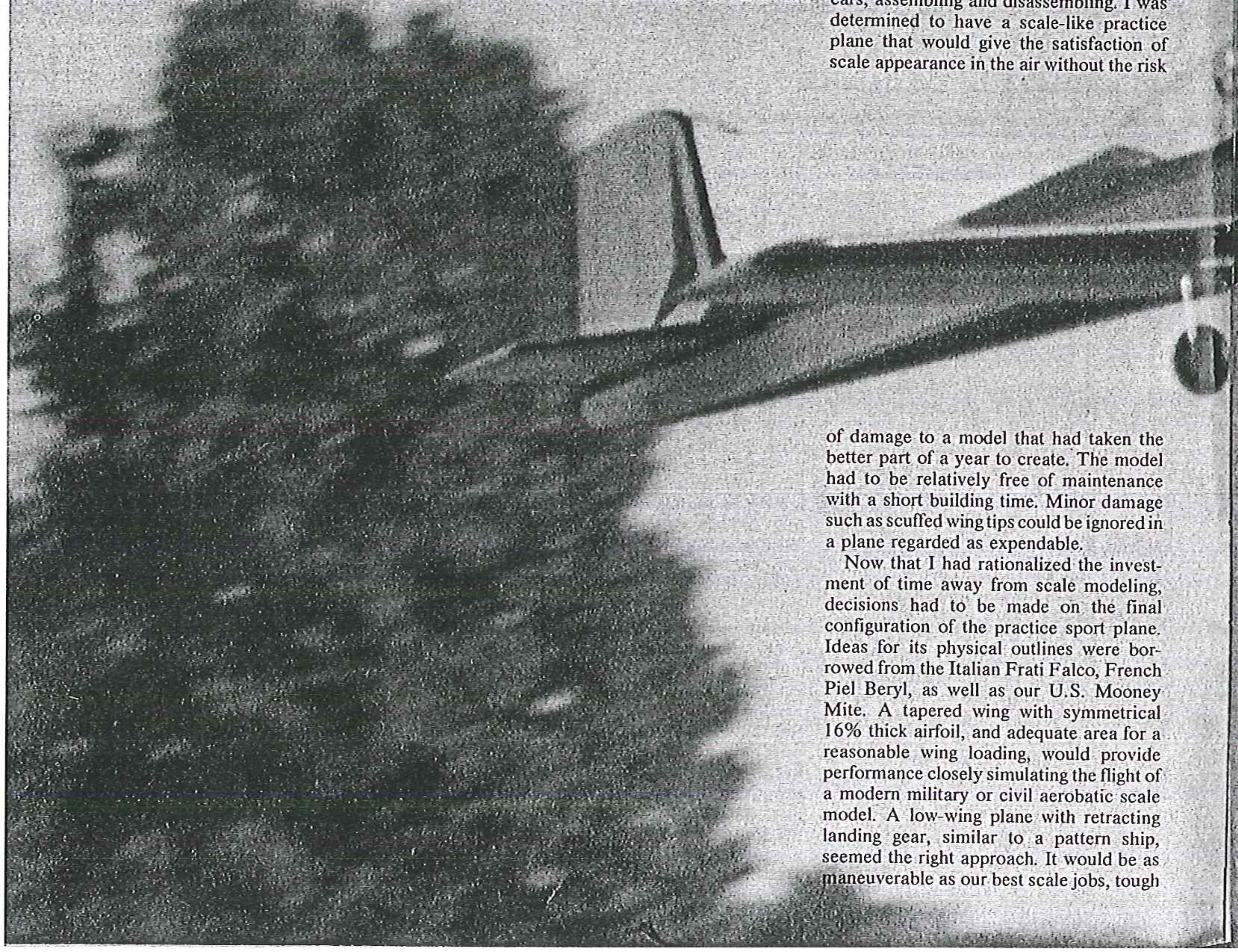
Bob Wischer

ARIEL SPORT

Realism is the active word; this 60-powered ship is a pleasure to behold—doing aerobatics, on a fly-by, just taxiing or even parked in the pit area.

Editor's Note: We are especially pleased to publish this fine article and excellent design. The text presents a well-coordinated picture of design considerations and structural techniques and materials as employed by a master builder—even the experienced flier will find much that is food for thought. And, as to the design itself, Bob perceived his need to be a scale-like plane which could be enjoyed for active flying without being subject to "hangar rash" which is the bane of true scale aircraft. This seemed especially important to us. With the continued evolution and added expense of pattern aircraft, pattern ships are of much diminished interest to "sport" fliers. The Ariel therefore seems to fill that vital need—a maneuverable, realistic airplane that does not have to be thought of as a competitor to the more awesome Phoenix, Dirty Birdy, etc. In all, a deluxe project for the advanced sport pilot.

ON FULL-SIZE planes there is an ailment known as hangar rash that is the manifestation of minor damage from moving airplanes about while in closely packed storage. Hangar rash is also the blight that afflicts scale models more than the damage from bad landings and soaking in castor oil. The rash is the result of carrying the plane through narrow doorways, into and out of cars, assembling and disassembling. I was determined to have a scale-like practice plane that would give the satisfaction of scale appearance in the air without the risk of damage to a model that had taken the better part of a year to create. The model had to be relatively free of maintenance with a short building time. Minor damage such as scuffed wing tips could be ignored in a plane regarded as expendable.



Now that I had rationalized the investment of time away from scale modeling, decisions had to be made on the final configuration of the practice sport plane. Ideas for its physical outlines were borrowed from the Italian Frati Falco, French Piel Beryl, as well as our U.S. Mooney Mite. A tapered wing with symmetrical 16% thick airfoil, and adequate area for a reasonable wing loading, would provide performance closely simulating the flight of a modern military or civil aerobatic scale model. A low-wing plane with retracting landing gear, similar to a pattern ship, seemed the right approach. It would be as maneuverable as our best scale jobs, tough enough to take a few knocks. At the sacrifice of scale appearance, gear doors would be omitted to avoid maintenance. A large canopy would enclose a really scale-size pilot. Miniscule pilots in tiny blister canopies spoil the scale profile of too many planes. A semi-enclosed, side-mounted engine with cowl resembling that used on a flat engine would add character to contour and lines. For ease of construction the plane would have few curves in its external shape.

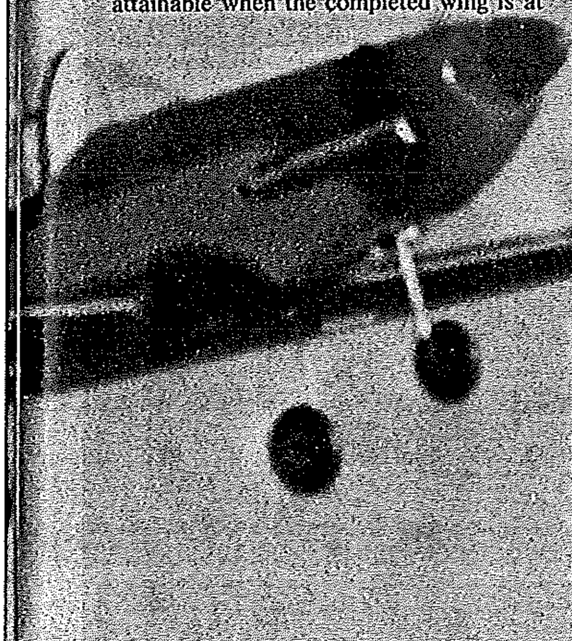
Ariel Sport was designed around a .60 engine, and to keep its performance scale-like an older Webra Blackhead was used. A later Schnuerle 60 engine would undoubtedly improve performance and the change may be made in the future to satisfy curiosity. There are no thrust offsets. Wing, stabilizer and engine are aligned at zero. Thick airfoiled tail surfaces, particularly the rudder, are borrowed features from Claude Piel's designs and were used because this gives maximum effectiveness and smoothest handling.

Construction

Wing: I prefer to start construction with the wing because a closer fit with the fuselage is attainable when the completed wing is at hand. The foam sheet used is white Armstrong Armalite insulation with a weight of one pound per cubic foot. To minimize waste, the wing and stabilizer can be cut by the hot-wire method, from a two-inch-thick foam sheet 2' × 4', a standard size at building suppliers. Cutouts in the cores are better made with the hot wire using simple 1/16 plywood guides. As shown on the drawing these cutouts include wheel wells, servo mounting space, and the long slots for the retract gear pushrods. The shallower grooves for retract mechanisms and their mounting rails are better accomplished with a very sharp knife for the outlines, digging out foam to the depth required. Roughness in the cuts can be avoided by making all cuts by the hot-wire method.

Short lengths of resistance wire can be bent to the exact shape of the groove needed, but this demands an adjustable power supply. Grooves can be machined in foam with a router bit in a Dremel tool. A mechanical guide with straight edges is a necessity for all cutting in foam. If the mounting rail slots are made too deep, the space will need to be filled later with epoxy glue as their depth is important.

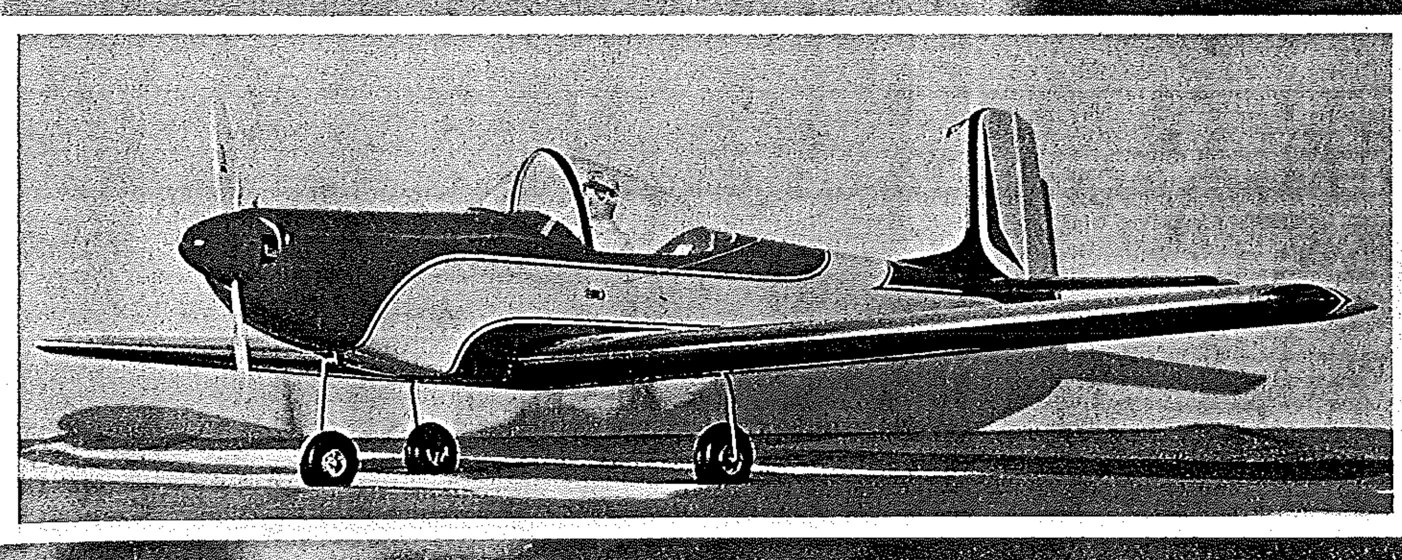
The hardwood rails are prepared by drilling and inserting the blind nuts for mounting the retracts. A dummy ¼ plywood block, the same size and mounting dimensions as the retract mechanism, hold the rails parallel while the epoxy hardens.



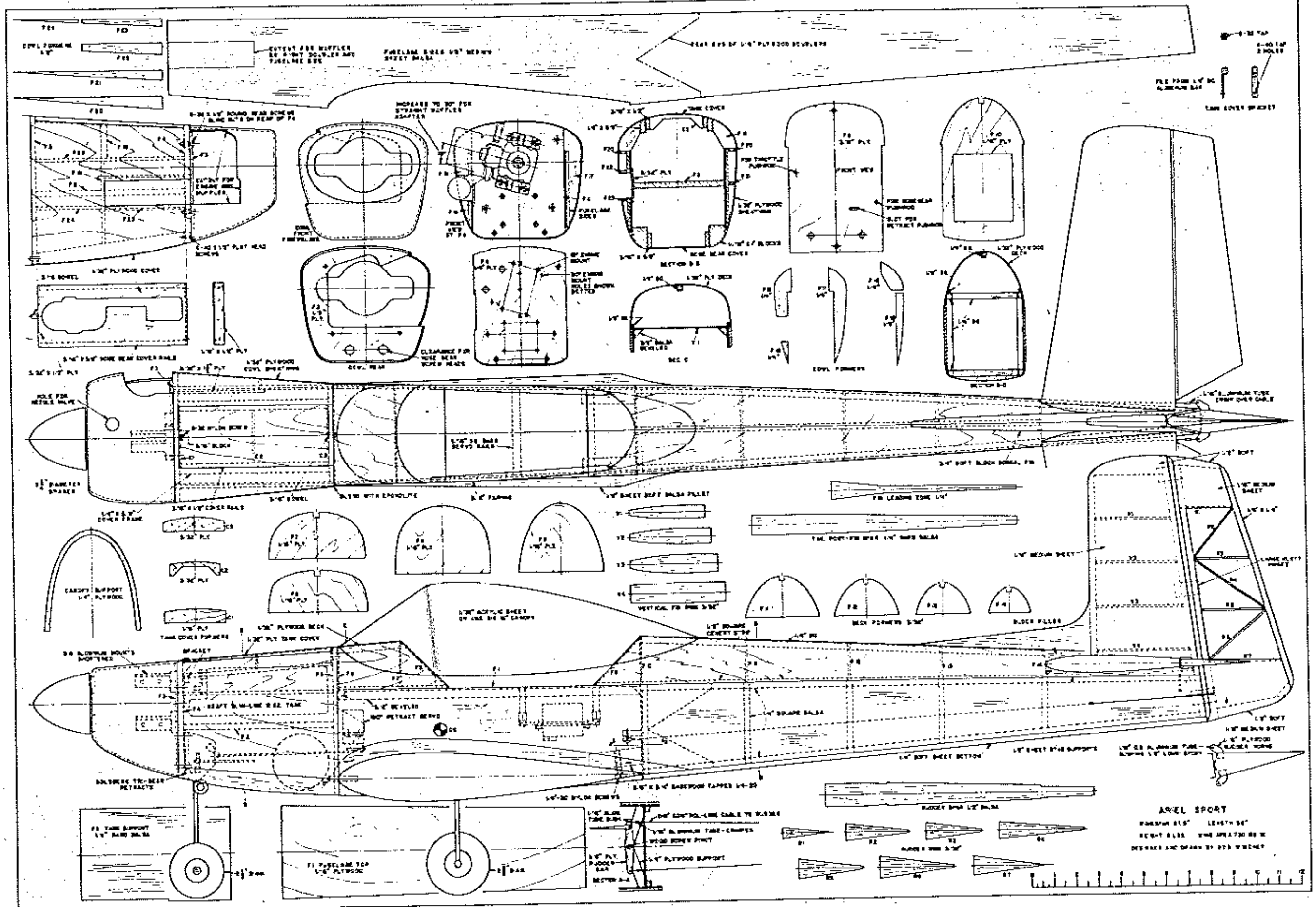
Measured from the wing bottom surface, if the depth of both rails is made the same, the landing gear legs will slope outward because of dihedral. They are set at different depths to compensate. It is also very important that the rails be epoxy glued into their foam slots so that the glue is in intimate contact with foam and wood in all areas. This is an ideal use for Hobbypoxy Thixotropic Epoxy Glue. It will fill the unavoidable gaps without the risk of gluing the mounting screws permanently into the blind nuts.

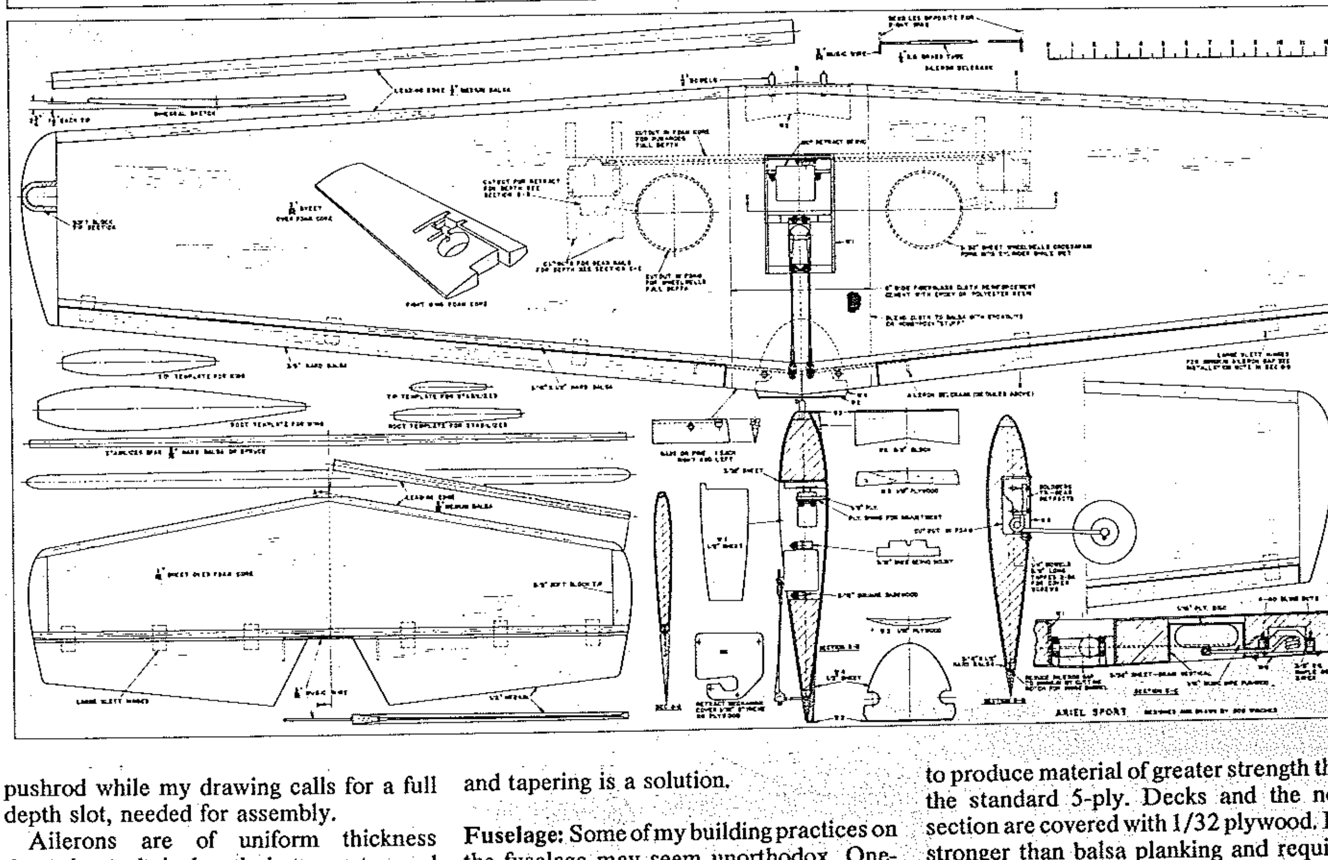
The sheet balsa wing covers are now prepared by edge cementing three 4-in. wide sheets of 3/32 balsa for each surface. The use of 3/32 sheet in place of the usual 1/16 permits some sanding without the hazard of thinning the material seriously. I have found that it does not add to the wing weight if care is exercised in selecting balsa. I weigh each sheet with a photographic scale, marking for reference. In this manner it is easy to find the lightest sheets and also to select comparatively for balancing right and left wings. Trimming for wing heaviness is possible, but a heavy wing will spoil maneuvers when G-forces and speed change. In other words, avoid using all six heavier sheets on the same wing; mix them for balance.

Cement the prepared wing skins to the foam cores, using a contact cement that will not dissolve foam. Using a white glue, add tip blocks, leading and trailing edges. Wing halves are now fitted for joining. I do this on a circular saw with its blade set at the dihedral angle of 2¾ degrees. It can also be done by hand with a sanding block. The wing halves are joined with epoxy. After carving and sanding edges to airfoil shape, cut-outs can be made in the top surface for servo space, and in the bottom surfaces for wheel wells and retract mechanisms. These openings are lined with balsa and plywood as shown. Epoxy the aileron bellcrank tubes into the trailing edge fillers, which are then epoxy glued to the wing, being careful to keep glue from the tube ends. A 6-in.



FULL SIZE PLANS AVAILABLE . . SEE PAGE 128



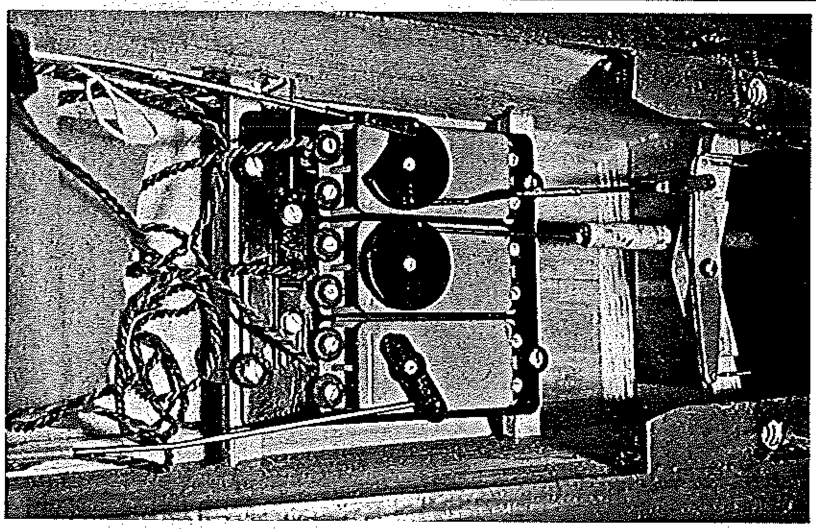


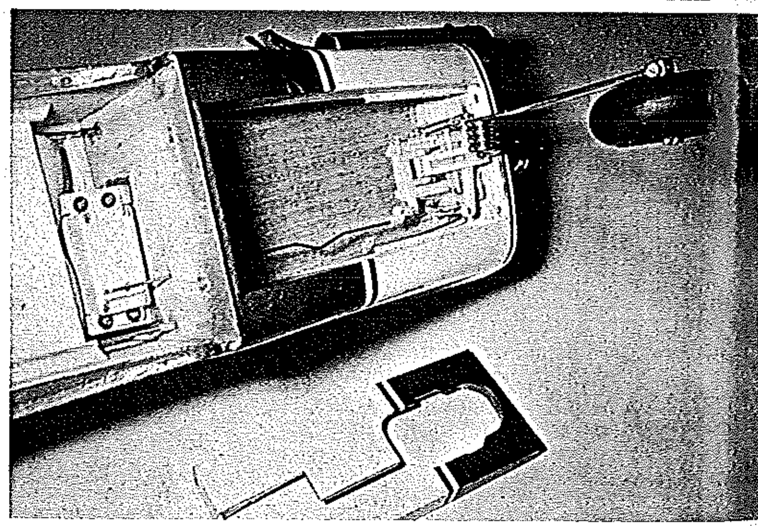
pushrod while my drawing calls for a full depth slot, needed for assembly.

Ailerons are of uniform thickness throughout their length but are tapered narrow toward the wing tip, because of the possibility of flutter at high speeds if springy, constant chord type are used. They should be of hard material. Extreme flutter can be hazardous with ailerons soft enough to twist and tapering is a solution.

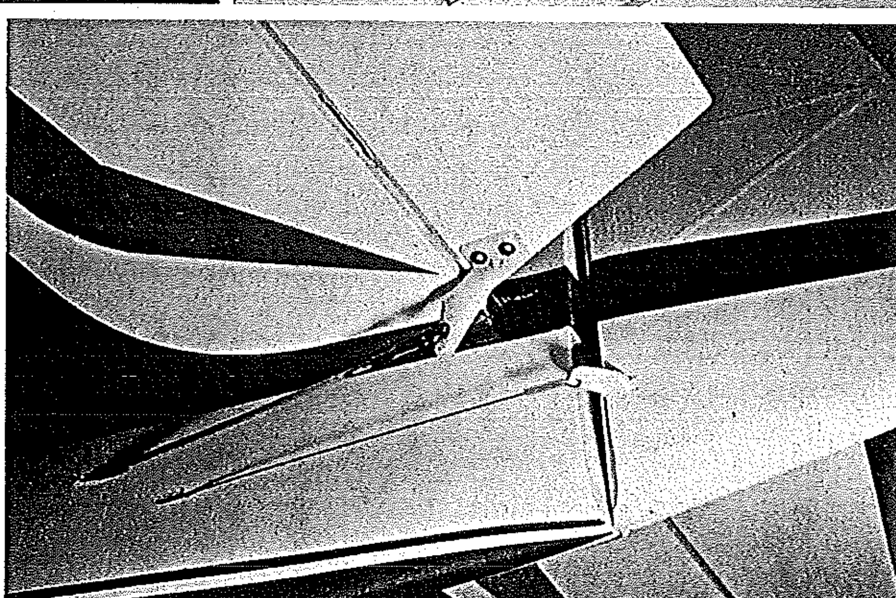
Fuselage: Some of my building practices on the fuselage may seem unorthodox. One-sixteenth plywood is used for sides, top, rear bulkhead and some formers. It is much stronger than ¼ balsa and weighs about the same. Wherever thicker plywood is specified it was laminated from layers of the 1/16 to produce material of greater strength than the standard 5-ply. Decks and the nose section are covered with 1/32 plywood. It is stronger than balsa planking and requires only a sealer and color coats for a fine finish. Block balsa was used only for the compound curves on the bottom of the nose section.

The fiberglass nose cowl could not be



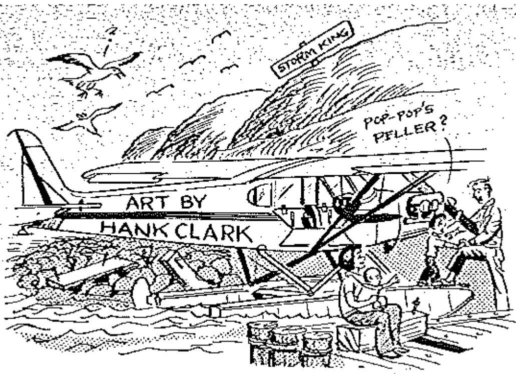


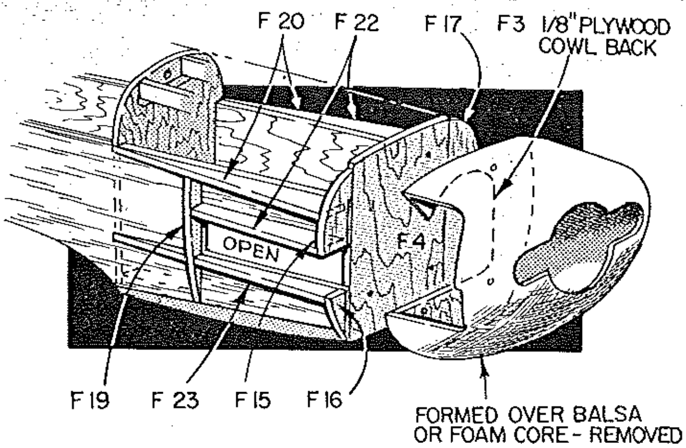
Top: Scale-like engine cowl and large canopy with greater than average fuselage depth provide an approach to realism. Left: Rudder bar, right in pic, with short pushrod to servo and cables to rudder. Above, right: Goldberg retract nose gear installation on rear of firewall. Retract 180-degree servo on rear of first bulkhead—direct connecting rod between, steering pushrod alongside. Right: Compare this view of tail surface actuation with black and white pic of bottom view of the thick rudder.

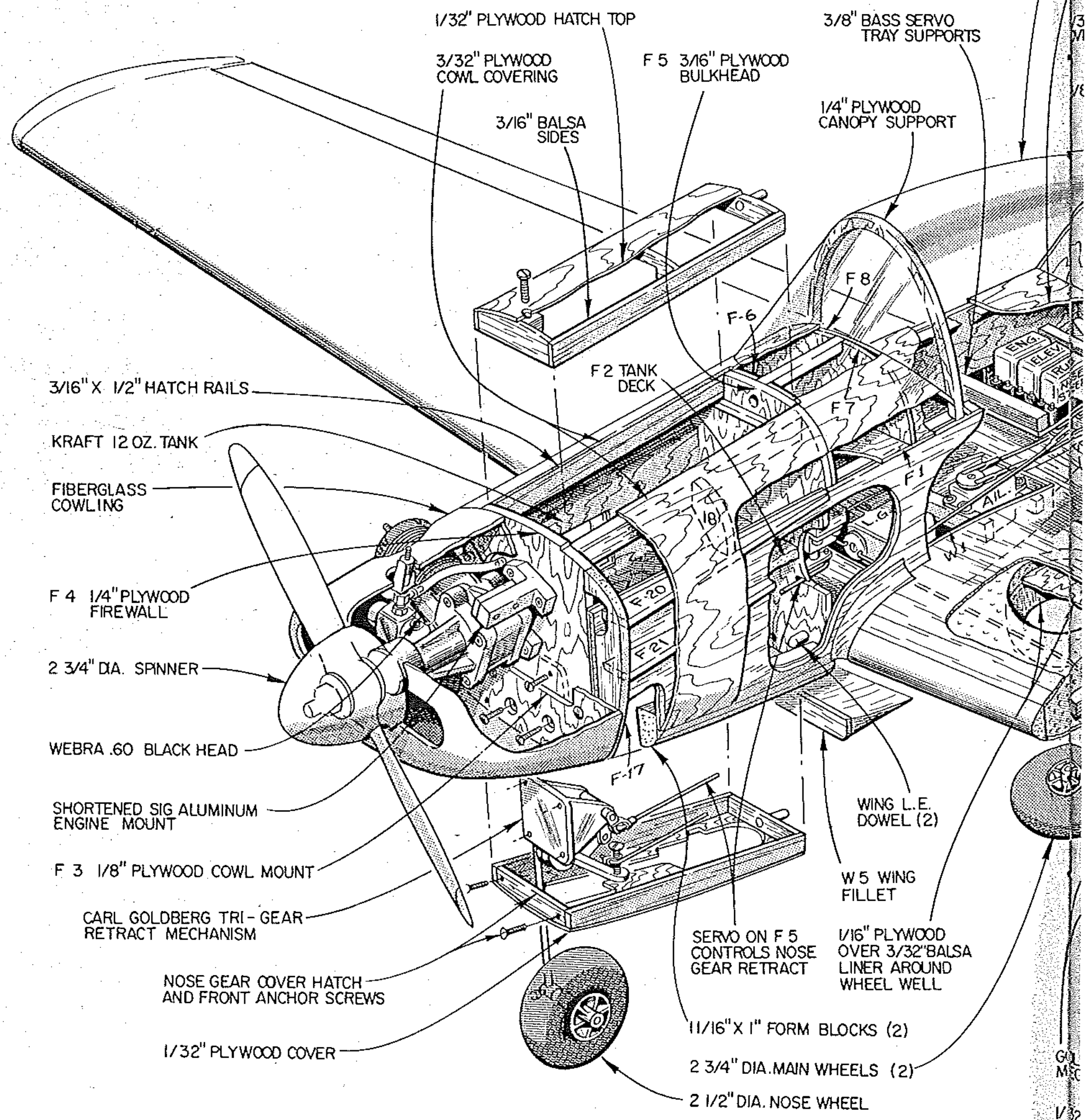


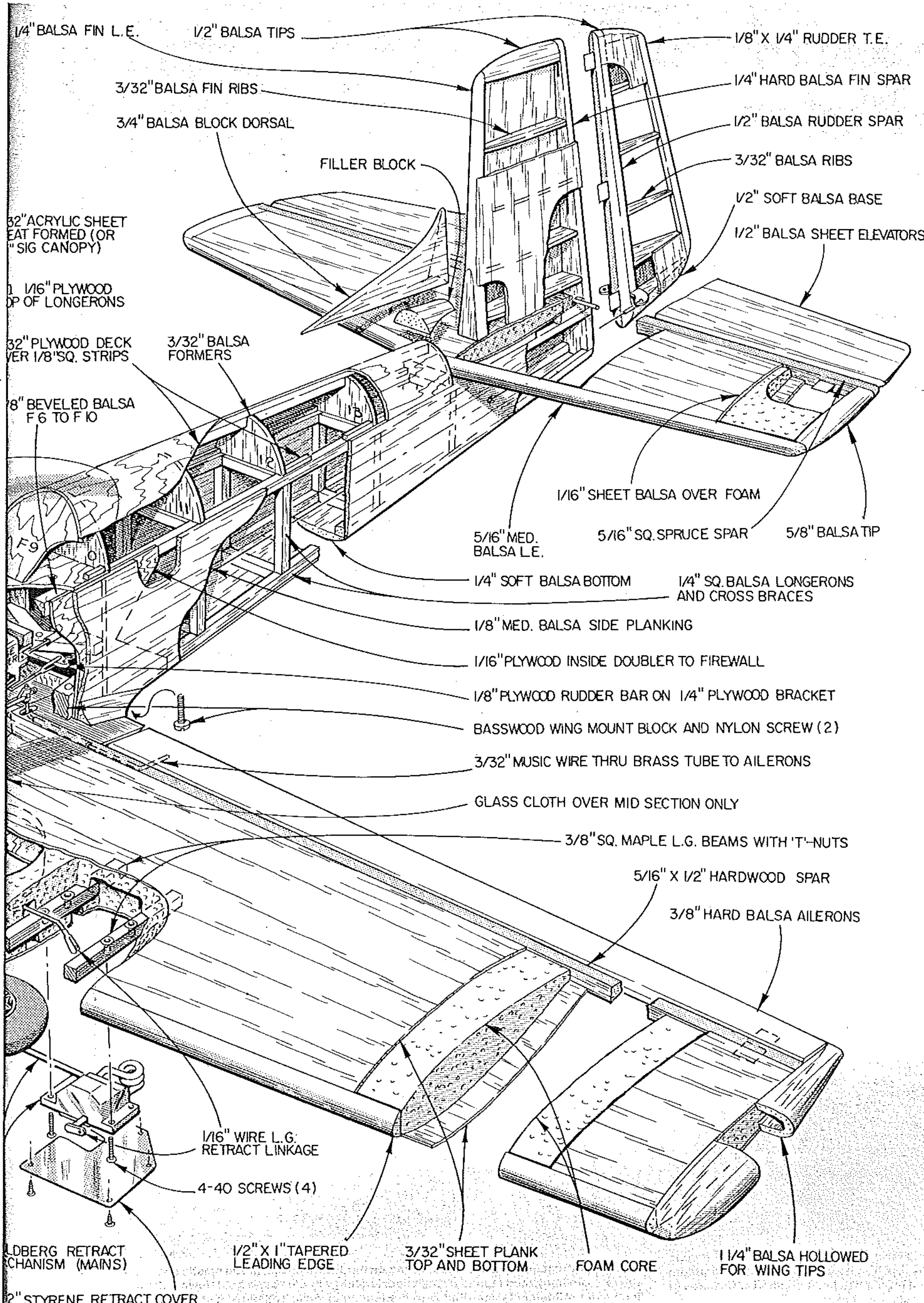
wide fiberglass cloth bandage is wrapped and cemented around the wing center section using either polyester resin or epoxy, keeping in mind that resin erodes foam. The fiberglass will require some sanding and blending with a filler at its edges.

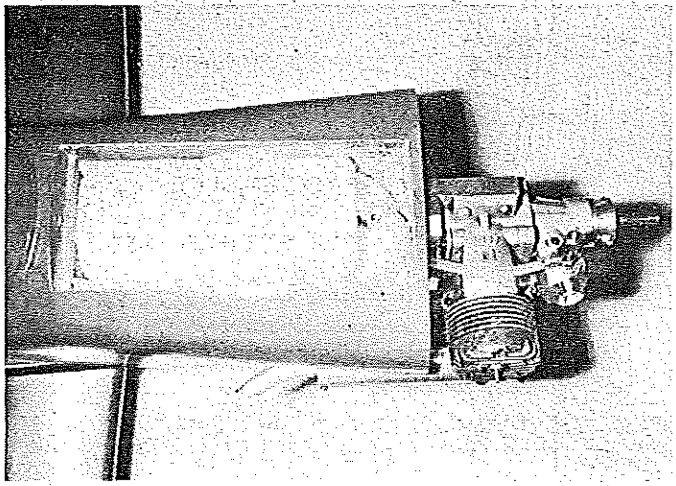
The installation of Goldberg retracts demands close attention to their instruction sheet. The music wire gear legs are to be given a set in the rearward direction to assure that the wheels will fit into the wells after a few hard landings. The instruction sheet specifies a small hole for the operating

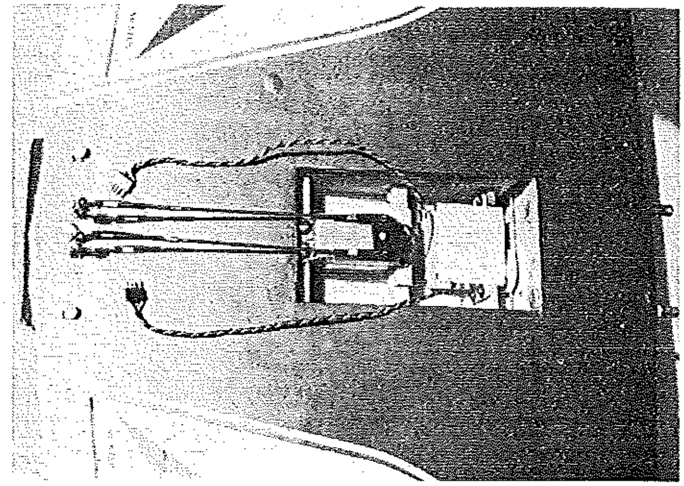

STORM KING
POP-POP'S PELLER?
ART BY
HANK CLARK


F 20
F 22
F 17
F3 1/8" PLYWOOD COWL BACK
OPEN
F 4
F 19
F 23
F 15
F 16
FORMED OVER BALSA OR FOAM CORE - REMOVED

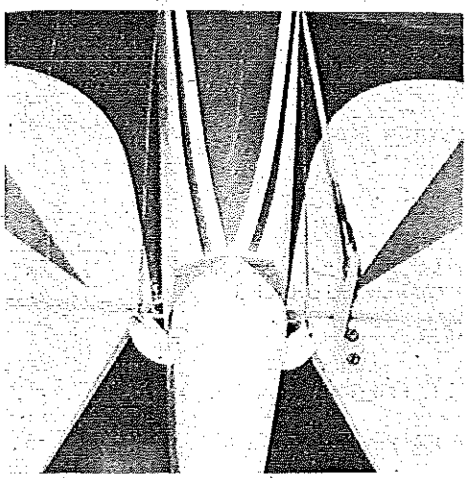

1/32" PLYWOOD HATCH TOP
3/8" BASS SERVO TRAY SUPPORTS
3/32" PLYWOOD COWL COVERING
F 5 3/16" PLYWOOD BULKHEAD
1/4" PLYWOOD CANOPY SUPPORT
3/16" BALSA SIDES
F 8
F-6
F 2 TANK DECK
F 7
F 1
3/16" X 1/2" HATCH RAILS
KRAFT 12 OZ. TANK
FIBERGLASS COWLING
F 4 1/4" PLYWOOD FIREWALL
2 3/4" DIA. SPINNER
WEBRA .60 BLACK HEAD
SHORTENED SIG ALUMINUM ENGINE MOUNT
F 3 1/8" PLYWOOD COWL MOUNT
CARL GOLDBERG TRI-GEAR RETRACT MECHANISM
NOSE GEAR COVER HATCH AND FRONT ANCHOR SCREWS
1/32" PLYWOOD COVER
F 18
F-20
F 21
F-17
L.G.
AIL.
ENG.
ELEV.
WING L.E. DOWEL (2)
W 5 WING FILLET
SERVO ON F 5 CONTROLS NOSE GEAR RETRACT
1/16" PLYWOOD OVER 3/32" BALSA LINER AROUND WHEEL WELL
11/16" X 1" FORM BLOCKS (2)
2 3/4" DIA. MAIN WHEELS (2)
2 1/2" DIA. NOSE WHEEL


1/4" BALSA FIN L.E.
1/2" BALSA TIPS
1/8" X 1/4" RUDDER T.E.
3/32" BALSA FIN RIBS
1/4" HARD BALSA FIN SPAR
3/4" BALSA BLOCK DORSAL
1/2" BALSA RUDDER SPAR
FILLER BLOCK
3/32" BALSA RIBS
1/2" SOFT BALSA BASE
1/2" BALSA SHEET ELEVATORS
32" ACRYLIC SHEET
EAT FORMED (OR
" SIG CANOPY)
1/16" PLYWOOD
P OF LONGERONS
32" PLYWOOD DECK
ER 1/8" SQ. STRIPS
3/32" BALSA
FORMERS
8" BEVELED BALSA
F 6 TO F 10
F9
1/16" SHEET BALSA OVER FOAM
5/16" MED.
BALSA L.E.
5/16" SQ. SPRUCE SPAR
5/8" BALSA TIP
1/4" SOFT BALSA BOTTOM
1/4" SQ. BALSA LONGERONS
AND CROSS BRACES
1/8" MED. BALSA SIDE PLANKING
1/16" PLYWOOD INSIDE DOUBLER TO FIREWALL
1/8" PLYWOOD RUDDER BAR ON 1/4" PLYWOOD BRACKET
BASSWOOD WING MOUNT BLOCK AND NYLON SCREW (2)
3/32" MUSIC WIRE THRU BRASS TUBE TO AILERONS
GLASS CLOTH OVER MID SECTION ONLY
3/8" SQ. MAPLE L.G. BEAMS WITH 'T'-NUTS
5/16" X 1/2" HARDWOOD SPAR
3/8" HARD BALSA AILERONS
1/16" WIRE L.G.
RETRACT LINKAGE
4-40 SCREWS (4)
LDBERG RETRACT
CHANISM (MAINS)
1/2" X 1" TAPERED
LEADING EDGE
3/32" SHEET PLANK
TOP AND BOTTOM
FOAM CORE
1 1/4" BALSA HOLLOWED
FOR WING TIPS
2" STYRENE RETRACT COVER





Fuel tank is easily accessible with cover removed. Tank packed in foam plastic for vibration insulation. Small balsa ledges glued in cover opening for leveling cover. Right: Notched support for aileron servo permits access to mounting screws for 180-degree retract servo. Note disc output of retract servo to insure positive locking of mechanism. Arm-type out-put will flex and break. Doing things right avoids annoying troubles.

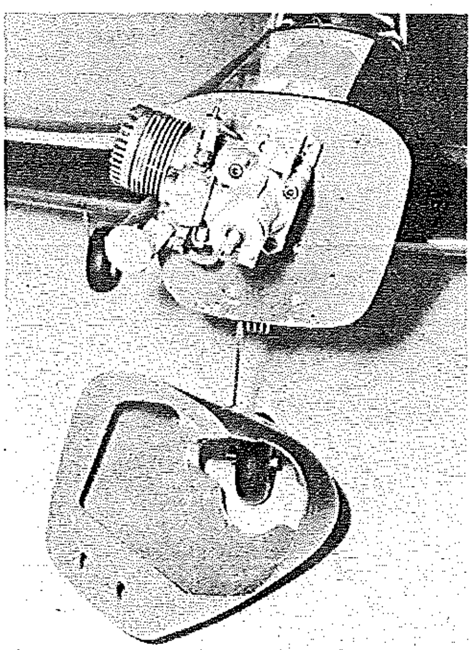


Thick rudder has plywood horns and stranded steel wires for control—neat and light installation. Elevator horn is exposed for convenient adjustment, could be hidden inside fuselage. Dual elevator horns recommend for split flippers on any large or fast aircraft to avoid uneven responses that introduce rolling moment.

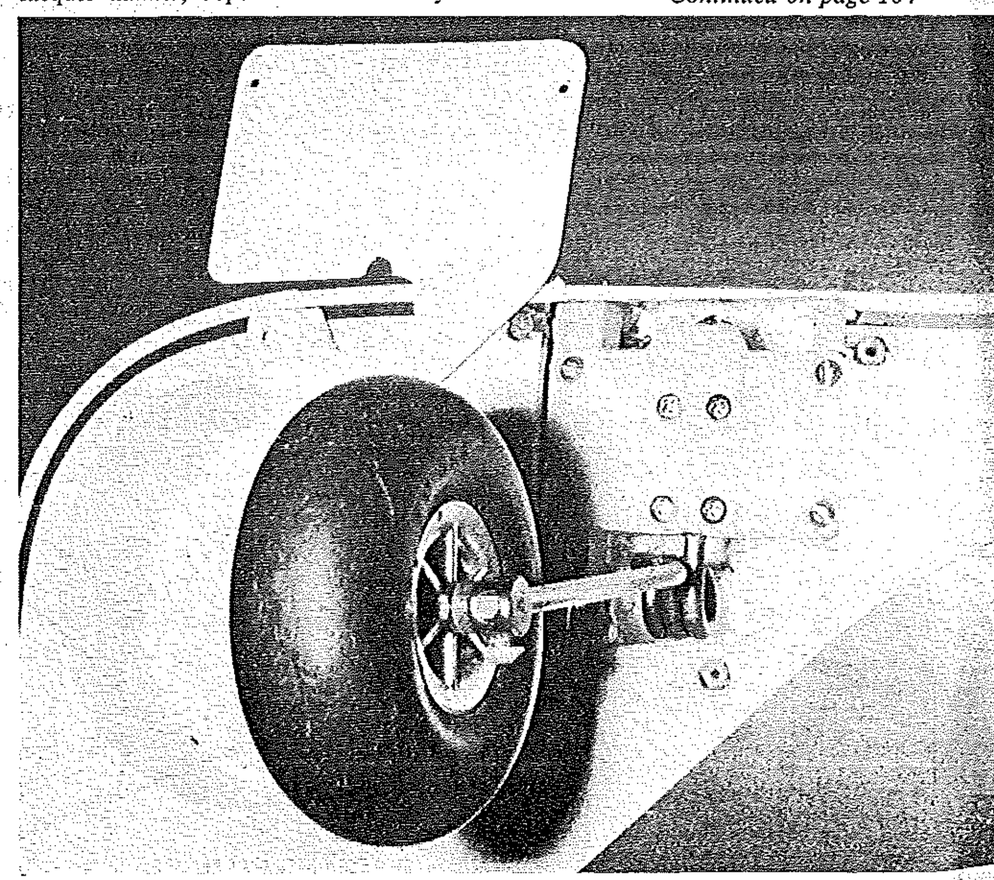
made in a conventional plaster mold because of its shape, which would have locked it into the mold. It was carved from scrap block balsa, made 1/16 inch undersize in all dimensions, covered with several layers of fiberglass cloth and epoxy or polyester resin. The balsa was then hollowed out completely leaving the fiberglass shell. I used a small sanding drum in an electric drill to quickly grind away all of the balsa. An alternate method is to carve and sand the shape from foam plastic, such as the remnants of the wing foam. This is covered with fiberglass and epoxy (not polyester) and the foam is dissolved with a solvent, lacquer thinner, dope thinner or methyl ethyl ketone, leaving the shell. A ⅛ plywood bulkhead is epoxy glued into the rear of the cowl to add stiffness and serve as a mount.

The drawing shows my home-made engine mount and muffler adapter. The adapter is cut at an angle that permits mounting the engine only 15 degrees above horizontal. A straight adapter, as found on most mufflers, would require that this angle be increased to about 30 degrees. The engine cylinder then projects a greater distance above the cowl top and is the reason for my angled adapter. The drawing of the engine mount bulkhead shows both 15- and 30-degree hole loca-

Continued on page 104



Offset muffler adapter is a trick to lower engine below top line of cowl. Note how aluminum engine mount has been trimmed to fit shape of cowl bulkhead below.



Goldberg retract mechanism in foam wing on hardwood rails. Styrene plastic gear cover removed above. Note hardwood tapped dowels epoxied into wing for cover hold-downs. Close attention to such extra refinements contributes to the feeling of scale enhanced by this aerobatic ship.

vide small portions of their time. Even to this day, with presently 128 pages, the magazine staff consists of only five who are full-time or nearly so, but others at AMA HQ also help out—to the equal of almost 2½ full-timers.

Schroder: ". . .they believe that they can finance a project that must cost them in excess of $200,000 with only nine months of unfulfilled subscriptions." Fact: Income available from unfilled subscriptions in 1975 and advertising, etc., amounted to $204,424, and all costs (including printing, salaries, rent, telephone, etc.) came to $201,394--for a surplus (or "profit") of just over $3,000.

Schroder: ". . .there is no magic basis for this [$200,000] figure as costs are fixed, and as a publisher I am well aware of what they are and will chart them for you: An 80-page book of 40,000 circulation will cost a minimum of $17,000 to be printed; will require $1,500 worth of typesetting; $3,500 2nd class postage; fulfillment (subscription) costs which include preparation of cheshire strips, $1,000; editorial content fees, $2,500." Fact: *MA* circulation was more than 40,000 in 1975 (closer to 50,000), but even so Schroder was way off in most cases. The actual averages were: printing, $11,062; typesetting, $1,014; postage, $1,113; labels, $445; editorial fees, $3,684. How could a person in the field for so many years, and who actually was using the same printer as *MA*, be so far off? Amazing!

Schroder: "He [the AMA Executive Director] says they can print it cheaper. How? . . . I used the most conservative figures in my estimate." Fact: The AMA Executive Director's cost figures were based on the *MA* publisher's gathering of cost information which coincided with the actual results.

Consider that Walt's motive in 1975 was professed to be in the interests of AMA—to save it from extinction from lack of growth and unaffordable magazine costs; the recommendation was to kill the magazine. Consider that Walt published a reader's letter in early 1979 which, without considering compensating income factors, suggested (wrongly) that *MA* used general AMA dues money, that the magazine should be killed and a newsletter substituted. Walt published the letter, supposedly as a right of AMA members to know, then didn't deliver on his promise to print the other (AMA's) side of the story. With his latest "message" it's apparent that he still wants *MA* killed—but the new reasoning is as faulty as the old.

Ariel Sport/Wischer

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tions for the aluminum engine mounts. Other holes that will be affected are those for fuel line, muffler pressure line and throttle pushrod. Since all fuselage bulkheads are needed before fuselage construction can begin, these hole locations must be decided upon.

Laminate fuselage sides from 1/16 plywood and ⅛ balsa using contact adhesive. The right side has the cut-out for muffler space. Add the ¼-square balsa bracing to the fuselage rear. My preference for a sequence of steps in construction begins with the 1/16 plywood fuselage top, adding the ⅜ beveled balsa strips and bulkheads F5 and F10, followed by the prepared fuselage sides. Add F2 and F4, the lower balsa nose blocks, and all of the nose formers F15 thru F24 including the cover frame. Follow with the tail post, ¼-sq. cross bracing, fuselage bottom and all top formers F6 thru F14, ⅛-square cement strips and ¼-square former brace.

Make heavy paper templates for each plywood deck and nose section to assure a good fit. The plywood is soaked with water on its outer surface to make it pliable and it can then be easily formed around the formers and fastened in place with white glue. Have a plentiful supply of heavy number 62 and 64 rubber bands at hand for applying pressure while the glue sets. A perfect joint is not a necessity as it can easily be leveled later with Epoxolite, but care must be exercised to be certain that the ply is in firm contact with all formers. This plywood covering process is much easier than it appears in description.

For ease of maintenance I prefer to make fuel tank and nose-gear retract mechanism accessible with removable covers for each. This bit of forethought has already paid dividends for cleaning and adjustment. The Goldberg retract mechanism has been quite free of maintenance problems, once adjusted according to their instructions, especially the locking down to avoid gear collapsing on landing. Having broken several servo output arms, I have switched to discs. I would recommend some means of adjusting pushrod length, a bend in the wire or a length of brass tube soldered over a break in the wire.

The canopy shown was fabricated from 1/32 acrylic sheet (Plexiglas), stretch formed after heating in the kitchen oven to 250° F. The balsa form was a leftover from a previous plane. The windshield portion was drape formed, in the oven, over an aluminum sheet bent to the desired shape. A 15-in.-long canopy, of lighter material but approximately equal size, is available from Sig.

Tail surfaces: Stabilizer is a foam core, cut with templates and the hot-wire technique. The foam halves are epoxy glued at the center and covered with 1/16 sheet balsa in one piece from tip to tip. This continuous sheet cover provides a stronger center. Leading and trailing edges are added and sanded to the airfoil section shape. Vertical fin is built up with ribs and covered with 1/16 sheet balsa. The rudder has the only open rib construction, requiring silk or plastic film cover, to reduce weight. For weight saving in the tail, my rudder is operated by means of steel control-line cable as on many full-size planes. This could be changed to a pushrod at the option of the builder. Elevator is controlled by a ¼ dowel pushrod, brought out to the nylon elevator horn through the fuselage side. For improved appearance, this horn could have been metal, brazed to the music wire elevator joiner at the center. If this is done the clevis hole in the horn should be 1 inch from the joiner wire.

Finishing: Being of the old school of aircraft finishing, I continue to use silk and dope because I like the toughness, strength and resistance to dents and scratches. However, the structure does not need the added strength and plastic film covering could be used with equal success. I make no effort to obtain a super finish. The complete structure is given three heavy brushed coats of clear dope with minimum thinner added. Silk is applied wet over all balsa surfaces, none on plywood. The silk is given five or six brushed coats of clear dope, followed by two coats of very thin dope and talcum powder mixture for filler. If this mixture contains too little thinner, the filler becomes difficult to sand. If too much talc is used the finish will reticulate (crack) and will also be difficult to sand because it loads the sandpaper. Using number 150 grade open-coat aluminum oxide paper, most of the talc will be removed in sanding, leaving pores of the silk filled but silk grain will be plainly visible. Two more coats of clear will seal the talc and prevent its bleeding through into the final color coats. The clear coats can be either brushed or sprayed. Color coats follow and I use a spray for an even and light finish. Color is not used to hide surface blemishes, which should be nonexistent after the talc sanding. Since color adds weight, keep the color coats light in density. Plywood surfaces and the fiberglass cowl need a minimum of preparation.

Flying: Check for correct center of gravity. My plane needed no addition of weight and its first flight also needed no trim change. Retracting the landing gear will have a greater effect than expected because the large wheels contribute to drag. The plane doesn't really need retracts and could easily be converted to a rigid gear by substituting hardwood mounts in the wings and a standard tricycle nose gear.

Takeoff and landing are a real pleasure with the nose gear length as shown. A touch of up elevator at takeoff speed lifts the nose gracefully without tendency to jump off. As the plane approaches the ground for landing, up elevator is fed gradually, holding the nose up so that touch-down is on the rear wheels first. There is no tendency for a wing tip to drop during this type of landing, which is used for scale-like performance and to reduce speed for minimum impact.

Control surface travel, each side of center, is as follows: elevator 11/16″; aileron 3/16″ and rudder 1½″ The low travel for elevator and aileron are contributing factors to the smooth handling I enjoy with Ariel Sport. Elevator only needs travel a sufficient amount to lower the tail for takeoff and landing. With the aileron travel indicated the plane will do an axial roll in less than two seconds. The wide rudder travel is used in the execution of stall turns. Spins and snap-roll maneuvers are positive, both in entry and recovery. Inverted flight requires a bit of down elevator to be held. I really enjoy flying this plane and I think you will too.

RC Technique/Myers

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the receiver. Ordinarily, a servo that is hooked up to an active system (but doing nothing) will draw between 5 and 15 ma. This will jump up to something like 250 ma when you move the stick on the transmitter, if the servo is able to move freely. When a servo is trying to work against hinges that you have accidently epoxied together, the current will go higher, usually to somewhere between 400 and 500 ma. A servo that needs cleaning will draw more current than usual, when doing nothing. That's because dirty servos usually jitter (shiver).

How about the transmitter? Most transmitters use some kind of special charging plug that's hard to find and expensive. Therefore, the easiest thing to do is cut one of the wires on the charger, then clip on the meter as before. One thing about this approach is unsatisfactory. You have to reconnect the cut ends to restore normal operation. Since you probably won't be measuring transmitter charging current very often (because it won't tell you much) just solder the cut ends together again and cover them with a piece of tape.

If you will take the time to measure your charging currents when the system is new, then write the measured values in your owner's manual, there will be some value in checking on it from time to time. The current will drop below normal values if the