to be sanded dull in preparation as shown.



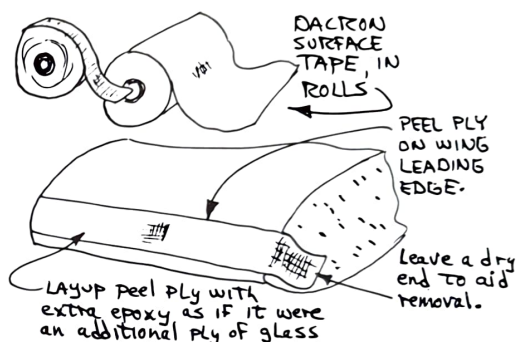
If a specific size of flox corner is desirable, an approximate dimension may be given as shown. Don't make your flox corners square. The extra flox only adds weight, not strength.



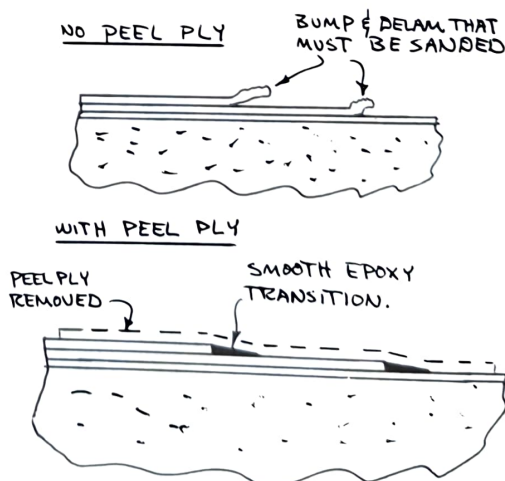
PEEL PLY

Peel ply is a layer of 2.7 oz. dacron fabric which is laid up over a fiberglass layup while the fiberglass is still wet, and is later removed by lifting an edge and 'peeling' it off. The most convenient form of dacron to use is 'surface tapes', normally used in covering fabric aircraft. These are available in rolls. You will need several rolls, 1 in., 2 in. and 4 in. wide. Peel ply is used for two purposes:

(1) Peel ply any area that will later be structurally attached to another fiberglass layup. Once the dacron is peeled off, the surface is ready for another layup, without sanding. If you do not use peel ply you will have to sand the surface completely dull (no shiny spots). This sanding is hard, itchy work and ruins the strength of the outer ply of fiberglass. So, remember to peel ply the following areas: leading and trailing edges of all flying surfaces, outboard 15 inches of wings and lower 10 inches of winglet (for CHAPTER 24 layups), canard and wing shear web surfaces (for sparcap layups) all joining edges of bulkheads and fuselage sides, fuselage skin at both ends, fuel tanks, and at landing brake, and all other places where a future layup will be made. Note that to peel ply the trailing edge overlap area, the peel ply is the first ply made to the foam core. Lay a strip of dacron down on the overlap notch and secure it with tacks or staples so it doesn't move when you layup the skin.



(2) The second use for peel ply is to transition the area where the top ply of a layup terminates on the fiberglass surface. These are found at the wing/winglet junction, where the fuel tank, cowl lip, and nose joins the fuselage, and on all corner tapes inside the fuselage. Refer to the adjacent sketches. If the top ply edge is laid up bare it results in a rough edge that can delaminate if a little dry. Sanding the rough edge is hard, itchy work and usually results in damaging the adjacent surface. If the edge is overlaid with a strip of dacron during the layup (lay on the dacron and wet out by stippling or squeegeeing) it will make the edge lay down flat and will form a wedge of epoxy to smoothly transition the edge. After cure, peel off the dacron. The result is a beautifully transitioned smooth edge with no delamination tendency. Use this method in all places where a cloth edge terminates on the surface.



HEALTH PRECAUTIONS

Skin Protection

If you work with epoxy on your bare skin, you can develop an allergy to it. This 'sensitization' to epoxy is an unpleasant experience and is to be avoided. You generally have to get epoxy on your unprotected skin to become sensitized. If you use a protective barrier skin cream like **Ply No. 9** (available from COZY distributors) or disposable plastic medical examination gloves (also available from COZY distributors) the allergy can be avoided. The barrier skin cream also allows you to clean up with soap and water after a layup.

The RA epoxy systems are low toxicity (SPI-2). However, many people (about 5 to 7 percent) are sensitive to epoxy to a great extent and thus will find it impossible to build their airplane without extensive skin rash, facial swelling, etc. These people can get some help by using doctor-prescribed anti-allergy medicines and/or by using elaborate masks/multi-gloves, etc., to reduce exposure, however, in many cases the allergy is sufficiently strong to preclude their ability to make layups. Remember to **always use skin protection**, never let epoxy come in contact with bare skin, even if you have no reaction to it. Sensitivity is accumulative, such that you may later develop an allergy unless you protect your skin.

Dust Protection

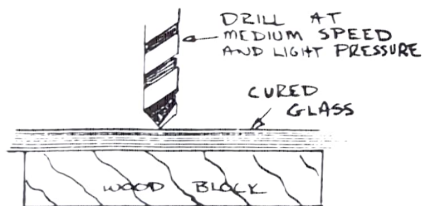
Sanding or grinding fiberglass and foams creates dust that can be harmful to your lungs. Use a dust respirator mask for these operations. Disposable dust masks are available at most paint stores.

Ventilation

Mix and work with your epoxy in a ventilated area. Some epoxy/hardener systems may irritate your eyes (like cutting onions) in a poorly ventilated work area. If your shop is not ventilated, set up a small fan to move a small flow of air in or out. Do not hotwire urethane.

DRILLING, GRINDING, & SANDING

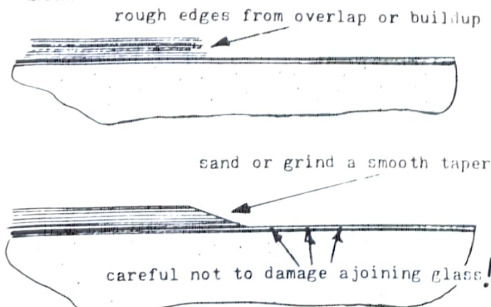
Drilling through cured glass tends to tear the surface plies on the back side. Backup a glass layup with a wood block for drilling as shown and drill at medium speed.



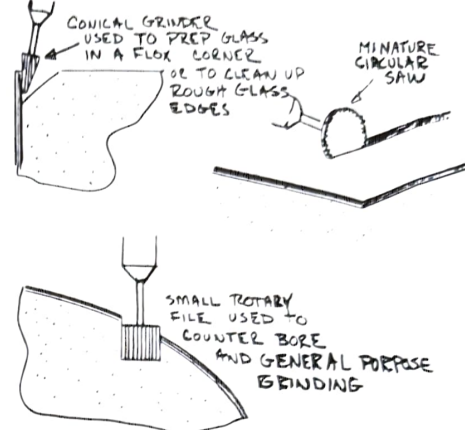
Using a small hone, grind the cutting edges of your drill bit flat as shown (not undercut). This will keep the drill from grabbing into the glass. Don't overdo it, just make a couple of light passes with the hone.



In several places rough cured glass surfaces occur where overlaps or thick buildups are done. These rough edges should be smoothed as shown using a grinder or sanding block.

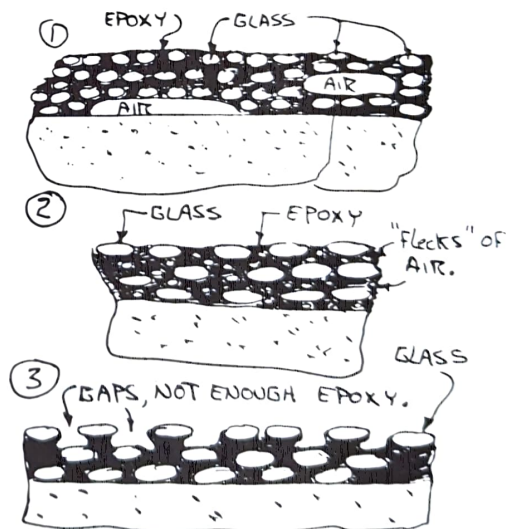


The Dremel (Moto Tool) or Home Shop (Weller) is a very versatile tool with many uses in the construction of your COZY. The kits usually have a nice selection of bits, cutters, grinders, stones, and mandrels for every conceivable use. The three types of bits shown here are the most useful for your project. Don't throw the others out, your buddy next door might be able to use them on his radio controlled golfball project.



Recognition of a Dry Layup

One of the most important things you must know is how to inspect for the presence of air within a layup. Air leaves somewhat crystal-like flecks of white areas, noticeably different than the white color of the microballons. The presence of air is shown in the adjacent sketches in 3 forms: (1) A bubble or large void at the foam surface or within the laminate, (2) small bubbles of air scattered throughout an area, or (3) inadequate filling of the outer ply. Make a layup of 3 ply BID in a 6-inch square over a scrap piece of foam, trying to achieve these 3 types of dryness. Let it cure with the defects. This will be a handy sample to use to instruct others who will help you inspect.



Some More Hints

You can generally tell the quality of a man's workmanship just by looking at his shop. Clean up and sweep after every step. Keep your tools organized and clean. Dirt in or under a layup will increase weight and decrease strength. A clean shop will reflect on your airplane, and will make construction more pleasant.

A flour sifter is excellent for getting any lumps out of micro. Keep micro bag closed to avoid moisture.

A key to a good glass layup is preparation. Copy the check list below and post in your shop:

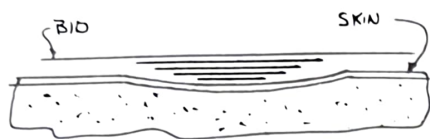
BEFORE ANY GLASS LAYUP

1. Tools cleaned and available: squeegee, cups & sticks, brush, scissors, roller, ply 9 or gloves
2. Workbench clean
3. Glass cut & rolled
4. Surface to be glassed--correct shape & smooth contour, sanded dull, dust blown or vacuumed off
5. Temperature of room and epoxy 70 to 80 degrees F

The following are accepted practice to repair common errors. Of course, it's best to be careful and avoid the error in the first place., Remember, most errors can be avoided by reviewing your newsletters.

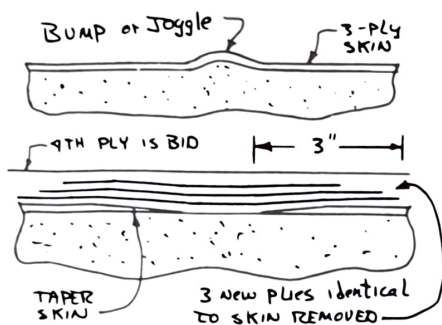
The following are accepted practice to repair common errors. Of course, it's best to be careful and avoid the error in the first place., Remember, most errors can be avoided by reviewing your newsletters.

ERROR: Depression in skin or spar cap in spanwise direction on wing, winglet, or canard. **REPAIR:** Sand surface dull. Layup UND plies cut as shown to fill depression, fiber orientation spanwise. Add one ply BID at 45 degrees lapping two inches on each side of depression. This repair is allowable for depressions up to 1/10 inch deep.



ERROR: Bump in skin or spar cap in wing, winglet, or canard.

REPAIR: Using a hard block, sand bump level. Determine number of plies in area of bump. Sand completely dull the area around bump to a radius in inches equal to number of plies at bump. Layup the same plies as effected area, being sure to observe fiber orientation. Add one ply BID at 45 degrees as shown.



ERROR: Inadvertently sanded through plies during finishing process.

REPAIR: Determine number of plies damaged. Repair as shown in 'bump' repair above.

ERROR: Due to incomplete wetting of layup, I have several pin holes in my wing fuel tank so it will not meet leak check.

REPAIR: Pull a mild vacuum (1500 ft) on the tank. Hold the vacuum for 1/2 hour as you brush, stipple, or rub epoxy over the area with pin holes. Then vent tank to equalize pressure. Paint a coat of epoxy over effected area. Be sure tank is vented during cure.

ERROR: Due to a poor or heavy layup, elevator or aileron will not balance to specification.

REPAIR: Start over; sloppy workmanship cannot be patched on these parts.

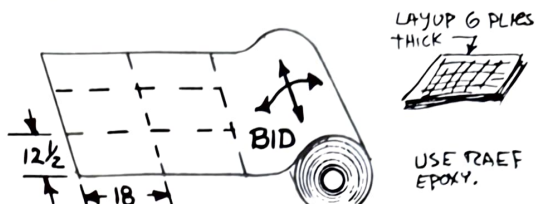
Adding extra systems, night lighting, or extensive avionics. Remember, the COZY is smaller than the average light plane and thus is effected to a greater extent by the addition of excess weight. A light COZY is a thrill to fly and has extensive utility. A COZY that is loaded down with extensive systems, avionics, etc., can be so heavy as to preclude two-place operation and destroy its exciting performance. Resist the temptation to add anything. In an airplane this small, you should be carefully counting grams, not just pounds of excess weight. The best test to decide whether something should go in the airplane is as follows. Take the object in your hand. Toss it up into the air—if it comes down, it's too heavy to belong in your airplane!

Starter. Electric start, while available for the COZY, does compromise it enough so that we recommend against its installation. The engines are easily hand-propped, particularly since you have a pusher with nose-down parking. In this configuration most aspects of manual start are considerably safer than for conventional aircraft—see Owner's Manual. The plastic airplane does not conduct. Thus, your large heavy start cable must run to the battery and back. Electric start adds over 25 lb. weight, most of it aft on the engine. You will initially want to fly your first flights at forward cg and at as light a weight as possible (see Owner's Manual). Therefore, even if you insist on needing electric start, leave the starter and heavy cable out for your initial test flying. This will avoid possible nose ballast (thus a double weight penalty).

FLAT LAYUP

The first practice layup that you will make is a layup of six **BID** plies onto a flat surface. This intended to give you experience in the techniques of glass/epoxy work and to give you a check on your workmanship. You should be able to complete this layup in about half an hour.

Protect your work bench by taping waxed paper over an area about 24 in. (or, find a piece of metal and wax its surface).

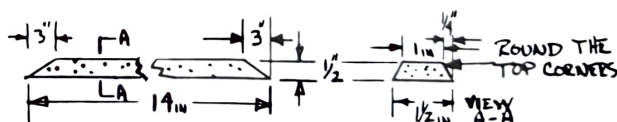


This will keep the epoxy from bonding to the table top. Cut six plies of **BID** that are about 12-1/2 inches by 18 inches. Laminate the six plies on top of the waxed paper. Try to do your best job of stippling and squeegeeing so that the plies are completely wetted but not full of excess epoxy. Let the layup cure to knife trim, about four hours. Carefully mark a 10 inch by 16 inch rectangle and knife trim the layup to that size using a sharp razor blade or trim knife. Allow the layup to cure completely. If you forget the knife trim, cut the cured piece with a coping saw or band saw.

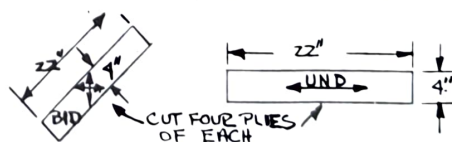
Take the cured 10 in. x 16 in. piece to your post office, or any accurate scale, and ask them to weigh it for you. Your laminate should weigh between 10-1/2 and 12-1/2 ounces. A 10-1/2 ounce layup is about as light as can be done without voids (white areas). A 12-1/2 ounce layup has too much resin, and if you make all of the layups in the airplane this wet, your COZY may be as much as **40 pounds** over weight. An 11-ounce layup is just about perfect. Save this piece: it will be useful material later on.

The second practice layup is one intended to give you confidence in the strength of your work. This layup is a sample of composite sandwich structure and is typical of the load carrying structures in your COZY. When this layup is finished and completely cured, you will subject it to a simple load test and thus demonstrate the strength of your workmanship.

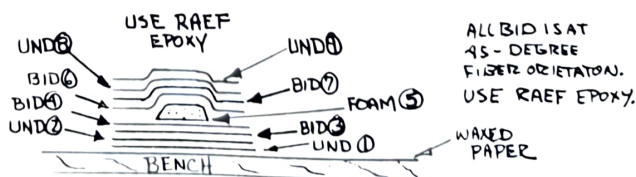
First, tape a piece of waxed paper about 30 inches long to the top of your work table. Shape a piece of green foam as shown.



Go to your glass cutting area and cut the glass plies shown.



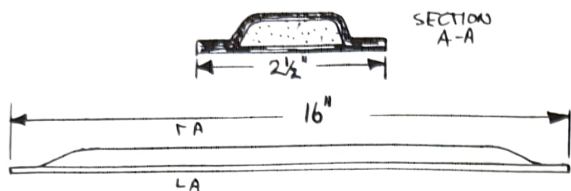
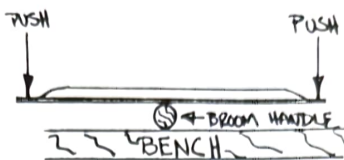
Lay up two plies of **UND**, two plies of **BID**, paint the foam with micro slurry and press it in the center. Then lay up the other **BID** and **UND** plies.



Be careful to work all air bubbles out of the corners. The best way is to stipple with the brush. The glass is oversized so that it can be trimmed to exact dimensions later. Trim to the dimensions shown after curing 24 hours, using a coping saw or band saw.

Allow the piece to cure for four days at room temperature before the load test.

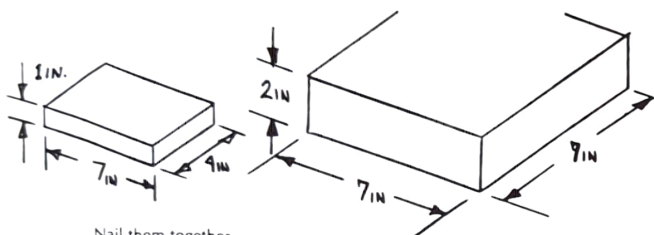
Now for the test: Lay a broom handle or piece of tubing on the work bench and try to break the sample by putting all of your weight on the ends. A 200-pounder will stress the sample more than any part of your airplane is stressed 10 g's!



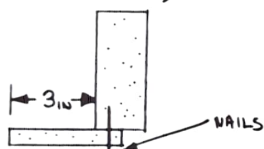
BOOK END

The last practice part that you will make before starting on your airplane is a book end. It takes three layups to make the book end and involves most of the operations that you will need to learn to build your airplane.

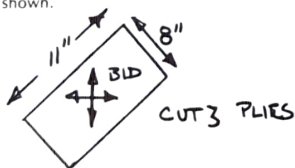
Cut the two blocks of green urethane foam (2 lb/ft³) as shown.



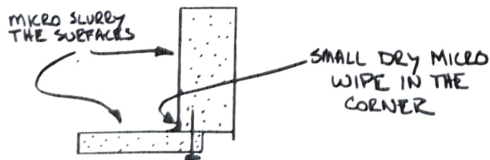
Nail them together.



Cut three plies of BID as shown.

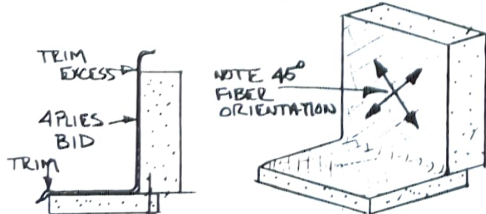


Mix 4 oz. of RAEF epoxy; using about 1 oz., make a small batch of micro slurry and coat the foam as shown. Make dry micro from the leftover slurry and make a small radius with it as shown.

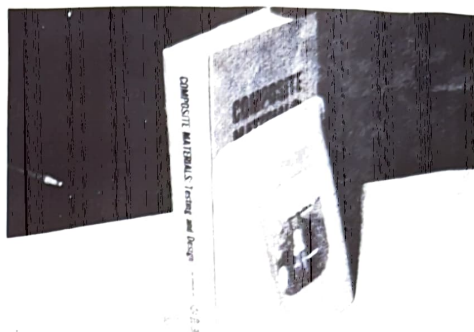


Lay up the first ply of BID as shown.

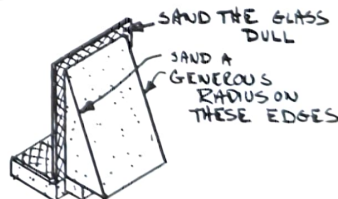
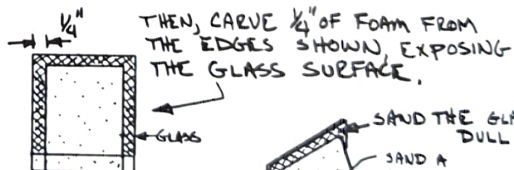
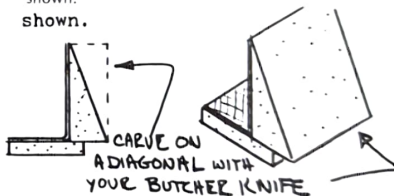
Using plain epoxy (no micro) lay up the other two plies and allow to cure. Note how the 45 degree fiber orientation allows the glass to lay down completely into the small radius.



Knife trim along the foam edges.

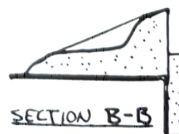
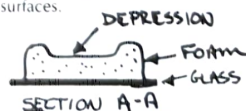
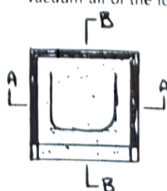


After the first layup has cured and the edges have been trimmed, the thicker foam block is carved and contoured as shown.

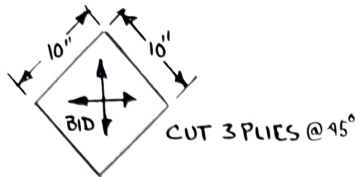


Put a generous radius on the foam edges and sand the 1/4 in. wide glass edges dull for glass to glass bond. Use your wire brush to rough out a depression in the middle of the block.

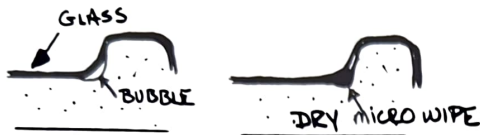
Finish smoothing the depression by rubbing it with a scrap of green foam. Radius the corners of the depression. Blow or vacuum all of the foam dust off the surfaces.



Cut three plies of **BID** as shown.



Mix **RAEF**, make a small batch of slurry and save the remaining epoxy. Slurry the foam surface and apply two plies of **BID** to the contoured surface. Start the layup in the center and work out toward the edges. If you have trouble getting the glass into the depression corners without bubbles, lift the plies and wipe in a little dry micro. You will then find that it will lay smoothly in without voids (see sketch). This depression is sharper than any in your airplane and is intended to give you a feeling of how sharply you can form the cloth.



Before laying the third **BID** ply down, place your favorite photo in the depression, and then lay the third **BID** ply over it. Scissor trim the excess glass cloth. Allow to cure and knife trim the edges.

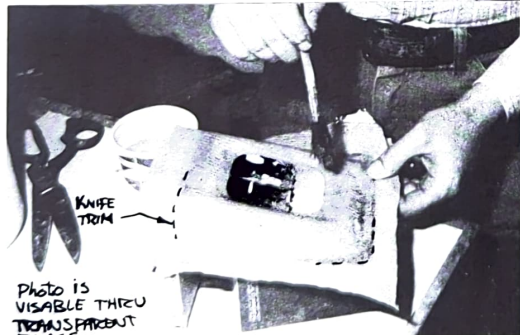
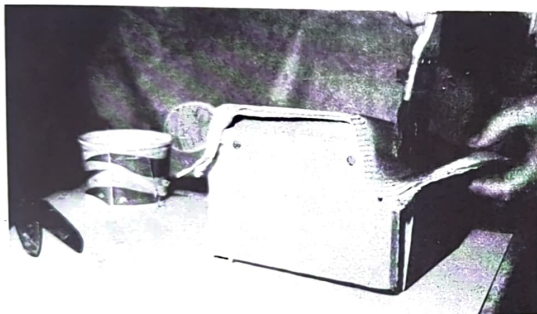


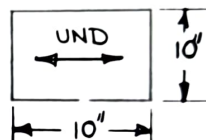
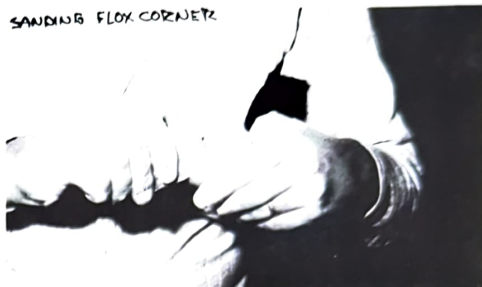
PHOTO IS
VISIBLE THRU
TRANSPARENT
GLASS.

The lower edge is trimmed flush with the bottom of the foam block.

Wait until the second layup is fully cured. Remove the 1-inch foam block with a butcher knife and sanding block. Remove foam for a 1/4 in. floc corner and sand the glass surface dull.

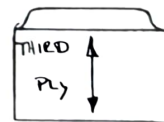
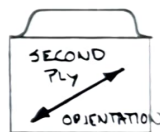


SANDING FLOC CORNER



CUT FOUR PLYS
OF UND

Mix **RAEF**, a small batch of floc, and a small batch of micro slurry. Fill the corner with floc and slurry the foam. Lay up the four **UND** plies with the orientation shown.



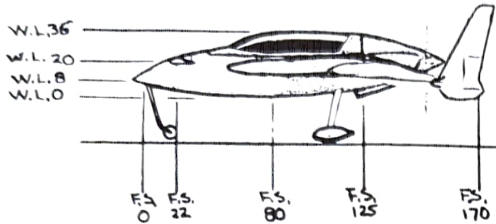
Knife trim the edges. After 12-hour cure, sand the edges with 100-grit sandpaper as required for smoothness and good appearance.

It may at this time seem a bit ridiculous to use three layups, about four hours work, and two days cure, just to make a book end! But remember, this book end was not designed for ease of construction; it was designed instead, to let you get a first hand exposure to the following operations before starting on your airplane: **Glass cutting**, **foam preparation** (slurry), **BID** and **UND** layups (flat surfaces, corners, and compound curves, floc corner, knife trim, concave and convex foam carving, glass to glass surface preparation and sanding edges. So, use this experience to your best benefit and spend the curing time studying the plans. Even if you're experienced in glass layups, the book end is a worthwhile project to get familiar with the workability of the **BID** and **UND** weave cloth.

AIRCRAFT MEASUREMENT REFERENCE SYSTEM

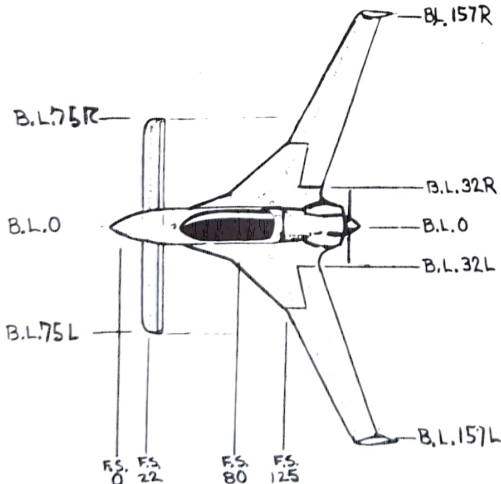
To ease the engineer's task of defining where things go in these odd-shaped gadgets called aircraft, a fairly standard system of references has been developed. Fortunately, the COZY is so simple that an elaborate measurement system is not necessary. It is, however, convenient to use the standard terminology for reference occasionally and you should be familiar with its meaning.

The three basic references are called **butt lines**, **fuselage stations**, and **waterlines**. Don't blame us for the absurd names, we didn't set the system up. All three are given in inches from some arbitrarily chosen reference, so fuselage station 100 is found 100 inches away from fuselage station 0, and similarly for butt lines and waterlines. Being as lazy as anybody else, we abbreviate these as **F.S.**, **B.L.**, and **W.L.** We use these abbreviations with periods, **F.S.**, not **FS**, so that they aren't confused with part numbers like **CS**, which do not use periods.



Fuselage stations (F.S.) are used to define the location fore and aft on an airplane. To make things easy, fuselage station 0 is generally located near the nose of an airplane and measurements are made aft. Fuselage stations are the most commonly used of the references and later on you will make a reference mark on your airplane to use as a **permanent F.S.** reference point.

Waterlines (W.L.) are used to define vertical locations. Waterline 0 is generally found near the ground and measurements are made up from **W.L. 0**. On your COZY the top surface of the fuselage longerons (**W.L. 23**) is used as the vertical reference. Waterlines are utilized in many places to position components or templates relative to each other by leveling reference waterlines with a carpenter's level.



Butt lines define positions inboard and outboard. **Butt line zero** is the vertical centerline of the airplane and measurements are taken to the left and right of **B.L. 0**. Since left and right depends on which way you are facing, it is standard practice to define left and right as the pilot would while seated in the cockpit.

Using these three references, any point in an airplane can be described with a fuselage station, butt line, and waterline. Fortunately, your COZY is so simple that we don't need to locate very many things this way. When you start on your 4/5-scale replica of a C-5A, this reference system will be real handy.

ATMOSPHERIC CONDITIONS

Temperature has the greatest effect on the working properties of your epoxies. Seventy-five degrees Fahrenheit is an ideal temperature. The range from 60 to 90 is acceptable with the precautions mentioned in the section on EPOXY. Humidity has a lesser effect on these materials than it does on aircraft dopes and some paints. Humidity will only create problems if it is over 75%. Don't undertake a layup if it is pouring down rain outside or, if you notice a cloudy 'blush' on the wet epoxy surface, or any evidence of whiteness in the epoxy due to moisture.

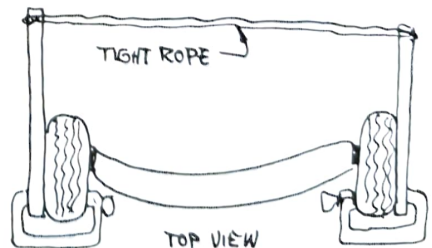
A pneumatic riveter is not required to build your COZY. The hard rivets used can be set with a hammer, using your vise as backup. The 'pop-type' rivets are pulled with a low-cost hand puller available at any hardware store. Note that **Cherry** rivets can be substituted for the **Avex** rivets (bill of materials).

Due to limitations of the printing process used, several of the full size drawings are broken down to more than one sheet. To assemble your full size drawing, trim the edge off one sheet as shown and glue it to the adjacent sheet, lining it up carefully at the lines shown. Be careful to keep all waterlines perfectly straight.

HEAT DEFORMATION AND CREEP

Several builders have had flying surfaces warp or bend due to being poorly supported until fully cured. **Do not** hang or support them at each end for long periods as they may 'creep' or slowly deform. Store them leading edge down with support in at least three places. Your surfaces can be better protected against 'creep' if you post-cure them. Sailplane manufacturers do this by putting the entire airplane in an oven at 160 degrees F. You can do it as follows: After you have painted on the black primer put the wing/winglet or canard out in the sun. Be sure it is well supported in at least three places along its span. At noon a black surface can reach 140 to 180 degrees F, giving it a relatively good post-cure. After the post-cure, the structure is more resistant to warping or creep. If you have a wing or canard that is twisted wrong, apply a twisting force in the opposite direction before and during the post-cure (weights applied to boards Bonded or clamped to the surface can be used). Remove the force only after the surface has cooled. A 200-ft-lb torque (50-lb weight on a 4-ft arm) applied twice, once while the top surface is post-cured and once for the bottom surface, can twist your COZY wing or canard over one degree. The twist correction will be permanent and will stay as long as the surface remains cool (below the post-cure temperature). This is generally referred to as the heat-deformation characteristic of the epoxy. If it is room-temperature cured only, it will soften above 140 degrees F. But if post-cured it will not soften until over 160 degrees F. Heat for post-curing or for intentional deforming can be applied by other means such as heat lamps, hair dryers or electric radiant heaters (household type), however this is generally not recommended, since it is too easy for the homebuilder to get the part too hot and ruin the part. The blue foam is damaged above 240 degrees F. If you want to use these heat sources, do so by applying the heat very slowly and checking the temperature often by placing your hand on the surface. If you can hold your hand on the surface five seconds without pain, the temperature is okay—three seconds is too hot.

Creep is rare on the main gear since this is post-cured. However, the main gear is subject to a continuous high stress over long periods when the airplane is parked. This stress can be greatly relieved if you lift under one wing and allow the gear legs to spring together, then set the airplane back down when you park it. It is doubtful if gear creep will be a problem with the COZY, but if you do notice creep (gradual spreading of the gear) it can be reset by pulling the wheels tightly together with a rope (weight off the gear) heating then cooling the strut, then removing the rope. Another handy use of the heat deformation method is setting toe-in. If you need more toe-in, clamp boards on the wheels as shown, heat, then cool the strut, remove the boards and presto, toe-in that's easier than installing shim plates!



AMATEUR-BUILT COZY

INSPECTION CRITERIA

1.0 Scope

This document has been prepared to assist inspection personnel by providing recommended acceptance criteria and acceptable repair practices for the COZY amateur-built composite sandwich structure.

2.0 Background Information

2.1 Design Criteria

The materials, methods, and practices employed by the amateur builder in the construction of the COZY type are new to light aircraft construction and may be unfamiliar to the inspection personnel involved with the licensing of amateur-built aircraft. Structural design criteria for the COZY are similar to those of the Long-EZ, which exceed F.A.R. part 23 requirements. Component testing of the primary flight structure of the Long-EZ has been conducted to 200% of design limits. Detail documentation of test data is on file at Rutan Aircraft Factory. The COZY is considered to be a normal category aircraft. COZY builders will be supplied with a complete owner's manual which specifies all placards, operating limitations, normal and emergency operations, flying qualities, maintenance specifications, inspection procedures, and initial flight test procedures.

2.2 Structural Approach

The basic structure throughout the design is a composite sandwich of load bearing fiberglass skins separated by a light-weight foam core. While the materials and processes are tailored to the amateur builder, the structural layout is very similar to the honeycomb composite structures utilized in military and transport type aircraft and fiberglass sailplanes. Loads are carried by epoxy/E-type fiberglass lamina. Foams of various types and densities are employed as a form (upon which the load bearing material is shaped) and as local buckling support. In no instance are foams used to transmit primary loads, as is the case in some other amateur-built designs.

2.3 Inspection Techniques

The transparent nature of the fiberglass/epoxy material allows for visual inspection of primary structure from the outside prior to finishing. Defects in the structure, as described in paragraph 3.0, are readily visible even in the deepest laminate.

2.4 Inspection Sequencing

The external visual inspection capability provided by the materials allow inspection of all primary structures at any point before finishing. All primary structures are at the surface, eliminating the requirement for 'pre-cover' or 'closure' inspections. Opaque filler materials are used throughout the airplane in finishing, and inspection must take place before any areas are obscured. Some areas may have opaque materials applied to one surface where the structure is inspectable from the opposite side (wing trailing edge for example).

3.0 Defects

3.1 Voids

Interlaminar voids in a new layup may be due to small air bubbles trapped between plies during the layup. These void areas look white and are distinctly visible even deep in a cured layup. Interlaminar voids up to 1 inch in diameter do not require repair, as long as they do not consist of more than 5% of the surface area.

Interlaminar voids (air bubbles) up to 2 inches in diameter are acceptable when repaired as follows: A small hole is drilled into the void and epoxy is injected into the void area. Small voids such as this may occupy up to 5% of the laminate surface area.

Voids greater than 2 inches in diameter should be repaired as shown in paragraph 4.

3.2 Lean Areas

Areas where the epoxy/glass matrix is incomplete because of inadequate wetting of the cloth with epoxy (lean area) are speckled whitish in appearance. The fully wetted laminate will have a consistent transparent greenish appearance. Epoxy lean areas are acceptable, as long as the white speckles area is less than 10% of the surface area. White to green ratios greater than 10% require rejection or repair as shown in paragraph 4.

3.3 Rich Areas

Resin richness primarily adds weight to the laminate. While some degradation of physical properties does occur, an overly wet (rich) layup is not grounds for rejection.

3.4 Inclusions

Bristle paint brushes are used throughout the layup process. As a brush begins to deteriorate, it will shed some bristles into the laminate. The bristle inclusions, up to 20 bristles per square foot, are not cause for rejection. Occasional inclusion of small woodchips or other small foreign objects is not grounds for rejection.

3.5 Fiber Disruption

In all instances, it is good practice to have the glass fibers lying flat and without wrinkles. Major wrinkles or bumps along more than 2 inches of chord are cause for rejection in the wings, canard, and winglets, particularly on the upper surfaces (compression side). Disruptions greater than 2 inches require repairs per paragraph 4.

3.6 Finishing Damage

Damage to the external structure by sanding in preparation for surface fill and paint can occur. Occasional sanding through the weave of the first skin ply is not grounds for rejection. Sanding through areas greater than 2 inches in diameter completely through the first ply or any damage to interior plies must be repaired in accordance with paragraph 4. A damp rag passed over the sanded surface will make the plies show up to determine how many plies have been sanded away.

3.7 Service Damage

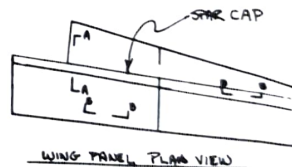
Damage to the glass structure will be evidenced by cracked paint, or 'brooming' of glass fibers. Both of these indicators are clearly visible. If either type of indication is present the paint and filler should be sanded away, bare laminate inspected, and repairs made per paragraph 4 as required. Where surface damage has occurred, it is also likely that local foam crushing has been inflicted.

3.8 Delaminations

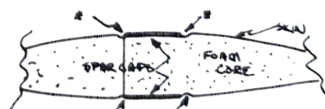
Delamination of glass/epoxy lap joints is evidenced by physical separation of plies. These defects are easily visible and easily repaired. The leading and trailing edges of flying surfaces (wing, canard, winglets) should be free of delaminations.

3.9 Multiple Defects

Where multiple types of small defects occur in a laminate (voids, fiber dislocations, and lean areas for example). They should not exceed a total of 10% of the surface area of the laminate, or 20% of the wing chord at any one spanwise position.

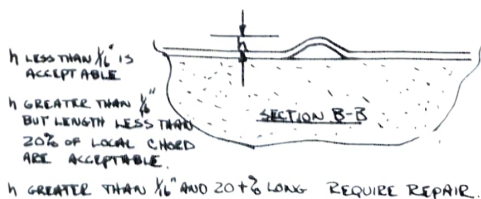


WING PANEL PLAN VIEW



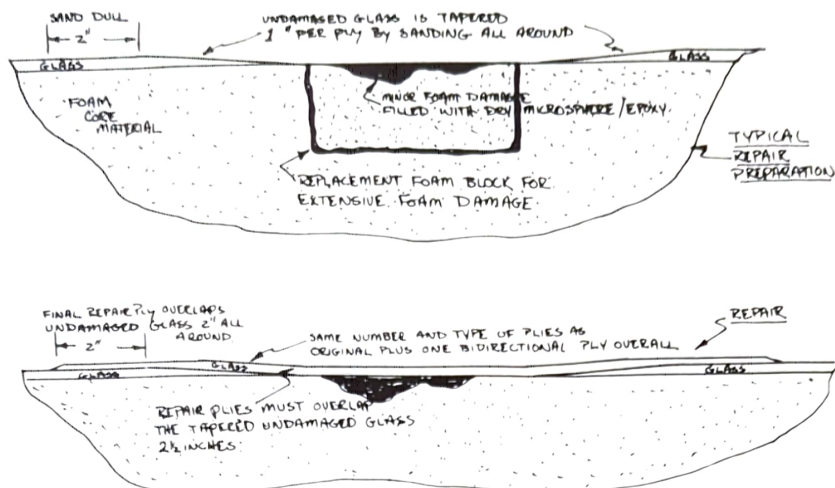
SPANWISE WRINKLES IN THE SURFACE IN THESE AREAS ARE NORMAL AND ACCEPTABLE.

SECTION A-A



h GREATER THAN 1/16" BUT LENGTH LESS THAN 20% OF LOCAL CHORD ARE ACCEPTABLE.

h GREATER THAN 1/16" AND 20% LONG REQUIRE REPAIR.



4.0 Repairs

There are seldom single defects so massive that a major component must be scrapped. The repair procedures described here may be applied throughout the COZY composite sandwich structures.

4.1 Small Void Repairs

Voids up to 2 inches in diameter may be repaired by drilling a small hole into the void and injecting the void full of epoxy. A vent hole opposite the injection point is required to allow air to escape.

4.2 Large Defects

Excessively large voids, lean areas, finishing damage, fiber disruptions, major fiber wrinkles, or service damage may be repaired using this procedure. Remove the rejected or damaged area by sanding or grinding and taper the glass laminate on a slope of approximately 1 inch per ply in all directions. The plies are visible as the sanding is done. The tapered glass edges and surrounding two inches of glass surface must be sanded completely dull. Damaged underlying foam should be removed and the void filled with a dry microsphere/epoxy mixture or a replacement foam piece. The damaged area is then laminated over using the same type and orientation of glass plies removed, each ply lapping onto the undamaged glass at least one inch. The whole repair area is covered with an additional bi-directional glass ply.

4.3 Delaminations

A delaminated joint should be spread, the mating surfaces sanded dull, gap filled with flox (epoxy/flocked cotton mixture), then clamped shut while it cures.

5.0 Materials

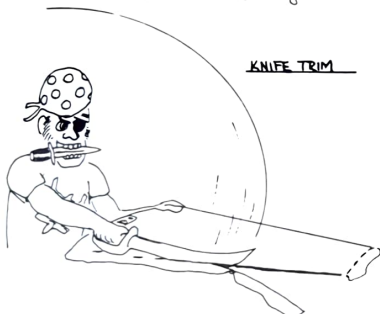
Since a wide range of similar appearing materials exists which exhibit substantial differences in physical (structural) properties, Co-Z Development Corp. has established a distribution system to provide the amateur builder with proven acceptable materials. Co-Z strongly discourages the substitution of materials. Homebuilder substitutions for the basic structural materials constitutes major structural modification to the COZY design, and could adversely effect flight safety.

6.0 Applicability

These acceptance criteria are different from and in some cases, much looser than for similar structures found in sailplanes and other contemporary composite structures. These criteria apply to the COZY and are the same as those applying to the Long-EZ and VariViggen structures. Design safety factors in excess of three enable somewhat relaxed acceptability criteria compared to other similar structures.

Education Supplement

Rip this page out of your plans and staple it to the wall of your shop. While it is a handy reference, it's still a good idea to read all the words in the education chapter once in awhile. Don't skip the details - they're all important.



URETHANE FOAM SHAPING

BASIC TOOLS: Sharp butcher knife, sanding block, surfboard file, wire brush and blocks/scrapers of urethane. Use a dust mask. Hack away, have fun.

HOT WIRE CUTTING STYROFOAM

Hot wire tool has two lengths: 62" for wings and 43" for winglets, canard and elevator. Wire must be tight. The adjustable voltage control is best, but the job can be done with 2 12-volt, 6-amp battery chargers or 12-volt car batteries. Foam block must be well supported and weighted. Templates must be nailed on tight. First cut the basic block to size; this determines the planform size and shape. Level the template level lines; this determines correct twist. Set hot wire temperature for about 1" travel through the foam in about 4 to 6 seconds with light pressure. Do the actual cutting at about 1" every 6-7 sec. (8-10 sec. around the leading edge). Practice on scraps first.

HARDWARE SKETCHES

AN3 3/16" dia bolt AN509 flush head screw AN525 washer head screw
AN4 1/4" dia bolt

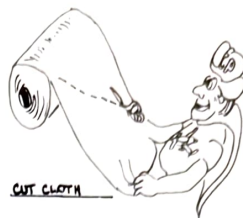


all metal lock nut MS21042 plain washer AN960 wide washer AN970



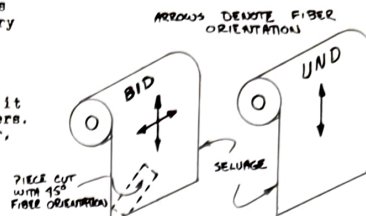
BASIC LAYUP PROCEDURE

- 1. PREPARATION:** Ply 9 or gloves on hands, shop temperature 75° ± 10°
- 2. CLOTH CUTTING:** You can get by with just a standard pair of good fabric scissors, but the job is much easier with the large pair of industrial scissors (Weiss model 20W). They're \$20 (gulp!) but worth it in the long run.



- 3. SURFACE PREPARATION:**
Foam - Hot-wire-cut surface needs no preparation. Sand ledges or bumps even, fill holes or gouges with dry micro immediately before the lay-up. Brush or blow away dust.
Glass - Always sand completely dull any cured glass surface (36-grit or 60-grit sandpaper). Resand if it has been touched with greasy fingers.
Metal - Dull with 220-grit sandpaper.

- 4. MIX EPOXY:** Follow all mixing steps shown on your epoxy balance. Mix two minutes, 80% stirring and 20% scraping the sides and bottom. Don't mix with a brush.
• Micro Slurry - Approx equal volumes of mixed epoxy and microspheres
• Wet Micro - Enough microspheres for a "thick honey" mix
• Dry Micro - Enough MICRO
• Wet Flox - Thick, but pourable mixture of epoxy and flocked cotton



APPLY TO SURFACE:

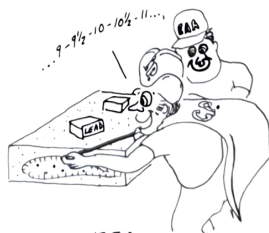
Layup Over Foam - Brush or squeegee on a thin micro slurry layer (thick over URETHANE)
Layup Over Glass - Brush on a coat of epoxy.

- 5. LAY ON CLOTH:** Pull edges to straighten wrinkles. If working alone on a long piece, roll the cloth, then unroll it onto the surface.
- 6. WET OUT:** Don't slop on excess resin; bring epoxy up from below with a vertical "stab" of the brush ("stippling"). Start in center and work out to sides. Most of the time of a layup is spent stippling. Stipple resin up from below or if required, down from above. "NOT WET, NOT WHITE."

EASTERN = HOT CUP: THERMAL CUP AWAY! 4 IN. MORE.



- 7. SQUEEGEE:** If you have excess resin, squeegee it off to the side. Use squeegee with many light passes to move epoxy from wet areas to dry areas.
- 8. PRELIMINARY CONTOUR FILL:** Save sanding by troweling dry micro over low areas while the glass layup is still tacky. This is done at trailing edges, spar caps, or over any low areas. The low places are overfilled with micro then sanded smooth after full cure.
- 9. KNIFE TRIM:** Save work of sawing and sanding edges by razor trimming the edges at the "knife trim stage," which is about 3-4 hours after the layup.
- 10. GENERAL INSPECTION:** Take a good look for dry glass, excess resin, bubbles, and delamination before walking away from your wet layup.
- 11. CLEANUP:** If you've used ply 9 skin barrier, you can get all epoxy off your hands with soap and water. Epocleanse is also excellent for removing epoxy and it returns natural skin oils. Brushes - rinse twice in MEK and wash with soap and water. Throw away after two to four uses.



THE SIZE AND SHAPE OF THE FORM BLOCK DETERMINES THE PLANFORM



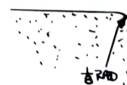
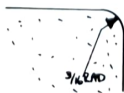
ALIGN THE TRAILING EDGE FORM TRIM LINES

LEVEL THE WATERLINE TO SET TWIST



Don't put foam or epoxy in the sun. Keep structure out of the sun until it's protected with the ultra violet barrier.

MINIMUM RADIUS FOR GLASSING OUTSIDE CORNERS



QUALITY CONTROL CRITERIA/REPAIRS
See the Education section

CHAPTER 4

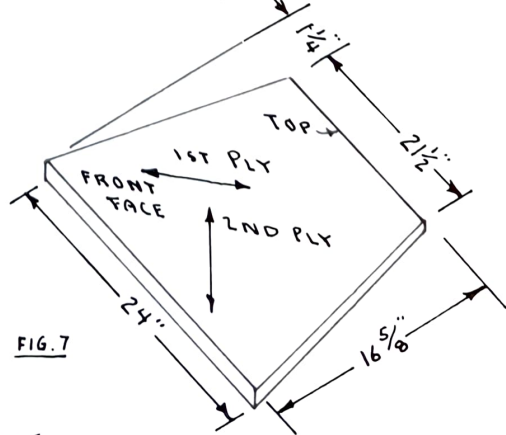
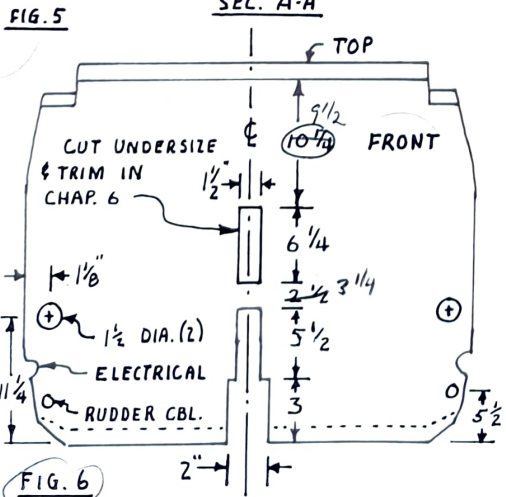
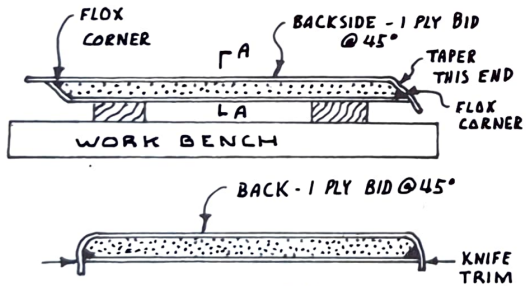
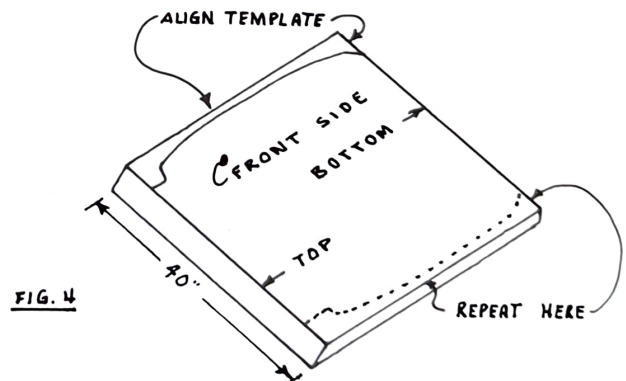
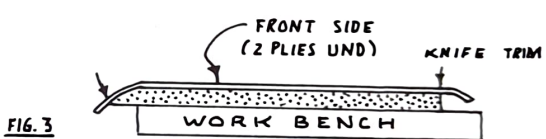
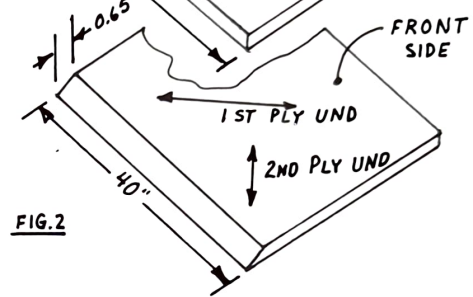
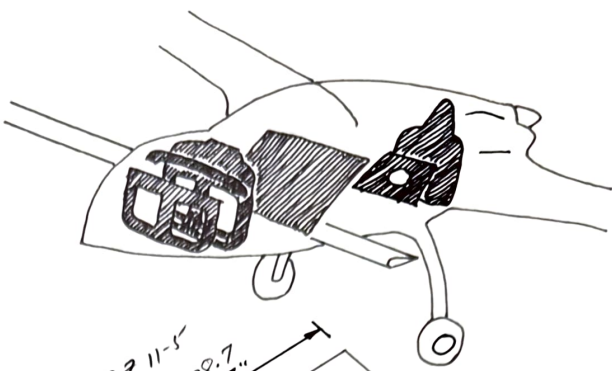
FUSELAGE BULKHEADS

OVERVIEW. In this chapter you will manufacture the six bulkheads which go into your COZY fuselage. Two of the bulkheads are your front and rear seat backs. Another is the instrument panel, and still another is the firewall. The remaining two bulkheads are forward and mount the canard. 0.2 in. thick, white, high density, Clark foam is used for the instrument panel and the two forward bulkheads. 0.75 in. thick, pink, low density, Divinycell foam is used for the seat backs, and birch plywood is used for the firewall. You will find that there are many short jobs in this chapter with cure cycles in between, so you may want to work on several of the bulkheads simultaneously to maximize your progress. Approximately 20 man hours are required for bulkheads.

STEP 1. FRONT SEAT BULKHEAD

Refer to Chapter 5 to see how the bulkhead fits in the fuselage. Because it is inclined at approx. 50 deg., both the top and the bottom edges are angled, as well as the notches for the longerons, and the holes passing through the bulkhead. Cut a rectangular piece of low density, pink, Divinycell foam 28.7 in. x 40 in. (Fig.1). Save the scraps, you can use them later. Now taper and round one edge as shown (Fig.2). Mix up some micro, stiff enough so it just flows, and squeegee it over the side to be glassed. Don't leave any excess. Now cut 2 plies of UND and glass over the front side and tapered end (the side you just microed, I hope!) (Fig.3). After partial cure, knife trim flush with the foam edges all around.

Now cut the template (better yet, trace it) from drawing A-5, which describes the correct shape of the right and left edges for a snug fit against the fuselage sides. Align the template with the bottom and side edges of the foam, trace, and trim the bulkhead (Fig.4). Visualize how the bulkhead will be inclined at 50 deg., and cut at this angle--at least the longeron notches. Repeat for both edges. Now flip the seat back front down, and taper the bottom edge (Fig.5). Round the corners to be glassed around, and make flox corners everywhere the glass surfaces will meet. Squeegee micro all over the remaining bare foam, and glass with one layer of BID with fibers at 45 deg. Scissor trim excess glass, and prop bulkhead up so glass edges can hang down unobstructed. Peel ply around edges and trim after cure. Cut holes where shown (Fig.6), angled so they will be horizontal when seat back is installed. Note that the map pocket hole should be cut undersize and trimmed to size after the pocket is installed in Chapter 6.



STEP 2. THE REAR SEAT BULKHEAD

This bulkhead closes the rear of the cabin compartment and provides structural support for the main gear attach structure (See drawing A-12). A large hole in the center provides access to the enclosed space. It looks complicated, but if you follow the steps, it will turn out O.K. It is (must be) symmetrical about its longitudinal axis.

Cut a 0.75 in. thick piece of pink Divinycell foam to the dimensions shown (Fig.7). Spread and squeegee micro on the front face and glass with 2 plies of UND at 45 deg. Second layer crossing the first. Knife trim all around after partial cure. After full cure, taper the top and bottom edges as shown (Fig.8), so the bulkhead will fit flush with the center section spar at the top, and with the floor at the bottom. See also Chapter 5 and drawing A-12. Now use a butcher knife and sanding block to remove the foam at the side edges as shown (Fig.9). This provides a strong edge and allows the bulkhead to set back in the correct position in the fuselage.

Use your knife to remove foam from the rear down to the front glass surface in a 8 in. dia. circle centered in the bulkhead (Fig.10). Round all foam edges, sand bare glass surfaces dull, micro the bare foam, and glass with 2 plies of BID at 45 deg. Use a saber saw to cut the 7 in. dia. hole (access to enclosed compartment). See (Fig.11). Then cut the notches for the lower longerons and holes for controls, gear removal, etc.

STEP 3. THE INSTRUMENT PANEL AND TWO FORWARD BULKHEADS

Full size patterns for the instrument panel, F-22, and F-28 are shown on drawings A-1, and A-3. These are made from 0.2 in. thick, white, high density Clark foam. The sheets are not large enough to cut out the complete bulkheads from one piece, so cut out pieces and glue together with 5-min. epoxy as indicated by the dashed lines (Fig.12). After cure, remove any bumps of epoxy, and before proceeding, check bulkheads to make sure the shape agrees with the drawings. If not, trim or add foam as required.

Now, squeegee micro on the aft faces of the bulkheads, and layup 2 plies of BID at 45 deg. orientation over the instrument panel, F-22 & F-28, and a third ply of BID to the instrument panel above the leg cut outs. Now layup one horizontal ply of UND on F-28, and above the leg cutouts of the instrument panel. While F-22 is still wet, press the doubler in place, micro the aft face and glass with 2 plies of BID at 45 deg. and one ply of UND horizontal, lapping 1 in. onto the previously glassed area. Peel ply the instrument panel for a smooth finish, and weight the bulkheads down flat for cure. Use peel ply and wax paper so the weights won't bond to your layups.

Now, flip bulkheads over, micro, and glass the forward faces. F-28 gets 2 layers BID at 45 deg. and 1 layer UND horizontal (Fig.13). The instrument panel gets 2 plies BID overall and one UND horizontal above the leg holes. F-22 gets 2 plies BID overall, one UND horizontal above the leg holes and then extra local build ups of 5 UND and 4 BID as shown (Fig.14). After part cure, knife trim, or saw trim after full cure. Cut all holes except instrument and avionics holes you are uncertain about. You can do those later.

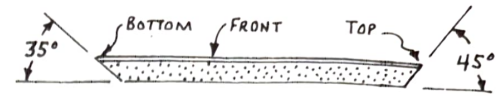


FIG. 8

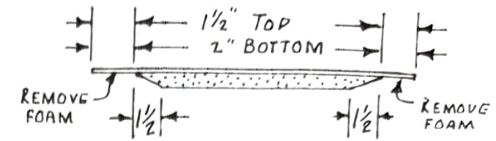


FIG. 9

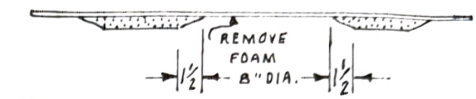


FIG. 10

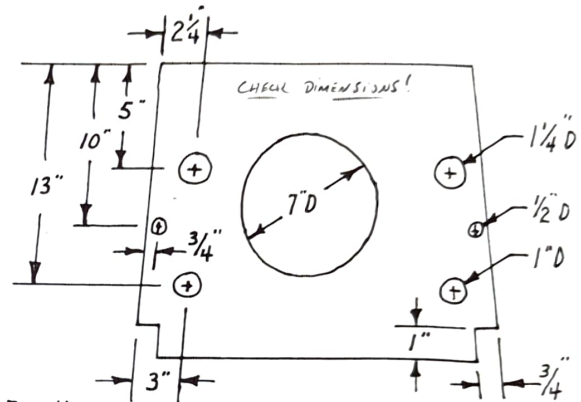


FIG. 11
NOTE: C2 6-3

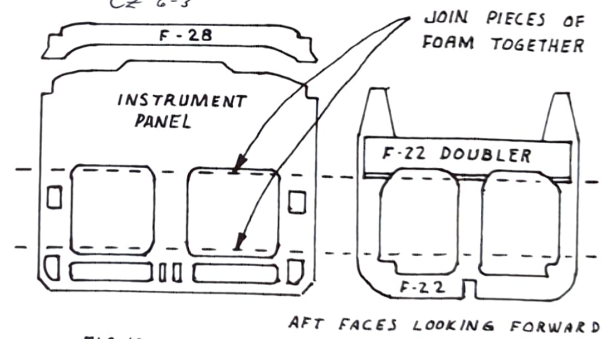


FIG. 12

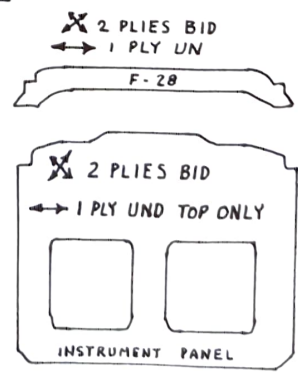


FIG. 13

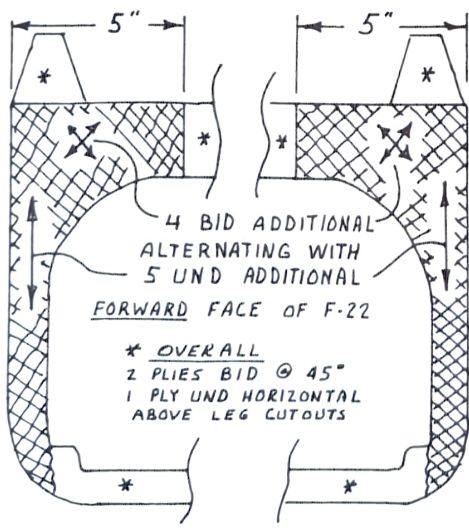


FIG. 14

For added stiffness, two horizontal and two vertical ribs are added to the forward face of the instrument panel. See drawing A-1, and (Fig.15). Sand with 36 grit and 5-min. epoxy 1-in. x 1/4 in. strips of foam where shown on A-1. Glass per detail (Fig.15). The ribs also serve as channels for electrical wires.

STEP 4. FIREWALL

A full size layout of the firewall is shown on drawing A-4. The firewall is made of 1/4 in. birch plywood, covered on both sides with 1 ply of BID and, after permanent installation, is covered on the aft face with 970-F Fiberfrax 0.04 in. thick, and then with 0.016 in. 2024 aluminum. It is installed temporarily during fuselage assembly (or a mock firewall made from 1/4 in. fir plywood may be used), but not installed permanently until after the centerspar is installed in Chapter 19. Note that there are 3 cutouts, which are replaced with 1/4 in. low density foam, to save weight in non-structural areas, and a 4th, circular one, cut at 45 deg. for oil filter clearance. The latter is left open until after the firewall is permanently installed.

The firewall is wider than 24 in., so it will be necessary to splice a small strip on either side with 5-min. epoxy (Fig.16), but it is better to do this after all the cutting is completed. You will get plenty of practice with your saber saw cutting all the curves. I like to use a piece of narrow fine-toothed band saw blade in my saber saw. It's cheap, and cuts curves much more easily. For the cutouts, drill a pilot hole first for the saw blade.

After all the cutting is completed, glue the side strips on (Fig.16). After cure, trace the 3 cutouts onto 1/4 in. low density white foam, cut them out and tack them in place with 5-min. epoxy, **flush** with the plywood. Now cover the **aft** face with 1 ply of BID. Scissor trim to 1/4 in.. If the plywood is at all bowed, cover with peel ply, wax paper, and weight (or nail) it down to your workbench **flat**.

After cure, trim off the excess glass and trace the outline of the firewall onto your Fiberfrax and 0.016 in. aluminum, and then cut them to shape. **Do not** cut lightning holes or longeron holes thru the Fiberfrax and aluminum. **Do** cut holes for the engine mount extrusions (see drawing A-4), the torque tubes, the rudder cables, the electrical wires, and the oil filter recess. Cut the hole for the oil filter recess 1/4 in. undersize, so the edges of the aluminum can be bent into the hole. Cut the aluminum 1/4 in. oversize at the centerspar sides, so the aluminum can be bent around the plywood edges.

Now clamp the firewall down on your workbench (fiberglassed side down) **on top** of the Fiberfrax and aluminum and drill the six No. 10 holes for the blind screws and countersink them on the **forward** face (should still be on top). Now put the aluminum and Fiberfrax away in a safe place until Chapter 19.

Now take your six AN 509-10R12 screws, grind a couple of flats on the side of each head (so they won't turn), floss them in place thru the **forward** face, and glass the forward face with 1 ply of BID. Fill the screw heads with epoxy so they bond to the glass. Knife trim and cure. Now you are ready to take on the fuselage sides. Exciting, isn't it?

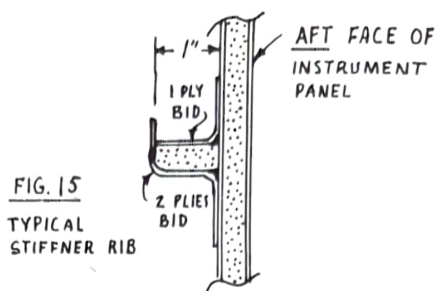


FIG. 15

TYPICAL
STIFFNER RIB

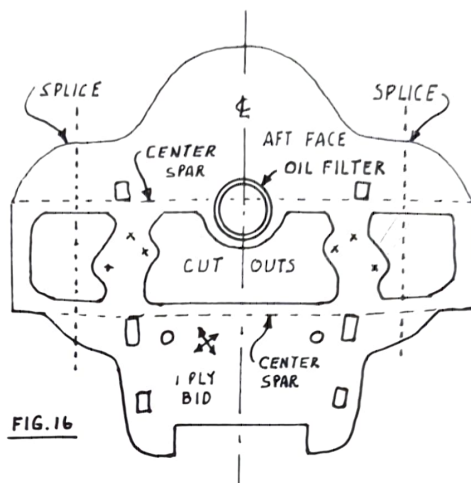
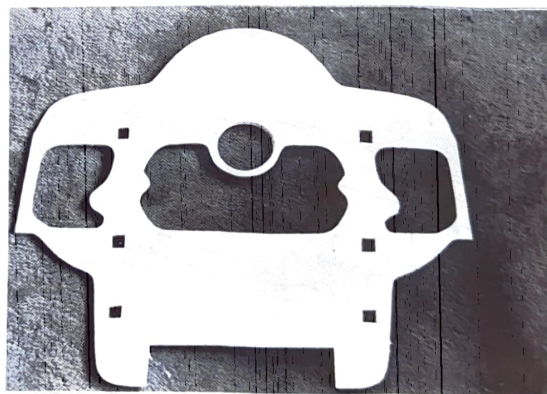
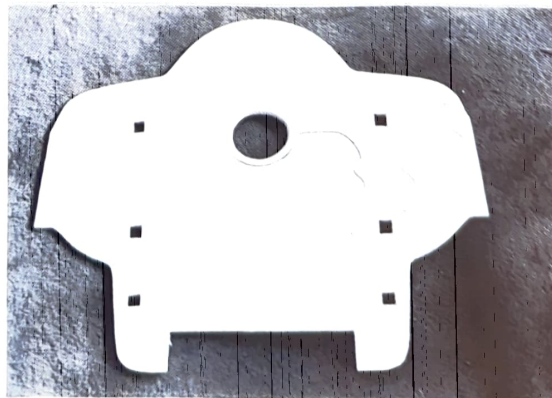


FIG. 16



Firewall cut out and pieces spliced together.



Foam inserted in cutouts and ready for glassing.

CHAPTER 5

THE FUSELAGE SIDES

OVERVIEW. In this chapter you will manufacture the sides of your fuselage. You will start by making jigs to provide the correct fore to aft curvature of the fuselage sides. The upper longeron jigs will first be laid flat on your work table so that the upper longerons may be laminated together with the correct curvature. The jigs will then be mounted upright on the worktable and covered with 1/8 in. masonite to provide a form for the fuselage side layup. Then 3/8 in. thick, pink, low density Divinycell foam is laid in the form and cut to the correct profile. Spacers of 3/4 in. low density Divinycell foam are glued to the top and bottom edges, landing gear-center spar cut out area, etc. The inside surfaces are contoured, that is, the spacers are beveled, fuel sight gage areas carved, depressions carved for stick clearance, etc. The inside surface receives a 2-ply UND skin and, while the layup is wet, the upper longerons are floxed in position. After cure, some local beef up is added to the upper longerons, the lower triangular longeron is installed, and local beef up to the landing gear and center spar attachment areas added. The area where the center spar mates to the fuselage is opened and the main gear attachment fittings are installed (Fig.1). The outside foam surfaces are left bare until after assembly of the fuselage is completed in CHAPTER 6.

STEP 1. CUTTING THE JIGS AND LAMINATING THE TOP LONGERONS

C2-7-3 3/4 x 2 FT x 8 FT

For this step, you will need either a piece of 3/4 in. x 2 ft. x 8 ft. plywood or 2 pcs. of 1 in. x 12 in. x 8 ft. pine board. Layout and accurately cut the fuselage jigs shown on page 5-2. Jigs FJA, FJB, and FJC will be used to laminate the top longerons to the required curvature. Lay two sets of these jigs flat, back-to-back along the centerline of your worktable, checking to see that they measure 103-1/8 in. total length, and spread the FJAs 1/2 in. at the forward end only and the FJCs 1/2 in. at the aft end only (Fig.3). Fasten securely in place with several nails. Apply duct tape on the table along the edge of the jigs (so you don't epoxy the longerons to the table). Take 6 pieces of 1/4 in. x 1 in. x 105 in. spruce from your kit (Fig.2), mix up some epoxy, paint the mating surfaces with epoxy, and clamp them (3 strips per side) in place tight against the jigs (Don't epoxy them to the jigs!). Nails driven into the table can also be used to hold the longerons in place (Fig.3). Allow a smooth transition curve where FJB meets FJC, and let the excess extend aft. After cure, take the 60 in. x 0.4 in. x 0.7 in. wood stiffeners (Fig.2), taper the ends as shown, saw cut 0.45 in. deep at 3/4 in. intervals for 8-1/2 in. starting 19 in. from the forward end so they can be bent to conform to the same curvature as the longerons. Make sure you make **one right and one left**. Epoxy them in place, using flox, on top of each longeron as shown, fastening them until after cure with 2 in. long finishing nails (Fig.3 and section A-A). Don't try to drive the nails into the wood, rather, predrill holes. After cure, remove the nails with pliers. Let cure for 24 hrs. **minimum**.

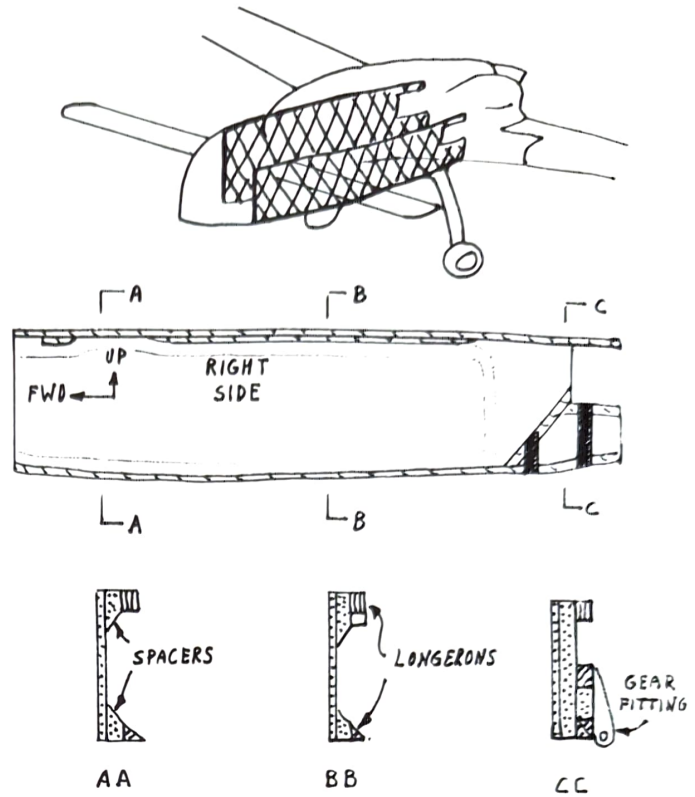


FIG. 1

WOOD PARTS - AIRCRAFT SITKA SPRUCE

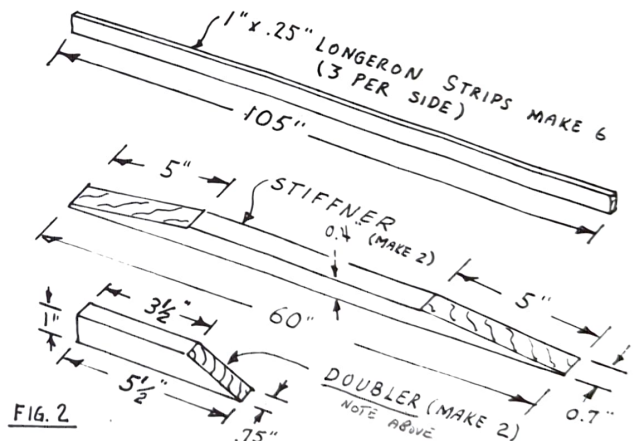


FIG. 2

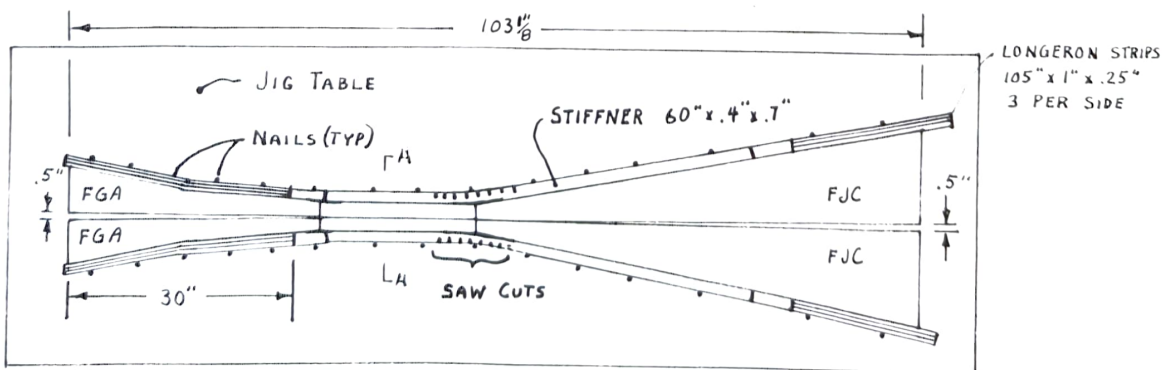
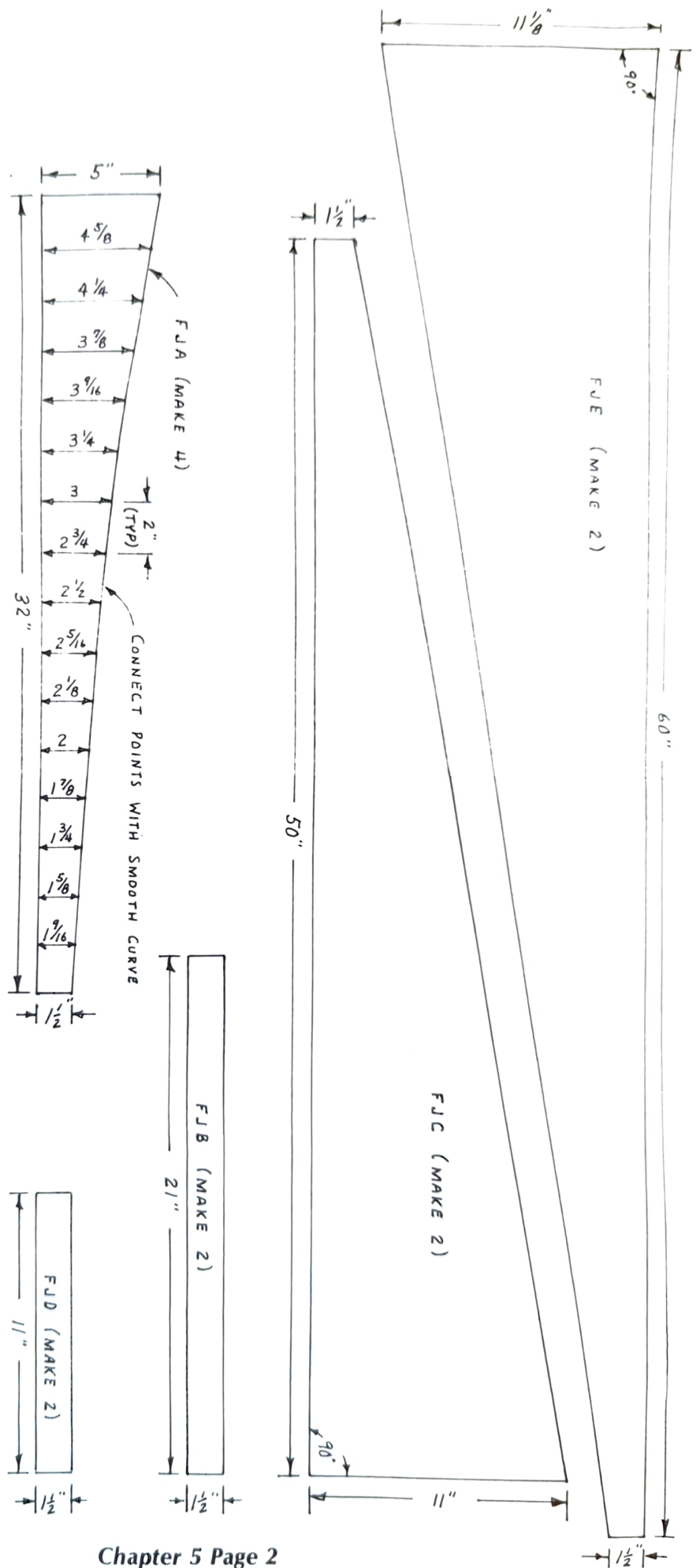


FIG. 3



FUSELAGE SIDE PLIGS
 MATERIAL: 1" PINE OR 3/4" FIR PLYWOOD

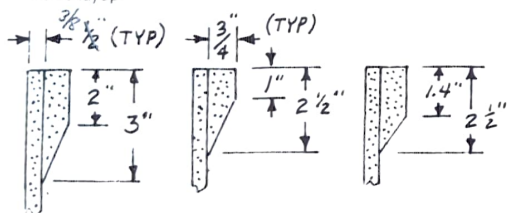
STEP 2. BUILDING THE FORMS FOR THE FUSELAGE SIDES AND PREPARING THE SIDES FOR CONTOURING

You will need one sheet of 1/8 in. x 4 ft. x 8 ft. masonite (hardboard). The two sides are mirror images of one another, so they will be built simultaneously. Erect the jigs which you made in STEP 1 on the table as shown (Fig. 4). Bondo them in place. Now cut two pieces of 1/8 in. masonite and 3/8 in. thick Divinycell foam to the dimensions of the fuselage side shown (Fig. 5). You will have to piece together both the 1/8 in. masonite and the 3/8 in. foam to meet the 104-1/4 in. length. 5-min. epoxy works well for this purpose. Note the 1/2 in. taper along the top edge. This is necessary because the sides have a slight twist, and this edge will form a straight line when the sides are pressed down against the jigs. Connect the points along the bottom with a smooth curved line. Now lay the masonite pieces on top of the jigs, leaving a 7/8 in. gap between the top edges (Fig. 6). Scraps from the 1 in. x 12 in. pine board work fine for spacers. Check that the top edges are straight and parallel with a uniform gap and nail the masonite to the jigs. Now lay the 3/8 in. foam on the forms using a few dabs of 5-min. epoxy at the ends and at the bend to hold them down and in place. Use weights, or you won't have enough hands!

Now cut spacers from 3/4 in. Divinycell foam as indicated (Fig. 7). These are needed to give the inside a hollowed-out shape and at the aft end, to support the landing gear attach structure. You can cut them at 45 deg. on your band saw and then sand them to the angles shown in the cross sections. The spacers along the bottom can be cut straight and then bent to conform when installed. Micro the spacers in place, holding them in place with small finishing nails (angled) until cured.

STEP 3. CONTOURING THE INSIDES

layout the depressions for the control sticks (both sides, Fig.7 and section D-D). These allow extra hand room around the sticks. Dish 1/4 in. deep with 36 grit sandpaper. Refer to the dimensions for the fuel sight gage depressions (Fig.7, section F-F). Also refer to Chapter 7 and 21 to see the function of these. Note how the depression is tilted to face the pilot. All foam is later removed in this area so the fuel may be viewed through the translucent skins. After carving, apply a 2-1/2 in. strip of shiny surface grey duct tape to this area so the layup does not bond to the foam. 5-min, a strip of 0.016 in. aluminum over the electrical wiring channel after rough sanding the aluminum surface, to support the layup (Fig.7, section G-G). Round all foam edges so the glass cloth will conform. Trial fit the previously laminated upper longerons to the sides to make sure the fit will be good after glassing. If everything was done correctly, no adjustment should be necessary. Everything should now be ready for the inside layup.



The diagram illustrates a three-story building frame with the following dimensions and member labels:

- Overall Dimensions:**
 - Height: 48' (16' per story)
 - Width: 103 1/2'
- Member Labels:**
 - Columns:** Labeled FGA, FJD, and FJE on the left side of each story.
 - Beams:**
 - Top story: Labeled FJB and FJC.
 - Middle story: Labeled FJB and FJC.
 - Bottom story: Labeled FJB and FJC.

FIG. 4

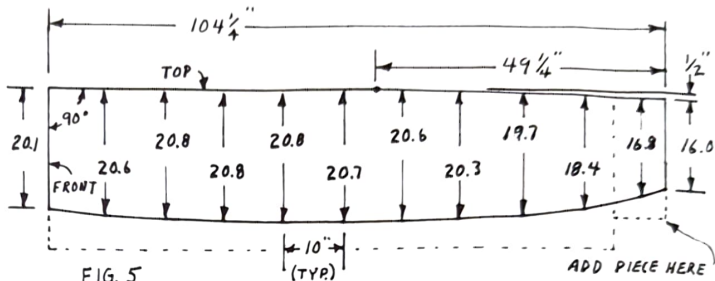


FIG. 5

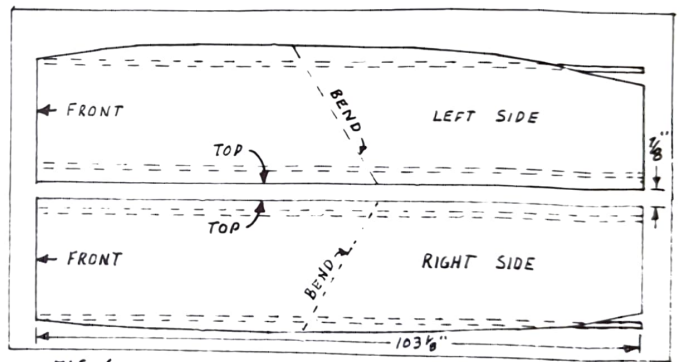


FIG. 6

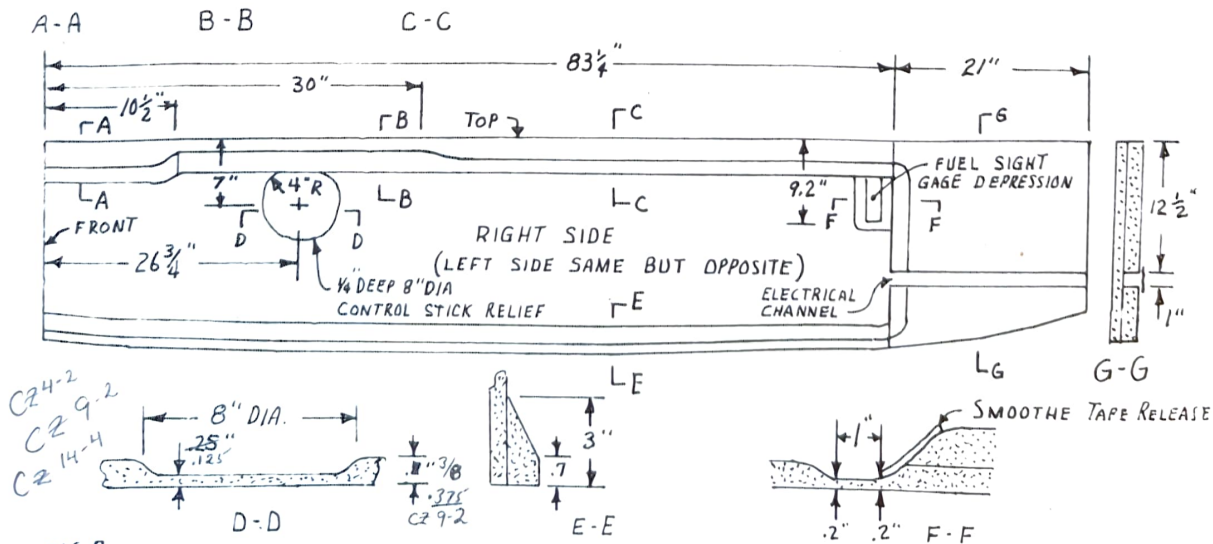


FIG. 7

STEP 4. INSIDE LAYUP AND INSTALLING THE UPPER LONGERONS

This step should take you about 3 to 4 hours. An assistant is handy in helping to place the glass cloth. Check over the foam once more to be sure the 3/4 in. spacers are tapered correctly (a slight dish is preferred), the depressions for the sticks are correct, fuel gauge sight glass taped, sharp edges radiused, etc. Vacuum the top surface of the foam to remove all sanding debris and dirt. Now mix a slurry of micro and apply over the entire surface to be glassed (except the fuel sight gauge). Remove excess with a squeegee. Now lay down the first layer of UND cloth at a 30 deg. angle, keeping the fibers straight, and use butt seams (Fig.8). Wet out with epoxy. Now lay down the 2nd layer at 30 deg. **crossing** the first layer. Wet out with epoxy and squeegee well, removing any excess. Scissor trim (leave a 1/8 in. surplus along the lower edge) and peel ply along lower edge, where bulkheads join, and in the landing gear attach area. Scissor trim **flush** with the foam at the top of each side (Fig.9).

Now put 7/8 in. spacers between the tops of the two fuselage sides (to position the longerons), first covering them with wax paper so they won't become glued in place (Fig.10). Mix up some wet floc and apply to the mating surface of the two, previously laminated upper longerons. Put the upper longerons in place on the layup (with the 0.4 in. x 0.7 in. wood stiffeners toward the bottom edge of the fuselage side) and clamp them against the 7/8 in. wood spacers, and clamp or weight them down against the fuselage sides. Make them flush at the forward end and let the excess extend at the aft end. There should be no gaps between the longerons and the fuselage sides. Remove any excess floc, and apply peel ply on the glass alongside the longerons. Check the layup to make sure there are no air bubbles or dry areas and allow to cure for 24 hours.

After cure, remove peel ply, sand and apply 3 layers of UND with fibers oriented in the fore and aft direction, the entire length of the upper longeron, lapping 1/2 in. onto the fuselage side, and cover with 1 ply of BID at 45 deg. (Fig.11).

STEP 5. INSTALLATION OF LOWER TRIANGULAR CROSS SECTION LONGERONS

This step should take about 1-1/2 hrs. Remove peel ply along the bottom edges of the fuselage sides and landing gear attach area and sand lightly with 36 grit sandpaper. Recheck dimensions and trim any surplus side lower edges. The triangular longerons (Fig.12) will have to be notched with saw cuts to the fuselage curvature in two different directions. The saw cuts should **always** be on the inside of the curve, through the thin edge of the wood toward the flat side. Where the curvature is sharp, every two inches. Where the curvature is mild, every four inches should do. Cuts should be no deeper than 0.45 in., leaving 0.25 in. uncut. Before attempting to floc the longerons in, **trial fit**, starting at the forward end, holding in place with nails (Fig.13) at an angle, to hold them down as well. Notice that the triangular longerons extend thru the firewall at least 1/2 in. (Fig.14). **Don't** try to drive the nails with a hammer. Drill holes for the nails so they can be inserted by hand. When the fit is perfect, remove all the nails, floc the mating surfaces, (longerons and fiberglass) and reinstall. There should be no gaps. Weight or clamp as required. Remove excess floc and allow to cure.

Now floc in place the wooden stringers LWX and LWY (Figs.12 & 14). Notice that LWY extends through the firewall at least 1/2 in. Hold them in place with nails through predrilled holes. Apply 1 ply BID tape corners where shown (Fig.14). Weight down stringers and allow to cure.

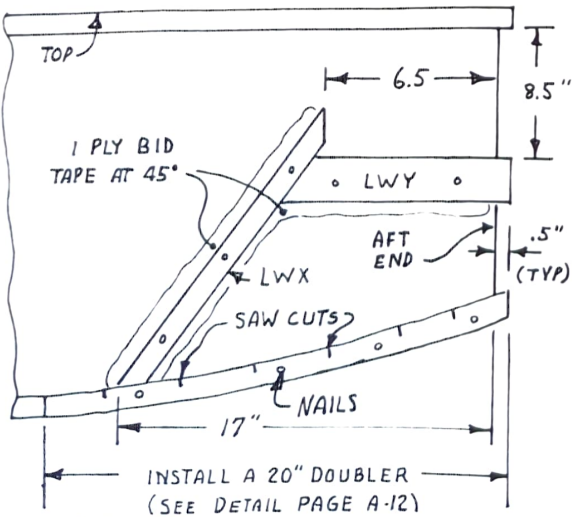


FIG.14

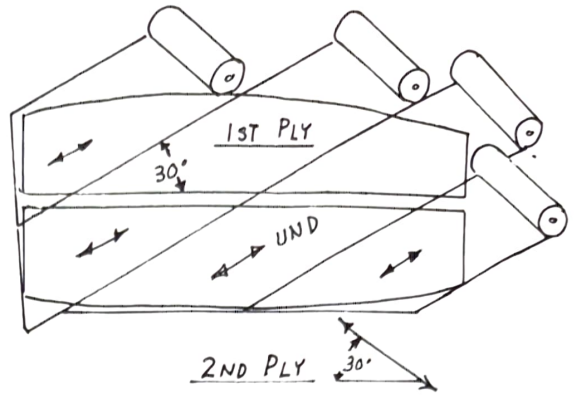


FIG.8
DO NOT TRIM SELVAGE! BUTT EDGES.
DO NOT OVERLAP UND EDGES.

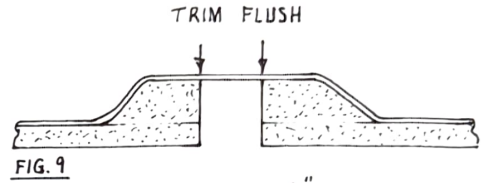


FIG.9

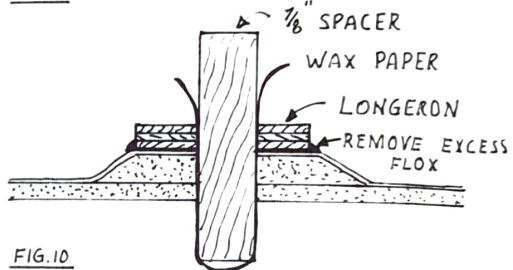


FIG.10

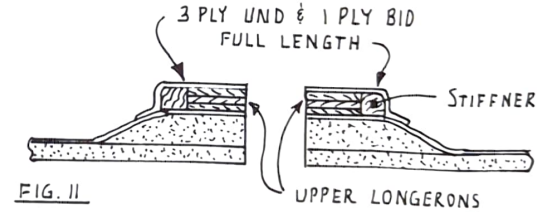


FIG.11

STEP V. WOOD PARTS - SITKA SPRUCE

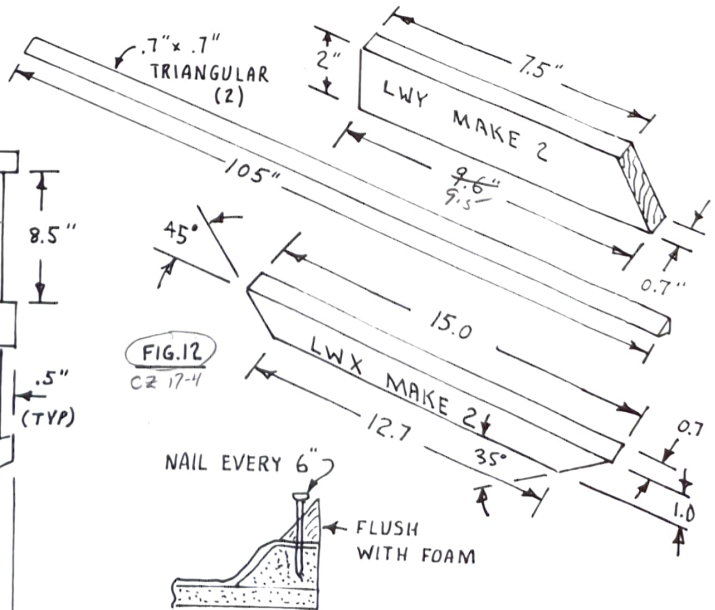


FIG.12
CZ 17-4

FIG.13

STEP. 6 COMPLETION OF THE FUSELAGE SIDES

This step involves a number of separate operations, some of which must be done in sequence with cure time allowed in between.

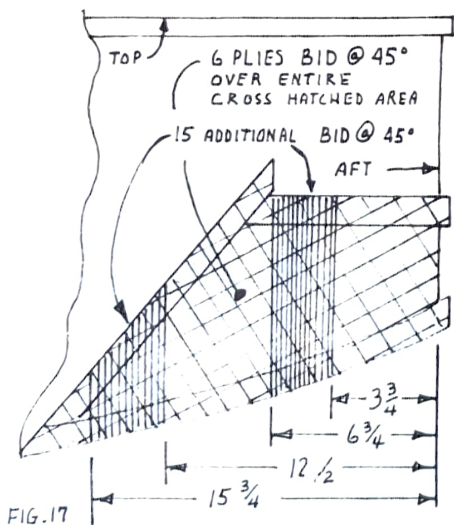
At the bottom rear of the fuselage sides, the lower triangular longeron is doubled to form a square cross section (see drawing A-12). The 48 in. length 0.7 in. x 0.7 in. triangular spruce in the kit is for this purpose. No notching is necessary. A few clamps and nails can be used to position the doubler while the flux cures. Notice that the lower longeron, upper longeron, and stringer LWY extend 1/2 in. through the firewall.

After the doubler on the lower longeron has cured, remove the clamps and nails. Cut out a piece of 3/4 in. thick pink Divinycell foam to exactly fit the area bounded by the lower longeron, LWX, and LWY. Micro this foam in place, weight it down, and allow to cure.

The landing gear attach area will now be built up with wedge-shaped pieces to bring the surfaces closer to parallelism. The 3 pieces shown (Fig.15) in top and side views are for the right fuselage side. The pieces required for the left fuselage side are mirror images of the right. The tapers may be sawn (*carefully*) on a band saw. Flox the tapered pieces in place (Fig.16), position with nails, weight down, and allow to cure.

After cure, remove the nails and excess flox. Then drill a 3/8 in. hole through LWX (**not lwx**), at the location shown (Fig.16) parallel to the upper longeron, and 1/2 in. above the fuselage side, for the rudder cable conduit. This passes underneath the attach fittings and misses the fitting bolts. Now cut a 3/8 in. wide groove in the top surface of the foam, lined up with the hole and parallel with the upper longeron. Tape 2 soda straws together (*make sure the 3/16 in. rudder conduit will slide through*), and place them in the groove and through the hole. Cover the last 2 inches of the slot with tape, so the last 2 inches (at the firewall) will remain loose. Now cut some Dymecell foam to fill in the space bounded by lwx, lwy, and lwz, micro in place, weight down, and cure. After cure, cut the foam down until it is level with lwx, lwy, and lwz (Fig.16).

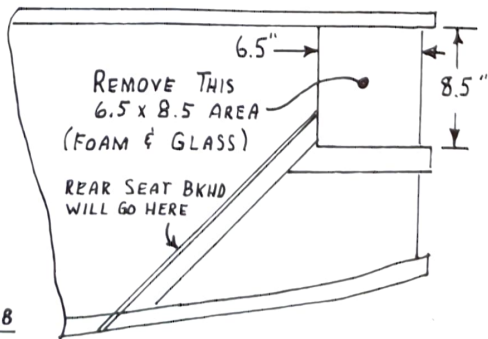
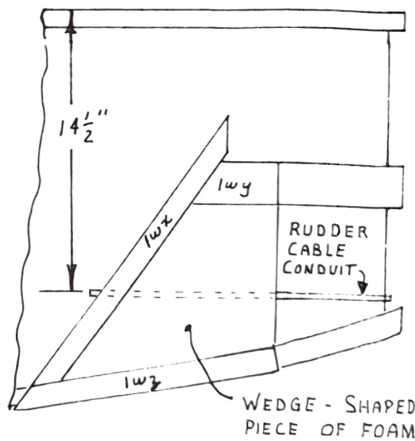
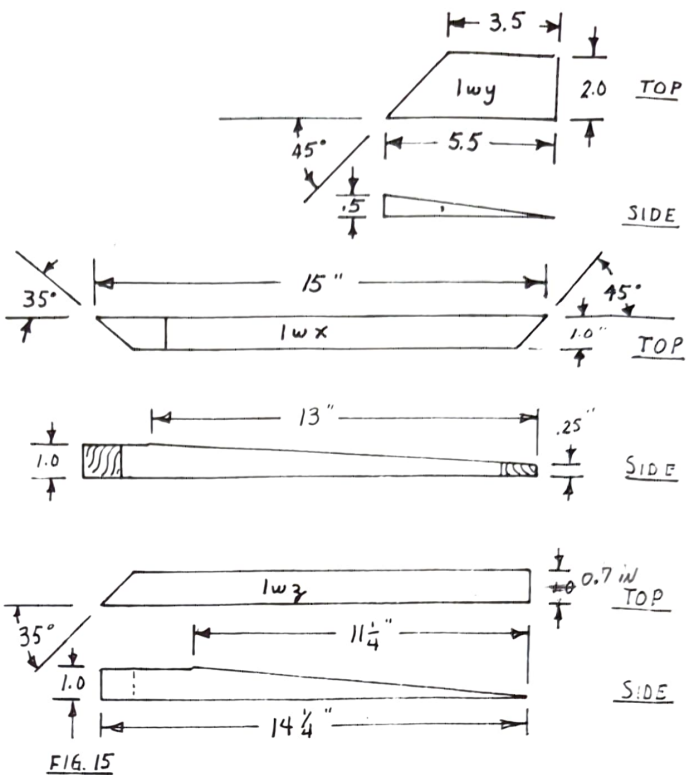
Vacuum foam surface, fill any voids with dry micro, fill pores with wet micro, and layup 6 plies of BID with a 45 deg. orientation over the entire foam and stringer area, and then an additional 15 plies of 45 deg. BID in the local areas shown (Fig. 17), under the attach fittings, which will absorb the main landing gear loads. Lay a final layer of UND, fibers horizontal, over the entire area to hold down the edges, then a layer of peel ply, wax paper, and then place a flat board on top of the reinforced area and weight it down to make sure the layup cures flat. **CAUTION:** The board will have a tendency to slide on the wax paper and disturb your layup. Tape it in place before adding weights. After cure, trim flush all around with a hacksaw blade.

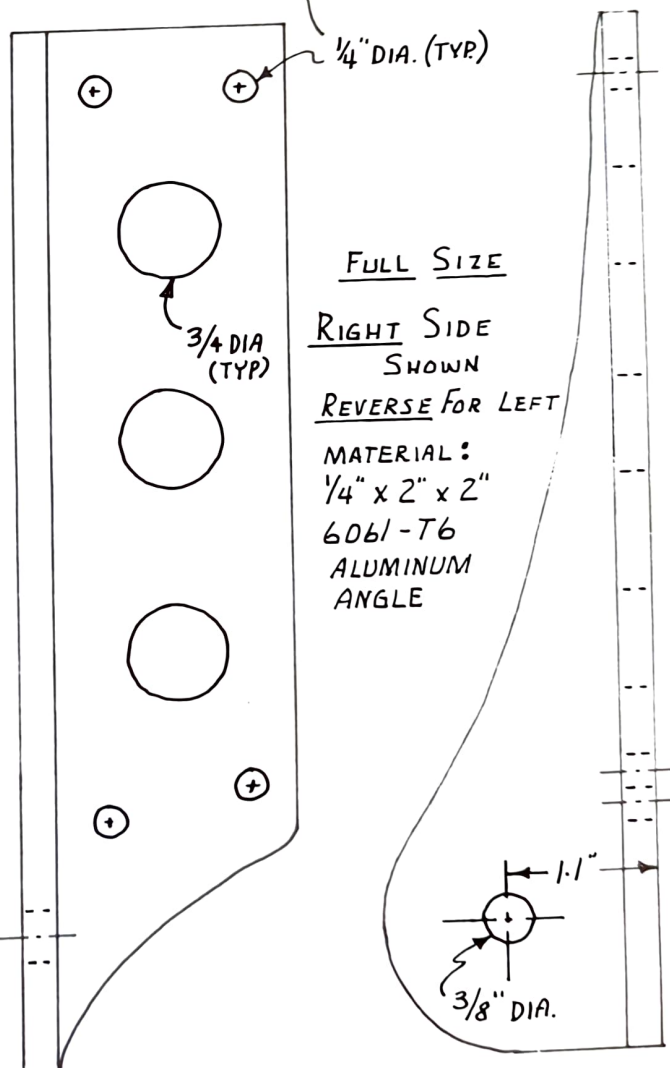


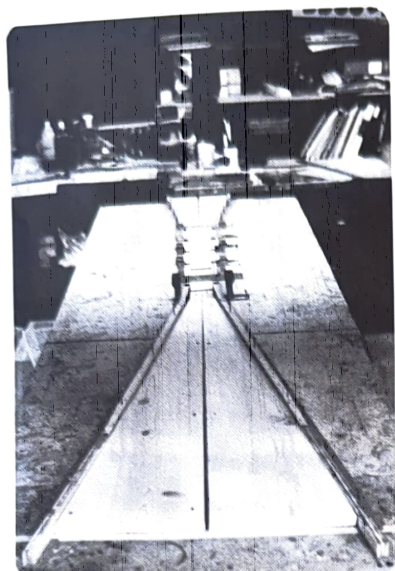
SEE ALSO A-12 FOR DETAIL

DIMENSIONS SHOWN SHOULD BE MEASURED
ALONG LOWER LONGERON INSTEAD OF HORIZONTAL
ALSO ANGLE PADS AND BRACKETS SLIGHTLY AS
SHOWN ON A12

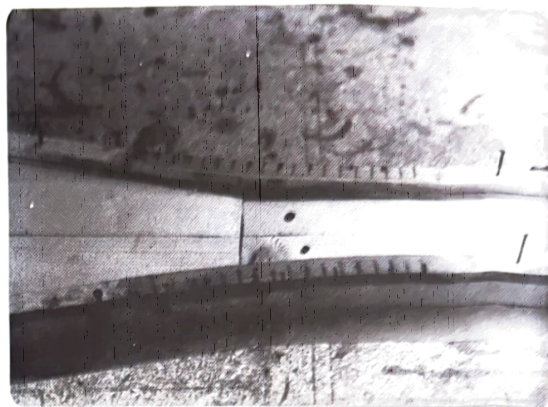
WOOD PARTS - STEP VI - SITKA SPRUCE



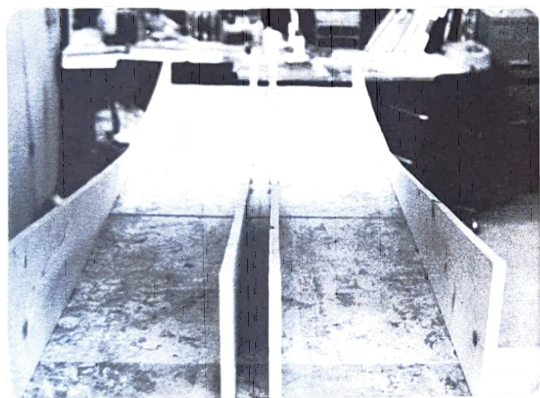




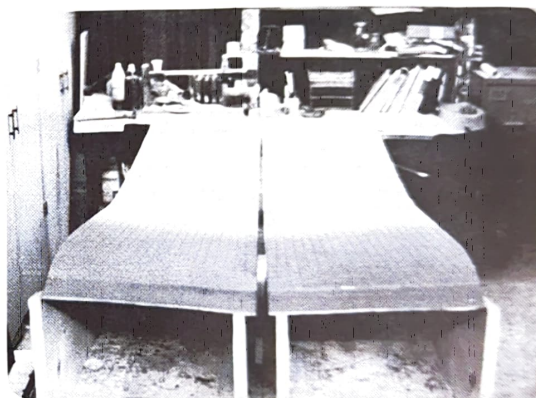
Laminating top longerons



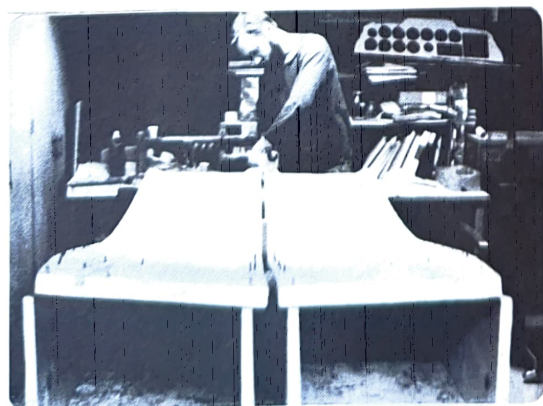
Saw cuts in doubler



Jigs bondoed to table

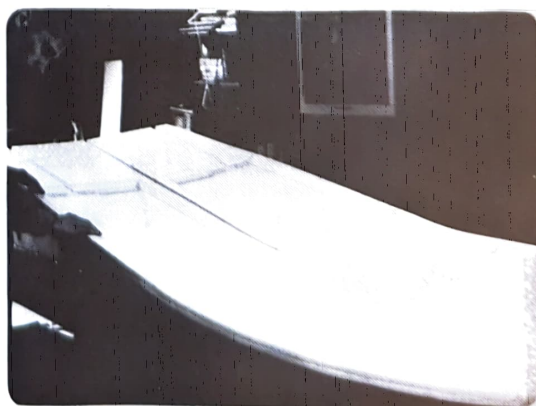


1/8 in. masonite nailed to jigs

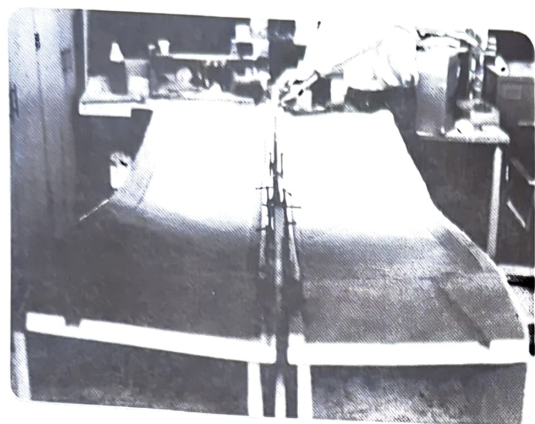


Fuselage sides.

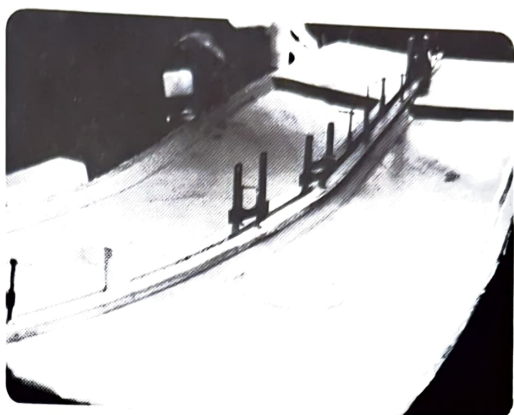
Spacers held in place with nails.



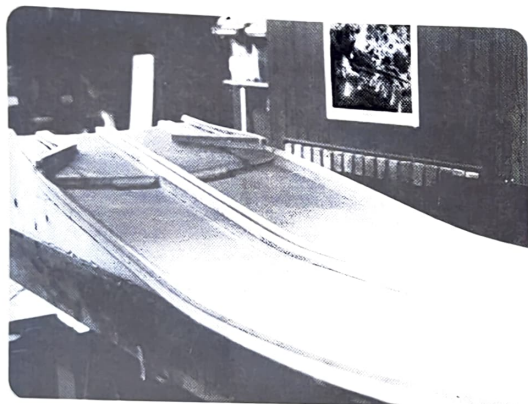
Sides contoured ready for glassing



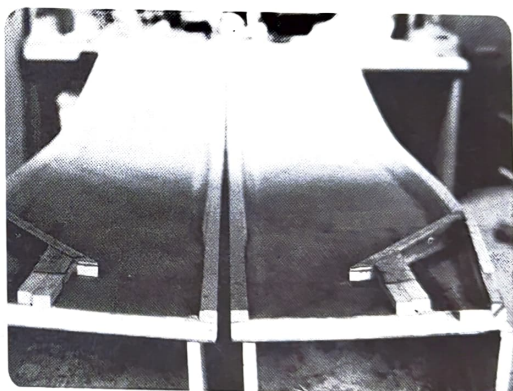
Upper longerons clamped in place for cure



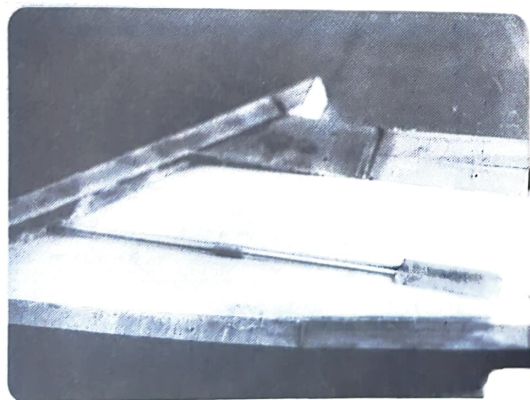
Another view. Note spacers between longerons.



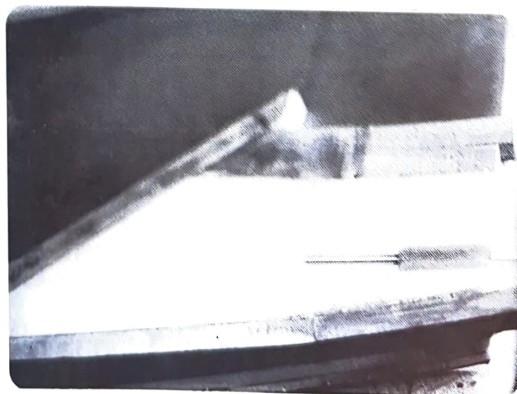
Lower longerons in place.



Landing gear attach stringers in place.



Foam insert and rudder pedal conduit in place.

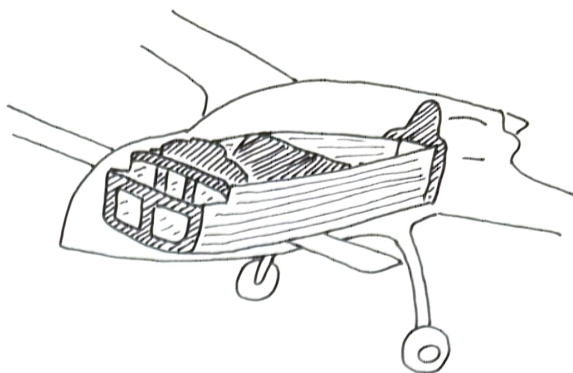


Ready for glassing.

CHAPTER 6

FUSELAGE ASSEMBLY

REAR MAP POCKETS
USED FOR FUEL



Overview. In this chapter you will assemble the fuselage sides, install all of the bulkheads, taping all the joints, build and install the center keel, and install the fuselage bottom. It will be exceedingly important to double check dimensions and make sure everything is square, because after this chapter the fuselage will be rigid, and adjustment will not be possible. If your work to this point has been accurate, assembly should be a breeze.

Step 1. ASSEMBLY OF THE FUSELAGE SIDES

While the fuselage sides are still laying in the jigs on your work table, trial fit all of the bulkheads. Hold F-22 bulkhead in place vertically at the forward end of each fuselage side (Fig. 1). You may have to trim some foam to get a good fit, but be careful because the distance between the aft face of F-22 and the forward face of the firewall, when both are vertical, must be exactly 103 in.. Both F-22 and the firewall must also fit square (90 deg.) with the top of the top longerons (Fig. 2). Trim foam or add shims as required. When the 103 in. dimension has been confirmed, with good fits at the fore and aft ends of each side, accurately mark the position of the instrument panel and front seat bulkhead (Fig. 3). Note that dimensions are horizontal (parallel to the longitudinal axis), not along the longerons. If you measure along the longerons, you will be about 1/4 in. short. Hold each bulkhead in place against the fuselage sides and trim off any high spots until a snug fit is obtained. Sand the fuselage sides for a good bond, and re-mark the positions with double lines which can be seen on either side of the bulkhead when in position. Now drill holes through the fuselage sides along the bulkhead centerlines for nails which will hold the bulkheads in place during cure.

Now hold the rear seat bulkhead in place and trim for a good fit (Fig. 4). This bulkhead must be symmetrical so the fuselage will be too. With the bulkhead held in place, drill about 5 holes through into the stringer for wood screws to hold it in place for assembly. Check the holes for the rudder conduits. Sand all mating surfaces and overlap areas for tapes. You should now be ready to start assembly. If the assembled fuselage will not clear doorways to the outside, consider assembly in your garage. Assembly on the floor is easier than on a table.

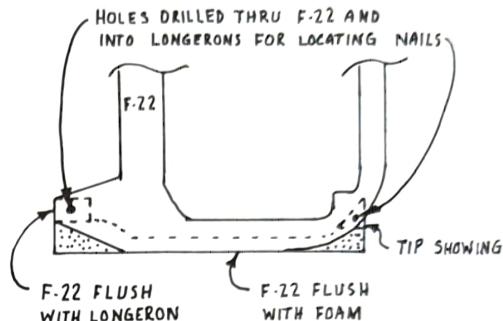


FIG. 1

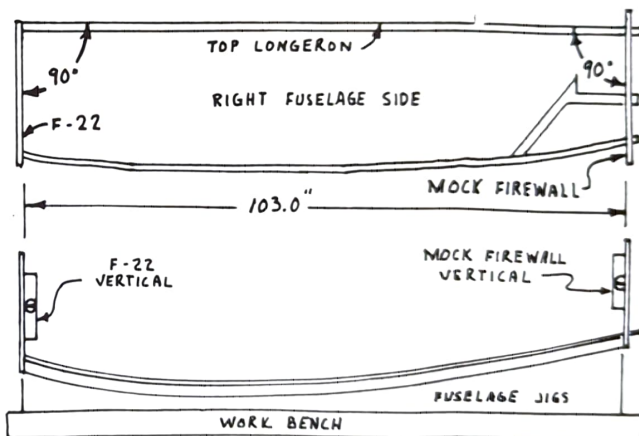


FIG. 2

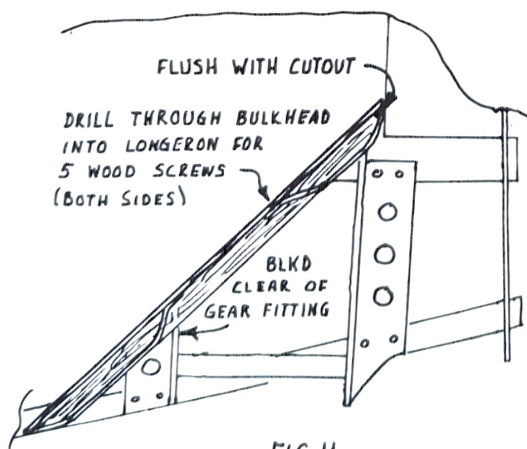


FIG. 4

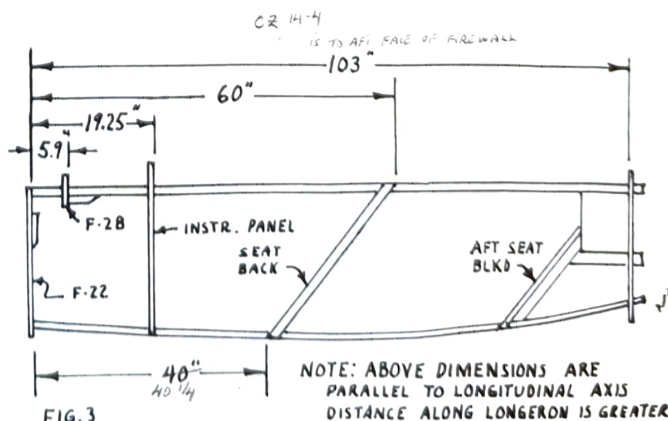
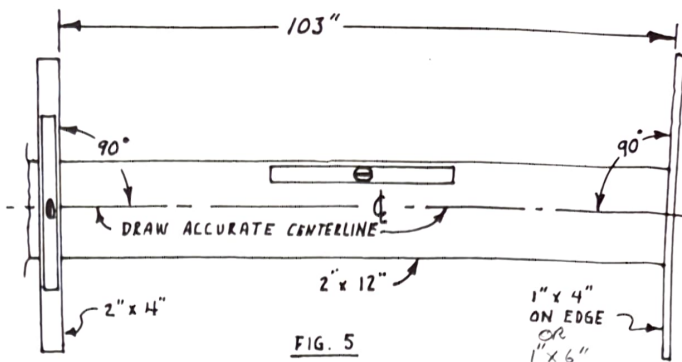


FIG. 3

NOTE: ABOVE DIMENSIONS ARE PARALLEL TO LONGITUDINAL AXIS
DISTANCE ALONG LONGERON IS GREATER

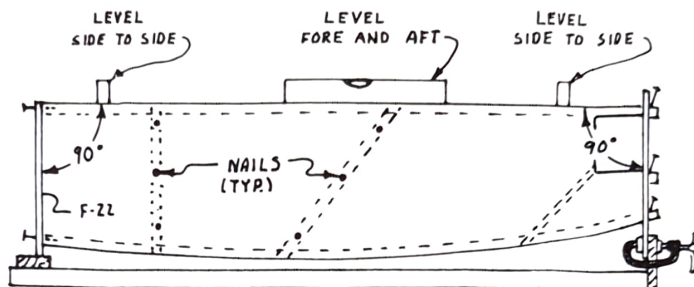
* FIVE SCREWS MAY NOT BE ENOUGH TO HOLD BULKHEAD AGAINST STRINGER. YOU CAN BEND FLANGE BY HEATING TO 150 DEG WITH HAR DRYER

Lay a 10 ft. x 2 in. x 12 in. board on the floor and shim so it is level fore and aft, and side to side (Fig. 5). Draw an accurate centerline fore and aft. Nail a 1 in. x 4 in. board at one end, on edge, perpendicular to the centerline, and level. Now nail a 2 in. x 4 in. 103 in. from the 1 in. x 4 in. perpendicular to the centerline and level. Clamp the firewall to the inside of the 1 in. x 4 in., making sure it is centered and level.



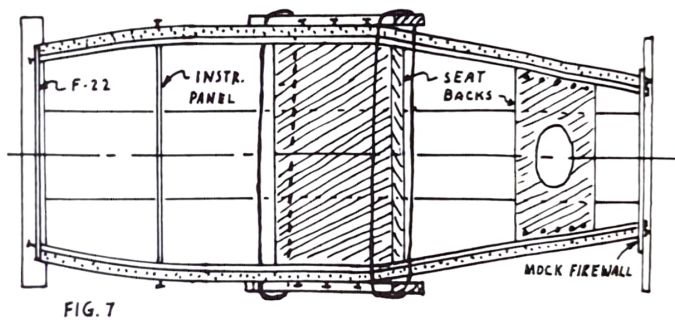
Now, make a trial assembly. Fit both sides into the firewall (Fig. 6). Fasten the rear seat bulkhead in place with a couple of screws. Hold the front seat bulkhead and instrument panel in place accurately and drill through the previously drilled pilot holes in the fuselage sides into the bulkheads. Hold F-22 in place at the forward end. Check tabs once more to be sure they are equal in height. Align top of tab and top of longeron, and side of F-22 with side of fuselage (Fig. 1), and drill pilot hole for finishing nail through tab and into longeron, and insert nail. Now check alignment with fuselage side and bottom longeron. The tip of the triangle should be showing (Fig. 1), because it will be trimmed off later. Carefully drill another pilot hole through F-22 and into the bottom longeron and insert nail. Repeat for the other side.

The bottom edge of F-22 should now be resting on the 2 in. x 4 in. Check that it is level (if not, add shims), vertical, and the correct distance from the firewall. When everything is perfect, bondo the forms down and any shims in place. Since the sides are pre-curved and exactly symmetrical, all the bulkheads should be exactly centered. Now is the time to check everything and correct anything which isn't right, before gluing everything in place.



When you are satisfied everything is perfect, disassemble, prepare all mating surfaces (sand with 36 grit), mix up a bunch of floc, and start reassembly. Do not install firewall with floc now; it must be removed to install centerspar. Assembly goes best with least smearing of floc if you put both sides through firewall but spread them apart slightly. Then carefully install the bulkheads along one side first, and then bring the sides together, working forward from the aft end and installing F-22 last. Always butter both mating surfaces with just enough floc so a little will be squeezed out when the surfaces are pressed together.

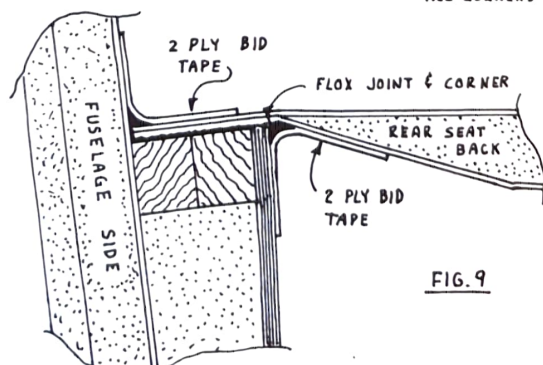
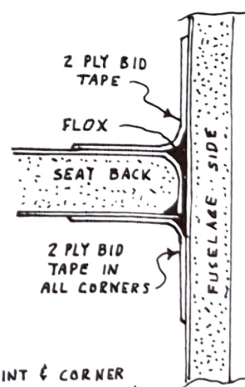
After everything is in place, even with good fits, the sides should be squeezed together for cure (Fig. 7). This is best done with two boards, on the outside of the fuselage, held tightly together with shock cords, filament tape, rope, or whatever. Remove excess floc from corners. If you don't mind, wiping with a finger works pretty good. Nails inserted into pilot holes into the longerons and stringers extending through the firewall will hold it snugly in place. Make sure F-22 is snug against the foam and longerons. Hold snug with filament tape wrapped around instrument panel, F-22, and nails holding instrument panel in place. Now, recheck everything. Longerons level fore and aft, firewall level, centered, and vertical, F-22 level and vertical, bulkheads centered on centerline, and joints tight. Don't accept anything less than perfection! Bondo firewall, shims, and forms so they can't move, lock the door, and don't go near it for 24 hours. Don't even let the dog in!

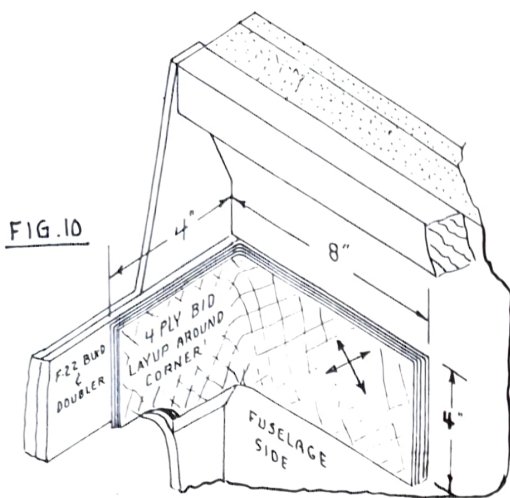


After cure, sand and tape all corners at joints with 2 plies of BID cut at 45 deg. See cross sections, Figs. 8 and 9. Instrument panel and F-22 are similar. The backside of the front and back seat backs are taped more easily by turning fuselage upside down. Taping is easier if you cut two 8 in. wide strips of BID at 45 deg. and lay them down over each other on a long sheet of waxed paper. Tape paper down so it won't slide. Mix epoxy and pour several bands lengthwise on the top layer. Let soak in a bit, and then lightly squeegee. Add extra epoxy where needed with a brush. Now paint a light film of epoxy on the surfaces to be taped. Cut the 8 in. wide strip into 4 strips 2 in. wide, wax paper and all. Measure the length needed and cut to length. Press into place and rub down. Then peel the wax paper away carefully and cover with peel ply. Your corners will look neat, and you will impress people (and inspectors) with your workmanship.

Don't forget to remove all nails (you will need to use your pliers) and the wood screws through the rear bulkhead. The tapes are going to make the assembly more rigid, so be certain your fuselage is perfectly aligned again while the tapes are curing.

FIG. 8





There is a very important reinforcement to be added for the canard attach hard points (Fig.10). This is a 4-ply BID corner layup both sides (right and left) on F-22. Fibers are at 45 deg. and edges peel plied.

Now F-28 can be installed. Carefully measure the 5.9 in. dimension shown and fit the F-28 bulkhead and two 1 in. x 75 in. x 3.5 in. wood doublers (Fig.11). When good fit has been obtained, install with flox, and hold in place for cure with clamps and small finishing nails (holes pre-drilled). Glass over with 2 plies lapping top longeron and 1 in. onto fuselage side and F-28. After cure, you should be ready to build and install the center keel and the front seat brace.

STEP 2. CENTER KEEL AND SEAT BRACE

The center keel provides strength for the fuselage and contains the hot air duct. It forms the base of the center control console and contains a hard point for mounting the safety belts. The seat back brace contains hard points for mounting the landing brake actuating mechanism and the fuel selector valve. It contains a pocket for storage of sectionals, and the control cables pass through it. It is advisable to have the fuel valve in hand for this step to make sure it fits as intended. Refer to Fig.12 and full size drawings A-8, A-9, and A-10.

Layout the parts shown in Fig.13 on a sheet of 1/4 in. thick white, low density, Clark foam. Group for most efficient use of foam. Where 2 identical parts are required, lay out opposites. One side of all the parts will be covered with glass before they are cut out. After assembly, the outsides will be covered.

Now, while still in sheet form, squeegee micro on one side of the foam. Cover the triangular pieces (make sure they are opposites) with 2 plies of BID, any orientation. Cover the long narrow pieces with 2 plies UND, lengthwise orientation. After cure, cut out.

Now make 2 identical triangular pieces out of 1/4 in. birch plywood, according to the full size plan in Fig.14. To make sure they are identical, fasten the pieces together with double coated tape or several small nails, holes pre-drilled. Cut accurately on a band saw and accurately drill the 3/8 in. hole through both pieces. Make a pilot hole first with a small drill.

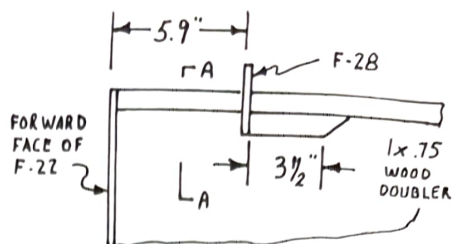
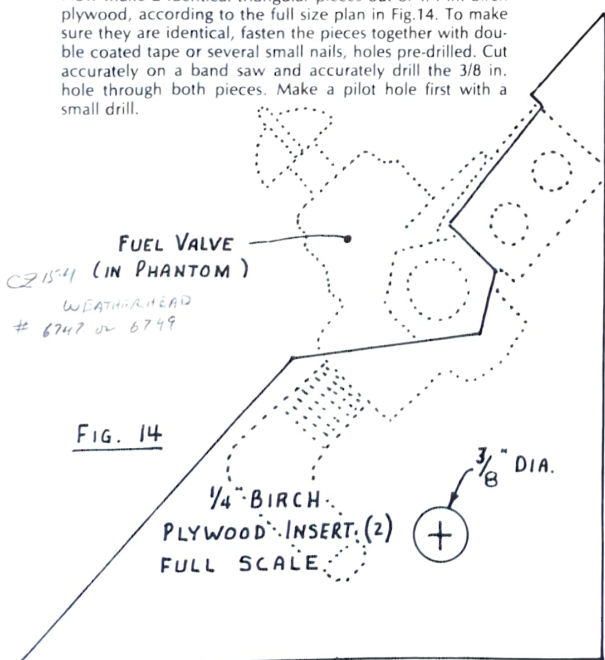
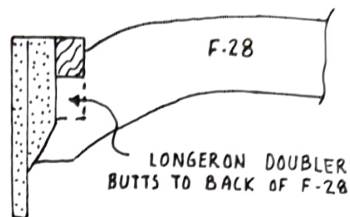


FIG. 11



SECTION A-A

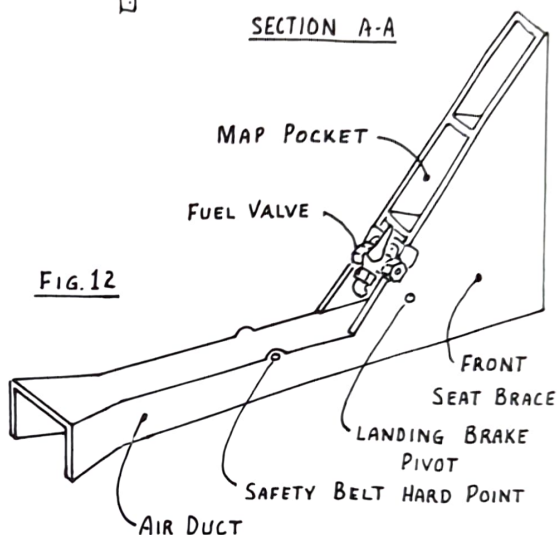


FIG. 12

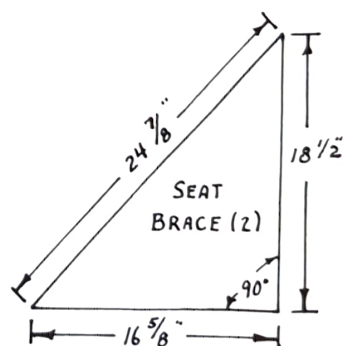
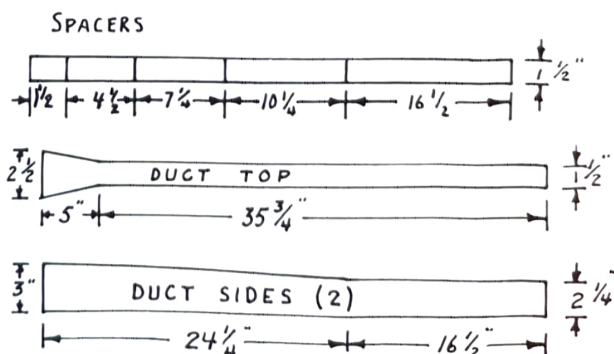
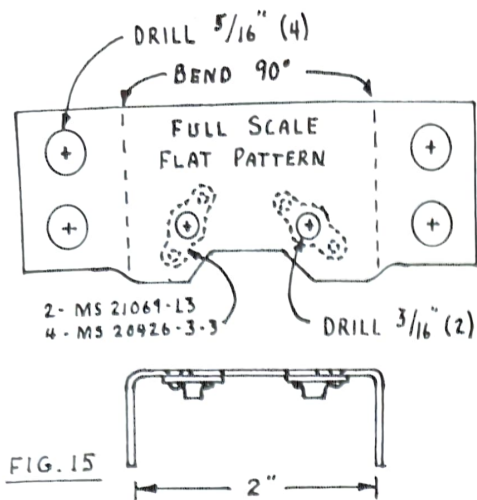


FIG. 13





Now make the fuel valve mounting bracket (Fig.15) from 1/16 in. 2024 aluminum. Trial fit the fuel valve to this bracket and the bracket to the two plywood triangles. You will have to radius the plywood where the bracket mounts to match the bend radius of the bracket, and also remove any interference with the nut plates. When you have a good fit, you are ready to flex the plywood pieces to the foam triangles. They fit in the angle included between the 24-5/8 in. and 16-5/8 in. sides (Fig.16). Mark where the plywood fits, and carefully remove the foam from the fiberglass in that area with a wood chisel. Flex the plywood inserts in place on the fiberglass. Make the rounded edges (for the fuel bracket) are on the outside (foam side). Cure.

Now on the glassed side of one of the triangular braces, mark where the map pocket spacers go and trial fit, beveling ends of spacers as required for good fit (Fig.17). You can 5 min. epoxy them together where they meet, for ease in handling during assembly. Now stack the triangular braces together, foam to foam, and drill holes for nails to hold the spacers in place for cure. Sand the glass surfaces where the spacers go, and flex the spacers in place against the fiberglass on one side, inserting nails to hold them in place. Now apply a 1 ply BID tape to the unglazed side of the map pocket spacers, apply floc to the edges, and put the other triangular brace in place. Line it up squarely with the other side, and put in nails to hold it in place. Now fasten the fuel valve to the bracket, and flex the bracket in place (Fig. 14). Use small pieces of saran around the fuel valve to avoid also flexing the fuel valve in place, because it should be removable. Flex the 3/8 in. x 2 in. aluminum tube (Fig. 18) in place in the plywood inserts. Make sure everything is square and allow to cure.

Assemble the 3 pieces which make up the hot air duct (glassed surfaces inside) with floc and allow to cure (Figs. 12 & 13). Use temporary spacers inside, if necessary, to maintain squareness. After cure, remove foam (Fig. 19) for the 2 in. safety belt tube, and flex in place. Also remove foam for the fuel line clearance (don't go through the glass). Radius the edges of the foam in preparation for glassing. At this point it would be wise to check the fit of the air duct and seat brace in the fuselage before glassing the outsides. Make any adjustments necessary by either removing or adding foam, but maintain accurate location of the fuel valve and landing brake pivot with respect to the seat back.

The hot air duct has a 7-ply UND reinforcement over the safety belt mounting hard point, with ends tapered. Cut out a piece of UND as shown (Fig. 20). Lay the 24 in. edge on wax paper and wet out a strip about 2-1/4 in. wide. Fold over 2 in., and cut at fold with a razor. Continue similarly until you have 7 layers. Now transfer the layup to the top of the duct, centering it over the aluminum tube (Fig.21), and strip off the wax paper (you microed the foam surface first, didn't you?). Carefully scissor trim any ragged edges.

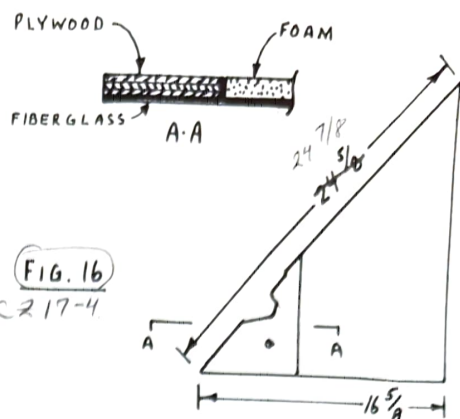


FIG. 16
C 217-4

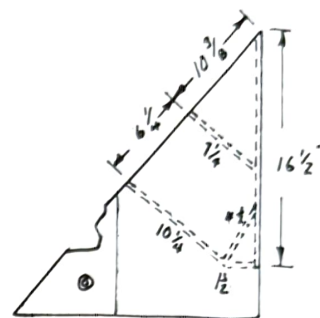


FIG. 17

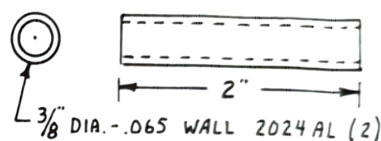


FIG. 18

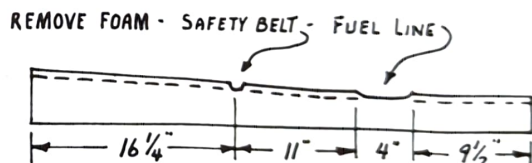


FIG. 19

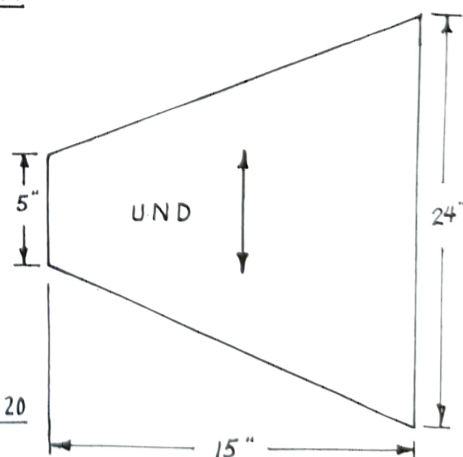
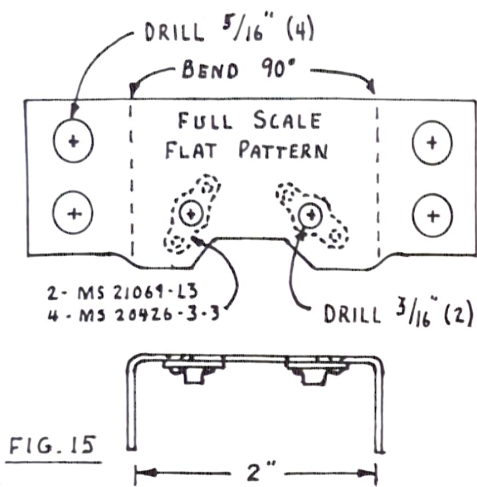


FIG. 20



FIG. 21



Now make the fuel valve mounting bracket (Fig. 15) from 1/16 in. 2024 aluminum. Trial fit the fuel valve to this bracket and the bracket to the two plywood triangles. You will have to radius the plywood where the bracket mounts to match the bend radius of the bracket, and also remove any interference with the nut plates. When you have a good fit, you are ready to flex the plywood pieces to the foam triangles. They fit in the angle included between the 24-5/8 in. and 16-5/8 in. sides (Fig. 16). Mark where the plywood fits, and carefully remove the foam from the fiberglass in that area with a wood chisel. Flex the plywood inserts in place on the fiberglass. Make the rounded edges (for the fuel bracket) are on the outside (foam side). Cure.

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Assemble the 3 pieces which make up the hot air duct (glassed surfaces inside) with flex and allow to cure (Figs. 12 & 13). Use temporary spacers inside, if necessary, to maintain squareness. After cure, remove foam (Fig. 19) for the 2 in. safety belt tube, and flex in place. Also remove foam for the fuel line clearance (don't go through the glass). Radius the edges of the foam in preparation for glassing. At this point it would be wise to check the fit of the air duct and seat brace in the fuselage before glassing the outsides. Make any adjustments necessary by either removing or adding foam, but maintain accurate location of the fuel valve and landing brake pivot with respect to the seat back.

The hot air duct has a 7-ply UND reinforcement over the safety belt mounting hard point, with ends tapered. Cut out a piece of UND as shown (Fig. 20). Lay the 24 in. edge on wax paper and wet out a strip about 2-1/4 in. wide. Fold over 2 in. and cut at fold with a razor. Continue similarly until you have 7 layers. Now transfer the layout to the top of the duct, centering it over the aluminum tube (Fig. 21), and strip off the wax paper (you microed the foam surface first, didn't you?). Carefully scissor trim any ragged edges.

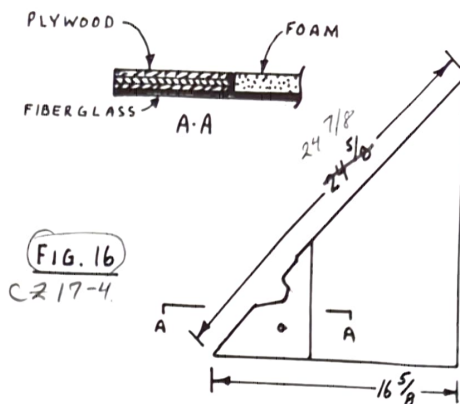


FIG. 16
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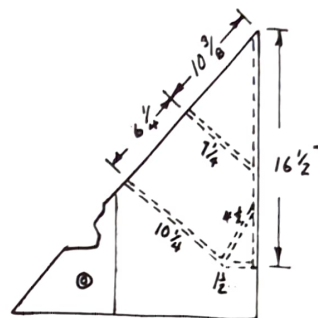


FIG. 17

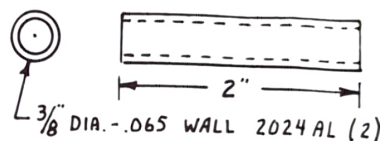


FIG. 18

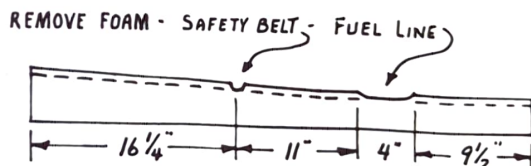


FIG. 19

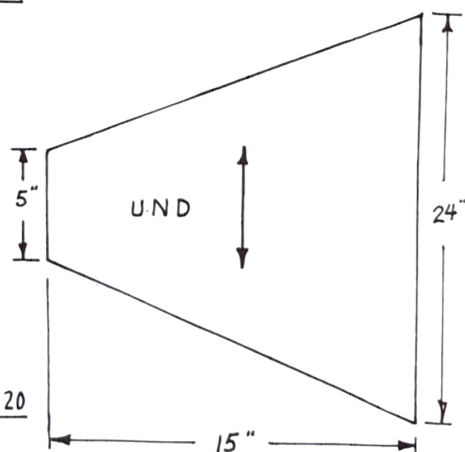


FIG. 20



FIG. 21

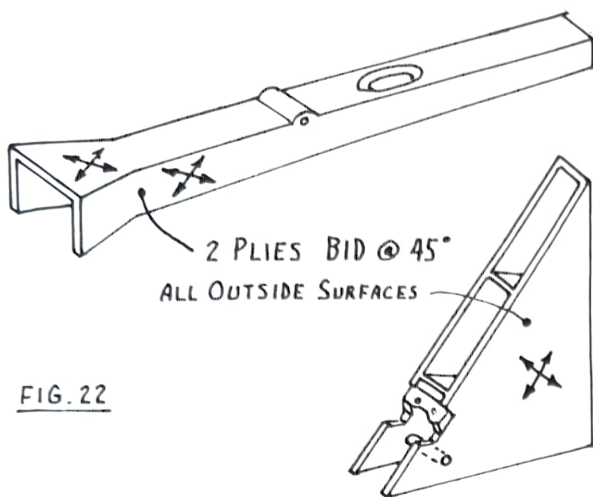


FIG. 22

Now cover the outside of the duct with **2 plies of BID** at 45 deg., top and sides (Fig. 22). Support on blocks and scissor trim. Glass the seat brace on the outside with **2 plies of BID** at 45 deg. Scissor trim and floc in place on top of air duct and tape joint with **2 plies of BID** at 45 deg., lapping each side of joint 1 in.. Support in place for cure (Fig. 23).

Now set fuselage upside down on two saw horses; shim so top longerons are level side to side, both fore and aft, and bondo saw horses to floor. Sand instrument panel and seat back where air duct and brace butt, and adjacent areas for taping. Floc in place with bottom edges flush with instrument panel and seat back, and aligned with lower, triangular longerons (Fig. 24). Use nails at strategic locations to hold everything in place. Tape joints with **2 plies of BID** lapping 1 in. each side and peel ply for neat joints. After cure, you are finally ready to install the fuselage bottom!

STEP 3 CONTOURING AND INSTALLING THE FUSELAGE BOTTOM

The fuselage should already be upside down on saw horses (Fig. 24). The top longerons (now underneath) *must* be level from side to side (no fuselage twist) because after the bottom is installed, the fuselage will be rigid, and no adjustment will be possible. Make sure all surfaces the bottom will mate against are smooth, with no bumps, epoxy blobs, or whatever.

Take 3 pieces of **H 45** 3/8 in. x 34 in. x 47 in. pink PVC foam, lay them on the fuselage bottom, the first sheet butted against the forward bulkhead (F-22), the second against the first, etc. Weight them in place, crawl underneath, and mark the inside edge of the bottom longerons, the forward edge of the back seat bulkhead, both sides of the other bulkheads, heat duct, etc. (Fig. 25). Now carry the pieces back to your work table and cut the sheets 3/4 in. wider than the lines marking the inside of the longerons, and 3/4 in. longer than the forward edge of the rear seat bulkhead (Fig. 26).

Glue the three pieces together with 5 min. epoxy (wax paper underneath, hold butt edges together with small finishing nails). Now locate the foam sheet back on the fuselage, weight down again, make sure the lines previously drawn are in place (Fig. 27). Now position three 1 in. x 2 in. wood strips at the fore and aft ends to keep them from rocking on the curved foam. Use Bondo dabs to hold the 1 x 2 s in place on the foam. Don't use huge blobs, but plenty of small ones, to hold the framework to the foam, so the bottom can be transferred to your work table for further work, with the correct curvature maintained.

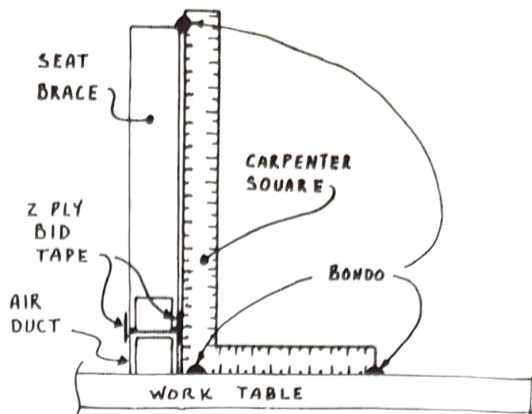


FIG. 23

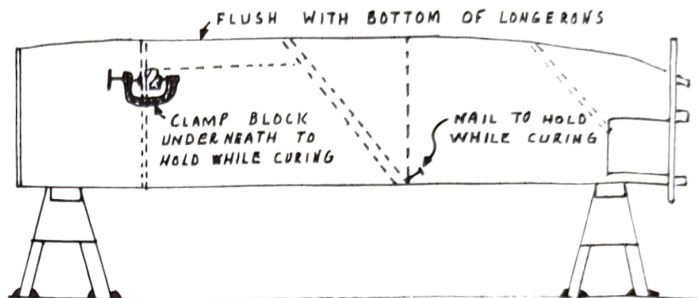


FIG. 24

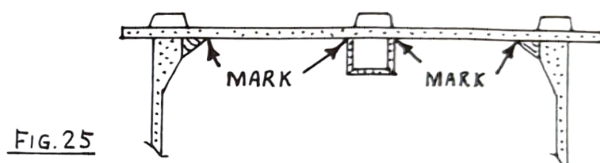


FIG. 25

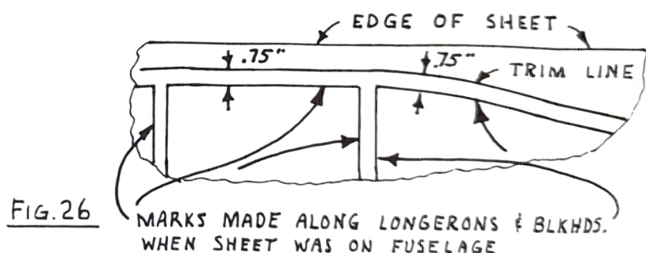


FIG. 26

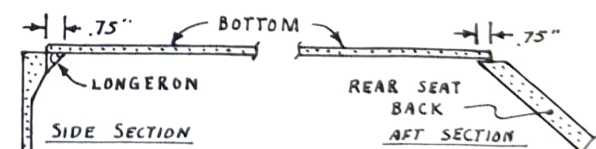


FIG. 27

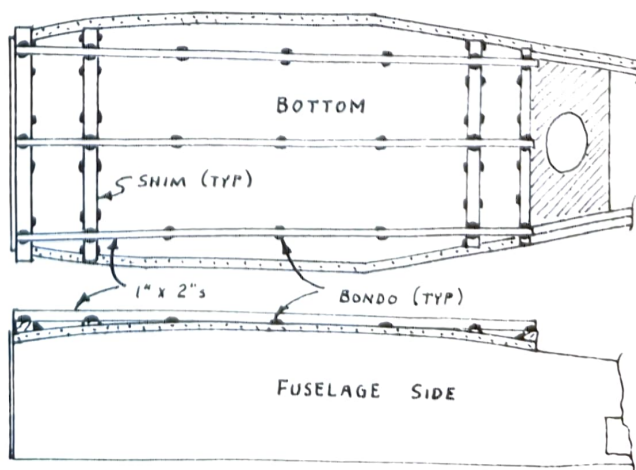
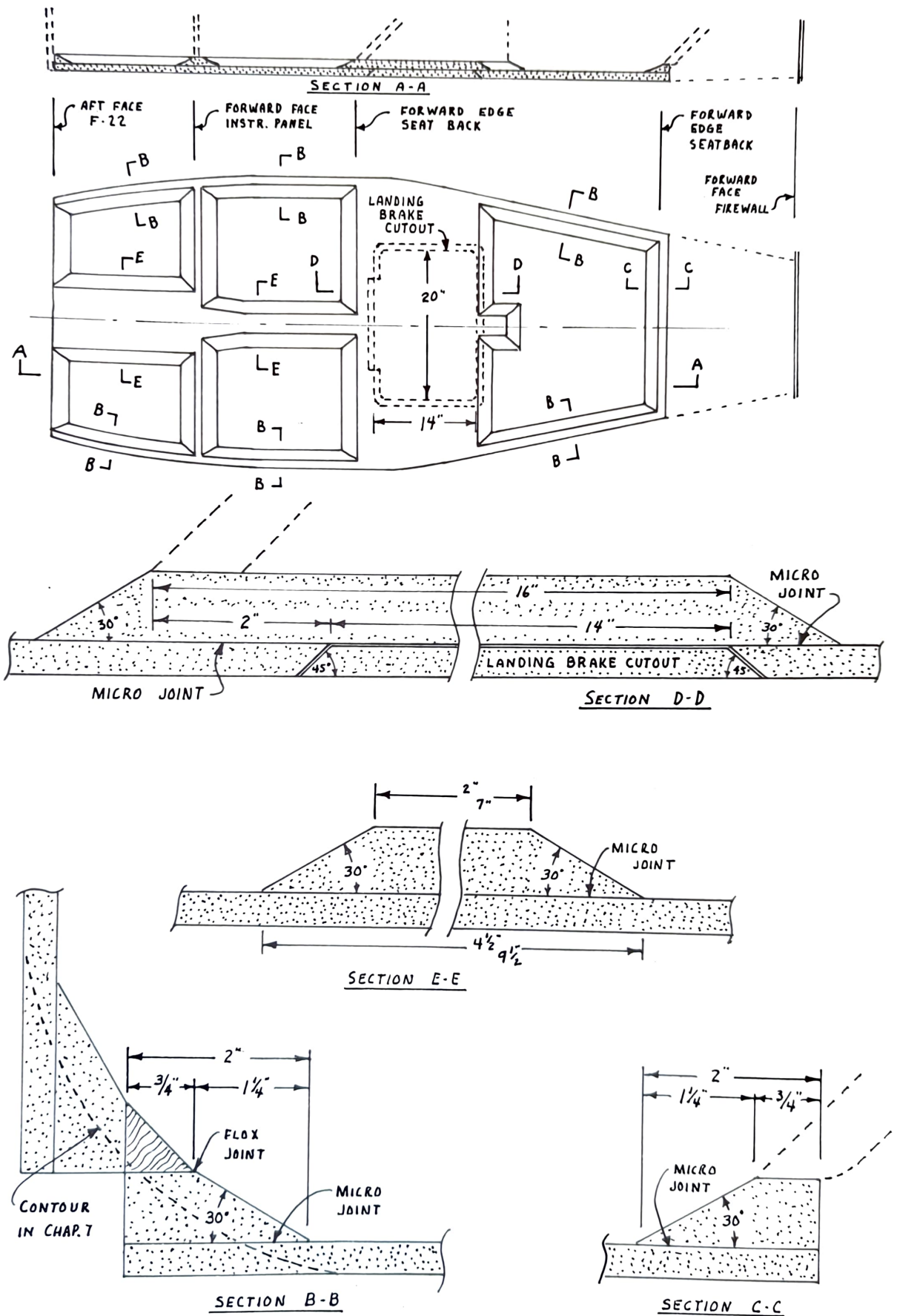


FIG. 28



Transfer the assembly to your work table. Mark the cut out for the landing brake, using the forward edge of the front seatback and the fuselage centerline as references (Fig. 29).

Cut out the landing brake at a 45 deg. angle on all four sides (Fig. 29), and leave in place. The fuselage bottom is given depth and contour by gluing on tapered spacers made from 3/4 in. thick **H 45** PVC foam, the same as with the sides. (Refer to page 6-1).

The spacers are all tapered at 30 deg. They can be made most easily by cutting oversize at 45 deg. on a bandsaw, and then removing the excess material with a hand-held hacksaw blade and finish sanded with 36-grit paper.

Note that the floor immediately behind the front seat back is continuously 1-1/8 in. thick (3/8 in. + 3/4 in.), to allow space for the landing brake to retract inside the fuselage bottom (Ref. A-9 & A-10).

Cut all of the spacers and trial fit them in place on the fuselage bottom. When everything fits, vacuum the foam surfaces, squeegee micro slurry on all mating surfaces (but not on the landing brake), and fasten in place for cure with small finishing nails pushed through both layers at alternating angles. Allow to cure.

After cure, remove nails and locate foam bottom and frame in place on fuselage. Check all spacers for smooth transition to longerons, bulkheads, seatbacks, heat duct, etc. (see sections page 6-6). Mark any areas needing additional sanding, put assembly back on work table and make any necessary corrections. The top edges should be radiused, so the glass cloth will conform. Also radius the forward edge, where the bottom butts against F-22, so the glass can be continued around the end (Fig. 30).

In preparation for glassing, remove any epoxy high spots, and vacuum the foam surface. Mix some dry (stiff) micro and make a generous radius in all corners to help glass lay-down. Then squeegee micro slurry over the entire surface.

The contoured surface gets **2 plies of BID** at 45 deg. fiber orientation. Lay up the first ply in one direction, and the second ply in the crossing direction. Overlap the joints 1 in. and be sure to remove the selvage. The glass runs down the forward end, and overhangs the aft end 2 in. (Fig. 30). Do not wet out the 2 in. overhang. Make sure you eliminate all air bubbles by pressing the cloth into the contour starting in the center of the layup, and working your way toward both sides, holding the cloth down with one hand while pressing it down with the other. Add a **3rd ply of BID** ahead of the back seat where the weight will be concentrated when climbing in. Scissor trim flush with the foam edges on the sides. Let this layup 'tack' for two to four hours. This will allow the epoxy to cure enough so the glass doesn't fall off when you turn it upside down onto the fuselage. Don't take a chance-it would ruin your whole day.

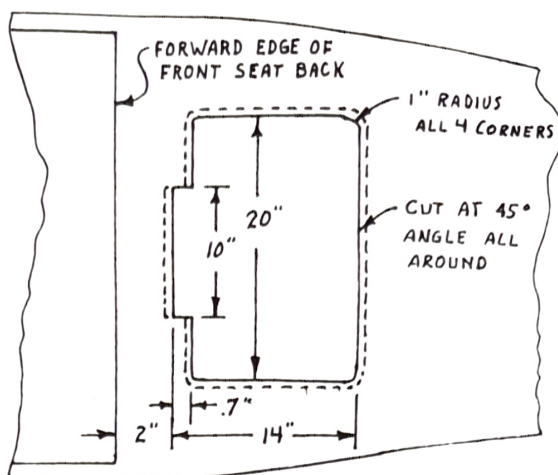


FIG. 29

While waiting for the layup to 'tack', it would be a good idea to sand all of the areas adjacent to the fuselage bottom, so the joints can be taped before the bottom is fully cured. When the layup is ready, mix a bunch of medium stiff flox and spread a liberal bead on all the mating surfaces of the longerons, seatbacks, heat duct, F-22, etc. Now pick up the glassed bottom, turn it over, and carefully set it in place on the fuselage. Weight it into position again, being sure to get good contact along the sides and on the bulkheads. Clean off the excess flox inside and outside. Refer to Fig. 30 to see what to do with the 2 in. of excess cloth overhanging the aft end of the bottom; it provides an excellent joint for the bottom of the rear seat. Before the bottom has fully cured (up to 12hrs.), the joints can be taped without further sanding. Crawl underneath and tape them just like you did the sides to the bulkheads earlier (Fig. 30).

After a full cure, you can remove the boards, Bondo blobs, and weights, and flip the fuselage right side up. Do not sit or stand in your fuselage yet. It does not attain its stiffness and strength until the outside is glassed in the next chapter.

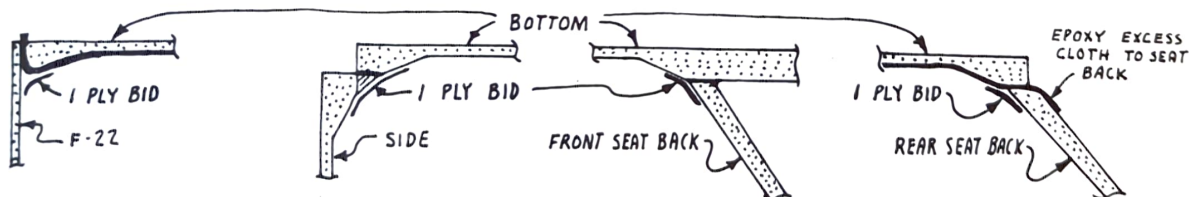
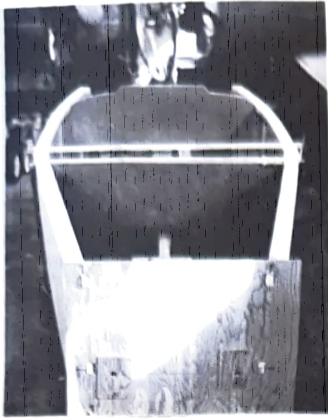
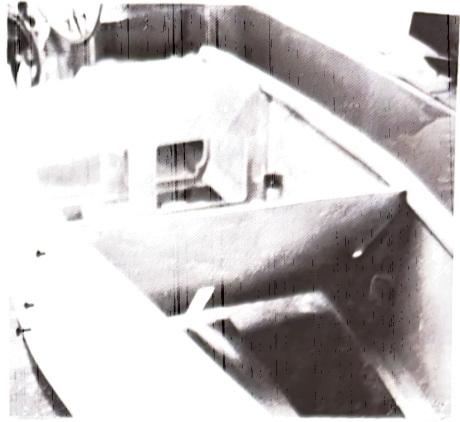


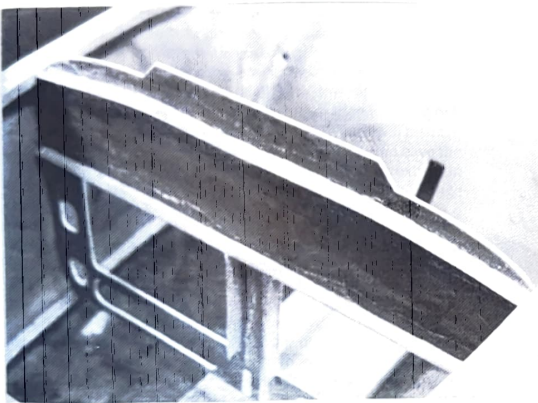
FIG. 30



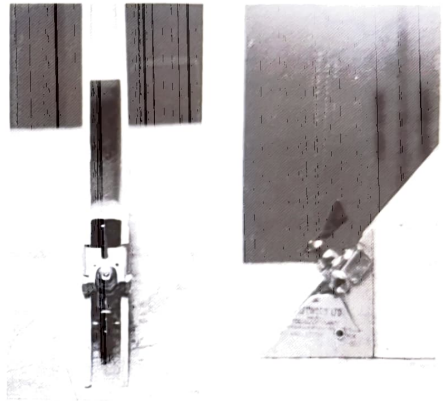
Fuselage assembly curing
Sides held in place with boards and filament tape



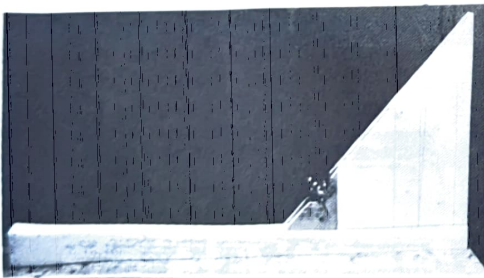
Note nails positioning seat-back



Instrument panel looking aft
showing reinforcing ribs



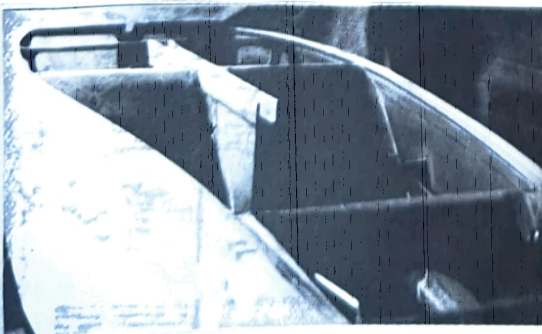
Fuel valve mounted on seat-back brace
Note map pocket



Brace and air duct ready to install



Brace and duct installed
Note fuel valve port



Fuselage ready for bottom installation

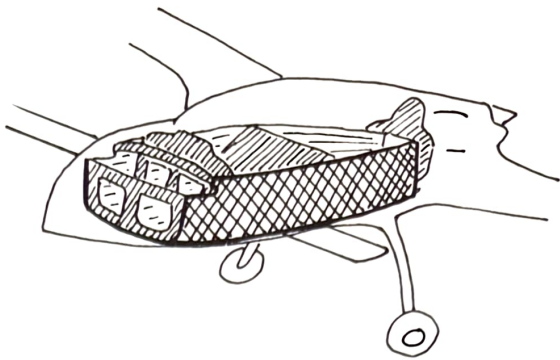


Frame holding foam to bottom contour for glassing

CHAPTER 7

FUSELAGE EXTERIOR

VENTS CR-11-3
RETRACTABLE STEP CR-12-3



OVERVIEW. In this chapter you will carve the fuselage exterior to shape, rounding the sharp corners for an esthetically pleasing airplane and preparing the fuel tank area. The outside foam surface then receives its two-ply skin. Up to this time your fuselage was a fragile, flexible, weak box. After it gets glassed, it will then be an extremely stiff, strong, composite sandwich structure.

STEP 1. CONTOURING THE FOAM CR-15-3 BUILDER HINTS FOR SHAPING

Believe it or not, this step should only take about 3 hours. This is where the ease of rigid foam carving really pays off. Your fuselage cross section, before carving, looks like (Fig.1) A-A. When you've finished carving, it will look like Fig.1 B-B. To do this contouring smoothly, you will need a long sanding block (30 in. is about right), your butcher knife (good and sharp), and a soft sanding block. A block of flexible foam with 36 grit sandpaper is an excellent carving tool for the finish smoothing. Start on the bottom first. A full size template for the bottom corners is shown on drawing A-4. Rough cut the corners with your butcher knife. Finish the rounding with your sanding block. Use the sanding block with the long dimension parallel with the longerons, and sand gradually along the full length, rather than finishing one area at a time. Gradually working the full length, will result in a smooth, even fuselage. Change sandpaper often. Leave the corner contour high at the aft end where the gear extrusion attach bolts would otherwise be ground off. Do not change the shape of the firewall, or your cowlings won't fit.

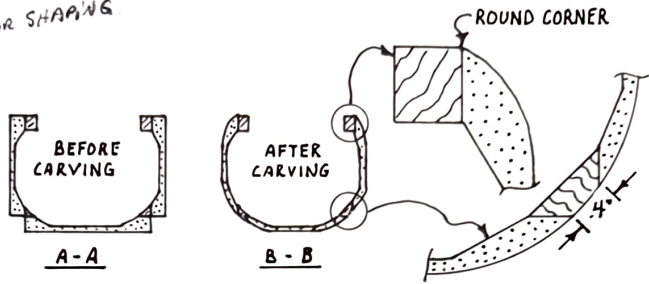


FIG. 1

The next job is to turn the fuselage right side up and cut out and contour the area in the forward top of the fuselage where the canard and elevator tubes pass through. This is done by making a template according to the full size pattern on drawing A-5 and locating it inside your fuselage (Fig.2), butted against the bottom side of the upper longeron. Since the inside of your fuselage is contoured, you can trace the cutout more accurately if you fasten a 3/4 in. foam spacer behind the template, cut to the same outline as the template, so you have a surface to trace against. Repeat similarly for the other side. Make the cut with a coping saw, removing the entire corner shown (Fig.2). This includes removing the longeron forward of F-28 and removing the tab of F-22 that sticks up above W.L.18.9. Refer to chapter 12 (canard installation) for additional clarification. Now, contour the top longeron and foam side behind the canard cutout as shown in the sections (Fig.2). Templates are found on drawing A-5. **Do not** sand into the longerons from the instrument panel on aft, except to radius the edge so the glass will conform.

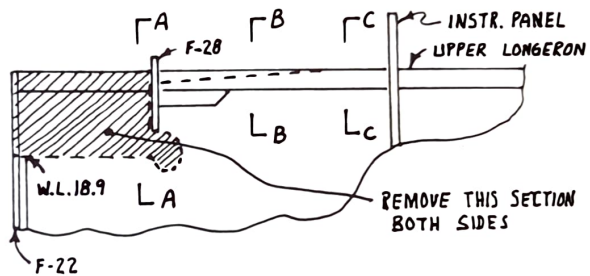


FIG. 2

Refer to Fig.3 and mark the outline of the fuel sight gauge on both sides of the fuselage. Sand the foam away from the fuel gauge as shown. Remove the 2 in. width of grey tape installed back in chapter 5. **Do not** contaminate this area. It must be clean to allow good fuel level visibility.

Micro some foam chips into the holes around the bolt heads at the landing gear fittings. Sand a slight depression, 1/16 in. deep and 1 in. wide in the foam (and bulkhead, if necessary) at F-22, sides, and bottom, so the skin on the nose can overlap later on without causing an unsightly bump in the contour. Remove the foam above and below the centerspar cutout, for later attachment of engine mount extrusions, and 1/2 in. forward of the centerspar cutout for a good glass-to-glass bond, and taper the foam for a smooth transition from outside to inside skin (Fig.4).

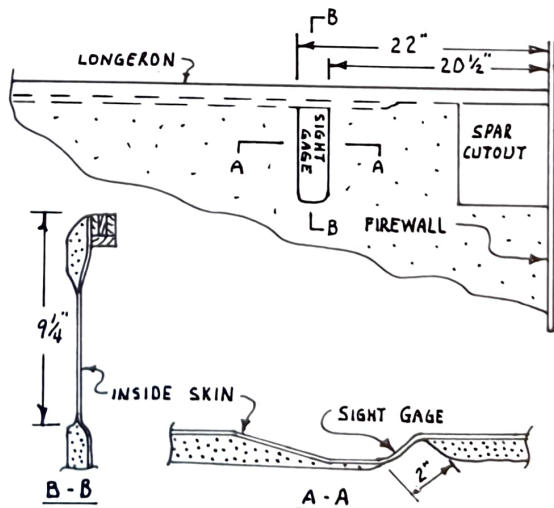


FIG. 3

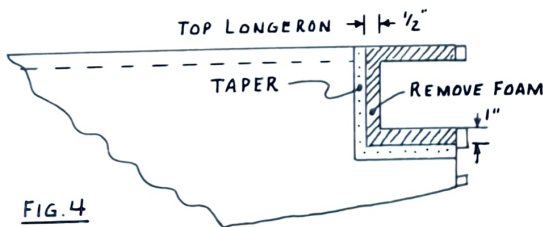


FIG. 4

Now turn the fuselage over again, and sand a 1/16 in. deep depression 1 in. wide forward of the landing brake and 2 in. wide alongside and aft of the landing brake (Fig.5). This allows an overlap later on without causing a bump. Now build up the area 1 in. wide alongside and aft of the landing brake with 1 in. wide duct tape until it is flush with the landing brake (Fig.6). The reason for doing this will become obvious in chapter 9.

Refer to Fig. 7 showing a small wood insert in the lower corner of the fuselage. Remove the bottom foam and micro this insert in place. This provides additional strength needed to support the external step installed in chapter 8. This is **only** on the **LEFT** side (when the fuselage is right side up).

STEP 2. GLASSING THE OUTSIDE SKIN

This step should take about 4 hours with 2 people, not counting cure, after everything is ready for glassing.

It is not practical to attempt to glass all around in a single layup. The glass will fall off when the fuselage is turned. Plan to do it in 2 layups, overlapping 2 in. at the bottom centerline, with a 2 to 4 hour (depending on temperature and epoxy) cure in between.

Make provision for supporting the fuselage firmly in a right 45 deg. bank for the first layup and a left 45 deg. bank for the second layup. 'A-frame' legs clamped to the firewall and F-22 work well (Fig.8). Also, the landing brake cutout should be tacked in place with several small dabs of 5-min. so it is firm for glassing.

The foam surface should be smooth, even, and dust and dirt free. Squeegeeing micro onto the surface is recommended as the lightest filler and strongest bond.

The skin layup schedule is two plies UND, crossing at 30 deg. to the longerons. A third ply of UND is added forward of the front seat bulkhead **only**. This third ply has a fiber orientation parallel to the longerons. Also, a 3-ply layup of UND is added on both sides to stiffen the upper longerons, starting 15 in. forward of the firewall and terminating at the canard cutout. The plies should be tapered at the aft end and along the side so they don't create a sharp bump; i.e., not all the same length and 3 in., 4 in., and 5 in. wide, respectively (Fig.9).

As shown in Fig. 9 details, the skin extends from the inside top corner of the longerons and around the fuselage. It terminates at the firewall, which must be removed for centerspar installation. It is knife trimmed flush at the bottom foam block aft end, near the bottom of the aft seat bulkhead. It is knife trimmed flush at the F-22 bulkhead forward edges, the canard cutout, and the spar cutout. Lap the skin onto the lower longerons at the lower aft edges.

The 2-4 hour tacking period should assure the glass will not peel loose. A close scissor-trim at the bulkheads and longerons will also prevent the glass from peeling.

Peel-ply the area where the wing strake will bond (chapter 21), a 2 in. strip around the spar cutout and a 1 in. strip at the firewall and F-22 bulkhead. You now have bare foam only at the aft edge of the bottom block, and around the canard cutouts. Leave these bare now. After cure, the fuselage should be strong enough, but sitting in it isn't recommended until after it is mounted on the gear, to avoid damaging the skin. Fit and comfort is **not** representative until the side consoles, thigh support, floor ahead of the instrument panel, nose section, and cushions are installed. From this point on, support the fuselage on large foam blocks to avoid skin damage.

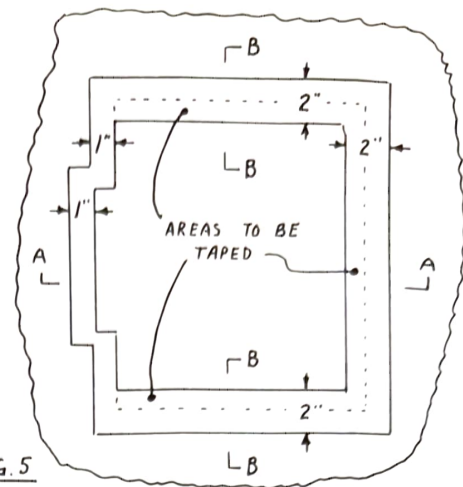


FIG. 5

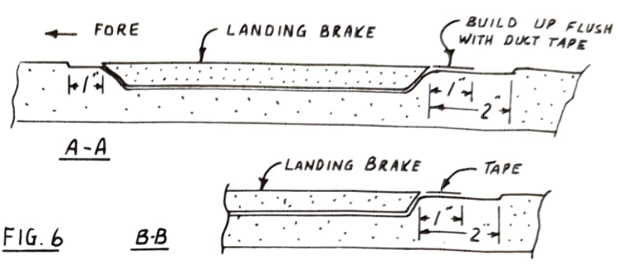


FIG. 6

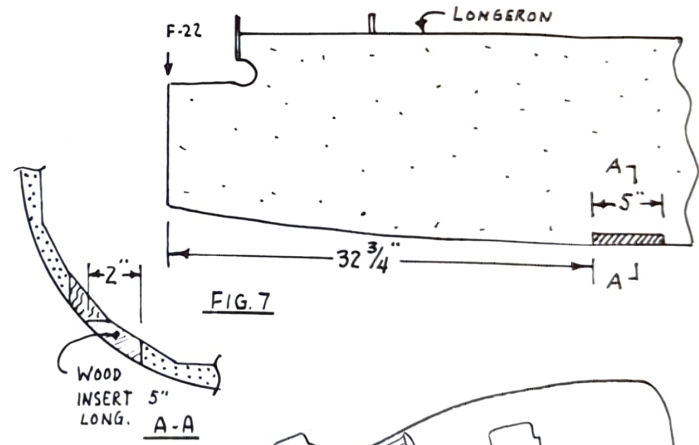


FIG. 7

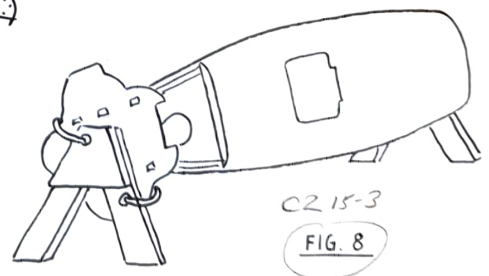


FIG. 8

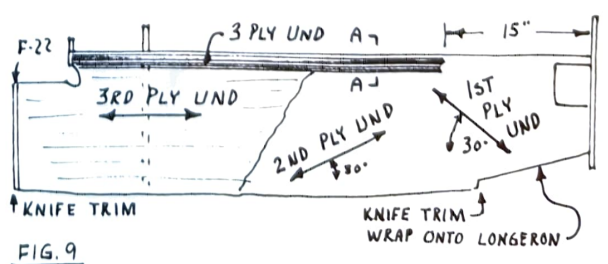
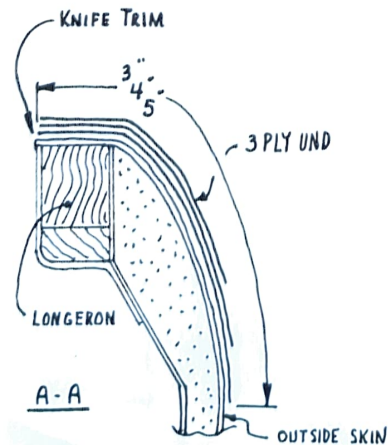
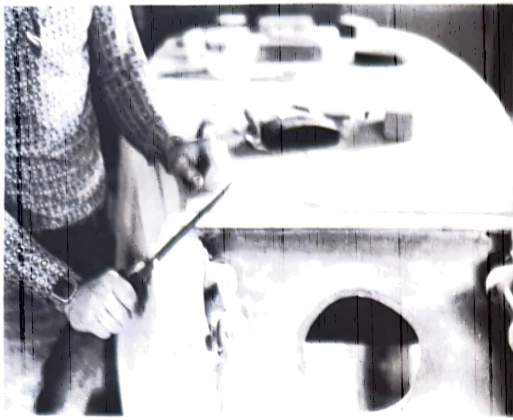


FIG. 9



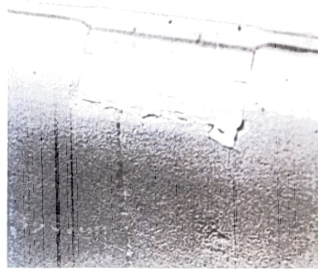
Carving fuselage foam



Sanding into longeron



Bottom contour check



Step reinforcement



Fuel sight gauge



Top contour check



Carving foam, centerapap cutout



Landing brake taped, ready to glass



One-half fuselage outside glassed

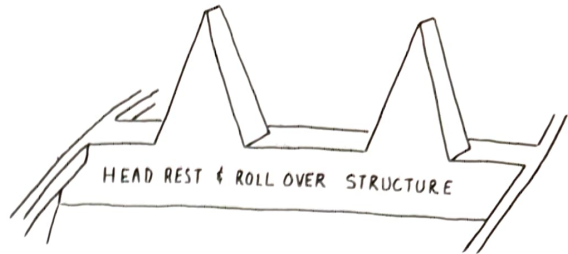
CHAPTER 8

ROLL OVER STRUCTURE &

SEAT BELTS

NOTE: C2 12-3 HEAD RESTS - ITB-1
C2 12-3 RETRACTABLE STEP

CHAP 21



OVERVIEW. In this chapter you will install the headrest/rollover structure which mounts on the front seat-back. This structure is fabricated from low density PVC foam sheets which are glassed inside and out with local inserts and buildups for the shoulder harness mount points. Holes may be cut in the sides of the headrests for map storage, or in one headrest for an RST intercom (it isn't really needed), or in the front of the headrests for speakers (they aren't necessary either). Local reinforcements are also added for the installation of seat belts, front and back.

STEP 1. CARVING THE FOAM PIECES

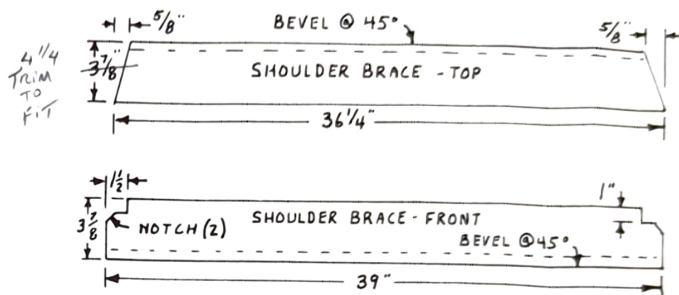
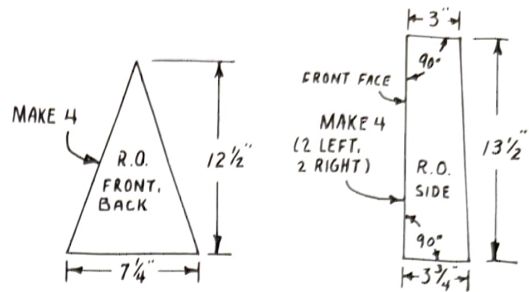
Cut the pieces shown in Fig.1 from 3/8 in. thick, pink, low density Divinycell foam. Notice that the headrests are vertical in the front, but sloped in the back. Although all 4 sides are cut identically, make sure you do 2 rights and 2 lefts when glassing the insides. Bevel the edges of the shoulder brace as shown, so there will be a good juncture with the sloping seat back. Trial fit all the pieces together (use nails) and trim (or add foam) as necessary for good fits (see also Fig.3).

Now disassemble the foam pieces (mark the inside surfaces) and cut the 4 birch plywood inserts (Fig.1). Center them on the shoulder brace top per the centering dimensions shown in Fig.2, trace the outlines and remove foam with a razor. 5-min. epoxy the inserts in place per detail Fig.2 Fiberglass buildups will be added later to level the top.

Before starting Step 2, turn to Chapter 18, Canopy, and install the canopy hinges. This will avoid having to cut into the roll over structure later on to install nuts on the hinge bolts going through the longerons.

STEP 2. GLASSING THE INSIDE SURFACES FOR WET LAYUP

Glass the inside surfaces of the headrest with 1 ply of BID (micro the surfaces first). Let the layup cure to knife trim, trim the foam pieces, mix wet micro and reassemble the headrests with nails to hold the pieces together (Fig.3). Now 5-min. epoxy the front and top shoulder brace pieces together (hold in place with nails for cure, Fig.5). Cut a 1 in. dia. hole (Fig.5) in the left-hand (pilot side) corner for the canopy lock push rod. Micro the inside surface and then glass with 1 ply BID. Make a couple of foam jigs to hold the assembly for glassing and 'tack' cure (Fig.4). Allow the glass to overhang 1 in. at each beveled edge, but don't wet the excess glass with epoxy (Fig.4). Let tack for 2 to 3 hours (heat from a hair dryer will speed things up). In the meantime, sand the front seat back mating surfaces. After the layup is tacky (so the glass won't fall off), install with flox, wet down the overhanging BID with fresh epoxy (Fig.5) and peel ply.



NOTE: C2 8-3
FIG. 1

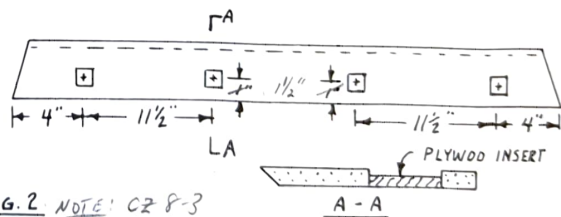
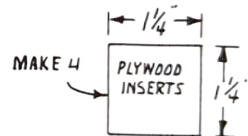


FIG. 2 NOTE: C2 8-3

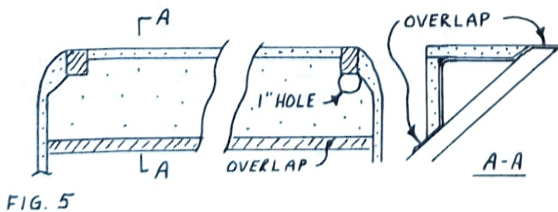


FIG. 5

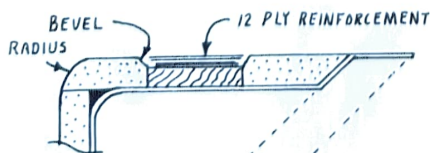


FIG. 6

FIG. 3

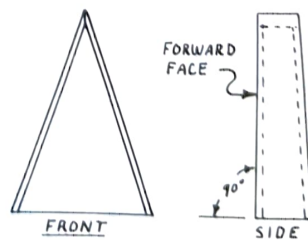


FIG. 4



STEP 3. GLASSING THE OUTSIDE OF THE SHOULDER BRACE AND INSTALLING THE HEAD RESTS

Radius the forward corner of the shoulder brace, and bevel the foam edges around the plywood inserts (Fig.6). Put in a 12 ply BID build up over the plywood inserts (Fig.6). This is done most easily by wetting out three 5 in. x 5 in. plies, on top of each other, on wax paper, and then cutting the layup into 16 squares 1.25 in. x 1.25 in., and stacking 4 each over each plywood insert (**remove the wax paper**).

Remove the peel ply installed previously and sand all areas adjacent to the foam. Vacuum the sanding dust, micro the foam (shoulder brace), and lay up 2 plies BID overall (Fig.7), lapping 1 in. on all adjoining surfaces, or add tapes in the corners if more convenient. Peel ply edges.

Now install the head rests with flox on the wet layup. The front face **must** be vertical and the aft face sloping. They **must** be in-line, and **centered** between the shoulder harness inserts. The peaks **should** be 17 in. apart. Hold in place for cure with nails, and peel ply all of the shoulder brace area which remains exposed (Fig.8). Allow to cure.

STEP 4. GLASSING THE HEAD RESTS

Remove the nails. Sand a generous radius on both peaks of the headrests and all edges. Remove peel ply and rough up adjoining fiberglass surfaces. Micro the foam. Apply 2 plies of BID overall including the top of the shoulder brace and overlapping the front 1 in. This is done most easily using long strips of BID cut 5 in. or 6 in. wide at 45 deg. doing all of the top surfaces first, that is, from one longeron over both peaks to the other longeron, lapping 1 in. around corners on the fore and aft faces (Fig.9). Then cover the fore and aft faces of the headrests with 2 plies, and add 3 plies of local reinforcement over the peaks (Fig.9). Peel ply everything for cosmetic purposes and allow to cure.

STEP 5. CUTTING THE ACCESS HOLES

Access holes shown in Fig.10 are cut in one side of each headrest, after cure, for stowing of sectionals. These holes may face each other in the center, for best accessibility by either pilot or passenger, or, if you wish to install an intercom or headset receptacles on the left side of the right hand headrest, then cut the access holes on the **right** side of **both** headrests. If you wish to install speakers (not really necessary), cut outs may be made in the forward face of the headrests and shoulder brace **below** the headrest seat cushions. This is optional.

STEP 6. INSTALLING THE SHOULDER HARNESS ATTACHMENTS

The seat belt/shoulder harness assembly made to fit the **COZY** and complete with all adjustments is available from distributors and included in your kit. Locate the position of the holes to be drilled through the reinforcements, and check your harness attach fittings to make sure they will clear the headrests. Then drill a 1/4 in. hole through the center (hopefully) of the inserts, and attach the harnesses. If you are installing speakers, you can reach through underneath to install wide-area washers and AN4 nuts. If you don't have access, then cut slots underneath each bolt in the forward face for a 3/4 in. wide x 1/16 in. thick aluminum tab with a nut plate attached (Fig.11). Flox it in place at first installation of the harness. After cure, remove the excess tab and glass over slot with 1 ply BID (Fig.11). The nut plate should allow repeated removal and reinstallation.

A shoulder harness may be installed in the rear seat by drilling 1/4 in. holes through the wood inserts provided in the centerspar for that purpose, after it's installation in Chapter 19.

FIG. 7

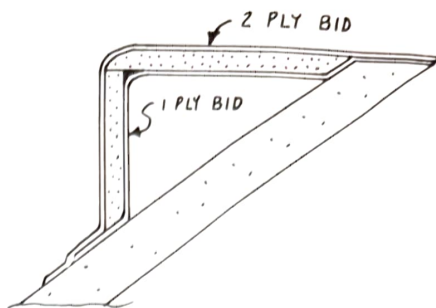


FIG. 8

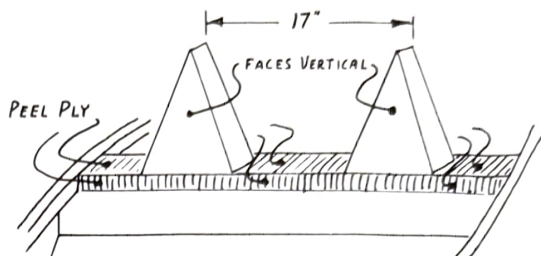


FIG. 9

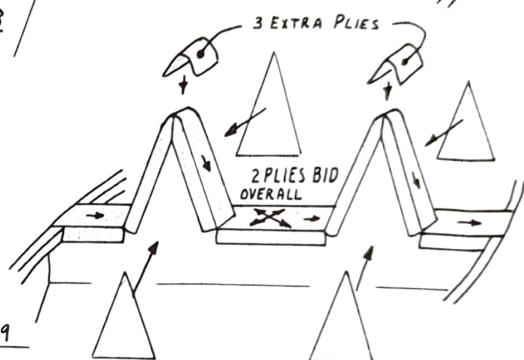


FIG. 10

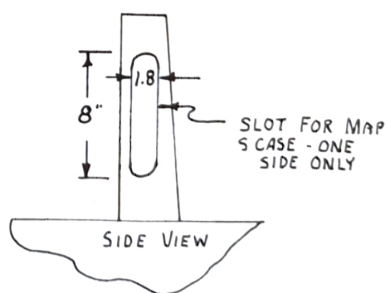
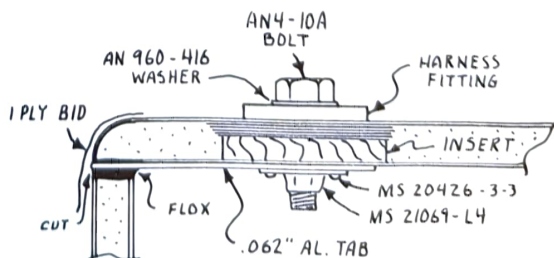


FIG. 11



STEP 7. INSTALLING THE SEAT BELT ATTACHMENTS AND THE EXTERNAL STEP

Seat belts in the rear seat and the outsides of the front seat are attached through the lower longerons (Fig.12) after appropriate reinforcements are added (Fig.13&14). The left side front seat safety belt attachment goes through the outside step (Fig.13). This step can be fabricated from 1/8 in. 2024 T3 aluminum (Fig.15), or purchased from a distributor. The latter is recommended.

Fabricate four 1/4 in. birch plywood inserts which fit fairly well against the longerons (Fig.13 & 14) at the locations shown (Fig.12), and four angle brackets from 1/8 in. x 1 in. x 1 in. 2024 T3 aluminum angle. Sand the areas where they will be installed with 36-grit, and install with sufficient wet flox to fill any voids, and immediately glass with 7 plies BID. The BID should lap adjacent areas 1 in. except where the step will be installed, lap 1 1/2 in. After cure, hold the extrusion angles in place and drill through the reinforced area with a 1/4 in. bit. Use a counterbore on the outside to recess the bolt heads flush except on the left, forward location where the step attaches. Install three of the angle brackets with wet flox and AN525 bolts (clean and rough the angle surface first). At the left forward position, install the step first with flox and the two AN509 flat head bolts which do not go through the angle brackets; then drill the two remaining holes through, and install the bracket with flox and AN509 bolts.

STEP 8. REINFORCING CENTER CONSOLE FOR CENTER SEAT BELT ATTACHMENTS

Sand area to be glassed with 36 grit. Lay up 7 plies (4 BID and 3 UND, alternating) approx. 4 in. wide, centered over the seat belt tube installed in Chapter 6, and extending down onto the seat bottoms approx. 6 in. each side (Fig.16). Vary widths and lengths for feathered edges (no bumps), and peel ply edges. After cure, open up 1/4 in. hole through the tube. Don't install the harness until fuselage construction is complete and painting done.

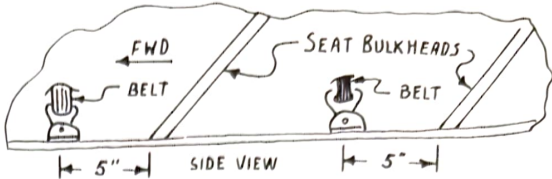


FIG. 12

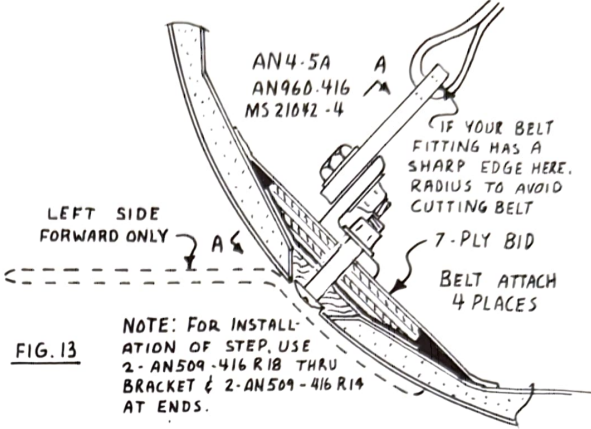


FIG. 13

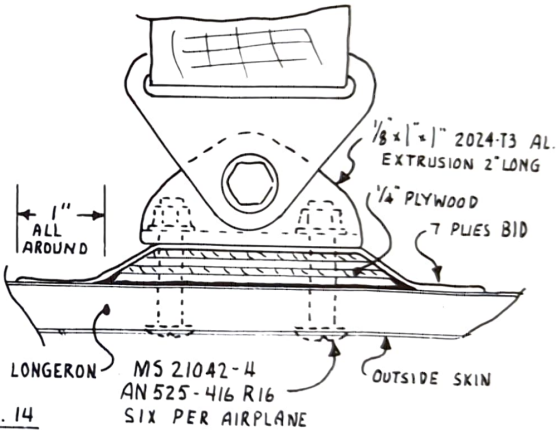


FIG. 14

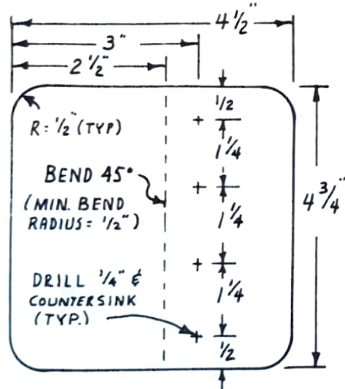


FIG. 15

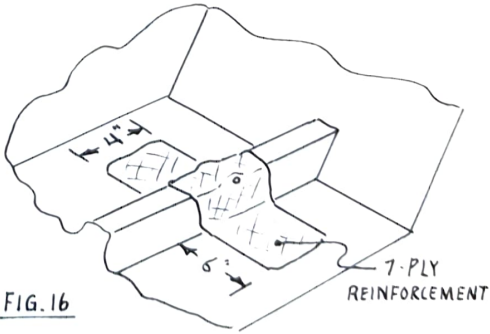


FIG. 16

CHAPTER 9

NOTE: CR 5-2 WHEEL PARTS + G210-1
INSTALL CENTERSPAR TO FUSELAGE BEFORE GEAR.

MAIN LANDING GEAR AND LANDING BRAKE

CR 13-5 BUILDUP PARTS
BRAKE FAILURE

NOTE: This chapter covers the preparation of the landing gear for installation, its installation, and construction of the landing brake. The gear installation is referenced to the center spar, however, so this part of the chapter **must** be postponed until after center spar installation. The landing brake actuating mechanism is installed in CHAPTER 16, CONTROL SYSTEM.

OVERVIEW: In this chapter you will mate the main landing gear to the fuselage and to the wheels, brakes, and axles. You will sand the entire gear dull, and layup 8 plies of UND at 35 deg. over the strut for torsional stiffness. You will install a conduit for the brake lines from soda straws and feather the trailing edge for minimum drag. You will jig the gear strut into position on the fuselage, make the attachment glass tab layups and assemble the gear onto the fuselage. With the gear installed, the axles are mounted, drilled in, and installed. Brake lines are installed and routed through the baggage compartment and firewall. The main gear strut is the same as used on the Long EZ. It is a one-piece, airfoil shaped S-glass molded part, available through your COZY distributor. **Do not** use a VariEze gear (16 lbs.). A Long EZ gear weighs 22 lbs. and is much stronger. The gear and its structure have been successfully drop-tested to the stringent requirements of FAR part 23 for certified aircraft. The Cleveland 500 x 5 wheel and brake assembly and axles are available from COZY distributors.

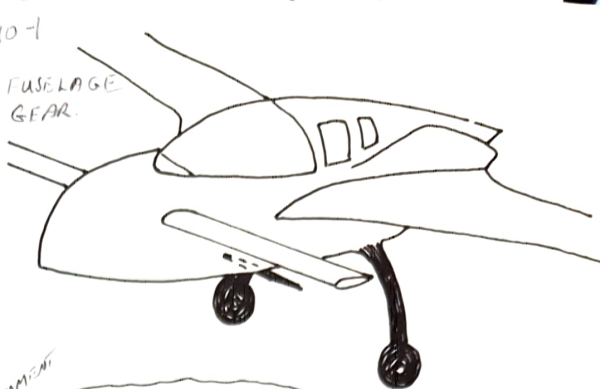
In this chapter you will also cut out the landing brake, install plywood inserts in the fuselage and landing brake, install the hinge, glass the recess in the fuselage and the top of the landing brake, and permanently install the brake. The hard point for the operating mechanism was installed in CHAPTER 6, and the mechanism will be installed in CHAPTER 16.

STEP 1. TORSIONAL STIFFNESS LAYUP AND BRAKELINE CONDUIT INSTALLATION

This step will take at least 4 hours. Remove any flash from the strut with a grinder (36 grit). Then, using new, 36 grit paper, thoroughly sand the entire gear surface dull, and fill any depressions with floc. Drive 3 nails into the top of your work bench so that the gear strut can sit on the heads of the nails (Fig.1). Rough the heads of the nails with a coarse file, and glue the gear strut, trailing edge up, to the nail heads with a dab of 5-min. epoxy mixed with a little floc. This will hold the gear in position in order to make the layup. After the epoxy is cured, make a layup using UND strips, cut 9 in. wide and 30 deg. to the selva edge. You will need 16 strips (Fig.2).

Now, paint a coat of pure epoxy (not 5-min.) all over the strut and layup the first ply of UND so that the major fibers cross the face of the strut at about 35 deg. on each face. It should take 2 strips of UND to layup one ply from end to end. **Do not** lap the UND, but rather butt them together at the center. Up to 1/4 in. gap between each piece is acceptable and better than a lap joint. The second ply is layed up with the major fibers **crossing** the first ply of UND (opposite angle). Thus, you will have a cross hatched effect (Fig.1). Similarly, the third and fourth plies of UND are layed up, giving you a torsionally very stiff 4-ply layup (Fig.3). In all cases the major fibers **must** be **straight** without wrinkles. Allow this layup to cure completely. A sharp blow will crack the gear strut free from the nail heads. Now you must trim the excess glass at the leading edge. Use a hard block and 36 grit, and sand the edges to a smooth transition to the molded S-glass, and sand the rest of the layup dull. Set the gear back on the nail heads (or bench) trailing edge up, and take some soda straws large enough so your 3/16 in. O.D. brake line will slide through, tape them together, and 5-min. epoxy them in place, centered on the trailing edge, starting 8 in. from the end of each leg and ending 11 in. from the center. Make sure the 3/16 in. tubing will slide through (or you can leave it in). Take some stiff tape, like aluminum tape or several layers of duct tape, and build a trailing edge support (Fig.4). Fill the gap between the soda straw and the gear with micro, lay up 2 plies of BID, and peel ply (Fig.5). Make sure you have at least 1/2 in. of glass extending beyond the straw after trimming, for a glass to glass bond. Let cure, remove the aluminum tape and peel ply, and sand both sides of the BID tape.

Now the strut is reversed, and remounted on the nail heads **trailing edge down**. Fill gaps along soda straws with micro, and lay up 4 plies of UND, crossing each other, exactly as you did the first 4 plies, except each ply should have one edge extending to the trailing edge of the strut, first on one side and then on the other (Fig.6). After this layup cures, remove the strut from the nail heads, trim the excess glass, and sand it smooth. **Do not** cut into the previous layup.



NOTE:

CRIP-3 EDITORIAL COMMENT: WHEEL AND BRAKES.

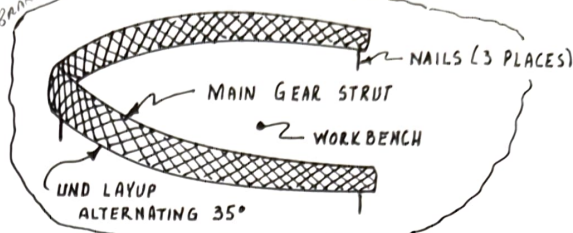


FIG.1

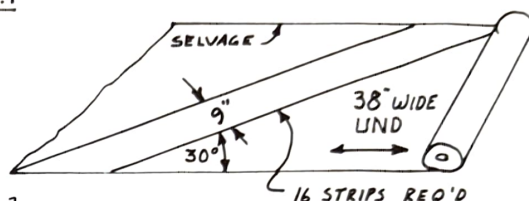


FIG.2

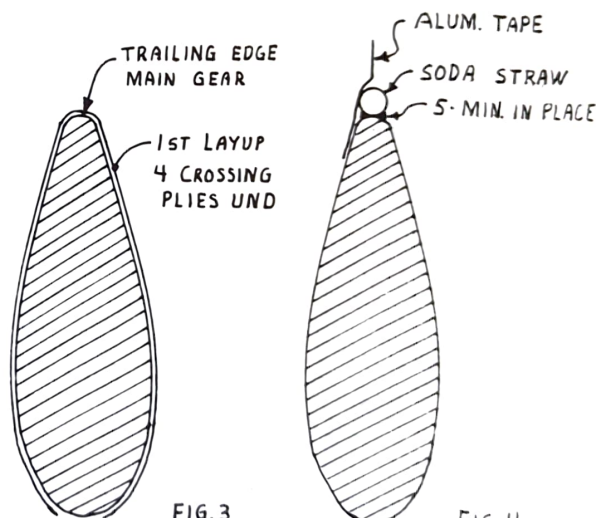


FIG.3

FIG.4

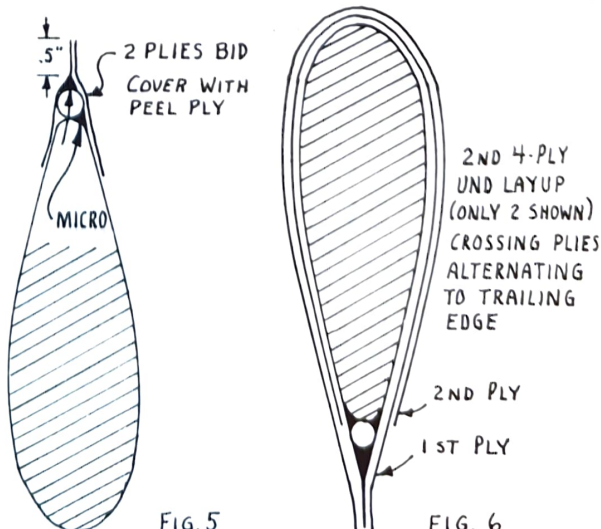


FIG.5

FIG.6

STEP 2. POSITIONING THE MAIN GEAR ON THE FUSELAGE AND INSTALLING JIG BLOCKS

Correct installation of the landing gear requires that it be centered in the fuselage, with both legs of equal length, and both legs swept forward correctly with the ends at the same fuselage station. References are the fuselage centerline, the upper longerons and the centerspar, which has been installed perfectly square (correct?). You will need a 4 ft. level, a 2 ft. level, a short level (but accurate) which can be bonded in place, 2 carpenter's squares, 2 plumb bobs (strings with weights on the ends), and plenty of 1 in. x 2 in. wood strips and bondo to build bracing to hold everything steady while the tab jig blocks are installed. If you follow this sequence, it will turn out okay, but you will need an assistant.

- 1) Cut four 1/4 in. thick jig blocks (Fig.7) from 1/4 in. plywood. Bevel the blocks as shown 0.8 in. to a sharp edge. Drill 5/8 in. dia. holes through all 4 pieces to fit nicely on the steel tube. Slip 2 jig blocks on each tube, bevels to the outside, and bolt the tubes into place between the aluminum angles on the fuselage.
- 2) Turn the fuselage upside down on a pair of saw horses. Level the fuselage fore and aft, and side to side using the top longerons as a reference (Fig.8).

NOTE: 2-6-3

3) Make sure the ends of each leg are trimmed identically; that is, level, fore and aft when the gear is in its swept forward position (Fig.9).

- 4) Mark the position of the axle centerline on the outside of both legs, identically. Drill a small hole and insert a small finishing nail to fasten a plumb line.

- 5) Mark the centerline of the gear and place it in position on the four jig blocks. Use small foam wedges as required to support the weight of the gear and hold it off the steel tube the required distance.

- 6) Bondo a straight board across the gear legs (Fig.10) and bondo your small level in the center. This will allow you to set both legs to the same length.

- 7) Drop plumb lines for each axle centerline (Fig.8 & 10). Bondo carpenter squares to the centerspar, next to the plumb lines on each side, equidistant from the fuselage centerline. The carpenter squares must be against the aft face of the centerspar and level.

- 8) Adjust the foam wedges until the gear is centered, the correct height above the steel tubes, the jig blocks are centered on the steel tubes with about 0.65 in. of tube showing each side of the jig blocks, the legs are equal in length, and sweep (read on the carpenter square) 15-1/2 in. on both sides (Fig.8).

- 9) Build a supporting framework with 1 x 2's and bondo to hold the gear in this correct position, hands off. Do not be concerned if the tabs are not exactly square with the leading and trailing edges; just do the best you can.

- 10) Now trowel a generous blob of bondo between the plywood and the gear leg. This must be strong enough to support the plywood blocks while you layup the outer glass tabs (Fig.11). Also, bondo the steel tube to the plywood block, using only a tiny dab (Fig.11).

- 11) After the bondo has cured, carefully remove the AN6-80A through bolts and lift the gear leg off the fuselage. Set it down on its axle ends and support it well.

- 12) Now bondo a small wood reference pointer (Fig.11) to the gear leg under each steel tube. When these have cured, scribe a mark on each steel tube to coincide with the reference pointer (Fig.11). This will enable you to replace the steel tubes in exactly the same position after glassing the tabs.

- 13) Now carefully scrape the small bondo dabs off the steel tubes, and withdraw the tubes from the jig blocks. Be sure not to displace the jig blocks or the reference points.

- 14) Now turn the gear leg upside down and support it well on two foam blocks, 3 feet apart (Fig.12). Thoroughly sand the main gear leg using 36 grit where the glass tabs will go, and sand (hard block) a good smooth transition from the plywood jig blocks to the glass gear leg. Stick grey duct tape on the plywood jig blocks for good release (Fig.13) (make sure the holes are covered). You are now ready to layup the glass tabs.

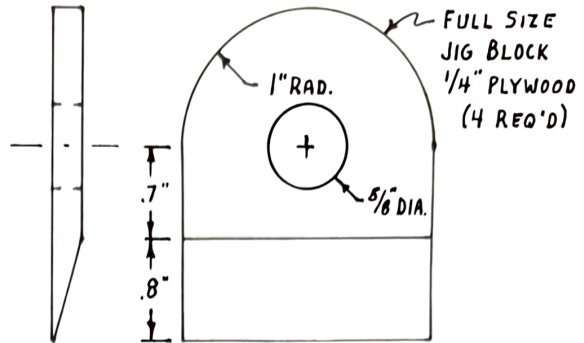


FIG. 7

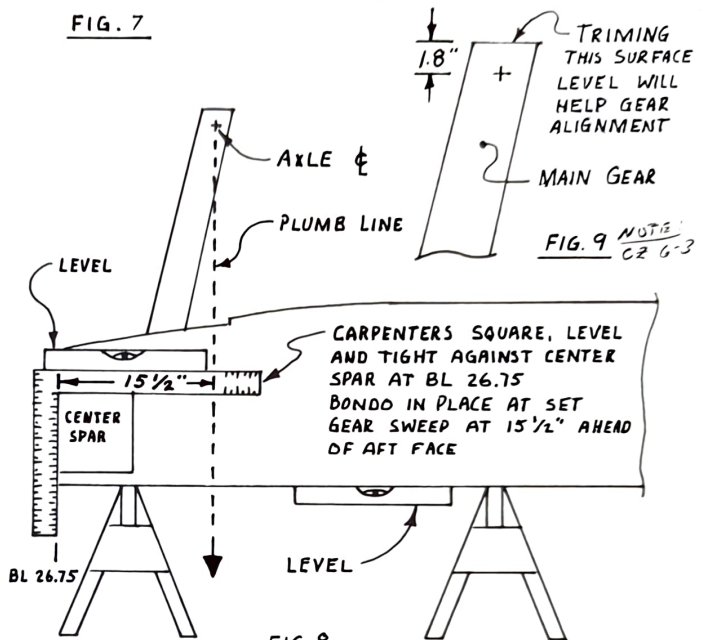


FIG. 8

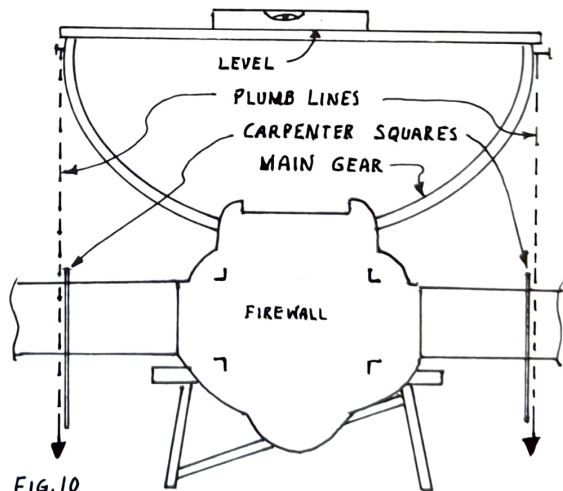


FIG. 10

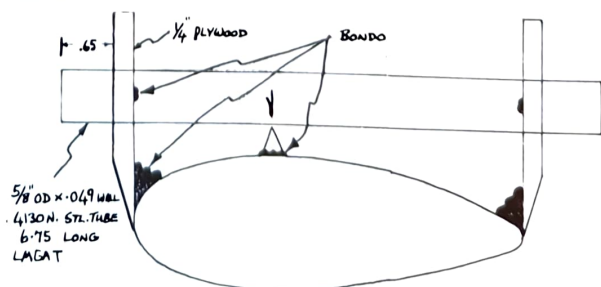


FIG. 11

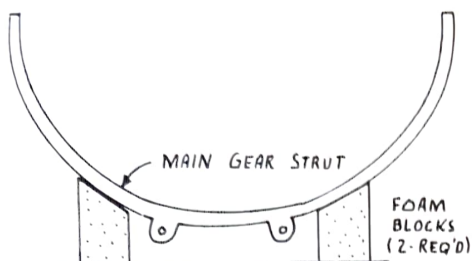


FIG. 12

STEP 3. GEAR ATTACHMENT TAB LAYUP

This step will take about 3 hrs., with cure time in between. You will need two 5/8 in. x 1/4 in. bushings and your 5/8 in. spot facing tool.

Cut 72 plies of UND 2-1/2 in. x 12 in. (fibers running lengthwise), 72 plies of BID 2-1/2 in. x 3-1/2 in., and 72 plies of BID 2- 1/2in. x 2-1/2 in. Wet out 18 plies of the UND 2-1/2 in. x 12 in. on a piece of paper (not wax paper) with RAEF or SAFE-T-POX and make a thick UND glass pad. Squeegee out excess epoxy and check for dryness. Paint a coat of epoxy over the gear leg and fore and aft plywood blocks. Now peel the wet 18 plies of UND off the paper and lay it across the gear and down the grey tape face of each jig block. This should overlap the plywood pieces all around (Fig.14). Squeegee out excess epoxy. Now, layup 18 plies of BID 2-1/2in. x 3-1/2 in. on a piece of paper, peel the wet layup off the paper and place it on the aft face of the plywood block over the 18 plies of UND, and lapped up over the trailing edge of the gear (Fig.15). Now make a similar 18 ply BID layup using 2-1/2in. x 3-1/2 in. pieces and place it on the face of the leading edge plywood block over the 18 plies of UND and lapping up over the leading edge (Fig.15). With the UND wrap and BID pads in place, cover with Saran wrap. Using 2-1/2 in. x 2-1/2 in. square blocks of 1/4 in. plywood, on either side of the jig block, and a small c-clamp, hold everything in place until cured (Fig.16). The Saran wrap keeps the plywood blocks from bonding to the glass tabs. The clamp should be snugged down to keep the blocks firmly in place, but **not** tightened hard.

Allow the layup to cure fully, then remove the clamps and clamping blocks and trim the glass tabs down flush with the plywood jig blocks (2 in. wide) with a coping saw. The layup is much too thick to knife trim. Use your dremel to smooth out any rough edges.

Using a 3/8 in. drill bit, drill a hole as nearly in the center of the 5/8 in. hole in the jig block as possible. This is a clearance hole and is not critical. Now, put a 5/8in. x 1/4 in. bushing in the 5/8 in. hole of the first jig block, thread the 1/4 in. shaft of your spot facer through it, fasten the tool on the end, and drill a 5/8 in. dia. hole through the far glass layup, using the 5/8 in. hole through the plywood for centering (Fig.17). Drill slowly to avoid heat. Backup the fiberglass with wood to get a smooth exit cut. Now reverse the procedure for the other tab, and drill holes similarly for the other set of tabs.

Before going further, reinsert the 5/8 in. steel tubes through the glass tabs so that the scribed mark lines up with the reference point (Fig.18). You do still have the reference pointer bonded on, don't you? With the marks aligned, scribe a mark on the steel tube, flush with the outside of each glass tab.

When you have 5/8 in. dia. holes bored through both sets of gear attach tabs, you can *carefully* chisel the bondo blobs from between the plywood jig blocks and the gear leg, and the jig blocks should then be easy to remove due to the grey tape release.

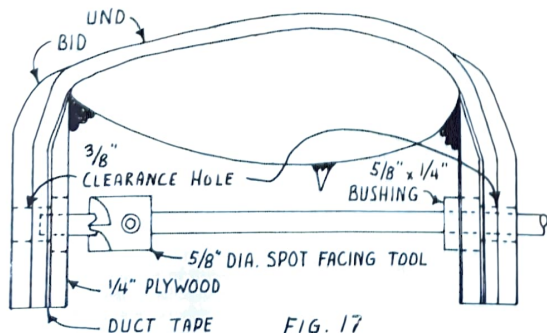


FIG. 17

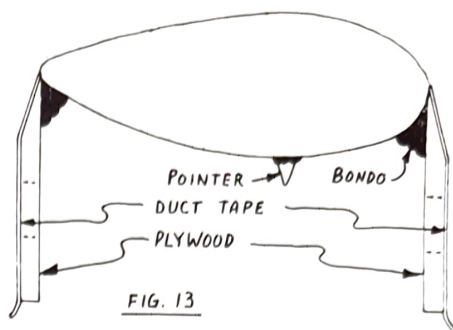


FIG. 13

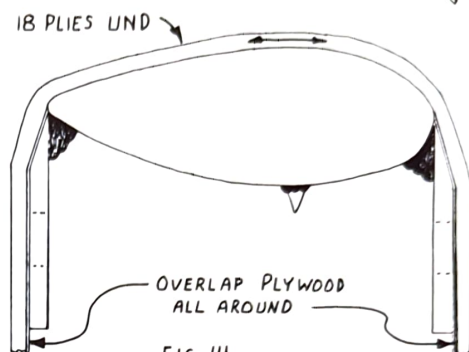


FIG. 14

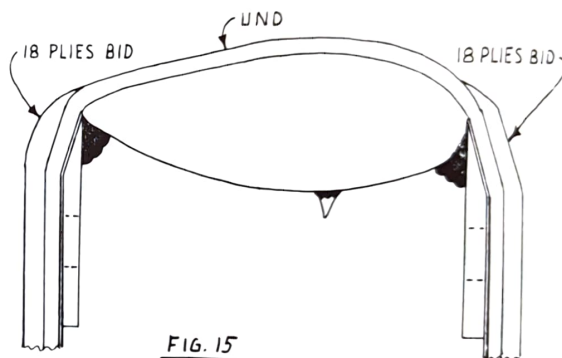


FIG. 15

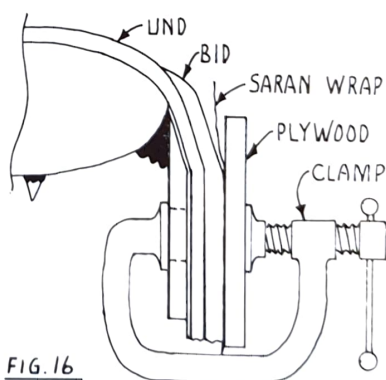


FIG. 16

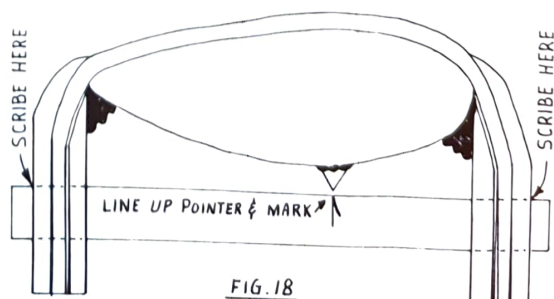


FIG. 18

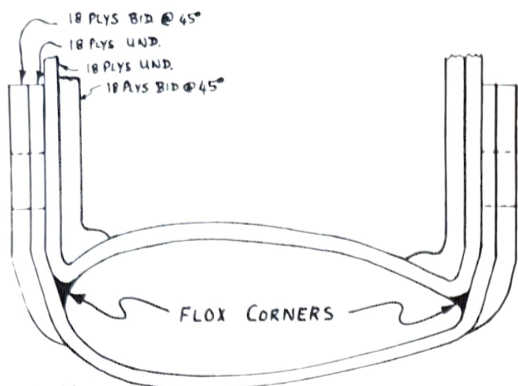


FIG. 19

Then knock off the reference pointer and sand the strut and inside of the tabs dull with 36 grit. Trowel a small amount of flox into the corner between the glass tab and the gear strut (Fig.19). Make a generous radius in the flox and, using the same methods, layup 18 plies of UND from tab to tab, carefully stippling the UND down into the corners fore and aft (Fig.19) against the flox. Now, same as before, layup 18 plies of BID pads 2-1/2 in. x 2-1/2 in., and lay the pads on to the glass tabs per Fig.19. Now use the same 2in. x 2 in. blocks of 1/4 in. plywood and with Saran wrap for a release, clamp the tabs with moderate pressure until fully cured (Fig.20).

After curing, trim the inside tab layups down flush with the outside tabs (2 in. wide), drill 3/8 in. clearance holes in the approximate center of the new layups, install bushings in the previously drilled 5/8 in. holes through the first layups, insert the 1/4 in. shaft of the spot facer through the first bushing and tab, install the tool, and drill the 5/8 in. hole through the far tab (Fig.21). Reverse this procedure for the opposite tab, and then drill out the other set of tabs similarly. If you follow this procedure, you will have perfectly aligned holes and be the envy of Long EZ builders who don't do it this way.

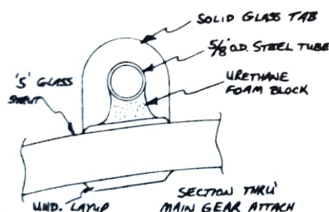


FIG. 23

Drill about ten No. 30 holes into each 5/8 in. dia. tube (Fig.22) between the glass tabs. These holes will provide a mechanical bond for a 2 ply BID wrap. Using wet flox, slide the tubes into the tabs and align the scribe marks previously checked. Get a scrap of foam and carve it to fit under the steel tube, and a reasonably good fit on the top of the gear leg (Fig.23). Now lay up 2 plies of BID at 45 deg. wrapping around the 5/8 in. steel tubes, over the small carved piece of foam, and down onto the inside face of each glass tab (Fig.24).

Flox an AN960-1016 steel washer onto the outside face of each glass tab (Fig.24) and lay up 2 plies of BID over the washers and lapping onto the glass tabs. Cure, then trim. Press the machined steel plugs (Fig.24) into the ends of each steel tube. Your gear attachment fittings are now complete.

STEP 4. INSTALLING AXLES, BRAKES, AND BRAKELINES

The critical operation in this step is setting wheel alignment. You must have toe-in to prevent the gear from spreading during taxi, take off and landing. You also want the wheels to be aligned with the fuselage centerline. You don't want too much toe-in or you will have rapid tire wear and extended take off distance; 1/4 degree of toe-in is ideal.

The Long EZ method uses carpenter squares to set toe-in. A much more precise, bore sighting method has been developed for the COZY and is recommended here. This step should take about 3 hours.

Cut two squares of 0.063 in. 2024T3 aluminum plate, 2-1/2 in. x 2-1/2 in. Be sure the flats on the ends of the gear legs are not toed out. About 1/4 degrees of toe-in is desired. To check this, study the alignment procedure which follows later on. It is a lot easier to do a good alignment job if the mounting surfaces are correct to begin with. A hard sanding block and elbow grease is all that is needed to true these surfaces.

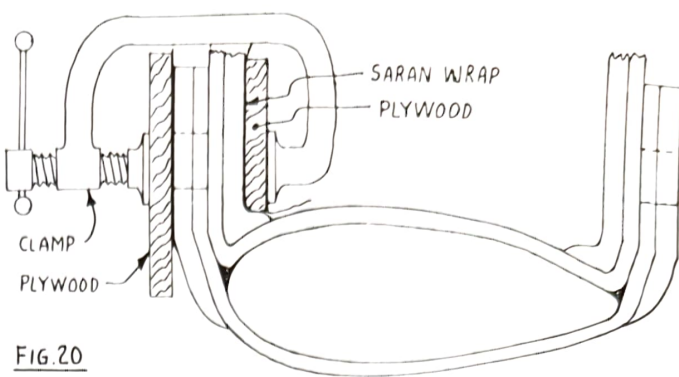


FIG. 20

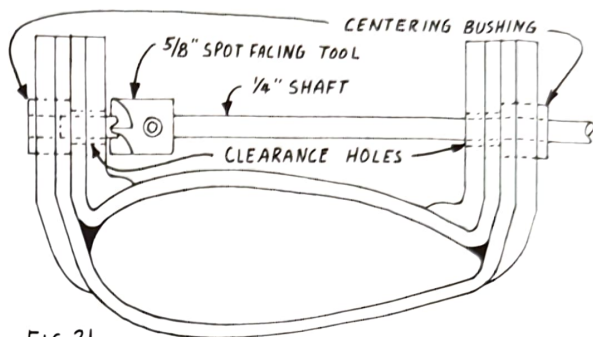


FIG. 21

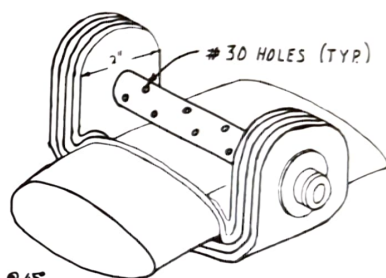


FIG. 22

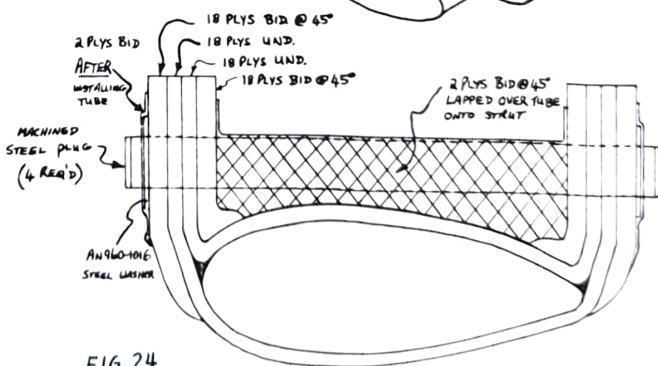


FIG. 24

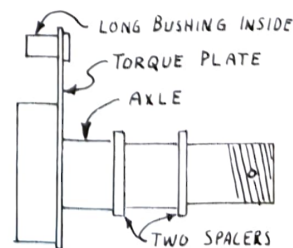


FIG. 25

Slip the Cleveland brake torque plate on the axle (Fig.25). It must fit flush on the axle flange. You will probably have to radius the edge of the hole with a half-round file. Slip the brake caliper on the torque plate and then, using this assembly as a pattern, carve the leading edge of the edge of the gear strut to fit, with 1/16 in. clearance (Fig.26). Also, trim the 0.063 aluminum plates to avoid interference with the caliper. Note that the caliper will move 0.1 in. as the brakes wear. Be sure to allow for this with clearance.

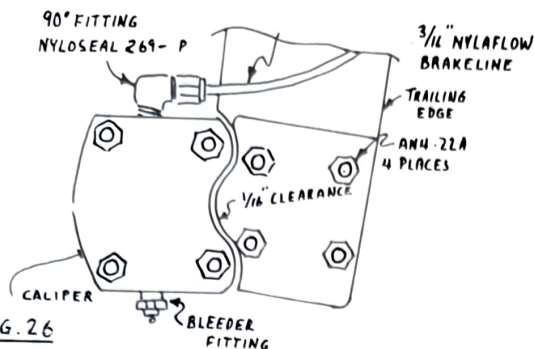


FIG. 26

Long EZ Method. When the mounting surfaces are correct, lay up 3 plies of BID on the inside and outside faces of the lower gear leg, where the axles mount. While this layup is still wet, clamp the square plates (inside) and the axles (outside) onto the gear legs (Fig. 27). Using a 2 ft. carpenter's square on each axle (Fig. 28), measure the distance between the tips A and the bases B of each square. Now B minus A should equal between 0.2 in. and 0.45 in. (1/2 to 1/4 deg. toe-in). Adjust clamping pressure as required to get this dimension.

COZY Method. Check fuselage. Should be upside down, longerons level fore and aft and side to side. Drop plumb lines from ceiling at firewall centerline and nose centerline. Paste a sheet of white paper on the far wall of your shop, in line with the two plumb lines and the same height above the floor as the axles will be. Mark the extension of the fuselage centerline on the paper with a big X (Fig. 29). On either side of this mark (centerline), accurately measure 1/2 the distance of the gear spread (outside face to outside face) (Fig. 30). Take a straight piece of 1/4 in. I.D. tubing about 3 in. long and hold it against each outside face. The 2 marks you have just made will appear in your view (thru the tube) if you have 0 degrees of toe-in. To obtain 1/4 degree, you must calculate where the 1/4 degree target should be. For every 24 in. the gear legs are away from the far wall, the target should be 0.1 in. closer to the centerline, each side of center. If the distance is 20 ft., the target should be moved 1 in. toward the centerline, each side. Use this method first for the gear leg surfaces, and then check (and adjust if necessary) the axles after they are clamped in position. Use the outside end of the axle as the reference surface for sighting, but **remember** to set up new targets, one axle length farther apart, each side of center (Fig. 30). Tolerance on toe-in is plus or minus 1/8 degree.

It is helpful to make up a couple of jig blocks to clamp on the gear legs which will support the axle flange in the right orientation while adjusting clamping pressure for toe-in (Fig. 31). After cure, use a long 1/4 in. drill bit to extend the mounting holes in the axle flanges through the gear legs and the 0.063 aluminum squares, and bolt the axles to the gear leg using four, AN4-22A bolts, each axle.

Now install the wheels, tires, and brake calipers and plumb the brake lines. Cut two pieces of 3/16 in. O.D. x 0.025 in. wall high-pressure NYLAFLOW nylon tubing about 72 in. long. Slide it thru the soda straw conduit, and connect one end to the top of each brake caliper (Fig. 26). Use a short (1/2 in. long) piece of brass tubing such as that found in hobby stores (or from a ball-point pen) 1/8 in. I.D. x 0.015 in. wall to slip into each end of the Nylaflo tubing to reinforce it where the ferrule compresses it to form a seal (Fig. 32). The brake line curves gently from the 90 deg. 269-P Nylaflo fitting to the trailing edge of the strut, passing between the brake disc and the strut (Fig. 26). To avoid heat damage, the tubing must lay flat on the strut, as far from the brake disc as possible. Make sure the other end of the tubing clears the attach tabs without kinking, and cannot rub against a sharp edge. Coil the extra length to protect it and keep it out of the way while preparing the hole through the firewall and until you are ready to attach it to the master cylinders. Now, drill two No. 10 holes through the firewall (drawing A-4).

Route the brake lines through these holes and connect to the master cylinders, using inserts as before. Pot the nylon tubing with RTV (silicone rubber) where it passes through the firewall to avoid abrasion. Now you can flip your COZY right side up on its own feet (if you have already completed the next step)!

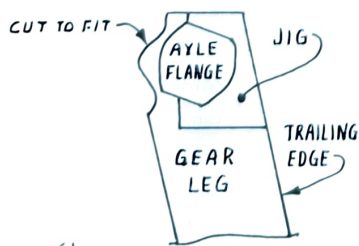


FIG. 31

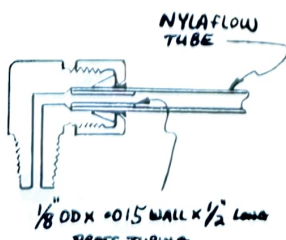


FIG. 32

CZ 5-1 MAIN GEAR STRUT EXTENDS 1/2" BEYOND AXLE NOT FLUSH AS SHOWN

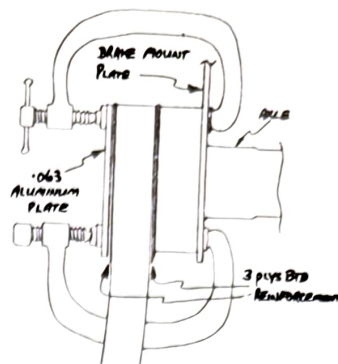


FIG. 27

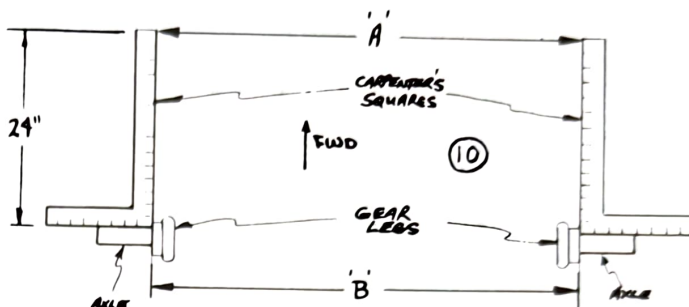


FIG. 28

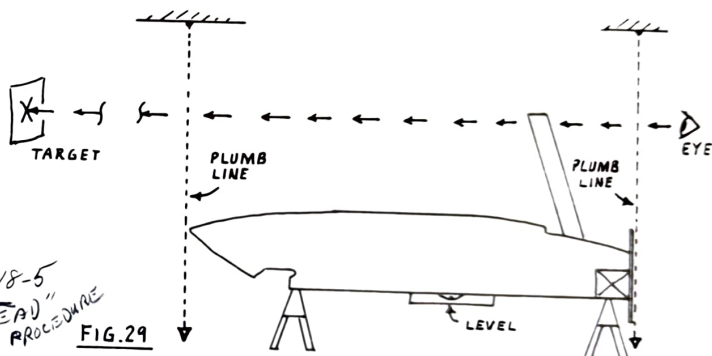


FIG. 29

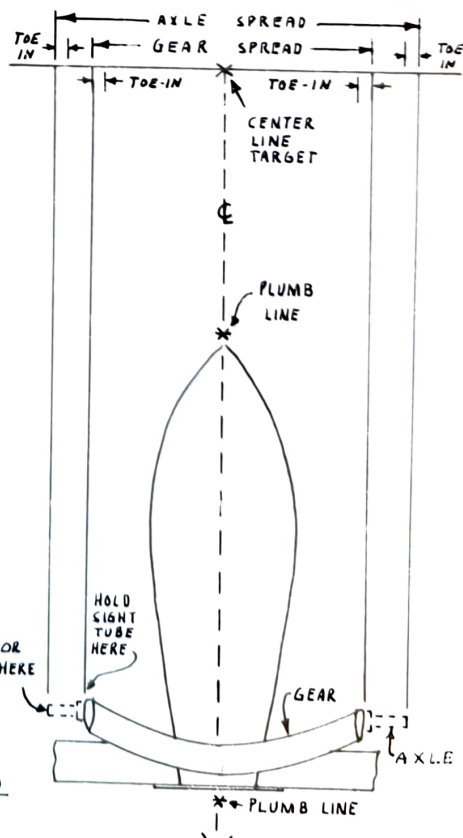


FIG. 30

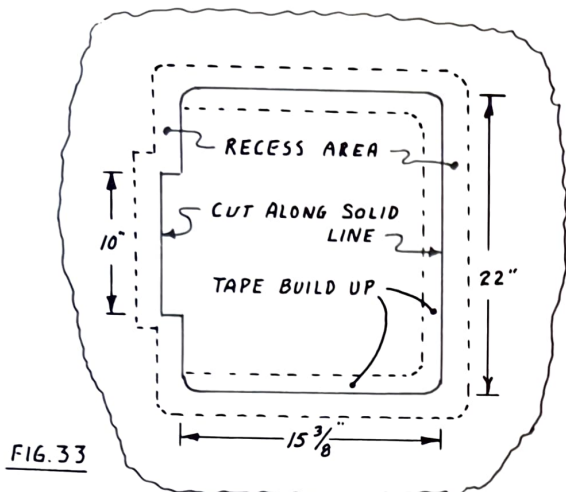


FIG. 33

STEP 5. CONSTRUCTION OF THE LANDING BRAKE

You prepared for this step in CHAPTER 7. Review this chapter and study fuselage drawings A-9 & 10. You will first need to cut through the bottom skin to remove the piece of 3/8 in. PVC foam and the 1 in. glass overlap at the side and aft edges which will be used to construct the brake. This can be done with a razor saw or a hand-held hack saw blade, held very flat so it doesn't saw into the foam. With a felt tipped pen and straight edge, mark where you will make the cut (Fig. 33). The cuts should be at the inside edge of the 1/16 in. x 1 in. depressions you provided in CHAPTER 7. These edges will govern the exact dimensions of the brake. After cutting through the skin, slip a knife under the edge and gently pry the landing brake loose, remove the 1 in. wide duct tape build ups, and set it aside temporarily.

Now fabricate parts LB-19 & LB-23 from 1/4 in. birch plywood (Fig. 34). Note that one edge of each is beveled at 45 degrees, and a recess is cut into LB-19 1/16 in. x 3/4 in. along the same edge for mounting the hinge.

Now, you need to prepare the location of LB-23, imbedded in the fuselage at a 45 degree angle, such that LB-24, piano hinge MS20001P6, 10 in. long, mounting on LB-23, will be exactly 2-1/4 in. aft of the bottom, forward edge of the front seat-back. To accomplish this, drill two 1/8 in. holes through the fuselage bottom, centered and about 12 in. apart, at the bottom, forward edge of the seat-back (Fig. 35). Put a nail through each hole (temporarily), and measure aft 2-1/4 in. from each and mark the hinge line. Now rout out the foam with a 1/4 in. drill at a 45 degree angle such that LB-23 slips in with the beveled edge flush with the fuselage bottom and the aft face lines up about 1/8 in. forward of the hinge line you just marked. Do not cut through the inside skin of the fuselage bottom.

Now cut four aluminum slugs 5/8 in. square from 1/4 in. thick aluminum. Rough up the surface and 5-min. them in place on the forward face of LB-23, centered at the dimensions shown (Fig. 36). Remove just enough foam locally from the fuselage where the slugs will be when LB-23 is reinstalled.

Now clean and rough (220 grit) the surface of hinge LB-24, lay it on a flat surface flat side down, and 5-min. LB-19 to it in the location shown (Fig. 37). Cover the center of the hinge with tape, so you don't get any epoxy in the moving part. Now cut three 1 in. square shims from 0.025 aluminum and tack them to the aft face of LB-23 with 5-min. epoxy. Now tack the hinge to the shims with 5-min. epoxy, while holding everything in line as shown in Fig. 38.

Trial fit this assembly in the fuselage, using shims if necessary, so that LB-19 lays 1/32 in. to 1/16 in. below the level of the fuselage bottom. Hold the landing brake over it and mark the foam to be removed from the brake so it will fit in place. If necessary, trim the glass so it does not cover the hinge pin. When you have a good fit, scrape and sand the glass surfaces smooth where the foam was removed, carefully mark where the brake mates with the hinge, apply floc to the mating surfaces, lay the brake down on your work bench glassed side down, cover the center of the hinge with tape to keep epoxy out, and weight the hinge and LB-19 in position on the brake until cured (Fig. 39).

Now LB-23 can be installed in the fuselage permanently. To prepare for this, bond the landing brake to a couple of straight 1 in. x 2 in. boards about 25 in. long (Fig. 40).

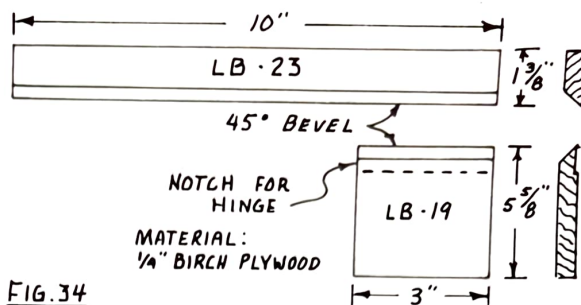


FIG. 34

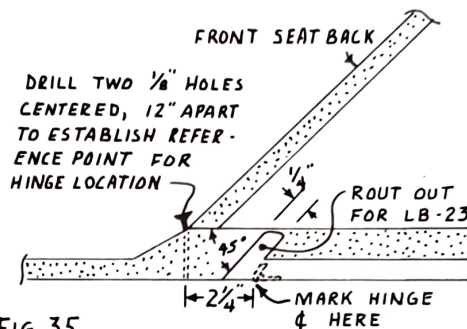


FIG. 35

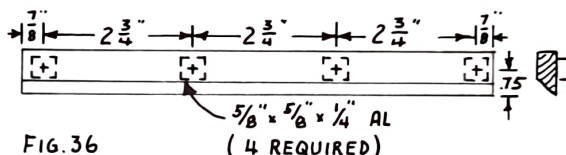


FIG. 36

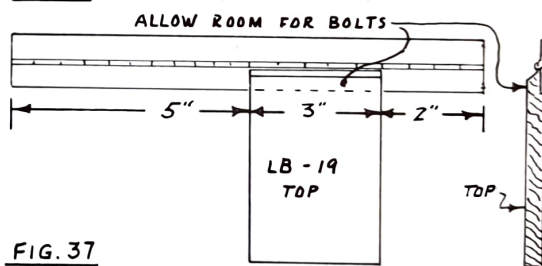


FIG. 37

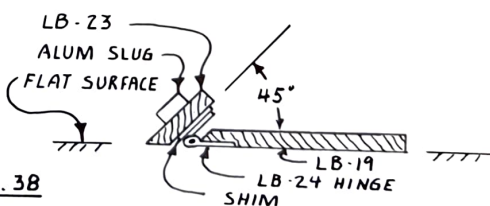


FIG. 38

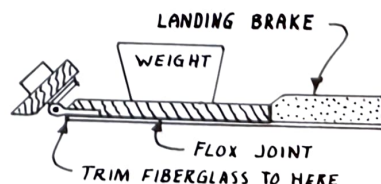


FIG. 39

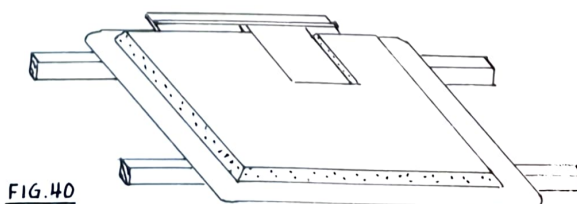


FIG. 40

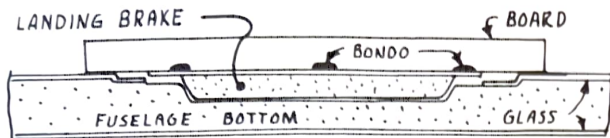


FIG. 41

Now set the brake, with LB-23 still attached, in position in the fuselage. Add whatever shims necessary to get the brake to line up perfectly over the cutout and its glassed surface level with the fuselage bottom (Fig. 41). Then spread micro on LB-23 and the mating foam surfaces, cover the other parts with Saran wrap so they don't get bonded too by any excess micro, and set everything back in place on the fuselage, perfectly aligned, and allow to cure.

After cure, pop loose the hinge and shims from LB-23, and set the brake, boards still attached, foam side up on your bench. Now remove 1/8 in. of foam all over the unglassed recess in the fuselage, to allow clearance for glass layups in both the fuselage recess and the top of the brake. The best way to do this is to cut a number of 1/8 in. grooves all over, which can be accurately gauged, and then sand down the areas in between until the grooves disappear. Sand the 1 in. wide glass area around the recess for good bond and radius the edges for good glass laydown (Fig. 42).

You now will cut the slot for the brake actuating arm. This slot is centered 5/8 in. from the right side of the front seat-back brace (when the fuselage is right-side up), or approximately 1-3/4 in. left of the fuselage centerline when the fuselage is upside down (confusing, isn't it?). Hint: LB-19 is off to the same side of center. If it isn't, stop right now and do the preceding steps over. The slot starts 3-1/2 in. aft of the hinge line (5-3/4 in. aft of the nail holes) and is 4 in. long. Drill 1/8 in. holes at these two points and check inside that they are 5/8 in. from the side of the seat-back brace. If not, adjust accordingly. Now, carve away the foam to bare a glass area 2 in. x 6 in., centered around these two points and cut the slot shown in Fig. 43 through the inside glass skin. Taper the foam surrounding this bare glass area less than 30 degrees for good glass conformation, and sand the glass for a good bond. When you are certain you have 1/8 in. clearance all around, edges radiused, etc., vacuum the foam, fill any sharp corners with dry micro, and squeeze micro all over the exposed foam. Then layup 2 plies of BID overall, cut at 45 degrees, starting by pushing the glass down in the center recess and working it to conform all around, and extending out to overlap the 1 in. wide recessed borders. Add a 3rd ply of 45 deg. BID around the slot and over LB-23, extending 1/2 in. beyond the side (Fig. 44). Peel ply edges of layup if cut to exact size, otherwise knife trim after partial cure.

Trim fit landing brake after the preceding layup (leave boards on) to make sure there is still clearance left for 3 plies of BID on the top of the brake. If not, remove foam accordingly. Make sure there is at least 3/4 in. of bare glass all around the edges (except for the hinge), the glass sanded, good transition foam to glass, edges radiused, foam vacuumed and microed, center of hinge taped, and then lay up 3 plies of BID all over (Fig. 45). After about 4 hours of cure, knife trim, coat the hinge (cover center) and LB-23 mating surface with floc, slide Saran between any other possible contact points, and put brake in place with hinge tight against LB-23. Weight down or shim as required for perfect alignment, because after a 48 hour cure, no adjustment will be possible.

After cure, remove bonded boards, open brake, and drill and tap 4 holes through hinge and LB-23 into aluminum slugs for AN525-10R10 screws (Fig. 46). Reference location dimensions in Fig. 36. Now close the brake and drill five No. 10 holes through the hinge and landing brake (Fig. 47), 1/2 in. aft of the hinge pin. Install 2 AN525-10R10 and 3 AN525-10R8 bolts and 5 M521042-3 nuts.

Make two LB-18 brackets from 0.063 2024T3 formed angle (Fig. 48). Bolt them together with a 3/8 in. spacer in between, and bondo them in place on the landing brake (LB-19) so they are centered in the wide part of the actuating arm slot. After cure, drill four No. 10 mounting holes through LB-19, and install four AN525-10R10 bolts and four M521042-3 nuts. Your brake is now complete; the actuating mechanism is installed in CHAPTER 16. Fasten the brake closed until that chapter.

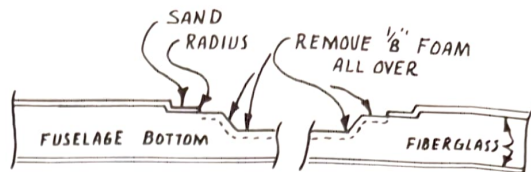


FIG. 42

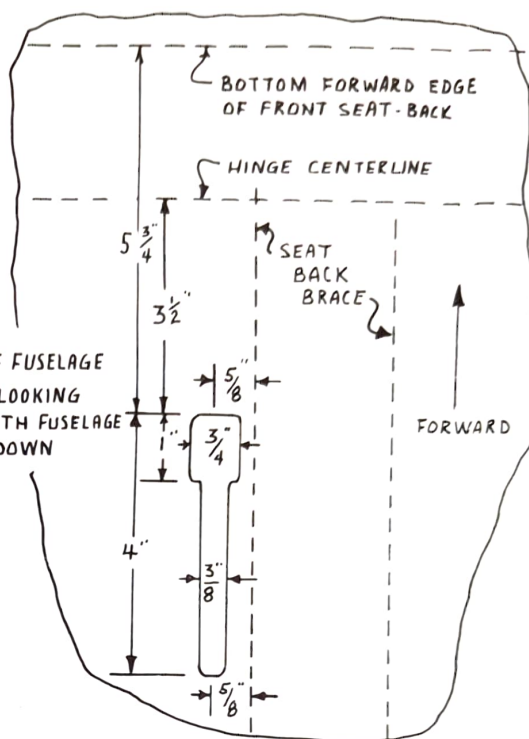


FIG. 43

VIEW OF FUSELAGE
BOTTOM LOOKING
DOWN WITH FUSELAGE
UPSIDE DOWN

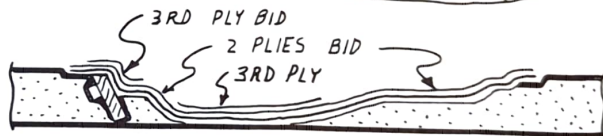


FIG. 44

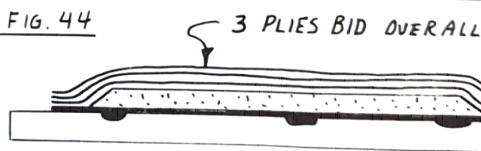


FIG. 45

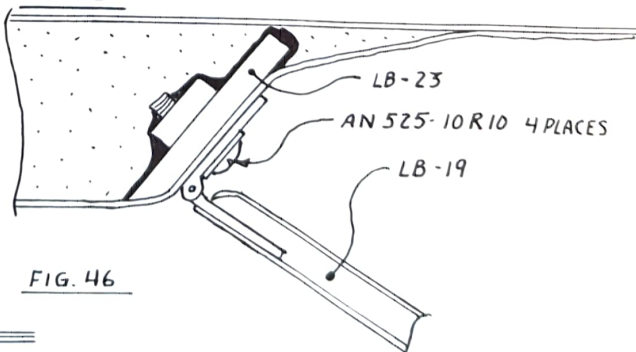


FIG. 46

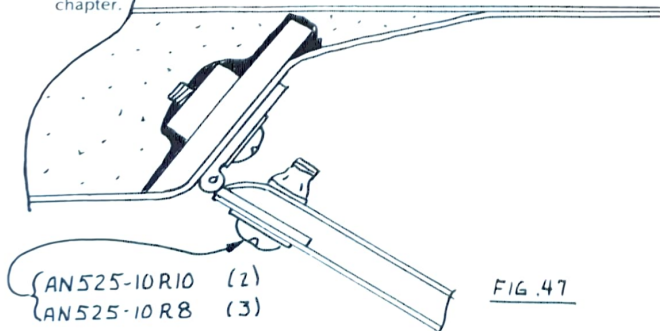


FIG. 47

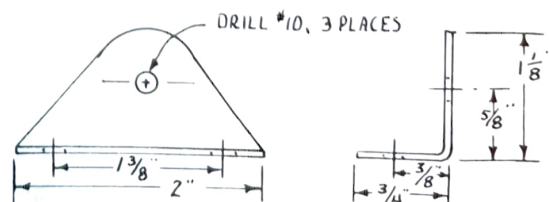


FIG. 48

CHAPTER 10

CANARD CONSTRUCTION

OVERVIEW: This chapter involves the construction of the canard wing, including the lift tabs that will attach to the fuselage, but not including the elevator attachment brackets. The canard is the **most important and most critical** airfoil in your airplane, so construct it carefully. The procedure which follows is highly refined to avoid difficulties encountered by earlier VariEze and Long-EZ builders, and we hope you will find it Vari easy. The canard consists of five foam cores; two outboard, two inboard, and one center core (Fig. 1). A trough (section BB) is cut in the top and bottom of the inboard and center cores to accommodate an efficient, tapered thickness spar cap. This trough is tapered from 1/32 inch deep at the outboard ends of the inboard cores to 1/4 inch deep in the center section, so the spar cap will blend into the airfoil shape. A vertical shear web (Fig. 2) is installed after slicing the inboard and center cores at the leading edge of the trough. This shear web is strengthened locally where the lift tabs are installed (Fig. 3). The canard **must** be built up without twist, so the cores are jugged and the incidence checked before installing the skins. The tapered bottom spar cap and bottom skin can be installed in one layup, or you can peel ply the spar cap and lay up the skin after the spar cap has cured.

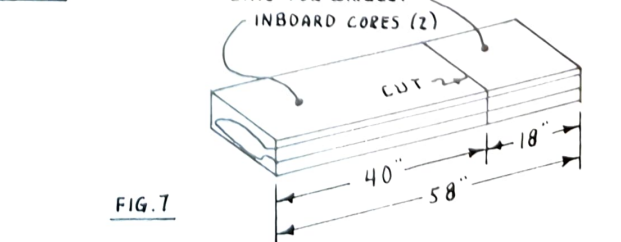
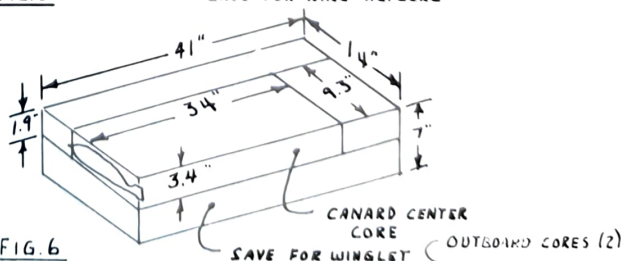
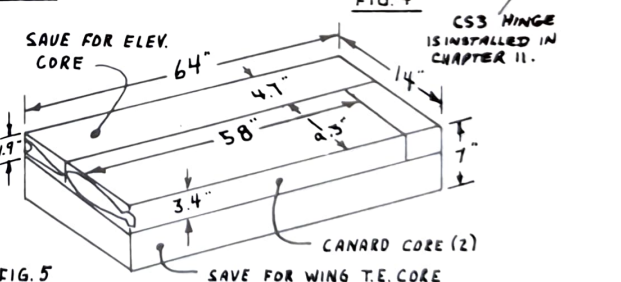
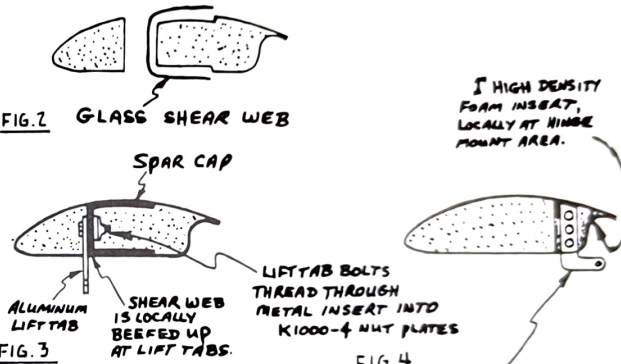
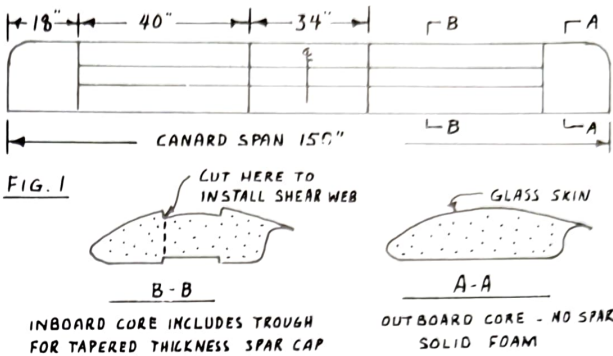
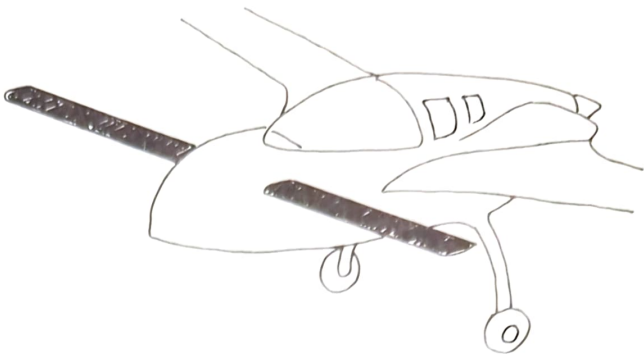
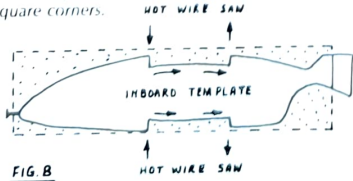
The canard is then turned over and rechecked for the absence of any twist. After installing 1 inch blocks of high density foam (Fig. 4) where the elevator brackets will be later attached (CHAPTER 11), the top spar cap and skin are installed. The bottom skin is 3 ply: 2 UND and 1 BID. The top skin is 4 ply: 3 UND and 1 BID.

STEP 1. TRIMMING THE FOAM BLOCKS AND CUTTING THE CORES

This step should take about 2 hours. You will need an assistant for the hot wire cuts. Make the five hot wire cutting templates shown on page A-2 by glueing them to a piece of 1/16 inch thick plywood, and trimming and smoothing (very smooth) the edges. Make a duplicate of the 'inboard end of inboard core' template because two will be needed for the center section. Avoid water based glues which shrink the paper. RAE epoxies work well, and you can squeegee the paper template in place. Your cores will only be as good as the templates, so **be accurate!** Since some of these templates must be used on both ends of the blocks, transfer the 'talking numbers' and the level lines to the other side of those templates.

You will use two styrofoam blocks 7 in. x 14 in. x 64 in. and one 7 in. x 14 in. x 41 in., saving the unused portions for later chapters. Review **Hot wire cutting** in CHAPTER 3. Take the two 7 in. x 14 in. x 64 in. blocks and, using your straight trim templates, page A-2, cut them up as shown in Fig. 5. This will give you two tapered foam blocks 3.4 in. x 9.3 in. x 58 in., from which you will cut the canard inboard and outboard cores. The 1.9 in. x 4.7 in. x 64 in. pieces must be saved to make your elevators (CHAPTER 11), and the tapered block 5.1 in. x 14 in. x 64 in. must be saved to cut the center trailing edge cores for the wings (CHAPTER 19). Take one 7 in. x 14 in. x 41 in. foam block and cut as shown in Fig. 6. This will give you a tapered foam block 3.4 in. x 9.3 in. x 34 in. from which to cut the canard center core, and leave a tapered 5.1 in. x 14 in. x 41 in. block to cut your winglets (CHAPTER 20).

Review CHAPTER 3 again. **Important:** You will have much better airfoils if you cut all core sections using the canard outboard templates (no spar troughs) first. Then put the 58 in. long sections back inside the trimmed off material and nail together to reform the block, and using your straight trim templates, cut off the 18 in. outboard sections (Fig. 7). Now, take the appropriate templates, and fasten them to the ends of the already cut cores, making sure you get perfect alignment all the way around, and cut the spar cap troughs with the hot wire saw, going straight down from above, across, and then straight up and out (Fig. 8). This will give you nice, straight troughs with square corners.



Remember, the center section has a 1/4 in. deep trough top and bottom all the way across, and the inboard cores have troughs tapered in depth from 1/32 in. at the outer end to 1/4 in. where they meet the center section. **Be sure** to make one right and one left! Mark all your cores now with a felt-tipped pen, fore and aft, top and bottom, so you don't get them mixed up.

Before cutting the leading edge off the two inboard and center cores, obtain 9 pieces of wood dowel 1/4 in. dia. and 6-1/2 in. long. sharpen one end to a point just as you would a pencil (Fig. 9). Insert these dowels equally spaced into the trailing edge of the 3 cores as shown (Fig. 10). Push them into the foam, twisting them with your fingers. They should protrude beyond the shear web cut line by about 1-1/2 in. Now pull the dowels out and hot wire cut these three cores into two pieces each at the forward edge of the spar cap trough (Fig. 11), using your straight trim templates. Lay the dowels aside temporarily. They will be used later on, after the shear web layout, to align the sections for a perfect airfoil.

Use a coping saw or knife to round the tips of the outboard cores (Fig. 12), making one right and one left. You should now have 8 foam pieces (Fig. 13). **Do not** reject a foam core due to minor imperfections caused by lifting or stopping the hot wire. High spots can be sanded level and low spots filled during the skinning step. A warped core can be held straight in the jig for glassing.

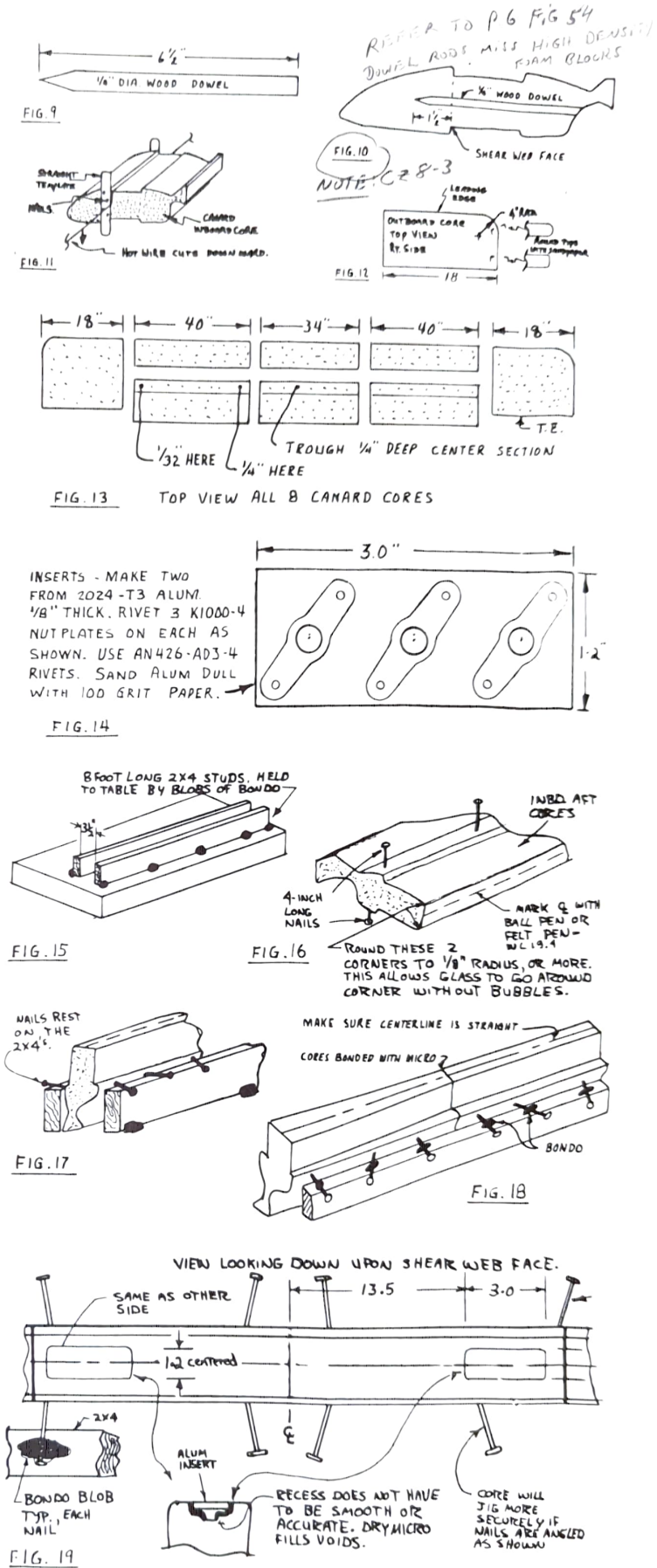
This would be a good time to lightly sand the bottom surface of the spar cap troughs with a hard block to make them level and smooth. You need a full 1/4 in depth on the bottom of the canard at the center and inboard ends of the inboard cores to accommodate all the layouts without distorting the airfoil, and a little more than 1/4 in depth on the topside of the canard, because there are several extra plies on the top side.

STEP 2. MAKING LIFT TABS AND INSERTS, JIGGING CORES, LAYING UP THE SHEAR WEB AND INSTALLING LIFT TABS

This step should take about 4 hours. Make two aluminum inserts as shown (Fig. 14). Bondo a pair of 8 ft. 2x4's to your table as shown (Fig. 15). They don't have to be perfectly straight or perfectly aligned. Grab the two aft inboard foam cores and the aft center core and mark centerlines on the shear web faces (W.L. 19.4) with a felt-tipped pen (Fig. 16). Sand a 0.2 inch radius on the corners (Fig. 16). Push large nails into these foam cores behind the spar cap trough spaced about 12 in. apart. Rest the nails on the 2x4's with the core trailing edges down (Fig. 17). Butt the center foam faces of the 3 cores together and check the alignment by holding a tight string or straightedge spanwise and lining up the foam centerlines to a straight line.

With the 3 cores aligned (which may require shimming or relocating some nails), bondo the nails of the center core to the 2x4's. A small dab of bondo where each nail touches a 2x4 is enough to securely position the core. Now, carefully check that the shear web centerlines of the 3 foam cores are aligned without any dihedral or sweep using a string. Also hold a tight string along the trailing edges to make sure that the trailing edges are straight and not twisted in different ways. Shim nails as required for good alignment (eyeball straight). Slip the loose cores away enough to spread dry micro on the mating surfaces, and push them back into position. Double check alignment (centerline straight, trailing edges straight) and bondo the remaining nails and shims to the 2x4's (Fig. 18). Clean the excess micro from around the foam joints. After cure, the cores should be secure for installation of the shear web.

Recess the foam for the aluminum inserts (Fig. 19). This can be done with a Dremel or a razor knife. Do not glue the inserts in with dry micro yet; they need to be positioned with jigs so the holes can be located exactly, after they are covered with the shear web. Refer to Fig. 20 and make two lift tabs out of 1/8 in. thick 2024T3 aluminum. Stack the lift tab, the aluminum insert (1.2 in. x 3 in. x 1/8 in.) and a strip of scrap metal (up to 1/8 in. thick) together and clamp in a vise (Fig. 21). Drill the three holes through all three pieces. Mount three K1000-4 nutplates on the aft side of the aluminum inserts. Bolt the strips to the inserts. Bond the inserts into the face of the shear web with dry micro. The metal strips extend to boards bonded to the table. After cure, remove the bolts and strip of scrap metal. Fill the holes in the insert with silicone to keep the epoxy out of the nut plate threads.



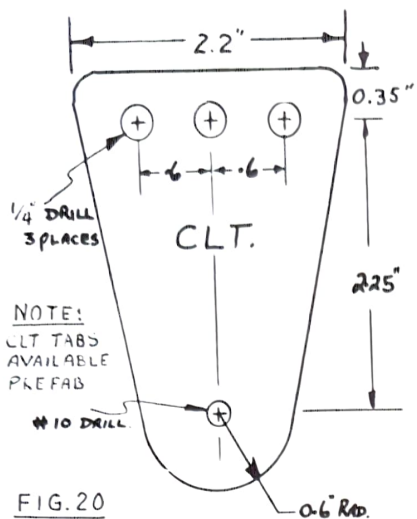


FIG. 20

The shear web layout extends full span over the forward face of the aft pieces of the inboard and center canard sections, and down the spar cap faces, full span (Fig. 22). Cut 9 pieces of 10 in. wide 45 degree **UND** (Fig. 23). Roll them up to prevent distortion (elongation along the long dimension). Cut 1 piece of 45 degree **BID** 10 in. x 34 in. Cut 2 plies of 45 degree **BID** 4 in. x 8 in., and 18 plies of 45 degree **BID** 1-1/2 in. x 4 in. (Fig. 24). Check the edges for radius. **Be sure** all foam faces are smooth without bumps or joggles. Vacuum foam and put strips of masking tape along the aft edge of the spar cap to protect the foam below from excess epoxy drips and slops (Fig. 25). **Be neat!** It will save heartache later on.

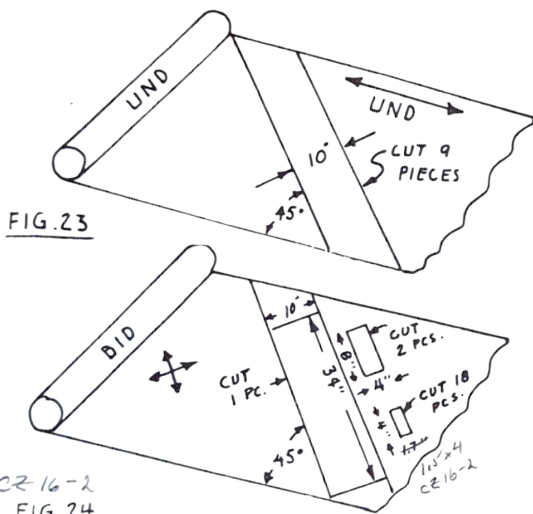


FIG. 23

FIG. 24

Mix micro slurry and squeegee a light coat over the shear web face and spar cap faces. Layup the first ply full span diagonally across the shear web face at 45 degrees. Wet out onto the three faces and then trim just short of the joggle (which I hope you have covered with tape). It's better to be 1/4 in. short of the joggle, than to bunch up against it, because there is just enough space in the spar cap troughs for the specified number of layups. **Do not** allow a build up there. Splice where necessary. **Butt joints. Do not** lap UND joints (ever)! The second ply is the same **except crossed diagonally** the other direction, also full span. Check the approximate 45 degree fiber orientation of the shear web and spar cap faces. Squeegee all plies well, from the center along the fiber direction, out toward the joggle. **Do not** leave excess epoxy or overlaps that build up this area incorrectly! **The thickness of this layup must be correct!**

The third and fourth plies are done similarly, except they do not extend full span. They are crossed and extend from B.L. 37R to B.L. 37L (total length of 74 in.). The fifth and sixth plies are similar, except extending from B.L. 27R to B.L. 27L (54 in.). The seventh ply is 45 degree **BID**, extending from B.L. 17R to B.L. 17L.

Now, lay up 9 plies of the 1-1/2 in. x 4 in. **BID** centered over each aluminum insert (Fig. 25). Apply a little dry micro in the corner at the edges of the 9 plies to allow a smooth, void free layup of one ply of **BID** 4 in. x 8 in. over the stack of plies as shown. This thick glass pad will later provide the bearing strength for the lift tab bolts. Check for voids or excess epoxy. Peel ply shear web and spar caps; then remove masking tape, and allow everything to cure.

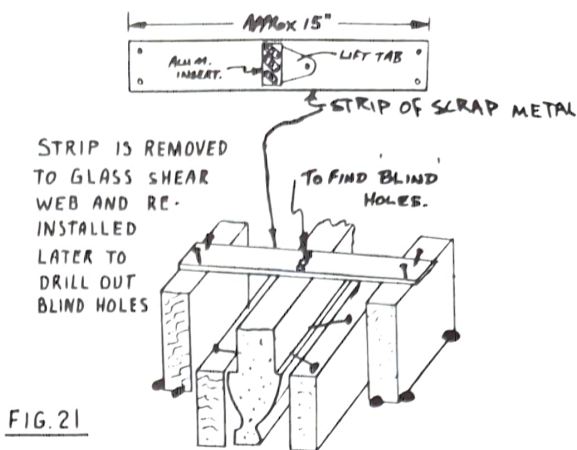


FIG. 21

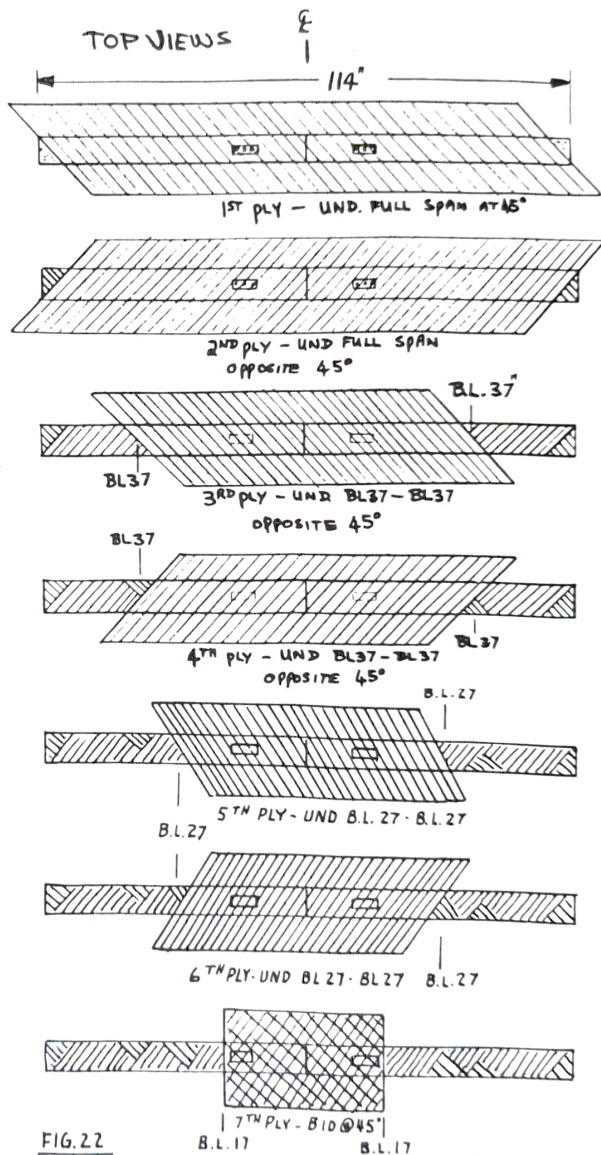


FIG. 22

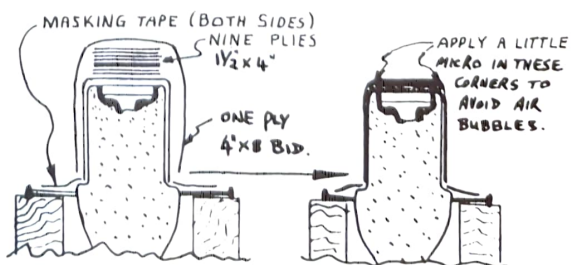


FIG. 25

After the shear web layup has cured, reinstall the metal strips used in locating the inserts, and use them as a drill guide to accurately drill the fiberglass pad (Fig. 21). **Caution:** Fiberglass grabs a drill bit; use a drill stop to avoid going into the nutplates and ruining the threads. Use a 1/4 in. drill.

Sand the lift tabs dull with 220 grit (don't you dare use anything coarser!), coat the tab and pad surfaces with wet flox, and install the lift tabs using AN4-7A bolts and AN960-416 washers. See page 10-8.

STEP 3. JIGGING AND BONDING THE CANARD SECTIONS TOGETHER

Refer to page A-2 and make 8 'A' jig blocks (only one is shown). Position the 8 jig blocks on your table, aligned along the edge so that the leading edge of the canard will overhang the edge of the table (Fig. 26). Use a string, straightedge, eyeball, and level to line them up in a straight line on an even plane and in perfect alignment with each other. Shim as required to correct for an uneven table. *This is important!* Once they are perfect, bondo them in place. Now grab your leading edge inboard and center foam cores and notch them (Fig. 27) to clear the lift tabs, pads, and bolts, and sand away a little foam if necessary to compensate for the shear web build up toward the center (careful, not too much!). Now, remember those 9 dowels you laid away earlier? Get them out, because you will need them shortly. Shine a flashlight through the dowel holes in the aft shearweb assembly, and drill a 1/4 in. hole through the shear web to open up all 9 holes. Use these dowels to trial fit the leading edge to the shear web, and then the entire canard, upside down in the jigs (Fig. 28). With the dowels in place, you shouldn't have to shim under the spar cap, to get the correct alignment of cores, but it might be a good idea anyway, just to make sure the spar cap trough is the correct depth, top and bottom (Fig. 29). Use 3 in. long nails to hold all the cores in position, and weights, while you check for a straight leading edge, and use the incidence block 'C' (page A-2) and a level to make sure there is no twist anywhere. Shim as required.

When you are sure everything is perfect, glue the aft inboard and center sections (the shear web assembly) to the jig blocks with small dabs of 5-min. (bondo dissolves styrofoam). After cure, withdraw the 9 dowels, and remove the leading edge sections and the outboard sections from the jigs. Mix up some dry micro and coat the leading edge cores with micro (Fig. 30) where they mate with each other and with the shear web. Put the leading edge cores back in the jigs, coat the 9 dowels with micro, and push them all the way in, until they are flush with the aft face of the canard. Now coat the mating surfaces on the outboard sections and put them in position on the jigs. Use nails and weights to hold everything tightly in place while you check for straight leading and trailing edges, and correct mating of all surfaces and **correct incidence everywhere with no twist** anywhere. Then secure everything in place with 5-min. epoxy. Remove excess squeezed out micro. It is very helpful later on to have nice, radiused and troweled micro corners in the spar cap trough to cut against when laying up the spar caps. Allow the assembly to cure in the jigs.

Now cut the following glass pieces: One piece of UND 114 in. long, tapering equally at both ends to 50 in., and one piece of UND 50 in. long, 6 in. wide and tapering to 42 in. (Fig. 31). These will be used to layup the bottom spar cap. Now cut two pieces of UND 12 in. x 160 in., which are needed for the first and third skin plies (Fig. 32), and three pieces of 45 degree BID 13 in. wide for the second skin ply (Fig. 33).

STEP 4. 'FLAGGING' THE SPAR CAP

Stop now unless you and your helper can work the next two (or so) hours straight through. Visit the bathroom. Inspect the spar cap trough. Sand it lightly with 36 grit, and remove any bumps or joggles (there aren't any, are there?). The spar cap **must be absolutely straight**. Mask off the foam surface on either side of the trough with newspaper and masking tape (like a surgeon doing an operation). Epoxy should be mixed in 5 to 6 oz. batches for this layup. A plastic squeegee (or rubber) 2-1/2 or 3 inches wide is necessary for this layup. Don't start without a supply of **sharp** razors.

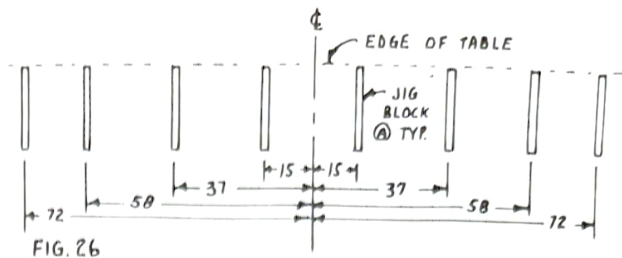


FIG. 26

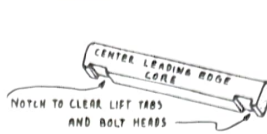


FIG. 27

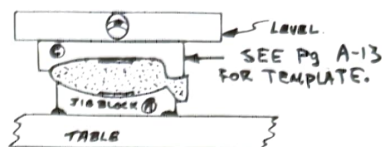


FIG. 29

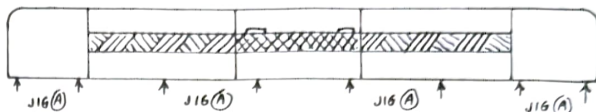


FIG. 28

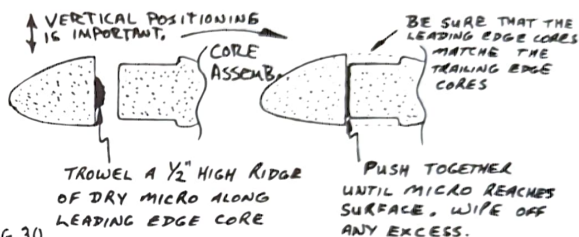


FIG. 30

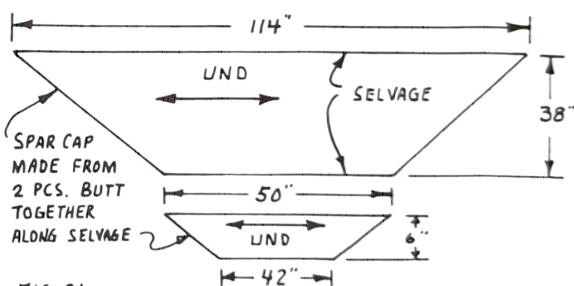


FIG. 31

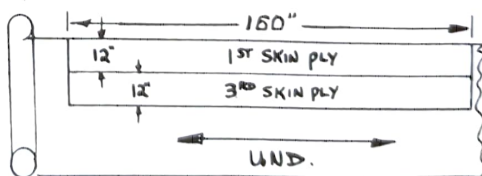


FIG. 32

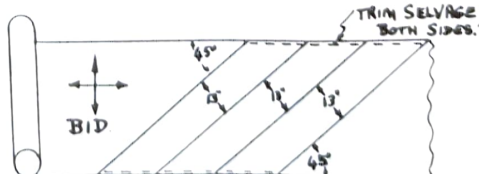


FIG. 33

THESE THREE PIECES OF BID @ 45° ARE FOR THE 2ND SKIN PLY

Apply a brush coat of epoxy to the spar cap trough. Lay the long edge of the spar cap ply straight along the forward edge of the spar trough. Wet out the cloth over the trough (Fig. 34). Fold the cloth over and wet out the cloth over the trough again (Fig. 35). Now, use a new, sharp, single-edge razor to slice through the fine cross fibers at the fold so that the cloth lays flat (Fig. 36). Don't gouge the blade in deep. A light pass right at the surface is all that's required. Keep folding, wetting, squeegeeing, and slicing until the spar cap is thirteen (13) full-width plies at the center, using as much of the second piece of UND as is necessary. Trim any excess and discard (Fig. 37).

Make sure that you keep the major unidirectional fiber bundles straight (Fig. 38). Do this by pulling the cloth from the ends and using the squeegee only in strokes from the center outward. You can now peel ply the spar cap, and allow this layup to cure, or you can continue with the layup of the 3-ply skin. In either event, use airfoil template 'C' to make sure the spar cap doesn't form a hump which will destroy your airfoil shape. Use a hairdryer and squeegee to remove any excess epoxy and to compress or redistribute the plies as necessary. The center 34 inches aren't critical because that part of the canard gets covered by a fairing.

When ready for skinning, remove the peel ply, masking tape and newspaper. Lightly spline-sand the foam surface to get rid of any wire cutting hairs. Level any jogs or bumps (Fig. 39). Mix some dry micro and fill any gaps at the sides of the spar cap (Fig. 40) so no large voids are trapped under the skin. Avoid micro on the spar cap itself, and fill any dings or nail holes. Apply masking tape to protect the foam on the underside of the leading edge from epoxy (Fig. 41), and spread a thin coat of micro slurry over the foam core. Wet the spar cap with plain epoxy, **not slurry**, and fasten a 1/2 in. wide strip of peel ply along the trailing edge (Fig. 41).

Drape the first skin ply (UND) over the full length. Let the cloth hang over the leading and trailing edges. Slice the cloth locally for the lift tabs. Pull from both ends to straighten the fibers and remove any wrinkles (Fig. 42). Wet out the skin using a 2 inch brush and a squeegee. Scissor trim the trailing edge and wing tips to about 1/4 in overhang (Fig. 43).

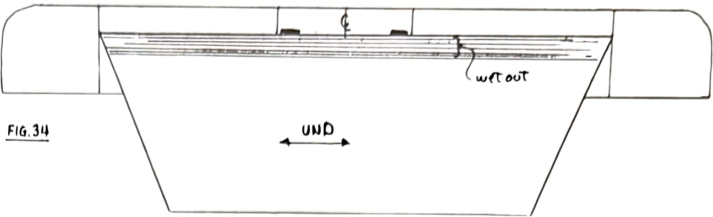


FIG. 34

Fold the cloth over and wet out the cloth over the trough again (Fig. 35)

FIG. 35

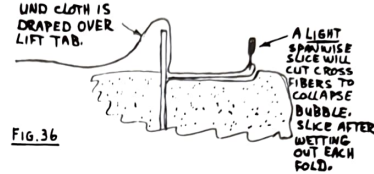
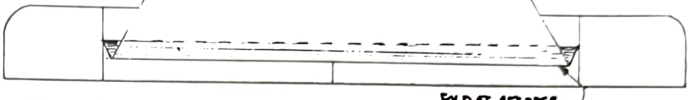


FIG. 36



FIG. 37

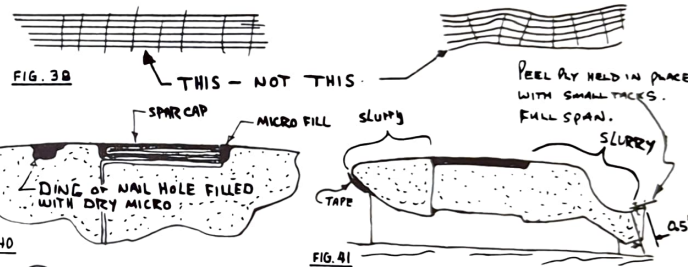


FIG. 38



FIG. 40

FIG. 41

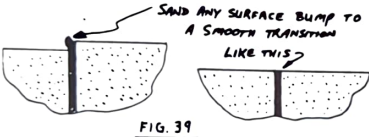


FIG. 39

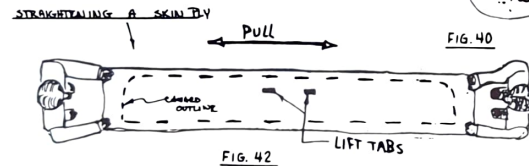


FIG. 42

The BID ply (2nd skin ply) is next. First use the scissors to trim off the selvage from each edge of the BID pieces; otherwise the selvage would cause a bump in the top skin. Drape the pieces as shown (Fig. 44). **Do not overlap the BID joints** (Fig. 45), because this would also cause a bump in the top skin. Wet out each piece before laying on the next. Each piece should lay down with the fibers straight and without wrinkles. The 3rd skin ply (UND) is laminated exactly like the 1st skin ply. Since it's the final ply, care should be taken to stipple and squeegee as much excess epoxy up from the preceding plies as possible before adding more. After the last ply is wet out, go over the canard and double check for air bubbles.

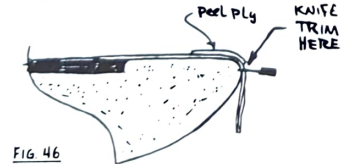


FIG. 46



FIG. 47

FIG. 43

TRIM CLOTH AT EDGE OF TIP TO AVOID WRINKLES.

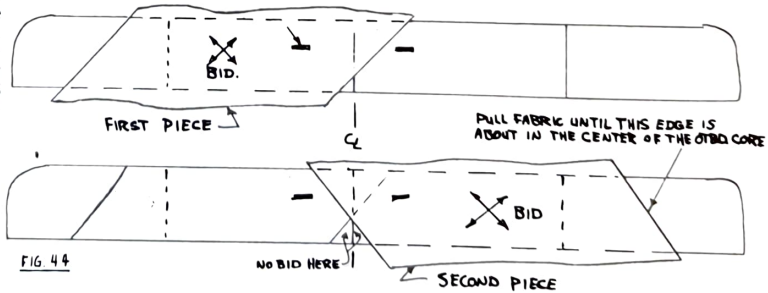


FIG. 44

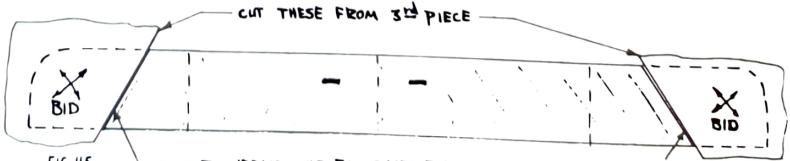


FIG. 45

DO NOT OVERLAP THE BID PLYS. THIS WOULD CAUSE A BUMP IN THE TOP SKIN PLY.

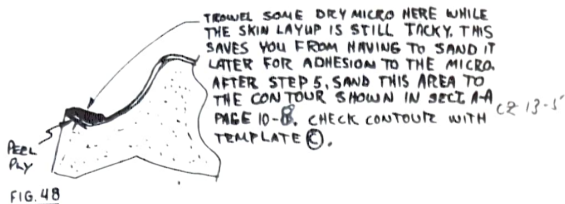


FIG. 48

Peel ply from the leading edge back 2 in. (Fig. 46). In three to four hours, go back and knife trim leading and trailing edges. Trim the trailing edge flush with the foam edge (Fig. 47). Trim the leading edge as shown (Fig. 46). The wing tips are trimmed similar to the leading edge. Trowel some dry micro along the trailing edge (Fig. 48) while the skin layup is still tacky. This save a sanding job later on to get the micro to stick. You should try for a contour as per template 'C' (Fig. 49).

STEP 5. INSTALLING HARD FOAM BLOCKS FOR ELEVATOR HINGES, THE UPPER SPAR CAP, AND THE UPPER SKIN

This step will take about 4 hours with 2 people (longer if alone). A 3rd person is handy to mix epoxy and pour coffee. Remove the peel ply and masking tape from the leading edge. Using a sanding block, taper the initial 1/2 in. of skin as shown (Fig. 50). Round up some 1x2's and refer to Figure 51. What you're doing here is stiffening and holding the trailing edge straight until the top skin is installed. You are also installing a very simple jig to hold the canard level and straight when you flip it over so you can install the upper skin. Let the bondo harden and then remove the canard from the jigs. Clean your work table off and set the canard right side up with the leading edge extending over the edge of the table, to simplify the leading edge overlap (Fig. 52).

Carve the trailing edge foam block off as shown (Fig. 53) and remove peel ply to provide a 1/2 in. wide glass-to-glass bond (see section A-A, page 108). Use the upper surface incidence block to recheck incidence spanwise and shim as necessary. Check dihedral and shim as necessary. When you are certain the canard is not twisted, and everything is straight, bondo the boards and shims to the table. This is it! No more adjustment will be possible. Now remove peel ply from the top spar trough (if it's still there).

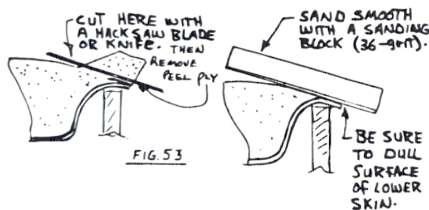


FIG. 53

Before glassing the top, install the 1 in. wide high density foam blocks at the positions you will later install the elevator hing brackets (Fig. 54). These provide the support required for the brackets. Dig the foam out of the areas shown with a knife or rout out with a drill (Fig. 55). Carve the high density blocks to fit and install with wet micro (Fig. 56). The digging doesn't have to be accurate and smooth, any roughness or oversized gouges will be filled with micro. If the blocks are installed immediately before the top skin, no sanding will be necessary, just level the surface with dry micro and glass over.

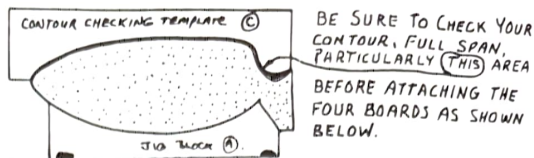


FIG. 49



FIG. 50

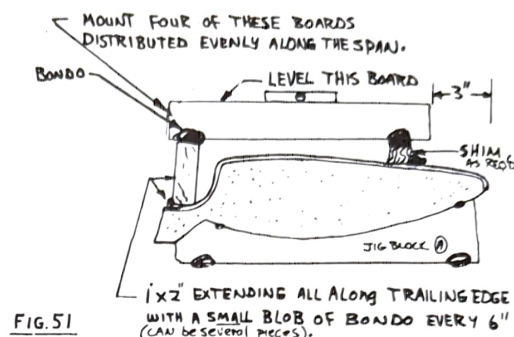


FIG. 51

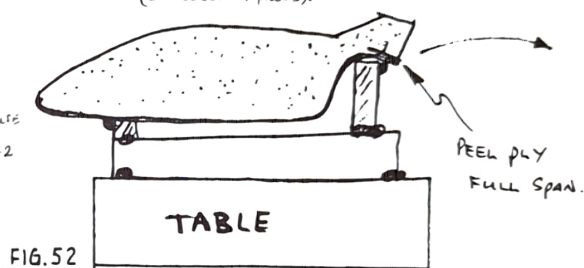


FIG. 52

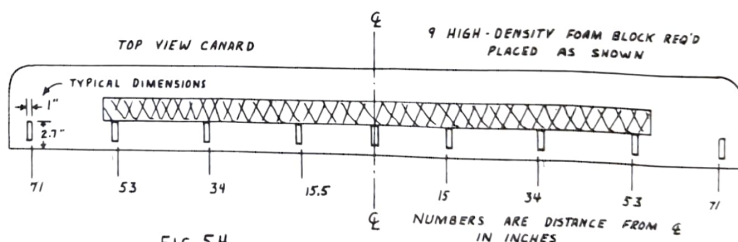


FIG. 54

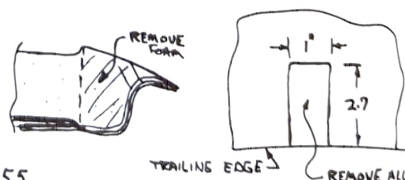


FIG. 55

NOTE: A STEEL OR ALUM 1/2" ROD CAN BE HEATED ON THE STOVE & THEN USED TO REMOVE THE BLUE FOAM BY MELTING IT OUT (PRACTICE THIS FIRST ON A SCRAP).

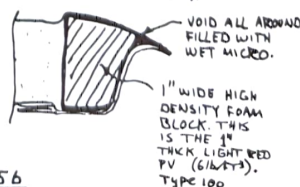


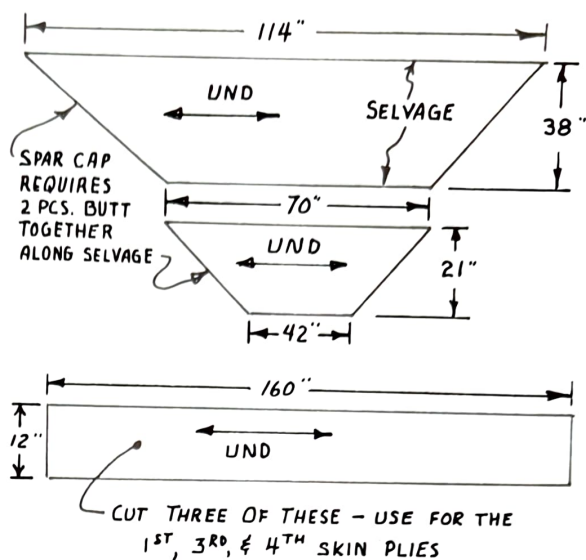
FIG. 56

The glass cloth for the top spar cap and top skin is cut as shown in Figure 57.

CZ 4-2 Don't start glassing unless you and your assistant can stay with it for the next several hours. You are ready to glass the top spar and top skins. This operation is done exactly like step 4, with two exceptions: (1) The top cap is thicker, requiring more folds until there are 19 thicknesses in the center, rather than 13. This requires two pieces of UND. (2) An extra skin ply of UND goes over the top. Everything else is the same. A careful scissor trim is made along the leading edge so that the four top skin plies overlap the bottom skin 2 inches (Fig. 58). The overlap will be faired in by sanding after it is fully cured (Fig. 59). Be sure to use micro slurry on the bare foam and plain epoxy on the leading and trailing edges and the spar cap before the first skin ply.

The trailing edge is knife trimmed even with the bottom skin edge (Fig. 60). Your treatment of the wing tips isn't critical. All foam surfaces should have at least two plies of glass for surface durability, but there isn't any further strength requirements at the canard tip.

A small cosmetic fairing is installed on both ends of the canard to fill the 1 inch void outboard of the elevators. This cannot be done until after the elevators are installed in CHAPTER 11, because they line up with the elevators. Make sure there is a 0.1 inch clearance after finishing.



THESE 3 PIECES ARE USED FOR THE 2ND SKIN PLY.

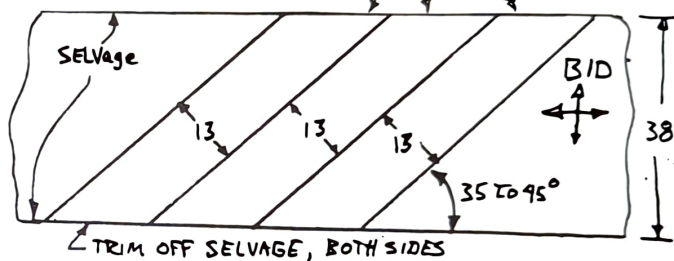


FIG. 57

LEADING EDGE
SKIN THICKNESS EXAGGERATED FOR CLARITY.

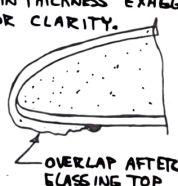


FIG. 58



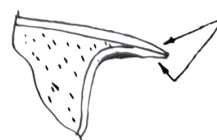
FIG. 59

DON'T DAMAGE BOTTOM SKIN!

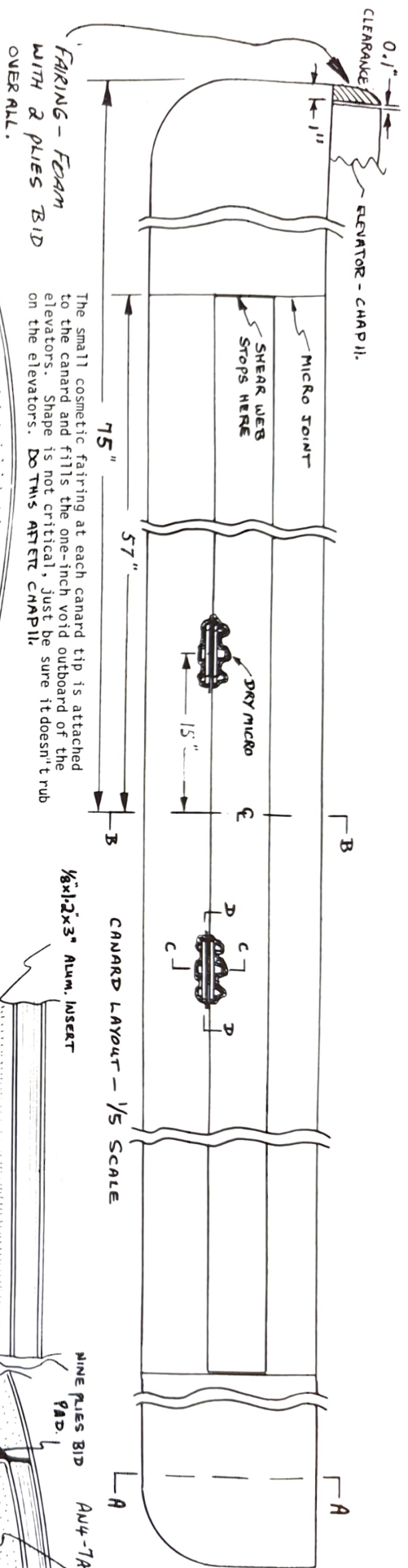
TRAILING EDGE



FIG. 60

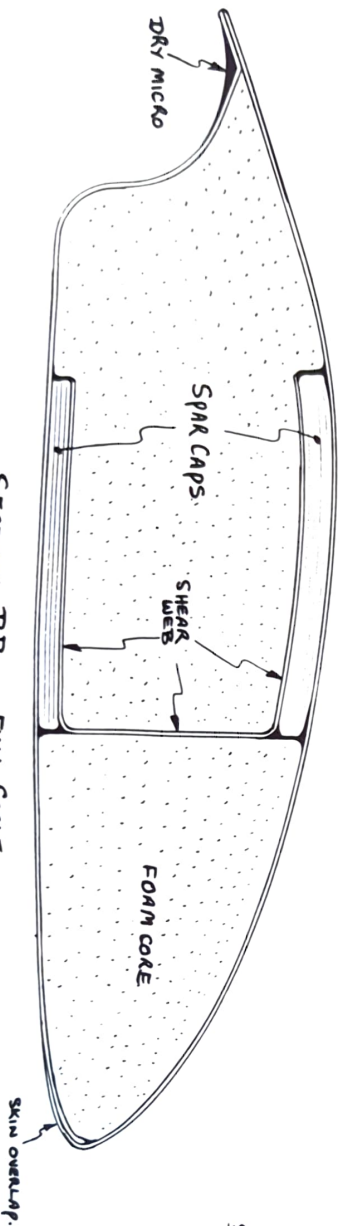
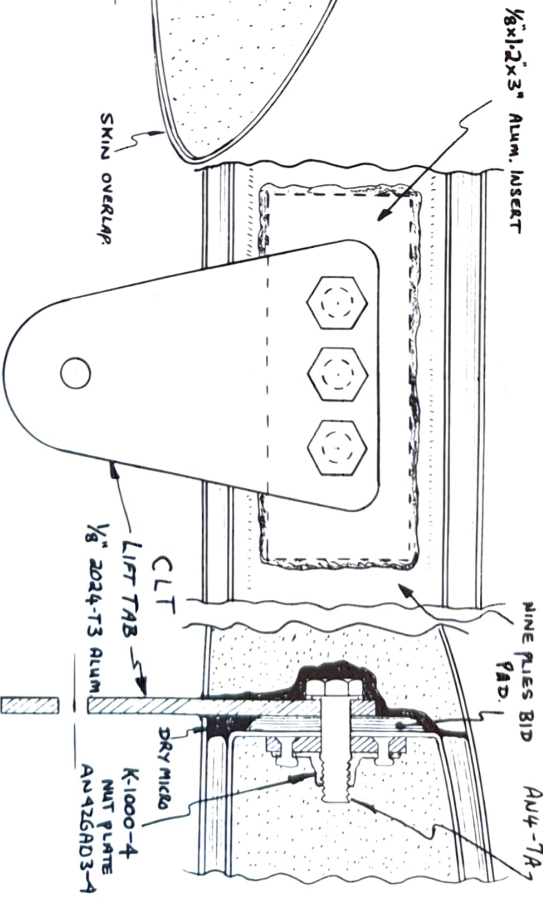
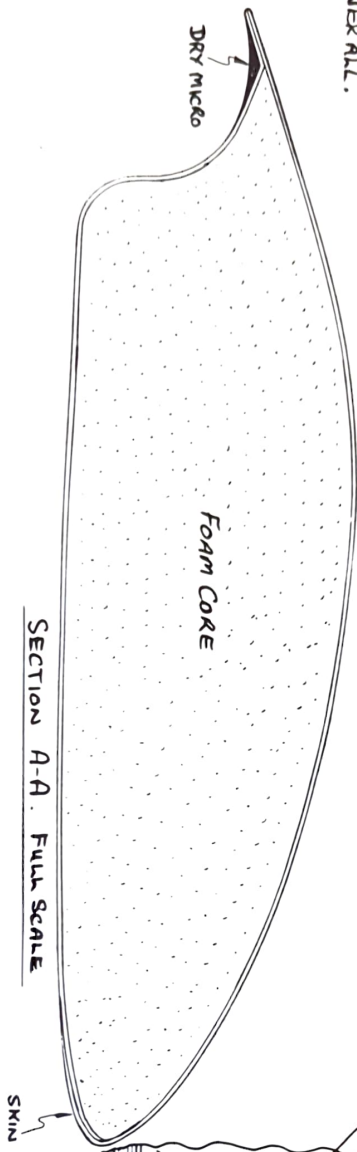


TE SANDED SHARPER AFTER CURE. FOR ACCURATE CONTOUR SEE SECTIONS A-A, & B-B PAGE 10-11. 10-5 CZ 16-2



FAIRING - FOAM WITH 2 PLYS BID OVER ALL.

The small cosmetic fairing at each canard tip is attached to the canard and fills the one-inch void outboard of the elevators. Shape is not critical, just be sure it doesn't rub on the elevators. DO THIS AFTER CHAP II.



CHAPTER 11

ELEVATORS

OVERVIEW. In this chapter you will manufacture and mount your primary pitch control surfaces. The elevator is a simple, hinged, slotted flap that attaches to the canard. The elevators move up and down together as the control stick is moved fore and aft.

To build the elevators, you will hot wire the foam cores, bond them to long aluminum tubes and glass over both surfaces. You will then install the hinge brackets, the actuator arms and the mass balance weights. You will also assemble the elevators to the canard.

The **critical** requirements in this chapter are: (1) The **elevator contour** must be **exact** to insure pitch stability, and (2) The **elevator weight** must be as **light** as possible and **balanced** to avoid flutter.

The following parts are available from your COZY distributor:

CS2	Bracket with bushing	(7)
CS3	Bracket	(9)
CS9	Plug	(4)
CS10	Lead weight	(2)
CS11	Lead weight	(2)
CS12	Belcrank with bushing	(2)
PTB	Pitch trim belcrank	(1)

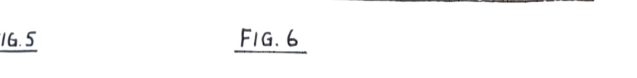
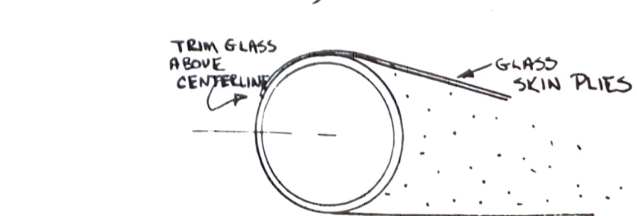
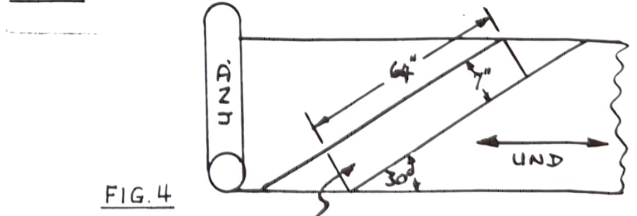
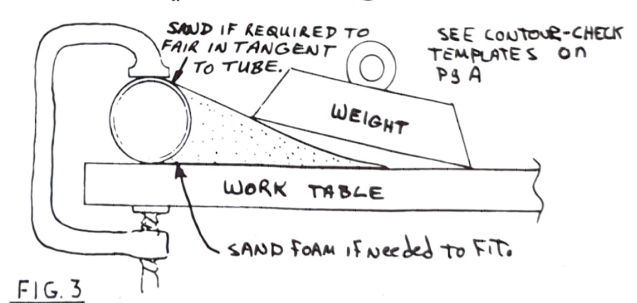
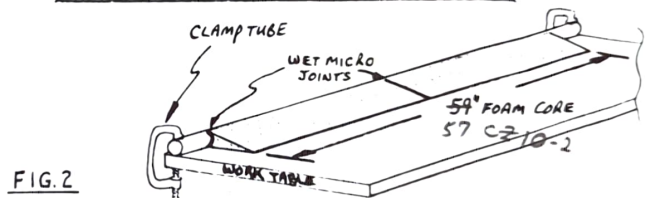
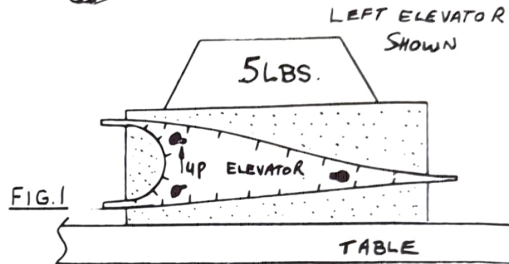
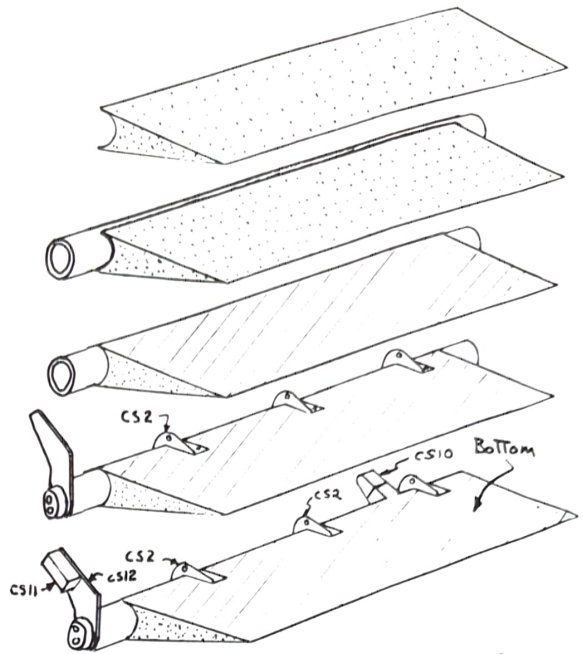
STEP 1. CUTTING FOAM CORES AND BONDING TO TORQUE TUBES

This step will take about 2 hours (or so), and you will need someone to help with the hot wire saw. The rest you can do alone. You will need the elevator templates from page A-2. If you have already cut these, proceed. Find the foam blocks left from CHAPTER 10. Hint: They are 1.9 x 4.7 x 64 inches. Your elevators will be about 57 inches long when complete (you will trim them to fit your airplane). So cut the 64 inch length down to 57 inches, and then cut this piece in half. 57 inches is too long a piece to hot wire cut to the accuracy needed in these small elevator cores. So you will now have four blocks of foam; two for each elevator. Weight the foam blocks down onto your work table (Fig. 1), nail the templates on each end **level** to each other, heat up the saw, and start cutting. First cut the tube notch, then the top (curved surface) of the elevator, and last, the bottom (flat surface).

Now you need two pieces of aluminum tubing 1-1/4 in. O.D. x .035 in. wall x 62 inches long (6061-T6). They **must** be **straight**. Bent or curved is not acceptable. Use MEK to clean off all oil film and sand lightly with 220 grit sandpaper. Check your table and remove any epoxy globs to make it perfectly flat where laying up your elevators. Then cover this area with Saran wrap and clamp (or weight) the tube to hold both ends down (and the entire length in between) (Fig. 2). Mix up some micro and apply an even coat to the foam cores where they will join the tube and each other. Push the foam cores into position on the tubes (top side up) and wipe off excess micro (Fig. 2). Weight the cores to be sure they sit flat on the table and allow to cure (Fig. 3).

STEP 2. INSTALLATION OF THE TOP SKIN

This step should take 2 hours and you can do it alone. Cut the following glass: 8 pieces of **UND** cut at 30 degrees to the selva edge 7 in. wide and 64 in. long (Fig. 4). Roll them up to avoid distortion, and save four of them for the bottom skin. The top side is **concave**; use template 'E', page A-2 to check the foam contour. If it isn't right, stop right here. When the foam surface is prepared (hairs sanded off, vacuumed, etc.) apply a light coat of slurry to the foam cores and lay up crossing plies of **UND** (Fig. 5) on each elevator **top** surface. **Do not** leave excess epoxy in this layup. It is better to be as dry as possible here. Your elevators **must not** be overweight. Scissor trim the leading edge (Fig. 6) so that the plies lap over the tube less than half-way. Allow to cure and knife trim the trailing edge **oversize** (Fig. 7) to about 4.75 in., so you can get 1/4 in. minimum glass to glass bond with as little removal of foam as possible.



STEP 3. INSTALLATION OF THE BOTTOM SKIN

This step should take 2 hours and again, you can do it alone. Turn the cured elevators over and clamp the tubes to your table again. Be sure that the tubes are straight. You may need to shim the tubes under the clamps to avoid bending the tubes. Clean up any excess epoxy or glass ravel on the aluminum tubes with 100 grit sandpaper. Taper the top skin edge (Fig. 8). Remove foam (only if necessary, and then the minimum amount) from the trailing edge to expose the last 1/4 in. of glass for a good glass to glass bond. Sand dull. Locate the 4 remaining plies of UND. Like the top skin, the bottom is also 2 plies thick. Apply a light coat of slurry to the foam core, and pure epoxy to the tube and area of top skin that the bottom skin will lap onto. Fiber orientation is the same as the skin at the leading edge (Fig. 9). This lap must be above the centerline so that the bump doesn't interfere with the CS2 hinge brackets. The slight bump is faired smooth with peel ply or by sanding after it cures. Remember to keep the layup as light as possible.

After both skin plies are wet out, wipe dry micro into the trailing edge (Fig. 9), only as necessary to fill any depression. Allow to cure and knife trim the trailing edge and ends.

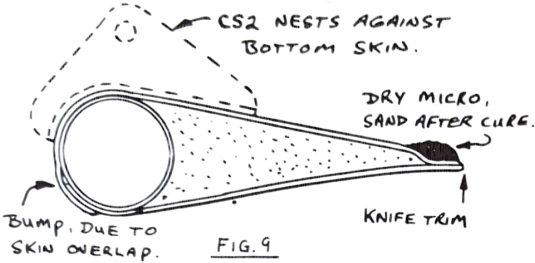


FIG. 9

STEP 4. INSTALLING THE OUTBOARD BALLAST WEIGHTS

This step should take about one hour. Refer to the scale drawing on page 11-6, for the final dimensions of each elevator. Trim the tube flush with the outboard foam edge. Trim the inboard end of the tube as required to the final length. Locate the counterweight jig (shown on page A-2) spanwise and glue it to the top elevator skin with a dab of bondo (Fig. 10). Flip the elevator upside down and locate the CS10 lead weight (Fig. 11) and spacer in the jig. The spacer is carved from a scrap of 1 in. thick 6 lb/ft³ (light red) core foam. See page A-2.

Bond the spacer (foam) and CS10 lead weight to the elevator skin with 5-min. epoxy. When the 5-min. is cured, knock the jig block off and sand the top and bottom glass skin dull behind the mass balance. Lay up 2 strips of UND 0.8 in. x 11 in. around the spacer weight and elevator (Fig. 12). The sides of the mass balance are painted with epoxy. While you still have a little fresh epoxy and some scraps of UND left, take the 32 in. piece of 1-1/4 in. O.D. tubing from your kit, cut it to 31-3/8 in. long (page 11-6), clean and sand the center, and lay up a 1-1/2 in. wide double thickness wrap of UND around the exact center (no overlap), and peel ply. This will insure that all of your hinge brackets are spaced the same height off the torque tube.

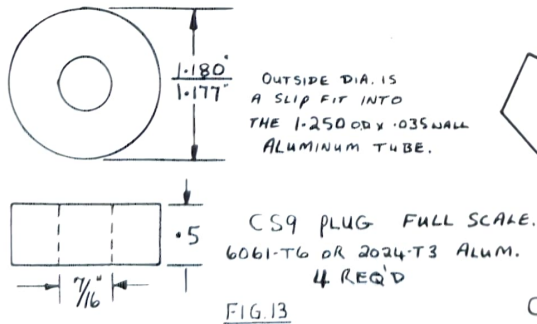


FIG. 13

CS3's and CS12's are made from 1/8 in. thick 2024T3 aluminum. Use the full size pattern. Homebuilding the CS2's is not recommended since they must be formed from 0.063 2024-0, and then heat treated to T3. The pivot must be 0.1 in. forward of the tube centerline with elevator bottom level.

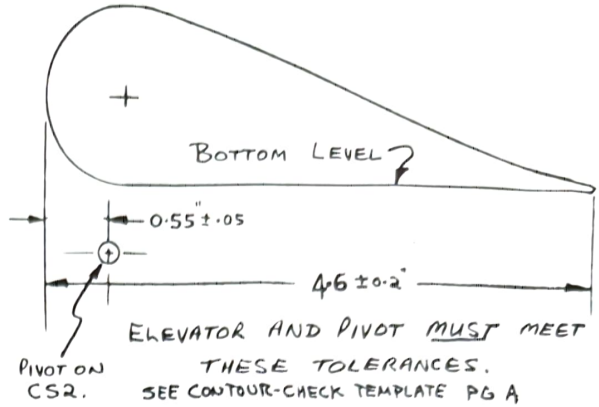


FIG. 7

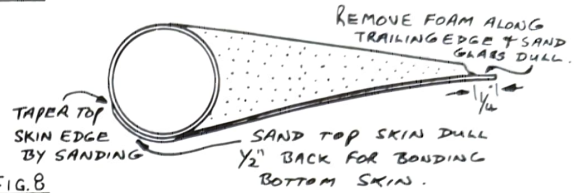


FIG. 8

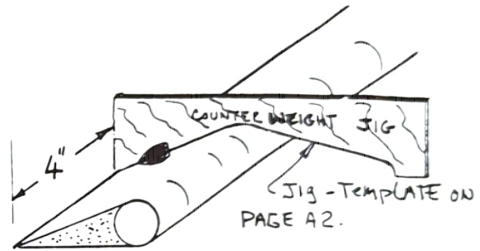


FIG. 10

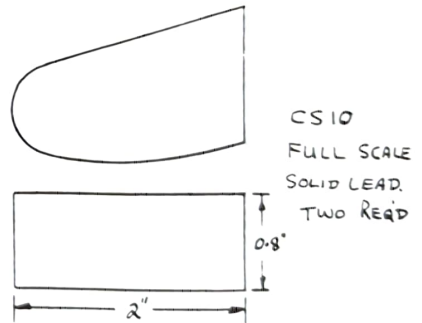


FIG. 11

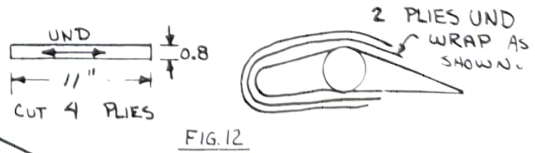


FIG. 12

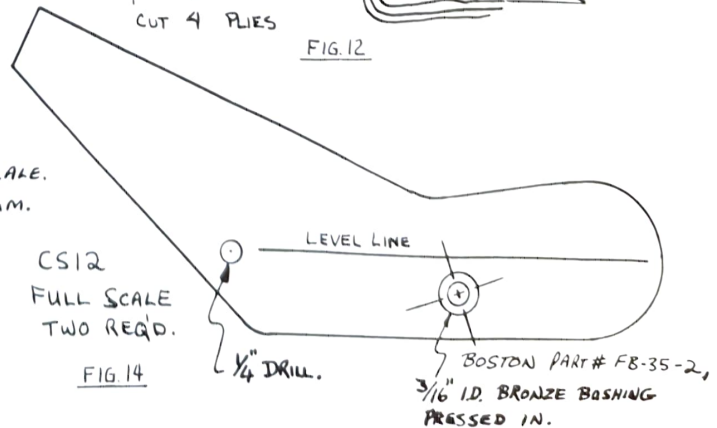


FIG. 14

CZ 18-5 "READ"

STEP 5. INSTALLATION OF BELCRANKS AND HINGE BRACKETS

This step should take about 2 hours. You will have to drill two No. 12 holes through two CS9 plugs (Fig. 13) and one CS12 belcrank (Fig. 14), keeping the holes straight and all three parts concentric (Fig. 15). You will have to do this in a drill press. With a center punch, mark the hole centers on one of the CS9 plugs. Then stack two CS9 plugs in a short piece of the 1-1/4 in. O.D. tubing you have just trimmed from your elevators. Drill one hole all of the way through both plugs, insert a bolt to hold the holes in alignment, and drill the 2nd hole. Now stack the plugs and the 1-1/4 in. tubing over the CS12 belcrank, making sure the hole alignment is as shown in Fig. 15 and plugs are concentric with belcrank and drill the 1st hole. Insert a bolt to maintain alignment and drill the 2nd hole. Repeat for the 2nd belcrank and other 2 plugs. Mark each set of 3 parts so you keep them matched. Now bolt each set together with AN3-14A bolts and MS21042-3 nuts. **Do not overtorque** these bolts! No. 10 bolts should not be torqued over 25 inch-lbs. With the upper elevator surface leveled on the table, insert the belcrank assembly into the tube and level the vertical level line (Fig. 16). Drill the No. 12 hole through the tube and CS9 plug. This hole is roughly parallel to the bottom surface of the elevator as shown.

Don't finally install these bolts until the elevator CS2 hinge brackets have been installed, but mark which elevator each goes on.

Refer to page 11-6 for a full size pattern for PTB, the pitch trim arm (CHAPTER 17). It is available prefab. Rivet it to a CS2 as shown. Use two AN470 AD4-5 rivets. Then trim excess CS2 at the aft end. Refer to page 11-6 for positioning the PTB-CS2 assembly on the centerline of elevator torque tube spool piece. Be sure to attach the PTB to the CS-2 hinge bracket **before** attaching this trimmed CS2 to the spool piece.

Now mark the positions of the six CS2 hinge brackets on the elevators as shown on page 11-6. The hinge bracket is located fore and aft, by nesting the fitting against the tube radius with the fitting flat against the bottom skin. Care should be taken to sand off any bumps or discontinuities that may keep the CS2 bracket from fitting correctly. With all the CS2 hinge brackets sitting on the elevator, sight through the bushings to assure that they line up. It is helpful to put a white piece of paper a few inches behind the last bracket of each elevator to deflect the light. When the bushings are lined up, and you sight through, you will see 3 concentric holes. With the brackets located properly, drill the No. 30 holes (3 per bracket). One of these holes is into the bottom glass skin only (Fig. 17). It serves only to locate the hinge bracket, not for strength. Apply wet flox to the CS2 flange. Position it over the previously-drilled holes and install the bracket with two pop rivets. Wipe off any excess flox. Recheck alignment of bushings. If not correct, remedy now. Drill the center hole out to No. 12 drill size and countersink it (100 deg. countersink) for an AN509-10R7 flush screw.

Installing the MS21042-3 nuts on the flush screws requires a long 1/4 in. box end wrench. This is easy to make using a cheap ignition wrench and a four-foot long stick or dowel of wood (Fig. 18). When the 5 min. cures you can bend the wrench so it is even with the edge.

It will take two people to install the locknuts, one to maneuver the nut into position inside the tube with the long wrench, and one to install and tighten the screw. After the lock nuts are installed on the hinge brackets, you can finally install the CS12 belcrank assembly. Make a small foam plug for the outboard end of the elevator tube and 5 min. it in place (Fig. 19). Lay up one ply of BID over the outboard end to seal and protect the foam and tube. Leave the inboard end of the elevator bare foam until CHAPTER 12.

STEP 6. MATING THE ELEVATORS TO THE CANARD

This should take about 2 hours. You will be working with both elevators and the canard in this step. Lay the canard bottom side up and mark its centerline (B.L.O.). Insert the elevator torque tube spool piece between the elevators, slipped over the CS9 plugs at each end. Center the elevators and mark the position of the outboard balance weights on the canard and cut a slot to accommodate it. Cut the slot oversize for clearance (approximately 1 in. wide) (Fig. 20), and then lay up 1 ply of BID to protect the exposed foam.

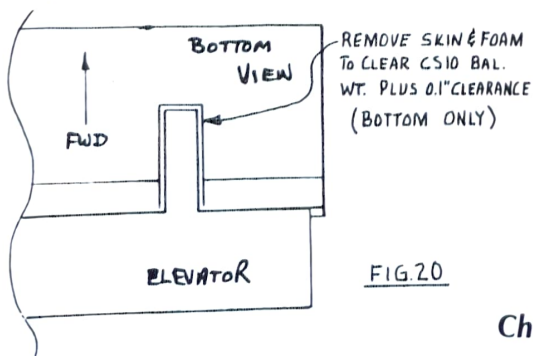


FIG. 20

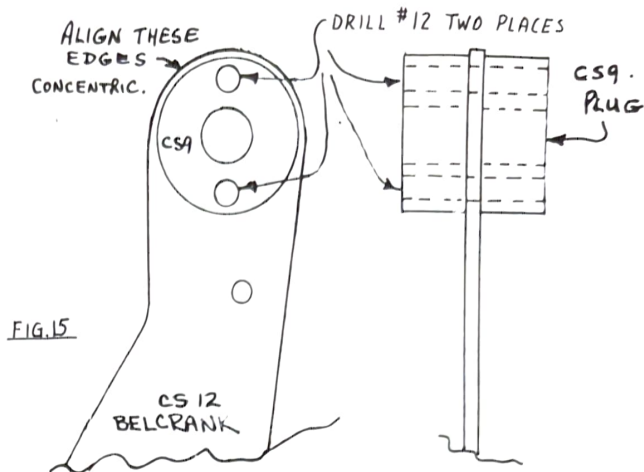
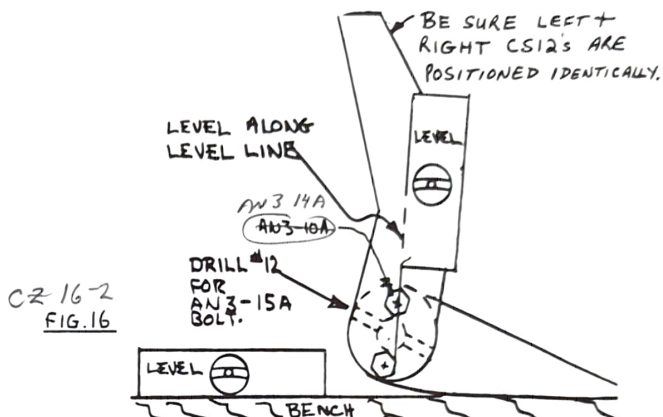


FIG. 15



CZ 16-2
FIG. 16

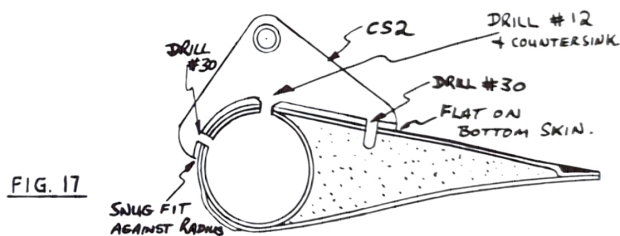


FIG. 17

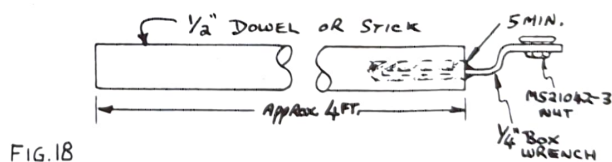


FIG. 18

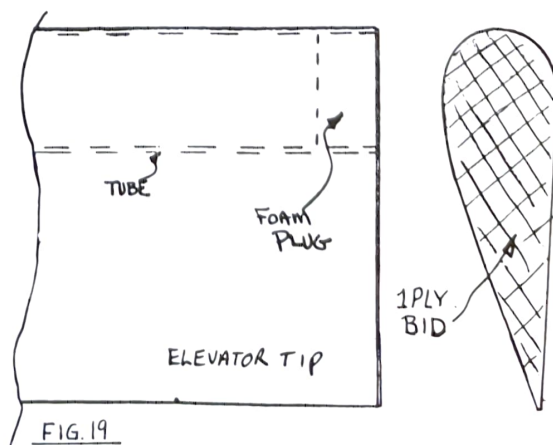


FIG. 19

Make 4 elevator jig blocks 'B' from 1/4 in. plywood or 1x12 in. lumber (page A-2). Bondo one elevator to the jig blocks with the jig blocks spaced about 1/3 and 2/3 of the elevator span. When the bondo is hard, position the elevator and jig blocks on the canard (Fig. 21). Check to see that the canard trailing edge lip is at least 0.1 in. from the top of the elevator. If not, shim the elevator up or down as required (Fig. 22). Bondo the jig blocks to the canard to hold the elevator securely in place. Mount the other elevator on the canard similarly, with the spool piece in place in between. Now sight through all of the bushings in both elevators. You should be able to see all the way through. If not, see if slightly deflecting the canard (such as weighting the tips down to simulate the air loads) will line them up. You can also shift one or more jig blocks aft slightly to line them up. **Do not** move any part of the elevator closer to the canard. That will prevent you from getting the required up and down travel. Also make sure both trailing edges are in line. When all is perfect, drill holes through the spool piece and CS9 plugs (Fig. 16) and insert AN3-15A bolts.

Now position the 7th CS2 bracket (with PTB attached) in place on the spool piece (page 11-6), over the 2 wraps of UND at B.L.O. Check that its bushing is in line (it should be). Then flex and rivet it in place. At next disassembly, drill out one of the rivets and bolt it in place as with the other 6 brackets. Now you are ready to install the CS3 hinges.

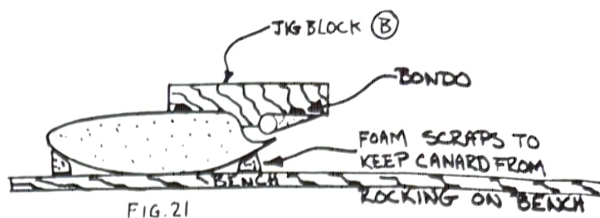


FIG. 21

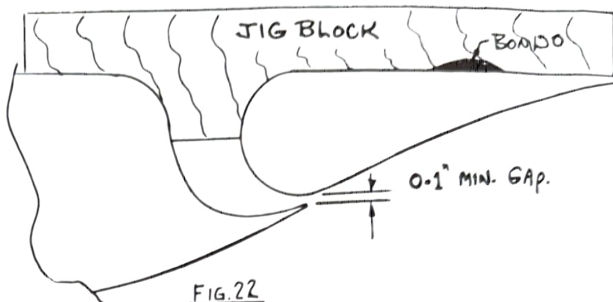


FIG. 22

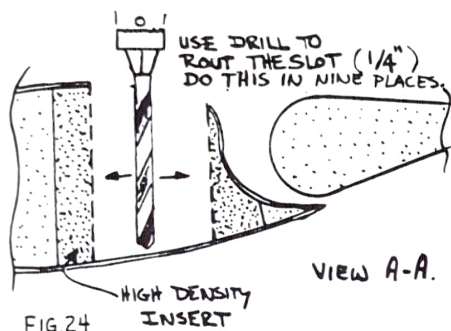


FIG. 24

VIEW FROM BOTTOM
FWD ↓

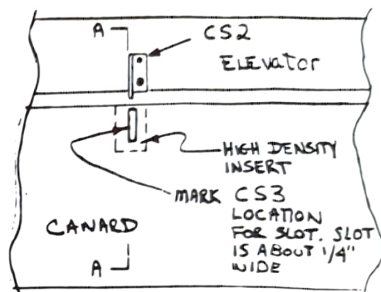


FIG. 23

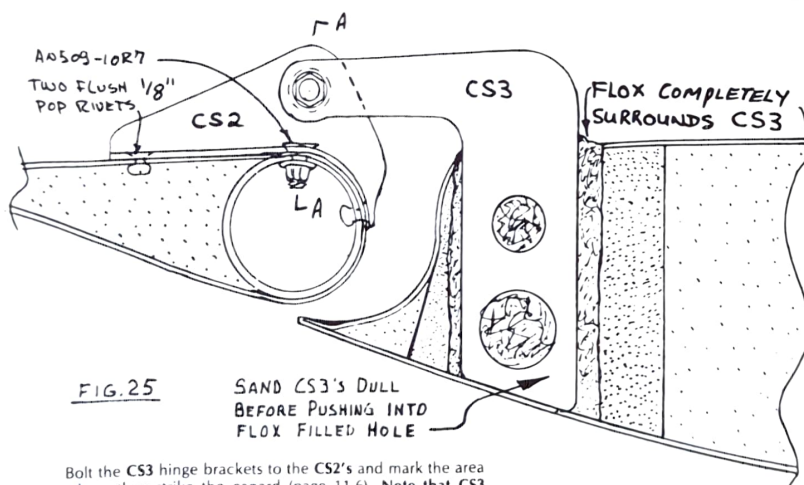
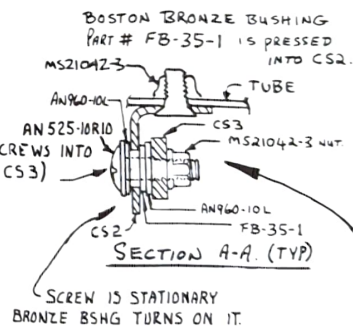


FIG. 25



NOTE! CS3 NESTS INSIDE CS2 IN ALL 7 PLACES

Bolt the CS3 hinge brackets to the CS2's and mark the area where they strike the canard (page 11-6). **Note that CS3 nests inside CS2** (Fig. 25, section AA). The marks should be at the center of the canard's high density inserts. Don't set your brackets off-center more than 0.3 in. Use a drill with a 1/4 in. bit and rout a slot in the canard's high density foam inserts along the marks (Fig. 23). **Don't** drill through the top skin, but do remove foam down to the top skin (Fig. 24). Unbolt the CS3's and drop them down in the slots for a trial fit. They should bolt to the CS2's and butt down against the canard's top skin as shown in Fig. 25, without being forced. If they stick out too far you may have to trim them slightly.

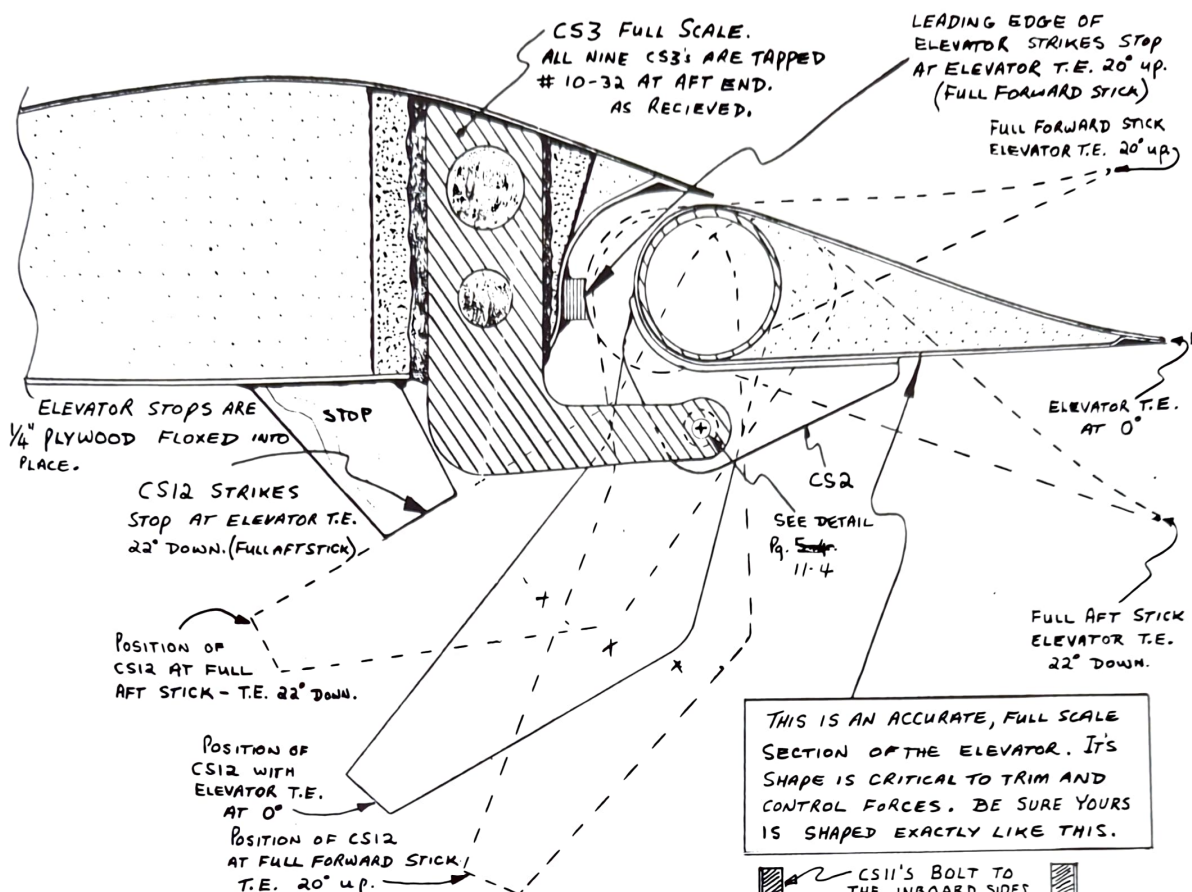
This paragraph is optional for those who wish to check their elevator travel **before** floc'ing the CS3's in place. Clamp a small board to each CS3 bracket and bondo the board to the canard. Now you can remove the 4 jig blocks and check freedom and distance of elevator travel. Elevator travel template is on page A-2, but a quick check is 1-1/2 in. travel in each direction from neutral. If elevators do not move freely, either your bushings are out of alignment or they are too tight around the bolts. In either case, correct, and then bondo the jigs back in place and remove the clamps and bondoed boards at the CS3's.

You can now remove the CS3's and fill the slots with floc just thin enough that you can **pour** it into the slots, and reinstall the CS3's. Wipe off the excess floc when you drop the CS3's into the holes and allow to cure at least 24 hours without moving anything.

Knock the jig blocks off after the floc has cured. Check for freedom of movement and slot clearance. Now remove the elevators (this is the time to bolt the 7th CS2 in place on the spool piece) and install the CS11 inboard balance weights (Fig. 26).



FIG. 26



They bolt on the inboard sides of the CS12 belcranks (Fig. 27). Now hang the elevators upside down by the pivot holes. Suspend them on fine wire, such as safety wire. The should hang 12 to 25 degrees leading edge down (Fig. 28). Recheck this after finishing and painting. Your elevators should weigh 3.3 to 3.6 lbs. **Do not** add more than 0.3 lb. of lead to balance an overweight elevator. If some extra lead is needed, add all of it to the outboard balance. An effective way to do this is to stick lead tape (3M) to the forward end of the mass balance and then cover it with one ply of UND. **WARNING: If your elevators are overweight or shaped wrong, strip them down to the bare aluminum tube and rebuild them.** This is the most important work you can do on your aircraft.

WARNING
If your elevators are overweight or shaped wrong, strip them down to the bare aluminum tube and rebuild them. This is the most important work you can do on your aircraft.

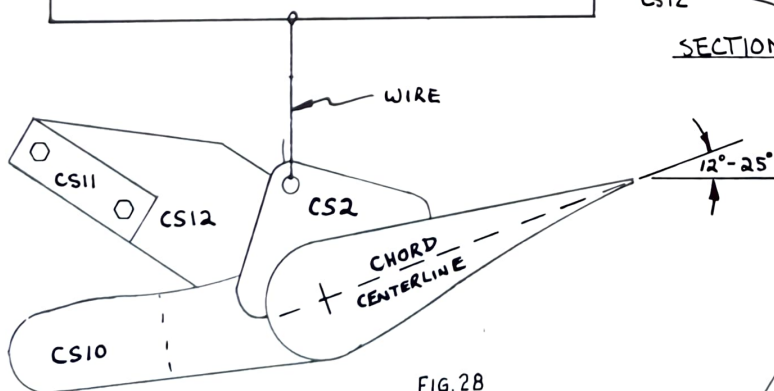
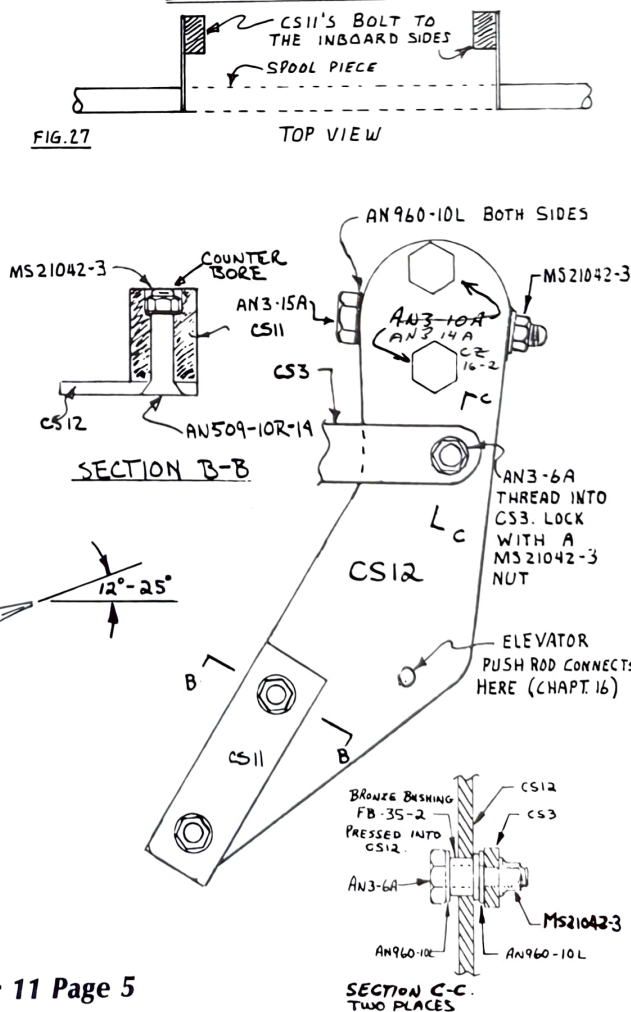


FIG. 28

You can now add the cosmetic pieces outboard of the elevators at the tips of the canard, as shown on the plan view of the canard at the end of CHAPTER 10. Use medium density PVC (6 lb/ft³). Shape it to correspond to the contour of the elevator in its neutral position, allow 0.1 in. clearance with the elevator, and cover with 2 plies of BID.



CHAPTER 12

CANARD INSTALLATION

OVERVIEW. In this chapter you will align and temporarily install the canard on the fuselage. The canard is aligned for zero sweep, zero dihedral, and zero incidence. Alignment pins are installed in the F28 bulkhead and alignment tabs installed on the canard to match. The canard tabs (aluminum tabs installed on the canard in CHAPTER 10) are drilled in place and nut plates are installed to facilitate removal in service. The following prefab parts used in this chapter are available from a COZY distributor:

CZ 8-3

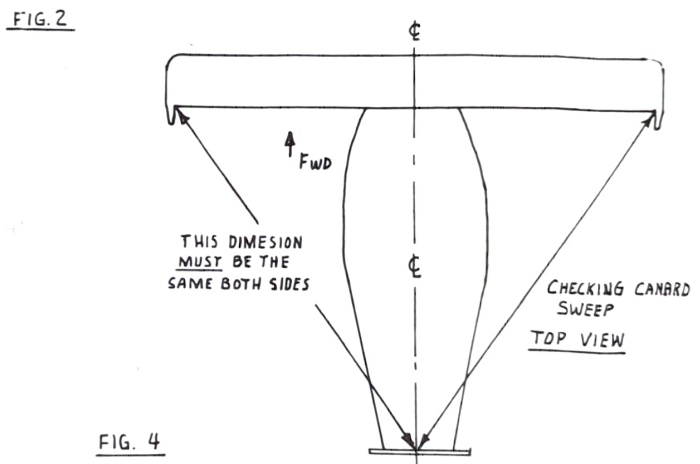
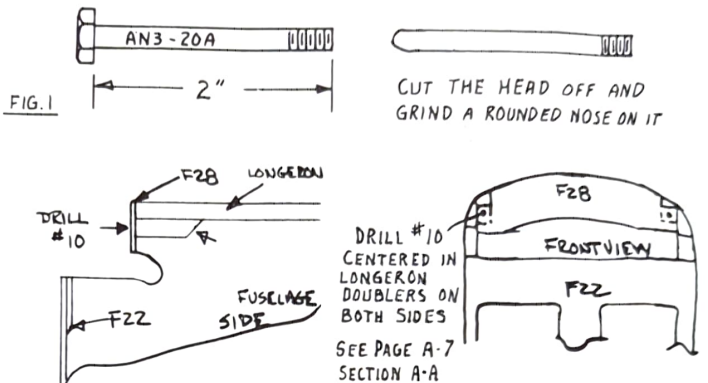
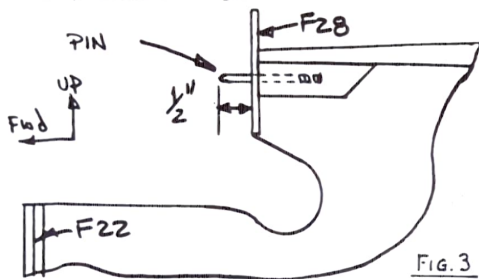
CNH	CNT	Canard attach bushing	(2)
CN2		3/16 in. flanged bushing	(2)

STEP 1. INSTALLING THE ALIGNMENT PINS

This should only take 1/2 hour. Cut the heads off of two AN3-20 or AN3-20A bolts and sand or file a round nose on the unthreaded ends (Fig. 1). Drill two holes in the F28 bulkhead and wood doublers (Fig. 2) about 1-1/2 in. deep. Make sure the holes are straight fore and aft and horizontal. Check that the pins will slip into the holes and stick out only about 1/2 in. (Fig. 3). **Do not** bond the pins in yet.

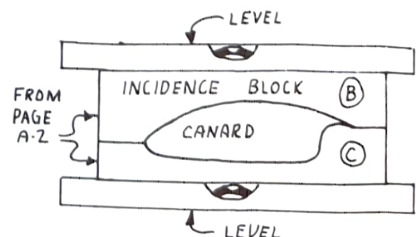
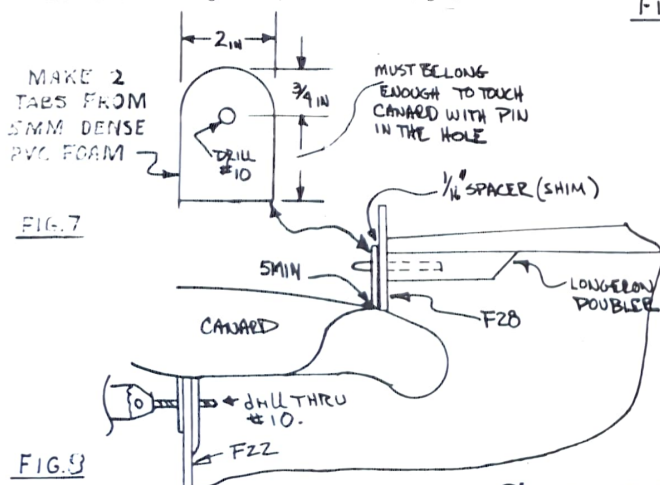
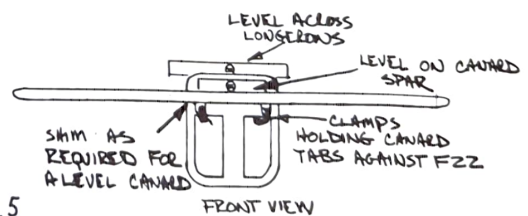
STEP 2. ALIGNING THE CANARD

This step may crowd your shop slightly, but only takes about an hour (or so), and you need an assistant occasionally to help measure things.



Check the top of F22, that it is straight and level with the longerons. Fasten 0.016 in. thick shims (to allow for 1 layer of BID and paint later on) on the top of F22 at the tab position. Now get your canard out of storage and position it (without the elevators) on the fuselage as shown on page A-7. Mark the centerline of the canard, and make sure it coincides with the centerline of the fuselage. Use a pair of 'C' clamps to hold the **Lift tabs** against the bulkhead (be careful not to bend or scratch them). Check for zero sweep-back by measuring from the canard tips to the centerline of the firewall. Both sides should measure the same. Use shims between the canard **Lift tabs** and the forward bulkhead to adjust the sweep if necessary.

Next, level across the top fuselage longerons and the canard spar cap (Fig. 5). Lastly (and most important), use your canard incidence blocks to accurately set the incidence at zero with respect to the top longerons (Fig. 6). The patterns for the incidence blocks are found on page A-2. If your canard has a slight twist, set the *average* incidence equal to the longerons. Recheck sweep, dihedral, and incidence and clamp firmly in position. Use the No. 10 pilot holes in the canard tabs and drill No. 10 holes through F22 bulkhead. Go and cut two tabs of high density foam as shown (Fig. 7).



Trim the foam tabs so that they fit against the top of the canard and against a 1/16 in. shim on the bulkhead with the pin in the hole as shown (Fig. 8). With everything trimmed to fit, 5-min. the tabs to the canard. When hard, carefully remove the canard without knocking the tabs loose.

CHAPTER 12

CANARD INSTALLATION

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CAN CN1	Canard attach bushing	(2)
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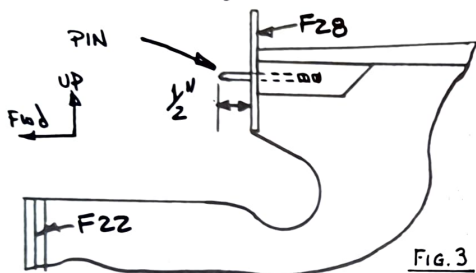


Fig. 3

Check the top of F22, that it is straight and level with the longerons. Fasten 0.016 in. thick shims (to allow for 1 layer of BID and paint later on) on the top of F22 at the tab position. Now get your canard out of storage and position it (without the elevators) on the fuselage as shown on page A-7. Mark the centerline of the canard, and make sure it coincides with the centerline of the fuselage. Use a pair of 'C' clamps to hold the **Lift tabs** against the bulkhead (be careful not to bend or scratch them). Check for zero sweep-back by measuring from the canard tips to the centerline of the firewall. Both sides should measure the same. Use shims between the canard **Lift tabs** and the forward bulkhead to adjust the sweep if necessary.

Next, level across the top fuselage longerons and the canard spar cap (Fig. 5). Lastly (and most important), use your canard incidence blocks to accurately set the incidence at zero with respect to the top longerons (Fig. 6). The patterns for the incidence blocks are found on page A-2. If your canard has a slight twist, set the **average** incidence equal to the longerons. Recheck sweep, dihedral, and incidence and clamp firmly in position. Use the No. 10 pilot holes in the canard tabs and drill No. 10 holes through F22 bulkhead. Go and cut two tabs of high density foam as shown (Fig. 7).

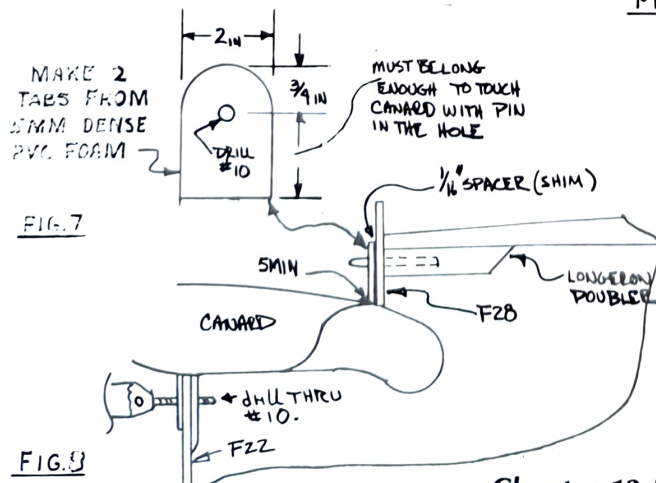


FIG. 7

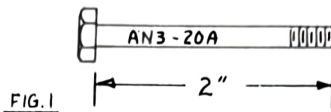
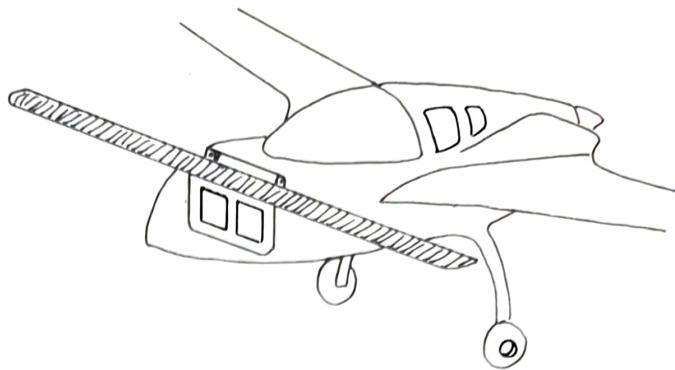


FIG. 1



CUT THE HEAD OFF AND GRIND A ROUNDED NOSE ON IT

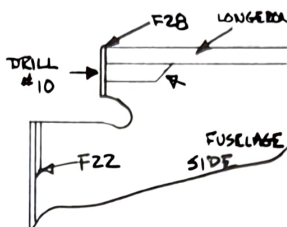


FIG. 2

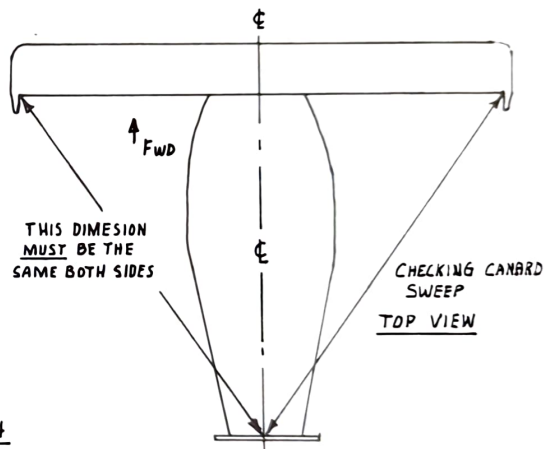
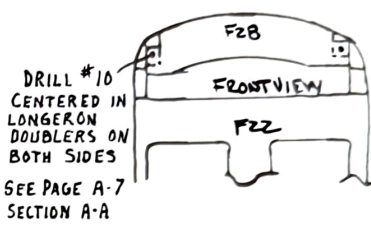


FIG. 4

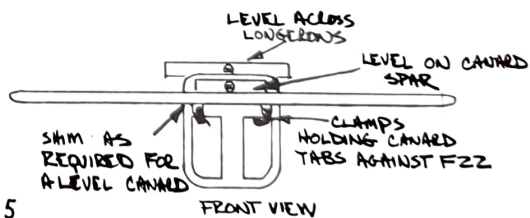


FIG. 5

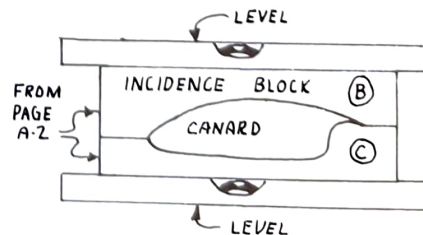


FIG. 6

Trim the foam tabs so that they fit against the top of the canard and against a 1/16 in. shim on the bulkhead with the pin in the hole as shown (Fig. 8). With everything trimmed to fit, 5-min. the tabs to the canard. When hard, carefully remove the canard without knocking the tabs loose.

Measure the thickness of any shim that was used to correct the sweep of the canard (any shim between F22 and the lift tabs). Remove the shim and dull the forward surface of the F22 bulkhead where the lift tabs rest, and lay up additional BID pads to the same thickness of the shim (BID is about 0.013 in. per ply). After cure, back drill No. 10 through the bulkhead and new glass. Thus, you have replaced the shim with additional glass pad. The tabs on the canard are glassed as shown (Fig. 9). Reopen the No. 10 holes with a drill (you can see the hole through the glass layup). Drill these holes out to accomodate CN2 3/16 in. I.D. flanged bushings (available from a COZY distributor)(Fig. 10). 5-min. the bushings in position. Reinstall the canard using AN3 (3/16 in. dia.) bolts to locate the aluminum lift tabs. Recheck your sweep and incidence.

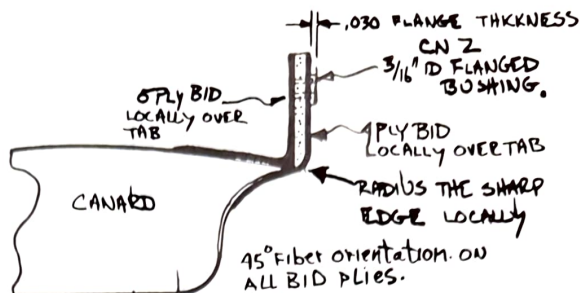


FIG. 9

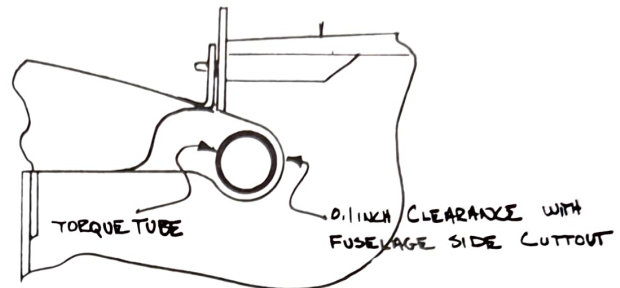


FIG. 10

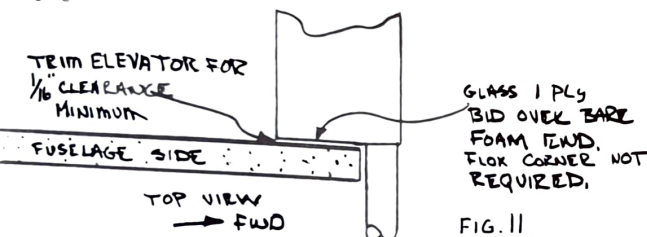


FIG. 11

Remove the AN3 bolts and drill the aluminum lift tabs and F22 bulkhead up to 1/4 in. dia. Remove the canard.

Using your 5/8 in. counterbore tool, drill the two 1/4 in. holes in the F22 bulkhead up to 5/8 in. for the CN2 5/8 in. O.D. x 1/4 in I.D. bushings (Fig. 12) available from your COZY distributor. They are supplied long, so you can trim to the exact thickness of your bulkhead (Fig. 12). **Do not** trim nor bond the bushings in yet, because during CHAPTER 13 you will be installing additional glass plies on the forward face of F22 to tie it into the nose sides. This will move your canard forward from where it now sits.

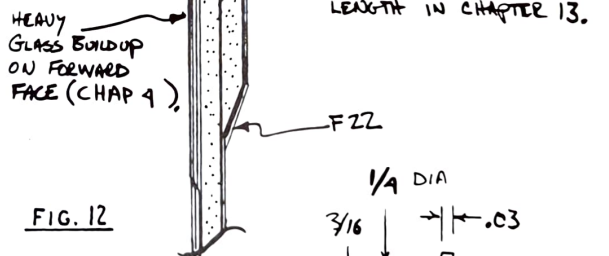


FIG. 12

Now, remove the 3/16 in. pins from the F28 bulkhead and apply one ply of BID to the entire area shown, using 1/4 in. floc corners at the edges of the bare foam (Fig. 13). When cured, drill out the No. 10 holes and permanently install the 3/16 in. alignment pins with wet floc. It is a good idea to reinstall the canard so the canard tabs hold the pins in the correct alignment. A small piece of Saran wrap between the bulkhead and the tab will prevent the floc from bonding to the tab.

Note: The hardware required to permanently fasten the lift tabs to the bulkhead is shown on page A-7. These are installed in CHAPTER 13.

Note: Incidence templates 'B' and 'C' have been adjusted to provide 1.0 degrees more incidence to the canard on the COZY than on the Long EZ. This is necessary to compensate for the slightly lower aspect ratio. **Do not** use incidence templates from the Long EZ (or the Varieze) on your COZY!

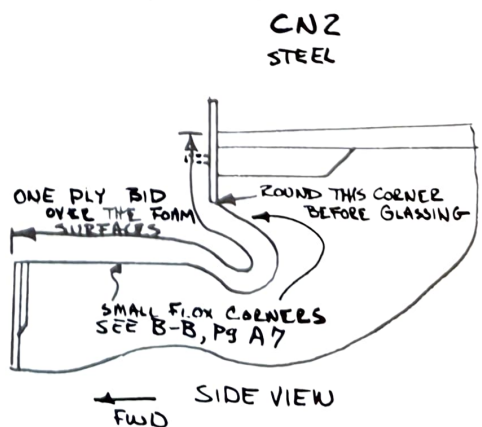


FIG. 13

CHAPTER 13

NOSE AND NOSE GEAR

OVERVIEW. In this chapter you will assemble a box consisting of two slabs of glass/foam/glass sandwich and nose gear hardware (worm drive system). The nose gear strut is mounted in this box, then the assembly and the nose bulkhead are installed on the fuselage. The nose floor foam pieces and side pieces are installed and glassed inside. The nose wheel and pivot assembly is then installed. The pitot-static plumbing and rudder pedals are installed. The top foam piece is then installed. The outside is carved to shape and then glassed. A door is laid up onto the top of the nose. The top piece is then removed to fabricate the door flanges. The SC strut cover and NB nose gear box is also installed. The following prefab parts used in this chapter are available from your COZY distributor:

NG-1	Nosegear fiber glass strut
SC	Nosegear fiber glass strut cover
NB	Nosegear wheel cover
NG-6	Nosegear strut pivot assembly
NG-3	Nosegear strut bracket (outside)
NG-4	Nosegear strut bracket (inside)
NG-15A	Castoring nose wheel assembly (complete)
LST	Nosegear shock strut
VENGR	Nosegear worm drive assembly
NG-14	Worm drive spacers
NGA-64	Crank welded assembly
NG-67	Crank bearing block
NG-61	Crank torque tube
NG-63	Crank torque tube sleeve
CZRP	Rudder pedals

The LST nosegear spring shock strut is optional on the Long EZ (in place of NG-10A push rod), but, because of higher front seat loads is **mandatory** for the COZY.

Caution: Do not use the NG-1 fiberglass strut manufactured for Varieze aircraft. It is 1 in. too short and only about 2/3 the strength of NG1-L.

Operation of the worm-drive nosegear. Figure 1 shows the operation of this system. The NG50 arms travel 156 degrees, striking the NG14 spacers at each end of travel. It is over-center in the down position, thus, landing loads are not applied to the worm gear. The pilot's crank uses 10.8 turns for full travel, taking five to seven seconds. The gear can be extended up to 140 mph, however, the crank is hard to turn above 130 mph. This mechanism is designed only for air loads, and is not intended to be used on the ground to either raise or lower the nose of the airplane, and such operation is not recommended.

STEP 1. FABRICATING METAL PARTS AND REINFORCING FIBERGLASS STRUT

The specialized prefabricated parts listed above are beyond the capability of most homebuilders to manufacture, and it is recommended they be purchased from a COZY distributor. Drawings of these prefabricated assemblies are shown at the end of this chapter for reference. Metal parts which can be fabricated by most homebuilders are:

NG5	Nosegear pivot casting cover plate	(1)
NG8	Nosegear pivot plates	(2)
NGFD	Nosegear front door	(1)
NGRD	Nosegear rear door	(1)

NG5 is made from 1/8 in. 2024T3 aluminum (Fig. 2). Counter sunk holes for four AN509-10R28 are not drilled until installation in Step 2. NG8's (2 required) are also made from 1/8 in. 2024T3 aluminum (Fig. 3). They may be predrilled for installation in Step 2. A full size pattern for NGFD nosegear front door and NGRD nosegear rear door (Fig. 3) is shown at end of this chapter and installed in Step 3.

NG1-L is a high pressure laminate of S-glass rovings and can be split, as supplied, by extreme bending loads. It is therefore required to make a 2-ply layup around this strut (Fig. 4) for protection against splitting. Before glassing, check the fit of the strut in NG6, nosegear casting, NG15A, nose gear pivot casting, and NG3, nosegear shock strut bracket. Trim strut, if needed, to fit the castings and bracket plus enough clearance for your 2 ply layup. Then round the corners of the strut and lay up 1 ply of BID at 45 degree orientation around 3 sides for the entire length. Peel ply. After cure, remove peel ply and lay up 1 ply of BID at 45 degrees from the other side as shown.

STEP 2. FABRICATION AND ASSEMBLY OF THE HIGH DENSITY FOAM PLATES

This step should take about 4 hours, not counting cure time. Use the full scale drawing on pages A-6 and A-7 as a pattern to cut out the outline of the plates and to accurately mark five holes (one at the gear forward pivot and four at the NG13 guide). Follow the double tick marks (!!) on the full-size drawing to obtain the correct outline of NG30 (Fig. 5).

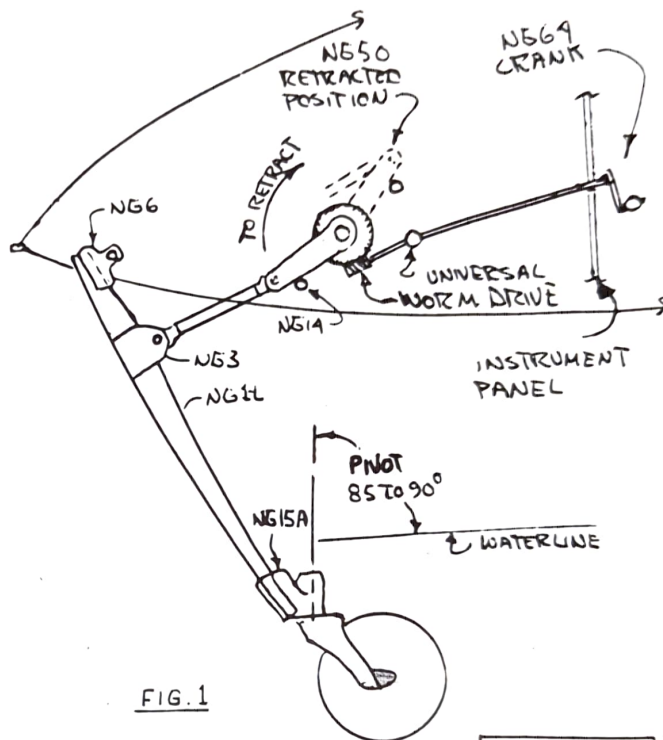
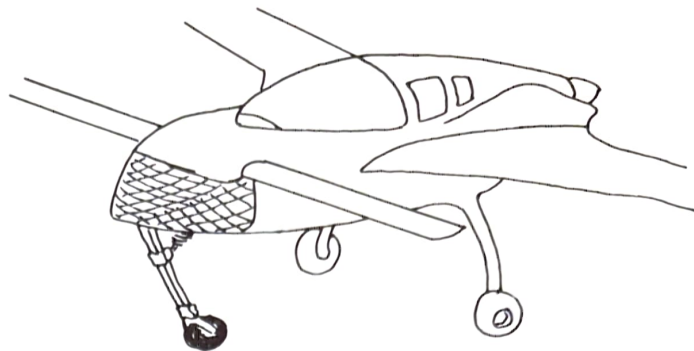


FIG. 1

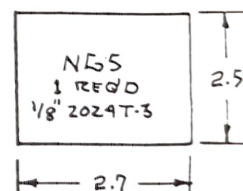


FIG. 2

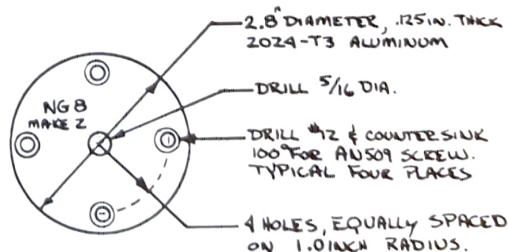


FIG. 3

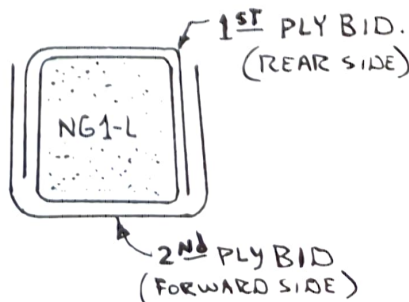


FIG. 4

Lay the NG30 pieces on your table with the **inside** surface up and lay up **four** plies **BID** (fiber orientation optional). Knife trim around all edges. When cured, place both NG30 plates together and drill pilot holes (in a drill press) at the five locations previously identified (Fig. 6). Lay the plates on the table with the fiberglass sides down. Remove all foam down to the fiberglass and round the edges in the areas shown (Fig. 7). A knife, dremel and coarse sandpaper are required. Cut the BID pads shown and lay them up in the depressions and then lay a four ply BID skin over the entire outboard surface of NG30. Clamp or weight a wood block over the pad areas to remove excess epoxy and force the pads to the correct thickness. Remember to use Saran under the blocks so they don't bond.

After cure, open the front pivot hole to 5/16 in. and the other four holes to 1/4 in. Use light drill pressure and a hard wood block as back up to cut clean holes. Use NG51 as a drill guide. For the second side, clamp both sides together in perfect register, inside to inside, and use the first side as a guide for drilling the holes in the second side. A drill press is recommended for perpendicular holes. While the two sides are still clamped together, locate the rudder pedal extension holes (see drawing A-7) and drill two 1/2 in. diam. holes through both sides in the location specified.

Check the worm drive assembly for freedom from binding before installation. It does not (nor should not) spin freely, just be sure it does not bind up enough to make the crank hard to turn. If it binds, loosen the NG57 blocks and shim as required. The NG53 and NG58 gears must be accurately positioned to avoid binding. Use a gear lubricant on NG53 and NG58. Note that four AN960-816 washers are used to position NG58. One at the roll pin end and three at the other end.

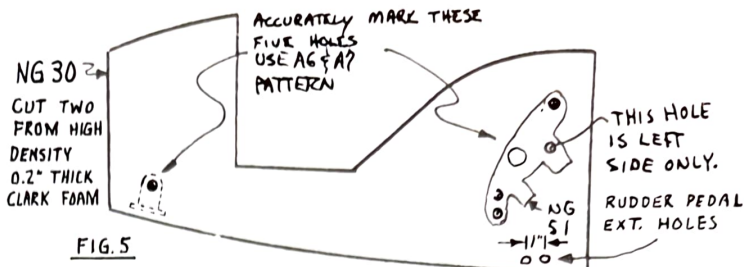


FIG. 5

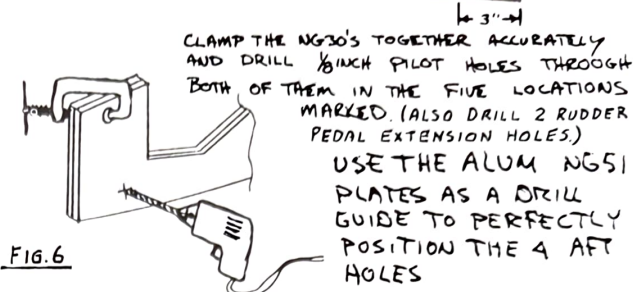


FIG. 6

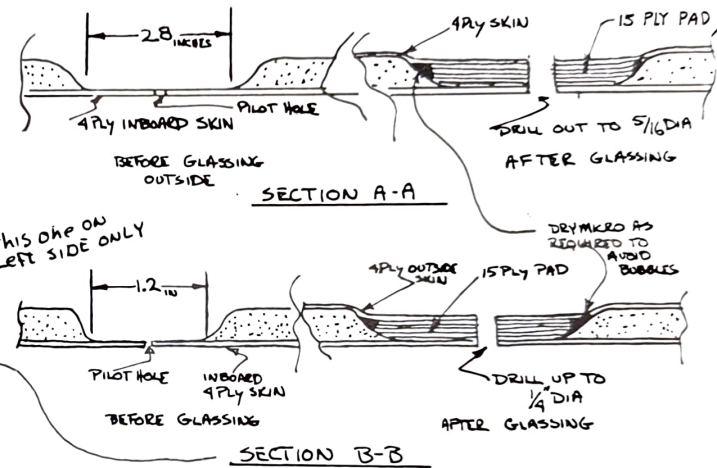


FIG. 7

Now round up the following parts and hardware:

- (2) NG30 plates
- (1) NG6 casting, NG23 bushings, and NG7 spacer
- (2) NG8 discs
- (1) AN5-41A bolt
- (2) AN970-5 wide area washers
- (1) AN365-524 nut
- (8) AN509-10R14 screws
- (8) AN960-10 washers
- (8) MS1042-3 nuts
- (2) NG51 plates
- (2) NG14 spacers
- (2) AN4-41A bolts
- (3) AN4-10A bolts
- (8) AN970-4 wide area washers
- (6) MS1042-4 nuts

Now bolt everything together (Fig. 8), using wet flox on NG8 where it mates the fiberglass. Check that the assembly is square all around. Now bolt the NG1 fiberglass strut and NG5 plate to NG6 with four AN509-10R28 screws. The strut is installed wet with flox. Check to be sure it is aligned straight (centered between NG30 plates when retracted).

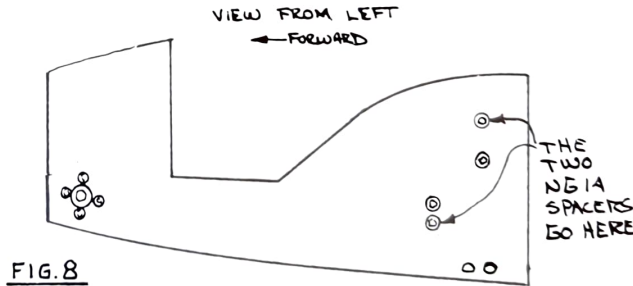
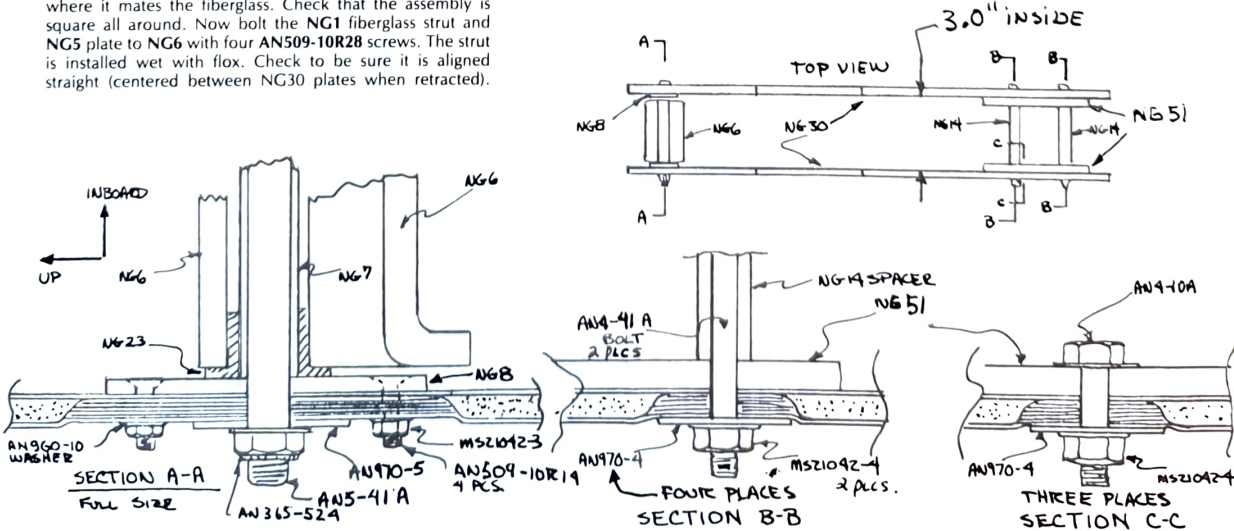
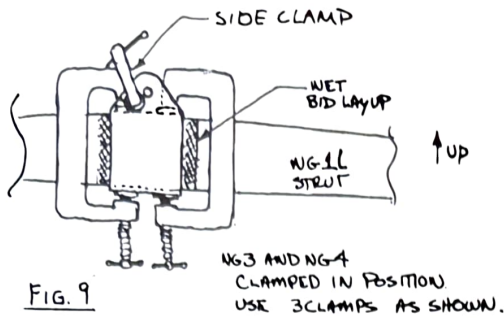


FIG. 8

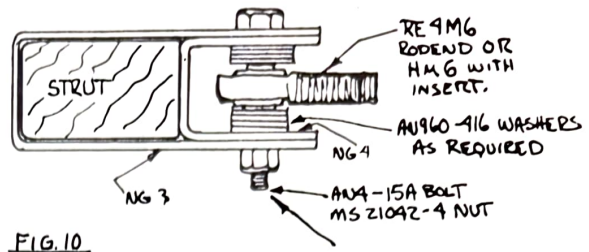
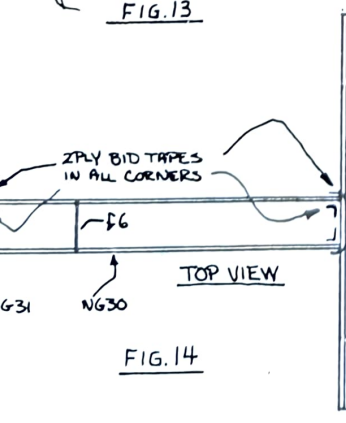
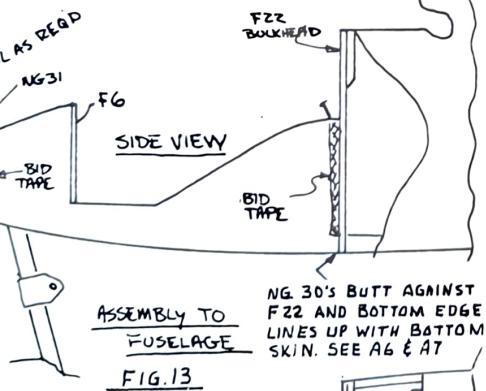




Refer to the full size drawing on page A-6 for strut position. Refer to this drawing and Figures 9, 10, and 11 for the installation of brackets NG4 and NG3 on the strut. The brackets are manufactured to a loose fit on the strut. Wrap the strut with dry BID until NG3 fits snug (2 to 3 plies). Remove NG3, sand the strut, lay up the BID wet, and coat the inside of NG3 with wet flox. Install NG4 and NG3. Remove excess flox. Clamp as shown until cured, then remove the clamps, drill the hole up to 1/4 in. diameter and install the AN4 bolt, spacer washers, and RE4M6 rod end. Note that the spacer washers can be shifted from one side to the other to correct for any strut misalignment, but there should be none.

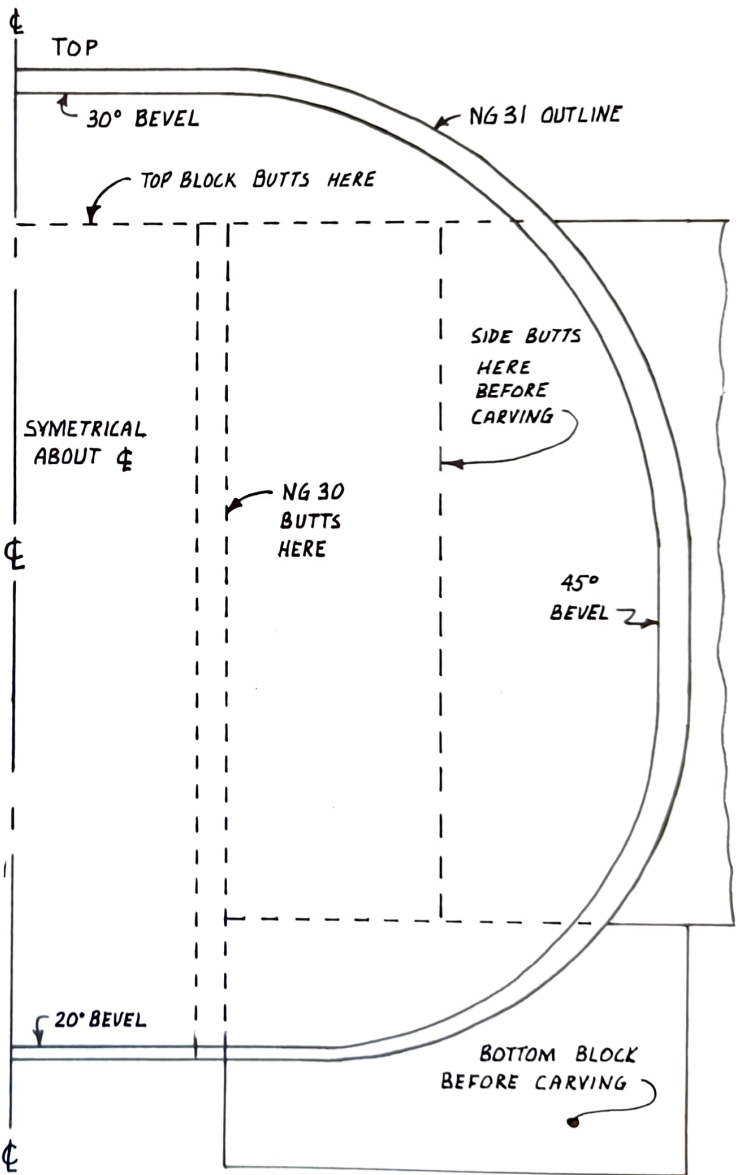
STEP 3. INSTALLATION AND ASSEMBLY ON FUSELAGE

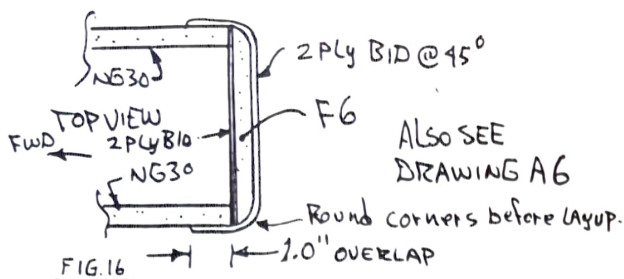
This step should take only about an hour or two. Cut out the NG31 disc from pink, 6 lb./ft³ (H100) 1/4 in. PVC foam, per full-size pattern in Fig. 12. Micro and glass the aft face with one ply of BID. While it is still wet (or tacky), install it at the forward end of the NG30 plates with flox and lay up glass tapes as shown in Figures 13 and 14. This job is easier if the tapes are wet out on a piece of paper and then put in position, pressed down, and the paper then removed. Now, cut out F6 (Fig. 15) from white, 18 lb./ft³ 0.2 in. thick Clark foam, glass the forward face with 2 plies of BID, scissor trim flush, and flox in place on the NG30 (Fig. 13 and 14). Hold in place for cure with nails (holes pre-drilled). Then mount the entire assembly on F22 with flox and BID tapes as shown in Figures 13 and 14. **Make sure** the NG30 plates are leveled vertically (assuming your fuselage has been leveled horizontally), or else your nosewheel will not extend vertically. Also make sure the assembly is parallel with the longitudinal axis of the airplane (use a carpenter's square against F22) or else your (the airplane's) nose will be crooked. The assembly can be held in place during cure with nails (holes pre-drilled). This will go better if you have removed as much weight from the assembly as possible first and perhaps clamp a couple of legs to the assembly to relieve stress from the nails. When you are sure everything is perfectly aligned, let cure. After cure, radius the edges of F6 and cover the aft face with 2 plies of BID at 45 degrees orientation, lapping 1 in. onto the NG30 plates (Fig. 16).



THE DISTANCE FROM THIS BOLT TO THE CENTER OF NG7 MUST BE 6.71" ± .05"

CHECK THIS!





STEP 4. NOSE FLOOR AND SIDES

This step involves about 7 hours of work. **Don't** try to support the fuselage on the nose gear now. It doesn't attain full strength and stiffness until Step 9 is completed.

Now, round up some 2 in. thick green urethane foam, and a hack saw blade and carve the 2 foam floor blocks (one right and one left) shown in Fig. 17. Best to start oversize and work down to a good fit. Note that both ends are cut at a **5 degree angle**, for snug fits against F22 and NG31 (Fig. 18). Note also that the floor blocks extend beyond the lower corners of NG31 (study Fig. 12) to align with the widest part of this bulkhead and similarly at F22. This is on purpose to assist in aligning the side blocks, and will be carved away later.

Now, dish out the inboard top surfaces of the floor plates as shown in Figures 17 and 18, to a maximum depth of 0.9 in. in the center of the dished out area, but no foam removal at the forward, outboard, and aft edges. Make sure that enough foam is removed inboard along NG30 to allow access to the screws at the nose gear pivot.

You may now install the floor blocks with wet micro where they butt against NG31, NG30, and F22. The floor blocks should butt 1.1 inches against NG31 at the forward end (Fig. 12) and the top surface should be level with F22 on the aft end. If there is a joggle in the floor aft of F22, carve a urethane block to fit the joggle for a smooth transition in the floor across F22. There should be excess foam hanging below NG31 and F22 (Fig. 18) for later carving to contour. After the micro has cured, squeegee wet micro on the top surface and glass with 2 plies of BID, lapping 1 in. up onto NG31, NG30, and across F22 and lap 1 in. onto the glass floor aft of F22. Lay up an additional ply of BID over F22 and 3 in. forward to protect it from damage from the pilot's (and passenger's) heels. **Do not** micro and glass all the way to the outboard edge (Fig. 19) at NG31 and F22, to make carving the outside easier later on. Peel ply along the outer edge of the glass for bonding the sides.

Now, before starting the sides, make nose templates from pink, 1/4 in. H100 Divinycel foam. The vertical template (Fig. 20) is shown full size on drawing A-6 (you have to piece it together at the match line). Cut a 1/4 in. wide slot for the pitot tube in the center, curving gently upward starting about 1 in. aft, and exiting the foam about 3 in. aft.

Now cut out two horizontal templates per Fig. 21. 5-min. the templates in place on NG31 using nails to hold them in place until cured (Fig. 22). The templates are left in place permanently and become part of the nose structure.

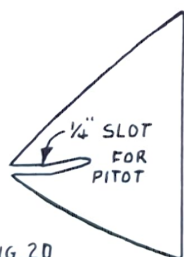


FIG. 20

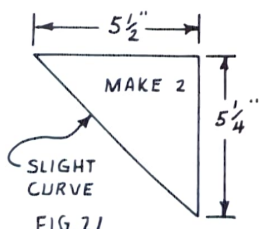


FIG. 21

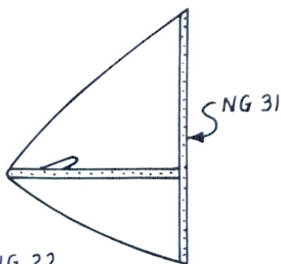


FIG. 22

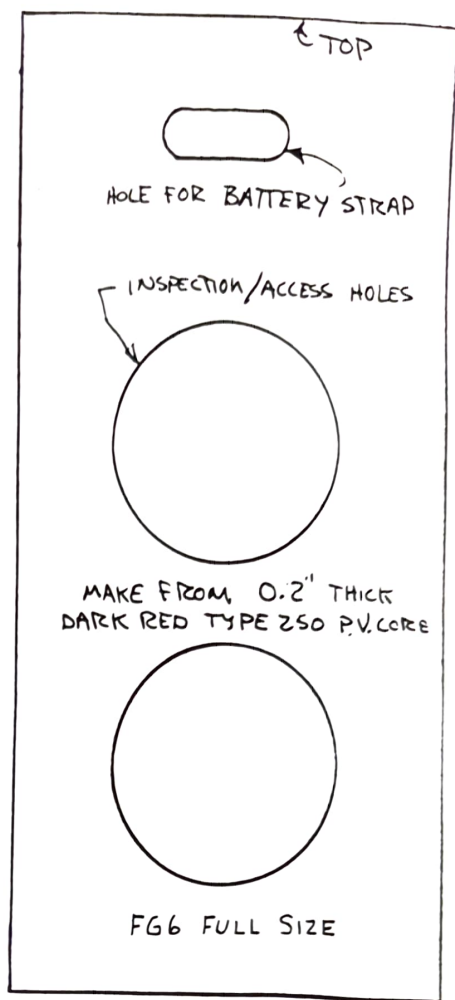


FIG. 15

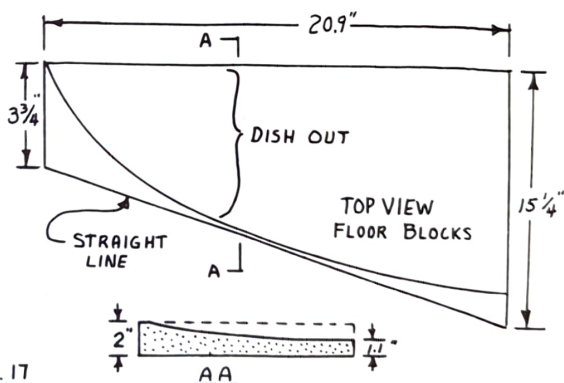


FIG. 17

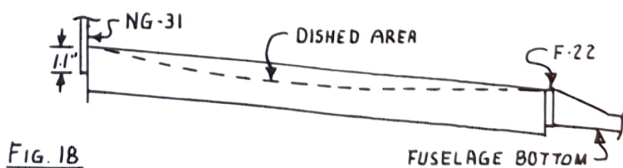


FIG. 18

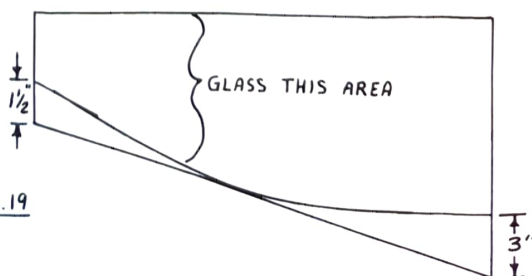


FIG. 19

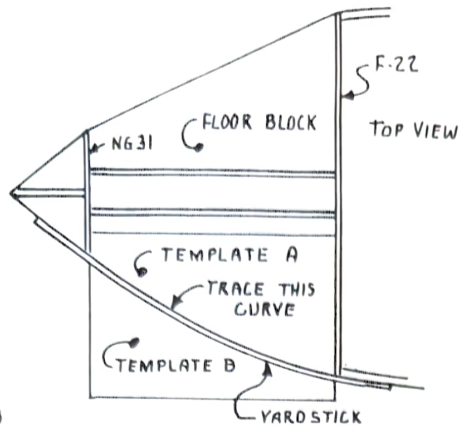


FIG. 23

Now is the time to make templates to assist in carving the sides to the correct curvature later on. Have your assistant hold a piece of corrugated cardboard or hardboard that is just long enough to fit between NG31 and F22 while you take a flexible aluminum yardstick and bend it in a smooth transition curve from the fuselage side to the nose templates (Fig. 23). Adjust the yardstick till you have a continuous, pleasing curve, and with your third hand, trace this curve on the cardboard. Mark the forward end. Cutting along your line will give you a pattern for carving both the inside (template A) and the outside (template B) of the sides.

The sides have too much curvature to carve out from a single 2 in. slab of urethane foam, so you will have to add additional material on the inside at both ends (Fig. 24). Block A is cut from 2 in. thick urethane to the dimensions shown in Fig. 25. Blocks B and C can be made most easily by starting with a rectangular block of 2 in. urethane measuring 11 in. x 18 in., and making a 60 degree cut lengthwise as shown in Fig. 26 in your bandsaw (or by hand). Fasten block A temporarily in place against the side of the fuselage (Fig. 24) with nails or a few dabs of 5-min. The bottom edge should line up with the bottom surface of the floor. Now fit blocks B and C, so they fit snugly against the top surface of the floor, NG31, and F22, and against block A. Now bond blocks B and C to A with 5-min. or micro. Mark the outside contour of the fuselage on both ends of block A, and the inside contour of F22 on the end of block C. Now remove the block assembly from the fuselage and set it on your work bench.

Trim blocks B and C as shown (Fig. 27). Now, looking at the forward end of blocks A and B (Fig. 28), measure in 1 inch from the outline of NG31 that you marked on the end of the block, draw a curved line for a 1 inch wall thickness, and trim block B down to this line.

Looking at the aft end of blocks A and C, measure in 1/2 in. from the outline of the outside edge of F22, and mark a line for a 1/2 inch wall thickness where the wall is straight, and thickening toward the bottom edge, with no foam removal at the bottom edge where the rudder pedal brackets will be attached (Fig. 29). Trim block B down to the line you have marked. Now grab template B, which describes the inside curvature, and dish out the inboard surface of the block assembly, as shown in Fig. 30 and sections AA, BB, and CC. There should be no foam removal along the top or bottom edges of blocks A, B, and C. Remove foam until the template rests on the 1/2 in. thickness line at the aft end and the 1 in. thickness at the forward end with a smooth curve from fore to aft and top to bottom.

Trial fit the side to the fuselage. At F22 (Fig. 31), the top inside edge should line up with the top inside edge aft of F22 so there will be sufficient clearance for the canard lift tabs. You may have to remove a slight amount of foam (locally only) to provide this clearance. Also, carve a small urethane block for the lower bottom corner to bring the side in so it lines up with F22, straight, fore and aft, where the rudder pedal bracket attaches. 5-min. this block in place (to the side only).

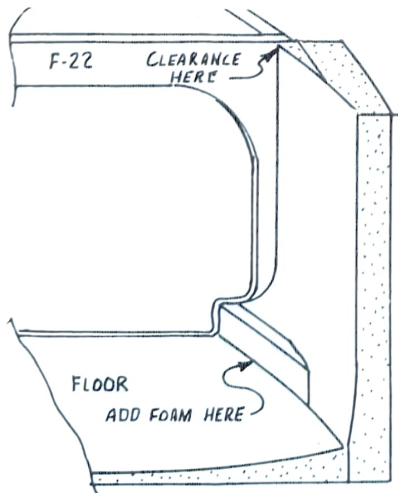


FIG. 31

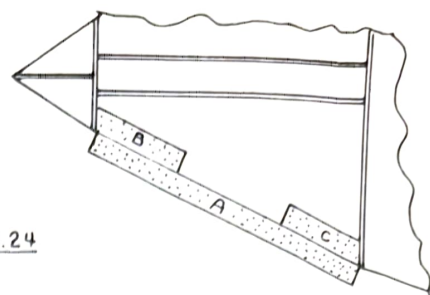


FIG. 24

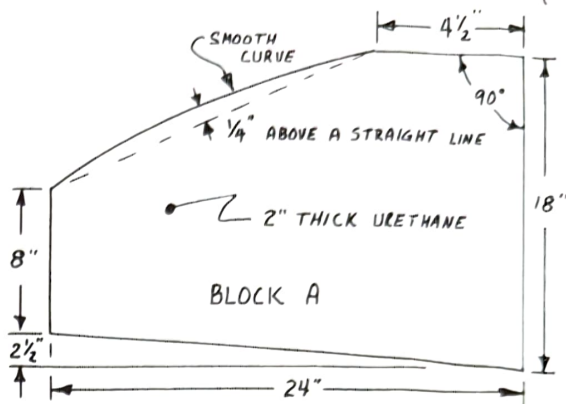


FIG. 25

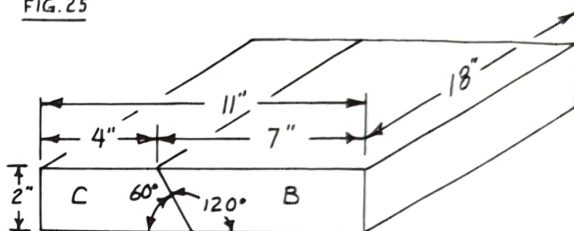


FIG. 26

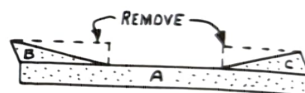


FIG. 27

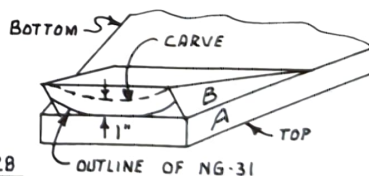


FIG. 28

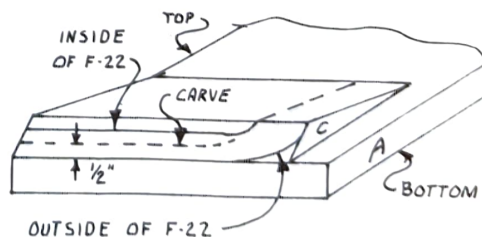


FIG. 29

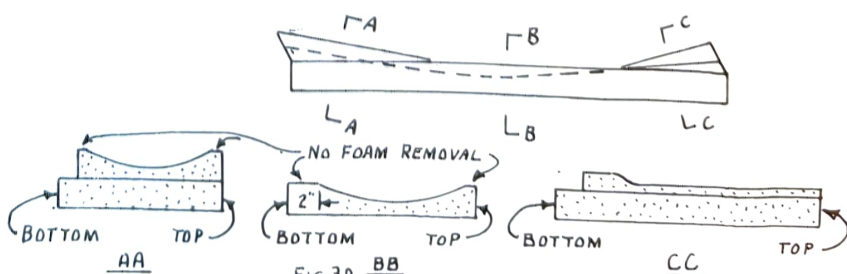
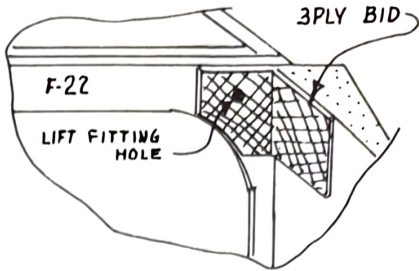


FIG. 30

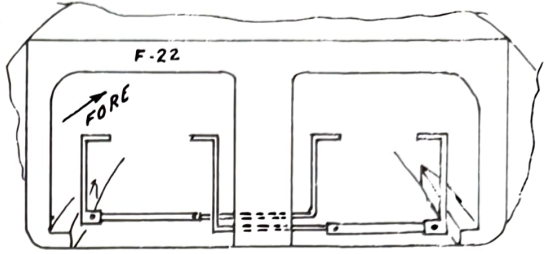
Now carry the side back to your work bench, micro the inside surface and glass with 2 plies of **BID** at 45 degree fiber orientation. Scissor trim the top edge, but leave 1 in. of excess cloth, unwet out, along the aft, bottom and forward edges. Allow to tack cure for a couple of hours. In the mean time, sand F22, NG31, and the floor where the side butts. Then install the side with wet micro on the fuselage. Wet out the glass cloth overlaps onto F22, the bottom and NG31. While the layup is still wet, apply 3 plies of **BID** into the corner at the top of F 22, as additional reinforcement for the canard lift tab attach area (Fig. 32). Peel ply and let cure. Repeat this entire sequence for the other side.

FIG.32



After cure, open the canard lift tab holes to 5/8 in. dia. Trial fit the CNL bushings in these holes and the canard in place with a 0.016 in. shim between the canard and F22, and AN4 bolts through the lift tabs and bushings. Recheck canard incidence. If everything is OK, install the bushings permanently in F22 with flox. Leave the canard in place with bolts through tabs and bushings to make sure it cures in alignment. After cure, remove canard, and trim bushings flush with F-22 (see drawing A-7). Now rivet K1000-4 nutplates to two 3/4 in. x 1-1/4 in. pieces of 0.063 2024T3 aluminum, sand the aft face of F22 and the forward faces of the nut plate retainers, apply flox to both, and bolt the nut plate retainers to F22 with greasy AN4 bolts and enough washers to hold them tight. Apply 1 ply of BID over the nut plate retainers, lapping onto F22, to hold them securely in place. Allow to cure.

FIG.33



STEP 5. INSTALLING THE RUDDER PEDALS

The rudder pedals are installed as shown in Fig.33. Each set is composed of 3 parts, i.e., 2 weldments and one extension piece. The weldments are available prefab:

- CZRPL1 Left master pedal (1)
- CZRPL2 Left extension pedal (1)
- CZRPR1 Right master pedal (1)
- CZRPR2 Right extension pedal (1)

In addition to the prefab parts, you will need the following hardware:

- K-1000-3 Nutplates (2)
- AN426AD3-3 Rivets (4)
- AN970-3 Washers (2)
- AN960-10 Washers (6)
- MS21042-3 Nuts (4)
- AN3-6A Bolts (2)
- AN3-7A Bolts (2)
- AN3-8A Bolts (2)
- CS13 Spacers (2)
- 24 inches 5/8 in.x.058 wall 4130 tubing

Carve rudder pedal pivot blocks from 2 1/2" thick, high density Clark foam (Fig. 34) to fit snugly in the lower outside corners of the fuselage, from the aft face of F22 forward, smooth transitioning to the fuselage side. They should be parallel fore and aft, and vertical up and down. Flox them in place.

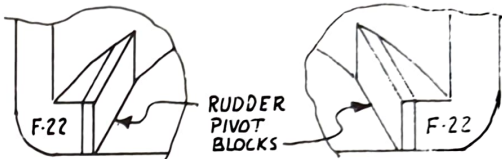


FIG.34

Now cut two pieces of .063 in. 2024T3 aluminum 1 in. x 1.5 in, drill a 1/4 in. hole through the center, and rivet K-1000-3 nutplates to the back. Trial fit the rudder pedals (Fig. 33) and locate the pivot position on the high density blocks, where the pedals will move freely without binding. Drill 3/8 in. holes 1/2 in. deep at those locations. Screw AN3 bolts into the nutplates to keep epoxy out of the threads, and 5-min. the nut plates in place on the high density blocks. When cured, remove the bolts. Put a little soap or wax into the nutplates, sand adjacent areas, radius edges, and glass over pivot blocks with 4 plies of **BID**, lapping 1 in. on all surrounding glass, including the aft face of F22.

After cure, open up the holes in the nut plates and install the rudder pedals permanently as shown (Fig. 35). The CS13 spacers are clamped tight by the bolts inserted through CZRPL1 and CZRPR1 into the pivot nut plates. The rudder pedals should pivot freely on the spacers.

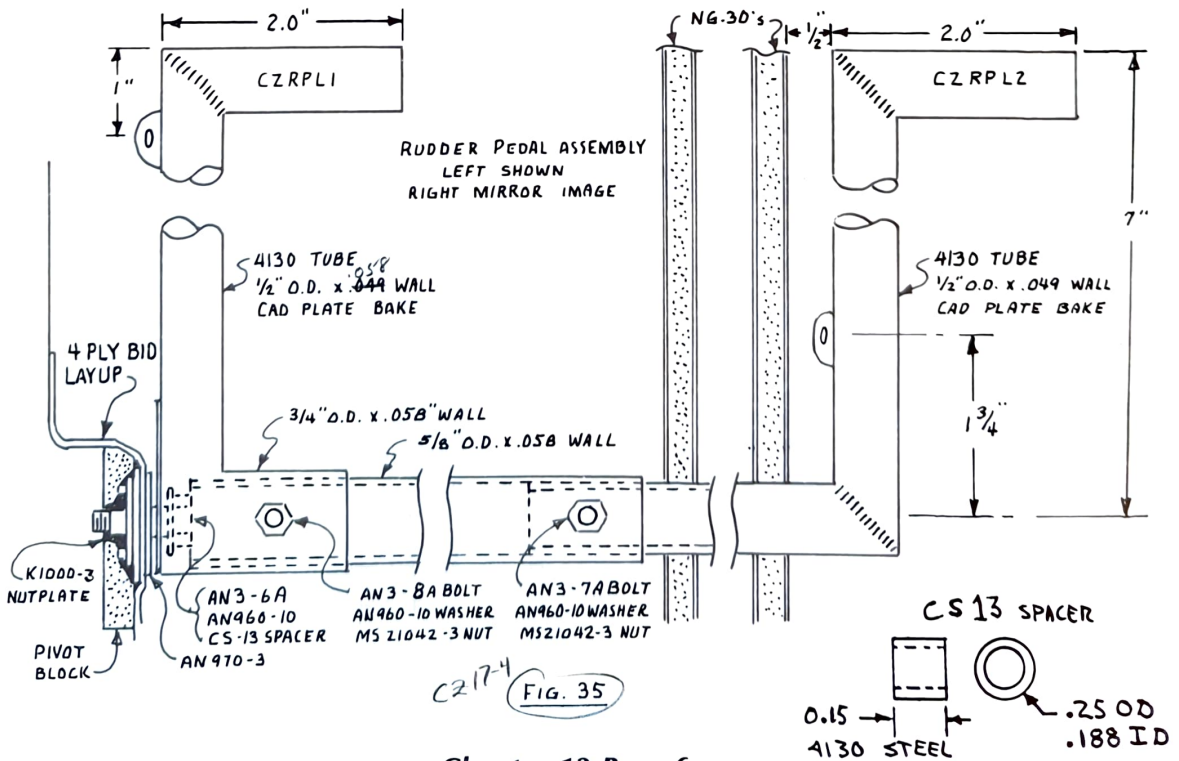


FIG. 35

Mount a small tab on the lower through bolt (through NG30 plates)(Fig. 36) and hook a light spring to the rudder pedal plates(Fig. 36) and hook a light spring to the rudder pedal tab as shown. This should not be a strong spring. Its only function is to overcome the weight of the pedal. This spring plus the rudder cable installed later will hold the pedals erect.

STEP 6. COMPLETION OF THE NOSE GEAR

This step involves mounting the lower nose gear assembly, fitting the strut to the bottom of the fuselage, fitting the nose gear box and strut cover, and rigging the retraction/extension system. If all goes well, it should take you only about three hours.

Put the strut assembly on your work bench. Trim the nosewheel end of the NG1L strut so that it nests into NG15A nosewheel assembly at the correct distance from the NG6 pivot block as shown (Fig. 37). See also section AA on page 13-12. Remove the assembly, sand the mating surfaces, and reinstall wet with flox. The four AN525-10R24 screws also mount the forward gear door. The aft gear door should not be mounted at this time.

Now grab your NB fiber glass nose gear box, make a pattern of the opening in the bottom, place this pattern with the large end 1-1/4 inch forward of the instrument panel, centered on the fuselage centerline, trace the outline, and cut out this part of the fuselage floor. Now, flip the fuselage upside down, take your dremel or razor saw and remove the bottom fuselage skin below the strut, from F22 aft to the nose wheel cutout (Fig. 38). Remove enough foam so that the strut will retract to the flush position shown on the full size drawing page A-7. The forward door should fit up against the skin; bend it, if necessary. Now, find your SC fiberglass strut cover. This is a prefab part that seals the voids between the nose gear forward pivot and F22. Note the cutout in the top of SC (Fig. 39). This area needs to be removed (dremel or coping saw) to allow the spring strut to pass through. Fit in position as shown (Fig. 40) and trim the outer edges as required. Check its fit to the strut. Sand bonding surfaces and bond in place with wet flox. Use two plies of BID to glass over all the bare foam in the wheel well/strut notch area aft of SC. Use a small flox corner at the bottom skin edge.

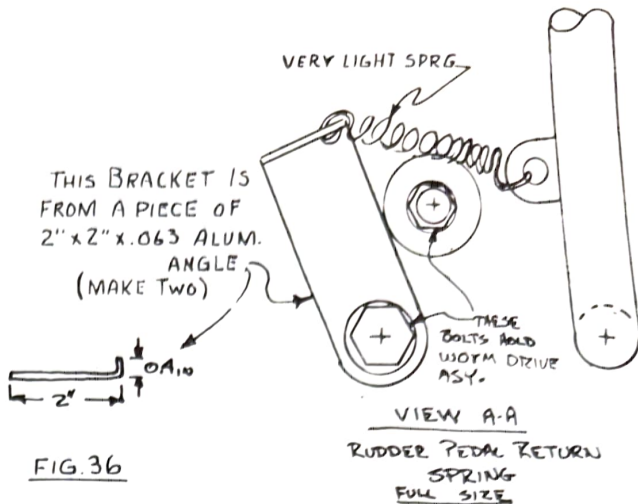


FIG. 36

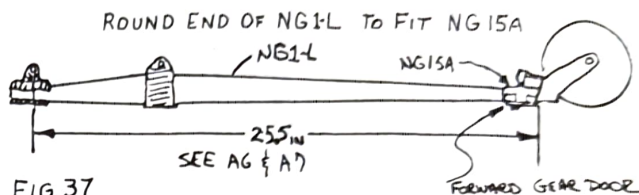


FIG. 37

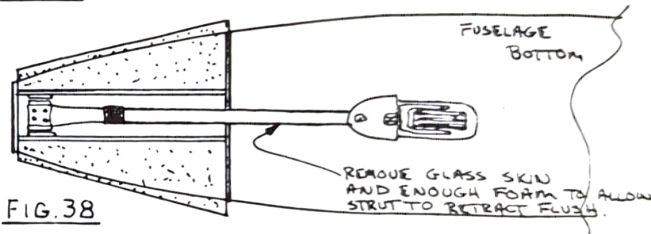


FIG. 38

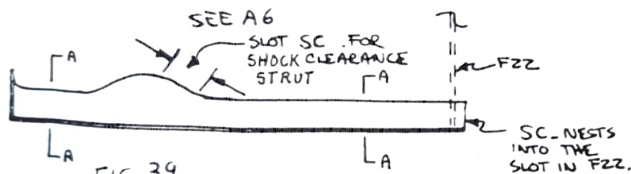


FIG. 39

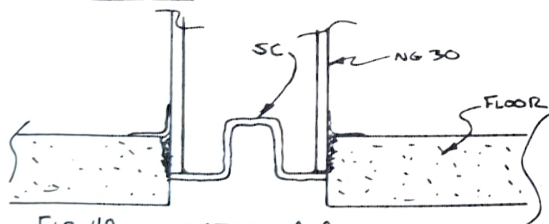


FIG. 40 SECTION A-A

Now flip the fuselage right side up, retract the strut with wheel attached, so the strut is flush with the fuselage bottom, and measure how far the nosewheel protrudes into the fuselage, above the floor level. You will probably need a spacer between NB and the fuselage floor to give you 1/2 in. clearance for the tire in the well (Fig. 41). Make this spacer and flox it and NB to the floor over the wheel. Allow a 1-1/4 inch space between NB and the instrument panel forward face for cabin air to exit from the duct. Apply a 1 ply BID tape over the NB flange, spacer, and lap 1 inch on the floor. Carve a wedge-shaped piece of foam to fit between NB and the instrument panel to close off the aft end of NB and divert air from the heat duct to both sides. Cover it with 1 ply of BID and install it with flox, and lap the glass onto NB (Fig. 42). In a similar fashion, put a solid block above the wedge-shaped block between NB and the instrument panel. Now cut a 1/2 in. x 1-1/2 in slot in each side of NB, near the top, and cement in a piece of plexiglas (canopy scrap) with silicone which will allow pilot and passenger each to see the position of the nose gear (Fig. 42).

Now, mount the aft nose gear door, using three AN525-10R10 screws (tap holes into the NG16 casting). Note that the nose wheel well is not completely covered by doors. The drag of the open hole can be reduced by rounding the aft edge of the hole. This is done by installing a rounded foam block to the sharp edge as shown (Fig. 41). At the same time, trim out the wheel well and cover any bare foam with 1 ply BID. The rounded aft corner assures that any air flow through the wheel well comes out smooth and attached, rather than turbulent. With the aft edge rounded, the open hole causes less than 1/2 mph drag.

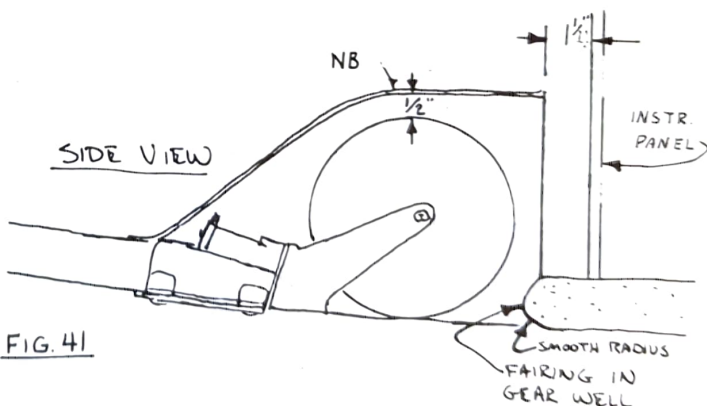


FIG. 41

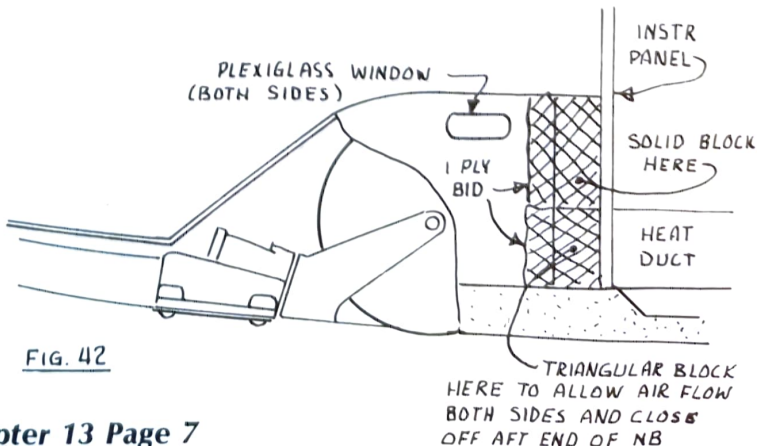


FIG. 42

Rigging the nose gear. Refer to page 13-10 for hardware used on the retraction mechanism. Install the universal, NG61 torque tube and crank on the instrument panel. Crank the mechanism to the fully retracted position. This is when the NG50 arms strike the upper NG14 spacer. Drill the No. 12 hole in the universal and NG61 for the AN3-6A bolt, with the crank in the best position to not block an instrument or hit the pilot's leg. Hold the nose gear in the retracted position. Then adjust one or both of the rod ends on the spring strut to fit between NG3 and NG50. Then shorten the spring strut by one turn of a rod end. This provides a good snub of the gear in the up position. Extend the gear and check for the correct down position (see page 13-1); i.e., lower pivot vertical or canted bottom-forward up to 5 degrees.

To install a gear-up warning, mount the micro switch so it is activated by NG50 or NG9 in its last 1/10 inch motion to the down stop. See Chapter 22 for electrical wiring, and switch mounting.

The gear is **not** designed to raise or lower the gear on the ground with weight on the nose. Refer to Owners Manual for normal operation of the gear.

STEP 7. PIPING THE PITOT AND STATIC SYSTEM

If this step takes you more than an hour, you must have bought the project from someone else!

Round up your soft aluminum (5052-0) 1/4 in. dia. tubing and cut one piece 6 in. long and one piece 38 in. long. Refer to the full size drawing A-6. Drill a 1/4 in. hole through NG31 bulkhead along the left inside wall (to keep the line away from the battery). Route the 38 in. tubing through the hole in the nose center, through NG31 aft, along the fuselage side, through F22 about 8 inches under the canard (Fig. 43). If you really want to get fancy, you can use AN tubing fittings and bury an AN910-1D fitting in the nose so you can use an AN840-4D hose nipple for a pitot (which makes it removable!).

Stack some oversize blocks of urethane in the nose and bond to NG31 and the nose templates with 5-min. or micro. Keep the epoxy below the final contour to make carving easier. Save the carving till a little later. Put a plug in the pitot tube to protect it from contamination. If you are doing it the fancy way, remove the hose nipple (it has a way of jabbing you in the wrong place anyway) and insert a 1/8 in. pipe plug.

The static port is located in the left fuselage side, 8 in. forward of the instrument panel and 10 in. below the top of the top longerons (W.L.13). Mark that position on the inside of the fuselage side panel. Now, refer to Fig. 44 for installation of the static line.

After installing the airspeed indicator and altimeter, hook up the pitot/static system using the hardware shown (Fig. 45). Add one adapter and one tee to the static line if using a rate-of-climb indicator.

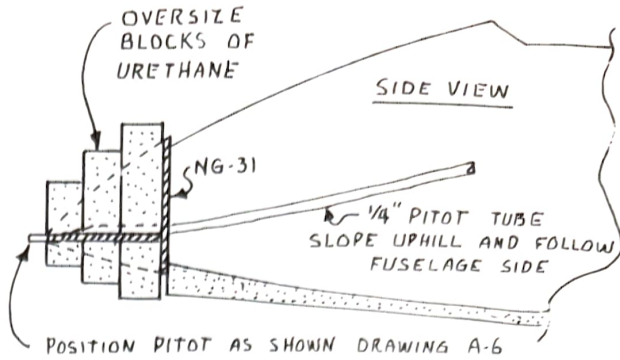


FIG. 43

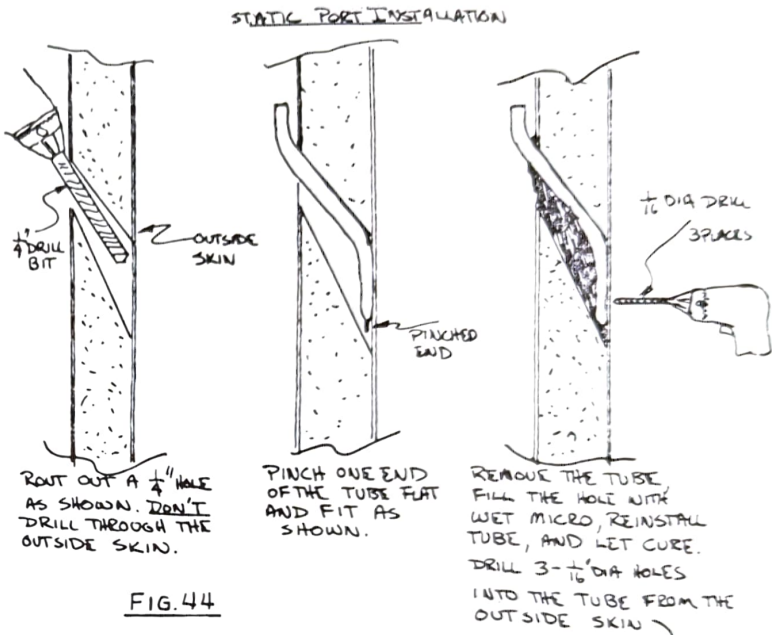


FIG. 44

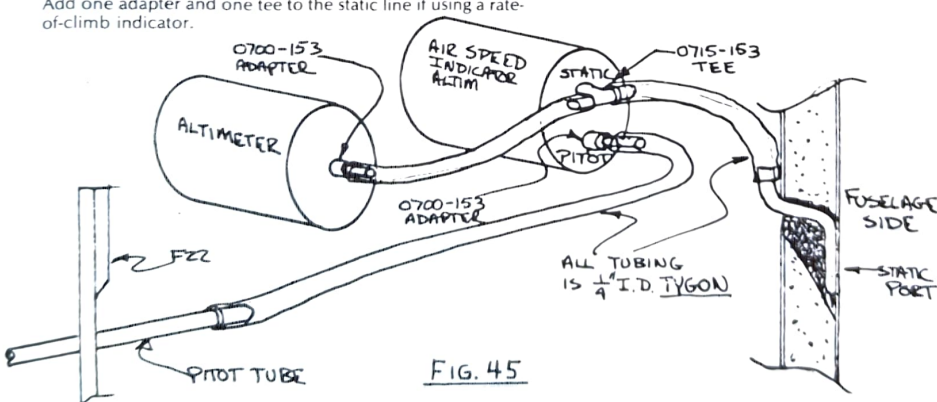


FIG. 45

STEP 8. TOP FOAM BLOCK

Refer to drawings A-6 and A-7. Cut the top block from 2 in. thick green urethane foam (Fig. 46). This is temporarily installed now. Make sure that the tops of the sides are squared off from side to side so the top makes good contact all around. Weight it in place and bond to the side pieces and NG31 with a few dabs of 5 min. epoxy.

STEP 9. CARVING AND GLASSING THE OUTSIDE OF THE NOSE

Due to the excellent carvability of urethane foam, your boxy/ugly nose section will look sleek and smooth and have a tough fiberglass skin in only about five hours work. You will need some help in turning the fuselage. Retract the gear for this step. The best tools for carving are the butcher knife (sharp), the surfboard file, the long sanding block and chunks of urethane, in that order.

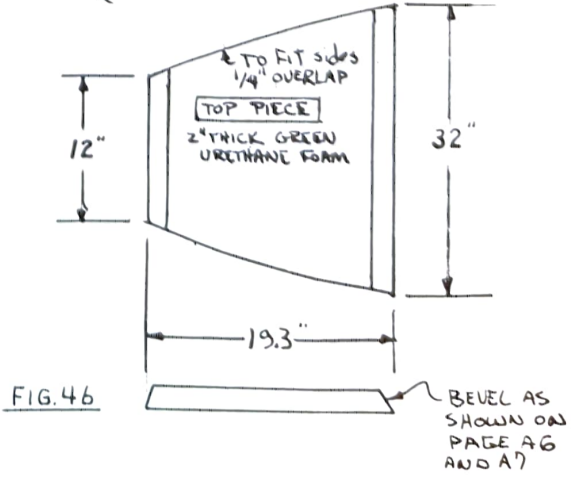


FIG. 46

The nose gear strut can be used as a reference in determining the bottom curvature, and it is suggested that you start carving there first. You have made templates for the side curvature. Although you could eyeball the top curvature, the top is the most critical from a beauty standpoint, so it is suggested that you make a template for the top curvature from drawings A-6 and A-7. Reference the top of F22 and NG31 on your template (Fig.47).

Fair the bottom and sides in tangent to the glassed fuselage and the SC cover. Carve down to the NG31 bulkhead all around. This is a good reference for symmetry. Turn the fuselage upside down when carving the bottom. Believe it or not, you will find that it is Varieze to carve it to a pleasing shape using templates and eyeball. **Note:** The radius on the bottom corners of the fuselage decreases toward the nose, whereas on the top it should remain constant. **Note also:** You will later be adding 1 ply of BID tape across the top of NG31 and over the seam between the top and side blocks (Step 10), so make sure you don't have high spots in those areas.

Fit a few small urethane blocks around the gaps at the front of the nose strut and bond with 5 min. (Drawing A-6). Now, glass the nose with two plies of **BID** lapping about 1 in. onto SC, the fuselage sides, and bottom. This glassing job is easy if you use several small pieces and overlap them. Turn the fuselage upside down or on its side as needed during the glassing operation. Fiber orientation is optional. Be careful not to have all of your overlaps at the same place, causing an unsightly bump and problems in finishing.

Knife trim around the canard cutout in the top. This leaves bare foam around the edges of the cutout. Glass these areas with 3 plies of **BID** using 1/4 in. flox corners. Refer to Fig. 48 and to the full size side view on drawing A-6 for details on the nose bumper. The bumper is made by cutting a hockey puck in half and fairing the trailing edge. Sell the other half to another builder, or save it for your first wheels up landing.

Secure the bumper to the fuselage with a flange of 4 plies of **BID** at 45 degree fiber orientation (Fig.48).

STEP 10. NOSE DOOR

In this step you will install the large battery access door in the nose top. This door also allows canard removal and landing gear inspection. Lay out the door outline on the top with a felt-tipped pen as shown (Fig.49). Tape a piece of Saran wrap over this area for a release and then lay up 4 plies of **BID** lapping over the door marks. This is your door. When cured, remove it and trim it to size. Now, measure in 0.7 in. all around the door outline, and cut this hole in the top of the nose (**make sure you follow the inner mark**). Now, using a razor saw, cut off the entire top nose piece (yes, the block you temporarily installed in Step 8). Turn the piece upside down and mark where it touches the NG30 top edges and the top of F6. Referring to Fig. 50, remove foam to make a bare-glass 0.7 in. flange around the door cutout and a smooth taper of the foam with rounded edges. Now, lay up 1 ply **BID** over the entire inside of the block and 2 more plies locally on the flanges to stiffen them. **While it is still wet**, stack flox on the sides, NG30, F6, and NG31, then weight or tape the top block back into place (Fig.51). Reach in from the canard cutout and wipe off excess flox.

After cure, lay up a 1 in. strip of 1 ply **BID** over the edges where the top block was cut from NG31 and the sides (Fig.51). Install ten equally-spaced screws (with nutplates inside) along the door edges. Use AN609-8R8 screws (flush No. 8) and K1000-08 nutplates (Fig.49).

For torsional rigidity, add a brace between the top of F22 and the top of the fuselage, with cut outs for the canard lift tabs (Fig.52). Take the dimensions from your airplane. Taper the forward edges so it fits flush under the nose top (refer to drawing A-7 for the angle). Carve this piece from 3/8 in. thick Divinycel PVC. Trial fit and prepare for its installation, flush with the top of F22, with a few judiciously placed nail holes. Glass the underside with 1 ply of **BID** and allow to tack cure (so the glass won't fall off). While still tacky, install with flox, and put in nails to hold it in place (you can also intersperse the flox with a few dabs of 5 min. applied just before installation. Tape the underside joints with 1 ply **BID** tape. You can use wax paper for these and leave it on till after cure. Then glass the topside with 1 ply **BID** lapping onto all surrounding areas.

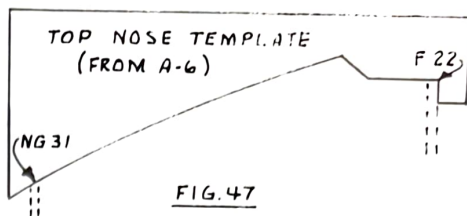


FIG. 47

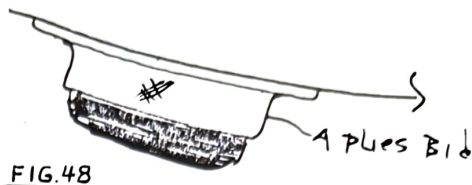
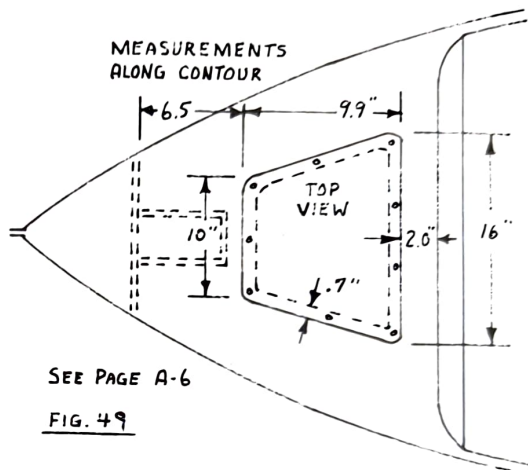


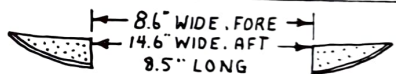
FIG. 48



SEE PAGE A-6

FIG. 49

TOP PIECE REMOVED, UPSIDE DOWN



SEE ALSO A-6 & A-7

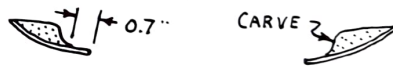


FIG. 50

CUTOUT FOR CANARD LIFT TABS

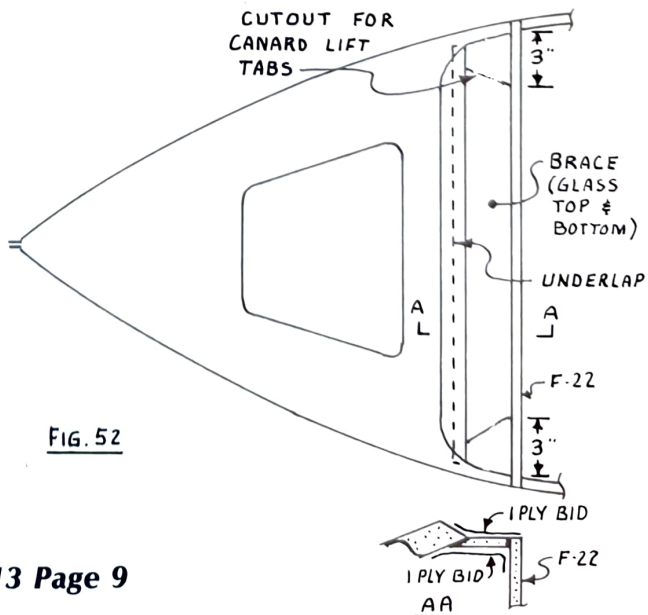


FIG. 52

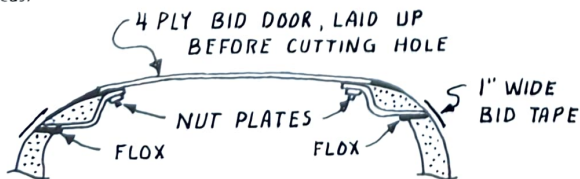
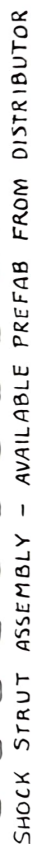
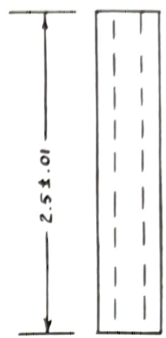
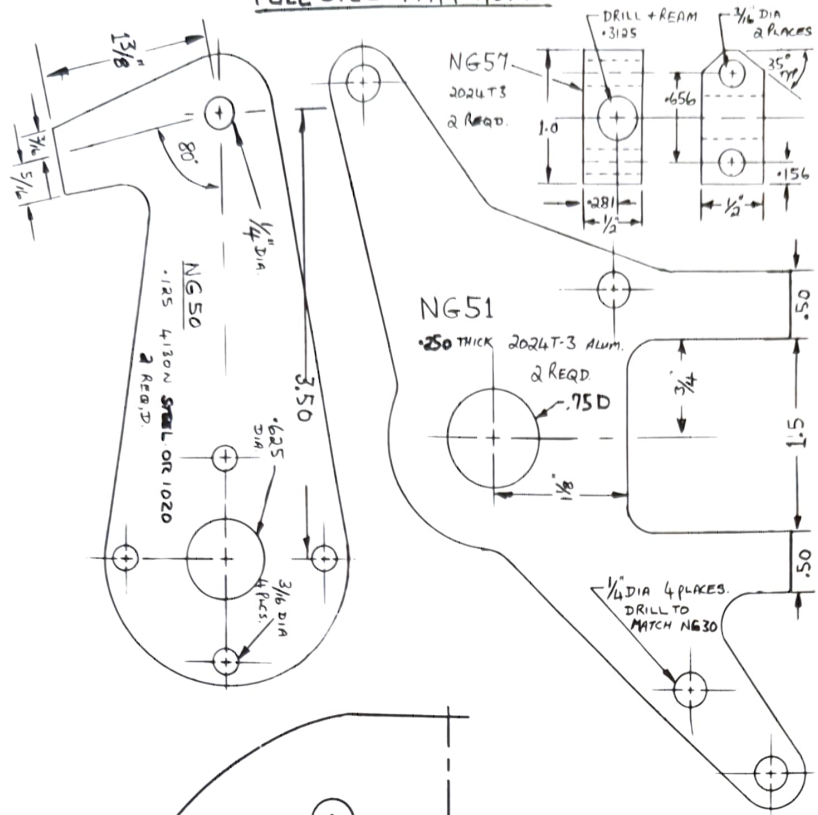


FIG. 51



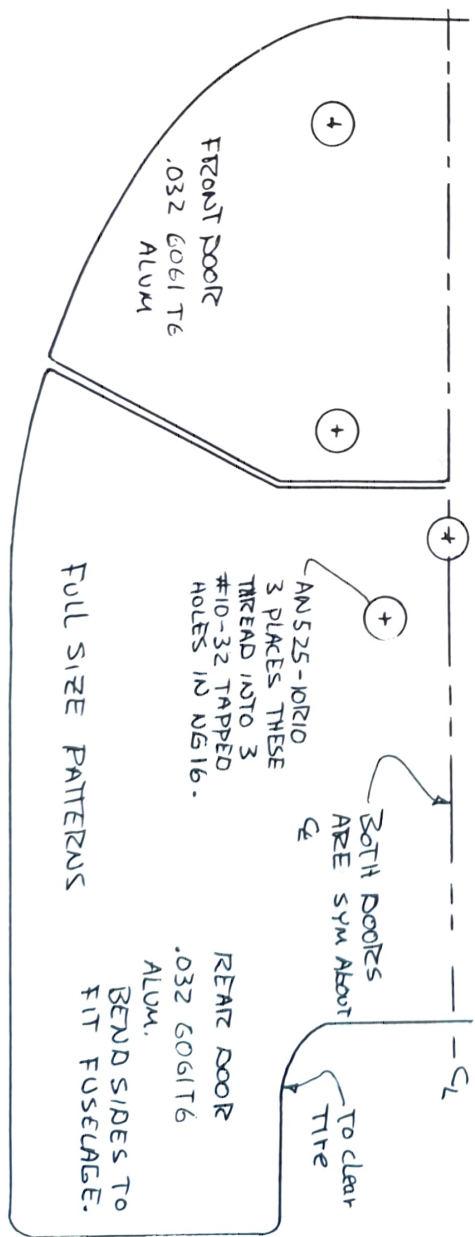
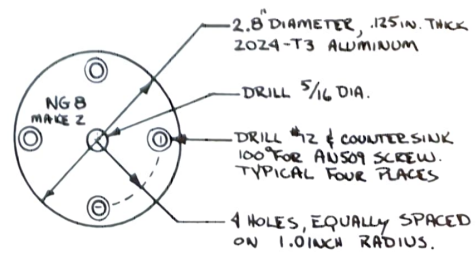
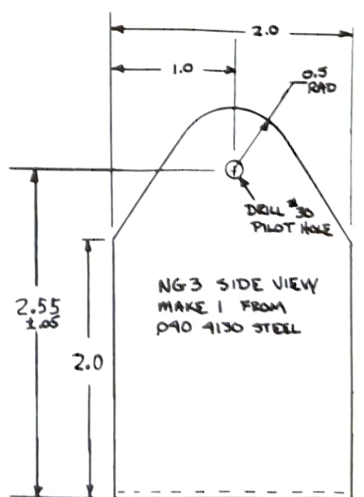
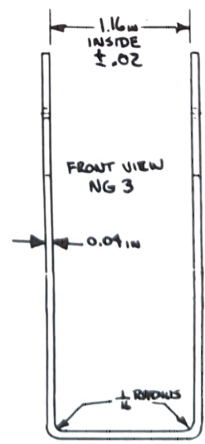
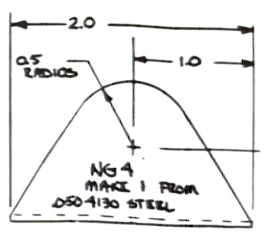
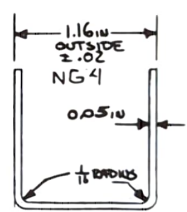
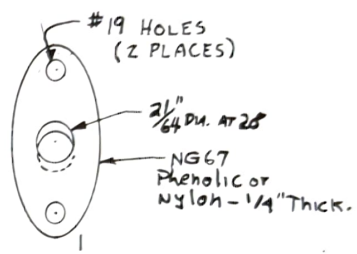
1	NG61	3/8" O.D. x .035 wall x 20 long, 2024T3
2	NG62	1/2" O.D. x 1/2" I.D. x .250 long 2024T3 alum SPACER.
1	NG63	.375 O.D. x 5/16" I.D. x 1/2" long 4130N steel sleeve
1	NG64	.062 4130N steel crank
1	NG65	5/16" O.D. x .035 wall x 2-1/8" long 4130N tube
1	NG66	Macrome wood bead handle
1	NG67	Phenolic block 1/2" x 1" x 1 1/2"
1	NG68	1/2" O.D. x .028 wall x 3/4" long 4130N steel tube

FULL SIZE PATTERNS

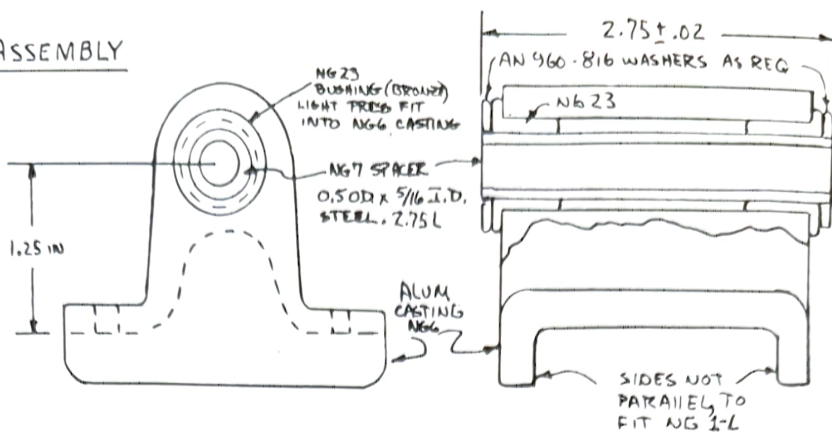


OD 0.5 ± .05
ID 0.25 ± .05

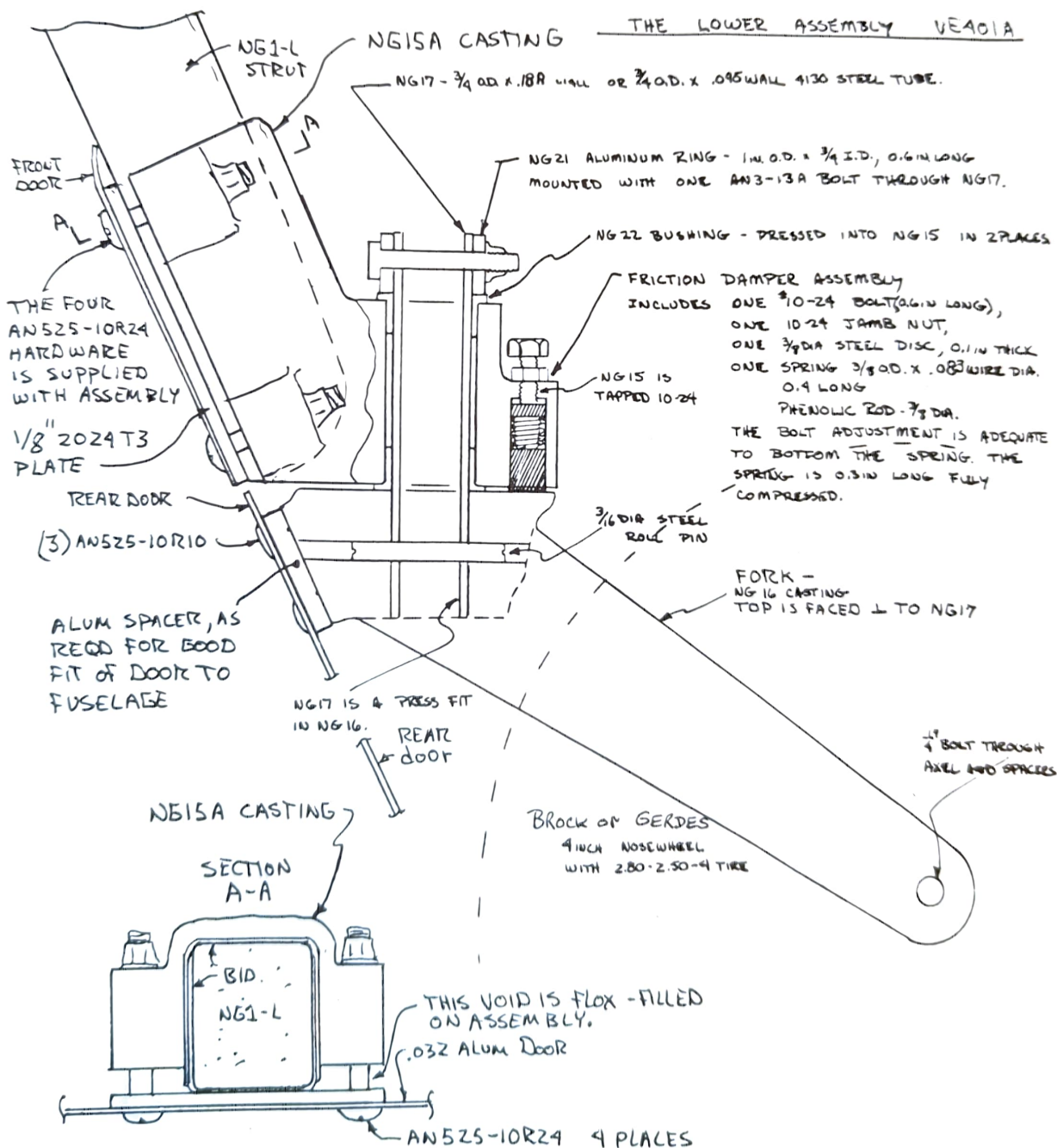
ENDS MUST BE FACED PERPENDICULAR



NG 6 ASSEMBLY



THE LOWER ASSEMBLY VIEW



CHAPTER 14

CENTERSECTION SPAR

NOTE:

SIG BORE THE CENTERSPAR TO WINGS BEFORE INSTALLATION TO FUSELAGE.

OVERVIEW. In this chapter you will build the center box spar which joins the wings to the fuselage. You first build an accurate jig from particle-board, then you assemble a box from 1/4 in. PVC foam and 1 in. urethane foam slab. It is glassed on the inside, and bulkheads are installed. The center section box is removed from the jig, the outside is contoured and carved to accept the spar caps, metal inserts are installed at wing attach points, a bi-directional glass shearweb is layed up, the uni-directional spar caps are layed up, then the external bi-directional shear web is layed up. Additional metal and glass is installed at the wing attach areas, and an oval-shaped panel is removed for access to the baggage area inside.

The center-section spar is the heart of your wing structure and in order to have a straight and true wing, follow all steps carefully and have patience. Before going on to Step 1, study page 14-5 very closely until you really have a good understanding of what the centersection spar looks like. Note that the top of the spar is flat; that it sweeps aft and that the bottom has positive dihedral in order that fuel will run inboard. If in doubt about exactly how things fit together, study the fullsize section drawings (Section A-A, B-B, C-C, D-D, and E-E).

STEP 1. CENTER SECTION JIG

In this step you will make the particle-board jig in which you will assemble your centersection spar (See page 14-6). Accuracy here is very important so don't rush! Particle-board is available at your local lumber yard. Bondo is handy to bond the pieces together, since it provides adequate strength and 5 minute cure. You will cut a strip of 3/4 in. thick particle-board 12-1/2 in. wide. This needs to be 112.92 in. long. You can join it in the center or anywhere you like. Now carefully and as accurately as you can, layout the top view outline of the spar on this 12-1/2 in. x 112.92 in. strip of particle-board (part D) as shown on page 14-6. To do this, determine the centerline, layout the 56.46 in. and 23 in. dimensions, measure down the 5.04 in. dimension, mark a point and draw the diagonal. Then layout the 90 degree angle to the diagonal and measure the 6.05 in. to the shelf line full span. Cut the diagonal top edge down to the shape shown. Now draw a straight line on the top of your work bench at least 112.92 in. long and stand part 'D' up at 90 degrees to your table top and carefully aligned along the straight line. Bondo it firmly to the table top. If it warps, support it straight with more lumber. Cut out parts A, B, and C, together with parts E, F, and G. Bondo parts E, F, and G into position against part D, such that when you bondo the shelf parts A, B, and C, to the upright part D, they fit exactly on the shelf line. Carefully check that the angle between shelf and upright is 90 degrees. **Caution!** The spar is mounted aft face down in jig, but all statements like 'top', 'forward', etc., relate to how it is mounted in your completed aircraft.

STEP 2. ASSEMBLY OF FOAM PARTS

Cut out all foam parts for the center section spar, page 14-7. Micro joints are ok if your pieces are too small. Carve or sand the local clearance depressions in the urethane pieces at the outboard wing attach points as shown (Fig.1). Lay the 6mm PVC foam aft face (part CS1) down on shelf 'ABC' (Fig.2). Use grey tape or Saran wrap on the jig for a release where applicable to keep the spar from bonding to the jig. Glue the three pieces together with micro (butt joints). Note that the 6 in. wide urethane parts are too wide. Set them up against the jig as shown (Fig.2) on top of CS1 and sand to flush with the jig; do this for all six urethane pieces. This assures correct spar width. Now micro the urethane foam (spar top, part CS2) to part CS1 against the jig upright (part D). Hold in place with grey tape (Fig.3). Part CS2 will also have two microed butt joints. Next, micro urethane foam (spar bottom, part CS3) into position along the edge of part CS1 (Fig.3). Hold it in position with a few nails, and bondo several 1 in. x 1 in. pine sticks to the fixture and up the face of part CS3 as shown. Use as many pine sticks and nails as it takes to hold CS3 aligned on the edge of CS1. The urethane will easily bend at the small angle change at B.L.9. Fit and bond with micro the end bulkheads CS5 & CS8 (Fig.4). They must fit flush with your jig all around and stick up 1/4 in. above the edge of the jig top. Nail to urethane pieces.

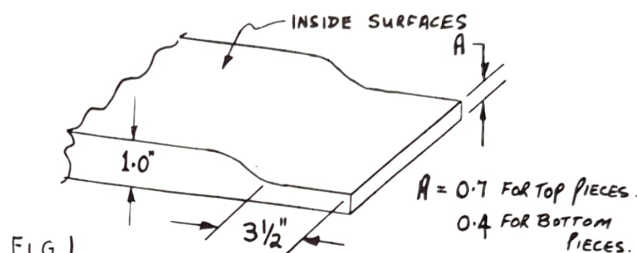
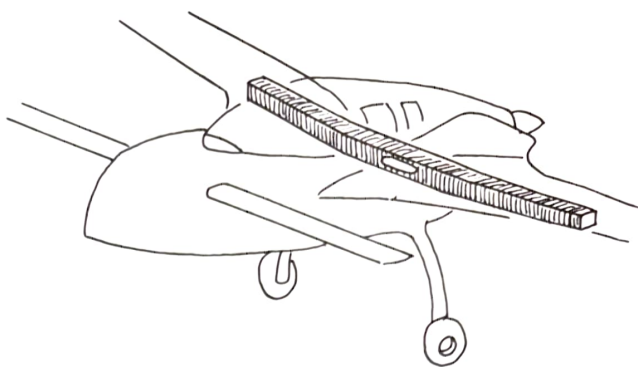


FIG. 1

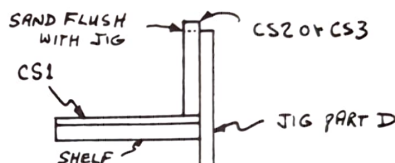


FIG. 2

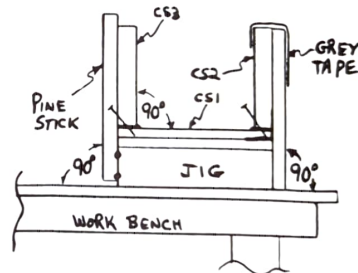


FIG. 3

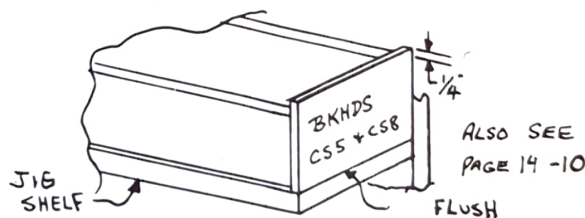


FIG. 4

STEP 3. FORWARD FACE

Lay the three pieces of 6 mm PVC foam that make up part CS4 (spar forward face), down on your table with the spar inside face up. Lay up one ply of BID at 45 degrees to the longest edge on each piece (layup 1). Peel ply 1 in. along all edges and allow to cure. Knife trim at the appropriate time.

STEP 4. INTERIOR LAYUPS

Fabricate all **LWA** metal pieces. Remove any grease or dirt and sand dull with 100-grit. They must be clean and dull on installation. Pull all nails out of the spar box interior. Fit (don't bond) interior bulkheads **CS6** & **CS7**, trim if necessary to allow for 1 ply of **BID** (Fig.5). They fit flush with edges of top and bottom pieces. The remaining layups of this entire step should be done in one layup without curing in between. Prepare all the foam surfaces inside the spar box with slurry and apply layup 2, which is **one ply of BID** at 45 degree orientation to all three faces, including the end bulkheads. Overlap where needed. Bulkheads **CS6** & **CS7** are now installed, using wet micro (Fig.5). These are perpendicular to aft face, 27 in. from center line. Nails through the urethane blocks will hold them. Be careful not to disturb the ply of **BID** already in place. Now, apply the local reinforcements (layup 3) at the inboard wing attach hard point areas (Fig.5, see also section B-B and H-H). The **first ply of BID** is laid up over the interior bulkheads (both sides) and lapped onto the top, bottom and aft faces of the spar box 1 in. except where the attach points will be, where it laps 5 in. Now lay up **three plies of UND** 4 in. wide over the inboard wing attach hard point areas as shown (lapping onto top and aft face). The first is 10 in. long, second 8 in., third 6 in., fibers run along long dimension. Flox two **LWA1** aluminum plates into position centered over the attach points B.L.25 (25 in. from center), transition the metal edges with floc and lay up **1 ply of BID** lapping over **LWA1**'s approximately 1 in. all around (Fig.5). Place Saran wrap over the metal **LWA-1** and weight in position with about 5 lb. weight. This removes excess epoxy and makes a strong reinforcement. To keep the plates from sliding, use two 3/8 in. brads along the edge. Now, while layup 2 is still tacky, apply the following reinforcements (layup 4) in the outboard wing attach hard point area. Refer to section C-C, E-E, F-F, and G-G, and Fig.6. As in the inboard reinforcement (layup 3) lay up the **1-ply BID** over the bulkhead lapping 5 in. inboard, then **3 UND** plies 4 in. wide as shown, then the metal **LWA-1** plates, then a final **BID** over the metal parts that laps onto the bulkhead. Weight in place for cure, about 5 lb. on each piece. The **UND** pieces are 4 in. wide and 15, 13 and 11 in. long with fibers oriented along long dimension. Layup 4 is now complete. **Note:** Be sure the radius on the **LWA-2** is in the corner as shown on the section views.

STEP 5. INSTALL FORWARD FACE

Now bond the three forward face pieces in place with wet micro to complete the box. Butt together. It is not required to lap glass across this internal joint. After a complete cure (2-3 days), remove your spar from the jig and place it forward face down on your work table. Layout the points shown (Fig.7) as dimensioned on the aft face (.50, .40, .55, .16 and .39 in.) and connect with straight lines. Using a razor saw or rigid sharp knife, cut along the lines through the aft face (**CS1**) and into the urethane (Fig.8). Break off the sliver of foam and discard. Refer to sections A-A, B-B, C-C, D-D to familiarize yourself with the size and shape of the spar cap troughs.

Cutout and mount on template board, the eight spar cap trough templates shown on page A-17. Using these and a 36-grit hard-block sanding block, carve the top and bottom troughs and contour the topside to size. These troughs must be straight and at the correct depth. Note that the three inch wide troughs follow the aft face and make a turn at B.L.23. Note that the top of the spar box is flat out to B.L.25, and tapers down to the aft, starting at B.L.25. The bottom is flat from fore to aft full span.

Using a saw, file and or hard block, cut the 1/2 in. x 1 in. angle on both top and bottom edges full span along the forward face (see section views A-A, B-B, C-C, and D-D).

STEP 6. OUTSIDE HARD POINTS

See Fig. 9 and section views to locate positions for the 1/4 in. thick aluminum blocks. Use your dremel to remove the **CS1** foam from the aft face to enable you to insert the 1/4 in. thick aluminum blocks (**LWA4**, four pieces and **LWA5**, two pieces). Thoroughly sand the aluminum blocks and floc them into the appropriate places so that they are flush with the aft foam face (**CS1**) with the radius on the outside corner. Allow to cure, then radius the foam corners with a hard sanding block. Now use duct tape and newspaper to protect the foam which will not be covered by the shear web (Fig.10). Lay up a **two ply UND** shear web at 45 degrees fiber orientation, alternate directions (layup 5). This shear web goes under both top and bottom spar caps, and across the aft face of the spar, full span. Be sure orientation is 45 degrees! Butt **UND** joints. **Do not overlap.** Peel ply this entire shear web layup.

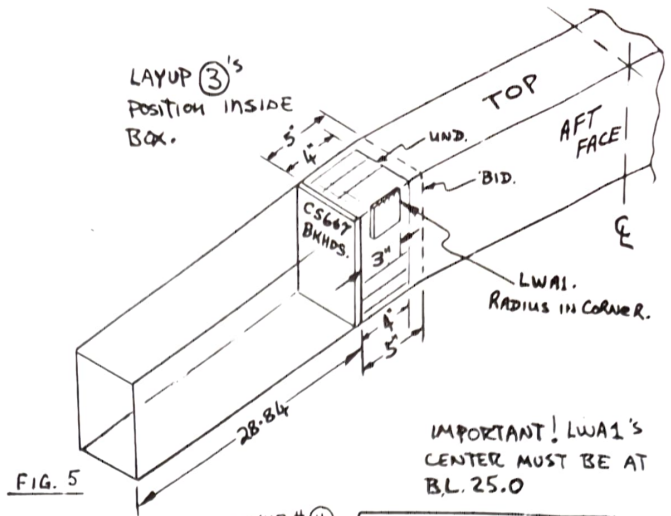


FIG. 5

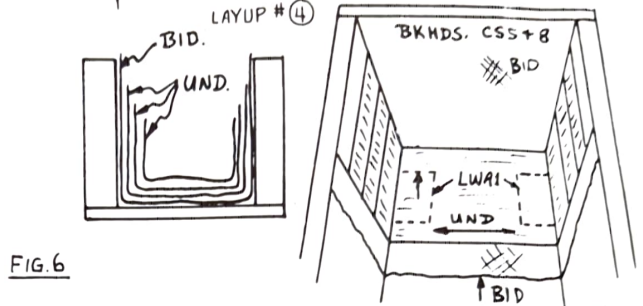


FIG. 6

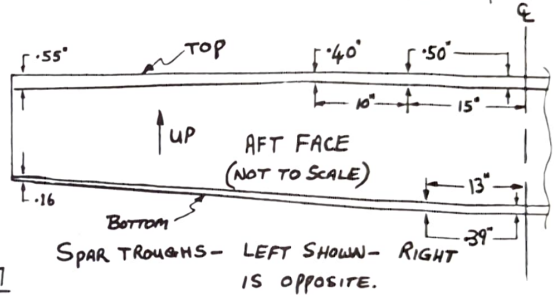


FIG. 7

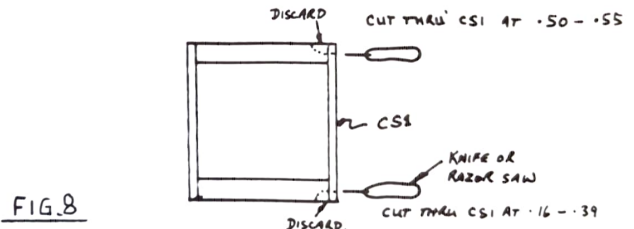


FIG. 8

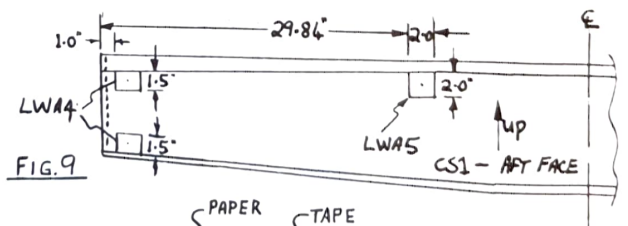


FIG. 9

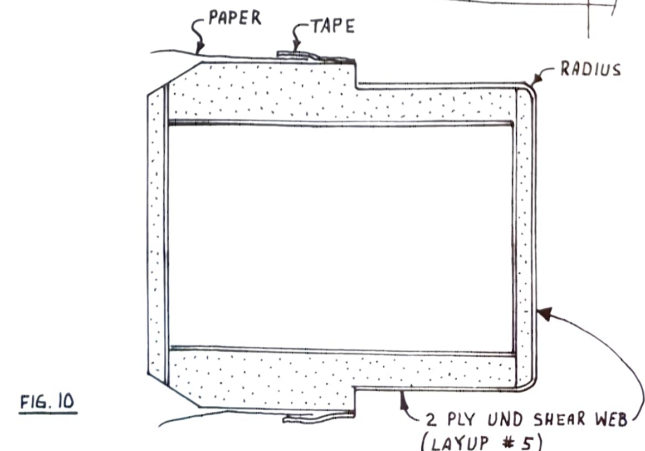


FIG. 10

STEP 7. LAYING UP THE SPAR CAPS

These are cut from a roll of uni-directional glass that is 3 in. wide and either .025 or .035 in. thick. You will need to determine which you have. To do this, make a trough 3 in. wide and 12 in. long from scrap foam and line it with duct tape. Now make a 5 ply layup in this trough, and after cure, measure the thickness. If you have .025 in. thick material (the most common), then your layup will measure slightly over 1/8 in. thick. If you have .035 in. thick material, your layup will measure just over 3/16 in. thick. The layup schedules which follow assume .025 in. thick material. If you have .035 in. thick material, omit the layers marked (*). **Do not use UND cloth!**

Top Cap		Bottom Cap	
Number Strips	Length	Number Strips	Length
4	113	3	113
1*	113	1*	113
1	100	1	96
1*	94	1*	90
1	90	1	82
1	80	1	68
1*	74	1*	60
1	70	1	54
1	60	1	40
1*	54	1*	30
1	50	1	26
1	40		
1*	34		
1	30		
1	24		

Build a dam along the aft face of the center section spar as shown (Fig.11). Use a firing strip, or a 2 in. wide strip of 1/4 in. plywood. Grey tape will assure an easy release and glue the dam to the shear web with small dabs of bondo every 6-8 in. Now cut the uni-directional glass tape pieces as shown in the above table for the top and bottom spars. Remove the peel ply in the top spar 'trough' and layup the spar cap. There are 18 plies in the top cap (if you have the .025 material), the first five plies are full span (a little excess has been allowed), then they taper inboard 3 in. or 2 in. per ply per side, and the last ply is centered between B.L.12s. Mark the B.L.s on the urethane foam ahead of the trough to assist in positioning the layup. This is an easy layup. Keep fibers as straight as possible and squeegee from the center to the outboard on each ply. A hair dryer can be used to warm the layup of these thick spar caps. This speeds the wetting of the heavy strands of glass. Allow to cure, then round the trailing edge to approximately 3/16 in. radius with a hard 36-grit sanding block (see sectional views). Flip the spar box and lay up the bottom cap, which is similar, but with only 13 plies and with only the first 4 plies full span; each ply is centered so that the spar cap thickness tapers an equal amount on each side. Allow to cure and round the trailing edge. Measure the depth of the spar. If the layup is oversize, sand (maximum of .04 in.) to size. Sand smooth the 'steps' at the end of each 3 in. tape.

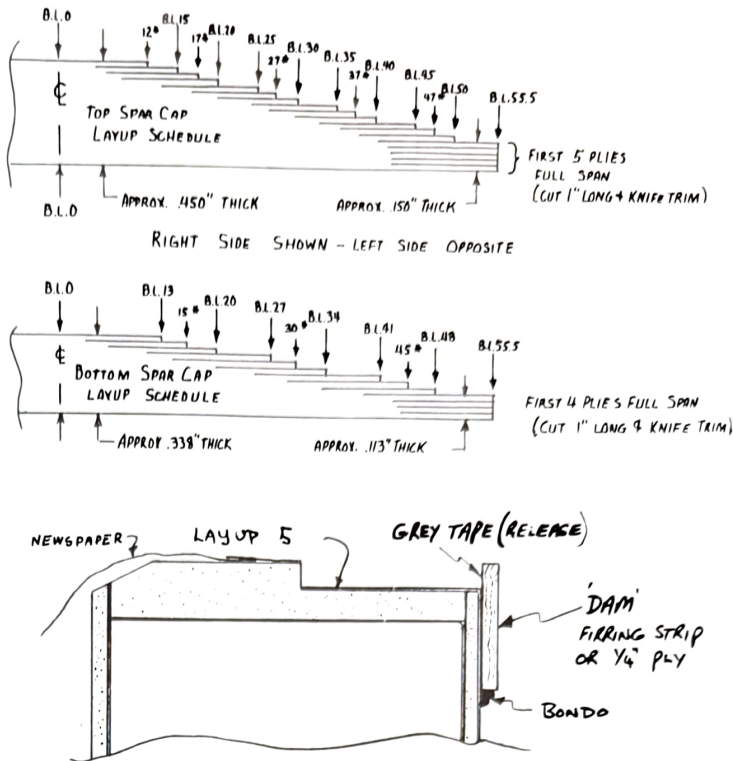


FIG. 11

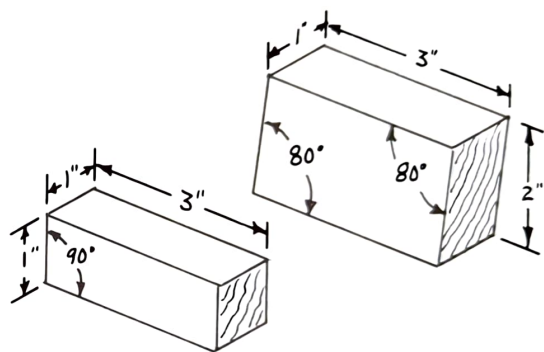


FIG. 12

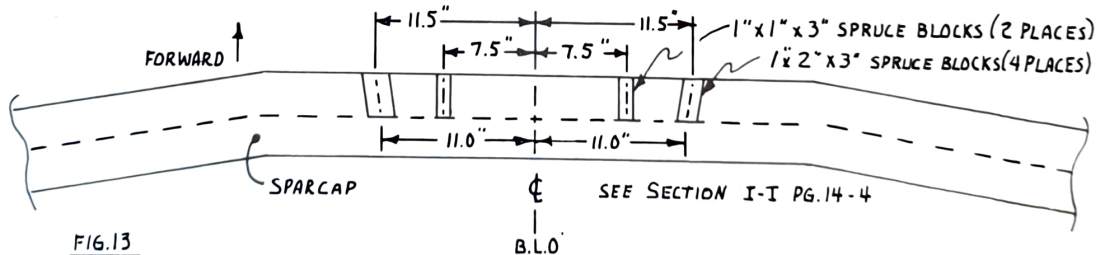


FIG. 13

STEP 8. MOUNTING BLOCKS

Cut two pieces of spruce 1 in. x 1 in. x 3 in. at a 90 degree angle (Fig. 12) and install these as shown (Fig. 13) by removing the urethane foam at B.L.7.5 left and right (top only). Now cut four pieces of 1 in. x 2 in. x 3 in. spruce at an 80 degree angle (Fig. 12) and install these as shown (Fig. 13) by removing the urethane foam at B.L.11 (center) to B.L.11.5 (forward) left and right, top and bottom. Micro the spruce blocks into the spar box flush with the foam. **Do not cut into the spar cap.** These blocks will later let you bolt the engine mount extrusions and also shoulder or luggage straps to the center spar. Now set the centersection spar box aft face up and make a 4 ply UND layup (at 45 degrees, alternating direction) from top leading edge to bottom leading edge around the three sides (Fig. 14). This is layup number 6 (see sections). Now flex LWA2 (two pieces) and LWA3 (two pieces) into position and weight these parts down until cured. These **must** be located **directly over** the other metal parts. See sections B-B, C-C, G-G and H-H. Peel ply the entire layup.

FIG. 14

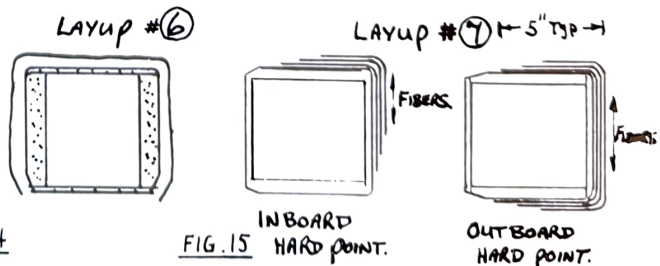


FIG. 15

STEP 9. HARDPOINT REINFORCEMENT

File the corners of the aluminum parts LWA2 and LWA3 to a 1/8 in. radius and lay up (layup 7) three plies of UND 3 in. wide centered over LWA2 and LWA3 as shown (Fig. 15), lapping onto the top and bottom at the outboard hard point, and onto the top at the inboard. Now add one ply of BID 5 in. wide at 45 degree orientation, centered over the UND strips, only on the aft face. **Do not** lap BID onto the top or bottom of spar box. Peel ply edges for a good transition. Allow to cure.

STEP 10. ACCESS PANEL

Layout and cut out a baggage access panel in the forward face of the spar centered up vertically and laterally 5-in. high and 14-in. long (see page 14-5). Sand the foam edges down as shown in Section A-A, to allow a glass-to-glass edge. This is a baggage hole and allows installation of inboard wing attach bolts. Jig the spar box aft face down and layup 2 plies of **UND** at 45 degrees, alternating directions, full span, lapping 1 in. onto the top and bottom as shown (Fig. 16, layup 8). Safe-t-poxy is preferred because part of this layup will be exposed to fuel. These two plies are glass to glass all around baggage access hole (see section A-A).

STEP 11. END LAYUP

Using your dremel, make a small flox corner all around the two out-board bulkheads, CS5 and CS8, trowel in flox and make a 1-ply **BID** at 45 degree layup over each outboard bulkhead, see section E-E (Layup 9).

STEP 12. ACCESS FOR WING ATTACH

Cut a 2-1/4 in. diameter hole through the **bottom** (not the top) of the spar box at B.L.53.5 as shown (section C-C). This is your access for wing attach nuts. After cutting the hole, remove a small amount of foam around the edges of the hole and trowel in dry micro to protect the bare foam.

STEP 13. MOUNTING TO FUSELAGE

Note: Installation of the centerspar in the fuselage should be deferred until after Chapter 19, Wings and Ailerons. It is much easier and more precise to mate the centerspar to the wings (one at a time) while the wings are jugged level on your bench, than to mate the wings to the centerspar after it is installed in the fuselage. Proceed with this step after finishing Chapter 19.

Your spar is now complete and can be mounted in the fuselage. Remove the firewall (it should have been installed only temporarily all this time) and slide the spar in from the rear (with the sweep aft). Accurately mark its centerline and the centerline of the firewall, and replace the firewall. Make sure the centerspar is **absolutely centered**, and then check for skew by measuring from tip to fuselage nose (equal, both sides). Incidence is most important. The level boards you bondeoed to the centerspar at the end of Chapter 19 should be level with the longerons. This will insure that your wing incidence will be correct. Level across the longerons and the spar to check roll. Remove foam or wood as required and/or install wedges as needed. When satisfied with fit, slide the spar out, coat all surfaces with epoxy, trowel in flox and then slide it back into place. Lay up **two plies of 45 degree BID**, two inches wide all around the outside of the spar at the fuselage skin. You can now install the firewall permanently. Trowel all mating surfaces (firewall, centerspar, and longerons) with flox, and slide the firewall in place. Check that it is square with the fuselage centerline. Use a **1-ply BID** tape to glass the spar to the firewall on the inside, top and bottom. After cure, trim off the ends of the longerons flush with the firewall and cut holes through the firewall **outside** of the longerons, above and below the centerspar to just clear the engine mount extrusions (allowing for a 10 ply pad of **BID** underneath). Make four **EM12** engine mount extrusions (Fig. 17) from 1 in. x 1 in. 2024T3 aluminum angle. The dynafocal mount for the 0-235 Lycoming is a very rigid structure which will not adjust to the engine mount extrusions, should they be slightly out of line due to manufacturing tolerances. It is a wise precaution, therefore, to check the fit before epoxyming the extrusions in place permanently. To do this, cut 40 pieces of **BID** at 45 degrees about 2-1/2 in. x 7 in. and divide them up into 4 pads of 10 plies each. Place one pad under each engine mount extrusion, between the extrusion, centerspar and longeron, both sides, top and bottom, and extend each extrusion 1.6 in. through the firewall (Fig. 18). Now clamp the engine mount to the extrusions with a 0.1 in. clearance between the mount and the firewall. Check the fit of all the extrusions, adding extra layers of **BID** if necessary. When a good fit has been obtained, wet out the pads on the top, clean the extrusions and sand them dull with 220 grit, and weight the two top extrusions in place on the pads, extending 1.6 in. aft, and clamp the engine mount to them, and to the lower two as well for positioning. After cure, flip the fuselage over and repeat the same procedure for the lower two pads and extrusions. This should give you a perfect fit between the extrusions and engine mount. After cure, drill the four 1/4 in. holes per corner as shown (Fig. 19), 2 into the longerons and 2 into the spar (Fig. 19), and install the 16 bolts. **Note** that none of these holes go through the centerspar.

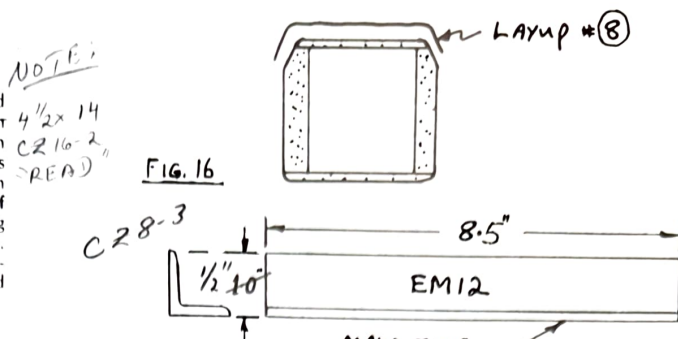


FIG. 16

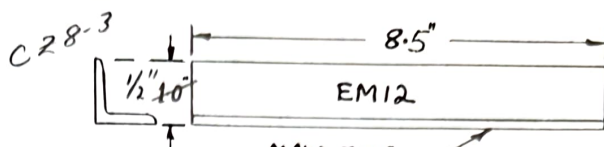


FIG. 17

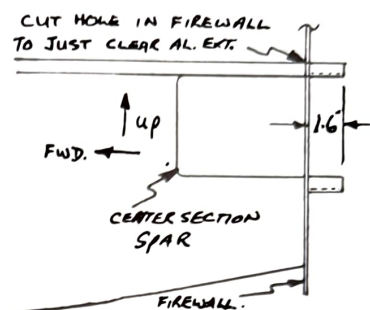


FIG. 18

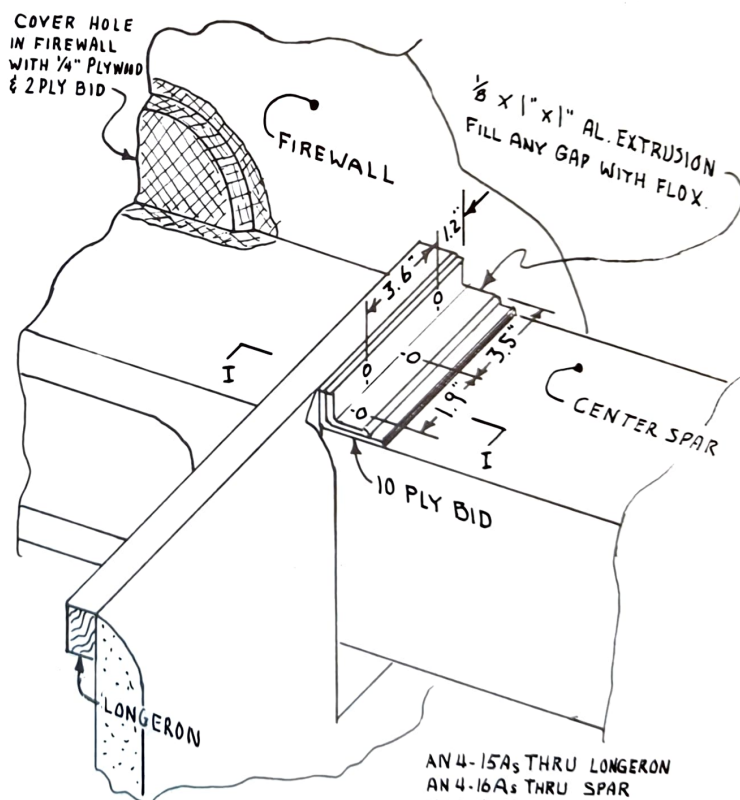
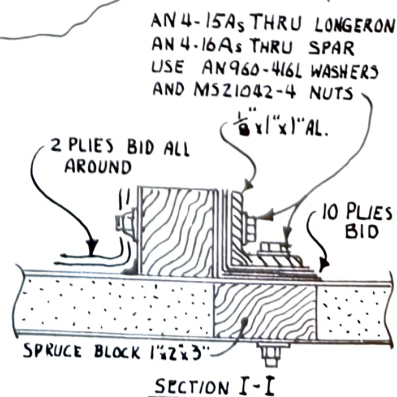
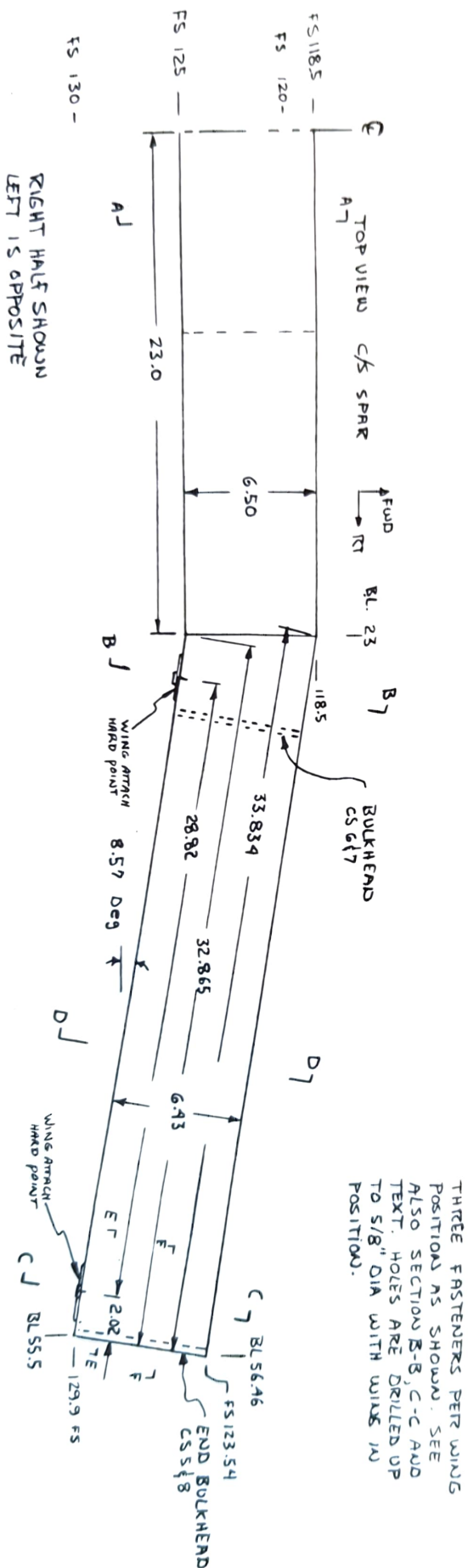
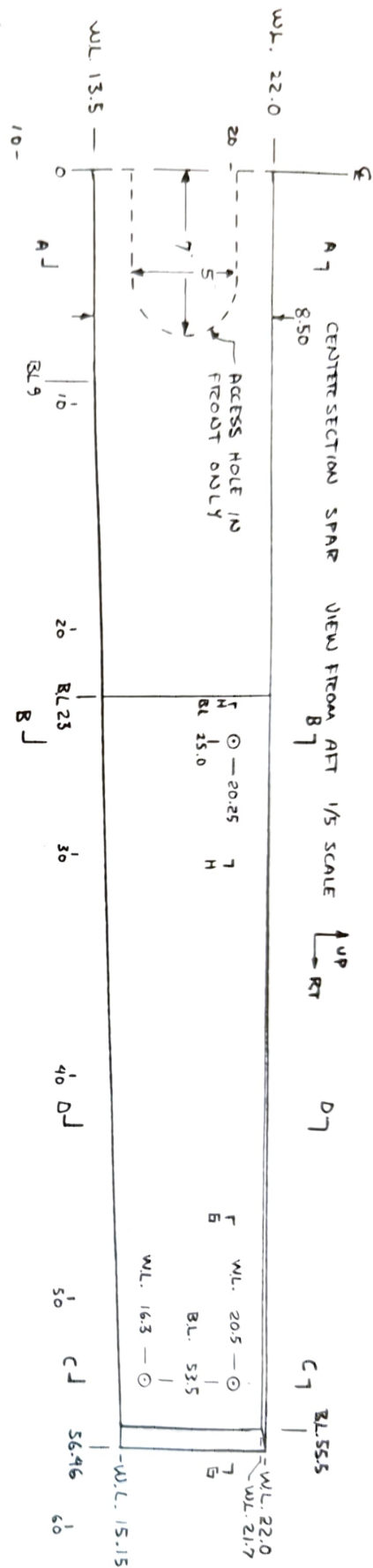
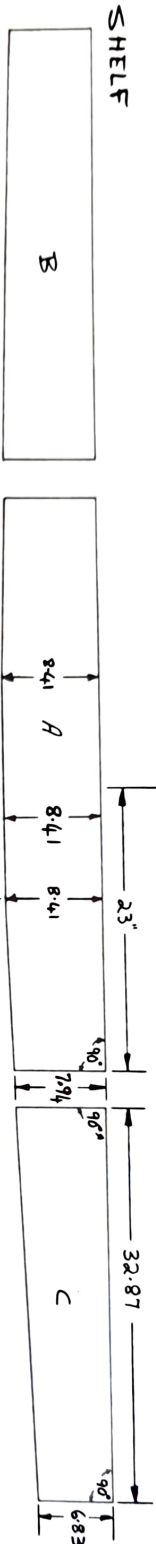


FIG. 19



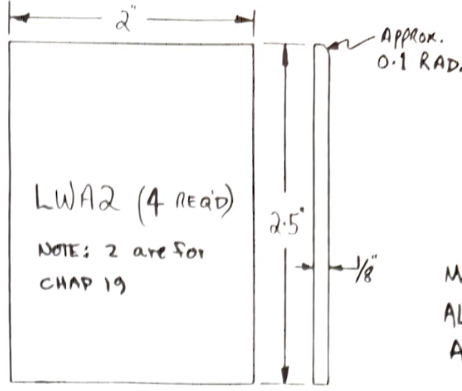
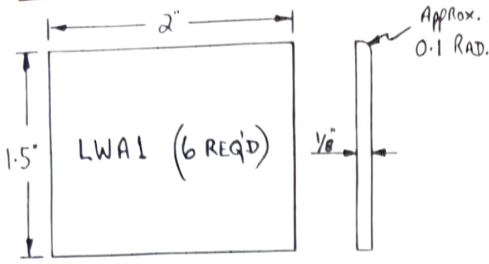
SECTION I-I



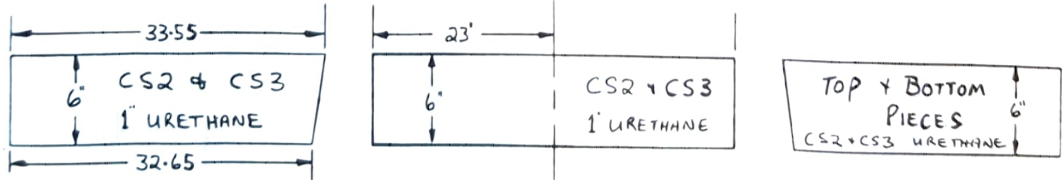
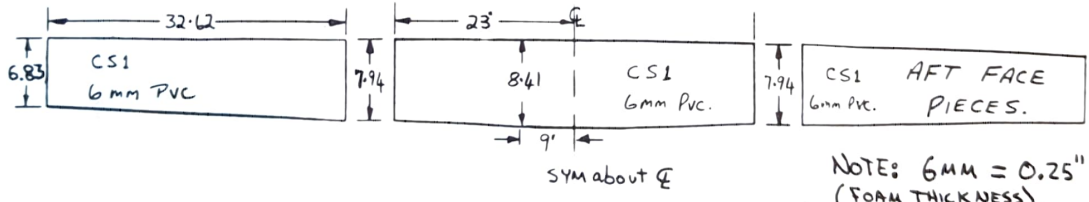
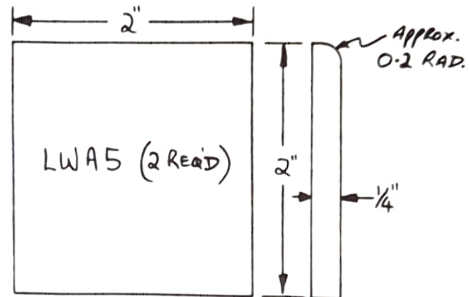
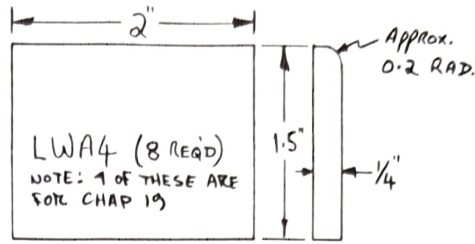
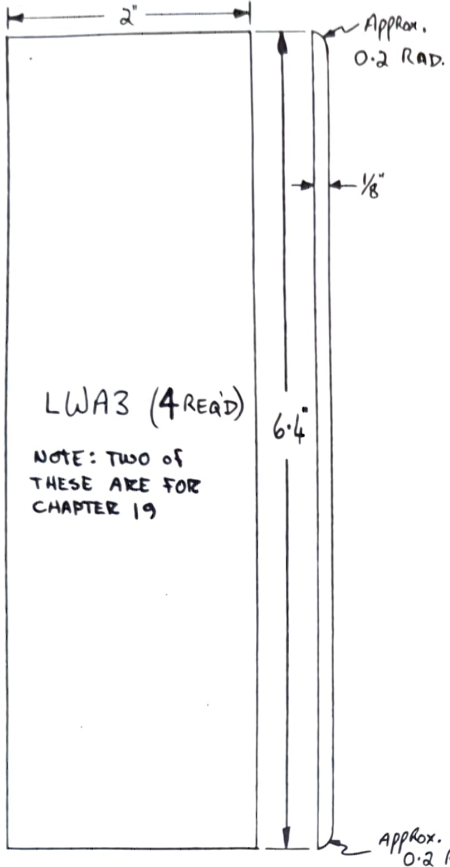


THIS BOARD MAY BE READ
IF D IS WARPED

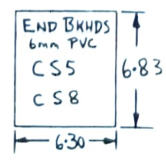
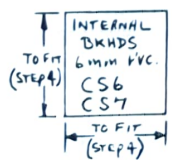
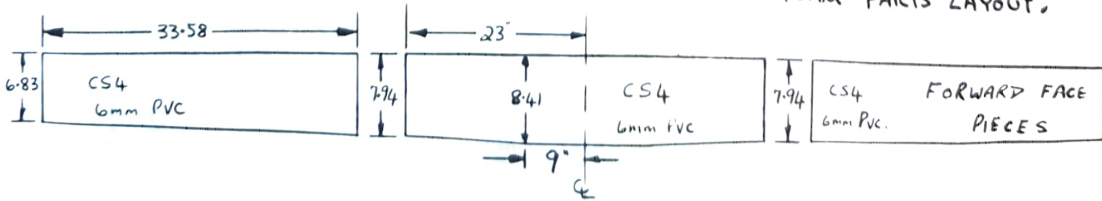




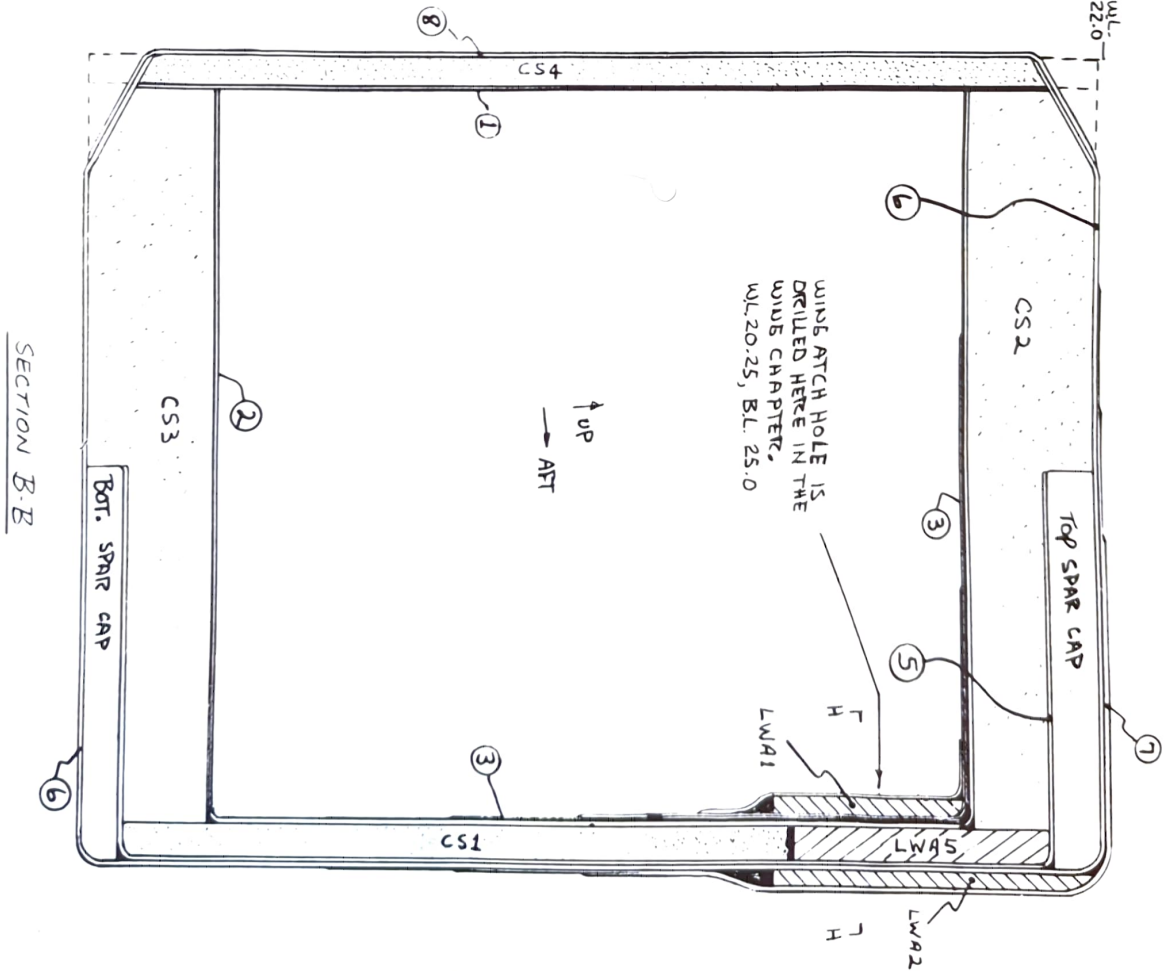
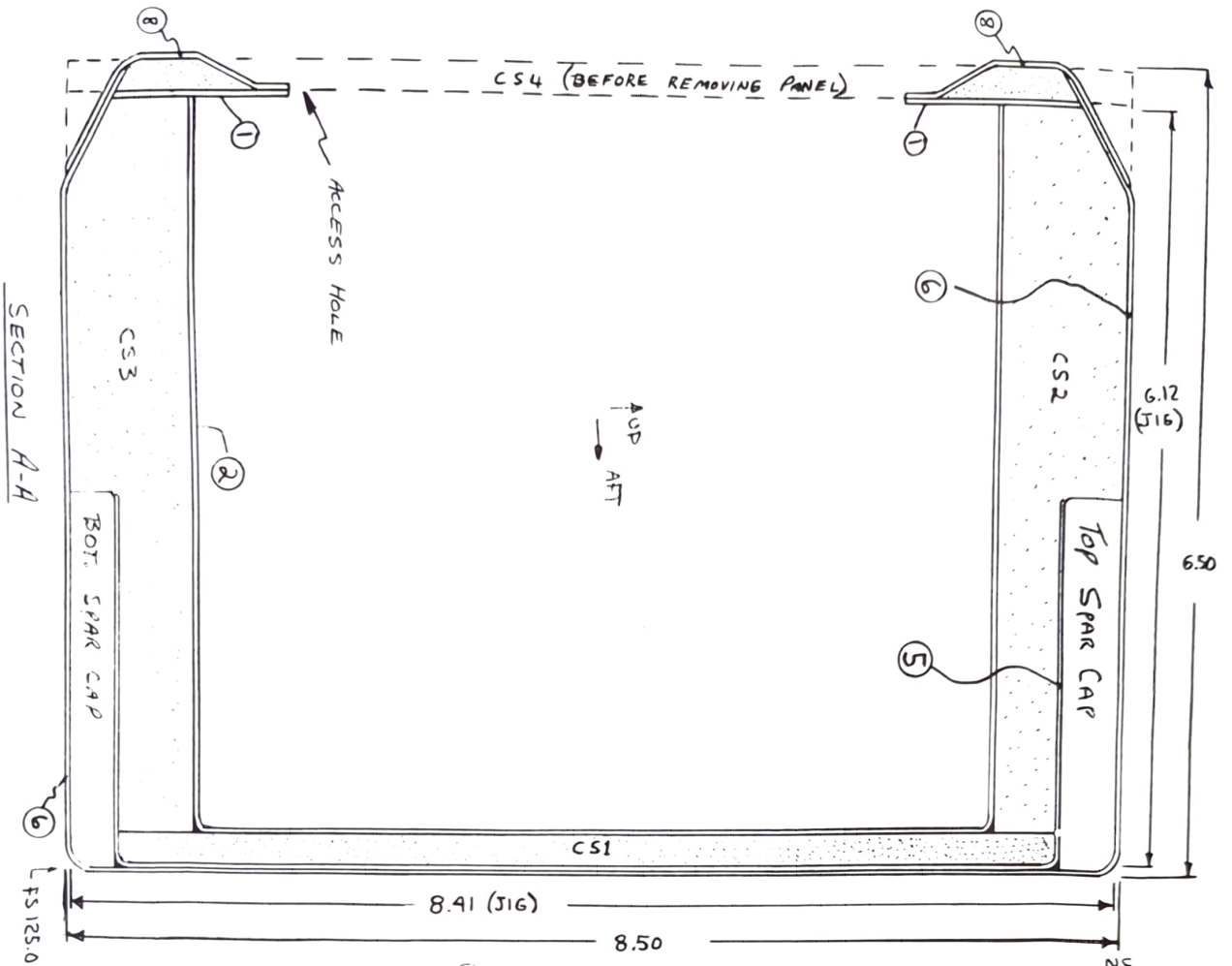
METAL PARTS
ALL 2024-T3
ALUM.

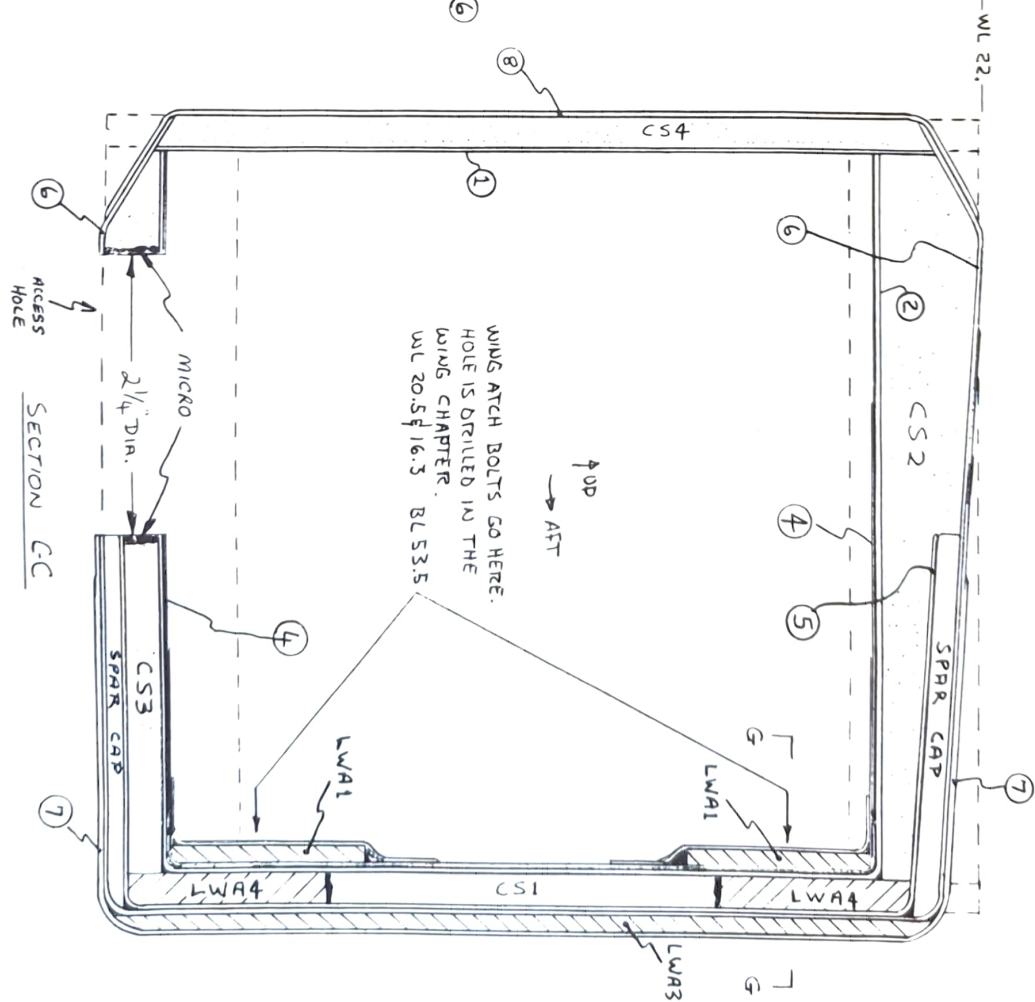
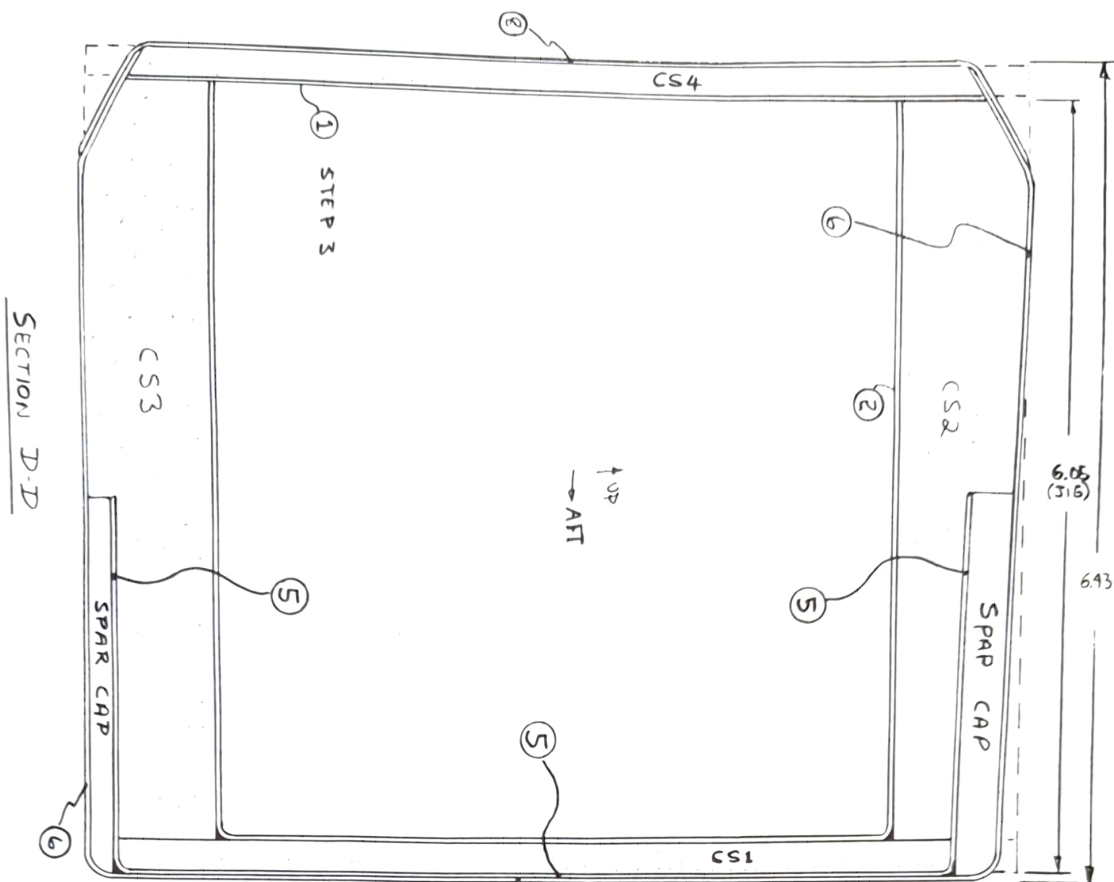


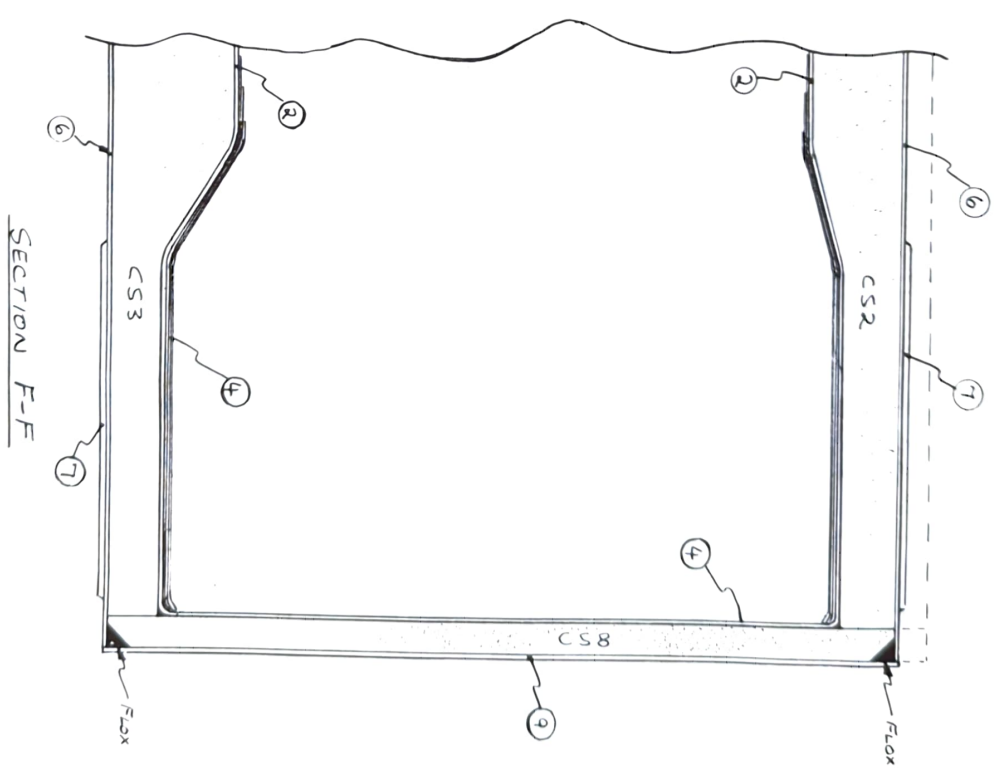
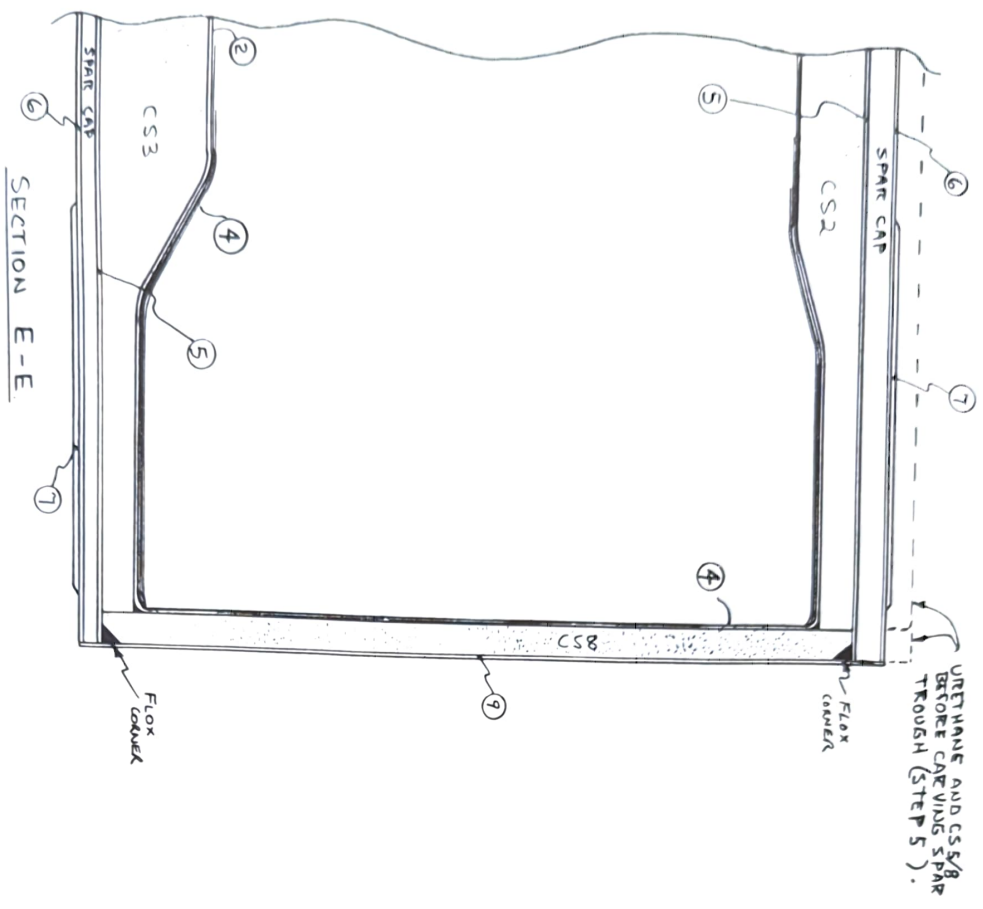
REFER TO pg 2-3 FOR
FOAM PARTS LAYOUT.



ALL 6mm PVC FOAM IS TYPER100, 6 LBS/FT³
ALL URETHANE FOAM IS GREEN, 2 LBS/FT³







CHAPTER 19

WINGS AND

AILERONS

NOTE:
CR 4-3 WING ATTACHMENT
CR 11-5 HIGH PERFORMANCE AIRCRAFT
CR 13-4 AILERONS

OVERVIEW. This is it, the big one!

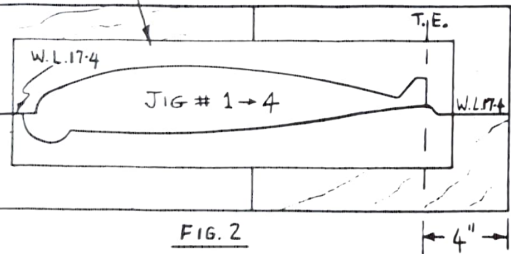
In this chapter you will build jig templates, cut foam cores, layup shear webs, spar caps and skins, install attachment reinforcements, build and rig ailerons and install wing-mounted aileron controls. Study carefully the dimensioned plan view drawing and all the section drawings to get thoroughly acquainted with your wings before you start. The wings have no roll trim tabs like the VariEze. Roll trim is provided in the cockpit and wing incidence can easily be adjusted to trim the airplane at neutral aileron. Do accurate and careful work here—smooth, straight wings make fast, good-flying airplanes. Make your layouts over the ailerons as light as possible to avoid having to do them over. Details show a right wing—left wing is a mirror image. Note: LWA9 (12), A2 (2) and A5(4) are available at a COZY distributor.

STEP 1. BUILDING THE JIG TEMPLATES

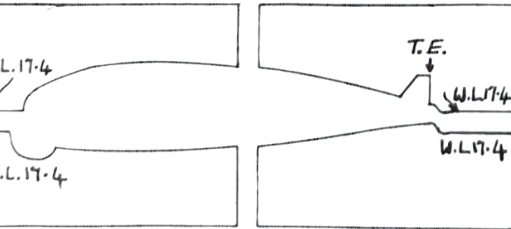
The jig consists of five templates that fit over the outside contour of the wing at five spanwise locations, perpendicular to the trailing edge. The tops and bottoms of all jigs are at the same waterlines (W.L. 24.4 for top, 10.4 for bottom), thus by merely sighting or stringing them in relation to each other in a straight line, you are assured a perfect wing with the correct twist. The jig templates disassemble into 4 parts (2 parts for jig No. 5) to allow you to partially remove the templates for wing skinning etc.

Cut the rectangles shown (Fig.1) from smooth, flat, 1/2 inch thick plywood. Draw the three lines shown (W.L. 17.4, trailing edge mark, and vertical line). **Note: Jig 5 does not have the vertical line.**

Now refer to pages A13, A17, and A18. Glue these pages together to obtain a full size drawing of the wing cutouts in the jig templates. Cut out the individual pieces and glue to your jigs as shown (Fig.2), using care to line up the W.L.17.4 lines and the T.E. (trailing edge) line. Now, saw along the rib shaped lines to obtain the correct wing cutouts in your jigs (Fig. 2). **Note that the reliefs in the lower leading edges are there to allow you to make the top skin overlap in step No. 8.**

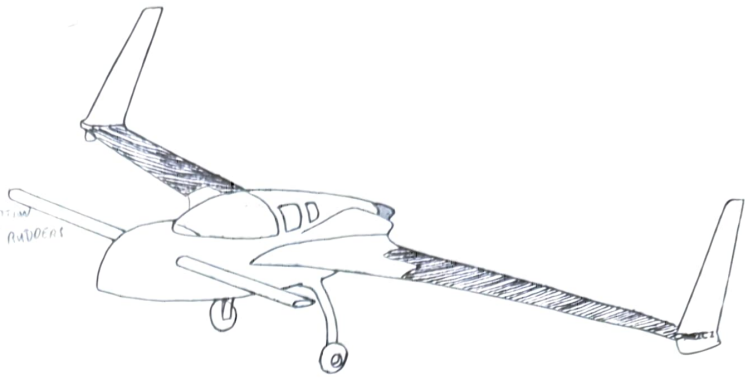


Now, saw each jig into 4 pieces (2 pieces for jig 5) by sawing along the W.L. 17.4 line and the vertical line (Fig.3).

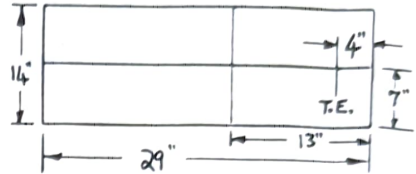


Cut out 17 pieces of 1/2 inch thick plywood 1 in. wide and 8 in. long. These provide 'links' to detach the various pieces of each template. Lay each piece as shown (Fig.4) across the W.L.17.4 lines and vertical lines flush with the template edge (27 places) on one side of each line drill two 1/4 in. holes spaced as shown (Fig.4). On the other side of each line carefully mark the outline of the link. On jig No. 1 through 4 the holes must be drilled on the T.E. side of the template. Number and remove the links.

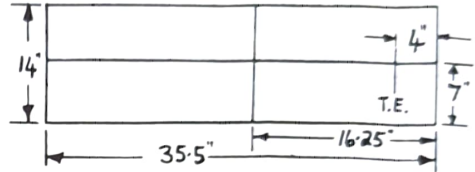
Reassemble the templates using 1-1/4 in. long, 1/4 in. diameter bolts (cheap hardware store type—you need 34 bolts and nuts) and glueing the links to the non-bolted sides with Bondo or wet flox. You now have rigged templates that can be unbolted into 4 pieces (2 pieces for jig No. 5). **Be sure the assembled jigs are square and parallel.** Your finished jigs should look like this (Fig.4).



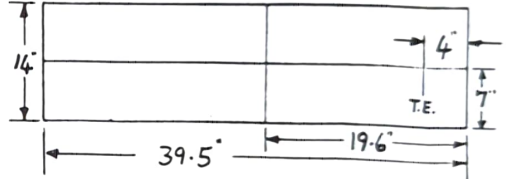
JIG # 1



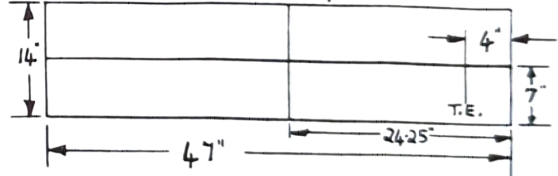
JIG # 2



JIG # 3



JIG # 4



JIG # 5

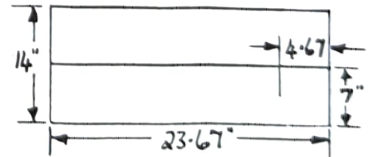
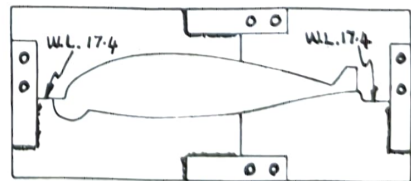
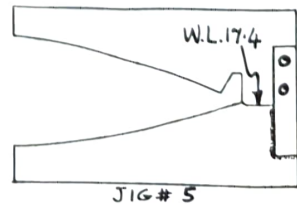


FIG. 1



JIG # 5

FIG. 4



STEP 2. SETTING UP THE JIG

The first set up jigs your wing leading edge **up**, to allow lay up of the full-span shearweb. It can be jugged on your table or floor. The shear web layup is reached easier if you jig on the floor.

Draw a straight line 125.6 inches long, set the jigs leading edge up as shown (Fig. 5) and shim as required to get them in a straight line and vertical. Use a string and level. Bondo the jigs to the floor. To provide adequate support, bondo some small diagonal wood pieces as shown. **Recheck accurately that they are vertical in both planes and top and bottom edges are in a perfect straight line.**

FIG. 5

STEP 3. CUTTING FOAM CORES

You will need five 7 x 14 x 64 in. and two 7 x 14 x 41 in. styrofoam blocks for each wing. You will have excess foam left over for winglet construction.

Template construction. Glue page A15 to page A16 at the line shown. Glue this entire page to a 2 ft. x 4 ft. piece of 1/16 in. birch plywood or formica. **Carefully trim and sand smooth all edges of each template.** Transfer the water lines and talking numbers to the opposite sides. Spray-can type paper adhesives, available at stationary stores is best to glue the paper down. Avoid water based paper glues-these shrink the paper. Study the plan view of the wing (page 19-10) to acquaint yourself with the three major areas of the wing: 1) Inboard, that portion from B.L.23 to B.L.55.5, aft of the centersection spar. 2) Center, that portion from B.L.55.5 to B.L.106.25. 3) Outboard from B.L.106.25 to the tip at B.L.157.

Now refer to page 19-11 which shows how to layout the planform and to cut the cores. Stack the cores together as shown and attached with sticks and 5 minute epoxy as shown. **Be sure to not leak epoxy down into the joint-it stops the hotwire. Do not use Bondo.** The angles on both sides of an individual core are the same-i.e., 78.64 degrees from center and outboard and 77.51 degrees for the inboard. Since it is difficult to accurately layout an angle, use the method shown--draw a 90 degree line with a carpenter's square, measure up 42 in. then over 8.44 in. (center), up 28 in. then over 5.63 in. (outboard) and up 28 in. then over 6.20 in. (inboard). Now layout the planform using all the dimensions shown. See Chapter three for hot wire suggestions. Use a vertical level on straight templates to make an accurate planform. Support the foam firmly with weights on a flat table. **Sloppy hot wire jobs make crooked wings.** Recheck dimensions on planform blocks and mark trailing edges. Use a straight, undamaged edge of a block for the trailing edge. Using the hotwire, cut all planforms. On outboard blocks, mount ribs high to allow enough foam for winglets.

Then using the suggestions in Chapter 3, hotwire the cores, start each cut resting on the small tabs on the leading edge. Do top first, then bottom, starting each cut on the tab. **Be sure wire is tight and temperature correct.** Adjust temperature for a cut of 1 in. in 4 to 6 seconds with light load. Check this on a scrap before each cut. A too hot wire makes 'craters' in the surface and makes the part too small. A correct temperature pulls tiny 'strings' (angel hair) from the foam when cut is through. Too cold causes wire lag, ruining the part's shape. **Before starting any cut, recheck for possible nail snags.** Be sure to pause 2 to 3 seconds at each talking number with a 'P' (all corners). This allows lag to catch up and makes accurate spar troughs. **Be sure the 'T.E. trim' line is accurately lined up with the trailing edge of the foam block. Be sure each waterline is level.**

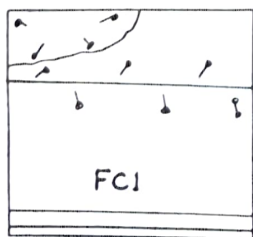
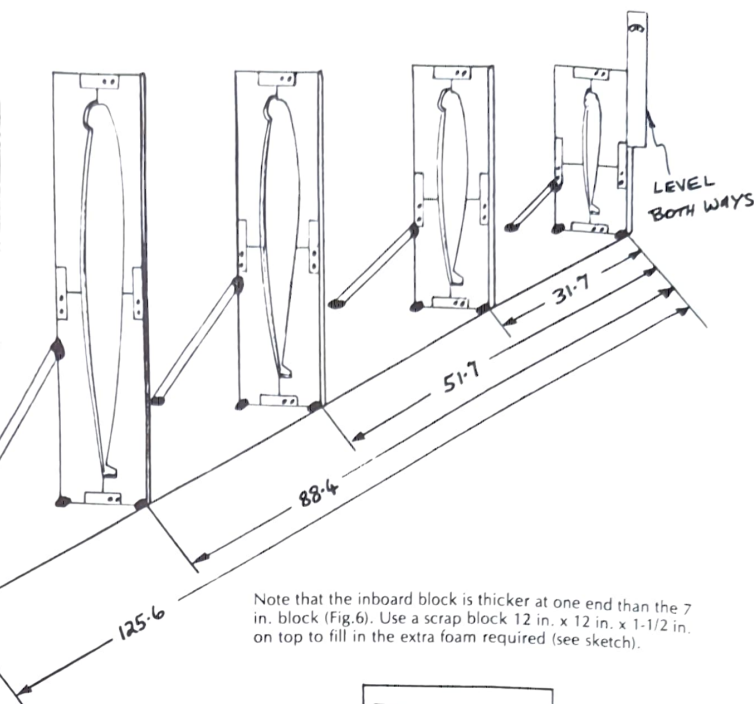
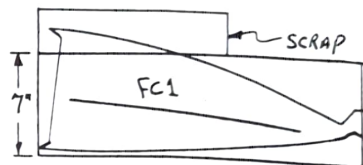


FIG. 8



Note that the inboard block is thicker at one end than the 7 in. block (Fig. 6). Use a scrap block 12 in. x 12 in. x 1-1/2 in. on top to fill in the extra foam required (see sketch).

FIG. 6



Note that the B.L.55.5 rib is used at the outboard of the inboard block--only to the front of the spar trough. The hot wire stops on the tabs of the B.L.23 rib. Then, remove both ribs and using the vertical straight templates, accurately cut the inboard cores' leading edge, double check the 22.8 in. and 25.1 in. dimensions. The length of the leading edge of FC1 should now be 32.87 inches. **Check this, it is important for correct positioning of wing attach points.**

Next, the center and outboard cores are cut into two pieces along the shear web (Fig. 7). This is done by aligning the vertical templates accurately along the forward edge of the spar troughs. **This cut should be perpendicular to the waterlines--check this.**

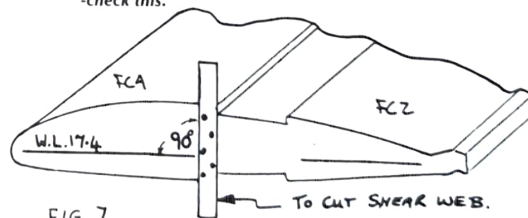
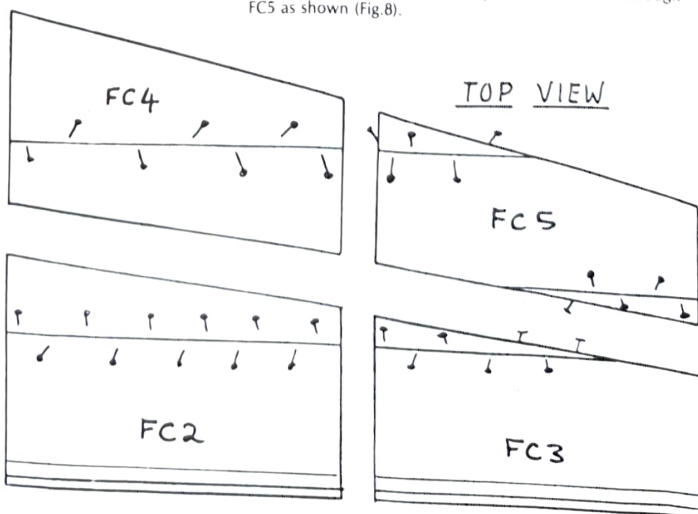


FIG. 7

Now, refer to Chapter 3, for instructions on foam core bonding. Bond the foam pieces together where there are joints due to the 14 in. blocks (Fig. 8). Use lots of nails to hold in place and cure. You now have 5 pieces labeled FC1 through FC5 as shown (Fig. 8).



Next, align the 'torque tube' templates against each end of the FC1 inboard core. One, at B.L.55.5 aligns with T.E. for positioning. The other, at B.L.23 aligns along top surface 9.2 in. from T.E. (along top surface) as shown (Fig.9). Using the hotwire, follow the numbers (0 to 16) and cut the core out, which will later allow installation of the aileron torque tube. **Move fast between No. 0 and No. 2 and No. 14 and No. 16, to avoid a large gap in the surface.**

Next you will modify the FC1 inboard core to allow later installation of aileron controls and wing attach reinforcements (Fig.10). Layout the 6 in. and 1 in. dimensions and bandsaw off the wedge on the inboard end. Turn this wedge up on end and bandsaw out its center as shown with a 0.6 in. width all around. Bond the 0.6 in. wide 'shell' back onto FC1, then reinstall the center piece to temporarily support the shell. **Note, if you do not have a bandsaw this wedge and shell can be cut with the hot wire, but only if you do it before gluing the individual pieces of FC1 together.**

The 0.6 in. dimension is critical **only** where it will later align the wing attach at the top forward edge (see section C-C). At other places it can vary $\pm .25$ in. without concern. For further clarification see view G-G and O-O.

Aileron cutouts. Now you will hotwire the aileron cutouts (Fig.11). This will not remove the ailerons from the wing, only make some inside cuts. **The ailerons are not removed until after the wing is skinned.** Locate the three 'aileron' templates, nail the root and mid span ones to FC2, lining up the templates to the T.E. **Be sure FC2 is placed and weighted flat on a straight surface (not warped),** then hotwire No. 0 through No. 15. Pause in corners, but move fast between No. 0 and No. 2 and No. 13 and No. 15, to avoid a large gap in the top foam surface. Now locate FC 3 and layout the dimensions shown (Fig.11). Using a coping saw or hacksaw blade, cutout the 3 in. x 8 in. chunk perpendicular to the T.E. Position the 'aileron tip' (B.L.118.1) template as shown (Fig.11) and hot-wire the inside cutout No.0 through No. 15, using the midspan template again, this time nailed to B.L.106.25 on FC 3. See Fig.11. After hotwiring, bond the 3 in. x 8 in. chunk back in using wet micro.

A few dabs of 5 minute mixed with flox can be inserted in the gap in the top surface to better stabilize the core from warping. Leave the center piece of foam in.

Now, locate FC 4, FC 5 and the two small templates that make a 1 in. diameter hole. This hole is located near the bottom surface and will later be used to install any desired electrical wires for position lights or strobes. Position the templates as shown (Fig.12). This gives a straight hole that misses any foam joints and ends up at the correct place at the wing top. Hot wire from 0 to 12, moving fast at the surface. Remove and discard the 1 in. core from both FC 4 and FC 5. This completes the hot wiring of cores. If you do not immediately jig them, store in the original blocks, weighted down, to keep them from warping. Protect from sunlight from now on, until your airplane is painted.

STEP 4. ASSEMBLY OF FOAM CORES AND LAYUP OF SHEAR WEB

Grab the foam cores for the right wing and slide them into the jig, positioned as shown (Fig.13). After confirming that they all fit accurately, remove and set aside the two large leading edge cores (FC 4 and 5). Now micro FC1, FC2, and FC3 to each other, positioned as shown in the jig. **Check the 1 in., 5 in. and 10 in. (3 places) dimensions.** Place a few small dabs of flox between jigs and cores to keep things from moving around, on top wing surface only. Now is a good time to **check the depth of your spar cap trough.** Review the test you made in Chapter 14 to determine the thickness of the uni-directional tape you are using.

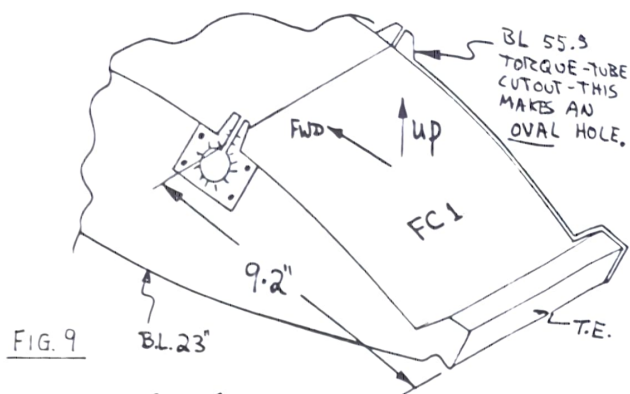


FIG. 9

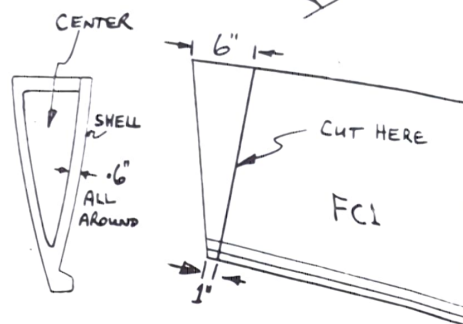


FIG. 10

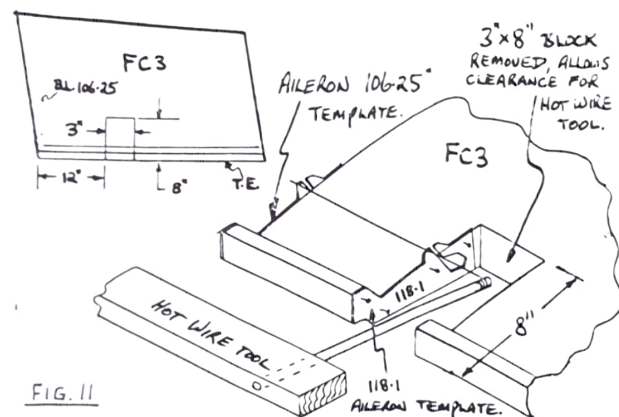


FIG. 11

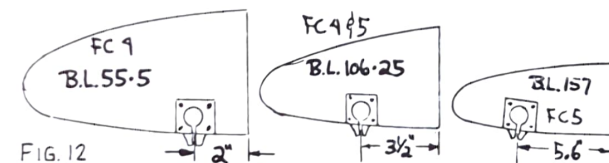


FIG. 12

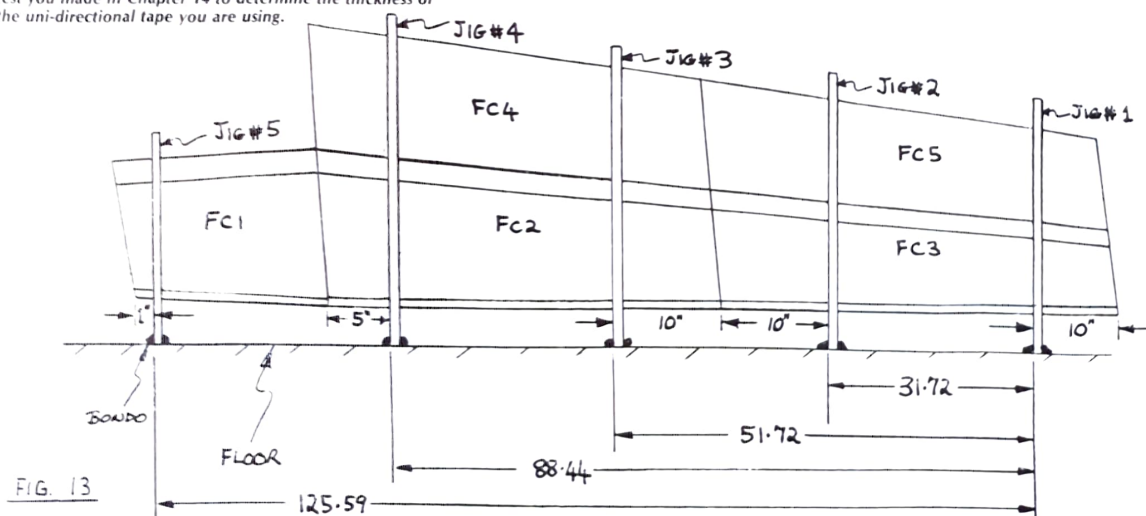


FIG. 13

Look at the table in Step 5 to see how many plies you will need and how thick they will be in given locations. Allow also for the thickness of the shear web overlap into the trough. It is .009 in. thick per ply. It is better for the trough to be up to 1/16 in. too deep than to have a hump which will destroy the shape of the air-foil.

Now remove the forward two pieces of jigs 1, 2, 3 and 4 to expose the shear web area (Fig.14).

Layout and cut the 1.7 inch wide wing-attach access depressions shown (Fig.15) in FC1, top and bottom. See also page 19-12, Section B-B. These should have round corners on the inside. A coarse rotary file bit as shown is used to cut the depressions. Refer to section B-B for accurate depth of these. **Top is not the same depth as bottom;** width and position is the same.

Now, using a sharp knife or razor saw, notch the shear web as shown (Fig.16), to position the three 1/4 in. thick 2024T-3 aluminum blocks flush with the shear web face. Outboard 2 pieces are LWA4, inboard single piece is LWA6.

Now, glass layup No. 1, a two ply BID 'liner' in the access depressions. Knife trim flush with edges all around. Micro in the two LWA4 and one LWA6 metal pieces flush with the shear web face and with the radius on the outside corner. Now, fabricate W18s, the two pieces of .016 thick aluminum shown, and bond them over the access depressions in the spar cap area (Fig.18)--5 minute epoxy is ok. They must sit perfectly flat against the foam--hold in place with small nails to cure.

Next is the shear web layup (layup 2), it extends across the shear web and down the spar cap faces top and bottom, full span. Cut 6 pieces of 13 in. wide and 6 pieces of 14 in wide 45 degree UND as shown (Fig.19). Use the 14 in. wide pieces over the wing root section (FC1). Roll them up to prevent fiber distortion (elongation of the long dimension). Use duct tape and newspaper to protect the foam which will not be covered by the shear web. Radius the foam edges, full span approximately 0.2 in. to match the radius of the metal blocks and allow a smooth layup around the corner. **Be sure all foam faces flow smoothly over all joints, without joggles.** Layup the first ply full span diagonally across the shear web face at 45 degrees (Fig.20). Wet out onto the three sides, then trim edges just short of the joggle. It's better to be 1/4 in. short of the joggle than to lap or bunch up against it (Fig.21). **Do not allow a buildup here.** You need 2 splices.

Butt, do not overlap the UND cloth at the splices. The second ply is the same except crossed diagonally the other direction, and running full span. Check the approximate 45 degree fiber orientation on the shear web and spar cap faces. Squeegee all plies well, from the center along the fiber direction out toward the joggle. **Do not leave excess epoxy or overlaps that buildup the area incorrectly. The thickness of this layup must be correct.**

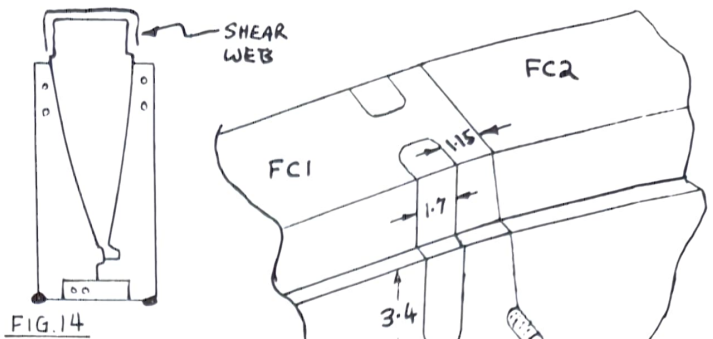


FIG. 14

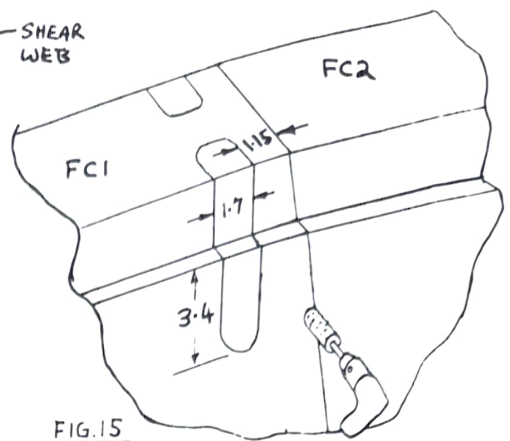


FIG. 15

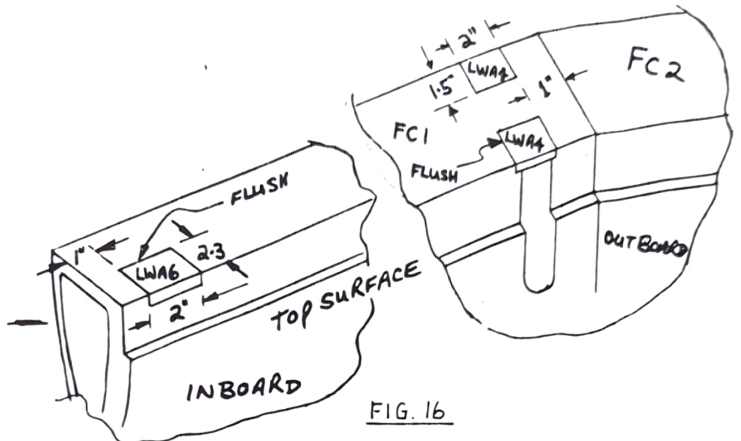


FIG. 16

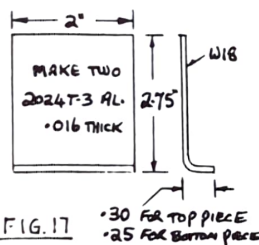


FIG. 17

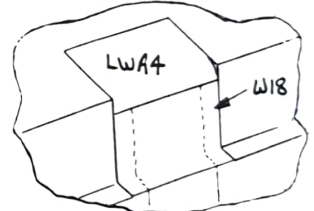


FIG. 18

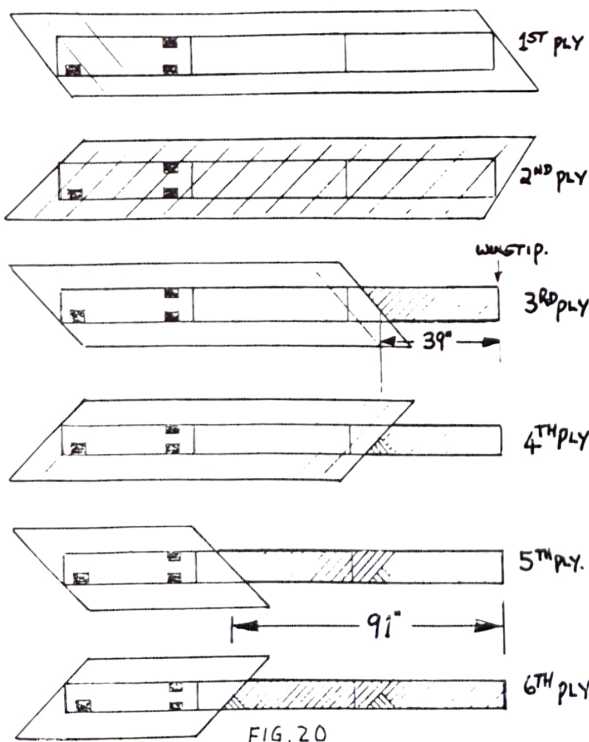


FIG. 20

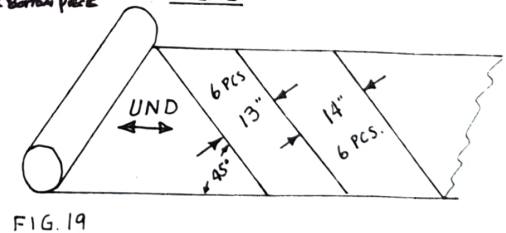


FIG. 19

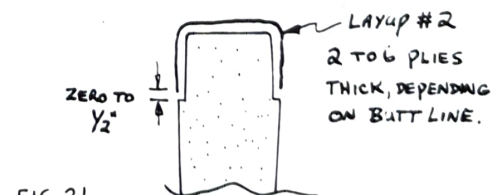


FIG. 21

The 3rd through 6th ply are similar, except they do not extend full span. 3rd and 4th are crossed and extend from 39 in. from tip to inboard end. 5th and 6th are crossed and extend from 91 in. from tip to inboard end.

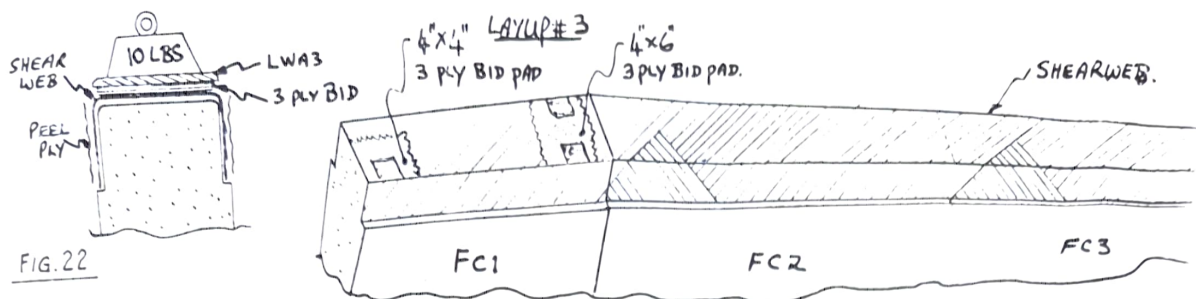


FIG. 22

The completed shear web is 6 plies thick from B.L.23 to B.L.70 4-ply thick from B.L.70 to B.L.120 and 3-ply thick from B.L.120 to B.L.157. Add a 3-ply BID at 45 degrees pad (layup 3) (Fig.22) at the two locations shown (Fig.23) to strengthen attachment areas. These pads are centered over the metal parts and do not extend over onto the spar cap area. Then, epoxy the LWA3 and LWA2 plates on, centered over the other metal parts. Weight in place for cure with about 10 lb. on each plate (Fig.22). Peel ply the spar cap faces.

Refer to Chapter 3 (foam block joining) then bond the FC4 and FC5 leading-edge cores in place over the shear web. If the shear web is not cured, it will allow you to use nails to hold FC4 and 5 in place. Replace the front pieces of jigs 1, 2, 3 and 4 to hold FC 4 and 5 in the proper position. **Accurately check the fit at the shear web so the joggle on each side of the spar cap area is the same dimension (Fig.24). Check that all jigs stand vertically in both planes to assure a straight wing with the correct twist.** Place small dabs of flox to bond the wing cores to the jig, top surface only.

Check all alignments by sighting all sides of jigs, and let cure. Your wing should look like the sketch below (Fig.25).

Now place a carpenter's square on the inboard spar cap joggle and mark FC4 as shown (Fig.25). Use a carpenter's saw or coping saw to saw off the corner--see plan view page 19-10.

STEP 5. BOTTOM SPAR CAP CR 16-2 GUIDER HINT #3

Break the bondo away from the jig T.E., lift the entire wing (with all jigs in place) to your table and lay it **bottom up**. If your table is perfectly flat your wing will set down with all jigs in contact with the table surface and with the wing aligned. If not, shim each jig as required until their edges 'string' and 'sight' flat. Weight in place if necessary. Bondo each jig to the table surface to hold it firmly in place. **Recheck alignment**, then unbolt the two bottom pieces of each jig (one for jig No. 5) to expose the bottom of the wing (Fig.26). Remove the peel ply on the spar cap area and sand if required to remove any bumps or high places. Install a 1/4 in. plywood 'dam' on the inboard area to contain the spar cap (Fig.26). The dam butts to LWA3. Now, cut the **seven strips of 3 in. x .025 in. thick uni-directional tape** (cut only 5 if it is .035 in. thick) to the lengths shown and lay up as shown (Fig.27). **Do not use UND cloth.**

Fig. 23

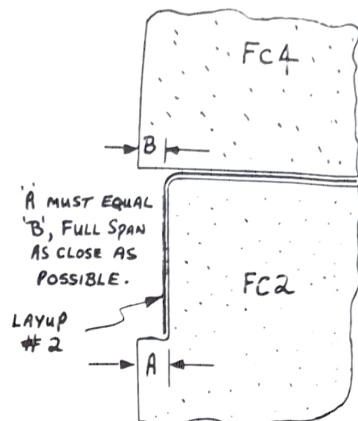


FIG. 24

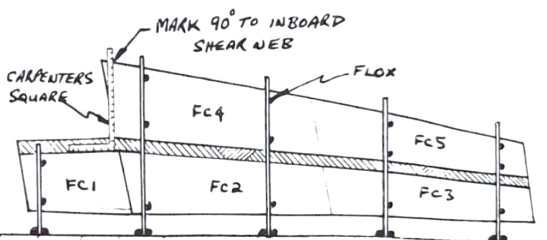


FIG. 25

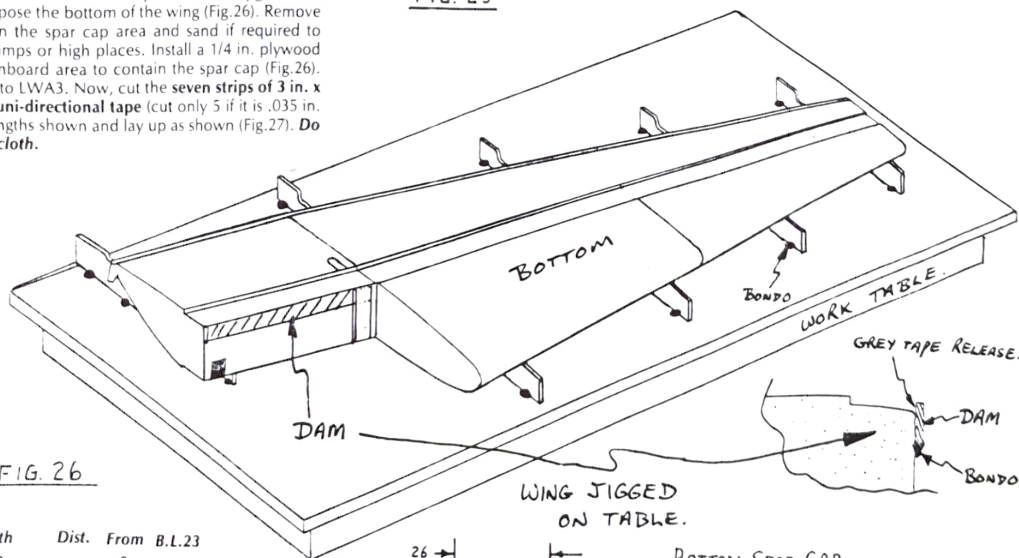


FIG. 26

No.	Length	Dist. From B.L.23
1	142	0
2	139	2
3*	105	5
4	84	12
5	63	17
6*	52	22
7	18	26

*Not used if spar mat'l. is 0.035 in. thick.

Note: The strips must be longer than the base lines would indicate because of wing sweep. Squeegee each ply from the center out to the ends. When you are done, the spar cap should be built up to just flush with the foam edges. A spar cap that is a little low is preferred to one that is high leaser

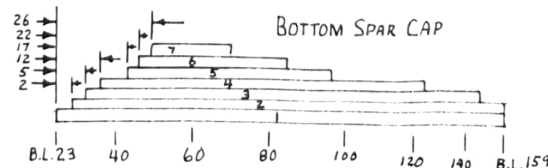


FIG. 27

filled and finishing sanding won't cut into wing skin). After cure, round the leading edge between B.L.23 and 55.5, to flow smoothly into the front face (Section B-B and C-C). Using a fresh 36 grit hard block remove the joggles at the ends of the spar cap strips and fair any high spots down to the foam level. If the cap is low, fair the foam down to it, this low place is easily filled with micro over the skin during finishing.

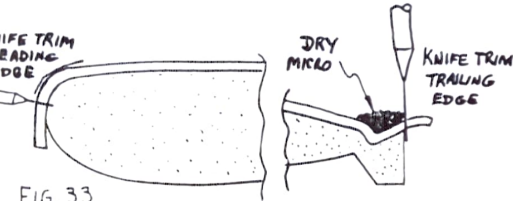
STEP 6. BOTTOM SKIN C212-3 UND LAYUP OF 2" AND 12"

Fair smooth any bumps or joggles at the joints on the entire bottom surface of the wing. Carve and radius the edges of LWA 3 and LWA2, to fair into the spar cap. The bottom only gets 2 plies of skin, so care must be taken to avoid any lumps. If the skin has a bump it is easily damaged there when sanding during the finishing process. A smooth, straight foam core makes a light, strong wing. A crooked, lumpy foam core makes a weak wing that gets heavy in the finishing process.

Blow or vacuum the wing clean as well as your entire work area before skinning. Cut a 65 inch length of 1 in. wide peel-ply. Using small brads or staples, tack it down in the position shown (Fig.28) on your foam core. The skin gets glassed over this strip of peel ply, so it must lay nice and flat. If you're curious why you are doing this, refer to step 10. Also, install peel ply held with small brads or staples every 10 in. along the T.E. overlap area (see Fig.29). This is later removed before skinning top. Fill any gaps around the spar cap with dry micro and make a small filox corner around the attach depressions (Section B-B).

The skin is two plies of unidirectional UND, each joint is butted, not overlapped. Do not trim selvage. Refer to Fig. 30 for ply orientation. Note that the first selvage edge orients diagonally across FC2 and FC4, then the remaining skin is butted parallel to it. This is also true of the 2nd ply of skin except it orients on the opposite diagonal, crossing the first ply. Be sure all fibers are straight and squeegeed from the wing's center toward the edges. The third ply is a reinforcement of BID at the tip as shown (Fig.31). Peel-ply the entire surface of this BID reinforcement.

Scissor trim the inboard edge B.L.55.5 rib wingtip edge L.E. and T.E. to less than 1/2 in. excess. At the leading edge face of FC1, lap each skin ply down the face 4 inches (Fig. 32). Use filox to avoid bubbles at the edges of LWA3 and LWA2. Be sure the glass is stippled well into the trailing edge overlap area without voids, and stippled/squeegeed down well around all edges including the leading edge. Peel-ply the 3 inch wide strips shown near the attach depressions (see step 9). Also peel ply the leading edge, 2 in. wide (Fig.32). At knife trim time, trim the T.E. flush with the foam edge and the L.E. at the L.E.tangent line as shown (Fig.33). Trim the inboard rib, B.L.55.5 rib and tip rib flush with the foam edge. Also, at knife trim time trowel some dry micro onto the T.E. depression as shown.

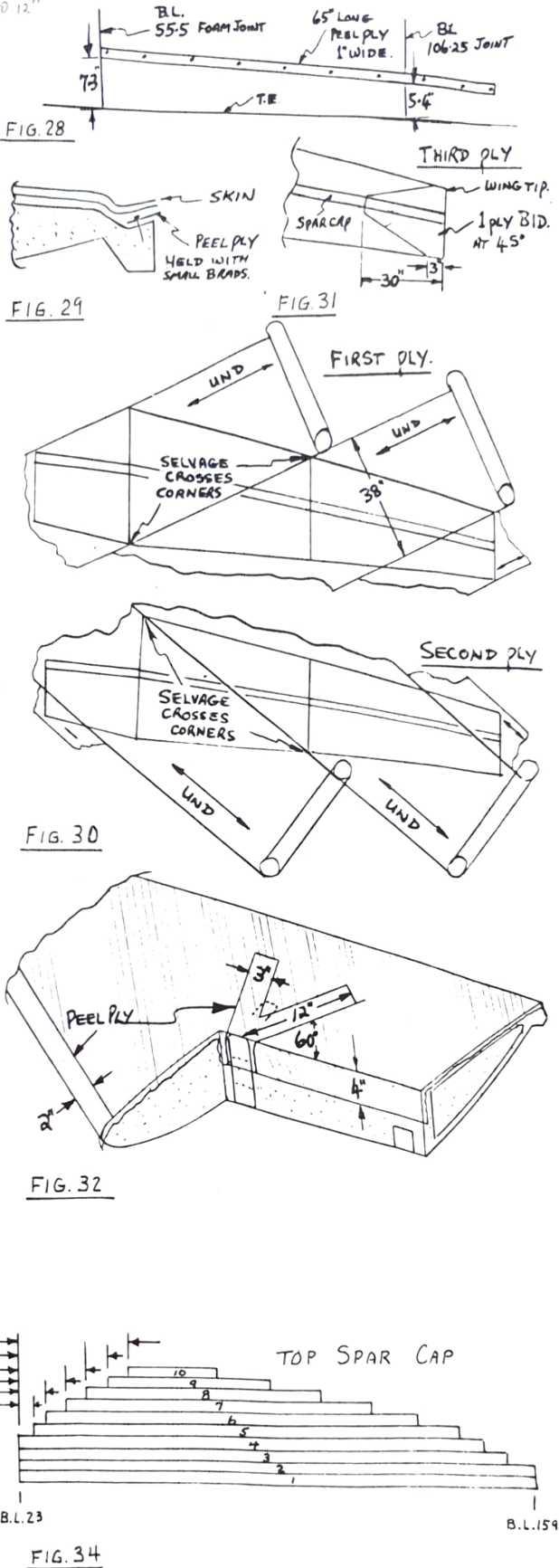


STEP 7. TOP SPAR CAP

After bottom skin cure, bolt on the jig pieces you removed in step 5. Apply some dabs of Bondo to join these to the cured bottom skin. Now, using a small chisel, knock off the Bondo dabs that hold the jig to the table. Turn the wing over, recheck alignment and Bondo the jig to the table. Make one final check for straightness and twist--there is no adjustment after skinning the top. Remove the top pieces of the jigs to expose the top of the wing. Follow the instructions in step 5 to layup the spar cap, except use the lengths and dimensions below (Fig.34). The top cap has ten plies (seven if you have .035 in. thick uni-directional).

No.	Length	Dist. from B.L.23
1	142	0
2	142	0
3*	130	0
4	119	0
5	90	6
6*	75	9
7	61	12
8*	49	15
9	39	18
10	20	24

*Not used if spar mat'l. is 0.035 in. thick.



STEP 8. TOP SKIN

C212-3 UND LAYUP OF 2" AND 12" RUDDEARS

NOTE: NEW HIGH PERFORMANCE RUDDEARS

C211-5

Follow the instructions in Step 6 with the following exceptions: Before skinning you must install the nylon conduit for the rudder cable. This is a .025 wall 3/16 O.D. **Nylaflo tube--do not substitute nyl-seal tubing.** Layout the location as shown (Fig.35) using the fullsize template for the small curve at the tip and a straight line to the dimension at the root. The dremmel tool held against a straight edge as shown works well for this groove. See the completed installation in Section A-A. At the root, curve the conduit downward (deeper groove) about 0.7 in. over an 8 inch length (see G-G). This 'points' the conduit at the rudder pulley. Hold the conduit in place with tooth picks every 10 in. Fill the groove with dry micro just before skinning. Cover with a piece of tape to keep epoxy off the outboard 3 in. of the conduit groove (see Chapter 20). The conduit should stick out 2 in. on each end of the wing. If you intend to use RST 'homemade' marker beacon or FM radio antennas installed on the top of the wing, **install them now. Make sure, however, that they are slightly recessed** into the foam so they don't cause any bumps.

Remove the leading edge peel ply from the bottom skin. Refer to Fig. 36 and carve a smooth taper on the last 1/2 in. of the bottom skin. A fresh 36-grit hard block works well for this. See also Section A-A, page 19-12.

Cut a 65 inch long strip of 1 in. wide peel ply. Brad or staple it flat on the foam surface immediately forward of the aileron hot-wire gap (Fig. 37). Lap this peel ply slightly over the gap to keep excess epoxy out of the gap. Using a hacksaw blade, remove the foam ridge at the trailing edge (Fig. 38). Then peel back the peel ply to expose the bottom skin. Then use a 36-grit hard block to fair the foam smoothly into the overlap (Fig. 39). **Do not gouge into the bottom skin--its only 2 plies!** If the T.E. is not straight between jigs, shim it as required to hold it firmly until the top skin cures. The top skin has a **third unidirectional ply**, installed before the top BID reinforcement. This third UND ply extends from the aileron hinge line forward **only** (Fig. 40). Stretch the selvage along the hinge line and smooth the cloth forward. Then proceed with the BID reinforcement. **Do not put the 3rd ply over the aileron!**

Wrap and squeegee each ply, lapping 2 in. onto the bottom skin at the leading edge (see section A-A). This is best done by first painting epoxy underneath, then on each ply (1) layup skin leaving excess hanging down (2) scissor trim to 2 in. (3) wipe onto bottom with a squeegee. Successive plies can be scissored shorter to taper overlap. Wrap the skin down the inboard face similar to the bottom skin, overlapping it 1 in., peel ply the 3 in. x 12 in. strips near the attach depressions. Install **3 plies UND** layup No. 4 over the inboard wing hard point (LWA2) as shown (Fig. 41). These are 3 in. wide and 14, 10, and 6 in. long (section C-C).

Squeegee well for a smooth, light layup. Check for voids and inspect for a good T.E. and L.E. overlap. Knife trim the T.E. accurately flush with the edge of the bottom skin. Knife trim the inboard and tip ribs. After cure, while the wing is still in the jig, **carefully check for level waterline** (reinstall a top jig template). Then bondo a 2-ft straight board on the cured top skin as shown (Fig. 42), shimmed to exactly level. This is now your **incidence reference for rigging wing to the centerspar.**

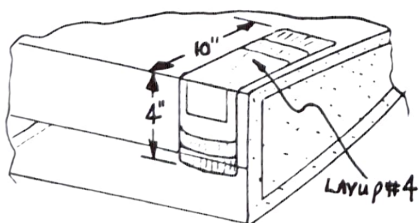


FIG. 41

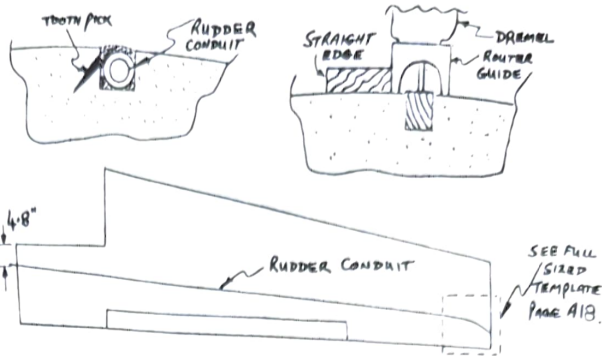


FIG. 35

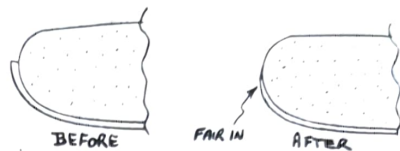


FIG. 36

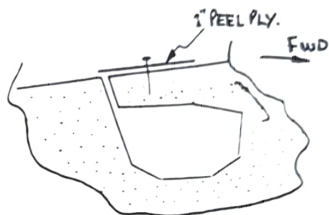


FIG. 37

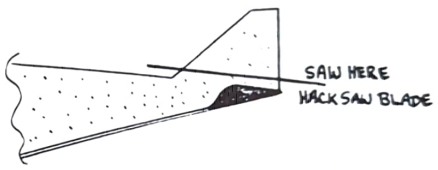


FIG. 38

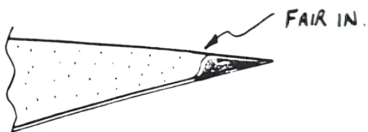


FIG. 39

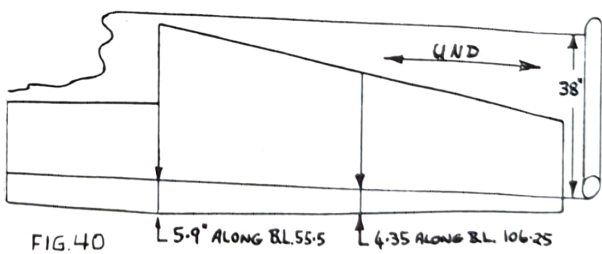


FIG. 40

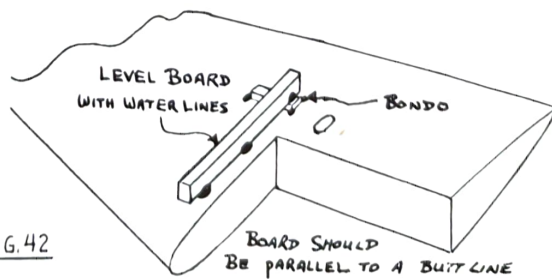


FIG. 42

STEP 9. WING RIBS

Refer to Fig. 43 and section F-F. Form the 0.7 in. rib by removing foam with a rotary file. Stand the wing on its trailing edge. Remove the 3 in. wide strips of peel ply around the attach depressions.

Lay up 3 in. wide UND strips as shown (layup 5) (Fig. 43) wrapping around the metal areas and lapping back 12 in. on to the wing skins, top and bottom. Two plies are required, each is 30 in. long. Fibers orient along long dimension. Then, lay up 3 plies BID in the rib hollow (layup 6) section F-F. One of the 3 plies laps 4 in. inboard, covering the previous UND reinforcement. After cure, cut out the attach depression holes as shown. **Note, the 3 in. UND strips are not cut.**

Now, remove and discard the large foam block in the wing's inboard end, exposing the face that is 90 degrees to the trailing edge. Study carefully view G-G and M-M. Also sections C-C, E-E, and N-N. **Note how the 0.6 inch foam 'shell' is completely removed** for glass-to-glass layup around all outside edges and at the forward face where the CS127 brackets will mount. The foam is also completely removed at the LWA6 (1/4 in. thick aluminum) block. **Note also the local removal at the CS132L belhorn** (view G-G and section E-E). **Caution:** leave the 0.6 in. directly above the inboard wing attach (view M-M and section C-C). Using a knife, rotary file and sandpaper, conduct the required surgery on the shell. **Use care** to not damage the nylon rudder conduit. Then layup a 3 ply rib in the entire area (layup No. 7). While its wet, layup 3 plies UND 2-1/2 in. wide lapping over the LWA 6 piece, extending 1 in. below it and 4, 5-1/2, 6 in. aft of it (layup 8 Section C-C). Clamp LWA7 in place and cure. After cure cover LWA 7 with 1 ply BID, extending 1 in. all around.

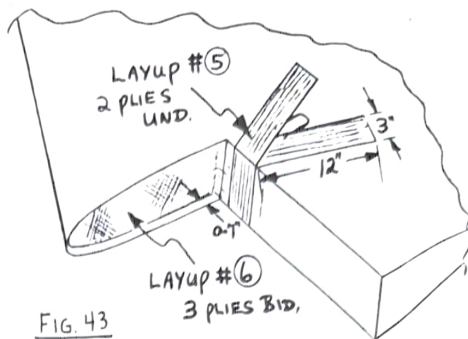


FIG. 43

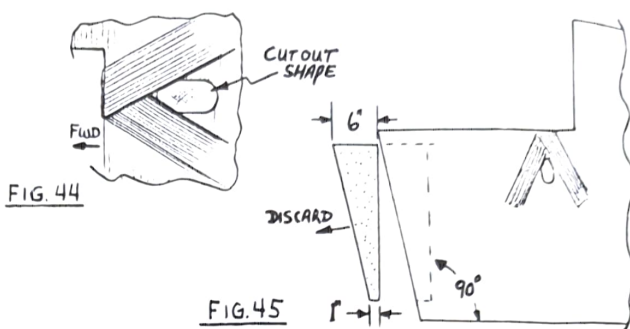


FIG. 44

FIG. 45

STEP 10. AILERONS

Study Sections H-H, I-I, J-J, K-K and L-L to acquaint yourself with your aileron and wing trailing-edge spar. Layout the dimensions shown (Fig. 46). Then using a razor saw--cut the skins and remove the ailerons (Fig. 47). Jig the wing leading edge down and remove the foam shown by peeling off the peel-ply installed before skinning the wing (see section I-I, H-H, and J-J). Smooth up this trough and extend it into the wing on each end--see sections K-K and L-L. Lay up (layup No. 9) the wing trailing edge spar (Fig. 48). This layup extends about 1 in. into the torque tube hole on the inboard end--round the foam edges here. This is 3 plies BID and 1 extra BID at the hinge locations. Overlap 1 in. where needed, but don't stack overlaps at one location. This layup extends out the edges to the T.E. (section K-K and L-L). **Be sure to avoid voids at the skin laps.** Scissor trim to 1/4 in. after each ply. Knife trim flush all around. Notch the wing top skin 0.2 in. deep in the places shown (Fig. 49). These will later accept the hinges and allow the skin to seal the gap between hinges.

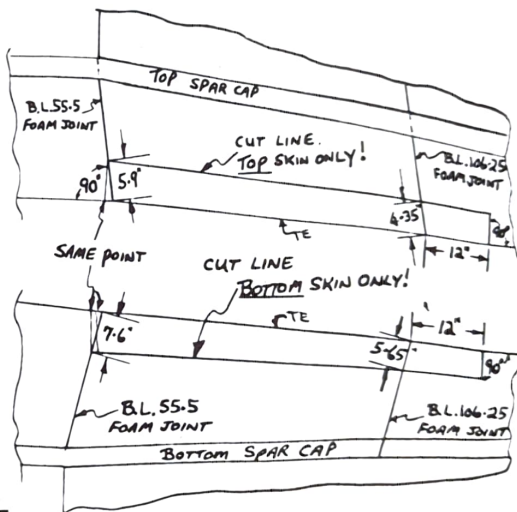


FIG. 46

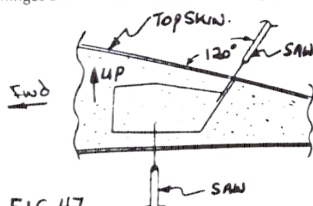


FIG. 47

Refer to the page 19-17 drawing and fabricate these metal parts. **Caution: Reverse the hinge halves before sawing to length (see 19-17).** Slice 3/8 in. of foam from the L.E. of the aileron and bond the 3/8 dia. steel rod on with dry micro-fill aileron span (Fig. 50). Mark the hinge positions from the wing, then remove foam to install the two A-5 pieces flush with the front face. Remove foam for the A-10 tube and fit it as shown on Section I-I, also fitting A2 flush with the forward foam face. The A10 tube extends one inch inboard from the inboard edge to the aileron. **Positioning is important to aileron balance;** accurately recess the A2 and A5 pieces. The 5/16 in. holes go against the top skin.

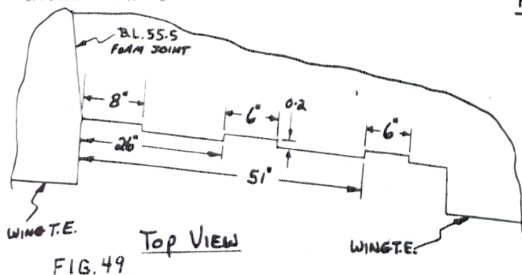


FIG. 49

After assuring A2 and A5 are parallel to each other, jig the aileron trailing edge down, round the corners, bond A10 and A2, and A5 in with wet micro and layup 1 ply BID at 45 degrees over the leading edge lapping 1 in. onto top and bottom skins. Peel-ply the edges (Fig. 50). This is layup No. 10. Set the aileron aside to cure.

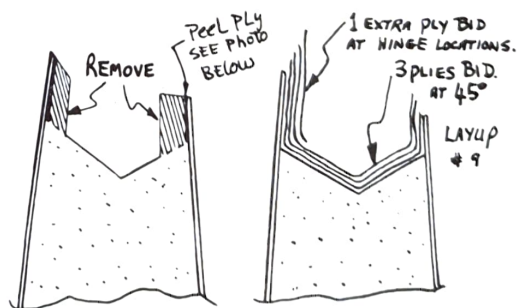


FIG. 48

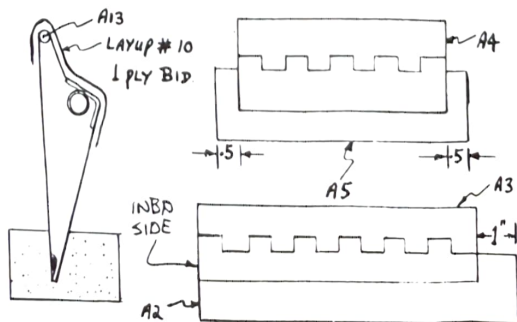


FIG. 50

Now remove the 0.4 in. of foam at the ends (section K-K and L-L). Layup 2 plies BID to form the end ribs (layup No. 11).

Back to the wing, now, using a straight edge, align the extruded hinges in the wing notches so they are all parallel. Drill the seven No. 12 holes through the wing and hinge as shown (Fig. 51) (drill No. 30 pilot hole, first). Install the AN 525-10R8 screws and K1000-3 nutplates (see I-I and H-H).

Now, place dabs of bondo on the aft hinge pieces and position the aileron on the wing to line up top and bottom skin and T.E. After the bondo cures, remove the 7 screws, remove the aileron and drill the 24 holes for the pop rivets (see page 19-17).

Then pop the bondo loose, remove the hinge pin, sand the aileron and hinge halves dull and pop rivet the 3 hinges on with wet floc and 23 pop rivets. Keep floc out of the hinge holes.

Now, hang the aileron by a fine wire, not string, through two hinges and check balance. **The aileron must hang between the angle that makes the top level and the angle that makes the bottom level after painting (Fig. 52).** So, if the bottom is nearly level it may be out of tolerance after painting. You can add maximum of 0.3 lb to the nose to balance by stacking lead behind the steel bar (do not extend forward, this ruins aerodynamic balance). If .3 lb aft of the steel bar is not enough you will have to discard and build new ailerons--your first ones have excessively heavy, epoxy-rich skins and cannot be made safe. This will happen only with poor workmanship.

Now, mount the ailerons and check all gaps (top, bottom and sides) against the tolerances on Section J-J and K-K. **The ailerons should move free with no binding.**

STEP 11. CONTROLS

First fabricate the phenolic block and metal parts shown full size page 19-17 (dimensions not shown). Drill (No. 12) and bolt the parts together as shown (Fig. 53).

Remove the layup No. 7 glass rib, in the 1.6 in. diameter area at the torque tube hot wire hole. Revise dimension A to position CS132L and CS152 as shown in Section E-E with CS151 about 1/4 in. from the glass rib. Install the aileron. Slip the phenolic block (sand its surfaces dull with 36-grit) onto CS152 and floc it up against the glass rib (section E-E and view G-G). After cure, remove the aileron/torque tube assembly and layup 1 ply BID (layup No. 11), over the phenolic, lapping 1 in. all around. After cure, remove glass from the hole. Install the aileron and the CS132L belhorn.

Refer to the CS127 bracket and all adjacent parts (view O-O). Assemble these, including the two pushrods. Position the stop bolt to stop CS128 20 degrees travel from the neutral position shown. Bolt the assembly on the shear web in the position shown in view O-O and view G-G, using the four AN 3-4A bolts. Hook up the pushrod. Adjust it so the stop bolt stops the motion at 20 degrees up aileron. A Sears 'Angle Finder' is real handy to check control surface travel.

STEP 12. ATTACHMENT, WING TO CENTERSECTION SPAR

This step and the subsequent installation of the centerspar in the fuselage will determine the rigging of your main wings, and it is important to do it correctly. Due to the 3 point attachment of the wings, small adjustments in sweep or incidence are possible later, but you want to avoid the need for this if at all possible. There are 3 considerations in rigging:

1) Incidence. This is the most important and must be exact. Both wings must be the same, or your airplane will have a tendency to roll, and require continuous aileron compensation. Wing incidence must also be zero with respect to the fuselage for correct performance and protection of the stall proof feature. Incidence of each wing is referenced to the centerspar, which is subsequently referenced to the fuselage longerons.

2) Dihedral. Dihedral should be zero, at the 17.4 waterline for both wings. Again, it is referenced to the centerspar, which is referenced to the fuselage. It is less critical for performance than for esthetics. You want your airplane to be 'square.' No adjustment of dihedral is possible later if you do it wrong.

3) Sweep. Sweep is not critical for performance (within limits) and errors are not readily apparent, but if your wings were built accurately (particularly the mounting pads), and the centerspar is installed square to the fuselage, sweep should be the same on both sides.

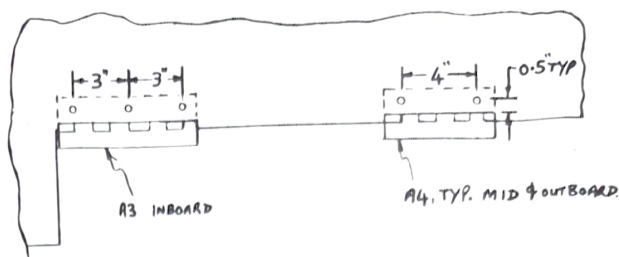


FIG. 51

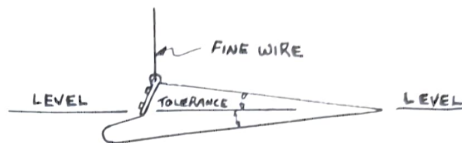


FIG. 52

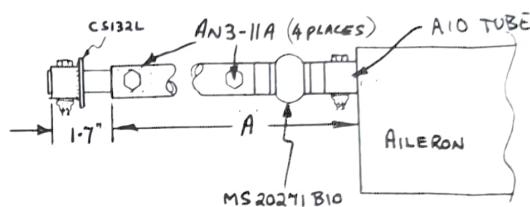


FIG. 53

A. Pilot holes and access holes in the centersection spar. Mark A and B marks on the wing top and centersection top directly above the center of the aluminum blocks. Hold the centerspar up to the wing to verify that the A-A and B-B marks line up. This verifies correct horizontal position of all blocks before drilling. Refer to chapter 14-8 and 14-9 section drawings and verify correct vertical positions before continuing. When the wing and centersection holes are drilled up to 5/8 in. diameter they must be drilled in place together to assure bolt angle and position alignment. The procedure is for right wing. Left wing is a mirror image.

The drawing below (Fig. 54) shows dimensions for the 3 holes on the aft face of the centersection spar. Lay these out accurately and drill straight through into the interior of the spar with a No. 10 drill.

While you're at it, layout the same dimensions on the centersection spar forward face. Drill these 3 holes 1/4 in. diameter.

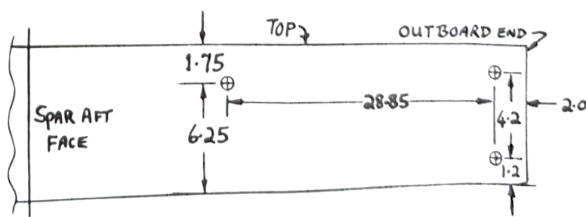


FIG. 54

FOR CONTINUATION, SEE PAGE 18

F.S.

16.2% THICK

0.6° WASH IN
CHORD = 42.7

TOP VIEW OF RIGHT WING - LEFT IS OPPOSITE

SCALE 1/10

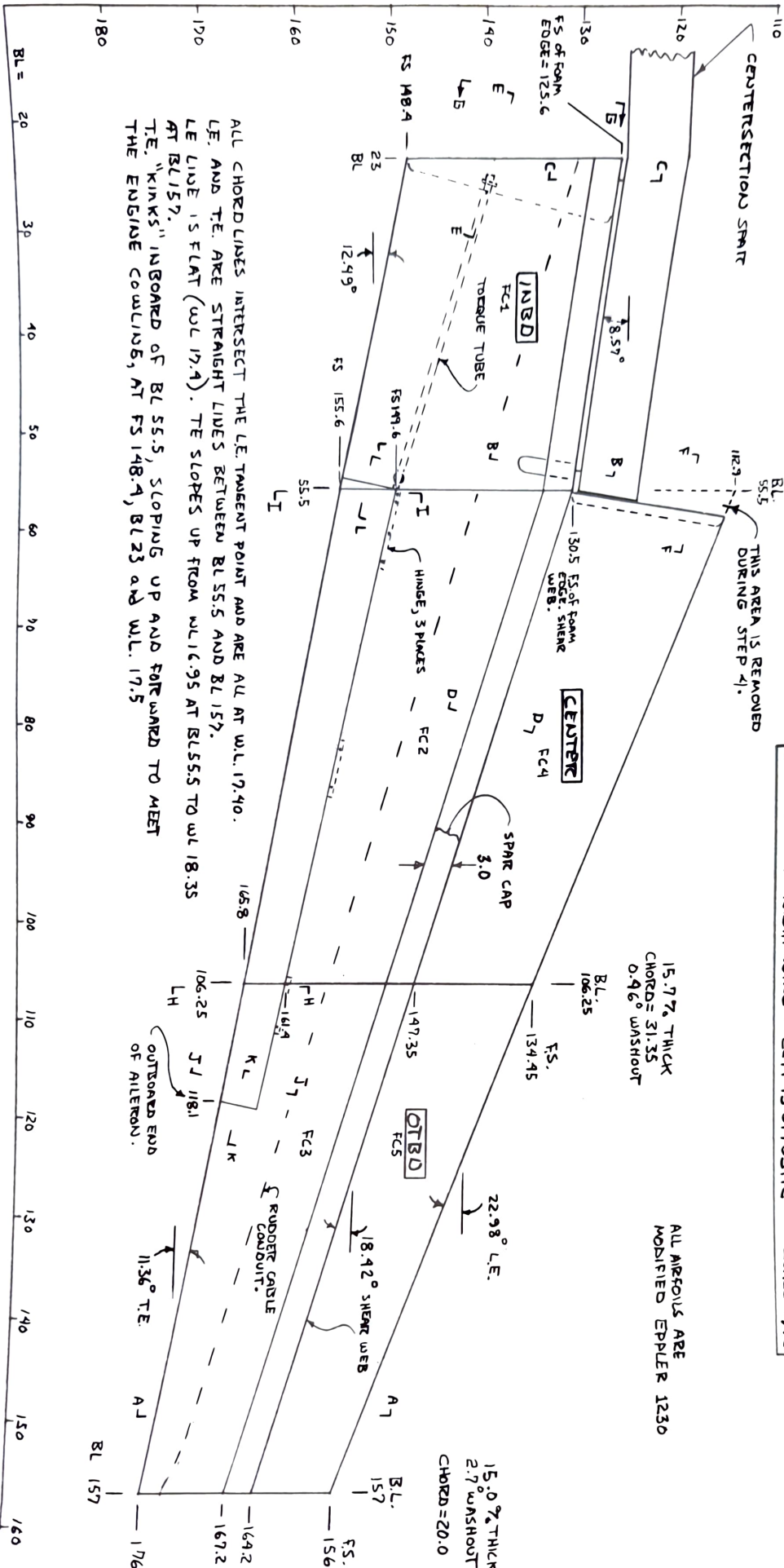
CENTERSECTION SPART

THIS AREA IS REMOVED
DURING STEP 4).

15.7% THICK
CHORD = 31.35
0.46° WASHOUT

ALL AIRFOILS ARE
MODIFIED EPPLER 1230

15.0% THICK
2.7° WASHOUT
CHORD = 20.0



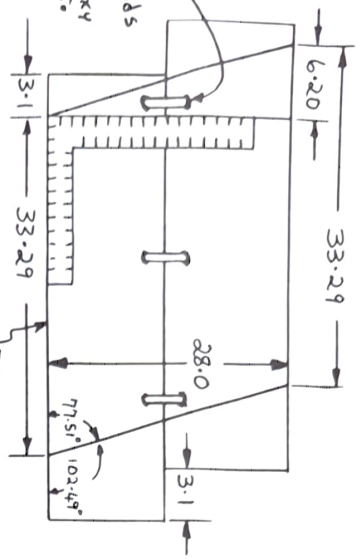
ALL CHORD LINES INTERSECT THE LE TANGENT POINT AND ARE ALL AT WL 17.40.
LE AND TE ARE STRAIGHT LINES BETWEEN BL 55.5 AND BL 157.
LE LINE IS FLAT (WL 17.4). TE SLOPES UP FROM WL 16.95 AT BL 55.5 TO WL 18.35 AT BL 157.
TE "KINKS" IN BOARD OF BL 55.5, SLOPING UP AND FORWARDED TO MEET THE ENGINE COMBING, AT FS 148.9, BL 23 AND WL 17.5

INBOARD.

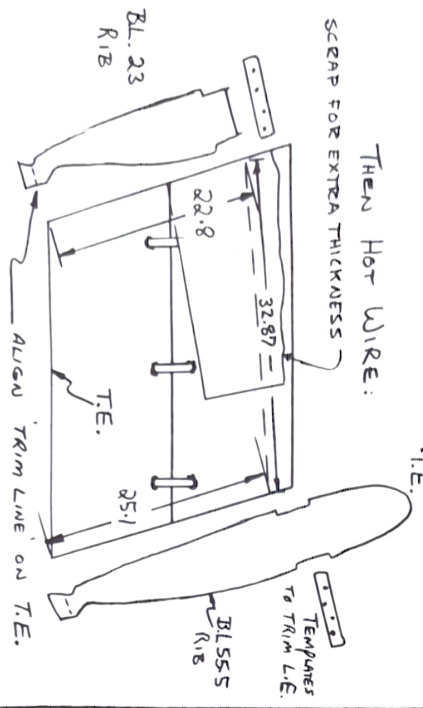
TWO 7"x14"x 41" Blocks.

PLATFORM

5-MIN ON ENDS
OF STICKS
TO KEEP EPOXY
OUT OF JOINTS.



THEN HOT WIRE:
SCRAP FOR EXTRA THICKNESS



AIRFOIL SHAPE

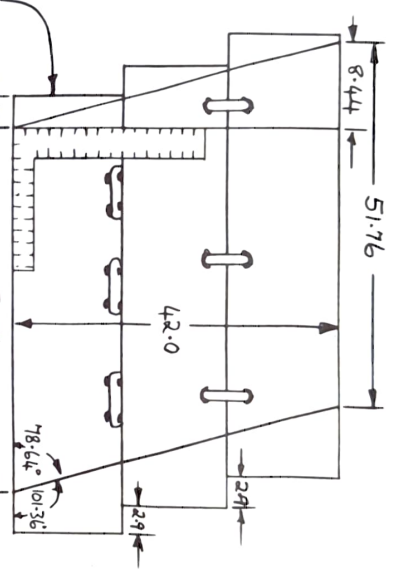
NOTE! THE 6.20 DIMENSION IS
VALID ONLY IF THE 28.0 DIM.
IS ACCURATE!
Parallel with BL. 55.5 w/ L
not necessarily level.



**FOAM BLOCK LAYOUT AND
HOT WIRING.**

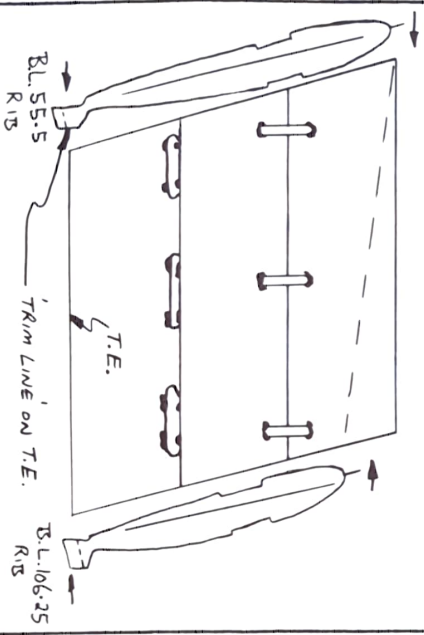
CENTER

THREE 7"x14"x 64" Blocks.



THIS IS THE THIN BLOCK LEFT OVER FROM CANARD CHAP.

THEN HOT WIRE:

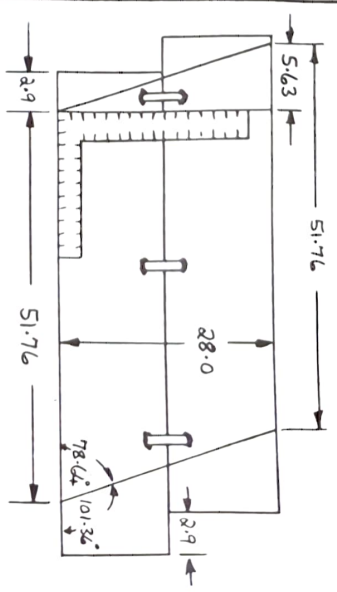


NOTE! THE 8.44 DIMENSION IS
VALID ONLY IF THE 42.0 DIM.
IS ACCURATE!

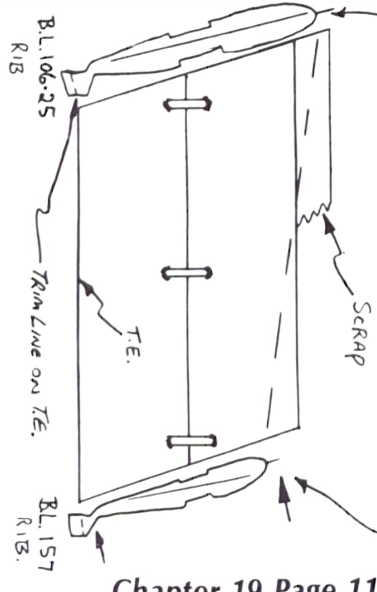
CAUTION!! RIGHT WING IS SHOWN, REVERSE
EVERYTHING, TEMPLATES, ANGLES, ETC. FOR LEFT. LOOK LEFT FOR FORWARD SWEEP!

OUTBOARD

TWO 7"x14"x 64" Blocks

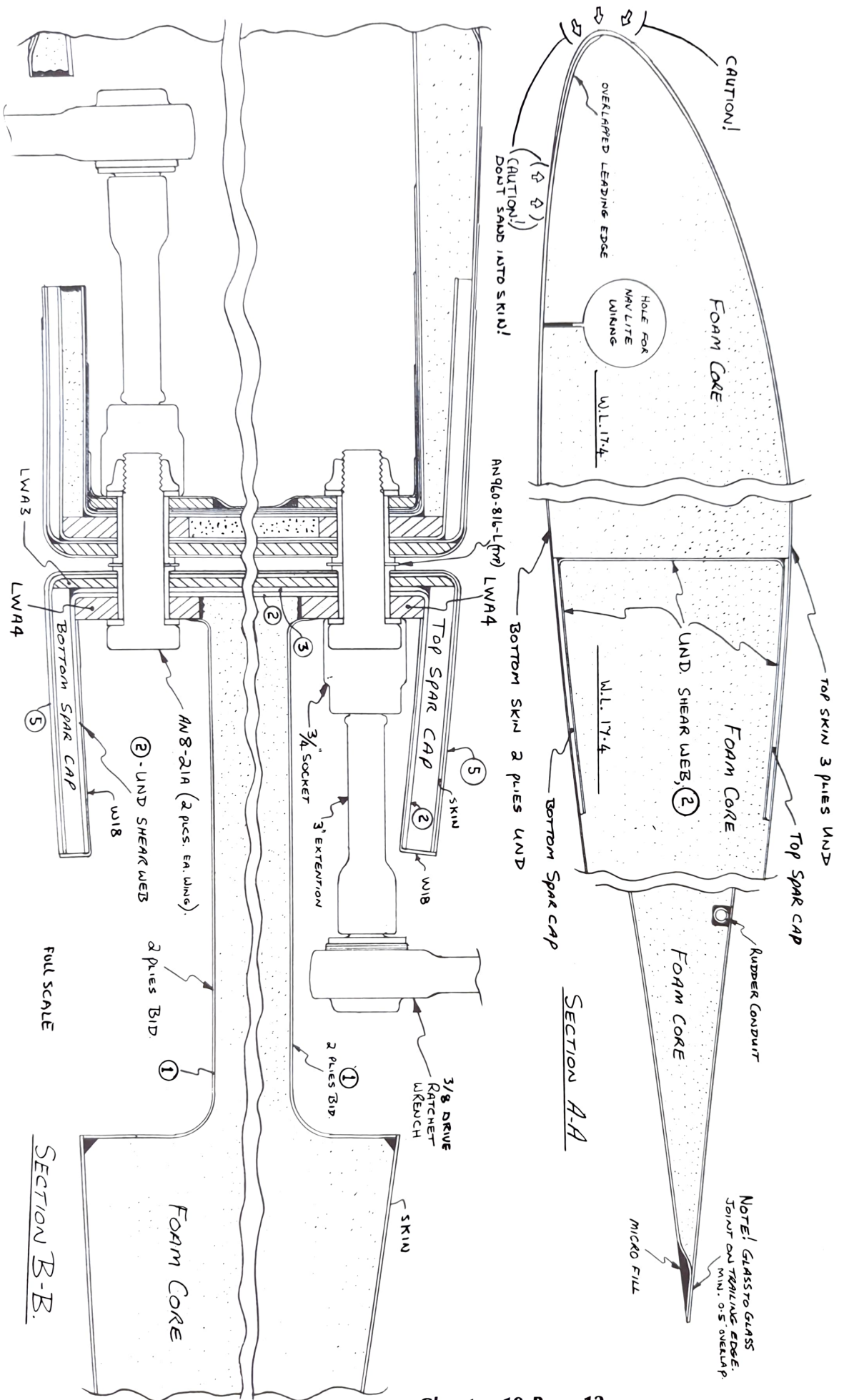


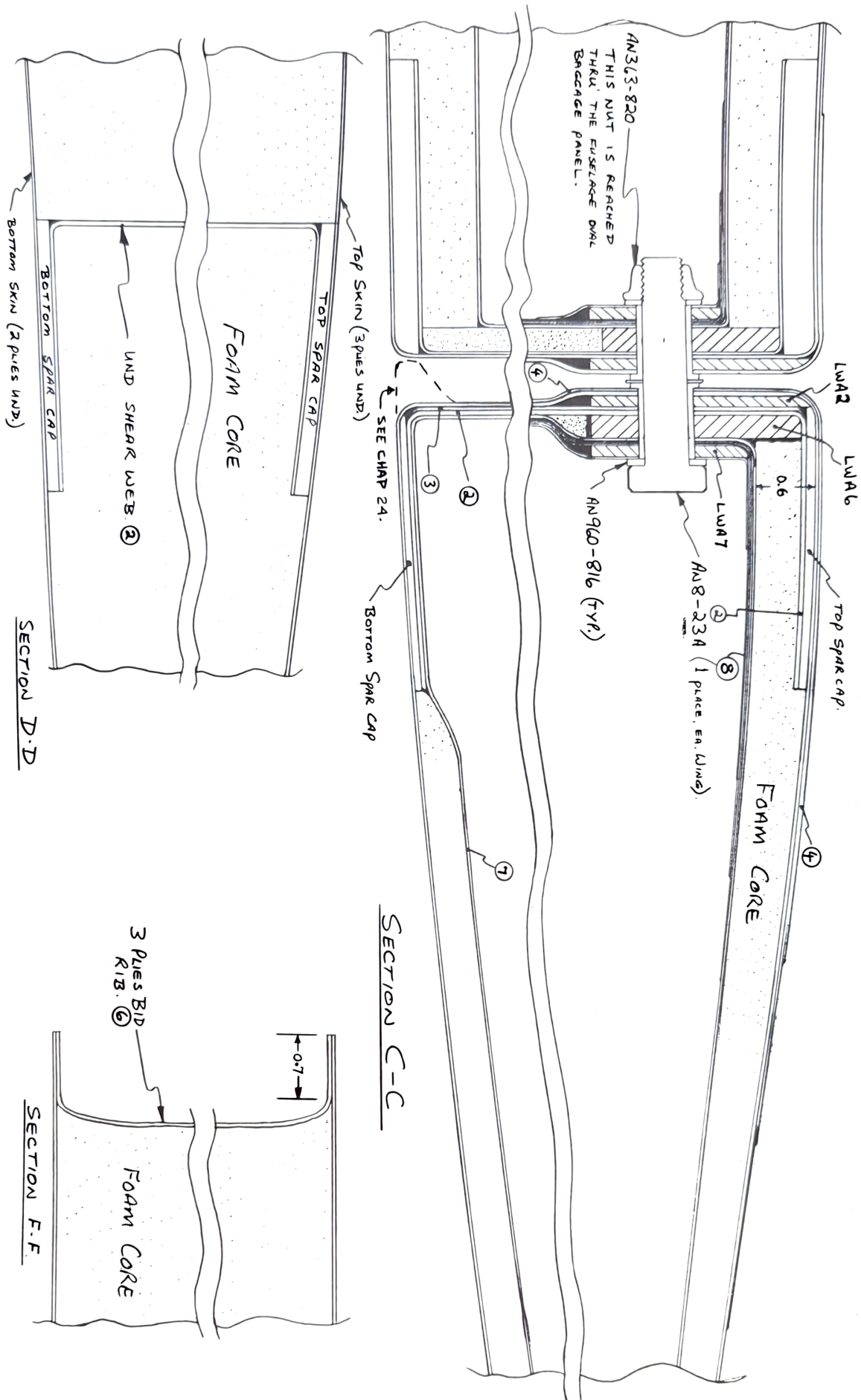
ALIGN THESE HIGH, TO LEAVE ENOUGH FORM
FOR WINGLETS



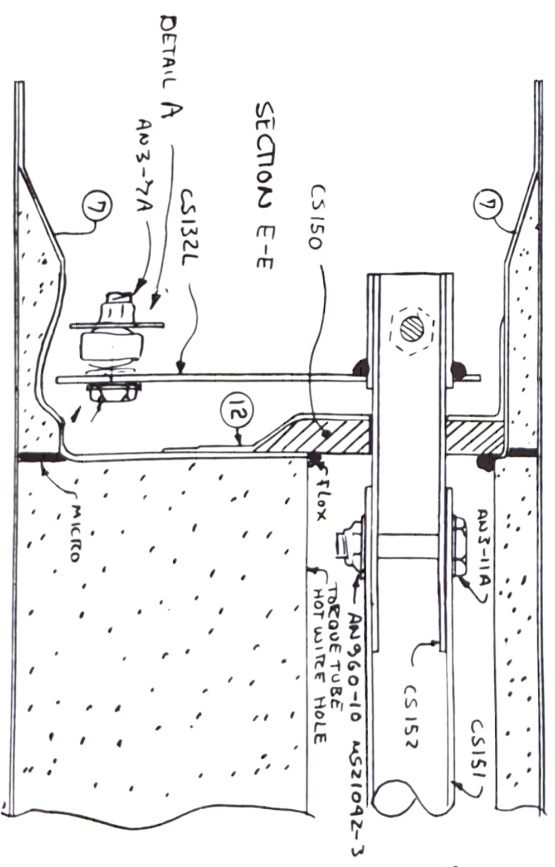
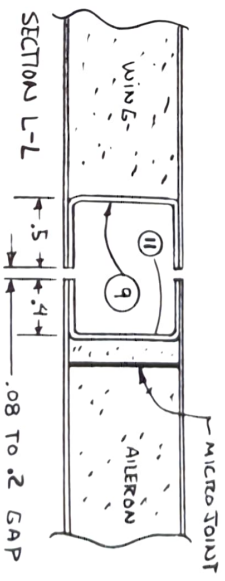
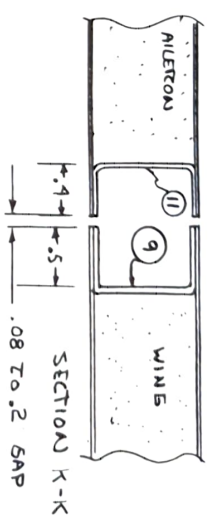
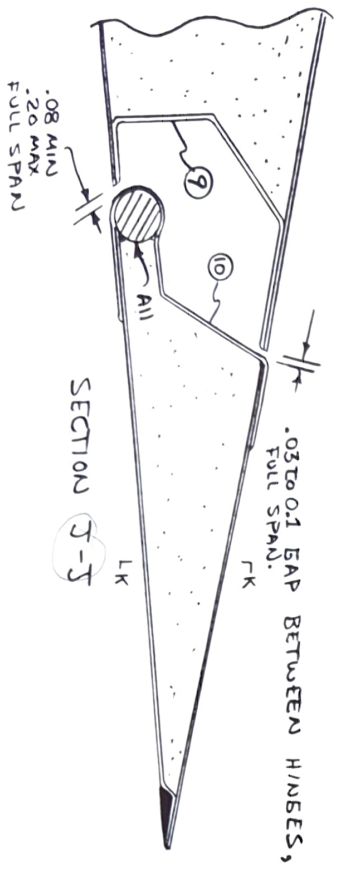
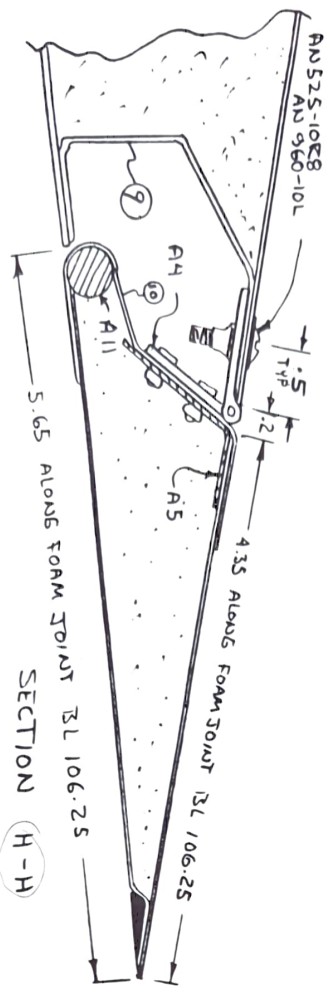
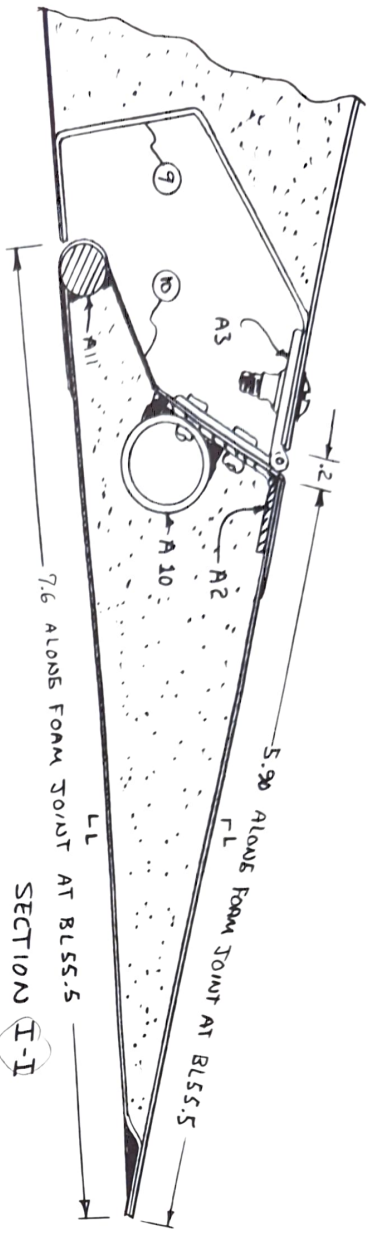
NOTE! THE 5.63 DIMENSION
IS ONLY VALID IF THE
28.0 DIM. IS ACCURATE!

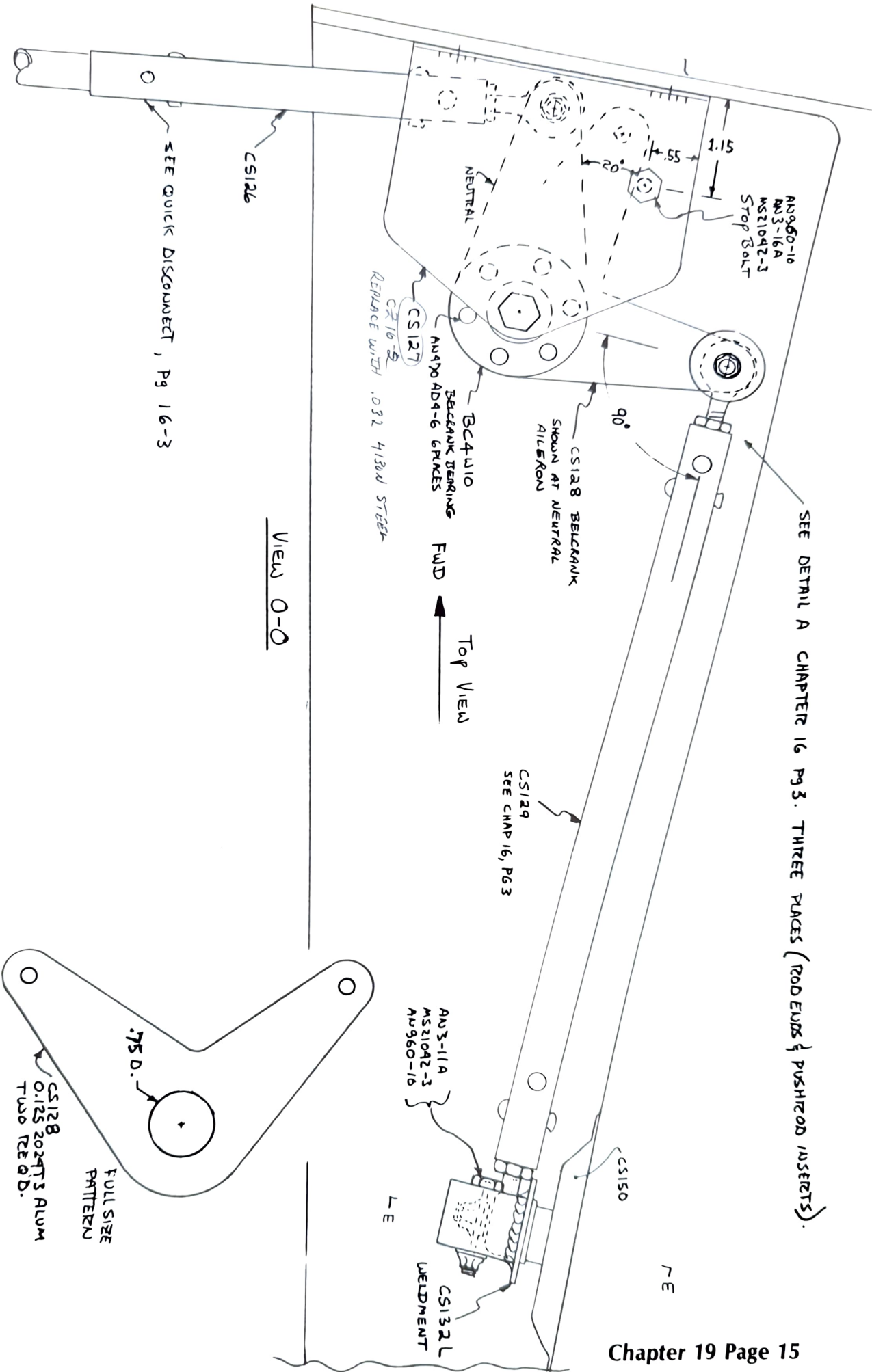
NOTE! THIS PAGE IS
NOT DRAWN TO SCALE.

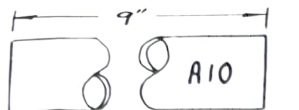




C2 16-2
 the I, H, S, S mount BRUNNIST ROD A-11 1/16" FARTHER FORWARD.



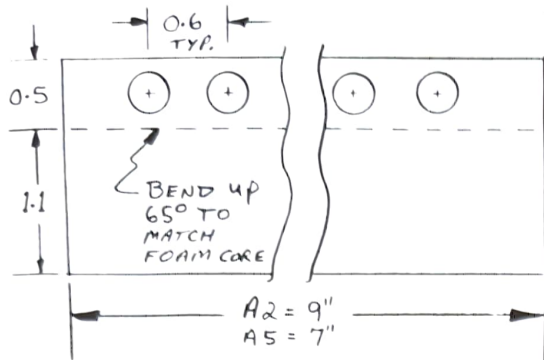




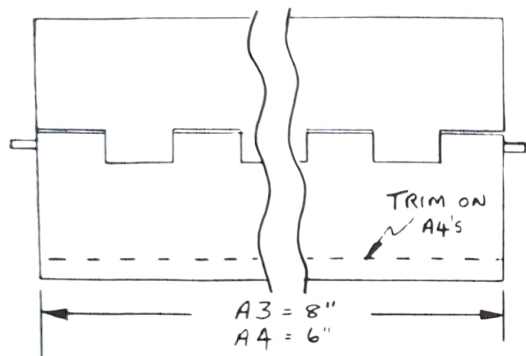
3/4" O.D. x .058 6061-T6
ALUMINUM TUBE



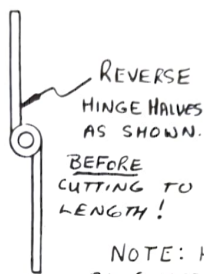
3/8" DIA. STEEL ROD
BALANCE (IT IS OK TO BUTT
SHORTER PIECES)



A2 & A5
BRACKETS
•032 THICK
2024-T3 AL.
ANAL PRETAB



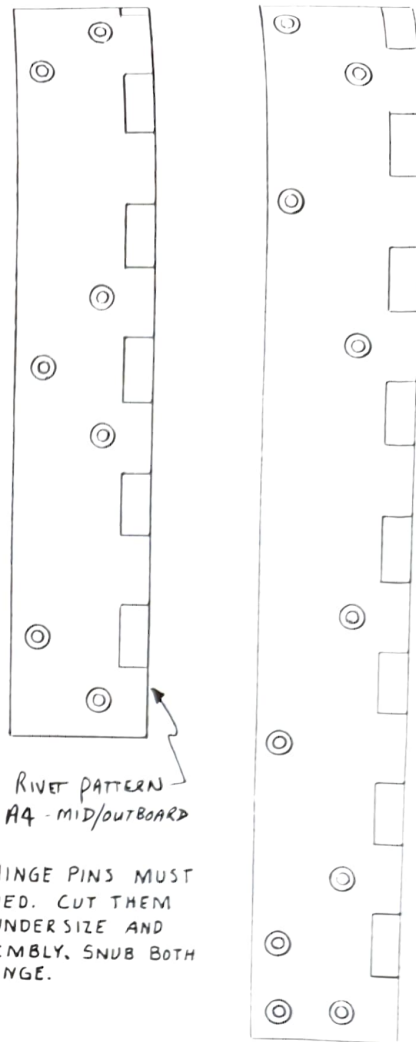
A3 = 8"
A4 = 6"



REVERSE
HINGE HALVES
AS SHOWN.

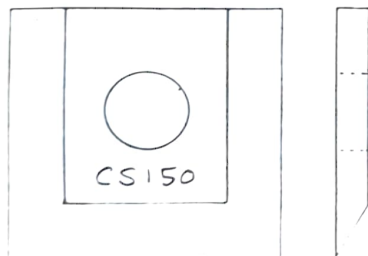
BEFORE
CUTTING TO
LENGTH!

NOTE: HINGE PINS MUST
BE SAFETIED. CUT THEM
SLIGHTLY UNDER SIZE AND
AFTER ASSEMBLY, SNUB BOTH
ENDS OF HINGE.

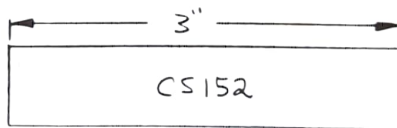


RIVET PATTERN
A4 - MID/OUTBOARD

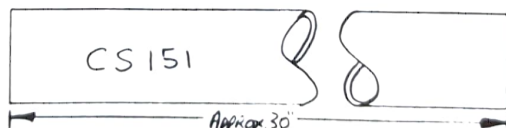
A3 & A4 HINGE IS MS20001-P6
EXTRUDED ALUMINUM PIANO HINGE
BOTH A4 HINGES HAVE ONE LEG
TRIMMED TO .85.



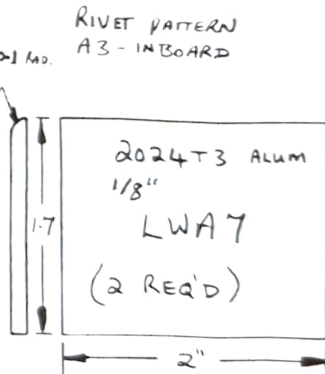
CS150 1/4" THICK PHENOLIC
FULL SIZE 5/8" DIA HOLE
REAM OR USE FOUR 5/8" DIA.
SPOT FACE USED IN CHAPTER
9 AND 14, FOR SLIP FIT ON
5/8" DIA STEEL TUBE (CS152)



5/8" O.D. x .049W - 4130N STL. TUBE

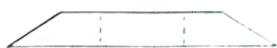


Approx. 30"
3/4" O.D. x .058 6061 T6 ALUM. TUBE

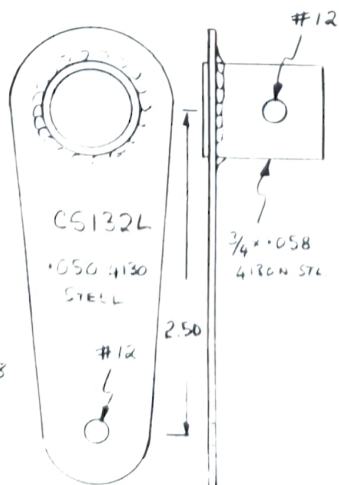


RIVET PATTERN
A3 - INBOARD

2024T3 ALUM.
1/8"
LW7
(2 REQ'D)

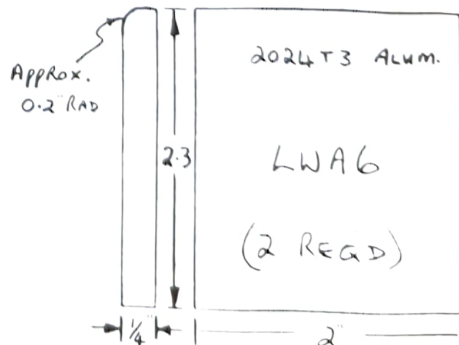


NOTE: CS127, CS128
ARE AVAILABLE
PRE-FINISHED



CS132L
•050 4130
STEEL

3/4" x .058
4130N STL



2024T3 ALUM.
LW6
(2 REQ'D)

OTHER NEEDED METAL PARTS ARE IN
CHAPTER 14.

B. Wing line-up and line-bore.

Jig the right wing top side up on your worktable so the incidence level board (Fig. 42) is **absolutely level**. Refer to page 19-8 and recheck if in doubt. Position the wing with the tip overhanging the end of your table as far as possible, so there is room to mount the centerspar in front of the wing (Fig. 55). You may have to extend your table to accommodate the center spar. Position the center spar, using blocks or shims as required, so the top surface lines up with the top surface of the wing, the bottom surfaces likewise, the A-A and B-B marks line up exactly, and the 3 hard points on the centerspar are tight against the corresponding hard points of the wing. A slight out-of-parallel of the hard points may be dressed with a hard sanding block and 36 grit paper. Apply a few generous blobs of bondo to secure the center spar to the wing (Fig. 56). Locate your 10-inch long, 1/4 inch diameter drill bit and drill through from the front all three holes as shown (Fig. 56). Clear the bit every 1/4 in. of drilling. Do not start this job with a dull bit.

Now, locate your 5/8 in. spotface with 1/4 in. pilot. This is the same tool needed in Chapter 9 and 16. As in the above paragraph, drill through with the spot face, going slow and clearing the bit often. Do not attempt this with a dull spot face. Don't allow the layup to get too hot. You can counter bore the inboard hole slightly from the wing side to avoid detaching the glass when the spot face tool cuts through. All holes are now opened to 5/8 and aligned with each other. At this point, bondo level boards on the top surface of the center spar, each side, between points A and B, in exact agreement with the right wing level board and with each other. This will be your reference in leveling the center spar to the left wing, and in leveling the center spar with the longerons when it is installed in the fuselage.

You must fill the inboard hole on the forward face of the spar (foam and 2 plies BID) to seal fuel from the spar. The out-board ones can be left open.

Machine or purchase the LWA9 bushings--see Fig. 57.

Now, knock off the bondo and using the tool shown, measure the actual depth of each of the six 5/8 in. diameter holes (spar and wing). Face the LWA 9 bushings to a length that is the same as, or .010 in. shorter than the hole length. Do not make the bushings longer than the holes. Epoxy the bushings in and let cure.

Jig boring the left wing to the centerspar is the same as the right **except** you may have to allow for one or more washers between either the top or bottom hard points so that both the wing and centerspar level blocks are level and in agreement with each other. Note in your plans the number, thickness and location of any washers needed on the left wing for future reference. Refer to chapter 7 section B-B and G-G for locations for the wing mounting hardware. Needed are (each wing):

2 AN 8-21A bolts (See note at bottom of page)

1 AN8 -23A bolt

6 AN 960-816 washers

3 AN 960-816L thin washers (between bushings)

3 AN 363-820 nuts

Additional 960-816L washers may be needed if required to shim incidence. One washer changes incidence by 0.4 degrees. Finer adjustments are made by filing washers.

Tools needed for wing attach:

Two each: 3/8 drive ratchet

3 in. extension

3/4 in. socket

Note: Due to the long (28.83 inch) distance between bolts, the tolerance on fit of bushing-to-bolt is not real critical, like it normally is on aircraft wing attachment. Even a .015 in. clearance (slop) is acceptable and safe. The large diameter 1/2 in. bolts are selected to get adequate washer--overlap on the bushings. From a purely strength stand point, 1/4 in. bolts are enough!

Now, return to Chapter 14 and install the centerspar in the fuselage.

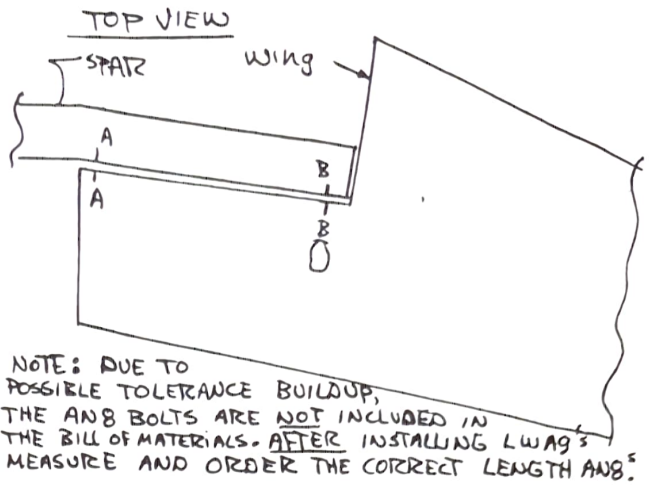


FIG. 55

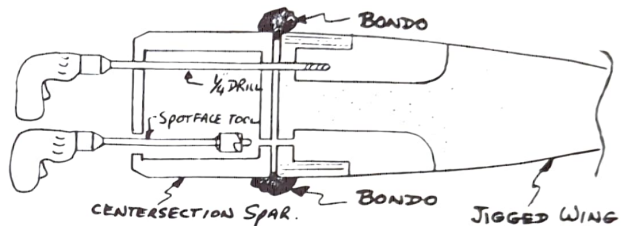


FIG. 56

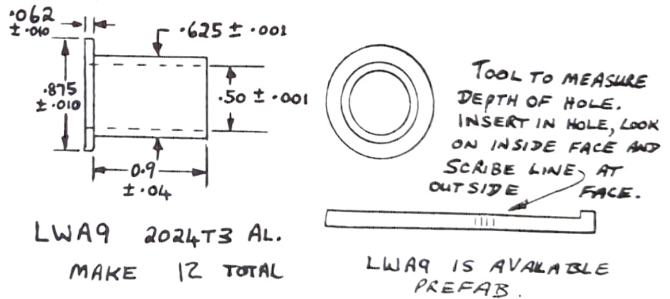
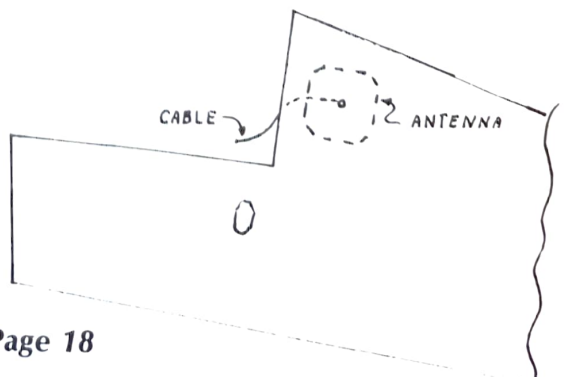


FIG. 57

TRANSPONDER AND DME ANTENNAS

BEST LOCATION FOR RST TRANSPONDER AND DME ANTENNAS IS INSIDE LEADING EDGE WING RIB. ROUTE SLOTS IN RIB AND FOAM WITH DRILL. PUT ANTENNA IN PLACE WITH MICRO, PATCH RIB WITH 2 PLYS BID, AND RUN CO-AX CABLE THRU CENTERSPAR. WORKS GREAT!



CHAPTER 20 WINGLET AND RUDDER

OVERVIEW. This chapter involves building the large vertical fins, mounting them to the wingtips, building and mounting the lower vertical fins, fabricating the rudders and hooking up rudder controls. The right wing tip is shown. Reverse to a mirror image for the left winglet. The upper fin has **undercamber facing outboard**. The lower fin has **undercamber facing inboard**. In-flight, the upper fin lifts inward and the lower fin lifts outward. This lift distribution works against the normal vortex rotation at the wingtip, increasing the effective aspect ratio. The result is an increase in climb and range, as compared to a vertical fin not designed using the NASA Whitcomb-winglet technology.

CZ 16-2
BUILDER HINTS
P 2



STEP 1. CUTTING CORES

Refer to the planform view and hot-wire configuration drawing on this page (Fig. 1). The hot-wire templates are on page A13 and A14. Refer to Chapters 3 and 7 for details on hot-wiring cores. The root (WL 18.4) template is used for top and bottom fin. Hot-wire the cores. Then round the bottom pieces L.E. and shape it's tip as shown. Do not round the top winglet.

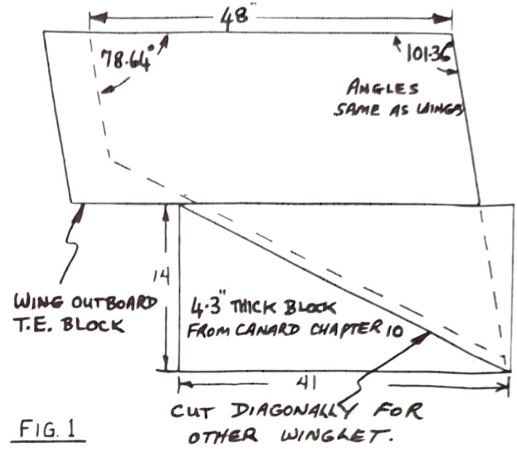
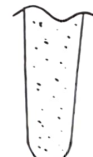
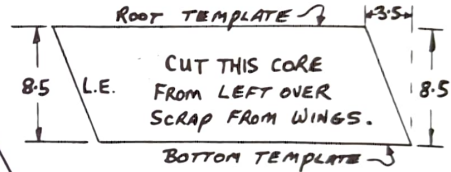


FIG. 1



ROUND ENTIRE TIP OF LOWER WINGLET.

F.S. 196.6

1" URETHANE FOAM 'CAP'

W.L. 66.4
W.L. 65.4

A A

RST COM ANTENNA
INSTALL IN STEP 2 BEFORE
GLASSING INBOARD SKIN

CO-AX CABLE

1/5 SCALE

RIGHT WINGLET
SHOWN - LEFT IS
MIRROR IMAGE.

F.S. 176.8

D

12.14

RUDDER

B

F.S. 186.8

10"

W.L. 18.4

E

14.5

E

11.5

3"

W.L. 9.8

F.S. 190

D

DRAIN HOLE, INBOARD
SIDE - SEE Pg 20-6

C

F.S. 160.5

B

W.L. 17.4

F.S. 156

F.S. 159.7

ROUNDED

STEP 2. GLASSING THE SKINS

Note the top fin is undercambered on the **outboard side**, full span. The bottom fin matches the top at W.L. 18.4 then transitions to a **cambered-inward** airfoil section at its bottom. The left-over blocks the cores were cut from are used to jig the cores flat. Glue these to a flat table (Fig. 2). The cores are easily warped until both skins are installed. Jig them for glassing by nailing at the root and tip and if necessary, with small dabs of 5 minute. **Recheck that root and tip level lines are parallel** (no twist).

Glass the outboard skin with the following schedule: **1st ply UND**, orientation diagonally from the root T.E. to the L.E. **2nd ply is also UND**, and crosses, from root L.E. to tip T.E., **3rd ply** is on upper surface only: it is **BID at 45 degrees** extending from root, up 18 in.(Fig. 3). Peel-ply the entire BID surface. Knife trim all around (Fig. 2).

Refer to wing Chapter 19 for similar L.E. and T.E. details to obtain the correct skin overlaps, then jig and skin the inboard side using the same layup schedule, as outboard side (Fig. 4). **Be sure the root and tip level lines are parallel.** Refer to the plan view. Carve the 1 in. tall tip cap from urethane foam. Round to a pleasing shape and skin with 1 ply BID.

STEP 3. JIGGING UPPER WINGLET TO WING

After cure, refer to page A17 for the winglet trim template. Cut this piece of paper out and wrap it around the inboard side of the upper winglet, lining it up with the L.E. (extend the level-line up the L.E.), and lining it carefully along the root edge(Fig. 5). Mark the trim line then saw the piece out (coping saw) sawing roughly perpendicular to the mark. Discard the piece.

Now, lay your wing **top-side up** on the table, wedge it up so it doesn't rock around. Weight it down with about 50 lb. of sand bags. Locate the Winglet Positioning Reference Point (**WPRP**) and mark it clearly (Fig. 6). This is the inboard front corner of the aileron cutout. B.L. 55.5 and F.S. 149.6 (see page 19-10). Now, set the winglet on top of the wing top surface (Fig. 7). Have someone hold it and move it around until the A, B and C dimensions are achieved (Fig. 8). It's best to set a box along side and tape a stick to it to hold the winglet upright while jiggling. The A dimension is from **WPRP** to the L.E. mark on the winglet at the top surface of the wing. The B dimension is from **WPRP** to the root T.E. of the winglet. The C dimension is to the tip T.E. of the winglet.

A and B are critical and should be within 0.05 in. C is not critical and can be ± 1 in. Once positioned, mark the wing top skin at the inboard edge of the winglet (Fig. 9). Remove winglet. Cut the wing all the way through, being careful to not nick the rudder conduit. Discard this piece (Fig. 10).

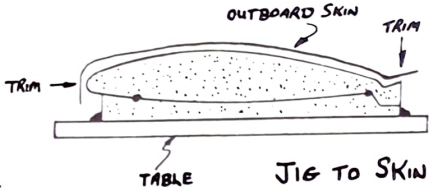


FIG. 2 JIG TO SKIN.

NOTE: INSTALL RST COM ANTENNA BEFORE GLASSING INBOARD SKIN. SEE PAGE 1.

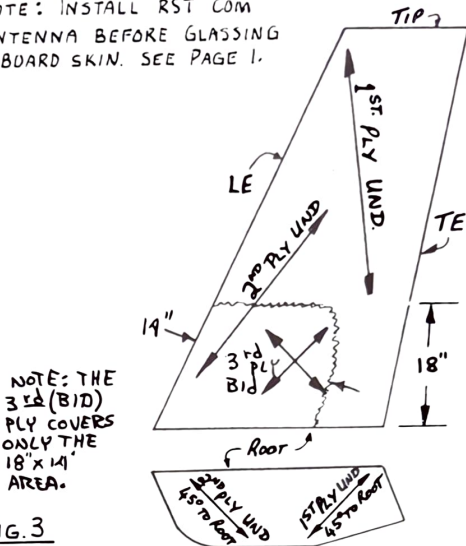


FIG. 3



FIG. 4

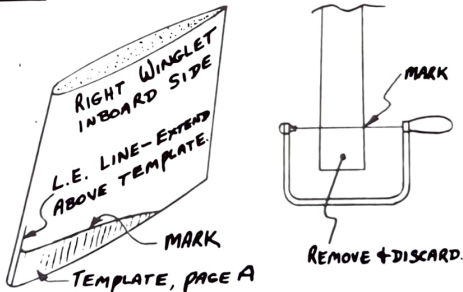


FIG. 5

FIG. 6

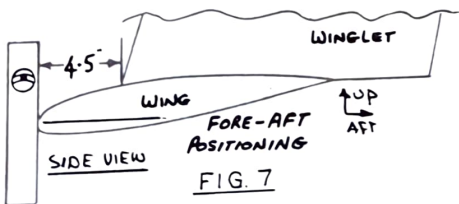


FIG. 8

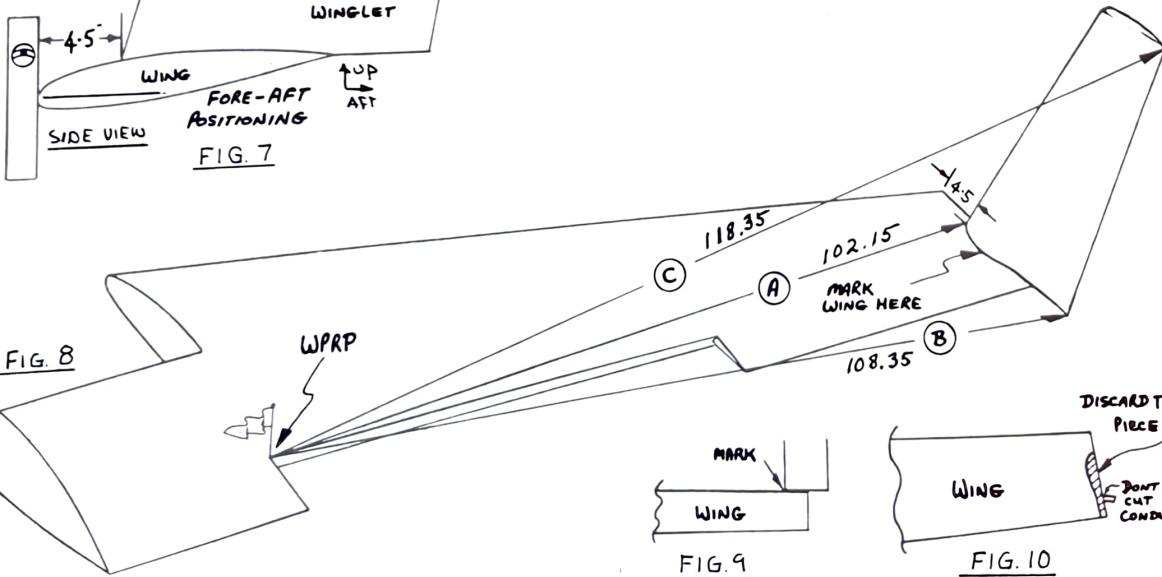


FIG. 9

FIG. 10

Now, lining up the edges as shown and rechecking the ABC dimensions, jig the winglet to the wing. This time hold it firmly in place with two or three 3/4" diameter lumps of Bondo. Support it sideways with a 3 foot length of 1 x 2 lumber with lumps of Bondo on each end (Fig. 11). Be sure this is not in the way of the A measurement (Fig. 8).

When the Bondo is hard, remove the box and recheck A, B and C.

STEP 4. INSIDE LAYUPS

Study Section C-C to see the inside layups. Turn the wing over, extending the winglet off the side of the table, exposing the bare foam faces (Fig. 12). Remove the foam locally, with a knife, as shown (Fig. 13), by cutting out a triangular flox corner all around. This is 2 in. deep in the **high stress areas**, and 1/2 in. deep around the other edges. The **high stress area** extends from the rudder conduit to the leading edge, along the winglet wing touching edges (Fig. 12). Do not remove the wings' shear web. Sand the inside glass surfaces. Carve block A to fit nicely as shown (Fig. 15). This extends from the wing T.E. to the winglet L.E. It is carved from 2 lb. (green-urethane foam). Laminate 2 pieces of 2 in. thick urethane. Do not glue in block A yet.

Cut 8 strips of **45 degree BID**, 4 in. wide by 12 in. long. Now, layup the eight small inside tapes, (layup No. 1, Fig. 14). Trowel in flox to fill the void. Where the void is excessive, fill portions of it with foam wedges (Fig. 14). The flox and foam wedges hold this laup firmly against the winglet skin and wing skin and spar cap. Notch the 8 plies locally to fit around the shear web in the wing.

Allow this to partially cure to avoid an exotherm, then fill the flox corners and glass layup No. 2, the inside ribs. These are **8 plies BID** forward of the rudder conduit. Extend two of the 8 plies aft to the winglet T.E. Position the rudder conduit at 13.2 in. from the winglet T.E. along the outside edge of the winglet. Layup No. 2 joggles up over the conduit-trowel in dry micro to avoid air bubbles. After sufficient cure to avoid exotherm, trowel in some wet micro and install block A. Block A must fit well enough to avoid air voids. Weight or nail block A in place for cure (Fig. 15).

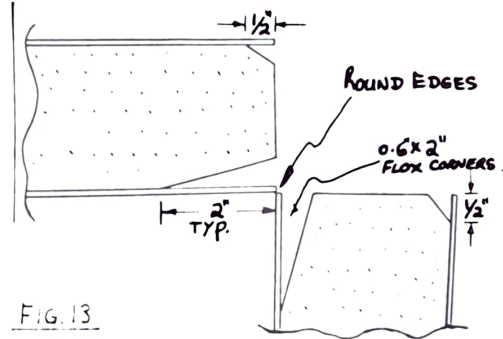


FIG. 13

STEP 5. OUTSIDE LAYERS

After cure, carve block A to a **flat diagonal**, not round, as shown (Fig. 16). Remove peel ply. Round the edges for layup

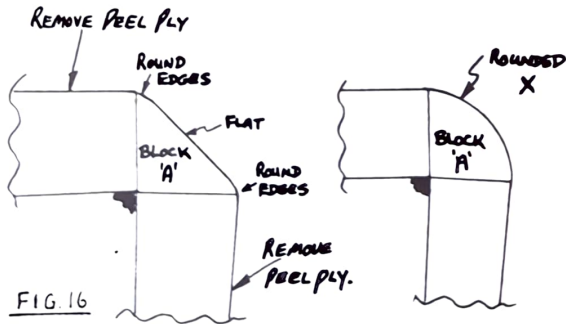


FIG. 16

✓ **CORRECT** X **WRONG!**

and glass layup No. 3, the structural bottom--outboard layup (Fig. 17). This layup consists of **2 plies BID**, extending 15 in. up the wing and 12 in. up the winglet in a tapering fashion as shown plus **7 plies UND**. Make the **2nd BID** ply about 2 in. shorter to taper its edges. Thread the BID around the rudder conduit. Now, cut the following **7 UND** plies, using care to orient fibers along the A dimension.

Ply No.	A-in.	B-in.
1	24	12
2	22	11
3	20	10
4	18	9
5	16	8
6	14	7
7	12	6

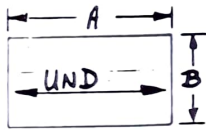


FIG. 15

FIG. 11

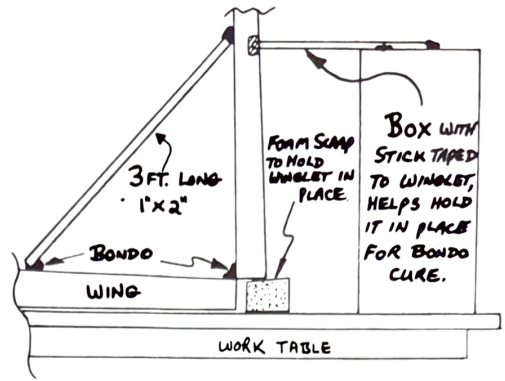
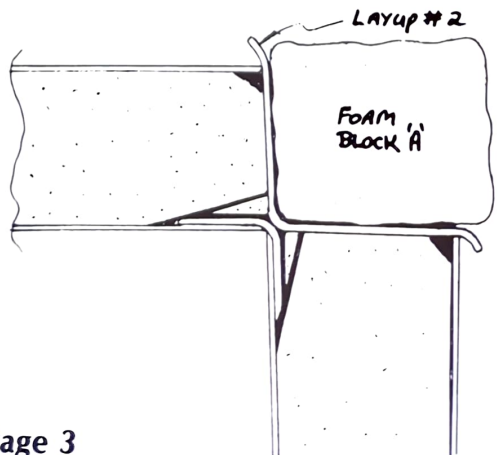
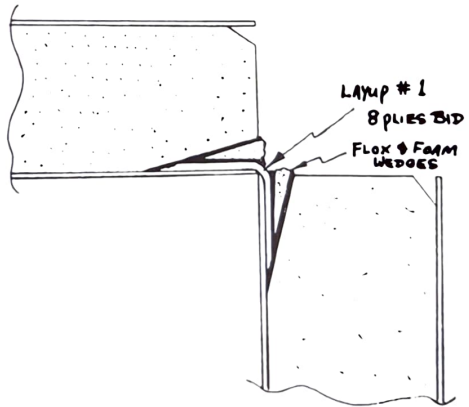
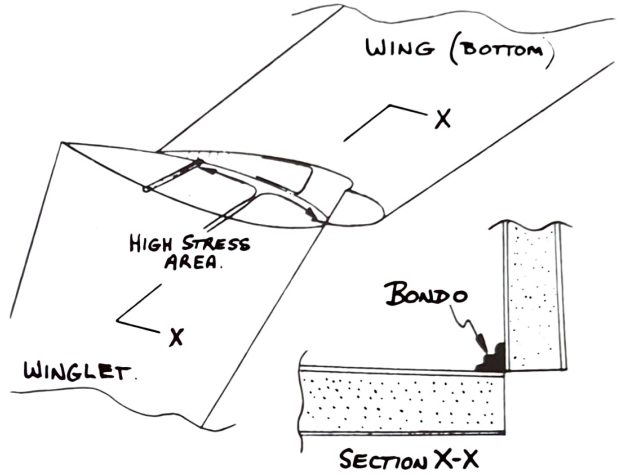
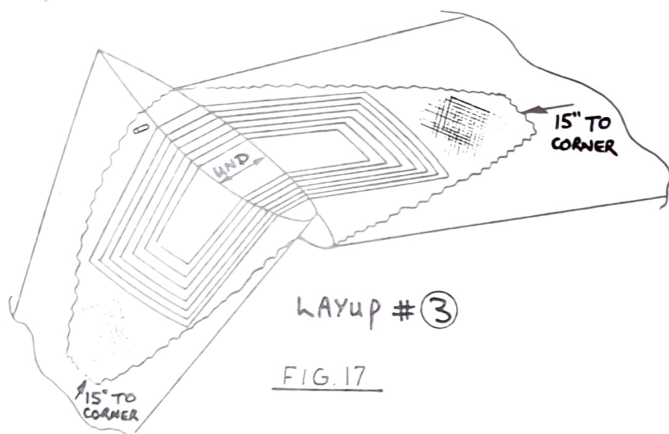


FIG. 12





Refer again to the sketch (Fig. 17), layup the 7 plies of UND with fibers running around the corner as shown, centered on the corner. Keep fibers straight. Peel-ply all edges to make a smooth transition. Cure.

After cure, turn wing over, knock out the Bondo lumps in the corner, remove peel ply, and glass layup No. 4, the structural top-inboard layups. This layup is identical in size, number of plies, and orientation as layup No. 3. Lap the 2 BID plies 1 in. onto the outside of the winglet at the lower leading edge. Peel-ply edges for a smooth transition. Cure.

The top winglet is now structurally attached to the wing. Remove the 3 foot 1 x 2 board.

Do not increase the number of plies--your winglet joint can withstand 90-degrees sideslip flight at 170 mph--considerably over normal requirements.

STEP 6. LOWER WINGLET ATTACH

Trim the lower winglet as shown (Fig. 19) so its root-W.L. 18.4 fits up to match the upper winglet. Fill the small voids shown with urethane foam and micro it in place. Glass a 2 in. wide tape of BID at 45 degrees to structurally attach the lower winglet at the outside and inside as shown (layup No. 5, Fig. 19).

Now you can install your desired wingtip light (see page 20-6, View B-B). The light must be installed at the position shown. Do not add weight aft of that location. Also do not cut into the structural area.

An optional fairing block can be installed as shown in View B-B to fair the wing tip into the winglet surface. Use any type foam covered with 2 plies BID.

STEP 7. RUDDER Carefully layout the rudder dimensions shown (Fig. 20), on the outside and inside of the winglet. Saw through the skin on both sides with a razorsaw, then cut through the foam, to remove the rudder. The rudder is hinged on its outboard edge with a piano hinge. The piano hinge is 7.5 in. long, extending from W.L. 18.4 up. Study section D-D, view B-B and Section E-E.

Set the wing leading-edge-down. Remove foam as shown, 0.6 in. deep at the top and bottom (Section D-D) and 1 in. deep at the front (View B-B). Glass 3 plies BID in this entire area plus an extra ply on the edge where the hinge will go (layup No. 6). Knife trim. After cure, trim the hinge area forward 0.2 in. x 7-1/2 in. to recess the hinge (Fig. 21). Drill and fasten the hinge to the wing with three AN525-10R8 screws, with K-1000-3 nutplates on the hinge (Fig. 22). Trim the hinge width as required to fit.

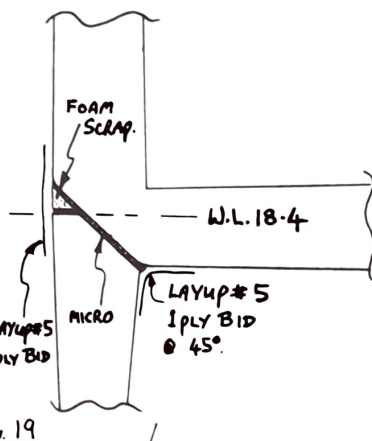
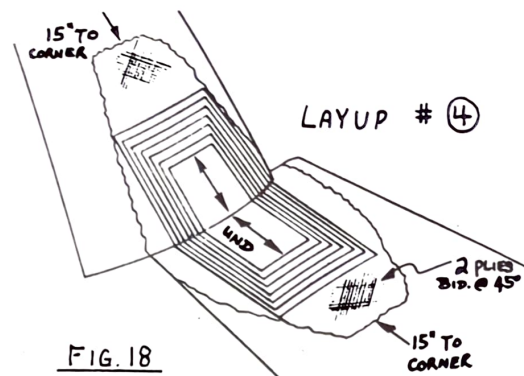
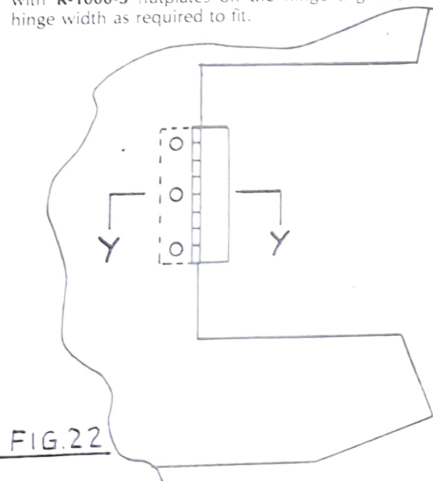


FIG. 19

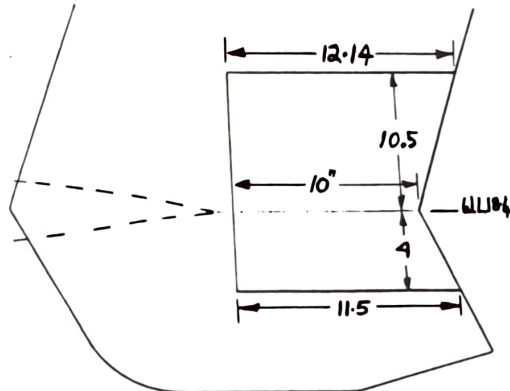


FIG. 20

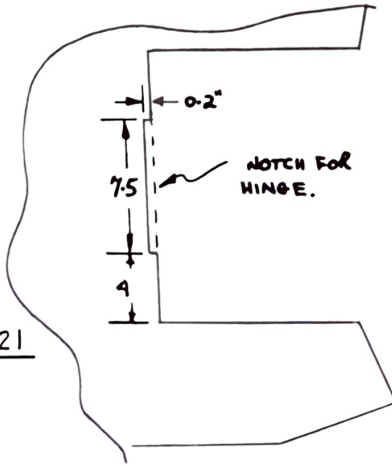
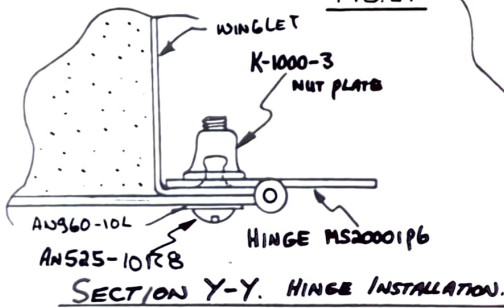


FIG. 21

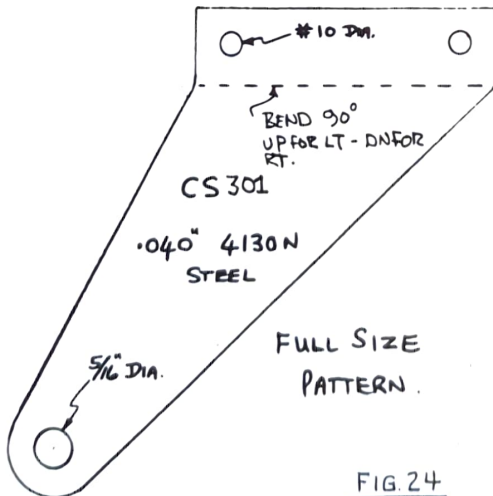
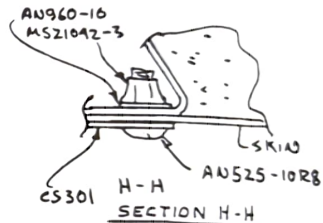
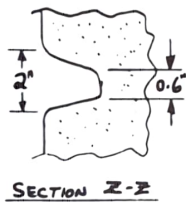
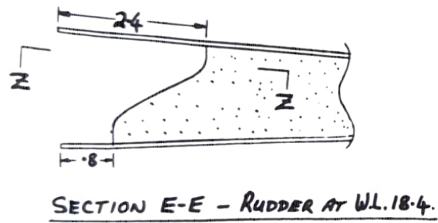
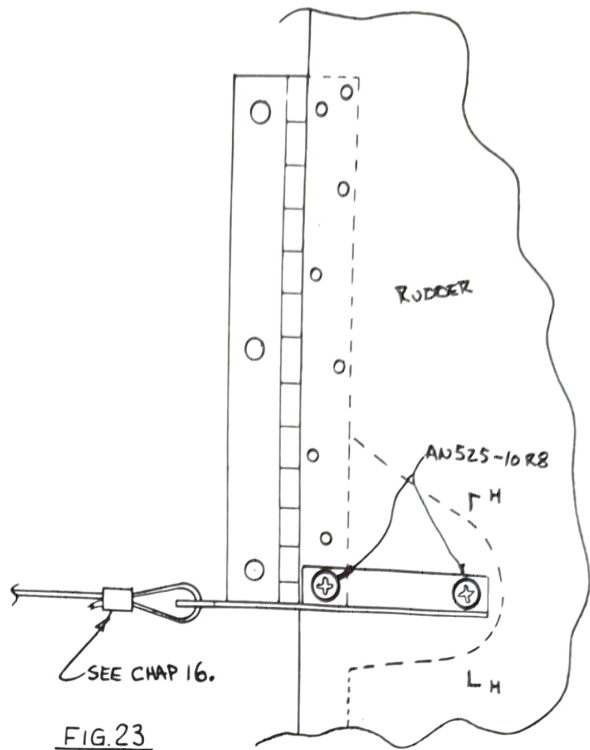


Grab the rudder and, in a similar fashion, remove foam all around the edges. Remove 0.6 in. top and bottom and 0.8 in. on the forward face. In addition, remove a tapered depression to reinforce the belcrank as shown (Fig. 23). The depression extends 2.4 in. deep from the hinge line, on the outboard side (Sections E-E and Z-Z). It is conical in shape and center at W.L. 18.7. Glass this area (layup No. 7) with **3 plies BID** plus an **extra ply** at the hinge and belcrank depression.

When cured, install the hinge and belhorn (available from your Cozy distributor) using the 7 pop rivets and 2 each **AN525-10R8** screws, **AN906-10L** washers and **MS 21042-3** nuts (Fig. 23). Install cable and swage fitting. Max rudder travel is 30 degrees however the swage must still have at least 0.7 in. travel until it bottoms on the conduit-brake master cylinder is the rudder stop--any other stop will leave you without brakes!

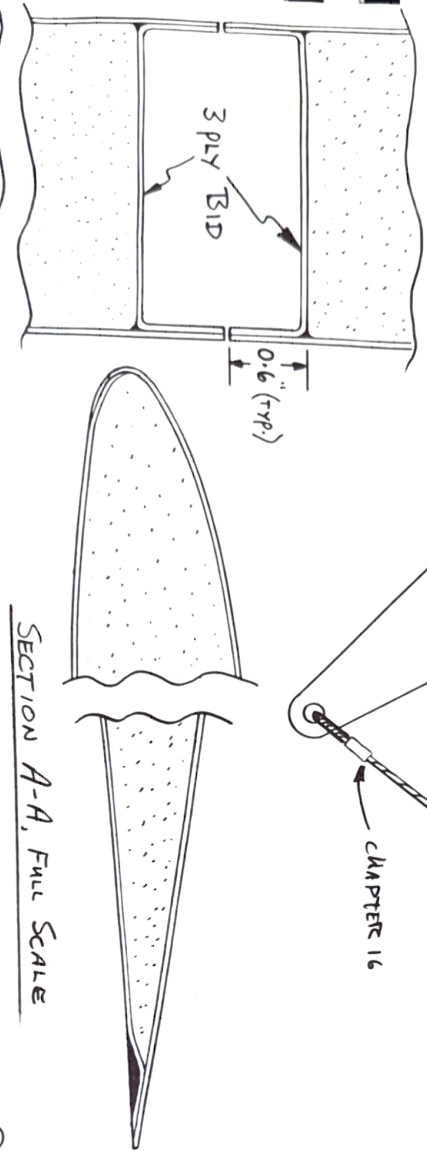
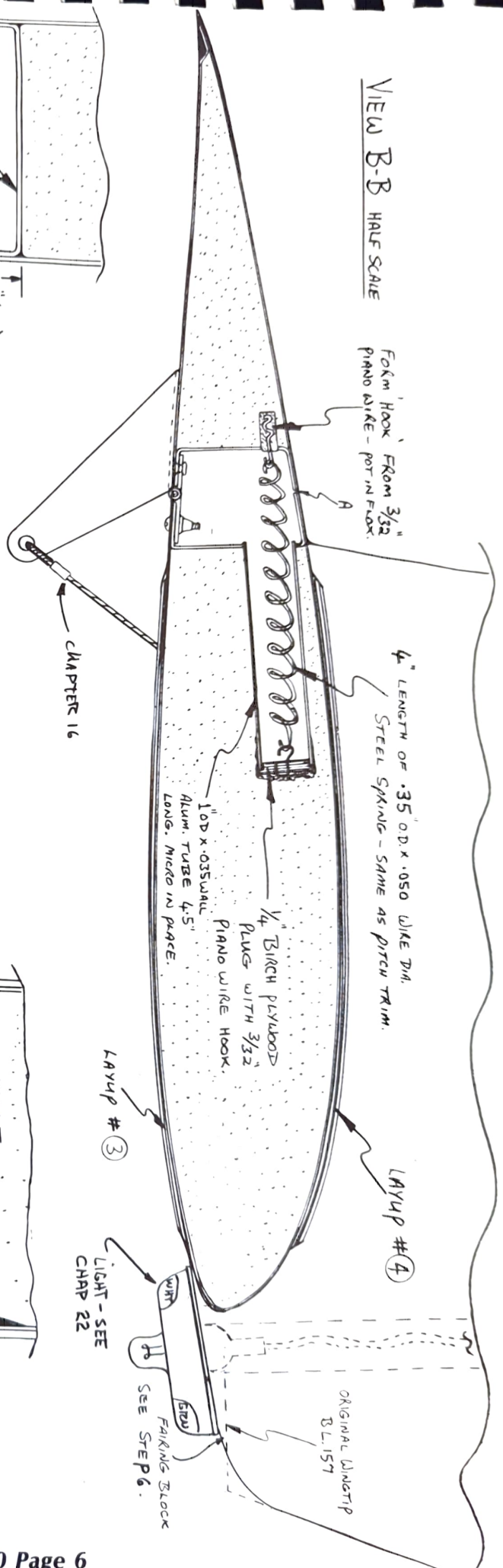
Return spring--this returns the rudder to neutral on the ground. In-flight, the airloads force the rudder to neutral unless the pilot steps on the rudder pedal. Install the tube and hook shown (View B-B), near the top of the rudder along the inboard skin. The 1 in. hole in the foam can be cut easily if you file some notches in the end of a tube and rotate it to saw the hole like a long 'holesaw'.

The edge, marked 'A' is the rudder stop. Cozys do not have, nor need inflight rudder trim. The edge at A can be trimmed to allow the rudder to move more inward or shimmed to move the stop outward, to provide ground-adjustable rudder trim. Once trimmed for ball-centered flight, further adjustment should not be needed.

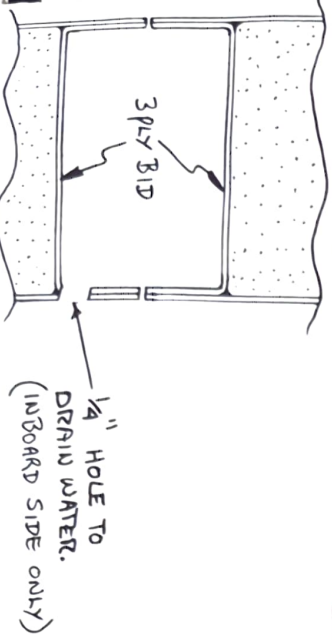


Now, go back TO CHAPTER 16 AND FINISH THE RUDDER CONTROL SYSTEM.

VIEW B-B HALF SCALE

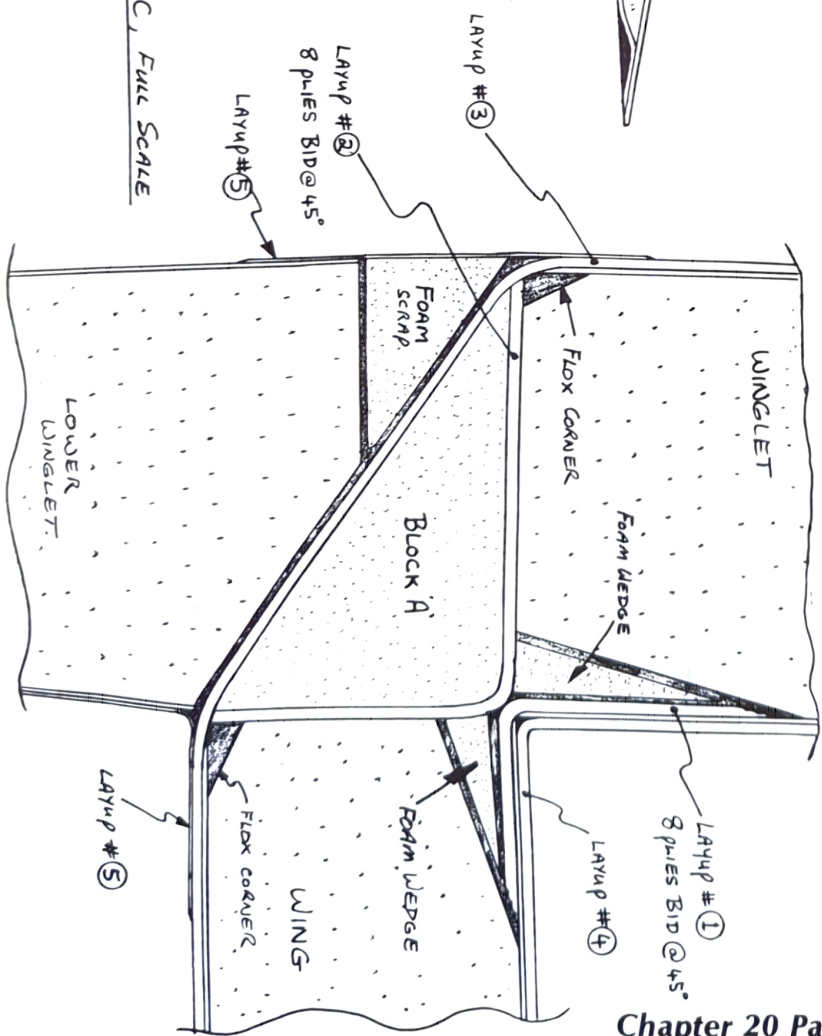


SECTION A-A, Full Scale



SECTION D-D Full Scale

SECTION C-C, Full Scale



CHAPTER 21

WING STRAKES & FUEL TANKS

OVERVIEW. This chapter is late in the construction sequence so other things can be built without having to lean over the large wing strakes. The strakes will have to be complete, however, before you can finish the fairings in Chapter 18. The strakes provide several functions: 1) Torsional stiffness and strength for the centerspar, 2) Two 25 gal. selectable fuel tanks with sumps, 3) Aerodynamic lift, and 4) Some crew accessible storage space.

In this chapter you will jig and build the fuel tanks and storage areas out of glass and H45 rigid PVC core, install fuel sumps (to provide fuel in unusual attitudes including sideslips, nose-down parking, and steep descents), plumb fuel lines forward to the selector valve and aft to the pumps and gascolator, and plumb vent lines. The location of all components and plumbing is important to the correct operation of the fuel system. **Do not modify.** The instructions refer to only the right side strake. The left is similar except where indicated. Start by studying the plan view drawing, and all section views to acquaint yourself with the strakes. Exact planform accuracy is not required. If necessary, trim or shim to obtain good fits of all parts. **Do use care** to set the **incidence** correctly by observing the 17.4° waterline. The strake is an aerodynamic surface.

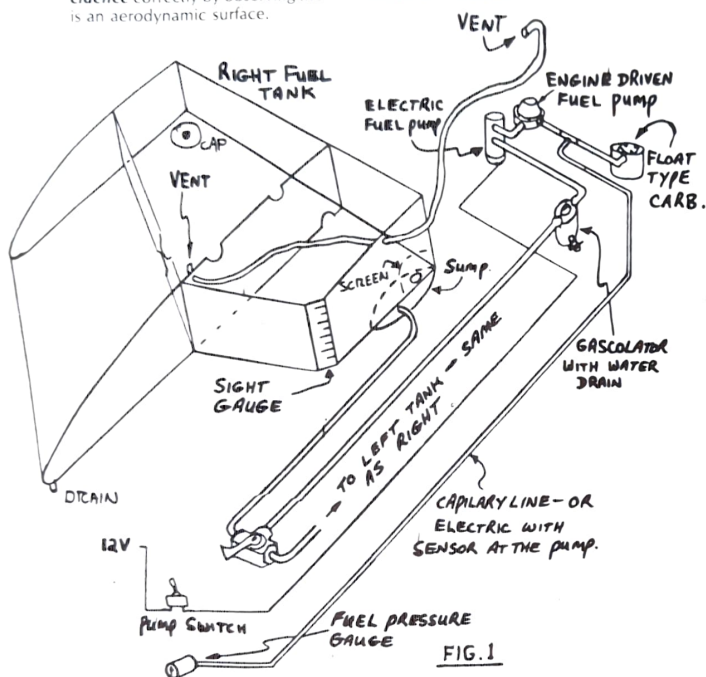


FIG. 1

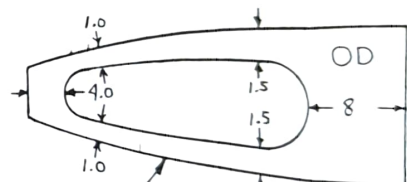
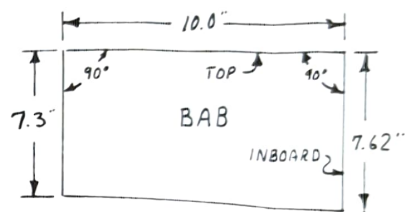
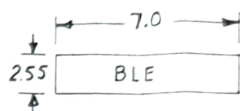
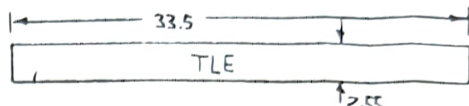
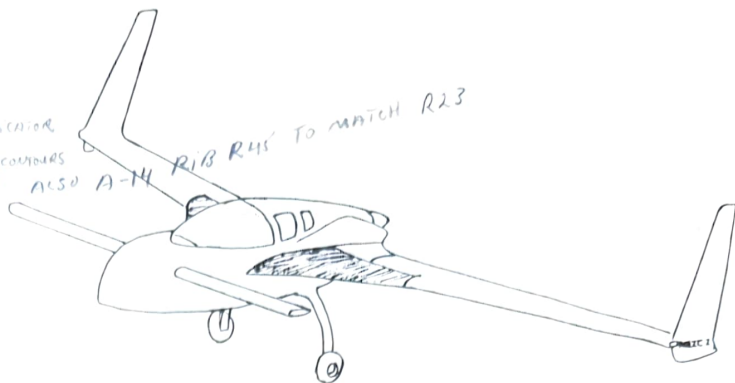
Figure 1 outlines the fuel system. It is a two-tank, selectable, pumped (not gravity) system with an engine-driven pump plus an electrical backup pump. This is similar to most low-wing factory built light planes.

The selection valve (left-right-off) is located in the center of the front seat-back, for accessibility of either pilot or passenger. The gascolator and electric pump are mounted on the firewall. Each tank has a sump to provide continuous fuel flow during unusual attitudes, descents and nosedown parking with low fuel levels.

Note: Safe-T-Poxy should be used on all fuel tank layouts, even if using RAE epoxy on the rest of your layouts.

STEP .1 FABRICATION OF PARTS

Fabricate the parts shown in Fig. 2 and the R23 and R45 ribs shown full size on page A-14. These are all made from type H45 PVC core (pink) foam. On the outboard skins layout the 22.4 in. and "A" dimension before cutting off the 32 in. x 4.9 in diagonal. The T.E. bevel is to fit under and over the bevels on the centersection spar. You will need six 34 in. x 47 in. sheets of type H45 PVC foam. Butt together with micro any necessary joints. Refer to the drawing on the next page showing dimensions for the fuselage cutout. Left side is shown, right side is similar. Lay out the lines shown, inside and outside lines of the fuel tank skin (0.35 in. apart). Using a sabre saw or pin router, cut the holes in the fuselage side. The aft edge of the forward hole is flush with the face of the front seat bulkhead. A 2 inch diameter drum sander with coarse drum on your drill motor is great for final shaping of these cutouts.



OUTSIDE SHAPE - TO MATCH TANK OUTSIDE CONTOUR IN STEP 6.

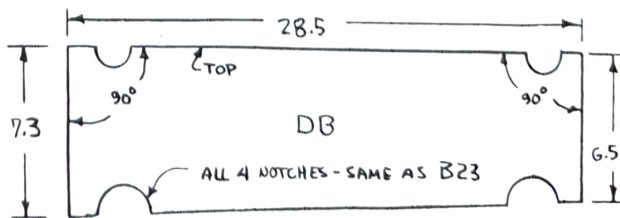
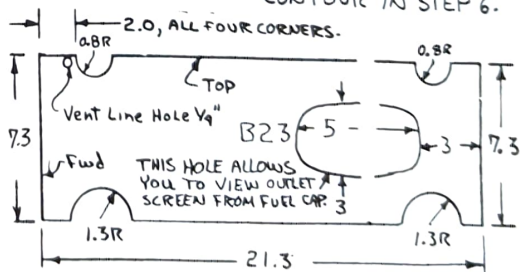


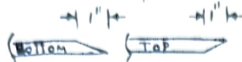
FIG. 2

WING STRAKE PARTS - ALL TYPE H45 PVC CORE PINK FOAM 0.35" THICK

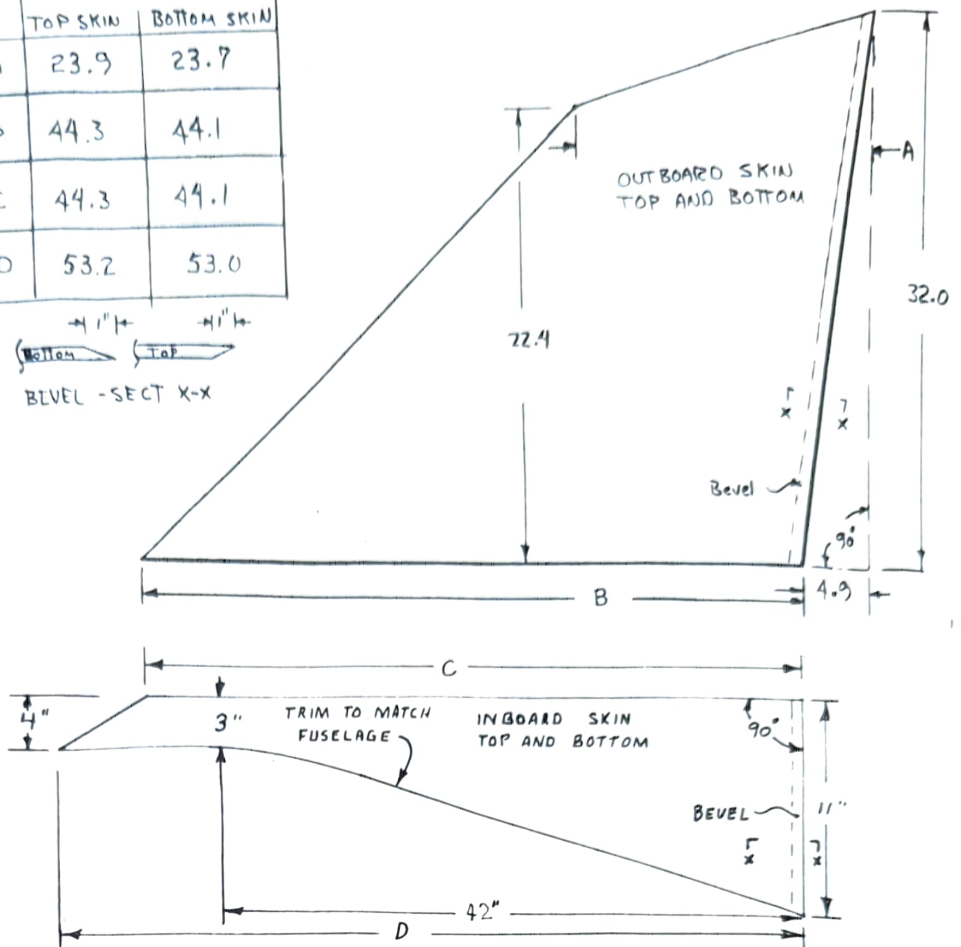
R23 AND R45 SHOWN ON PAGE A-14
ALL CORNERS 90° ON TLE, BLE, & B23

ABOVE DRAWINGS NOT TO SCALE

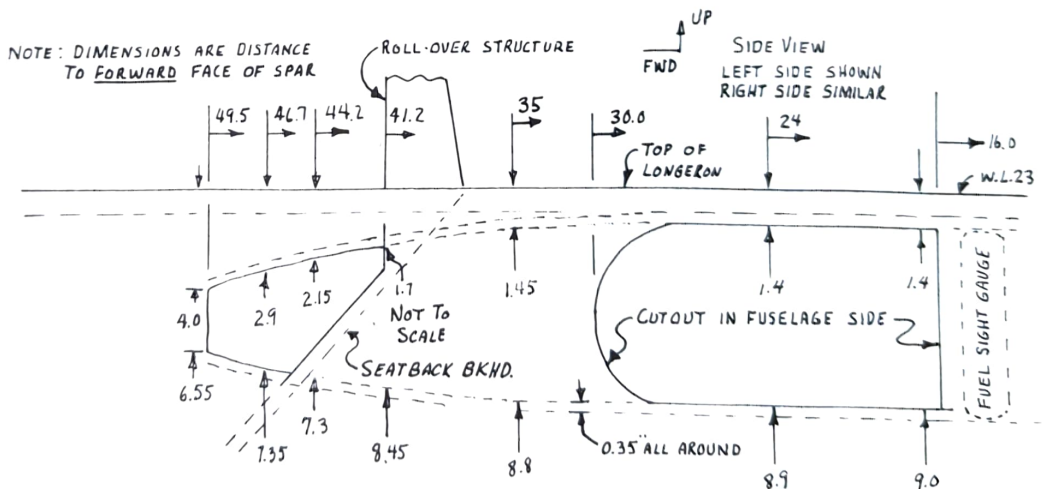
DIMENSION FOR:		
	TOP SKIN	BOTTOM SKIN
A	23.9	23.7
B	44.3	44.1
C	44.3	44.1
D	53.2	53.0



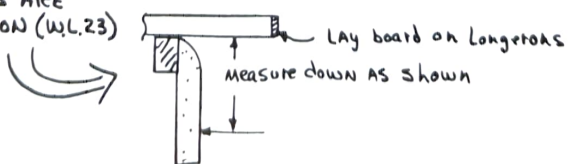
 BEVEL - SECT X-X



FUSELAGE SIDE "CUT OUT" DIMENSIONS



VERTICAL DIMENSIONS ARE TO TOP OF LONGERON (W.L.23)



NOTE C2 10-2

STEP 2. JIGGING AND ASSEMBLY OF PARTS

See page A-14. Jig the airplane to a flat table as shown (Fig. 3), first making sure the fuselage is level fore and aft along the longerons and from side to side. This table can be a flat 4 ft. x 4 ft. piece of plywood, flush with the bottom surface of the centerspar and fitting along the side of the fuselage reasonably well, and level fore and aft. Fasten the table securely to the fuselage and centerspar with globs of bondo. Fabricate the 35 in. x 1.45 in. x 2.15 in. jig board (Fig. 4) from wood or foam. Now, fit the inboard and outboard bottom skin in place and fit the DB, R45, R23, BAB, BLE and TLE parts together, temporarily held in place with nails. The inboard skins have been dimensioned oversize, so you can trim them to fit your fuselage. Bevel the ends of the TLE and BLE to fit. Jigging is easy if the curve in the skins is permanent. To put a permanent curve in the skins, weight them into a curved shape with 2 boards as shown and heat with a 1000 to 1500 watt hair dryer or heat gun. Foam is hard to heat through. One builder suggested laying a hot, wet towel on top of the foam, to obtain better heat penetration. After cooling, remove the boards. If hot water was used, dry.

When jugged properly, the W.L. 17.4 mark on rib R45 should be 2.65 inches above the table and rib R23's W.L. 17.4 mark should be 3.45 inches above the table. Refer to page A-14 to see the use of the 35 in. x 2.15 in. x 1.45 in. jig board. It supports the lower skin L.E. at the correct height, full span.

Lay some plastic or grey tape on the table to avoid glueing things to it, then mix up some micro and glue the following pieces permanently in place: outboard and inboard bottom skin, BAB, TLE, BLE, R45, and R23. Be sure to use enough micro to avoid voids in the fuel tank area. Wipe a small radius in all corners and recheck alignment. Allow to cure. Cut the 1-1/4 in. hole near the inboard aft corner of the inboard bottom skin (see page 21-7). Bevel it as shown in section H-H.

Install a 1 in. x 1 in. piece of 1/4 in. thick 2024-T3 aluminum at the low drain position for nose down parking (see section I-I). This piece is drilled and tapped 1/8 in. x 27 NPT pipe thread before installation. Be sure the tapped hole is deep enough for correct positioning of drain valve (Fig. 5).

STEP 3. INSIDE LAYUPS

Now glass layout No. 1, a one ply BID into the entire fuel area, lapping up 1 in. onto the fuselage and spar, and completely onto both ribs, TLE and BAB. See sections A-A, B-B, D-D, and G-G. This is easiest in several pieces. Overlap 1 in. on any joints. This layout should appear wet to avoid pinholes that can leak fuel. While it is still wet, install B23 and DB, glassing their sides with a single BID ply (layout No. 2) that laps onto the bottom (see section E-E). B23 should be installed first so its glass laps directly onto the outside face of R23. Glass one ply of BID (layout No. 3) on the outside face of R23 that also covers the bottom skin and laps 1 in. onto the centersection spar (section D-D). Add a 2 inch wide strip of 2 plies UND along the outer diagonal edge of the bottom skin, lapping 1 in. onto the spar. Fiber orientation along the long, 22 in. dimension (see section F-F). Layout No. 3 also includes 1 ply BID that covers the bottom floor of the storage area, lapping onto R23, BLE, BAB, and the fuselage, as shown in sections D-D, B-B, C-C, and G-G. This layout laps onto the glass-to-glass fuel sight-gauge on the fuselage side. Knife trim the baffle notches. Knife trim edges shown in all sections. Knife trim open the 1-1/4 in. diameter hole, and the drain hole. Remove the foam under the drain insert as shown (Fig. 6), and install a 1/8 in. pipe plug. Check that the drain is at the low point for nose-down parking (so you can drain water from your fuel). If not, trowel in micro as shown (Fig. 6). Now allow layouts No. 1, No. 2, and No. 3 to cure. It is a wise precaution, after a partial cure, to squeeze additional epoxy over all of the bottom and side layouts to fill remaining pinholes. Even wet layouts always have some pinholes, and you don't want your tanks to leak, do you?

STEP 4. VENT AND SCREEN

Refer to Fig. 7 and install the 1/4 in. aluminum vent line. You may either bring the vent lines out at the top, as illustrated, or continue them around and down, inside the cowl, and bring them out through the cowl flange underneath the centerspar. The latter subjects the vents to higher pressure, rain free air, hides them, and give tip over protection against fuel spillage. If you do this, the vent line has to go up to the top of the firewall first, before going down, to avoid spilling fuel from the vent in a climb. Apply a liberal amount of wet floc around the firewall hole, both sides. Be sure to sand the aluminum dull for bonding where it emerges from the tank and where it passes through the firewall. Install a dome-shaped aluminum screen over the 1-1/4 in. hole (Fig. 7 and section H-H). This provides the same function as a finger-strainer, protecting the fuel system from large-size contamination.

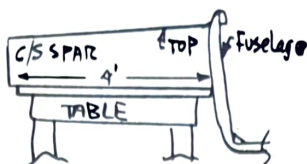


FIG. 3

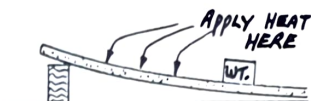


FIG. 4

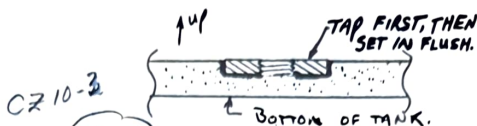


FIG. 5

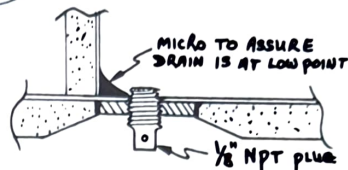


FIG. 6

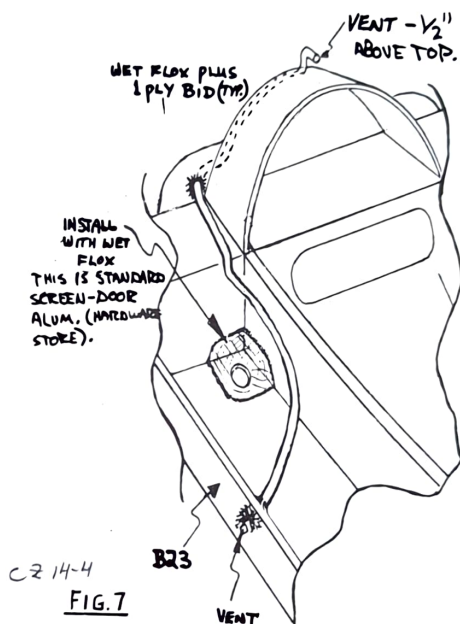


FIG. 7

STEP 5. TOP SKIN CORES

Now grab the two pieces of top skin, heat form the curve, and fit them into place. Hold in place with weights. Be sure they fit against, or within 1/10 inch, (Fig. 8) to all fuel tank walls. Stack the lumber on as shown (Fig. 9) and attach the lumber with dabs of bondo. This lumber holds the top skin in its correct shape while you remove it for glassing. If you do a good job here, it will save you a headache and a lot of fill when you get to finishing. If you omit the lumber trick, you will wrinkle the inside layout when installing the top skin.

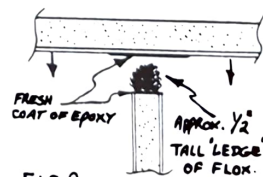


FIG. 8

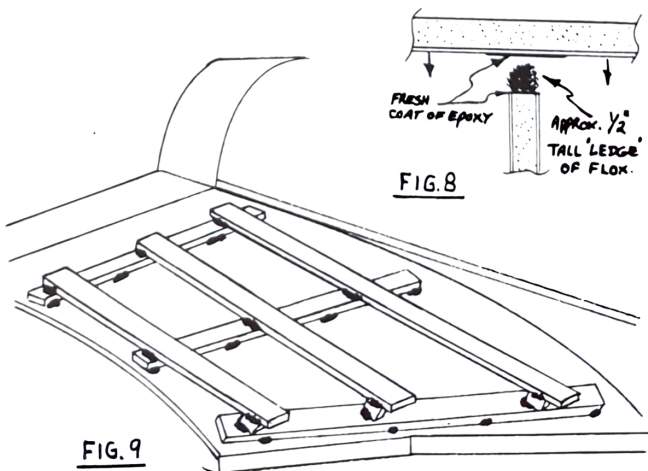


FIG. 9

Now, remove the top skin/lumber assembly, turn it inside-up, and glass its surface with 1 ply **BID** (layup No. 4), plus the 2 in. wide strip of 2 plies **UND** along the outboard diagonal (section F-F). Leave 1 in. of the **BID** dry and hanging over the edge all along the inboard edge. Scissor trim the other edges. This layup should appear a little wet. Let cure only about 2 to 4 hours, enough to get a good grip on the foam, but still tacky. Then, clean the tank insides, paint epoxy along all joining edges. Squeegee a fresh coat of epoxy on the inside skin all over (layup No. 4), and where it will join, then invert the assembly and carefully place it down into place using care to not wipe off the floc with a sideways motion (did we tell you to put floc on the top edges of all the baffles and where ever else it joins?). This trick takes 2 to 4 people with steady hands. Hold in place with weights, nails, or clamps. Wet the 1 in. dry edge of **BID** onto the fuselage side (see section C-C and G-G). Inspect in the baggage area and all around to insure the lid is down in place everywhere.

You may need to remove lumber to assure it is all weighted into position. Before cure, install layup No. 5: tapes of 1 ply **BID** that connect the top to **R45**, **R23**, and **BAB**. Also, layup No. 6, a one-ply **BID** tape at section C-C. Cover any remaining bare foam edges around fuselage cutouts with 1 ply **BID**. Use care not to get any micro or floc on the fuel sight gage area. Be sure these layups are wet enough to avoid air or pinholes that can leak fuel. Allow to cure, without moving things and with the vent line open, so the tank can breathe. **Do not** leak check yet, the tank is not structural until after Step 8.

STEP 6. END RIB AND OUTLET PIPING *NOTE!* *CZ 6-7*

You can now remove the table or plywood jig. Fabricate **OD** by holding a piece of foam against the skin cores and marking top and bottom. Cut out the oval hole. Glass the inside with 1 ply **BID** (layup No. 7) and floc in place holding with nails (section F-F). Layup No. 7 should connect to the spar at the aft end of **OD** similar to the inside layups of the top and bottom skins connecting to the fuselage.

Lay out and drill the 7/16 in. hole in the fuselage under the tank (Fig. 10). Fit a length of 3/8 in. x .035 in. wall 1100-0 soft aluminum tube from the fuel selector valve to the 7/16 in. hole. This tubing is approx. 6 ft. long and runs along the fuselage side and the aft face of the front seat back, downhill from the tank to the valve with no joggles to trap water, air or sediment. It needs to be long enough to extend through the 7/16 in. hole 0.4 in. Screw a **AN816-6D** adapter (using Teflon tape) into the fuel valve and connect the tubing using **AN816-6D** & **AN819-6D** flare fittings (Fig. 11). Don't run the tubing too high along the fuselage side, or it will not clear the aileron torque tube bearing bracket. Fabricate and install a small wooden plug (Fig. 12) in the end of the tube to keep debris and/or epoxy out of the tube while fitting and bonding it in place. Clean and dull the outside tubing surface for bonding. Paint epoxy on the tube and fill the hole with floc. Install the tube through the fuselage using liberal wet floc, covered with 1 ply **BID** to hold it firmly in place on both sides of the fuselage and against the aft seat bulkhead (Fig. 13). If you hold a finger over the outside hole as you push the tube through it will force the floc around the tube, rather than push it out. Remove the wooden plug after installation. Do not move things during cure. Cover the fuel line in several places along the fuselage side with 1 ply **BID** to provide support, but leave it unsupported at the seat back so that the fuel valve can be removed later.

STEP 7. BOTTOM OUTSIDE SKIN AND SUMP

Turn the fuselage over. Stuff a rag inside the 1-1/4 in. hole to prevent contamination. Using a hard 36-grit sanding block, fair the PVC edges as required to fair into the spar and fuselage. Round the leading edge and **OD** (section F-F and B-B). It is not a bad idea to sand a slight depression (1/32 in. x 1 in. wide) along the leading edge and likewise along **OD** to allow for an overlap later on without creating a bump. Sand the spar surface for bonding. Vacuum off dust. Trowel wet micro into any voids, particularly around the fuel tank area. Remove the rag. Remove the 1/8 in. npt drain plug. Trial fit the sump blister. Squeegee wet micro over the entire foam surface. See Fig. 14 for layup schedule. Glass layup No. 7, the two crossing **UND** plies, lapping 4 in. onto the spar, 3/4 in. onto the fuselage, fully down the face of **TLE** and **BLE** and half way down **OD**, lapping 1 in. on the forward face of the centerspar. The first ply covers the entire stake with fibers running fore and aft. **Butt** any required joints. The third ply is a 5 in. wide **UND** strip.

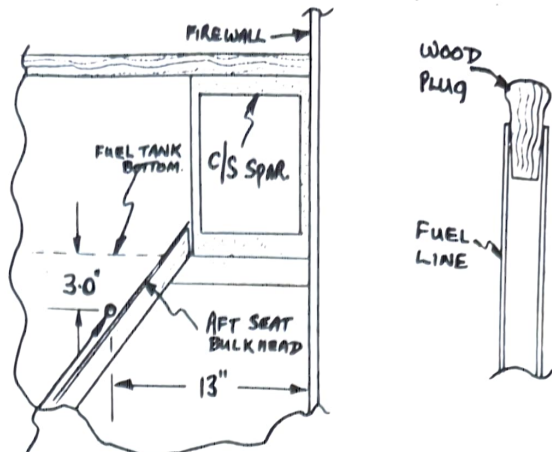
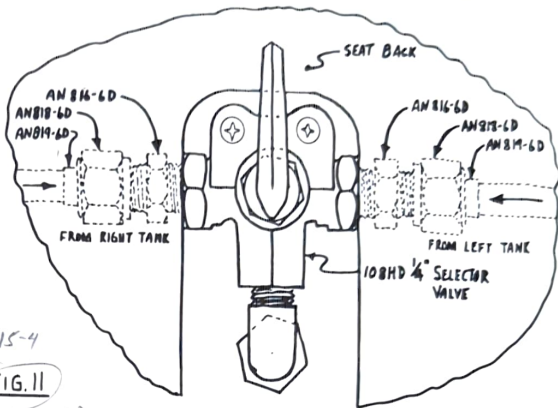


FIG. 10

FIG. 12



CZ 15-4
FIG. 11
WEATHER HEAD

FRONT VIEW

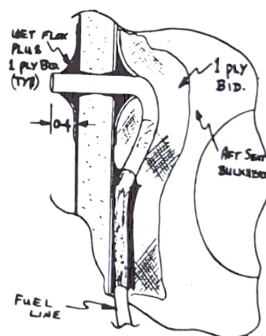


FIG. 13

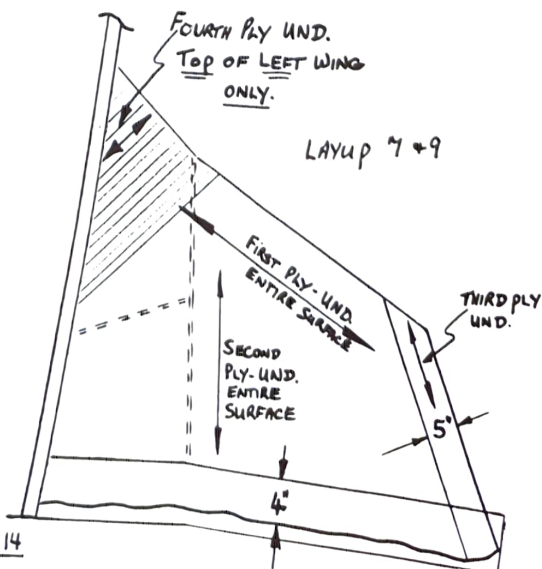


FIG. 14

Now, while this layup is still tacky, install the sump blister (Fig. 15). First sand it on the inside and squeegee a liberal coat of epoxy overall. Install with wet flox and a 1 ply BID tape 1 in. wide all around (layout No. 8, section H-H). **Caution!** Do not get flox into the 3/8 in. tube, or it will restrict fuel flow. This layup **must** be wet to avoid fuel leaks. Be sure the tank vent line and 3/8 in tube are open to allow the tank to breathe during cure; otherwise a pressure change will cause a leak.

STEP 8. TOP SKIN

Turn the fuselage over, fair the top, round the corners, sand the spar, provide depressions for future overlaps, remove dust, squeegee micro all over the foam, and glass layout No. 9, the top skin. It is similar to the bottom skin, except a 4th ply is installed as shown (Fig. 14) on the **left only** to allow you to later sit or stand on the strake when entering the aft cockpit (if you are willing to risk scratching the paint). Peel ply edges for a good transition. Cure.

STEP 9. PRESSURE CHECK

Don't omit this step or you will be sorry. Even the best workers have leaks. Retap the 1/8 in. npt drain hole and install the drain or a plug. **Do not over-torque.** Use Teflon tape thread seal. Plug the 3/8 in. line at the valve. Hook the vent line to an altimeter through a tee. Blow a pressure of 1500 ft. altitude change into the tee and plug. Let the tank set for several hours to check for leaks. Ignore small variations in the altimeter due to atmospheric pressure changes and temperature changes.

If you have a leak, first use soap bubbles brushed around all plugs and fittings, then around tank joints. It is ok to remove some of the forward end of OD to check or repair a leak in that corner. If you find a leak in the composite structure, first rinse off all soap with clear water and let it **fully** dry (hair dryer helps, otherwise give it a full day). Then suck a negative pressure on the tank (no more than 1500 ft. altitude) and continuously brush epoxy into the leak, letting the negative pressure draw the epoxy into the hole. Then, open the vent (no pressure) and continuously brush epoxy on the leak area. Let cure with no pressure.

STEP 10. LEADING EDGE AND OUTBOARD FAIRING BLOCKS

The leading edge fairing blocks may be made solid or hollow (you can save a little weight by running coax cables and wires through the leading edge). In either event, use only **urethane** foam. It is a wise precaution to sand the leading edge of the tank and squeegee still another coating of epoxy on this surface, because it will be impossible to reach later on. Now 5-min some urethane blocks in position, and carve to a rounded shape. Don't use a droop leading edge on the strakes. If you intend to make hollow leading edges, use duct tape for release. Cover the leading edge blocks with 2 layers of **UND** crossing at 45 degrees and lapping 3/4 in. onto the top and bottom skins. Peel ply edges.

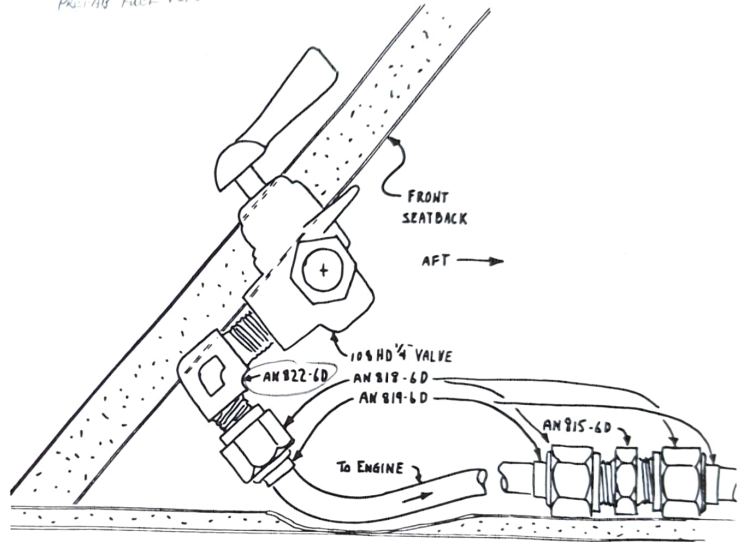
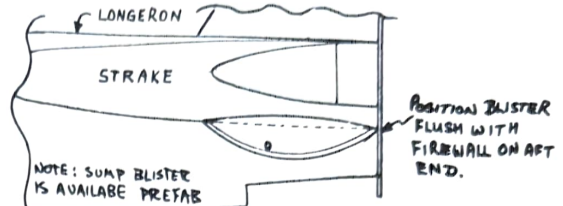
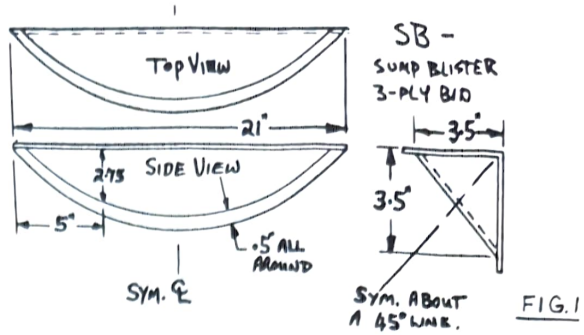
Drill a 1/4 in. hole through the bottom skin near the leading edge between OD and R45. This will vent this area and drain any collection of moisture. You really should install the wings to carve the fairing blocks for a smooth transition to the wings.

The fairing block is non-structural. You may make it solid or hollow. Use **urethane** foam. See Chapter 23 for installation of strobe unit, if desired. You may postpone this step if you wish until you have the wings on for finishing. After mounting the wings, fair the block to fit. Cross 2 plies of **UND** for a sufficiently durable skin.

STEP 11. FUEL VALVE, ELECTRIC PUMP, AND GASCOLATOR

You will have installed the fuel valve in Chapter 6 and the gascolator and fuel pump in Chapter 15. Run the line from the fuel selector valve through the front seatback support, under the back seat, above the landing gear, to the gascolator (Fig. 16). It will be necessary to remove the fuel selector valve to connect the 3/8 in tubing. You will need a **AN822-6D** 90 degree elbow and an **AN818-6D** & **AN819-6D** flare fitting. The tubing run is rather tortuous, so it is recommended that you install a disconnect coupling several inches aft of the seatback support for convenience of removing the fuel selector valve at some future date, should it become necessary. Mark the valve position so you can install the handle with the correct left-right orientation.

Fuel caps, specifically designed for the Long EZ and Cozy are available from your Cozy distributor. These are a sealed unit, locked as shown in Figure 17 by a Dzus fastener. Do not substitute a vented cap. Do not substitute a cap that does not have a reliable lock. Wait until **after** your aircraft is painted to install the fuel caps. This will result in a neat installation and avoids contamination of your fuel tank. To install the cap, Bore a hole in the position shown on page 21-7 with a 2-1/4 in. hole saw. Trial fit the cap. Dull the metal rim bonding surface with 100-grit sandpaper. Now, tape a 1 in. tube to your vacuum cleaner hose and thoroughly clean the



foam chips out of your tank. Check with a flashlight. Mix flox and trowel it into the lip and coat the metal rim. Drop the rim in place and wipe excess flox from around the rim edges, tip, and bottom. Orient the fuel cap so the slot is fore and aft when secured, for an easy visual check before every flight. Be sure to wipe any flox off inside of the rim. Weight it into place and cure.

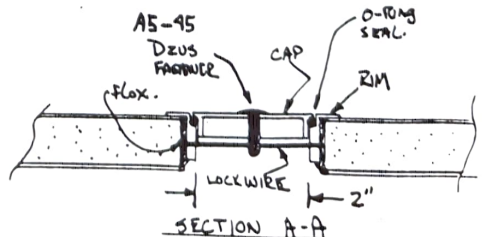
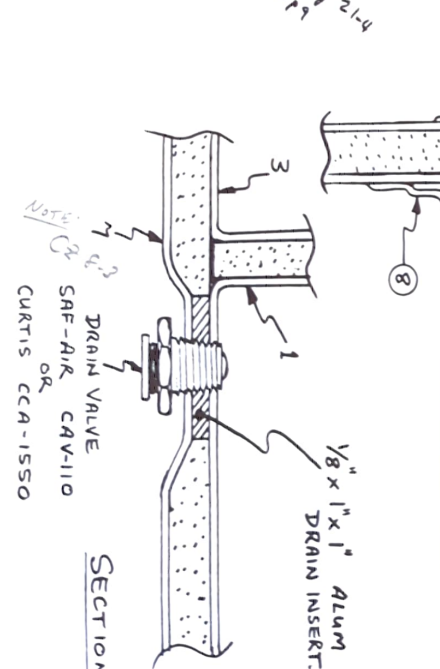
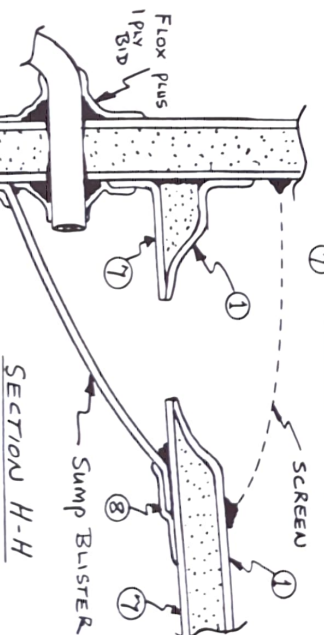
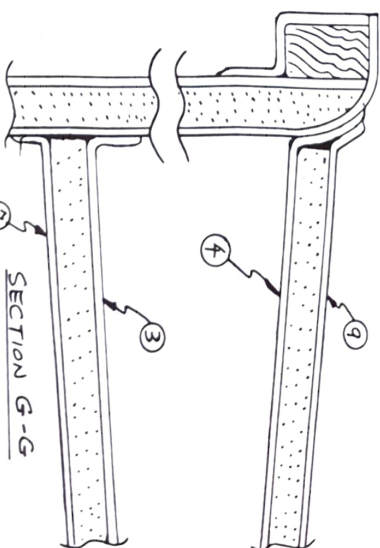
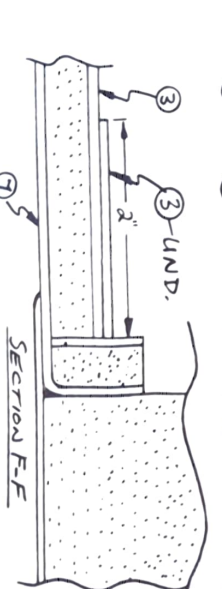
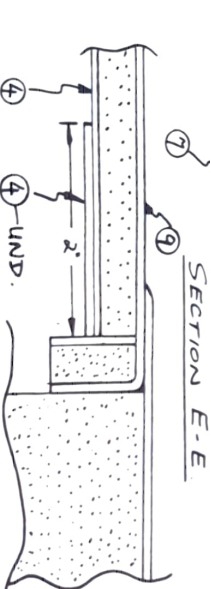
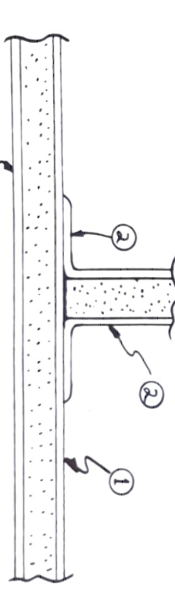
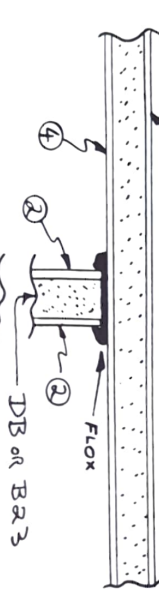
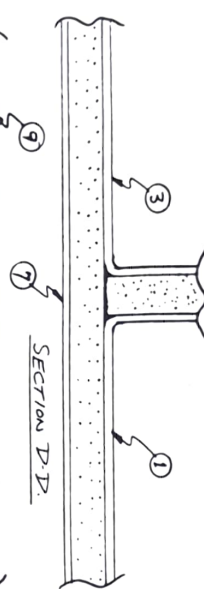
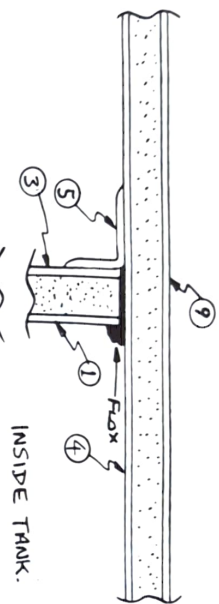
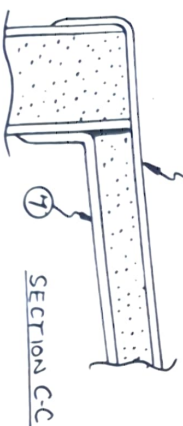
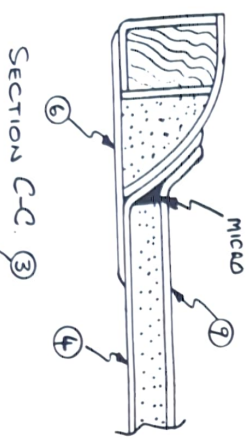
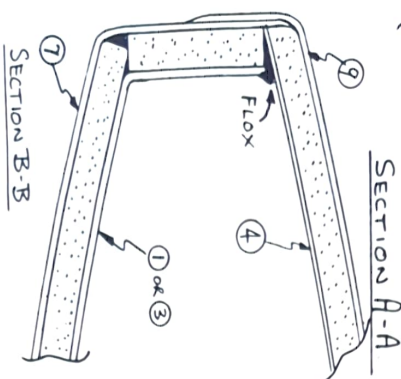
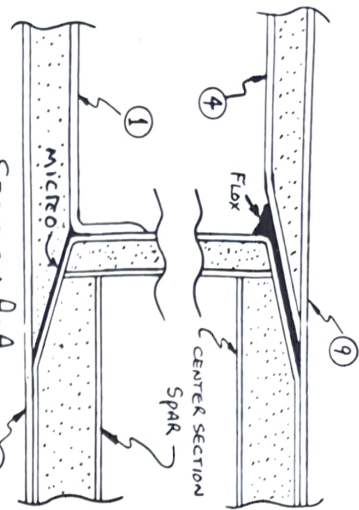


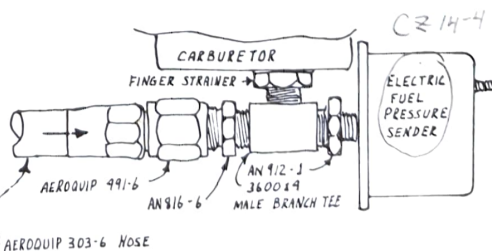
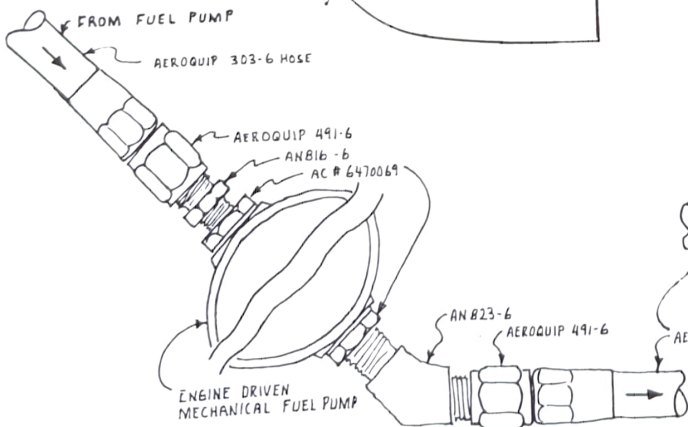
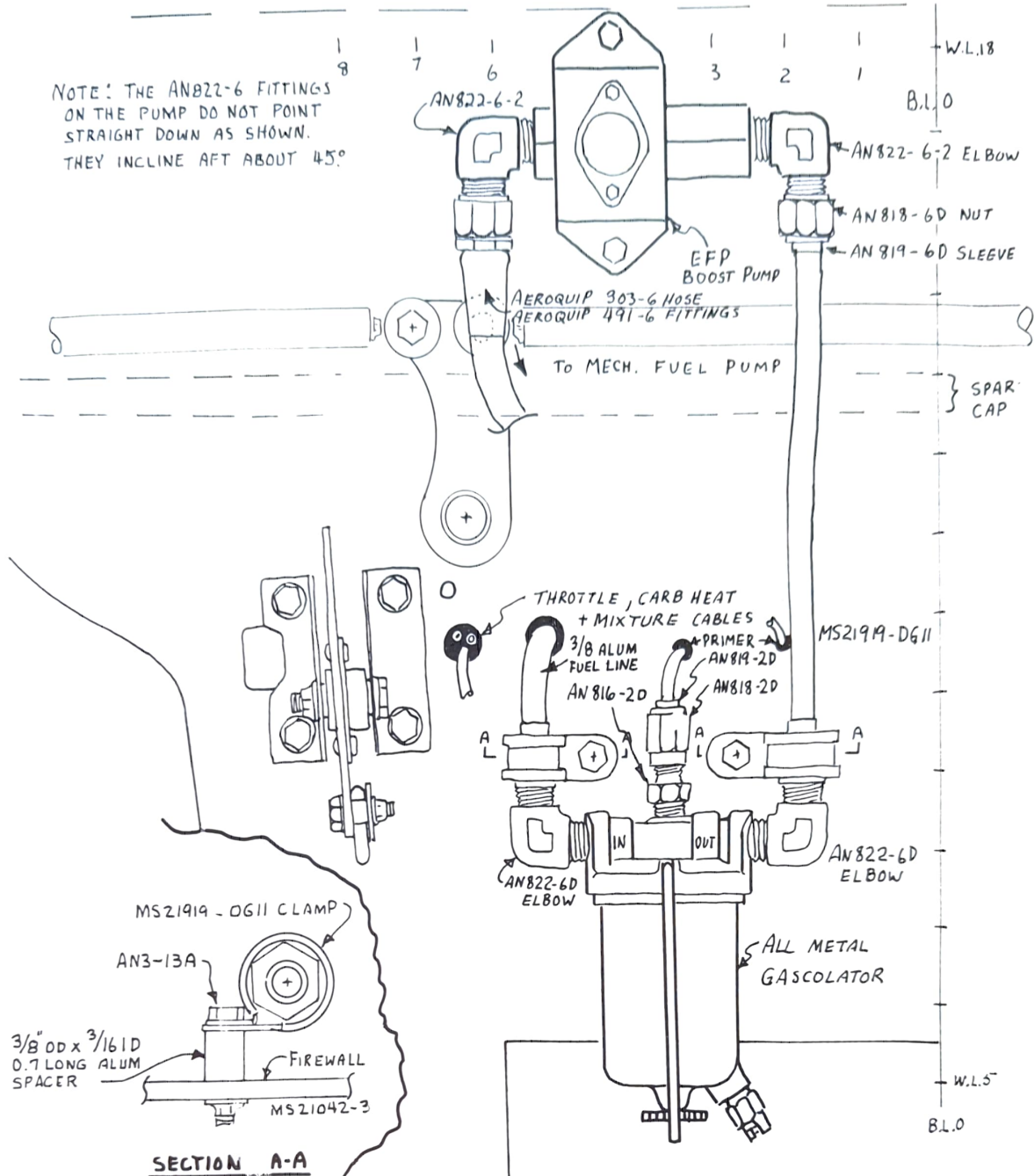
FIG. 17

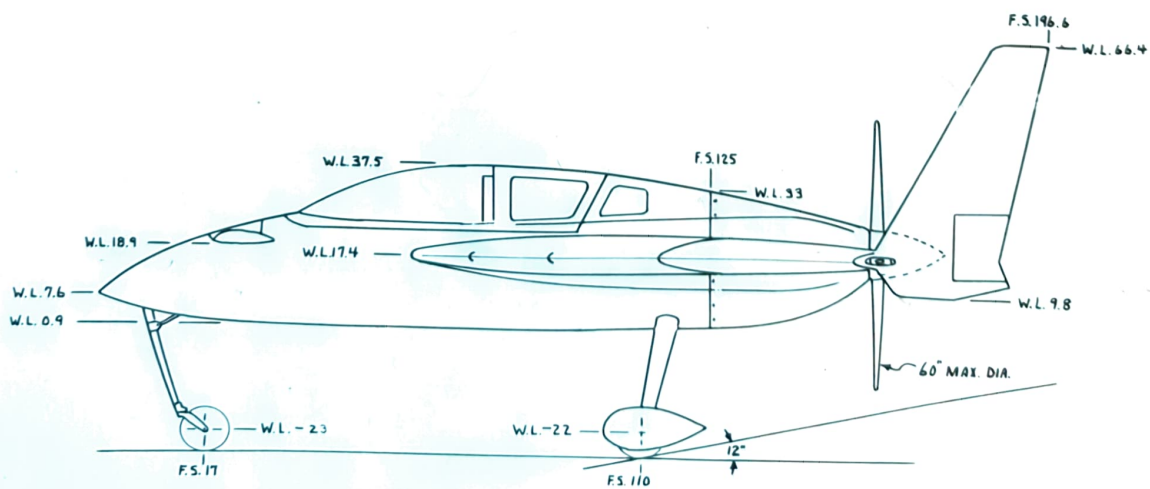
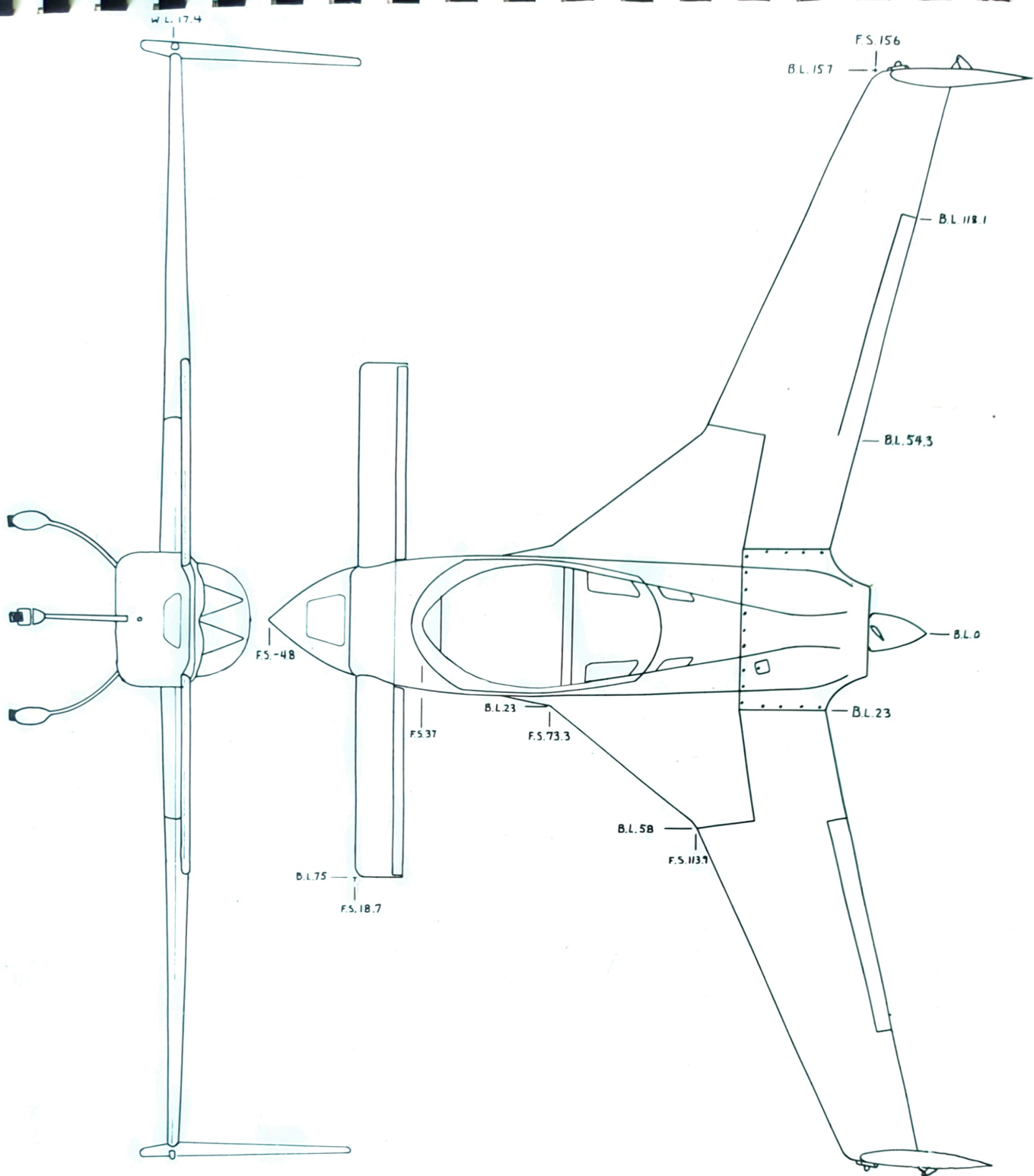
COMPLETE FUEL CAP ASSEMBLY
PART NUMBER IS FT-1B

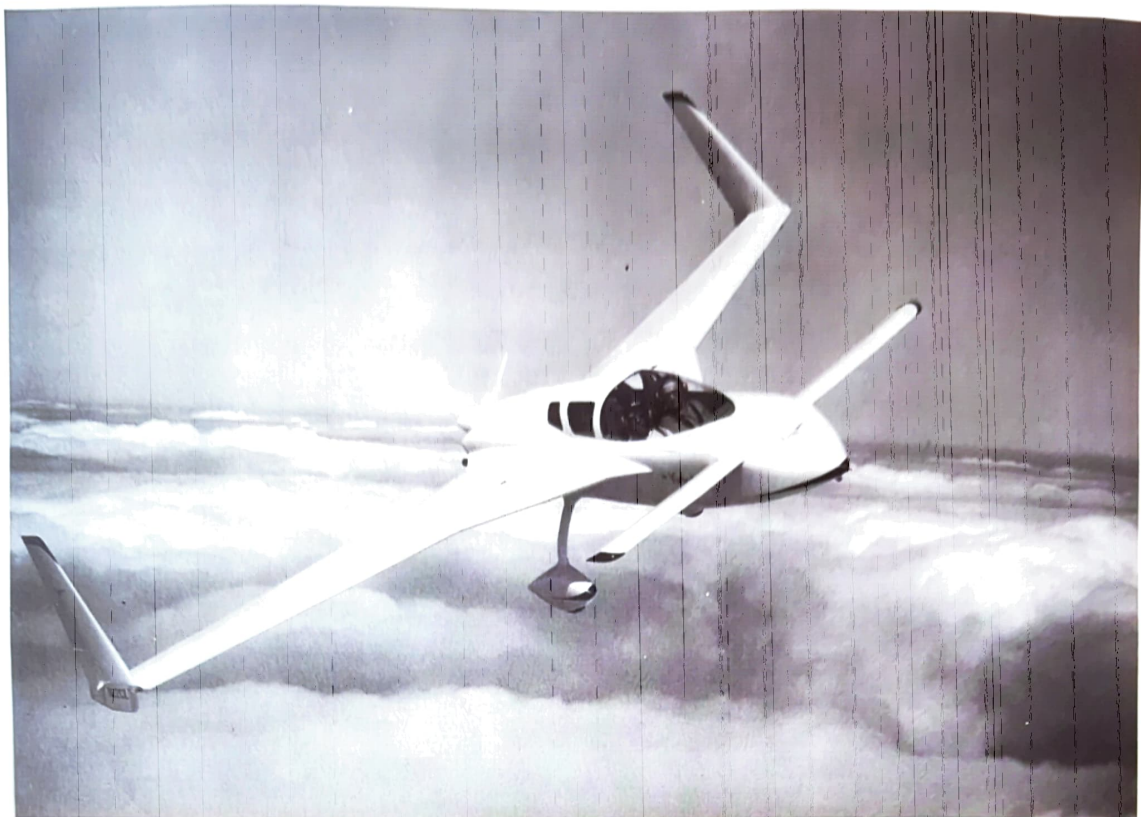
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NOTE: THE AN822-6 FITTINGS ON THE PUMP DO NOT POINT STRAIGHT DOWN AS SHOWN. THEY INCLINE AFT ABOUT 45°







The Cozy

PLANS SECTION I A

JANUARY 1985 - FIRST EDITION

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Printed in the U.S.A.

This manual, **COZY PLANS SECTION IA**, together with **COZY PLANS SECTION I**, published previously under separate cover, comprise 26 chapters and 29 drawings 18" x 23" and constitute the entire manufacturing instructions for the Cozy aircraft, including engine installation. **COZY PLANS SECTION IA** includes the engine installation instructions originally planned for a separate manual.

The custom prefab parts required in **SECTION IA** are listed on this page, and the materials needed in **SECTION IA** are listed as a complete kit on Preface Page 2, and broken down by Chapter on Preface Page 3 and 4. Photographs of construction details are included at the end of some of the chapters.

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SECTION IA

PREFAB PARTS

The following Prefab Parts are available from Distributors as follows:

Quality Aircraft Components (414) 857-7419
16223 - 93rd St., Bristol, WI 53104
(1) CZCT Cowling, Top (per Section I)
(1) CZCB Cowling, Bottom (per Section I)
(1) CZTB Cozy Turtleback (optional)

Sport Flight (901) 365-7606
Box 18690, Memphis, TN 38115
(1) Exhaust System w Carb & Cabin Heat Muffs

Great American Propellor Co., (805) 481-9054
1180 Pike Lane #5, Oceano, CA 93445

B & T Propellers, (209) 742-6743
3850 Sherrod Rd., Mariposa, CA 95338

Ted's Custom Props, (206) 568-6792
9917 Airport Way, Snohomish, WA 98290
(1) Cozy Propellor (same as Long EZ)

The Airplane Factory, Inc., (513) 845-9872
P.O.Box 24035, Dayton, OH 45424
(1) Cozy Plexiglass Canopy Bubble
(1) Set Cozy Molded Side Windows

Ken Brock Mfg., (714) 898-4366, 894-0811
11852 Western Ave., Stanton, CA 90680
(2) CZSA Stick Assemblies (Chap.16)
(10) CS-1 Inserts (Chap.16)
(4) CS-1A Inserts (Chap.16)
(4) CS-17 Spacers (Chap.16)
(2) CS-112 Bushings (Chap.16)
(2) CS-122/124 Belhorn, 1Rt, 1Lft (Chap.16)
(4) CS-127 Brackets (Chap.16)
(2) CS-128 Belcrank w Brg. (Chap.16)
(2) CS-131 Spacers (Chap.16)
(2) CS-132L Belhorn (Chap.16)
(4) CS-181 Inserts (Chap.16)
(8) CS-201 Bushings (Chap.16)
(2) RT-2 Roll Trim Br., 1Rt, 1Lft (Chap.17)
(1) CZRTH Roll Trim Handle (Chap.17)
(1) CZPTH Pitch Trim Handle (Chap.17)
(1) CZLB-1 Spacer (Chap.17)
(2) CZLB-6 Spacer (Chap.17)
(1) CZLB-10 Spring Bracket (Chap.17)
(1) LB-11 Bracket (Chap.17)
(1) CZLB-13 Ldg Brake Handle Ass. (Chap.17)
(1) CZLB-15 Ldg Brake Act. Ass. (Chap.17)
(1) CZLB-21 Arm (Chap.17)
(1) VECG Throttle Quadrant Ass. (Chap.17)
(1) C1-L Handle (Chap.18)
(2) C2-L Arms (Chap.18)
(1) C3 Lug (Chap.18)
(1) C4 Block (Chap.18)
(1) C4A Block (Chap.18)
(1) SC1 Safety Catch (Chap.18)
(1) C21 Handle (Chap.18)
(2) CS13 Spacers (Chap.18)
(1) CN-1 Bshg 1/4 ID x 5/8 OD Al. (Chap.18)
(1) CCB Carb Control Bracket (Chap.23)
(2) LL-3 Spacers (Chap.23)
(1) Cabin Heat Valve (Chap.23)
(1) Carb. Heat Valve Ass. VECHVA (Chap.23)
(1) Cozy 0-235 Conical/Dyna Mount (Chap.23)

THE FOLLOWING SECTION 1A MATERIALS KIT IS AVAILABLE FROM EITHER OF THE TWO DISTRIBUTORS LISTED:

AIRCRAFT SPRUCE &
SPECIALTY
P.O. BOX 424
FULLERTON, CA 92632
Telephone (714) 870-7551

WICKS AIRCRAFT SUPPLY
410 PINE STREET,
HIGHLAND, IL 62249
Telephone (618) 654-7447

CATALOG \$4 - REFUNDED WITH FIRST ORDER
ALPHA PLASTICS INC., ROUTE 1, BOX 231, WEST, TX 76691
Telephone (817) 826-3639
(Authorized distributor for foam, glass cloth, and epoxy.)

SECTION 1A MATERIALS KIT

CZ 9-2

BOLTS:

- (2) AN3-4A
- (9) AN3-5A
- (1) AN3-6
- (5) AN3-6A
- (1) AN3-7
- (28) AN3-7A
- (2) AN3-10A
- (15) AN3-11A
- (6) AN3-13A
- (2) AN3-14A
- (2) AN3-17A
- (2) AN4-10A
- (2) AN4-11A
- (4) AN4-12A
- (2) AN4-13A
- (2) AN4-14
- (2) AN4-14A
- (1) AN4-21A
- (1) AN4-35A
- (1) AN4-46

SCREWS, C/S:

- (60) AN507-1032R10 (MS24693-S273)
- (7) AN509-8R5 (MS24694-S2)
- (5) AN509-10R6 (MS24694-S48)
- (10) AN509-10R8 (MS24694-S50)
- (10) AN509-10R10 (MS24694-S52)
- (2) AN509-10R17 (MS24694-S59)
- (3) AN509-10R24 (MS24694-S66)
- (2) AN509-10R28 (MS24694-S70)
- (2) AN509-10R30 (MS24694-S72)
- (3) AN509-10R32 (MS24694-S74)

SCREWS, B/H:

- (5) AN525-10R10
- (8) AN525-10R12
- (1) AN525-10R16
- (4) AN525-10R18
- (2) AN525-10R20
- (1) AN525-10R24
- (12) AN500-A416-10

WASHERS:

- (200) AN960-4L (8) MS 35273-41
- (106) AN960-10 (4) LE 100-057
- (32) AN960-10L
- (1) AN960-416L
- (37) AN960-416
- (4) AN960-1016
- (22) AN970-3
- (9) AN970-4
- (12) AN936-A416
- (60) A-3235-028-24A

NUTS:

- (112) MS21042-3
- (14) MS21042-4
- (10) AN315-3
- (2) AN310-3
- (2) AN310-4
- (4) AN316-4

NUTPLATES:

- (64) MK-1000-3 (MS21069-3)
- (7) MK-1000-08 (MS21069-08)

RIVETS:

- (8) AN426AD3-3 (MS20426-3-3)
- (8) AN470AD3-4 (MS20470AD3-4)
- (4) AN470AD3-7 (MS20470AD3-7)
- (40) AN470AD4-10 (MS20470AD4-10)
- (34) BSC44-BSC44

CONICAL MOUNT: (Optional)

- (4) AN6-43A Bolts
- (4) AN960-616 Washers
- (4) Lyc.# Std 619 Washers
- (4) AN363-624 Nuts
- (8) #71032 Rubber Bushings

DYNAFOCAL MOUNT: (Optional) KIT EM 100-005'

- (4) AN7-35A Bolts
- (8) AN960-716 Washers
- (4) AN363-720 Nuts
- (8) Dynafocal Bshgs. for 2-3/4 ID Ret.
- (4) Steel Spacers

FITTINGS:

- (3)* AN818-2D Nuts
- (3)* AN819-2D Sleeves
- (2)* AN822-2D Elbows
- (1)* AN816-2D Nipple
- (2) AN822-6-6D Elbow
- (2) AN816-4 Nipple
- (2) AN816-6 Nipple
- (4) AN823-6D Elbow
- (1) AN910-1D Coupling
- (1) AN912-1 Bushing
- (1) 3600 x 4 Weatherhead Tee
- (2) AC#6470069 Fuel Pump Adapter
- (2) 491-4 Aeroquip Fittings
- (8) 491-6 Aeroquip Fittings
- (84) in. 303-6 Aeroquip Hose
- (6) in. 303-4 Aeroquip Hose

* Only required if a primer is used.

GLASS:

- (23) yds. BID
- (17) yds. UND

EPOXY:

- (2.3)gal.

FOAM:

- (1) pc. 24 x 60 x 1/4 in. 4.5 lb. Clark
- (3) pc. 34 x 47 x 3/8 in. H45 Divinycell
- (1) pc. 24 x 72 x 1/4 in. urethane 24 x 96 x 1
- (1) pc. 24 x 96 x 2 in. urethane
- (1) M-26 Kit urethane pour foam 1/2 GAL URETHANE INSTAFOAM

SHEET METAL:

- (2) (4) 6061-0 .020 x 20 x 24 Alum (See Sec.1) 6061-0 .23 x 9 x 24
- (1) 6061-T6 .025 x 30 x 48 Alum
- (1) 2024-T3 .032 x 4 x 6 Alum
- (1) 2024-T3 .063 x 3 x 7 Alum
- (1) 2024-T3 .125 x 5 x 10 Alum
- (1) 2024-T3 .125 x 1 x 1 Alum Angle
- (1) 2024-T3 .125 x .75 x 16 Alum Bar

METAL TUBING AND ROD:

- (1) 2024-T3 5/16 OD x .049 W x 42 in.
- (2) 2024-T3 1/2 OD x .035 W x 72 in.
- (3) 6061-T6 3/4 OD x .058 W x 72 in.
- (1) 6061-T6 3/4 OD x .049 W x 6 in.
- (1) 2024-T3 1.0 OD x .035 W x 8 in.
- (1) 4130N Steel .625 OD x .049 W x 36 in.
- (1) 1015 Steel 3/16 ID x .065 W x 1.0 in.
- (1) Threaded Steel Rod 1/4 x 20 x 4 in.
- (1) Bushing Stock 3/8 OD x 3/16 ID x 4 in.

MISC:

- (16) AN100-3 Thimbles
- (12) AN100-4 Thimbles
- (12) 18-1-C Nicopress Sleeves 28-1-C
- (12) 18-2-G Nicopress Sleeves 28-2-G
- (4) AN393-9 Clevis Pins (MS20392-2C9)
- (4) AN393-18 Clevis Pins (MS20392-2C18)
- (7) AN416-1 Safety Pins
- (6) AN380-2-2 Cotter Pins (MS24665-132)
- (2) AN111-4 Cable Bushings
- (1) 1/4 in. ID Flanged Bronze Bushing # F8-46-02
- (1) pt. Spraylat
- (1) gal. Glass Bubbles
- (1) gal. Flox
- (1) pc. MS20001-P6 Hinge 20 in. Long
- (1) pc. MS20257-P2 Hinge 2.5 in. Long
- (1) pc. MS20001-P3 Hinge 3 in. Long
- (4) Lyc#77611 Blow Proof Exhaust Gaskets
- (8) MS35333-41 Lock Washers
- (8) Exh Manifold Nuts Std. 1410 5/16-18 Lyc
- (1) pc. Tygon Tube 3/4 ID x 1/8 W x 18 in. #0500-180
- (24) Nylon Ty-raps TY-525M x 6 in Long
- (24) Nylon Ty-raps TY-528M x 12 in Long
- (1) Tube High Temp RTV Silicone, Silver # 732A
- (2) AN931-6-16 Rubber Grommets
- (1) pc. 2.5 ID Scat Aeroduct x 48 in. long
- (1) pc. 1.5 ID Scat Aeroduct x 24 in. long
- (1) pc. 1.5 ID Cat Aeroduct x 48 in. long
- (1) pc. 1.0 ID Cat Aeroduct x 72 in. long
- (4) QS100-M16W Stainless Worm Clamps 1 1/2 Hose Clamp
- (6) QS100-M24W Stainless Worm Clamps 1 3/4 "
- (4) QS100-M36W Stainless Worm Clamps 1 7/8 "
- (1) 25 ft. Coil .041 Stainless Safety Wire 1/16
- (1) Tension Spring .350 dia. x .05 x 18 in.
- (2) (4) Tension Spring .375 dia. x .06 x 18 in. 375 DIA X .06 X 12.5"
- (4) Comp. Spring .350 dia. x .06 x .5 in. # LE-100-064
- (2) #C-161 Springs
- (1) H-5000-2 Hartwell Flush Latch
- (1) pc. Phenolic 1/4 x 4 x 6 in.
- (2) MS20271-B10 Universals
- (10) HM-THHM Rod Ends MM-3 Aurora
- (4) HM-THHM Rod Ends MM-4 Aurora
- (37) ft. 1/16 dia. x 7 x 7 Steel Cable STAINLESS
- (26) ft. 3/32 dia. x 7 x 19 Steel Cable STAINLESS
- (16) ft. 3/16 OD x .025 W Nylaflo Tubing
- (2) FB-1013-8 Boston Bronze Flanged Bearings
- (2) CAV-110 Drain Valves
- (1) K2404-1/8 Essex Primer (Optional)
- (1) Harrison Oil Cooler P/N 8526250 STEWART WARNER oil cooler # 8406-R
- (1) 5 in. Prop Hub Extension
- (1) Prop Plate
- (1) Cozy Spinner Ass. w Airflow Guide
- (6) Propellor Bolts (Length as req'd)
- (200) AVEA 1601-5416

MATERIALS LIST BY CHAPTER

The materials listed here are the same as those listed in the **SECTION IA MATERIALS KIT**. They are arranged by chapter in the **SECTION IA MANUAL** rather than by distributor. This list does not include tools, filler materials, or jiggling materials. You will find this list handy to assure that you have all the appropriate parts and materials before starting a major job, and will help you to keep track of hardware.

Chapter 3: Education

Materials: See Section I

Chapter 4: Fuselage Bulkheads

Materials: See Section I

Chapter 5: Fuselage Sides

Materials: See Section I

Chapter 6: Fuselage Assembly

Materials: See Section I

Chapter 7: Fuselage Exterior

Materials: See Section I

Chapter 8: Roll Over/Seat Belts

Materials: See Section I

Chapter 9: Main Gear/Landing Brake

Materials: See Section I

Chapter 10: Canard

Materials: See Section I

Chapter 11: Elevators

Materials: See Section I

Chapter 12: Canard Installation

Materials: See Section I

Chapter 13: Nose/Nose Gear

Materials: See Section I

Chapter 14: Center Section Spar

Materials: See Section I

Chapter 15: Firewall and Accessories

Materials: See Section I

Chapter 16: Control System

Prefab: (2) CZSA Stick Assemblies
(10) CS-1 Inserts
(4) CS-1A Inserts
(4) CS-17 Spacers
(2) CS-112 Bushings
(2) CS-122/124 Belhorn (1RT, 1LFT)
(4) CS-127 Brackets
(2) CS-128 Belcrank with bearing
(2) CS-131 Spacers
(2) CS-132L Belhorn
(4) CS-181 Inserts
(8) CS-201 Bushings

Hardware: (8) AN3-5A Bolts
(4) LE 100-057 (2) AN3-6A Bolts
(18) AN3-7A Bolts
(14) AN3-11A Bolts
(2) AN3-13A Bolts
(2) AN4-10A Bolts
(2) AN4-11A Bolts
(2) AN4-14 Bolts
(90) AN960-10 Washers
(8) AN960-416 Washers
(4) AN960-1016 Washers
(15) AN970-3 Washers
(2) AN970-4 Washers
(45) MS21042-3 Nuts
(4) MS21042-4 Nuts
(10) AN315-3 Nuts
(2) AN310-4 Nuts
(4) AN316-4 Nuts
(8) AN100-3 Thimbles
(12) AN100-4 Thimbles
(40) AN470AD4-10 Rivets
(12) BSC44 Flush Pop Rivets
(8) 18-1-C Nicopress Sleeves
(12) 18-2-G Nicopress Sleeves
(4) AN393-9 Clevis Pins
(4) AN393-18 Clevis Pins
(7) AN416-1 Safety Pins
(2) AN380-2-2 Cotter Pins

Glass: (2) Yds. BID
Epoxy: (1) Gal.
Foam: None
Metal: (15) Sq. in. .063 2024-T3 Alum.
(2) 6 ft. pcs. 1/2 x .035 w 2024-T3 Alum Tubing
(3) 6 ft. pcs. 3/4 x .058 w 6061-T6 Alum Tubing
(1) 3 ft. pc. 5/8 x .049 w 4130 Stl Tubing
Wood: 1/4 in. Plywood Scraps from Firewall
Misc: (24) sq. in. 1/4 in. thick Phenolic
(2) MS20271-B10 Universals
(10) HM-3 HEIM Rod Ends
(4) HM-4 HEIM Rod Ends
(32) ft. of 1/16 dia 7 x 7 Steel Cable
(26) ft. of 3/32 dia 7 x 19 Steel Cable
(14) ft. of 3/16 OD x .025 w Nylaflo Tubing
(2) FB-1013-8 Boston Bronze Flanged Bearings

Chapter 17: Pitch & Roll Trim, Ldg Brake & Center Console

Prefab: (2) RT-2 Roll Trim Bracket (1RT, 1LFT)
(1) CZRTH Roll Trim Handle
(1) CZPTH Pitch Trim Handle
(1) CZLB-1 Spacer
(2) CZLB-6 Spacer
(1) CZLB-10 Spring Bracket
(1) LB-11 Bracket
(1) CZLB-13 Landing Brake Handle Assembly
(1) CZLB-15 Landing Brake Actuator Assembly
(1) CZLB-21 Arm
(1) VECG Throttle Quadrant Assembly

Hardware: (1) AN3-5A Bolt
(1) AN3-6 Bolt
(1) AN3-6A Bolt
(1) AN3-7 Bolt
(1) AN3-7A Bolt
(1) AN3-11A Bolt
(1) AN3-13A Bolt
(1) AN4-21A Bolt
(1) AN4-35A Bolt
(5) AN509-10R6 Screws
(2) AN525-10R10 Screws
(16) AN960-10 Washers
(1) AN960-416L Washers
(3) AN960-416 Washers
(1) AN970-3 Washers
(7) AN970-4 Washers
(6) MS21042-3 Nuts
(2) MS21042-4 Nuts
(2) AN310-3 Nuts
(2) AN380-2-2 Cotter Pins
(8) AN100-3 Thimbles
(4) 18-1-C Nicopress Sleeves 28-1-C

Glass: (1) Yd. BID
(1) Yd. UND
Epoxy: (2) Gal.
Foam: (2) sq. ft. 1/4 in. 4.5 lb. Clark
Metal: None
Wood: 1/4 in. thick scraps from Firewall
Misc: (5) ft. of 1/16 dia 7 x 7 Steel Cable
(2) ft. of 3/16 OD x .025 w Nylaflo Tubing
(5) ft. of .041 dia Safety Wire
(1) 18 in. x .05 wire x .350 dia Tension Spring
(1) 18 in. x .06 wire x .375 dia Tension Spring
(2) 0.5 in. x .06 wire x .350 dia Comp. Spring

Chapter 18: Canopy

Prefab: (1) Cozy Plexiglass Canopy Bubble
(1) Cozy Side Window Set
(1) C1-L Handle
(2) C2-L Arms
(1) C3 Lug
(1) C4 Block
(1) C4A Block
(1) SC1 Safety Catch
(1) C21 Handle
(2) CS13 Spacers
(1) CN-1 Bushing 1/4 ID x 5/8 OD Alum.

Hardware: (10) AN509-10R10 Screws
(2) AN509-10R17 Screws
(3) AN509-10R24 Screws
(2) AN509-10R28 Screws
(2) AN509-10R30 Screws
(3) AN509-10R32 Screws
(3) AN525-10R10 Screws
(8) AN525-10R12 Screws
(1) AN525-10R16 Screws
(4) AN525-10R18 Screws
(2) AN525-10R20 Screws
(1) AN525-10R24 Screws
(2) AN3-4A Bolt
(2) AN3-6A Bolt
(3) AN3-7A Bolt
(3) AN3-13A Bolt
(1) AN4-46 Bolt
(32) AN960-10L Washers
(2) AN960-416 Washers
(6) AN970-3 Washers
(43) MS21042-3 Nuts
(4) MK1000-3 Nutplates
(8) AN470AD3-4 Rivets
(4) AN470AD3-7 Rivets
(22) BSC44 Flush Pop Rivets
(2) AN380-2-2 Cotter Pins
(1) 1/4 in. ID Flanged Bronze Bushing
Glass: (13) yds. BID
(17) yds. UND

Epoxy:	3(1.2) Gal.
Foam:	(+) 2 pc. 24 x 48 x 1/4 4.5 lb. Clark
	(1) pc. 34 x 47 x 3/8 H45 Divinycell
	(1) pc. 24 x 48 x 1 urethane
	(1) pc. 24 x 48 x 2 urethane
Metal:	(1) 6 x 1 x 1 x 1/8 2024-T3 Alum Angle
	(1) 1-1/2 x 5 x .032 2024-T3 Alum
	(1) 5 x 10 x 1/8 2024-T3 Alum
	(1) 2 x 3 x .062 2024-T3 Alum
	(1) 16 x 3/4 x 1/8 2024-T3 Alum Bar
	(8) in. 1 OD x .035 w 2024-T3 Alum Tubing
	(42) in. 5/16 OD x .049 w 2024-T3 Al Tubing
	(1) in. 3/16 ID x .065 w 1015 Stl Tubing
	(4) in. 1/4 x 20 Threaded Stl Rod
Misc:	(1) pt. Spraylat
	(1) gal. Glass Bubbles
	(1) gal. Flox
	(20) in. MS20001-P6 Hinge
	(2.5) in. MS20257-P2 Hinge
	(1) H-5000-2 Hartwell Flush Latch
	(6) ft. 1 in. ID CAT Flexible Ducting
	(4) QS100 M16W Stainless Worm Clamps

Chapter 19: Wings, Ailerons/Wing Attach

Materials: See Section I

Chapter 20: Winglets and Rudders

Materials: See Section I

Chapter 21: Strake/Fuel/Baggage

Materials: See Section I

Add (2) CAV-110 Drain Valves
Add (1) Essex K2404-1/8 Primer (optional)

Chapter 22: Electrical

Note! Due to the various options, this bill of materials does not include electrical items. Order approved aircraft grade materials to suit.

Chapter 23: Engine Installation

Prefab:	(1) CZCT Cowling, Top (per Section I)
	(1) CZCB Cowling, Bottom (per Section I)
	(1) Cabin Heat Valve
	(1) Carb Heat Valve Assembly VECHVA
	(1) Cozy 0-235 conical or dynafocal eng. mount
	(1) Exhaust with Carb & Cabin Heat Muffs
	(1) 5 in. Prop Hub Extension
	(1) Prop Plate
	(1) Cozy Spinner Assembly w Airflow Guide
	(1) Propellor w Prop Hub Bolts
	(1) Harrison Oil Cooler P/N 8526250 STEWART WARNER Oil Cooler 87106-R
	(1) CCB Carb Control Bracket
Hardware:	(2) LL-3 Spacers
	(6) AN3-7A Bolts
	(2) AN3-10A Bolts
	(2) AN3-14A Bolts
	(2) AN3-17A Bolts
	(4) AN4-12A Bolts
	(2) AN4-13A Bolts
	(2) AN4-14A Bolts
	(18) MS21042-3 Nuts
	(8) MS21042-4 Nuts
	(10) AN509-10R8 Screws
	(60) AN507-1032R10 Screws
	(60) K-1000-3 Nutplates
	(60) A-3235-028-24A Countersunk Wshrs
	(24) AN960-416 Washers
	(200) AN960-4L Flat Washers
	(12) AN936-A416 Lock Washers
	(200) Avex 1601-0410 Pop Rivets
	(12) AN500-A416-10 Baffle Screws
	(2) AN111-4 Cable Bushings

Conical Mount: (Optional)

- (4) AN6-43A Bolts
- (4) AN960-616 Washers
- (4) Lyc. # Std 619 Washers
- (4) AN363-624 Nuts
- (8) #71032 Rubber Bushings

Dynafocal Mount: (Optional)

- (4) AN7-35A Bolts
- (8) AN960-716 Washers
- (4) AN363-720 Nuts
- (8) Dynafocal Bushings (for 2-3/4 ID Ret.)
- (4) Steel Spacers

Fittings:	(3)* AN818-2D Nuts
	(3)* AN819-2D Sleeves
	(2)* AN822-2D Elbows
	(1)* AN816-2D Nipple
	(2) AN822-6-6D Elbow
	(2) AN816-4 Nipple
	(2) AN816-6 Nipple
	(4) AN823-6D Elbow
	(1) AN910-1D Coupling
	(1) AN912-1 Bushing
	(1) 3600 x 4 Weatherhead Male Branch Tee
	(2) AC#6470069 Fuel Pump Adapters
	(2) 491-4 Aeroquip Fittings
	(8) 491-6 Aeroquip Fittings
	(84) in. 303-6 Aeroquip Hose
	(6) in. 303-4 Aeroquip Hose
	* Only required if a primer is used.
Glass:	(3) yds. BID (per Section I)
Epoxy:	(.2) gal. (per Section I)
Foam:	(1.5) sq. ft. 1 in. urethane
Metal:	(1) pc. 20 x 24 x .020 6061-0 (per Section I)
	(1) pc. 30 x 48 x .025 6061-T6 Alum sheet
	(1) pc. 2 x 6 x .032 2024-T3 Alum Sheet
	(4) in. 3/8 OD x 3/16 ID Bushing Stock
	(6) in. 3/4 OD x .049 w 6061-T6 Alum Tube

Wood: None

Misc:	(3) in. MS20001-P3 Hinge
	(4) Lyc#77611 Blow Proof Exhaust Gaskets
	(8) MS35333-41 Lock Washers
	(8) Exh Manifold Nuts Std. 1410 5/16-18 Lyc.
	(18) in. 3/4 ID x 1/8 w Tygon Plastic Tube
	(24) TY-525M Nylon Tyraps 6 in. long
	(24) TY-528M Nylon Tyraps 12 in. long
	(1) Tube High Temp RTV Silicone, Red or Silver
	(2) AN931-6-16 Rubber Grommets
	(48) in. of 2.5 ID Scat Aeroduct
	(24) in. of 1.5 ID Scat Aeroduct
	(48) in. of 1.5 ID Cat Aeroduct
	(4) QS100-M36W Stainless Worm Clamps
	(6) QS100-M24W Stainless Worm Clamps
	(2) #CS Comp Springs 1/2 x .35 OD x .06 wire
	(2) #C-161 Springs

Chapter 24: Covers, Fairings, and Consoles

Prefab:	None
Hardware:	(7) MS21069-08 Nutplates
	(14) MS20426-3-3 Rivets
	(7) AN509-8R5 Screws
Glass:	(4) yds. BID
Epoxy:	(.6) gal.
Foam:	(2) Sheets 3/8 x 34 x 47 H45 PVC
	(1) sq. ft. 1 in. Thick Urethane
	(3) sq. ft. 2 in. Thick Urethane
	(1) M-26 2-qt. Kit Urethane Pourfoam

Chapter 25: Finishing

Sandpaper:	9" x 11" Sheets, Silicon Carbide or Aluminum Oxide type.
	(100) Sheets 36 grit
	(100) Sheets 100 grit wet/dry
	(100) Sheets 220 grit wet/dry
	(100) Sheets 320 grit wet/dry
	(25) Sheets 400 grit wet/dry
Fillers:	Epoxy and Micro as Required
	(2) gal. U-1761 Sterling or Featherfill
Primer:	(3) gal. duPont 1315 or Ditzler Kondar DZ-3
	(1) Tube 3M Spot Putty
	(1) qt. Stitts Micro Putty
	(1) Tube Silicone Bath Caulk
Paint:	(2) gal. duPont Imron or Ditzler Deltron

Note! These materials are available locally in most areas through auto paint suppliers, and are not supplied with the basic materials kit.

Chapter 26: Upholstery

Note! Your local auto upholstery shop can custom make seat cushions for you cheaper than we could supply through a distributor.

CHAPTER 15

FIREWALL

OVERVIEW. In this chapter you will install the Fiber Frax insulation and aluminum liner over the plywood firewall bulkhead. The rudder pulley brackets and rudder/brake belcrank brackets are then installed. The brake master cylinders are located and temporarily installed. This chapter involves about eight hours of work. **CS15, CS71, CS72, and CS75** are available prefab. It is recommended that you purchase at least the **CS72s** and the **CS75s** because they are difficult to make. Materials for all the other parts are supplied in the kits.

STEP 1. INSTALLING FIREWALL LINER AND RUDDER PULLEY BRACKETS

Purchase or make the **CS72** brackets (Fig. 2) and assemble the pulleys in the brackets as shown in Fig. 3 before starting firewall assembly. Locate and drill the three #10 mounting holes so the brackets will fit on the **AN509-10R12** screws which you installed through the firewall in Chapter 4.

Trial fit the 0.016 in. aluminum liner you made in Chapter 4 to the plywood bulkhead, over the 6 screws and engine mount extrusions installed earlier. Trim the aluminum 1/8 to 1/4 in. smaller than the plywood, all around. Also, cut 4 notches about 1 in. wide and 2 in. long at the locations shown in Fig. 1 to allow direct bonding of the cowl lip (later) to the bulkhead at these points. Deform the edge of the oil filter clearance hole into the depression by tapping lightly all around with a plastic hammer, supporting the aluminum firmly with a block of wood while so doing, so the flat area won't bow. Remove the liner, paint the forward face of the aluminum with beads of silicone glue about 2 in. apart and all around the edge and laminate the **Fiber Frax** to it. Don't use epoxy; it will soak up like a blotter and destroy all insulating value. Cut out a 4-1/2 in. diameter piece of aluminum and Fiber Frax and laminate them to the bottom of the filter depression. Sand the bulkhead overall with 36 grit and apply silicone same as above.

Install the liner on the bulkhead with Fiber Frax sandwiched in between. Squeegee from the center out to remove air. Bolt the **CS72** rudder pulley brackets in position as shown on drawing A-4. If one of the blind screws should turn during assembly, slot its end and use a screw driver to hold it while tightening the nuts. Use boards clamped across the firewall (or your temporary firewall) with something resilient underneath to hold the aluminum flat during cure.

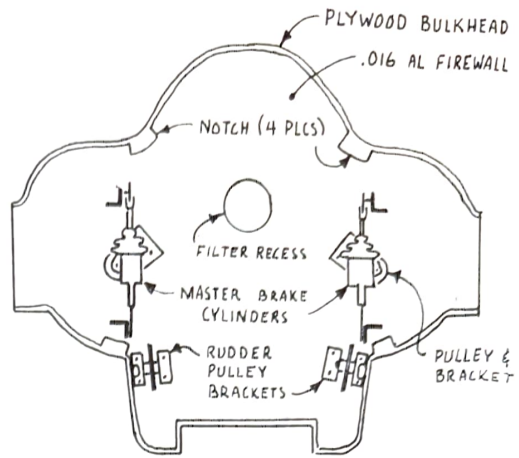


FIG. 1 FIREWALL VIEW FROM AFT

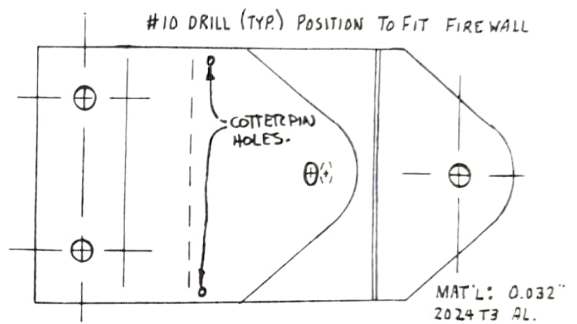
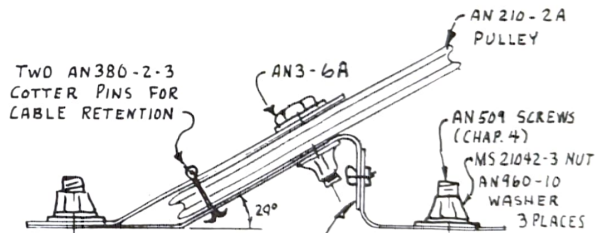


FIG. 2. CS 72 BRACKETS - TOP VIEW - 2 REQ'D.



THIS PART MAY BE MADE IN ONE PIECE OR IN TWO PIECES AS SHOWN P&P RIVETED TOGETHER.

FIG. 3 CS 72 BRACKET ASSEMBLY - SIDE VIEW - 2 REQ'D

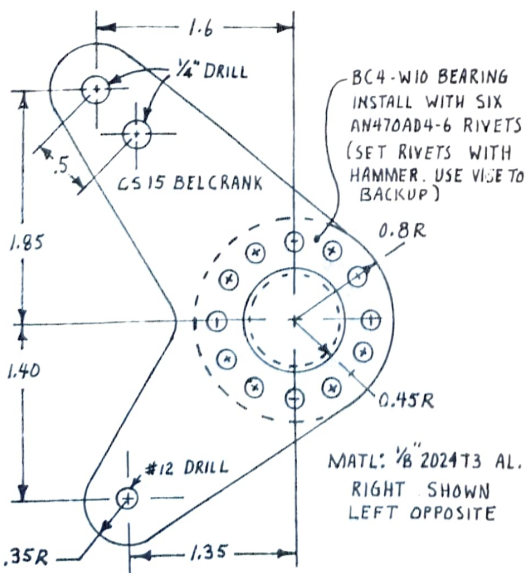


FIG. 5 CS 15 BELCRANK - 1 LEFT, 1 RIGHT REQ'D

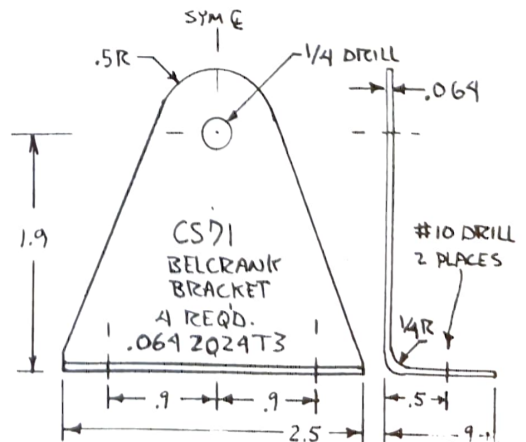
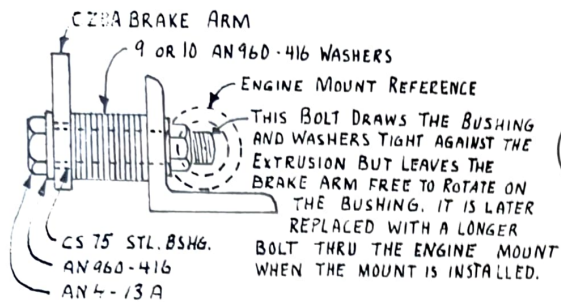


FIG. 4 CS 71 BELCRANK BRACKET - 4 REQ'D.



SECTION A-A LOOKING AFT

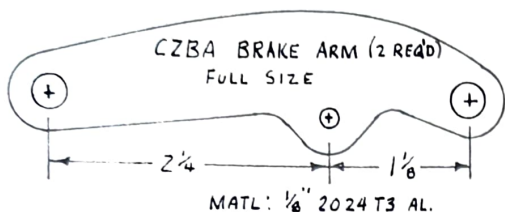
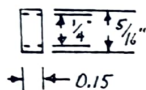


FIG. 6 CZBA BRAKE ARM - 2 REQ'D.



CS 75 BUSHING (2 REQ'D)
MATL: 4130 STEEL

FIG. 7 BUSHING - 2 REQ'D.

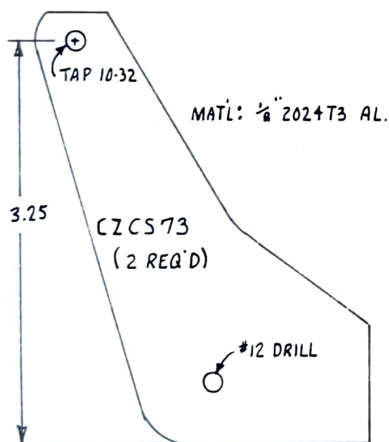
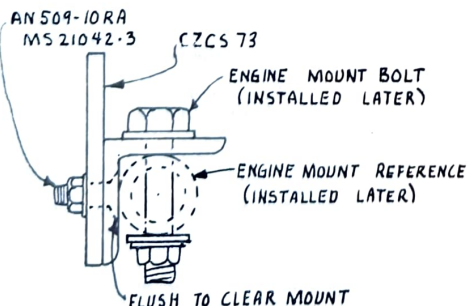
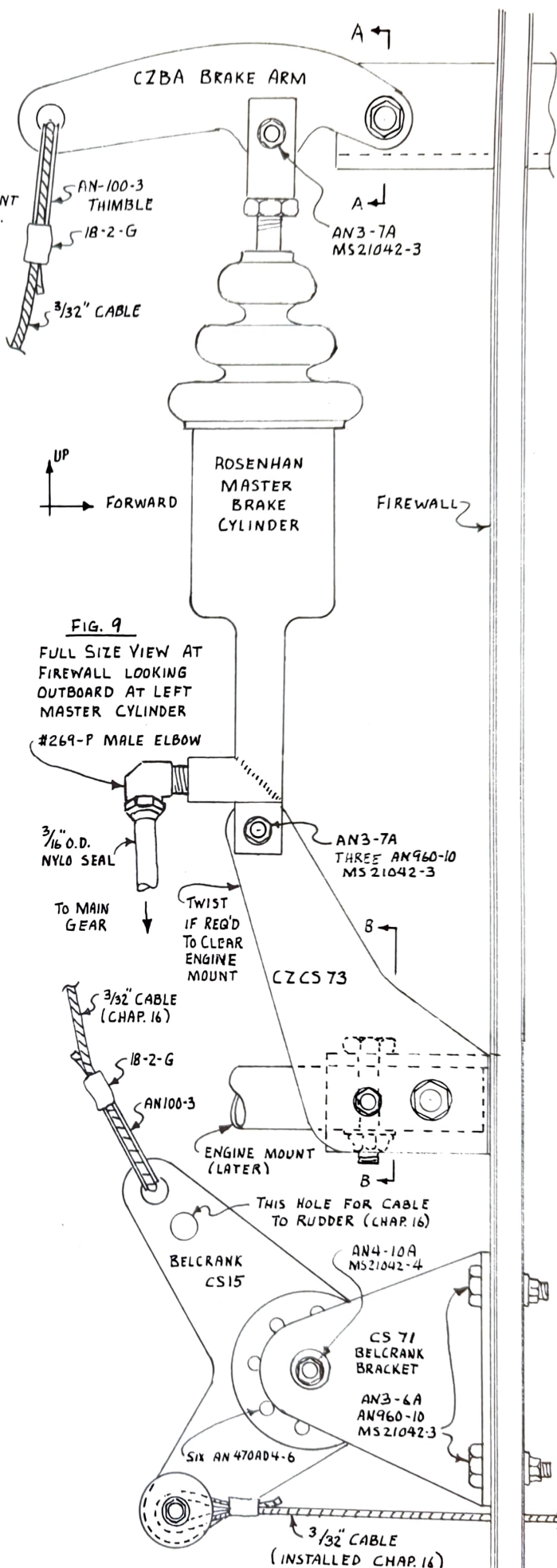


FIG. 8 BRACKET - 2 REQ'D.



SECTION B-B LOOKING AFT



STEP 2. INSTALLING THE BELCRANK BRACKETS

Make four **CS71** belcrank brackets per Fig. 4, and two **CS15** belcranks (opposites) per Fig. 5. Cut holes through the firewall for the electrical conduits and rudder cables as shown on drawing A-4 and page 16-5. Notch the two **CS71** outboard brackets to fit around the electrical opening as shown on page 16-5, (*not* as on A-4). Assemble the belcranks in the brackets and mount the assembly on the firewall as shown on **page 16-5**. Right side is shown; the left is the **mirror** image. Drill mounting holes through brackets, aluminum, Fiber Frax and plywood. The inboard holes enter into the baggage area. Install **AN3-6A** bolts and **MS21042-3** nuts using **AN960-10** washers against the forward face of the firewall. To put nuts on the outboard bolts, you will have to grind holes through the outside fuselage skin (use your Dremel) and dig out the foam. After installing washers and nuts, fill holes flush with dry micro.

STEP 3. INSTALLING BRAKE MASTER CYLINDERS

Rosenhan brake cylinders have been specified because they deliver a greater pressure per given force than Cleavelands or Gerdes, and hence better braking. The cylinders are positioned vertically between the upper and lower engine mount extrusions as shown in Fig. 9. Make two **CZBA** brake arms as shown in Fig. 6 and two **CZCS73** brackets as shown in Fig. 8 from 1/8 in. thick 2024T3 aluminum. Purchase or make two **CS75** bushings as shown in Fig. 7. Clamp the **CZCS73** brackets in place on the lower extrusions and drill **one** #12 hole through each extrusion as shown in Fig. 9 and Section B-B for the flush **509** screw (one per side). Countersink the outboard side of the extrusion and install one **AN509-10R8** screw per bracket. The second bolt through the bracket and extrusion will be installed later with the engine mount.

Location of the **AN4** bolt which goes through the upper extrusion to provide the pivot for the brake arm deserves special consideration because it will later secure the engine mount to the extrusion also (a longer bolt, of course!). Study Section A-A, page 15-2. If this hole is drilled through the extrusion without the engine mount being in place, it will be difficult (if not impossible) to drill the engine mount later and have a perfectly aligned hole through both. What you don't want is a sloppy hole for the engine mount attachment. It would ruin your whole day! The solution is to grab your engine mount (remember, you used it to position your extrusions, didn't you?) and clamp it in position on the extrusions. The mount should not quite touch the firewall. 0.030 in. clearance is ideal. If it touches anywhere, file a little off the end to give a minimum clearance. If you have clearance, it should snug real good into the extrusions. Clamp it there. Now drill a pilot hole (1/8 in. drill) from the **outboard** side through the mount and extrusion, at the position shown for the brake pivot. Make sure this hole goes through the center of the mount and is square with the extrusion. Then open up this hole to 1/4 in. Make sure the drill you use will give a tight fit for an **AN4** bolt. Otherwise drill undersize and ream to 1/4 in. Now you can remove the mount, breathe a sigh of relief, and continue installation of the master cylinders.

The brake arms mount on the **inboard** side of the extrusions. Use **AN4-13A** bolts, with one **AN960-416** washer under the head, 9 or 10 between the brake arm and the extrusion, and one under the **MS21042-4** nut (Section A-A). This bolt will later be replaced with a longer one when the mount is installed. *Don't forget* the **CS75** bushing through the brake arm. The 9 or 10 washers are necessary to provide clearance for the brake arm travel later, when the mount is installed. Now install the cylinders in place, between **CZCS73** and **CZBA**, using the hardware specified. Make sure **CZBA** is free to pivot at both the extrusion and the piston rod, and that the cylinder is just free enough to pivot on the bolt through **CZCS73** as well. Adjust the fork on the end of the piston rod so the brake arm is approx. horizontal.

In Chapter 16 you will connect the brake cables, connect the brake lines, fill the system and check its operation. After the mount is installed, if the brake arm touches it, the brake arm may be bent in it, the brake arm may be bent inboard slightly. If either the cable or the brake line touch the mount, the **CZCS73** bracket may be twisted to improve clearances.

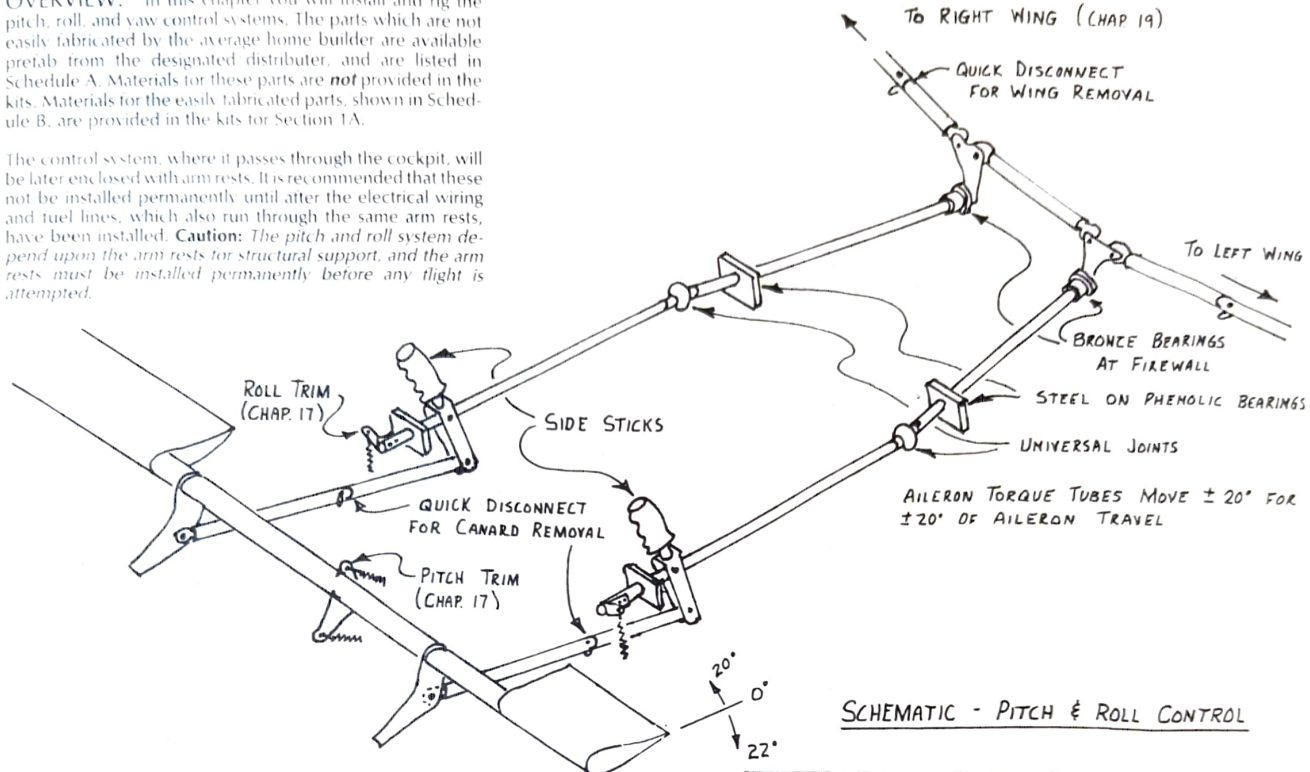
CHAPTER 16

CONTROL SYSTEM

CZ 9-3 BUILDER HINTS CR 18-5
BUILDER HINTS - CONTROL STIFFNESS

OVERVIEW. In this chapter you will install and rig the pitch, roll, and yaw control systems. The parts which are not easily fabricated by the average home builder are available prefab from the designated distributor, and are listed in Schedule A. Materials for these parts are **not** provided in the kits. Materials for the easily fabricated parts, shown in Schedule B, are provided in the kits for Section 1A.

The control system, where it passes through the cockpit, will be later enclosed with arm rests. It is recommended that these not be installed permanently until after the electrical wiring and fuel lines, which also run through the same arm rests, have been installed. **Caution:** The pitch and roll system depend upon the arm rests for structural support, and the arm rests must be installed permanently before any flight is attempted.



SCHEMATIC - PITCH & ROLL CONTROL

STEP 1. PIVOT MOUNTS

Fabricate 2 each of CS-109 and CS-118 bearing blocks from 1/4 in. 5-ply birch plywood as shown on page 16-2. They hold the torque tube bearings, and will later be bonded and glassed to the fuselage sides in assembly to hold alignment. Then fabricate 2 each CS-108 and CS-117 (identical) bearings from 1/4 in. thick phenolic as shown on page 16-2. Use your 5/8 in. counterbore tool to drill clean 5/8 in. diam. holes in the bearings. Mount them in their respective bearing blocks as shown in Views D-D and E-E on page 16-4.

Now refer to page 16-5 and locate points on the firewall at B.L.6.5 left and W.L.12.6, and B.L.6.5 right and W.L.12.6. Drill 1 in. diam. holes through the firewall centered at these points. A hole saw works best, or you can drill multiple smaller holes around the perimeter and use a rotary file to clean up the edges.

Oil impregnated, flanged, bronze bearings (Boston Gear FB1013-8) are used at the firewall as shown on pages 16-3 and 16-5. These bearings, CS-123, are potted in position with flox later, in assembly, to maintain alignment. Dimple these bearings as shown in Fig. 1 to provide a 'tooth' for the flox to hang on to. Only dimple. **Don't drill through!** A grinder wheel on your Dremel can also be used to dimple.

STEP 2. FABRICATION OF PITCH AND ROLL PARTS

Procure or fabricate the parts shown in Schedule A and detailed on page 16-2. It will save unnecessary work in Chapter 17 if you also procure and install roll trim brackets RT-2 (left and right) at this time. Weldments and brackets should be corrosion proofed by cadmium plating. Cut the tubing parts shown in Schedule B, leaving CS-121 a little long for later trimming to fit. Identify the parts to avoid later confusion. Study the assembly drawing, page 16-3, and the details, page 16-4 until you are familiar with how everything fits together. **Note** that the forward bearing, CS-108, with washers on either side, takes the thrust loads of the stick and a good fit (no slop) is required. The other bearings, CS-117 and CS-123, have clearances fore and aft, and do not carry thrust loads. **Note also** that all bolts are in a vertical plane (with nuts on the bottom so the bolts cannot fall out should the nuts loosen--this is standard aircraft practice), except through the sticks (CZSA) and the roll trim brackets (RT-2), where they are horizontal. **Note also** that wherever AN3 bolts are installed through the torque tube, a #12 hole is required for a snug fit with no slop. Use a pilot drill, #30 or 1/8 in. first, then redrill with #12 to avoid sloppy holes.

CZ16-2
CS 50 STEEL INSERTS
CCP-42 STAINLESS POP RIVETS

SCHEDULE A - PREFAB PARTS				
<u>Part No.</u>	<u>Material</u>	<u>No. Req'd.</u>	<u>Description</u>	
CZSA	STL4130	2	Stick assembly	
CS 124	STL4130	1 left 1 right	Aileron Belcrank	
CS 1	2024T3	10	AN3 rod end insert	
CS 1A	2024T3	4	AN4 rod end insert	
CS 17	2024T3	4	Spacer	
CS 181	2024T3	4	Disconnect insert	
Note: Detailed drawings page 16-1				

CZ16-2
1/2" O.D. x .028 4130N
STEEL TUBING

SCHEDULE B - PARTS MADE FROM TUBING					
Part No.	Material	O.D.	Wall	Length	No. Req'd
CS 102	2024T3	1/2	.035	12.7	2
CS 104	6061T6	3/4	.058	5.2	2
CS 105	6061T3	3/4	.058	26.0	2
CS 106	STL4130	5/8	.049	4.5	2
CS 107	6061T6	3/4	.058	1.6	2
CS 112	STL4130	3/8	.065	0.8	2
CS 115	STL4130	5/8	.049	3.8	2
CS 116	6061T6	3/4	.058	6.4	2
CS 121	6061T6	3/4	.058	46.0*	2
CS 122	STL4130	5/8	.049	2.6	2
CS 125L	2024T3	1/2	.035	11.0*	1
CS 126	2024T3	1/2	.035	4.6	2**
CS 126L	2024T3	1/2	.035	14.7*	2
CS 129	2024T3	1/2	.035	9.1	2**
CS 131	STL4130	3/8	.065	0.65	2**
CS 136	2024T3	1/2	.035	8.5*	2
CS 201	STL4130	5/16	.031	0.125	8
* Length will vary. Leave long and trim to fit.					
** See pages 19-15 and 19-16.					
Note: All 4130 steel is condition "N".					

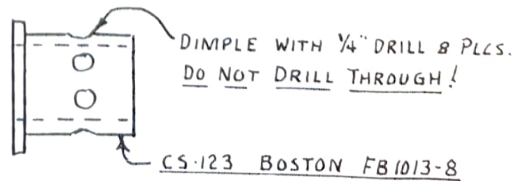
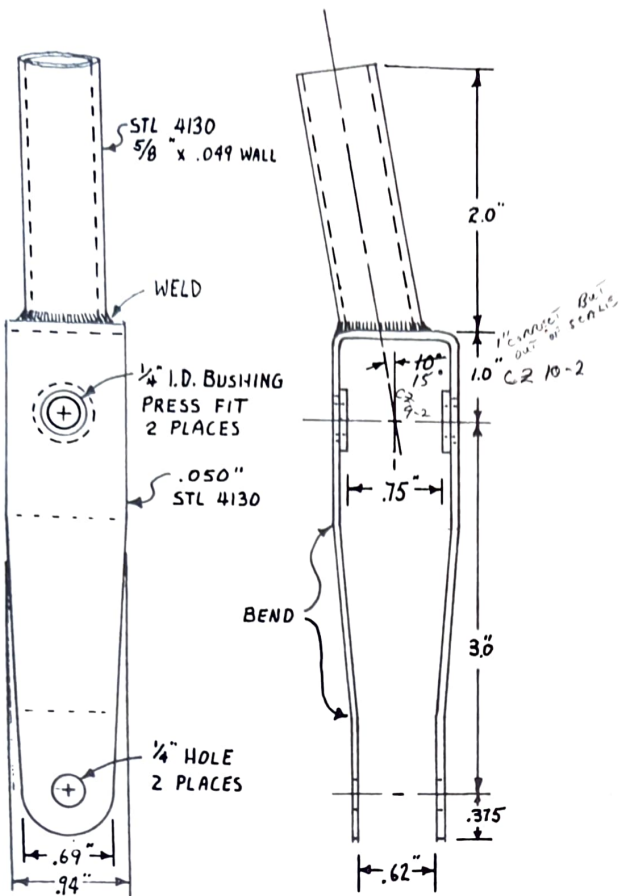
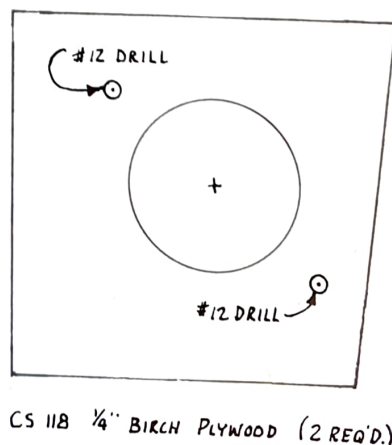
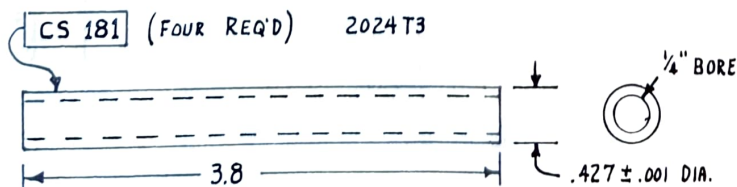
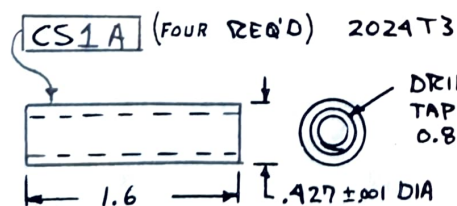
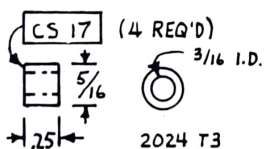
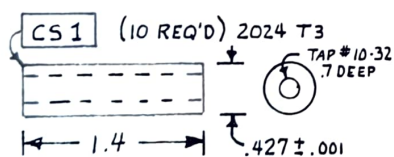
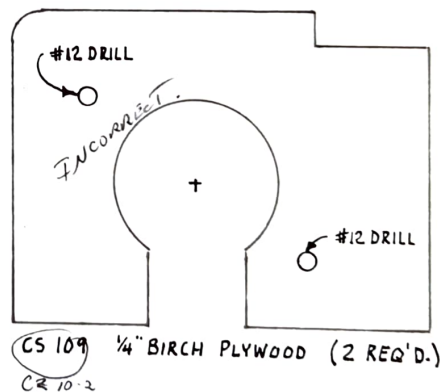
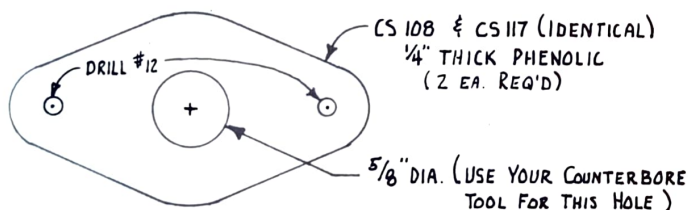
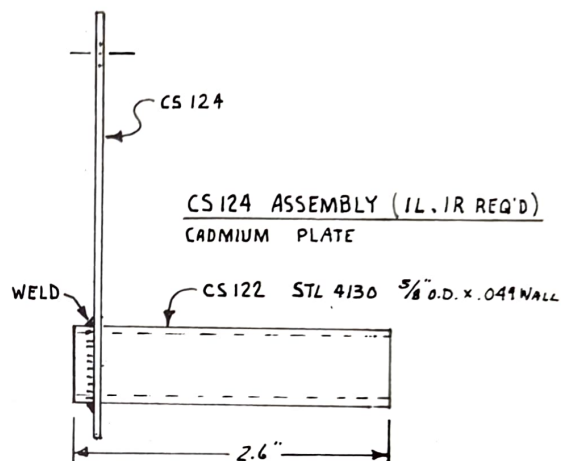
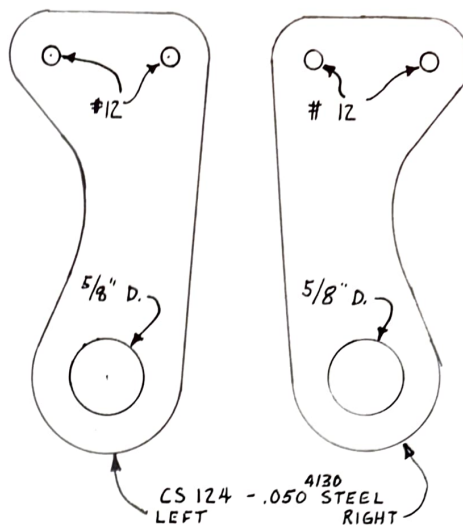
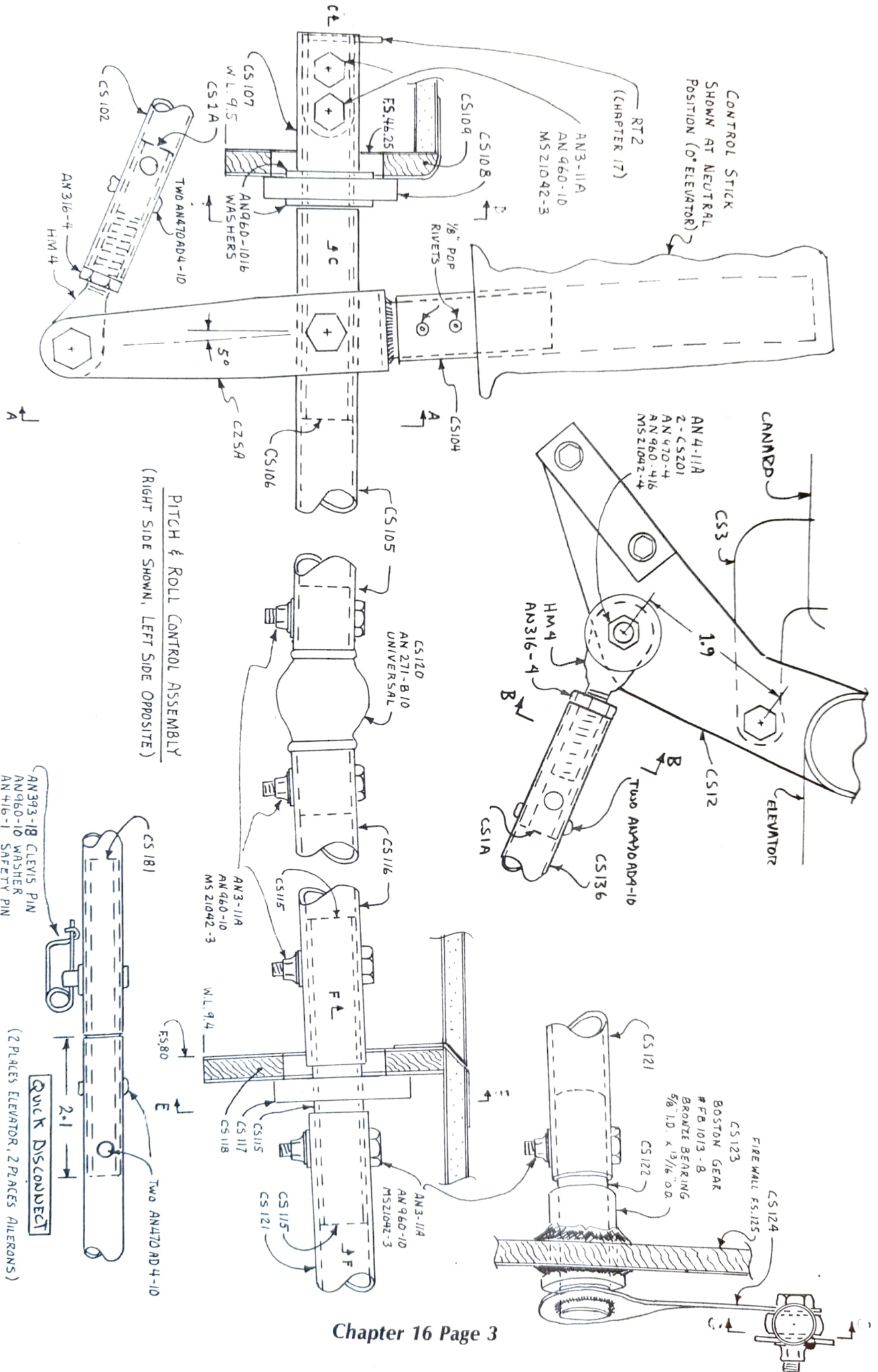


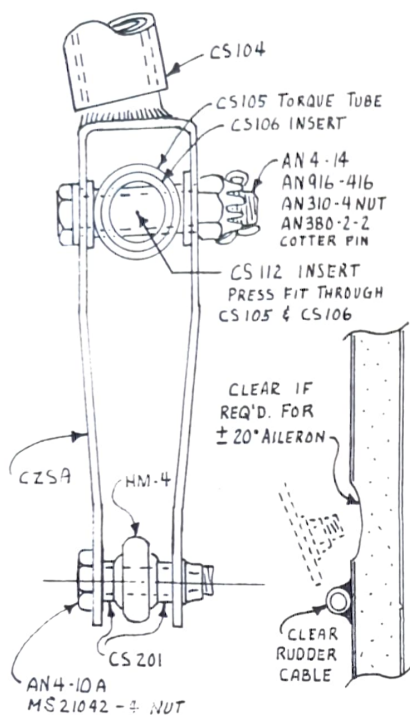
FIG. 1



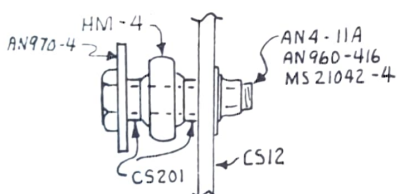
COZY STICK ASSEMBLY - CZSA (2 REQ'D.)
CADMIUM PLATE



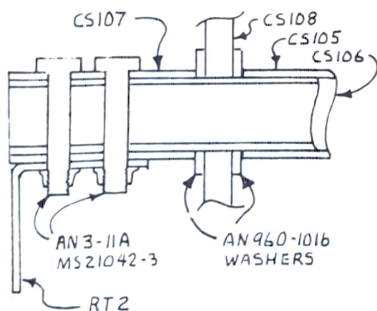




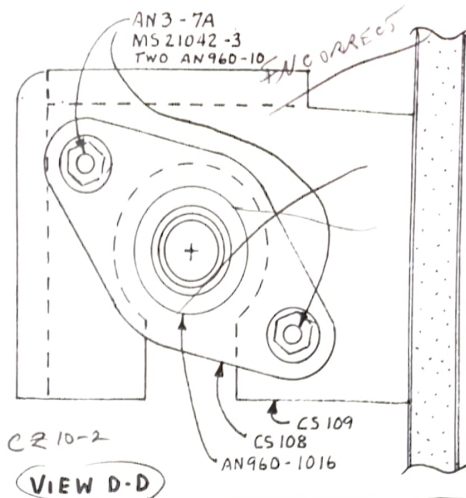
C29-2 REVERSE BOLT AT THE BOTTOM OF THE STICK
 FORK SO BOLT HEAD FACES FUSELAGE
VIEW A-A



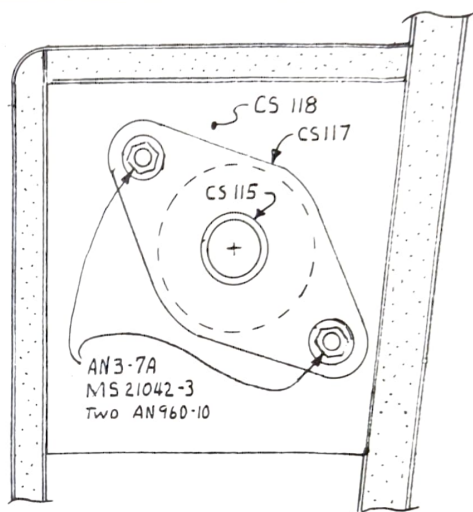
VIEW B-B



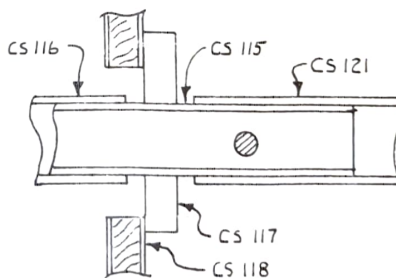
VIEW C-C



VIEW D-D

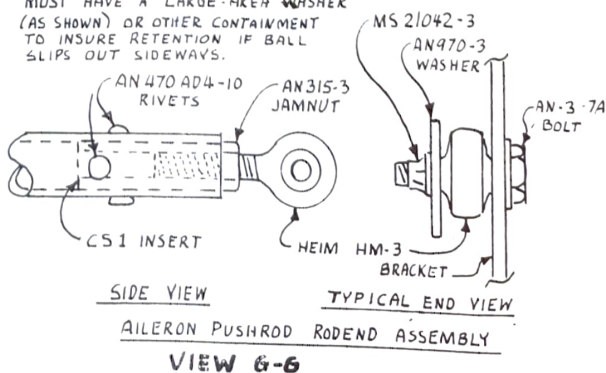


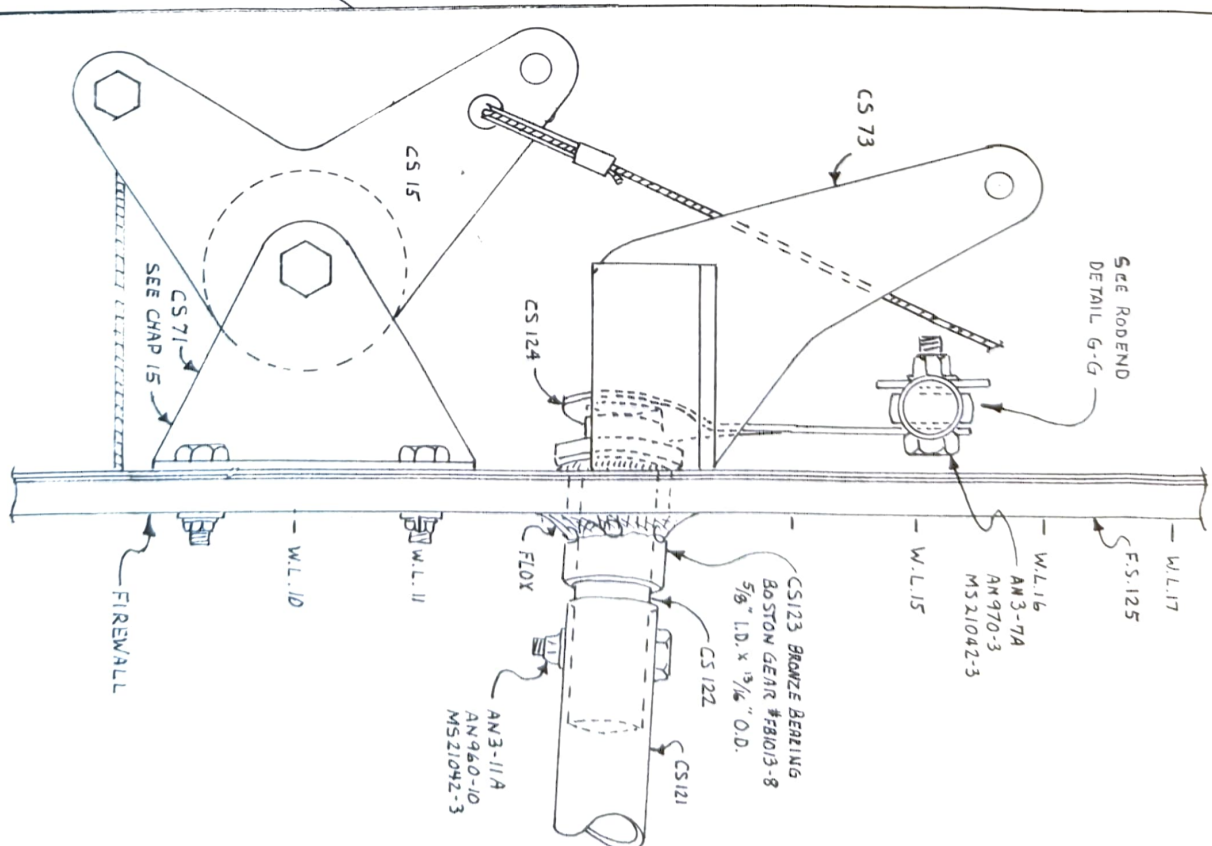
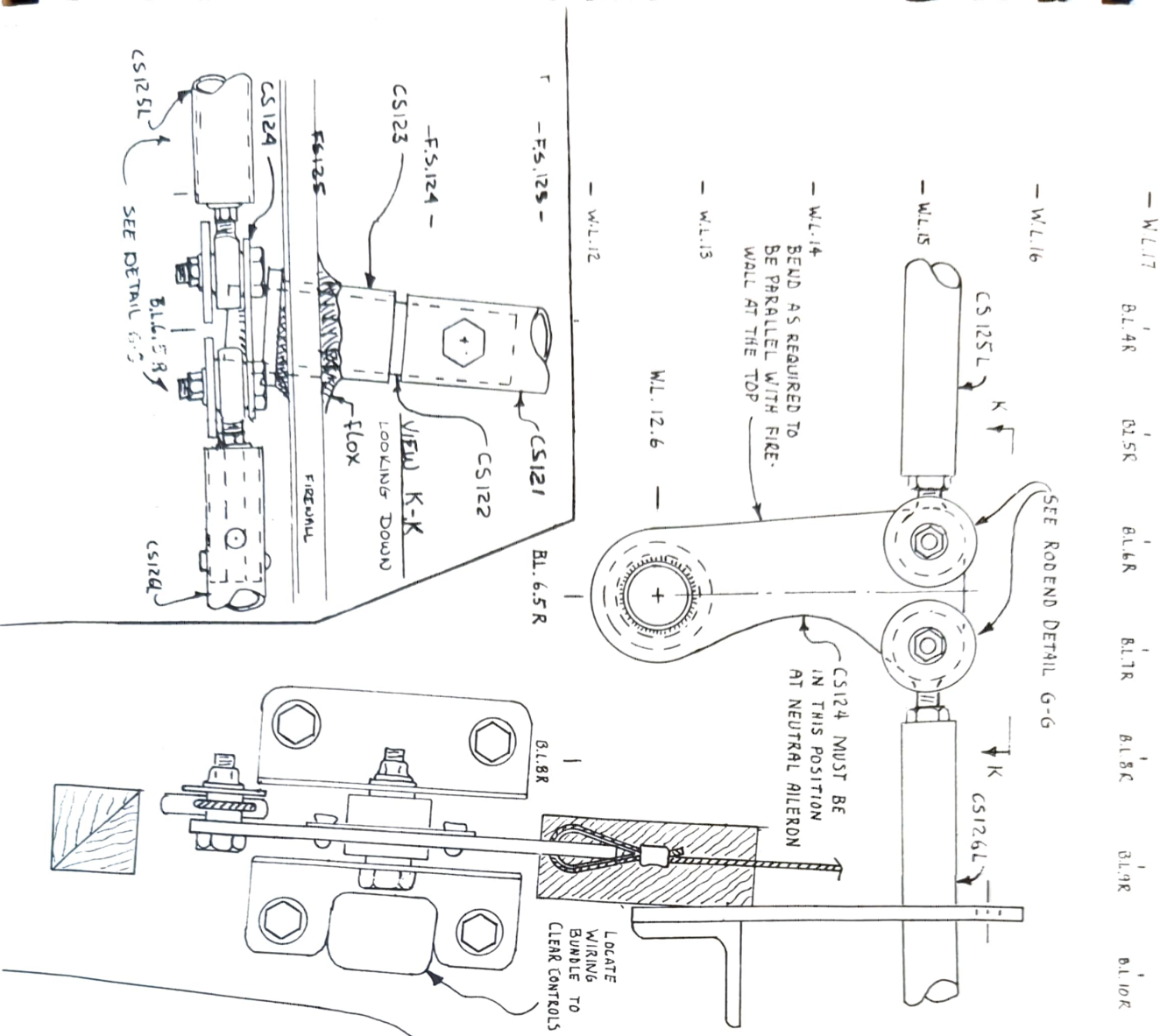
VIEW E-E



VIEW F-F

NOTE: ALL RODEND INSTALLATIONS
 MUST HAVE A LARGE AREA WASHER
 (AS SHOWN) OR OTHER CONTAINMENT
 TO INSURE RETENTION IF BALL
 SLIPS OUT SIDEWAYS.





STEP 3. ASSEMBLY OF ROLL AND PITCH SYSTEM

Trial fit steel tubing parts **CS-106**, **CS-115** and **CS-122** into their respective bearings. You want a good fit with no drag and no slop. Hand rework phenolic bearings or buff (3M Scotch-brite wheel) metal tubing until you are pleased with the fit. Now slip **CS-106** into **CS-105** and pilot drill (#30) the stick pivot hole through both the tube and insert. Increase the size of the pivot holes to 23/64 inch (or use a 3/8 in. press fit reamer) for a press fit on **CS-112** insert. File or grind a slight bevel on one edge of the **CS-112** insert and press it through **CS-105** and **CS-106** using a vise or arbor press. Ream 1/4 in. I.D. on the **CS-112** insert for a free fit to the 1/4 in. bolts. Dress ends of **CS-112** for a smooth fit between forks of **CZSA**. Slip **CS-108** on **CS-106**, with **AN960-1016** washers on either side. Slip **CS-107** retaining ring on **CS-106**, snugging the two washers to avoid end play (see View C-C), position **RT-2** as shown (also shown in Chapter 17), pilot drill the two holes indicated in the same plane as the stick pivot, open to size, and bolt together. In a similar fashion, referring to assembly drawing page 16-3 and details page 16-4, assemble, drill in assembly, and bolt together the remaining parts **except CS-121 to CS-122**, which must be fitted **after** installation.

STEP 4. INSTALLATION OF PITCH & ROLL ASSEMBLY

These instructions provide for attaching bearing blocks **CS-109** and **CS-118** to the fuselage while they are assembled on the torque tube. This is a little more difficult, but will result in perfectly aligned bearings and a better end result.

Measure and mark the positions the bearing blocks will mount on the inside fuselage walls. The fuselage stations and waterlines are shown on page 16-3. Sand these areas for bonding and taping, and then remark. Take a couple of wood scraps, cut a 1/4 in. groove in them to support the bearing blocks and bondo them to the fuselage wall with a couple of dabs of bondo. Disassemble the torque tube only as required to thread it through the seat backs and firewall, with **CS-123** temporarily in place, dressing out clearance through seat backs as required, reassemble and **tighten** all bolts **except** through **CS-121** and **CS-122**, which you haven't drilled yet, right? Check to see that the bearing blocks, when supported on the temporary wood jigs, will be in the correct position. This will require 2 people. When everything is ready, mix up some floc and butter the mating edge of the bearing blocks, **except** leave and **unbuttered** area at the top and bottom of each bearing block. When everything is ready, mix up some 5-min. epoxy with floc and put a dab on the unbuttered areas, lift up assembly and hold it in place with the bearing blocks against the fuselage wall until the 5-min. cures (this will take at least 5 minutes). The 5-min. will hold assembly in place while the floc cures. Don't touch for 24 hours. Do the other side the same way. After a 24 hour cure, carefully disassemble the torque tube and remove, then carefully remove the bearings from the bearing blocks, resand the fuselage area, radius the inside corners with floc or micro, and lay up 2 plies of **BID** on each side of each bearing block, covering the entire bearing block and lapping 1 inch onto the fuselage skin. Allow to cure for 24 hours.

After cure, trim away the excess glass from the bearing blocks, and reinstall bearings and torque tube. Slide bearing **CS-123** into firewall, and **CS-122** through bearing into **CS-121**. Trim **CS-121** as required for a gap of 1/8 in. when bearing is as far through firewall as it will go. Twist the top of **CS-124** so that it is parallel with firewall (refer to drawings 16-3 and detail K-K on page 16-5) and determine how far it must extend through the bearing so that the heads of the bolts attaching the rod ends will not strike the firewall when the torque tube rotates ± 20 deg. from vertical. Block **CS-124** in the correct position fore and aft and absolutely vertical (use a piece of wood and bondo) and block the torque tube so the fork of the stick is absolutely vertical (the grip will be canted inboard 10 deg.), and drill first a pilot hole and then a #12 hole through **CS-121** and **CS-122**. Now slide **CS-122** out of **CS-121** far enough to slide the bushing out of the firewall, butter the bushing with floc, slide it back into the firewall as far as it will go, and **bolt CS-121 to CS-122**. This is important to keep the torque tube from sagging while **CS-123** cures. Apply a floc bead on the forward side of firewall at bearing, and allow to cure. After cure, check smooth rotation of torque tube ± 20 deg. and clearance between stick fork and fuselage side (View A-A). Removal of a small amount of skin and foam locally with a Dremel is permissible to increase clearance if necessary. You can rivet the stick grip assembly to **CZSA** at this time with six dome head pop rivets. The stick grip assembly is available prefab or you can make your own from a fancy set of ski pole grips (if you are fortunate enough to live in snow country).

Now install the elevator push rods, **CS-102** and **CS-136** (2 ea.) with a quick disconnect joining them together as shown on page 16-3, with both sticks at a 5 deg. forward cant when elevators are neutral (0 deg.). **Note that the disconnect pin is installed vertically (always) with safety pin at the bottom (always) so pin cannot drop out even if safety pin comes off.** To be super safe and doubly redundant (pitch is the most important control) you can also drill another hole through the disconnect and insert a cotter pin. **Note that HM4 rod ends are**

used on elevator push rods. This is an absolute requirement. Be sure to install the **CS-201** bushings on both sides of the elevator pushrod rod ends (Views A-A and B-B) to allow sufficient spherical movement of rod ends during roll control.

You should have completed the wings and jig bored them to the centerspar before this chapter and can now install aileron pushrods and quick disconnects. Ailerons should be rigged at 0 deg. with stick forks centered (handles at 10 deg. inboard cant). Maintain the 90 deg. angles shown on pages 19-15 and 19-16 (ailerons neutral). The 90 deg. angles insure aileron differential within ± 0.3 in. Now apply a small amount of light grease to the bearings and pivots in the control system.

WARNING: Check control system for use of AN bolts and locknuts as specified. A minimum of 2 threads must show outside each (Fig. 2). If not, select next longer bolt.

AT LEAST TWO THD.



FIG. 2

WARNING: Control system rod ends HM3 and HM4 are susceptible to being damaged if you do not use care in installing them. When adjusting the pushrod under the front stick **be sure** the normal stops in roll are reached before a twisting load is applied to the rod ends. Be careful to not bend the rod end threads. If an HM3 or HM4 has been bent, twisted, damaged or overloaded in any way, it must be discarded. Check your rod ends, particularly in the pitch system. If they are marked HM4C, return them to be replaced with HM4. The 'C' is a commercial grade and is not as strong as the aircraft HM4.

STEP 5. ROUTING AND RIGGING RUDDER CABLES

This step should take about three hours. A helper is handy to set the rigging and hold the cables for swaging. Cut two lengths of 3/16 OD x .025 wall high-pressure **Nylaflo** semi-rigid nylon tubing. They are 82 in. long. These tubes are the rudder cable conduits and are routed inside the cockpit along the fuselage side contours at W.L.B. Refer to drawings A1-B, A-5, A-12, and A-4 to see where the conduit passes through the instrument panel, front seat back, aft fuselage panel, and firewall. Sand the entire length of the 82 in. conduit dull for bonding. Use 60 or 100 grit. Thread it through the various holes, tape (glass and epoxy) it to the fuselage every 6 in. along the fuselage side as shown (Fig. 3). You want as smooth a curve as possible, with no joggles, for minimum drag on the rudder cables. Make sure bottom of stick cannot touch con-

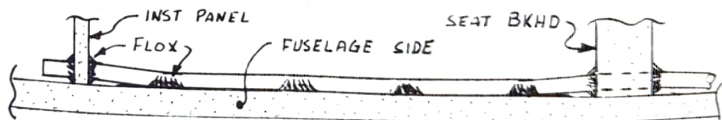


FIG. 3

duit (View A-A, page 16-4). You may have to hold the conduit in place for cure with sticks bridging across fuselage while floc and tapes cure. The conduit sticks out 1 or 2 inches in front of the instrument panel. Get two 10-ft. lengths of 3/32 diam. 7 x 19 aircraft control cable and swage and **AN100-4** thimble and **18-2-G** sleeve on one end and bolt to the inside of **CS-15** as shown (Fig. 4).

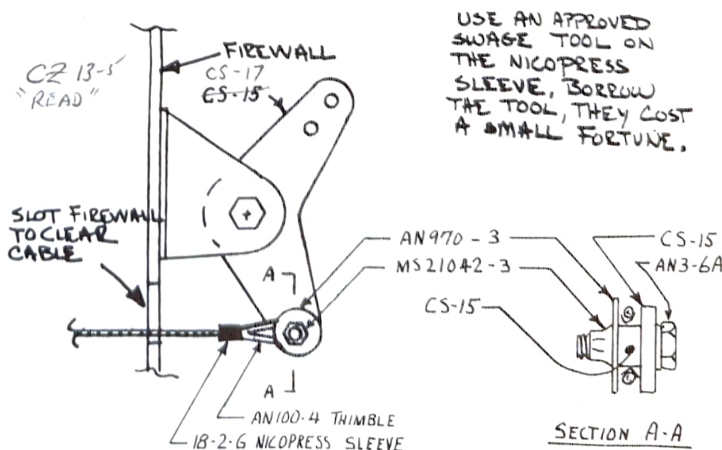


FIG. 4

Push the free cable end forward through the firewall slot and conduit to the front cockpit. Carefully position the rudder pedals and CS-15 belcrank as shown (Fig. 5) and swage the forward cable ends as shown.

This position (rudder pedal vertical at full rudder travel) is about right for the medium height pilot. Tall pilots like the pedal about 2 in. forward at full rudder and short pilots need it 2 in. aft of vertical. If you want to have the pedals adjustable, install the parts shown (Fig. 6), about 8 in. forward of the instrument panel where they can be reached from the cockpit.

The rudder cable from the belcrank to the rudder is 1/16 in. 7 x 7 aircraft cable. Swage one end to the CS-15 belcrank (inner hole), route the cable through the pulley and swage on another thimble about 8 in. from the pulley (Fig. 7). Be sure the cable guards in the pulley brackets (the two cotter pins) are positioned to keep the cable in the pulley if the cable is slack. Make the quick disconnect shown (Fig. 7). This disconnect is unhooked when the wing is removed.

Swage another thimble and sleeve on a 13-ft. length of 1/16 in. 7 x 7 cable and attach to the quick disconnect with a clevis pin and aircraft safety pin AN416 (Fig. 7). Push the cable through the wing conduit until it comes out at the wing tip. If it does not come out at the wing tip, recheck the length of your wing (Chapter 19)! Position the rudder with the top of the trailing edge 6 inches outboard from neutral (30 degrees of rudder). Hold it there by sticking a wedge between it and the winglet (Fig. 8). **OOPS!!** You and I have just remembered that the winglet/rudder is not yet installed on your wing tip! Stop right now and complete Chapter 20 before finishing the rest of this chapter.

With the CS-15 belcrank positioned as shown earlier, with the nicopress sleeve 0.7 in. away from the firewall (Fig. 8), take up the slack in the cables and swage the cable end through the rudder bellhorn as shown (Fig. 9).

STEP 6. RIGGING THE BRAKE ACTUATING CABLE

This is a quickie. One hour is enough. Your brake system should be installed and fully serviced with aircraft brake fluid (be sure to bleed your brake lines by filling from the bottom) before you proceed. Install a piece of 3/32 in. cable (thimble and sleeve on each end) from the CS-15 belcrank to the master cylinder brake arm, so that as you reach the full rudder deflection shown in Step 5, you are **hard** on the wheel brakes. Slip a piece of soft rubber tubing over this cable before swaging both ends to prevent the cable from chafing on the brake master cylinder and engine mount when it is slack. Note that this short length of cable is slack until the rudder reaches its full position. Note also that the stop for full rudder position is provided by the brake master cylinder. No turnbuckles are required. Any adjustment to maximum rudder deflection that may be required, can be done with the adjustment already provided at the top of the master cylinder. The stops in this position also allow the use of small 1/16 in. cable to the rudders since the maximum load attainable in this cable is only about 20 pounds. Check that your rudder and brake system works smoothly. The spring at the rudder is much stronger than the one at the rudder pedal, so the rudder should return to neutral. In flight, airloads return the rudder with loads much greater than the spring.

CAUTION! Be sure you have at least 0.7 in. overtravel at the firewall and at the wingtip when at full rudder and hard on the brakes.

You have now graduated to Chapter 17!

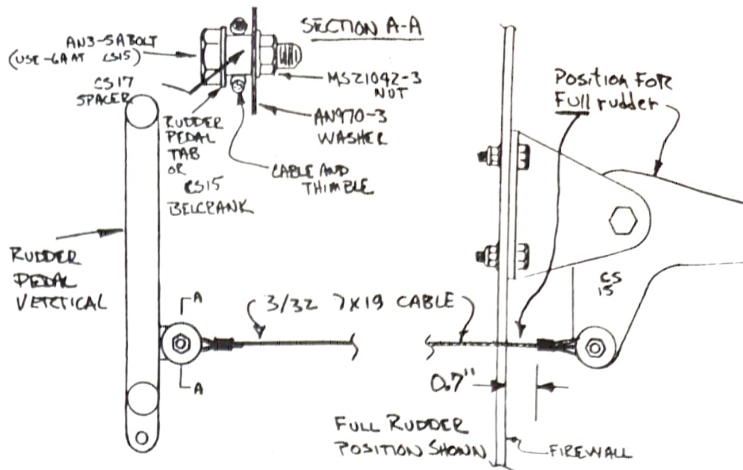
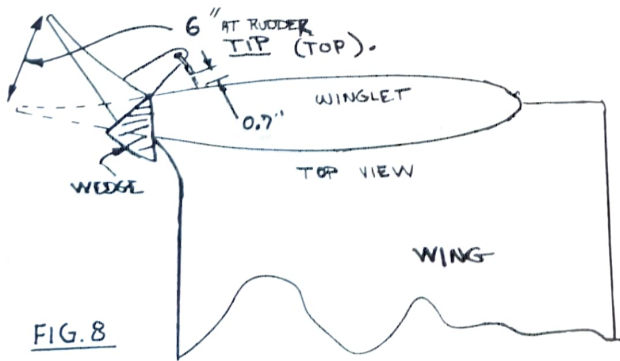


FIG. 5

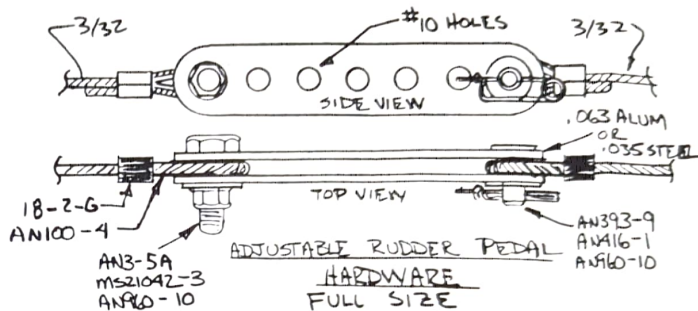


FIG. 6

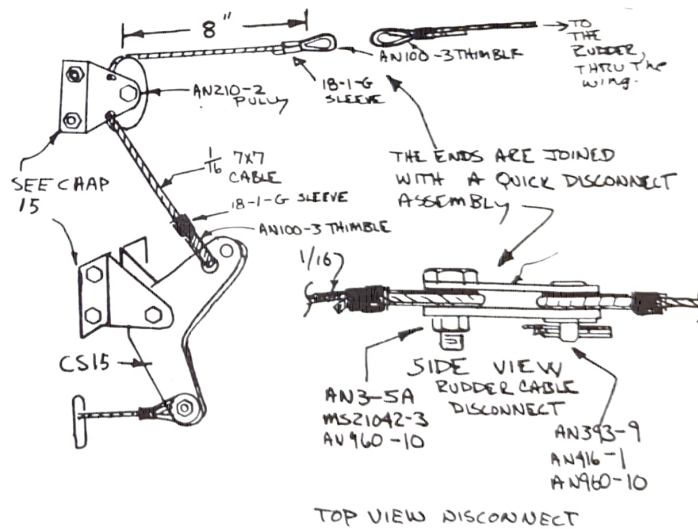


FIG. 7

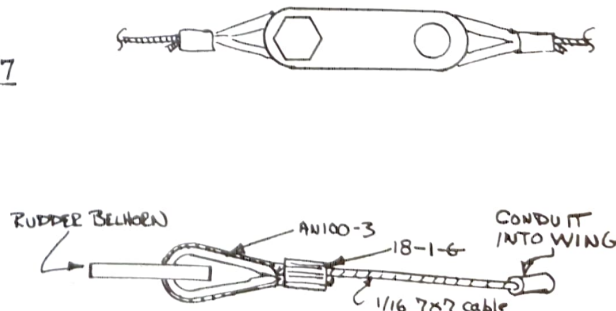


FIG. 9

CHAPTER 17

PITCH AND ROLL TRIM, LANDING BRAKE, AND CENTER CONSOLE

OVERVIEW

In this chapter you will install the pitch and roll trim. The pitch trim control is mounted on the wheel well, right of center, and the handle extends out into the cockpit through the right side knee hole, just right of the center console. The roll trim handle is mounted on the instrument panel, just ahead of the throttle quadrant. Both handles are easily accessible from either seat.

You will also install the landing brake operating mechanism behind the front seat back, build the center console and install the landing brake handle and throttle quadrant. The prefab parts which are used in this chapter are listed in Schedule A.

STEP 1. ROLL TRIM

The roll trim parts and assembly are shown on page 17-2. You were instructed to install the **CZRT-2s** (left and right) in Chapter 16, so we will assume they are in place. Purchase or make roll trim handle **CZPTH** (1/8 in. 2024T-3 Al.) and make **CZRT-1** from 1/4 in. birch plywood. Drill two 3/16 in. holes (#12) 7/8 in. apart, centered in the panel, at W.L. 7.125 and W.L. 8.0 as shown on drawing A-8. **Caution:** Drawing A-8 is incorrect as regards the type of bolt, their lengths, and their method of installation. Install bolts **AN3-11A** and **AN3-6** through the instrument panel, with flox, heads against the forward face, as shown on page 17-2. Check that the recesses in **CZRT-1** are deep enough and correctly positioned, and flox it over the bolt heads on the **forward** face of the panel. Use excess flox, clamp in position, wipe off excess, and after cure, glass over with 1 ply BID. Install **CZPTH** with the hardware specified, Section A-A, page 17-2.

Now, cut two **CZRT-3** bulkheads from 1/4 in. thick, birch plywood as shown full scale Fig. 1. Shape to fit the bottom of your fuselage as shown on page 17-2. These bulkheads will be installed slightly cocked, to line the cable up with **CZRT-2** above and **CZPTH** inboard. Cut two pieces of 3/16 in. O.D. x .025 wall Nylaflo tubing 5 in. long and sand the outside of both with 120 grit sandpaper, 5-min. or flox the tubing to the inside radius of the bulkhead as shown in Fig. 1 and on 17-2. Best way to do this is to fasten everything securely to a board for cure as shown in Fig. 1. After cure, reinforce bond of tubing to bulkhead by applying 2 layers of UND around tubing. Use narrow strips to conform to curvature (Fig. 2). You can lay them back in your jig board for cure. Now trial fit bulkheads in bottom corner of fuselage. Pieces of piano wire or coat hanger wire can be used to align the tubing with the roll trim handle (**CZPTH**) in the center of the panel and the brackets (**CZRT-2**) on the torque tube. Now flox bulkheads in place. A couple of dabs of 5-min. mixed with flox at either end will hold bulkheads in position while the regular flox cures. Tape bulkheads to fuselage with 1 ply BID, both sides, using flox corners.

After bulkheads are cured, rig roll trim cables and springs as shown on page 17-2. Refer to Schedule B for **RTS** spring specifications. Using two loops of .041 safety wire and an **AN100-3** thimble, sew each of the two **RTS** springs to the two **CZRT-2** brackets. Now cut two lengths of 1/16 in. 7 x 7 aircraft cable 27 in. long. Form a tight loop on one end by threading the cable through and back through a **18-1-C** sleeve and crimp. Then thread the other end through the Nylaflo tubing and swage it to the Roll Trim Handle using an **AN100-3** thimble and **18-1-C** sleeve. The length should be set such that with the trim handle and the torque tubes in the neutral position, the roll trim spring stretched length will be 3 inches and there will be a **minimum** of 5/8 in. of travel available for the cable without the sleeve striking the nylaflo tubing. The tubing may be shortened if necessary. **Make sure the springs do not rub against the cable conduit.**

STEP 2. PITCH TRIM

The general layout of the pitch trim assembly is shown on drawing A-8; however the detailed configuration of bracket **CZPT-1** and handle **CZPTH** was altered as shown on page 17-3 to eliminate an interference with the nose gear torque tube. Make or purchase **CZPTH**, and make **CZPT-1** from 1/4 in. birch plywood and cover it with 1 ply BID, both sides. **CZPT-1** is installed as shown on 17-3 and A-8 between the instrument panel and the nose wheel cover, on the right side, flush with the knee hole in the instrument panel bulkhead. **CZPT-1** assumes that the nose wheel cover is flat on top and as wide as the center post of the instrument panel. If you have used a rounded prefab nose wheel cover, fashion a urethane block on the cover to square it off on the top and on the side (Fig. 3) and glass with 2 plies BID. Also, if you have installed vertical stiffeners on the forward face of the instrument panel, you will have to remove a segment so **CZPT-1** can butt solidly against the forward face. After these preparations, flox **CZPT-1** in place against panel flush with knee hole cut out and wheel cover, and tape both sides of both joints with 2 plies of BID. After cure, install **CZPTH** with the hardware shown on page 17-3.

SCHEDULE A - PREFAB PARTS

Part No.	Material	No. Req'd.	Description
RT-2	.049 4130 Stl.	1-Left 1-Right	Roll trim bracket
CZPTH	.125 2024T-3 Al.	1	Roll trim handle
CZPTH	.125 2024T-3 Al.	1	Pitch trim handle
CZLB-1	6061T-6 Al.	1	.25x.37x.75 spacer
CZLB-6	4130 St.	2	.187x.25x.25 spacer
CZLB-10	.125 2024T-3 Al.	1	Spring bracket
LB-11	.06 2024T-3 Al.	1	Bracket
CZLB-13	Assembly	1	Handle
CZLB-15	Assembly	1	Actuator
CZLB-21	.125 2024T-3	1	Arm
VECG	Assembly	1	Throttle quadrant

SCHEDULE B - SPRINGS

Part No.	Outside Dia.	Wire Dia.	Unstretched Length	Installed Length	No. Req'd.
RTS	.350	.05	2.0	3.0	2
CZPTS-1	.350	.05	6.0	9.0	1
CZPTS-2	.350	.05	6.5	9.5	1
CS	.350	.06	0.5	0.25	2
LB-12	.375	.06	12.5	16.5	2

FIG. 1

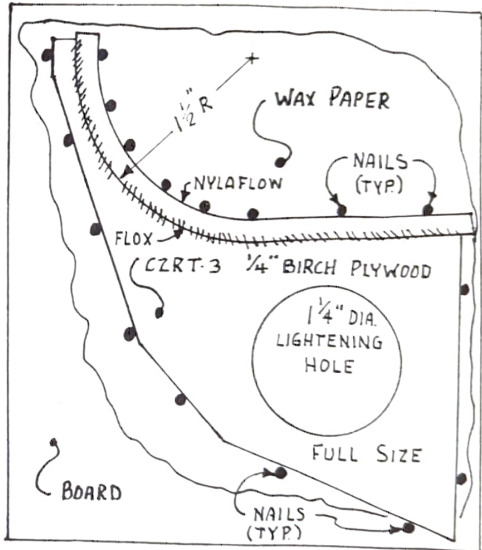
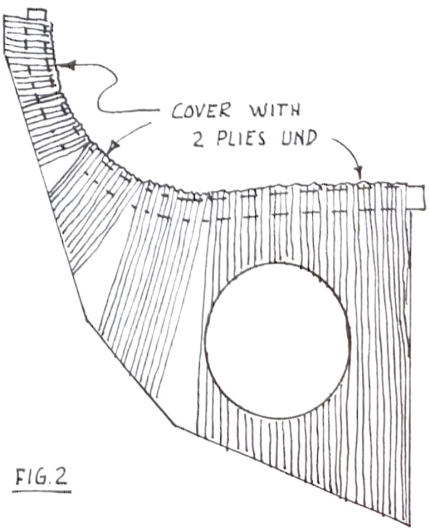


FIG. 2



CHAPTER 17

PITCH AND ROLL TRIM, LANDING BRAKE, AND CENTER CONSOLE

OVERVIEW

In this chapter you will install the pitch and roll trim. The pitch trim control is mounted on the wheel well, right of center, and the handle extends out into the cockpit through the right side knee hole, just right of the center console. The roll trim handle is mounted on the instrument panel, just ahead of the throttle quadrant. Both handles are easily accessible from either seat.

You will also install the landing brake operating mechanism behind the front seat back, build the center console and install the landing brake handle and throttle quadrant. The prefab parts which are used in this chapter are listed in Schedule A.

STEP 1. ROLL TRIM

The roll trim parts and assembly are shown on page 17-2. You were instructed to install the **CZRT-2s** (left and right) in Chapter 16, so we will assume they are in place. Purchase or make roll trim handle **CZRT-1** (1/8 in. 2024T-3 AL) and make **CZRT-1** from 1/4 in. birch plywood. Drill two 3/16 in. holes (#12) 7/8 in. apart, centered in the panel, at W.L. 7.125 and W.L. 8.0 as shown on drawing A-8. **Caution:** Drawing A-8 is incorrect as regards the type of bolt, their lengths, and their method of installation. Install bolts **(AN3-11A)** and **AN3-6** through the instrument panel, with flox, heads against the forward face, as shown on page 17-2. Check that the recesses in **CZRT-1** are deep enough and correctly positioned, and flox it over the bolt heads on the **forward** face of the panel. Use excess flox, clamp in position, wipe off excess, and after cure, glass over with 1 ply BID. Install **CZRT-1** with the hardware specified, Section A-A, page 17-2.

Now, cut two **CZRT-3** bulkheads from 1/4 in. thick, birch plywood as shown full scale Fig. 1. Shape to fit the bottom of your fuselage as shown on page 17-2. These bulkheads will be installed slightly cocked, to line the cable up with **CZRT-2** above and **CZRT-1** inboard. Cut two pieces of 3/16 in. O.D. x .025 wall Nylaflo tubing 5 in. long and sand the outside of both with 120 grit sandpaper, 5-min. or flox the tubing to the inside radius of the bulkhead as shown in Fig. 1 and on 17-2. Best way to do this is to fasten everything securely to a board for cure as shown in Fig. 1. After cure, reinforce bond of tubing to bulkhead by applying 2 layers of UND around tubing. Use narrow strips to conform to curvature (Fig. 2). You can lay them back in your jig board for cure. Now trial fit bulkheads in bottom corner of fuselage. Pieces of piano wire or coat hanger wire can be used to align the tubing with the roll trim handle (**CZRT-1**) in the center of the panel and the brackets (**CZRT-2**) on the torque tube. Now flox bulkheads in place. A couple of dabs of 5-min. mixed with flox at either end will hold bulkheads in position while the regular flox cures. Tape bulkheads to fuselage with 1 ply BID, both sides, using flox corners.

After bulkheads are cured, rig roll trim cables and springs as shown on page 17-2. Refer to Schedule B for **RTS** spring specifications. Using two loops of .041 safety wire and an **AN100-3** thimble, sew each of the two **RTS** springs to the two **CZRT-2** brackets. Now cut two lengths of 1/16 in. 7 x 7 aircraft cable 27 in. long. Form a tight loop on one end by threading the cable through and back through a **18-1-C** sleeve and crimp. Then thread the other end through the Nylaflo tubing and swage it to the Roll Trim Handle using an **AN100-3** thimble and **18-1-C** sleeve. The length should be set such that with the trim handle and the torque tubes in the neutral position, the roll trim spring stretched length will be 3 inches and there will be a **minimum** of 5/8 in. of travel available for the cable without the sleeve striking the nylaflo tubing. The tubing may be shortened if necessary. **Make sure the springs do not rub against the cable conduit.**

STEP 2. PITCH TRIM

The general layout of the pitch trim assembly is shown on drawing A-8; however the detailed configuration of bracket **CZPT-1** and handle **CZPTH** was altered as shown on page 17-3 to eliminate an interference with the nosegear torque tube. Make or purchase **CZPTH**, and make **CZPT-1** from 1/4 in. birch plywood and cover it with 1 ply BID, both sides. **CZPT-1** is installed as shown on 17-3 and A-8 between the instrument panel and the nosewheel cover, on the right side, flush with the knee hole in the instrument panel bulkhead. **CZPT-1** assumes that the nosewheel cover is flat on top and as wide as the center post of the instrument panel. If you have used a rounded prefab nosewheel cover, fashion a urethane block on the cover to square it off on the top and on the side (Fig. 3) and glass with 2 plies BID. Also, if you have installed vertical stiffeners on the forward face of the instrument panel, you will have to remove a segment so **CZPT-1** can butt solidly against the forward face. After these preparations, flox **CZPT-1** in place against panel flush with knee hole cut out and wheel cover, and tape both sides of both joints with 2 plies of BID. After cure, install **CZPTH** with the hardware shown on page 17-3.

SCHEDULE A - PREFAB PARTS

Part No.	Material	No. Req'd.	Description
RT-2	.049 4130 Stl.	1-Left 1-Right	Roll trim bracket
CZRT-1	.125 2024T-3 AL	1	Roll trim handle
CZPTH	.125 2024T-3 AL	1	Pitch trim handle
CZLB-1	6061T-6 AL	1	.25x.37x.75 spacer
CZLB-6	4130 Stl.	2	.187x.25x.25 spacer
CZLB-10	.125 2024T-3 AL	1	Spring bracket
LB-11	.06 2024T-3 AL	1	Bracket
CZLB-13	Assembly	1	Handle
CZLB-15	Assembly	1	Actuator
CZLB-21	.125 2024T-3	1	Arm
VECG	Assembly	1	Throttle quadrant

SCHEDULE B - SPRINGS

Part No.	Outside Dia.	Wire Dia.	Unstretched Length	Installed Length	No. Req'd.
RTS	.350	.05	2.0	3.0	2
CZPTS-1	.350	.05	6.0	9.0	1
CZPTS-2	.350	.05	6.5	9.5	1
CS	.350	.06	0.5	0.25	2
LB-12	.375	.06	12.5	16.5	2

FIG. 1

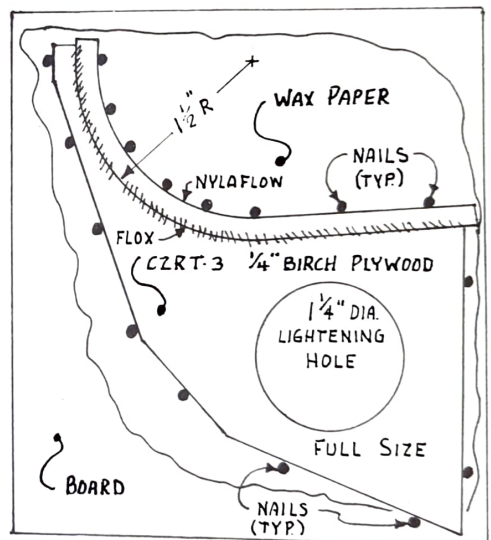
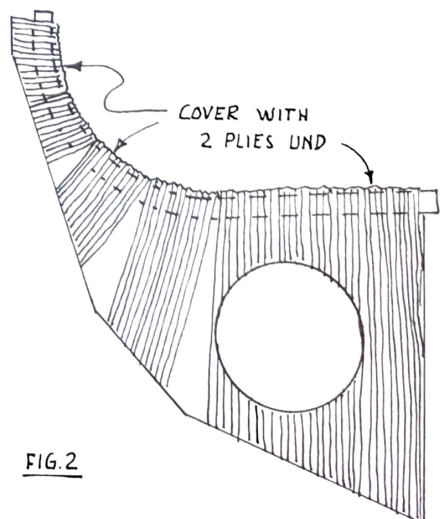
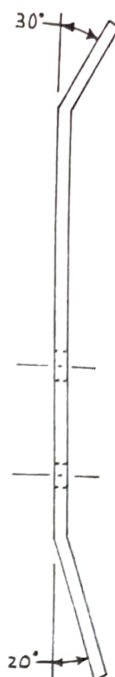
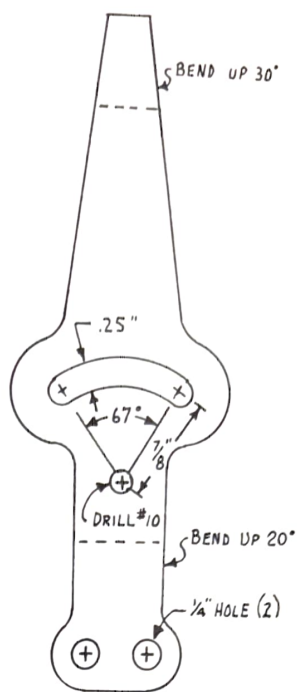
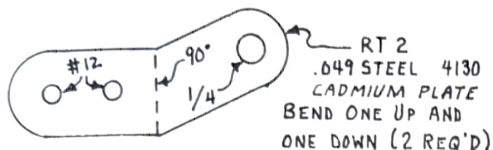
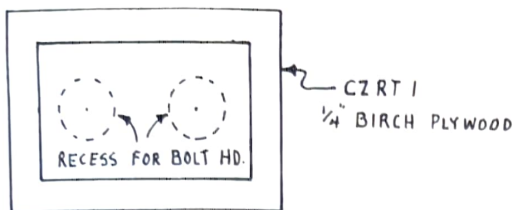
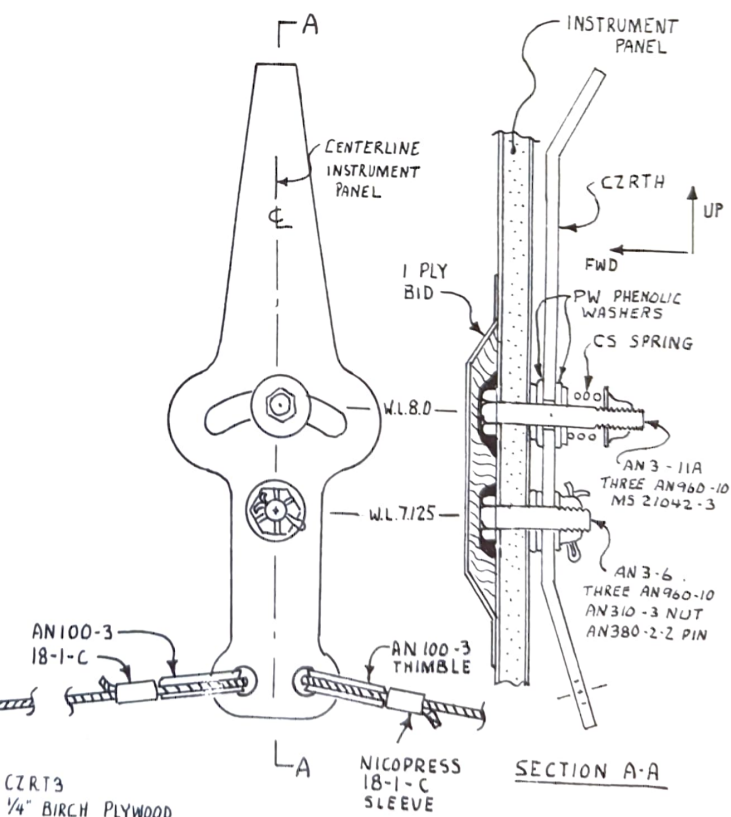
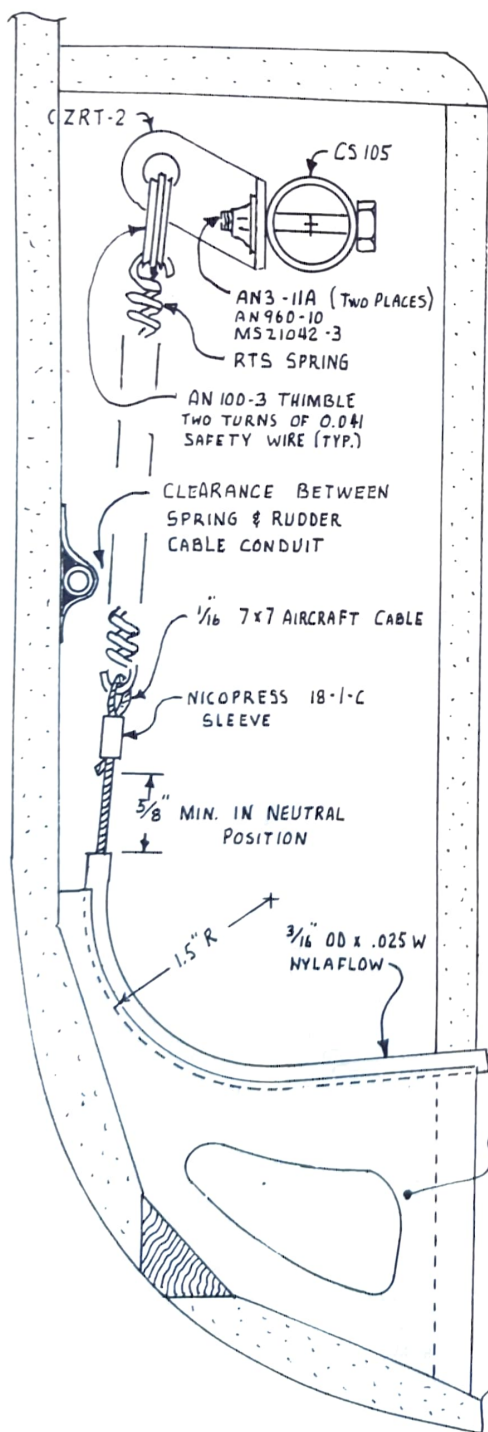


FIG. 2





COZY ROLL TRIM HANDLE - CZRTH (1 REQ'D)
MAT'L: 2024T3 AL 1/8" THICK
FLAT PATTERN (BEFORE BENDING)

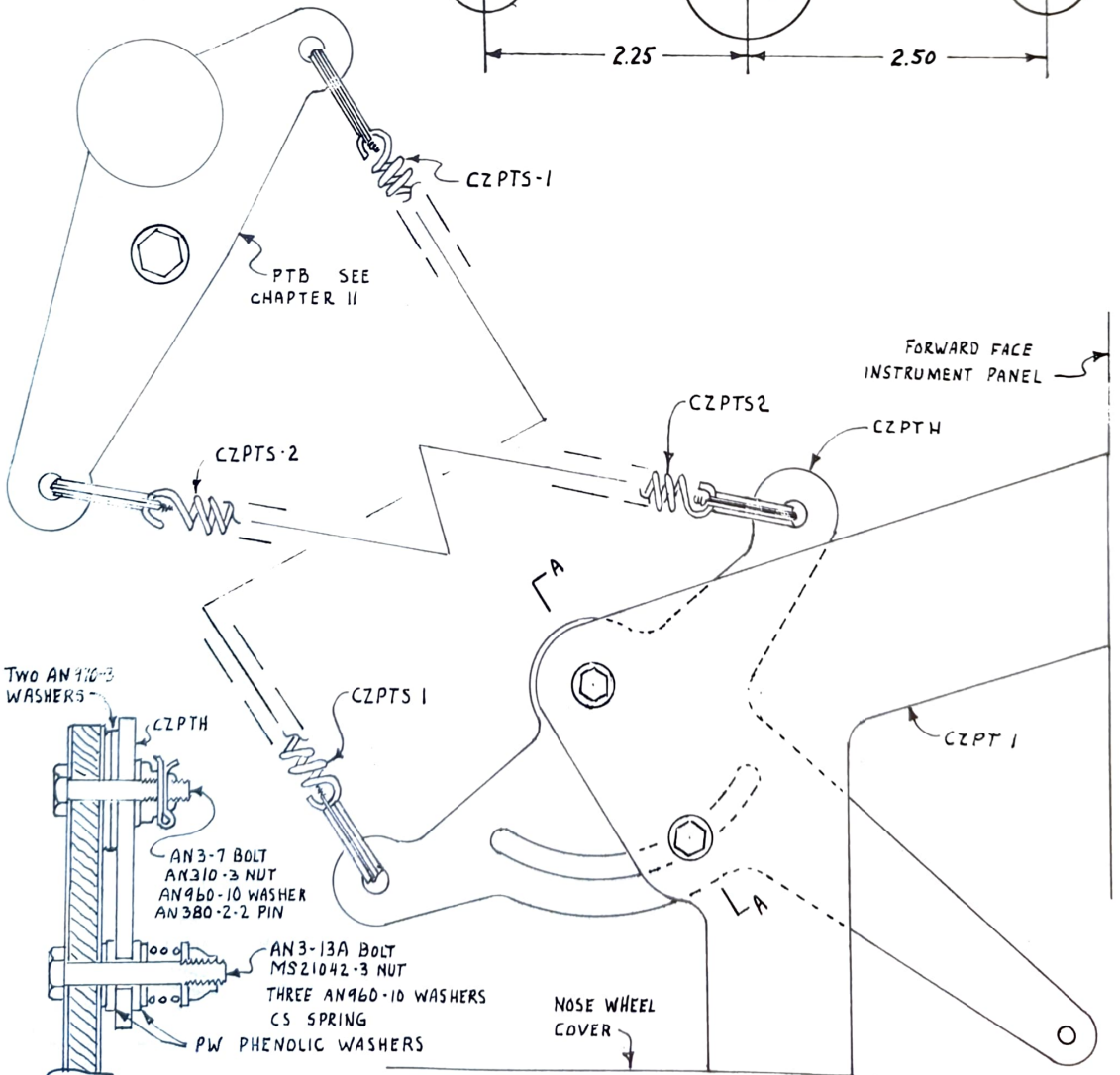
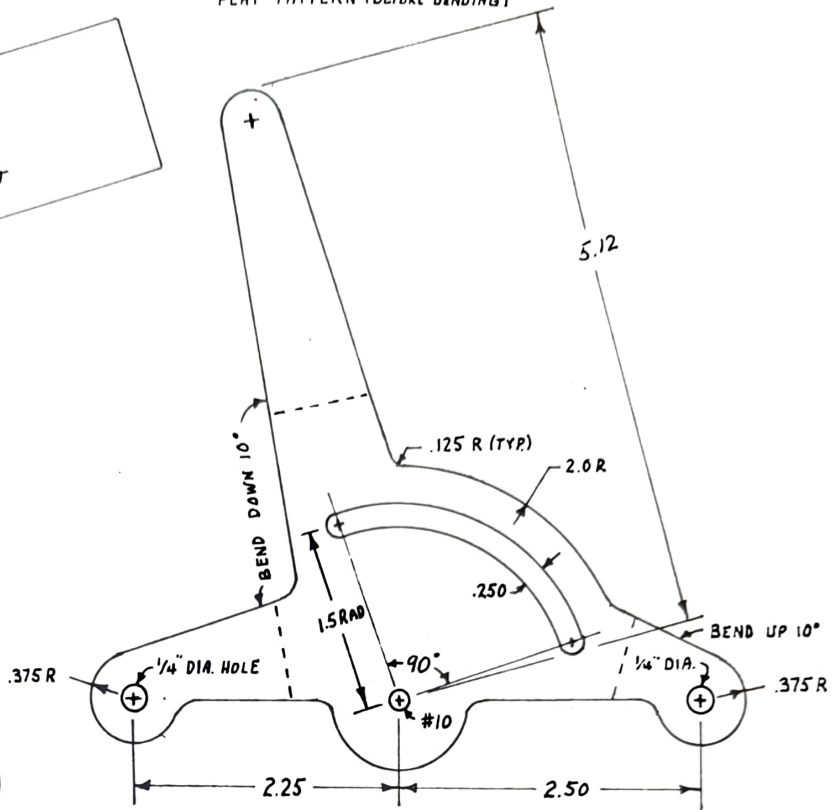
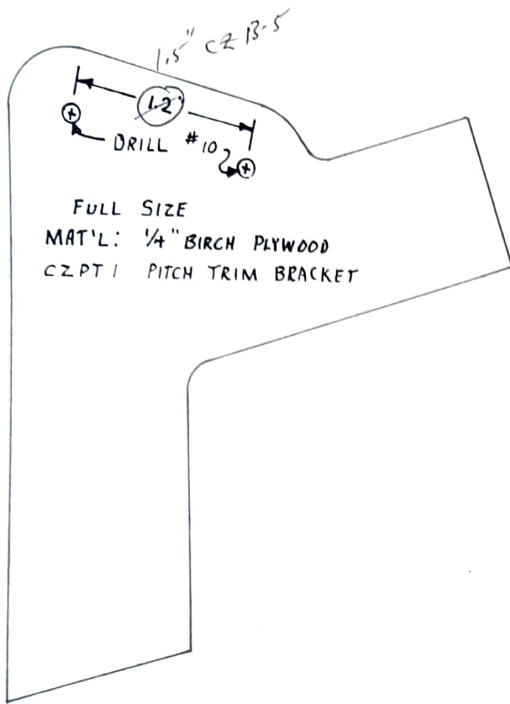


LEFT SIDE LOOKING FORWARD
RIGHT SIDE OPPOSITE

COZY PITCH TRIM HANDLE - CZPTH (1 REQ'D)

MAT'L: 2024T3 AL. $\frac{1}{8}$ " THICK

FLAT PATTERN (BEFORE BENDING)



Now, install **AN100-3** thimbles in the elevator bracket (PTB Chapter 11). Cut two **PTS** springs from 0.35 x .05 spring stock to the **unstretched** length shown in Schedule B. Sew the **PTS** springs on as shown on page 17-3 to PTB with two loops of .041 stainless safety wire. Safety wire (2 loops of .041) two **AN100-3** thimbles in **CZPTH** as shown on page 17-3. Now install the canard. Position the elevator at 0 deg. and the pitch trim handle in neutral position as shown on A-8. **Cross** the springs and check the length each will have to be stretched to hook them up. It should be approx. 3 in. for each spring. Now hook up the springs (crossed). They should not touch each other. Adjust friction to **just** hold **CZPTH** at full aft trim with full forward stick. The springs should never be slack.

This rigging should give you a trim authority sufficient to fly hands off at 60 knots at aft trim or hands off at 165 knots at forward trim. If your trim is insufficient on either end of the range you can make a minor adjustment by shortening one of the **PTS** springs up to 1-1/2 inches shorter or you can replace one of the springs with a slightly stronger one. If this is insufficient, your elevator contour is incorrect. Further trim authority adjustment must be done either by adding a fixed trim tab to the elevator (Fig. 4). If you add a trim tab, rebalance elevators to avoid flutter. **Note:** The pitch trim system provides redundancy for the pitch control system. The airplane can be flown and landed using only the pitch trim.

STEP 3. LANDING BRAKE AND CENTER CONSOLE

The landing brake parts are detailed on pages 17-5, 17-6, and 17-7. Most builders will wish to purchase these parts prefab from the designated supplier, so the fabrication materials are not included in the kits.

Assemble the landing brake actuating mechanism **CZLB-15** as shown on drawing A-23. Install the 1/4 in. birch plywood stop to restrain brake arm so that it can't travel more than 3/16 in. past center (from a line drawn from the pivot of **CZLB-15** to the pivot in **CZLB-18**). Flox the stop in place and cover with 1 ply BID lapping 1/2 in. onto floor and seat back brace.

Measure the distance between cable **CZLB-25** and the seat back brace, and mark this location on the forward face of the front seat back. Now mark the vertical locations where cable **CZLB-25** passes through the forward face of the seat back (drawing A-9, A-23, and Fig. 5). The upper cable exits 58 deg. to the seat back and the lower cable 52 deg. (Fig. 5). Cut blocks of wood at these angles (you can use drawing A-9 to trace the angles) to guide your drill and drill a #10 hole through the seat back at these locations and angles. Insert a piece of piano wire through the holes to verify that they are in line with the cable groove in **CZLB-15**. **Do not** accept any misalignment. Now slot the holes, on the forward face of the seat back only, about 1/4 in. toward the center console, so the cables can be redirected toward the inside of the center console. You will install a 6 in. length of Nylaflo tubing for a cable conduit through these holes after building the center console.

From drawings A-8 and A-9, trace a pattern of the center console side walls (Fig. 6). These mount on top of the air duct and extend from the seat back forward to 3 in. aft of the instrument panel. **Do not** notch out the upper forward corner as shown on A-8 at this time. Trace a right and left (mirror images) on 1/4 in. low density white Clark foam and glass one side with 2 plies BID, any orientation. After cure, cut out parts and check them for fit. Now clamp them together in register with the glassed inside faces together and drill a 1/4 in. hole through both for the **CZLB-13** landing brake handle assembly pivot bolt in the location shown on drawing A-9. Study the cross section on page 17-7 to see how the sides are recessed and reinforced where the pivot bolt is mounted. Now remove 1-1/8 in. diameter of foam around the 1/4 in. holes down to the glass and floc in **AN970-4** large area washers. On the left console side only, floc in a **AN970-3** large area washer (remove the foam first) 8 in. aft of the 1/4 in. hole and the same elevation. This hard point will be used to mount a cabin heat control handle. Bevel the foam down to the washers, micro the exposed foam, and glass the outside faces with 2 ply BID overall, and an extra ply locally over the washers. After cure, open up the holes through the washers (3 places). Make a trial assembly of **CZLB-13** landing brake handle assembly on the console right side and hold in place in the cockpit on the console side wall. Mark where the **CZLB-25** cable and conduit must come through the wall to make a smooth, gradual joggle to line up with the cable grooves in the handle assembly, and slot the right side wall accordingly.

Now remove the handle assembly from the right side wall and floc the side wall of the console in place permanently, using a couple of boards and bondo to hold it vertical until cure. Tape inside corners and outside seam with 1 ply BID. After cure, reinstall handle assembly on right side only. Mark where the handle joggle strikes the side wall, and saw a slot deep enough for the handle to be in a horizontal position when the landing brake is retracted. Now sand your two six inch lengths of 3/16 in. O.D. nylaflo tubing, and thread them through the console side wall and seat back as shown in Fig. 7. Thread the cables through the conduit and around the handle pulley as shown on page 17-7. Snug the cables a little (not too tight at this point) and check cable alignment. Reposition conduits as required for correct cable alignment and smooth joggle, and floc conduit in place permanently. **Do not** tighten cables until the left side wall has been installed and the pulley is supported from both sides.

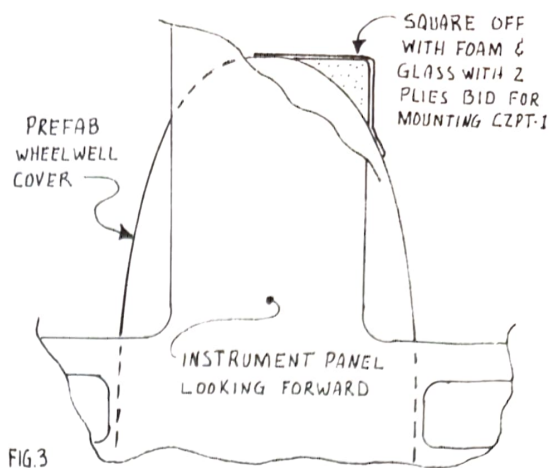


FIG. 3

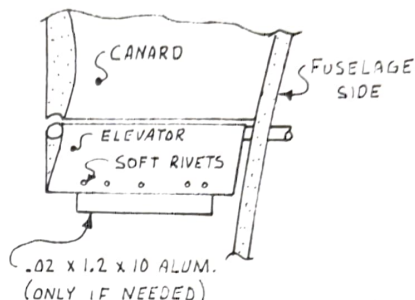


FIG. 4

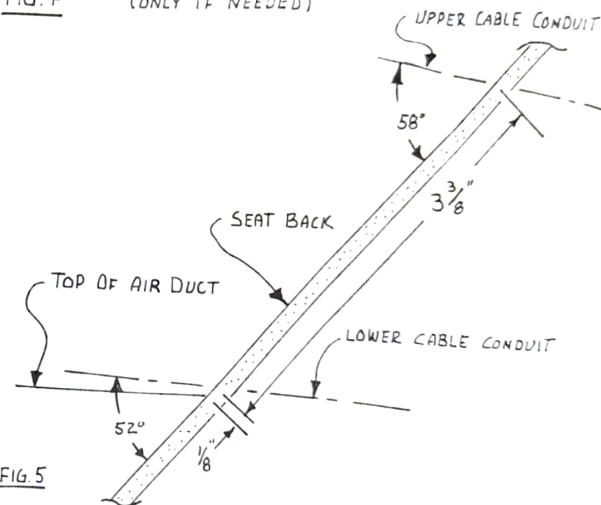


FIG. 5

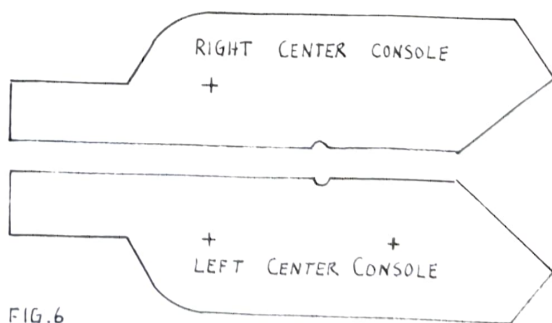


FIG. 6

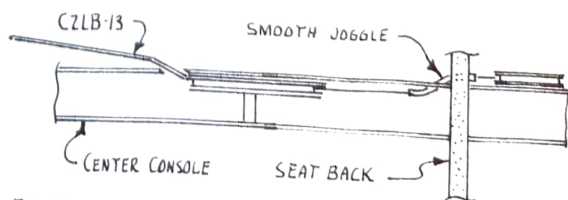
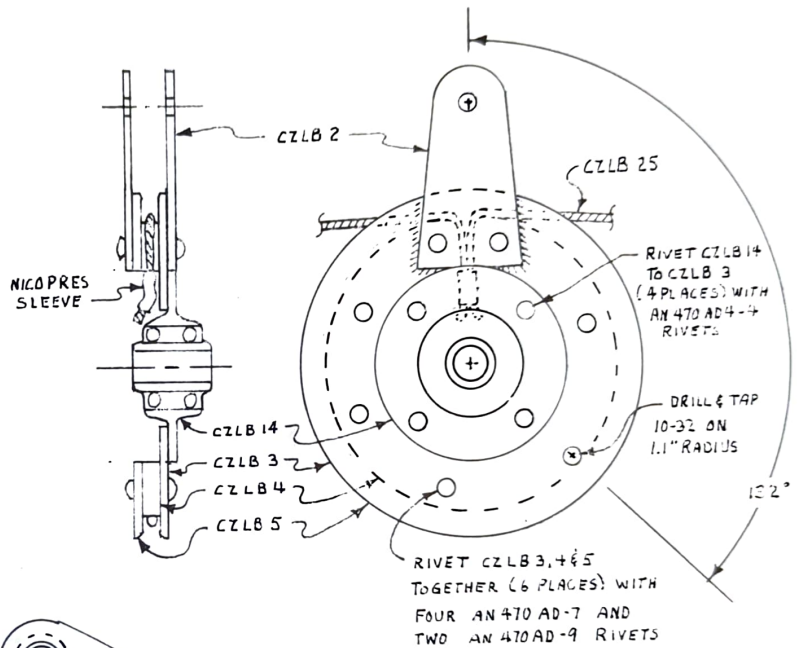
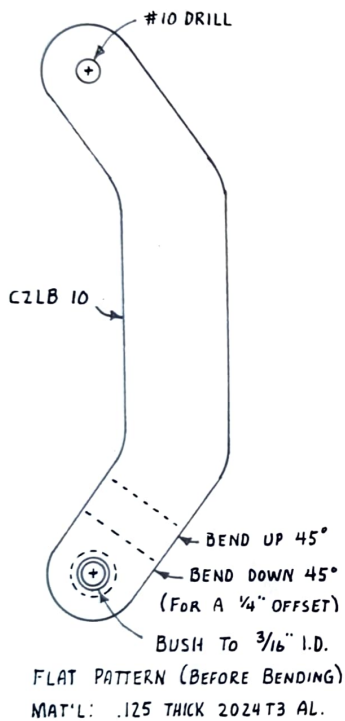
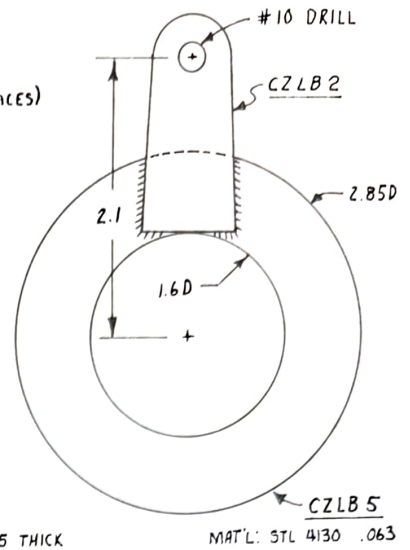
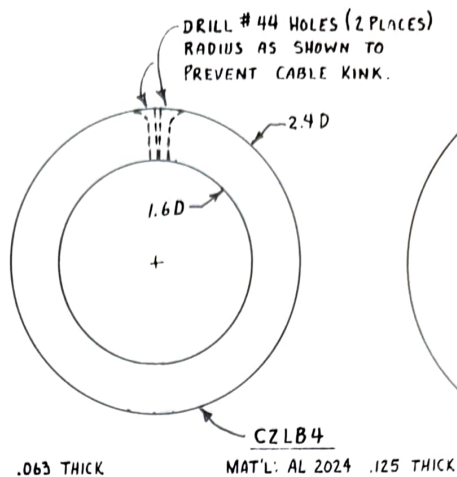
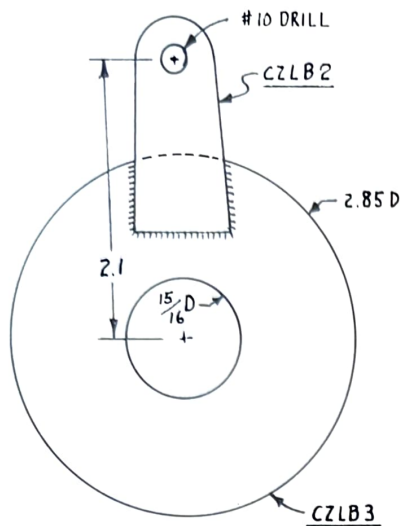
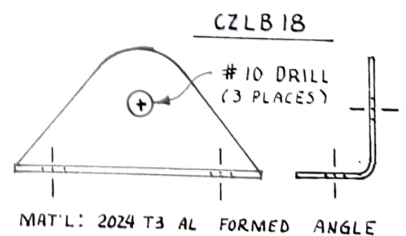
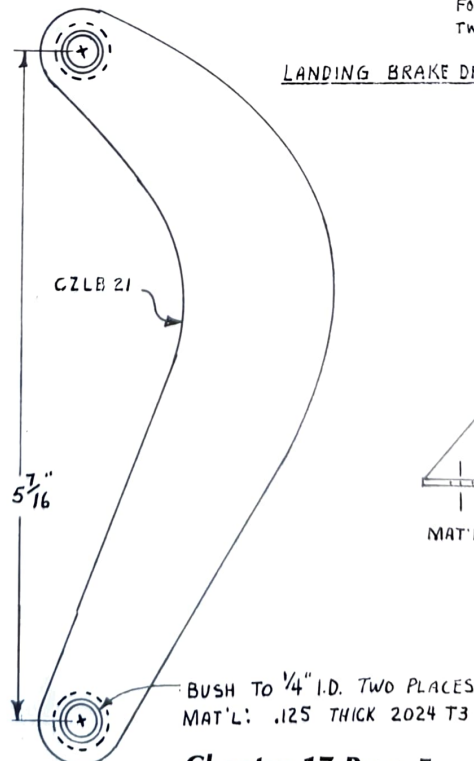
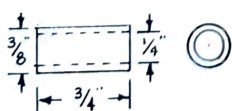
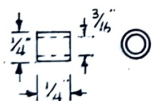
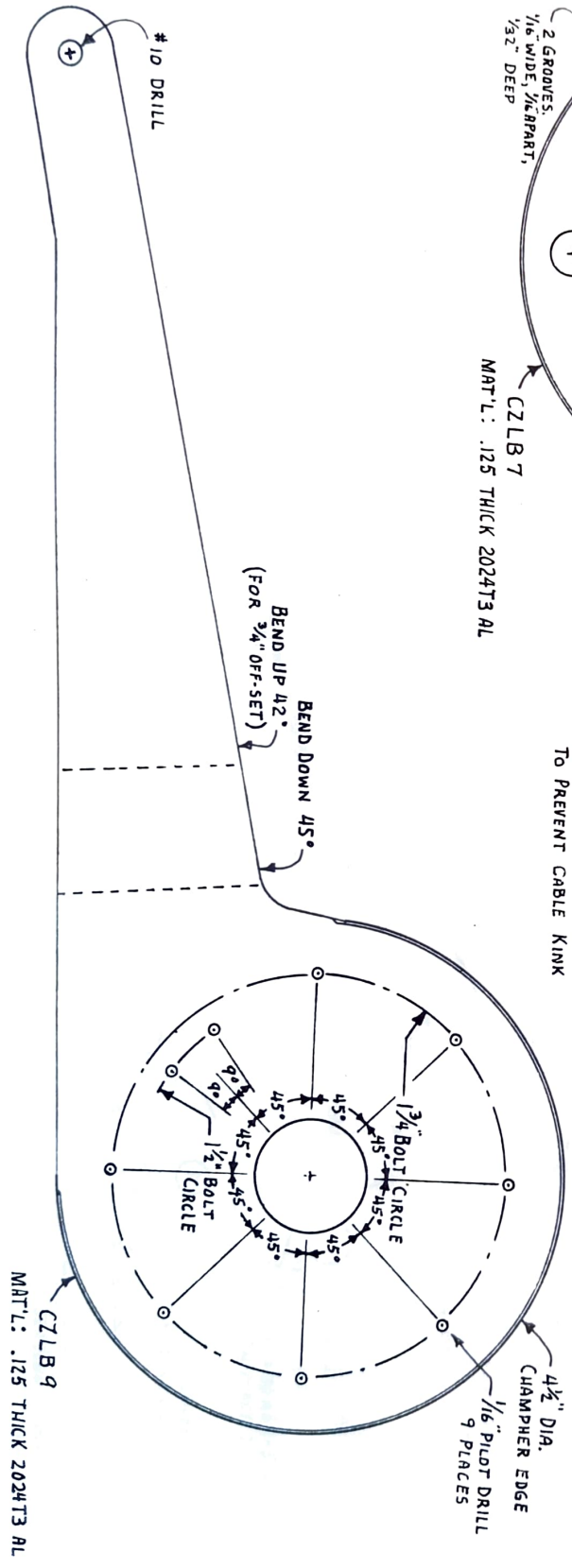
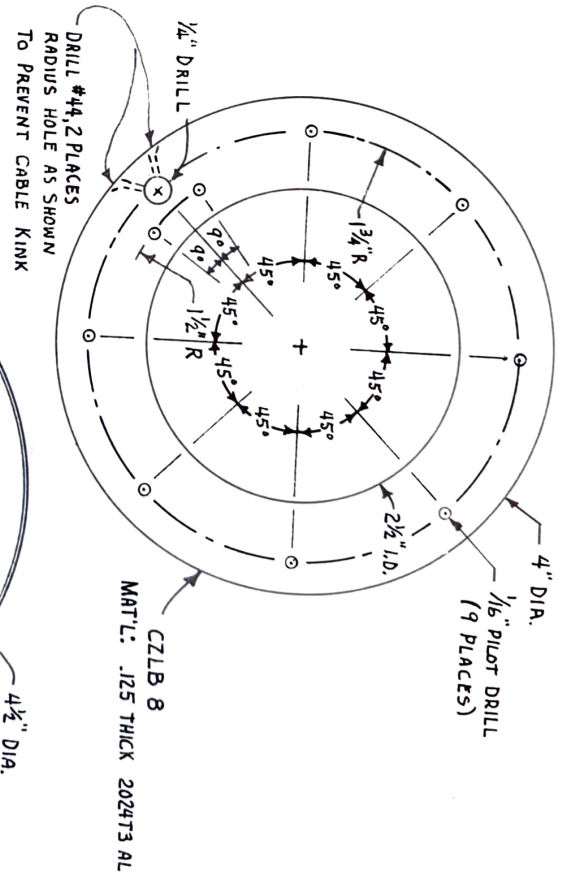
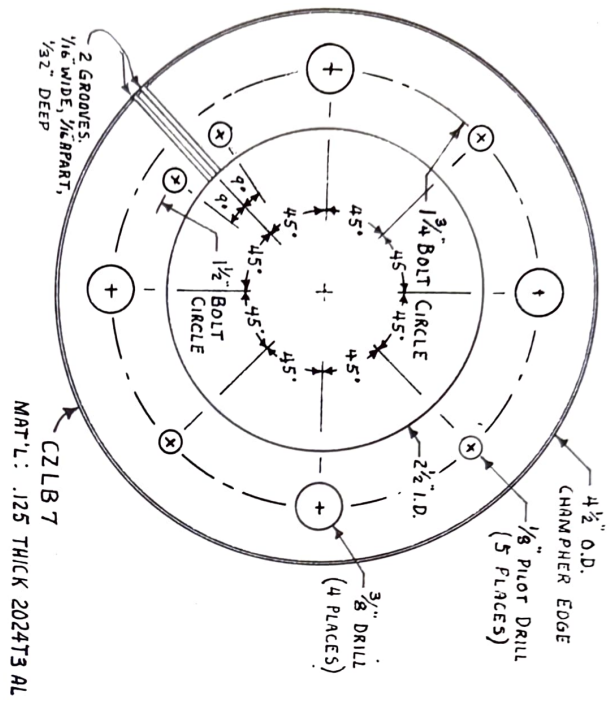


FIG. 7



LANDING BRAKE DRIVE PULLEY ASSEMBLY CZLB15





Before installing the left side wall, remove a slot 1-1/2 in. wide (Fig. 8) positioned so you can reach the cable ends where they are threaded through the lock on CZLB-13 pulley with a needle nose pliers and the screws with a screw driver. Bevel the cut out to facilitate reinstallation. Now, skip to Step 4 and install the throttle quadrant bulkhead and, after cure, install the throttle quadrant. It is necessary for the throttle quadrant to be installed slightly off center to the left (17-10) so the mixture and throttle handles will not interfere with CZLB-13 handle. Now notch the left side of the center console where it interferes with the throttle quadrant as shown on 17-10. Then you can install the left side permanently with flox and tape, similar to the right. Make sure the pivot holes on both sides are aligned, square to the fuselage centerline. After cure, trial fit CZLB-13 and check its operation. Make sure there is ample clearance between it and the mixture control, the throttle, and the nose gear crank in all positions, so there is no possibility of interference. If there is any doubt, remove CZLB-13, put it in your vise, and bend the handle further outboard. When satisfied, install it permanently, snug the cables, flox the cut out back in place, and patch with 1 ply BID. It is very important that all of these controls, which are used in preparation for and during landing are installed correctly with no chance of interference. Do not accept less than a perfect job.

A cover for the center console is made by taping over the top and down both sides with duct tape, and then making a 3 ply BID lay up over the duct tape. After cure, peel loose the cover, trim the edges neatly, and saw a slot in the curved portion so the landing brake handle can be operated.

A remote operating handle for your cabin heat valve (at the firewall) is shown full size in Fig. 9. The handle is made from 1/8 in. 2024T-3 alum. and installed with the hardware shown in the cross section. It is shown flush with the top of the console and a depression built into the top cover so it will not put pressure on the arm when using the console as an armrest. To make the depression, cut away an area of the cover, 5-min a block of urethane underneath, hollow it out to form the depression, and lay up 2 plies BID in the depression. After cure, remove foam and cut slot. Procure an automobile choke cable long enough to reach the cabin heat valve and attach the end of the cable to the handle as shown (Fig. 9). Clamp the cable conduit to the left side wall in a convenient location. Thread the cable through the tunnel in the seat back brace and coil it temporarily in the back seat area.

STEP 4. THROTTLE QUADRANT

The throttle quadrant with mixture control and carburetor heat are available pretab from Ken Brock Mfg. It is installed on a 2-1/2 in. x 4-3/4 in. x 1/4 in. birch plywood bulkhead mounted on the forward end of the center console (A-8). Cut out this bulkhead as shown in Fig. 10 and glass both sides with 1 ply BID. Check the throttle quadrant to see if the 3 operators are spaced as shown on 17-10. If not, shift washers until they are. Make a template locating the tapped mounting holes on the forward face of the throttle quadrant elements, transfer the hole locations to the plywood bulkhead so the left side of the quadrant will be 1/4 in. from the left side of the bulkhead and flush at the top, and drill six #12 mounting holes. Check fit. Ream holes as required. Now flox plywood bulkhead in place at forward end of center console positioned as shown on A-8, and centered on the air duct, and tape seams and corners with 1 ply BID overlapping joint 1/2 inch each side. After cure, the throttle quadrant may be installed, the cables threaded thru the tunnel and coiled in the back seat. For knobs on the throttle quadrant, you may use LL-1, as shown on page 17-10, or 3/4 in. dia. wood macrame beads. A square bead is preferred for mixture. Paint throttle black, mixture red and carb heat white. The quadrant will have to be removed in a later chapter for a micro switch installation, so it might be better to leave it out till then.

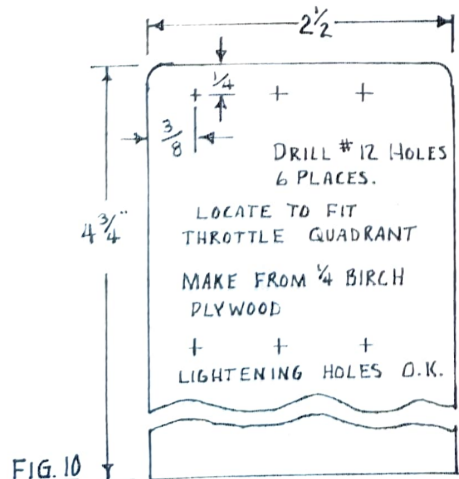


FIG. 10

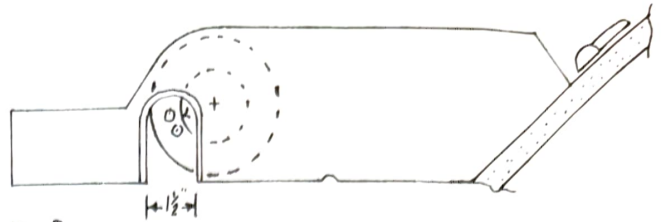


FIG. 8

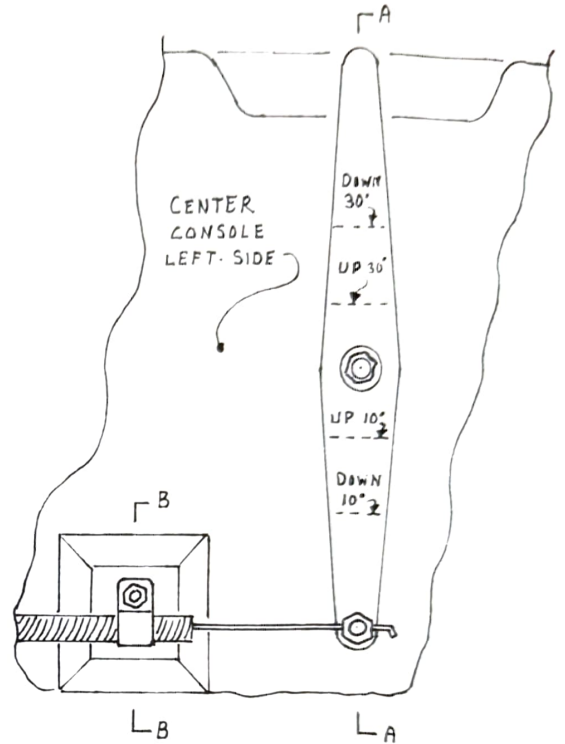
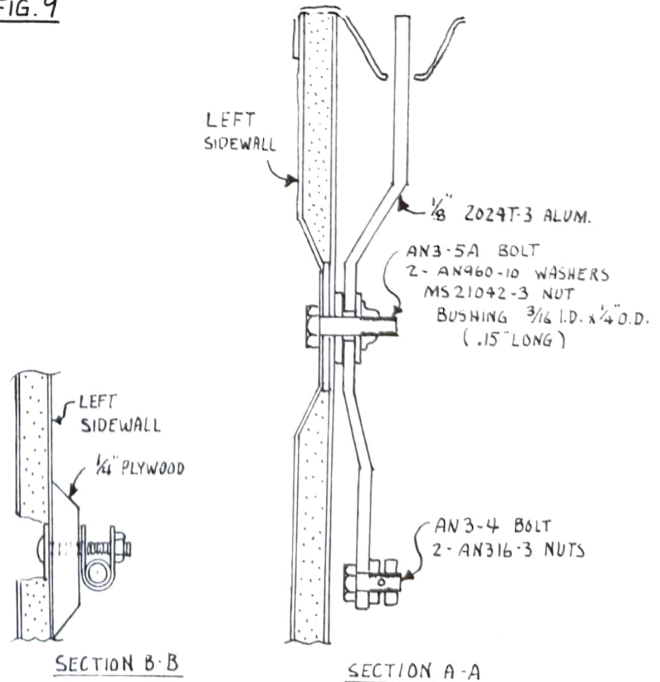
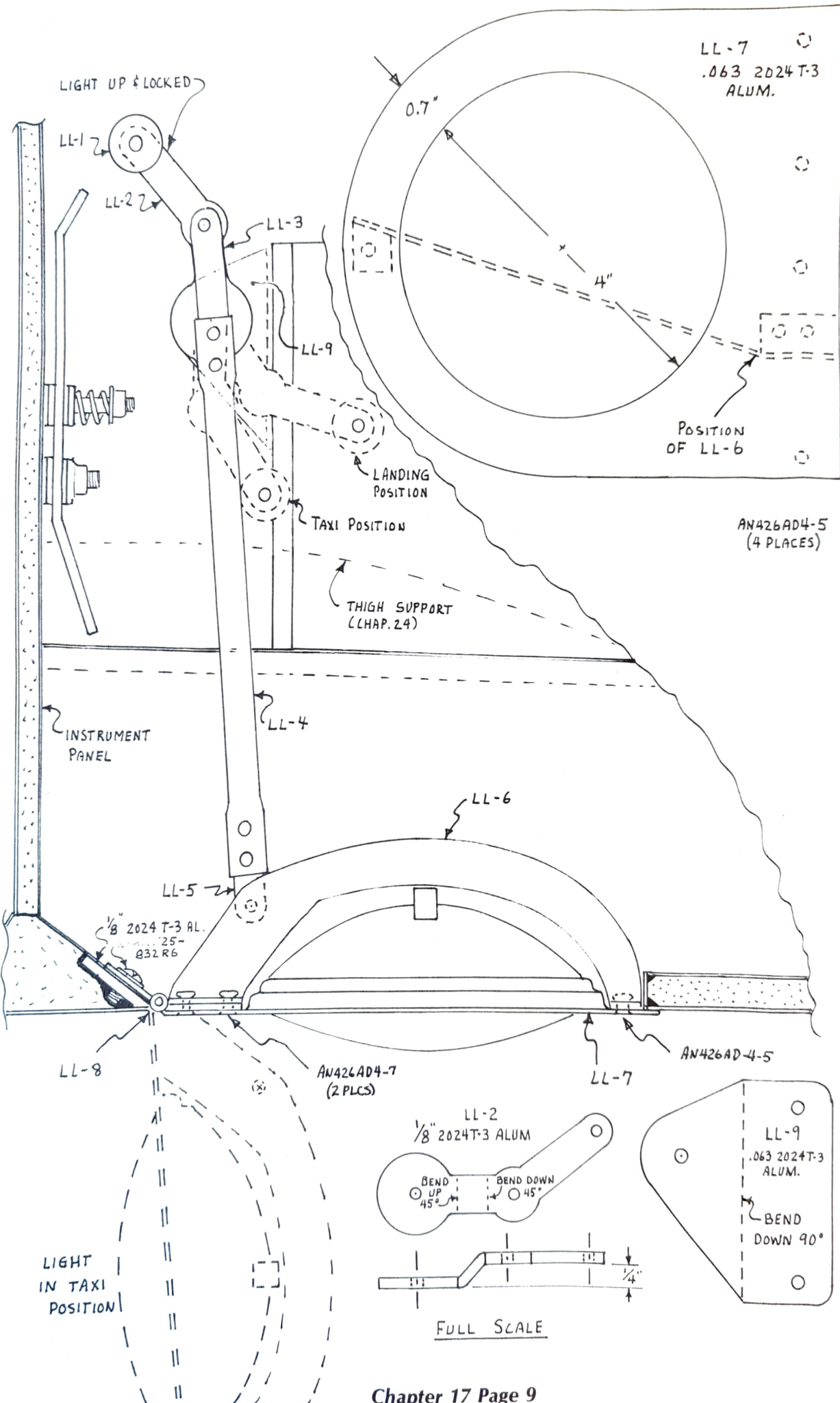


FIG. 9





FULL SCALE
VIEW LOOKING FWD.

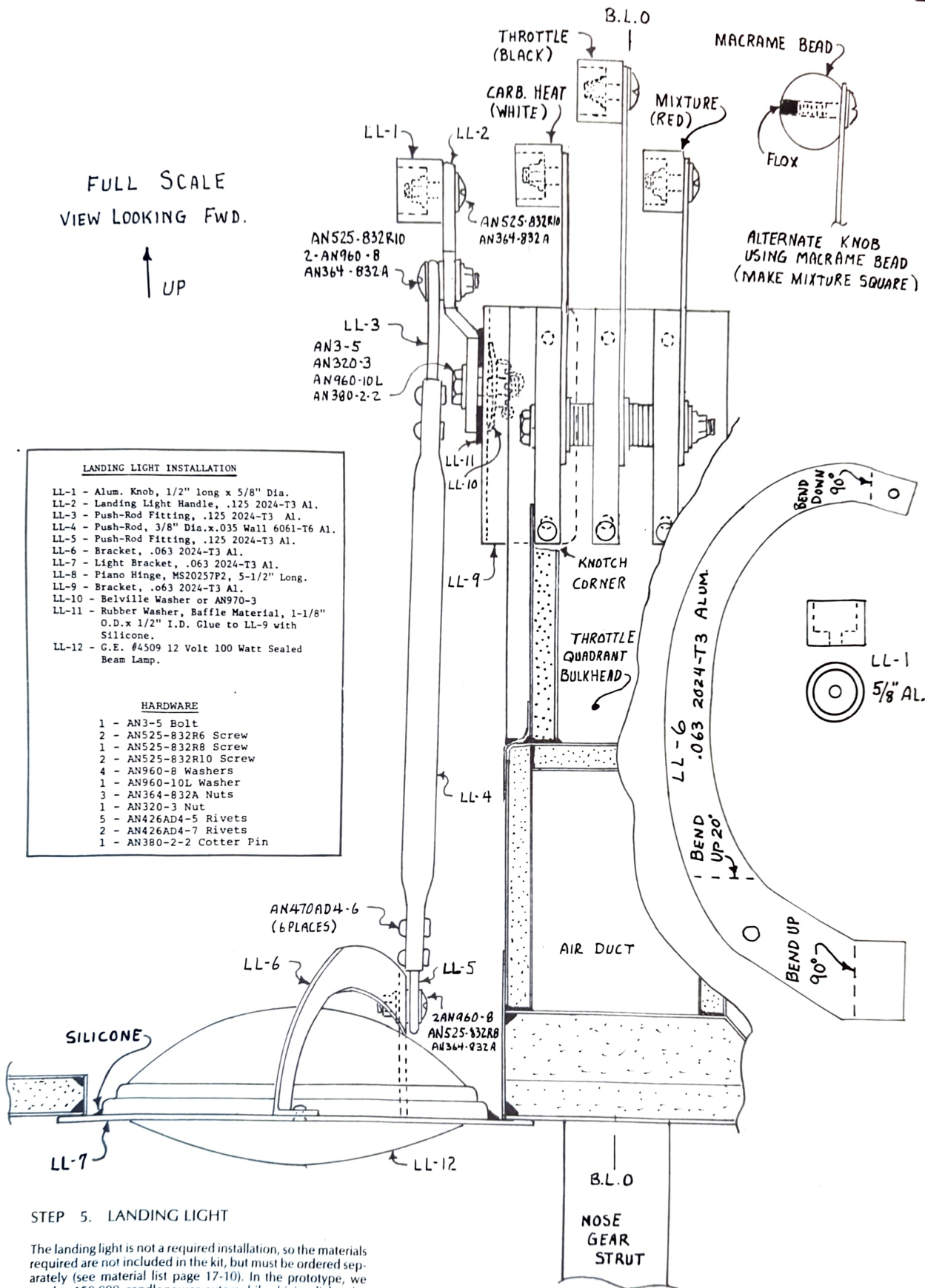
↑ UP

LANDING LIGHT INSTALLATION

- LL-1 - Alum. Knob, 1/2" long x 5/8" Dia.
- LL-2 - Landing Light Handle, .125 2024-T3 Al.
- LL-3 - Push-Rod Fitting, .125 2024-T3 Al.
- LL-4 - Push-Rod, 3/8" Dia. x .035 Wall 6061-T6 Al.
- LL-5 - Push-Rod Fitting, .125 2024-T3 Al.
- LL-6 - Bracket, .063 2024-T3 Al.
- LL-7 - Light Bracket, .063 2024-T3 Al.
- LL-8 - Piano Hinge, MS20257P2, 5-1/2" Long.
- LL-9 - Bracket, .063 2024-T3 Al.
- LL-10 - Belleville Washer or AN970-3
- LL-11 - Rubber Washer, Baffle Material, 1-1/8" O.D. x 1/2" I.D. Glue to LL-9 with Silicone.
- LL-12 - G.E. #4509 12 Volt 100 Watt Sealed Beam Lamp.

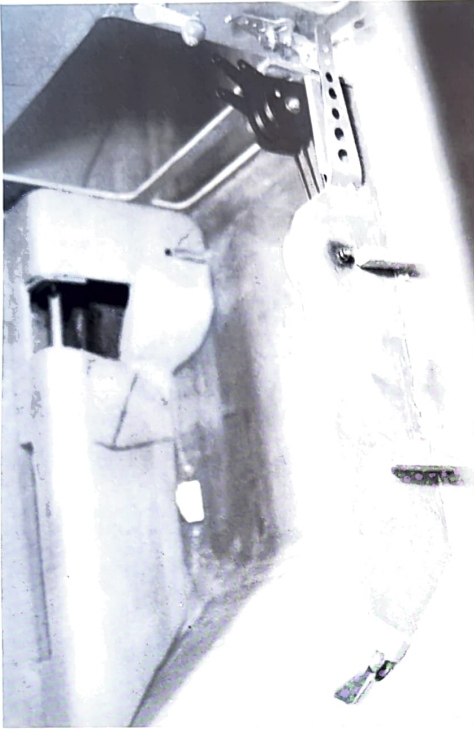
HARDWARE

- 1 - AN3-5 Bolt
- 2 - AN525-832R6 Screw
- 1 - AN525-832R8 Screw
- 2 - AN525-832R10 Screw
- 4 - AN960-8 Washers
- 1 - AN960-10L Washer
- 3 - AN364-832A Nuts
- 1 - AN320-3 Nut
- 5 - AN426AD4-5 Rivets
- 2 - AN426AD4-7 Rivets
- 1 - AN380-2-2 Cotter Pin

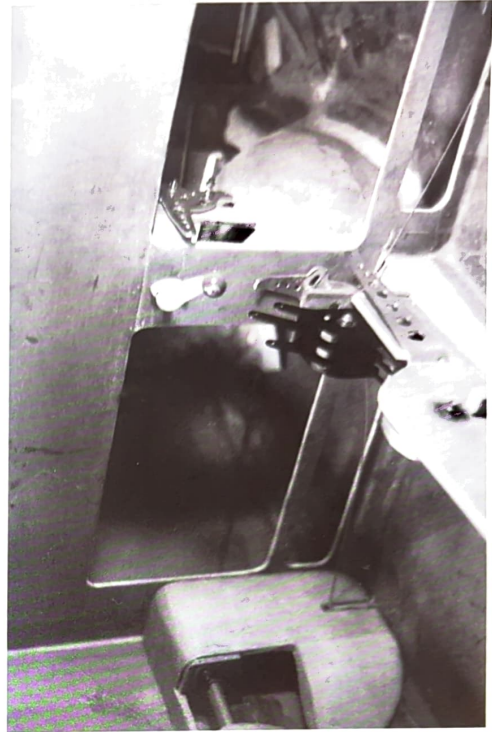


STEP 5. LANDING LIGHT

The landing light is not a required installation, so the materials required are not included in the kit, but must be ordered separately (see material list page 17-10). In the prototype, we used a 150,000 candlepower automobile driving light, designed for bumper mounting. This is the installation shown on drawing A-8. The extra brilliance did not justify the difficulty of installation and the extra weight, so the Long EZ design shown on pages 17-9 and 17-10 is recommended. The light is mounted off center, under the left seat, so the beam is unobstructed by the nose gear. The operating lever is mounted on the center console, on a bracket attached to the throttle quadrant bulkhead. The drawings are full scale, and may be used as patterns and dimensions may be taken directly from them. The side view drawing, page 17-9 and the rear view drawing, page 17-10, should be self explanatory and installation is straight forward.



Wood blocks hold center console side vertical while curing.



Note Pitch Trim Handle, Throttle Quadrant and Landing Brake Handle.



View of center console showing CZRTH Roll Trim Handle mounted on instrument panel, VECG Throttle Quadrant Assembly, and CZLB-13 Landing Brake Handle extended.



Center console, both sides assembled.

CHAPTER 18

CANOPY

OVERVIEW. You're making good progress on your airframe. So far the fuselage looks like a boat. Hang in there for one more chapter and it will start looking more like an airplane.

In this chapter you will build a form for the turtle back, build the turtleback and bulkheads, install windows in the turtleback, fit the canopy, build the canopy frame and fuselage top forward to bulkhead F28, and install the hinges, latches, locks and cockpit vents.

Before installing the turtleback permanently and building the canopy frame, it is recommended that you complete the wings (Chapter 19), jig the wings to the centerspar, and permanently install the centerspar, firewall, and engine mount extrusions.

An excellent quality, formed plexiglass canopy and molded side windows are available through the recommended Cozy distributor. The canopy is free blown into a 3-dimensional mold to match the turtleback and fuselage contours, while maintaining excellent optical quality. The side windows are drape molded to match the curvature of the turtleback. Canopy hardware is available prefab from the recommended distributor.

STEP 1. BUILDING THE TURTLEBACK FORM

The key to having the right curvature to the turtleback is to construct the form with accuracy and precision. You will need a sheet of 3/8 in. plywood and nine 4-ft. strips of 1-1/8 x 1/4 in. lattice. Take the plywood and saw *five exactly equal* pieces 17 x 40 in. The lumber yard can do this accurately for 50 cents per cut. Mark the centerlines on each piece (Fig.1). Patterns for jigs J-1, J-2, J-3, J-4, and J-5 are shown full size on drawing A-20. Right side is shown; left is the reverse. Each is symmetrical about its centerline. Cut out the largest, J-1, first, or better yet, trace it on another sheet of paper and cut it out. Use the inside, pie-shaped piece to transfer the curve to the plywood, one half at a time, lining it up carefully along the bottom and the centerline. Before cutting, check that the width across the cut is exactly twice that of the half section (Fig.2). Mark the nine notches on J-1, and then proceed in similar fashion to cut out the remaining jigs in order. Then cut out all the notches (Fig.2).

Now, draw a centerline down your worktable. Mark off the distances shown in Fig.3 *accurately* along the centerline and each edge of the table and draw lines through them. Check that the lines are 90 deg. to the centerline. Bondo each jig to the table so the forward face is on the line, it is vertical, centered, and square, starting with J-5. This is easier if you drive 3 brads along each line to align the jig, and use carpenter squares on each side to hold the jig vertical. You can wrap masking tape around the jig and carpenter square to hold everything in place while the bondo cures (Fig.4). Bondo diagonal braces in place before removing the carpenter squares. Repeat for the remaining jigs. There won't be room for braces on J-2, so spacers between J-1 and J-2 will provide necessary rigidity (Fig.5).

You can now 5-min. epoxy the lattice strips in place, one at a time. Use weights, clamps, or brads in pre-drilled holes as required to hold the strips curved or twisted while the epoxy cures (Fig.6). Now bondo plywood pieces about 3 in. wide

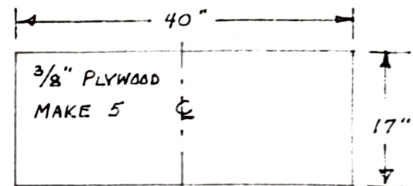
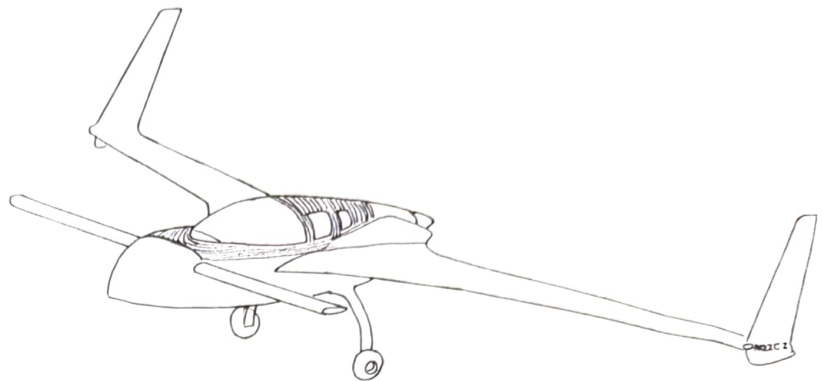


FIG. 1

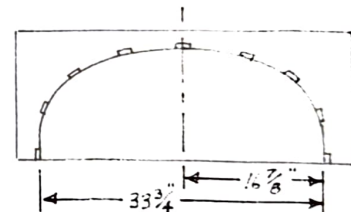


FIG. 2

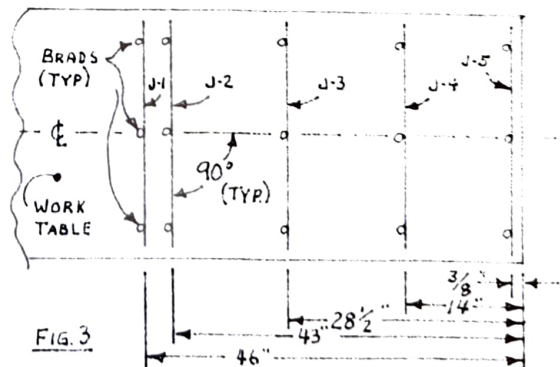


FIG. 3

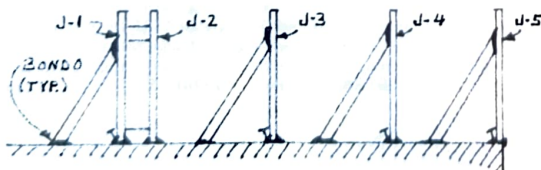


FIG. 5

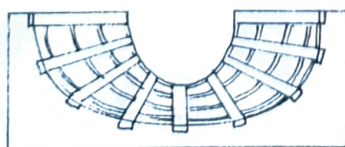


FIG. 6

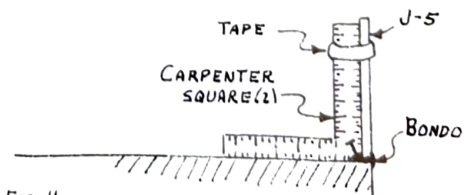


FIG. 4

between the jigs at the top to form a flange. Run 2 in. wide duct tape fore and aft on this flange, extending down around the inside edge about 1/2 in. each side (Fig. 7, sec A-A).

STEP 2. CONSTRUCTION OF TURTLEBACK AND INSIDE LAYUP

A large sheet of foam will not conform to the compound curvature, so it will be necessary to use strips. Grab two sheets of low density (4.5 lb./cu.ft.) Clark foam, 1/4 in. thick x 24 x 48 in., and cut into strips 6 x 48 in. Starting at the aft end (firewall), push one strip into the form with just enough overhang on I-5 so it can be trimmed flush, and with most of the surplus length at one end (you will need the scraps later). Mark where the edge of the foam crosses the lattices (Fig. 7). Now cut a 2 in. wide strip of shim stock (or .016 alum.) long enough to go completely around the curve, from the first lattice to the last, to support the edge of the foam so it won't bulge when forced into the compound curve (Fig. 7, Sec B-B). Tape the metal strip in place, and then push the foam strip into the form hard enough so it makes good contact with all the lattices, but does not bulge, and secure it in position with a couple of dabs of 5-min. at each end.

Now take the second strip of foam and trim the edge so it makes a tight joint with the first strip and secure it in the form alongside the first. **Don't** epoxy the joint between the two strips, and don't forget the strip of metal for the next joint. Continue similarly until the entire form is lined with foam, smoothly contoured with no joggles. You will need to splice some scraps on the last couple of strips to make them long enough. Trim the foam flush at the top, and then with your left-over scraps build a flange along the top (Fig. 8) 3 in. wide at the forward end tapering to 1 in. wide at the aft end. Bond this flange to the foam in the form with 5-min. epoxy and radius the corner (Fig. 9). Vacuum the foam and then tape the seams between the strips of foam with 1/2 in. masking tape so epoxy won't run into the seams (Fig. 10). You are now ready for layup 1.

Cut two pieces of **UND** 92 in. long. Mix up some wet micro and squeegee it all over the foam surface. Then take one length of **UND** and place it diagonally across the foam (Fig. 11). Scissor trim after wetting out and use the surplus to complete the 1st layer with butt seams and fibers all running in the same direction. Repeat for the second ply, except cross the fibers in the opposite diagonal direction. While the layup is still wet, cut **TB-4** from a piece of 3/8 in. thick low density Divinycell (see A-11) to fit inside the aft end. Flox in place and fasten with a few brads pushed thru from the outside so you can glass 1 ply of **BID** both sides. This bulkhead is only needed temporarily for stiffness, and will be cut out before permanent installation of turtleback.

STEP 3. TURTLEBACK BULKHEADS CAN ELIMINATE TB2 AND TB3

The pattern for turtleback bulkhead **TB-1** (Fig. 12) is shown on drawing A-21. Right side is shown; reverse for left. Cut it from 3/8 in. low density Divinycell foam. Layup is easier if you only mark the inside cutouts with a felt tip pen and cut them out after the layups cure with a saber saw. Layup schedule is 3 layers of **BID** each side with a **90 degree** fiber orientation. Micro the foam first. Weight down if necessary for flat cure (use wax paper so the weights don't bond).

Bulkheads **TB-2** and **TB-3** (Fig. 13) are shown on drawing A-22. Right sides are shown, reverse for left. You may piece these together from scraps of 3/8 in. Divinycell to save foam. The cross braces are needed temporarily for stiffness and will be removed after installation. Layup schedule is 3 layers of **UND** each side with fiber orientation **parallel to the edges**. Use scraps of **UND** a couple of inches wide and 12 to 18 in. long. Stagger overlaps to avoid building up bumps. Peel ply and weight down for flat cure. After cure, install **TB-2** and **TB-3** permanently with flox. Location is shown in Fig. 14. Bevel edges as required for a snug fit. Install **TB-2** first. Brads pushed through turtleback shell into the bulkhead or forward of it will hold it in place. Drill a number of 1/8 in. holes just aft of **TB-2** so you will be able to locate from the outside where to saw through the turtleback after permanent installation. Then stick some 1/4 in. foam spacers on the aft face of **TB-2**, and permanently install **TB-3** 1/4 in. aft of **TB-2**.

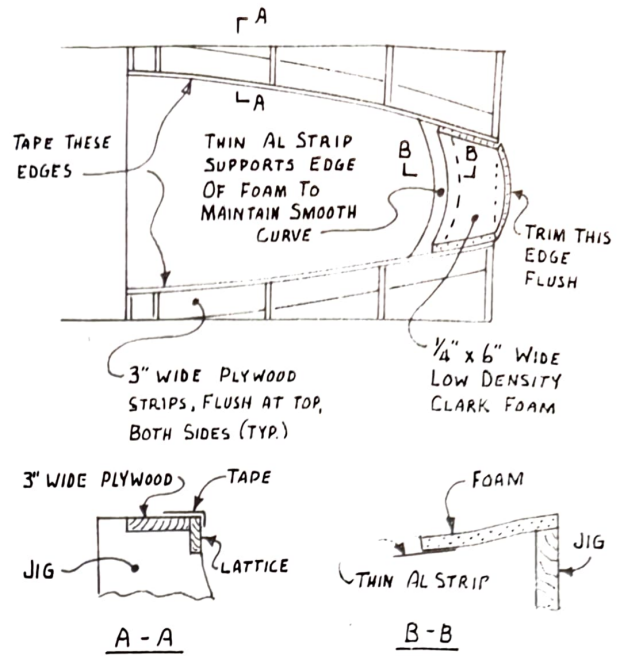


FIG. 7

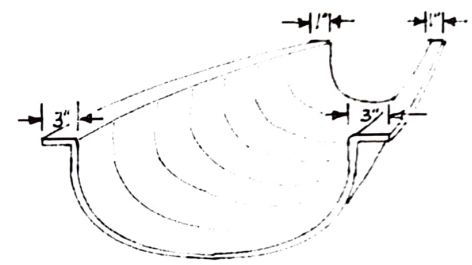


FIG. 8

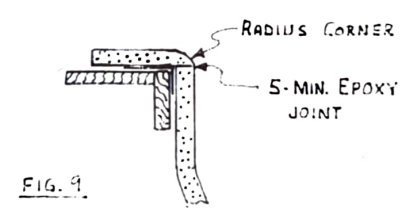


FIG. 9

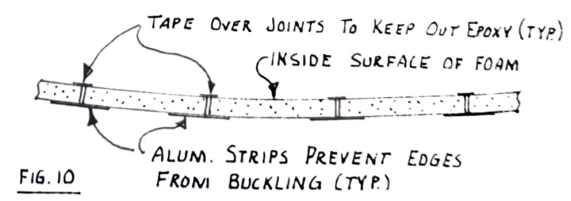


FIG. 10

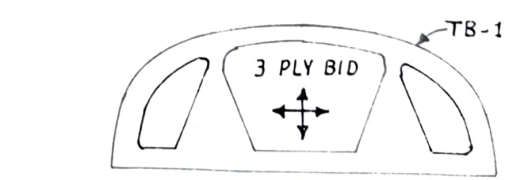


FIG. 12

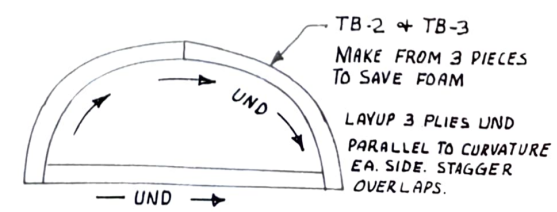


FIG. 13

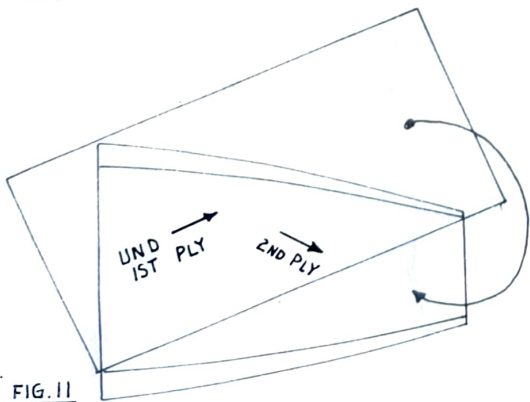


FIG. 11

After cure, sand with 36 grit and tape exposed surfaces of TB-2 and TB-3 to shell with 1 ply BID. Install TB-1 temporarily (Fig. 14) with a few dabs of bondo until after the turtleback is installed on the fuselage and the canopy is hinged. Cut turtleback loose from form by sliding a thin-bladed knife between the top lattices and the foam, and trial fit on fuselage. After the canopy is hinged, TB-1 will be positioned permanently and floxed and taped in place so the bottom cross member just clears the headrest (one thickness of tape) and the top of TB-1 is about 3/4 in. behind the top of the headrest.

STEP 4. CONTOURING AND GLASSING OUTSIDE OF TURTLEBACK

Set turtleback right side up on blocks on your work table. Secure with a few dabs of bondo so it will stay put while you work on it. Check contour to make sure you have smooth compound curves with no flat spots, bumps, or joggles. Correct as necessary with a sanding block at least 12 in. long. When correct, remove 1 in. of foam from the forward edge to receive the plexiglass canopy (Fig. 15, Sec. A-A), and sand a 1/16 in. depression 5/8 in. wide for a glass overlap. Similarly, sand depressions for the opening lip (Sec. B-B) and the cowl lip (Sec. C-C). Now vacuum the foam, fill the seams and any gouges with dry micro, squeegee wet micro overall, and glass with 2 layers of UND with crossing fiber orientation same as in STEP 2. Peel ply depressions (or the entire layup) to make finishing easier.

STEP 5. INSTALLING WINDOWS

Windows which have been molded to the correct shape are supplied with the canopy from the designated distributor. You can do a nice, neat job by installing them from the inside, after removing a portion of the inside skin to use for the frame after installation. The location and cut out dimensions are shown in Fig. 16. Radius the corners for a pleasing appearance. Do a neat job of cutting the openings through both skins and finish edges by sanding. Then mark off a 1 in. wide frame on the inside skin and remove it by cutting through the inside skin only with a saw blade in your Dremel. Remove just enough foam so the window fits in place snug against the outside skin. Mask off the windows with masking tape along the edge of the opening, both sides, so you won't get epoxy where you don't want it. Cover the windows with a generous coat of Spraylat, except for the edges which will be bonded to the fiberglass. Dull the areas to be bonded with 220 grit paper. Make provision to hold the windows snugly in place against the outside skin for cure, either with Cleco clamps (Fig. 17) or with small bolts, to be removed after cure. **Do not** drill through the plexiglass. Install the windows with a light coating of wet flox on the mating surfaces. Wipe away any surplus. After cure, install the inside frames in a similar fashion, and after they have cured, apply a 1 in. wide, 1 ply BID tape over the seam between the inside skin and the frame (Fig. 18). Peel ply for a good finish. You are now ready to install the canopy hinges.

STEP 6. INSTALLING HINGES ON THE LONGERONS

The longerons are curved, but the hinges must be aligned in a straight line, as far apart as possible. Accordingly, the rear hinge will overhang the longeron at the aft end. The fairings, which are installed later, will hide the overhang. To support the rear hinge, cut a piece of 1/8 in. thick 2024 T3 aluminum to the dimensions in shown in Fig. 19. Mark the hinge locations per dimensions in Fig. 20. Cut a notch at the rear hinge location for the rear hinge support, 6-1/2 in. long and 3/16 in. deep, tapering the glass layup on either side (Fig. 20, sec. A-A). Grab a scrap of 2 in. urethane about 10 in. long. Shape it to fit the fuselage by abraiding it against the fuselage skin, and then 5-min it in place centered at the notch. Clean and sand the aluminum hinge support and flox it in place, level in the notch, radiused edge up and out (Fig. 20, sec. B-B). Contour the foam for good glass laydown, and glass with 3 layers BID, 45 degree orientation. Make sure there are no bubbles in the layup (Fig. 20, Sec. B-B).

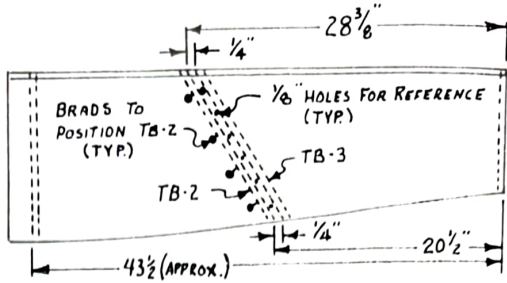


FIG. 14

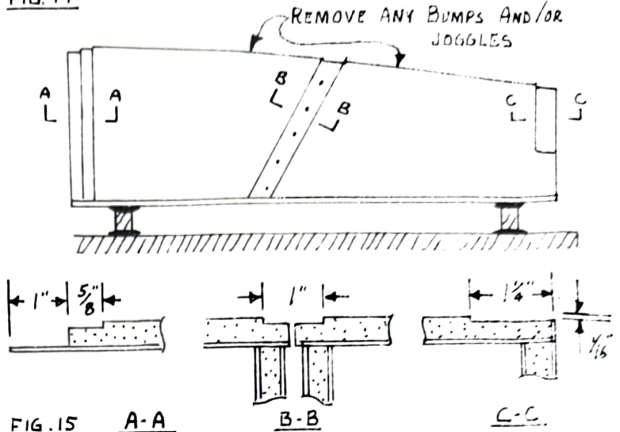


FIG. 15

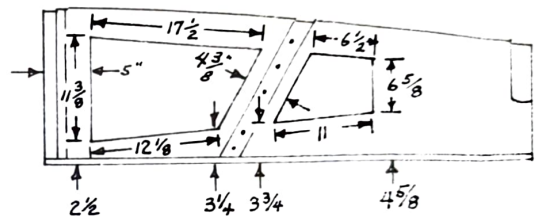


FIG. 16

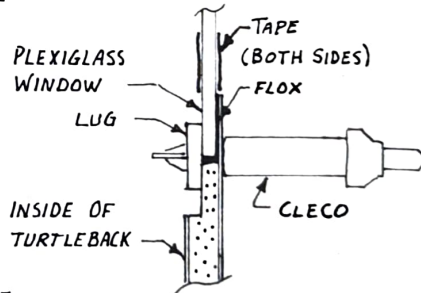


FIG. 17

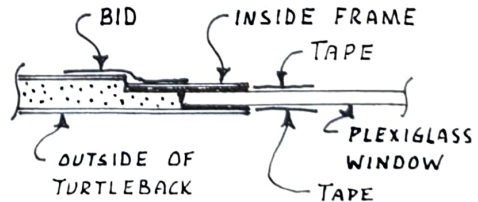


FIG. 18

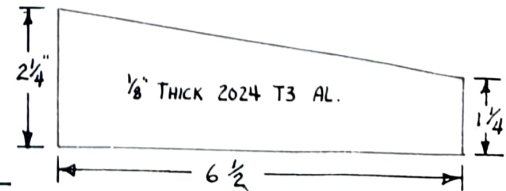


FIG. 19

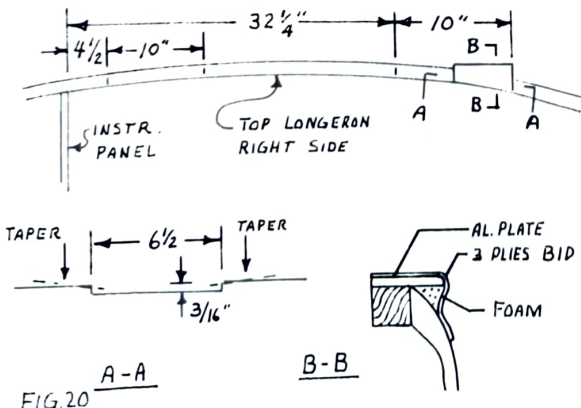


FIG. 20

After cure, sand with 36 grit and tape exposed surfaces of TB-2 and TB-3 to shell with 1 ply BID. Install TB-1 temporarily (Fig.14) with a few dabs of bondo until after the turtleback is installed on the fuselage and the canopy is hinged. Cut turtleback loose from form by sliding a thin-bladed knife between the top lattices and the foam, and trial fit on fuselage. After the canopy is hinged, TB-1 will be positioned permanently and floxed and taped in place so the bottom cross member just clears the headrest (one thickness of tape) and the top of TB-1 is about 3/4 in. behind the top of the headrest.

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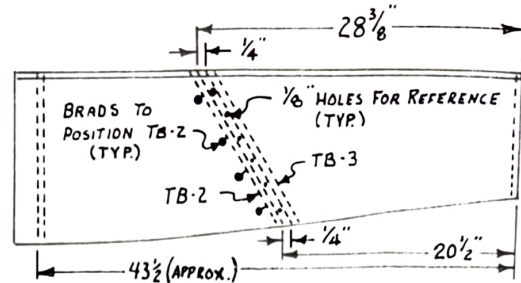
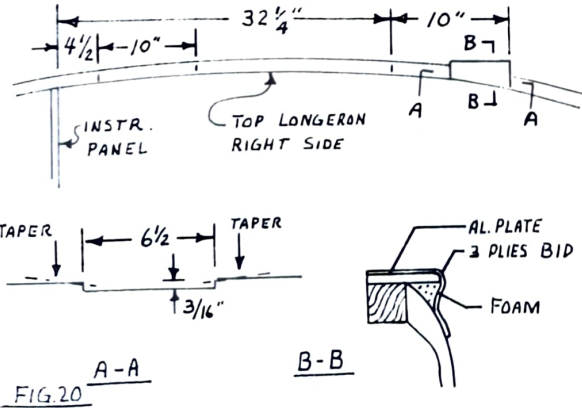


FIG. 14

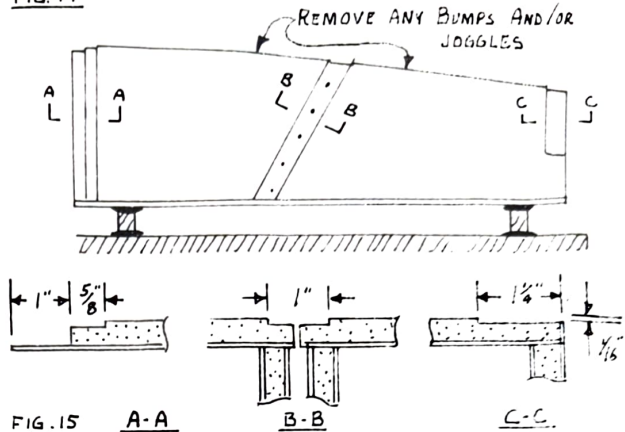


FIG. 15

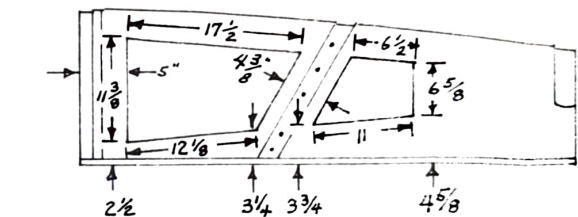


FIG. 16

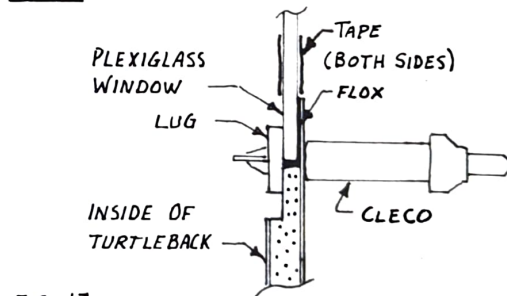


FIG. 17

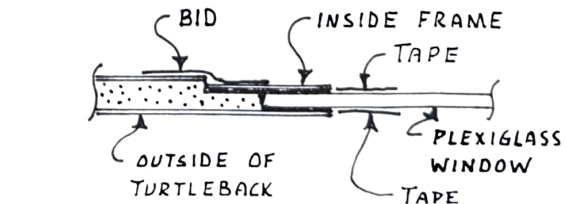


FIG. 18

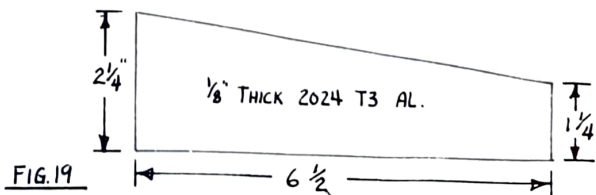


FIG. 19

Cut two pieces of MS20001-P6 hinge 10 inches long. Separate the halves. Clean and sand the bonding surface of the hinges with 220 grit, and the glass bonding surface with 36 grit, and then flox the hinges in position on the longeron and support plate. Use your 4-foot level to hold them down in the same plane (both horizontally and vertically) with the hinge pins perfectly aligned until cured (Fig. 21). **This is important to prevent the hinges from binding.** Now drill #12 holes through the hinges (or support plate) and longeron and countersink for AN509-10R screws as shown in Fig. 22. If the AN509-10R screws are too close to the fuselage side to install a washer and nut, mill away a little material with your Dremel for the necessary clearance. Also drill 1/8 in. holes through the rear hinge and support plate and countersink for pop rivets. Install screws and pop rivets as shown (Fig. 22).

STEP 7. INSTALLING THE TURTLEBACK

The TB-4 bulkhead was only temporary, to maintain correct curvature of the aft end of the turtleback until after it was glassed and cured on the outside. It may be cut out now. Trial fit the turtle back to the fuselage. Note that the firewall is slightly oversize—don't worry, it will be trimmed later. Mark

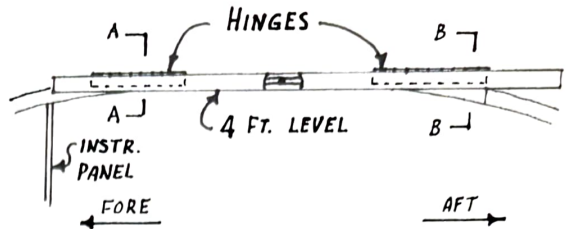
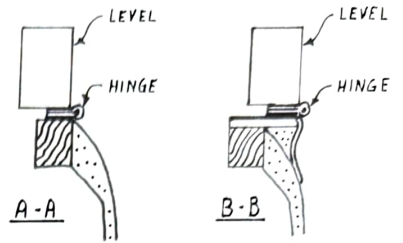


FIG. 21



FORE

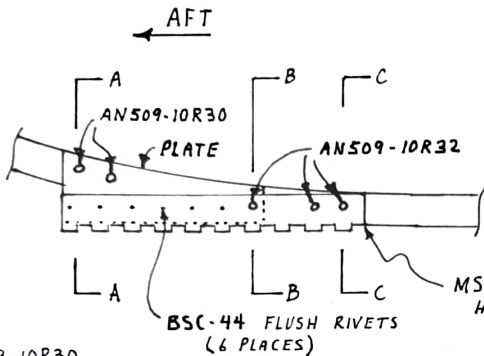
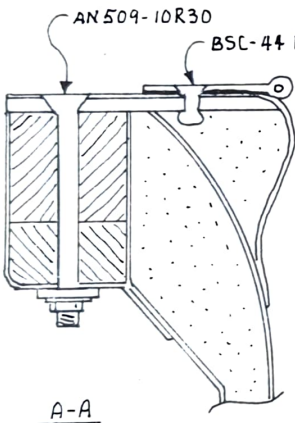
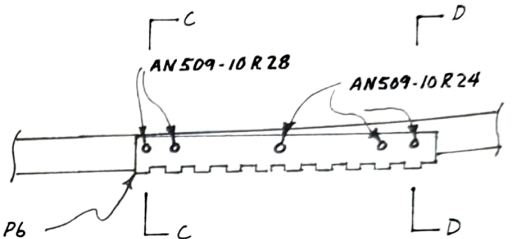
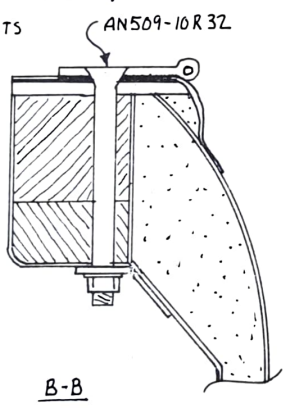


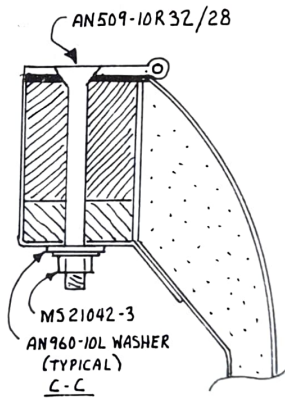
FIG. 22



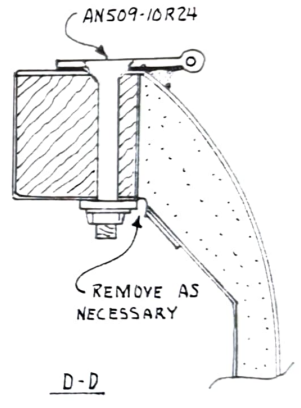
A-A



B-B



C-C



D-D

the location of TB-3 on the longerons. Remove the turtleback and sand the top surface of the longerons from the firewall to the forward face of TB-3 for bonding. Also the outer edge of the forward face of the firewall and the flange of the turtleback. Set 1/16 in. shims (tongue depressors will do fine) on the longerons, and flox the turtleback in place, 1/16 in. above the longerons, against the firewall and forward to TB-3 (Fig. 23). **Do not** flox the forward half in place, because it opens with the canopy to gain access to the back seat. Instead, use a few dabs of bondo to hold the turtleback in place while the flox cures. **Note**, we want the turtleback to be installed 1/16 in. above the longerons. After cure, trim the turtleback flange from TB-3 aft, and tape with 1 ply BID, lapped 1/2 in. on the fuselage and on the longeron (Fig. 23, Sec. A-A). Tape the inside against the longeron and firewall later in this chapter when you have access to the back seat (Fig. 23, Sec. A-A, B-B).

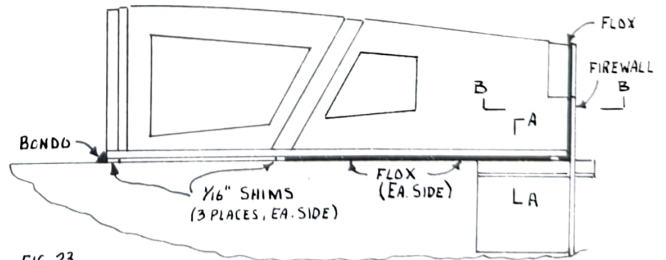


FIG. 23

STEP 8. BUILDING THE COWLING FLANGE

You can now trim the top of the firewall to match the 1/16 in. groove at the aft end of the turtleback. A sanding drum on your dremel works well (Fig. 25). Fasten some blocks of 1 in.

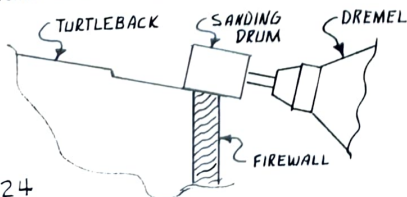
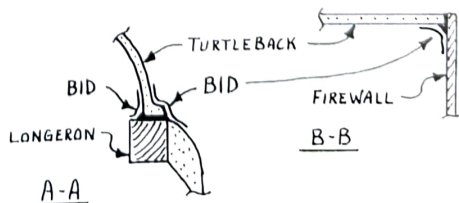


FIG. 24



A-A

B-B

thick urethane foam on the aft face of the firewall around the edge to support the flange layout. Shape the urethane so the flange will follow the turtleback line at the top, but flare out-board about 1/8 in. from a straight line at the sides (Fig. 25, Sec. A-A). Layup the flange with 4 plies of BID, and trim to 1 in. after cure. Although you will have to wait until after the strakes are built and fairings installed to finish the flange, this much will help immensely in mounting the top cowlings. In a similar manner, build a short section of flange along the fuselage side, under the centerspar (Fig. 26), for supporting the bottom cowlings later on.

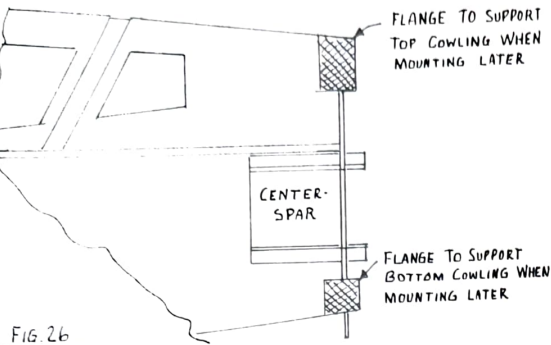


Fig. 26

STEP 9. INSTALLING THE CANOPY

General considerations: The plexiglass canopy bubble, as received, will have sparkling clear optics and be unblemished, and you will want to keep it that way thru the construction and finishing process. Both inside and out must be covered with a protective layer. The plastic covering will do fine for the outside, but you should paint the inside with Spraylat. You will need to expose 3/4 in. of plexiglass along the edges for bonding to the frame (1/2 in. locally is absolute minimum), inside and out, and you will want a nice, sharp edge where the fiberglass terminates on the plexiglass. You will use tape (Fig. 31) to obtain this edge. You don't want to tape a larger area than necessary, however, because the adhesive may transfer and be difficult to remove months later. Don't use masking tape. Grey duct tape is recommended. Several layers are recommended, so you will have a safety factor later when grinding away the excess fiberglass with your Dremel (Fig. 32). Don't use a razor blade to trim the fiberglass against the tape. It could cause a crack later. The instructions which follow will direct you when to expose each edge and tape it, and when to coat the inside with Spraylat. Keep the plastic covering on the outside at all times.

Apply 4 layers of duct tape on top of the longerons only from the turtleback to F-28, and a 5th layer on top of the longeron and going down over the side of the fuselage. Trim the top of the instrument panel in accordance with the trim template shown on drawing A-22. Bondo a 4 in. wide board, inside both longerons, from the shoulder support to the instrument panel, level with the top of the longerons after taping. Bondo a piece of plywood (or several boards) from longeron to longeron between the instrument panel and F-28, level with the longerons after taping. These platforms will support the foam blocks you will be using to build and shape the canopy frame (Fig. 27).

Now trial fit the canopy (leave the protective covering in place). The supplier has been asked to factory trim 1 inch off the bottom edge from the instrument panel forward, and transition from the instrument panel aft, to save you the trouble (Fig. 28). Check this. 5-min 1/4 in. thick shims in the instrument panel notches (Fig. 29) to hold the canopy 1/4 in. above the notch. The canopy will have to be pushed down on the top and in at the sides to conform to the flange on the turtleback. You will also want to spread the canopy so it is 34-1/2 inches wide inside at the widest spot, 10 inches forward of the head rest, and centered, to give you the 34-1/2 in inside dimension, and bondo them in place on the platform (Fig. 34). Locate the other two about 6 inches ahead of the first to help distribute the bending load on the canopy and to smooth out the curve. Now check how well the canopy seats on the turtleback flange. You should have about 3/4 inch overlap between the canopy and the flange. If it isn't at least 1/2 inch everywhere, you may widen the flange where necessary by grinding away material from the turtleback so the canopy will slide a little farther aft. Now mark on the outside of the canopy

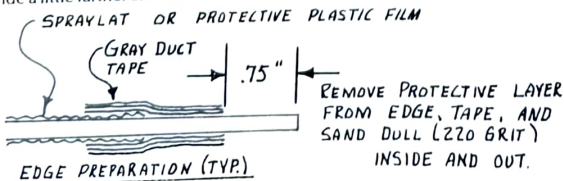


Fig. 31

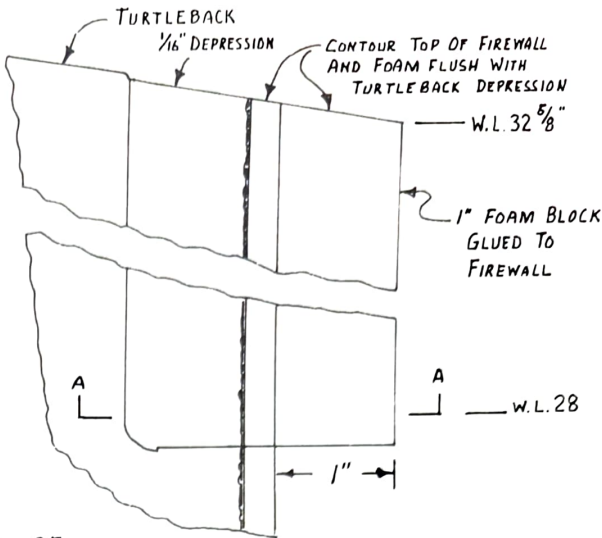


Fig. 25

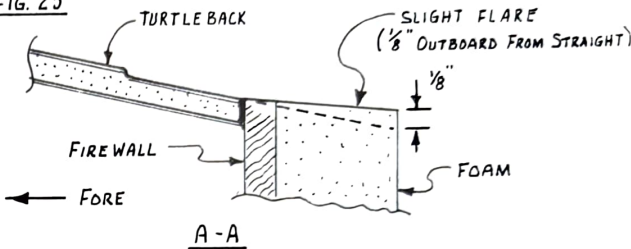


Fig. 27

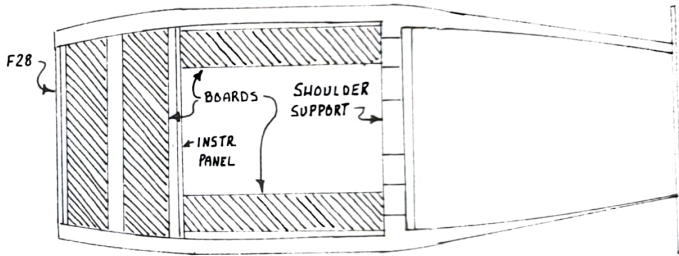


Fig. 28

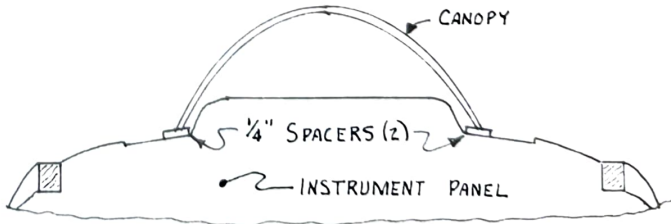
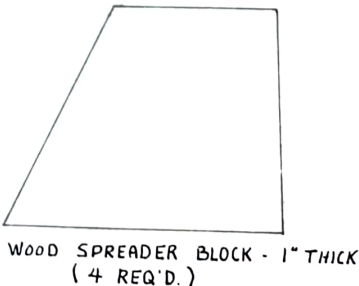


Fig. 29

Fig. 30



where the forward edge of the flange extends, remove the canopy, and tape off the area on the inside forward of the flange to protect it from the epoxy which will ooze out during mounting. Use several layers of tape exactly on top of each other (Fig. 31) because you will be doing some grinding against the tape later (Fig. 32). Now dull the mounting surface with 220 grit, the flange with 36 grit, apply floc to both surfaces, and put the canopy in position. A good way to hold the top down is to cut a piece of 3/8 inch PVC foam about 15 inches long and 2 inches wide and stack weights on it. You can keep the weights from sliding off (it might spoil your day) by putting some nails through the foam from underneath to form a fence (Fig. 33). A good way to hold the sides in is to bondo a 2 inch board on each side of the turtle back and a loose fit on the canopy. After the bondo is well cured, then you can slide a wedge in to tighten up on the canopy. Keep the 2 inch boards 1-1/2 in. above the bottom edge of the canopy, so they won't interfere with the next step. Check that your shims are in place holding the canopy 1/4 in. off the instrument panel, and let everything cure (Fig. 31).

STEP 10. BUILDING THE CANOPY FRAME

Make templates for the canopy frame contour from the template drawings on pages A-21 and A-22. Adjust them so they fit the side contour of your fuselage and form a smooth curve up to the canopy, observing the longeron location and the tape location on the canopy. Mark the tape location on the canopy at each template. Remove the protective covering from the lower edge of the canopy to about 1/2 in. above the tape mark. Now run a smooth curve with tape with the bottom edge of the tape starting 3/4 in. above the blister at the firewall, coinciding with the bottom edges of the side windows, and falling on the marks you made on the canopy using the templates (Fig. 35). The lowest point of this curve should be 10 in. forward of the headrest, which is also the widest point of the canopy, right? Use several layers of tape on top of each other so you will have a good edge on the fiberglass after grinding off the excess. Now hold F.S.41 template in place over the instrument panel and note how thick the top of the fuselage can be at this point and not interfere with the panel (Fig. 36). Now tape over the top edge of the instrument panel, 5-min, 1/4 in. of foam on top of F-28 for sanding reference (Fig. 37), but **do not** tape it. Now dull the exposed bottom edge of the canopy with 220 grit for bonding. A 3/4 in. wide bonding area is preferred, but you may allow only 1/2 in. at the canopy low point. Apply 1 layer UND all around the bottom of the canopy (Fig. 37), lapping onto the turtleback at least 2 in. each side. When the UND layer has cured and been trimmed, remove the weights on top and the bondo boards at the sides, and prepare for 3 layers of BID over the top joining the canopy to the turtleback (Fig. 38). The BID should just cover the flange at the sides, but at the top it can curve forward toward the high point of the bubble, so the slight dip between the canopy and the turtleback can be faired to a straight line with micro during finishing. Prepare the bonding surface as before, peeling back the protective layer, taping the edge, and dulling with 220. Use peel ply over the BID and wet out well to minimize sanding and finishing work near the edge.

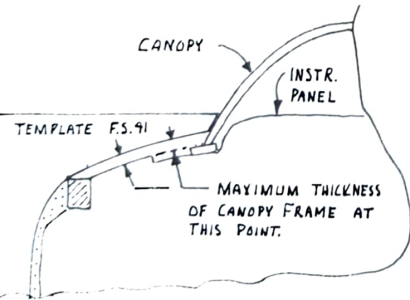


FIG. 36

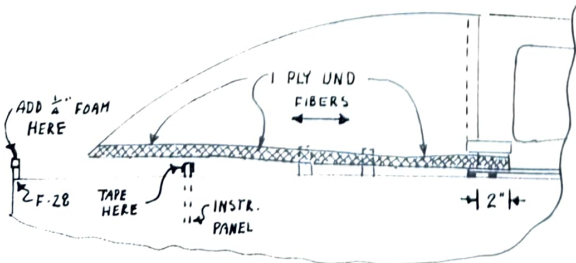


FIG. 37

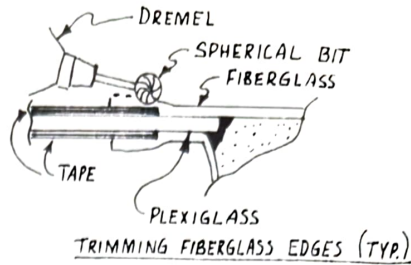


FIG. 32

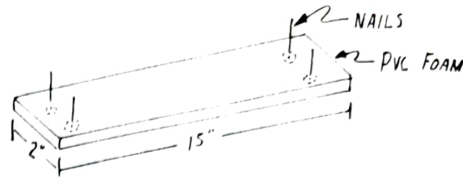


FIG. 33

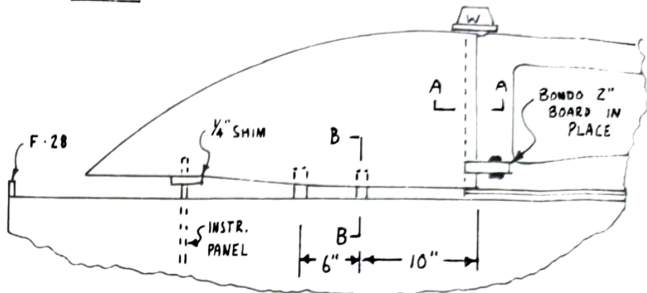
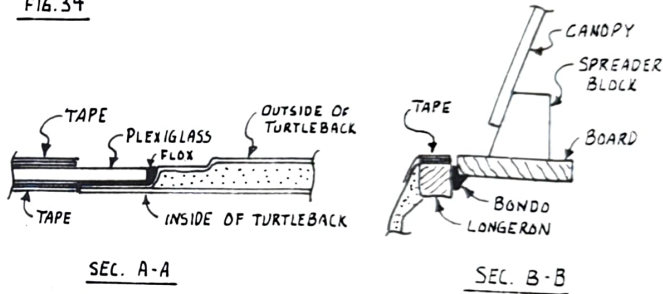


FIG. 34



SEC. A-A

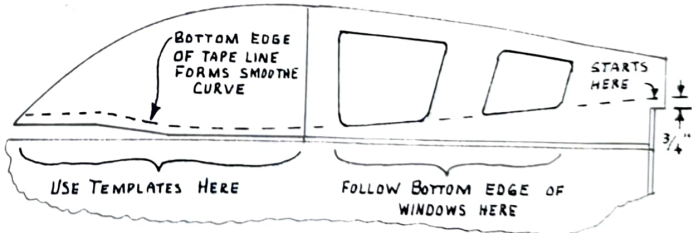


FIG. 35

NOTE: USING TEMPLATES AS REFERENCE SHOULD GIVE YOU AT LEAST .75" BONDING AREA EVERYWHERE EXCEPT AT WIDEST PART OF CANOPY, WHERE YOU CAN ACCEPT ANYTHING GREATER THAN 0.5"

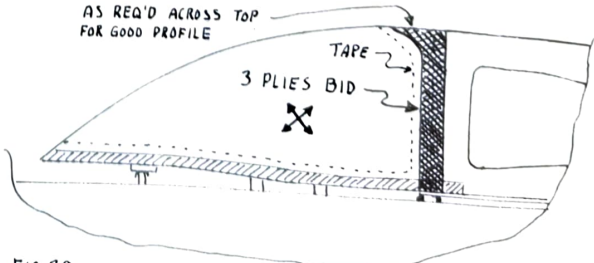


FIG. 38

Now fit blocks of 2 in. thick urethane all around the canopy (Fig. 39). Stand them on edge (to avoid horizontal joints), and make sure they are flat on the bottom against your platform, and make good contact with the bottom edge of the canopy, extending underneath the edge (Fig. 39, Sec. A-A). At the turtleback, make a transition piece down to the flange, and on the hinge side the transition down to the flange should start aft of the hinge. When they are all cut out, you can micro them together, using micro **very sparingly**. Cover the platform with wax paper to avoid microing the blocks to it. At F-28, use a few dabs of micro toward the bottom, where you can reach through underneath after glassing to cut them loose. Use just thin beads of micro between the blocks near the bottom to hold them together. A small bead of micro along the bottom edge of the canopy is sufficient there. An occasional dab on top of the longerons can be used to hold everything down.

When the micro has cured, you can start your contouring, using the templates as guides. Rough shaping can be done with a butcher knife or hacksaw blade. Follow with 36 grit, and end up using a block of urethane. Template B.L.O. determines curvature from F-28 to the canopy (Fig. 40). Sand down to but not into the 1/4 in. foam on F-28, except at the longerons where it should feather down to the fuselage sides. At the transition blocks down to the turtle back, shape isn't too important because they will be covered with a fairing later, but be sure the foam extends all of the way out to the hinge pins on the right side and allow a little extra thickness over the hinges so you will be able to bury the hinge bolts inside the contour (Fig. 52, Sec. A-A). Contour the foam slightly undersize because glassing will add 1/16 in. to the thickness (Fig. 40, Sec. A-A). When the contour is correct and the same on both sides, mark where the frame will be cut (Fig. 41). This will be 3-1/2 in. from the canopy around the front, and then a straight line to the forward end of the forward hinge on the right side, and the same distance aft on the left. Sand a 1/16 in. deep by 1 in. wide depression centered all along the future cut line (Fig. 40, Sec. A-A). Also sand a 1/16 in x 1 in. depression over F-28 (Sec. B-B). These depressions allow the building of lips later on to cover the joints and shed rain. Now dig a small groove into the foam at the canopy (Fig. 40, Sec. A-A) to allow bonding of the glass layup to the UND around the base of the canopy. Make sure everything is right (you are working on an area everyone looks at), vacuum the foam, micro it, and start your layup. Schedule is 2 BID layers at 45 degree orientation and 2 UND layers fore to aft orientation (Fig. 42). All layers lap onto turtle back at least 2 in. First layer BID goes into groove around canopy. Then fill with flox, and 2nd layer goes over top of flox. Sissor trim as close to tape edge as possible. Peel ply and wet out layup at tape edge to facilitate trimming later on. Inspect layup to be free of bubbles. At knife trim stage, trim sides level with top of longerons and front flush with forward face of F-28. Let cure for 48 hours.

After cure, saw thru turtleback between TB-2 and TB-3 (Fig. 43). Hitting dead center isn't critical because the cut will be opened up to 1/4 in. later. Free the layup from the foam over F-28, reach under and free the foam from F-28, and free the foam anywhere it was microed to the longerons. The canopy should be free to lift it off, but don't move it until you build a frame on top to hold it rigid and aligned, with legs which will permit you to stand it up on your work table upside down (Fig. 44). Now you can move it to your work table. You can now saw out the cross braces on TB-2 and TB-3, climb in the back seat, grind away xs flox at longeron and firewall joints, and tape with 1 ply BID. Peel ply to prevent rough edges (Fig. 23, Sec. A-A and B-B).

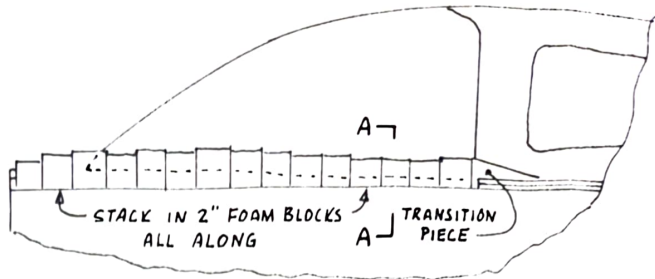


FIG. 39

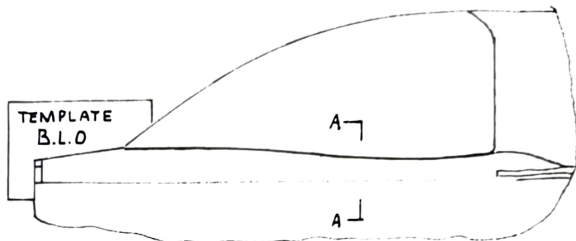
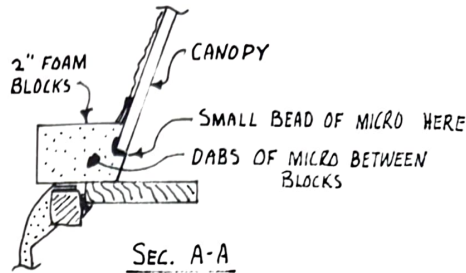


FIG. 40

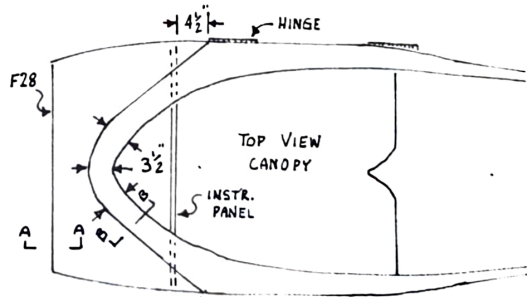
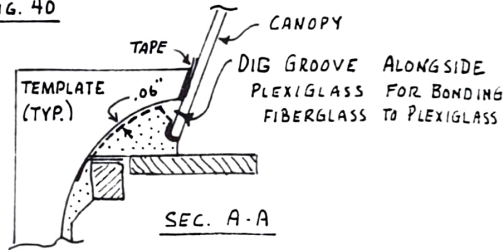


FIG. 41

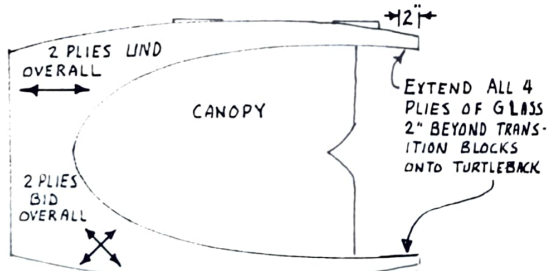


FIG. 42

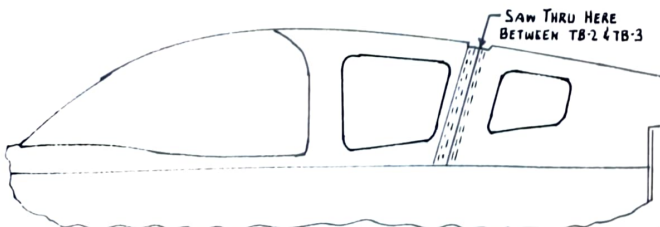
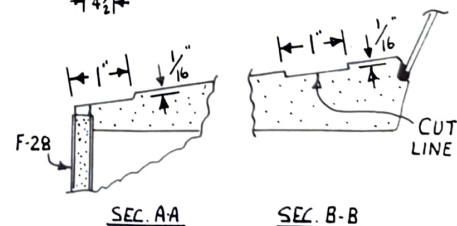


FIG. 43

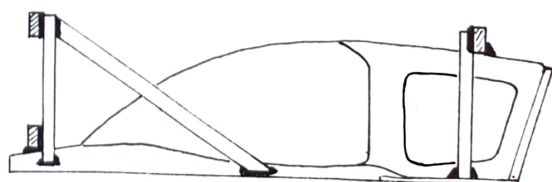


FIG. 44

STEP 13. INSTALLING HINGES, CUTTING OUT FRAME, AND INSTALLING DRIP RAIL

Put several layers of tape between the hinge halves to allow for screw head clearance, and put canopy back on fuselage to check fit. Remove any high spots until fit is good. Make sure canopy is perfectly aligned with turtleback in the rear, top and sides, and longerons at front. Drill a small hole at each corner, through the canopy into the longerons, for small finishing nails to serve as alignment pins (Fig.48). Then clean and dull mounting surface of hinge, tape over outer edge to protect hinge pin, rough mating surface of canopy, apply flox (or 5-min. mixed with cotton or bondo) to both surfaces, and set canopy in place on fuselage (Fig.49). Drop your 4 alignment pins in place and allow to cure. It would be a good idea also to put a few dabs of bondo along each side of the canopy and forward fuselage top to help hold it firmly for cure and for cutting out the frame. After cure, remove part of your wooden canopy support as necessary to cut out the forward edge of frame (review Fig.41). Cut at approx. 45 deg. (Fig.50) along the center of the depression you sanded in the foam in step . Be careful not to saw through instrument panel. After sawing, open up the saw cut to 1/8 in. wide by routing with a 1/8 in. drill. Then bondo about 6 or 8 tongue depressors across saw cut to hold the two pieces together, rebuild your wooden support, pull out the hinge pins, and transfer the whole assembly back to your work table (upside down). Now build up the surface of the canopy frame aft of the saw cut 1/8 in. high by 1-1/2 in. wide. Use either 1/8 in. balsa or 1/4 in. foam sanded down to 1/8 in. and 5-min. in place. Cover balsa or foam with tape, and glass across saw cut with 2 plies BID, lapping 1/2 in. on fiberglass and 1-1/2 in. on foam. Wetting out glass on paper first will avoid running epoxy into saw cut (Fig.51). While this layup is curing, you can install bolts through canopy hinges and frame. Drill 5 holes, each hinge, as shown in Fig.52, with a #12 drill. Be sure these holes go through the reinforcing pads of the canopy. Countersink (100 deg.) the hinges for AN509-10R-10 screws. Counterbore the top of the canopy frame for MS21042-3 nuts to sit below the contour as shown (Fig.52, Sec. A-A), except leave a minimum thickness of 1/4 in. fiberglass. You may grind away a portion of the screw which protrudes above contour. Fill the holes with micro and raise contour with micro if necessary to hide nuts.

When the drip rail has cured, you can separate the fuselage top from the canopy and reinstall both on the fuselage. The exposed foam surfaces of both should be glassed with 1 layer BID on the fuselage top and 2 layers BID on canopy frame, using flox corners (Fig.53). On the fuselage top, extend the BID over the drip rail as well. The drip rail may collect water when parked nose down in the rain. You can put a 1/4 in. hole at the low point for a drain into the wheel well via a 1/4 in. tube.

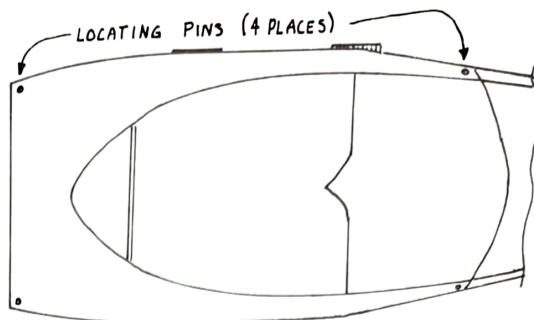


FIG. 48

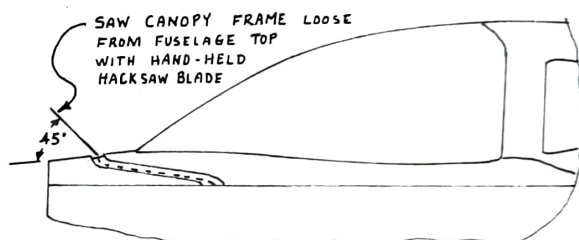
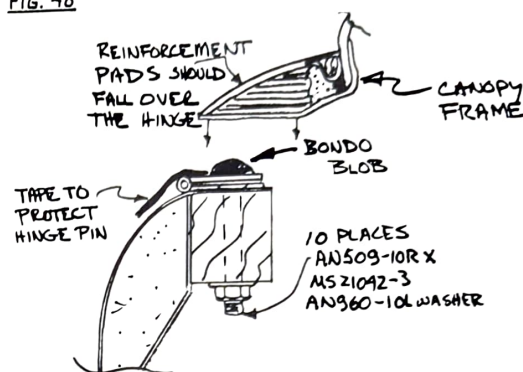


FIG. 50

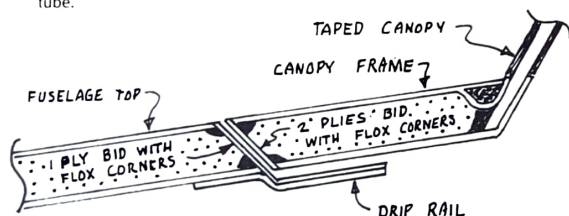


FIG. 53

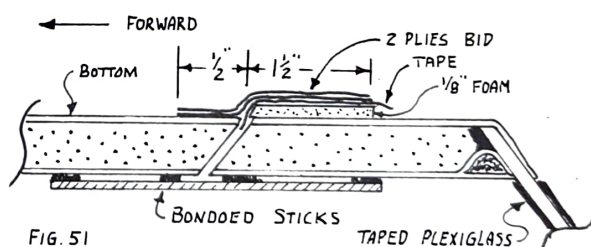


FIG. 51

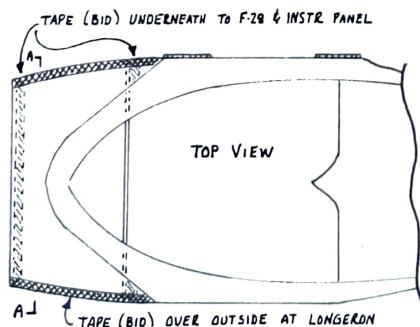


FIG. 54

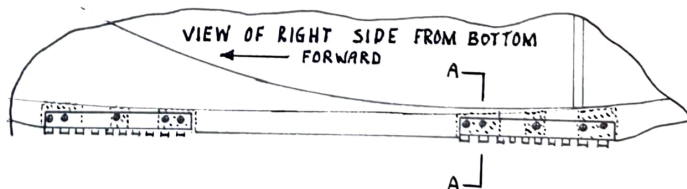
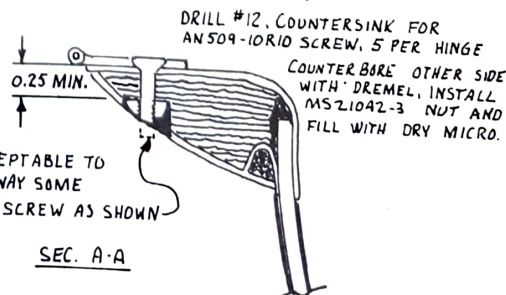
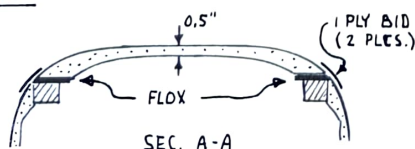


FIG. 52



SEC. A-A



SEC. A-A

STEP 19. CANOPY HANDLE

Make two handles per Fig. 66. One of these handles is installed on the right longeron, from F.S.56.75 to F.S.61.5 (forward bolt 15-1/4 in. aft of I.P.) to assist the right side passenger in entering and exiting the seat. It is installed through the longeron in the same way that the latch pivot bolts are installed. For better appearance, you can use AN509 screws with the heads on the inside of the longerons and nutplates on the outside (Fig. 67). If you grease the screws, the handle can be removed later for the installation of a space saver electrical panel on the right side (and then reinstalled). The other handle is installed on the underside of the canopy, so the pilot can hold it firmly while opening and closing. The reinforcing pads were installed earlier in Steps 11 and 12 (Fig. 45). Center the handle over the pads and install with two AN509-10R12 screws (heads inside) and nutplates countersunk below the surface contour (Fig. 68). Fill holes after with flox.

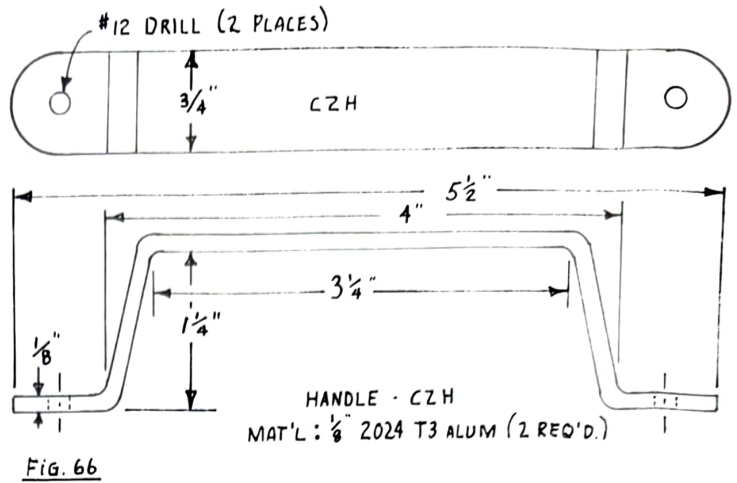


Fig. 66

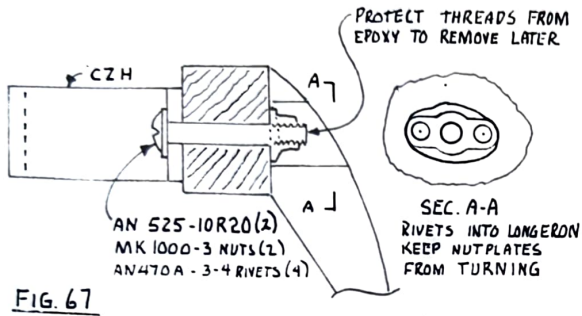


FIG. 67

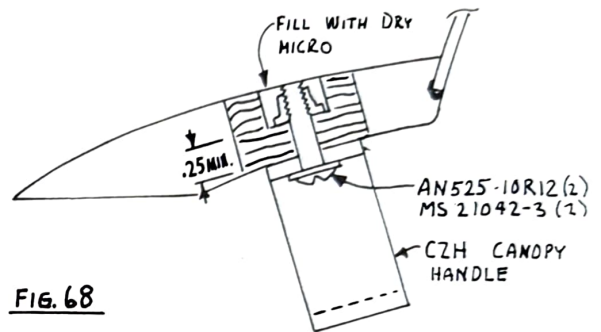


FIG. 68

STEP 20. CANOPY STOP

To restrain the canopy from opening too far, and to hold it open while entering or exiting the cockpit, a locking pin has been designed which fits in the right headrest and automatically engages a bracket mounted on TB-1 cross brace when the canopy is opened. Check your canopy installation and see what the clearance is between the cross member and the top of the headrest. It should be 3/4 in. Good! Now cut a piece of PVC foam about 2 in. long and 5-in. it to the aft face of the right headrest at the top (Fig. 69). Taper the bottom edge, shape the sides to conform to the headrest, radius the edges, and glass with 3 plies BID. After cure, measure down 5/8 in. from the top of the head rest and see if a 5/8 in. dia. hole will clear inside the outside glass (Fig. 69, Sec. A-A). If so, drill a 1/4 in. hole straight through the headrest fore to aft, centered, 3/4 in. down from the top (It would work best to drill half way from each side). Using the 1/4 in. shaft of your spot facing tool as a pilot, enlarge the hole to 5/8 in. I.D. from the aft face all the way through **except** don't cut through the forward fiberglass face (Fig. 70). Enlarge the hole in the forward face to 5/16 in. and flox in a 1/4 in. flanged, bronze bushing (Fig. 71). Now take your AN4-46 bolt, saw off the head, round the end, and drill a 1/16 in. hole 3-1/4 in. from the threaded end. Now assemble a AN960-416 washer, the compression spring, another AN960-416 washer, a AN380-2-2 cotter pin, and a CN-1 bushing (available pre-fab) on the bolt and trial fit the assembly in the head rest. If everything is correct, you will have to compress the spring in order to push the threaded end of the bolt out of the front of the headrest, and you will be able to compress the spring enough more to retract the rounded end of the bolt into the headrest. If your hardware store doesn't carry a selection of compression springs, take a 1/4 in. I.D. x 3/8 in. O.D. screen door spring, put one end in your vise, and stretch it until it has only 10 turns/in. and cut off 2-1/2 in. When everything fits correctly, dimple the outside of the CN-1 bushing by drilling a few 1/8 in. holes into it, grease the spring and bolt, insert the assembly into the headrest, and flox the CN-1 bushing in place, as shown in Fig. 71. Hold everything in place for cure with a nut on the forward end with a suitable number of washers stacked underneath. After cure, make or purchase a suitable knob to either thread or flox in place and pin it through the safety hole in the bolt if you wish.

Now make the stop shown in Fig. 72 from .063 2024T3. Cut it out and make the bends, but before drilling the 1/4 in. hole, hold it up against the head rest and check the location to make sure the pin will engage. Then drill the hole. Now, with the stop in place, check the clearance between the cross member of TB-1 and the stop. It will probably be about 3/8 in. so you will need a spacer between the cross member and the stop. Hopefully a 1/4 in. birch plywood spacer will bring the clearance down to 1/8 in. If not, add alum. shims as required and install the stop on the cross member as shown in Fig. 73. Use 3/16 in. I.D. bushings inserted in the cross member from the rear so it will not collapse when the two mounting screws are tightened. As always, install with wet flox. You now have a canopy support which will hold it open in the wind, and you will be the envy of all Long EZ drivers!

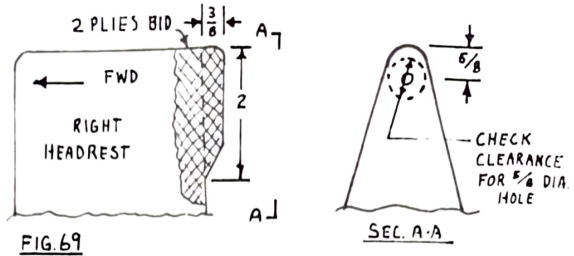


FIG. 69

SEC. A-A

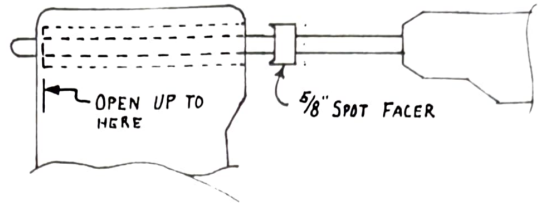


FIG. 70

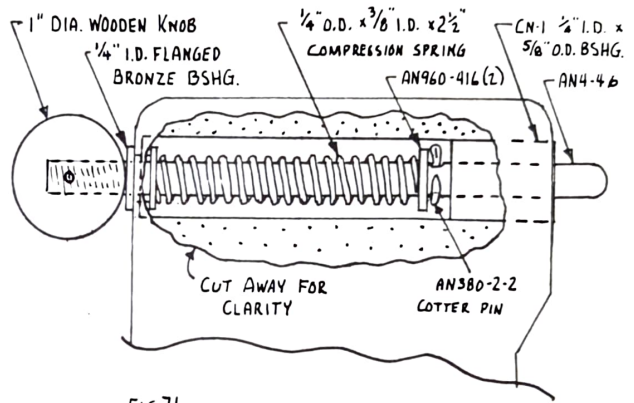


FIG. 71

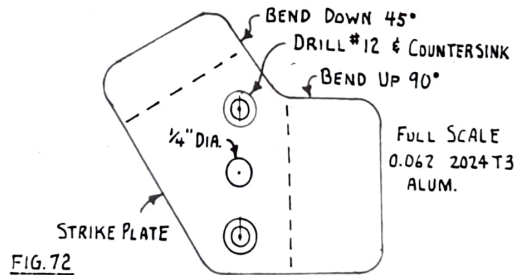


FIG. 72

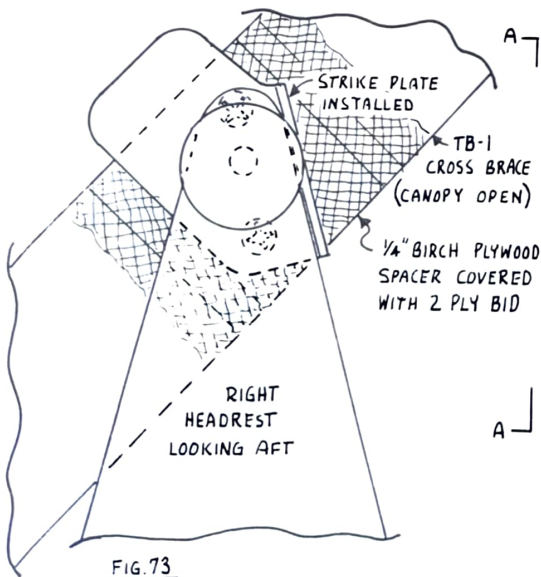
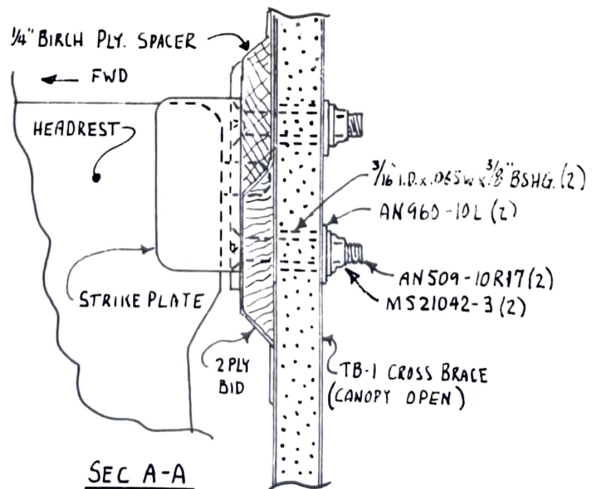
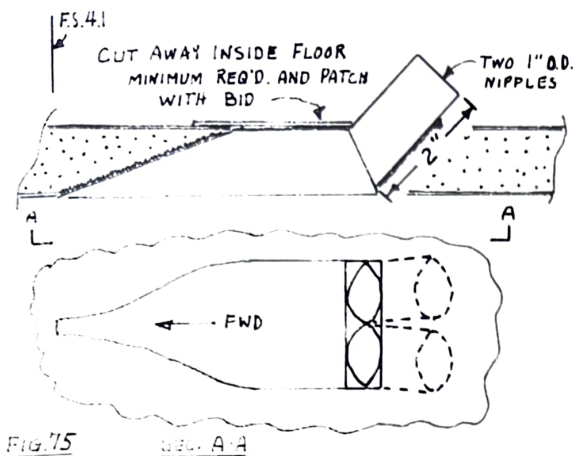


FIG. 73



SEC. A-A



STEP 21. COCKPIT VENTILATION

Cockpit ventilation on the Long EZ, because of its location on the top of the fuselage in front of the canopy, has two disadvantages: 1) It blanks off in a climb, when you need it the most after take off in the summer, and 2) When you fly through rain, you get water in your face. Although slightly more work, the solution to both of these problems is to locate the scoop under the nose.

Cut and shape a piece of foam accurately as shown in Fig. 74. Stick it to a piece of cardboard and glass with 2 plies of BID. After cure, cut as shown in Fig. 74, remove the foam, and sand smooth. Trace the outline on the bottom of the nose, to the right of center so it will miss the NG30s, and with the forward end at F.S.4.1 (same as the nose gear pivot, see page A6). Drill a bunch of small holes thru the skin along the outline and remove the outside skin. Remove just enough foam to slip the scoop in place, flush with the outside skin. Install with micro, but use floc corners. The corners are critical and must be kept sharp. Now you have a choice. If all you need is cabin ventilation, you can floc in two 1 in. O.D. x 2 in. long nipples into the aft end of the scoop (Fig. 75) at a 45 deg. angle and run 1 in. I.D. CAT flexible ducting to two 1 in. O.D. nozzles flocxed in to the upper corners of your instrument panel (Fig. 76). On the other hand, if you will be installing avionics which require outside air cooling, you can make a fiberglass transition piece, 1 x 2-3/8 in. rectangular on one end and oval on the other (Fig. 77) for a 2 in. I.D. flexible ducting to a distribution box (Fig. 78) installed on the forward face of F-22. The latter will allow you to run two 1/2 in. lines to radio transmitters and two 3/4 in. I.D. lines to the upper instrument panel. In either event, the lines from the scoop to the panel must avoid interference with the forward battery location, the rudder pedals, the elevator torque tube and trim, and instruments. After installing either of the two exits from the scoop and repairing any damage to the inside floor with BID tapes, then install the scoop lip (Fig. 79). Make the lip from a scrap of fiberglass about 4 plies thick. Grind away enough material with your Dremel from the side walls of the scoop and the fuselage bottom so the lip can be installed flush, and cover with 1 ply of BID, and peel ply. The vents in the panel can be closed with corks (champagne corks are a nice touch), or if you are really sophisticated, you might consider eyeball vents like they use in the heavies.

If you have a tight fitting gasketed canopy (less wind noise), you will need an air exhaust. The best place is in the back seat area, each side, under the strakes. Pick a spot where you will miss rudder cables and electrical harness and install the exhausts shown in Fig. 80. Micro and glass (1 ply BID) the exposed foam. If you have survived this chapter, you are well on your way to Oshkosh!

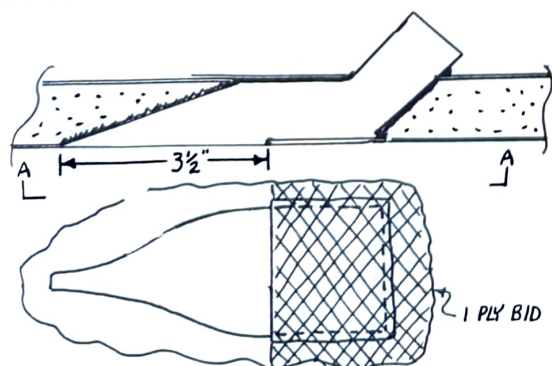


FIG. 79

SEC. A-A

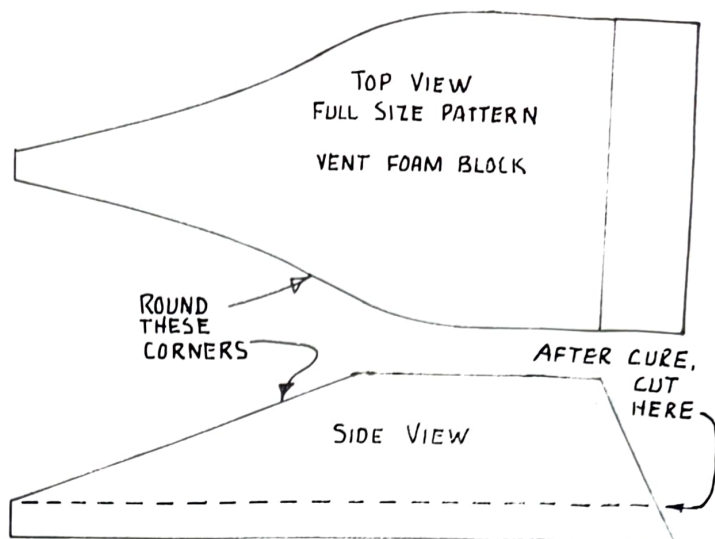


FIG. 74

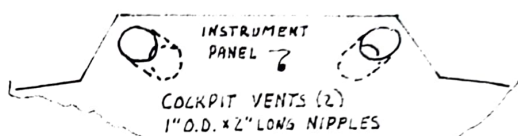


FIG. 76

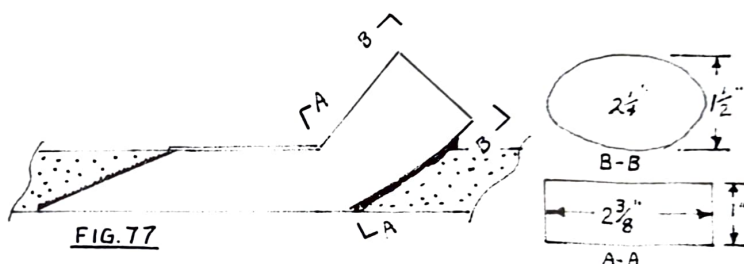


FIG. 77

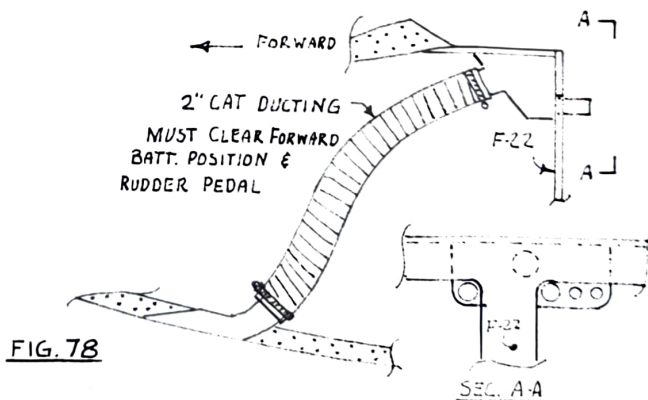


FIG. 78

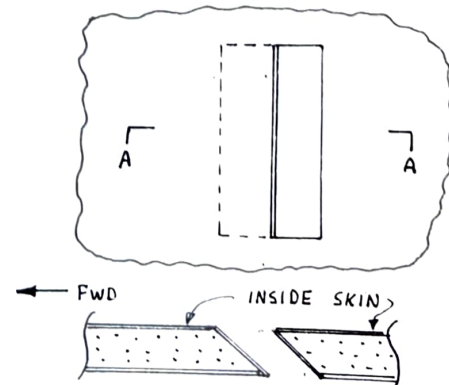
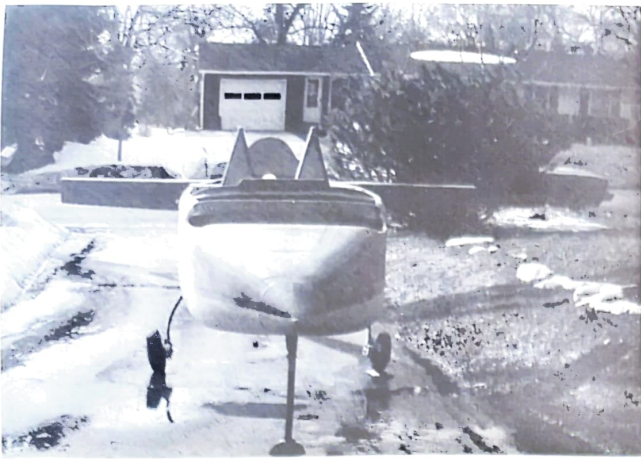


FIG. 80

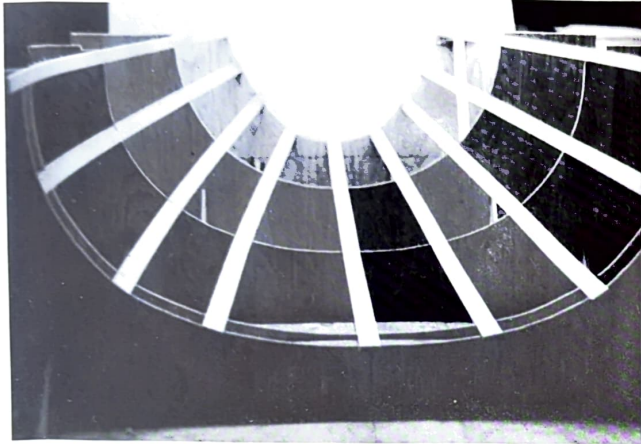
SEC. A-A



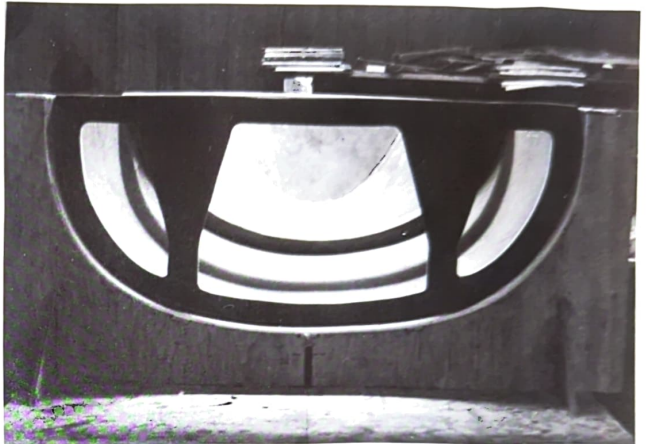
Roll over structure in place. Ready for canopy.



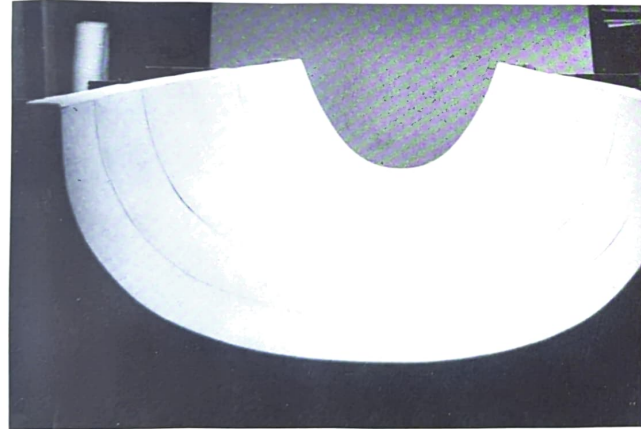
TB-2 and TB-3 installed.



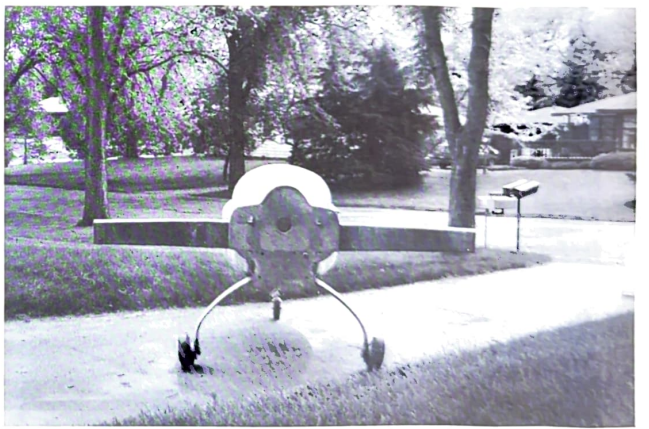
Turtleback forming jig.



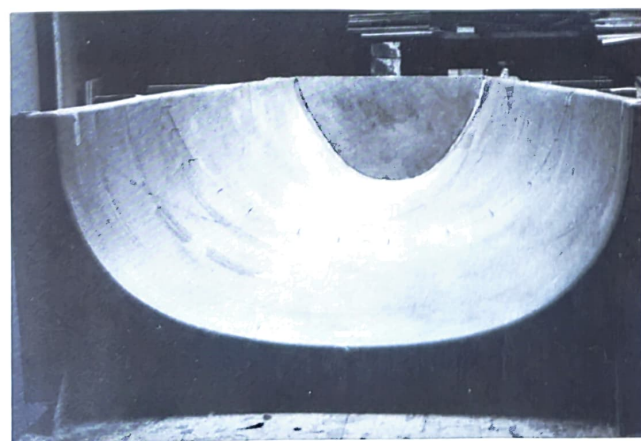
TB-1 installed.



Turtleback jig lined with 1/4 in. Clark foam.



Turtleback on fuselage.



Turtleback after glassing with 2 plies UND crossed fibers.



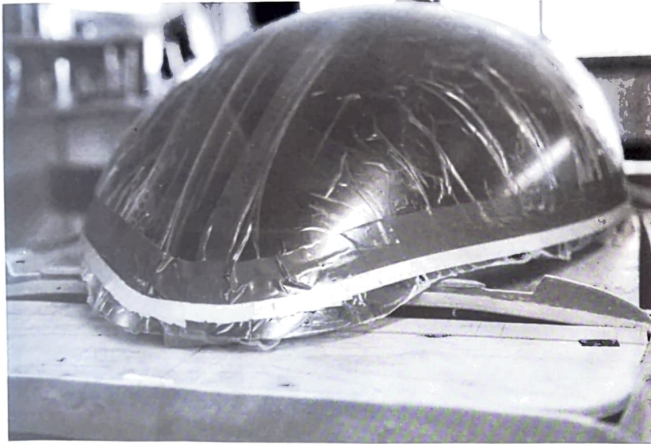
Spreader blocks for plexiglass bubble.



Plexiglass bubble mated to turtleback.



Curvature check F.S. 50



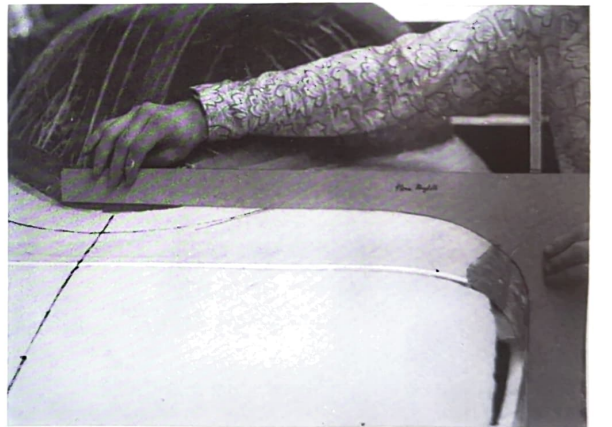
Masking tape used as a guide for duct tape.



Curvature check F.S. 41



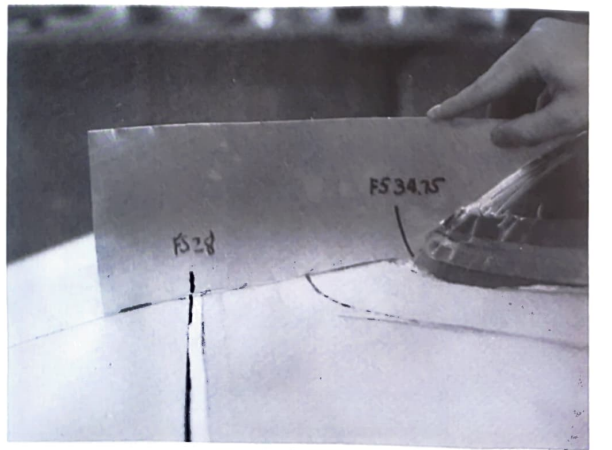
Curvature check F.S. 70



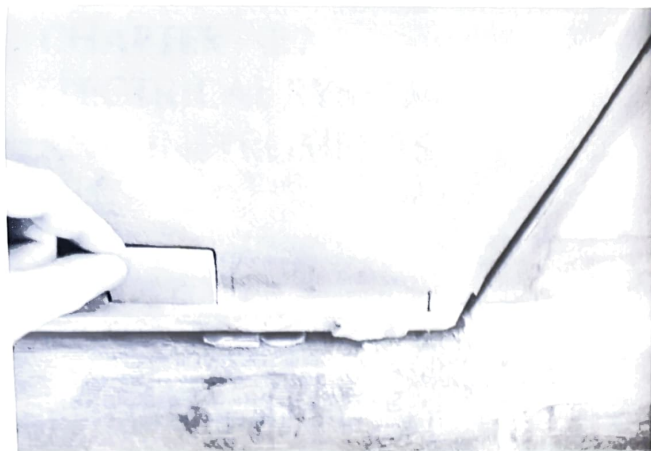
Curvature check F.S. 35



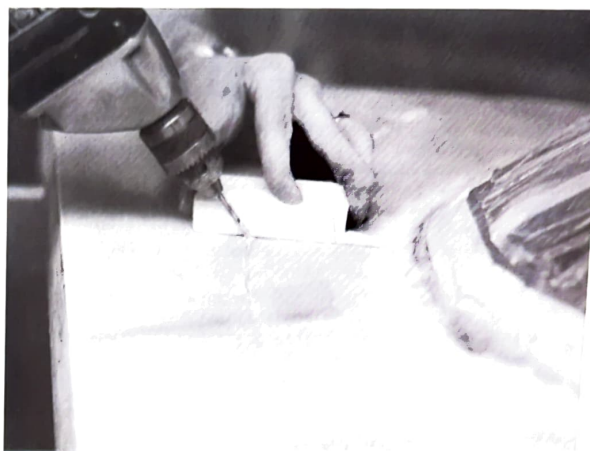
Curvature check F.S. 60



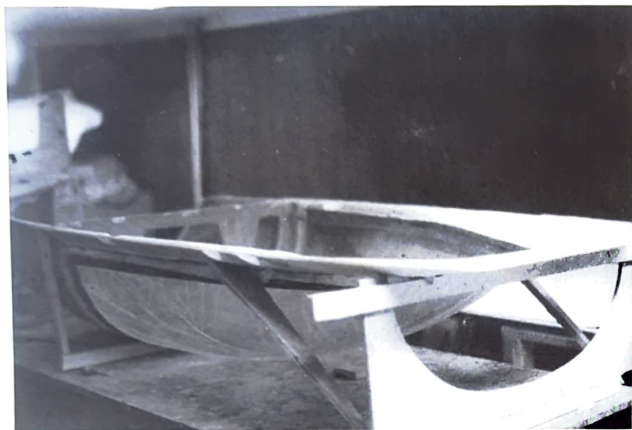
Curvature check B.L. 0



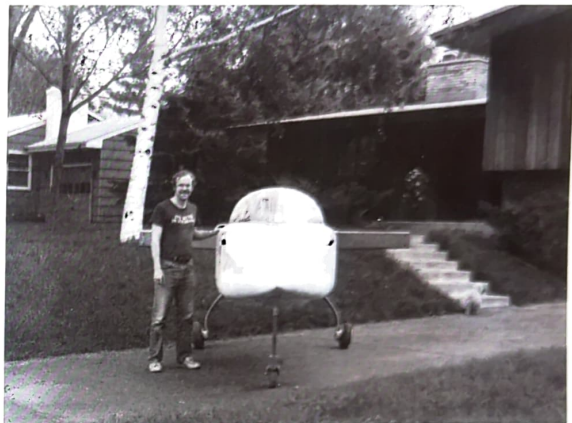
1/4" plywood insert for mounting C-7



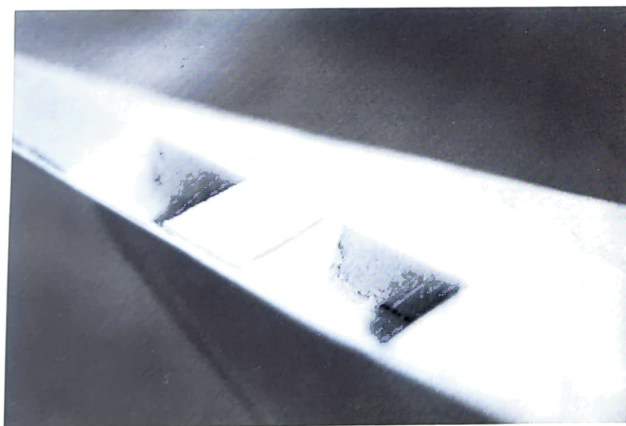
Opening cut with an 1/8" drill.



Glassing underside of canopy frame.



Looks nice, don't you think?



Close up of cut out for hinge and latch reinforcing pads.



Continuous smooth curve from front of bubble to prop.



Cutting out canopy frame.



Door with key lock (after painting)

CHAPTER 22

ELECTRICAL SYSTEM

AND INSTRUMENTS

NOTE: CZ 18-4 BUILDER HINTS #78
COPPER SPRAY

GENERAL. It is possible to install a low cost, light weight, electrical system in a COZY using a solar cell to trickle charge a battery. Such a system is adequate to power engine instruments, the warning system, and allow for occasional use of a Nav/Com radio and/or electric turn and bank gyro. It would be a minimum system for day - VFR flying. Inasmuch as the Cozy was optimized for long cross country travel (even IFR for qualified pilots), it is believed that most builders will require more electrical power, and some type of light weight alternator is therefore recommended.

A word of caution is in order at this point, however. The care you use in building and finishing your airplane, the amount of equipment you install, and where you locate it will affect the final c.g. location, which will determine the minimum and maximum front seat loads, and will also determine the payload you can carry without exceeding the gross weight limit of 1500 lbs. Use care in building and finishing. Install only the equipment you absolutely need, and make sure the equipment you do install is the lightest available. Keep a few options open, such as the final permanent location of the battery and the strobe power unit.

As an example, in the prototype, we use the recommended 0-235 L2C Lycoming engine **without** starter, and even removed the heavy starter ring gear. Instead of the standard Lycoming alternator, we used a 6 lb., 35 amp alternator from a GLC Mazda. The battery is located on the center spar and the strobe power pack in the centerspar. Even though we filled the panel as shown on drawings A-1 and A-1L, we used the lightest instruments and avionics available. Our empty weight is just over 900 lbs. (lighter than some Long EZs), and our front seat range is 185 lbs. min. to 340 lbs. max. Since the two of us weigh 280 lbs., this range is ideal for dual flight. Since I weigh only 150 lbs., I add a little ballast in the nose (its more effective there than in the passenger seat) when I fly solo.

In deciding how to equip your airplane, take into account how much care you took while building, how heavy you and your passenger will be and what weight range you want in the front seat, and what you really need in the way of equipment, but most importantly, keep it light! In an airplane this small you should be carefully counting grams, not just pounds of excess weight. The best test to decide whether something should go in the airplane is as follows. Take the object in your hand. Toss it up into the air. If it comes down, its too heavy to belong in your airplane!

The basic wiring system, including alternator, is presented first. Following that are individual sections for the warning system, panel layout, lighting, antennas, speakers, space saver panel, ignition, and starter (if you insist in not following recommendations). Due to the wide variety of individual builder preferences, no attempt is made to diagram avionics installations or to list a bill of materials. Add up your own requirements from the specifications shown. Make sure you use approved aircraft wiring. Other types can generate noxious fumes if you ever have an overheated circuit. **Always follow individual manufacturers recommendations** when installing electrical equipment (strobes, regulators, etc.).

If you are not familiar with aircraft electrical systems, get some help from someone, or study references covering basic wiring practices/techniques. The "Mechanics Bible", EA-AC 43.13-1A2 Aircraft Inspection and Repair - Acceptable Methods and Practices covers much of this. Obtain from US Government Printing Office or Aviation Maintenance Foundation, Box 739, Basin, WY 82410.

1. BASIC SYSTEM WITH ALTERNATOR

The basic electrical system with alternator is shown in Fig. 1. If you use a generator, you will need a different wiring schematic and regulator. Since most builders will be using alternators, that is the schematic shown. The alternator needs the field circuit energized (12V) before/during operation. It won't operate without a battery (dead or disconnected). The presence of a battery on-line provides a buffer against voltage spikes or surges, and offers some protection to your avionics.

We show an overvoltage relay in the alternator field circuit. This relay is not required for normal operation but would protect your radios if the regulator failed closed and the alternator produced more voltage than the other systems could handle. Generally, the battery prevents this from happening, but the overvoltage relay is good insurance if you have a stack of expensive radios.

We show a combined master switch and circuit breaker rated at 35 amps, which happens to be the maximum output of our alternator. With everything on, it might be possible to exceed that current draw, but this has not yet occurred. Should it happen the master switch would automatically open. Closing it again automatically resets the breaker.

Remember throughout your wiring that each unit must be grounded. Leave enough room on the ground buss to accommodate the large number of ground wires that will be connected there.

The 12 volt DC buss is simply a heavy #10 wire feeding all of the circuit breakers. The engine instruments and warning system have no on/off switches, because they are intended to be on all of the time. The avionics on/off switches are integral to each chassis. Power to the Hobbs meter should be run through a relay operated either by engine oil pressure or suction pressure, so it records only engine time. All power should go through the master switch so all circuits will be dead when the master switch is off.

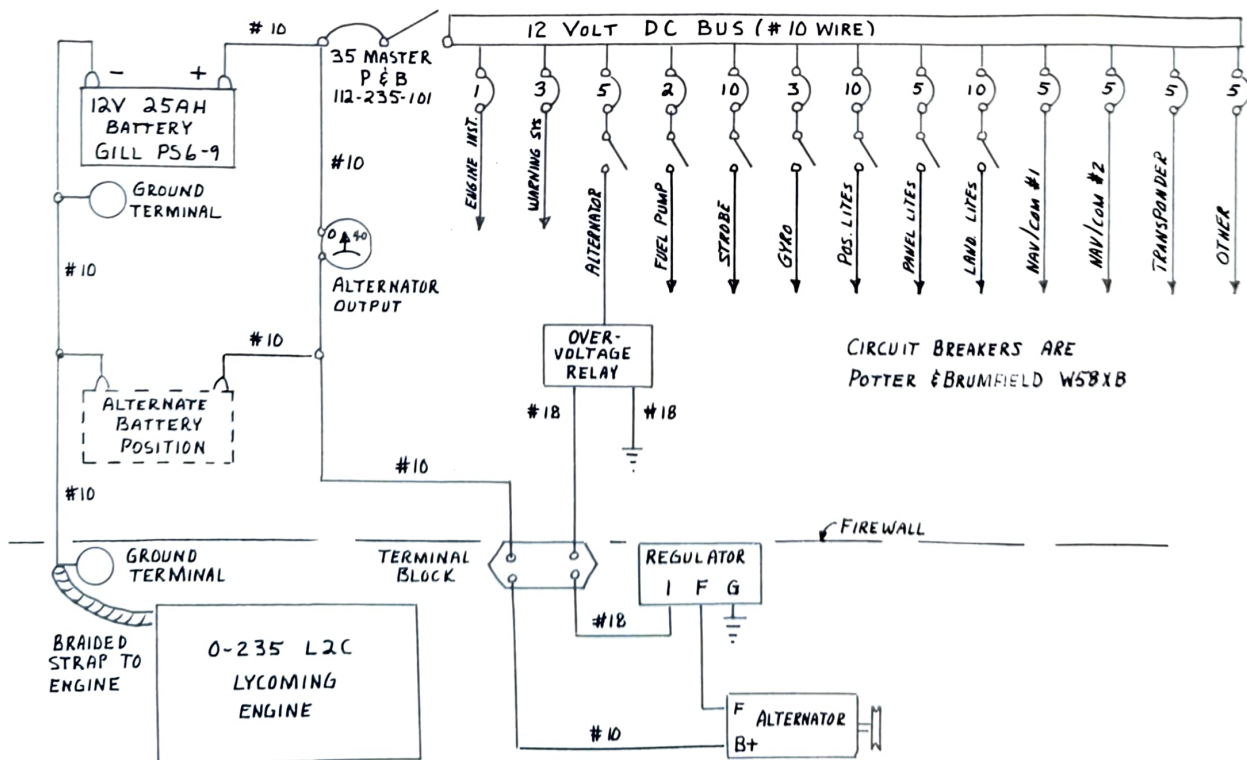


FIG.1 BASIC ELECTRICAL SYSTEM WITH ALTERNATOR

In the prototype, all circuit breakers and switches and Hobbs meter are mounted in a "space saver" panel on the right side of the fuselage. This simplified power distribution, and kept the panel free of switches and wiring. If you have an extensive electrical system, you may wish to combine a few similar systems, to keep the number of circuit breakers from getting out of hand. For example, warning system might be combined with engine instruments, nav lights with panel lights, and some avionics might be combined. By so doing, we reduced the number of circuit breakers to 14.

The prototype was wired so the battery could be installed either in the nose or on the center spar. It was kept in the nose during the first 40 hours of solo flight, and then moved permanently to the rear. This was a very convenient capability, and is recommended. For those who might be entertaining thoughts of using a starter, this would require running a very large and heavy start cable to both battery positions and back. Unfortunately, with a starter back by the prop, you would be more likely to need the battery in the nose, unless pilot and anticipated passenger are heavy.

Be sure to diagram the circuit you install in your airplane, and record it in your plans. Tag all wires at both ends of every harness or run, and record those numbers on your circuit diagram. The FAA requires all switches and circuit breakers to be labeled.

If you have a complex electrical system with a lot of avionics and antenna cables, you will have quite a large electrical bundle, which you will want to split and run half down each side. You can cross over, from one side to the other, on the forward face of the panel, using the reinforcing ribs as electrical channels, or, under the front seat, passing under or through the bottom of the heat duct. The wiring bundle should be routed along the fuselage side, under the stick and over the seat belt attach, through the front seat back, under the back seat arm rests, and into the duct to the firewall. The exact route is diagrammed in Chapter 23, Step. 3, Engine Installation. Make sure that there are no sharp edges contacting the electrical bundle. Run a few extra wires for future use, and after all the wires have been run, pot them in the holes with silicone rubber, and support them about every 8 inches with 1 inch BID hangers.

2. BATTERY INSTALLATION

The battery installation consists of a fiberglass tray, a fiberglass cover, and a metal strap over the cover and around the battery, holding it in place. You will need two trays, one for the front and one for the back, but a single cover should do. The cover and tray are constructed by first taping the battery with 4 thicknesses of duct tape as shown in Fig. 2.

For the tray, layup 4 plies BID on a piece of wax paper or plastic. While wet, set the battery on top, slit the corners, and wrap the glass up on the sides. Wrap duct tape over the glass on the sides to hold it in place for cure. After cure, work it loose from the battery and trim to a height of 0.6 in. on the sides. Make two.

For the cover, lay up 3 plies over the top and wrap duct tape around the sides to hold it in place for cure. After cure, notch at the terminals for the lead wires.

In the nose position, flocx tray to NG 30 and F 6 (Fig. 3). A long, stainless worm clamp wraps around cover, battery, tray and F 6 to hold everything in place. See Also A-6.

The second battery position is in the rear cockpit on top of the center spar (Fig. 4). Flocx the second tray to the centerspar and firewall. Then make a 2 in. wide strap from .062 2024T-3 Alum. and bolt it to the firewall with 2 AN3 bolts and wide area washers. The other end of the strap bolts to the center spar. Fashion a small block of fir (from a longeron scrap) to spread the compression load over a larger area, inside the centerspar.

You can now run a #10 ground wire from the negative terminal of the battery in the nose position, to the ground terminal at the instrument panel (Fig. 5) which should be located in the lower right corner of the panel bulkhead. From the rear position, run a #10 ground wire through the firewall to the ground terminal at the firewall (Fig. 6).

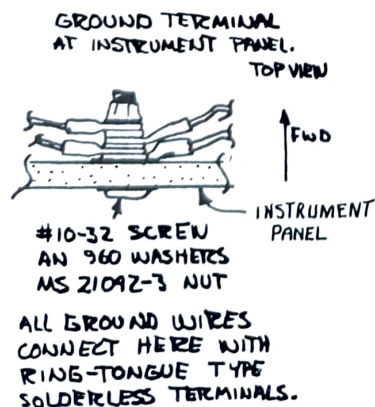


FIG. 5

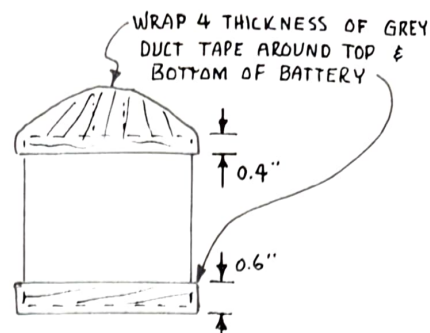


FIG. 2 PREPARATION TO MAKE TRAY & COVER

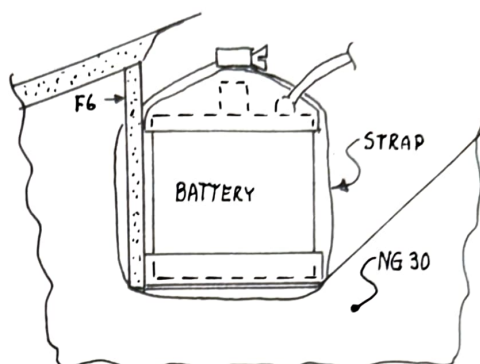


FIG. 3 INSTALLATION OF BATTERY IN NOSE

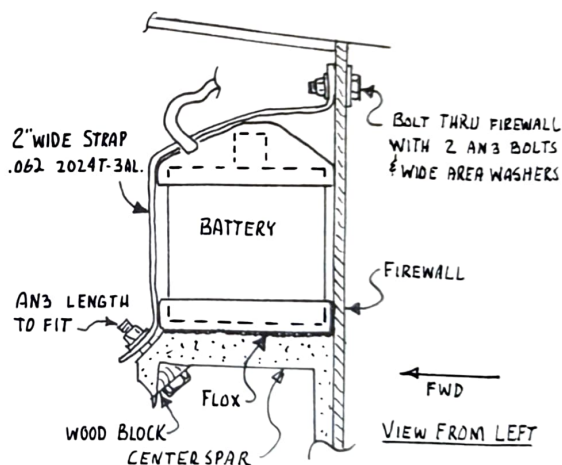


FIG. 4 INSTALLATION OF BATTERY ON CENTERSPAR

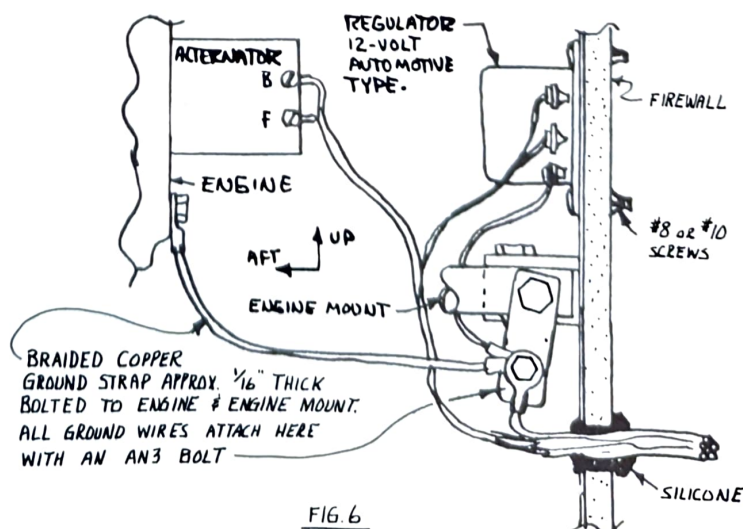


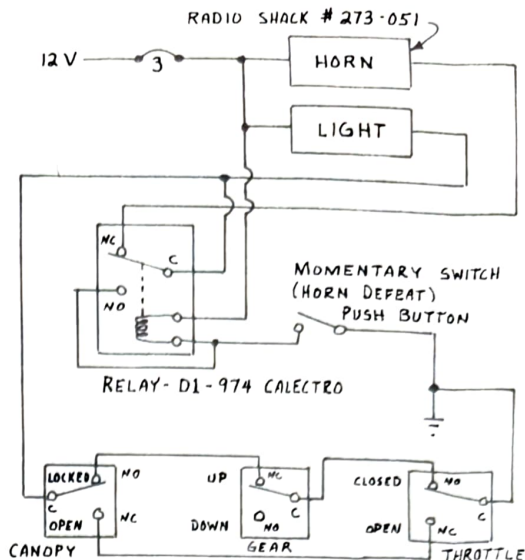
FIG. 6

3. PANEL LAYOUT

A few words are in order about panel layout. Refer to drawings A-1 and A-1L. The magnetic compass is located in the upper left corner, to be a maximum distance away from electrical and electro magnetic disturbances. It is surrounded by air operated instruments; i.e., airspeed, altimeter, and rate of climb. Farther to the right are vacuum operated directional gyro and gyro horizon. The vacuum line from the engine is run along the left side of the fuselage, and the filter is mounted on the aft face of F-28. The turn and bank is an electric gyro (for redundancy) and is mounted as close to center on the panel as possible. The Nav indicators, avionics and engine instruments, all electrically powered, are located on the right side, away from the compass, and close to the space saver panel to simplify and minimize wiring. Most of the electrical wiring is run along the right side of the fuselage to the firewall. Ignition switches are located at the top center of the panel, where they are not likely to be bumped, and can be seen from the rear of the aircraft when propping. Radios, Nav indicators, and engine instruments are lighted internally. A few post lights are used to light the compass and air operated instruments (Fig. 12). Except for these lights, there is no wiring on the left side of the panel. This arrangement has proven to be ideal. Everything on the panel is very visible and accessible from either seat. Much thought and study went into this layout and it is recommended that it not be changed.

4. GEAR AND CANOPY WARNING SYSTEM

The gear and canopy warning system is a required installation. It alerts the pilot with a horn and light if he advances the throttle for take off without locking the canopy, or if he closes the throttle on approach to landing without having first lowered the nose gear. There is a horn defeat switch which will silence the horn (but not shut off the light) while taxiing with the canopy open, or slowing down in preparation for lowering the gear. The defeat resets when the throttle is cycled. The wiring diagram is shown in Fig. 7. The mounting of the micro switches for the canopy lock, nose gear, and throttle are shown in Figures 8, 9, and 10, respectively. The horn is mounted forward of the panel bulkhead, below the thigh support on the right side. The light and horn defeat push button are mounted on top of the instrument panel.



MICRO SWITCHES ARE RADIO SHACK #275-1102
OR MICRO TYPE V3-1801JY7 OR MICRO TYPE SMJS-2

FIG. 7 GEAR & CANOPY WARNING CIRCUIT

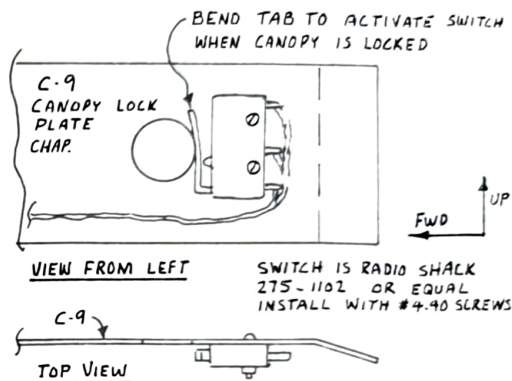


FIG. 8 MICROSWITCH ON CANOPY LOCK

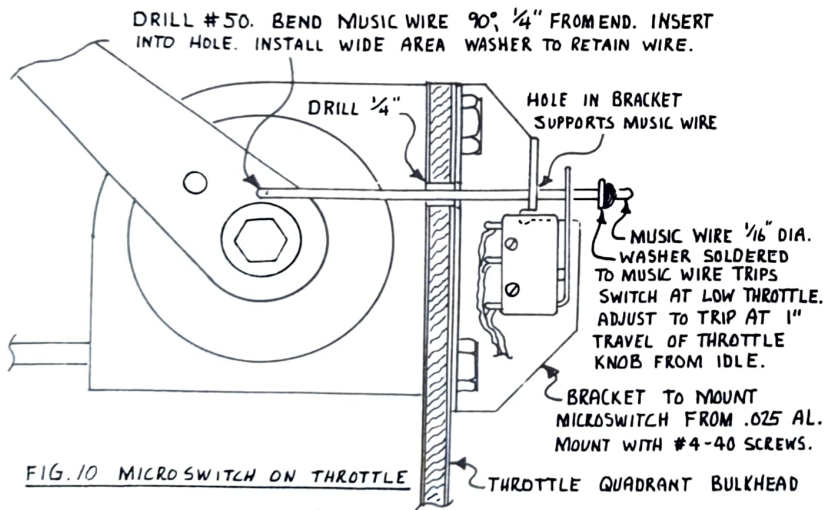


FIG. 10 MICROSWITCH ON THROTTLE

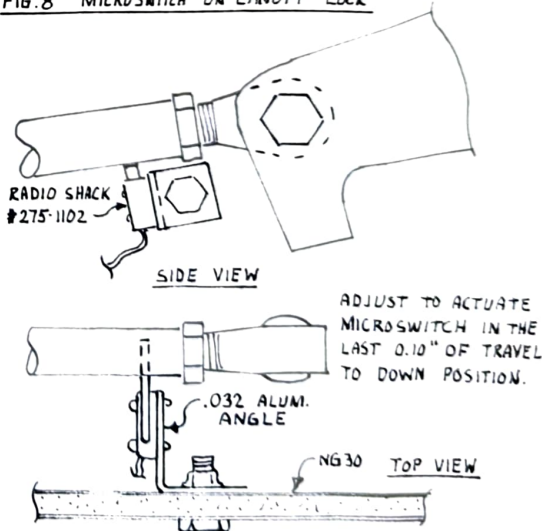


FIG. 9 NOSEGEAR MICROSWITCH INSTALLATION

5. STROBE LIGHTS

The Cozy is relatively small and is sometimes difficult for others to see especially in areas of low visibility. Therefore a strobe light system is advised, even for daylight flying. This can be a single strobe under the nose (Fig. 11), or the Whelen System shown in Fig. 12, which provides wingtip strobes and all the red/green/white position light requirements. It meets the FAA requirements for operations at night. If you select another system be sure it meets the FAA requirements. When ordering the strobe power supply, be sure to state Model A413A-HDA-14 "single flash". This model is specially designed for a 30% reduction in current drain. If it has a "DF" after the HDA it is the higher current model. Mount the power supply in the center spar as shown in Fig. 13. The A600 KPG/R-14 lights must go where shown in Fig. 14. Do not mount lights in the structural winglet attach area or up on the winglet.

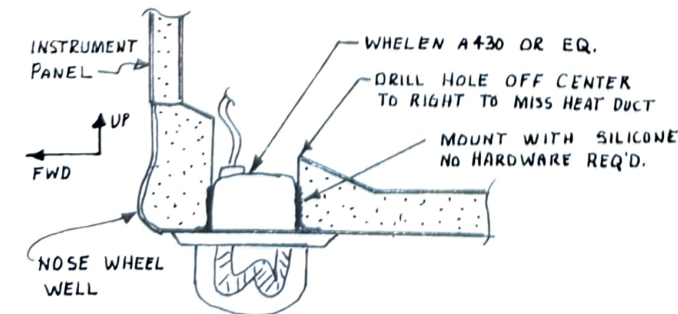


FIG. 11 SINGLE STROBE FOR DAY VFR ONLY

6. LANDING LIGHT

The landing and taxi light on our prototype N22CZ is mounted under the left thigh support as shown on Drawing A-8. It extends when needed to a taxi or landing position. The simpler, lighter, and easier to install design shown on pages 17-9 and 17-10 is recommended. See Fig. 12 for wiring diagram.

7. ANTENNAS

The advantage of a plastic airplane is that all antennas can be built into the structure, or attached to the surface, and need not extend into the airstream. In our prototype Cozy, we have 8 antennas located as follows:

- Com #1 - right winglet
- Com #2 - left winglet
- Nav #1 - under canard
- Nav #2 - under fuselage
- Glide slope - uses Nav #2
- Marker beacon - right wing
- DME - right wing root
- Transponder - left wing root
- ADF - under right thigh support

All of these antennas except the ADF are "home made" from Jim Weir of Radio Systems Technology, 10985 Grass Valley Ave., Grass Valley, CA 95945. They are inexpensive, simple to install, and work well.

The ADF combined loop-sense antenna is from King Radio, and is designed to eliminate the long "clothes line" you see on most airplanes. It is about 8 x 5 x 3 in. and fits under the thigh support. It requires an 18 in. dia. ground plane, which we made from copper foil and epoxied to the surrounding structure.

Loran is a more recent development and a more complicated installation. We have no experience with Loran, but can refer you to an article by Jim Weir in March 1984 Sport Aviation. Apparently it requires an extensive ground plane which must be built into the entire aircraft structure.

The practice which must be followed in locating antennas is that they must not be close to one another. It is particularly important to keep transmitting antennas (DME, transponder, etc.) at least 8 ft. away from receiving antennas. They must also be oriented correctly with respect to the radiation field. The installation in our prototype meets these requirements.

The Com antenna installation is described in Chapter 20. Some modification will be necessary if we approve the new, larger Long EZ rudders.

The Nav antenna locations are shown in Figures 15 and 16. The DME/transponder antennas were located inside of the trailing edge wing rib on the right wing, to be farther away from the marker beacon antenna, and the leading edge wing rib on the left wing, where location was not critical. We merely milled slots through the wing rib into the foam with a 1/4 in. drill, covered the antennas with micro and slid them in place, and patched the wing ribs with a 2-ply BID tape (Fig. 17).

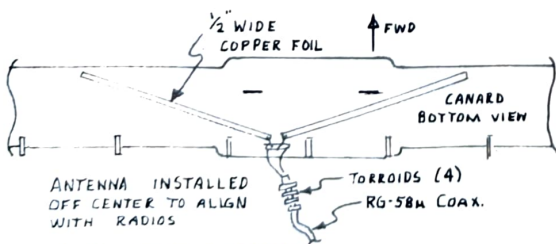


FIG. 15 NAV ANTENNA - CANARD

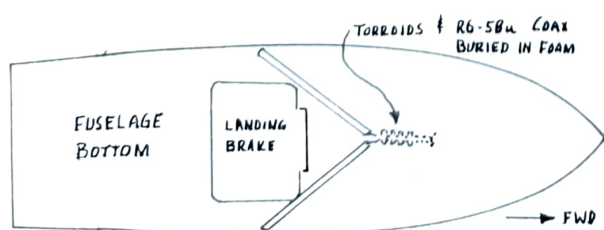


FIG. 16 NAV ANTENNA - FUSELAGE

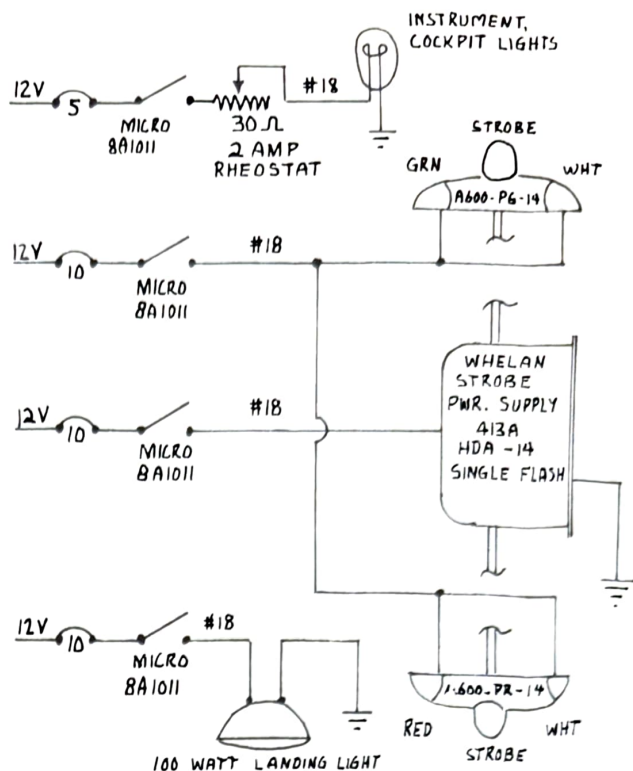


FIG. 12 LIGHTING

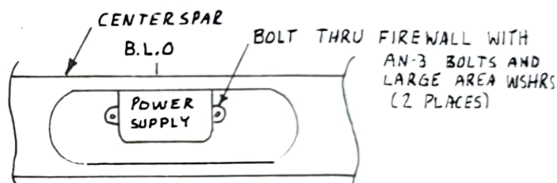


FIG. 13 MOUNTING OF STROBE POWER SUPPLY IN CENTERSPAR

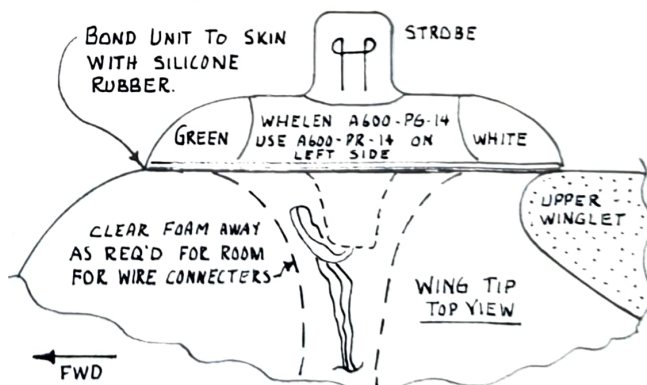


FIG. 14 MOUNTING NIGHT LIGHTING

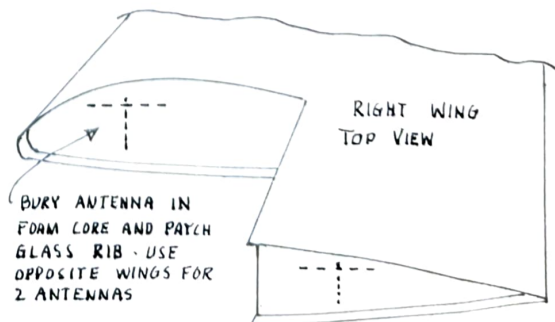


FIG. 17 DME/TRANSPONDER ANTENNAS IN WINGS

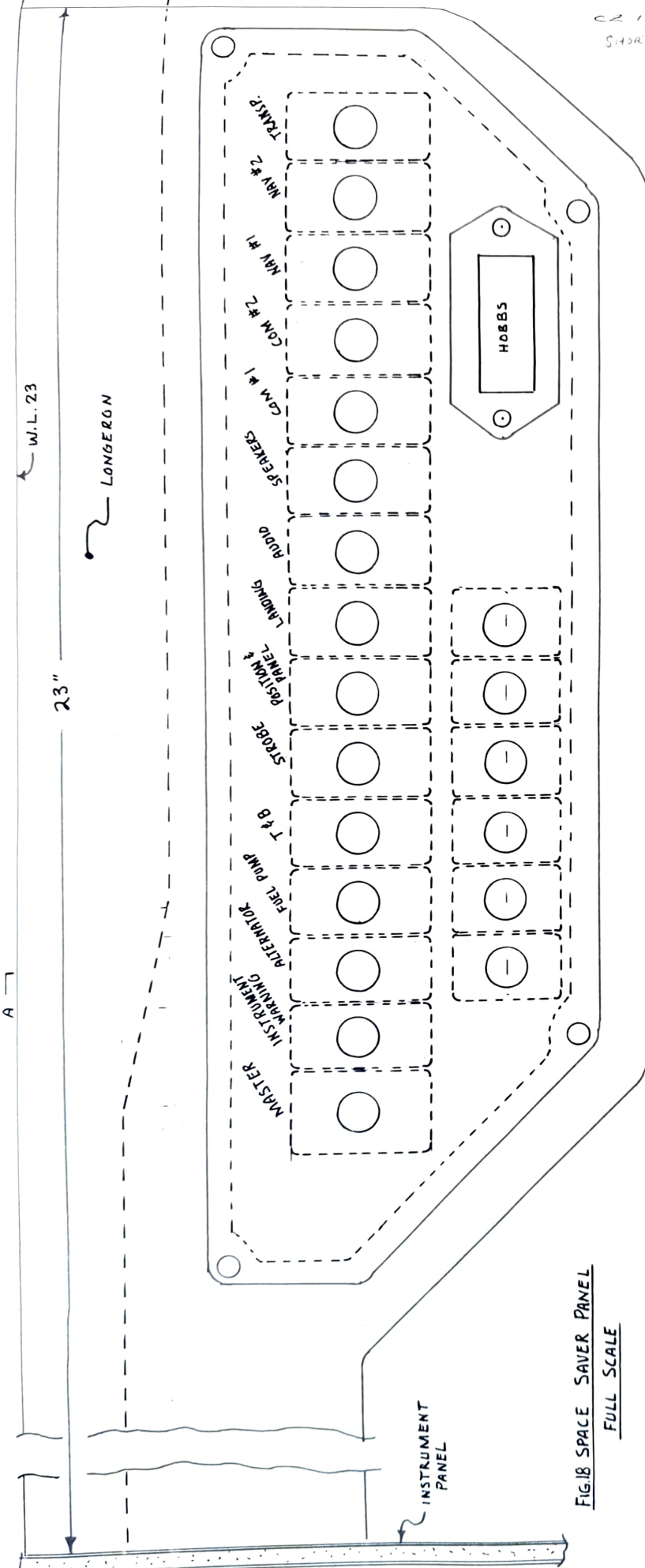


FIG. 18 SPACE SAVER PANEL
 FULL SCALE

8. SPEAKERS, MIKE BUTTONS, AND INTERCOM

Speakers are not necessary (everyone wears headsets) but since our radios were wired for them, we installed them anyway. We used lightweight automotive type and installed them in the forward face of the shoulder support-head rest, in the gap between the back seat cushion and the head rest cushion. Push to transmit switches were installed on each stick grip (ski pole grips). Intercoms are not necessary, but we installed a voice powered RST intercom on the left side of the right headrest. This was the best location we could find for plugging in head sets.

9. SPACE SAVER PANEL

Space saver panels for the Long EZ are available from Rusty Foster, P.O. Box 4273, Ventura, CA 93004, but they probably don't fit the Cozy. Don't despair, however, because they are very easy to make. A full size drawing of the one we made for our prototype is shown in Fig. 18, with a cross section view in Fig. 19. This panel has a little unused space, and should be ample for almost everyone. To build this, proceed as follows: Tape the right side of the cockpit with duct tape, and build a box in place on the taped area from 1/4 in. low density Clark foam and 5 min. epoxy, (or a solid block of urethane foam) taking dimensions from Fig. 18 and 19. Now, round all the corners, and glass overall with 3 plies BID. After cure, pry the layup and foam loose from the duct tape, remove the foam, trim, and neatly cut out the front cover. Using techniques you have already learned, build a flange behind the cover, reinforce the corners for the installation of nutplates, and 4 screws. Mount all the circuit breakers and switches through the cover as shown. Cut a hole in the upper right hand corner of the space saver, the same size as the forward end of the space saver, for the wiring bundle. When everything fits and you are ready to install the panel permanently, epoxy it in place with flox. Clecos can be used to hold the flange tight against the fuselage side, all around. When wiring, allow enough slack in the wiring bundle so the cover can be removed and folded back to work on it. It is permissible to remove foam locally from the fuselage side to eliminate any interferences, provided you patch the carved out area with 2 layers BID, overlapping onto the original layup.

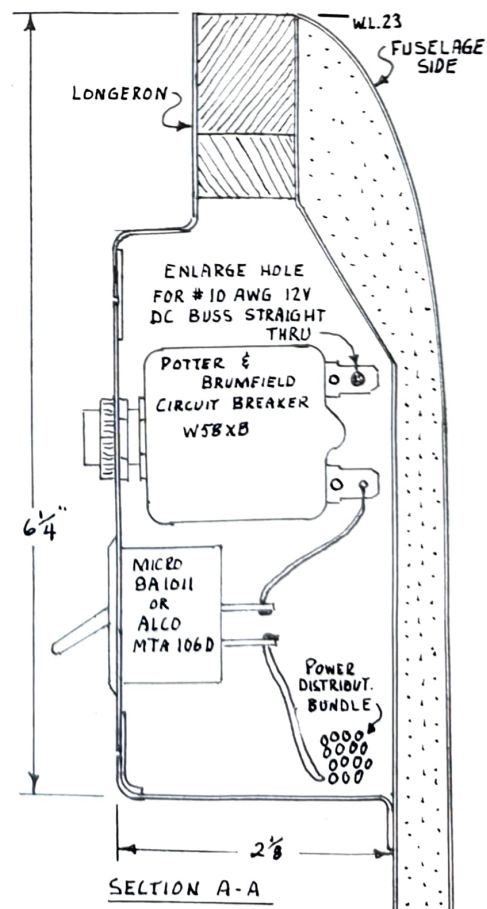


FIG. 19 SPACE SAVER CROSS SECTION

10. IGNITION SWITCHES

Ignition switches simply short the magneto P-leads to ground. If you are using a magneto powered tachometer, you cannot connect both P-leads to one tach at the same time, because this would be cross connecting 2 mags, which may not be timed to fire at identical times. The problem can be solved by using a double pole double throw switch on one of the mags and wiring in such a way that when that mag is grounded, the other signal is sent thru the tach (Fig. 20). Use a fuse-to-ground on the tach, so a short in the tach will not shut off one mag. Also use shielded wire on the P-leads from the mags to the tach. When wiring toggle switches, remember that the toggle points in the opposite direction to the contacting blade inside the switch. If you use the Carr tachometer shown in Fig. 21, with a separate pulse generator, the special wiring is not necessary. More on ignitions in Chapter 23.

11. ENGINE INSTRUMENTS

Many different engine instruments are available, and individual builder preferences will vary. A good, workable selection is shown in Fig. 21. In our prototype, we used combination gages for oil temp./press and CHT/EGT to save panel space. We used CHT sensors on all cylinders, and a 4-position selector switch to a single gage. This allows checking CHT of every cylinder. Make sure you use the correct sensor for each gage. You might wish to add fuel pressure. Electric senders are preferred over running oil and gas lines to panel. More on engine instruments in Chapter 23.

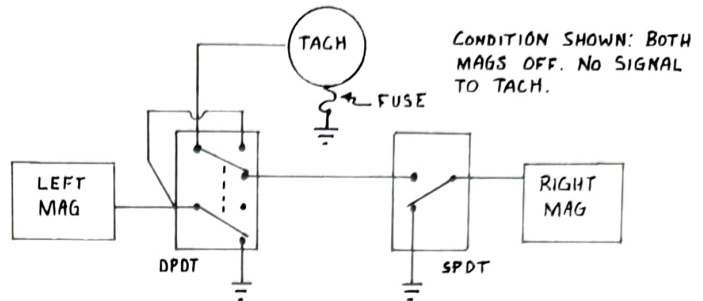


FIG.20 WIRING FOR MAGNETO POWERED TACH.

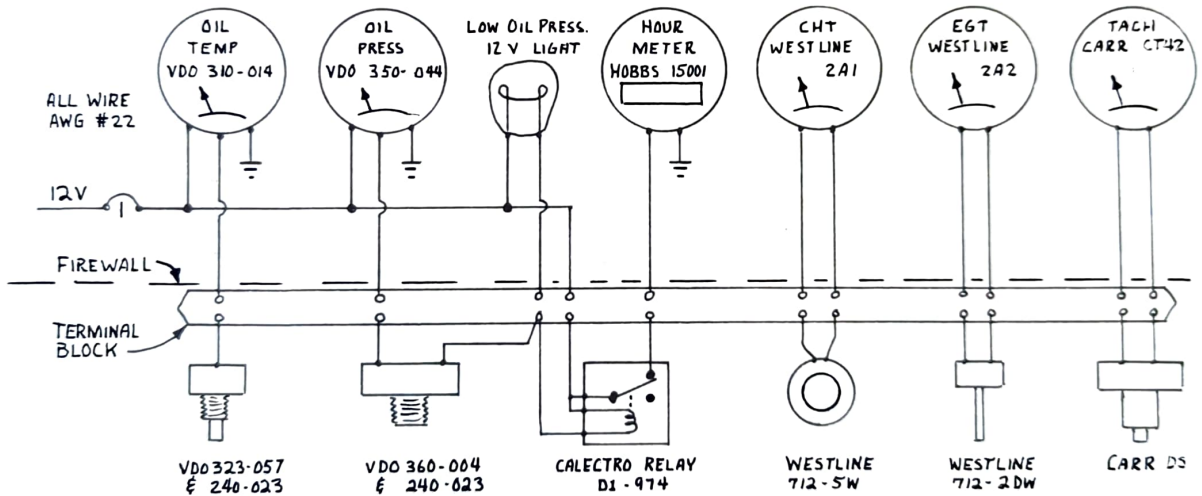


FIG.21 ENGINE INSTRUMENTATION

12. STARTERS

Starters are not recommended because of the weight penalty and the fact that it moves the c.g. aft. The engines are easily hand-propped, particularly since you have a pusher with nose-down parking. In this configuration most aspects of manual start are considerably safer than for conventional aircraft - see Owners Manual. A plastic airplane does not conduct. Therefore, if you use a starter, a large heavy start cable must run to the battery **and back** (Fig. 22). Electric start adds over 25 lbs. weight, most of it aft on the engine. You will initially want to fly your first flights at forward c.g. and at as light a weight as possible (see Owners Manual). Therefore, even if you insist on needing electric start, **leave the starter and heavy cable out for your initial test flying**. This will avoid possible nose ballast (thus a double weight penalty). If you install a starter, you will have to be careful that it is not inadvertently activated. Use a guard on the switch and **always** disconnect the starter lead before performing **any** maintenance on the aircraft.

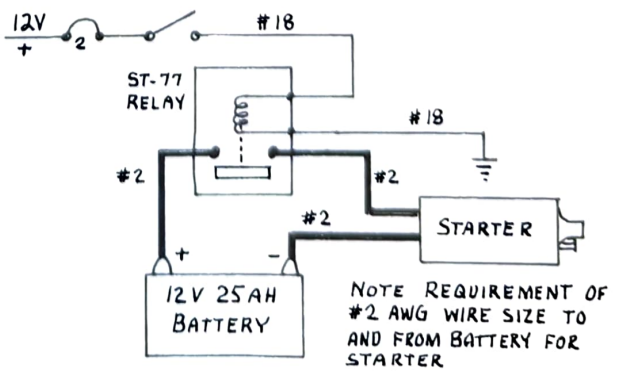


FIG.22 STARTER WIRING DIAGRAM

CHAPTER 23 ENGINE INSTALLATION

CZ 15-4

PREFACE

We have been asked repeatedly whether we approve larger engine installations in the COZY. The answer continues to be **No!** We are not just being stubborn. There are a number of good reasons we can't approve.

1) Ethics dictate that a designer cannot sell a design or recommend changes that he has not proven. This protects the homebuilder against unscrupulous practices.

2) We are licensed by RAF to use the Long EZ design, which has been well tested and thoroughly proven. The largest engine approved for the Long EZ is the 0-235 Lycoming. As licensee, we must follow the same practice.

3) Proving a larger (and heavier) engine installation would involve a number of considerations, such as, structural, c.g., gross weight, engine cooling, and flight performance. It would also increase the likelihood of builders flying over gross at higher speeds, which would compromise safety. The side-by-side design already has more builder controlled variables than the Long EZ, such as front seat loading, weight of instruments and avionics, battery location, etc., and to introduce additional variables such as larger engines and starters, even if all other questions were answered, would make it exceedingly difficult to predict, much less control final c.g. to the desired position.

In summary, these plans provide instructions on how to build a side-by-side modification of the Long EZ without sacrificing much, if any, of the Long EZ's exceptional performance, while offering advantages of dual control, large panel, and 3rd seat capability. If you, as a builder, do not follow these instructions, recognize that you are building your own design and must accept the responsibility for proving it with whatever risk is attendant thereto.

INTRODUCTION

The only recommended engine is the Lycoming 0-235. Any dash number version of this engine is acceptable. These engines, with alternator, are within COZY weight requirements. They have a history of proven reliability and provide more than adequate performance for the COZY. They are currently in new production or can be purchased used or overhauled at a considerable cost savings. Stripped down versions of higher horsepower engines, even if meeting the weight requirement, are not recommended because the aircraft would be operating in an area outside the design/aerodynamic envelope intended (quoted from RAF).

Any model 0-235 Lycoming is approved and may be installed in a COZY. The installation methods and configurations shown in this section have been carefully developed to provide the builder with a simple and reliable engine installation.

Builder initiated modifications are **not** recommended. An individual who does initiate his or her own installation or systems modifications must consider himself or herself to be in the developmental engineering business and must be prepared to accept the significant risks and to take the appropriate precautions that go with such a program.

Co. Z Development does not encourage the use of any engine or installation component which would not be considered fit for service in a certificated aircraft. Specifically, engine service standards as defined by Avco Lycoming's service manuals and bulletins, should be complied with. Any Lycoming 0-235 that is not fit for service in a Piper Colt, Tomahawk or Grumman TR2, probably is equally unfit for service in your COZY. This philosophy applies to the use of non approved accessories such as carburetors, turbo chargers, etc.

Each builder should complete the education he has begun in building his or her own aircraft by becoming knowledgeable about the engine he or she buys, flies, and maintains. You can save yourself some big bucks, not to mention grief, by learning all you can about your engine, before you buy it. Very complete and informative maintenance and overhaul manuals are available at low cost from many aviation supply houses. Buy a copy of the manual covering your choice of engine and study it closely. **You depend on your engine.**

Note: The scope of these installation drawings does not include educating a home builder in all the disciplines learned by an A & P mechanic to allow him to work on aircraft engine installations. Thus, if you are not an A & P mechanic, you should consider having an A & P install your engine and accessories or at least have an A & P inspect and approve your work.

THE ENGINE

As you become more knowledgeable about the Lycoming 0-235 engine, you will soon discover that there are some model variations. The commonality of all models and dash numbers, etc., that makes it possible to cover their installation in one manual is this: all 0-235s are dimensionally similar; the cooling characteristics are similar; the cowling fits them all; the exhaust system fits them all; the details of wiring and accessories are nearly identical. The only area of major differ-

ence is the mount. All of the older 0-235 engines are machined to use a conical mount. A few dash numbers, particularly the newer engines are machined to use a dynafocal mount. We have tested the latter, but this manual covers the installation of both. The minor dimensional differences between the various models require no major modification of the system which has been thoroughly proven by service testing.

WHICH MODEL ENGINE?

The Lycoming 0-235 comes in approximately 25 dash numbers, each dash number signifying a difference, most times a minor difference, but in some cases a major one. We do not intend to try to "sell" you on a particular model of the 0-235, rather we will try to describe generally what they are, what they weigh, etc.

0-235	H.P. @ RPM	Mount	Basic Dry Wt.	Fuel Octane	Weight with Alternator	Weight with Alternator & Starter
-C1	115 @ 2800 rpm	Conical	209	80	229	246
-C1C	115 @ 2800 rpm	Conical	206	80	226	245
-C2C	115 @ 2800 rpm	Conical	207	80	227	244
-H2C	115 @ 2800 rpm	Dynafocal	207	80	227	244
-F1	125 @ 2800 rpm	Conical	215	100/130	235	252
-F2B	125 @ 2800 rpm	Conical	214	100/130	234	251
-J2B	125 @ 2800 rpm	Dynafocal	214	100/130	234	251
-K2B	118 @ 2800 rpm	Conical	214	100/130	234	251
-L2C	118 @ 2800 rpm	Dynafocal	212	100/130	232	249

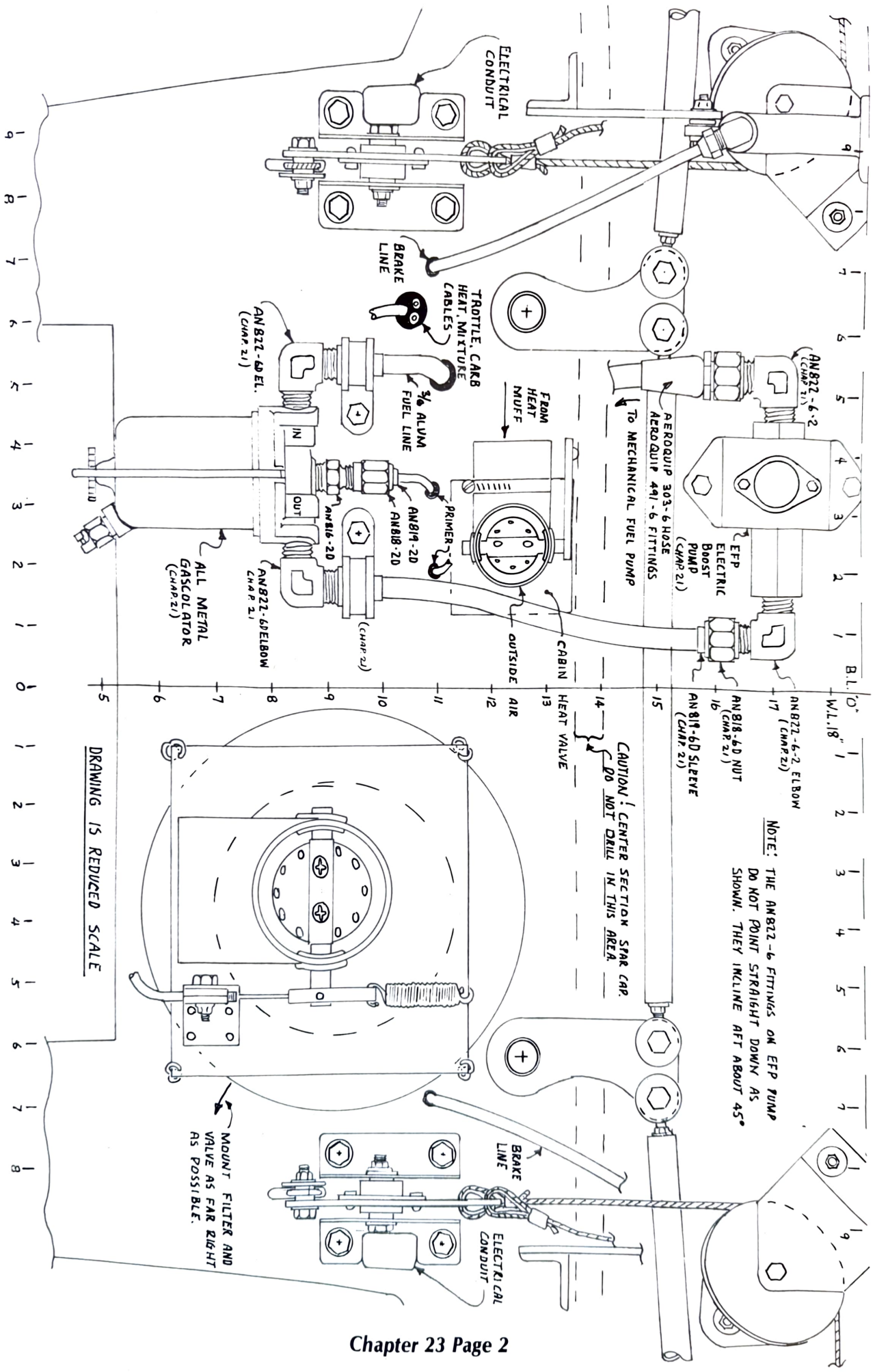
All 0-235 engines are based on the original 0-235-C1, an engine of 235 cubic inches capacity, developing 115 hp. at 2800 rpm. There are 11 different dash numbers that are 115 hp. and all of them are made to use 80 octane fuel only. Converting these engines to use 100LL or 100/130 fuel, while possible, probably is not cost effective. The pistons must be replaced with high compression pistons, the exhaust valves and seats have to be replaced (**very expensive**) and the cylinder walls have to be nitrided. If 80 octane fuel is not readily available in your area you may want to consider one of 14 other dash numbers that are built specifically to use 100LL or 100/130 fuel. Of these engines, 4 dash numbers are 118 hp at 2800 rpm and 10 are 125 hp at 2800 rpm.

Unfortunately, not all of these engines are readily available. Some were built for export only, some were built in very small quantities and a few are no longer in production. Below is a breakdown of the more commonly available Lycoming 0-235 engines, showing the dash number, horsepower, rpm, type of mount, basic dry weight, weight with alternator only, and weight with starter and alternator.

The -C2C, -H2C, and -L2C come equipped with Slick magnetos, which are very compact. We think the Cozy engine mount will also accommodate Bendix mags, but we haven't demonstrated this. Of course, Slick mags can be installed on any of the Lycoming 0-235s, but this would be an additional expense.

The next item to consider is the type of mount. Conical mounts are common among older engines, and these, generally, are not quite as soft and free of vibration as the dynafocal mount. As you can see by the half scale drawings on pages 23-6 and 23-7 of this manual, the dynafocal mount is much more complex and a little heavier than the conical mount. Access to the engine accessories is also more difficult with the dynafocal mount. The type of mount is not optional or alterable from engine to engine. It is the way the crankcase has been machined.

Next consideration is the type of oil filter. The engine installation on the Cozy has been designed to accommodate a "spin on" oil filter. Some 0-235s come equipped with "spin on" oil filters. Others have larger filters with replaceable elements, but can be converted to "spin on" by simply purchasing an adaptor nipple. The standard oil screen installation is commonly found on many 0-235s and is adequate. The most important item to consider is the mechanical fuel pump. The Cozy fuel system (same as the Long EZ) is designed to **require** the use of an engine driven fuel pump, backed up by an inline electric booster pump. This is a **mandatory** requirement, and there is no acceptable way around it. Most 0-235 engines come at least machined to accept a mechanical pump, however there are exceptions. Generally, if the engine came out of a high wing aircraft (Cessna, Piper Colt, etc.) it probably will not have a mechanical pump installed, and may not even have provision for one. If it came out of a low wing (Piper Tomahawk, Grumman TR2, etc.) it will have a fuel pump. If you come across a good deal on an engine, for example, a Lycoming 0-235 L2C out of a Cessna 152, this engine will not have provision for a mechanical fuel pump but may still be a good choice, as it is not very difficult to buy an accessory case which has been machined for the fuel pump, plunger and a timing gear with the necessary cam on it, and with minimum of engine teardown, you can have a good engine with the mechanical fuel pump. Accessory cases from Lycoming 0-320s are virtually identical to the 0-235, and can be bolted on. In most cases the 0-320 case will have been machined to accept a mechanical fuel pump.



NOTE: THE AN822-6 FITTINGS ON EFP PUMP
 DO NOT POINT STRAIGHT DOWN AS
 SHOWN. THEY INCLINE AFT ABOUT 45°

One more consideration is provision on the engine to install an oil cooler. An air-cooled engine depends upon the oil to remove approximately 40% of the heat of combustion, and some provision is necessary to cool the oil. We tried to baffle air flow around the case on our 0-235 L2C to obviate the need for a separate oil cooler, but it wasn't adequate. You will most certainly need a cooler. A few of the older, lower power Lycomings did not have provision for coolers. Make sure the engine you buy does.

Almost all Lycoming 0-235 engines come equipped with a Marvel Schebler MA-3A carburetor. This carb does **not** have a built in accelerator pump. This means that the engine would be difficult (or impossible) to start in cold weather. There are two ways around this: 1) You can buy a MA3-SPA carb and install it. This carb has an accelerator pump and will make the engine easy to start in any weather. The only disadvantage is that this solution is expensive. 2) You can install a primer. This works as well or better and is much cheaper, but requires plumbing 1/8 in. copper lines into the cockpit and mounting the primer pump on the instrument panel. It is possible to mount a primer inside of the engine compartment where it can be reached through the scoop, but most people would find this very inconvenient.

STEP 1. INSTALLING THE CABIN HEAT VALVE

This may seem like an inauspicious way to start an engine installation, but if you have ever dealt with building trades, you will realize that it is important to get the ductwork installed before the electricians and pipefitters clutter up all of the open spaces. This is also true with airplanes. There is a heat duct, control cables and a fuel line which must be run from the center console around the back seat, through the seat back **over** the landing gear to the firewall. Over the gear is important. If you ever remove your main gear, either intentionally or unintentionally, you will not want your fuel line and control cables severed in the process. Study the firewall drawing on page 23-2. Disregard any minor disagreements with other drawings. Although this drawing is not full scale, the Base Lines and Water Lines are numbered so you should be able to scale them quite accurately. Note that all of the items spelled out above pass through the **left** side of the firewall. Ignore the note on drawing A-11 which says to put the heat duct through the right side of the seat back.

Hold your engine mount in position and verify that the cabin heat valve and the duct attached thereto will miss the lower cross member of the dynafocal mount. If an interference appears likely, the valve could be raised a little or inclined slightly.

The heat valve assembly and individual parts are shown on page 23-4. It is available prefab from Brock Mfg. This valve provides for either all hot air, or a mixture of hot and cold air, or off. This is not really necessary. If you choose, you can simplify it by eliminating the branch (side) connection and just supply it with hot air. You can also fabricate this valve from fiberglass, first carving a 1-1/2 in. tee (undersize), then glassing with 3 plies BID, and then installing the butterfly. When you have fabricated the valve and checked out clearance with the mount, install it through the firewall. You might as well drill the other indicated holes through the firewall for the heat control cable, the carburetor control cables, the fuel line and the primer lines (if you need a primer). Don't crowd these lines so you can't make a 90 deg. bend into the gascolator, and above all, **don't drill into the centerspar spar cap!**

Now we have to consider how to get all of these lines from the center console to the firewall, in the neatest way possible, avoiding sharp bends (in the control cables) using the least amount of back seat space, and doing the least amount of structural damage. The strategy will be to run the air duct first, along the floor, negotiating all the turns as gradually as possible. Next the heat valve control along with the duct. Then the carburetor controls with the most gradual bends possible, and lastly the fuel line, on top, with insulation between it and the hot air duct to avoid heating the fuel. The final step will be to enclose all of these where they are exposed, in a housing to make it all neat. Start out by making a transition piece (Fig. 1) to go from the rectangular duct in the center keel to 1-1/2 in. I.D. CAT duct. Carve undersize from urethane foam and glass with 3 plies BID (3 times around with one layer). After cure, clean out foam, verify fit, and floc transition piece in place in duct under front seat back brace.

Next make the back seat bulkhead (see A-11) per full scale pattern on drawing A-24. Glass both sides with 2 plies BID, and floc in place at F.S. 95.75. Tape both sides with 1 ply BID (1 in. wide) tape. While bulkhead layup is curing, cut oval shaped hole 1-1/2 in. high and 2 in. wide in lower left hand corner of back seat back, along floor, and centered 3-1/2 in. inboard of lower edge of lower longeron (Fig. 2). Everything can be run through this hole except the fuel line, which you can run a little higher (to avoid low pockets) thru the existing access hole for the landing gear bolt. Because we have done some structural damage cutting through the seat back, put a 2-ply BID patch on both sides of the seat back, extending 1 in. beyond the cutout (Fig. 3). Deburr all of the holes, and run the 1-1/2 in duct from the transition fitting to the air valve. Clamp both ends. Also hook up the hot air valve control, as shown on 23-4.

STEP 2. THROTTLE QUADRANT

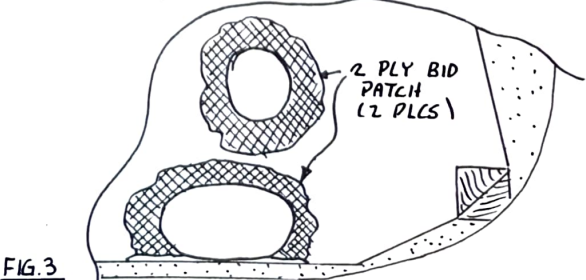
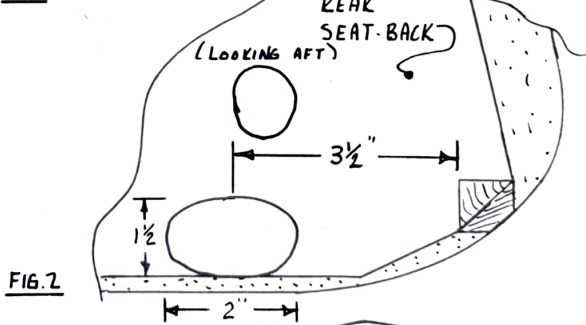
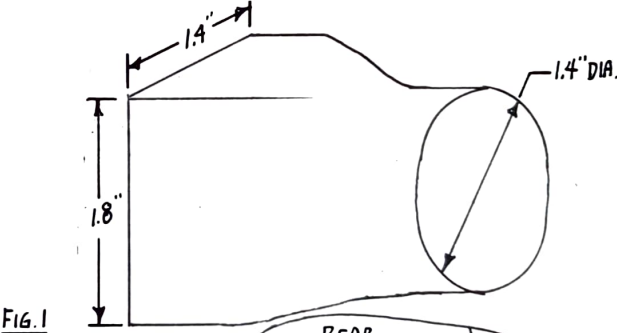
In Chapter 17 you installed the throttle quadrant, and the landing light, and in Chapter 22, the throttle limit switch. You can now run your throttle, mixture, and carb heat controls back thru the firewall. Make sure there are no burrs, to chafe the cables, particularly where they pass thru the firewall. Make all turns as gradual as possible. Organize the 3 cables to lay flat on the bottom of the center console and use strips of duct tape to hold them temporarily in position. Use small blobs of dry micro to bond them in position in the bottom of the center console. They can be attached to the 1-1/2 in. duct with nylon tie raps. They should pass **over** the landing gear without touching it. Sliding them through some heavy wall tygon tubing will help to protect them from rubbing against the gear. Pot the cables generously with RTV silicone where they penetrate the firewall for chafe protection, and to seal the firewall. Your cables will still be too long. Coil them up and tape them to the firewall so they don't get damaged. Don't bend them too sharply.

The elements of the throttle quadrant are identified on page 17-10. In the forward, vertical position, the carb heat is off, the throttle is full, and the mixture is rich.

STEP 3. ENGINE INSTRUMENTS

In this step you will mount your engine instruments in the panel and route the associated wires (and/or tubing) to the firewall. Engine instruments were discussed in Chapter 22, and an electrical schematic shown in Chapter 22, Fig.21. A more complete selection of instruments is shown below:

RECOMMENDED INSTRUMENTATION			
	Rochester	VDO	Westach
CHT			
- Gauge	3070-61	310-909	2A1
- Sender	3080-14	323-701	712-5W
EGT			
- Gauge	-----	-----	2A2
- Sender	-----	-----	712-2DW
OIL TEMP			
- Gauge	3070-62	1310-0142A9-2	
- Sender	3080-37	323-057	399-57
OIL PRESS			
- Gauge	3050-54	350-044	2A8-1
- Sender	3060-18	360-004	387-11S
FUEL PRESS			
- Gauge	3050-58	-----	-----
- Sender	93060-17	-----	-----
TACH			
- Gauge	Carr CT42	-----	2AT3-2, 381, AGC-1/409
- Sender	Carr DS	-----	-----



A few comments on the above are in order. Westach has the most complete line, including combination oil temp/oil press and CHT/EGT, which we used; they work fine, and save panel space. Westach fuel pressure gauge has too high a range, however for the fuel pumps we are using.

Purchase your engine instruments internally lighted, and make sure you match the right sender to each gauge. We recommend against using direct reading oil and fuel pressure gauges, which would require at least 10 ft. lines to the gauge and back.

A mechanically driven tach is not practical. The Carr tach operates from a small signal generator which screws directly to the tach cable mount on the accessory case of your engine, and is independent of the magnetos. The Westach tach is magneto driven. If you use it, make sure you use the recommended fuse to ground so a short in the tach cannot short out a mag. Also, if you use the Westach, you should wire your ignition switches in accordance with Chapter 22, Fig.20.

If you have a starter, a standard key-type on-left-right-start switch works well, but then you will need a Carr type tach. If you use toggle ignition switches, mount them where they are least likely to be bumped; the top center of the panel is a good choice.

With all of your instruments mounted, prepare to run all the leads along the side of the fuselage to the firewall, using whichever side is appropriate. The routing is shown on Fig.4. They will run through the hole provided in the lower corner of the panel bulkhead, stay at that level until they clear the bottom of the stick, then rise to W.L.6 to clear the seat belt attach fitting and pass through the front seat back, and then rise to W.L.9 to be hidden under the torque tube cover and pick up the electrical conduit leading to the firewall. In Chapter 24 you will install map pockets on each fuselage side in the arm-rest. The electrical bundle passes just below. You may wish to install those pockets now so the bundle can be supported from the pocket. Before you start running wires, make sure all holes have been deburred.

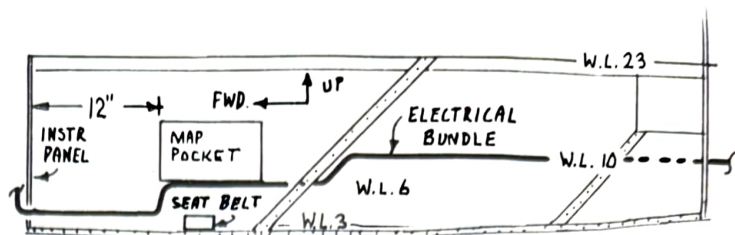
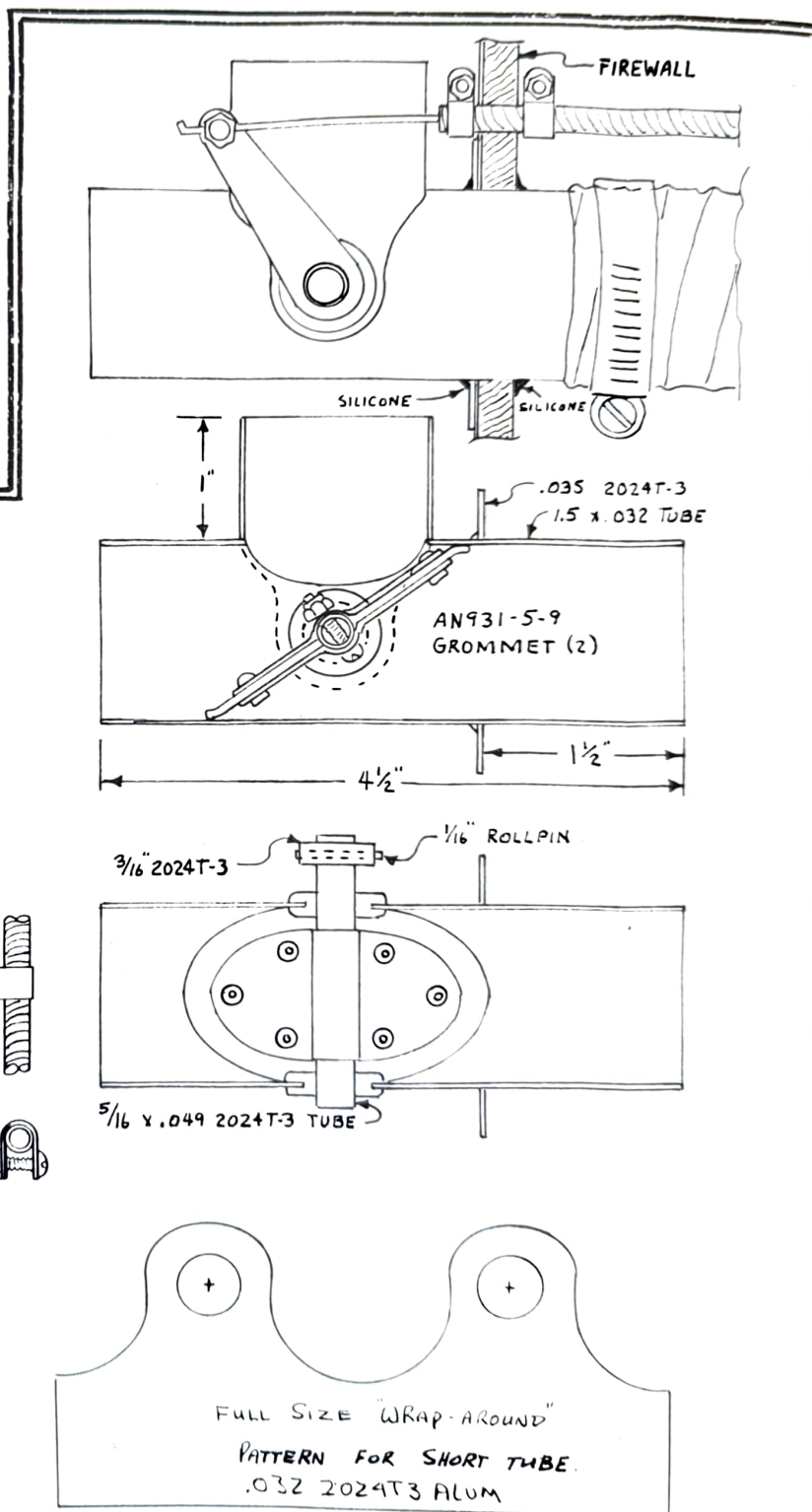


FIG. 4



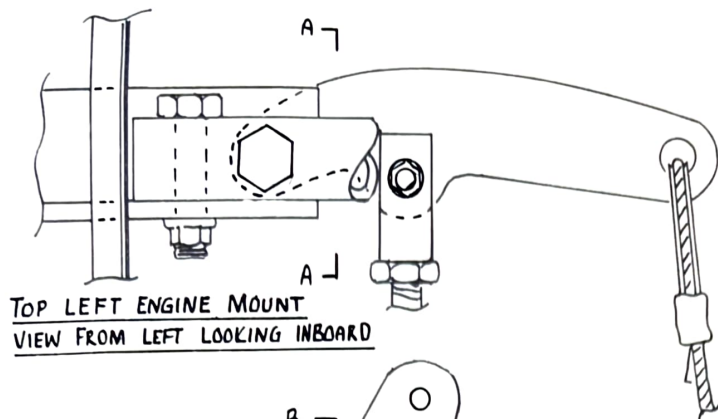


FIG. 5

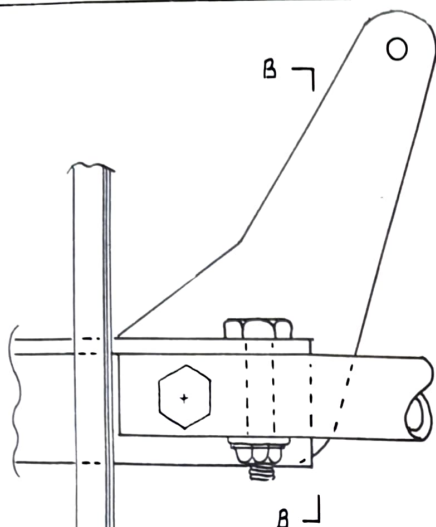
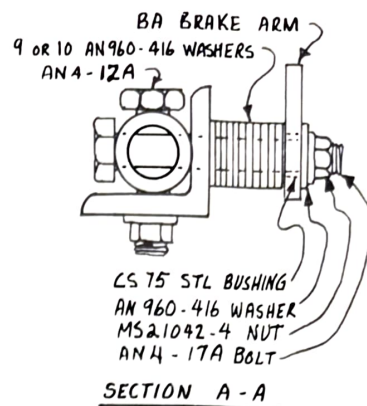
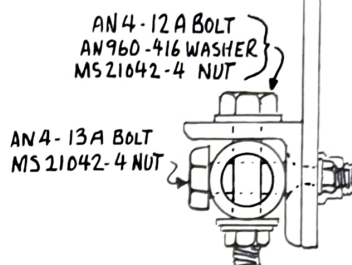


FIG. 6

LOWER LEFT ENGINE MOUNT FROM LEFT LOOKING INBOARD



SECTION A-A



SECTION B-B

STEP 4. INSTALLING ENGINE MOUNT

Depending on your engine, you will require either a conical or a dynafocal engine mount. Both of these are available as a welded-up, bolt-on assembly from Ken Brock Mfg. The builder who wishes to fabricate his own engine mount can refer to pages 23-6 and 23-7 for configuration, dimensions, and specs. If you intend to build your own dynafocal mount, we strongly recommend purchasing the pre-welded dynafocal ring from Wicks or Aircraft Spruce. Dynafocal mounts are complicated beasts!

If you have been following the construction sequence recommended, and the instructions religiously, you will already have obtained your engine mount, you will have mounted the extrusions to fit the engine mount perfectly (Chapter 14, Step 13) and you will have already drilled half of the mounting holes (Chapter 15, Step 3 and page 15-2, sections A-A and B-B), but you will have installed the master brake cylinder assembly on the extrusions and will have to remove them before reinstalling the engine mount. Put the mount back in position on the extrusions, and check the fit. If it is not perfect, stop right now and correct the problem. Then bolt on the mount through the existing holes and drill and install the remaining bolts per Fig. 5 and 6. Be very careful in drilling the holes. It is very easy to have the drill wander off and elongate the holes or to drill holes which are not square and centered. Best procedure is to drill the holes undersize, and then drill or ream them up to size.

STEP 5. INSTALLING THE CARBURETOR FILTER & HEAT VALVE

Before proceeding with the air filter installation, if you do not have the CS123 bushing and CS124 belhorn installed, install them now (Chapter 16).

You can obtain an air filter from your local auto parts store. A Purolator AFP-117 or an A.C.448C or similar filter will work fine. Don't get a larger diameter filter than these, however. Study the firewall layout on page 23-3 and locate the filter as shown on the lower right side of the firewall. Be sure that there is no interference with the brake lines or rudder cable or belcrank. Use a felt tip pen and mark around the filter, and then set aside.

Next, fabricate the carburetor heat and air valve shown on page 23-8. This part is available prefab from Ken Brock Mfg. Locate your air valve over the outline you marked for the air filter, so that the four corners overhang it roughly equally. Mark the location of each corner on the firewall. Check again for possible interference with the brake line or cables. Drill two small holes (1/16 in. dia.) through the firewall and make a loop of .041 in. stainless safety wire through the holes as shown, at each corner. Cut four lengths of 3/8 in. O.D. screen door spring and install the air filter and valve assembly with springs holding the valve and air filter tightly against the firewall at all four corners.

STEP 6. GASCOLATOR & ELECTRIC FUEL PUMP

Carefully study page 23-2. This drawing is reduced scale, but clearly shows where to position the gascolator and fuel pump on the firewall. Disregard the drawing on page 21-8, where the gascolator is mounted too low and obstructs the air flow through the scoop.

The gascolator is hung from the firewall so that you can reach in through the air scoop and drain the gascolator during pre-flight inspection. The 3/8 in. dia. aluminum fuel line from the fuel valve should come through the firewall, just to the right of the throttle, carb. heat and mixture cables. Drill a 1/2 in. dia. hole through the firewall (if you have not done so already) and push the fuel line through from the rear. Install the indicated tubing fittings, flare the end (Make sure you use an aircraft flaring tool. Automotive flaring tools do not produce the correct flare. Make sure you have deburred and polished the ends of the tubing before flaring, so you don't set up any stress cracks). Carefully bend the tubing 90 deg. (use a tubing bending tool so you don't kink the line), connect it to the gascolator, and mount the gascolator as shown on page 23-3, using two AN822-6D elbows screwed into the gascolator, two clamps, MS21919-DG11, two AN3-17A bolts with AN960-10L washers and MS21042-3 nuts and two 3/8 O.D. x 3/16 I.D. x 1 in. spacers. Be sure to orient the gascolator correctly for fuel flow in and out. After mounting the gascolator and connecting the fuel line, pot the line generously where it comes through the 1/2 in. hole with RTV silicone.

If your engine has an MA3 carburetor, it will not have a built in accelerator pump. The MA3 SPA carburetor has the pump. Without an accelerator pump, the engine will be difficult, if not impossible to start, particularly in cold weather. This can be remedied by installing a primer. The primer should be installed on the instrument panel if you have a starter, or you could install it closer to the engine if you plan to hand start. Fuel for the primer should be taken from the top of the gascolator using an AN816-2D fitting on a 1/8 in. dia. soft copper tube passing through the 1/4 in. dia. hole indicated in the firewall. Pot the copper line in the hole with RTV silicone.

The electric boost pump is required for your Cozy and under no circumstances should you omit it. It is available from Wicks and Aircraft Spruce. Mount it where shown on page 23-3 using two AN3-10A bolts, AN960-10L washers, and MS21042-3 nuts. Because of the lightening cutout in the plywood firewall bulkhead, you will need to position a small piece of plywood in the area where these two bolts go to secure the electric fuel pump. Be careful not to drill through the firewall into your centersection spar cap! That would spoil your entire day. These two bolts will be accessible from inside the centersection spar box. Plumb the electric pump to the outlet of the gascolator with 3/8 in. dia. soft aluminum tube.

F.5.135.9

B.L. 7.8

W.L.27.0—

B.L.7.8

$\frac{3}{4}$ " O.D. x .049 WALL 4130N

5/8" O.D. x .120 WALL
4130N TYPICAL
4 PLACES

2/8 O.D. x .058 WALL
4130N TYPICAL
8 PLACES

APPROX. THRUST

LINE _____

3/4" O.D. x .049 WALL
4130N .065 C27-2

Diagram showing the top view of the engine mount extrusions. The distance from the FIREWALL to the left extrusion is 11 1/2 inches. The distance from the FIREWALL to the right extrusion is 11 1/2 inches. The word FORWARD is written below the FIREWALL line, with an arrow pointing to the right.

COMPLETE 0-235 LTC DYNAFOCAL ENGINE MOUNT FOR COZY AVAILABLE FROM DISTRIBUTOR DYNAFACAL RINGS, PROPERLY ALIGNED, AVAILABLE SEPARATELY FOR THOSE WHO WISH TO BUILD THEIR OWN MOUNTS.

VIEW FROM AFT

VIEW FROM LEFT

FWD

F.S. 125.43

W.L. 13.05 —

1/8 O.D. X .049 WALL 4130N
- .050 GUSSET 4130N

B.L.9.9

B.L.9.9

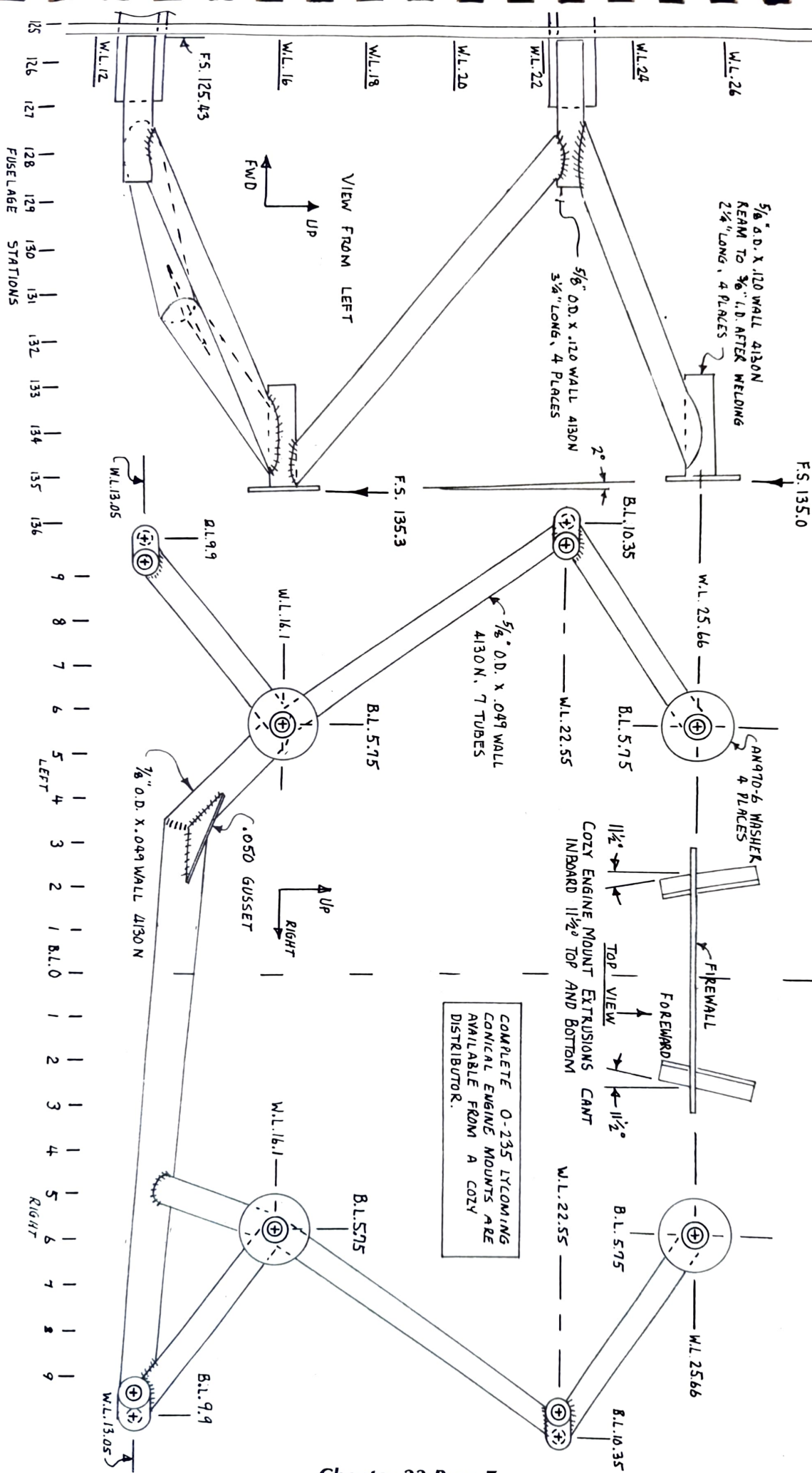
FUSELAGE STATIONS

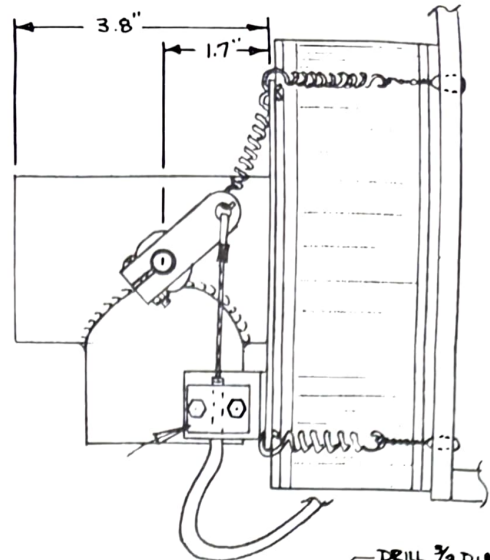
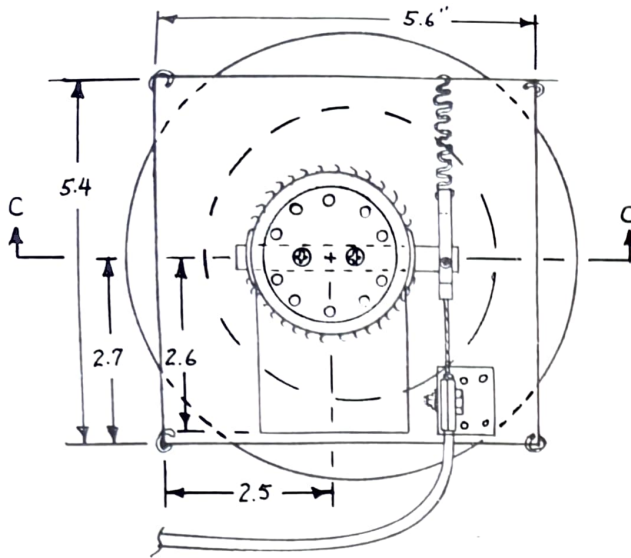
LEFT

BASE LINES

RIGHT

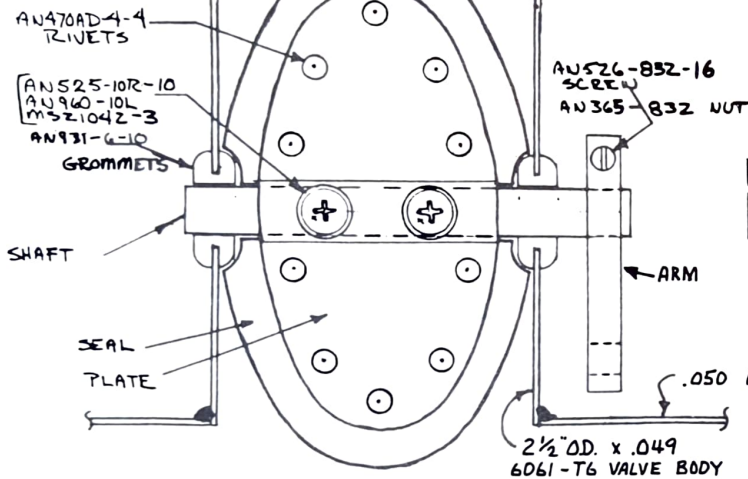
FORWARD FACE OF
FIREWALL AT F.S. 125.0





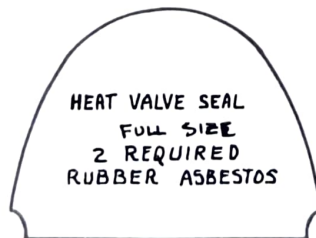
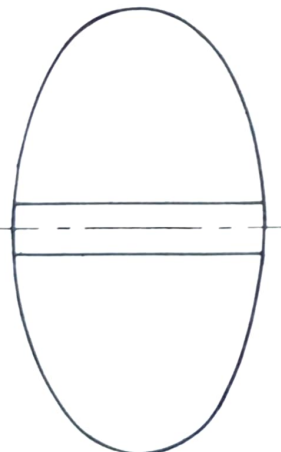
VALVE SHOWN AT THE 1/2 POSITION.

NOTE: TABS AND RIVETS CAN BE SUBSTITUTED FOR THE WELOS.



CARB HEAT VALVE ASSEMBLY

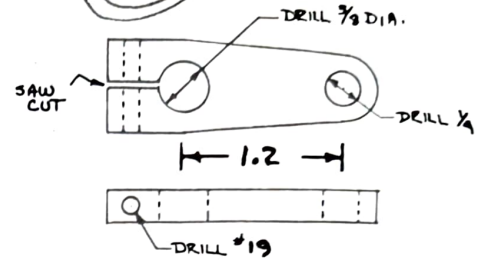
SECTION C-C
FULL SIZE



HEAT VALVE SEAL
FULL SIZE
2 REQUIRED
RUBBER ASBESTOS

RADIUS TO FIT
VALVE SHAFT

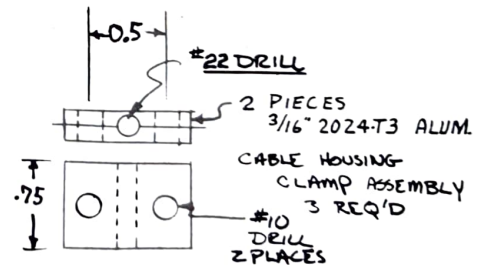
HEAT VALVE PLATE 2 REQ'D
.025 6061-T6 ALUMINUM
FULL SIZE



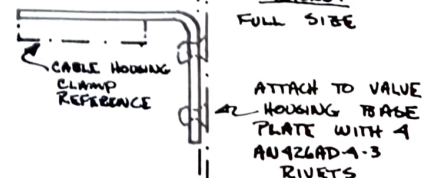
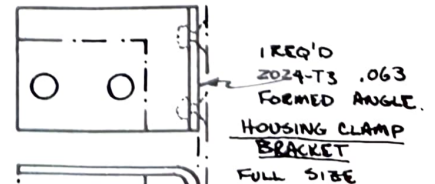
VALVE ARM USE .25THICK 2024-T3 ALUMINUM. 1 REQUIRED.



HEAT VALVE SHAFT - 1 REQ'D 3/8 O.D. x .049 WALL 2024-T3 TUBE



MAKE 3 ASSEMBLIES, USE ONE FOR THE HEAT VALVE. THE OTHER TWO ARE FOR THROTTLE AND MIXTURE



This tube must be bent such that it clears the aileron pushrod. It can **not** pass between the aileron pushrod and the firewall, but rather should curve away from the firewall at at least 45 deg. to pass **aft** of the aileron pushrod. **Note:** The EFP fuel pump is drilled and tapped with a 1/8 in. pipe thread, and you will require two special elbows. **AN822-6-2 (steel)**, which are available from your Cozy distributor. **Make sure** you use **teflon tape** on all threaded connections, to lubricate and seal the threads. Plumb from the electric boost pump to the mechanical pump on the engine using Aeroquip flexible hose. **#303** hose and **#491** hose fittings are called out, but you can substitute Aeroquip **#601** hose and **#816** fittings if you wish.

STEP 7. MOUNTING THE ENGINE

At last! The big moment! With the exception of the hardware, mounting the conical or dynafocal engine is essentially the same. Some people use an engine hoist, which can get to be a little hokey, and we heard of someone actually dropping the engine. What we found to be just super is to build an engine stand from 2 x 4s, on casters, which supports the engine slightly inclined from horizontal, and slightly lower than the engine mount. You can store the engine on the stand, and when ready, wheel it up to the airplane, raise the nose until the mounting points match the engine, put blocks under the nosewheel to hold it in that position, and then bolt the engine in place. Then take the blocks out from under the nosewheel, push down on the nose, and the engine lifts right off the stand. Don't forget to put weights in the nose at this point, before pushing the stand away. This procedure makes engine installation a one-man job, and it is so easy, you will want to remove it again when you have to turn the fuselage upside down to build the NACA scoop, fairings, and finish the bottom.

If you insist on doing it the hard way (with a hoist), load up the front seat with ballast so the fuselage can't tip backwards, hoist the engine into position, and have someone hold it there while you install all four shock mounts, bolts and nuts. Be careful not to bash the engine or accessories against the mount, particularly the mechanical fuel pump. Support the engine weight from the hoist until all four bolts and nuts are torqued up. Torque requirements are: Conical mount - 3/8 in.x24 bolts, 220 to 320 inch pounds. Dynafocal mount - 7/16 in.x24 bolts, 430 to 580 inch pounds. The conical mount hardware assembly is shown in Fig. 7, and the dynafocal mount hardware is shown in Fig. 8.

STEP 8. AIR INDUCTION SYSTEM

In this step you will make a fiberglass elbow which bolts onto the carburetor, and connect this elbow to the air filter valve with flexible 2-1/2 in Aeroquip duct.

The fiberglass elbow is shown in 3 views in Fig. 9. To make it, glue a couple of pieces of urethane foam together and carve it to the correct shape and stick a sanded 2-1/2 in. O.D. x .049 wall aluminum tube over the end. Mount the block on a flat surface covered with duct tape for release. Layup is 4 plies BID overall. Overlapping small pieces makes the job easier and is O.K. After cure, trim the flange to dimensions, dig out the foam and sand it smooth on the inside, and drill the 1/4 in. holes.

Bolt the elbow to the inlet flange on the bottom of the carburetor. Use a gasket, or sealant that is fuel proof (**not** RTV silicone). Be sure the elbow is oriented to point forward to the carb air/heat valve.

Next, mount a length of **CAT-10 (or SCAT-10)** duct to the elbow. Pay careful attention to the clamping details shown in Fig. 10. Make **certain** that the outer cord and inner wire are **both** trapped under the worm gear clamp exactly as shown. If this not done, the wire can unwind, allowing the duct to collapse, which would result in engine failure. Do **not** substitute ceet or sceet duct, or any other duct which has an inner lining, which could delaminate, collapse, and also cause engine failure.

Route the inlet duct to the bottom of the carb air/heat valve and clamp it in place. The inlet duct should not be stretched tight. A little slack is required to allow for engine torque during operation. Drill a 1/4 in. dia. hole in the low point of the duct (when nose is down if hand started, or on nose wheel if electric started) to allow excess fuel to drain out if the carburetor floods.

STEP 9. ENGINE WIRING AND CONTROLS

It is helpful to have an assistant to verify control positions and travel in the cockpit, while you work on the engine.

First, make all the metal parts shown on page 23-10. Install the throttle/mixture bracket on the carburetor studs. This bracket becomes a **gasket** between the carb. and engine, and requires two normal gaskets (one on each side), when installing the carb. The small tab on the aft end of the bracket should be bolted to a .063 x .6 alum. strap. The strap should be bolted to an oil pan bolt. Apply additional damping by bonding the bracket to the oil pan with RTV silicone rubber.

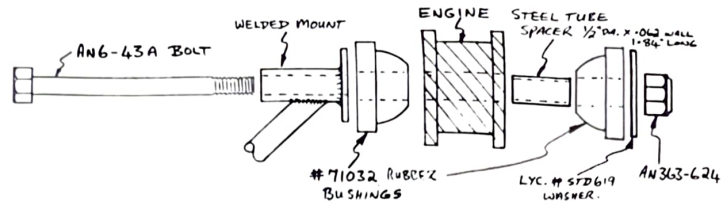


FIG. 7

EXPLODED VIEW OF A LYC. O-235 CONICAL MOUNT AND ASSOCIATED PARTS.

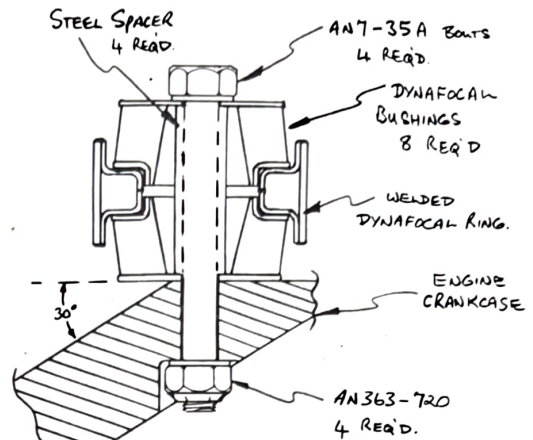


FIG. 8

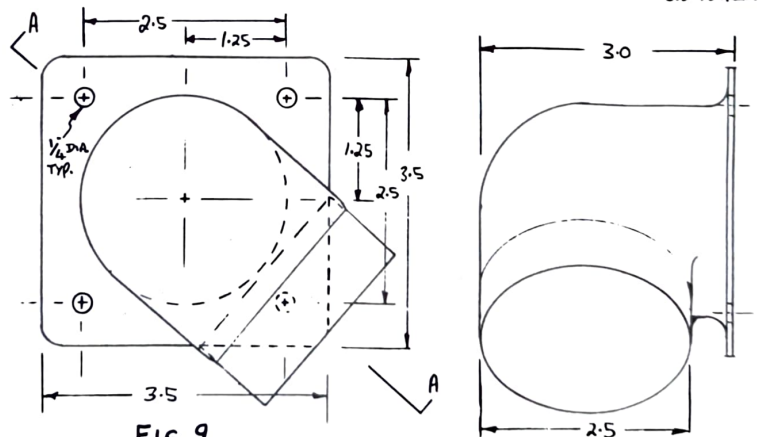
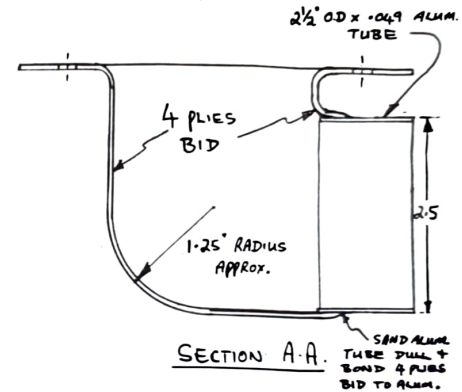


FIG. 9

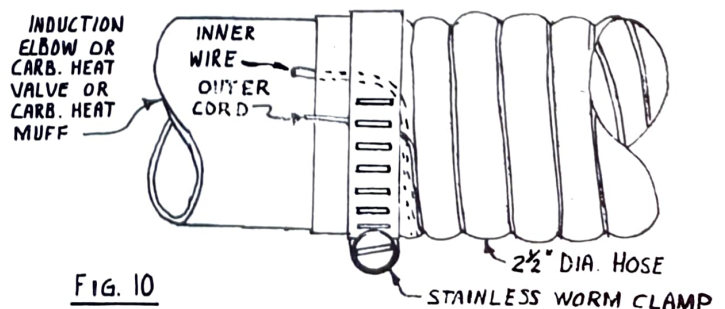
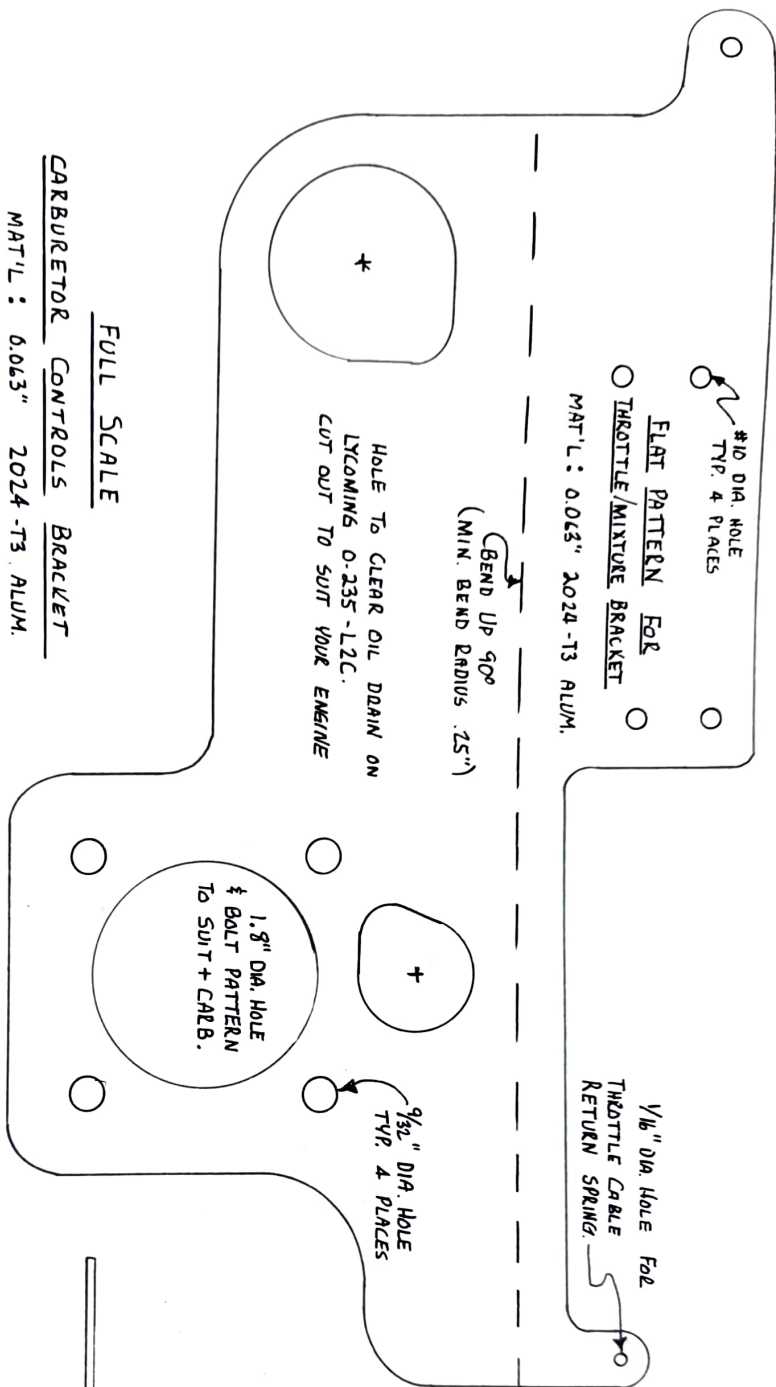


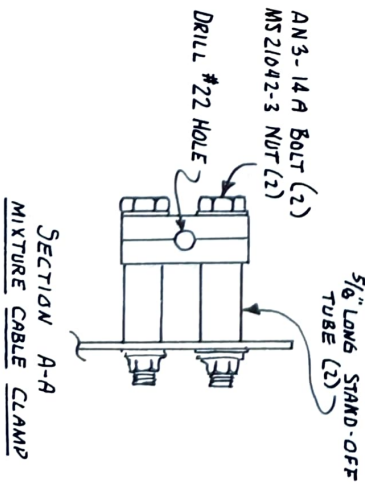
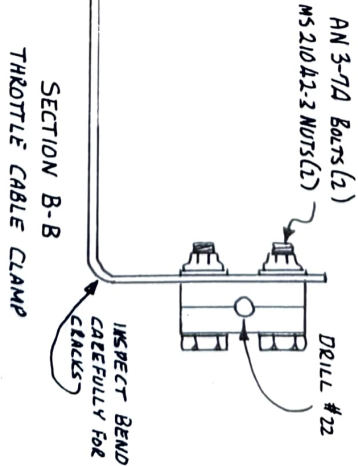
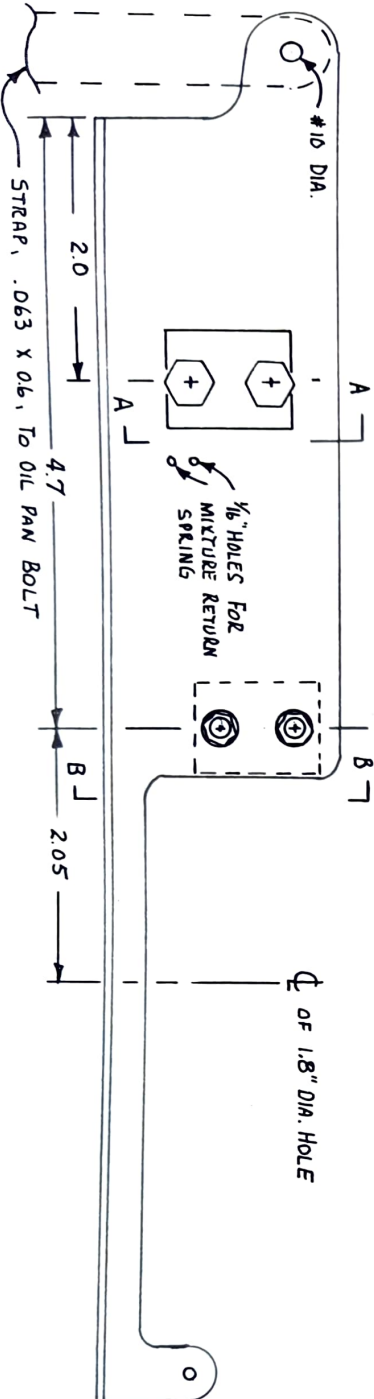
FIG. 10



FULL SCALE

CARBURETOR CONTROLS BRACKET

MAT'L: 0.063" 2024-T3 ALUM.



Next, run your throttle cable out from the firewall around the left side of the carburetor and mount to the bracket as shown in Fig. 11. The mixture cable follows the same route as the throttle cable, except it clamps to the forward side of the carb control bracket. Be sure the clamps aim the cables **directly** at the actuating arms, with as little flexing as possible. The controls must work **without** the return springs. Check this before installing the springs. The springs take all of the **slop** out of the system for smooth throttle and mixture control, but do **not** depend on the springs. The springs will return the throttle to full open and mixture to full rich in the event of a cable failure.

Mark the cable housing to be trimmed so that it protrudes about 1/2 in. beyond the housing clamp. Before you try cutting the cable housing to final length, try a practice cut way out on the end of the housing. The idea is to use your dremel (stone grinding wheel) to grind part way through the housing wire, **not** into the cable (Fig. 12), and then break the wire with a twist (using pliers). **Don't** damage the cable inside. With the housing cut to length you can use your dikes to cut the cable. Be sure you have enough extra cable to make a loop around the **AN111-4** thimble. Install the mixture arm bracket on the carburetor mixture arm as shown in Fig. 13. Clamp the cable between your thumb and finger and verify that you have full mixture control at the carburetor when the mixture control is cycled in the cockpit **before** you swage the sleeve. If you don't get it perfect, an adjustment can be made at the housing clamp. Tighten the bolts on the cable housing clamp. Add a dab of silicone rubber over the cut end of the cable; it will save some pain and expletives later. The throttle cable is installed in a fashion similar to the mixture. A Century Spring Corp. **C-161** spring is used to preload the throttle in the full open position (Fig. 11).

The throttle cable is swaged with an **AN111-4** cable bushing and **18-1-C** sleeve as shown in Fig. 14. The cable is attached to the throttle arm with an **AN3-7A** bolt, **3/16 I.D. x 1/4 O.D. x .25** long spacer, **AN970-3** washer, and **MS21042-3** nut as shown in Fig. 15. The **AN111-4** bushing **must rotate freely** on the spacer. Double check the throttle travel in the cockpit and at the carburetor before swaging. Dab the cut cable end with silicone rubber.

The carburetor heat cable housing clamp, cable and return spring are installed as shown on page 23-8. Don't force the cable and housing around tight corners; leave enough slack for a gentle loop to the cable housing clamp.

Next, attach each magneto ground to the electrical wires running forward to the mag switches. A schematic diagram is shown (Fig. 16) for wiring the mag switches. If you are using a mag-operated tach, refer to the wiring diagram in Chapter 22, Fig. 20 (don't forget the fuse).

Connect the switches to the aircraft ground as shown. Connect the aircraft ground wire to one of the engine mount bolts. Install a short length of braided strap from the mount to a convenient stud on the engine.

Install your CHT probe on the number 4 cylinder, top side. During your initial runs and initial flights you should move the probe to other cylinders. Once the hottest cylinder is determined, leave the probe on it. All cylinders should run within 20 deg. F of each other. If you have a wide variation, the cause could either be mixture distribution, or a baffling problem. A better solution is to put a probe on each cylinder and install a 4-position selector switch in the panel so you can monitor all cylinders in flight. This can help you detect a fouled plug.

Follow your engine service manual and route the ignition wiring (spark plug leads) to each plug. Snug the plug caps (shielded harness only) using a 3/4 in. wrench; don't overtighten. Be sure to guard the ignition wires against chafing on the cylinder cooling baffles. Use rubber grommets where they pass through baffles. The EGT probe should be installed on number 4 cylinder exhaust pipe.

Note which mag has the impulse drive. That is the mag you will want **on** for hand propping.

Install the oil pressure sender as shown in Fig. 16A. The sender mounts to an engine mount tube using two Adel-type clamps, **MS21919-DG10**, bolted together, one around the mount tube and one around the **AN910-1D** coupling. The orifice fitting is normally supplied with the engine. It has a tiny hole, which prevents massive oil loss in the event of hose or sender failure. It is absolutely **mandatory** that an orifice fitting be used. If you have to make one by bushing a standard fitting, a #60 drill will give you the right size orifice. Do **not** mount the sender directly on the engine. Do **not** use metal tubing between the engine and sender.

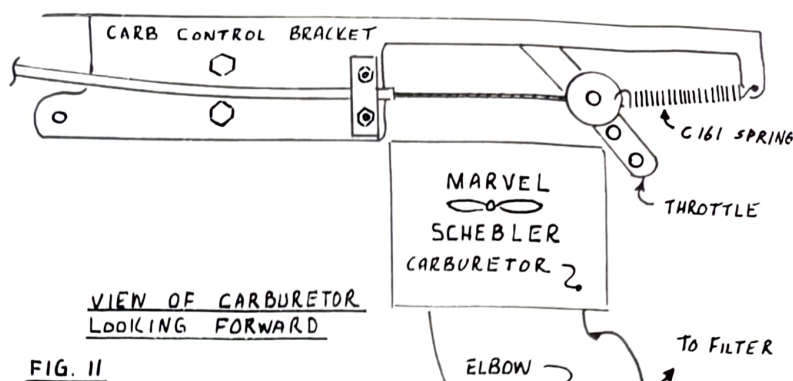


FIG. 11

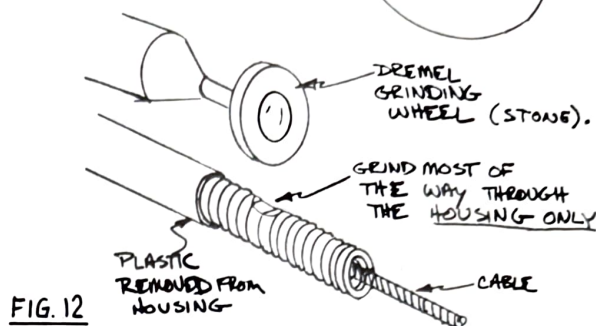


FIG. 12

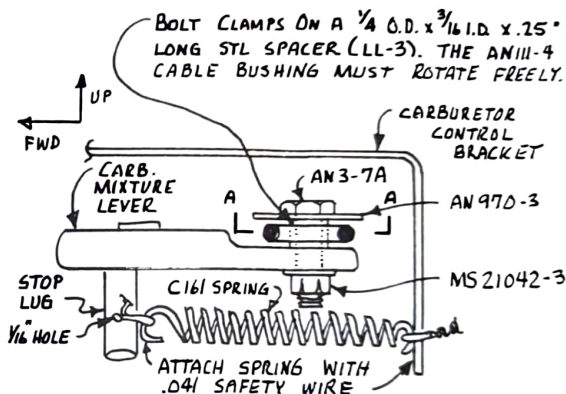


FIG. 13 MIXTURE ARM VIEW FROM LEFT

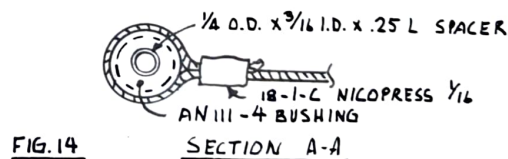


FIG. 14

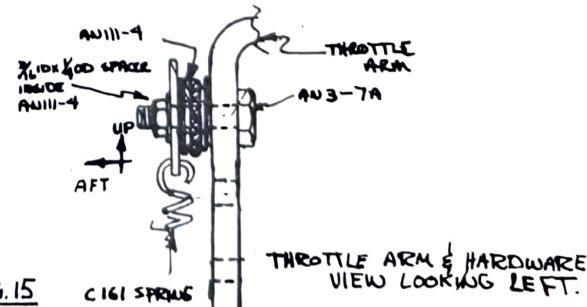


FIG. 15

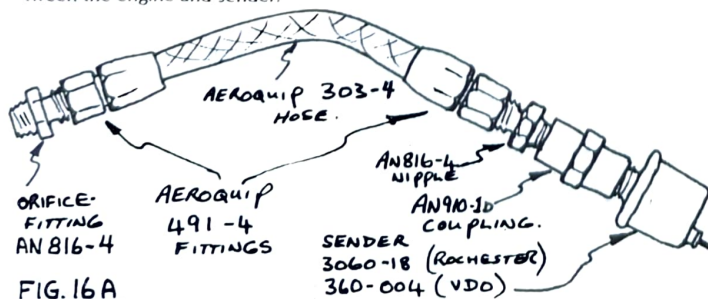


FIG. 16A

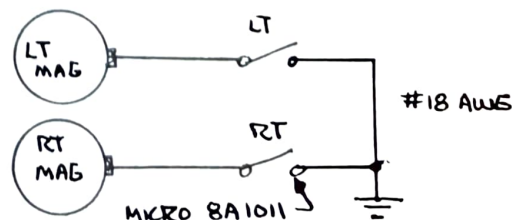
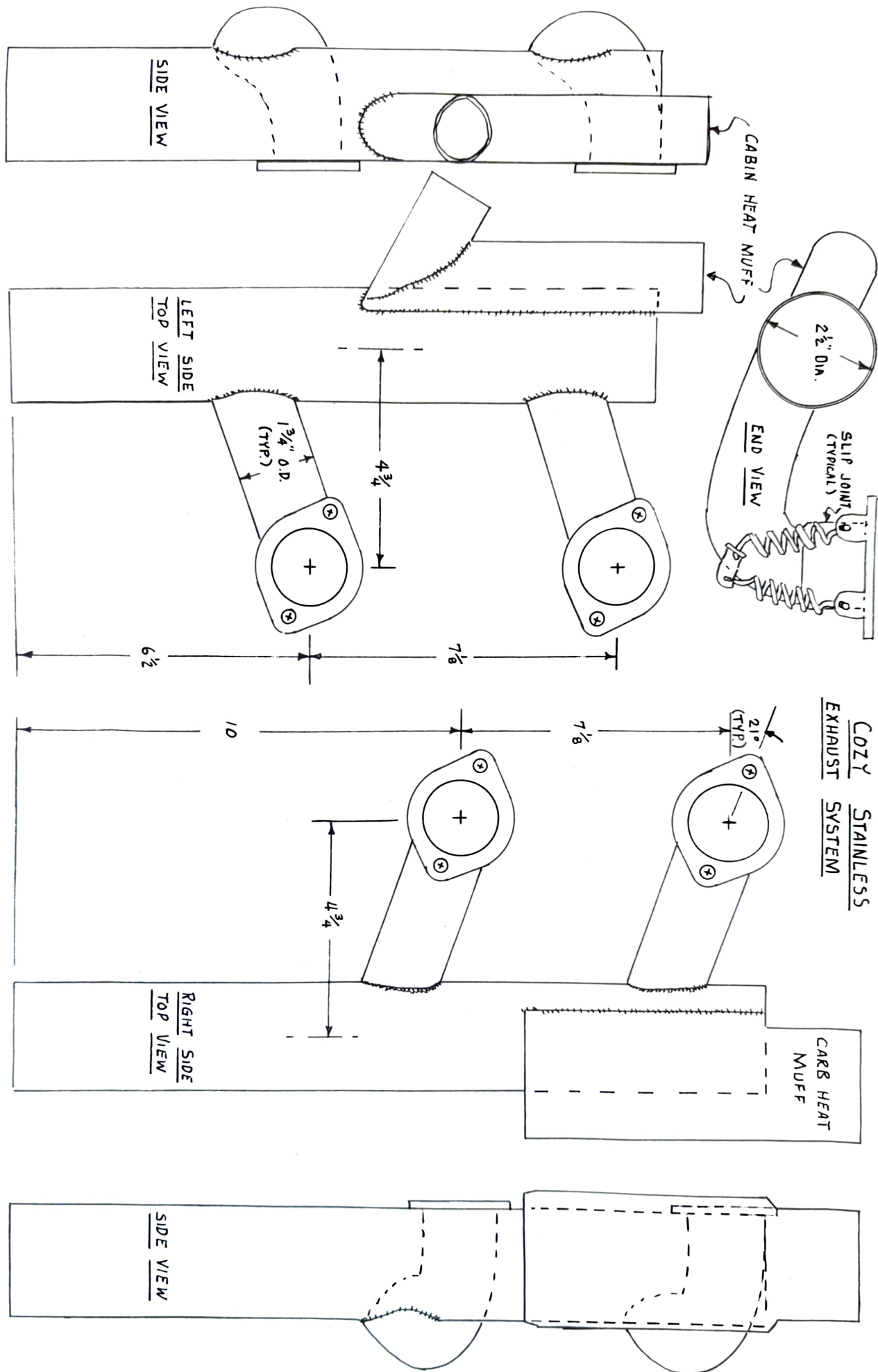


FIG. 16



STEP 10. COWLING INSTALLATION

Cozy cowl halves are available from the designated Cozy distributor. These parts will require some additional work as part of the installation on your airplane. You will have to install the stiffening ribs supplied with the cowlings, trim the outboard ends of the cowl halves (not very much, we hope) to fit the wing roots; lay up a closeout flange in the trailing edge of the cowl; lay up a fiberglass attaching flange along the centersection spar, fuselage and wing roots, and finish the flush scoop inlet on the bottom cowl. You will also fabricate an oil check door, and install the upper baffle ribs.

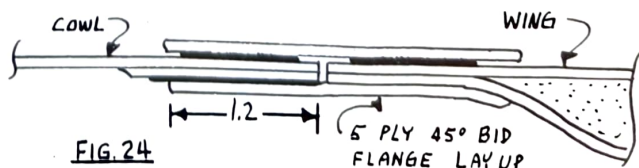
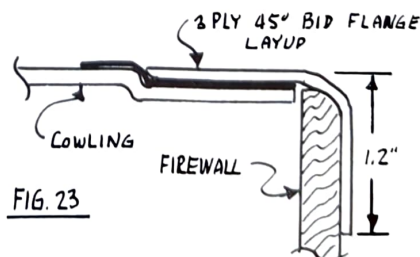
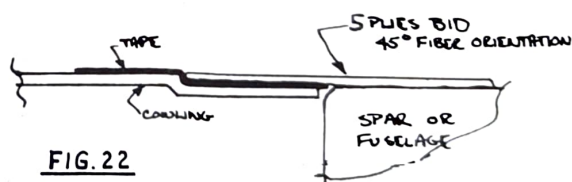
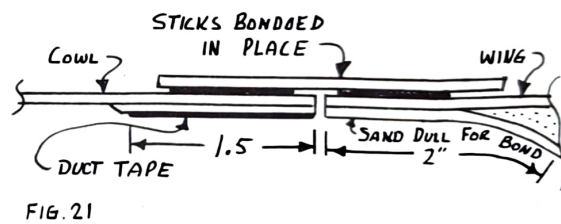
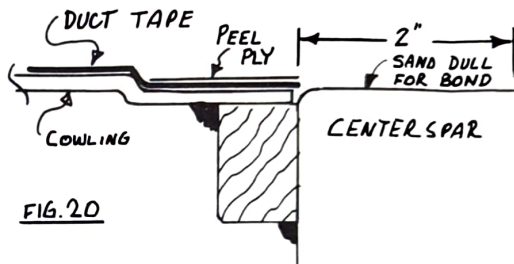
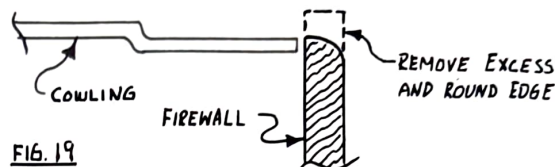
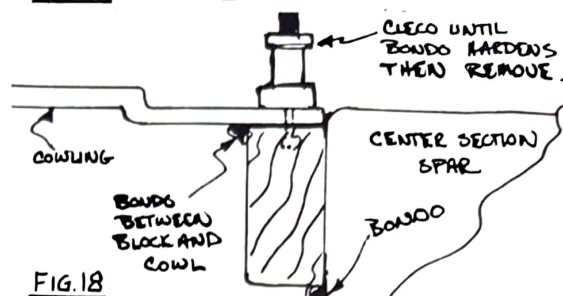
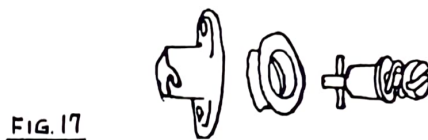
The cowl is attached to the airplane with #10-32 screws (AN507-1032R10) and nut plates (K1000-3) and countersunk washers (A3235-028-24A). Camloc fasteners (Fig.17) may be substituted as a quick disconnect feature along the wing roots, top and bottom and along the cowl trailing edges. Camlocs along the centersection spar and fuselage are not recommended due to the requirement to physically remove the camloc before the cowl can be pulled out from under the attach lip. Dzuz type fasteners should not be used as they do not provide adequate shear load-carrying capability.

It is much better (and more certain of a good fit) to install the cowl with the engine mounted, with your 5 inch prop hub extension in place, and spinner at least located on the prop flange (you don't have to have cutouts for the prop and the prop installed). It is, of course, necessary to have the wings installed, because the cowl attaches also to the wing roots. If your work area does not allow you to install both wings at the same time, you can install one wing, lay up the wing root flanges for top and bottom cowl, remove that wing, then install the other wing and do the wing root flange layups on it. If you have to do it this way, it is a big help to bond a rib to the aft face of the centersection spar, to define accurately the wing root trailing edge of the wing that will **not** be installed while you are installing the cowl.

Before you start the cowl installation, install the stiffening ribs supplied with the cowlings. They go inside each cowl half, near the aft end (The stiffening rib in the lower half is optional, because a baffle installed later will provide adequate stiffness). Find where they fit, hold them in place, and drill some #30 holes through the rib flanges and cowl. Sand that area of the cowl and the mating rib flanges. Butter the flanges with floc and cleco them in place with the flanges snug against the cowl. Wipe away any excess floc and allow to cure.

While they are curing, you can thoroughly sand (36 grit) the top and bottom aft edges of the centersection spar, the forward faces of the exposed firewall, and inside the wing roots, top and bottom. In Chapter 18, you installed a cowl flange over the top of the turtle back. Use this flange now to support the forward end of the cowl. Position the top cowl under this flange, against the firewall, high enough to clear the starter ring gear by .4 in. minimum, and centered over the propeller flange (you may have to trim the trailing edge a little to clear the spinner, if it is also installed), and drill a #30 hole through the flange and cowl lip, top of the turtleback, and install a cleco. Then drill and install clecos 7 in. away on either side. The cowl should form a continuous, smooth curve from the canopy to the spinner, with no bumps or joggles. Now bond some wooden blocks on the aft face of the center spar (Fig.18) to support the cowl lip flush with the top surface of the center spar. This is the time to trim the outboard edges of the cowl to remove any interference with the wings, and to make them straight as an arrow. Drill holes through the cowl lip into the wooden blocks for clecos, bond the cowl to the wooden blocks using clecos to hold the cowl in place while the bondo cures (Fig.18). Do not be disturbed if the cowl curvature does not match the firewall. The firewall was intentionally made slightly oversize so it could be trimmed to match the cowl. Trim it now (Fig.19) and round the forward edge so you can lay up around it. Remove the clecos, and apply duct tape (for release) to the forward cowl lip (Fig.20) and the under surface of the outboard edges of the top cowl (Fig.21). Now position the outboard edges of the top cowl so that they accurately follow the contour of the wing roots, and fasten them in this position by bonding sticks across the wing root/cowl joint (Fig.21). The cowl trailing edges should match pretty close to the wing root trailing edges.

Now lay up 5-ply (45 deg. orientation) BID flanges across the center section spar onto the cowl lip (Fig.22), and a 3-ply BID flange around the exposed firewall (Fig.23) which tapers onto the cowl flange over the top of the turtleback. Lay up a 5-ply BID flange on the under side of the wing flange and the cowl (Fig.24). This last layup is an upside down operation, but is easy to do, particularly if you do the 5-ply layup off the airplane on a piece of visqueen (plastic) first, then while it is wet, lift the visqueen and layup and place it in position under the cowl edge, lapping under the edge of the wing root. Squeegee it well through the visqueen and allow to cure, checking it carefully from time to time to make sure it hasn't peeled away. The plastic will easily peel off later.



After cure, drill #30 holes evenly spaced as shown in Fig.25 through the flange, duct tape, and cowl lip. These holes will be used to cleco the top cowl back in position after it has been popped loose, reinforcements added, and then re-installed. They will be opened up later for screws or camlocks. Knock off the wooden blocks now and remove the top cowl. Be **careful** when you are removing the cowl, not to peel the flanges up off of the spar, firewall, or wing roots. Now, sand the flanges dull, and apply a 1 ply BID reinforcement on the top of the wing root flange (Fig.26), using peel ply to hold the edges down, and a 1 ply reinforcement under the centerspar/fuselage flange (Fig.27). After cure, reinstall the top cowl (with clecos), and drill out the #30 holes along the leading edge, one at a time, to #10 for AN507 screws and install K1000-3 nutplates on the inside of the cowl lips (Fig.28). Fasten the leading edge in place with screws, and then drill out the outboard edges and install either screws or optional camlocks. Camloc part numbers are: Stud - 4002-6 or 4002-7 (depending on thickness of your cowl lip and flange), and Grommet - 4002-N, Grommet retaining snap ring - R4G, and Receptacle - 214-16N. It is helpful in installing the top cowl to install a little ramp (Fig.29) on the firewall to hold the top cowl up high enough to engage the screws in the nutplates.

The bottom cowl is installed in exactly the same manner, except the right-side-up layups will now be upside-down, and vice versa. It is not necessary to turn the airplane over. The same precautions must be exercised to make sure the upside-down layups do not peel away before they are cured. In Chapter 18, you also installed some flanges on the lower fuselage side, which are now used to support the weight of the cowl (with clecos) while the rest of the preparations are being made. You will probably also have to trim the trailing edge of the lower cowl for a minimum clearance of .5 in. on the spinner. In the same manner as with the top cowl, bondo blocks in place on the centerspar to hold the lips flush, and sticks on the wing to hold the outboard edges flush, and trim the lower firewall flush with the lip and round the forward edge, and prepare all of the surfaces (tape, where appropriate, and sanding, where appropriate). Before actually laying up the flanges, it would be a good idea to put the top cowl back in place and make sure the two halves are aligned along the trailing edge as the cowlings curve back to the prop. If they don't, this is the time to correct the problem. Now, make the same schedule of layups as before. After cure, don't neglect to install the 1-ply reinforcing layups.

Now, when everything is cured, and fasteners installed, you are ready to install the cowl closeout flanges at the trailing edge. Prepare the bottom cowl by taping the last 3 in. with grey duct tape (Fig.30). Sand to dullness the same area on the top cowl. Now install both cowlings on the airplane and either tape the trailing edges together or bondo sticks across the seam to hold them aligned. Cut 10 strips of BID 4 in. wide and 9 in. long with 45 deg. fiber orientation, and lay up a 5 ply BID closeout flange on each side, from the exhaust pipe opening aft (Fig.31). Let this layup cure, and then drill two #30 holes 4-1/2 in. apart, centered, about 1 in. from the seam, through the bottom cowl, duct tape, and cured flange, each side.

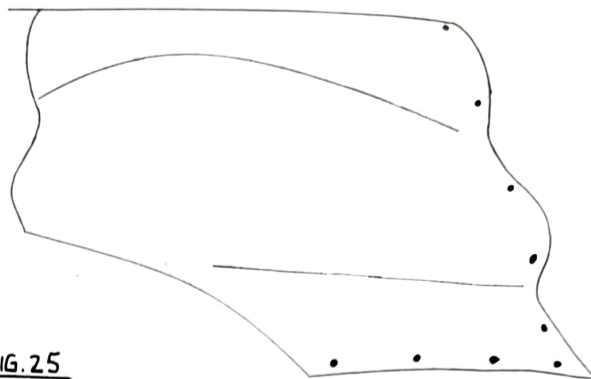


FIG. 25

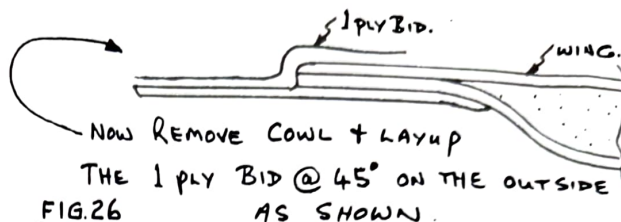


FIG. 26

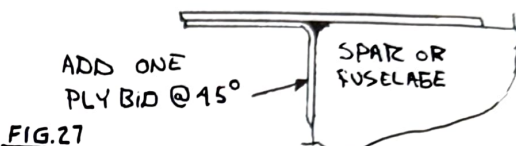


FIG. 27

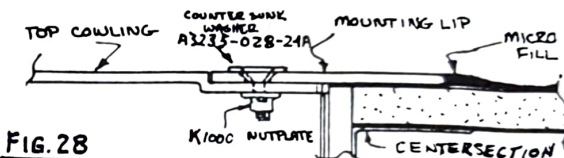


FIG. 28

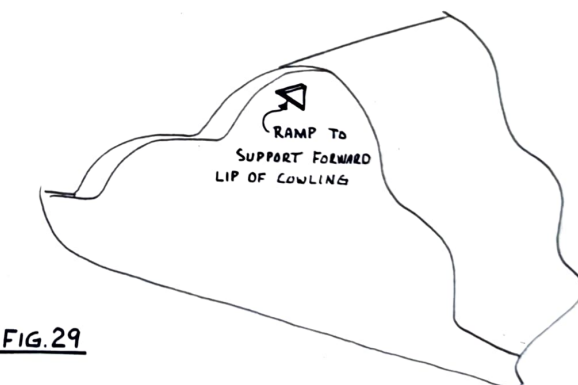


FIG. 29

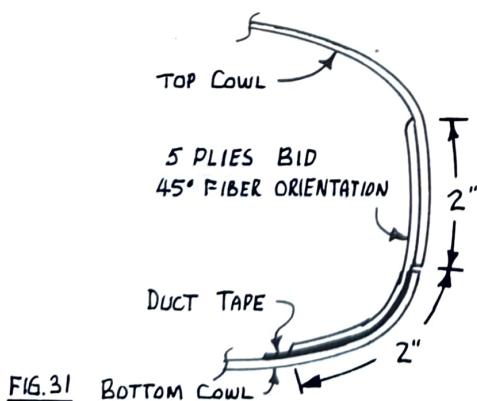


FIG. 31

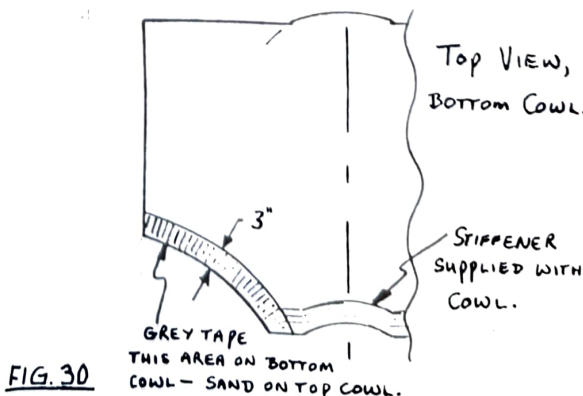


FIG. 30

Now remove the cowlings, and jig them together on the floor, **aft end down**, clecoed together through the holes just drilled, the trailing edges taped together, and the leading edges spread apart 8-1/2 in. (Fig. 32) Now layup the rest of the closeout flange (Fig. 33) from the exhaust opening to the wing root. This is also 5 ply. You will need 10 strips of BID 4 in. wide by 7 in. long. After cure, drill two more #30 holes each side through the bottom cowling, about 3 in. apart and 1 in. from the trailing edge. Now pop the cowlings apart again, sand the closeout flange and top cowling, and apply a 1 ply BID reinforcement as shown in Fig. 34. After cure, trim the closeout flange to 1.6 in. wide (Fig. 34), open up the #30 holes and install either nutplates or camlocs (Fig. 35).

Now that the cowling installation on the airplane is complete, you should finish the scoop lip on the lower cowling. Carve a piece of 1 in. thick urethane foam so it fits snugly in the bottom of the lower cowling (Fig. 36) and will provide a smooth transition for air entering the scoop. Sand the area it covers and several inches adjacent, including overlap areas at the leading edge of the scoop. Micro the foam in place, fill any cracks with micro, micro the foam, and lay up 2 plies BID over the foam lapping at least 1/2 inch on all adjacent glass. Peel ply. Install on the airplane so this layup cures in the right curvature.

You will need to install an oil check door in the top cowl. The location and dimensions are shown in Fig. 37. If you are careful in making the cut out, you can use the piece you remove from the hole for the door. Follow the same procedure you used for the door in the side of the fuselage. Mark the door outline. Drill through the cowling with a 1/8 in. drill in the hinge area. Insert a hand held saw and carefully saw out the door. Line the back side of the door with tape, bondo the door in position in the hole using popsicle sticks on the outside, and lay up a 4 ply BID flange on the inside. After cure, pop out the door, trim the flange to 1/4 in. (Fig. 39), and install a 3 in. long section of MS20001-3 hinge with flush, pop rivets, and a camloc fastener to secure the door shut (Fig. 38). The oil check door must close tightly so high pressure air cannot leak out.

STEP 11. EXHAUST SYSTEM

The Cozy cowlings were contoured to accept the Sport Flight Lycoming stainless steel exhaust system shown on page 23-12. This system exits directly aft to take advantage of the high velocity exhaust gases for a little extra propulsion. Although the gases pass through the propellor arc, there is no adverse affect on the propellor. There are slip joints at each exhaust port to minimize temperature induced stresses, and to make it possible to remove the exhaust system without unbolting the exhaust flanges. The exhaust system is supplied with a carburetor heat muff on the right side, and a cabin heat muff on the left. The carb heat muff draws air from the engine compartment. It should be connected to the carburetor heat valve mounted on the air filter with 2-1/2 in. dia. red, high temperature, **Scat** flexible duct, observing the same clamping instructions followed for connecting to the carburetor. The cabin heat muff has both an inlet and outlet hose connection. It is **absolutely mandatory** that the cabin heat muff be supplied by **outside** fresh air. The scoop for supplying fresh air to the heat muff is installed in the fairing between the fuel sump and the firewall in Chapter 24. The scoop is connected to the **aft** 1-1/2 in. dia. tube on the heat muff with red **Scat** flexible duct. The clean, cold air impinges on the hot exhaust pipe and is heated and forced forward by ram pressure through another length of **Scat** duct to the cabin heat valve previously installed on the firewall. Fresh, clean air **must** be brought into the heat exchanger to avoid possibility of getting carbon monoxide into the cockpit. Engine cooling air could get contaminated by a small exhaust gasket leak or undetected exhaust leak. Because the possibility always exists of carbon monoxide getting into the system, it is highly recommended that you install a **carbon monoxide indicator** in the cockpit.

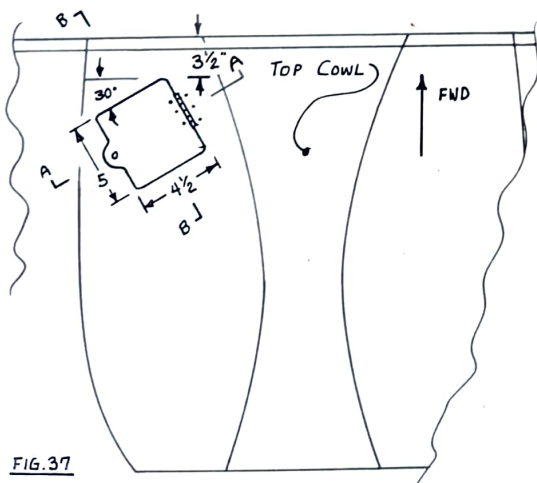


FIG. 37

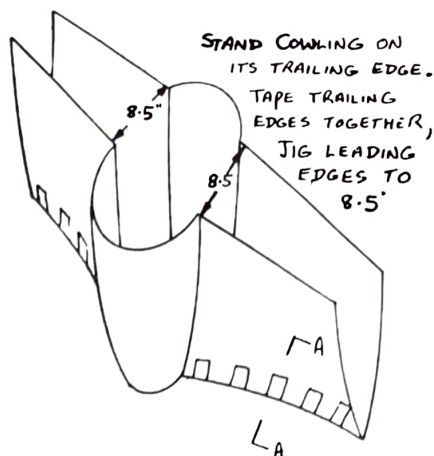


FIG. 32

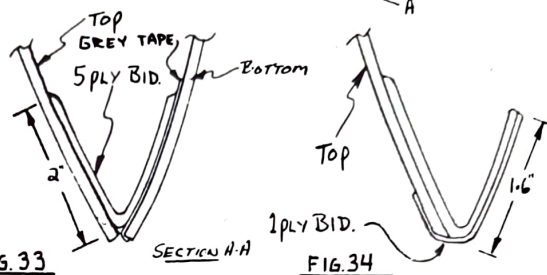


FIG. 33

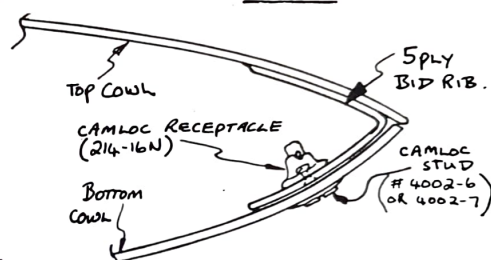


FIG. 34

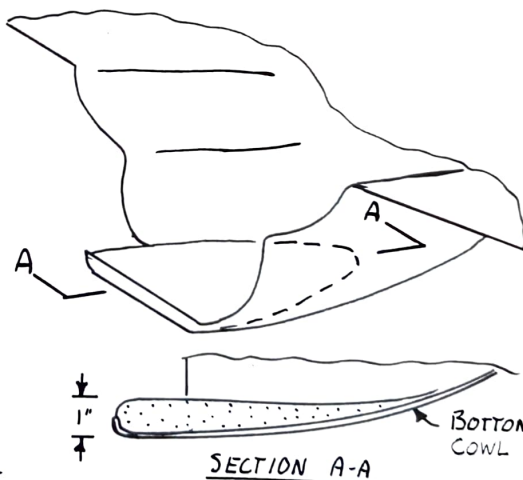


FIG. 35

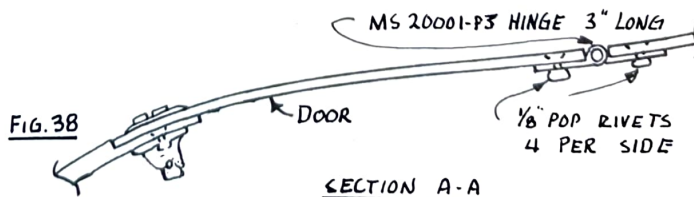


FIG. 38

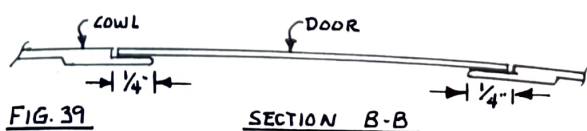
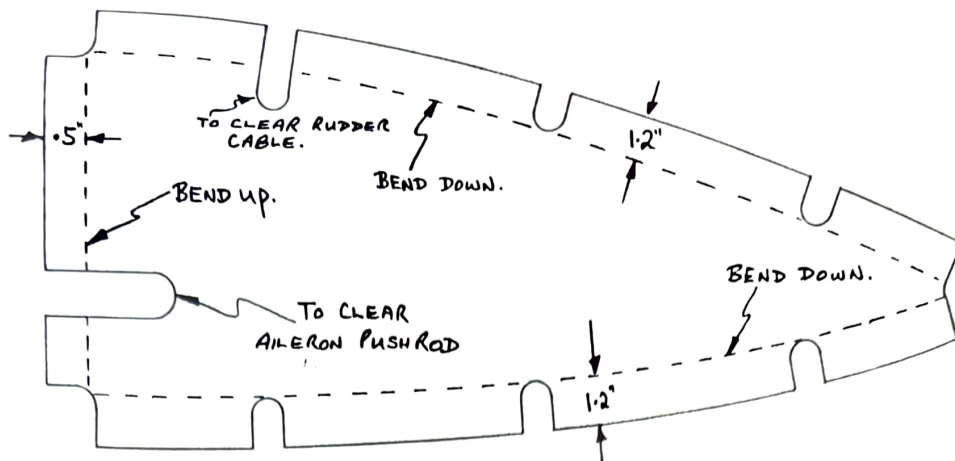


FIG. 39



SOFT ALUMINUM - 6061-0, .020" THICK.

After installing the exhaust system (and the engine baffling), make sure that air cannot leak out of the high pressure side of the cowl around it. Check the fit of the lower cowl around the pipes. You will need a **minimum** of 1/4 inch clearance all around the pipes and cowl to allow for engine shake and torque. If the clearance is too small anywhere, you can build up the outside contour by laying up however many plies of BID are required, and grinding away material on the inside. You can also shift the pipes slightly by either shortening or lengthening the slip joints.

The exhaust system, with the engine running, will get hot enough to glow in the dark. The radiated heat can cause damage to the cowl and the wing root. The cowl can be protected by laminating aluminum foil to the inside areas directly over and under the pipes. The wing root should be protected by installing the aluminum radiation shield shown in Fig. 40, both sides. These are bent to fit over the cowl flanges on the wing root and slotted to accommodate the screws or camlocs.

STEP 12. ALTERNATOR INSTALLATION

Before you install the engine baffling, you should decide what alternator to use, because it mounts through the baffling. In the prototype Cozy N22CZ, we threw away the Lycoming alternator, because it was too heavy, and selected a 6 lb., 35 amp alternator from a GLC Mazda. With a slight alteration of the Lycoming alternator mounting bracket, we mounted it with the pulley aligned with the ring gear/pulley on our O-235. The alternator had a perforated end housing, so the fan (weighing .6 lbs.) was not necessary for cooling. The high pressure air from the forward side of the baffle supplies enough air for cooling.

STEP 13. COOLING BAFFLES

A few words about engine cooling are in order. All of the air passing through the engine compartment adds to total drag (and lower speeds). It is worthwhile, therefore, to cool the engine using the least amount of air possible.

The flush NACA scoop designed into the COZY adds about 4 mph, compared to the ram scoop used on the Long EZ. It also ingests less air, but is quite adequate **if** you do a good job of baffling.

The only air flow which does any cooling, is that which goes **through** the engine. Air leaking around your baffles is wasted, so it is important to have tight seals **between** the engine and the cowl. These will have to be flexible because the engine shakes and torques when it is running.

The only air passing through the engine which does much cooling is that passing **between** the fins. Air going around the fins is wasted, so it is important to only let the air get through by passing between the fins.

Air cannot turn sharp corners efficiently, so it is important to guide the air into and out of the fins as smoothly as possible.

If you observe these rules, you can have good engine cooling and a fast airplane. If you don't, you will have an overheating problem. Now, let's get on with the job!

We have provided full size patterns to assist you in making the engine cooling baffles. These are shown on drawings A-24, A-25, A-26, and A-27. Due to builder differences, these may not be perfect fits in every case. It is well worth the little extra effort involved to test each pattern on your engine using cardboard, or some stiff material less expensive than the 6061T-6 Al. specified for the permanent installation. Note that the forward and aft baffles are made in 3 pieces. While it is possible to make these two baffles in one piece, you will find it much easier to fabricate them in 3 pieces as shown. They are joined together with pop rivets or small bolts (for easier disassembly).

The baffles are bolted to the engine wherever a hole is shown and further secured in place by applying a generous bead of RTV silicone (the red or silver high temp RTV is best and is generally available at auto parts stores) along the edges of the baffles wherever they touch the engine, or to seal imperfect fits, and as an anti-chafing material.

Start the baffle installation with the cylinder head baffles shown on A-24. Each side is made in two pieces so the cylinder heads will not be locked together. Each piece fits around the rocker arm cover so it need not be disturbed during installation or removal.

Next, fabricate the forward baffle (in 3 pieces) as shown on A-25. It crosses over the top of the engine at a slight angle, because of cylinder offset, one side vs the other. Trim as required for a tight fit against engine and 1/4 to 3/4 in. clearance with the top cowl. Bend the bottom tabs so they fit tight against the cylinder head fins, and then bend back again at the ends as shown in Fig. 41. Adjust (if necessary) the holes thru the baffle to line up with the tapped holes in the engine, and bolt them in place.

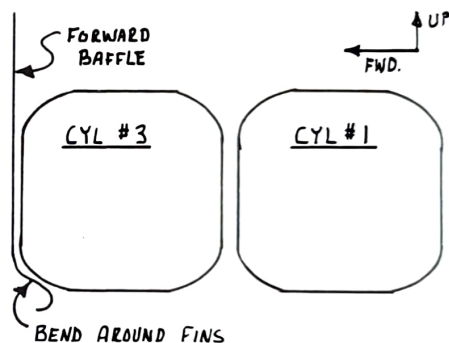


FIG. 41 VIEW THROUGH CYLINDER HEADS FROM LEFT

Now from A-27 make one **Top Forward Right Cylinder Head Baffle #1** as shown, and one opposite, and install them over the cylinder head fins top, forward, both sides as shown in Fig. 42. Rivet in place with flush pop rivets (flush on the fin side).

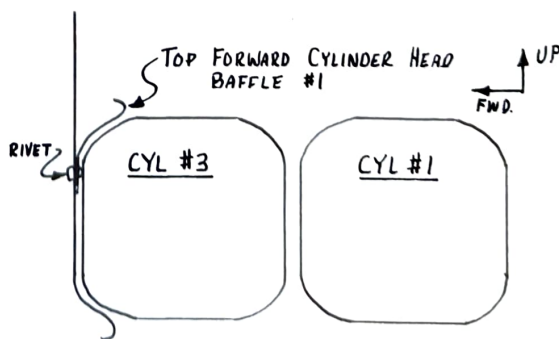


FIG. 42 VIEW THROUGH CYLINDER HEADS FROM LEFT

Now, to baffle the cylinder fins forward, top and bottom, both sides, make one **Right Forward Cylinder Baffle #2** as shown, and one opposite, and install them as shown in Fig.43. These should be bolted to the forward baffle at the bottom, and riveted to the forward baffle mid way at the tangent point.

Before proceeding further, we must consider how we are going to hold these baffles tight against the fins, and make provisions for doing this later. Each pair of baffles will be wired together with .041 safety wire, as shown in Fig. 44. To prevent the safety wire from cutting through the aluminum baffle, make inserts from 3/16 in. dia. coat hanger wire as shown full scale Fig.45. Drill an 1/8 in. hole as shown in Fig.46 for the hook end of the insert, and two 1/16 in. holes, centered, for the safety wire. Glue the inserts in place with silicone rubber so they will not fall out or rattle and abraid. Prepare the ends of all fin baffles in this way. Now, make two **Lower Inter Cylinder Head Baffles #3**, and two **Top Inter Cylinder Head Baffles #4** as shown on drawing A-27, bend them to fit snugly against the fins, but with the ends rolled up, and install them as shown in Fig.47 using two, double loops of .041 safety wire.

Now, make two **Inter Cylinder Baffles #5**, two **Brackets**, and two **Top Inter Cylinder Baffles #6**. Rivet the brackets to the Inter Cylinder Baffles and install on the cylinders as shown in Fig.48.

You can now make and install the **Aft Baffle** (3 pieces). The right and left sides are shown on A-26 and the center section on A-27. You may have to modify the center section to fit the particular alternator you are using. Our alternator was too short to extend through the baffle, but we wanted to use the high pressure air inside the cowling to cool the alternator, so we made a sleeve of silicone coated glass cloth to bridge the gap between the baffle and the alternator. This sleeve was sewed to the baffle with safety wire, and glued to the alternator with silicone rubber (Fig.49).

The Aft Baffle has tabs on the top which are bent down over the cylinder head fins, with the ends rolled up (Fig.50).

For the cylinder fins, make a **Left Aft Cylinder Baffle #2** and the opposite **Right Aft Cylinder Baffle**, as shown on A-27 and install them the same way you did for the forward location (Fig.51). Bolt these to the aft baffle on the bottom, rivet them to the aft baffle mid way, and safety wire them down at the top. Underneath, use a spring and a coat hanger wire as shown (Fig.51).

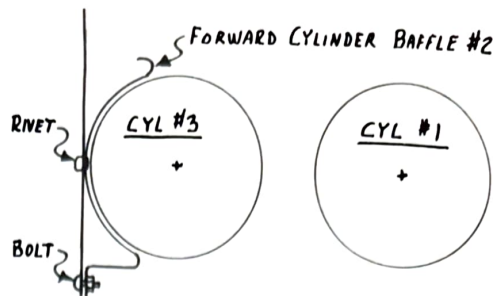


FIG. 43 VIEW THROUGH CYLINDERS FROM LEFT

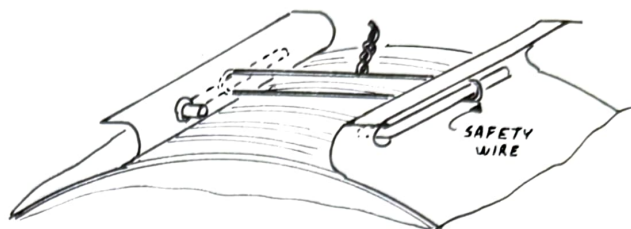


FIG. 44

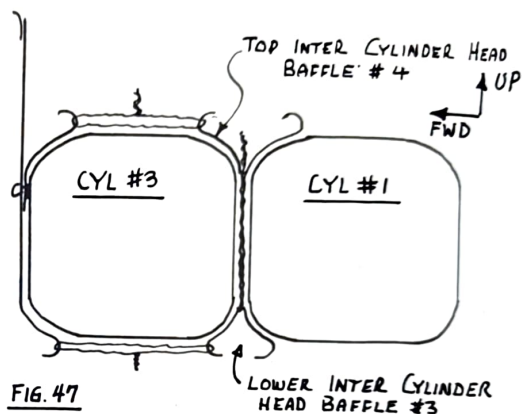


FIG. 47

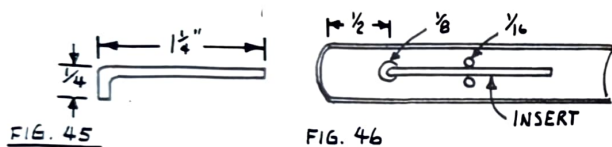


FIG. 46

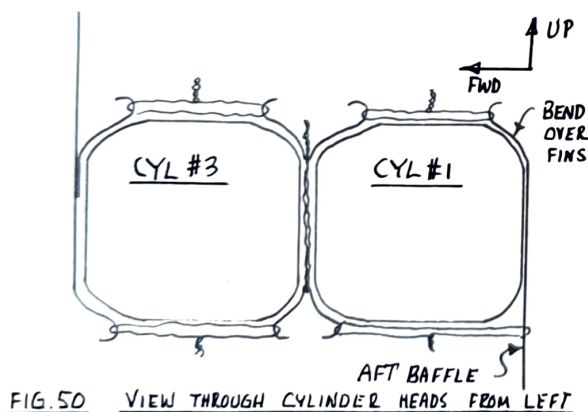


FIG. 50 VIEW THROUGH CYLINDER HEADS FROM LEFT

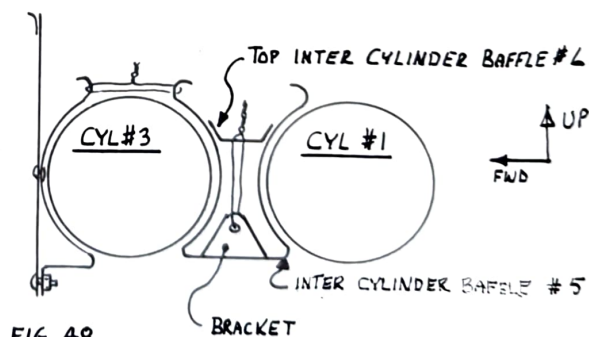


FIG. 48

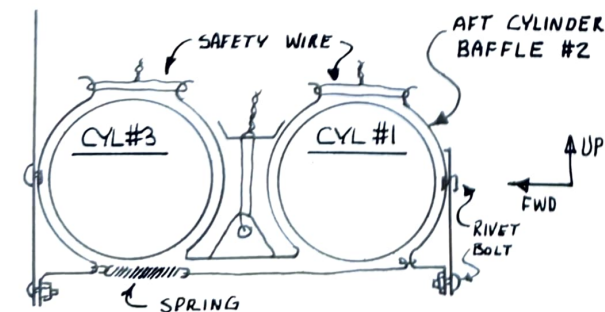


FIG. 51

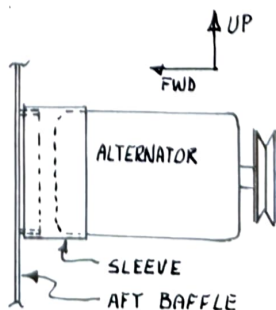


FIG. 49

With all engine baffling in place, install the cowl one half at a time and measure the distance from the top of the aluminum baffles to the cowl. This dimension should be from 1/4 to 3/4 in., except along the cylinder head baffles where it should be 3/4 to 1-1/4 in. Make up neoprene asbestos strips and rivet them to the aluminum baffles to seal the gaps. (Fig. 51A)

With the top cowl in place, mark the inside surface of the cowl adjacent to the outboard edge of the cylinder head baffles. This mark will help you locate the two glass baffles that have to be layed up into the top cowl. See drawing A-24 for full size templates for these baffles and also the cross section detail showing how they function in providing a surface for the gasket to seal against. Lay these out on a piece of 1/8 in. plywood, or something similar. Cut them out and stick grey duct tape to the outboard faces of the plywood. Now bond these pieces into the top cowl, along your marks. When the bondo is hard, trial fit the top cowl to be sure the neoprene asbestos cylinder head baffles rest nicely against the grey duct tape on the plywood. Remove the top cowl and sand the inside adjacent to the grey tape. Lay up 2 plies of BID at 45 deg. and allow to cure. Knife trim to the edge of the plywood at the appropriate time.

Carefully remove the plywood pieces and sand the shiny surface of the glass ribs, and adjacent to it on the cowl. Lay up 2 plies of BID at 45 deg. Knife trim to the previous glass layup and cure. This gives you two permanent fiberglass ribs in the top cowl that the cylinder head baffles seal against, which allow you to remove the rocker covers for periodic maintenance, without disturbing the baffling.

You will have noticed that the aft baffle does not go down all the way into the bottom cowl. Cut a piece of 3/8 in. thick PVC foam to fit into the bottom cowl, extending up to meet the engine baffling. 5-min. it in place, make micro corners, micro both faces, and glass each face with 1 ply of BID. This permanent cowl baffle provides stiffness and saves weight. Drill a drain hole at the bottom to allow any rain water to dissipate.

With all the baffling in place, carefully check for any potential air leaks. All leaks should be sealed or you will have unacceptably high cylinder head temperatures.

STEP 14. OIL COOLER INSTALLATION

An air cooled engine depends on the oil for removal of about 40% of the heat of combustion. You must make some provision for removing this heat from the oil. In the prototype Cozy N22CZ, we tried to avoid use of an oil cooler with special baffling to direct a cold air blast against the crankcase. This was not effective so we bit the bullet and installed a Harrison oil cooler (Fig.52). What a difference it made! The oil cooler is simply bolted to the inside of the cowl on the left side, near the wing root, and suspended by safety wire to support it when the cowl is removed. A 2-1/2 in. dia. hole was cut through the cowl directly under the oil cooler. This allows high pressure cooling air to escape from the cowl through the cooler. This system provides good oil cooling, (180 deg. - 200 deg. F) at cruise and a little higher in a long climb. Of course the 2-1/2 in. dia. opening can be varied to suit. People operating in extreme climates may need a large opening in summer and smaller in winter. With a little ingenuity, you can even make it adjustable!

STEP 15. PROPELLOR INSTALLATION

Install the 5 in. prop hub extension (if not already in place), propellor, and spinner. Follow the instructions supplied by the manufacturer. **Do not** install a prop hub extension **without** drive lugs, which locate in the forward face of the prop. The prop is driven mainly by the friction developed between the prop hub and the engine flange or prop extension. Proper torquing of the prop bolts is necessary to provide this friction. Extensive testing has shown that wood props generally should be compressed about 0.006 in. per inch of hub thickness. That is, a Cozy prop, normally about 3-3/4 in. thick at the hub, should have the bolts torqued up such that the wood in the hub is compressed $3.75 \times 0.006 \approx 0.0225$ in. Since your prop bolts are 3/8 in. x 24 threads, you can readily figure that you must turn each bolt 0.54 turn after the front face plate, the prop hub, and the prop extension flange are in contact ($0.225 \times 24 \approx 0.54$ turns). The difficulty here is in knowing exactly when the prop and flanges are in contact, particularly if you have bolts that are tight in their holes. Generally, you can achieve the same prop hub compression, assuming your threads are clean, and dry, and in good condition, by torquing your 3/8 in. dia. bolts to approx. 200 inch-lbs.

IMPORTANT!! ALL RUBBER BAFFLES MUST LAY TOWARD HIGH PRESSURE SIDE.

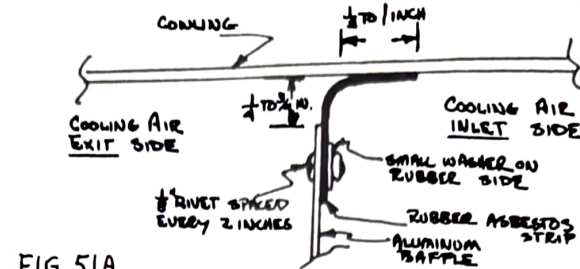


FIG. 51A

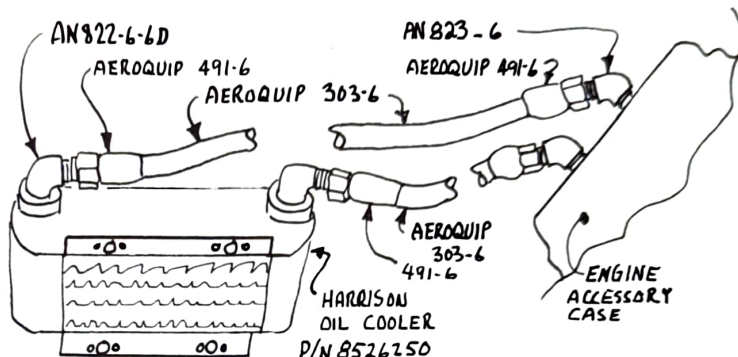


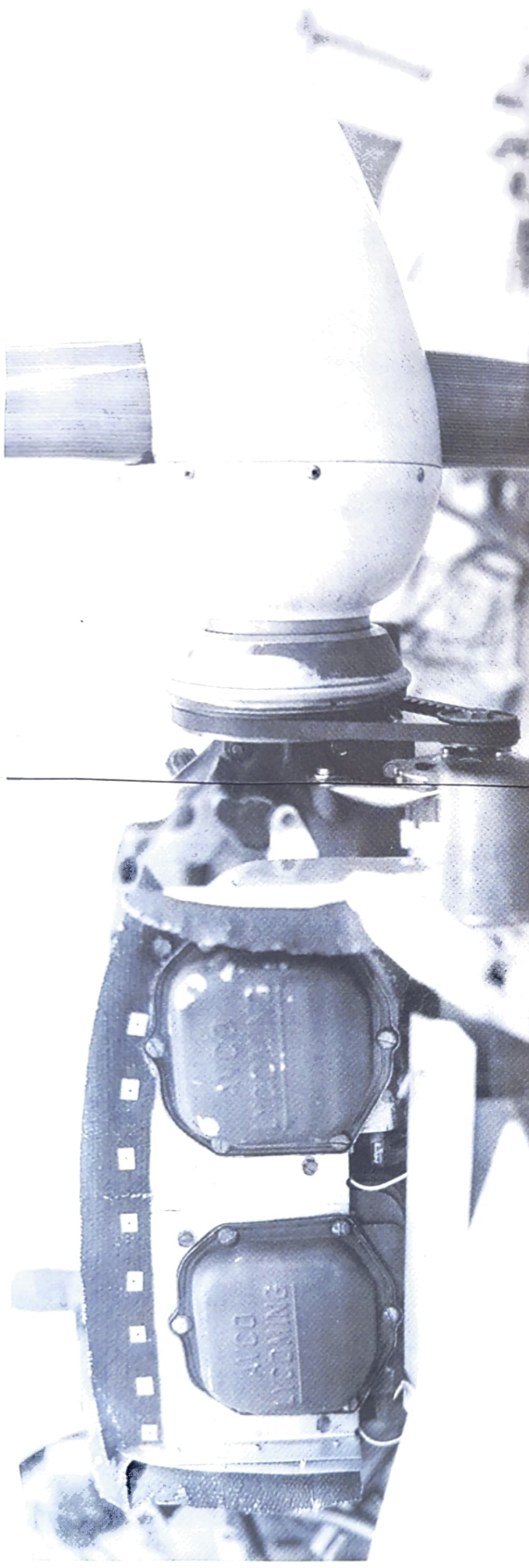
FIG. 52

Caution: Over-tightening prop attaching bolts will cause the wood in the hub area to crush. This could crack the finish and allow moisture to enter the wood and **will** reduce the drive-torque capacity of the installation. Check track of the blade tips by rotating the prop past a fixed object mounted on the floor. Prop tips must track within 1/16 in. of each other when the installation is completed.

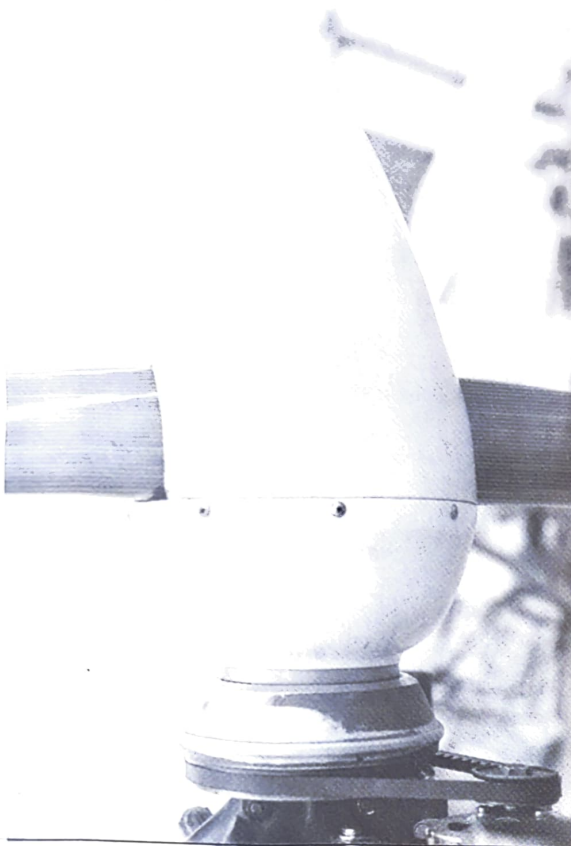
Protect your prop by waxing with a good quality paste wax, and place prop in a horizontal position when parked. Inspect and check prop bolts for tightness at least every 100 hours or annually. More frequent inspection may be necessary when climatic changes are extreme. Properly cared for, your wood propeller is a safe and reliable part of your airplane.

When you install the spinner, make the cut outs for the propellor as small as possible. A 1/16 in. clearance around the prop is ideal. A larger opening than this is a source of drag. An aluminum spinner is under stress when the engine is running. Make sure you polish the edges of the cut out to eliminate stress concentration and eventual fatigue. You will find that you will need a new spinner cone each time you install a new prop. You can make an excellent spinner cone from fiberglass (2 plies BID lapped on opposite sides, and reinforced around the edges of the cutouts).

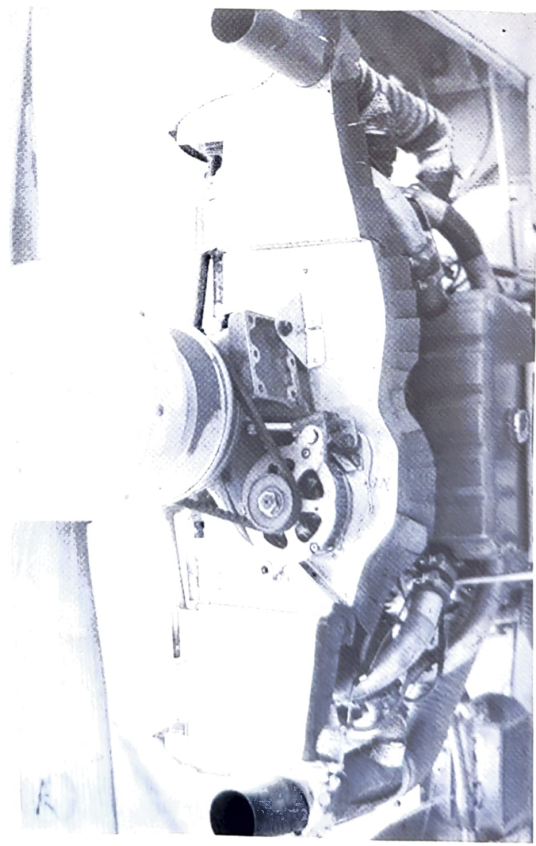
An air-flow guide forward of the propeller is recommended. This is simply a bowl-shaped member which covers the prop hub extension and flange, and which smoothly directs the air out of the cowl and into the propeller with a minimum of drag. In addition to the spinner assembly, consisting of the cone, air-flow guide, and two flanges, you will also need a pressure plate to distribute the load of the prop bolts on the propeller. These assemblies are available from Wicks and Aircraft Spruce.



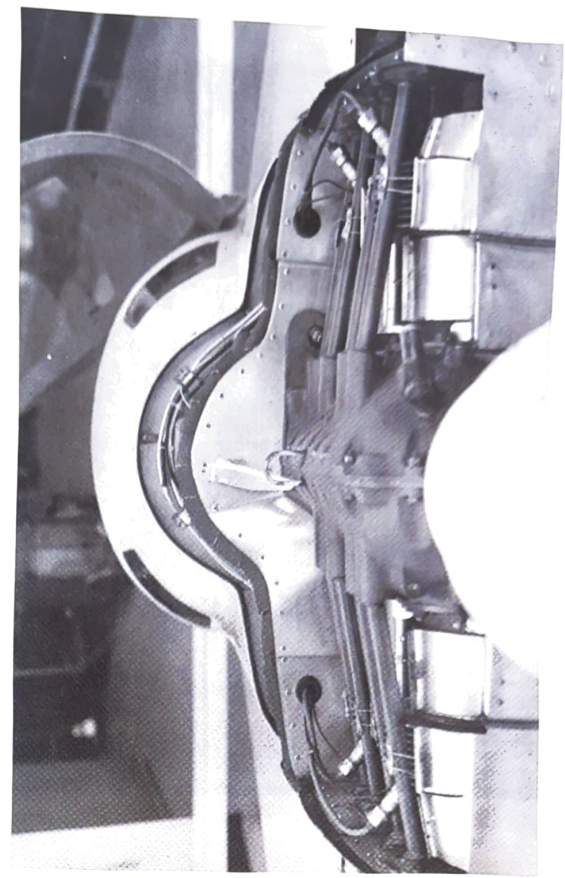
Side view of engine showing cylinder head baffles (A-24) installed between forward and aft baffles. Note heat deflector installed over exhaust pipe. Note ring gear has been removed



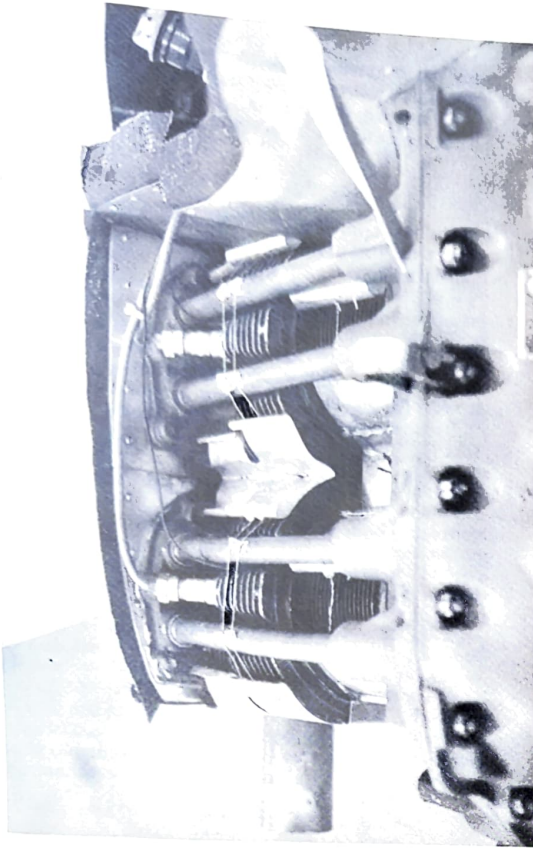
to save weight for starterless installation. Note special air flow guide for 5" prop hub extension and fiberglass spinner cone. Propellor shown is Great American.



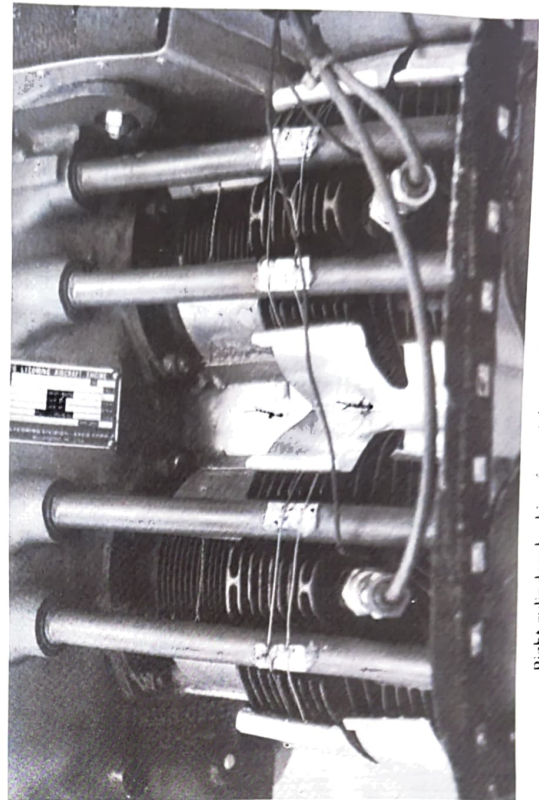
Aft baffle installation. Alternator is mounted through baffle. Air flows through alternator, from front to aft, to cool it. Aft baffle seals along the bottom against a baffle built into the lower cowl.



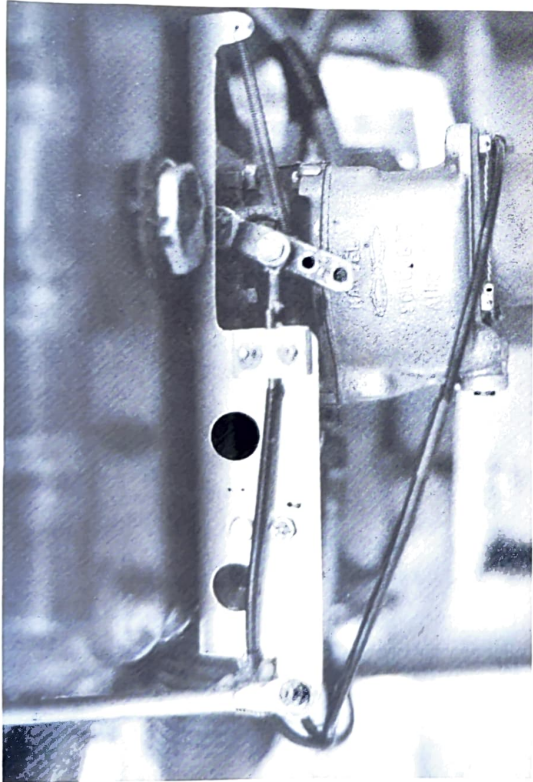
Forward engine baffle.



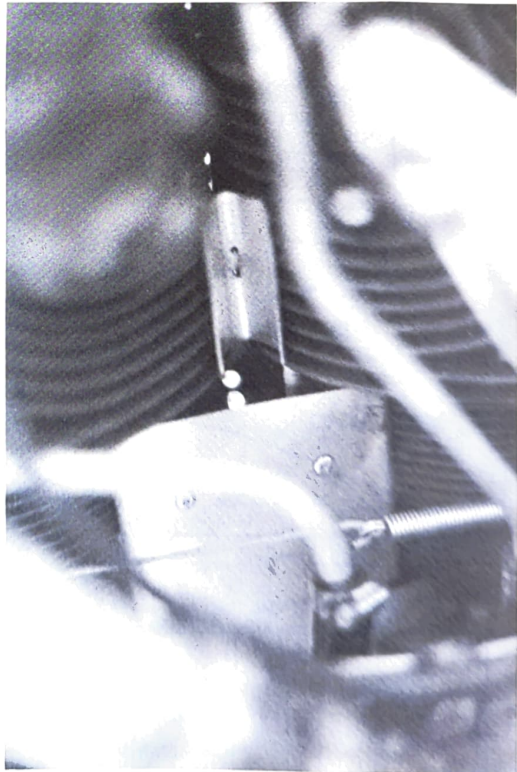
Left cylinders looking from right to left. Forward and aft baffles bend over fins. Also top intercylinderhead and intercylinder baffles. Tight baffling forces air to flow between fins.



Right cylinders looking from right to left. Tight baffling forces air to flow between fins and gives excellent cooling with least air volume and least cooling drag.



Carburetor control bracket installation.



Lower intercylinder baffles and lower intercylinderhead baffles force air to travel between fins.

CHAPTER 24

COVERS, FAIRINGS, & CONSOLES

OVERVIEW. This chapter involves installation of the map pockets, armrests, and thigh supports in the front seat, armrests, seat and air duct cover in the back seat, lower aft fuselage cover, NACA scoop and cylinder blister fairings, and canard fairing.

STEP 1. MAP POCKETS

There is room between the aileron torque tubes and the inside of the fuselage sides for map pockets to be built into the side consoles (armrests) and this is a very convenient location for them. Carve two pieces of foam 1-3/8 in. x 5-1/2 in. x 11 in. (you can use 3/8 in. PVC on top of 1 in. urethane), round the corners, stick them to the top of your work table, cover with duct tape for release, and lay up 2 plies of BID (Fig. 1). After cure, remove foam and trim mounting flange to 1/2 in. wide. Sand fuselage side and install pockets with flox as shown in Fig. 2. Hold in place to cure with clecos.

STEP 2. FRONT ARMRESTS

The right front seat arm rest is shown in Fig. 3. The left side is a mirror image. Cut out the pieces from 3/8 in. thick PVC foam. Glue them together with 5-min, using small nails to hold together while the 5 min. cures. Put them in position and trim to fit or add foam to any gaps. Cut a small bead of foam on a 45 degree angle and glue in the corner (Fig. 4), and lay up 1 ply BID on the inside. Knife trim. Trial fit. Remove foam locally as required to provide clearance for roll trim bracket RT-2 (see page 17-2). Then bond to instrument panel, CS 109, floor, fuselage side, and seat bulkhead with micro, round the corner, and lay up 2 plies BID over the top and sides, lapping onto CS 109 (Fig. 5) and at least 1/2 in. onto fuselage sides, floor and bulkheads. Note that a large hole is open around the stick. Make a cosmetic cover for this hole which allows for full stick travel, and is removable for stick access.

STEP 3. REAR ARMRESTS

The rear seat right armrest is shown in Fig. 6. Left is opposite. Cut out the pieces, assemble, glass inside, install, and glass outside using the same procedure and lay up schedule as for the front armrests.

STEP 4. THIGH SUPPORTS AND DUCT COVER

See drawings A-8 and A-9, and note thigh support shown as dotted line. Cut out 4 ribs from 3/8 in. thick PVC foam as shown in Fig. 7, using curvature from A-8 and A-9. Cut slots as shown to clear aileron roll trim cable. In addition, the left in-board rib will have to be cut out to clear the landing light. Glass with 1 ply BID each side and micro in position as shown in Fig. 8 (The outboard ribs are against the armrests).

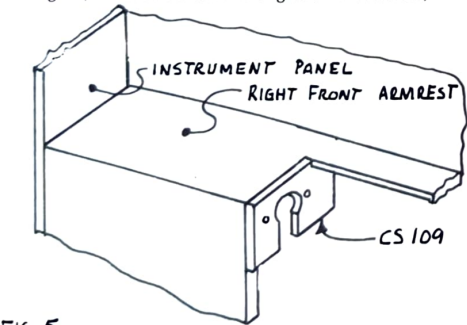


FIG. 5

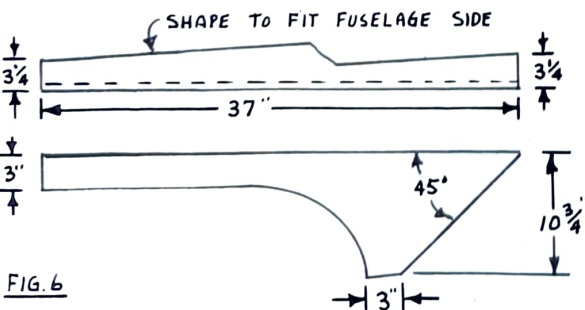


FIG. 6

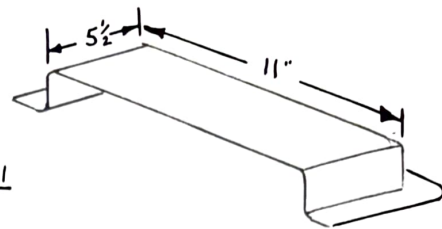


FIG. 1

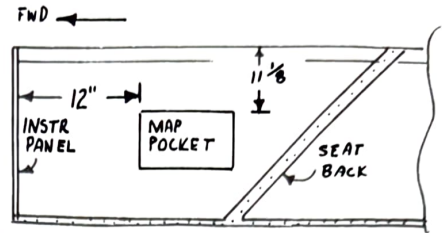


FIG. 2

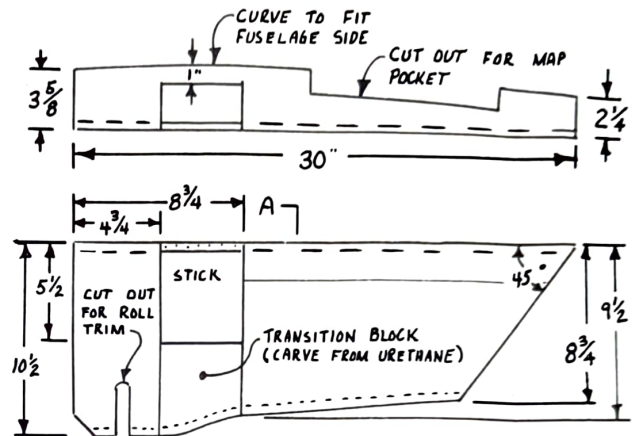


FIG. 3

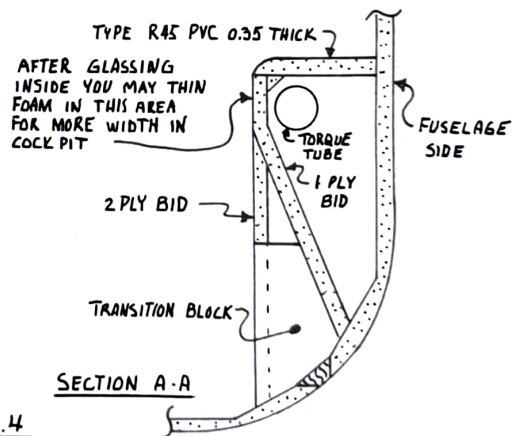


FIG. 4

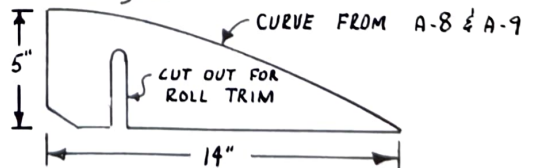


FIG. 7

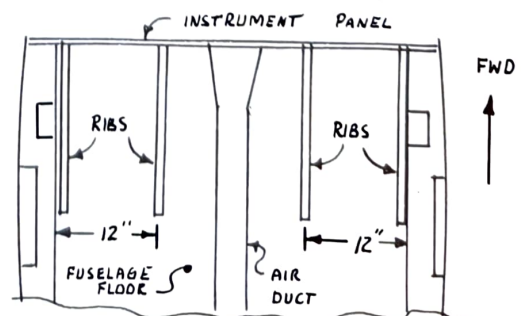


FIG. 8

After the ribs have cured, cut out 2 floors as shown in Fig. 9. These dimensions are only approximate. Use paper or cardboard to make patterns which fit exactly and transfer these to 3/8 in. thick PVC foam. The left floor will require a cut out for the landing light linkage. The floors overlap the instrument panel, butt to the side and center consoles, and the aft edge is beveled and butts to the fuselage floor (Fig. 10).

Now heat each floor piece to 280 deg. F in the oven, place it in position, and hold it there while it cures, and it will retain the correct curvature permanently. Glass the inside of each floor piece with 1 ply BID, and bond in place with wet micro. When cured, glass with 2 plies BID, lapping at least 1/2 in. onto all surrounding surfaces.

For the back seat, make 2 ribs as shown in Fig. 11. Glass with 1 ply BID each side and micro in place 12 in. apart, 6 in. each side of center.

Now, cut the back seat from 3/8 in. thick PVC 6-1/2 x 23 in., beveled where the aft edge meets the floor (Fig. 12). Trim as required to clear the seat belts, air duct, carb controls, and fuel line. Glass with 1 ply BID on bottom and micro in place. After cure, glass with 2 plies BID on top side, lapping at least 1/2 in. onto fuselage bottom. If you wish, you may hinge back seat so space underneath may be used to store tools, since it is exactly over the c.g., and a good location for anything heavy.

Now cut a piece of 3/8 or 1/2 in foam and install between the hot air duct and the fuel line. Build a cover over the air duct, carb controls, and fuel line from the front seat brace to the back seat out of 3/8 in. foam, glass with 1 ply BID inside, micro in place, and glass with 2 plies BID on the outside, lapping all surrounding surfaces by 1 in. This will protect your lines and strengthen the fuselage bottom.

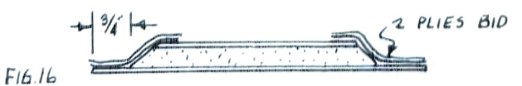
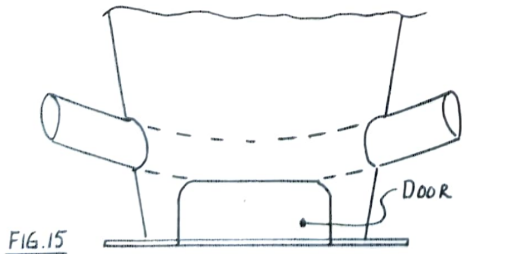
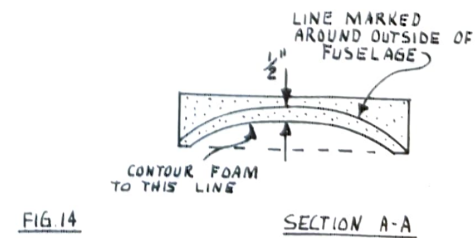
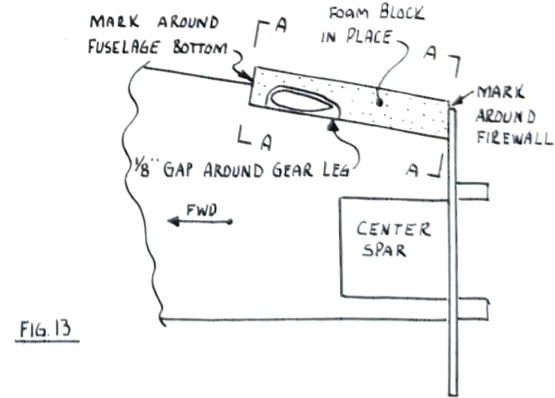
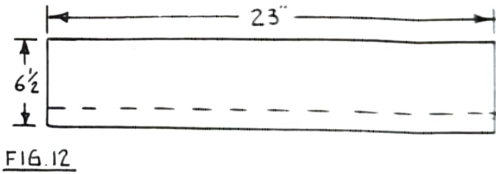
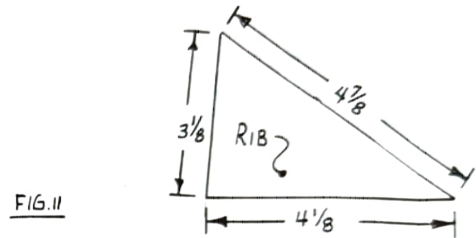
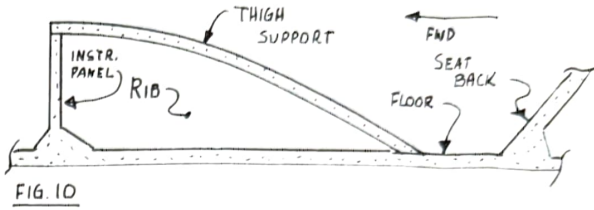
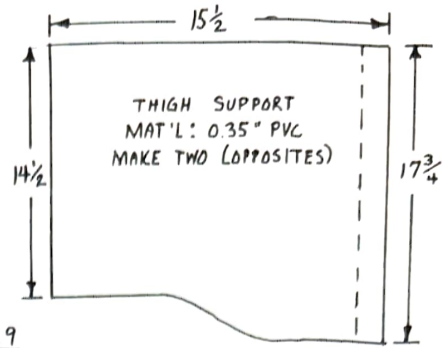
STEP 5. FUSELAGE LOWER AFT COVER

Take a deep breath! You have to turn the fuselage over (upside down) for the next several steps. Remove the canopy first, get some help, turn it over and set it on saw horses.

The lower aft cover closes up the space around the main gear forward of the firewall, and it completes the structural part of the fuselage bottom.

Grab a chunk of 2 in. thick green urethane foam 18 in. x 24 in., sharpen your butcher knife, and hack away until it sits down on the bottom longerons, and butts against the firewall and the fuselage bottom block, and has about a 1/8 in. clearance around the main gear strut (Fig. 13). Hold it in place while you mark around the front and back as shown (Fig. 13). Now remove the block and draw a line about 1/2 in inside the previous mark on both the front and the back (Fig. 14). Dish out the block up to the new lines. This dish job is done to maximize the space in the gear compartment and to clear the fuel system components at the firewall.

Place the block on your table with the dished side up and glass the dished area with 1 ply BID, any fiber orientation. After cure and trim, install on the fuselage with a few dabs of bondo or 5-min. epoxy. Now carve the outside to fair the contour in with the forward fuselage, sides and firewall. Cover the forward fuselage and sides with 1 layer of duct tape (for release), and glass the outside of the cover with 2 plies BID, any orientation. Knife trim around the main gear strut. After cure, mark the outline of the inspection hole and door as shown on drawing A-19 and Fig. 15. Carefully saw around this mark and remove the inspection door. Put the door upside down on your work bench, trim the glass and foam away down to bare glass, about 3/4 in. back, all around the edge. Glass with 2 plies BID (Fig. 16). Now lay up 1 ply BID on the bare foam inside the inspection hole, using flex corners (Fig. 17).



After cure, pop the fuselage cover loose from the fuselage, and trim and sand the layup on the inside edges of the hole. Cover the back side of the door with tape or plastic and fasten it in the inspection hole with A-sticks and bondo. Now lay up a 4 ply BID flange inside the hole against the backside of the door (Fig.18). You will have to skip the flange at the firewall, and build that later. After cure, drill five #12 holes through the door and flange as shown (Fig.19), pop the door loose, trim the flange down to 5/8 in. width, and install **MS21069-08** nutplates. Then install the door with **AN509-8R5** screws (for rigidity).

Now install fuselage cover in place on fuselage with flox. Hold in place with weights to cure. Reach inside and wipe away excess flox. Do not flox to gear. Gear must be free to bend with landing loads. Tape joints with forward fuselage and fuselage sides and firewall with 2 plies BID. After cure, build flange on forward face of firewall with 4 plies BID (or aluminum angle) for fastening aft edge of access door, and install one or two nutplates and screws.

STEP 6. NACA FLUSH SCOOP

Drawing A-19 gives the dimensions for the NACA flush scoop. It extends from the firewall forward almost to the landing brake. It is absolutely necessary for the outside edges of the scoop to be sharp (Fig.20). The inside corners are not critical.

Trace the outline of the scoop on the fuselage bottom (Fig.21). Make sure it is centered. Now build a fence along the outline using 1/4 in. low density Clark foam (or 3/8 in. PVC) and 5 min. in place (Fig.22). Height of the fence is given by the Z-shaped cross sections on A-19, but make the heights a little oversize for now. Use blocks of wood or foam to hold the fence at 90 degrees, if necessary, and glass the inside of the scoop with 2 plies of BID (Fig.23), using micro corners (remove the door and glass over the flanges, except fill the nutplates with wax or grease to keep the epoxy out). Knife trim.

Now line some cardboard with wax paper or cover with 2 in. wide box sealing tape (for release) and tape it in place along the side of the fuselage as a dam for the pour foam you will be using (Fig.24). Special treatment is necessary around the main gear. First, tape with masking tape the clearance between the gear and the fuselage, so the pour foam won't run in. Next, with wide tape, build a pocket around each gear leg (Fig.25), so the pour foam will run under and form some foam you will need to make the fuselage-gear transition fairing. When all the dams are set up (check for leaks), you can start mixing and pouring foam. All of the foam should be poured at once, but this is difficult to do in practice, so get set up ahead of time to make a number of small pours in rapid succession. You need throw-away mixing containers. 1 qt. milk cartons work well, but cut them down to about 8 inches tall. They should be clean and dry. Get some long mixing sticks (like for paint) and mark them 2 in. and 4 in. from the bottom. Now pour 2 in. of part A and 2 in. of part B into one of the containers and start mixing. After about 1 minute, the mixture will start to foam and expand. Let it grow to almost twice the original volume and then start pouring. Don't pour too much in one place, because it doesn't spread sideways very well. Don't distribute it too thinly, because it loses the heat and then doesn't foam very well. Shoot for something in between (Don't try to spread the foam with a trowel—it just doesn't work). Get it poured in a hurry and start mixing some more so you can fill in the low spots as though it is a continuous pour. The foam will really billow out in places, but continue mixing and pouring until all the low spots are above the trim lines.

When the foam has cured and cooled, peel away the cardboard, and carve away the excess foam. Spline sand the fuselage bottom and sides to fair in smoothly with the existing contours. The height of the scoop doesn't have to be exactly as shown on A-19, as long as it forms a smooth, pleasing curve from the landing brake to the firewall.

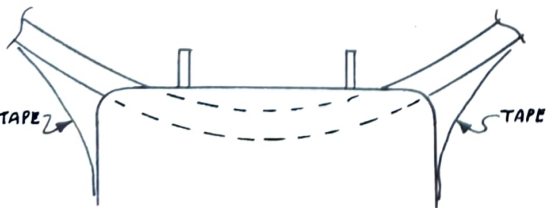


FIG.25

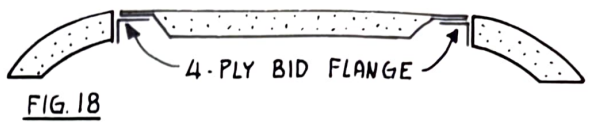


FIG.18

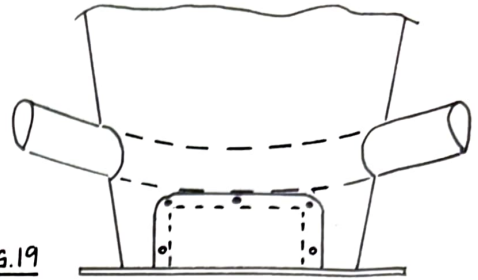


FIG.19



FIG.20

CROSS SECTION NACA SCOOP

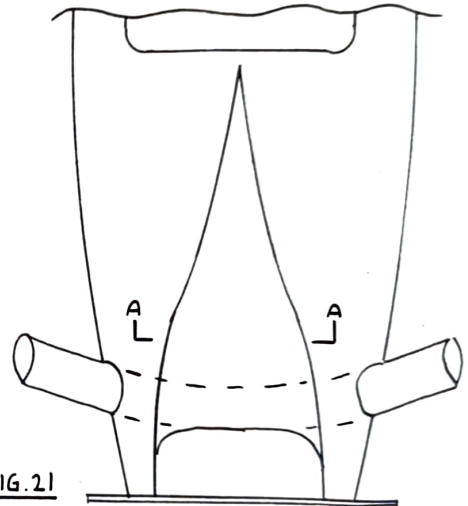


FIG.21



FIG.22

SECTION A-A

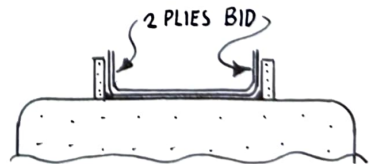


FIG.23

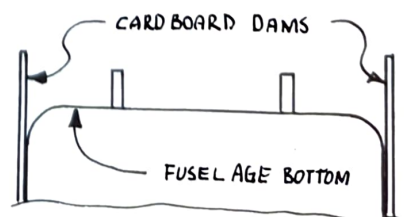


FIG.24

FUSELAGE BOTTOM

Carefully shape the foam to get a nice transition from the fuselage to the gear. Make floc corners on the edge of the flush scoop and glass with 2 plies BID, 45 degree orientation (Fig.26). After cure, carefully saw through the glass and foam around the gear (don't saw into the gear) to allow the gear to flex without breaking the fiberglass or cracking the paint (Fig.27).

It will improve the airflow inside the cowl and improve engine cooling efficiency if you install a turning vane where the NACA scoop terminates at the firewall (Fig.28). This can be made from foam and glass or from .025 in. aluminum.

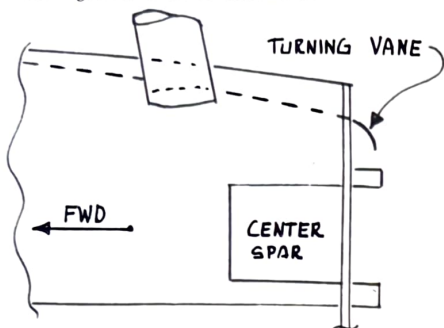


FIG. 28

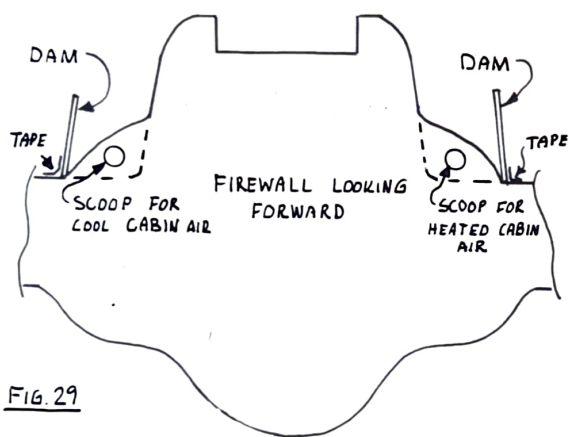


FIG. 29

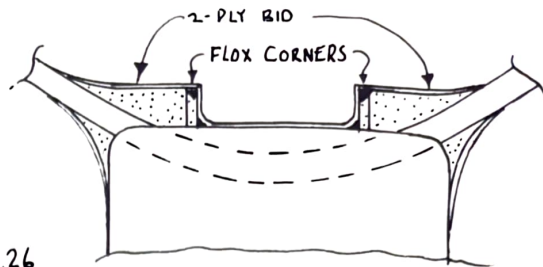


FIG. 26

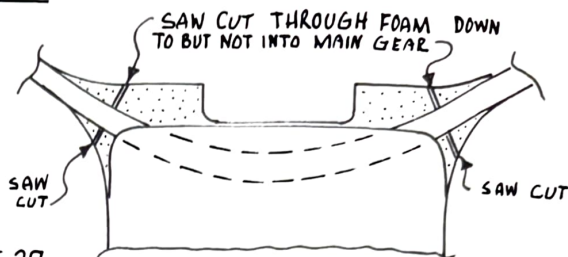


FIG. 27

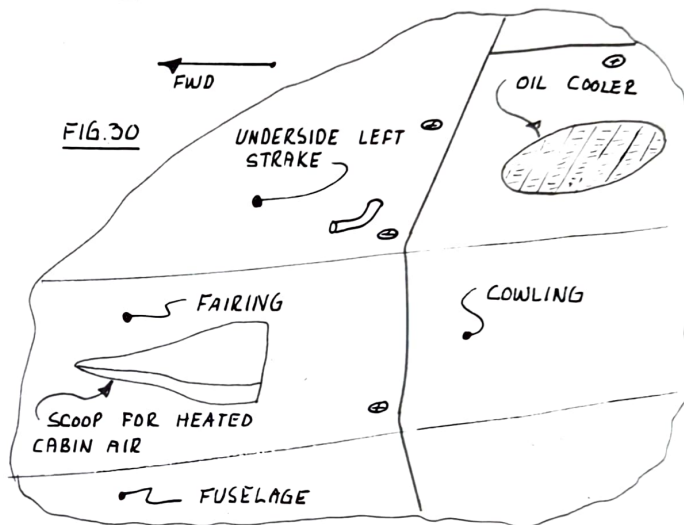


FIG. 30

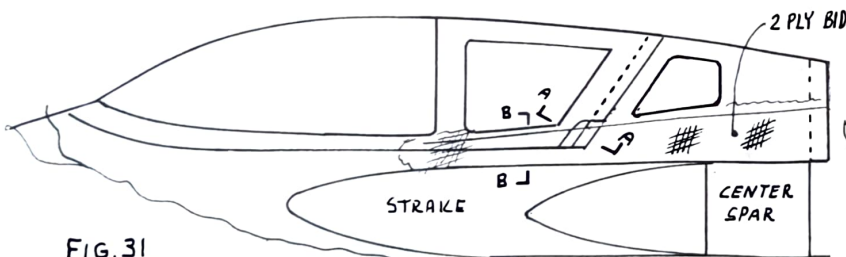
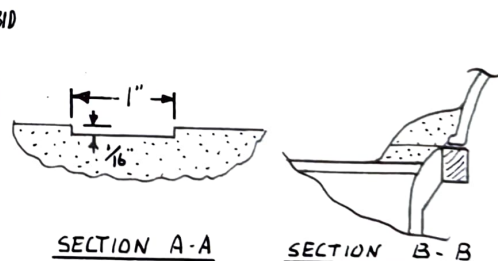


FIG. 31



SECTION A-A

SECTION B-B

STEP 7. BOTTOM STRAKE FAIRINGS

These fairings taper forward from the firewall all of the way to the leading edge of the strake, enclosing the fuel sumps in one continuous, smooth curve. They are made from pour foam the same way you made the NACA scoop. Make a dam along each side with cardboard and tape it in place at the bottom (Fig.29). Then pour foam in place. After cure, contour to shape and glass with 2 plies BID.

Then install a small NACA scoop on each side (Fig.30), to bring fresh air from outside into the engine compartment, through the firewall, one for the cabin heat muff and the other for cool cabin air. The scoops are made and installed the same way as in Chapter 18, except the delivery pipe is 1-1/2 in. dia. and passes through the firewall (Fig.30).

STEP 8. TOP STRAKE FAIRINGS

Now turn the fuselage right side up and build the top strake fairings. This job is slightly more complicated because the fairings extend forward and a portion of them open with the canopy.

If you have already built a lip on the aft end of the canopy, remove that portion of the lip which will be covered by the fairing. Tape over the crack between the canopy and the fixed part of the turtle back, and between the canopy and the longerons, using masking tape just wide enough to bridge the

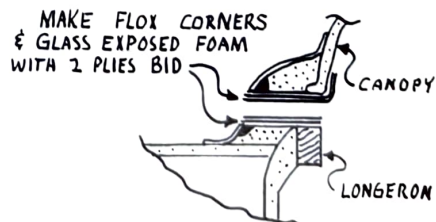


FIG. 32 VIEW THROUGH FAIRING LOOKING FORWARD

gap. Now, in the same manner as the bottom fairings, build a dam, pour foam, and after cure, contour it. Be sure to sand a 1/16 in. deep x 1 in. wide depression (Fig.31) for the later installation of a cowl lip.

Now, glass the fairing with 2 plies BID. After cure, cut through the fairing with a saw so you can open the canopy. Open up the saw cut to 3/16 or 1/4 in. and glass the exposed foam with 2 plies of BID using floc reinforced corners (Fig.32). Now complete the lip on the aft end of the canopy, so it extends over the fairing as well as the fixed portion of the turtleback for rain-proofing.

STEP 9. CANARD COVER

Install the canard on the fuselage. Cut a 2 in. thick urethane foam block and fit it to the fuselage and canard as shown (Fig. 33). Make the block wider than the fuselage contours; it will get carved down later. Protect the fuselage, nose, F-28, elevator slot, etc., with gray tape or Saran wrap. Sand the top of your canard dull for bonding where it contacts the foam block. Mix wet micro, apply it to the top of the canard, and squish the foam block into position. Clean off any squeeze-out. Let the micro cure. Carve the outside of the foam fair with the fuselage contours. Sand a 1/16 to 1/8 in. deep depression at the aft edge, just forward of F-28, for a lip to be built later to rain proof this joint (Fig. 34). Apply duct tape on the top of the nose, forward of the canard cover, for release for the lip which covers this gap (Fig. 35). Now glass with 2 plies BID. Glass should lap outboard on the canard at least 1/4 in., and forward on top of the nose 1/2 in. Knife trim edges when ready. After cure, remove canard. Remove enough foam to allow for thickness of the inside layup. Glass all bare foam surface with 2 plies BID and use floc corners. Knife trim.

After finishing, install some soft foam rubber where the elevator torque tube passes through the fuselage side, to seal major air leakage. Bond the foam to the fuselage and/or canard with silicone rubber.

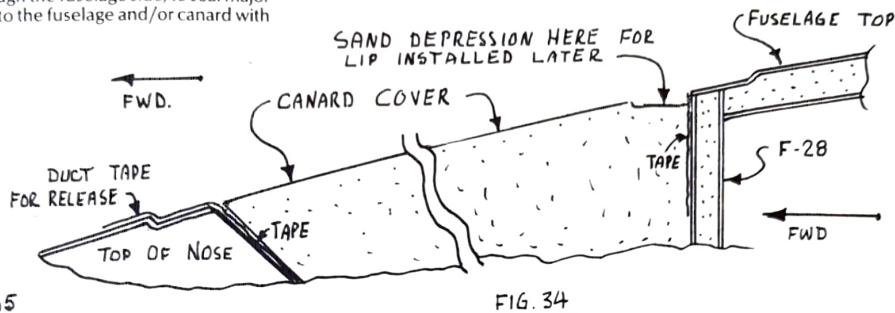
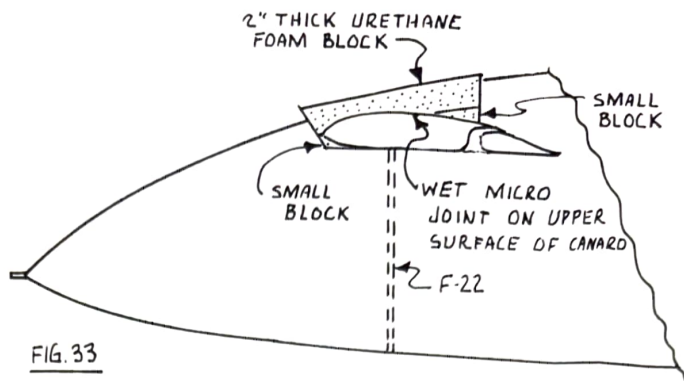


FIG. 35

FIG. 34

STEP 10. WING CENTERSECTION SEAL

Refer to Fig. 36, which shows how to seal the 1/2 in. gap between the wing and centersection spar. Cut wedges of urethane foam, apply micro to the wing side, push them into place and allow to cure.

Sand to contour and sand a 1/16 in. gap at front. Remove wing and glass around with 1 ply BID. Cure. After painting fill the gap with silicone rubber. Use release (Saran wrap) on one side if you plan to remove wings often. If not, simply fill the small gap (cut with razor blade when removing wing). Seal this area, including wing leading edge/strike gap, well. Air spillage here reduces performance significantly and spills engine cooling air.

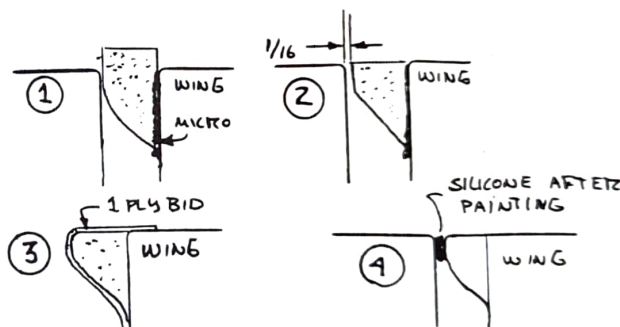


FIG. 36

STEP 11. OPTIONAL ICE SHIELDS

The Cozy was not designed to fly in icing conditions. No de-ice or anti-ice provisions have been made. The aircraft has **not** been tested in icing conditions. However, RAF does have some limited icing experience in the Defiant, an aircraft with similar structure and configuration. They found that that aircraft handled ice quite well, with no discernable trim changes. However, they found that ice forms on the blunt leading edge of the outboard elevator balance weight, and could restrict elevator travel. They installed ice shields on the Defiant to correct this problem.

If you are contemplating IFR operation of your COZY, you should install ice shields detailed in Fig. 37 and Fig. 38. They are merely a 3-ply BID shield in front of the balance weight.

Wait until after the featherfill application so the shields don't interrupt your ability to smoothly contour the canard surface. Install the elevator with 2 hinge screws. Tape it in the 10 degree elevator position (use the elevator template in Chapter 11). Sand away any featherfill down to bare glass on the canard skin out to 1/2 in. from the balance weight. Apply at least 8 thicknesses of grey duct-tape to the balance weight sides and front to provide clearance. Then layup 3 plies BID as shown in Fig. 37 & 38 over the weight lapping 1/2 in. onto the canard skin. After cure remove elevator and grey tape.

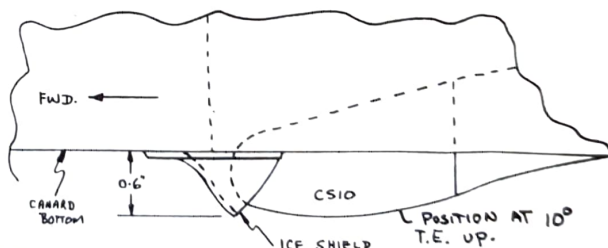


FIG. 37

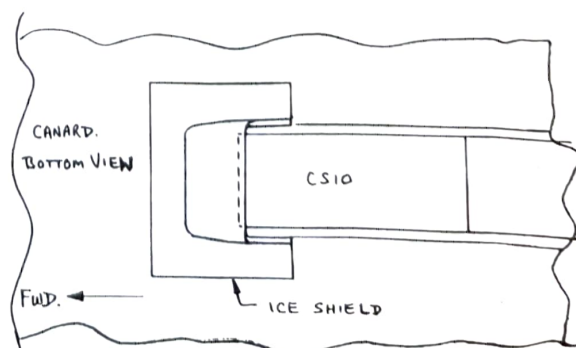
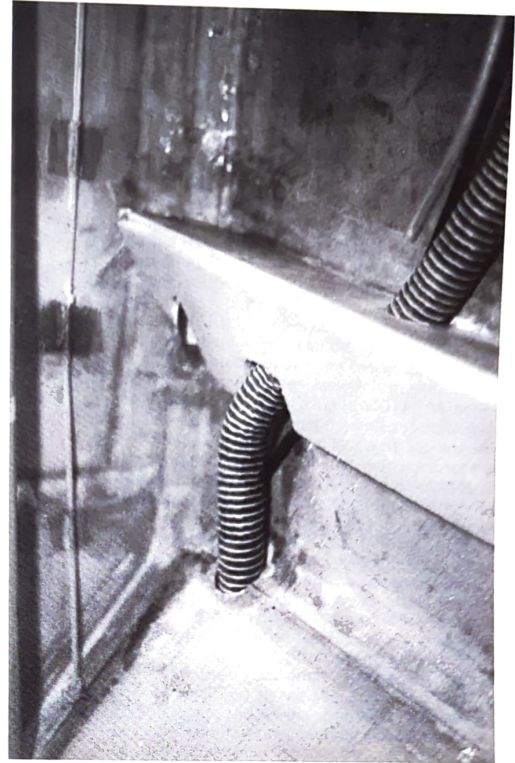


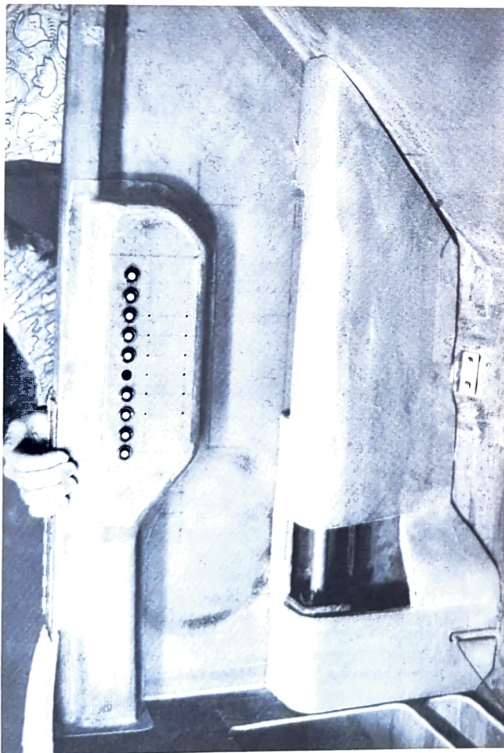
FIG. 38



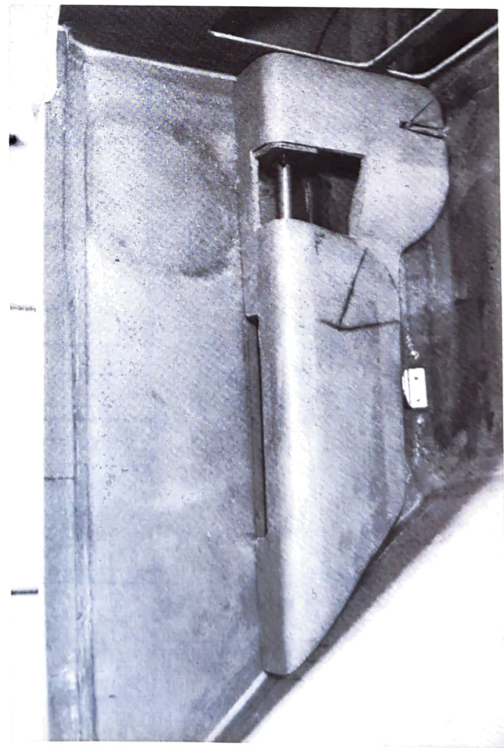
View under left strake showing flush scoop for heated cabin air and oil cooler outlet through cowl.



Duct for heated cabin air from fire wall passing through back seat.



Space saver panel (above) and right arm rest (below)



Left arm rest.

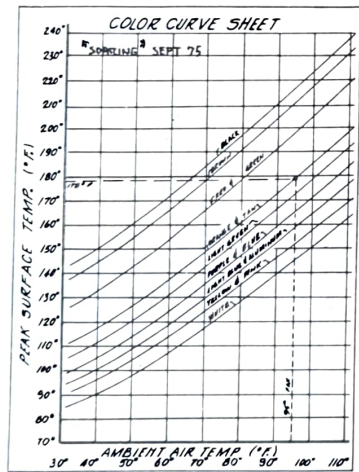
CHAPTER 25

FINISHING

Finishing the composite airplane is more important than simply obtaining an attractive paint job. The finish on a composite aircraft serves to protect the structure from weathering and deterioration from ultra violet radiation (sunlight). The finishing materials also give the airplane its final aerodynamic shape. Using the proper materials and techniques, the finishing process is fast, pleasing (both esthetically and aerodynamically), and provides for long maintenance-free service. Use of sub-standard materials can limit the life of the finish, result in an overweight airplane, or even limit the service life of the airframe. Sanding is done constantly during the finishing process and extreme caution must be exercised to avoid damaging the structure. A poorly executed finishing job can destroy the structural integrity of the airframe. Even the finish color of the composite aircraft can effect its structure. Proper techniques must be adhered to for safety as well as to obtain an attractive airplane.

FINISH COLORS AND HEAT

Epoxies and foams are all sensitive to high temperatures. Room temperature curing epoxies soften and lose their rigidity at only moderate temperatures (160 degrees F). Foams are also heat sensitive and tend to soften and swell with moderately elevated temperature (250 degrees F). The sun is a potential source for heat. In still air, on a hot sunny day it is possible to obtain surface temperatures that approach 220 degrees F on a black airplane. Color of the surface determines how much solar heat it will absorb. White surfaces absorb very little (10%) of the sun's heat while a black surface (95% absorption) will heat up tremendously. The accompanying graph shows the relationship between color and surface temperature. White has been chosen as the only color for fiberglass sailplanes to preclude any possibility of excess temperature due to solar heating. The same criteria apply to the Long-EZ. White is the only recommended color for these aircraft. Trim colors in non-critical areas are acceptable as desired, such as the fuselage, vertical winglet surfaces, and the underside of wings and canard. Dark trim colors are definitely not approved on the upper surface of the wings and canard. Do not stripe wing or canard with trim, except at the canard tip where structure is not critical.



MATERIALS AND TOOLS

The materials you will be using to finish your airplane fall into four categories. The first is contouring materials. The material commonly used on automobiles, bondo, is a filled polyester and is not recommended because it is heavy, and does not bond well to fiberglass. The best material is one you are already familiar with, namely, dry micro (epoxy loaded with microspheres). It is the lightest material available, bonds well (if the fiberglass is clean and has been sanded) and sands well (if you mix in the maximum amount of microspheres). Unfortunately, dry micro does not spread or trowel very well on the first application, so you will have to apply it more than once, with a cure in between. Dry micro is the material recommended to bring all of the surfaces into contour; that is, level and of the correct shape. After the surfaces have been contoured, you will need to use a filler, to fill pits and waviness up to .030 in. There are polyester fillers (Feather fill and Eliminator), epoxy fillers (Viking Paint's EP-2) and urethane fillers (Sterling U-1761, U-1762). The polyester fillers are the cheapest and most popular. They are fast curing and sand well. Unfortunately, however, they do not bond well to fiberglass, and

instances have been reported where large areas of finish have peeled off. If you do use a polyester type, make sure the surface underneath is clean, and has been well sanded with 36 grit paper to give the filler a maximum mechanical "bite". Feather fill does not like humidity or moisture and you must never wet-sand Feather fill. You can add a fair amount of microspheres to most fillers, which will make them lighter and easier to sand. Epoxy type fillers are a little more expensive, but bond very well and sand very well. Unfortunately they typically take 48 hours to cure, even though they may be dry to the touch in a couple of hours. Urethanes are famous for their adhesive qualities and, given a clean surface, they will generally stick forever. Sanding the glass is still recommended, however, as there is nothing more disappointing than having your beautiful finish peel off! The Sterling product can be applied in high humidity environments, and wet sanding is recommended. In other words, the material is essentially impervious to moisture. Sterling is more expensive than Feather fill and it does seem slightly more prone to having pin holes after final sanding. But these can be filled with more Sterling, or 3M spot putty. One of Sterling's finest attributes is that it cures rapidly and can be sanded about an hour after application. After the filler comes the primer. Primers smooth and prepare the surface for the final finish paint. Primers provide U.V. protection, they are easy to apply by spraying, they are fast drying, they are easy sanding, and capable of providing a very smooth surface (up to 600 grit). Whichever top coat you intend to use (we recommend a good brand name such as duPont, Ditzler, Sherwin Williams, Sterling, etc.), it is recommended that you use that manufacturer's primer. The duPont primer is 1315, and any of duPont's top coats, acrylic lacquer, acrylic enamel, or polyurethane (Imron) go well with it. For the final topcoat, you can use any of the (white) automobile lacquers, enamels, or urethanes. The lacquers are easy to work with, but provide the least durable surface. Acrylic enamels are a good choice. Some (like duPont) offer hardeners which impart some measure of urethane. The urethanes are absolutely the best. They are tougher, more flexible, and stick on better. They give your airplane that sexy, "wet" look. Urethane spraying fumes are a health hazard, but you should use a good quality spraying mask regardless of the type of paint you select. We used Ditzler's Deltron acrylic polyurethane, and it went on well, it looks great, and it is reportedly easy to repair. Sanding will occupy a large percentage of the time spent finishing the composite aircraft. Sandpaper in 36 to 60 grit, 100 grit, 220 grit and 320 grit roughnesses will be used. Standard 9 in. x 11 in. sheets are the most versatile. Use a good quality aluminum oxide, or silicon carbide sandpaper. Don't waste your money on the cheap flint-type sandpapers. Power sanders are not recommended; it is too easy to damage the structure while using them. Hard (wood) and soft (foam) sanding blocks and a sanding spline (Fig. 1) will be your primary finishing tools. A paint spraying setup will be needed for the filler, primer, and finish painting. Some hand brushing of filler and primer will also be done.

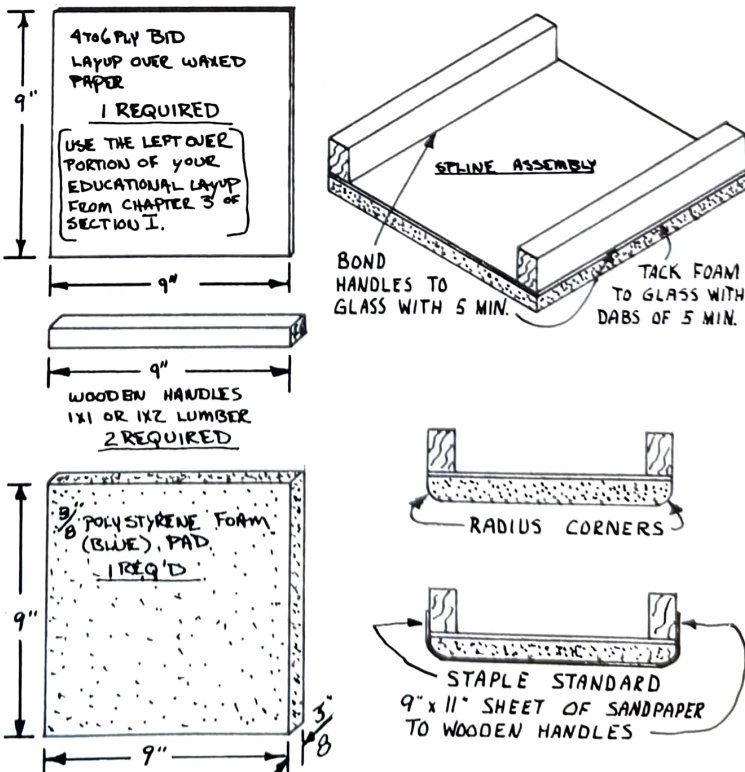


FIG. 1

THE SPLINE

The sanding spline is a finishing tool common to the sailplane industry. It is an easy tool to make and does an excellent job of contouring. You may find it handy to make two, one for coarse grit sandpaper and one for medium or fine sanding. The accompanying sketches (Fig. 1) show the piece of fiberglass, the styrofoam pad and the wooden handles which are needed to make the spline, how they are assembled, and then how the sandpaper is attached. The spline is easy to use but it may require your close attention at first. The spline is always held with handles parallel to the leading edge of an airfoil surface (wing, canard, etc.) as shown (Fig. 2). The sanding motion is on a diagonal to the leading edge while the spline's handles are held parallel. This takes a little getting used to but becomes second nature after a little practice.

THE FINISHING PROCESS

Finishing the composite airplane is a five-step operation. Repairs or rework of structure must be completed first before the obscuring finish is applied, and final structural inspections must be complete. Second, coarse contour filling is done with micro mixed with epoxy (dry micro) as required in areas requiring .03 inch to .20 inch of fill. Any exceptionally gross filling (over .20 in) is also accomplished at this stage using a foam filler. The initial contour sanding begins with the cured dry micro, and exceptional caution must be exercised to avoid damaging the structural skins while sanding. Third, a filler is applied to fill medium sized surface defects up to .03, and as a general fill of the glass surface weave. The fourth step is the application of an ultra violet barrier primer. Fifth, the final finish paint is applied.

Sketches are provided to illustrate each of the points in inspection/repair/finishing. The sketches are exaggerated in scale to illustrate the point more clearly.

STEP 1. Inspection/Repairs

When you begin finishing, the entire structure must be airworthy. You can hide poor workmanship from your own eyes and from the inspector who will finally approve your first flight, but you can't fool mother nature! Everything has to be structurally sound before finish materials are applied. The following sketches (Fig. 3) are a review and clarification of the quality control criteria found in Chapter 3.

Each airplane must have a thorough inspection and required repairs completed as the first step in finishing. Comply with the 12" ruler check (page 3-10) for bumps, joggles, and dips. Inspect both the wings and the canard for defects illustrated in Sections A-A, B-B, C-C, D-D, and detail E (Fig. 3). For any defects found requiring repair, refer to Education Chapter 3.

FIG. 2

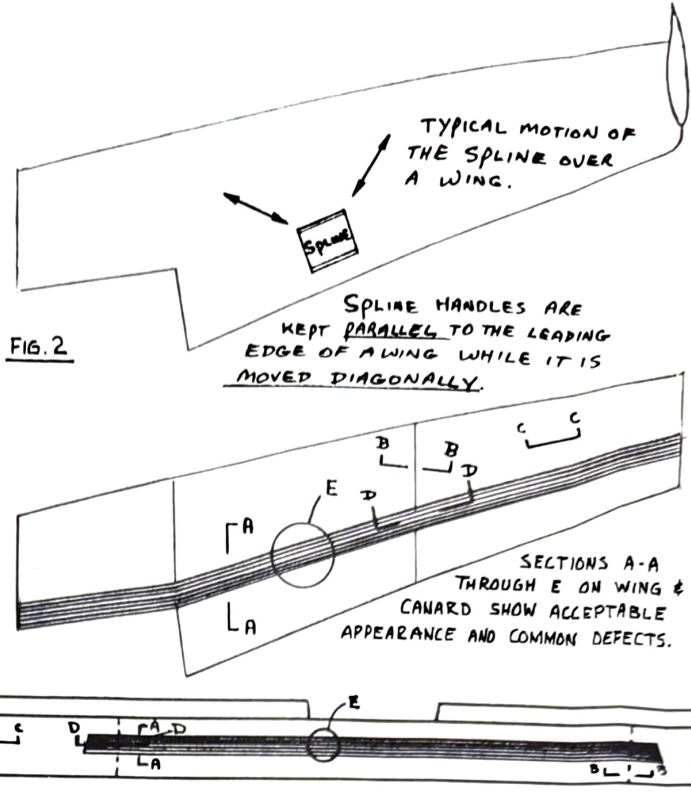
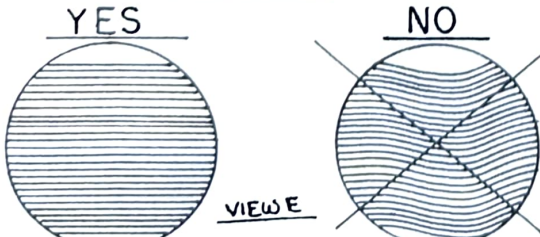
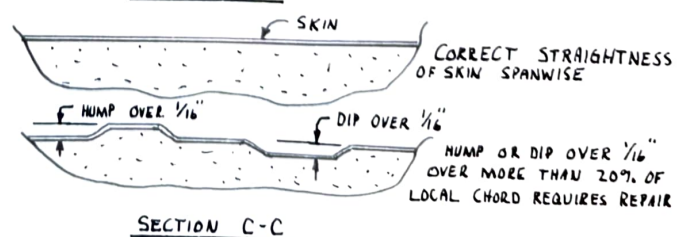
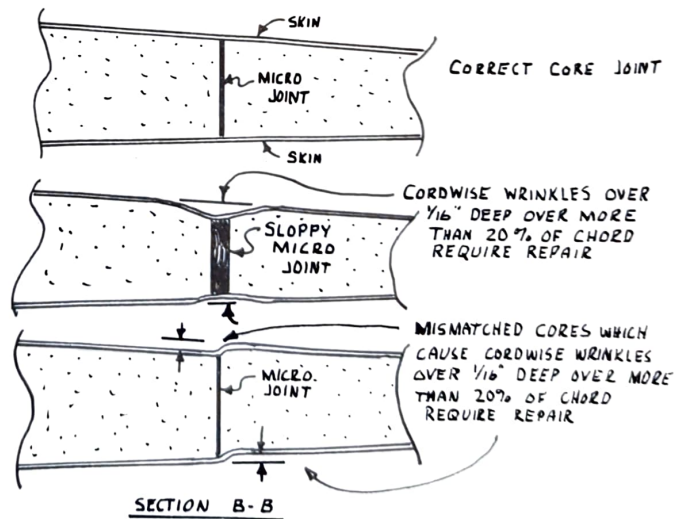
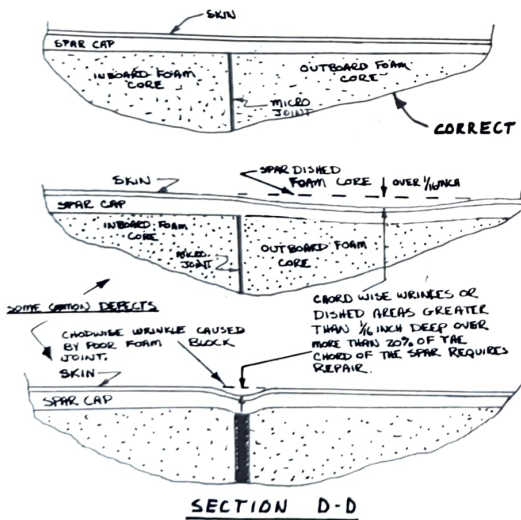
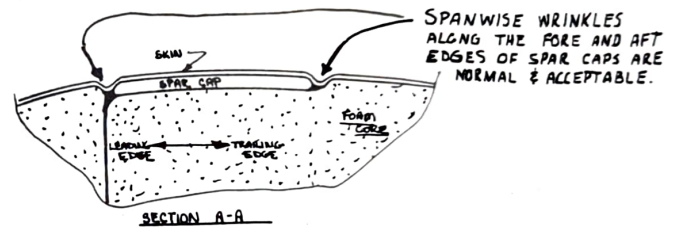


FIG. 3



THE UNIDIRECTIONAL FIBERS SHOULD BE STRAIGHT AS SHOWN ABOVE.

THE FIBERS SHOULD NOT BE DISRUPTED OR CROOKED AS SHOWN HERE.

STEP 2. COARSE FILLING TO CONTOUR

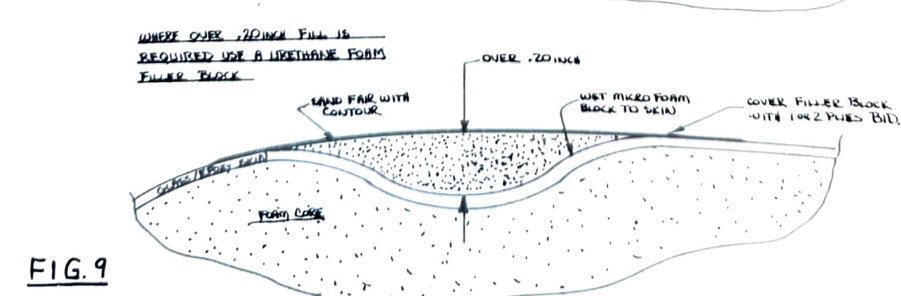
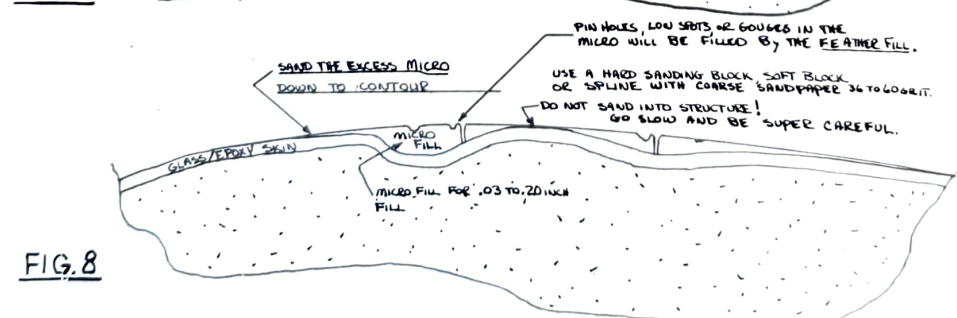
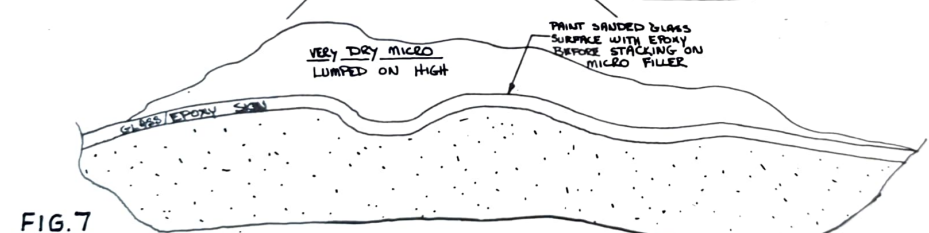
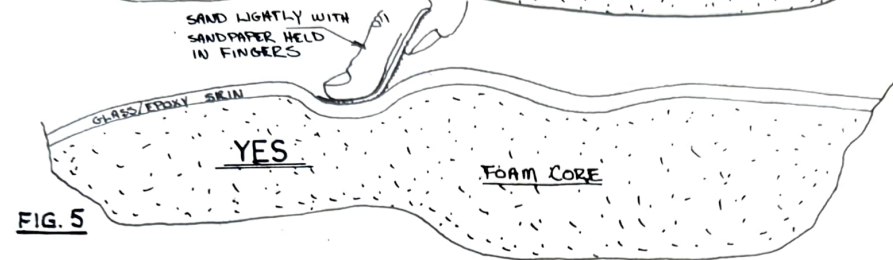
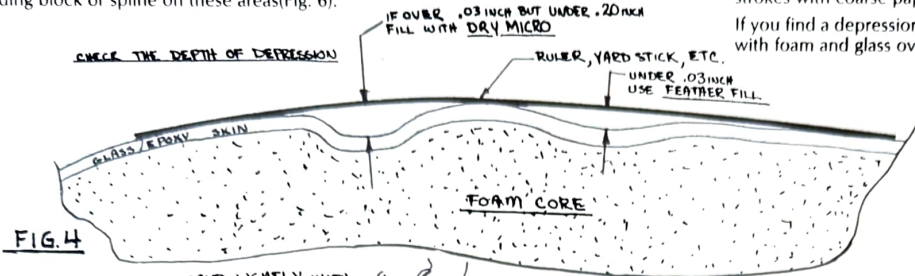
You must be extra cautious in this step or you may destroy your structure. When you take a piece of sandpaper and start grinding on your composite structure, it's like using acid to clean a metal wing spar. It must be done carefully!

Start by determining which areas require micro filler as shown (Fig. 4) using a flexible yard stick and a scale. Prepare the areas to be filled by hand-sanding lightly (Fig. 5). Do not try to use a sanding block or spline on these areas (Fig. 6).

Paint a thin coat of epoxy over the area to be filled (Fig. 7). Dry micro is then lumped over the area. The fill must be high, such that material is sanded away to bring the area into contour (Fig. 7). The micro should be mixed very dry (lots of microspheres to save weight). Let the micro cure at least 24 hours. Be sure to use glass bubbles, not microspheres with Safe-T-Poxy.

Sand the micro overfill into contour using a hard sanding block, or spline with coarse (35 to 60-grit) sandpaper (Fig. 8). Exercise extreme caution while sanding. A few careless strokes with coarse paper can ruin your structure!

If you find a depression deeper than .20 in., you should fill it with foam and glass over as shown in Fig. 9.



STEP 3. FILLER (FEATHER FILL, ETC.)

Sand the surfaces lightly by hand or with a soft foam sanding block in preparation for Feather fill (Fig. 10). A brush coat of Feather fill will build up .02" to .03" thick, fill the glass weave and any medium size out-of-contour spots (Fig. 11). Feather fill will require several hours curing time before it can be sanded. The cured feather fill is sanded to contour using a spline or soft block and 100-grit sandpaper (Fig. 12). Do not use 36-grit on feather fill. Again, extreme caution must be exercised not to damage the glass structure in pursuit of a good finish. The contouring must stop immediately when the highest glass peaks begin to be visible as the Feather fill is sanded away.

If you find that you have underestimated the fill required or just have a thin coat, don't hesitate to use a second coat of Feather fill. A well prepared surface generally won't need more than one coat. When you have finished contouring the Feather fill, the surface should be basically smooth and fair. The primer to follow is not intended to be contoured heavily, just smoothed with finer sandpaper for a smooth finish while leaving a substantial ultraviolet barrier. Be sure the surface is

dry, dull and clean. Be sure the Feather fill and shop is at least 70 degrees F. Mix the catalyst with a paddle or wire on your electric drill motor. After mixing catalyst, mix in about 25% by volume of micro balloons, and brush on. Micro balloons makes it go further, fill better, and sand easier. Feather fill catalyst is extremely dangerous to sensitive tissue. Use eye protection. A small amount in the eye can cause vision damage.

When finishing glass in preparation for Feather fill, use coarse 36-grit paper, since Feather fill requires a mechanical bond, not a chemical bond.

Do not wet sand Feather fill, it absorbs moisture. Feather fill cannot be used over primer. 3M sanding screen type 18N FABRICUT WETORDRY silicone carbide 180 works excellently on Feather fill. It is available at lumber yards.

After you have filled and contoured, reinspect for sanding damage, it is an easy thing to do! Remember you are only allowed to sand into the first skin ply in local areas no greater than 2 inches in diameter and all of these areas must total less than 5% of the surface area. Be careful!

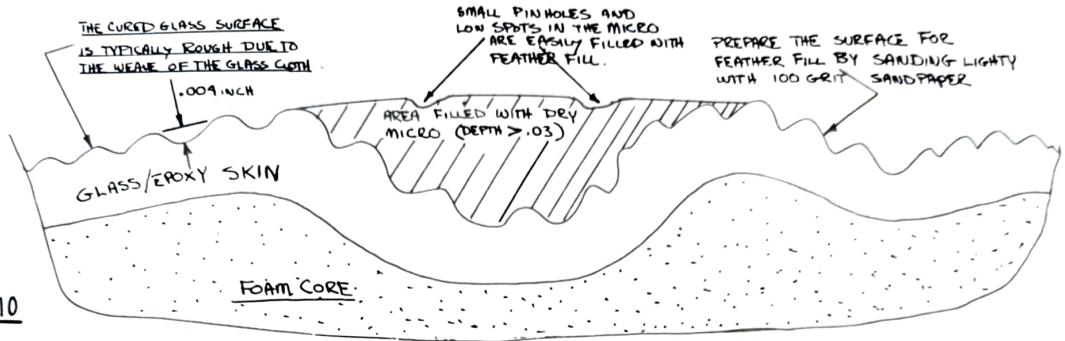


FIG. 10

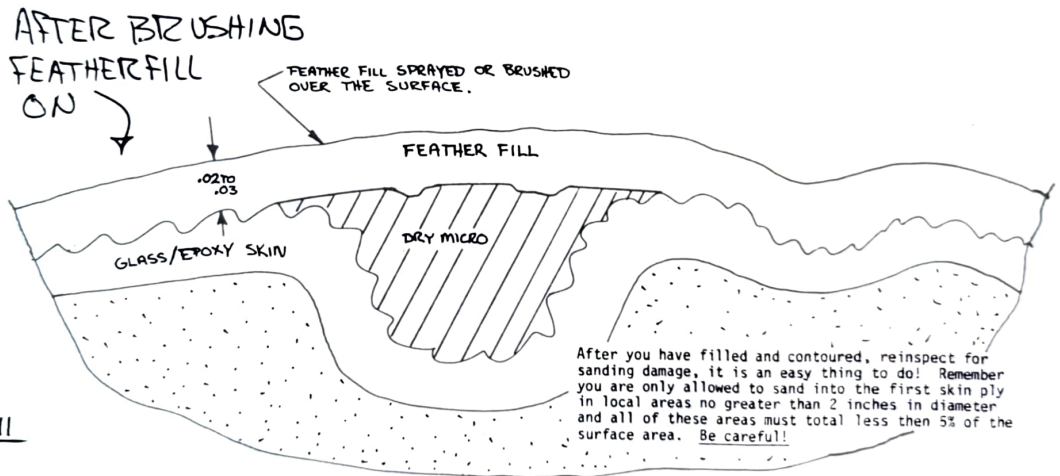


FIG. 11

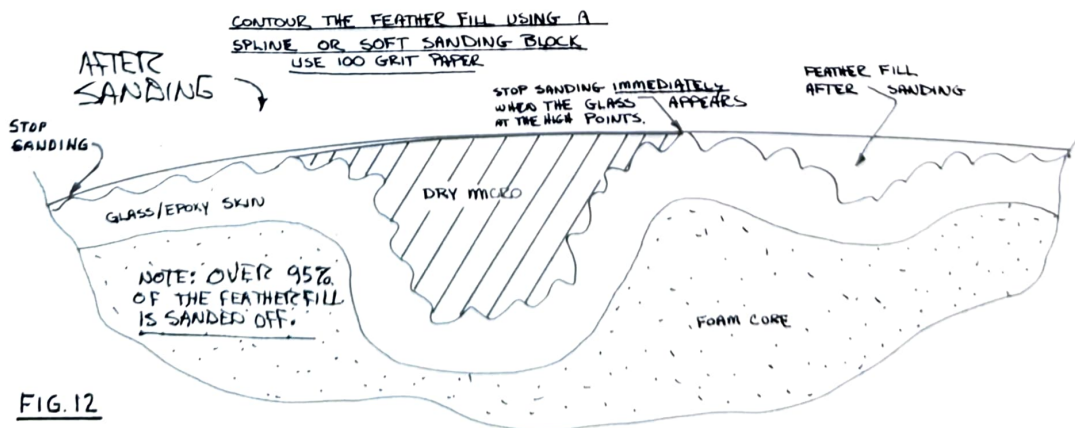


FIG. 12

STEP 4. PRIMER

The ultra violet radiation barrier is provided by the heavy carbon black content of the dried primer (Fig. 13). The primer gives the whole surface a flat black or dark grey color and the sanding should never remove it completely, exposing the light gray Feather fill below. The primer is sprayed on, allowed to dry, and sanded lightly to achieve a smooth surface. The first primer coat is sanded using 220-grit and the second coat very lightly wet sanded with 320-grit. When complete, the primer is very smooth, dark, and ready for finish paint. Inspect for imperfections or pin holes. Fill with lacquer spot putty (in a tube) and feather with 320-grit.

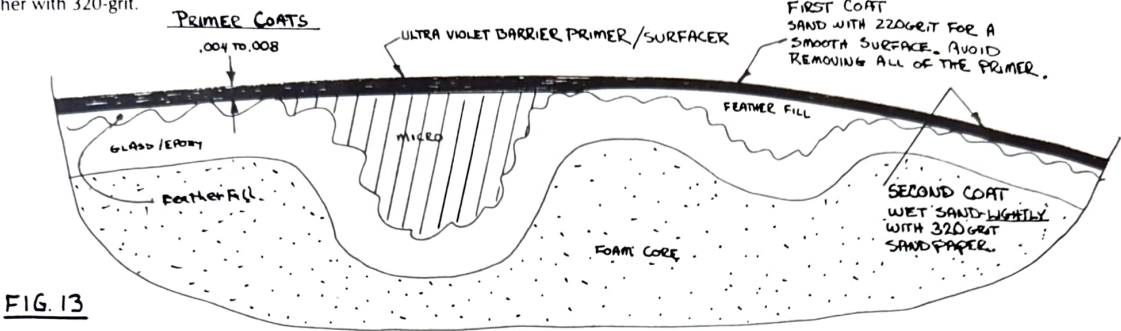


FIG. 13

STEP 6. SEALS

Where a flexible, durable seal between two assemblies is required, white silicone rubber (RTV) is recommended. For a removable seal, such as between the wing root and fuselage, or canard and fuselage, one side of the seal is bonded to the part and the other side is treated before application of the sealant so that it can't adhere. A simple release can be achieved by taping Saran Wrap tightly over one side of the joint (Fig. 14). The seal is installed by assembling the two components with Saran Wrap protecting one side, lightly sanding the other, and then wiping the wet silicone into the gap (Fig. 15). Remove all excess silicone at the surface. This assembly has to dry for at least two days before the parts are disassembled. The Saran Wrap will easily peel off of the cured silicone.

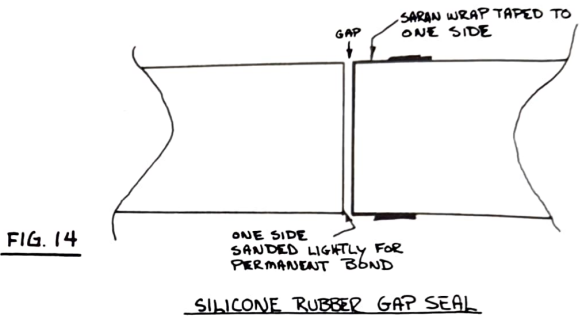


FIG. 14

STEP 7. MISMATCH TREATMENT

Where joining surfaces mismatch (Fig. 16), the low area should be faired into the high area, to ensure smooth air flow and minimum drag. Cover the high area with duct tape, sand the low area for good bonding, and lump dry micro on the low area (Fig. 17). After cure, sand fair (Fig. 18).

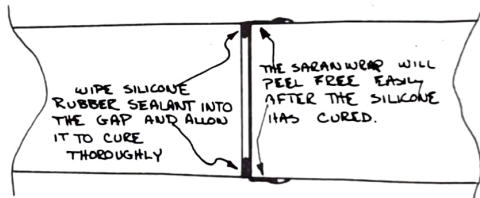


FIG. 15

STEP 8. COCKPIT INTERIOR PAINT

You may use colored cockpit interior paint to suit your own taste. For example, gray was used on the prototype COZY. It is not necessary to fill the glass weave. Some very light sanding may be done to smooth the surfaces slightly. Apply one coat of the primer to the interior glass surfaces for ultra violet protection and color to suit over that. Be sure to mask the nose gear window and fuel gauges before painting. A light color (light gray, green, or blue etc.) is recommended on the cockpit interior to avoid high heat buildup when the airplane is parked in the summer sun with the canopy locked. The instrument panel is shaded and can be black. Spackle paint is attractive and does an excellent job of hiding the fiberglass weave. The spackle paint used in the trunks of automobiles is available in spray cans at automobile parts stores. It is not 100 percent waterproof, however. A better spackle paint is Zoletone, stocked by both Wicks and Aircraft Spruce. This paint really dresses up the interior and is easy to apply. Charcoal gray #40-59 is attractive and can be applied directly onto bare fiberglass, with only a little scuffing with 40 grit sandpaper. A primer or undercoat is not necessary, because the Zoletone is adequate UV protection.

STEP 9. N-NUMBERS (REGISTRATION NUMBERS)

You may use adhesive type letters and numbers or paint your registration marks directly on the airplane; your choice. Some simple hints may save some trouble on either method. When installing the self-adhesive tape, first use Windex window cleaner to wet the area where you want the markings, strip the protective backing off the letter or number, and apply it to the wet surface. The Windex will allow you to slide the markings around for perfect positioning, and then when located properly, just press them down lightly. The pressure squeezes the Windex out and allows the adhesive to bond to the airplane. If you paint the registration marks directly onto your airplane, first mask off the outlines for painting, then sand lightly with 320-grit sandpaper, then paint and remove the masking tape.

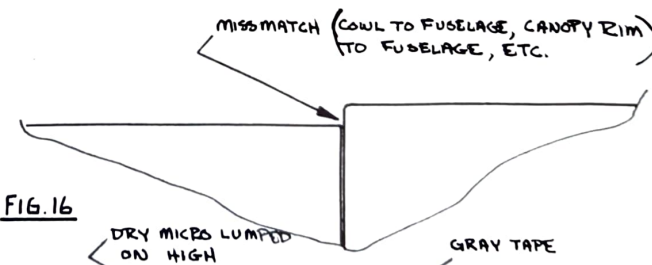


FIG. 16

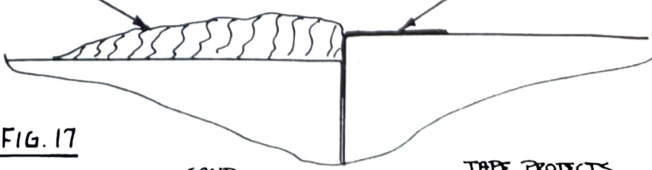


FIG. 17

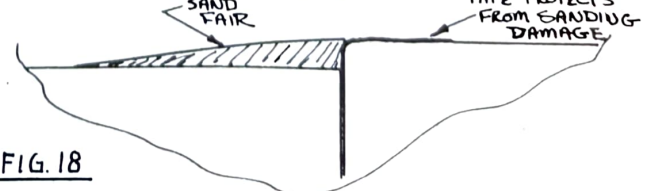
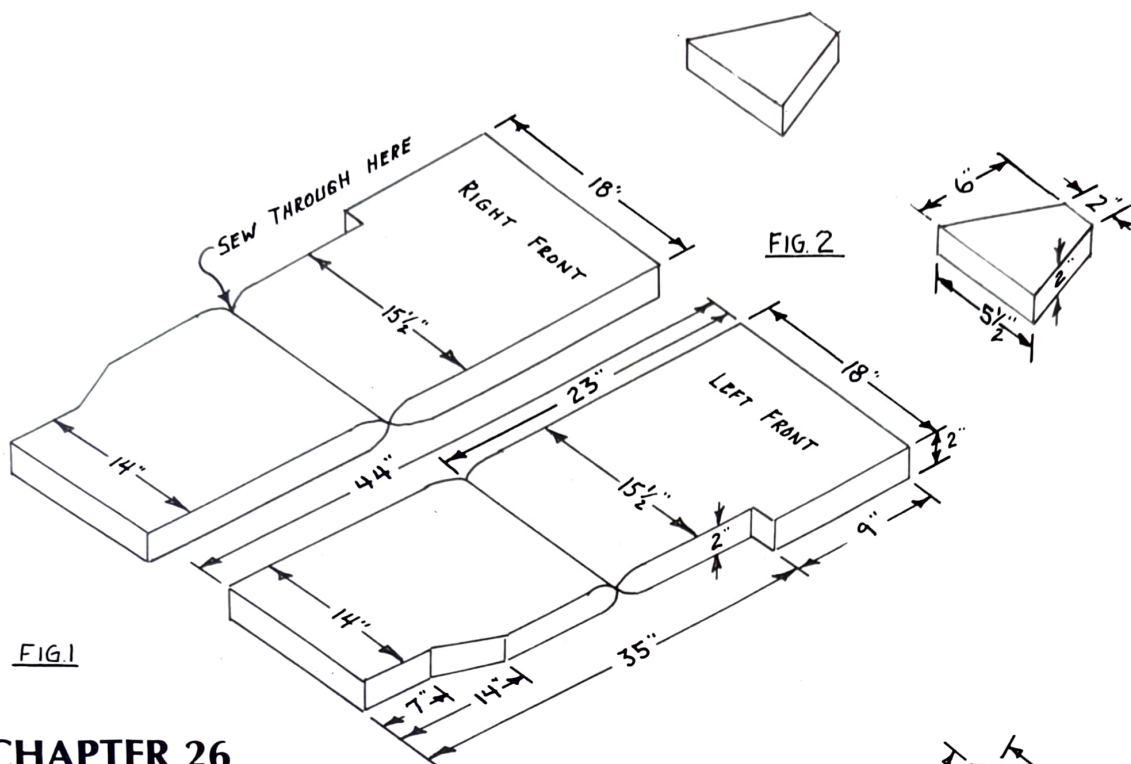


FIG. 18

STEP 5. Finish Paint

Follow the manufacturer's directions for the type of finish paint that you have chosen. Best results are obtained by painting in a spray booth. Make sure you use recommended health precautions. If a spray booth is not available, outside at the airport, where there are no trees or dust, in the early morning hours when there is no wind, is the next best alternative.



CHAPTER 26

UPHOLSTERY

Well, its almost over now except for the celebrating! In this chapter all you have to do is make the upholstery, and most builders will enlist the help of their better halves, or else the local upholsterer. You will be pleased to know that the upholstery doesn't have to be white (although white sheepskin isn't a bad choice--its supposed to be the most comfortable material available) and it looks like a good choice for an airplane called "Cozy"), and automobile upholsterers have a wide variety of suitable materials to choose from. You can suit your own taste and go as spartan or as exotic as you wish. The minimum requirement is for cushions (Fig. 1) and headrests (Fig. 2) in the front seat. It is recommended that you make a matching cushion for the back seat (Fig. 3), even if you intend to use it only for carrying luggage (it will indicate to others that you have a legitimate 3-place aircraft).

The cushions and headrests are made from normal, 2 in. thick seat cushion foam. They are reversible, for longer life, and they are sewn all of the way through so they will bend as required to conform to the seat. The headrests are attached with 3M Scotchmate (or Velcro) fasteners, and the cushions can also be attached the same way.

The seats and cushions are designed to accommodate pilots 6 ft. and taller. Shorter pilots will probably need an extra cushion or two (Fig. 4). You can use the extra cushions to good advantage by installing zippers in the sides so the foam can be removed and they can double as brief cases or suitcases.

Congratulations! You have just completed your Cozy! It has been great working with you! You may now proceed to your Owners Manual to get ready for your first flight.

Short pilots (less than 5'11") may want to take advantage of some extra baggage room rather than fly sitting on several cushions. This can be done by fabricating two inserts to custom-fit the unused area. The two inserts can be used as custom-made map cases or briefcases. Some use these areas for a survival kit and/or ELT.