The finest selection of Model Plans in the World

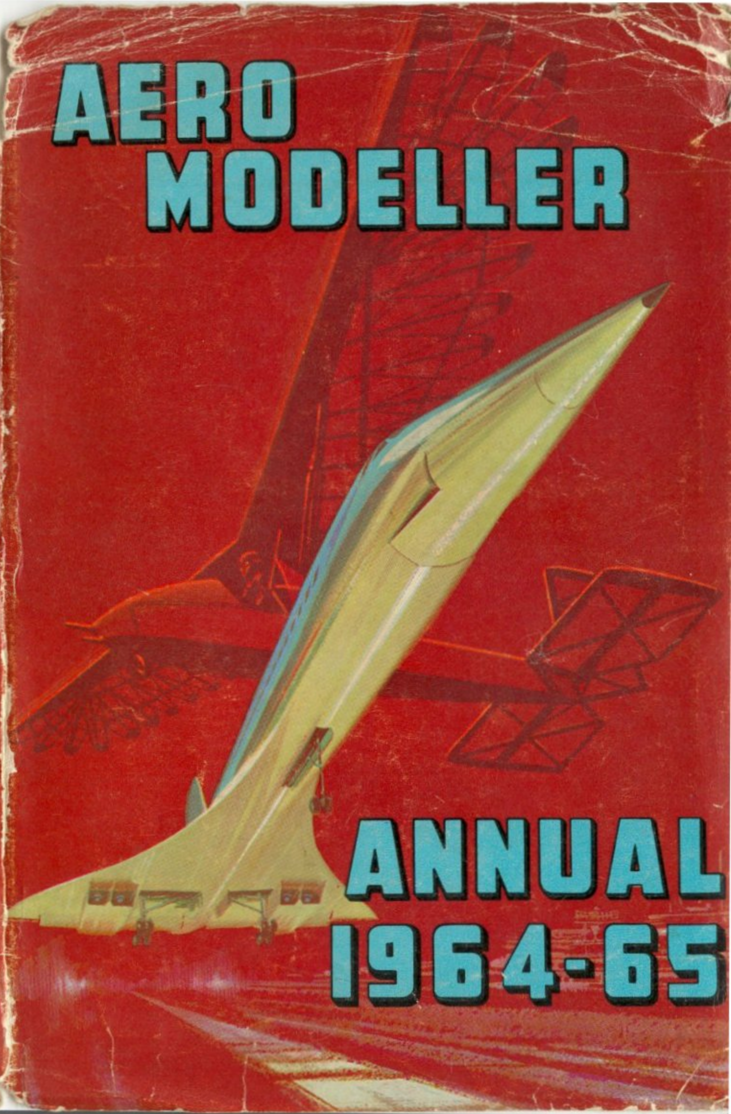
EVERYONE who starts making models of any kind soon gets to hear of AEROMODELLER & MODEL MAKER PLANS SERVICE and the magnificent full-size working drawings that it offers. The selection numbers overs a thousand different model designs, including boats, racing yachts, cars (vintage, veteran, modern and racing), power boats, naval craft, submarines, schooners, marine miniatures, aircraft, gliders, flying boats and workshop accessories—in fact, a fantastic list, which is justly claimed as the widest and finest in the world. Such a list deserves a fine catalogue, and the PLANS HANDBOOK comprises no fewer than 160 pages, $7\frac{1}{4}$ in. by $4\frac{3}{4}$ in., with nearly every drawing on offer duly illustrated. In addition, it was found that so many would-be builders had similar queries that now it is more than a catalogue; it is also a text-book in miniature to set newcomers on the right road from the start. In over sixty countries half-a-million copies of previous editions of this Handbook Catalogue have been sold. YOUR COPY is waiting for you at the address below, and will be sent immediately on receipt of your postal order for 2s., which is all this mammoth handbook costs!

Articles by experts cover the most usual sources of difficulty and deal with such subjects as : BUILDING FROM PLANS : SCALING PLANS UP OR DOWN : STARTING & OPERATING DIESEL & GLOW PLUG ENGINES : DOPING : TRIMMING FOR FLIGHT : RADIO CONTROL FOR BOATS : RADIO CONTROL FOR AIRCRAFT : F.A.I. REQUIREMENTS : PLASTIC MOULDING : DATA ON THE WORLD'S MODEL I.C. ENGINES : COVERING WITH SILK : and a host of other useful items of information.

Latest fully illustrated catalogue and handbook featuring over 1,000 plans. Group headings include the following main divisions : FLYING SCALE AIRCRAFT in every category : FREE FLIGHT POWER : CONTEST POWER : A2, OPEN-CLASS & A/1 GLIDERS : RUBBER MODELS : WATERPLANES : INDOOR MODELS : RADIO CONTROL : CONTROL LINE SPORT, SPEED, STUNT, TEAM RACING : SOLID SCALE PLANS : RACING YACHTS : SAILING CRAFT : POWER BOATS : AIRSCREW DRIVEN HYDROPLANES : STEAM ENGINES : CARS including PROTOTYPE PLANS : HOVERCRAFT : MARINE MINIATURES : BOOKS FOR MODELLERS.

MODEL AERONAUTICAL PRESS LTD
38 CLARENDON ROAD · WATFORD · HERTS

AERO MODELLER ANNUAL 1964-65



AEROMODELLER ANNUAL 1964-65

AEROMODELLER ANNUAL 1964-65 follows the "mixture as before" formula with a difference. We have retained all those features which have helped to make it the "old faithful" that it is—there has been a completely new and different Annual every year since 1948!—but have expanded the plans section, so that this year we are offering even more drawings than usual—with contributions from most of the aeromodelling countries of the world. We are particularly strong in radio controlled models, with a generous helping from Japan, whose modelling activities seem especially vigorous and supported by an enthusiastic model press, plus items from most countries in Europe, the Commonwealth, and the United States . . . these are all dimensioned and complete with vital statistics so that a fair to medium skilled reader should be able to build any model described . . . every modelling interest is covered indoor, outdoor, rubber, glider, power, control line stunt, scale, racing combat, jet. . . . Not always the famous model, we have sought the odd slant even an occasional weirdie . . . we hope you like the mixture. Articles include a useful feature on Building from Foam Plastic Kits, a wonderful Flapping Wing Model article (probably the finest in English!) more on Muscle Power Flying, articles on scaling up plans, model adhesives, and so on. . . . Engine Analysis in brief covering 1964 engines, National and International contest results.

Laurie Bagley has done an eyecatching cover, depicting the Concord just taking off, with a man-sized ornithopter in a shadow background symbolising the efforts of the year.

A MODEL AERONAUTICAL PRESS PRODUCTION

Publishers of
AEROMODELLER

10/6

AEROMODELLER

READERS of this Annual will doubtless be well acquainted with our monthly publication, which gave rise to this yearly collation of all that is best in aeromodelling.

To those of you who have yet to peruse a copy of AEROMODELLER, may we say that it appears on the bookstalls and in your local model shop on the third Friday of each month. Providing as it does up-to-the-minute news of world-wide aeromodelling activities in a manner that can never be achieved with an Annual, AEROMODELLER has the widest circulation of any like publication in the world, containing each month articles, designs, engine and trade tests, contest reports, and, in fact, deals with every phase of the most modern of hobbies.

Costing 2s. per month, AEROMODELLER is a "must" for everyone interested in the operation of model aircraft, and all matters aeronautical.

MODEL AERONAUTICAL PRESS also produces a wide range of books dealing with specialist modelling subjects. Each publication contains the widest collection of information on a particular subject, and the range is constantly increased.

MODEL AERO ENGINE ENCYCLOPAEDIA	12/6
DESIGN FOR AEROMODELLERS	5/-
CONSTRUCTION FOR AEROMODELLERS	5/-
AIRCRAFT IN MINIATURE	12/6
SIMPLE RADIO CONTROL	6/-
FLYING SCALE MODELS	10/-
MODEL BOAT RADIO CONTROL	7/6
BOAT MODELLING	5/-
MODEL MAKER ANNUAL	10/6
PLASTIC MODEL CARS	10/6
THE AMATEUR ROD MAKER	4/6
POWER MODEL BOATS	12/6
CARDBOARD ENGINEERING	5/-
AEROMODELLER POCKET DATA BOOK	5/-
SECRETS OF SHIPS IN BOTTLES	4/6
CONTROL LINE MANUAL	15/-
GLASS FIBRE FOR AMATEURS	7/6
USING THE SMALL LATHE	8/6
R/D BIG FOUR	5/-

AEROMODELLER ANNUAL 1964-65

A review of the year's aeromodelling throughout the world in theory and practice; together with useful data, contest results and authoritative articles, produced by staff and contributors of the *AEROMODELLER*

Compiled and Edited by
D. J. LAIDLAW-DICKSON
and
R. G. MOULTON

Published by
MODEL AERONAUTICAL PRESS, LTD.
38 CLARENDON ROAD
WATFORD :: :: HERTS
1964

AEROMODELLER ANNUAL 1964-65

acknowledges with thanks the undernoted sources, representing the cream of the world's aeromodelling literature.

Aero Revue	*Switzerland*
American Modeler	*U.S.A.*
Bartabschneider	*Germany*
D.C.R.C. Symposium	*U.S.A.*
F.A.I. T/R Newsletter	*U.S.A.*
Flug Modelltechnik	*Germany*
Flying Models	*U.S.A.*
Hothead (Vancouver) Newsletter	*Canada*
Illinois M.A.C. News-sheet	*U.S.A.*
Ilmailu	*Finland*
Mechanikus	*Germany*
Model Airplane News	*U.S.A.*
Modelar	*Czechoslovakia*
Modelarz	*Poland*
Model-Avia	*Belgium*
Modellezes	*Hungary*
Modellistica	*Italy*
Modellflyg Bladet	*Sweden*
Modele Magazine	*France*
Modele Reduit D'Avion	*France*
N.I.M.A.S. Newsletter	*U.S.A.*
Northern Area News	*Great Britain*
Rassegna Di Modellismo	*Italy*
R/C Modeler	*U.S.A.*
R/C Models	*Japan*
R/C Technique	*Japan*
Scatter Newsletter	*U.S.A.*
Sea Dog Newsletter	*Great Britain*
Skrzydlata Polski	*Poland*
Torque Newsletter (Christchurch)	*New Zealand*
Tulsa Glue Dobbers Bulletin	*U.S.A.*
Varese Newsletter	*Italy*
Wellington Bullsheet	*New Zealand*
Western Area News	*Great Britain*

Trade Distributors
ARGUS PRESS LTD.
23/27 TUDOR STREET, LONDON, E.C.4

Printed in Great Britain by
PAGE & THOMAS LTD., 16 GERMAIN STREET, CHESHAM, BUCKS

CONTENTS

(continued on page 4)

INTRODUCTION

CONTEST flyers may remember this year for the grand weather and magnificent attendance at the Nationals, held once again at R.A.F. Barkston Heath, with all programmes sold out halfway through the Whitsun weekend, and more maxs for flyoffs than ever before. Notable also was the immense public interest in radio control events, with r/c scale stealing the show, until one wondered if there were any other events taking place!

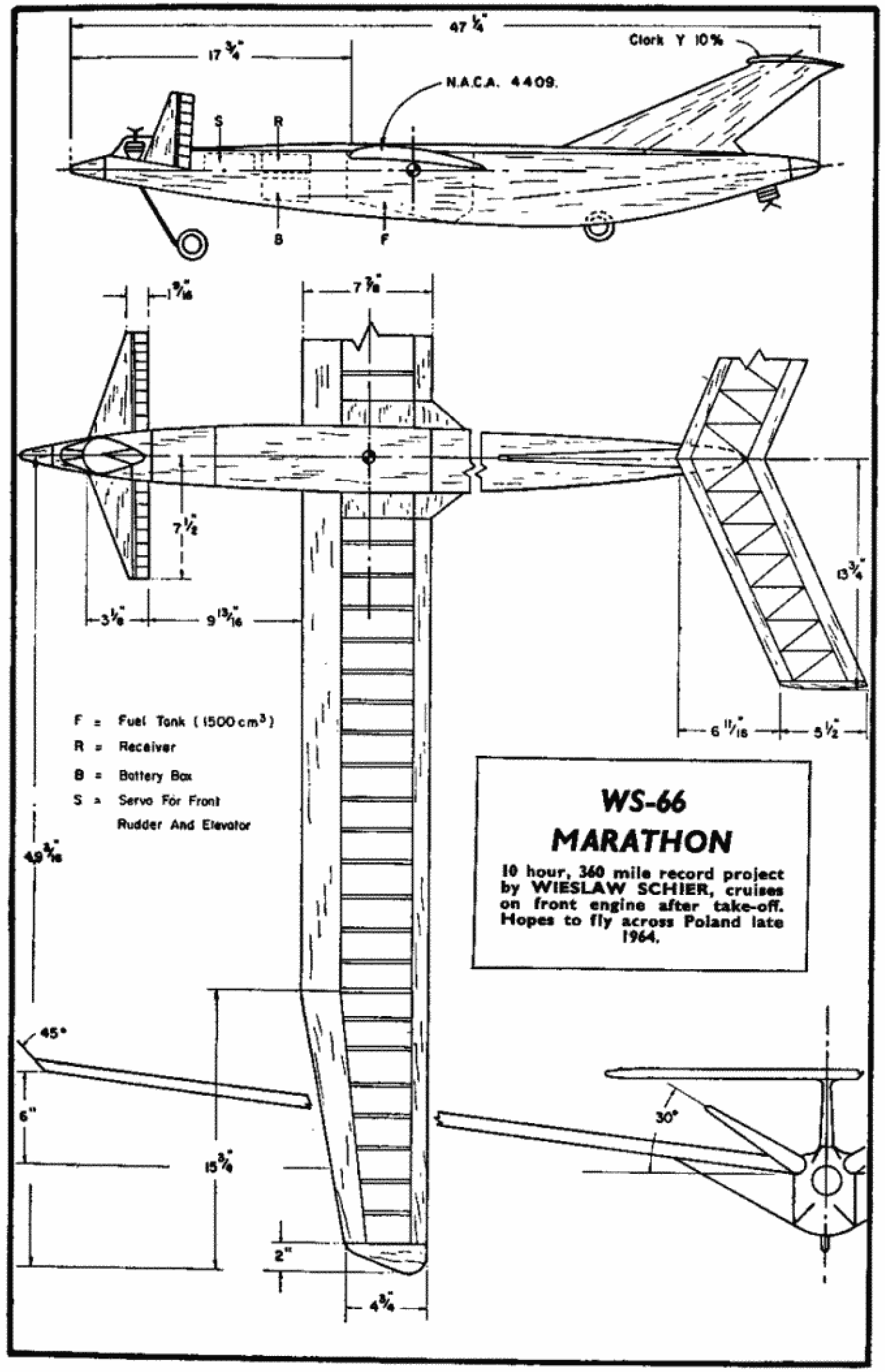
Alas, it has also been a year of sad losses to the aeromodelling movement. On the day following last year's S.M.A.E. Dinner held as an experiment at York, where he was to have received a presentation, Alex Houlberg died at the age of 68, having completed no less than 50 years of active association with the movement nationally and internationally. Then Northern Heights M.F.C. President, Dr. A. P. Thurston, died in the early summer. He will always be remembered as the doyen of the Northern Heights Gala, and for his great day when in 1948 Queen Elizabeth visited Langley to present for the first time the "Queen Elizabeth Trophy." Then we have lost that colourful personality P. E. Norman, noted for his wonderful freeflight and r/c scale models, his unconventional attitude to flying attire, and the elegant trophies he designed and made for the movement. He died suddenly as he would have wished while flying his models on Epsom Downs. Latest loss is that great Wakefield flyer Roy Chesterton, whose flying of the Ted Evans' designed Jaguar brought the trophy back to G.B. in the first post-war contest held at Akron, Ohio, U.S.A., in 1948.

Domestic flying problems have continued to centre round the closely allied problems of flying places and noise, which appear to be mutually self-cancelling! However, the S.M.A.E. has ruled that silencers shall be fitted to all engines entered in contests as from January 1st, 1965. In almost similar vein the Model Trade Federation has ruled that from the same date its members shall not make or distribute engines for which silencers are not available. In other words the modelling horse has been led to the water, whether he will drink is quite another thing!

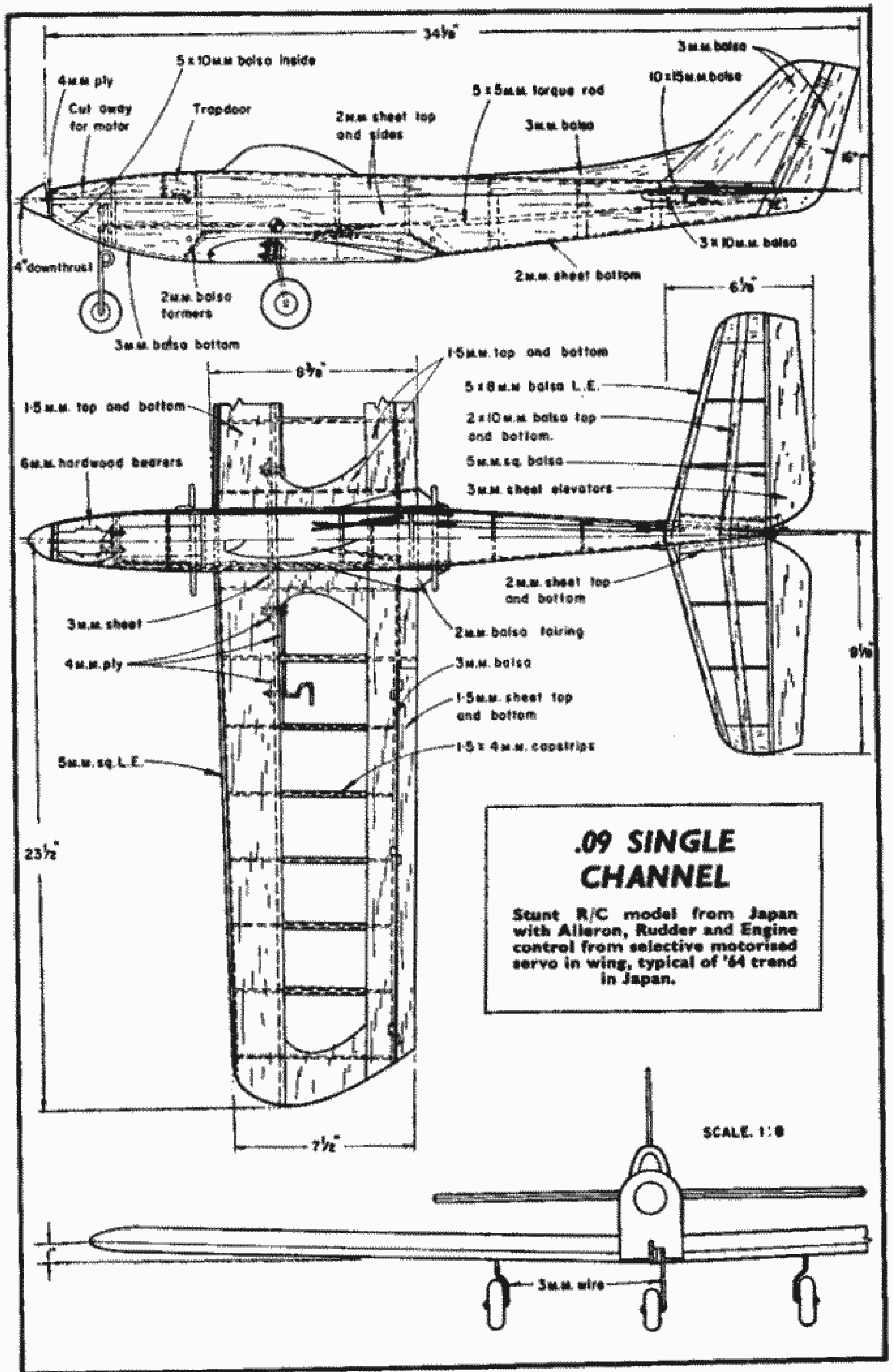
Trend of the year has undoubtedly been more and more towards radio control flying. Reliability of modern equipment, ability to fly in comparatively restricted areas, our affluent state have all contributed towards this end. Only rival in numbers continues to be control line in its many ramifications, with team racing and combat flying to the fore numerically. Freeflight is tending to be the province of the specialist on the one hand, and the young entrant to modelling on the other . . . that is until he sees his first control line model . . .

Once again we have Laurie Bagley providing the cover painting, which follows our "achievements of the year" theme, showing a prophetic Concord taking off in the foreground, and behind it a muscle-power ornithopter, symbolic of man's continuing struggle to conquer that aspect of flying.

CONTENTS *(continued from previous page)*



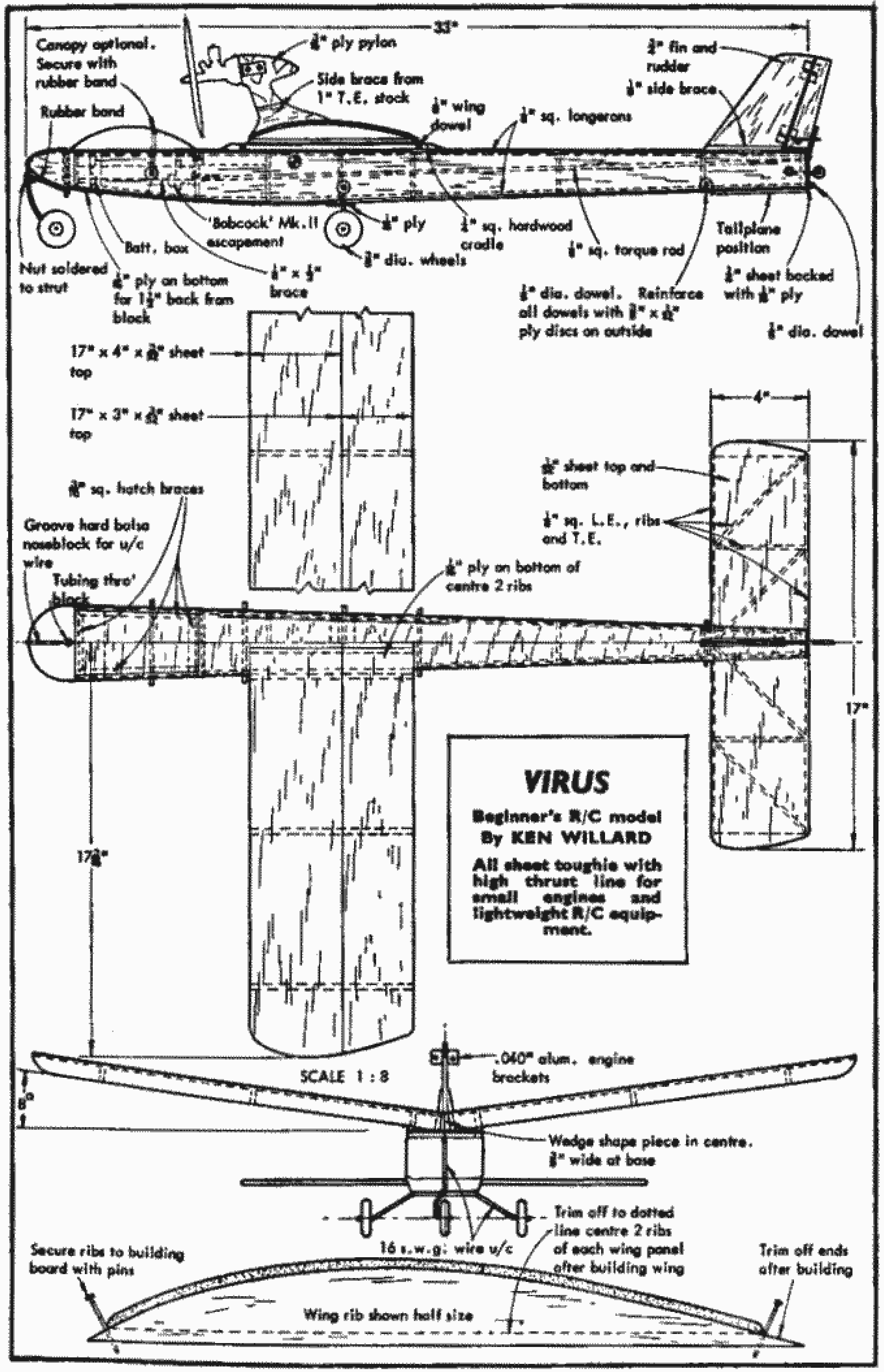
POLAND



.09 SINGLE CHANNEL

Stunt R/C model from Japan with Aileron, Rudder and Engine control from selective motorised servo in wing, typical of '64 trend in Japan.

RADIO CONTROL TECHNIQUE, JAPAN

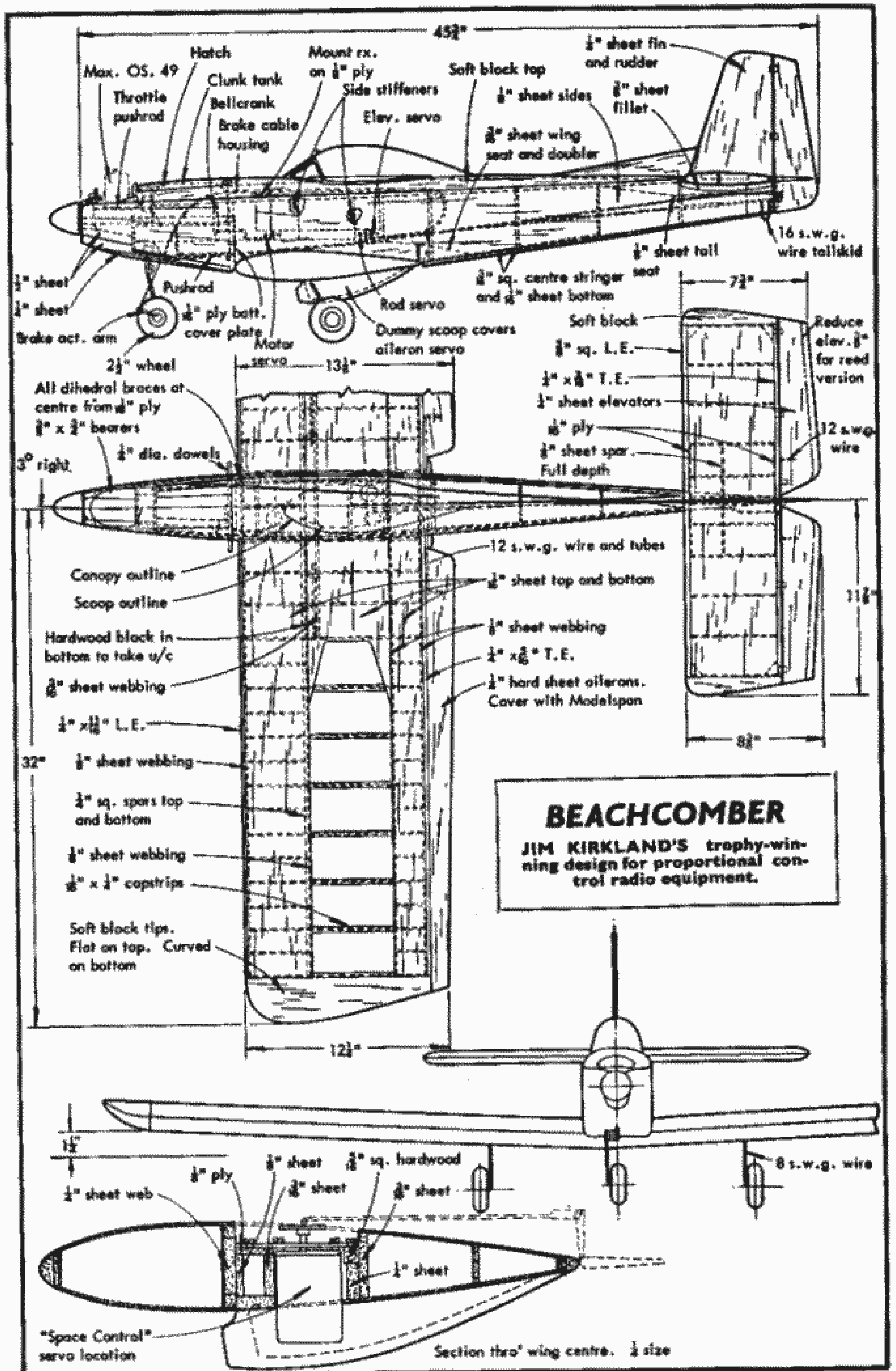


VIRUS

Beginner's R/C model
By KEN WILLARD

All sheet toughie with high thrust line for small engines and lightweight R/C equipment.

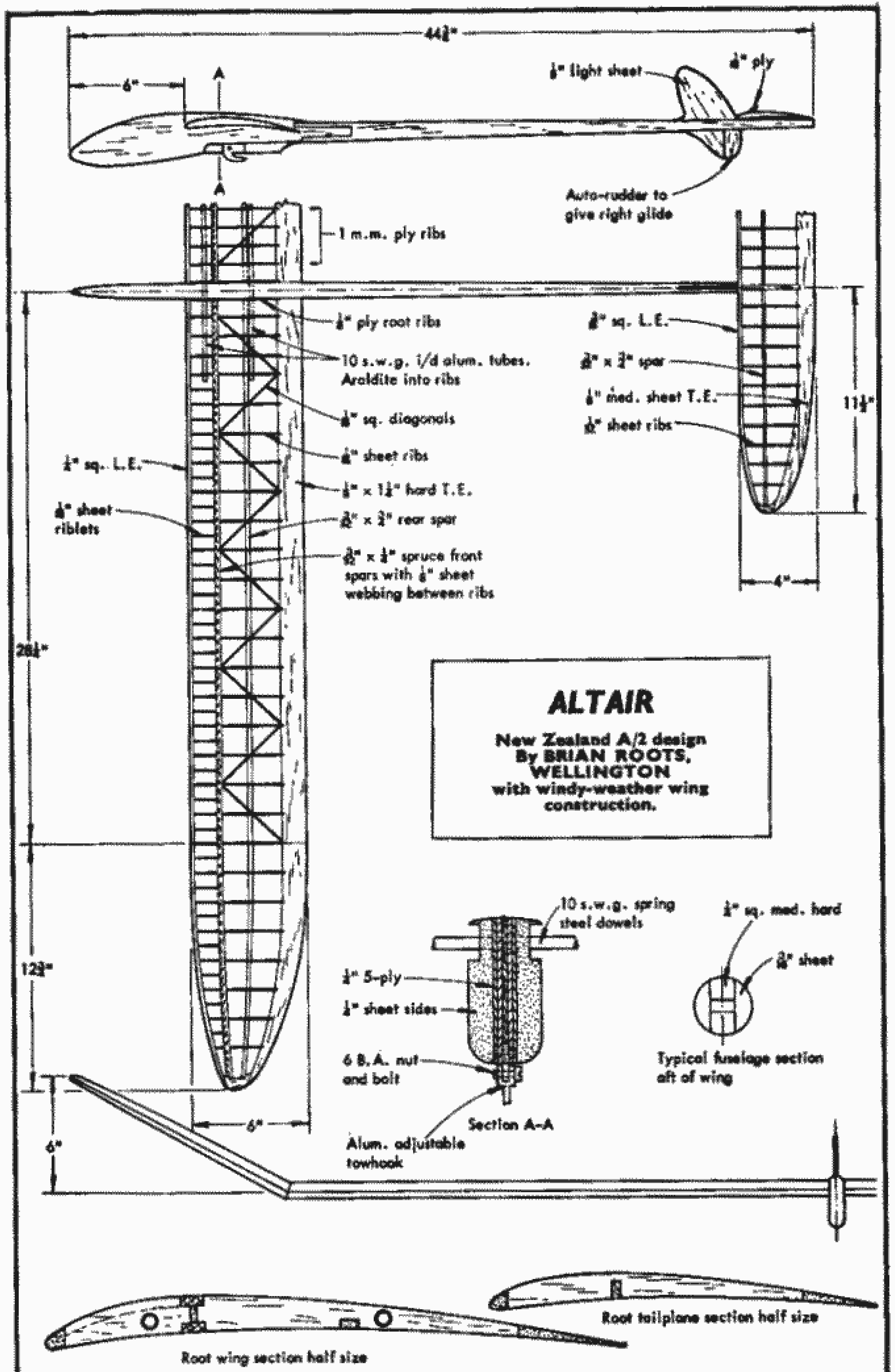
RADIO CONTROL MODELER, U.S.A.



BEACHCOMBER

JIM KIRKLAND'S trophy-winning design for proportional control radio equipment.

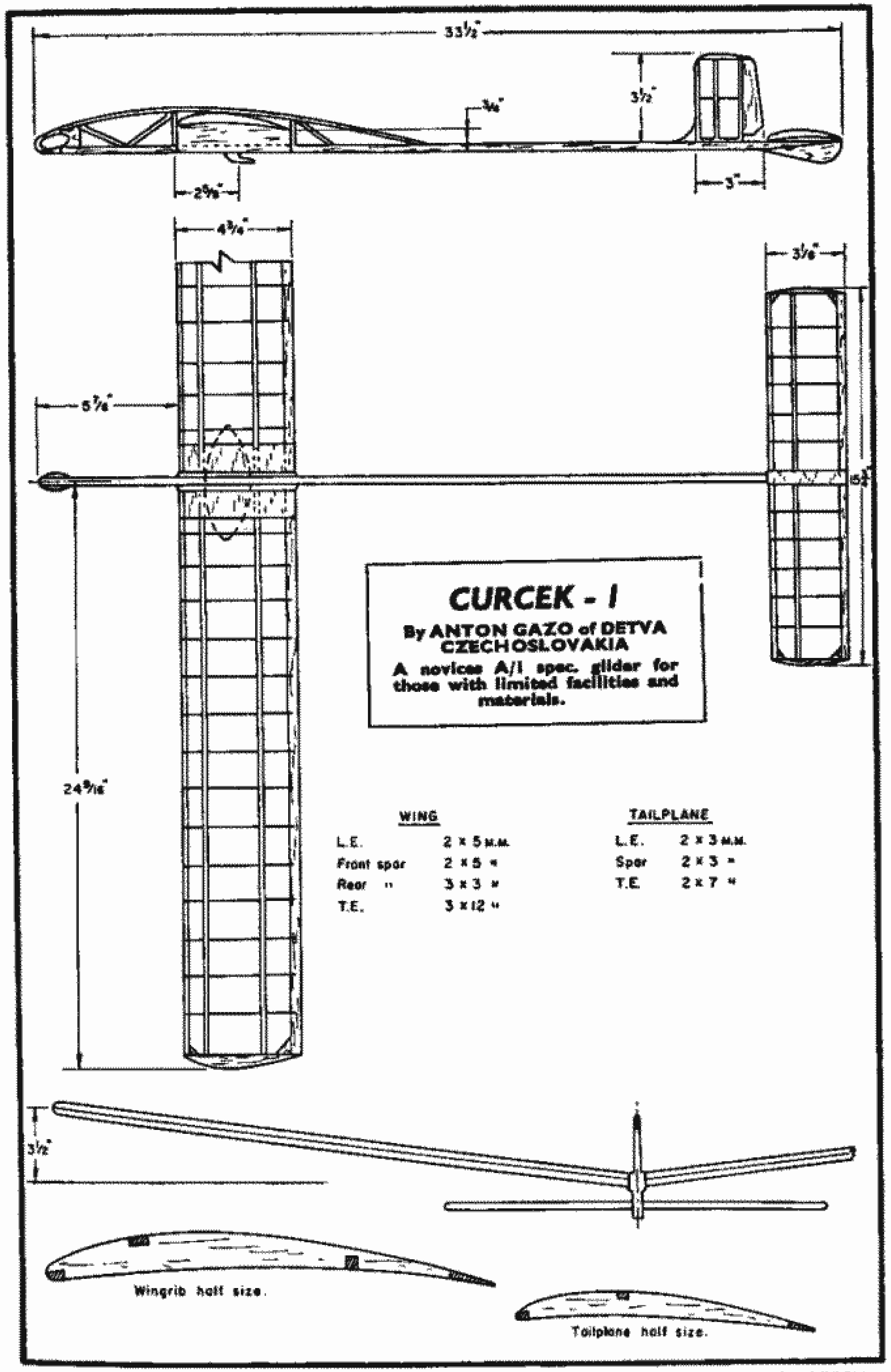
MODEL AIRPLANE NEWS, U.S.A.



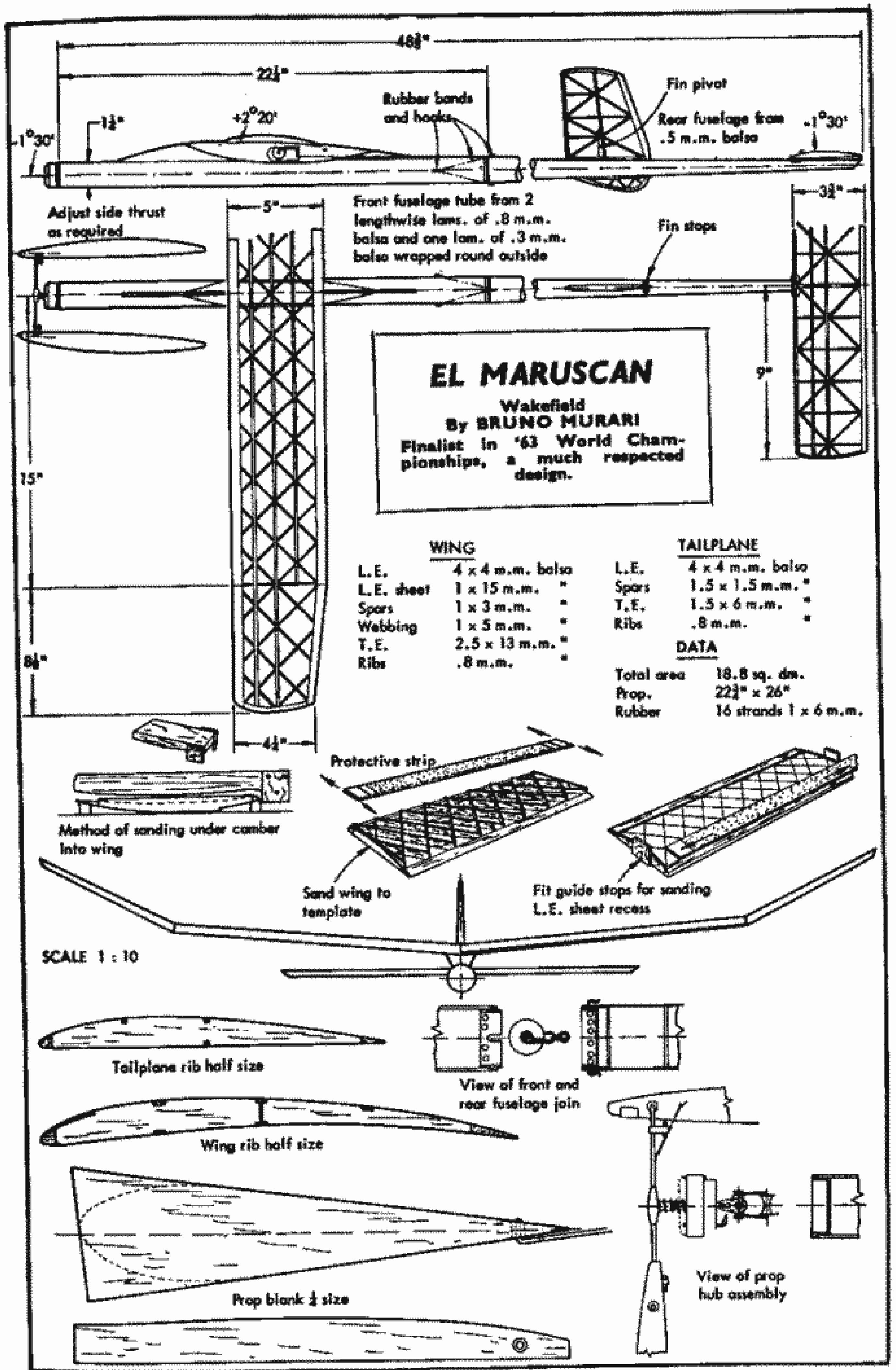
ALTAIR

New Zealand A/2 design By BRIAN ROOTS, WELLINGTON with windy-weather wing construction.

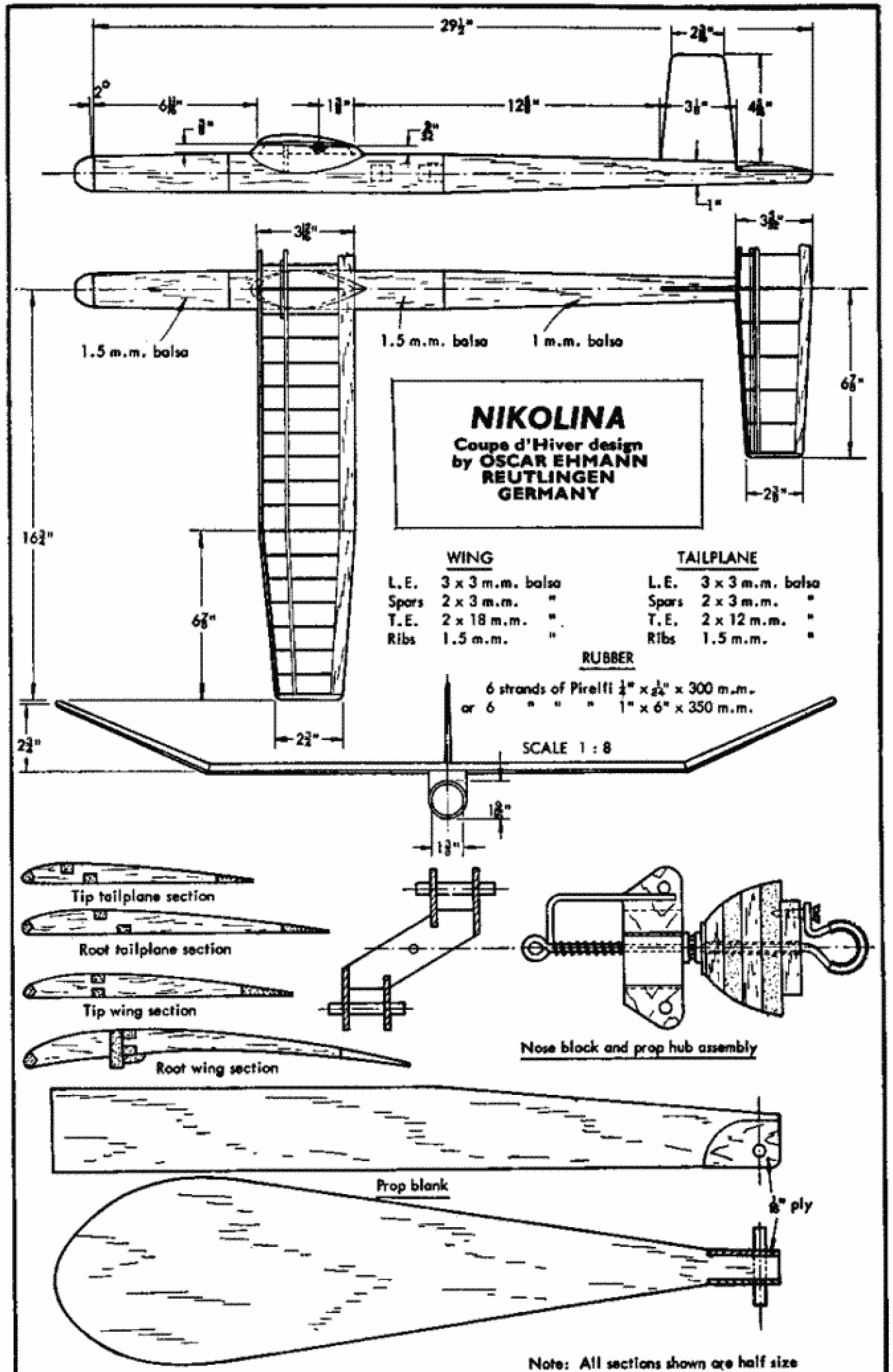
WELLINGTON (NZ) BULLSHEET

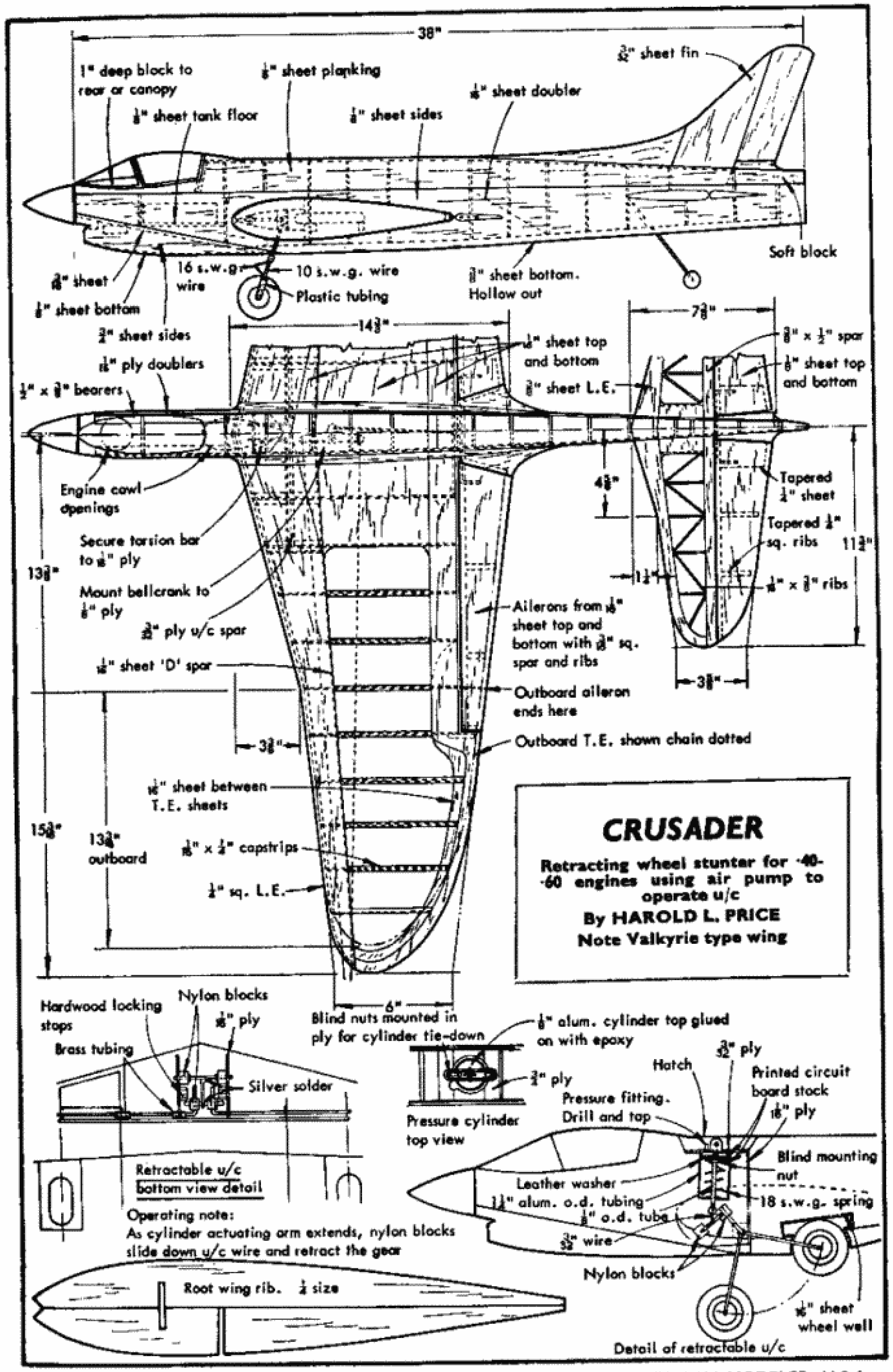


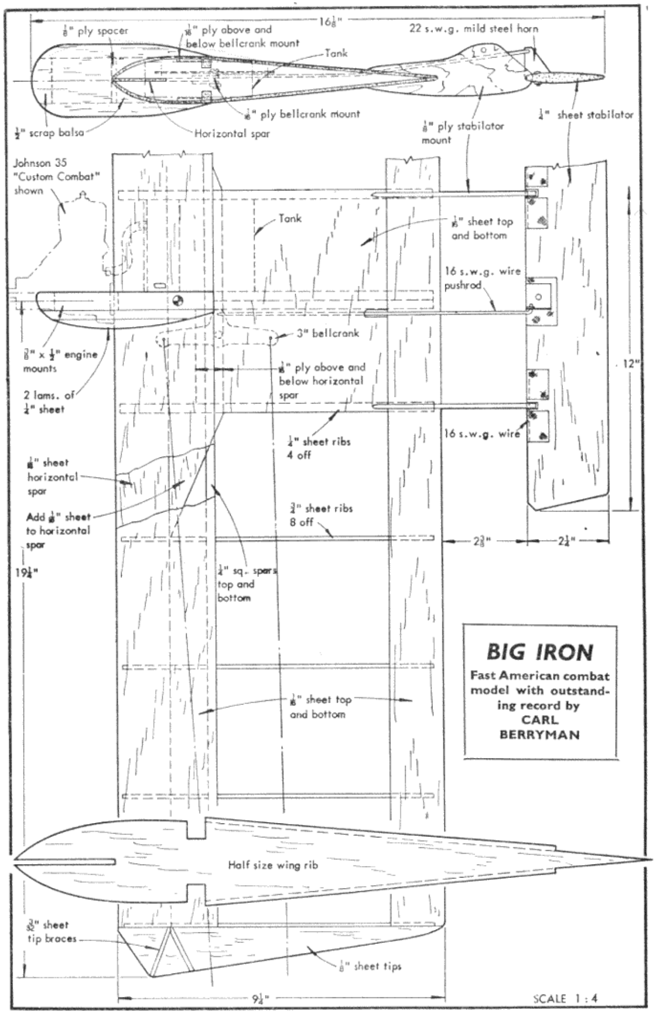
MODELAR—CZECH



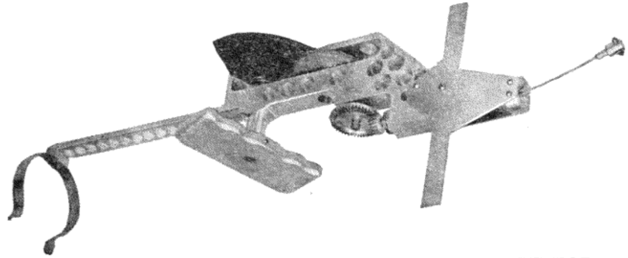
MODELLISTICA, ITALY


NIKOLINA
Coupe d'Hiver design
by OSCAR EHMANN
REUTLINGEN
GERMANY
1.5 m.m. balsa
1.5 m.m. balsa
1 m.m. balsa
WING
L.E. 3 x 3 m.m. balsa
Spars 2 x 3 m.m.
T.E. 2 x 18 m.m.
Ribs 1.5 m.m.
TAILPLANE
L.E. 3 x 3 m.m. balsa
Spars 2 x 3 m.m.
T.E. 2 x 12 m.m.
Ribs 1.5 m.m.
RUBBER
SCALE 1 : 8
Tip tailplane section
Root tailplane section
Tip wing section
Root wing section
Nose block and prop hub assembly
Prop blank
Note: All sections shown are half size


38"
1" deep block to rear or canopy
sheet planking
sheet doubler
sheet tank floor
sheet sides
sheet fin
Soft block
sheet
sheet bottom
16 s.w.g. wire
10 s.w.g. wire
Plastic tubing
sheet bottom. Hollow out
sheet sides
ply doublers
bearers
sheet top and bottom
sheet L.E.
spar
sheet top and bottom
Engine cowl openings
Secure torsion bar to ply
Mount bellcrank to ply
ply u/c spar
sheet 'D' spar
Ailerons from sheet top and bottom with sq. spar and ribs
Outboard aileron ends here
Outboard T.E. shown chain dotted
Tapered sheet
Tapered sq. ribs
ribs
sheet between T.E. sheets
outboard
capstrips
sq. L.E.
CRUSADER
Retracting wheel stunter for ·40-·60 engines using air pump to operate u/c
By HAROLD L. PRICE
Note Valkyrie type wing
Hardwood locking stops
Nylon blocks
ply
Brass tubing
Silver solder
Blind nuts mounted in ply for cylinder tie-down
alum. cylinder top glued on with epoxy
ply
Pressure cylinder top view
Hatch
ply
Printed circuit board stock
Pressure fitting. Drill and tap
Blind mounting nut
Retractable u/c bottom view detail
Leather washer
alum. o.d. tubing
o.d. tube
18 s.w.g. spring
wire
Nylon blocks
Operating note:
As cylinder actuating arm extends, nylon blocks slide down u/c wire and retract the gear
Root wing rib. size
sheet wheel well
Detail of retractable u/c



AMERICAN MODELER



GLENN LEE'S SPEED MODEL CONTROL HANDLE FOR SINGLE LINE OPERATION

Among the many outstanding features of the 1964 World Championships for Control Line Speed models, held at Budapest, Hungary, at the end of July, was the introduction of many new types of control line handle for the single line system.

For the greater part of the speed contest, leading place was held by Glenn Lee of the U.S.A. Glenn could well be called the "quiet American" and is himself a remarkable character, who we were pleased to meet. His enthusiasms are broad and embrace many classes of aeromodelling from large size helicopters through free flight power duration to carrier scale. Naturally inventive, he created this special handle in order to convert the "conventional" handle motion as used with two line control into the rotary motion employed for torque control, with a single line system. The result is an intriguing device which attracted considerable attention among the world's top modellers at Budapest. The handle is unique in that it can be operated with one hand only, and is, therefore, very easy to locate on the anti-whip pylon. The simple gears are by no means quiet and give a jangling ring which, coupled with the clump clump of Glenn's cowboy boot heels, add to an unusual impression. Glenn's eventual 3rd in the World Speed Championships is in no small part due to this control line handle.

Prior to publication, we gave an advance print to a visiting Italian modeller and lo and behold an exact copy appeared in the 1964 Italian team at the World Champs! This is a tribute in recognition of a clever design.

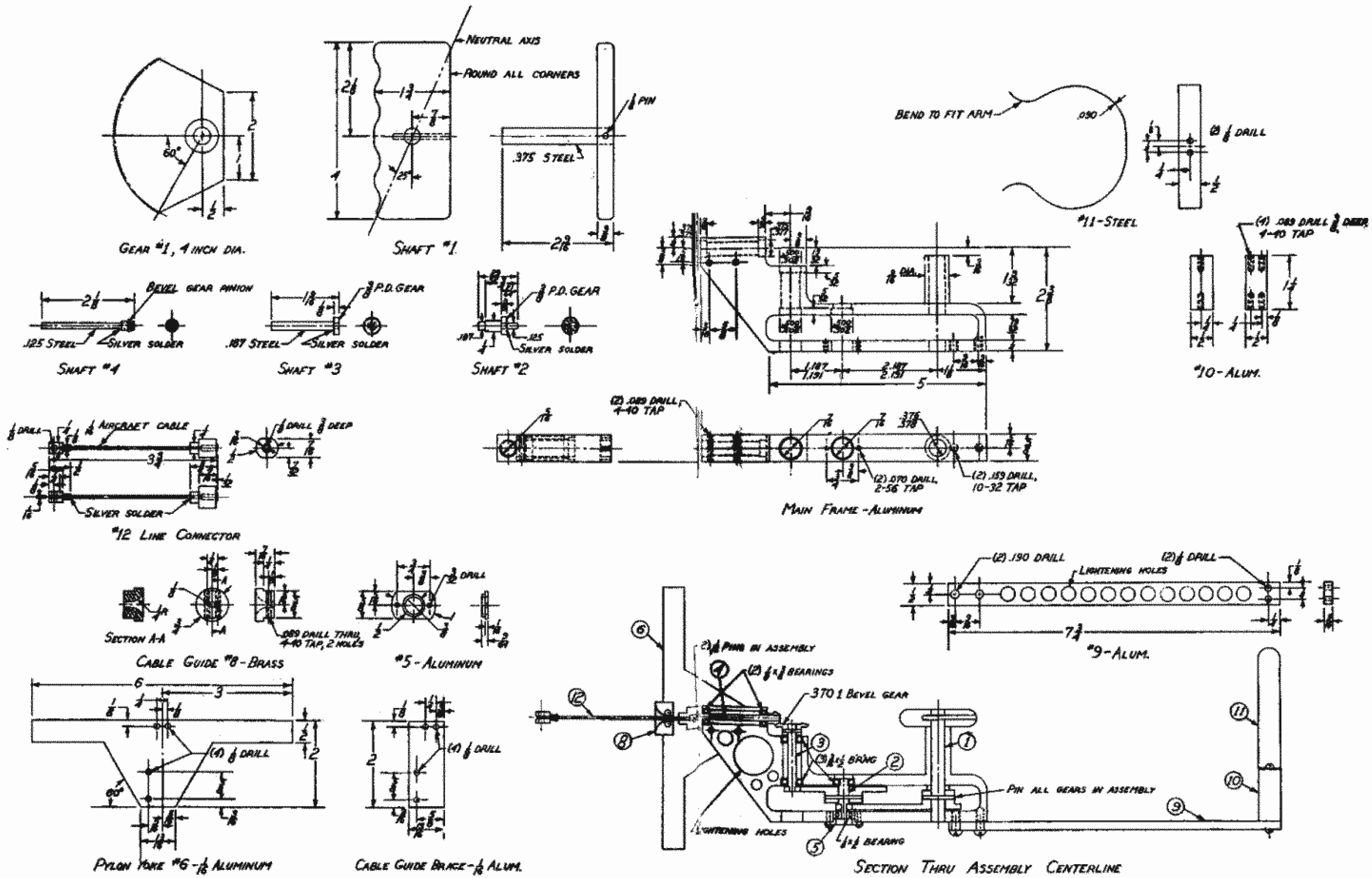
Model control is very similar to Conventional-Control-line, but is not as fast in action. Plus and minus 30° movement can give 40 turns of the line.

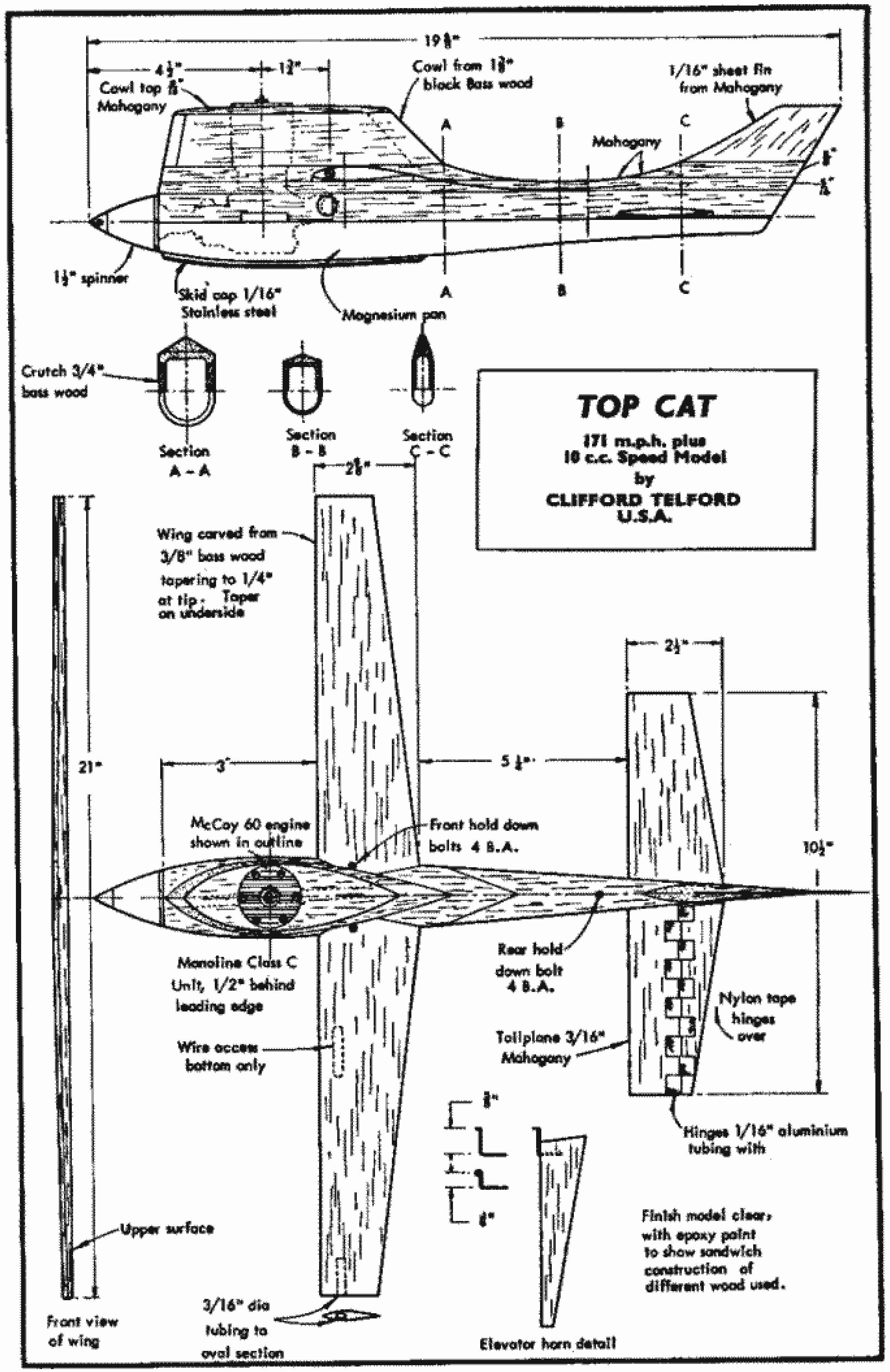
The actual gear ratio is not critical as long as it is high enough to give adequate control to the model. The following gears were used for a ratio of approximately 170:1.

The first set is a 120° segment of a 4 inch 48 pitch spur gear driving a 3/8 diameter pinion. The pinion is soldered on a shaft with a 2 inch diameter 48 pitch spur gear driving another 3/8 diameter pinion. The second pinion is soldered to the shaft driving the 3:1 bevel output gear.

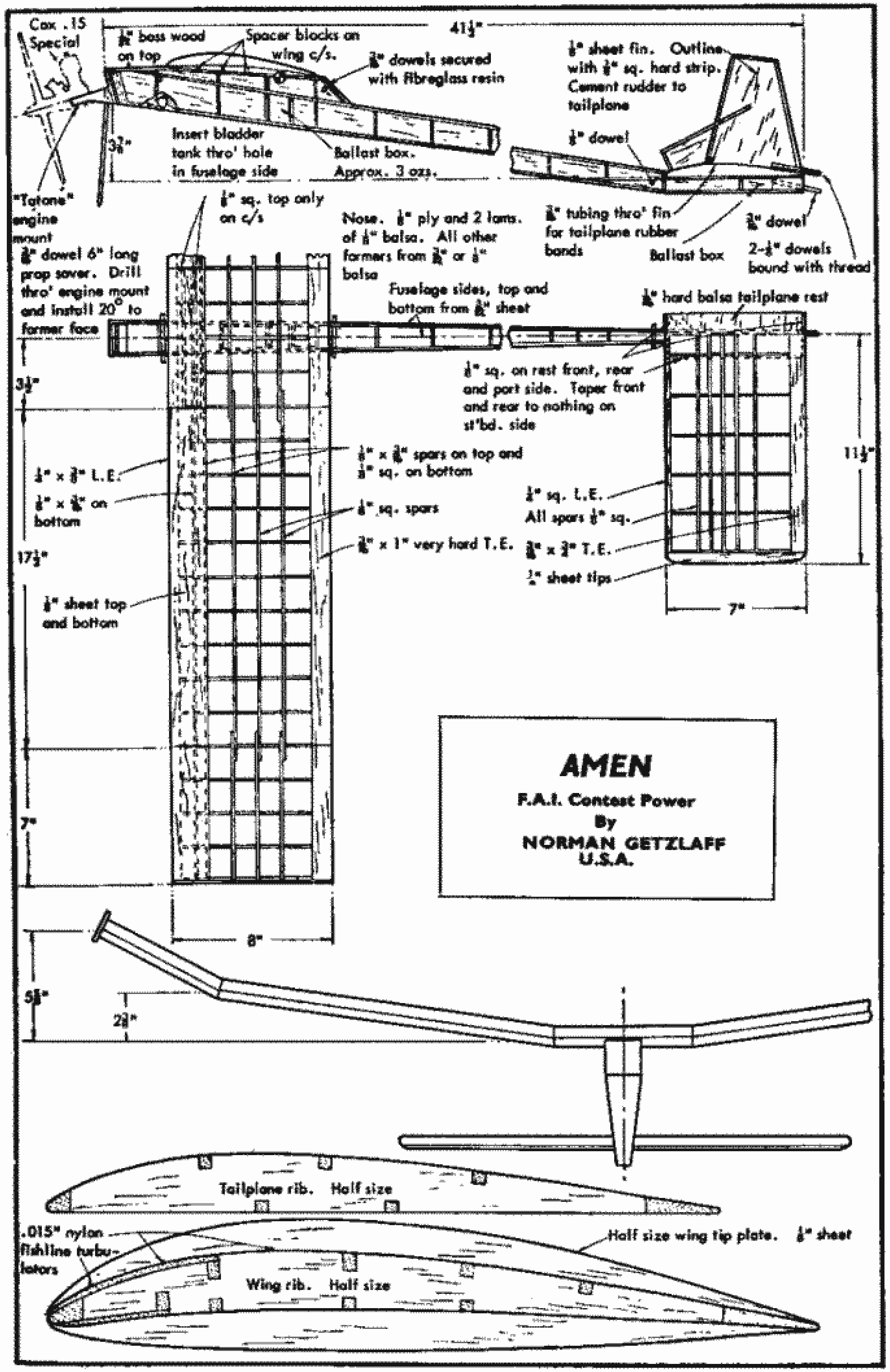
Elimination of all friction is very important. The ball bearings must be the open type without shields. The flexible cable connector and bell-mouthed guide is superior to a universal joint since side loads are eliminated.

For F.A.I. speed flying, Glenn used about 30 feet of ·022 diameter wire and the remainder to the aircraft is of ·014 diameter.

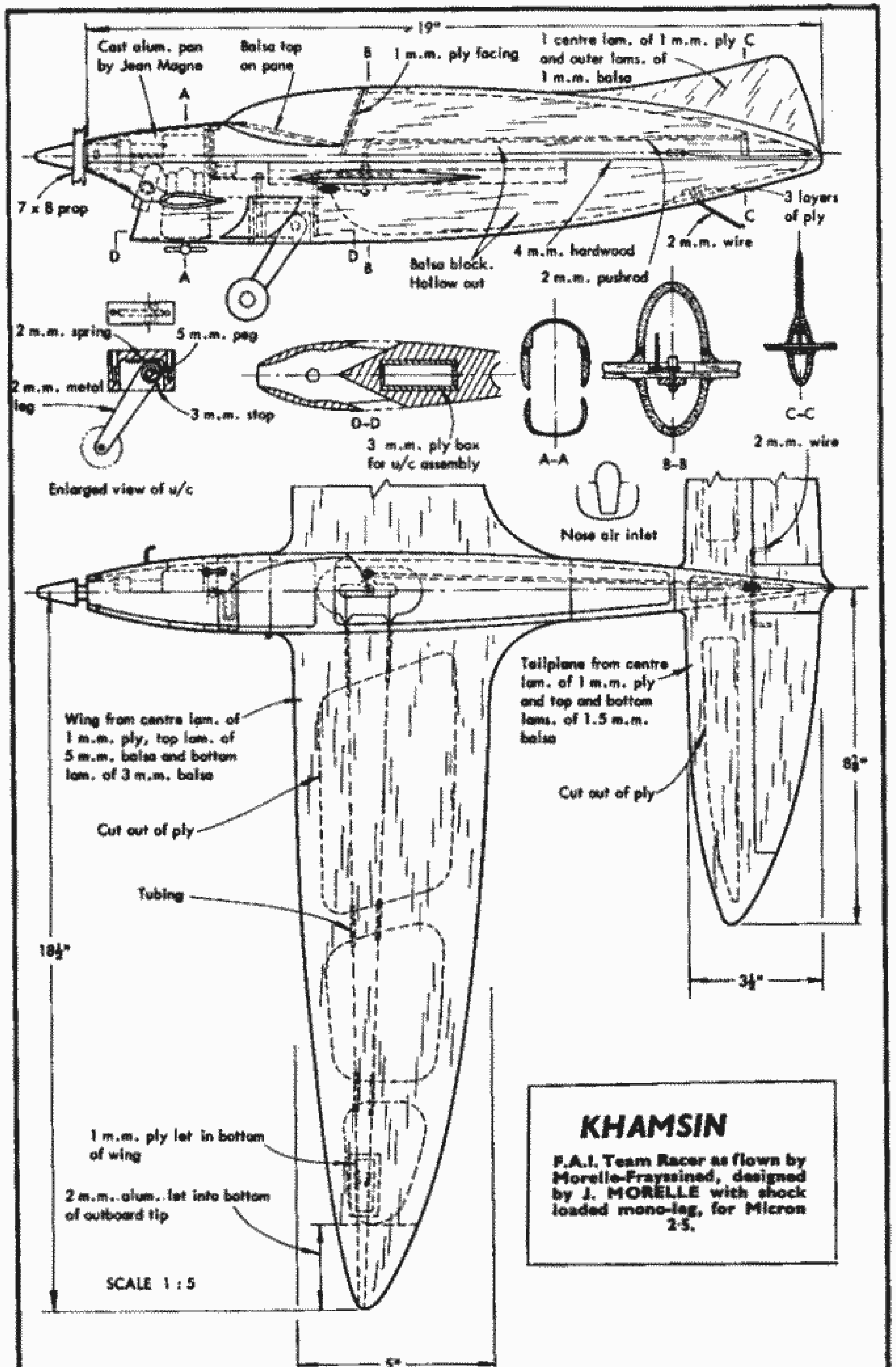

NEUTRAL AXIS
ROUND ALL CORNERS
.375 STEEL
GEAR #1, 4 INCH DIA.
SHAFT #1
BEND TO FIT ARM
#11-STEEL
BEVEL GEAR PINION
.125 STEEL
SILVER SOLDER
SHAFT #4
.187 STEEL
SHAFT #3
P.D. GEAR
SHAFT #2
#10-ALUM.
AIRCRAFT CABLE
SILVER SOLDER
#12 LINE CONNECTOR
(2) .089 DRILL
4-40 TAP
(2) .070 DRILL,
2-56 TAP
(2) .159 DRILL,
10-32 TAP
MAIN FRAME-ALUMINUM
SECTION A-A
.089 DRILL THRU
4-40 TAP, 2 HOLES
CABLE GUIDE #8-BRASS
#5-ALUMINUM
(2) .190 DRILL
LIGHTENING HOLES
#9-ALUM.
PYLON YOKE #6
CABLE GUIDE BRACE
PIN ALL GEARS IN ASSEMBLY
LIGHTENING HOLES
SECTION THRU ASSEMBLY CENTERLINE



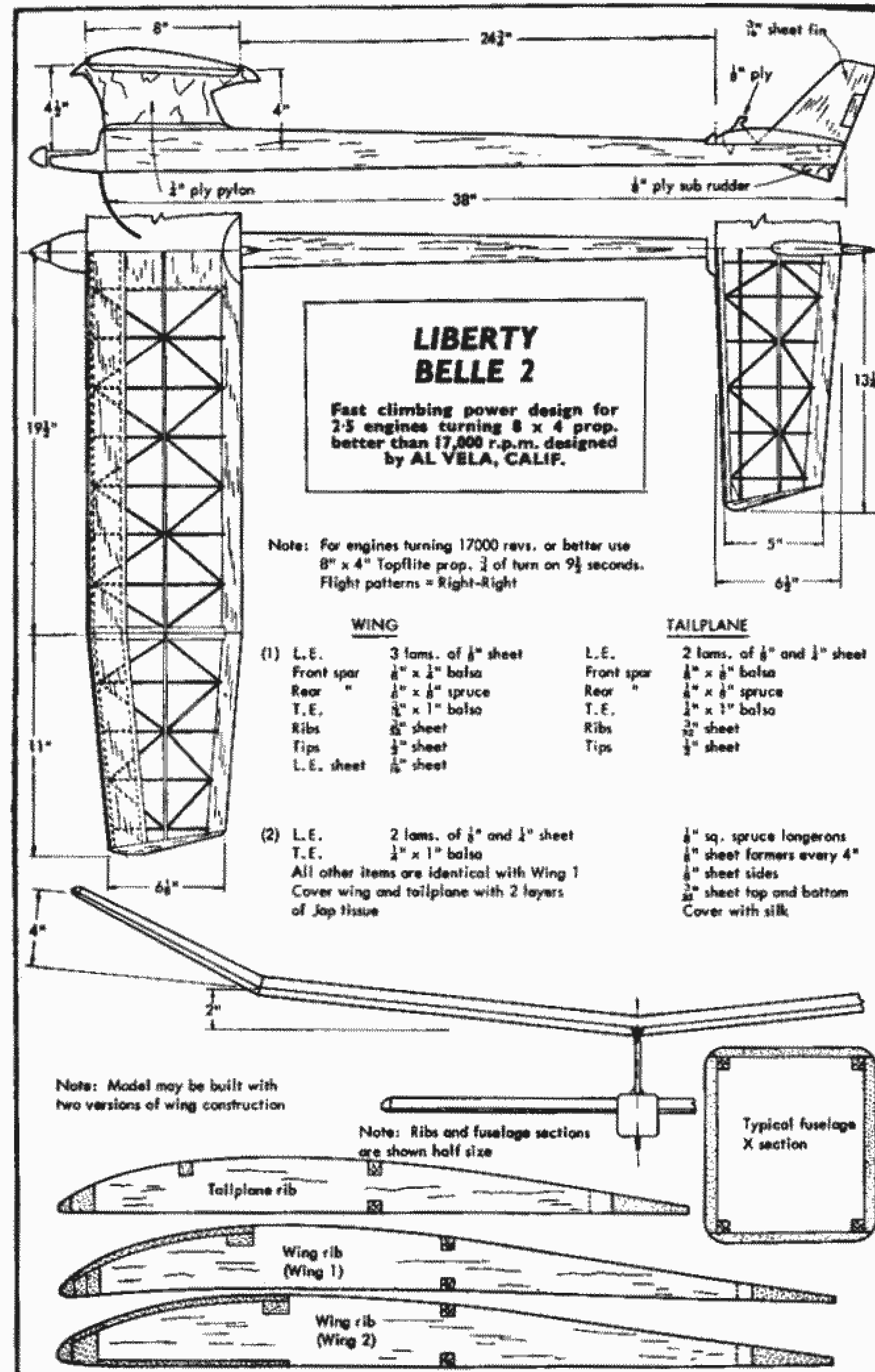
MODEL AIRPLANE NEWS, U.S.A.



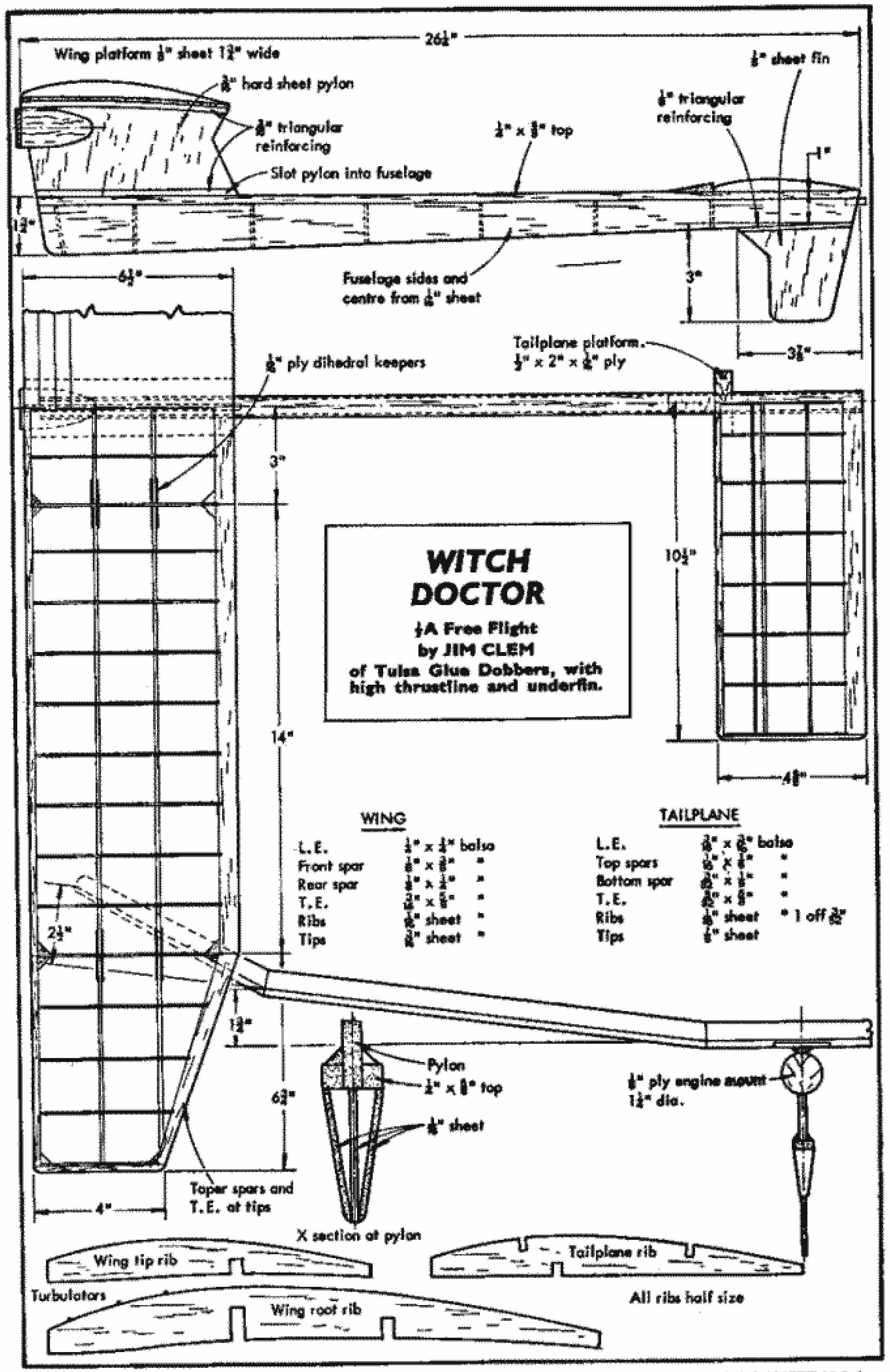
AMERICAN MODELER, U.S.A.



LE MODELE REDUIT D'AVION, FRANCE



"SCATTER", U.S.A.



WITCH DOCTOR

½A Free Flight by JIM CLEM of Tulsa Glue Dobbers, with high thrustline and underfin.

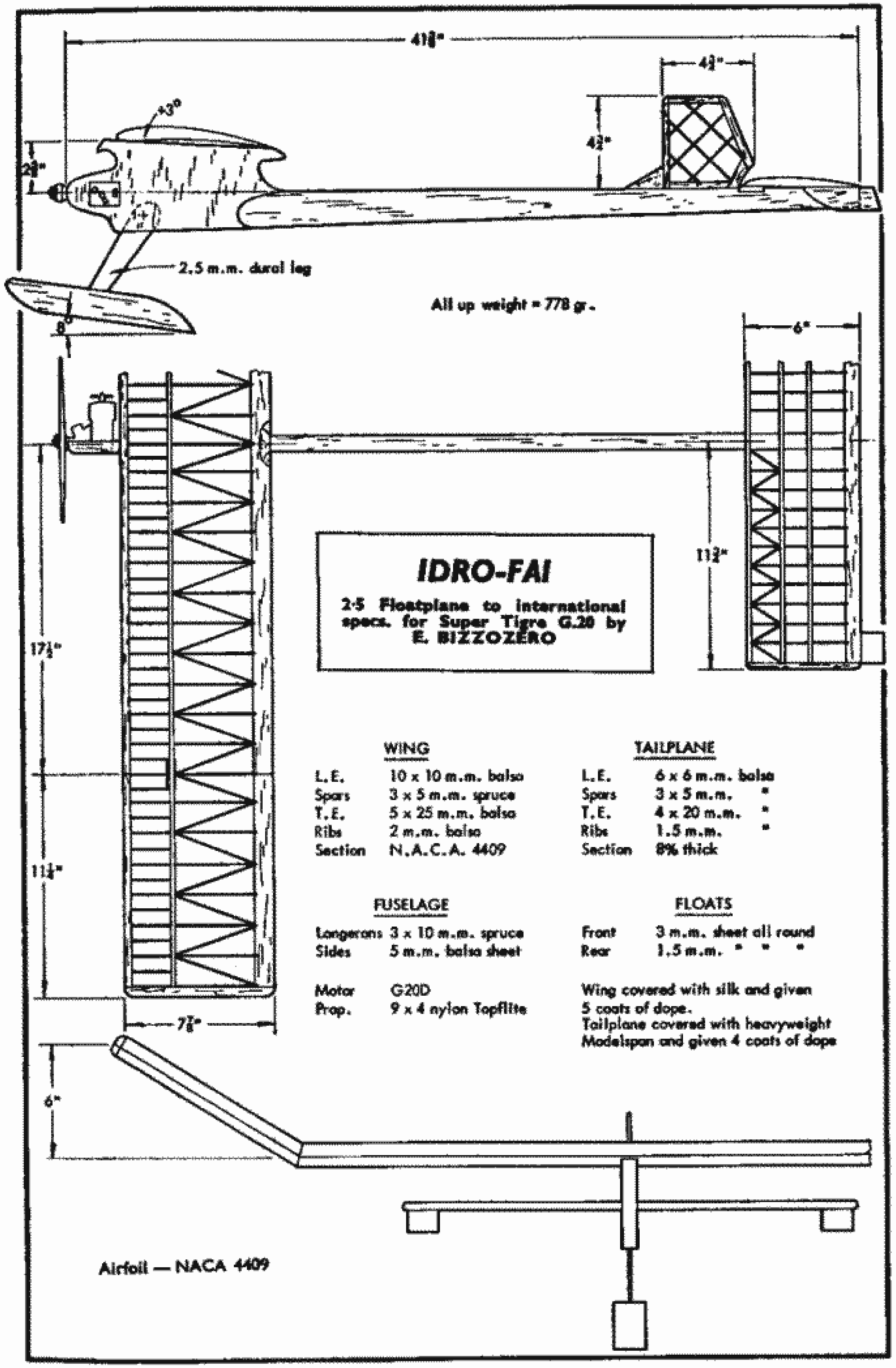
WING

L.E.	¼" x ¼" balsa
Front spar	⅛" x ⅜" "
Rear spar	⅛" x ¼" "
T.E.	3/16" x ⅝" "
Ribs	1/16" sheet "
Tips	3/32" sheet "

TAILPLANE

L.E.	3/16" x 3/16" balsa
Top spars	1/16" x ⅛" "
Bottom spar	3/32" x ⅛" "
T.E.	3/32" x ⅝" "
Ribs	1/32" sheet " 1 off 3/32"
Tips	⅛" sheet

TULSA G.D. NEWS-SHEET U.S.A.



IDRO-FAI

2·5 Floatplane to international specs. for Super Tigre G.20 by E. BIZZOZERO

WING

L.E.	10 x 10 m.m. balsa
Spars	3 x 5 m.m. spruce
T.E.	5 x 25 m.m. balsa
Ribs	2 m.m. balsa
Section	N.A.C.A. 4409

TAILPLANE

L.E.	6 x 6 m.m. balsa
Spars	3 x 5 m.m. "
T.E.	4 x 20 m.m. "
Ribs	1.5 m.m. "
Section	8% thick

FUSELAGE

Longerons	3 x 10 m.m. spruce
Sides	5 m.m. balsa sheet

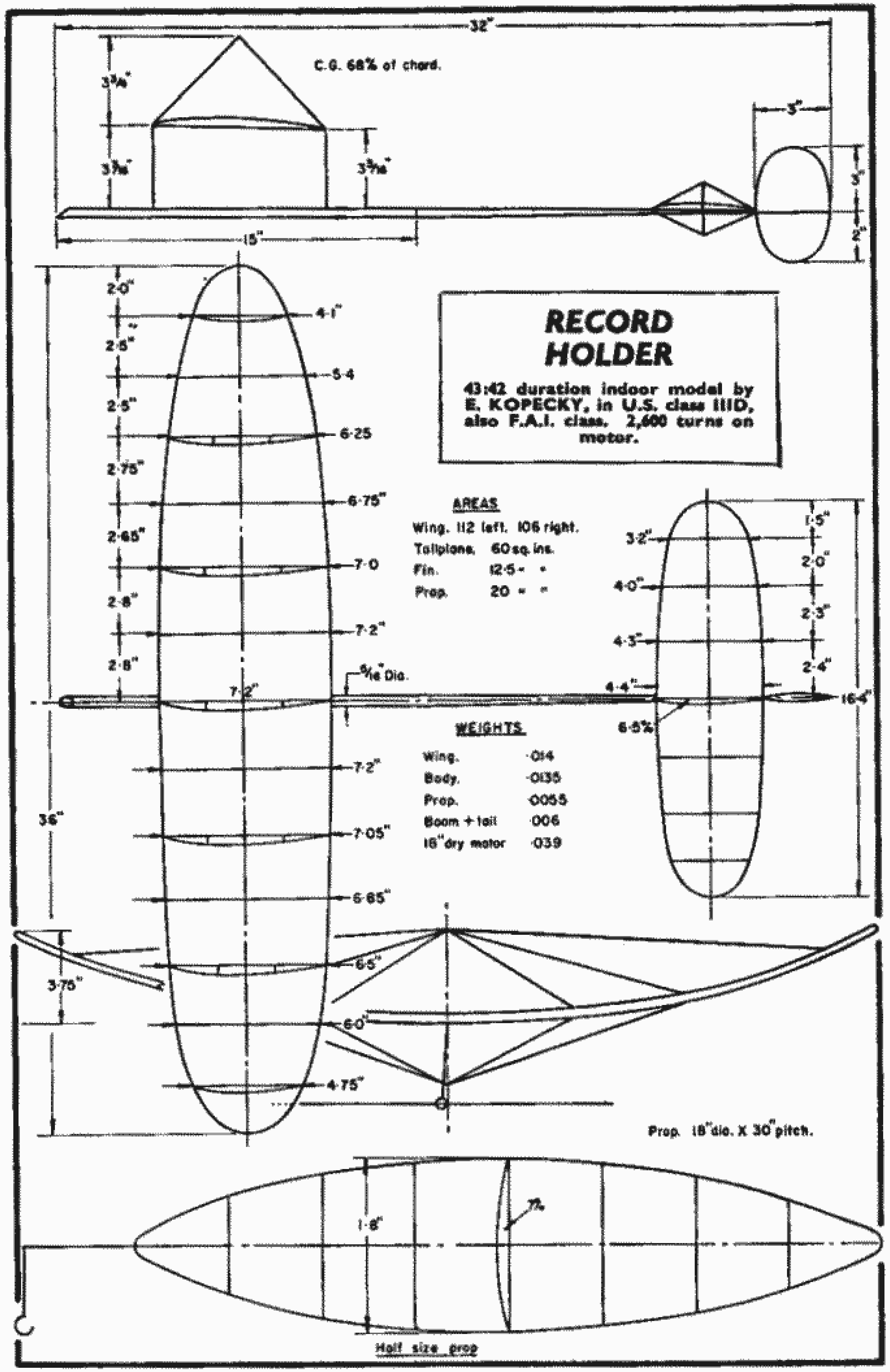
FLOATS

Front	3 m.m. sheet all round
Rear	1.5 m.m. " " "

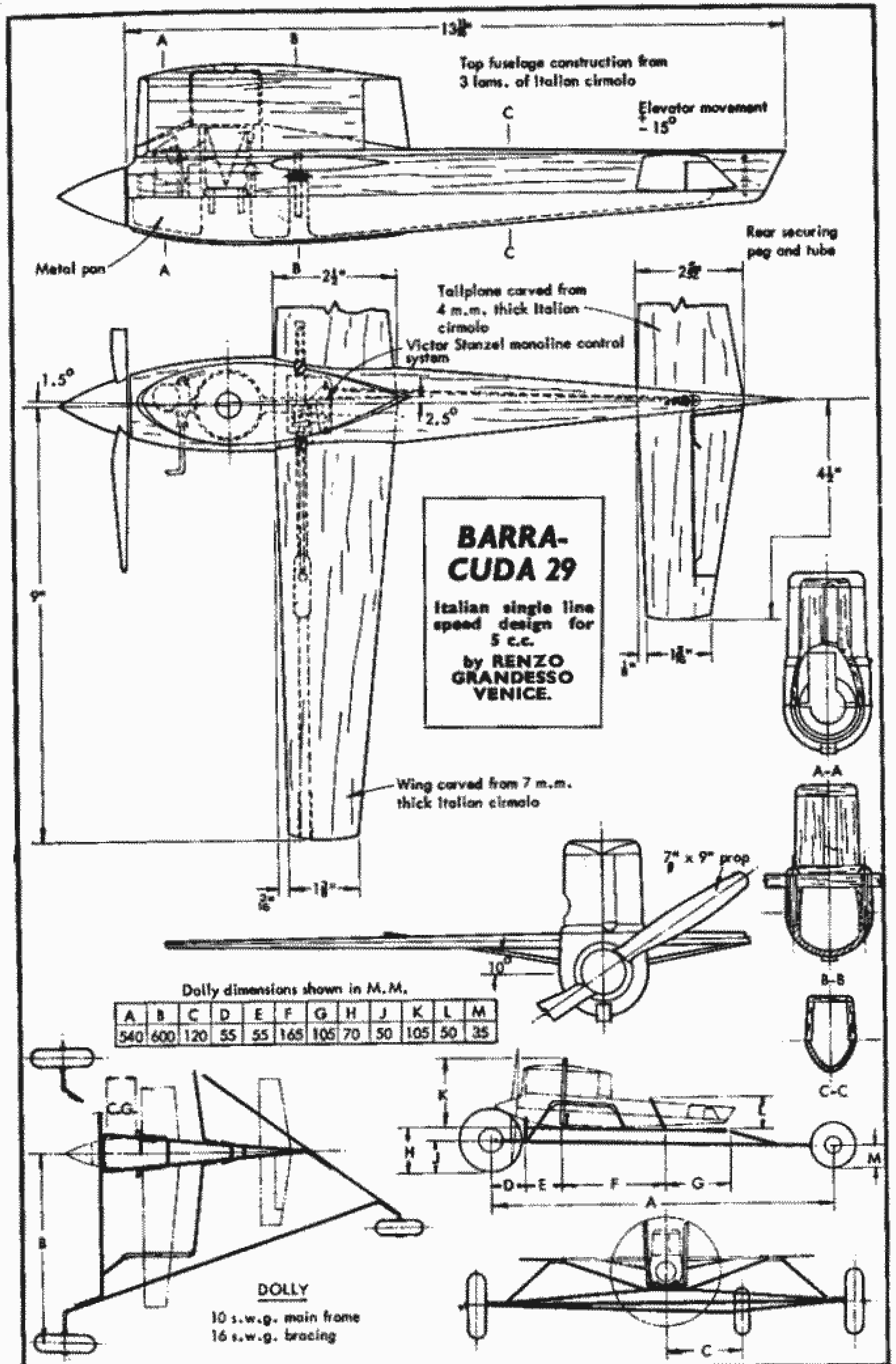
Motor	G20D
Prop.	9 x 4 nylon Topflite

Wing covered with silk and given 5 coats of dope.
Tailplane covered with heavyweight Modelspan and given 4 coats of dope

VARESE AERO CLUB, ITALY



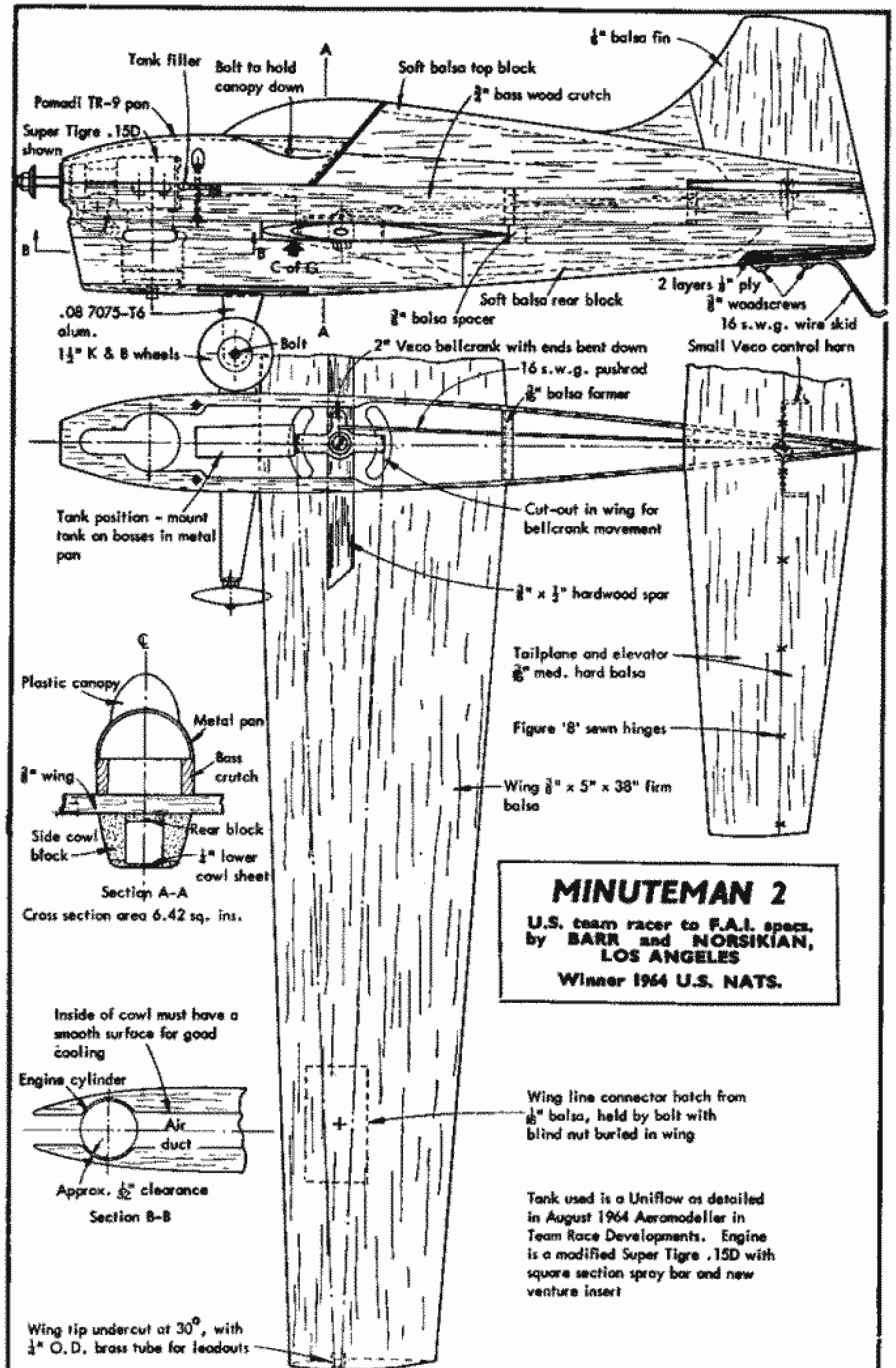
INDOOR NEWS & VIEWS, U.S.A.



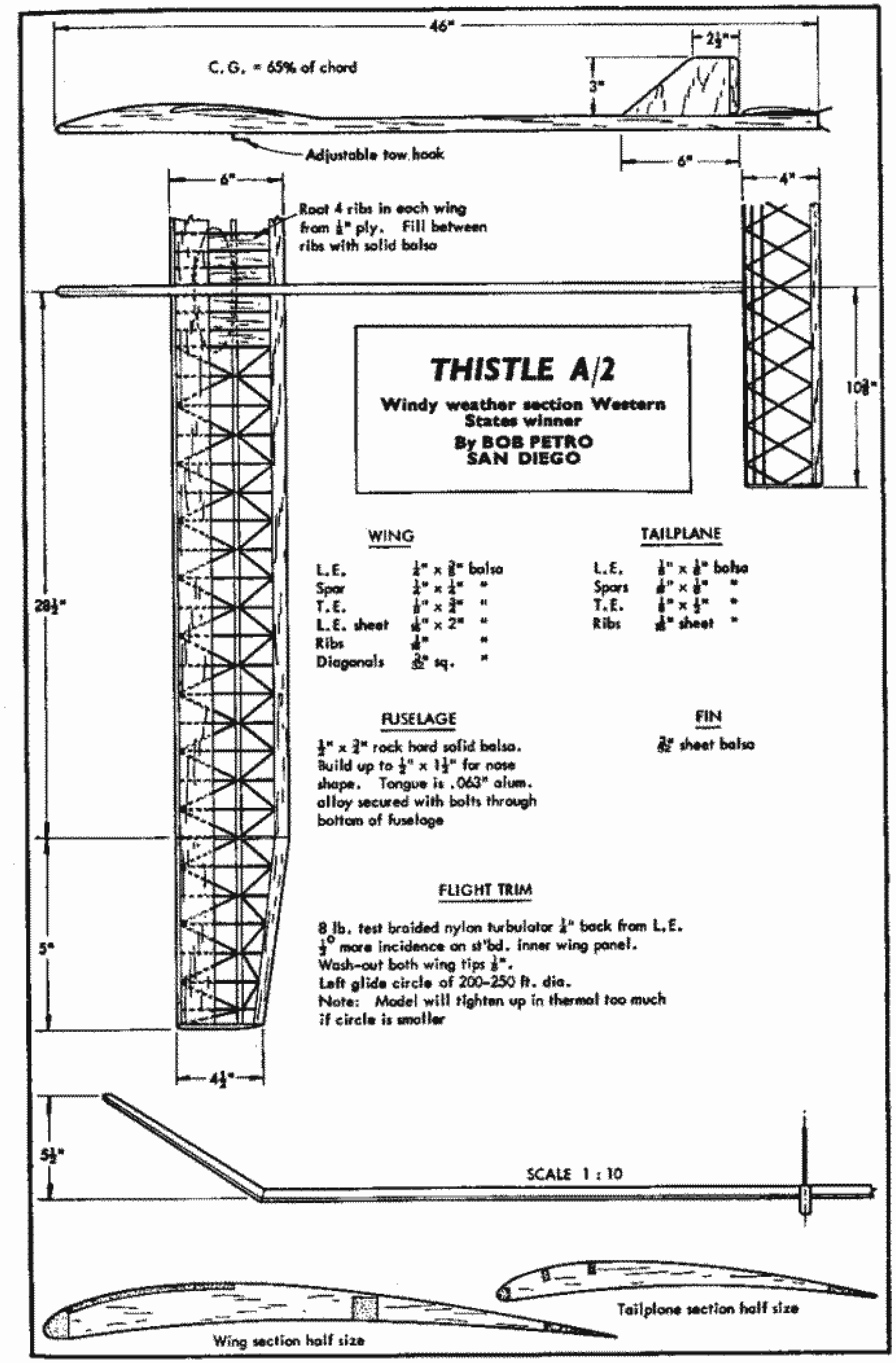
Dolly dimensions shown in M.M.

A	B	C	D	E	F	G	H	J	K	L	M
540	600	120	55	55	165	105	70	50	105	50	35

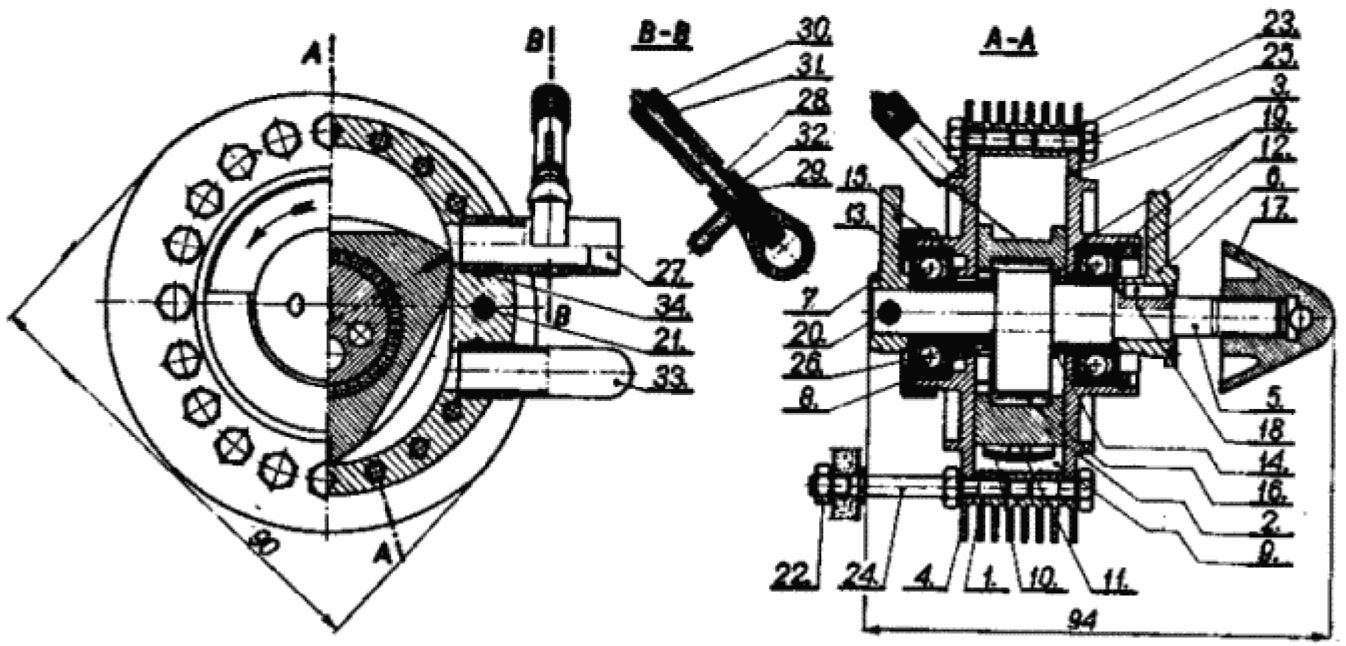
MODELLISMO, ITALY



MODEL AIRPLANE NEWS, U.S.A



"SCATTER", U.S.A.



POLISH EPITROCHOIDAL ENGINE

by JULIAN FALECKI

No excuses offered for Polish language drawings, this World-first in model engines will be fully understood by those who can machine and make it!

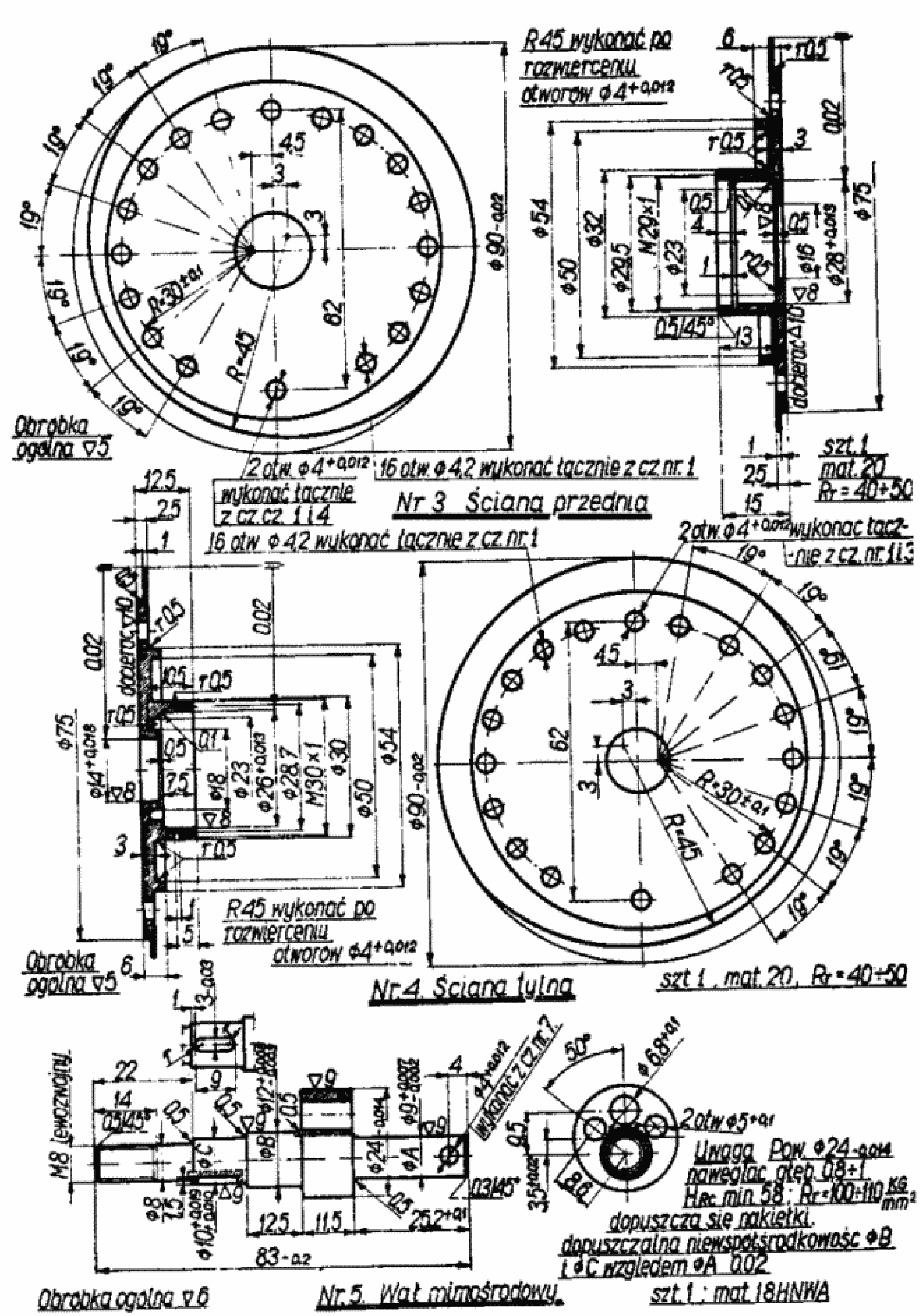
IN February 1960 *Aeromodeller* magazine issued a challenge to the first to make an Epitrochoidal engine for model aircraft. To date, only three examples of successful engines have come to our notice, two by Stanislav Gorski in Poland and one in the U.S.A. Then, in mid '64 the Polish aero weekly published these drawings with a most significant statement attached—in Russian and English language. It read: "*The article presents—for the first time in the world—constructional drawings, building instructions and description of running, maintenance and possible developments of a 9·2 c.c. capacity* (0·56 *cu. in.*) *rotary combustion model engine based on the Wankel principle, air cooled with glow ignition, developing* 1-1·5 *h.p.*

We congratulate "Wings of Poland" for its enterprise and reprint the most part of the drawings here. Only the simple bolts and carburettor details which are of common type, are omitted. Regretfully, we cannot include a full translation of the instructions but for those who want guidance in design of the Wankel type engine, the drawings offer lots of information.

Ing. Felix Wankel developed his rotary engine at N.S.U. in Germany and it has been taken up by Curtiss-Wright in the U.S.A. A triangular rotor revolves via planet gearing over a crankshaft in the ratio of 3 : 1, thus the firing on each of its three specially shaped sides is three times per revolution of the propeller shaft. High power figures have been extracted from such small capacity engines and this particular example, known as the SW-92 is said to peak at only 12,000 r.p.m. Note the external balance weights (6 & 7), the single exhaust port (33) and the sliding vanes in the rotor (2).

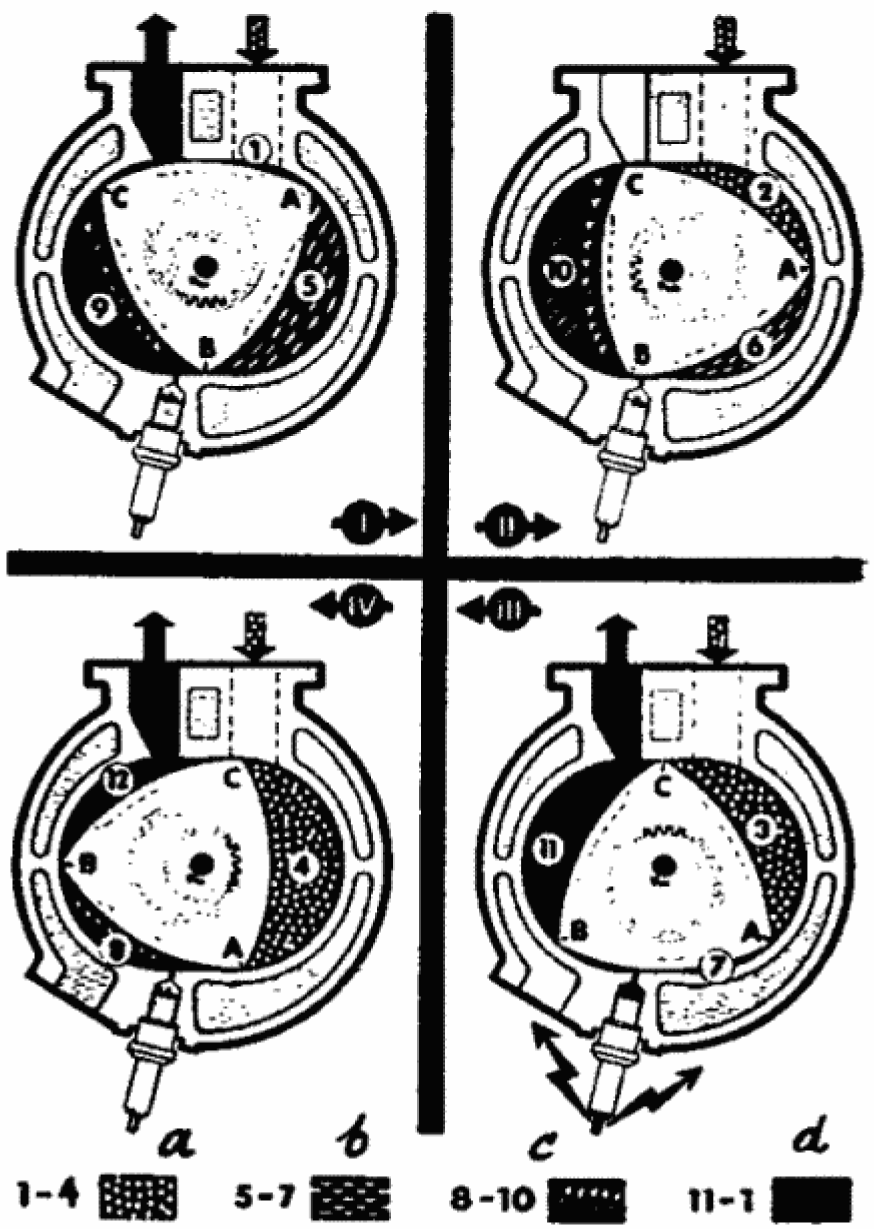
Total weight of the SW-92 was about 15 ozs. and it has been tested on a mixture of Methanol and 10-20% castor oil.

Stan Gorski revealed a 12 c.c. engine in 1961 that peaked with 1·5 h.p. at 10,000 r.p.m. and later that year developed a 4 c.c. version which was pictured in September 1961 *Aeromodeller*. An American experiment was used by F. Neale of St. Louis (U.S.A.) in a Smog Hog for successful radio control flights and was illustrated in August 1961 *Aeromodeller*. Next step after the Wankel type becomes a practical proposition, is for it to become "accepted" by International Federations in the Aircraft (F.A.I.) Boat (Naviga) and Car fields (F.E.M.A.). The prospects can be exciting and we look forward to hearing from experimenters throughout the world.



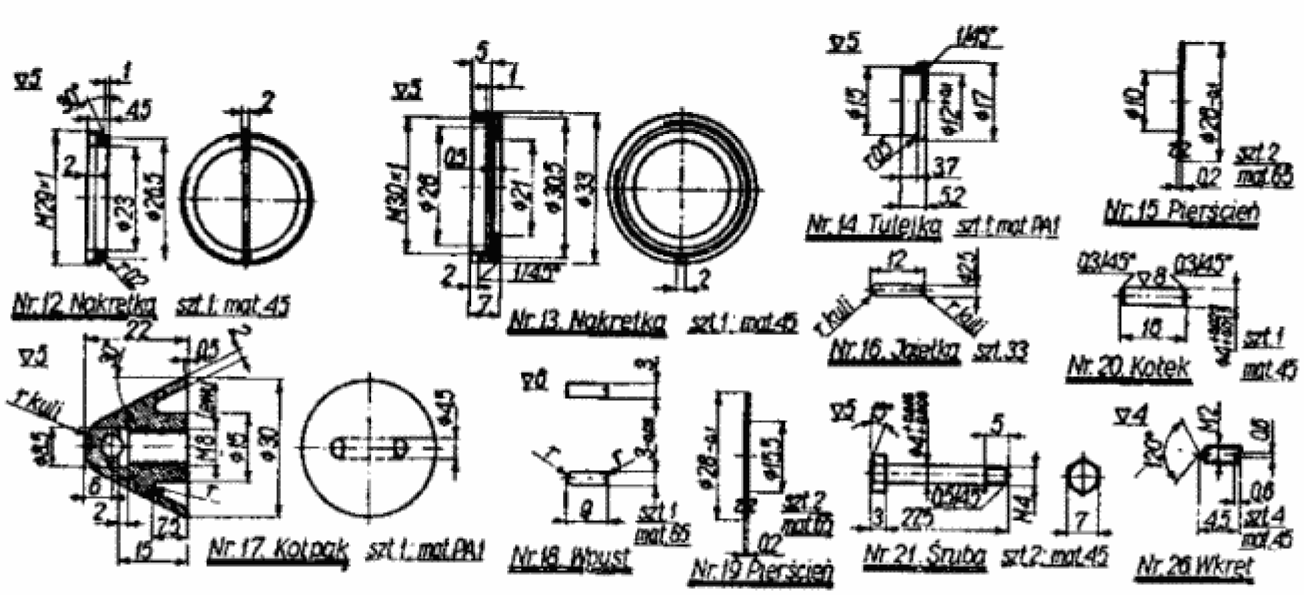
Front and rear flange plates, and the unusual crankshaft with machined planet gearing are vital components of the Polish SW-92 Wankel-type rotary combustion engine.

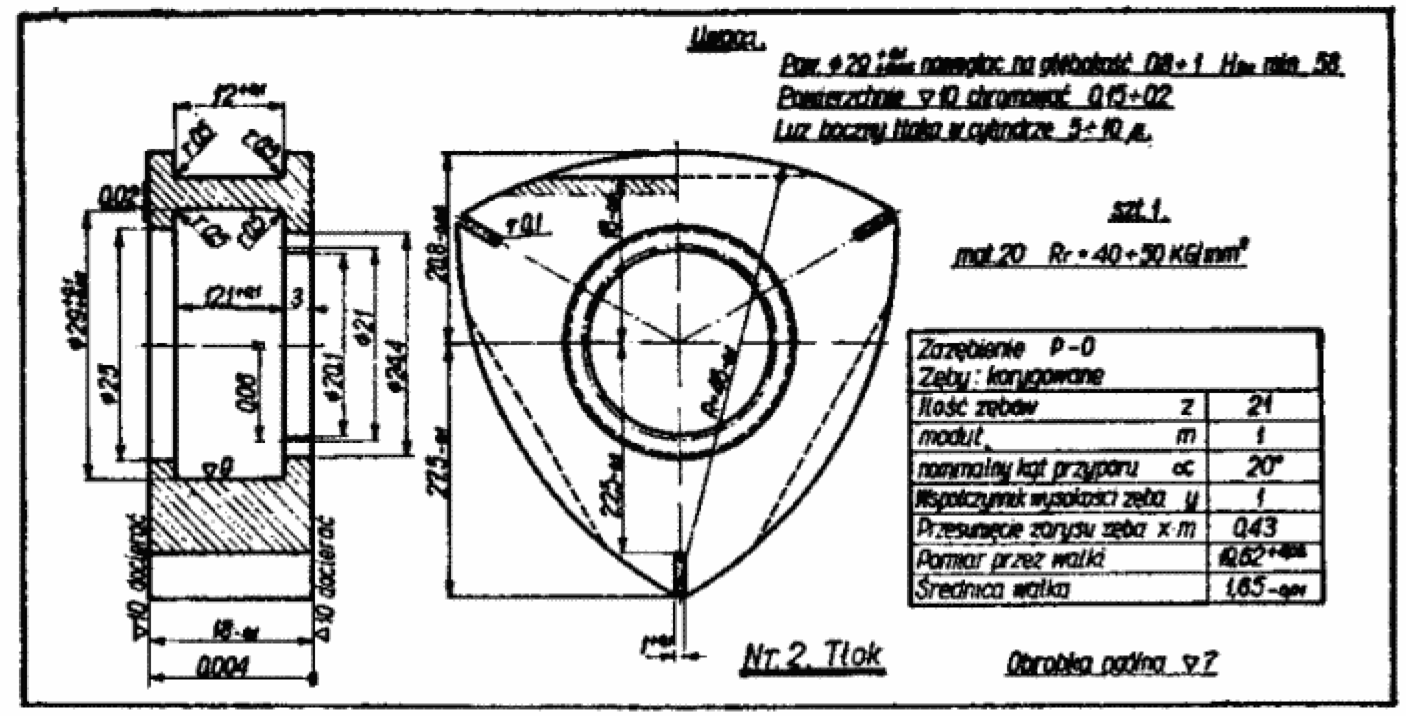
SKRZYDLATA-POLSKI, POLAND

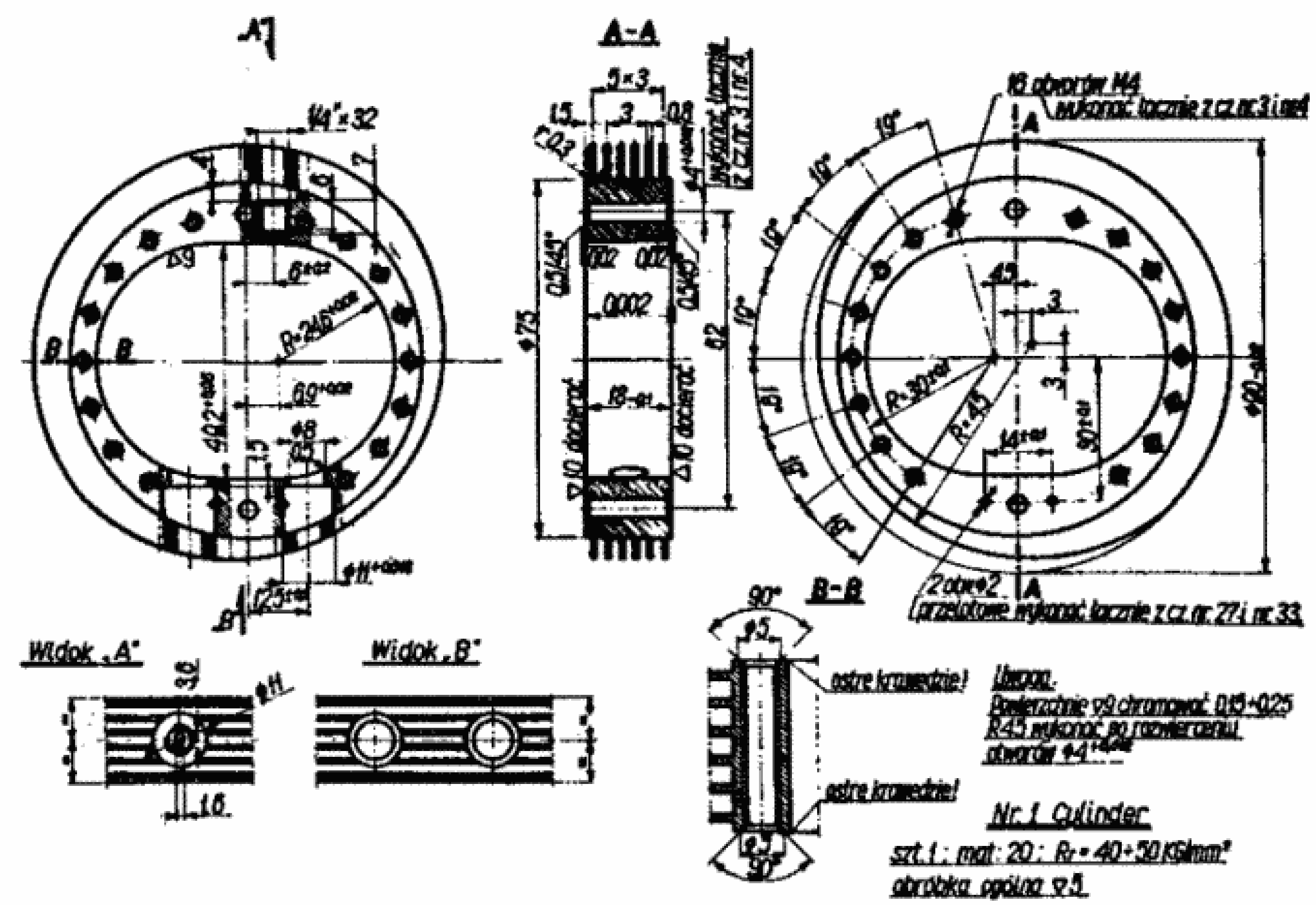


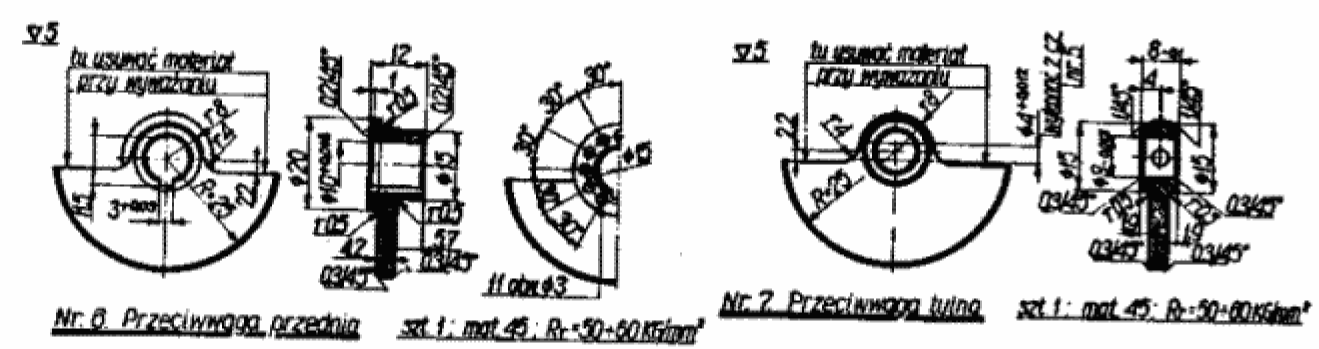
Four stages of Wankel engine operation at left show how in each revolution of the shaft there are three "power strokes". Planet gearing is not too clear in this illustration, black spot is shaft line, off centre to centre of the rotor. SW-92 engine uses identical firing stages, as in new N.S.U. engine for cars.

Components below and opposite call for careful machining. Original Polish text includes description of all operations. One main advantage of this engine is its freedom from vibration. A disadvantage is the need for high speed starting.

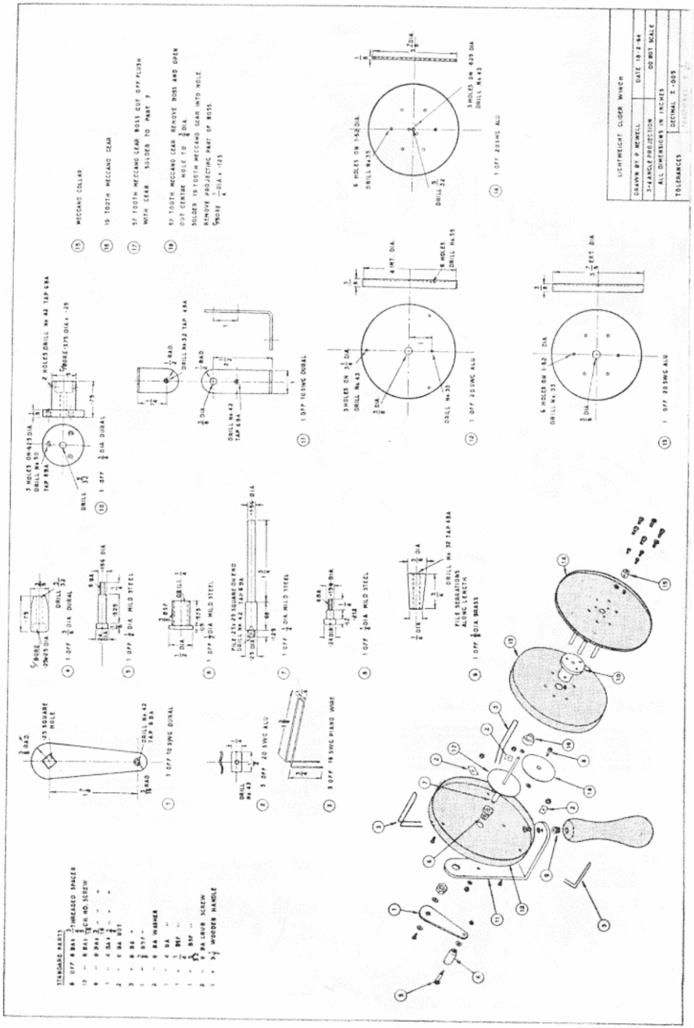


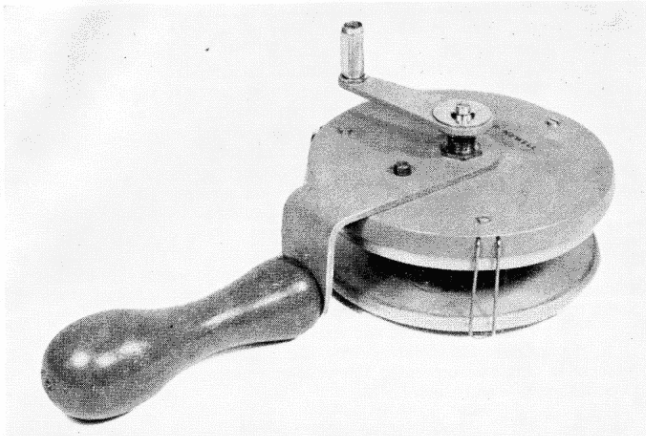






SKRZYDLATA-POLSKI, POLAND





LIGHTWEIGHT GLIDER WINCH

by PAUL NEWELL

EXPERIENCE has shown that it is necessary to be able to wind in a 50 metre towline in about 5 seconds. A drum of around 4 ins. external diameter is about the largest that can be conveniently carried, and allowing for heavy gauge nylon lines, a hub diameter of about 2 ins. is required. A gear ratio must therefore be chosen that will give sufficiently fast winding. Using the Meccano gears shown on the drawing, a ratio of 9:1 results, this being about the maximum that can comfortably be turned by hand. A double gear train is used because of good mechanical design and size limitations. The gears are completely enclosed to avoid the line getting into the gear teeth and also to keep out the grit. The latter was the main reason for not using ballraces. All up weight of the winch is only 6 oz. and it fits into a jacket pocket whilst retrieving the model.

The exploded view shows the general construction of the winch, and it is recommended that this is studied carefully before construction is commenced. The drawing is dimensioned allowing for tolerances, but a superior job will result if the parts are individually fitted.

Parts 1-3 are benchwork and need no further explanation.

Parts 4-10 are straightforward lathework and present no difficulties.

Part 6 may be the exception since screwcutting facilities are required. This may be overcome by turning this part from a $\frac{3}{8}$ in. BSF screw. Alternatively the main bush from a worn out radio/t.v. control may be used. If this is the case, the length of the 0·25 in. diameter portion of part 7 may require altering to suit. Allow 0·025 in. for washers and clearance.

Part 11 should be annealed and then formed around a $\frac{3}{32}$ in. radius.

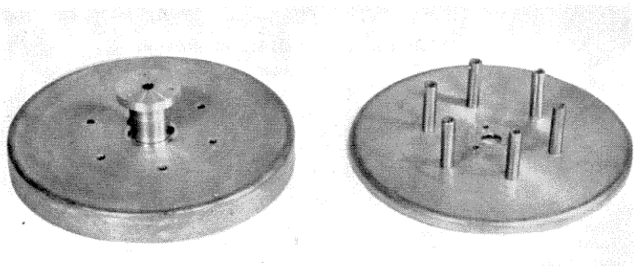
Parts 12-14 are best made by spinning but if this is not possible they may be beaten $\frac{3}{8}$ in. plywood formers. Part 12 should be made first so that the former can be used for parts 13 and 14 after suitable reduction in diameter. Two 4 in.

diameter $\frac{3}{8}$ in. ply discs are required with $\frac{5}{32}$ in. holes at their centres. These should be roughly sawn to shape, bolted together with $\frac{5}{32}$ in. screw and nut, and cleaned up on the lathe. A piece of annealed 20SWG aluminium $\frac{1}{2}$ in. larger radius than the formers should be clamped securely between the discs. The edges are then beaten down with a wooden mallet or soft faced hammer. At first the edges will not form very well, but fairly soon they take on the required shape. The formed part may be cleaned up on the lathe whilst still on the formers. Measure the external diameter of the part and of the former so that the increase in diameter due to metal thickness can be found. Add $\frac{1}{8}$ in. to this increase and turn down the formers by this total amount. Part 13 may now be made in the same way and $\frac{1}{16}$ in. all round clearance with part 12 should result. Part 14 is flanged only for rigidity and to avoid grazing of the towline.

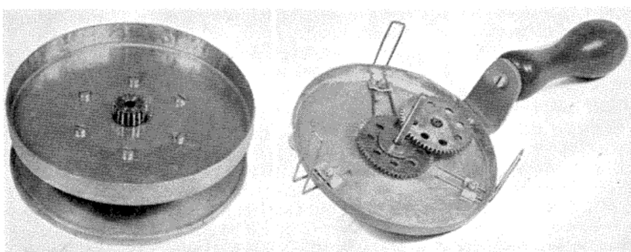
The soldering on parts 17 and 18 should be done with a small gas flame and acid flux (Baker's Fluid). These parts must be thoroughly cleaned after soldering. The gear assemblies should be checked for concentricity on the lathe, and a triangular needle file discreetly used if necessary.

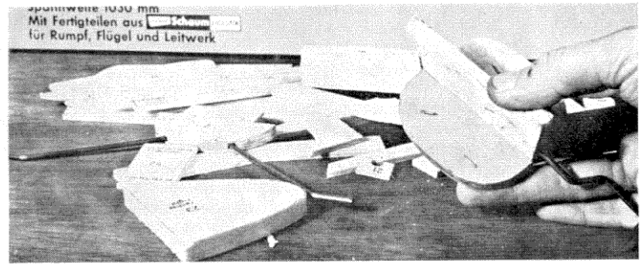
Part 9 should be forced and Araldited into the wooden handle.

Completely assemble checking the fits on all running surfaces, using washers to eliminate unwanted sideways movement on bearings. Dismantle, pack with grease and reassemble.



Inside view of Paul Newell's lightweight glider winch illustrates the use of standard "Meccano" gears and beaten 20 s.w.g. aluminium discs which are made as described in text above. Note adjustable piano wire keepers at three points to retain glider towline neatly on drum.





Plywood and balsa parts are used to support the landing gear and engine mounting bulkhead on the Graupner "Consul" taken as an example of expanded Polystyrene kit design for this article.

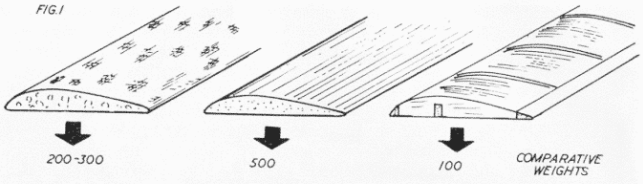
FOAM PLASTIC KIT MODELS

ANY new lightweight, rigid material with "structural" possibilities would appear automatically to have a considerable interest for aeromodelling, especially on the commercial side for kit and ready-to-go models. Yet when expanded polystyrene first appeared some seven or eight years ago, nobody—modellers or manufacturers—seemed to want to bother with it. It found other commercial outlets for packaging and insulation, but the first really serious attempts to evaluate it as an aeromodelling material appear to have originated in the United States with individual modellers carving wings and tail units from solid stock with heated wire "cutters".

At around the same time manufacturers in Germany and Japan started using the material for the moulding of "toy" aeroplanes—small ready-to-go models for toyshop sale—and it was not until about two years ago that foam plastic mouldings were introduced for "serious" models, leading exponents in this field being Graupner of West Germany. The material proved its worth, and the current trend is definitely towards more and more of this type of production in the kit field, although again all the "serious" commercial models of this type available in this country to date have been of German origin. No British manufacturer has so far incorporated foam plastic mouldings in a new kit design (and a model needs specially designing for the material), although a number are considering such a move, or have prototypes under development.

On the face of it, expanded polystyrene mouldings supply a long-felt need in prefabrication—the possibility of supplying complete wings, tail units, fuselages as finished mouldings at a weight comparable to that of a conventional built up structure. The behaviour of the material is generally satisfactory in the manner in which it can stand up to impact loads, etc., although it has certain limitations. Handling the material presents entirely new problems, even when merely assembling finished moulded components, and requires new techniques.

Expanded polystyrene, which is a discrete cell rigid foam produced by "aerating" and expanding solid polystyrene pellets, can vary in density from as little as 1 pound per cubic foot up to 8-10 pounds per cubic foot, or more. The rigid foam is produced by expanding the material in suitable moulds, pretreatment and the method and degree of expansion controlling the final density.



Weight comparisons for solid Expanded Polystyrene, Solid Balsa and conventional structure wings outline the advantages of E.P. in Fig. 1. Surfaces cannot adopt sharp edges however, as shown in Fig. 2.

For the lightest densities the original pellets are pre-expanded before putting into the mould. Heavier densities can be produced by limiting the degree of expansion in the mould.

Regardless of density, the resulting material is still a rigid foam but actual strength is more or less directly proportional to density. The other factor is that the lighter the density the more "open pore" the surface appearance and structure of the finished moulding, and the more irregular the surface finish is likely to be. For the production of "clean" mouldings, therefore, a medium density is usually chosen, typically of the order of 3 to 4 pounds per cubic foot, or roughly one half the density of light medium balsa. To be competitive with balsa on the basis of weight, therefore, the total volume of the solid moulding must not be more than twice the "solid" volume of a comparable built-up balsa structure. In fact, the "solid" volume required is usually rather more than two, so that solid foam plastic mouldings usually work out heavier than the figure which could be achieved by a conventional balsa structure, although not so much heavier that any drastic performance penalty results. Fig. 1.

There is another way of improving surface finish on the mouldings without resorting to heavier foam densities. If the moulding is "coined" in a further heated mould the surface layer of the moulding can be melted and reset, giving in effect a toughened, smoother skin. This is the preferred method as giving the best possible appearance using the lightest practical foam density, and also improves overall strength if the skin is properly formed. Such a surface will, however, still need further treatment in order to render it perfectly sealed and smoothed, and may well need a protective coating in any case to resist chemical attack by fuels, etc.

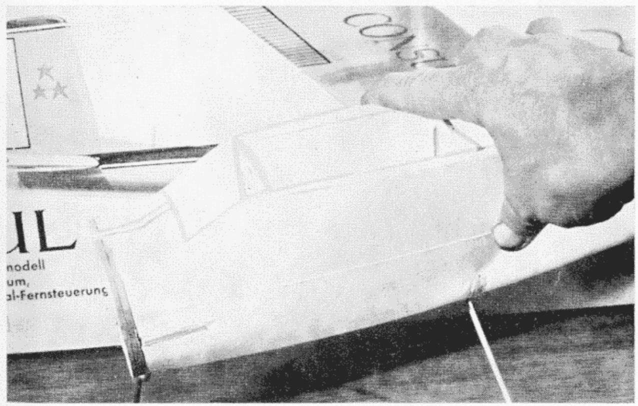
Invariably commercial mouldings for aerofoils (wing panels, tailplanes, fins) are produced as solid forms, with a fairly generous thickness at the trailing edge and tips since the material is too weak to work to thin sections—Fig. 2. The foam is mostly air, any way. Solid polystyrene has a density of about 70 lb./cu. ft., so the foamed plastic with a density of, say, 3.5 lb./cu. ft. consists of air and plastic in the ratio 19:1 air to plastic—*i.e.* one cubic foot of solid plastic would have to be expanded to 20 cubic feet to have a density of 3.5 lb./cu. ft. Fig. 3.

A certain amount of reworking can be attempted, and may be necessary to remove moulding flash, but this must be done with care. Flash can be trimmed off with a *sharp* razor blade, which is preferable to using a heated wire. The latter can cause the adjacent area of the main moulding to shrivel and deform, especially if the wire is too hot. Glasspaper is not recommended for smoothing off the edges of a foam moulding since this has a tendency to tear out lumps of the material. Careful work on the trailing edge and tips with fine glasspaper can, however, produce a better edge thickness. In the case of skin-hardened mouldings some of the skin may be removed by this treatment, but since the surface will probably need further sealing and finishing anyway, this does not matter greatly. The main thing is not to attempt anything too ambitious on the moulding in the matter of cleaning up or thinning down as this may lead to crumbling of the material.

The solid moulded aerofoil is far from the ideal application of foamed polystyrene as a structural material, but has to be accepted as more or less standard production technique at the present time. In the case of wing panels (and even large tailplane panels) a moulded-in hardwood of balsa spar would be preferred as providing better resistance to bending loads. An even more satisfactory form of construction would be to "skin" the whole moulding with another material, such as balsa sheet, so that the foam plastic merely forms a rigid core with the skin providing the bulk of the mechanical strength, supported against buckling failure by the core. Fig. 4.

Large wing panel mouldings can, in fact, be reworked in this manner with advantage, although there is a weight penalty involved. If the foam density is correctly chosen for the strength required from a larger wing it will be on the heavy side to start with, compared with a built-up structure. Skinning with

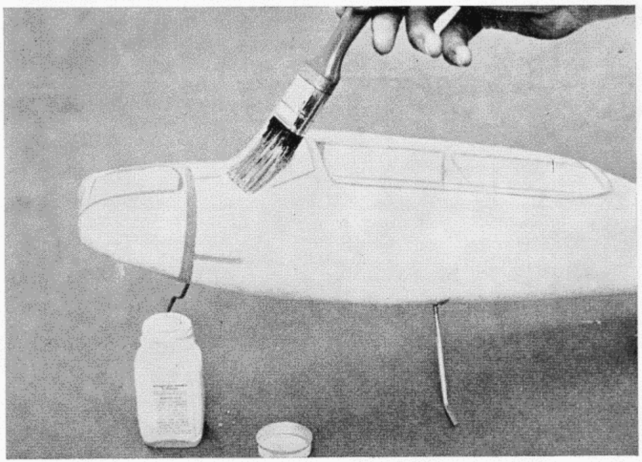
The "Consul" fuselage is supplied ready moulded with slots to accept the bulkheads for the main landing gear and the cruciform support arrangement for the engine bulkhead and nosegear. These are cemented in place with a P.V.A. such as UHU-Coll after pre-fixing wide to bulkheads with UHU-plus or Araldite.

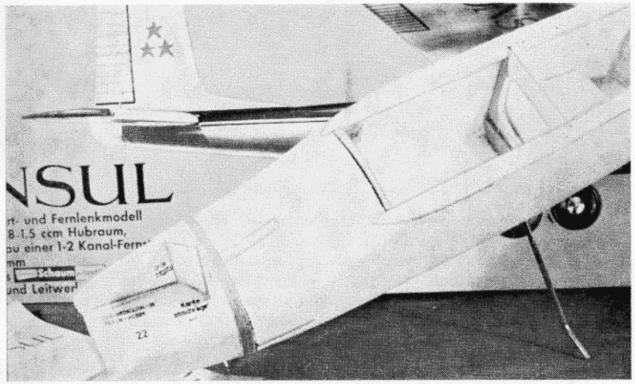


balsa will put the weight up that much more. "Skinning", however, is also one of the standard finishing techniques for foam plastic mouldings, using tissue which at the same time does add materially to the strength of the moulding.

Fuselage mouldings are normally produced as thick-shell mouldings in two halves; or "semi-solid" mouldings with sufficient cut-out area to accommodate radio gear or necessary internal fittings, *etc.* A fairly thick wall thickness is absolutely necessary to prevent local crushing. Where a passageway is required through the length of the fuselage, and this cannot be provided by using two separate half shells, it is virtually essential to incorporate a tube in the moulding (*e.g.* to carry the pushrod from a radio control actuator to the tailplane or rudder). Although such a hole could be bored out of a solid moulding with a heated tube, considerable damage to and weakening of the moulding would almost certainly result. This represents a problem where a model may have a "solid" fuselage moulding and the builder wants to adapt it to R/C. Rather than attempt to "bore out" a hole through the rear fuselage it would be better to bring the control rod out through the side and then along outside the fuselage.

Assembly of moulded polystyrene components is merely a matter of cleaning up the edges of mouldings, as necessary for a good, accurate fit and then cementing in place with the incorporation of any key pieces necessary (*e.g.* balsa or ply dihedral keepers slotted into the wing panels). The choice of adhesive used for such a job is, however, important. Ordinary plastic cement has far too strong a solvent action and will dissolve and eat away the surface of mouldings to which it is applied. Balsa cement will *not* stick satisfactorily to foam plastic, whilst many other types of adhesives will also attack the material. A special adhesive is usually supplied with the kit, which may be a thinned down polystyrene cement, or a PVA adhesive. Both are capable of producing clean, strong joints.





On the "Consul" balsa nose cowl parts project forward of the ply engine bulkhead. The model is covered with tissue using P.V.A. or UHU-Coll as an adhesive. This forms the base for later finishing with materials that would otherwise dissolve the Expanded Polystyrene.

The special cement has the advantage that it is fairly quick drying so that joints are set completely in a matter of about half an hour. PVA is generally excellent for all gluing jobs with foamed polystyrene, but takes a considerable time to set. There are also other special adhesives you can try, if you prefer, such as those produced specifically for sticking foamed polystyrene (*e.g.* ceiling tiles). Do not, however, use normal "contact" adhesives as these will dissolve and eat away the plastic.

Joints can be clamped with pins whilst setting, just as with balsa, except that placing pins too near an edge should be avoided. Shell mouldings are best strapped together with rubber bands or a binding of rubber strip whilst drying, but do not bind too tightly or you may find that the rubber has indented the surface. Once the joint has been assembled properly, and clamped up, leave until *completely* set.

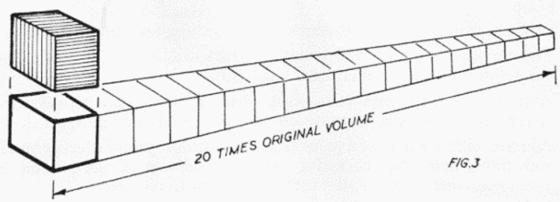


FIG.3

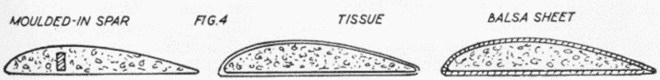
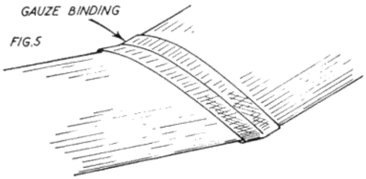
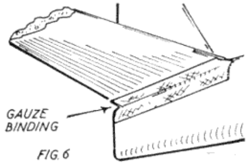


FIG.4





As with conventional assemblies, the strength of a joint can be improved by reinforcement. This applies particularly to two-piece wings formed by gluing together two moulded wing panels with inset dihedral braces. After the initial joint has been made and allowed to set, a reinforcement of bandage applied with PVA adhesive will considerably improve the joint strength—Fig. 5. The added weight is negligible, and if the joint is properly made it will be several times stronger than the solid material. Similar reinforcement is also useful where a tailplane is permanently glued to a fuselage, or to a tailplane—Fig. 6.

Local reinforcement is also advisable where hold-down rubber bands pass over the leading and trailing edges of a wing. A gauze binding may be adequate, but an inset piece of hard balsa is better, plus a gauze binding—Fig. 7. In some cases provision is made in the design and shape of the mouldings to accommodate balsa inserts at such points (when gauze binding can be added as a desirable "extra"). If the moulding has to be cut to take a balsa insert, then this can be done most accurately with a razor saw—*i.e.* a very fine toothed model saw. It is virtually impossible to produce an accurate, matching cut-out with a hot wire or a normal modelling knife.

So far, assembly will have set no particular problems—other than in using the right adhesive for the job and allowing ample time for joints to set before handling the assembly. Finishing, however, is quite a different matter. Cellulose base finishes will attack and soften the material, as will both diesel and glow fuels, although the effect varies with different mouldings. Some mouldings dissolve extensively and rapidly in contact with engine fuels, others are more resistant—although all are attacked to some degree or the other. When used on power models, therefore, the surfaces of all mouldings *must* be given a protective finish.

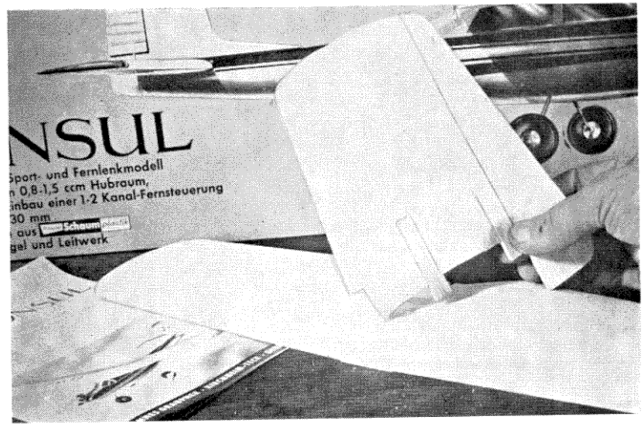
Basically there are three different ways of finishing foam plastic surfaces—

(*i*) The use of special fillers and/or sealers which are chemically inert to both the polystyrene and normal final finishes.

(*ii*) Covering the mouldings with tissue when, with a suitable adhesive, an "inert" skin is formed on to which normal finishes may be applied.

(*iii*) Painting with a water-base paint (*e.g.* an emulsion paint) which provides both filling and finish colouring, when a final coat of fuel proofer can then be applied to render the surface resistant to oils, *etc.*

All three have their particular merits, and disadvantages. Method (*i*) is the most troublesome and follows conventional "filling and rubbing down" practice. The main trouble is that it is easy to scratch, indent or even tear out pieces from the surface in rubbing down between coats. If persisted with and



The vertical tail surfaces of "Consul" are balsa for the very good reason that there is no advantage in making them of E.P. They key into the moulded E.P. tailplane and are cemented permanently in place with PVA. Our preference is to do this before cementing the tailplane to the balsa platform on the rear fuselage, though the kit instructions reverse this order of assembly. Picture below shows the platform with a cutaway section for travel of the rudder push-rod which passes through an alloy tube.

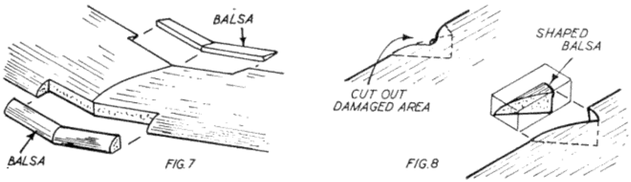


FIG. 7 FIG. 8

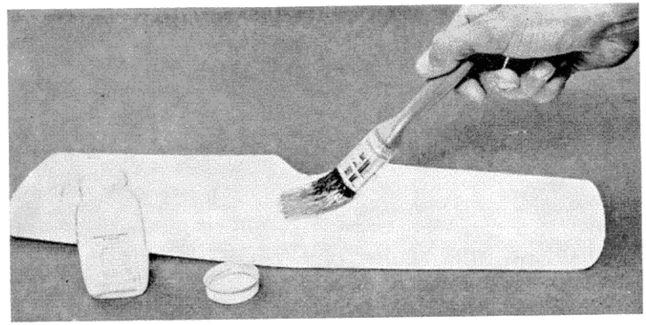
tackled carefully, however, this method can, in the long run, produce the smoothest results without any great increase in weight.

Method (*ii*) is direct and straightforward, although it can add quite a bit of extra weight if coloured finishes are applied as the final treatment. Better, normally, to use a coloured tissue and finish with a clear fuelproof dope or polyurethane varnish, although the colour effect may not be so consistent.

Ordinary model aircraft tissue can be used, applied with PVA adhesive, or "Polycell" wallpaper adhesive. Preferably use "wet strength" tissue as both these adhesives wet the paper thoroughly and ordinary tissue is likely to disrupt in being pushed and smoothed in place, leaving damaged areas to spoil the appearance. Adhesive must be applied over the whole of the surface of the moulding and the tissue covering smoothed down uniformly all over, trimming and slitting, as necessary, to negotiate compound curves, or applying the tissue in strips with slightly overlapping joints. Once thoroughly dry a generous coat of dope can be applied as a seal, followed by lightly sanding with garnet paper to remove any rough spots, and then the final finish coats. A further virtue of a properly applied tissue covering is the added "skin" strength produced which also improves the overall strength of the moulding and its resistance to local damage.

The third method—applying ordinary domestic emulsion paint as a combined filler and finish colour—is simple and effective, but can add appreciably to the weight of the moulding. Two coats may be required, applied fairly thick and lightly flatted with garnet paper between coats, followed by a final clear "proofing" coat. If two coats still leave porous patches, these need filling with further application of emulsion paint (before applying the proofing finish). The overall result can be quite pleasing, and achieved with a minimum of time and trouble, and there should be little difference in added weight between white and coloured emulsion paints.

Crash damage represents a further problem, although expanded polystyrene mouldings can stand up to a surprising amount of abuse with only minor damage resulting. The most common damage is a badly kinked leading edge caused by hitting an obstruction, or a "scrubbed" wing tip after cartwheeling or rubbing along the ground. It is difficult to repair such damage neatly, and it is usually best to leave alone as it is not weakening the structure. If you feel that a repair is necessary, cut out the damaged area in the form of a triangle as shown in Fig. 8 and replace with a piece shaped from soft balsa, gluing in place with PVA and a binding of tissue. If you fly in areas where local damage of this type is likely, a gauze, heavy paper or even a thick tissue binding over the whole of the leading edge will provide a certain amount of protection and reduce the depth of the indentations received.



UHU-Coll used as advised for tissue application on the tailplane. As text describes, "Polycell" wallpaper adhesive is equally good—or one can eliminate tissue for time saving and paint with an Emulsion paint for filling and colour. Be liberal with the protective whatever you do for the engine fuel eats into E.P. quicker than a tropical sun consumes butter! Styrene can also be covered (with weight penalties) with Melinex for near indestructible components.

Major damage where a complete panel or moulding is broken through is more difficult to tackle. Theoretically, at least, it should be possible to glue it back together (with the correct adhesive), but the resulting repair will be very weak and may not be all that improved with a binding of gauze, unless it is just an outboard wing panel which has cracked along a polyhedral joint line.

A more durable type of repair is produced by dowelling the two pieces back together as well as gluing—Fig. 9. Drill holes for the dowels in one piece, using an ordinary drill held in the fingers and rotated slowly, and take the holes to half the length of the dowels. On the matching piece, locate the dowel positions as accurately as possible and drill to one quarter the length of the dowels. The dowels are sharpened at one end only—the blunt ends pushed into the part with the longer holes, the whole joint area coated generously with adhesive and then pushed together firmly. Make sure that the joint has closed properly and then clamp up the assembly true and tight and leave until completely set. Complete the repair with a gauze binding around the whole of the joint line.

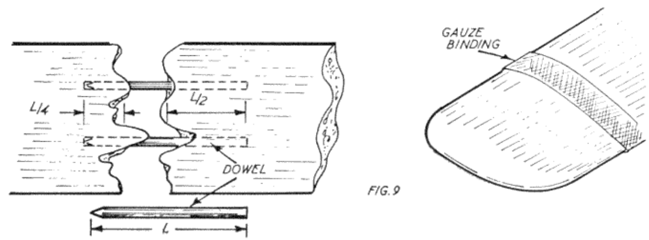
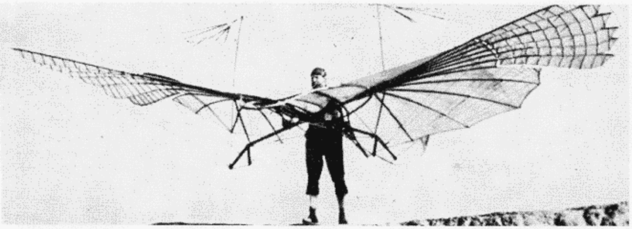


FIG. 9



FLAPPING WING FLIGHT IN NATURE AND SCIENCE

Translated from the original series of articles by Karl Herzog in MECHANIKUS magazine (W. Germany).

Experiments in the history of Aviation

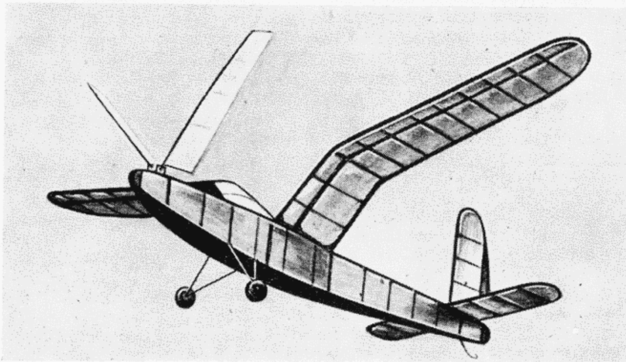
ALL the research and development in aviation throughout the ages has brought us to the stage where in nearly every field success has crowned man's efforts.

Gliders, sailplanes and powered aircraft are all at a stage where only refinements to increase performance and safety are possible.

All the fundamental laws are known and understood. Only in one area has man failed to obtain success and this is to emulate the flapping wing flight of the bird.

Otto Lilienthal built a flapping wing with a span of 8 metres and a weight of 40 kg. (Fig. 1). Lilienthal made several gliding flights but died before he could make flapping wing flights.

Alexander Lippisch in the years before World War II built many flapping wing models (Fig. 2). In some the propeller was replaced by two small wings, which on the upswing were turned negative and positive on the down swing.



The span of one was 3 metres, the weight 1950 grammes. A 4 c.c. Kratmo engine in the fuselage nose drove the small wings at 280 beats per minute. With R.O.G. heights of 4 to 5 metres and durations of 4 minutes were attained. A hand launch from a slight rise resulted in a record flight of 16 minutes 8 seconds with a height of 45 to 50 metres.

Of special interest is Schwan I by Dipl.-Ing. Walter Filter (Fig. 3). It featured a very short fuselage with the wings in the mid wing positions. The wing was in two distinct halves, a very massive inner wing and a strong flapping part with a flapping angle of 75°. Each flapping wing part was divided into six long and narrow flaps. These flaps did not overlap but were next to each other and capable of rotating round their longitudinal axis, so that on the down beat the T.E. was raised somewhat and on the up beat somewhat downwards. The aircraft was powered with a 4 h.p. motor, which was in fact found to be not powerful enough.

Recently experiments were also conducted in the U.S.A. and England.

An outstanding example amongst these is the Ikarus designed by Emiel Hartman. Ikarus was built for him in 1959 and tested at the end of that year and in the spring of 1960 (Fig. 4). On test the height obtained was only 3 metres, but nevertheless constituted a significant stride forward on the road to man-powered flight.

Both wings were hinged at the fuselage in the C.G. position. A scissor type lever activated by a rubber bungee and springs held the wings in the up position against their own weight. (Fig. 5).

The wings were pulled in the down position by five strong cords, fastened to the centre of the span. (Fig. 6).

During the up and down beat the finger type wings are turned in such a way that the part of the wing behind the main span gets more washout.

The flapping wing action is driven by muscle power.

The launch was aided by a powerful bungee cord..

On tests heights of 3 to 3·5 metres were obtained under power after which the aircraft glided to earth. Most tests were made with Auto-tow.

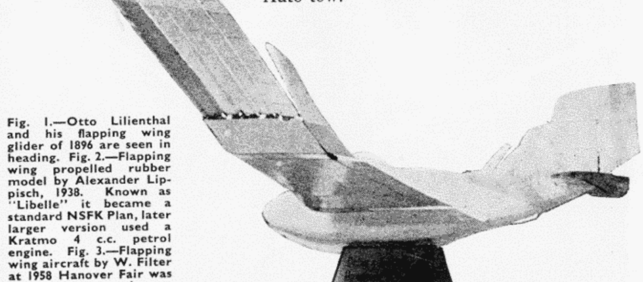


Fig. 1.—Otto Lilienthal and his flapping wing glider of 1896 are seen in heading. Fig. 2.—Flapping wing propelled rubber model by Alexander Lippisch, 1938. Known as "Libelle" it became a standard NSFK Plan, later larger version used a Kratmo 4 c.c. petrol engine. Fig. 3.—Flapping wing aircraft by W. Filter at 1958 Hanover Fair was underpowered.

Fig. 4 above shows Emiel Hartman's "Ikarus" gliding after an auto-tow at Cranfield in 1959. Fig. 5 below illustrates the mode of power by rowing action and Fig. 6 opposite shows wings in the depressed position (*Daily Mail* photographs).

Biophysics of Birdflight

A bird is able to lift himself into the air by flapping his wings. For this he uses very powerful breast muscles, which account for approximately $\frac{1}{8}$ of the

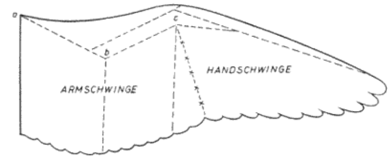
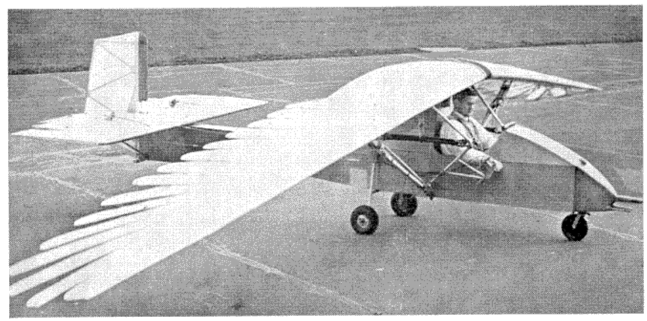


Fig. 7.—The "arm" and "hand" areas of a flapping wing.

total weight in smaller birds. One would think that the body of the bird would rise, when the wings flap down, and fall, when the wings go up. As is well known this doesn't happen, the body follows a straight path with approximately constant velocity.

To help us understand the bird wing, which incidentally is not much different from the human arm, it will help if we make a wing out of stiff paper. The planform is shown in Fig. 7 and can be transferred to stiff paper complete with the fold lines. After cutting to shape fold the wing along the dotted lines



downwards. This causes the areas alongside to move back. Dotted lines with crosses mean that the neighbouring areas are folded forward.

The small triangular area alongside the dotted line with crosses divides the wing now in two parts, *i.e.* the arm and the hand.

Point A is the shoulder joint, point B the elbow and point C the wrist. The elbow joint *b* is somewhat higher than *a* and *c*. If one now imagines that our paper wing is covered with feathers the hard edges are no longer in evidence.

The wing is now convex on the upper surface and concave on the bottom with the max. camber well forward.

This camber flattens out quickly not only behind the point of max. camber, *i.e.* chordwise but also spanwise. A bird wing could be compared with a cambered plate fitted to a trapezoidal wing with the camber decreasing towards the tip.

The division between the arm and hand part of the wing is important.

As the hand part can turn in the wrist joint it can adopt a different angle of incidence than the armpart.

As soon as the drag sets on the trailing edge of the hand it will deflect

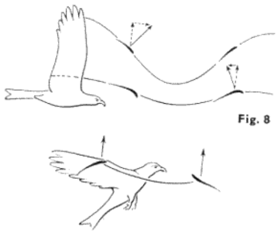


Fig. 8

downwards on the wing's upswing and upwards on the wing's downswing.

This action is held between definite limits by powerful muscles, and consequently can be controlled at will.

Hence a weak or strong flapping motion or gliding flight can be obtained. The bird uses different parts of his wings to support his weight during the upswing and downswing.

During the downswing he supports his weight with the parts of his wings closest to his body and on the upswing with his outer wings (Fig. 8). The inner wing halves are nearly always aimed in the direction of flight, while the outer ones rotate.

The arm furnishes the necessary lift to support the bird, while the hand acts as a propeller. For the R.O.G. the bird can rotate his wings such that the wings move backwards and forwards instead of up and down. The propelling force horizontally now becomes a vertical one and the bird takes off. A comparison between bird wing section and say Clark Y, shows that a bird wing is highly cambered with the max. camber well forward. To obtain the same lift for minimum drag a Clark Y airfoil will need an angle of attack of $-26°$ against a bird wing's angle of $-10°$. On the upbeat the figures are $+40°$ and $+17°$ respectively.

Erich Jedelsky of Vienna has for many years experimented with highly cambered airfoils. The best results were obtained with airfoils in which, over the last $\frac{1}{3}$ of the chord the lower surface came so near to the upper surface that there was only a paper thickness left.

On these highly cambered airfoils there is a considerable centre of Pressure travel making the wing sensitive to gusts, which for gliding flight is a definite disadvantage. In gliding flight the bird is subject to the same laws as the model. The C.G. is below the centre of lift and as the bird glides in the shoulder wing configuration the C.G. is well below the life centre and it has ample pendulum stability. During flapping flight however the wings are sometimes above, alongside or below the body. The body is therefore sometimes in a stable, sometimes in an indifferent and sometimes in an unstable state.

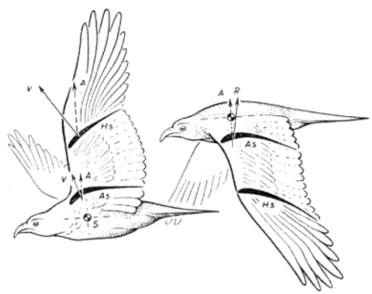


Fig. 9.—Force distribution on a bird wing during flapping wing flight. On the wing down beat (left figure) the weight of the bird is mainly supported by the outer wings (Hs). The forces show a forward component (A = lift, V = Forward Force). On the wing up beat (right figure) the outer wing is turned upwards. The weight is now supported by the inner wings (As). The lift component is directed somewhat backwards. During the wing motion the lifting force remains the same, the forward force is always larger. S = Centre of Gravity.

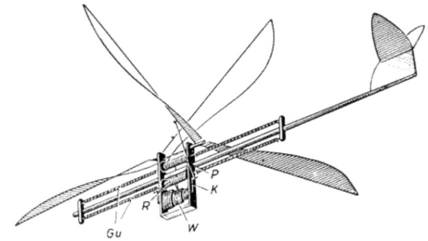


Fig. 10.—Dragonfly and its mode of power. Gu = rubber motor. R = thread roll. W = stepped roll plate. K = Crank. P = connecting rod. This is the Eric V. Holst design.

One would think that the bird has to do something about this, in fact it doesn't have to as is shown in Fig. 9. During the downbeat the weight is carried mainly on the somewhat swept forward outer wings (hands).

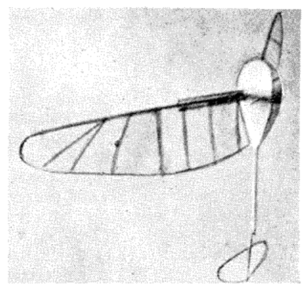
However their Centre of Lift is now somewhat ahead of the C. of G. and the bird is somewhat tail heavy. The wing couple works however against this. On the upswing the weight is carried by the inner wing halves and the wing is brought upwards in such a manner that C. of L. and C.G. are in line.

Ornithopters of E. v. Holst

Dr. Erich von Holst studied for many years the flight of insects and swallows. In 1939 he built a model insect to prove his observations. The model had a span of 35 cm. and the low weight of 7 grams. The model was constructed from straws, sewing silk and tissue paper.

In spite of the small rubber motor a height of 2 metres and a duration of 44 seconds was obtained.

In 1940 von Holst built a Dragonfly (Fig. 10). The model had a span of 53 cm., a length of 48 cm. and an A.U.W. of 12 grams. As the dragonfly the model had two pairs of wings, which are turned during the flapping motion. Both wings which have dihedral are on a common axis. Motive power is supplied by a rubber motor which drives the wings via a system of rollers and threads. Through the thread system the one wing goes up while the wing behind goes down. On the other side the action is reversed.



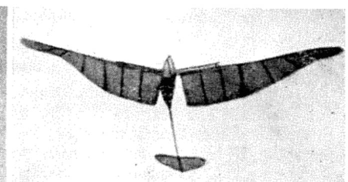


Fig. 11.—The "Buzzard" in a climb and Fig. 12 above, in horizontal flight, see Figs. 13, 14 for more detail.

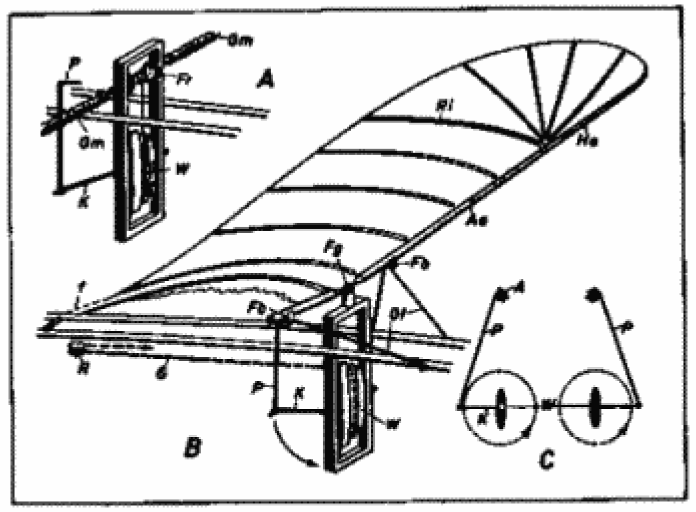


Fig. 13.—Driving mechanism with rubber motor as developed by Prof. E. v. Holst.

E. von Holst's Buzzard (Fig. 11) had an overall length of 45 cm., a span of 97 cm. and a weight of 24 grams. Two stiong rubber motors, one in front of the wings and one behind the wings powered the model. The slinking angle is approximately 45° (Fig. 12).

The most interesting part of E. von Holst's models is the drive mechanism (Fig. 13). The heart of the mechanism (Fig. 13A) is a thread drive, which consists of a stepped or conical formed reel (Fr) and a stepped eccentric rollplate (W). Because of the eccentricity the downbeat takes place with a larger force than the upbeat. When turning the rollplate (W) by hand the thread is unrolled from the reel (Fr) and onto the plate (W) and at the same time the rubber motor (Gm) is wound up. As soon as the rollplate (W) is released the reel (Fr) is turned by the rubber motor and the thread winds back. The rollplate (W) drives the cranks (K) which in turn drive the connecting rods (P) to the wing halves.

Later von Holst simplified the mechanism, as used on the Swan (Fig. 13B). Here a long rubber strand was led over several rollers (R) in the fuselage. The stretched (not wound) rubber band was taken round the various diameter steps of the rollplate (W). When only slightly stretched the band was brought round the larger diameter and as the tension increased round the smaller diameter. In Fig. 13B the direction of rotation of the cranks (K) is shown.

Fig. 13C shows the section of the connecting rods on the fixing point (A) where small brackets (F6) make the connections. The rubber strands G_t fixed to F_b on the one hand and to hooks on the fuselage on the other half to make the downbeat stronger than the upbeat, as they are stretched both forward and outwards. Only one rib (Ri) is fixed to the L.E., all other ribs are only fixed to the L.E. through the covering. The T.E. of the innermost rib is fixed to the fuselage. Hence the inner wing part is not completely free to follow the action of the L.E. Once flapping, the outer part of the L.E. transmits its action via rib (Ri) onto the outer wing, while the inner wing is kept back. Hence a twist is developed across the span.

Throughout the construction emphasis should be laid upon precision.

Building Instructions for the Buzzard (Fig. 14)

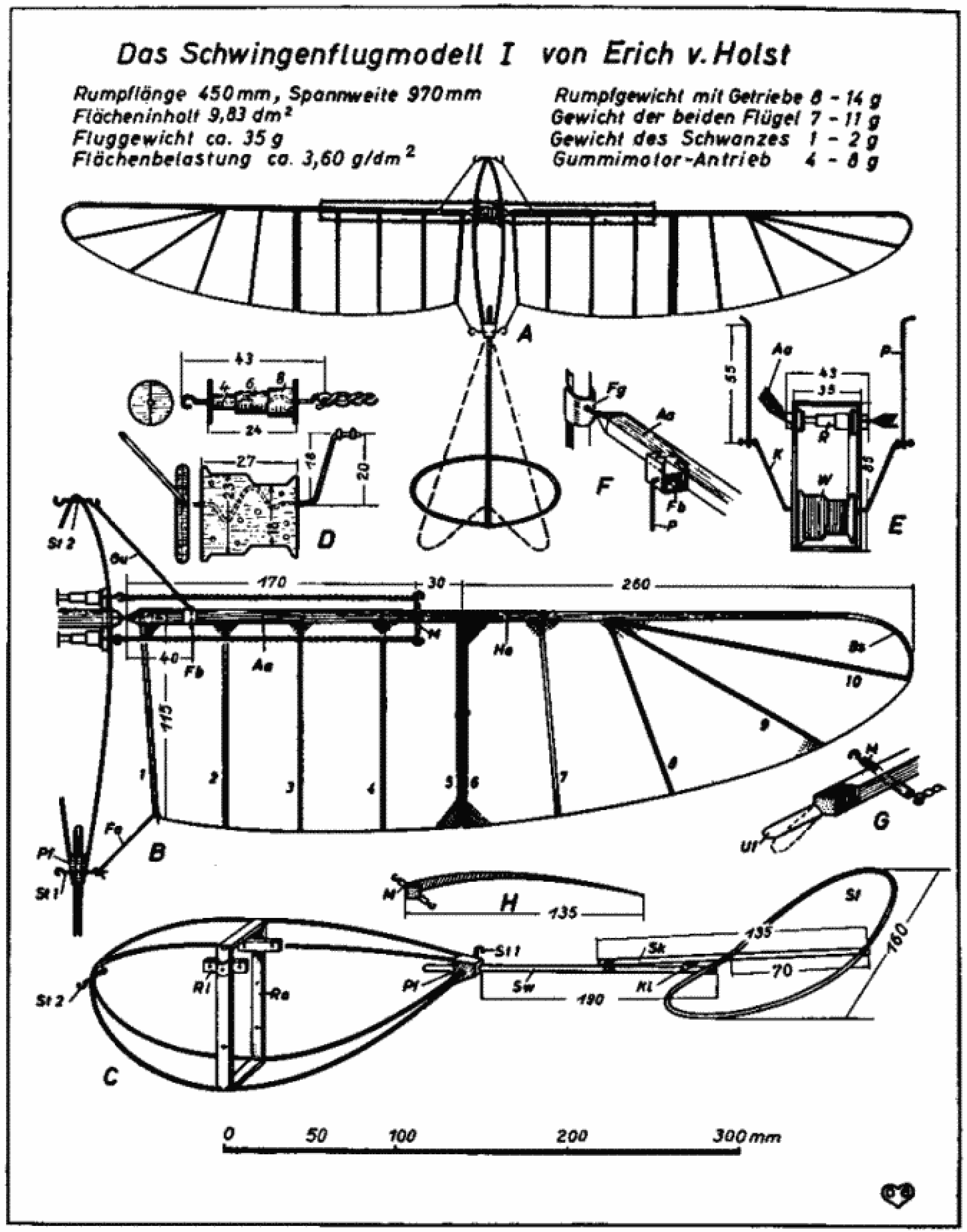
The construction starts with the main former (Ra) of the fuselage, from 7 x 2 balsa. The bearings (R1) for the thread end are made from the same material and cemented at the top of the former on the inside. The two thread reels (Fig. E) have 0·5 mm. dia. piano wire shafts, while the rollplate has one of 1·25 mm. dia. As can be seen in Fig. D the shafts are in both instances zig-zagged inside to prevent any danger of turning and hence the reels and plate are best laminated during their construction of hard balsa. The ends are both reels and the rollplates are reinforced with 0·3.

The rollers and rollplate are pushed into the bearings (R1) which have slits at the top to allow this. After positioning, the slits are filled in with cement

(Araldite or UHU-hart), the rollers and rollplate freed after the cement is dry, and a bearing of properly hardened cement is achieved.

The rest of the fuselage consists of 0·8 mm. bamboo, both ends stuck into small balsa blocks. Sw is made of balsa and Sk from a straw which is bound and cemented to Sw. A small piece of balsa (K1) is pushed between Sw and Sk and fixed with a small rubber band. This allows the angle of incidence of the

Fig. 14.—The "Buzzard" by Eric v. Holst with original German text as published in "Mechanikus" magazine; all dimensions in millimetres.



tailplane Sf to be varied by repositioning of K1. The tailplane outline consists of bent grass or pampas grass, which is formed into an ellipse and cemented to Sk.

The fuselage and tailplane are covered with Japanese tissue. The wing (Fig. B) has a square spar, which acts as both L.E. and main spar. This is made from balsa and tapered towards the tip. It consists of two parts (Aa) the arm and (Ha) the hand part. Both parts are connected by a 2 mm. wide, 0·25 mm. thick watch spring strip (Uf).

At the shoulder joint the spar is sharpened to a point (Fig. F) and a small piece of piano wire cemented in. This connects into the bearing Fg which is made from tinplate.

The hooks for the rubber motors are fixed to a piece of balsa (M) which runs diagonally from the lower rear surface of the spar to the upper front surface of the spar. The connecting rods (P) are fixed to the spar through a U shaped bearing (Fb) (Fig. F).

The wing ribs 1 to 10, with the exception of 5 and 6, consist of thin bamboo or straw strips and are fixed to the L.E. only by thin gauze strips.

Rib 5 is a 2 mm. thick spruce one cemented to the end of the cross main spar. Rib 6 is also cemented to the L.E. but consists only of a strip of bamboo. Ribs 5 and 6 are fixed together by small S hooks. As the wing will not obtain its proper outline until it is covered with Jap tissue the construction is best done on a jig. After fixing the finished wing to the fuselage it is finally fixed by a rubber band (Gu) between the fuselage nose (St 2) and (Fb) and a thread (Fa) between the trailing edge and (Pf) through hooks (St 1).

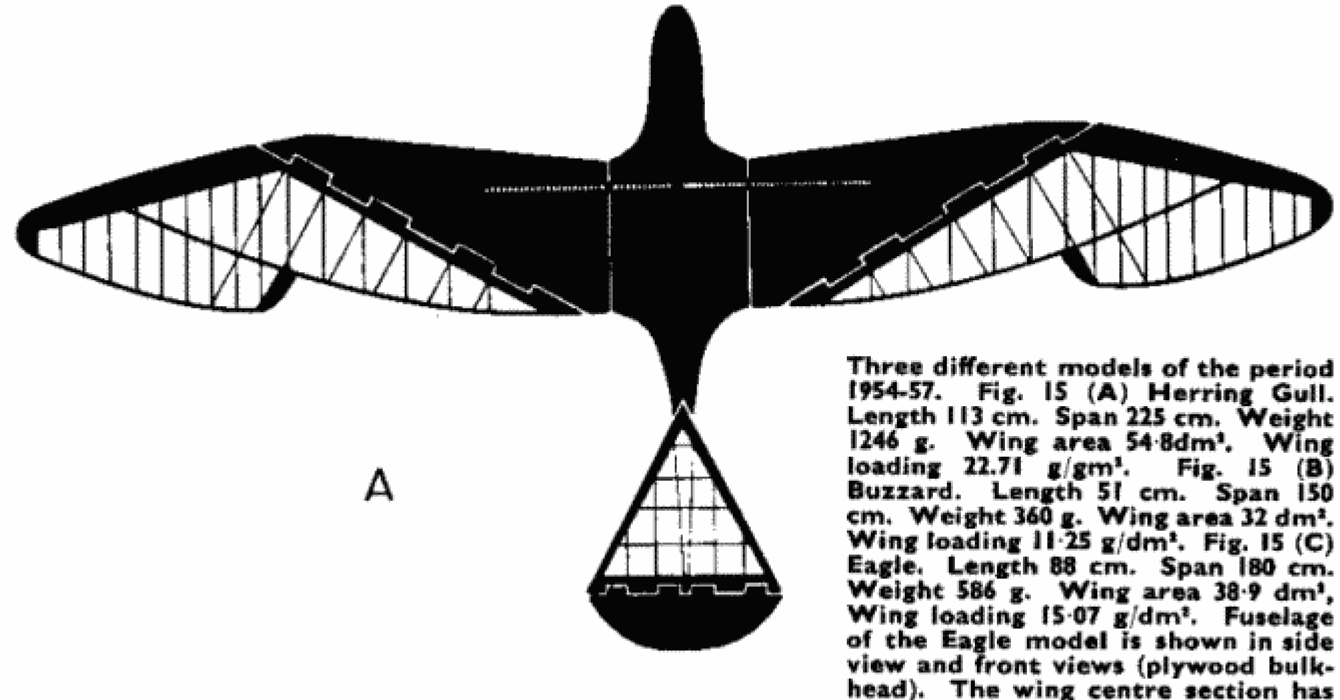
Free flight Bird models

It can be understood that the main wing spar of a bird model has to be stiff both in the direction of flight and in the direction of the flapping motion, but the wing surface itself must be flexible. With normal model wing construction the last requirement can hardly be said to be met. Hence the only way out is to divide the wing into hinged parts. The problem now is to decide how to divide the wing and along what axis. As a result of numerous experiments three types of construction were evolved. (Fig. 15.)

Model A is based on the herring gull. The slim fuselage is considerably fattened at the C.G. position and formed into a strong centre section. The wings are hinged to the centre sections on axes parallel to the fuselage axis. However as seen previously it is not enough to hinge the wings in this way as no rotation of the wing can take place along its spanwise axis and as we have seen it is this rotational motion that furnishes this forward motive power. Hence the same type of single hinge point is required as previously described. The actuation is also as described earlier. Inside the fuselage a crank drives the connecting rods to the wings. As we have both a hinged motion and a rotation of the wing root relative to the centre section and hence on the downbeat, the join will open up somewhat and close again. To avoid interference with the desired smooth flow of air a thin rubber sheet fairing is cemented over the junction.

A simpler solution can be found for the hingeing of the outer wing to the inner one. As the planform of the inner wing closely resembles a right angled triangle, the required rotational effect is obtained by the hingeing over the outer wing along the base of this triangle.

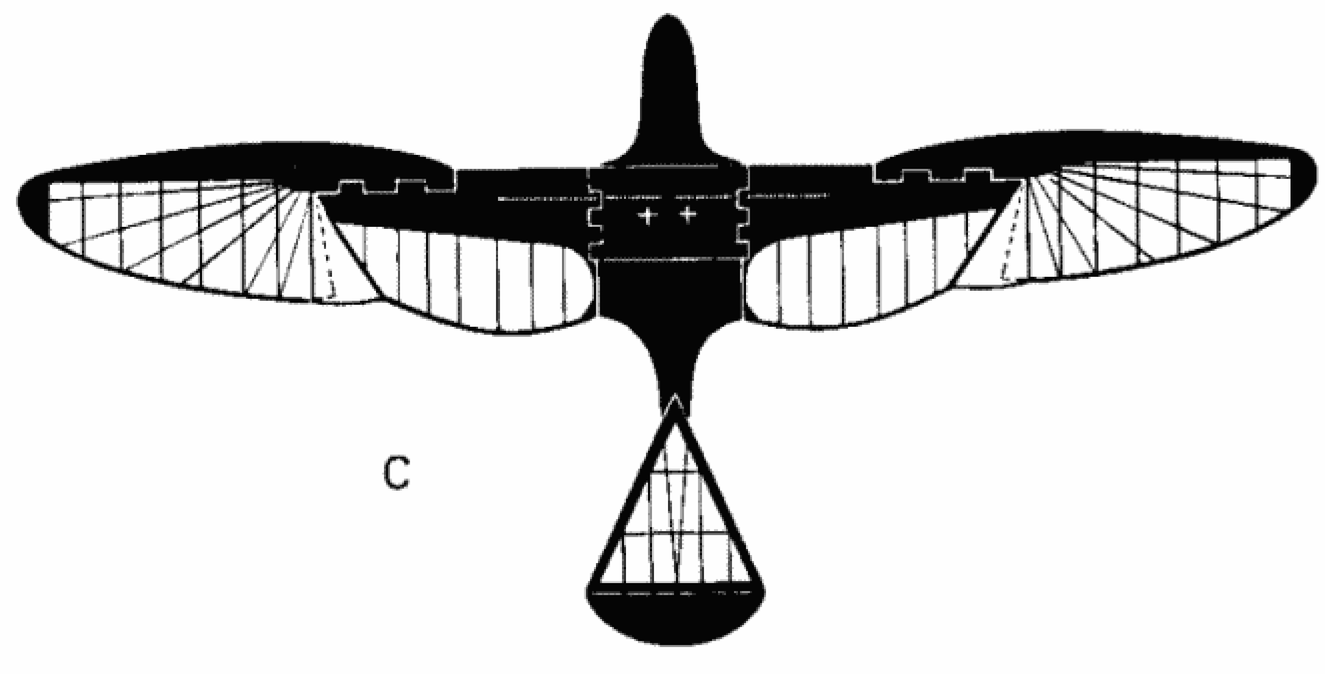
When the inner wing goes up, the outer wing will move slightly down under the action of the drag. When the wing moves down however, the



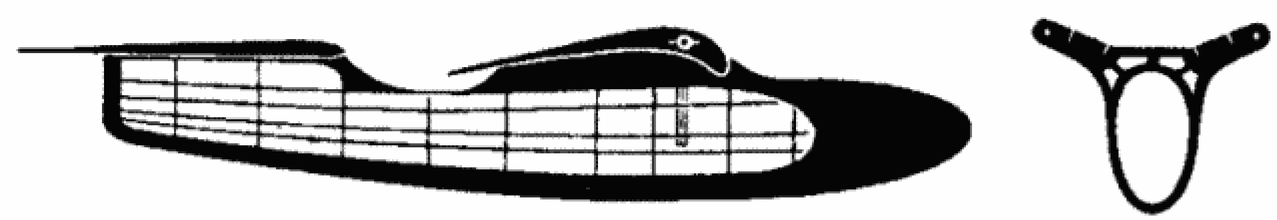
A

Three different models of the period 1954-57. Fig. 15 (A) Herring Gull. Length 113 cm. Span 225 cm. Weight 1246 g. Wing area 54·8dm^2. Wing loading 22.71 g/gm^2. Fig. 15 (B) Buzzard. Length 51 cm. Span 150 cm. Weight 360 g. Wing area 32 dm^2. Wing loading 11·25 g/dm^2. Fig. 15 (C) Eagle. Length 88 cm. Span 180 cm. Weight 586 g. Wing area 38·9 dm^2, Wing loading 15·07 g/dm^2. Fuselage of the Eagle model is shown in side view and front views (plywood bulkhead). The wing centre section has dihedral.

B



C



rotational movement furnishes the forward motive power. However as the outer wing works at an acute angle to the virtually straight working inner wing, the forward force works at an angle to the direction of flight and some part of it is cancelled out between the wing halves.

A better solution is the Wingform shown in Fig. 15B which is based on the Buzzard. Both wings have sweepback and hence the hinge between inner and outer wing is at a much less acute angle. The forward force is still not fully parallel to the direction of flight and hence there is still some loss due to the sideways component but the position is better than on Model A.

A considerable part of the improvement is due to the part of the outer wing lying in front of the inner wing.

One fault was found, namely, an airflow breakaway over the wing region where the inner wing and outer wing meet. On the wing downbeat, vortices are formed alternatively above and below the wing.

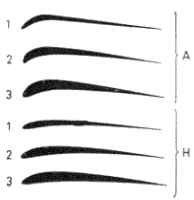
The breakaway is independent of the beat frequency but the effect is stronger on a slow beat than on a fast beat. It is obvious that on any model every effort should be made to obtain the smoothest possible airflow. The best solution was found in the Eagle model (C). As the balljoint had given difficulties on model A a different solution was tried. This consisted of a hinge, with limit stops, round which the inner wings, fixed to the centre section, were able to make an undulating motion.

In contrast to the previous model a better action was obtained from the outer wings. Part of the outer wing overlaps the L.E. of the inner wing. When the outer wing rotates on its axis, it acts as a lever, with its short arm in front and long arm behind. On the downbeat the part aft of the axis moves upwards and the part in front of the axis down. On the upbeat the reverse happens. In this way the natural action of the bird wing is fairly closely imitated.

On the Eagle model it should be possible to obtain the required rotational motion from the inner wings.

The principle seems fairly simple. The construction however is not so easy. One solution could be to make the centre movable and drive it in some way. Fig. 16A shows this with the centre section capable of rotation round a central axis. One problem remains, the axis round which the inner and outer wings rotate respectively are at right angles to each other and hence at maximum deflection a gap opens up between the wing halves. In addition the action of the inner wings should be light while that of the outer wing should be damped.

Fig. 17.—Examples of wing sections. (A) = inner wing. (H) = outer wing. 1 = Airfoil for models with span 60-85 cm. 2 = Airfoil for models with span 90-150 cm. 3 = Airfoil for models with span 160-220 cm. Fig. 18. Wing mechanism. H = wingspar with SR = steel tube. DG = universal joint. L = fixing struts. P = connecting rod. Kw = Stop for Sth and hence rotation of St (hinge axis) of the outer wing. R = inner wing rib. Rl = trailing edge.



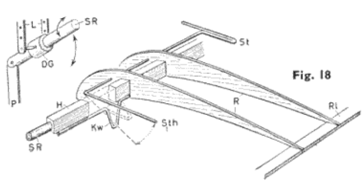
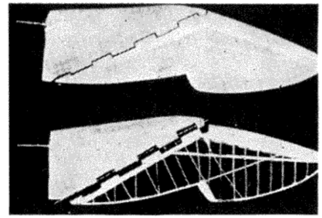


Fig. 18



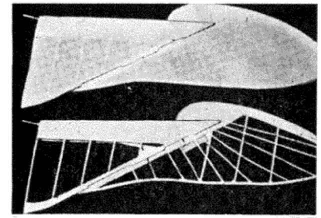


Fig. 19 above shows angled outer hinger Herring Gull. Fig. 20 above right is Buzzard shape and Fig. 21 at right, the Eagle. Refer to Fig. 15.

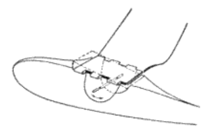
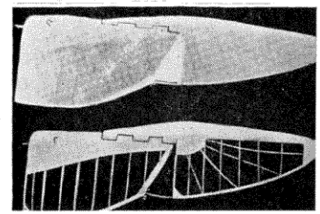


Fig. 16. — Proposed solution for obtaining rotation at wing root.



Both difficulties can be overcome by fixing a flexible division between the inner wing and the outer wing.

Test flights have proved that model C is superior to A and B in powered flight. A and B are however better in gliding and for thermal flight. As the wing is constantly moving sufficient thought must be given to the distribution of weight. As we move out to the wing tip the weight must get less and less.

The wing profiles of the inner wing should be much more cambered than those of the outer wings (Fig. 17 A and H). For smaller models a higher cambered aerofoil is best, for larger models less camber is required. The most important difference between the aerofoils of the inner wing compared to that of the outer wing is that for the inner wing the nose droops strongly down while for the outer wing a more normal aerofoil is required. The outer wing has 3° of washout built in.

Control functions

The angle through which the outer wing should be able to turn must be controlled. On my models I used wire pieces which are fixed to the outer wing and protrude into the inner wing where they are limited by vernier screws. On model C especially it is necessary to have a limiting device as the rotation is obtained indirectly. However there is still one disadvantage as the limiting device only works during the motor run. During the glide the outer wing should however be fixed at its optimum angle of incidence. A possible solution is given in Fig. 18. Here the axis is used for control. It consists of 2 mm. piano wire with the free end bent through 90° (St). The other end runs over the hinge between the inner and outer wing. In this way a small lever is formed through which the outer wing rotation can be limited. The top stop is the wingspar which is also the correct incidence for the glide. Rubber bands which pull the lever up see to it that the glide position is automatically achieved as soon as no stronger forces oppose it. The action depends on using the hinge as a torsion bar.

On the wing downbeat the bent over end hits the wing spar. The wing drag works especially on the aft portion of the outer wing which will try to deflect upwards. It works against the torsion of the hinge which increases on an increase of the deflection and so gives a progressive stamping. As soon as the wing is on the upbeat the drag works on the top surface of the outer wing and this will deflect downwards. The only counteracting force is now the rubber band. The bottom stop consists of Kw which can be altered at will by hand and which limits the wing deflection.

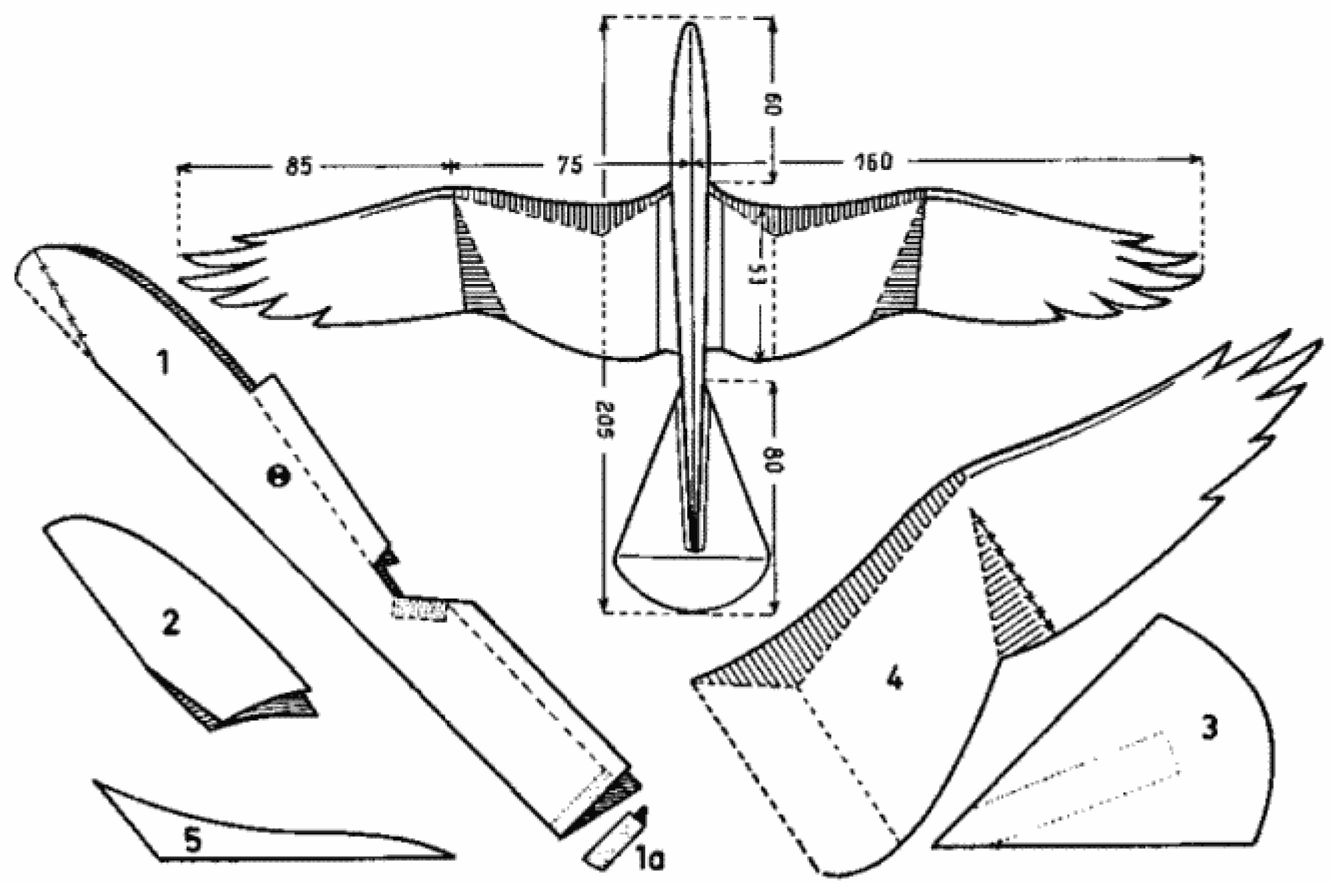
From a series of experimental models, built to assess which wing planforms and proportions were best, the model shown in Fig. 21 showed most promise.

In Fig. 22 a small experimental model is shown made from stiff drawing paper. With a model of this type experiments to assess the optimum angles of incidence are simple to carry out.

First of all the model is adjusted for straight flight. After that the model can be adjusted for other types of flight paths (Fig. 23). The dihedral of the outer wing is adjusted between $+3°$ and $+5°$. With the outer wings at 0° angle of incidence straight flight is obtained. When the left outer wing is turned so as to lower the nose and hence raise the trailing edge and turn to the right is achieved (Fig. 23a). If one decreases the angle of incidence of both outer wings the model will fly straight but faster and with a steeper glide angle.

These alterations of the flight path occur only when the angles of incidence are changed up to approximately $-5°$. If this value is exceeded on one wing the lift will break down and the wing on this side will go down. The opposite effect occurs when the outer wing is adjusted so that the wing L.E. is up and the T.E. down. In this case the wing is braked by the action of the air-

Fig. 22.—Rook shape model to be made from drawing paper or similar.



stream and lifted up (Fig. 23C). When the left outer wing has a negative incidence but a positive angle of attack the model will turn left but due to the combination of the wing lifting and braking actions a negative turning movement exists which causes an unstable motion. A positive incidence of the left wing will however result in a smooth right hand turn (Fig. 24A).

A strong positive incidence of both wings will result in a landing flap action (Fig. 23d). On ornithopters the climb, turning and control of the forward speed can be achieved solely by alteration of the angle of incidence of the outer wings. Obviously experiments of this nature are only of use for the gliding flight as during powered flight much larger variations of the incidence occur without any great effect on the flight path.

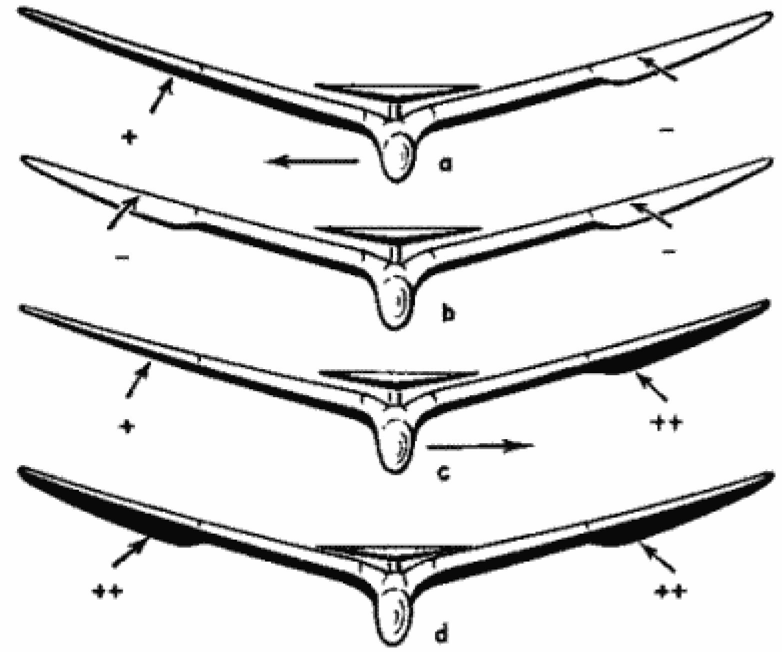


Fig. 23.

During the powered flight the angle of attack varies between $+20°$ and $-12°$ without airflow breakaway. This is due to the fact that during the powered flights the model moves forward so that different forces come into effect than during the glide.

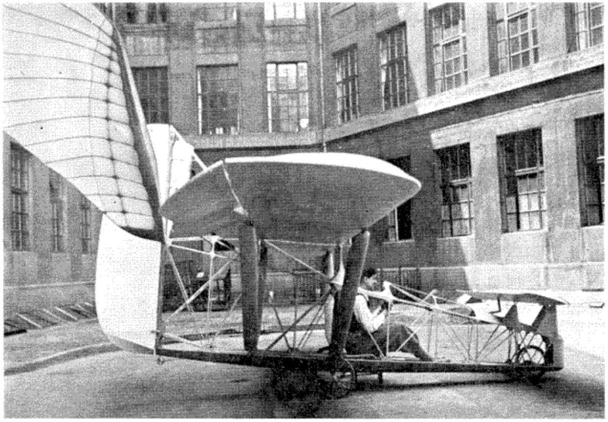
As is known the performance of an ornithopter during the power run is greatly dependent on the rotation of the outer wing. On the Eagle model (Fig. 15c) a system was evolved through which this rotation could be regulated by means of a control arm. The same mechanism was used on the model in Fig. 21. When the rotation is limited to a small value a strong wing beat is obtained which results in a fast straight flight over a considerable distance. When the rotation has a greater value a steep climb is achieved.

Hence a choice must be made between the two and so far it has not yet been possible to develop a wing, which will automatically attain its optimum performance as a function of the wing beat frequency. However I feel a solution should be possible. It has often been thought that the circling flight of a bird was due to one wing beating faster than the other. That this is not so was proved by E. von Holst in 1943 when he tested a model on which only one wing could move.

As long as the model was held in the hand the movable wing beat through 90° while the other stood still. However as soon as the model was released both wings beat through 45° and the model flew straight. Although only one wing was driven the other wing moved in sympathy with identical frequency.

Hence it can be deduced that both during the power runs and during the glide any turns are the result of changes of angle of incidence on the outer wings. Fixed rudders which I tried on some of the models did not produce any change in course.

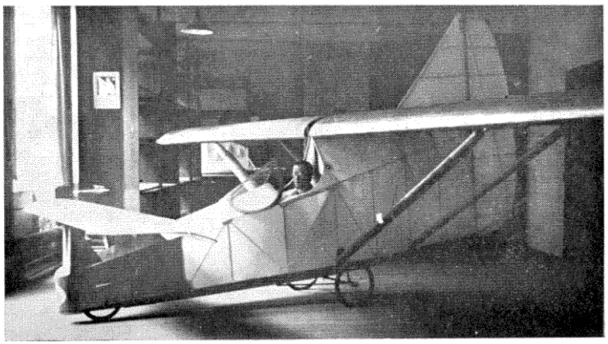
A steep climb or even hover flight which E. von Holst obtained on some of his models are possible with my models. I hope that many more aeromodellers will turn their attention to this fascinating aspect of model flight which will undoubtedly advance the results very much.



MUSCLE POWER

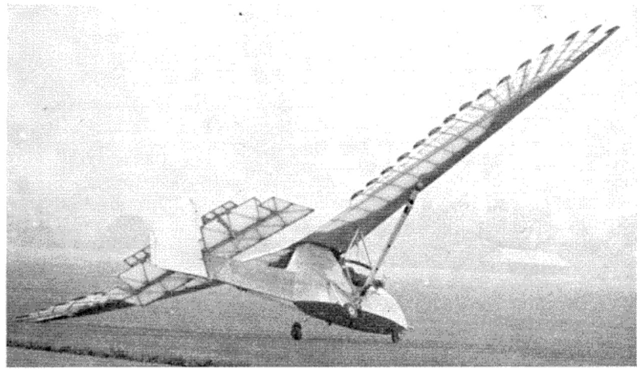
More developments and discoveries in Man-Powered Flight uncovered
by R. G. Moulton

SINCE the survey of Man-powered Aircraft progress, dealing in particular with the Hatfield "Puffin" and Southampton machines as published in the 1962 Annual, there has been very little to report in terms of flight achievement. The Henry Kremer £5,000 prize for the first to fly a figure of eight course around markers half a mile apart remains unclaimed as this is written; but is still the target of several very keen groups. A bibliography of literature



on the subject, even excluding the grossly inaccuate features which have appeared in the popular press, would extend to many pages of this book so that no serious student of the subject need ever remain ignorant of the technicalities of the task, or of the practical aspects of the many experiments since the attempts for the Oscar Ursinus prize in Germany first offered in 1933.

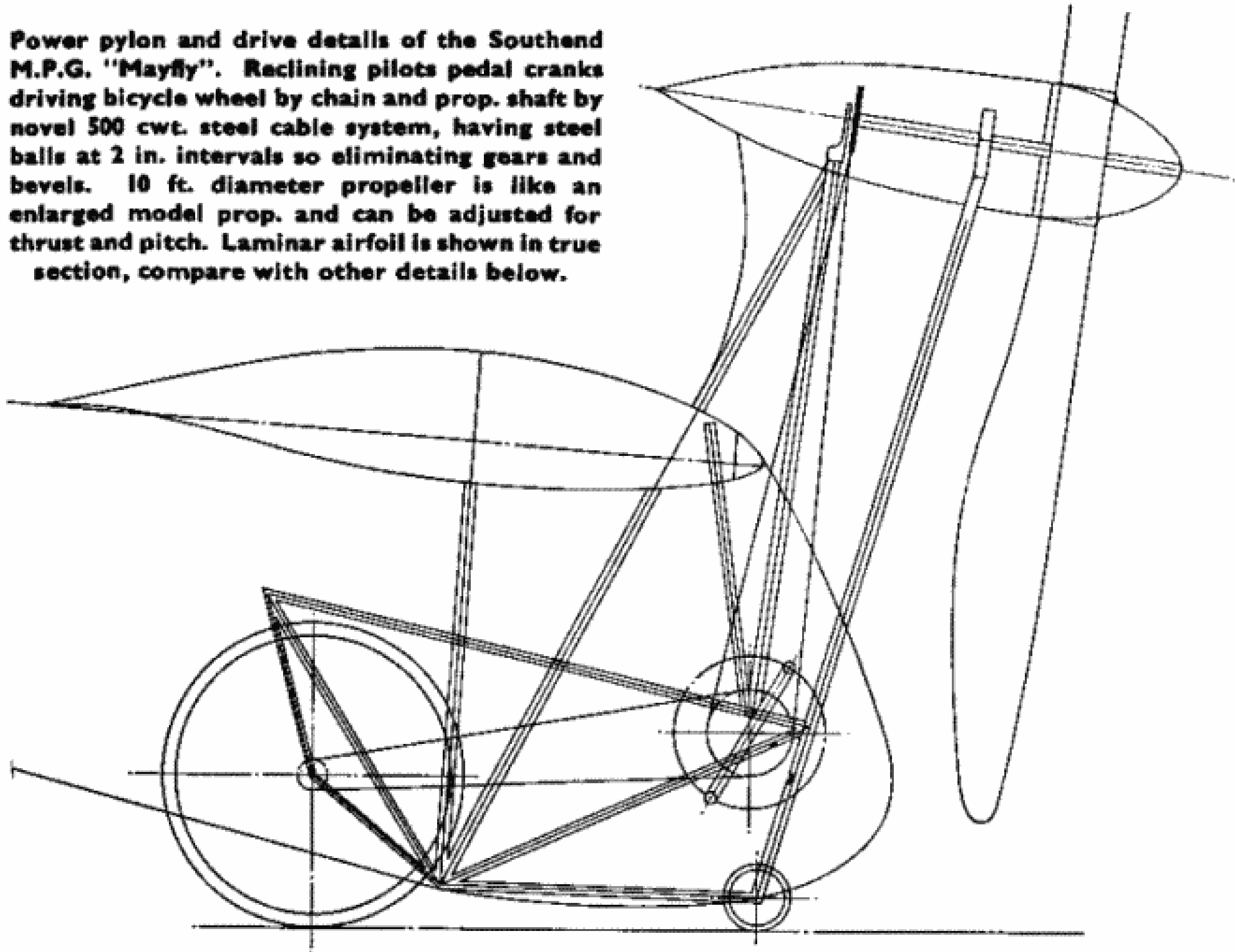
Distinction between the pre-war German and Italian machines, and the current experiments is that stored power in the form of wound bungee is no longer permitted. Thus the target has become more difficult to attain, and has created many unorthodox approaches ranging from the helicopter to the single and two-seat high aspect ratio lightweights and the intriguing ornithopter.



Photographs opposite show Canard ornithopter made in Germany between 1932 and 1935 by Dr. Martin Sultan. Unfortunately it was not completed before he was forced to leave the country. Now a resident of Tel Aviv, Israel, and almost 73 years old, Dr. Sultan retains a very keen interest in flapping wing propulsion and Canards. Above, shows the unfortunate demise of Emiel Hartmann's "Ikarus" at Cranfield, damaging wing on landing. Machine is still stored at the College of Aeronautics, Cranfield, no further flight attempts have been made. (*Daily Mail* photograph).

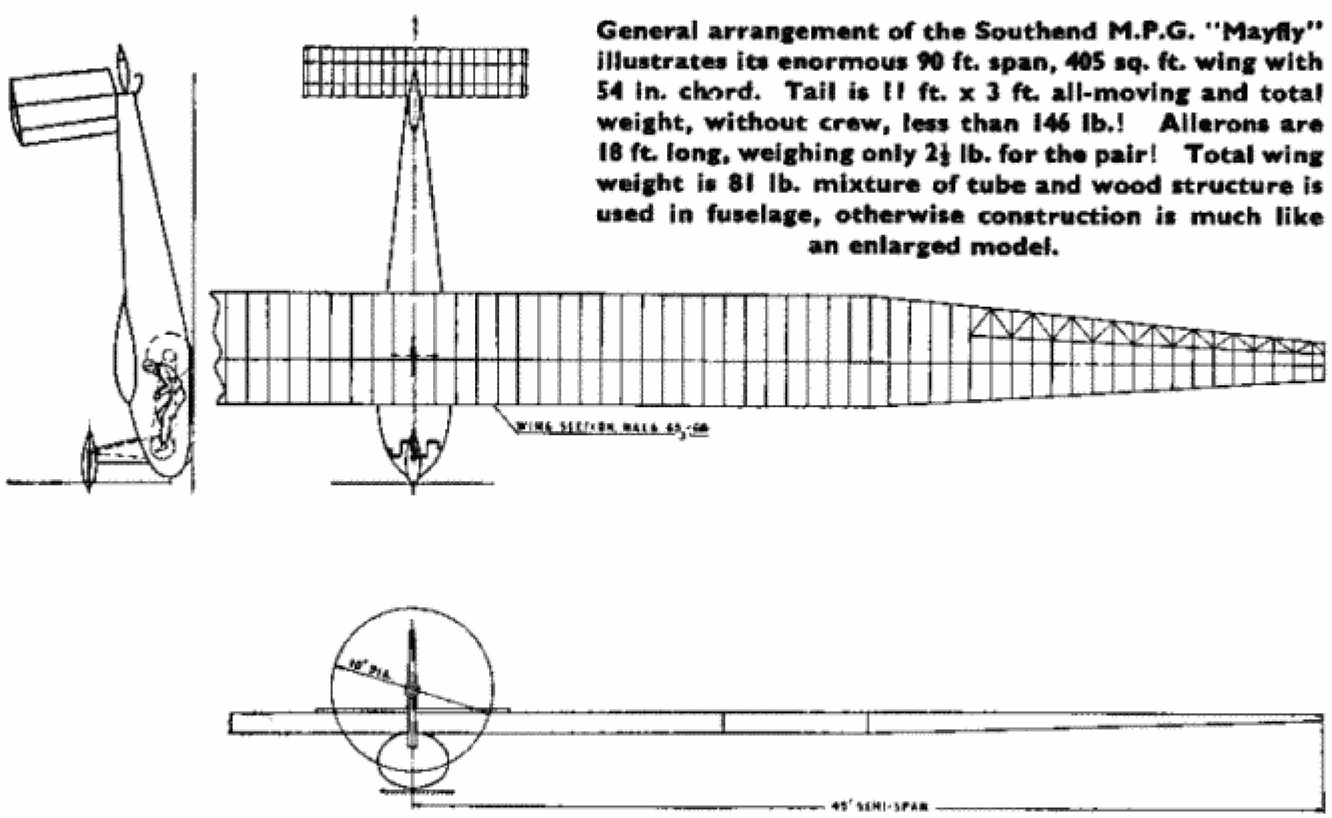
The two machines which *have* flown successfully as described two years ago, are now modified. "Puffin" is re-winged with an increase of area through a 9 ft. span extension to 93 ft. and a constant chord centre third of the span, with change of airfoil to an undercambered type. This offers an aspect ratio of 22 : 1 and the spar is of spruce and balsa girder structure. Sheeted balsa areas are reduced and Melinex covering retained. By the end of the year, the new "Puffin" may well have flown, and having the advantage of tremendous technical background and general facilities, it stands a great chance. However, the time aspect has brought many delays in progress at Hatfield and the Group is, like all others in the contest, keenly aware of the loss of many magnificent flying periods in the summer of 1964.

The Southampton Machine has moved to London and though it is known as the London M.P. Group aircraft it is very much the baby of Alan Lassiere, one of the designers. The tiny 5% all-moving elevator on which we commented has now been increased in area by 5 sq. ft. and made conventional

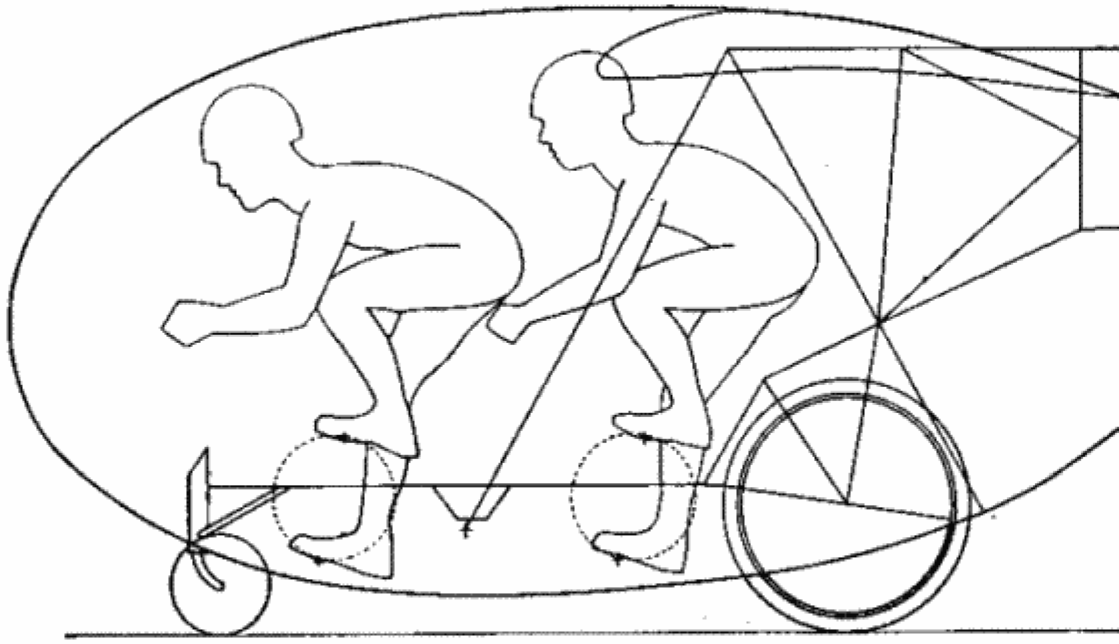


Power pylon and drive details of the Southend M.P.G. "Mayfly". Reclining pilots pedal cranks driving bicycle wheel by chain and prop. shaft by novel 500 cwt. steel cable system, having steel balls at 2 in. intervals so eliminating gears and bevels. 10 ft. diameter propeller is like an enlarged model prop. and can be adjusted for thrust and pitch. Laminar airfoil is shown in true section, compare with other details below.

with a portion as a fixed stabiliser as also have the vertical surfaces become a fin and hinged rudder. These are now covered in clear Melinex in contrast to the wing which remains in opaque doped parachute nylon. Transmission changes have held up any attempt at flying, the original scheme is subject to alteration.



General arrangement of the Southend M.P.G. "Mayfly" illustrates its enormous 90 ft. span, 405 sq. ft. wing with 54 in. chord. Tail is 11 ft. x 3 ft. all-moving and total weight, without crew, less than 146 lb.! Ailerons are 18 ft. long, weighing only 2½ lb. for the pair! Total wing weight is 81 lb. mixture of tube and wood structure is used in fuselage, otherwise construction is much like an enlarged model.

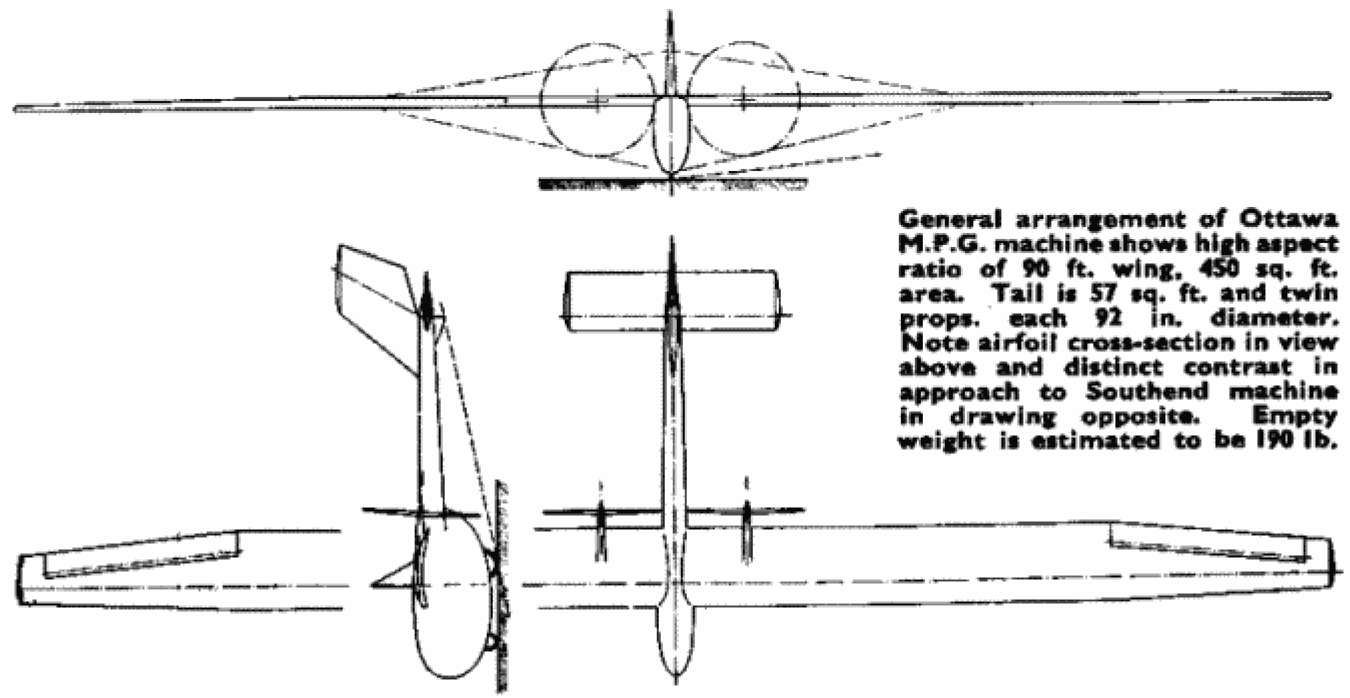


Ottawa M.P.G. twin pilot arrangement carries crew in tandem bringing weight penalty in drive mechanism to twin pusher props.

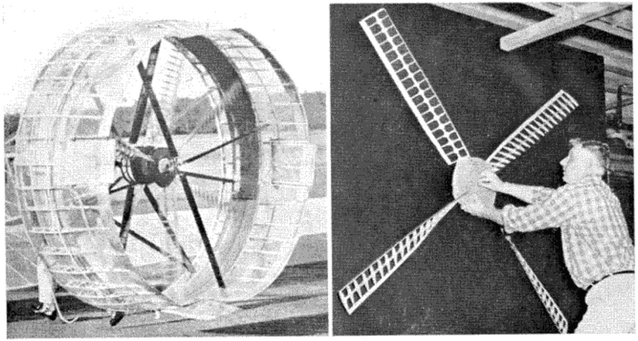
In South Woodford, London, S. Hodgess-Roper's 79 ft. span design nears its testing time. Configuration is after the style of the 1935 Haessler-Villinger with pylon mounted pusher propeller.

In the U.S.A. Dr. A. M. Lippisch, designer of the successful "Schwingguin" M.P. ornithopter flown in many demonstrations by Hans Krause in 1929, was the Research Director at Collins Radio, Cedar Rapids, and engaged on a 50 ft. span, 200 sq. ft. machine with 6 ft. 6 in. pusher prop. and remarkable empty weight of 60 lb. This contrasts with the McAvoy MPA-1 low wing 54 ft. machine with tail surfaces formed into an annular duct for the rear mounted pusher prop. and weighing 125 lb. During a first flight attempt, the right spar cap failed and after repairs, MPA-1 was once more severely damaged in a photo session. A feature of this machine was the replacement of ailerons by differential wing flaps, interconnected with the rudders in the prop. shroud. Mixed aluminium/balsa structure was Mylar (Melinex) covered.

In Calgary, Alberta, another unconventional approach was made by Maurice Laviolette and Alvin Smolkowski. This is a biplane with the three-blade tractor airscrew projecting forwards on a boom and tail surfaces similarly



General arrangement of Ottawa M.P.G. machine shows high aspect ratio of 90 ft. wing, 450 sq. ft. area. Tail is 57 sq. ft. and twin props. each 92 in. diameter. Note airfoil cross-section in view above and distinct contrast in approach to Southend machine in drawing opposite. Empty weight is estimated to be 190 lb.

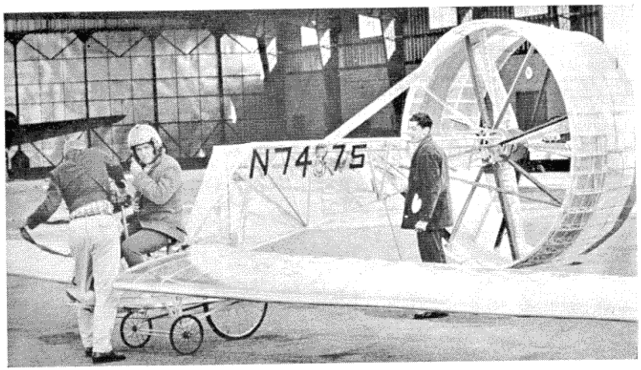


Mylar covered circular propeller shroud which also provides tail surfaces on the McAvoy MPA-I made in the U.S.A. show small rudders and elevator trimmers in action. At right, James M. McAvoy displays the frame of his 84 in. diameter, 4-blade, propeller designed to operate at 240 r.p.m., driven by torque tube from bicycle type drive.

supported aft of the pilot pod between the wings. End plates on wing tips and airscrew blades conserve tip losses on the comparatively short spans and overall one must consider the heavy drag penalties of such a design. Current news is that the most serious penalty is that of accommodation, but we hope the Canadians will make flight attempts as their design abounds with refreshing original thought.

Another Canadian project is the two-seater by the Ottawa Branch of the Canadian Aeronautical & Space Institute. This started as a 70 ft. twin pusher concept in May 1962 and in 1963 this became enlarged to a 90 ft. 450 sq. ft.

Preparing MPA-I for flight, low wing position is most evident, taking advantage of ground effect Port wing proved to be structurally unsound in first tests. (Howard Levy photographs.)

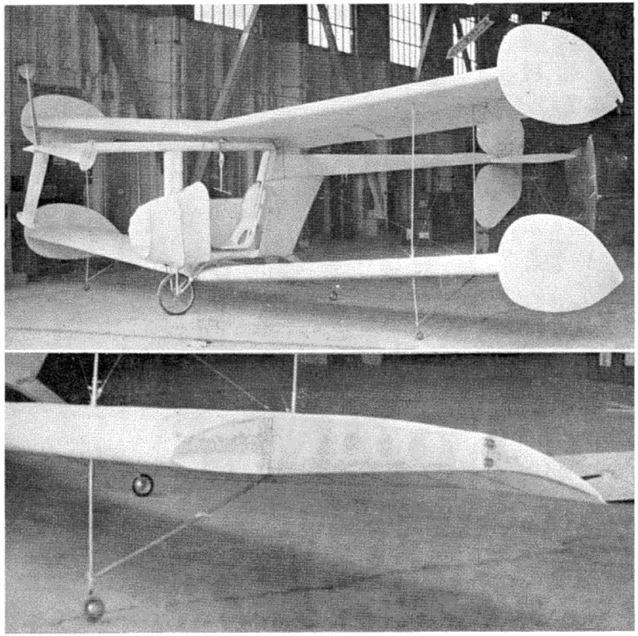


wing design with undercambered 12% airfoil and two crew in orthodox tandem cycle stance in a nose pod, driving two 92 in. diameter pusher props. Results obtained from test structure analysis indicate an empty weight of less than 190 lb.

However, this is not the only "twin" in the field, and no greater contrast in approach could be found than in the Southend M.P. Group's "Mayfly" with gratifyingly low weight of less than 146 lb. empty. Designed by Messrs. Drescher, Barbeary, Basu, Kerry and Prentice, it is most likely to have made flight tests before the end of 1964 and is the culmination of strenuous efforts by part-timers in difficult conditions and without much backing or facilities. Choice of two pilots avoids pilot distraction, enabling one to concentrate on power, the other on control. Structural weight penalty over a single seater is low, and much of the weight saving is due to the simple between pilot drive using a common shaft. This dictated a reclined attitude for seating. Optimum

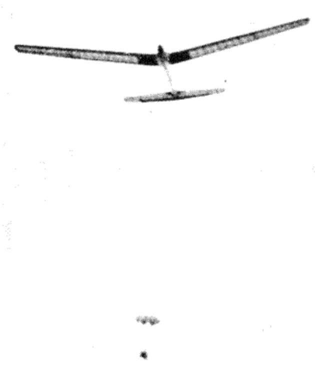
(*Continued on page 137*)

The Canadian Laviolette and Smolkowsky biplane built at Calgary, has many novel design features, not the least being the 3-blade tractor airscrew chain driven through pylon in front of the cockpit. Note suspended Tee bar controls and low speed airfoil section with deflected trailing edge.

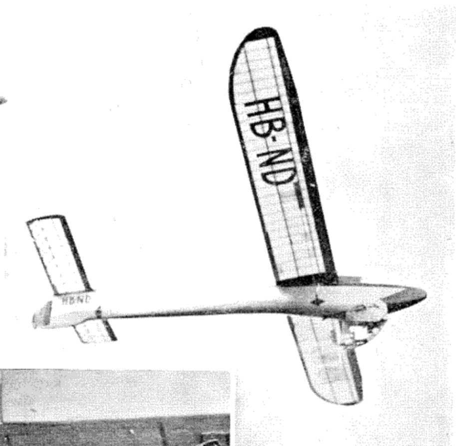


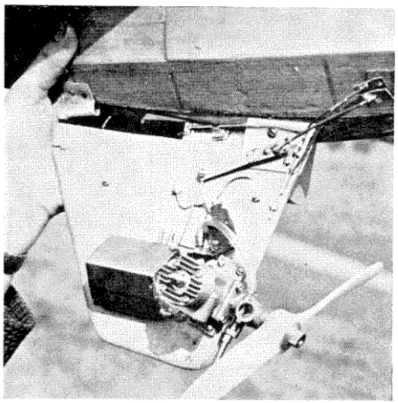
TWO-WAY RADIO FUN

Flat site soaring is no problem with this West German Power Disposal System of glider launching.



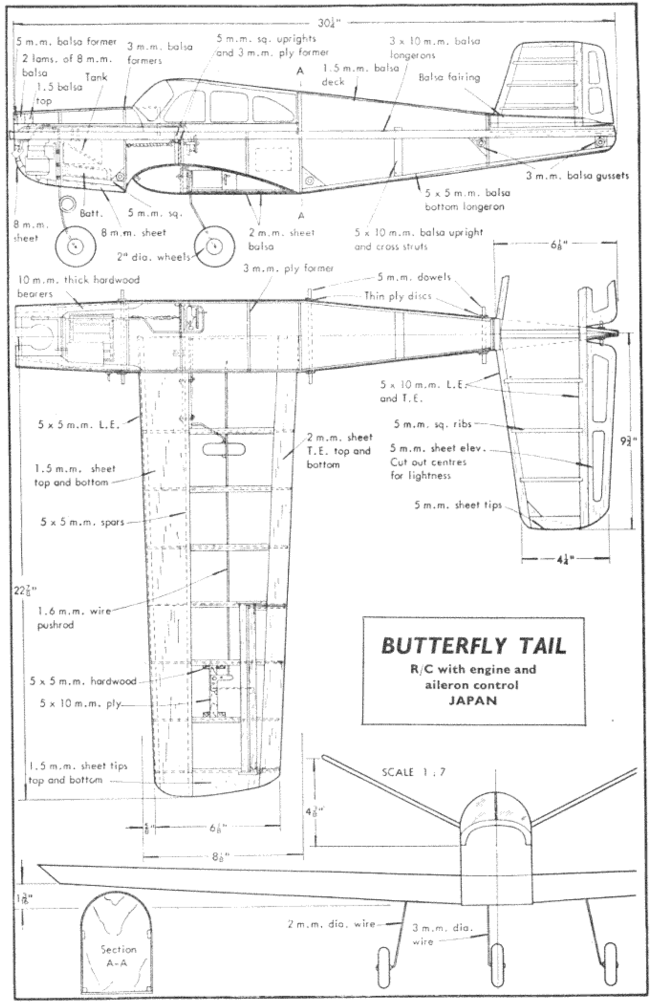
Heigh-ho and away, for thermal soaring! Parachuted power pod from glider above is descending after the engine run has ceased. Glider now continues with lighter loading after controlled climb over the launch base.





This glider, different from that in upper left picture, shows how the power pod is pendant beneath nose. Ply plate carries clockwork timer for lengthy run with Enya glow plug engine (note size of tank) and model is radio controlled in circling climb to altitude. When engine stops, ply plate is released and parachute opens for safe recovery. Pusher thrust force incorporates upthrust. This is a useful idea from West Germany for those who cannot get to hillsides for R/C glider duration flights.

FLUG & MODELL TECHNIK, GERMANY



R/C TECHNIQUE, JAPAN

THE STORY OF BALSA

By S. Greenhouse

It was not long ago when the mention of Balsa wood evoked only a blank stare, and even today we occasionally run across somebody who has not yet heard of the word.

We used to get some peculiar questions about Balsa wood, such as how do you blow it up to make it so light? Is it really a wood or only a composition material? I understand that they use it to make dynamite; will it blow up on me?

Fortunately, Balsa wood is much better known today, largely through the efforts of aeromodellers. As a matter of fact, the hobby enthusiast has remembered this basic material in his business and professional life, so that it is no longer only a hobby item, but has become a true engineering material, and is used for the most exacting industrial requirements.

However, the production of Balsa has a romance of its own, and while you all know what Balsa is and what it can do, some of you may not know how Balsa comes about and what it goes through before you buy it off your dealer's shelves. It is my object to tell you what we have to go through so that you can make your model aeroplane, or that a plastic boat manufacturer can make a stronger, more buoyant product, or that an aircraft manufacturer can obtain the greatest possible weight-strength advantage from the world's available materials.

The best way to start is with the tree. Even to see one in the woods surrounded by other trees, you would stop to give it a second glance—I know I do, but perhaps that is because I am prejudiced. Its clean, handsomely mottled bark and large leaves attract attention in a forest where most of the trees are vine-covered, and with small compound leaflets. It is hard to believe that only about forty years ago the Balsa tree was considered a weed and a nuisance just because of the very advantages with which nature endowed it to serve its purpose in life. Nature did not intend the Balsa tree to be the final tree in the complex chain of species following species, until as we call it in forestry, the climax association is reached. You would call this the Virgin forest. In nature's scheme of things, and nature is a wonderful engineer, the Balsa tree is a tool, a tool used to achieve an end, and the end is the climax association, or the Virgin forest.

Let us start from the beginning of the chain. An open area appears in the jungle either through human agencies or from natural causes such as disease, storm or death from old age—yes, trees die of old age too. The hot tropical sun shines down on the forest floor, but the vegetation in the tropics is not static for long. At once a mass of plants begin growing in the open space. These plants could not live in the shade of the old trees, they need direct sunlight, and the only reason they are growing now is that for the first time in many, many years, they are receiving direct sunlight. Most of these plants are low to medium-sized annuals or perennials with occasional low shrubs. They form an impenetrable thicket. In an environment such as this, it would be very difficult for a young seedling to survive—the seedling which will eventually grow up to be the tree that will take over the open space left by the dying of his parent. However, in this mass of herbage there are also the seeds of the Balsa tree. The wind has spread these far and wide borne on pieces of downy floss which look very much like the fur of a rabbit. As a matter of fact Balsa's Latin name "lagopus" means rabbit's foot, referring to the appearances of the seed pod before the seeds are dispersed. They may have lain in the ground for years awaiting just this moment. When the sun shines hot on the denuded area, the Balsa seeds spring up, in some cases as thick as grass on a lawn. They are the only plants which can grow faster than the other herbage. In doing so they shade out and kill not only the herbage but their own weaker numbers. It is a case of survival of the fittest. And this competition for light and space goes on until perhaps only one or two Balsa trees are left where literally thousands of seedlings began.

There is a purpose behind this procedure. The Balsa tree shading out everything beneath it leaves a forest floor practically clean. There is then enough room for the final species to develop. Nature has ordered it so that at this age the final species is tolerant of shade, and protected from the hot sun and from overcrowding by weeds, it takes root and flourishes.

Now if you were an engineer who had to write the specifications for a tool to do this job required of the Balsa tree, what would you want? In the first place you would want that tool to grow fast—so fast that no other plant could catch up with it to crowd it out; not even the fast-growing, tree-strangling vines of the tropics. You would want the trees to have large crowns, yet to be few in number in order to provide shade to prevent the drying out of your final species in the hot tropical sun, but not too thick to prevent the circulation of the air, a condition which would create an ideal breeding environment for fungal diseases. You would not worry much about putting fancy colours in the wood of your tool tree, or giving it axe-breaking hardness. All you would be interested in is getting a trunk big enough and strong enough to hold up the wide-spreading crown, with emphasis on speed of growth. You would also write into your specifications that you do not want this tool tree to live too long. You would want it to die off at just about the time when your climax tree has reached the stage when it is firmly established and can take care of itself.

Nature has written these specifications exactly into the Balsa tree, and since it is wood we are interested in, let us look into what is happening in the trunk of our tree. We look at the wood under a microscope and we find that it is made up of several wood elements. We may be surprised that they are the same elements you find in all other woody plants. Nature has struck on a good basic construction, and like a good engineer or architect, by switching the elements around, by modifying them and by adding a pinch of salt here or a drop of resin there, she comes up with an innumerable variety of woods. But if we were to take only the basic elements as a solid mass of cellulose, which it is, we would find that it would weigh 97 lbs. per cubic foot, practically the same as for any other wood species. Compare this with the Balsa board you buy in the stores which will weigh between 4 to 18 lbs. per cubic foot.

We find under the microscope that the 97 lbs. of cellulose have been blown up like a sponge. The walls of the cells, fibres and tubes are thin, so that the Balsa is more air by volume than it is cellulose. Most woods have quantities of heavy plastic-like cement holding the various elements together. This is called lignin. In Balsa the lignin is kept to a minimum. Many trees have other weight-adding substances, such as dyes, crystals, oils, which are all lacking in Balsa. This construction in itself is one with a high strength/weight advantage, and it is this that mainly concerns us here. However, when the tree is in the forest it is given still more strength. First it has a tough, stringy bark which helps a great deal to keep the tree from snapping in heavy winds. In addition, the cells are literally pumped full of water, thus giving additional strength in the same manner that air gives rigidity to a car tyre. In a growing tree the weight of water it contains may be four or five times the weight of the cellulose.

Nature goes a step further to cut every possible corner. When the Balsa tree is small the wood material is light and soft, in keeping with the size of the crown. As the tree grows older, concentric layers of wood are added under the bark, and as each layer is laid down, it is slightly harder and heavier than the layer just beneath it—the cell walls are a little thicker. The space to wood ratio is a little smaller. This is why you get some pieces of Balsa which weigh as little as 4 lbs. per cubic foot, and other pieces of Balsa which weigh 18 or 20 lbs. per cubic foot. However, the causes of Balsa density are not quite as simple as that. Numerous environment factors enter into it. The drainage, the amount of sunlight it receives, soil conditions, competition, all tend to dictate the density of the wood of any particular Balsa tree. Only one thing is outstanding—one peculiarity. If Balsa is damaged in any way, such as a man walking along and striking it with a machete, or if a branch of an adjoining tree begins to rub constantly on its surface, the wood from then on becomes very hard, sometimes attaining a density of 30 to 40 lbs. per cubic foot. The natives call this a "macho" tree which means "male". A "macho" tree is worthless for commercial purposes.

We now have the Balsa tree growing nicely in the jungle, and if we are lucky and it is not eaten up by insects, blown over by the wind or becomes "macho", it grows into a commercially valuable tree in six to eight years. At that time it is about 10 in. in diameter at chest height and it may be more than 60 feet tall. Now is the time to harvest it if you are going to harvest it at all. You will remember that I mentioned that the wood becomes harder as the tree becomes older, and after eight years or so the wood may be too hard for commercial purposes. You will also remember that one of nature's specifications for Balsa is that it cannot live too long. About that age the first signs of deterioration begin to appear. This is usually a small area in the centre of the base of the tree, which becomes saturated with water, and the cell walls begin to deteriorate through rupture and decay. The cone becomes higher and wider with time. The tree should be moved to the sawmill before this condition, called "waterheart" goes too far. If left untouched, the tree will grow much larger. I have seen Balsa trees 6 ft. in diameter at the base, and over 100 ft. high, but such a tree would be of very little commercial value. From this you can begin to get an inkling why Balsa boards are so small—we get them from logs which, of necessity, are small.

Practically all of the world's supply of Balsa comes from Ecuador. There are several reasons for this, not all of them valid, in my opinion. In spite of the great progress made in that country since the war, the backwoods where Balsa is harvested is still quite a primitive place and the extraction of Balsa or for that matter any other species, is quite primitive, too. This is not because we are against progress, it is because of the economic facts of life. The chief difficulty is that the Balsa trees do not grow in groups, but are scattered throughout the forest. You may find one Balsa tree here and you may not find another for ⅛ of a mile or more. Occasionally you may be lucky and come across an old abandoned field, or the cut for the right-of-way of a road, and find your trees in small batches. This does not happen very often. To put in expensive logging equipment such as high-lines or tractors is not feasible economically. We rely on more primitive but more economical methods.

The logger is usually not a professional. That is, he does not depend on the cutting of Balsa alone for a livelihood. His main concern is raising food to feed his family and that means the staples such as rice, corn, beans and bananas. He cuts Balsa for extra money when his farm duties leave him free. Sometimes this does not coincide with the demands of the industry, but he is an independent individual and we have learned to live with his routine. His tool is a broadaxe. He never uses a saw because it takes too much work and know-how to keep a saw in condition. His method of chopping a tree down is by cutting all around its periphery just as a beaver would do, and it then falls in any direction it chooses. There is one advantage to this method. It gives him a point on the end of the log like a blunt pencil point, and when the log is dragged on the ground, it acts in the same manner as the upturned runners of a sled. Immediately behind this point he cuts a groove completely around the circumference, about 2 in. deep. This is where his rope or chain goes for dragging out the log. Incidentally, he usually gets only one 16 ft. log to the tree—rarely will he get more.

He peels the log in order to lighten it further for the dragging or skidding process. He does this by chopping a series of X's in a line down the length of the log and then using his machete, he prises off the bark.

The next step is to get the log to the water which is the most common means for transporting it to the mill. Usually loggers work together under a boss or contractor and in that case a yoke or two of oxen are generally available. In the dry season the yoke of oxen may be able to drag one large log down to the river, or two or three small ones. However, in the rainy season when the oxen flounder in mud up to their bellies, it may take two teams to pull a single log to the water. Occasionally when a man is working by himself, or with a partner or two, he may drag the log down to the water by sheer man-power. Believe me, this is not the easiest way to make a living!

When the logs are in the water, they are formed into rafts about 10 feet wide, and are bound together by vines and wooden pegs which are driven into the Balsa. The rafts of the various loggers are floated down the river with the help of a steering sweep in the stern, and with pole men in front and at the sides keeping it on the right course.

Within one day to a week depending on where they are logging and the condition of the river, they will come to a concentration point on the river. Here the various rafts are consolidated and strengthened. They are formed into a long train of rafts and a thatched hut is built on one of them for living quarters for the crew on their long trip down the river. A little extra money is often made by acting as freighters and they may load local produce such as bananas, coffee, or cocoa on the rafts. This pushes the logs lower in the water and helps to keep out Ambrosia beetles, the insects which make little holes in the wood.

Running a train of logs down the rivers calls for a special breed of man. In fact one who has a very strong resemblance to the old swash-buckling loggers of the early United States. It takes a strong back, an intimate knowledge of an ever changing river and a considerable amount of courage since the journey is not without danger. If you have read Mark Twain's account of life on the Mississippi you have a faint idea of what is involved, but the banks of these rivers are considerably closer together, they are rock-strewn and the upper reaches, at least, consist of a series of rapids.

In due course—up to two weeks, sometimes, depending on the condition of the river—the raft arrives at tide-water. Here the tide takes over and acts as the motive power instead of the current of the river. As the tide runs out the raft is carried swiftly seaward surrounded by a mass of floating islands of water hyacinths. When the tide comes in the raft ties up at the bank and waits for the turn. Within a day or two they are at Guayaquil where our main sawmill is located.

There was a time, not very long ago, when this was the only way to get Balsa logs to market. However, Ecuador has been extending her road system and where it is economically feasible, logs are shipped to the mill by truck. As yet, however, truck transportation accounts for only a very small percentage of our log supply.

At the mill the log rafts are broken apart and are hauled up an incline into the mill by means of a tramway. Each log is placed on the head saw, which consists of a large circular saw blade rotating beside a pair of tracks. A carriage holding the log in position is run over these tracks exposing the log to the saw. The purpose of this saw is to cut two slabs off the log opposite each other, in other words, to put two flat faces on the log.

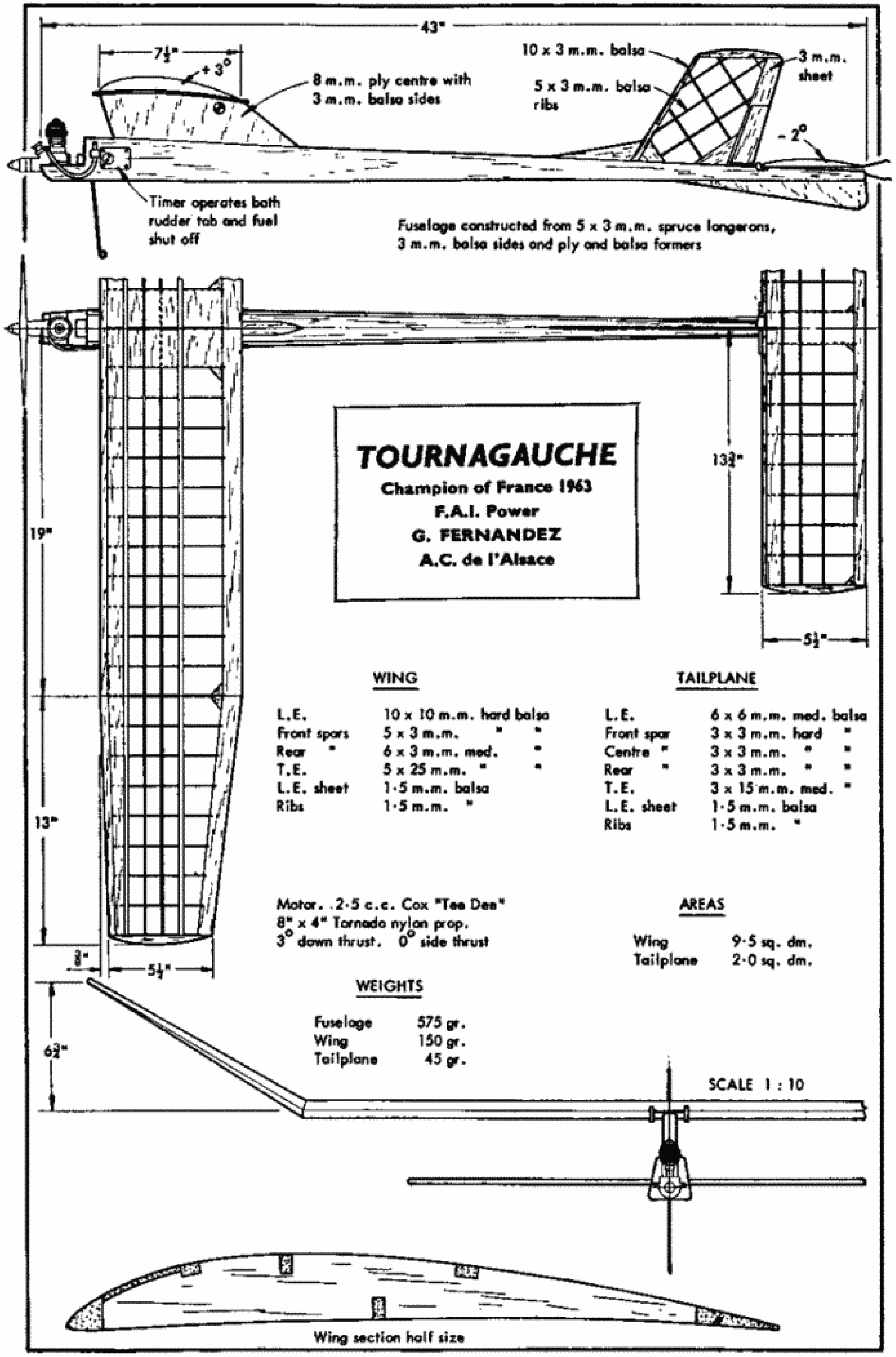
From the head saw the log goes to one of the sash gang saws. This machine contains a series of saw blades like giant hack-saw blades. They are spaced far enough apart to cut the required thickness of the board, plus the considerable allowance for shrinkage which will take place in drying, plus enough material to remove in planing. From the sash gang saw the boards go to a cross cut saw, where the crooks are cut out as are the larger, more obvious defects. They then go to a machine called the edger. This consists of two saws movable on its arbor which are manipulated by the operator in accordance with the width of the board being sawn. It comes out of this machine as lumber but it is hardly the finished product yet.

The boards are then stacked on trucks with strips of wood between them, so that air may circulate between them and are placed in a kiln, where the moisture is removed and where, in the procedure, they go through a sterilisation process which kills the various insects and fungi which would lower the quality of the boards.

The drying process is complicated and would take too long to describe here. However, I cannot emphasise too strongly the necessity for proper kiln drying conducted in accordance with the latest scientific procedures. The wood must not be dried too fast since in shrinking as it dries it will develop checks and internal stresses, but again it must not be dried too slowly for it will be attacked by various fungi and insects. Drying follows a specified schedule of heat, humidity and circulation which must be strictly adhered to. Sometimes there are penalties that have to be paid for kiln drying. One, for example, is the fact that in order to reach sterilisation temperatures the sap substances may change chemically, giving the Balsa a slightly darker colour which some hobby enthusiasts, for reasons best known to themselves, find objectionable. However, the advantages outweigh the disadvantages to such a degree that Balsa should always be kiln dried.

After drying in the kiln and the subsequent cooling until they regain room temperature, the boards are passed through the planer. This surfaces the two faces. From the planer it goes to a series of rip and cross cut saws. These are manually operated because each board is studied individually for its best possibilities. A mass production machine here would be impracticable. Various defects are cut out to give the best grade possible. In the process, of course, the size of the lumber produced becomes smaller. That is why it is difficult to supply long lengths or widths.

This, then, is the story of Balsa insofar as it concerns model aeroplanes.



MODELE REDUIT D'AVION, FRANCE

LAMINATED OUTLINES

FUNCTIONAL simplicity is all very well, but the resulting shapes are not always that pleasing and may carry unexpected penalties. The use of square-cut wing tips, for example, which has become more or less standard practice on duration models, means that such tips are usually carved from solid block, adding weight where it is least needed or desirable, and often unbalanced when the two tip blocks are of different density. Lack of stability in manoeuvres or vicious turning characteristics on a radio model are often traceable to overweight tips, or solid block tips which may be an ounce or more different in weight. The latter is particularly likely to occur in kit models where the tips are prefabricated. One shaped tip may weigh four or five ounces and the other only two ounces or so, because they have been cut from different stock. It saves a lot of bother to use the tips as supplied, but the unbalance added to the wing can only have a detrimental effect on performance. Adding more weight to the light tip to even out the balance is a classical example of expecting two "wrongs" to make a "right". The other alternative—hollowing out the heavier tip—is not always feasible.

In any case square cut tips are poor aerodynamically, except where maximum performance is required only at low angles of attack—*e.g.* on a speed model. And the use of tips cut from block implies, almost inevitably, adding more weight to the structure than is necessary, as well as the weight being in the wrong place. If block tips must be used they should be carved from the very lightest balsa it is possible to find (4 to 6 lb density), or from expanded polystyrene (1 to 3 lb density).

Almost any shape is better looking than a square tip, although structurally more difficult to achieve. Typical construction for rounded tips a decade or so ago featured the tip parts cut from sheet, broken up into sections so that the grain of the wood ran substantially parallel to the curve—Fig. 1. The main limitation with this form of construction is the difficulty in obtaining a 100 per cent glued joint along the scarffed joints. Too often these broke up when carving and sanding the tip to final shape, or failed after the wing had been covered and was in service.

One of the main reasons why this tip construction was not persisted with with kit designs, incidentally, is that the thickness of sheet required for a model of moderate size—*i.e.* $\frac{3}{16}$ in. or $\frac{1}{4}$ in. sheet, or even more—cannot readily be die-cut cleanly and accurately. Thus as die-cut sheet became more or less

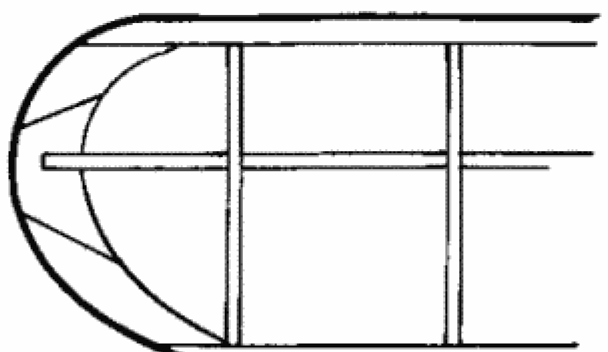


FIG. 1

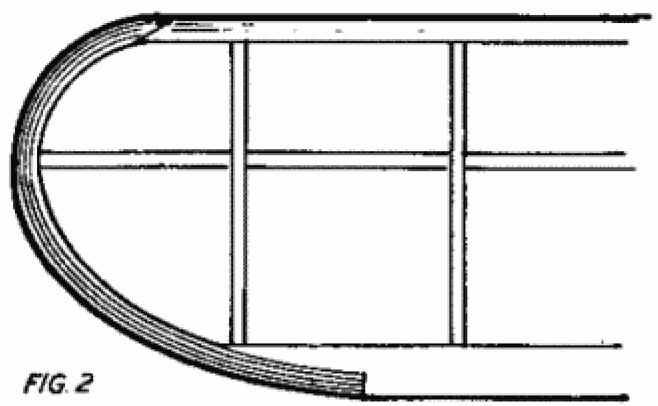


FIG. 2

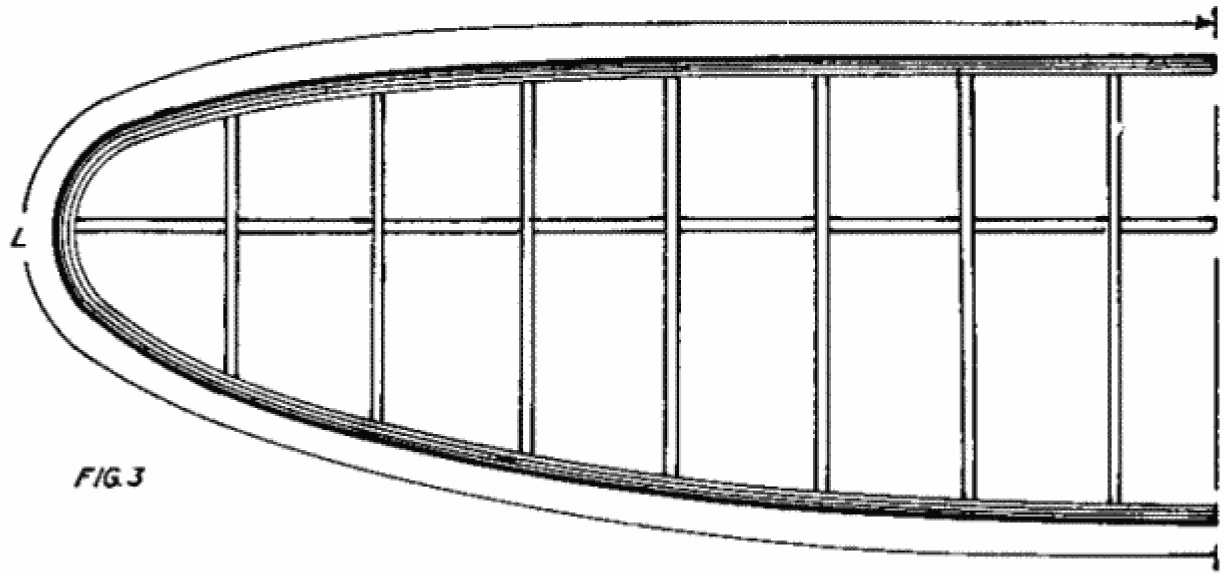


FIG. 3

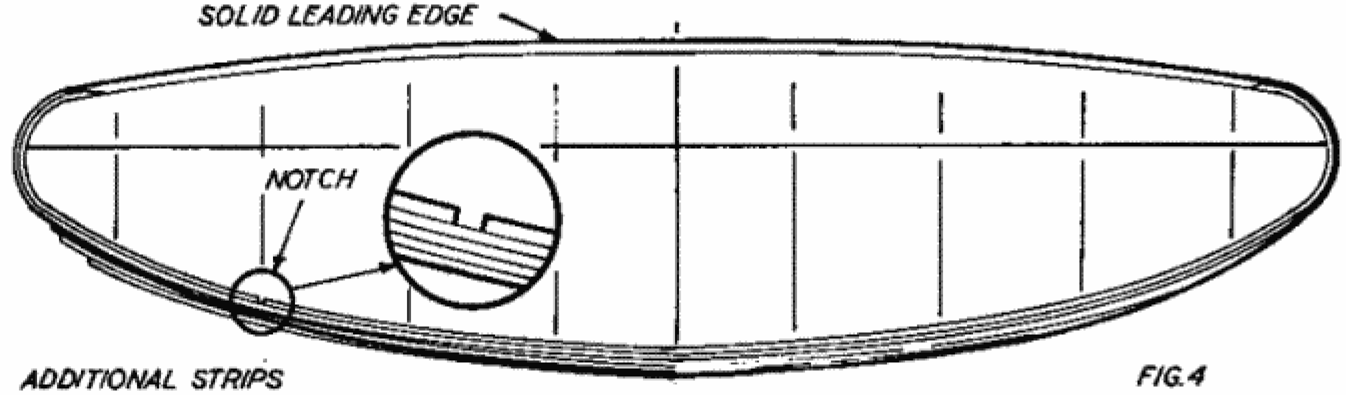


FIG. 4

standard in kits, simpler square cut tip designs became favoured to dodge this question, although some kits have persisted in giving printed sheet for rounded tips and others have used similar rounded tip designs with layer-laminated pieces which can readily be die-cut from thinner sheet.

A layer-laminated tip can be stronger since joint lines can be staggered on adjacent layers. Unless all the parts are very accurately cut, however, the resulting glued up assembly can show gaps. Also final trimming to shape is not so easy when glue lines also have to be chamfered through. All these troubles can be avoided by using a simple outline lamination made from strip with the laminations vertical.

The vertical laminated outline is particularly versatile as regards the shapes to which it can be adopted, and also in width. By choosing strips of $\frac{1}{32}$ in. thickness for small wings, $\frac{1}{16}$ in. thick for medium size wings, or $\frac{3}{32}$ in. thick for large wings, and selecting flexible stock for cutting the strips (not stiff quarter-grain stock) most practical tip shapes can be bent with the wood dry. If necessary, too, additional strips can be added to the laminate to build up greater width at a particular point—*e.g.* at the trailing edge. The tip width can, in fact, change from a matching width at the leading edge to a matching width at the trailing edge, giving a balanced, economic structure—Fig. 2. This enables the average width of the tip to be less than that for a corresponding sheet strip, with a saving in weight, and the laminated tip will still be stronger.

Equally, of course, laminated construction can be applied to the complete outline of a wing panel which has an elliptic or curved taper planform with rounded tips—Fig. 3. About the only limitation is this respect is that if the

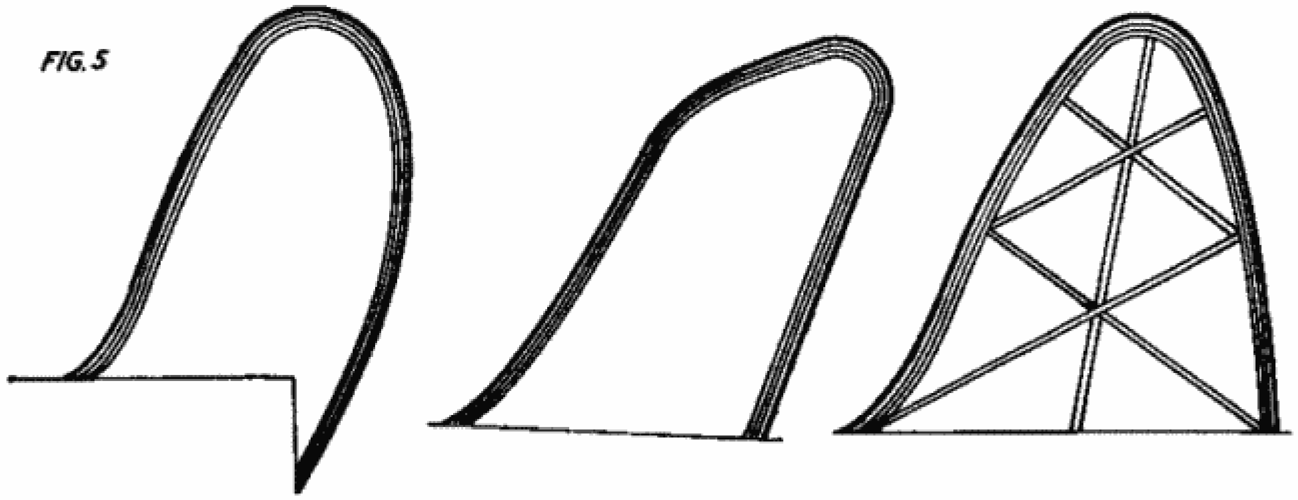


FIG. 5

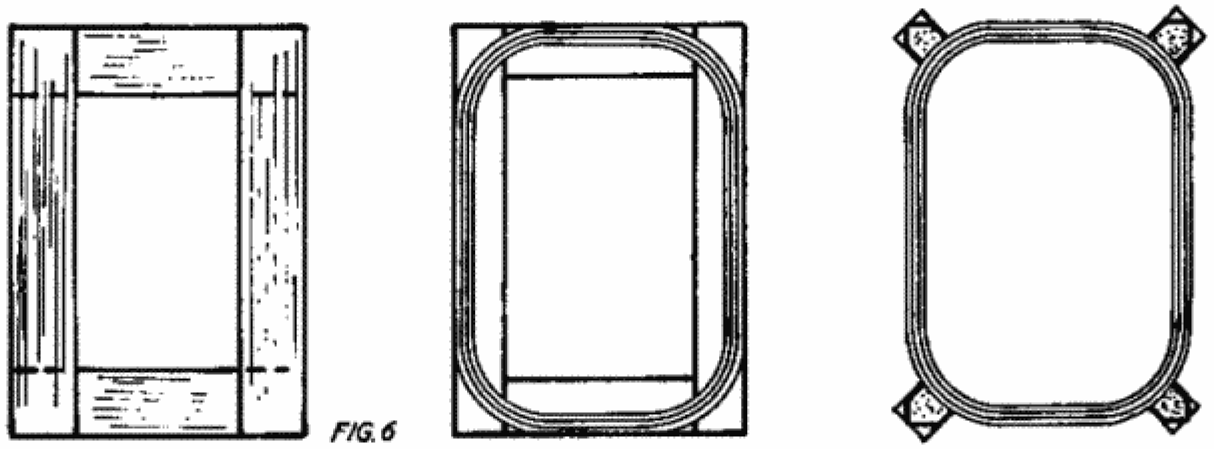


FIG. 6

peripheral length L is greater than 36 in. then individual strips cut from standard 36 in. long sheet will have to be jointed in length.

In the case of an elliptic planform tailplane the whole outline may be laminated as one or, usually more conveniently, using a solid section for the bulk of the leading edge where the curve is moderate and a laminated outline for the remainder—Fig. 4. An additional advantage provided by the vertical glue lines in the trailing edge is good resistance to warping, laminated outline being more resistant to distortion than built-up structures. There is also no objection to notching the laminated outline to locate and recess ribs, restricting the depth of cut to the first layer only (or two layers at the most in the case of a wide trailing edge section).

Compound outlines can also be accommodated readily with laminated outlines, such as a curved fin shape—Fig. 5. Used in conjunction with geodetic ribs the resulting structure is very light and extremely rigid—virtually completely proof against warping—although not as easy to make as a conventional built-up structure or a fin cut from solid sheet. Although the latter form of construction has become more or less universal for power models, a relatively thick fin section can be an advantage on R/C designs since it is less prone to stalling than a thin flat plate section. Carved from thick sheet, even of the lightest density available, a solid fin can be relatively heavy. A laminated outline with geodetic ribs with thin sheet covering (or tissue covering) will be very much lighter.

Laminated construction was also very popular at one time for formers for streamlined fuselages, a "hoop" former being very much stronger and more rigid than a built-up or cut-out sheet former, as well as being lighter. Light-

weight streamlined fuselages are rarely called for these days, however, and where streamlined sections are employed it is usually on models where weight is not a critical factor and so rounded sections can most conveniently and easily be produced by using solid or partially hollowed balsa blocks on sheet sides.

Laminated construction has virtually nothing to offer for the production of square or rectangular formers since it cannot accommodate "square" bends and where a lightweight former of this type is required it is a simple matter to build it up from strip—Fig. 6. This gives the best grain direction on all sides and is preferable to a former cut from sheet which will always be weak in compression at right angles to the grain direction, unless a generous thickness of sheet is used. The strength and rigidity of a light former built up from strip may, however, be improved by the addition of a laminated ring, as shown in the second diagram of Fig. 6, where the weight saving afforded justifies the additional work involved.

So much for the general design applications of laminated outlines. Now let us consider the practical details involved in making up such outlines. Starting point is selection of a suitable strip thickness for the individual strips, as previously mentioned, and then deciding the width of the laminate required (which fixes the number of individual strips). Width of the finished laminate can be decided, basically, as the same overall dimension which would normally be chosen for a solid *strip* section, assuming that such a solid section could be formed to the required curve; or in the case of a wing tip, as "matching" widths conforming to the existing leading and trailing edge widths, as previously mentioned. In a complete outline, thicker strips can be used to build up width where required, using thinner strips for the more sharply curved regions where a small width may be required—see Fig. 7.

Rather than select the number of strips required from strip stock, these are best cut from a single sheet of the required grade and cut. Light density wood is perfectly adequate, and will usually bend better in any case, avoiding quarter-grain stock and selecting a sheet which will bend readily end to end. The cutting width for each of the individual strips must then be decided.

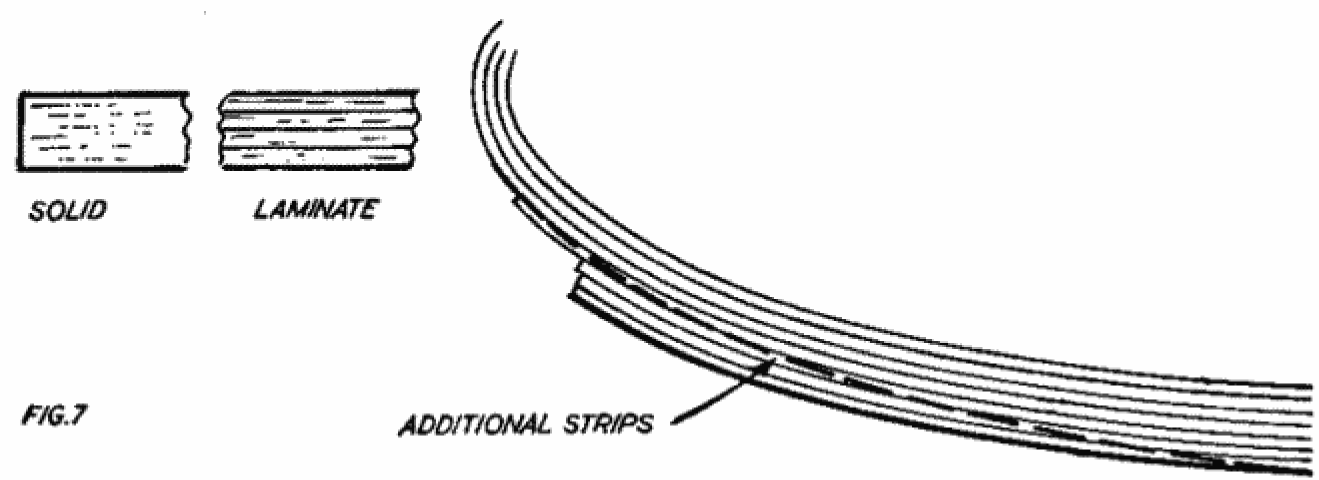


FIG. 7

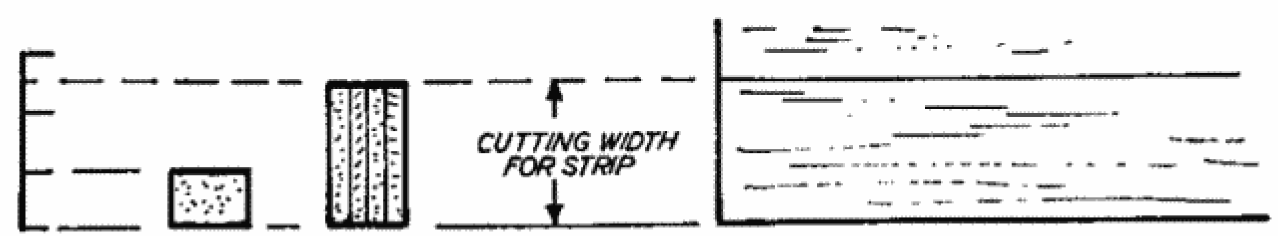


FIG. 8

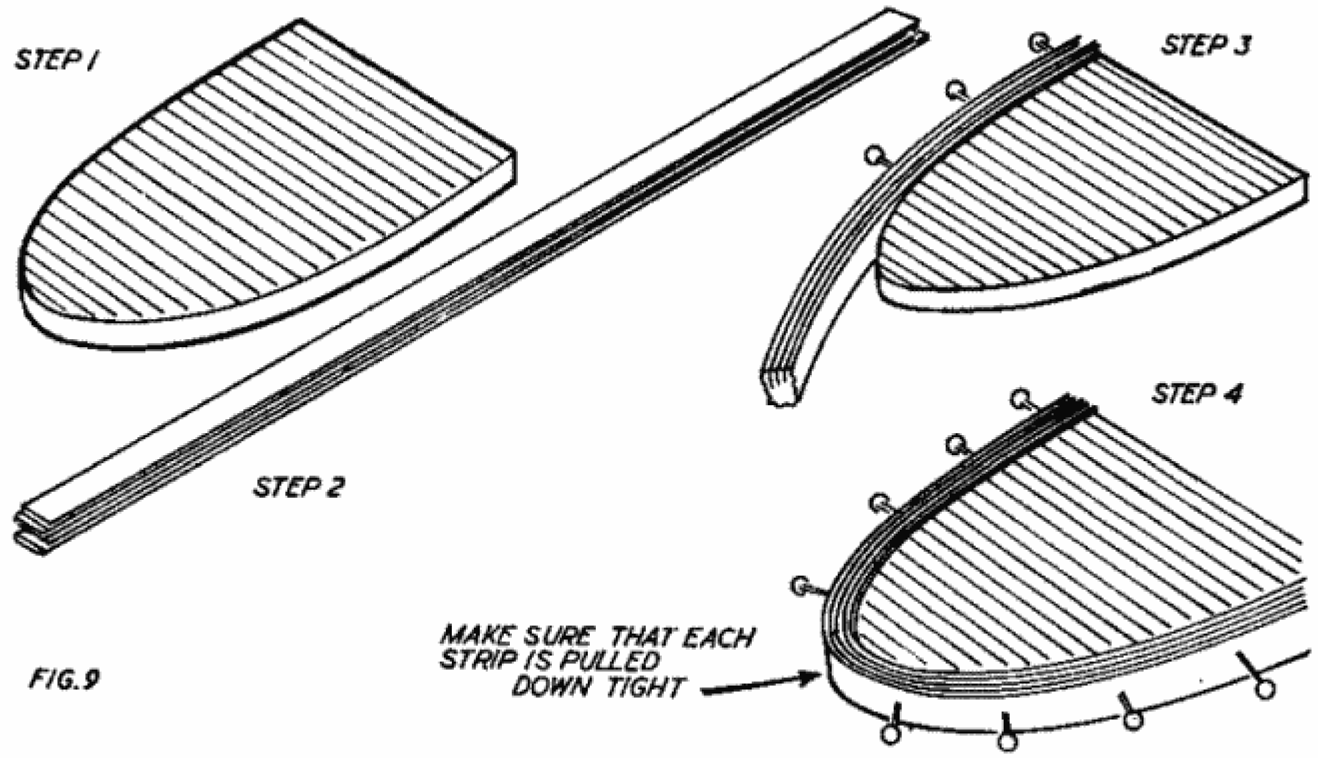


FIG. 9

Where identical pairs of laminated outlines are to be produced—*e.g.* a pair of wing tips—these should be made as one, and subsequently cut down the middle to separate. Strip width for laminating must therefore be equal to twice the actual section thickness, plus an allowance for the cut to separate them, plus a further allowance for cleaning off. A generous allowance will be two and a half times the *finished* section depth required—Fig. 8—but this can be reduced a little if preferred and you can be sure of making an accurate cut to separate the laminate into two matched pieces.

Suitable adhesives for laminating are balsa cement, casein glue or UF resin glue (the latter two types being standard woodworking glues). Balsa cement is suitable for making small laminates, but UF resin is usually to be preferred, although taking longer to set. It also has a further advantage in that it is a water mixture and the wetting the strips receive in applying the glue will assist in bending them.

A pattern is needed around which the laminate is to be formed. This is best cut from fairly thick balsa sheet, if the size is not too large, cut to the exact inside outline shape required, carefully smoothed down and the edge then well wax-polished by rubbing with a candle. All of the strips for the laminate should then be individually glued and stacked one on top of the other, ignoring any extra layers for the moment (*i.e.* additional strips to be used to build up a trailing edge width.

Now pin the stack of glued up strips in place at the starting point on the pattern. Rest the pattern on a suitable flat surface and pull the strips around the curve, making sure that they are kept in close contact with the contour of the pattern and that all strips are pressing tightly against each other. Pin at intervals, as necessary, until the whole laminate has been formed. Working on a flat surface the bottom edge of the laminate will be flat and true. Follow the basic stages in Fig. 9. If additional strips are required, these are added after completing the main outline, again making up the additional strips as a separate stack, each strip coated with adhesive, and then pinning up in place. Now leave until the laminate has set completely—overnight if using UF resin and at least four or five hours if using balsa cement.

Before removing the laminate from the pattern sand both top and bottom surfaces perfectly flat and true. These will then represent finished surfaces which will require little or no reworking when finally assembled. It is far easier to do this at this stage than when a wing tip has been added to a wing frame. Then cut the laminate down the middle using a fine saw to separate into the pair of identical parts, if necessary. From then on the laminate can be treated as any other piece of solid balsa for trimming to fit and cementing in place to the rest of the structure.

Where the laminate is large and it is not convenient or economic to use a solid sheet balsa pattern, it can be laid out around a jig of pins, as shown in Fig. 10. There is, however, the distinct possibility that the pins will kink the inner strip on the sharper bends, so to overcome this set the pins up on an outline one strip thickness in from the final inner outline required and use a spare strip length as the first layer which is *not* glued up when making the stack of laminates. This strip is then removed and discarded when the laminate is finally removed after setting. It will probably have stuck in places, but can easily be trimmed away as necessary. Alternatively the strip can be rubbed with a candle in the first place to prevent it from sticking.

Faults which are likely to occur in making laminates are invariably "material" or "technique" faults, which may be summarised as under:—

(*i*) **Strips crack when bending to shape around the pattern**—the usual cause being that the wood selected for the strips is too rigid, or the thickness of the strips is too great for the radius of bend attempted. To check the suitability of a strip for bending, try bending dry without adhesive around the pattern first. If satisfactory, other strips cut from the same sheet should make a suitable laminate. If the strip cracks, try to select a more "bendable" piece of sheet, or use a thinner sheet for the strips.

(*ii*) **Separation of strips on the final laminate.** This can be caused by a variety of reasons:

- (*a*) Glue drying before the strips are set up in place on the pattern—usually only applicable when using balsa cement.
- (*b*) Insufficient glue—leaving dry spots in the laminate.
- (*c*) Wrong glue mixture—such as too much water, again leading to dry spots.
- (*d*) Failure to keep all strips in the laminate tightly pressed against each other in bending to shape—this allows gaps to develop, producing a break in the glue line.

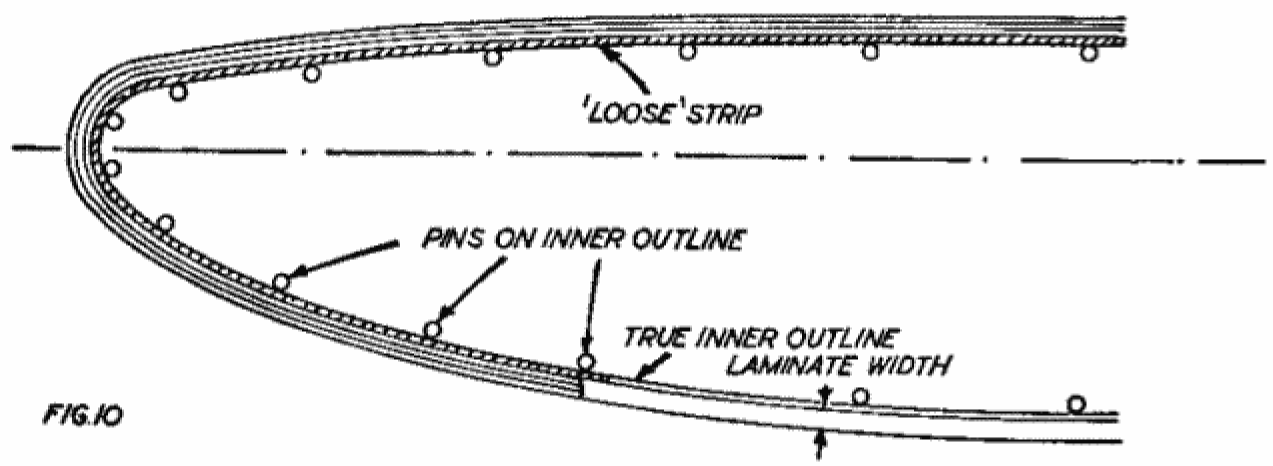
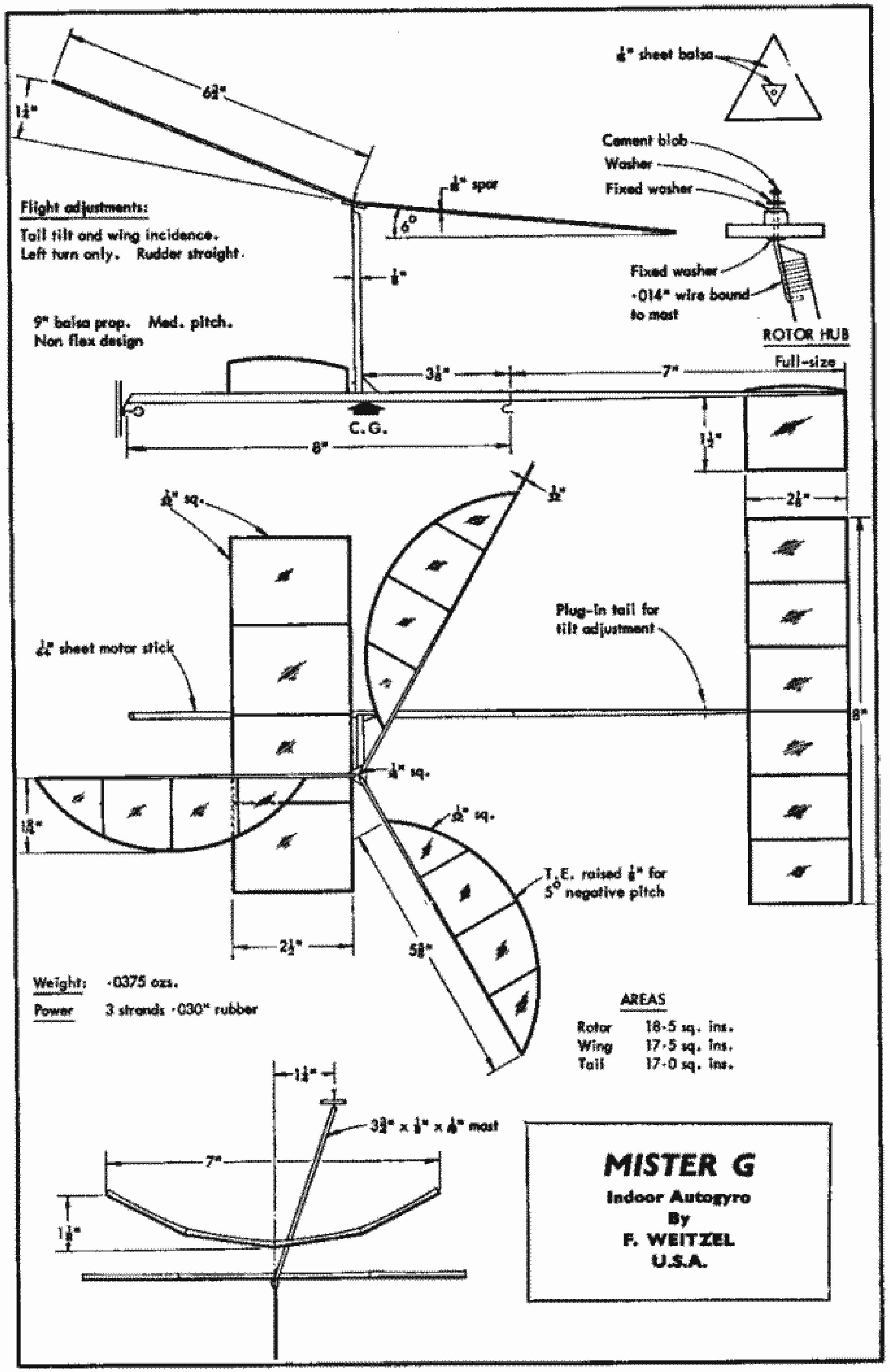
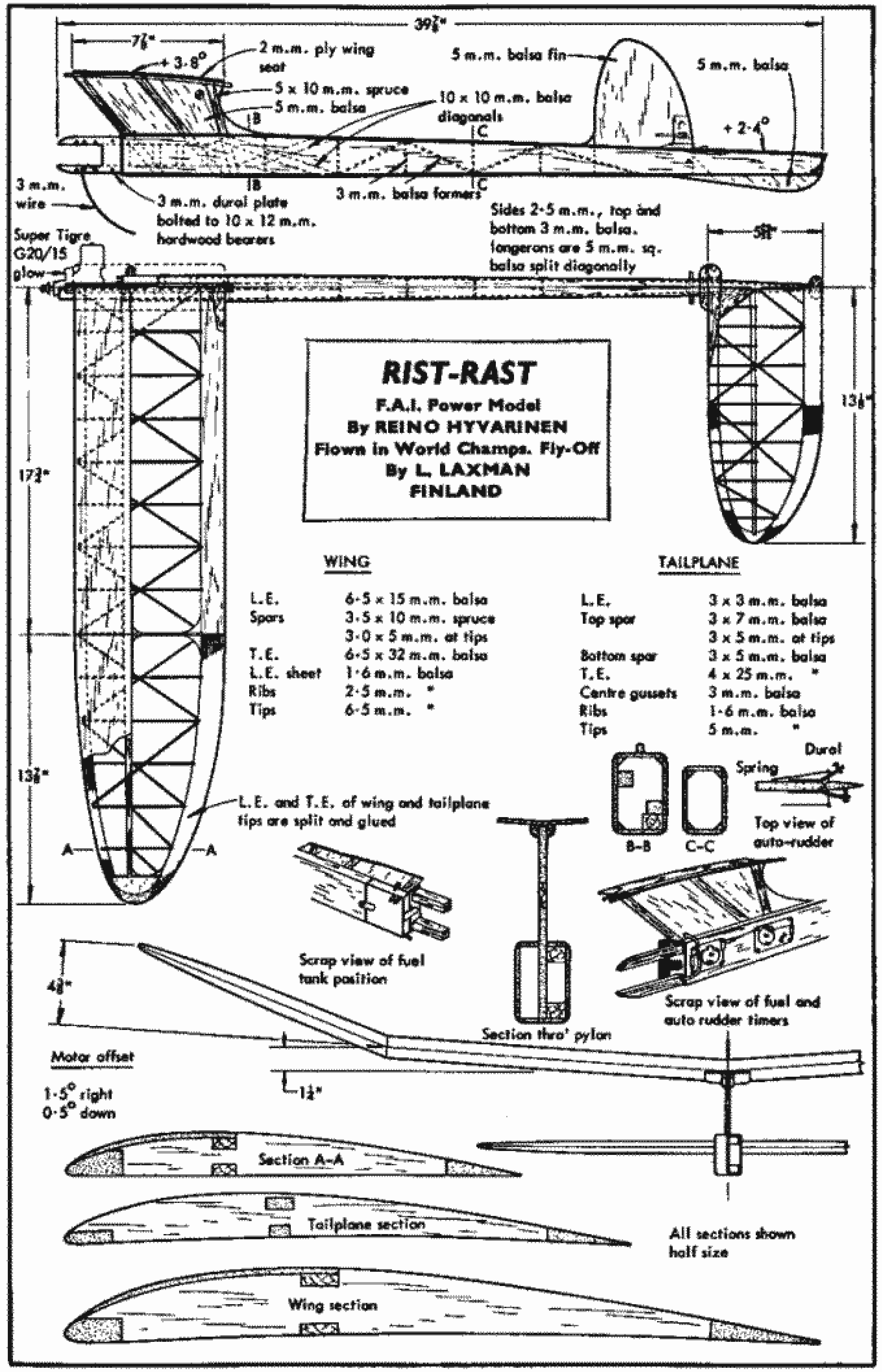


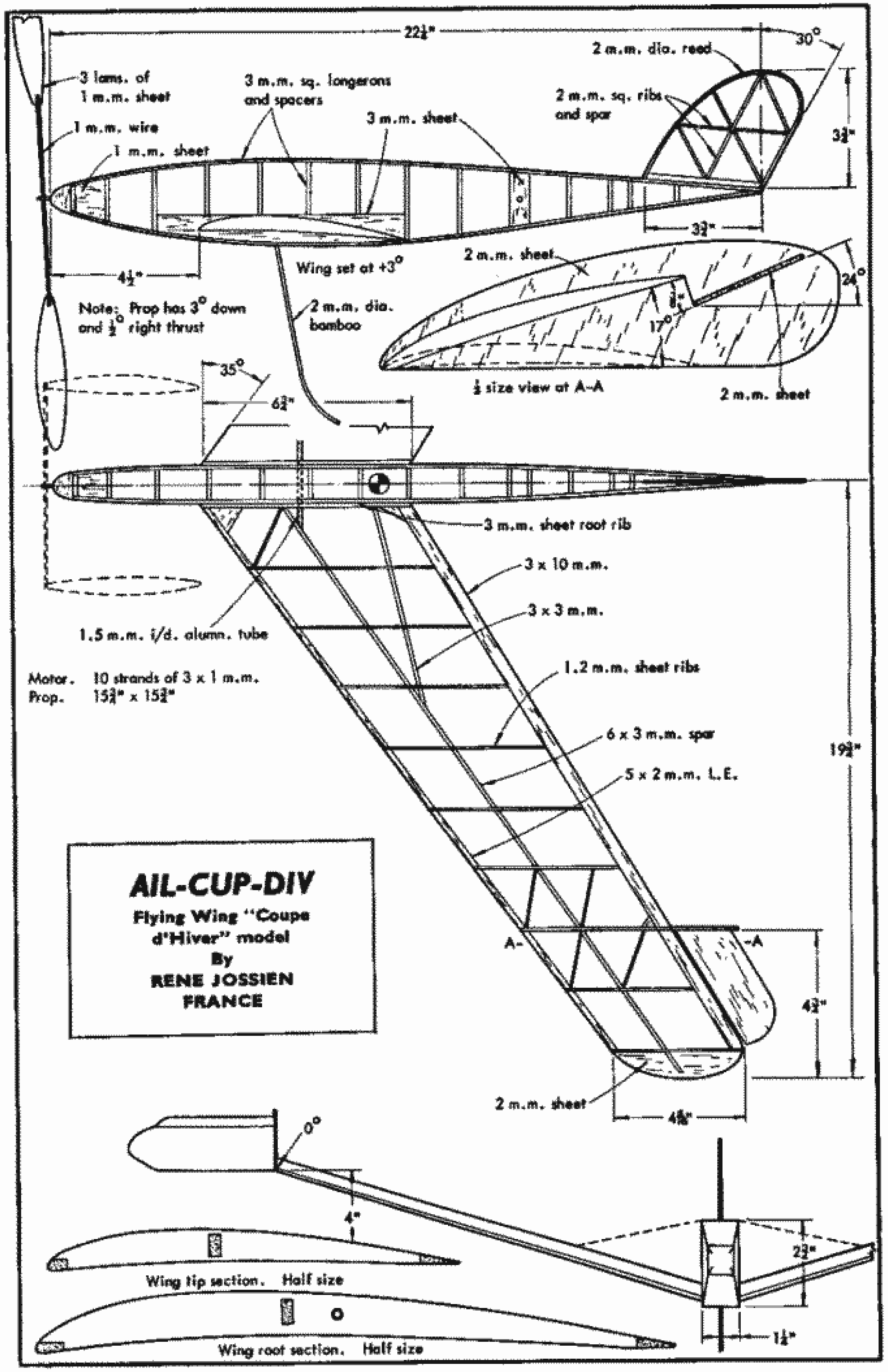
FIG. 10



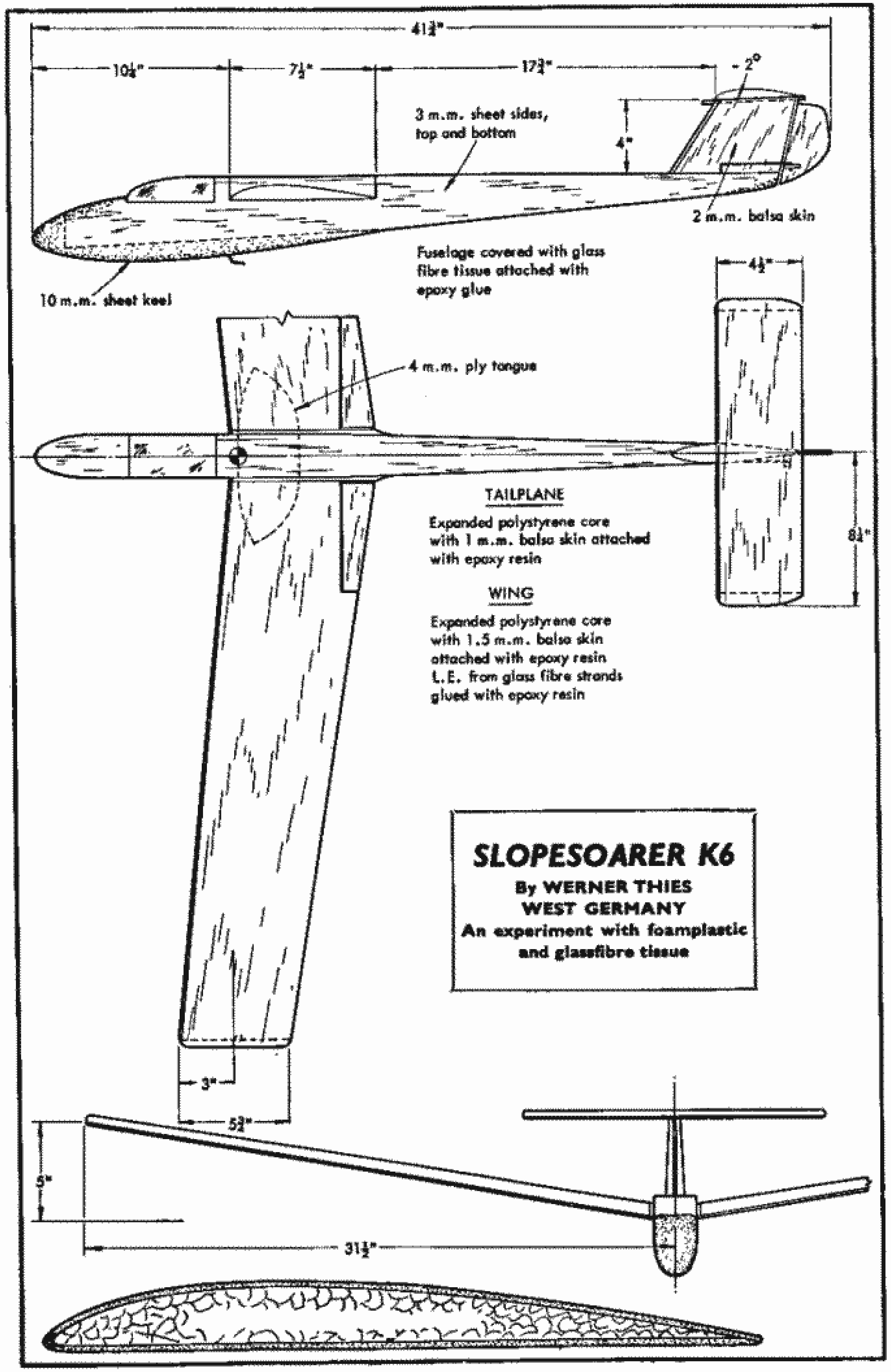
INDOOR NEWS & VIEWS, TEXAS, U.S.A.



ILMAILU, FINLAND



NEWSLETTER, FRANCE



AERO REVUE, SWITZERLAND

MODEL ADHESIVES

THE traditional aeromodelling adhesive is Balsa cement which, in its original form, comprised simply a solution of cellulose nitrate (celluloid) in acetone or some other suitable solvent and was available as a quick-drying general purpose adhesive before balsa became a standard material for model aircraft structures. Balsa cement, or cellulose cement as it is more correctly termed, has been considerably improved in properties by the addition of resins to add strength to the glue line, and remains a general purpose adhesive for woodworking as well as a standard Balsa cement. As such it is an adhesive sub-type rather than a specific formulation, for the properties of different Balsa cements may vary considerably Choice may be dictated by preference, or necessity.

Balsa cement is an excellent adhesive for most porous, non-greasy surfaces. Wetting characteristics, or ability to penetrate below the surface of the materials to be jointed, are good with balsa, but tend to be less satisfactory in the case of hardwoods, although this is less noticeable (or such a limitation entirely overcome) with the resin-reinforced or "strong" balsa cements. At the same time, however, these "strong" balsa cements may show other limitations, such as slower setting time or high contraction on setting. The latter property would preclude their use on very light or fragile structures as cement joints may pull ribs, *etc.*, out of line when set.

Very quick drying balsa cements, based on the use of a highly volatile solvent, were at one period widely used for rapid field repairs, *etc.*, producing a "hard" joint in a matter of a minute or so. The faster drying the cement, usually the weaker the glue line when set, although this is not an invariable rule in the case of balsa. Another limitation of the rapid drying cements was a tendency to blush or produce a white glue line due to "chilling"—a tendency which was aggravated if the atmosphere was at all damp. Modern balsa cements are free from this defect and the majority are moderately fast drying rather than very fast. All have a superior performance to the original straight celluloid acetone mixture.

Apart from its capability of producing a strong and rapid drying bond with balsa, cellulose cements have the advantage of being "sticky" so that parts glued up will hold in place without the joint being subject to pressure (although clamping the joint by pinning is recommended where necessary), and are also gap-filling to a certain extent with a non-brittle glue line stronger than the wood. A tightly clamped joint is not always good with Balsa cement since the bulk of the cement may be squeezed out of the joint, leaving only a very thin even incomplete joint line. If a joint is tightly clamped, *e.g.* the shape of the frame is such that the member being glued in place will be in compression, double-cementing is recommended.

Double-cementing simply means that the joint areas (both joint surfaces) are thinly coated with cement which is allowed to dry, and the joint then completed by recoating the joint with fresh cement and bringing the two parts together. In practice, the simplest way of doing this is usually to lightly coat the joint with cement, bring the two parts together and then part them. Leave apart for a minute or so to give the cement a chance to set, re-cement and complete the joint. All critical joints in balsa structure—i.e. those which are subject to loads tending to "break" or pull the joint apart should be double-cemented for maximum strength.

Double-cementing should also be employed when using balsa cement to joint hardwoods, or hardwoods to balsa. Not all balsa cements are suitable for jointing hardwoods, but the strong balsa cements are capable of giving excellent results.

One of the limitations of balsa cement is that where a large area has to be cemented up—*e.g.* leading edge sheeting on a wing—the cement first applied to the joint area may already have started to harden and set by the time all the joints have been coated with cement, and before the two parts have been brought together. This means working quite rapidly when applying the cement, and using a moderate-speed rather than a fast-drying cement. Many modellers prefer to use one of the other types of modern adhesives for this class of work because of the longer "shuffling time" they provide.

Another basic limitation of balsa cements is that they are not fully waterproof. This is seldom likely to prove troublesome on balsa aircraft structures. However, the use of balsa cement to attach a ply skin to a model boat hull is usually quite unsatisfactory, unless the hull is subsequently sheathed for protection. Joints on cemented skin panels, etc., will tend to open up after a period of immersion in water, leading to leaks developing.

Actually cellulose *nitrate* cement (the usual kind) is less waterproof than cellulose *acetate* cement, but the joint strength of the former is usually better under normal applications. The latter is sometimes specified as a "waterproof" balsa (or cellulose) cement, which is not strictly true. At best it can be classed as "water-resistant". No cellulose cement is fully waterproof, although those heavily reinforced with resin may be more water-resistant than others. Fortunately this is not a problem which is critical with aeromodelling constructions.

Numerous other adhesives are also produced as "cements"—*e.g.* plastic cement and Perspex cement—consisting of a solution of a particular plastic in a suitable solvent. These are special purpose cements, intended *only* for jointing the particular plastic which forms the base of the cement. They are generally unsuitable for use with other materials. Thus polystyrene cement (basically styrene plastic dissolved in a suitable solvent) is usable only for gluing up polystyrene plastic mouldings; Perspex cement for jointing Perspex, and so on. Balsa cement is quite useless for gluing these materials. On the other hand, being a cellulose cement, balsa cement is the correct adhesive for jointing cellulose acetate plastic (the original material used for plastic model kits, but now mainly confined to small mouldings for toys).

Most of the thermoplastic materials have their own particular cement, which can be made by dissolving scraps of that plastic in a volatile solvent. Scraps of polystyrene dissolved in carbon tetrachloride (*e.g.* Thawpit) will produce a polystyrene cement. Scraps of Perspex dissolved in chloroform will produce a Perspex cement. Proprietary "plastic" cement (*i.e.* polystyrene cement) may, however, contain other additives to prevent "stringing" and make the cement cleaner to use.

Some plastics can be jointed merely by use of a suitable solvent. This is applied to the surfaces to be jointed and turns them sticky by its solvent action. The parts can then be pressed together and allowed to set (by drying off of the solvent). The result is a clean, welded joint as strong as the plastic material, if the joint is properly made. This is a method of producing the cleanest joints with polystyrene plastic mouldings, using carbon tetrachloride instead of plastic cement. It has to be done with care, however, for solvents are very "runny" and if allowed to run over the surface of the moulding will attack and damage the moulding.

A number of other thermo-plastic materials are less amenable to glue jointing with an appropriate cement, although some may be bonded by modern multi-purpose rubber-base adhesives. Materials like PVC and nylon have their corresponding adhesives. Polythene is quite "unglueable" because of its greasy nature.

Cements are quite useless for gluing thermoset plastics, about the only exception here being that polyester resins are a satisfactory adhesive for gluing to glass fibre mouldings. Virtually all the other thermoplastic materials are unaffected by solvent action of any adhesive and can only be bonded satisfactorily by using one of the modern rubber-base "contact" adhesives, or an epoxy resin.

The traditional evil-smelling woodworking glue of animal origin is now obsolete, although tubed glues of this (and fish origin) are still used to a limited extent. Although one of the least waterproof of all adhesives, such glues can produce strong joints in wood for reasonably "dry" services. In the pre-balsa days, glues of this type were used for jointing birch and spruce structures, usually reinforced with a small brad or pin.

The first development in woodworking glues was the introduction of casein glues—a synthetic resin in the form of a white powder which was mixed with water when required for use and then set hard in a reasonable short period of time. Besides being the first of the synthetic woodworking glues, casein adhesives were the first of the "non-sticky" types—a characteristic maintained in most modern synthetic resin adhesives. By this we mean the glue itself when applied had very little stickiness, so that parts had to be clamped or held together until set, the bond only being developed by the setting of the glue line. It took a long time for people to accept that the "stickiness" of a glue as first applied to a joint was no measure of its strength when set.

Casein glues were used to a limited extent in aeromodelling in the days when laminated balsa structures were popular, the slower setting time and the fact that it could be used with wet balsa being specific advantages for this type of work. Casein glues are not waterproof, however, and have thus largely been replaced by the modern synthetic resin adhesives with even better joint strength and excellent water-resistant properties. Thus whilst casein glues are still produced, there is little virtue in using them rather than a modern woodworking glue for "wet" applications or for producing maximum strength joints in hardwood assemblies.

Urea formaldehyde resin is the main modern woodworking glue in the form of a two-part mixture comprising resin and hardener. This is produced both as two separate constituents—*i.e.* resin and hardener— which become activated as soon as they are mixed together and set hard in a matter of an hour or so. Once mixed, therefore, they must be used at once as they have only a limited pot life. Equally, one should mix up only that amount of adhesive required for use as any left over will set hard and be wasted.

The more convenient form of UF resin for general use is a powdered mixture of resin and hardener which is inactive until mixed with water to form the final adhesive solution. This is commonly referred to as a "one-shot" adhesive. Properties and joint strength are virtually the same as a two-part mixture, provided water is added in the specified proportions, despite the fact that many people think that a two-part mixture must be stronger.

Once a UF resin mixture has been activated (*i.e.* by mixing the two separate constituents or activating a powder mixture with water) it starts to "cold cure" and turn into a solid thermoset plastic. Setting time is influenced by the ambient temperature, and also controlled to some extent by the type of hardener. Glues of this type are not suitable for use in ambient temperatures below about 50 degrees F because setting time will be very long and the cure possibly incomplete. Shuffling time (*i.e.* the time available during which the joint can be "adjusted") and setting time decreases rapidly with increasing temperature—see Table 1.

A one-shot UF resin is a very useful addition to any model workshop, although only having limited application for aeromodelling work. It is a better adhesive than a strong balsa cement for jointing hardwood bearers to ply bulkheads, and also for gluing up laminated constructions in balsa. For other airframe jobs it is not as convenient to use as balsa, nor does it offer any particular advantages as regards strength. For model boat construction, however, particularly with hardwood frames and ply skinning, UF resin adhesives are more or less standard.

As a point of interest, UF resin adhesives are not *fully* waterproof, although their performance in this respect is normally more than adequate even for "immersed" applications—*e.g.* UF resins are standard for full size ply-skinned boat construction. Phenolic resins are fully waterproof, but these are suitable only for curing under heat and pressure (these are used for the manufacture of plywood). Resorinol resins, which are cold curing, are also fully waterproof and also gap-filling to a certain extent, whereas UF and phenolic resins are not.

A quite different type of adhesive which has come to the fore during recent years for woodworking joints and general purpose applications is PVA (polyvinyl acetate). PVA is, basically, a solid vinyl derivative which is soluble in many common solvents such as acetone, butyl acetate, toluol, etc.; but produced in the form of a general purpose adhesive is normally compounded as an emulsion in water. The result is usually a fairly thin white runny "paste" with no initial stickiness but a final joint strength which completely belies its initial rather umpromising appearance. Such emulsions are, however, capable of embracing a wide range of solids content, particle size, viscosity, plasticiser content, etc., and so a "PVA" adhesive is really a "family" description rather than a specific formulation. Some are less satisfactory than others as adhesives.

PVA can be employed as an alternative to balsa cement for all airframe construction, being equally good with balsa and hardwoods, and is very clean to use. It does not stain the wood and excess glue can readily be wiped off before it has set without leaving any residue or mark. Many modellers now prefer PVA adhesive to balsa cement, particularly for the construction of larger models with a high proportion of sheet balsa in the assembly, and for applying sheet covering. PVA is also suitable for gluing up expanded polystyrene foam mouldings or attaching tissue covering to the surface of such mouldings.

PVA is another of the "non-sticky" adhesives and all joints must be clamped up in contact to ensure a satisfactory bond (*e.g.* using pins, etc. to hold sheet covering in place in the usual manner). "Rubbed on" joints are quite satisfactory without clamping in the case of gluing reinforcing blocks, fillets, etc., in position. Drying time is considerably longer than with balsa cement—12 hours is the usual minimum to leave assemblies clamped up or pinned down—but the resulting joint strength is at least comparable to, and often better than, balsa cement joints. PVA joints dry absolutely clean with complete absence of staining or "tearing" so that a PVA bonded airframe is free from the hard nodules and fillets of excess adhesive common when using balsa cement.

Unlike the other synthetic resin adhesives, PVA is a thermoplastic which never sets "brittle hard" and so retains a certain amount of flexibility which enhances, rather than reduces, the bond strength. The bond is, however, weakened at higher temperatures (*e.g.* a maximum service temperature of 160 degrees F is typical, above which the bond is weakened). Also PVA is not a waterproof adhesive. In fact, its resistance to water is very little better than animal or vegetable glues. However, no limitations have shown up in this respect for aeromodelling work (except that one would not select PVA for a seaplane or flying boat), although lack of water resistance makes it unsuitable for model boat construction.

Since PVA does not "cure" like the other synthetic resins it does not suffer from a limited pot life, although some skinning or drying out may occur in a partly used jar. Stock jars also should not be kept where they might be subject to freezing temperatures as if a PVA emulsion freezes it may suffer some loss of properties on thawing out again. This is not a characteristic of all PVA adhesives. Some can undergo freeze-thaw cycles without suffering any ill effects.

A further group of cold-curing synthetic resin adhesives which have a limited application for aeromodelling include those with the property of being able to key to non-porous as well as porous surfaces which, together with a high glue line strength, enables very strong glued joints to be produced with normally "unglueable" materials such as metals, glass, etc. The two chief types are the epoxy resins and the polyester resins, the latter better known as the resin normally used for the making of glass fibre mouldings and laminates. Both types are invariably supplied as two-part materials for cold-setting use comprising separate resin and hardener, which, like the other synthetic resins, have limited pot life once mixed. Epoxy resins are, however, also available in resin form only for curing under heat and pressure.

The epoxy resins are suitable for bonding metal to metal (*e.g.* taking the place of mechanical fasteners in the fabrication of an aluminium case for radio control gear), metal to wood (*e.g.* hardwood motor mounts to a metal firewall), laminated plastic components to other materials or to the same material, and so on. Although a relatively expensive adhesive, resin and hardener are usually supplied in a fairly solid paste form so that there is no volume loss on mixing (as with powdered resins).

Polyester resins have more limited application, although they key admirably to clean metallic surfaces and may be particularly useful for applying a gauze (or glass fibre tape) binding over metallic and other fittings. Adhesion to woods is, however, not always as good as with other adhesives, particularly woods with a hard, smooth surface (like plywood). Polyester resins mixed with fillers are, however, the basis of "fillers" for automobile repair work (*e.g.* filling in dents in metal work) and have a variety of uses in modelling for detail construction or the addition of fillets to reinforce metal fittings, etc., fastened to wooden members. Polyester fillers set "metal hard" and so the surface can only be worked with a file or by grinding once set. They should not be used to fill in dents in wood surfaces as it will be impossible to flat off properly once set. An ordinary soft cellulose-base filler—*e.g.* "Polyfiller"—is much better for this sort of work.

The variety of other "general purpose" and "specific purpose" adhesives now offered on the domestic and "do-it-yourself" market is now so vast as to be confusing. Few, however, have any specific application to aeromodelling, except

for some of the rubber-base adhesives. The so called "impact" adhesives (actually a "contact" adhesive) are used by some modellers for attaching sheet covering to wings, etc., although this would appear to offer no advantage over PVA for this application, and some possible disadvantages. Resin-reinforced rubber solutions are excellent for attaching metallised paper or metal foil coverings to sheet structures. Both "contact" adhesives and normal rubber-resin cements are suitable for attaching foam rubber insulating pads to fuselage sides or bottoms.

Another recent use for "contact" adhesives is the bonded mounting or R/C servos, where the servo is bonded to a neoprene rubber pad which, in turn, is bonded to the fuselage side or bottom. This form of resilient mounting has much to recommend it, provided the metal surface to be bonded is clean and grease free. The objection sometimes made that such a mount does not permit easy removal or repositioning is not valid. Using a knife blade dipped in the appropriate solvent for the adhesive, or ether, the mounting pad can readily be stripped off from the fuselage and the joint immediately remade, if required, by applying more contact adhesive to both surfaces.

TABLE I

"CASCAMITE" ONE-SHOT U.F. ADHESIVE

Temp. of	50	60	70	80
Pot Life (hours)	9	3	1-1½	¾
Clamping Time Required (hours)	18	5-6	2½-3	1½

AEROLITE 300 U.F. ADHESIVE (GBMX HARDENER)

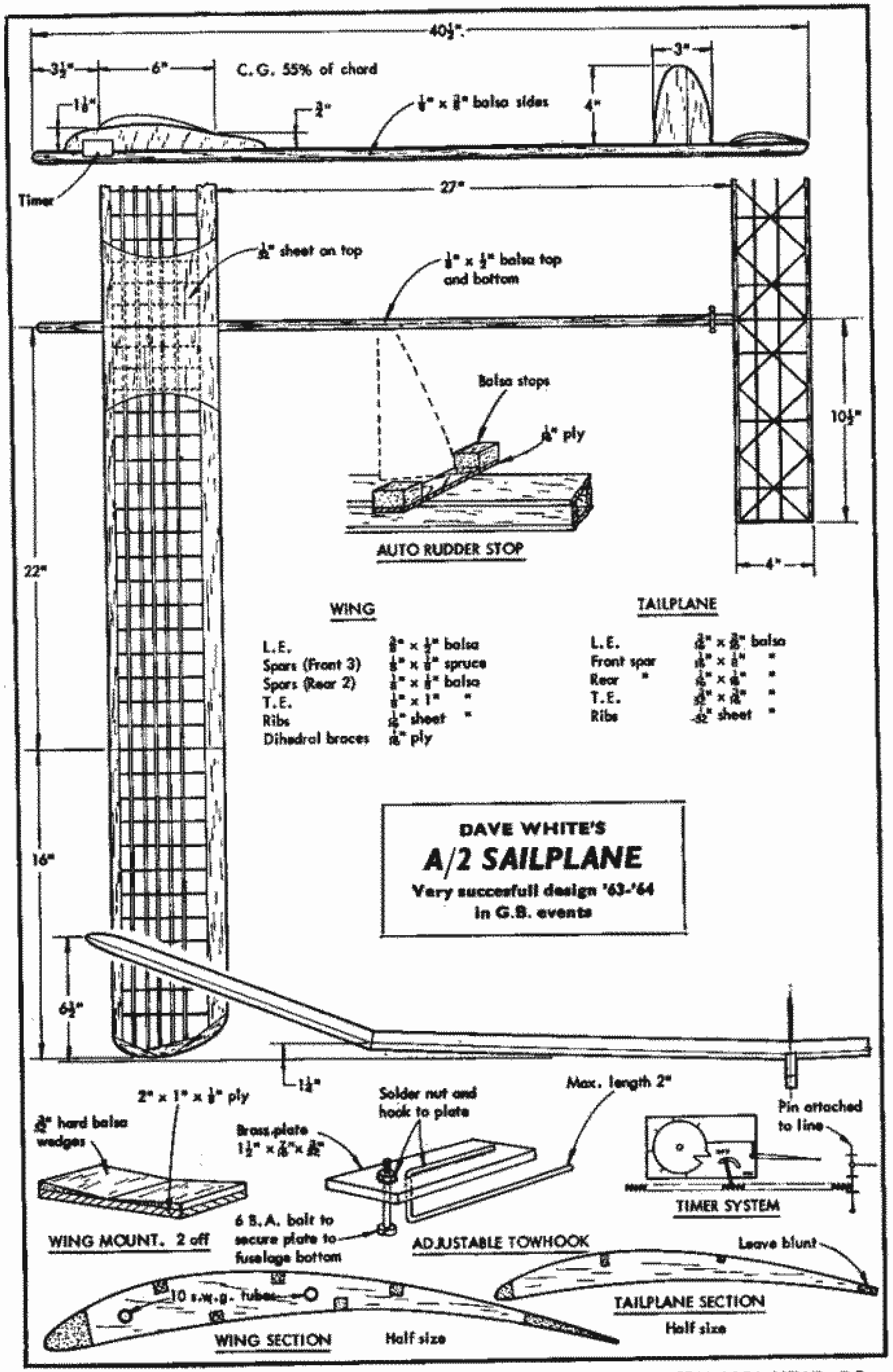
Temp of	50	60	70	80
Shuffling Time (mins.)	60-70	40	20	10
Approx. Setting Time (hours)	2-3	1	½	¼

TABLE II

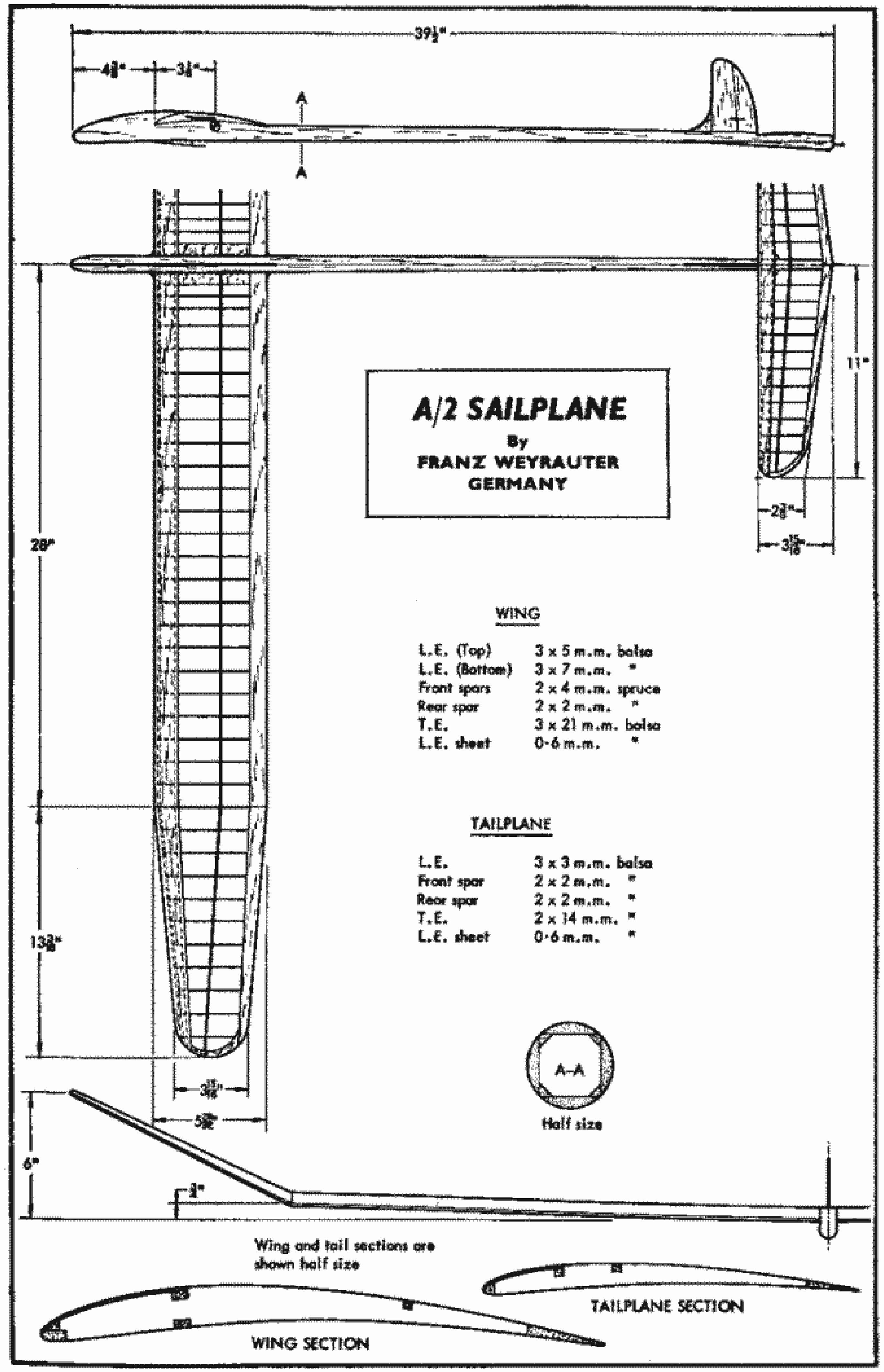
BASIC CLASSIFICATION OF ADHESIVES

I Animal	II Vegetable	III Mineral	IV Plastic/ Solvents (Cements)	V Rubber Base	VI SYNTHETIC RESINS Thermo-Plastic	VII THERMO-SETTING (a)	(b)
Albumen Casein Gelatin	Cellulose Dextrins Flours Gums Starches	Bitumen Sodium Silicate	Cellulose Acetate Cellulose Nitrate Poly-styrene Perspex PVA PVC	(*a*) Latex (*b*) Rubber Solutions (*c*) Rubber Cements (*d*) Rubber-Resin Compounds (*e*) Rubber-Resin-Vulcanising Compounds (*f*) Contact Adhesives	PVA	Urea Phenolic Resorcinol Melamine	Epoxy Polyester

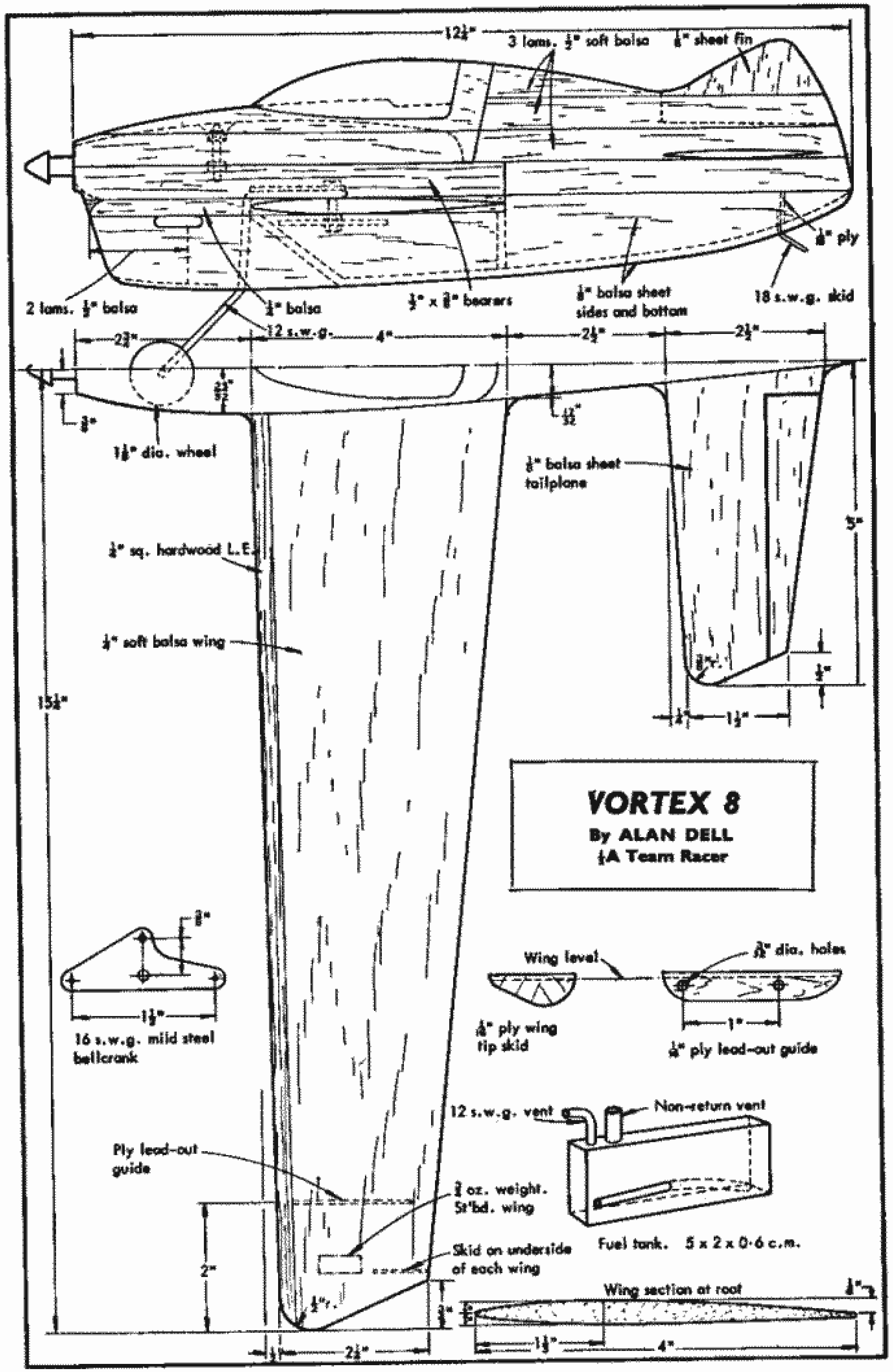
For aeromodelling purposes, the bulk of gluing requirements are met by group IV cements. PVA is not normally used as a cement, however, but in water-emulsion form (Group VI). Group II adhesives (notably dextrin pastes) are widely employed as tissue pastes. Group VIIa represent the modern "woodworking" glues; and group VII (*b*) the multi-purpose high strength synthetic resin adhesives. All adhesives in group VII are of two-part type when produced as cold-setting glues. Heat-curing resins of these types (particularly the phenolic resins) are used industrially, setting under combined heat and pressure.



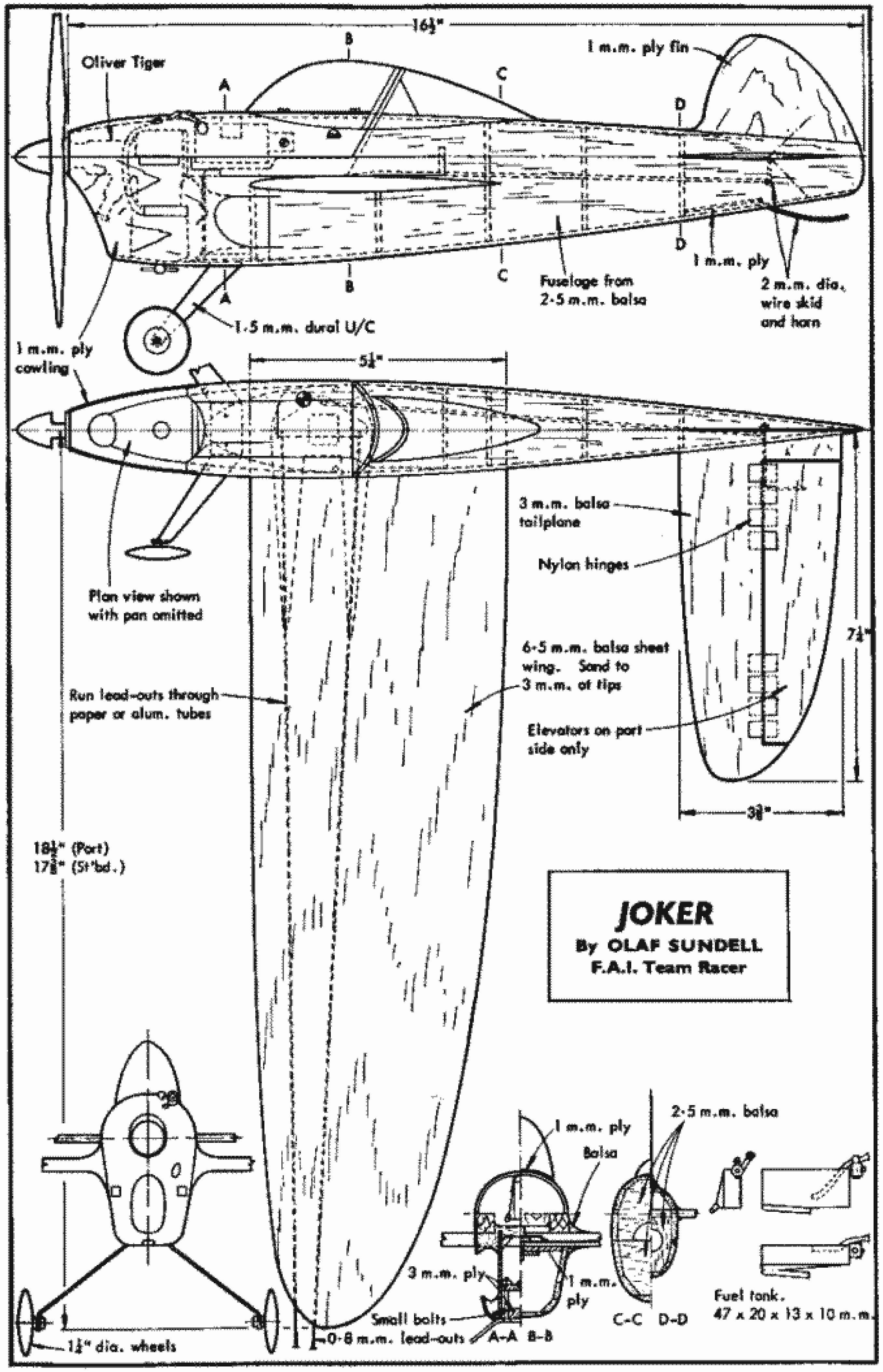
NORTHERN AREA NEWS, G.B.



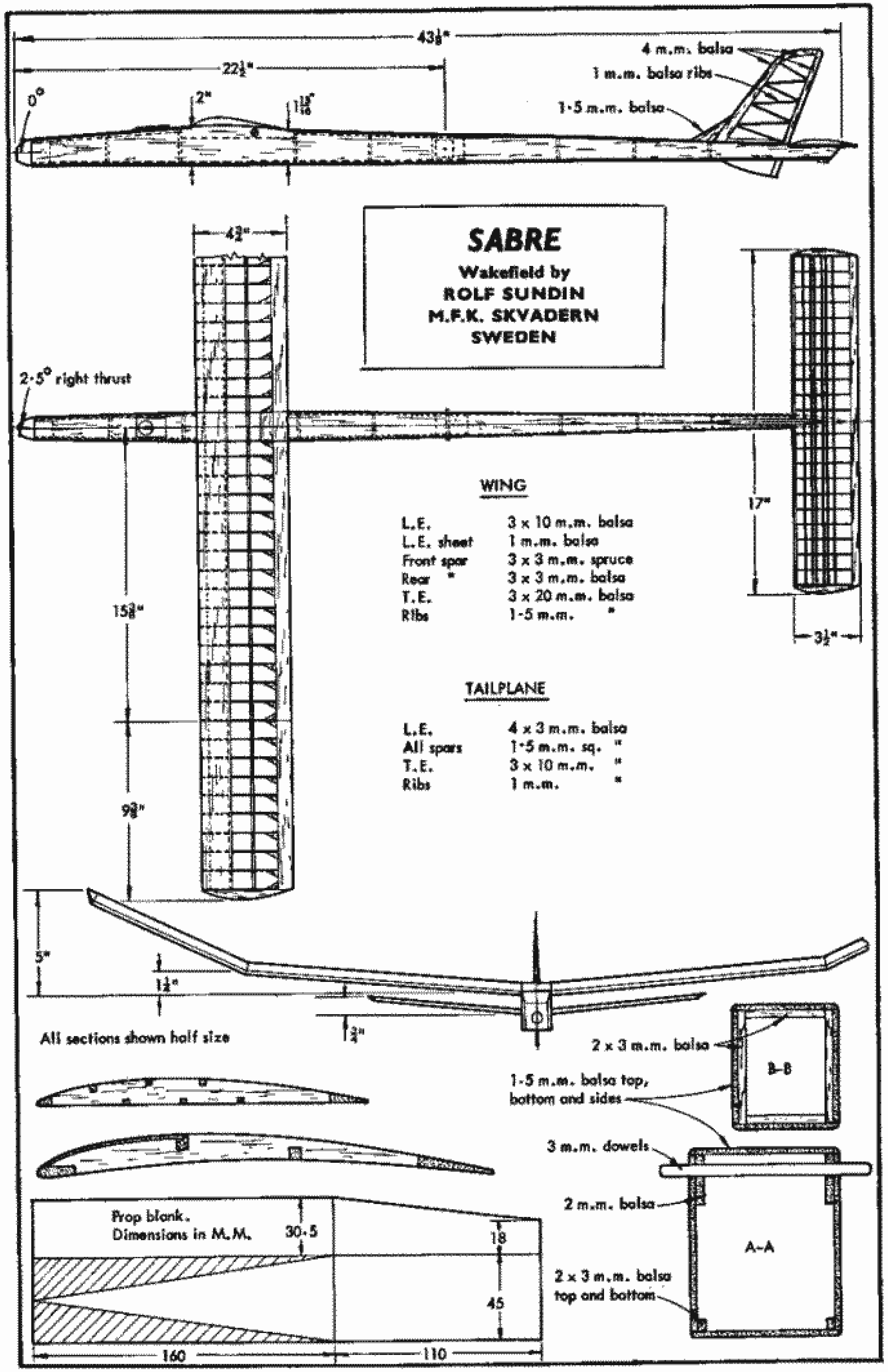
W. GERMANY



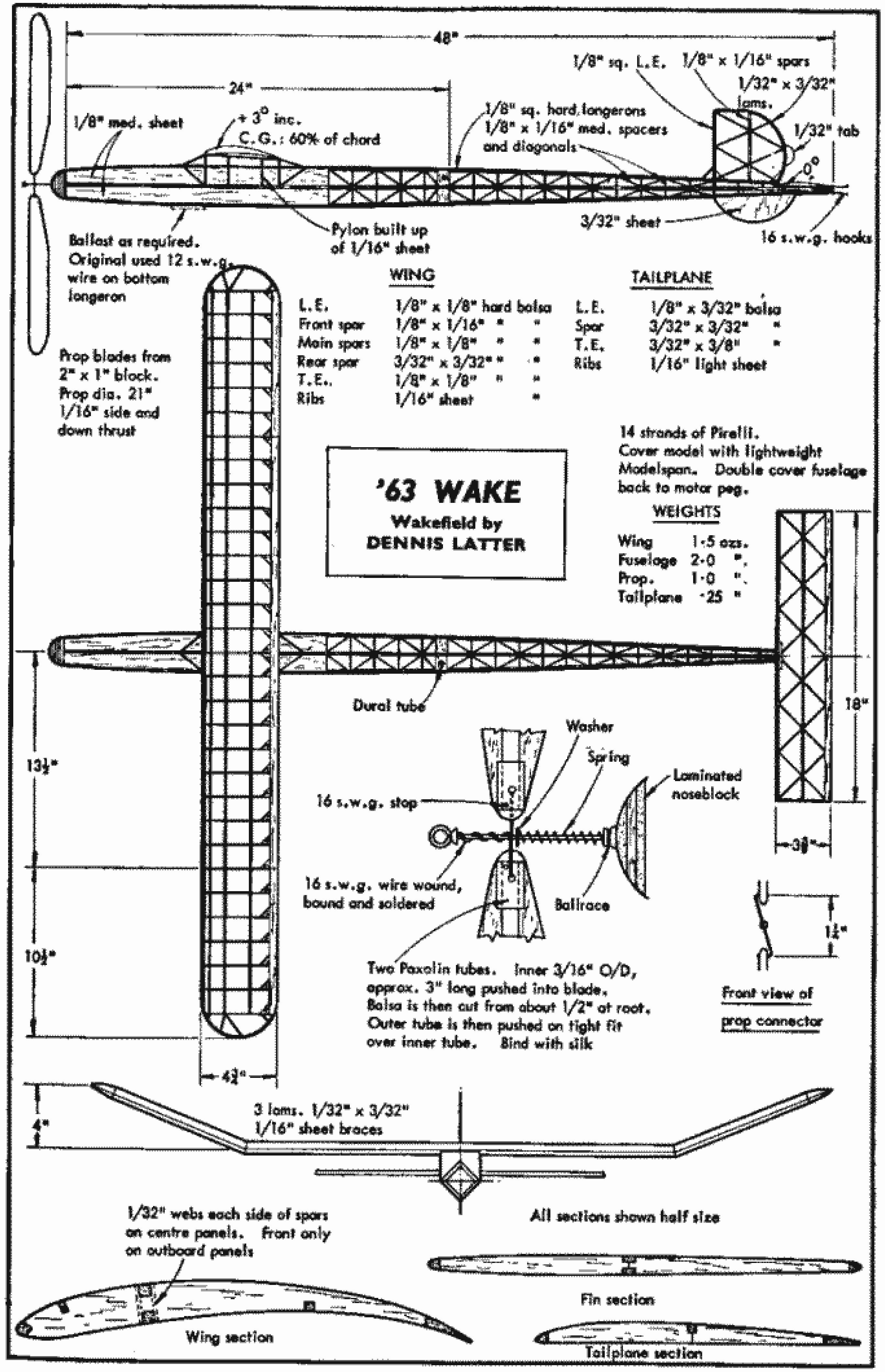
VORTEX 8
By ALAN DELL
½A Team Racer
3 lams. ½" soft balsa
⅛" sheet fin
⅛" ply
18 s.w.g. skid
2 lams. ½" balsa
¼" balsa
12 s.w.g.
½" x ⅜" bearers
⅛" balsa sheet sides and bottom
1⅛" dia. wheel
⅛" balsa sheet tailplane
¼" sq. hardwood L.E.
¼" soft balsa wing
16 s.w.g. mild steel bellcrank
Wing level
⅛" ply wing tip skid
⅛" dia. holes
⅛" ply lead-out guide
12 s.w.g. vent
Non-return vent
Ply lead-out guide
⅜ oz. weight. St'bd. wing
Skid on underside of each wing
Fuel tank. 5 x 2 x 0·6 c.m.
Wing section at root



JOKER
By OLAF SUNDELL
F.A.I. Team Racer
Oliver Tiger
1 m.m. ply fin
1 m.m. ply cowling
1·5 m.m. dural U/C
Fuselage from 2·5 m.m. balsa
1 m.m. ply
2 m.m. dia. wire skid and horn
Plan view shown with pan omitted
3 m.m. balsa tailplane
Nylon hinges
6·5 m.m. balsa sheet wing. Sand to 3 m.m. at tips
Run lead-outs through paper or alum. tubes
Elevators on port side only
18½" (Port)
17⅝" (St'bd.)
1 m.m. ply
Balsa
2·5 m.m. balsa
3 m.m. ply
Small bolts
0·8 m.m. lead-outs
1¼" dia. wheels
A–A B–B C–C D–D
Fuel tank. 47 x 20 x 13 x 10 m.m.



PROFILEN, SWEDEN



S.E.A. NEWSLETTER, G.B.

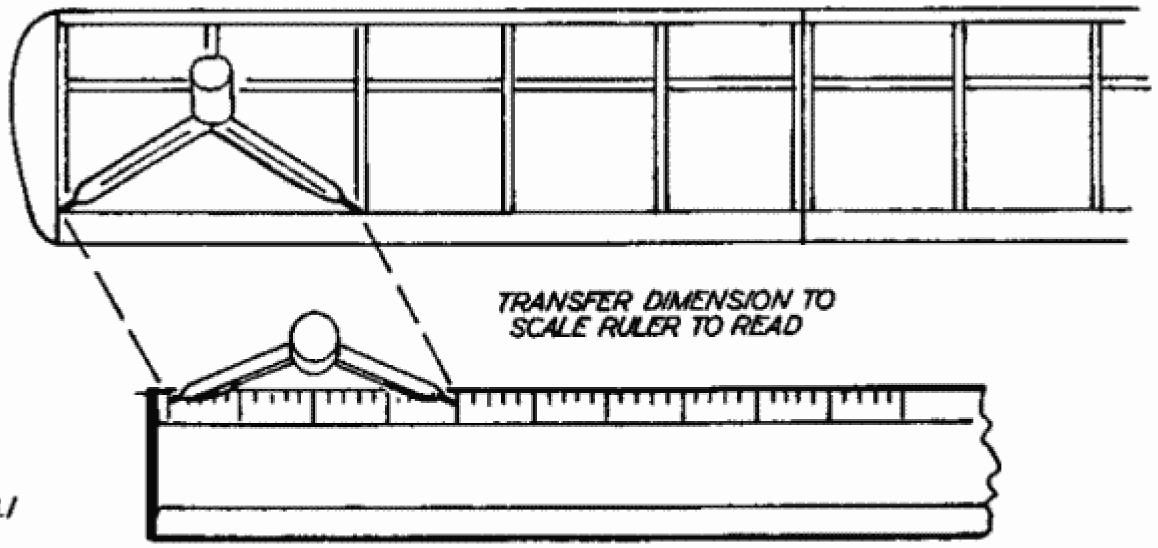


FIG. I

SCALING UP PLANS

SCALING up model plans reproduced in a magazine into full size building plans is not a very difficult job, provided it is tackled in the right manner. You do not have to be an expert draughtsman, nor have the plans got to be very elaborate. All you need is to convey *accurately* all the critical shapes, proportions and positions of vital components onto a full size working drawing. Details do not matter, as these can be followed from the reduced scale reproduction.

One of the best materials for drawing out working plans is ordinary drawing office tracing paper of fairly substantial weight. This is quite a cheap material. You can buy a 30 yard roll of it at most office equipment suppliers or good stationary shops for a little less than one pound, or shorter lengths at proportionate prices. This is preferable to using a roll of white lining paper, as often recommended, for the tracing paper is stronger for handling and, having a slightly greasy surface to start with, can be built right over when you have finished the drawing without all the wood sticking to it, so the plan can be used over and over again for building with care. If the plan is wanted to be used again it is advisable to rub over the outline positions with the end of a candle just to ensure that it does not stick to the frames.

Other requirements are a drawing board of suitable size, a T-square and a large (12 in.) 30-60 set square, plus a medium hard pencil (an HB is about the best for use on tracing paper), dividers, a good ruler or scale, compasses, and a rubber. These are essential requirements. Other instruments and sets of drawing curves may be helpful, but you can get by without them.

Now to decide the method of scaling up from the plan. There is the "correct" way of using a scale ruler which enables you to read scale dimensions directly in terms of full size dimensions; or the "factoring" method whereby dimensions on the reduced scale drawing are measured as accurately as possible and then multiplied by the appropriate factor to turn them into scale dimensions which are then laid out on the full size drawing.

The first method relies implicitly on the reduced scale plan being to an exact and standard scale—*e.g.* one quarter, one eighth, *etc.*, which is seldom the case. More than that, the fact that the reproduction may be labelled "¼ full size", or "¼ scale" does not necessarily mean that it will be *exactly* ¼ full size as reproduced. Blockmakers seldom work to tolerance of less than $\frac{1}{16}$ in. on a given overall dimension for final size, shrinkage of the plate may also take place in

processing—and editors are not always infallible in marking up drawings for correct size for blockmaking!

First point, therefore, is to check the *exact* scale of the reproduction. The best way to do this is to take the greater dimension *marked* on the plan (*e.g.* a fuselage length), *measure* this actual dimension and then divide one by the other to see exactly what the scale ratio is. Even this is not infallible, as leading dimensions are sometimes approximate, so to be absolutely sure repeat the process on another one or two plan dimensions and see if they work out to exactly the same ratio. If there is one obviously critical dimension—*e.g.* a wing chord or tailplane span, use this as the "key" for calculating the exact scale.

Even this falls down where the plan is reproduced as at reduced scale from a full size drawing which carries no dimensions at all marked on it. It is of little use using a nominal dimension, such as a stated wing span, to fix the scale accurately. The best this can be relied upon to give is a near approximation of the true scale of the reproduction. Also, remember the remarks about blockmaking and do not jump to conclusions if the scale appears to be, say ¼ full size, that it is *exactly* this scale. It probably will not be exactly so. In many cases the difference may not matter very much. In others it could mean drawing up a competition model for building which will not conform to the specification because of a slight inaccuracy in assumed or stated scale of reproduction.

Starting with no dimension on the reduced scale plan, and no indication of scale, the probable scale can usually be deducted from an examination of the drawing. Most designers, for example adopt a whole number of a ½ in. fraction for a wing chord, particularly with rectangular planform wings. Assuming a likely dimension, the probable scale can be calculated and re-checked against other component sizes. Do not, however, rely on balsa spar sizes being exact to scale—they are not necessarily drawn to absolute accuracy as regards width or thickness to start with, and the small dimension to be measured and then factored will exaggerate any error. Even stated wheel diameters cannot be relied upon to be absolutely accurate, but a stated propeller size usually is, if drawn on the plan. Failing everything else, one dimension, which is usually marked on the plan, although not necessarily drawn as a dimension is wing dihedral. This will usually be a small dimension to measure and scale up, but at least it will give a starting point as to the scale of the drawing.

If you do have to work from an undimensioned reproduction and arrive at the scale by deduction and a series of guesstimates and cross checks against likely sizes, draw up the outline only if a contest model designed to a particular specification. You can then work out areas to see that they do conform to the contest specification. If not, you will have to adjust your estimate of scale accordingly—or having got that far some people may prefer to adjust the outline to conform—*e.g.* by altering a wing or tailplane chord slightly. If the change necessary is quite small (*e.g.* involving not more than, say, a ¾ in. on the chord dimension), it is unlikely to alter the characteristics of the model.

Unless trained as a draughtsman and familiar with the use of scale rulers, the direct method of scaling by calculation is best and easiest, provided you first teach yourself how to use a slide rule for simple multiplication (which is very easy), or can already use a slide rule. This, applied to a scale or accurate ruler graduated in 1/50th or 1/100ths of an inch and a small pair of dividers will make scaling up of measurements taken directly off the reproduction easy.

It is more accurate to transfer a dimension from a plan to a scale ruler than use the ruler directly over the plan. Thus, to establish the reproduction scale from a stated dimension, use the dividers to transfer the dimension to the scale ruler, as shown in Fig. 1. Now set the corresponding figures on a slide rule—the large dimension on scale B, sliding the centre part of the scale along until the measured dimension comes opposite the quoted dimension. The appropriate factor for scaling all dimensions taken off the reproduction is then the figure on scale A coming opposite 10 on scale B. In fact, the slide rule is simply left in this position and "full size" readings read off scale A opposite measured dimensions taken off the reproduction on scale B—see Fig. 3. The only need to alter the slide rule setting is if a measured dimension comes off the end of scale A. In this case the slide must be moved along to bring the "I" on scale B in line with the scale factor, as shown in the diagram.

Since the slide rule is calibrated in decimals, all measurements taken off the reproduction must also be decimals—hence the use of a 1/50th or 1/100th inch rule. Full size dimensions are also rendered in terms of decimals, so the same scale rule is used to measure them out on the full size drawing. The only dimensions which would not be scaled in this manner are specific dimensions—*e.g.* 24 in. for a wing panel semi span, or wood sizes in inch fractions—which would simply be measured off as the specified dimensions. Apart from wood sizes, however, very few of the full size dimensions given on a plan are directly useful for laying out the final drawing, hence the need for measurement and scaling up of dimensions taken from the reproduction.

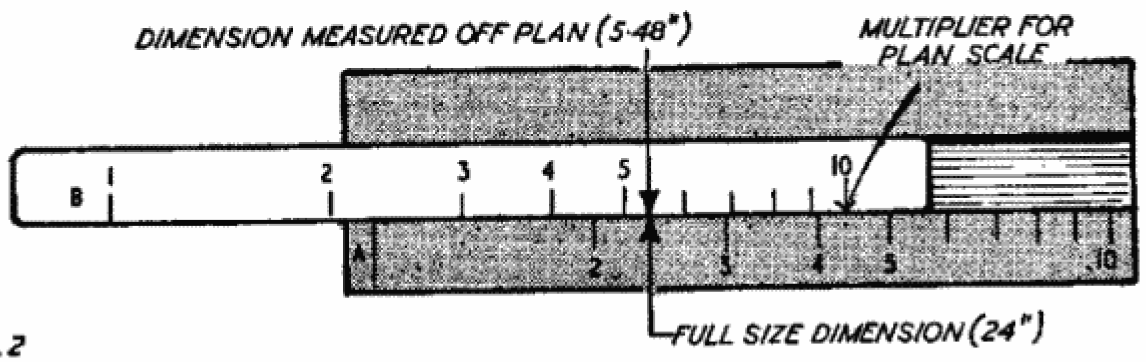
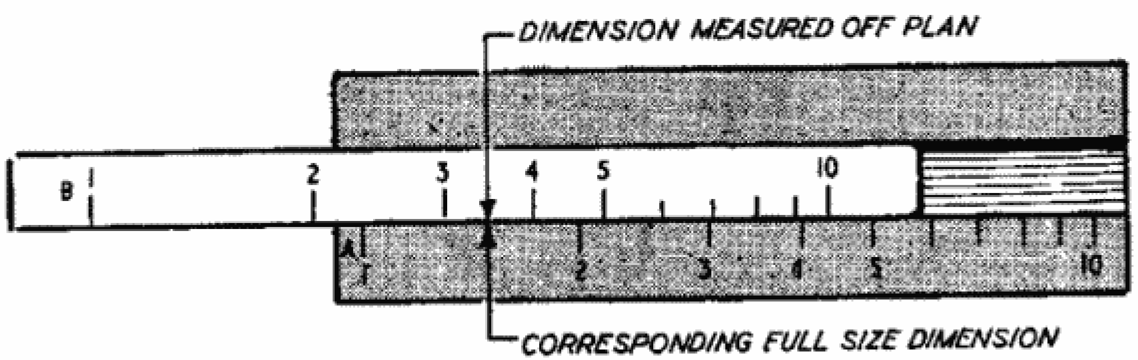


FIG. 2



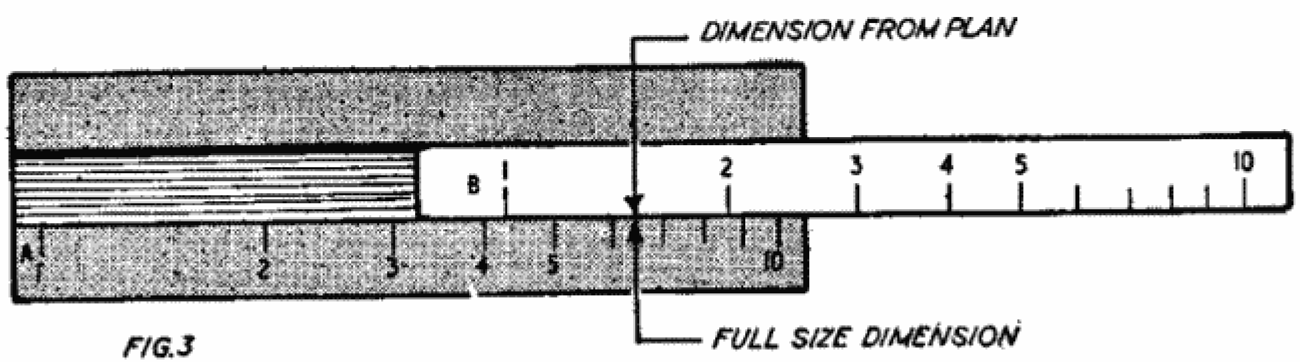


FIG. 3

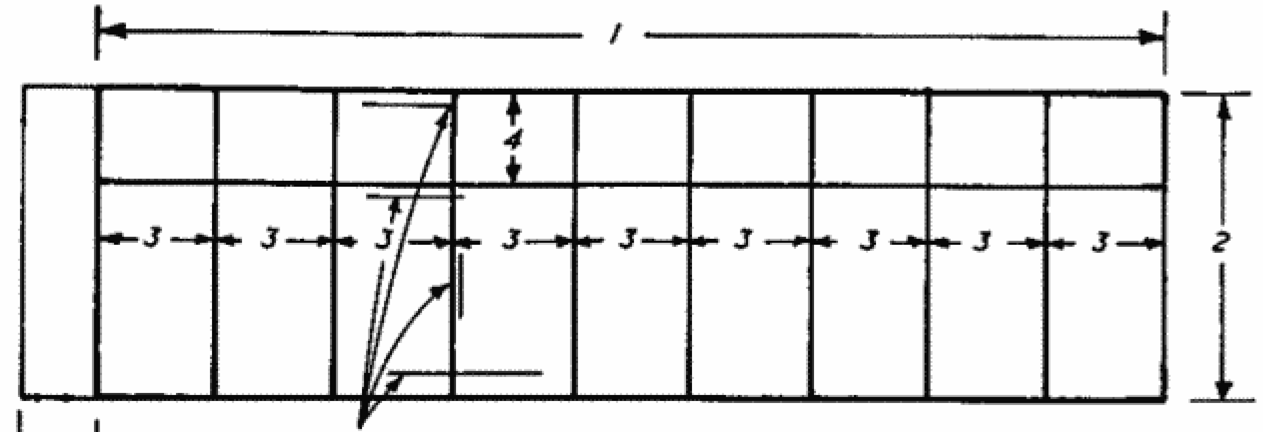


FIG. 4

After that it is a matter of commonsense application. Basically, the full size plan wants laying out as a working drawing. If the reproduction is in the form of a three-view, wings, tailplane and fuselage need drawing separately. If the reproduction is a scaled down reproduction of a building plan, this will already be done.

The wing is probably the simplest unit to draw, so start with that. Fig. 4 show a typical sequence of layout:

(1) Lay off the semi-span measurement (1) and draw two vertical lines.
(2) Lay off the wing chord dimension (2) and draw two horizontal lines.
(3) Lay off the rib spacing (3), drawing vertical lines at each rib position.
(4) Lay off the mainspar position (4), followed by any other spar positions.
(5) Lay off the tip shape (approximately) in a "box" of the correct dimension (5).

You can then complete the wing building plan by setting off the actual spar sizes, *etc.*, relative to the outline drawing you have completed.

In the case of a tapered wing the procedure is very similar—Fig. 5. First establish the semi-span dimension (1). Follow this by marking off the sweepback dimension (2) for the leading edge and draw in the leading edge. Note that you should always use a *measured* dimension for this may not work on a measured *angle*. Then proceed to mark off the root chord (3) and tip chord (4), which enables the trailing edge outline to be added. Complete layout for ribs, spars and tip as before.

Note that only a half wing panel need be drawn (unless the whole wing is to be built in one piece). The second half of the wing can either be built over the original drawing reversed, or a tracing off this drawing reversed.

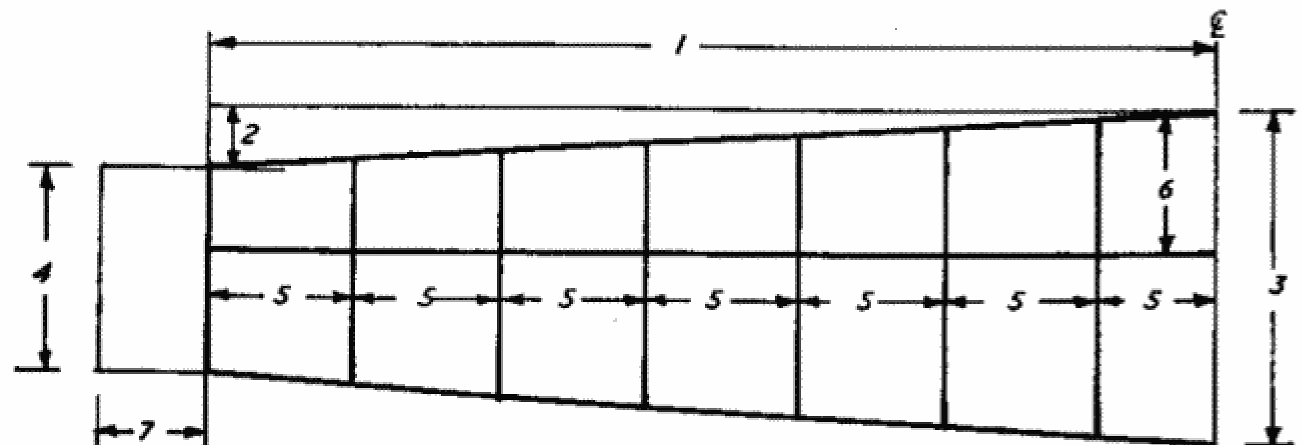


FIG. 5

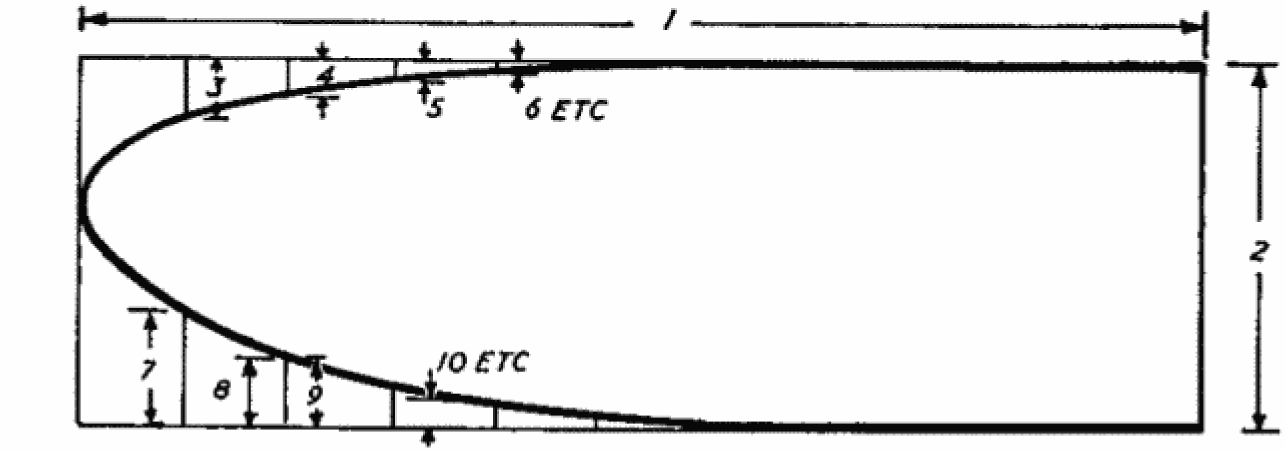
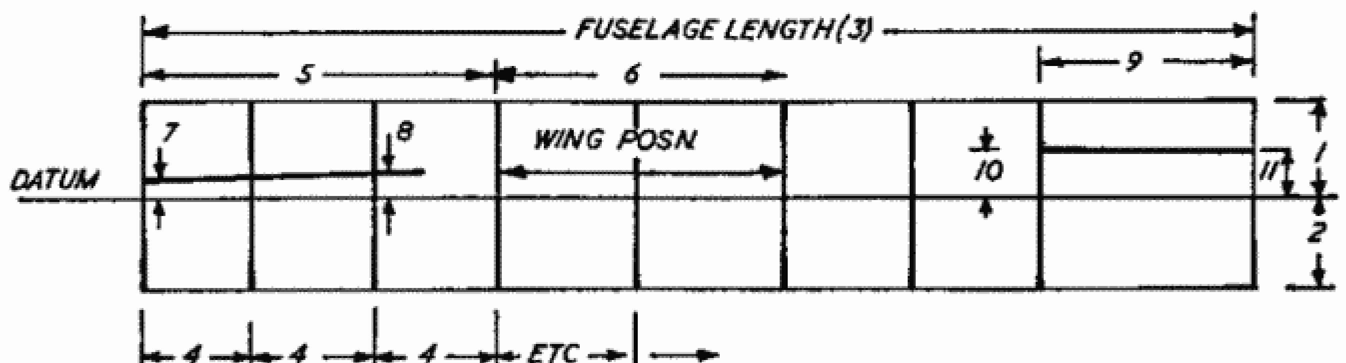


FIG. 6 STATION LINES (VERTICALS)

Tailplane layout can be tackled in a similiar manner, provided the outline is straight edged. With elliptic or curved outlines, plotting the corresponding full size shape is a little more complicated. The most satisfactory way is usually to "box" the original drawing as shown in Fig. 6 and then sub-divide into a number of vertical stations as shown—*e.g.* at rib positions or logical spacings, such as 2 in. full size, closer if necessary where there is most change of curvature. After laying out the box (dimensions 1 and 2) on the full size drawing, and the vertical station lines, outline points are spotted by scaling dimensions 3, 4, 5, 6, *etc.*, right round the outline. To join up in a smooth curve, use a strip of balsa and either sketch in freehand or use French curves (if available) for completing the tip shape.

The fuselage may or may not have a centre line or datum line marked. If it has, adopt this as the reference line for laying out the full size drawing. If not, draw a logical reference line on the reproduction. By "logical" we mean any convenient line—*e.g.* a line corresponding to the bottom of a substantially flat bottomed fuselage, or a line through the fuselage at right angles to marked former positions. Do not adopt the thrust line as a "logical" datum line as this may be angled upwards towards the rear—when all the formers will not be at right angles to the datum. Full size fuselage layout will then normally comprise the following stages, starting with a horizontal line drawn as the datum line.

(*i*) Lay off maximum height above (1) and below (2) the datum line.
(*ii*) Lay off the fuselage length dimension (3).
(*iii*) Lay off the various vertical stations corresponding to former positions (4).
(*iv*) Measure wing leading edge position from the front of the fuselage (5) and wing chord (6). Check that these correspond to the appropriate former positions marked in (*iii*). If not, re-check and adjust as necessary.
(*v*) Measure and establish position of top of engine bearers by two dimensions (7 and 8) taken as far apart as possible.
(*vi*) Mark off tailplane seating position (chord length).
(*vii*) Scale very carefully the tailplane vertical height dimensions 9 and 10.
(*viii*) Repeat for wing position with dimensions 11 and 12.



FORMER OR UPRIGHT SPACER POSITIONS FIG. 7

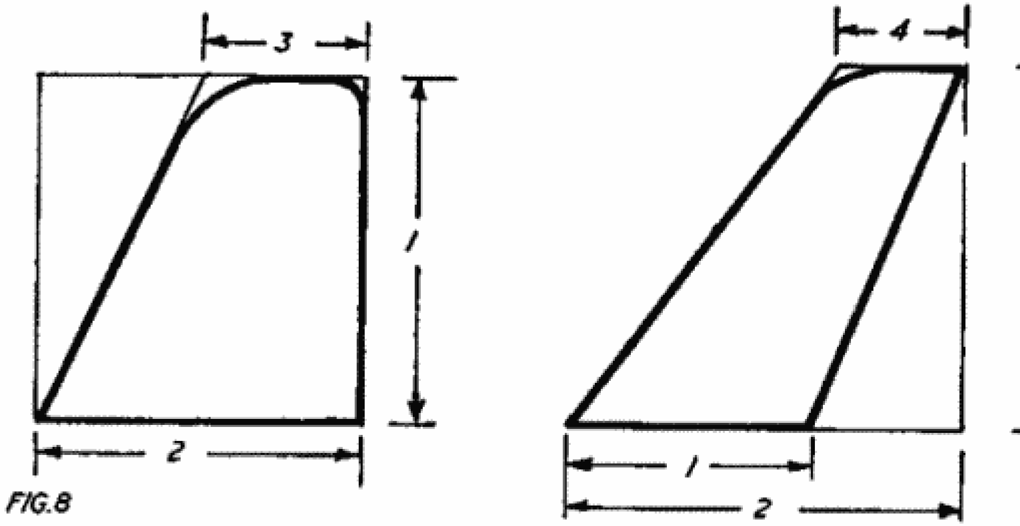


FIG. 8

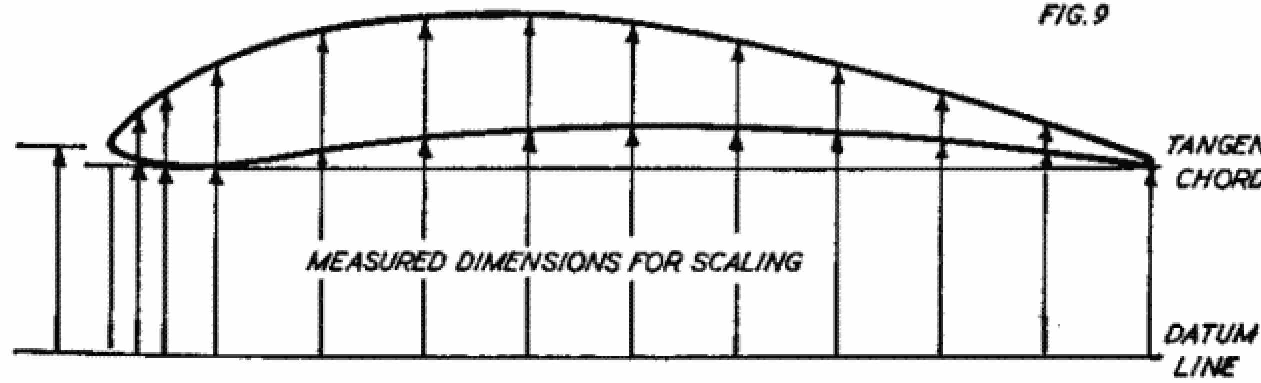
The balance of the fuselage outline can then be plotted by measuring and factoring offset heights above and below the fuselage datum line at each former position. Additional details can then be added, as necessary.

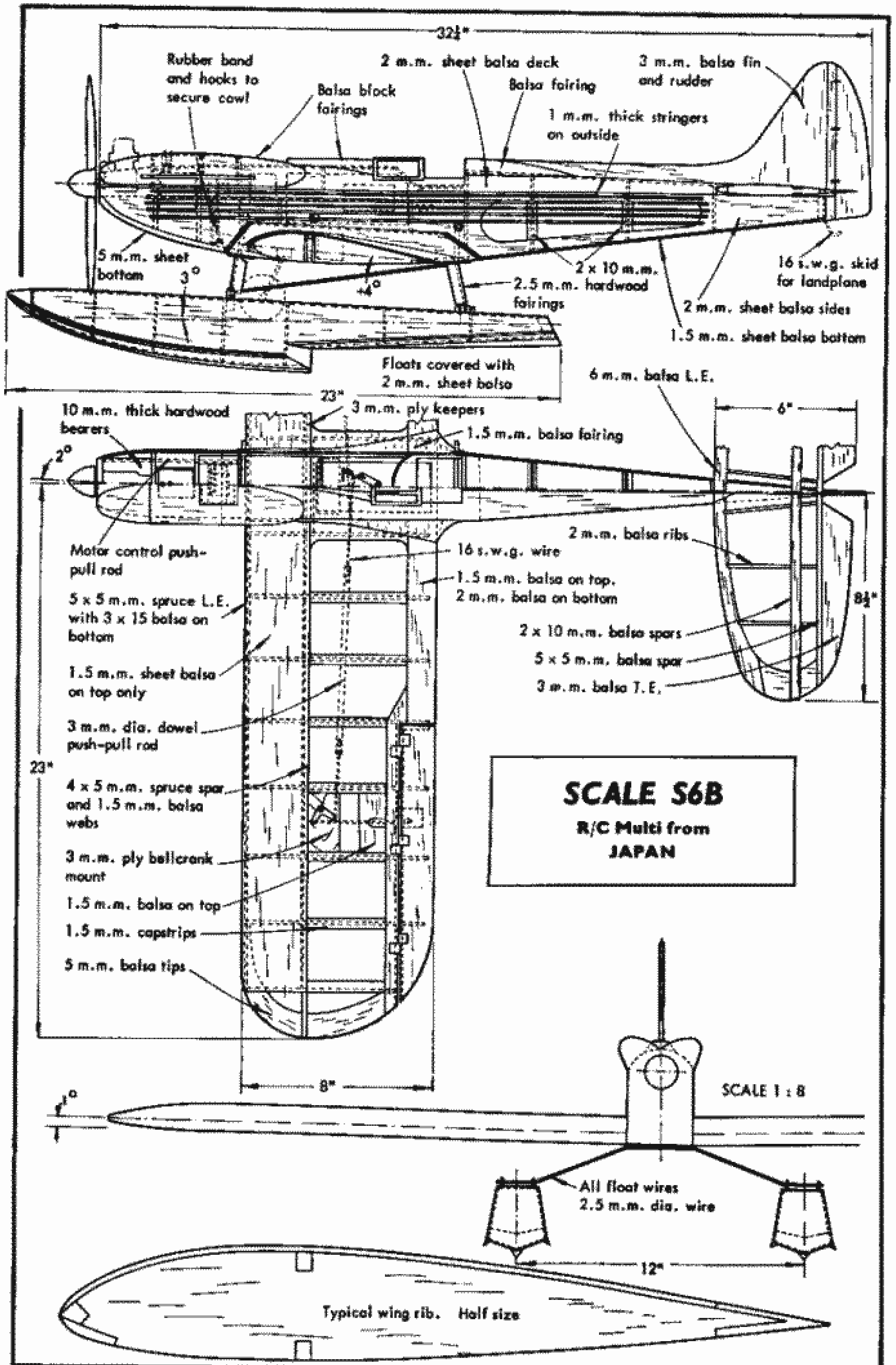
For fin shapes, treat by "boxing" as in Fig. 8, or if the shape is curved adopt the method already described for Fig. 6. The shape is hardly likely to be critical and the outline can be drawn in freehand, if necessary.

Aerofoil sections are more difficult to scale up, particularly if reproduced to quite a small size—*e.g.* consistent with the reduction for the rest of the plan. A further trouble lies in the fact that the original drawing of the aerofoil may not be all that accurate anyway and scaling up may well exaggerate errors.

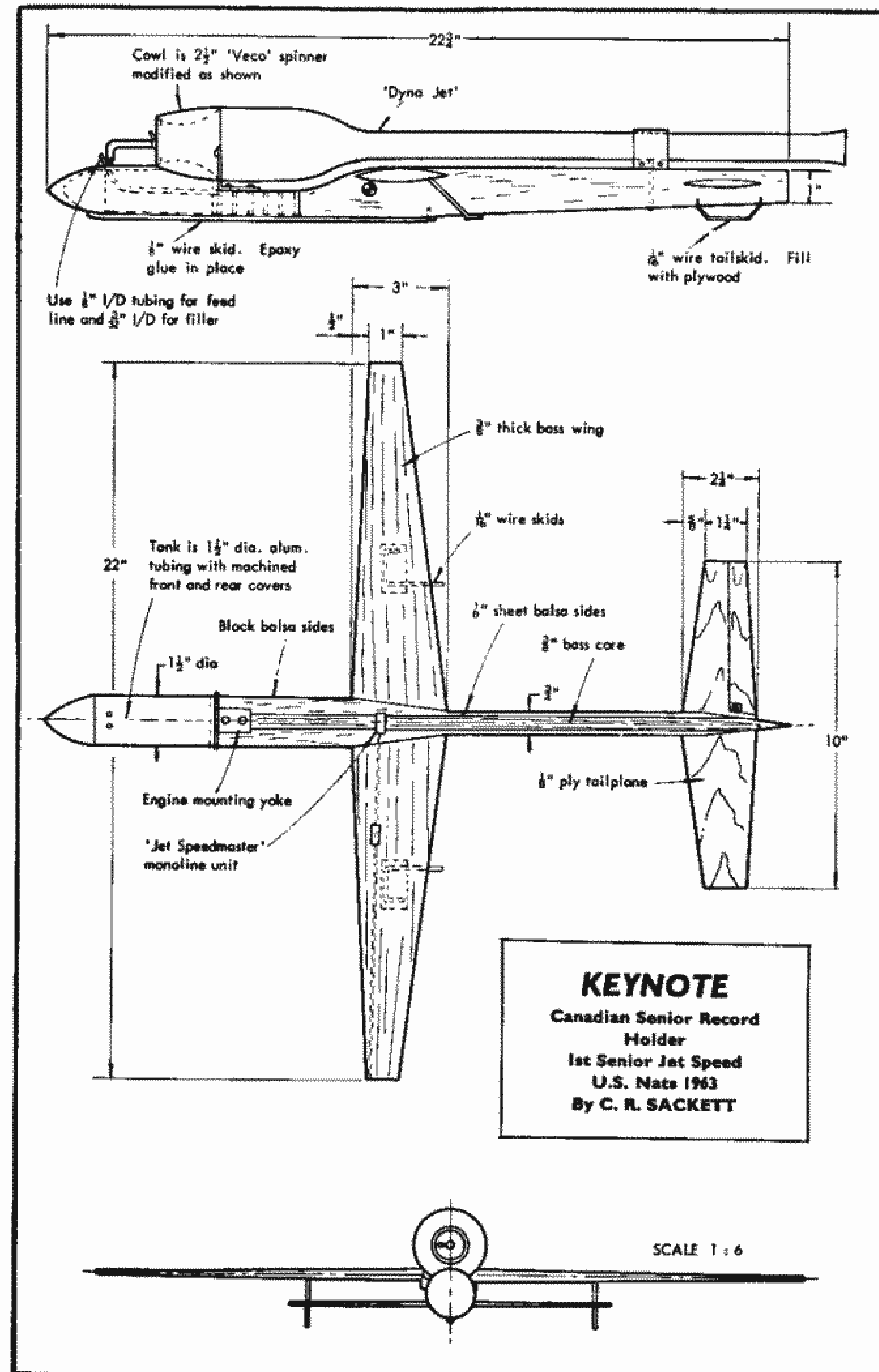
If the aerofoil is a known type, then it is best to plot full size from a table of ordinates for that section. Otherwise it will have to be scaled up from measured ordinates for the upper and lower surface, as shown in Fig. 9. Note that it may be better to adopt a datum line well below the actual section drawing, although parallel to its tangent chord, to avoid the possibility of error in measuring very small dimensions for the lower surface above the tangent chord. Even with careful work the plotted full size points may need "smoothing" when finally drawing the required aerofoil outline.

FIG. 9

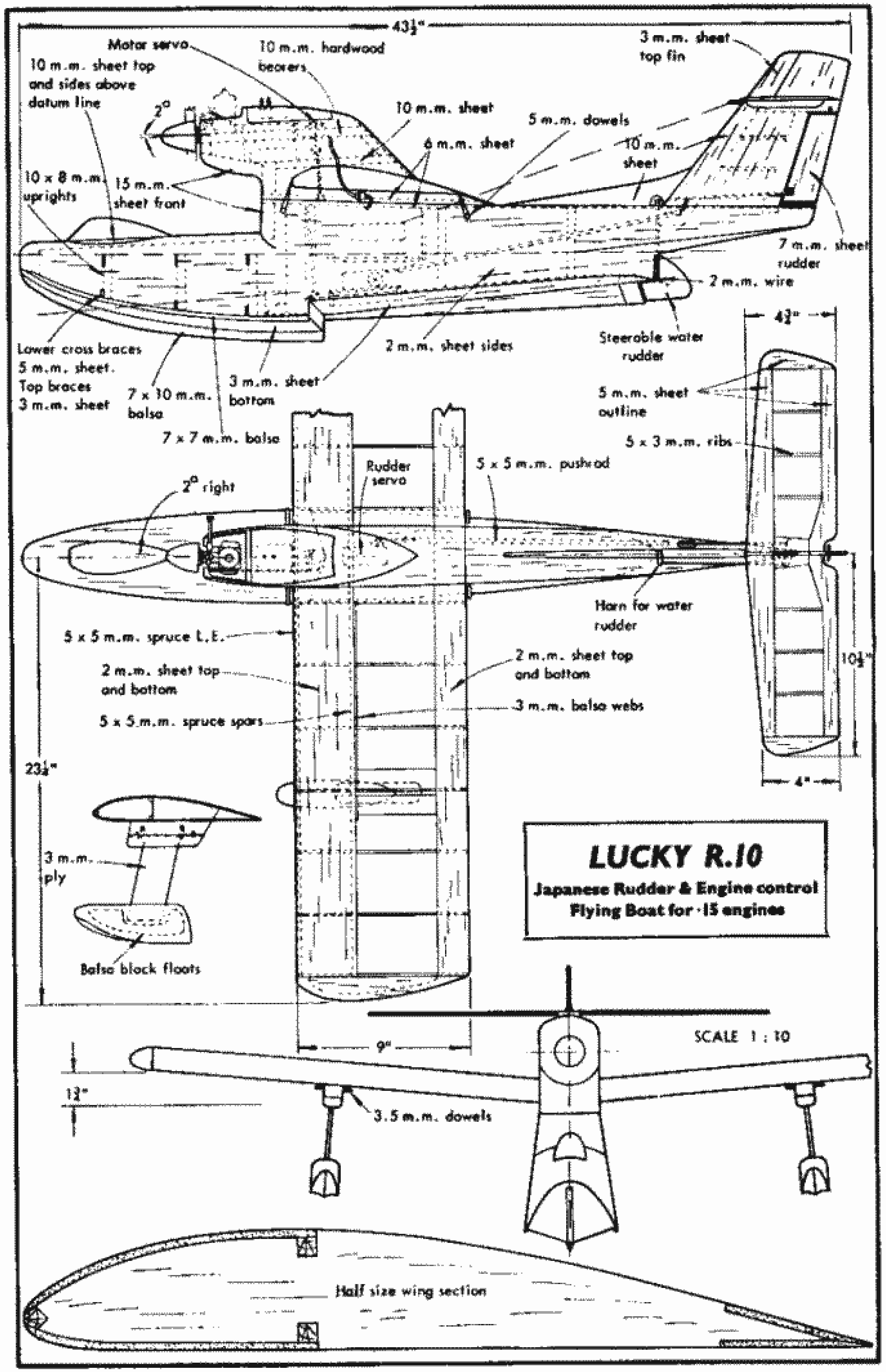




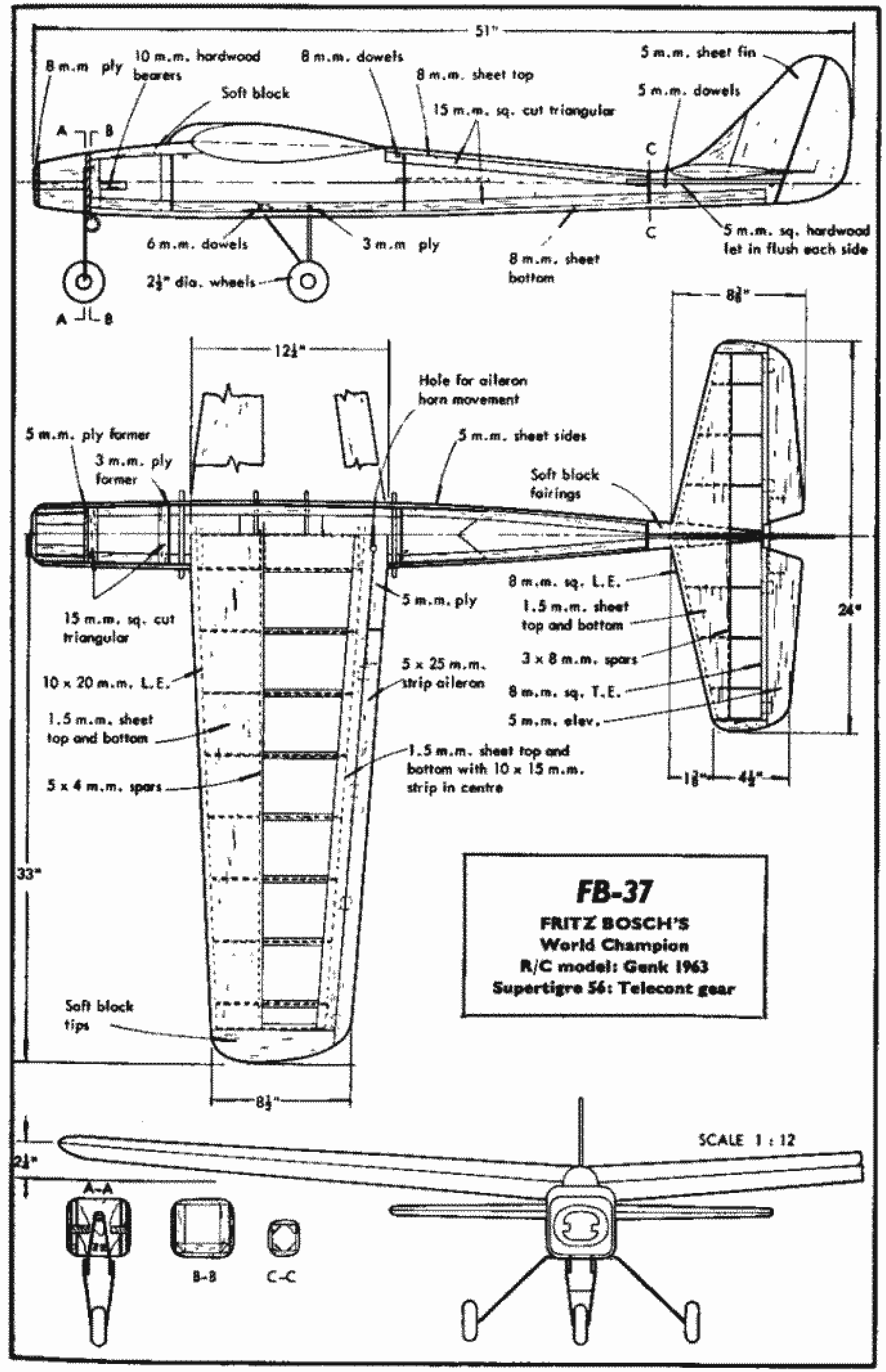
R/C TECHNIQUE, JAPAN



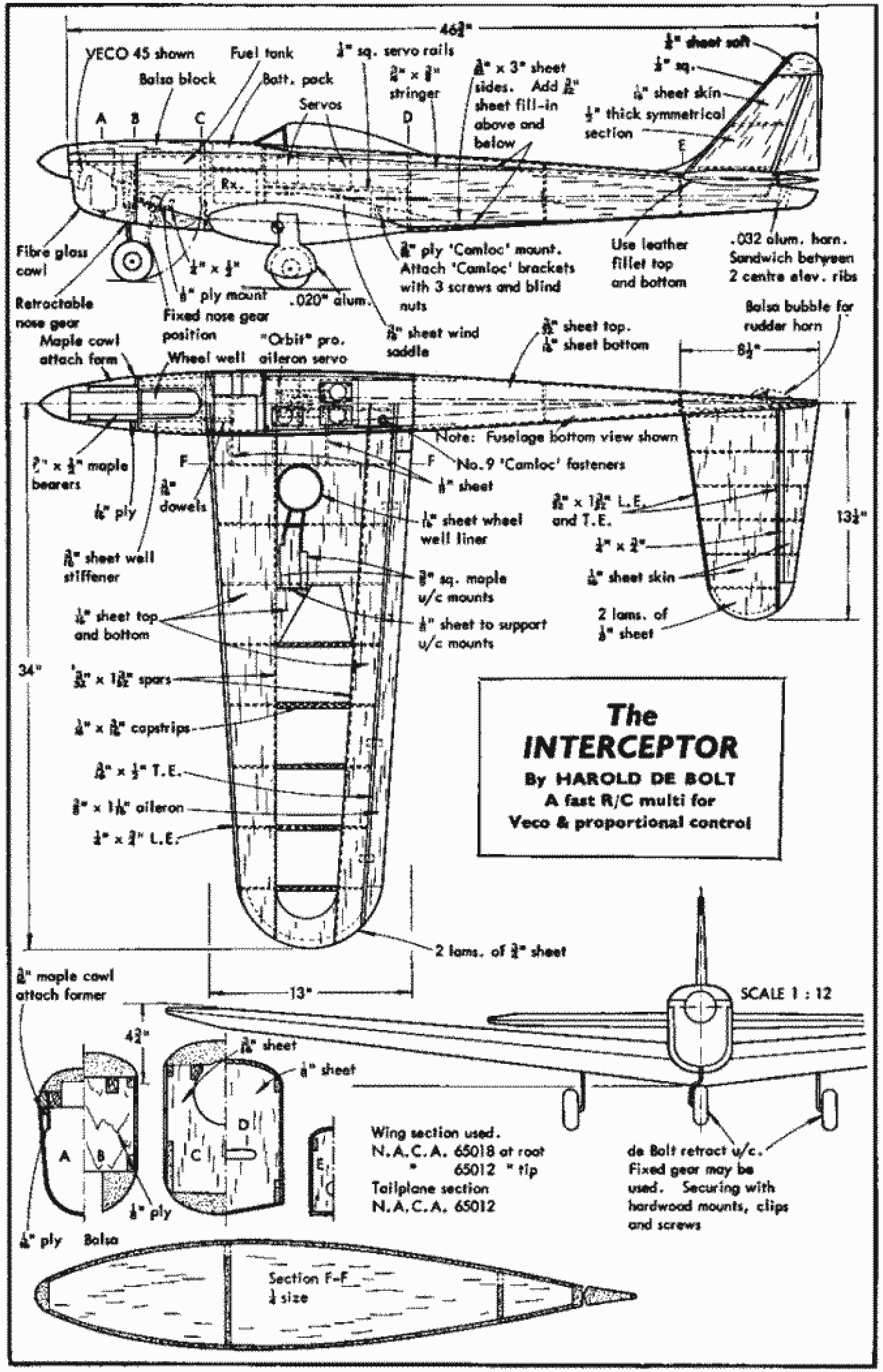
HOTHEAD—VANCOUVER, CANADA



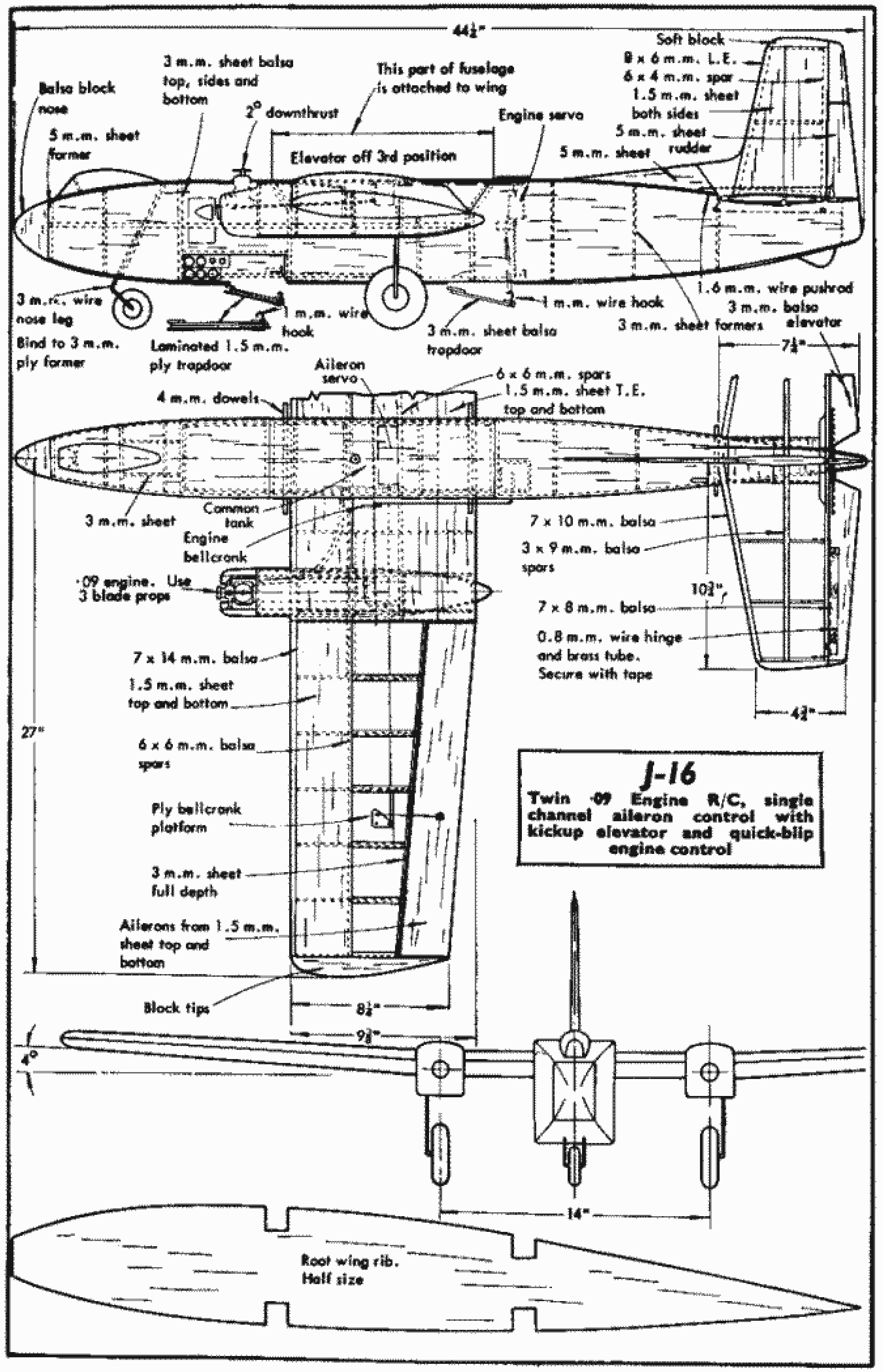
RADIO CONTROL TECHNIQUE, JAPAN



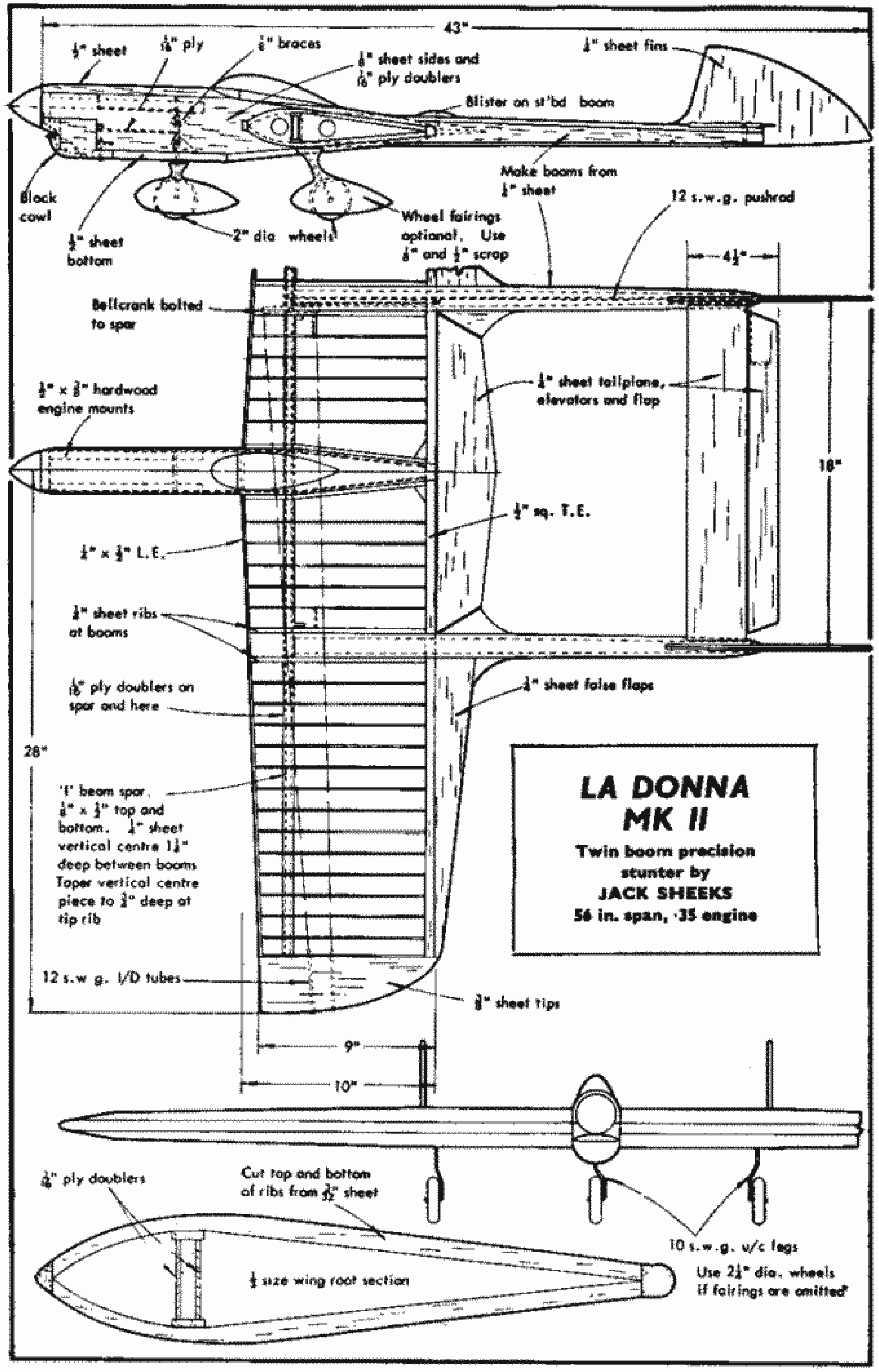
MODELL FLUG TECHNIK, W. GERMANY



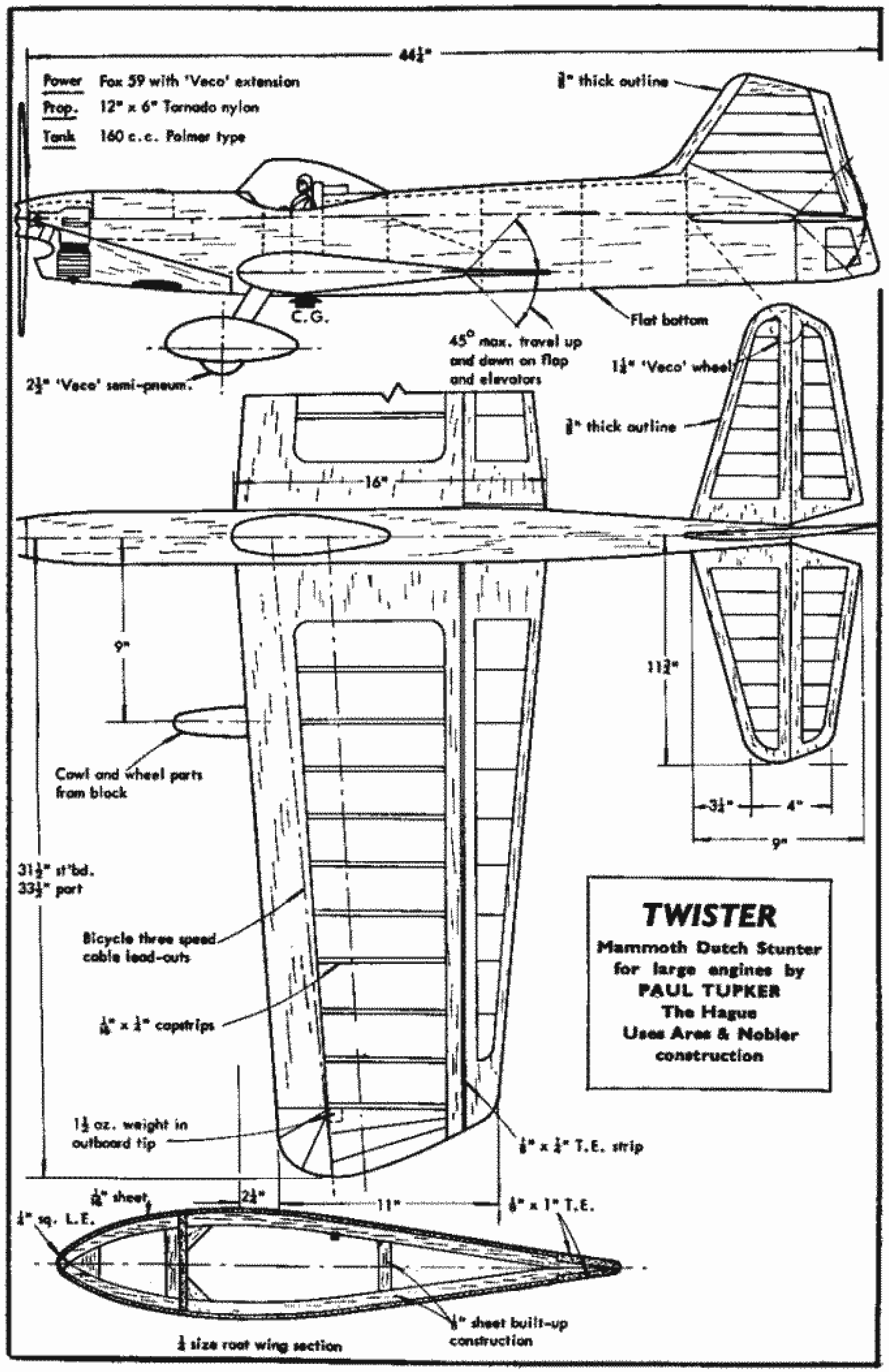
MODEL AIRPLANE NEWS, U.S.A.



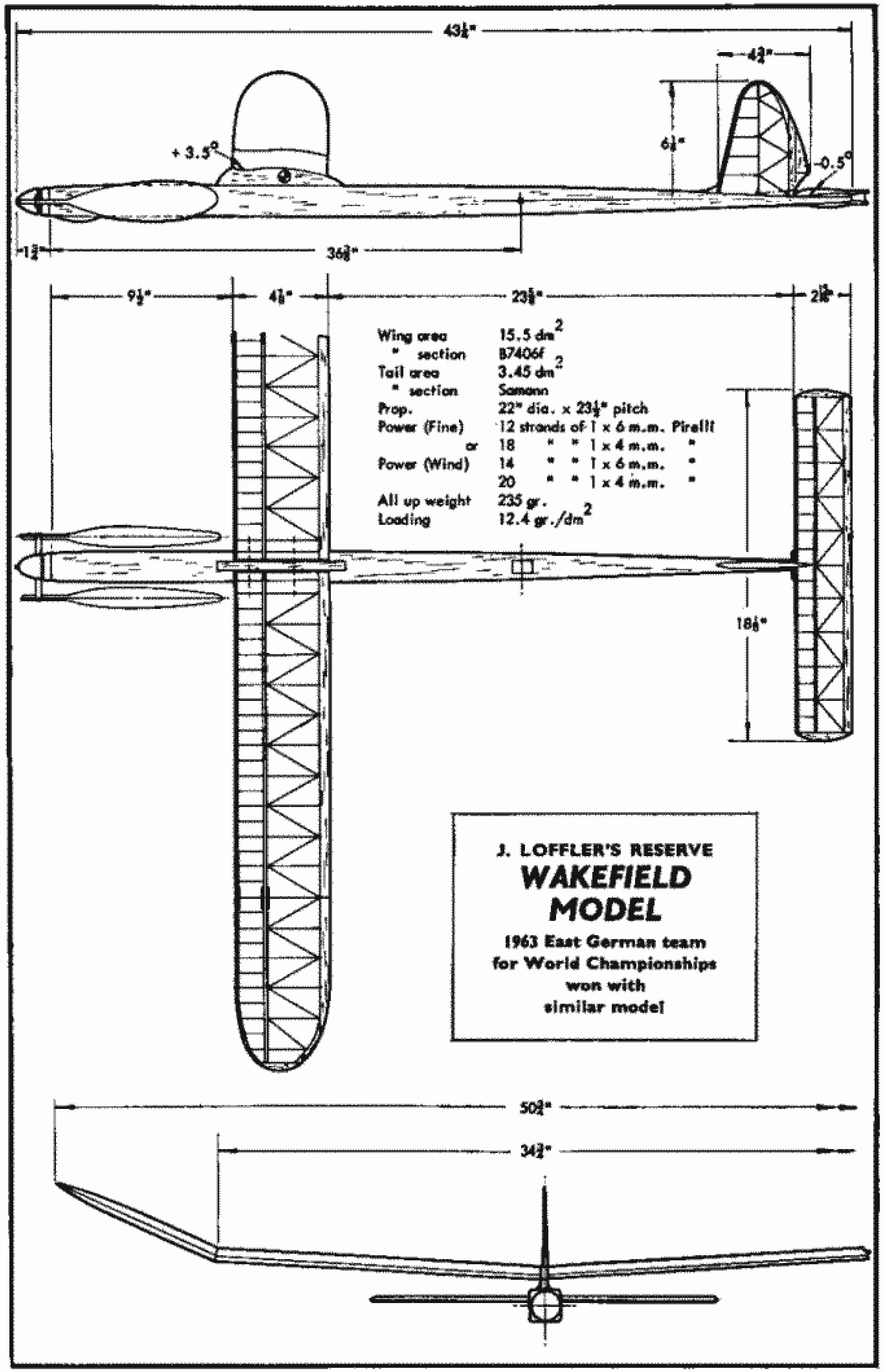
R/C TECHNIQUE, JAPAN



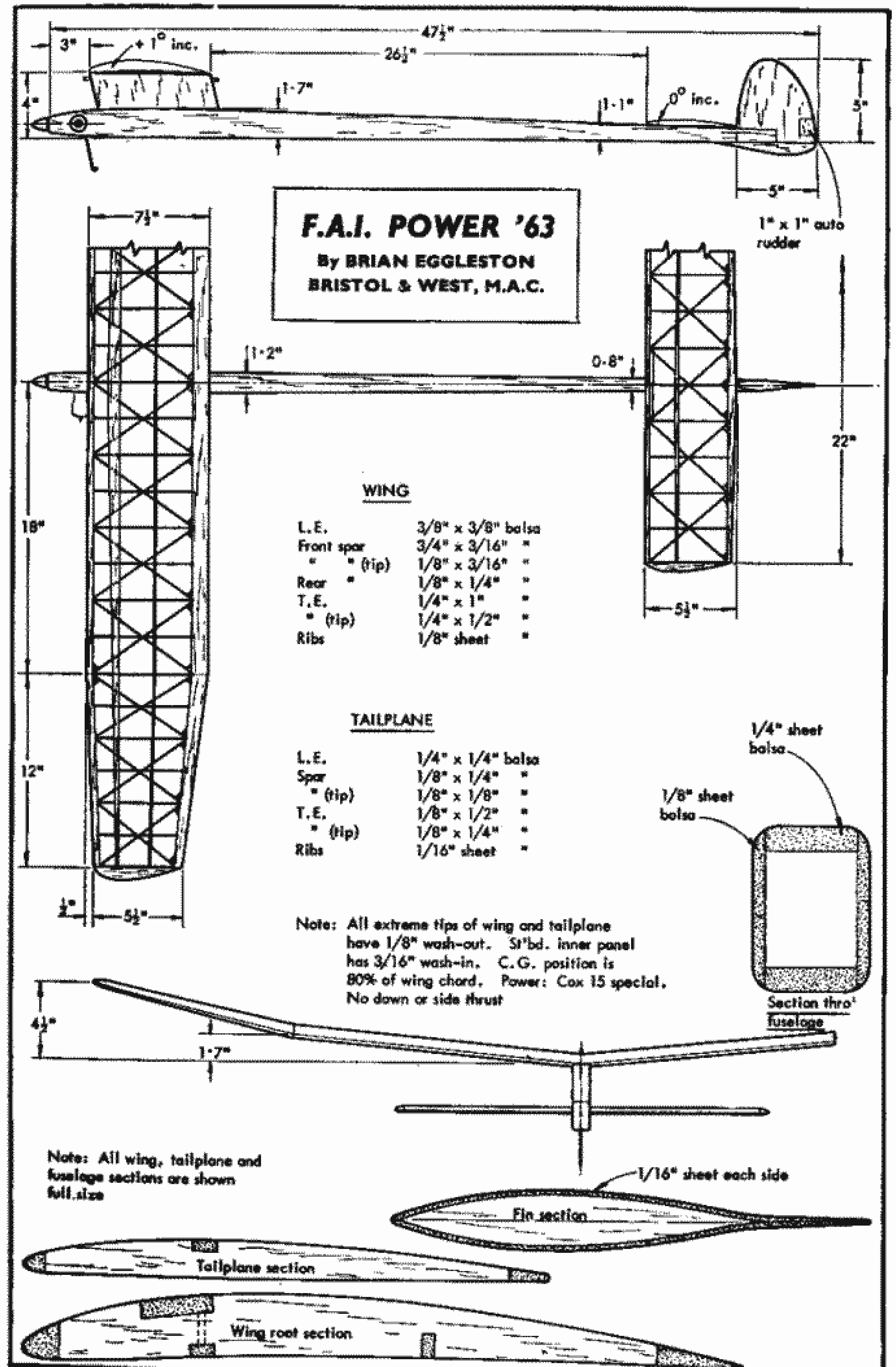
43"
½" sheet
1/16" ply
⅛" braces
⅛" sheet sides and 1/16" ply doublers
¼" sheet fins
Blister on st'bd boom
Block cowl
½" sheet bottom
2" dia wheels
Wheel fairings optional. Use ⅛" and ½" scrap
Make booms from ¼" sheet
12 s.w.g. pushrod
4½"
Bellcrank bolted to spar
½" x ⅜" hardwood engine mounts
¼" sheet tailplane, elevators and flap
18"
½" sq. T.E.
¼" x ½" L.E.
⅛" sheet ribs at booms
1/16" ply doublers on spar and here
¼" sheet false flaps
28"
'I' beam spar, ⅛" x ½" top and bottom. ¼" sheet vertical centre 1¼" deep between booms Taper vertical centre piece to ¾" deep at tip rib
LA DONNA MK II
Twin boom precision stunter by JACK SHEEKS
56 in. span, ·35 engine
12 s.w g. I/D tubes
⅜" sheet tips
9"
10"
1/16" ply doublers
Cut top and bottom of ribs from 3/32" sheet
10 s.w.g. u/c legs
½ size wing root section
Use 2¼" dia. wheels if fairings are omitted



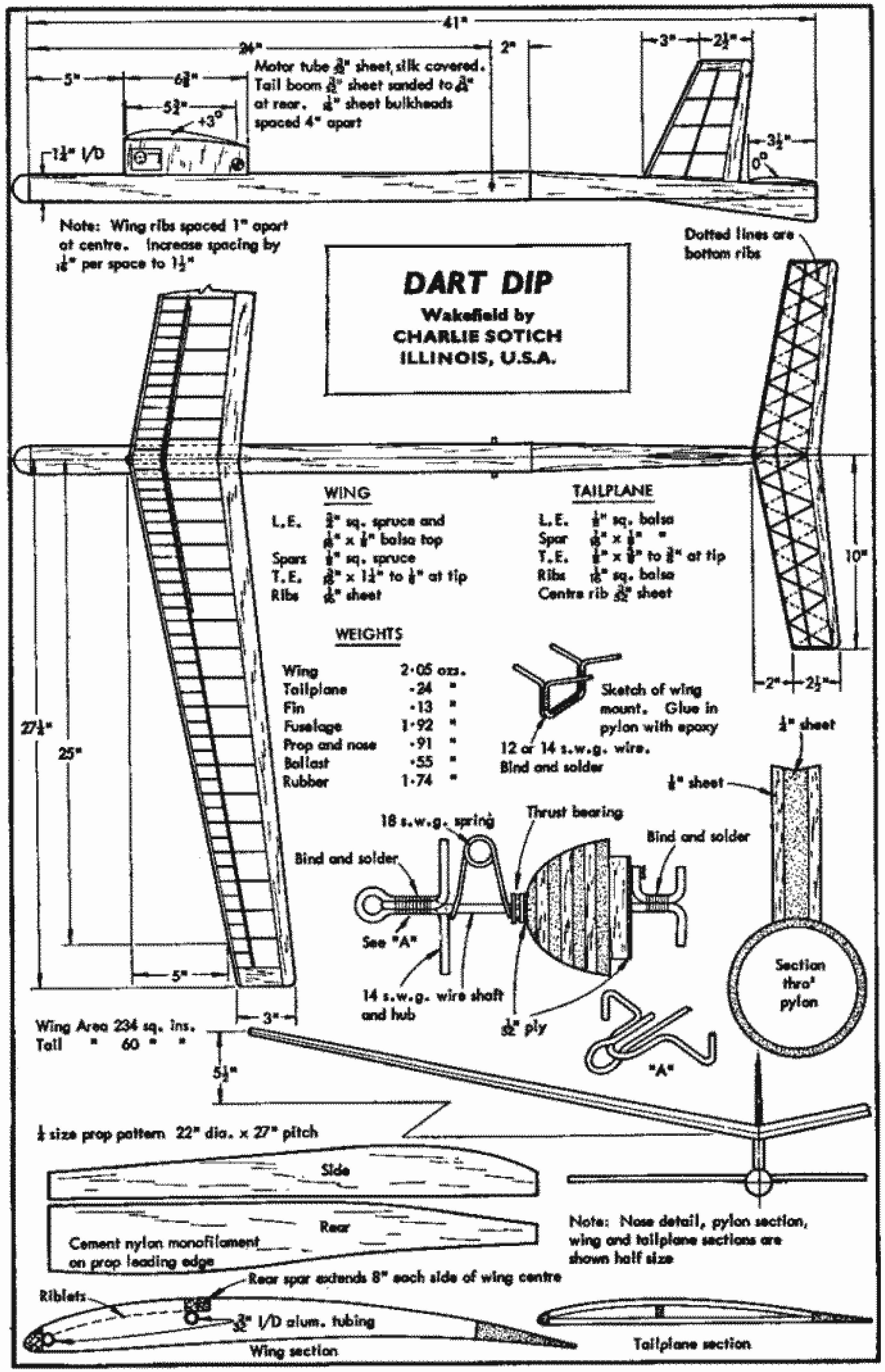
44½"
Power Fox 59 with 'Veco' extension
Prop. 12" x 6" Tornado nylon
Tank 160 c.c. Palmer type
⅜" thick outline
C.G.
45° max. travel up and down on flap and elevators
Flat bottom
1¼" 'Veco' wheel
2½" 'Veco' semi-pneum.
⅜" thick outline
16"
9"
11¾"
Cowl and wheel parts from block
3½"
4"
9"
31½" st'bd.
33½" port
TWISTER
Mammoth Dutch Stunter for large engines by PAUL TUPKER The Hague
Uses Ares & Nobler construction
Bicycle three speed cable lead-outs
1/16" x ¼" capstrips
1½ oz. weight in outboard tip
⅛" x ¼" T.E. strip
1/16" sheet
2½"
11"
⅛" x 1" T.E.
½" sq. L.E.
⅛" sheet built-up construction
½ size root wing section



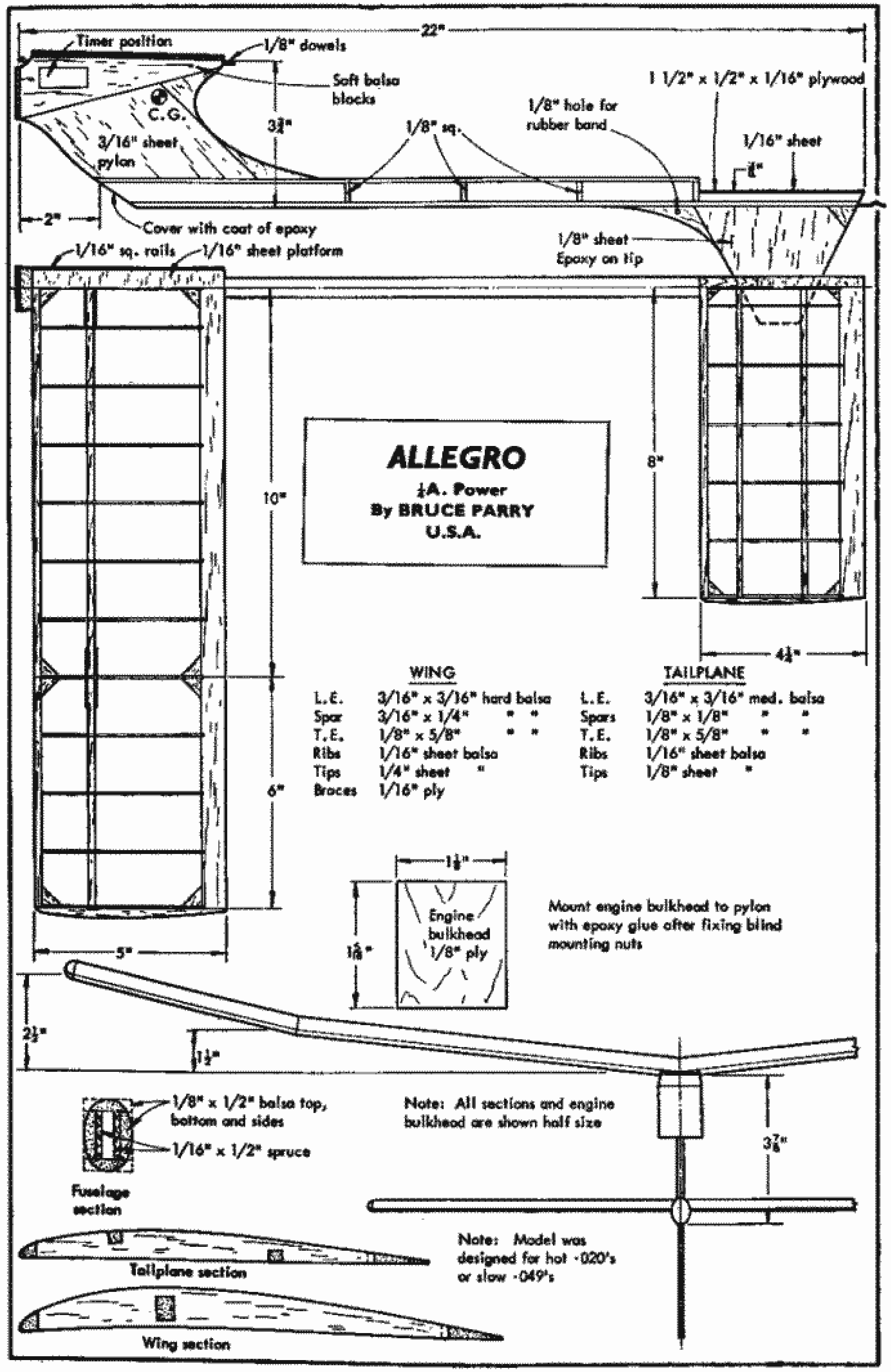
EAST GERMANY



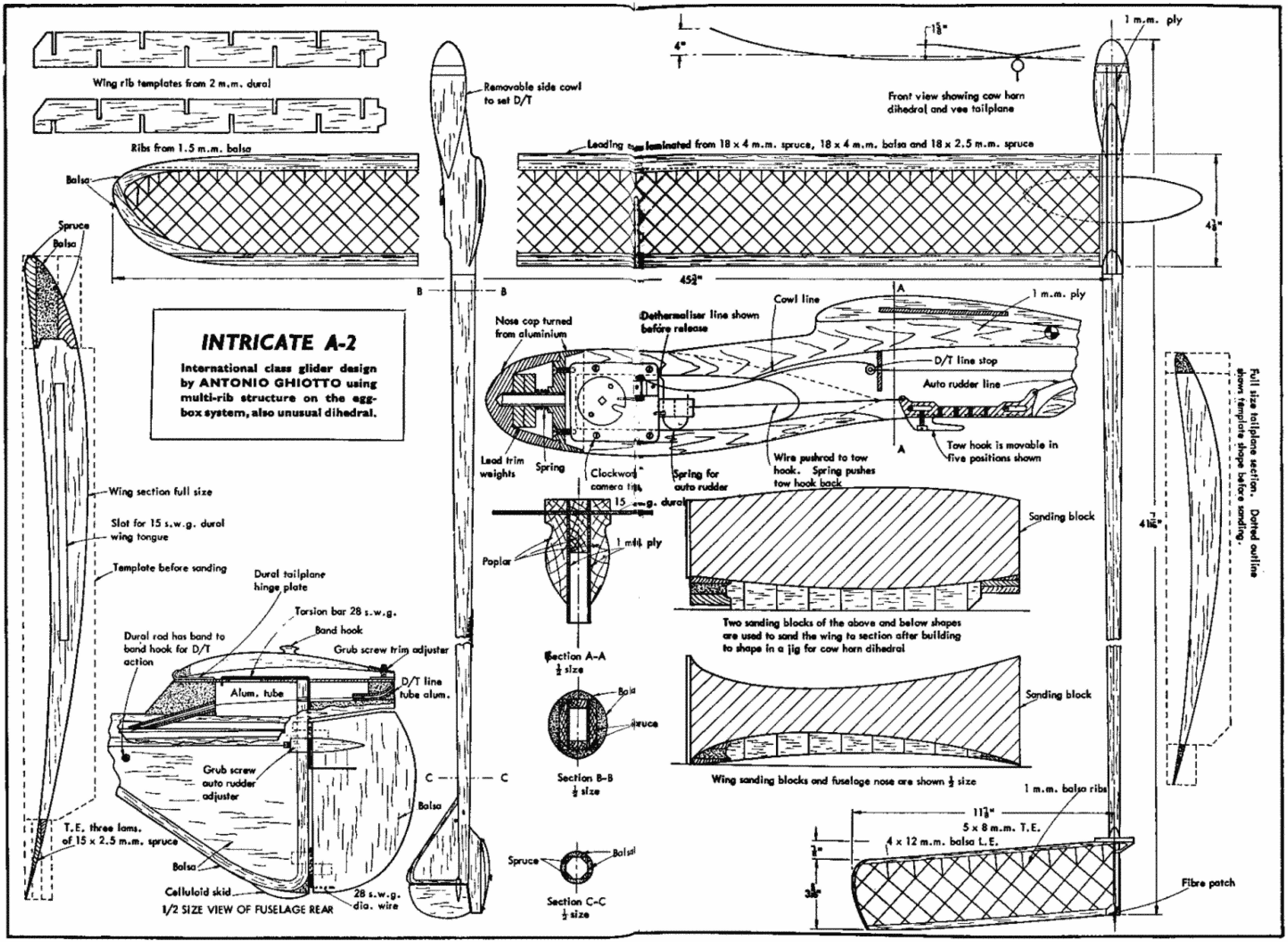
WESTERN AREA NEWSLETTER, G.B.



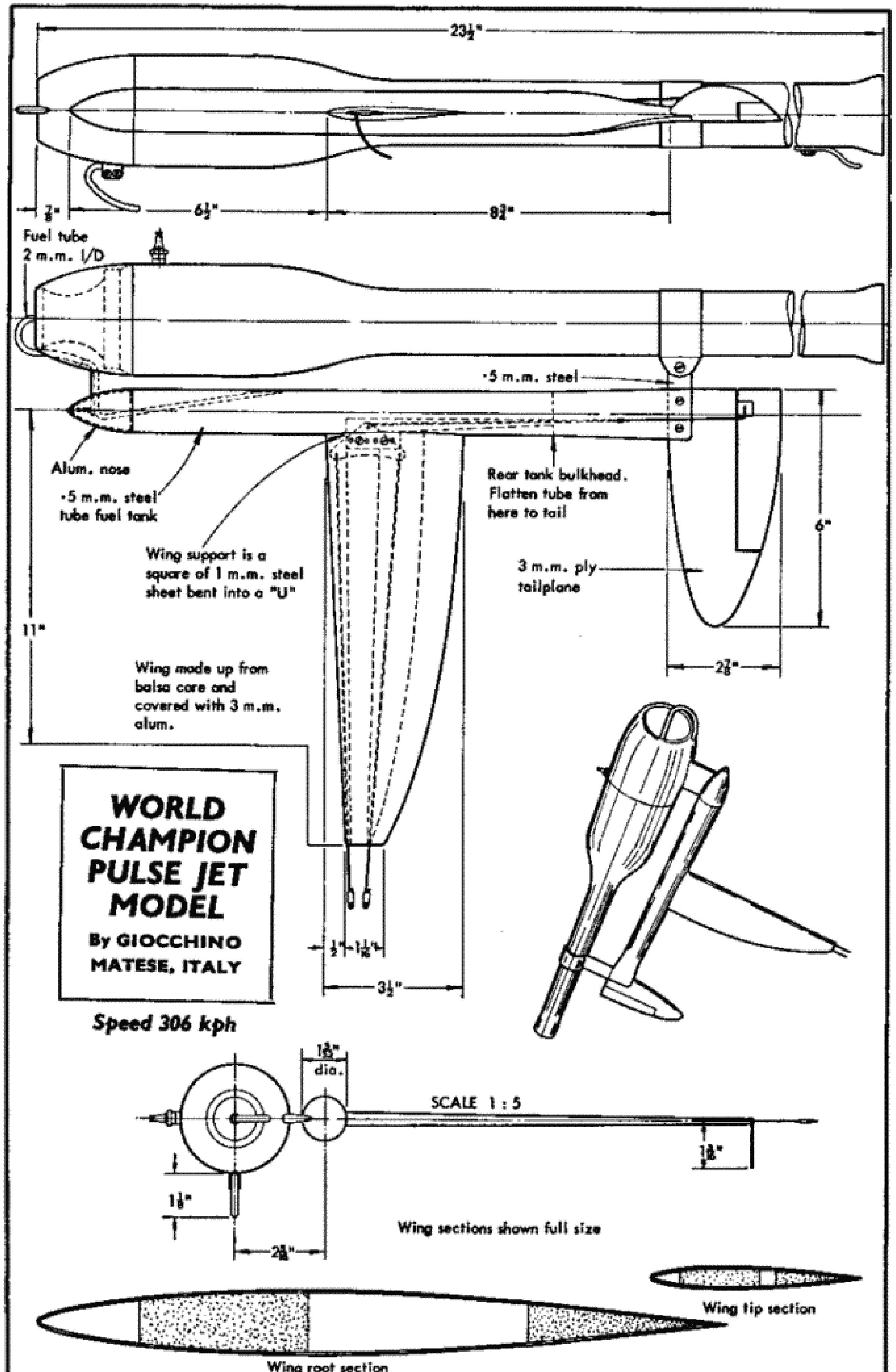
IMAC NEWSLETTER, U.S.A.



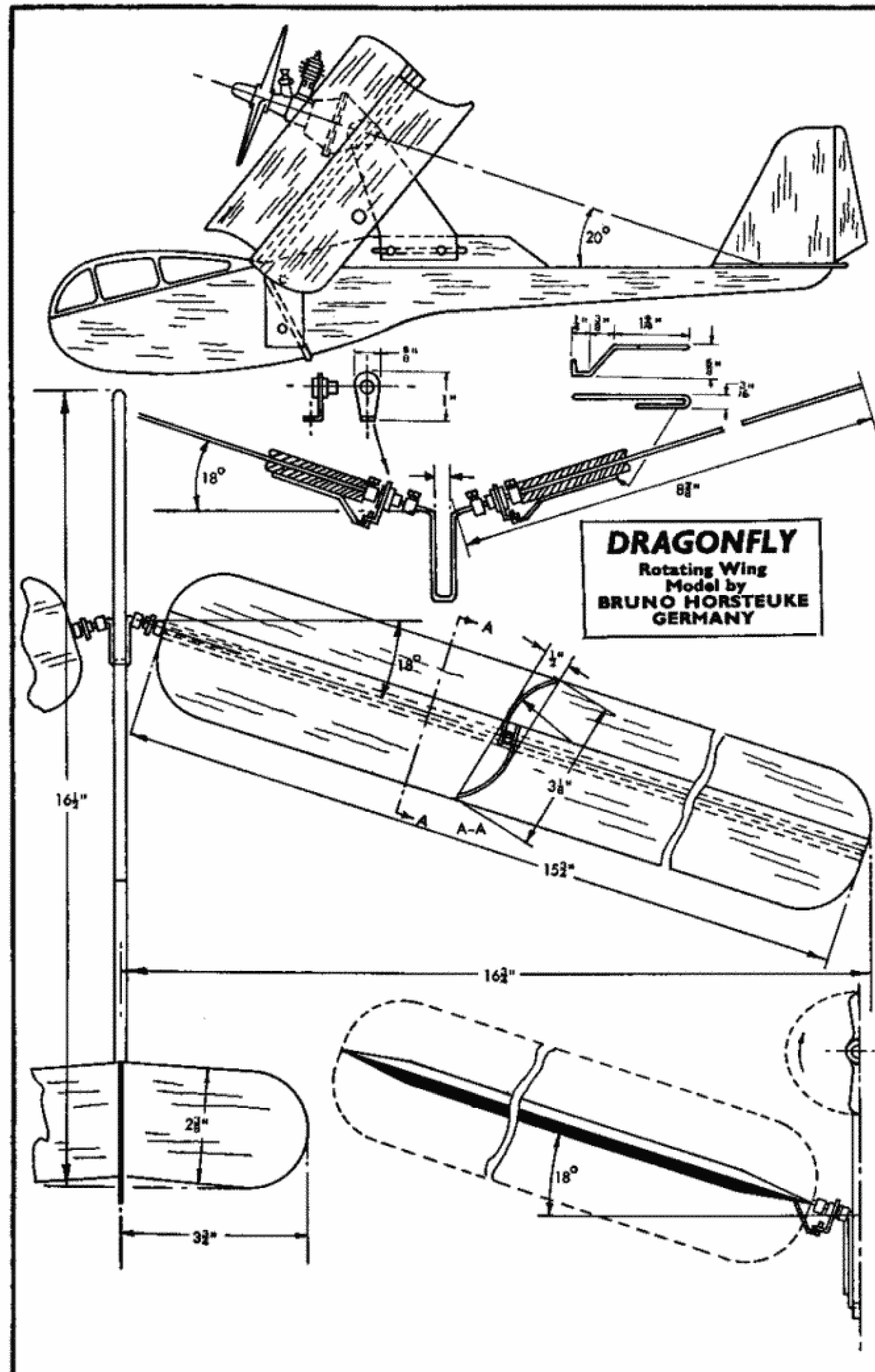
ILLINOIS M.A.C. NEWSLETTER, U.S.A.



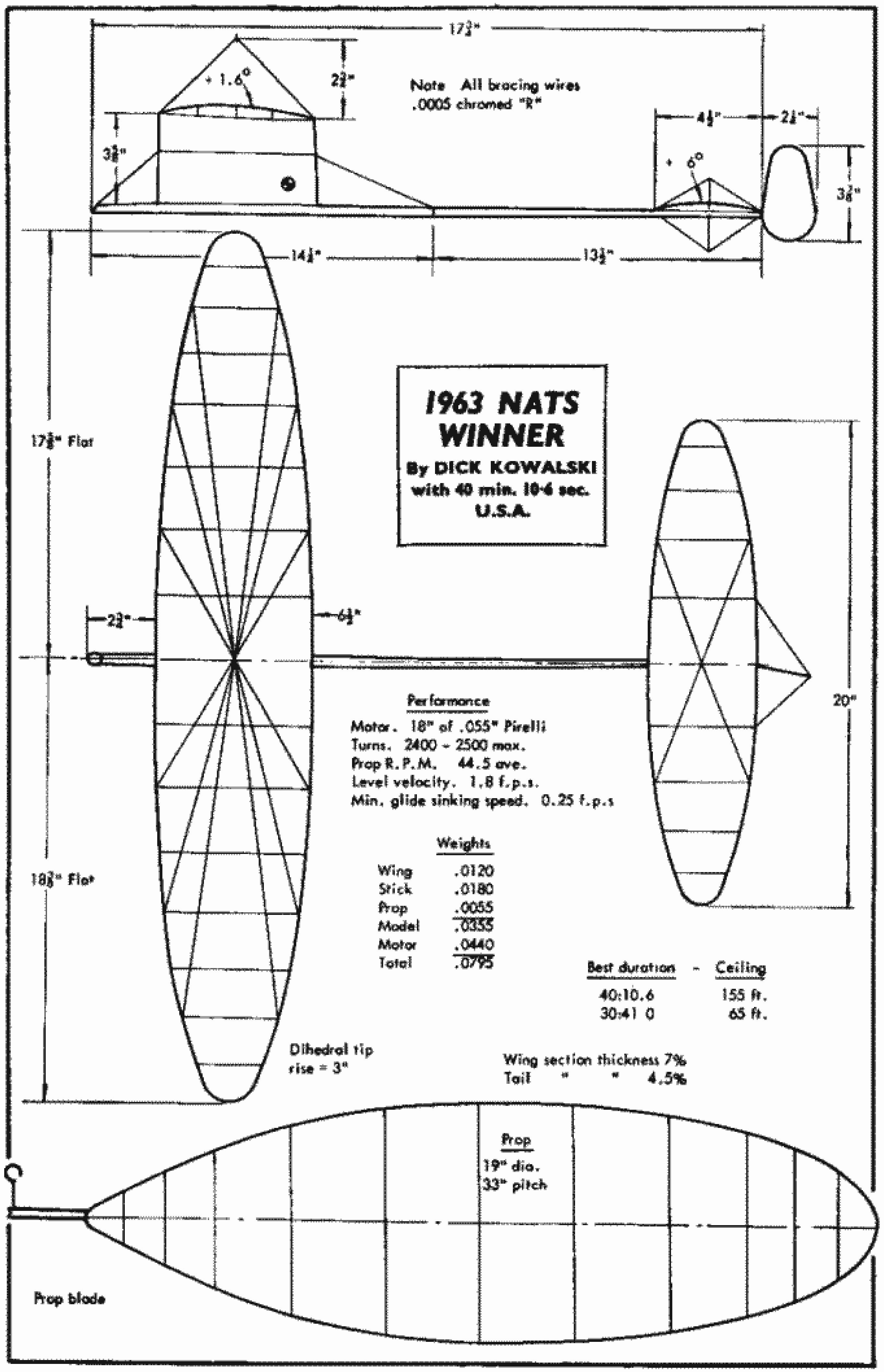
MODELLISMO, ITALY



RASSEGNA DI MODELLISMO, ITALY



FLUG MODELL TECHNIK, W. GERMANY



1963 NATS WINNER

By DICK KOWALSKI with 40 min. 10·6 sec. U.S.A.

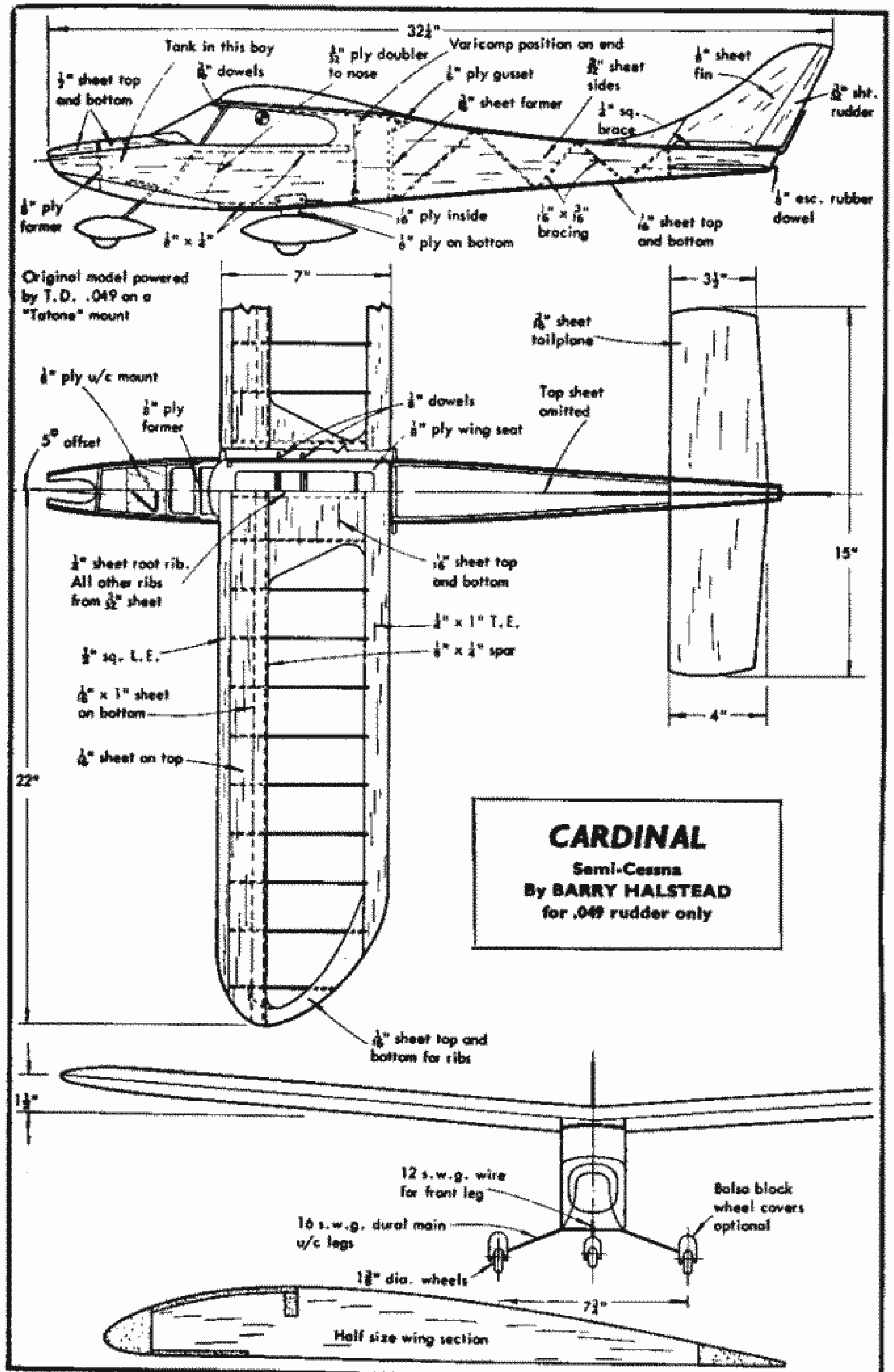
Performance

Motor. 18" of .055" Pirelli
Turns. 2400 - 2500 max.
Prop R.P.M. 44.5 ave.
Level velocity. 1.8 f.p.s.
Min. glide sinking speed. 0.25 f.p.s

Weights

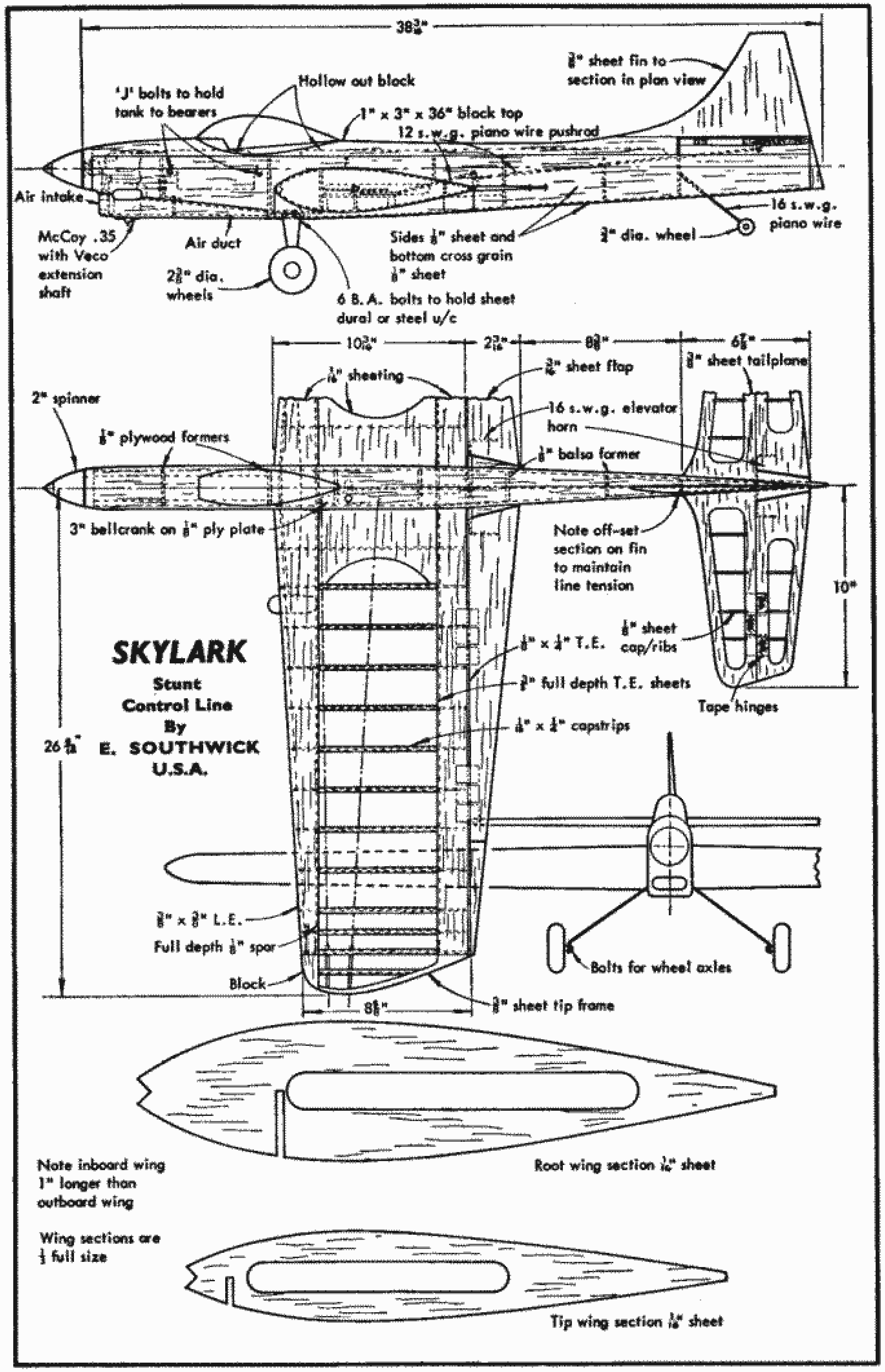
Wing	.0120
Stick	.0180
Prop	.0055
Model	.0355
Motor	.0440
Total	.0795

Best duration	Ceiling
40:10.6	155 ft.
30:41 0	65 ft.

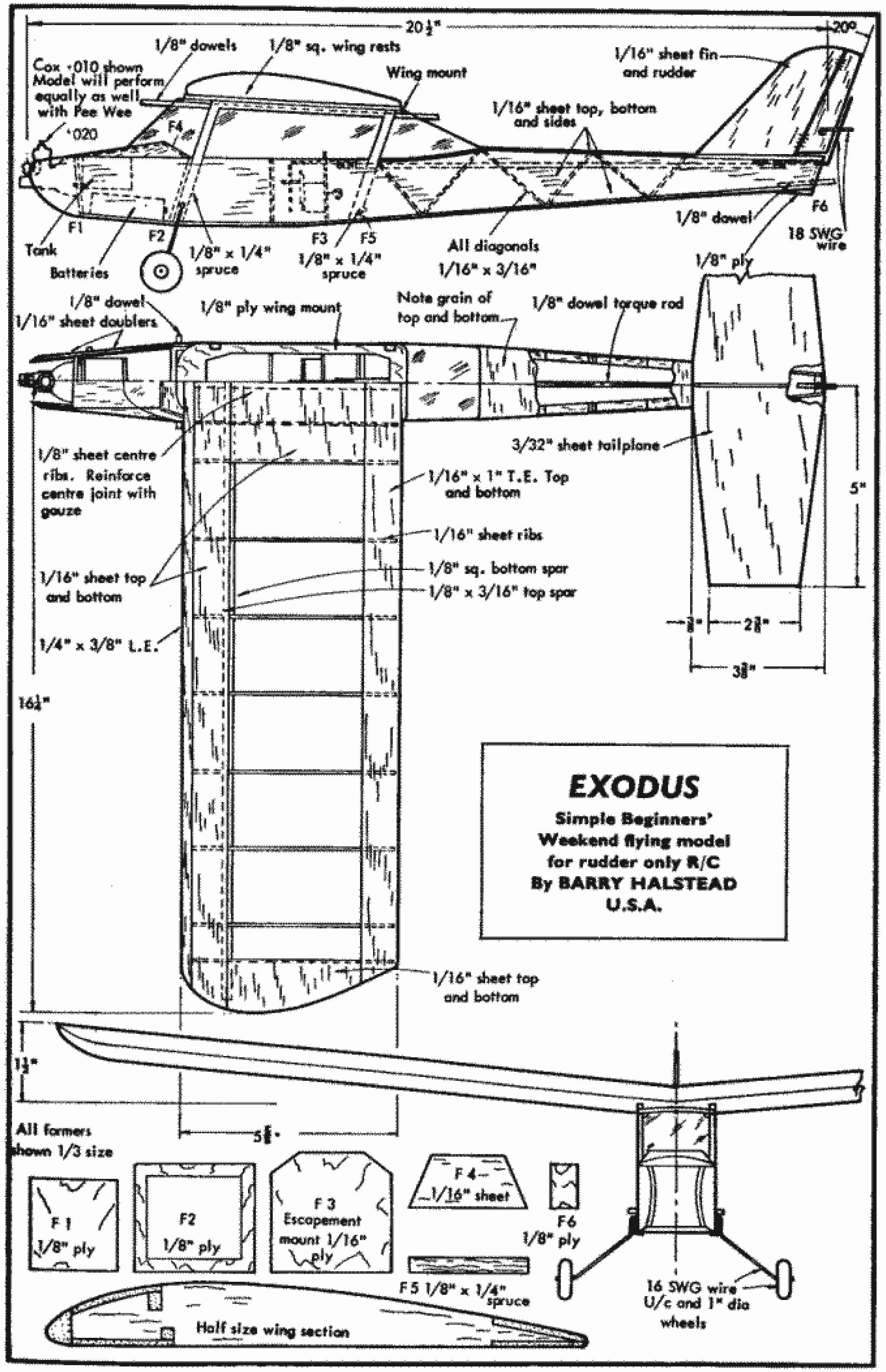


CARDINAL

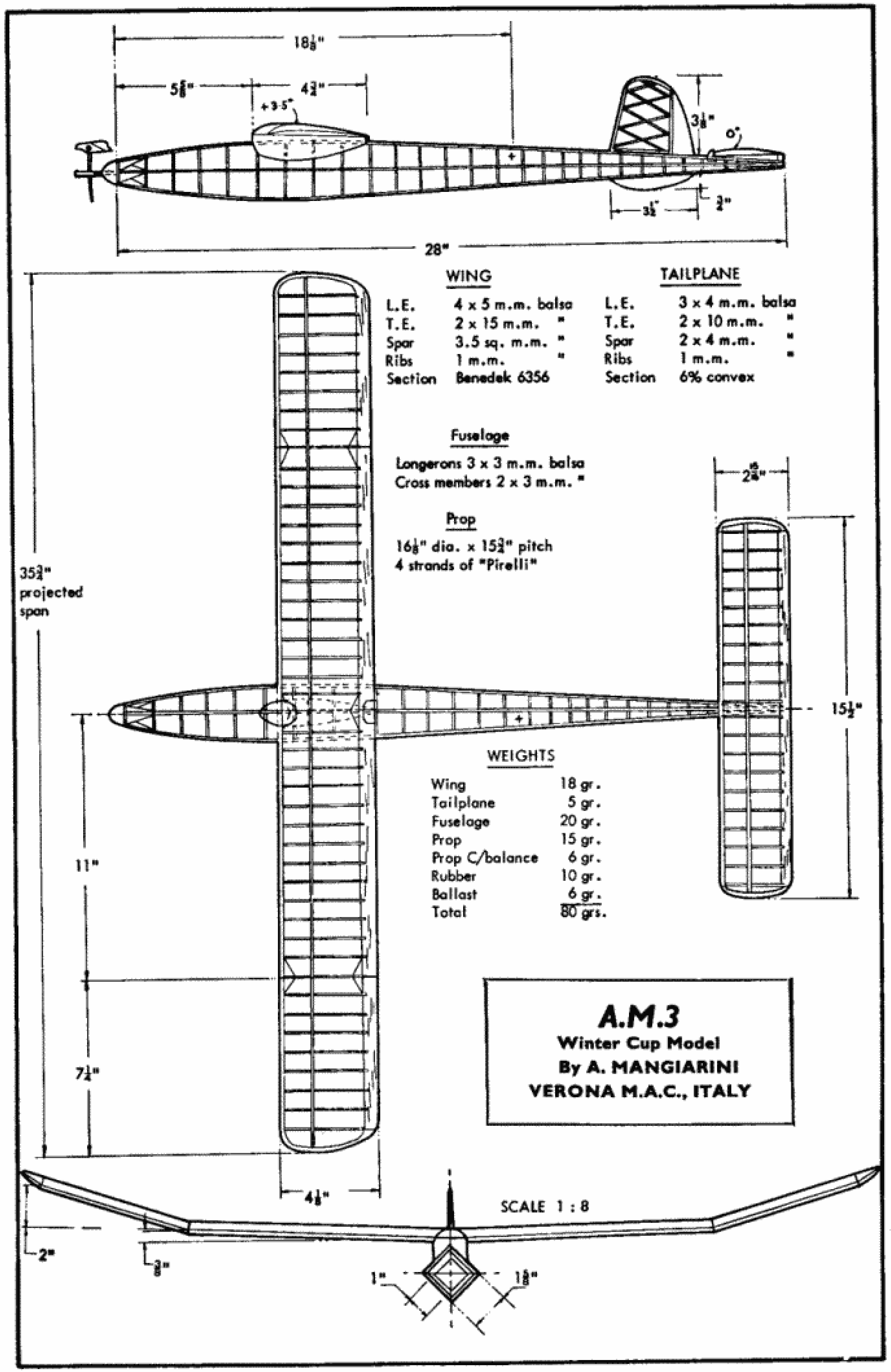
Semi-Cessna By BARRY HALSTEAD for .049 rudder only



MODEL AIRPLANE NEWS, U.S.A.



R/C MODELER, U.S.A.



ITALY

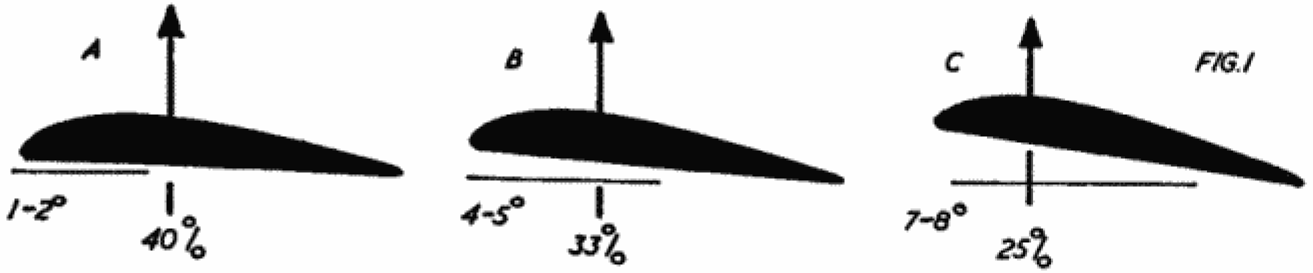
A QUESTION OF BALANCE

ANY AEROPLANE—model or full size—can be trimmed out to fly over a range of gravity positions. A particular trim simply represents a balance of all the forces acting on the aircraft, consisting of aerodynamic and weight forces in equilibrium. The particular trim is positively stable if the aircraft will return to the same flight attitude if momentarily displaced, with the degree of stability expressed by the time it takes to achieve its original flight condition; neutrally stable if the aircraft will assume any new attitude as a "trim" if displaced; and unstable if displacement from the original flight attitude causes it to diverge still more from the original trim.

All free flight models need positive stability. With radio models the degree of positive stability can be reduced to improve manoeuvrability and, provided *full* control of the model is available, can even be reduced to the neutrally stable condition. The *full* control necessary in this case comprises rudder (only necessary to a limited extent), elevators and ailerons as a minimum, with motor speed and elevator trim highly desirable as well. With only limited control—*e.g.*, normal single-channel equipment operating rudder and possibly engine speed through a third sequence position—the model must possess some degree of positive stability in order to be flown successfully, although this can be less than that required for free flight sports or contest models.

The overall balance of forces is affected by the outline design of the model (shape and disposition of the various components, and in particular the wings and tailplane;) rigging angles; and weight distribution. The centre of gravity or balance point is the main variable, so let us first examine its influence on fore-and-aft trim or longitudinal stability.

Aerodynamically, the object of trim is to get the wing to operate at a specific angle of attack, regardless of all the other forces operating, or even the actual rigging angle of the wing. It is merely a matter of convenience that the wing is usually rigged at an angle of around 3 degrees relative to a nominal fuselage centreline. For a model to fly fast the wing must operate at a relatively low angle of attack (A—Fig. 1). For the model to develop maximum lift, the wing must operate at the highest angle of attack possible without actually stalling (C). At an intermediate angle of attack (B) the trim will be safer in that the wing is not operating on the point of stall, neither is the speed excessive to produce the lift required.



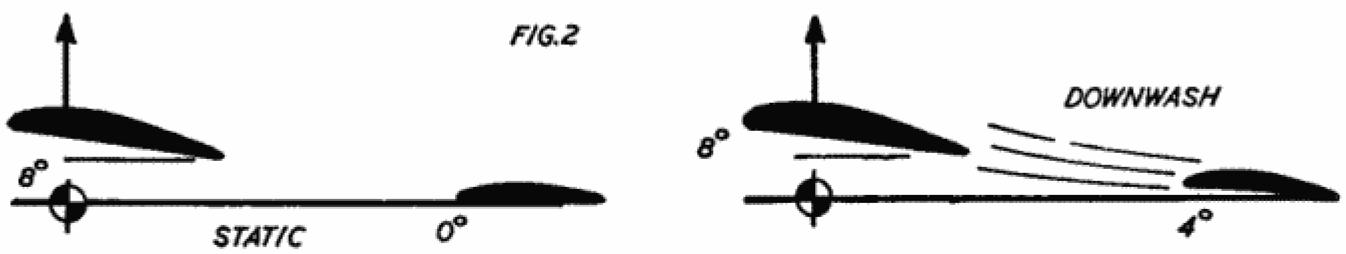


FIG. 2

Given a particular model, it can be trimmed to fly under any of these three conditions by one of two basic methods—adjusting the position of the centre of gravity to match, or adjusting the rigging angles of wing and tailplane (usually tailplane only); or employing a combination of both adjustments. In general terms adjusting (or adopting) a particular centre of gravity position establishes a rough trim *which will largely determine the flying characteristics of the model*, when fine trimming can be done by means of small adjustments of tailplane rigging angle.

The three flight conditions described in Fig. 1 are typical. High speed trim (A) corresponds to the power-on trim of a power-duration model and to the desirable "hands off" trim on a radio model. The intermediate trim B is typical of sports model trim. Low-speed, high-lift trim C is typical of the trim required for maximum glide performance (minimum sinking speed being achieved when the trim is such that the model is virtually on the point of stalling without actually stalling). For maximum performance a duration model is normally called upon to change its trim from A to C when the power run ceases, calling for two distinct "trims" to be worked out—"power on" and "glide" trim. In the case of an engine-powered model the change is abrupt when the engine stops. With a rubber-powered duration model the change is progressive from A to C, as the torque output of the rubber motor falls off gradually.

In actual fact, a rubber motor power curve is, typically, an initial burst of high power falling off quite rapidly to a more or less constant level (diminishing slowly), followed by a final tailing right off. It is a measure of the success of the trim how well the initial burst can be accommodated by maintaining an "A" type trim for this period, then approaching a "C" type trim for the remainder of the flight. A majority of rubber models trimmed for duration flying do, in fact, dwell much too long on a "B" type trim and end up with an intermediate B-C type glide trim, with a considerable loss of performance as a consequence. The more or less standard folding propeller is not helpful in this respect as if the glide trim is right—*i.e.*, a near-stalling "C" type trim, the latter part of the power run with the blade(s) still unfolded must represent an under-elevated trim. There is thus a strong argument in favour of using higher powers and shorter propeller runs with folding prop. rubber models in order to reduce the tendency towards level flight power-on "cruise" which can occur with lower power, longer run motors.

Using a long motor run, the ideal trim aims at approaching a type "C" trim over the latter part of the power run. The shift in CG aft when the propeller folds may then upset the trim to the extent that the model stalls on the glide, unless mechanically compensated (*e.g.*, by arranging for a counterweight to swing forwards as the propeller blade(s) folds back and so cancel any CG shift.

Given optimum glide trim, to avoid stalling towards the end of the power run, the power-on trim at this point may correspond to slightly *diving* flight, which is destroying much of the possible merits of using a longer power run anyway. CG shift can, therefore, be quite critical on a rubber model trimmed out for optimum performance.

CG shift can also be responsible for inconsistent performance with a rubber model using a long pre-tensioned (corded) motor. The motor may account for anything up to 50 per cent of the total weight. Its particular CG is apparently fixed, but a motor does not unwind evenly and in the case of a very long motor the resulting CG shift of the motor itself can be quite appreciable sufficient, in fact, to move the CG of the whole model by as much as half an inch or more. The effect will not be very apparent in flight if the CG shift is forwards, but if the shift is aft the model may stall or "wallow" at some point on its power run, simply because it is momentarily completely out of trim. The most likely time for this to occur is during the first quarter of the power run, when trim is the most critical.

Any of the three trim conditions (and intermediate trims) can be realised with any centre of gravity position, within a logical range. Foremost position of the centre of lift (centre of pressure) occurs at the highest angle of attack, when it will approach 25 per cent of the chord back from the leading edge. That same point represents a nominal forward CG position, although not necessarily an efficient one. Ignoring drag forces which could affect the balance, the CG at 25 per cent would require neutral tailplane lift to balance with the wing at, say, 8 degrees angle of attack—Fig. 2. For zero lift the tailplane would *not* have to be set at 8 degrees less incidence to the wing (assuming a symmetrical tailplane section for simplicity), but at some positive angle. This is because it will be operating in downwash from the wing, the degree to which the airflow over the tail is affected by wing downwash depending on the position of the tailplane (vertical position relative to the trailing edge of the wing and horizontal distance from the trailing edge). Assuming a conventional tail moment length and the tailplane mounted in the wake of the wing, downwash over the tailplane will be about one half the wing angle of attack. Thus the tailplane will have to be rigged to have an (apparent) angle of attack of 4 degrees under trim conditions—*i.e.*, 4 degrees difference in rigging angle between wing and tailplane, this difference normally referred to as longitudinal dihedral.

This sort of trim will have a powerful stabilising action should the wing stall, since downwash will be reduced and so the tail suddenly starts to operate

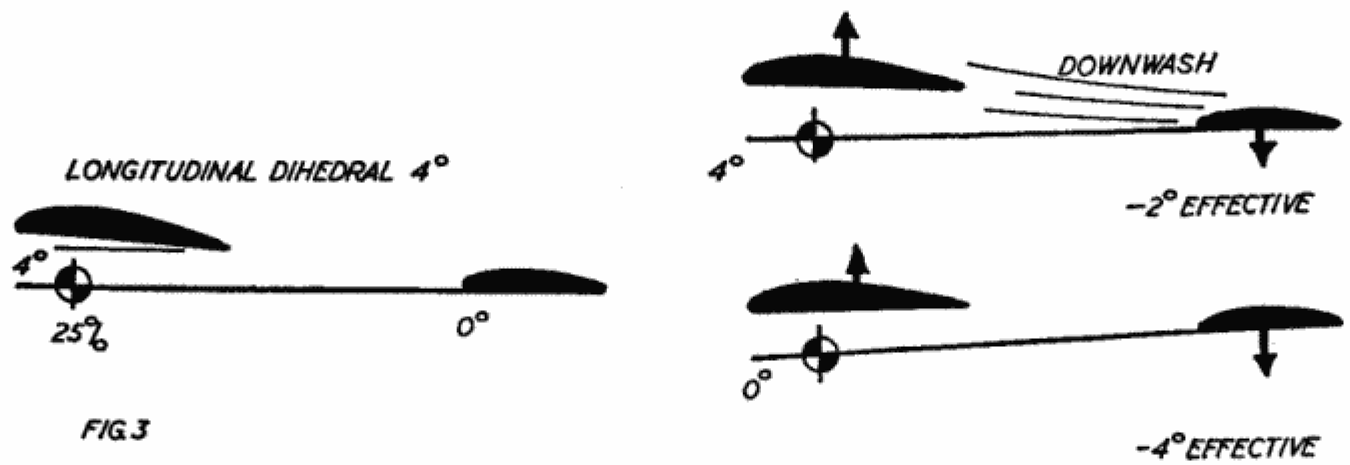


FIG. 3

at a positive angle of attack. However, if directly in the path of the stalled wing wake, airflow over it may be considerably disturbed and its efficiency as a lifting surface considerably reduced.

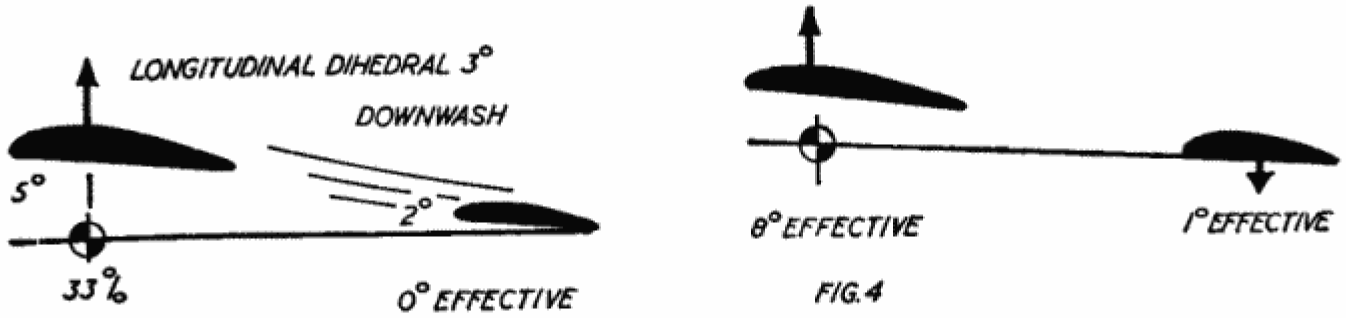
Should the model momentarily nose down, say to give the wing an operating angle of attack of 4 degrees, the centre of pressure will move back producing a diving moment about the CG. The tailplane, however, will now be operating at *minus* 2 degrees angle of attack, giving a strong recovery effect—Fig. 3. Thus a forward CG position for rigging demands a large longitudinal dihedral to balance (3 or 4 degrees difference between wing and tailplane) and has a very strong recovery action when the model is displaced from its original trim attitude. It is not necessarily a very efficient set-up, however, since recovery is initiated by *downward* lifting forces. Against this, however, is the fact that recovery is effected *rapidly* with minimum loss of height.

A more logical forward limit for the CG is 33 per cent of the chord. This corresponds to type "B" trim with the tailplane rigged to contribute no lift. The difference called for between the rigging angles of the wing and tailplane will be about 2½ degrees—see Fig. 4. In practice the longitudinal dihedral angle will probably need to be a little greater as downwash at this wing operating angle of attack will probably be a little less than half the wing angle of attack.

To turn this into a type "C" trim for best glide performance will require a slight amount of negative lift from the tailplane to hold the wing at the higher angle of attack necessary—*i.e.*, packing under the tailplane trailing edge. The 3 to 4 degree longitudinal dihedral resulting will, however, react fairly violently to changes in flying speed and about the only satisfactory method of controlling the thrust for "power on" trim will be to add a generous amount of downthrust. It is, in fact, a characteristic of most powered models (engine or rubber powered) that a fairly forward CG position demands a generous amount of downthrust to trim out fully, and in some design layouts an excessive amount of downthrust. One thing in its favour, however, is that the generous longitudinal dihedral of about 3 degrees of so (rigged) does provide rapid recovery from disturbances.

It is, therefore, a good balance position for sports type free flight models, although there is some advantage in putting the CG slightly farther aft (say 35 to 40 per cent) for a slightly more efficient set-up—*i.e.*, getting a type "C" trim without "negative" lift from the tailplane. The latter also represents a good CG range for R/C models, with a slight reduction in longitudinal dihedral to promote type "A" trim rather than type "B". In the case of a "multi" R/C model the longitudinal dihedral may be reduced to zero for a more or less neutral stability trim, relying on the elevators or elevator trim to recover from any unstable movement which may develop; and elevator trim and engine speed control for adjusting flying speed and attitude.

The farther aft the CG is moved the more efficient the wing and tailplane set-up becomes as a lifting combination, but the more critical the trim becomes as regards rigging angles. Longitudinal dihedral is necessarily reduced as the tailplane must operate at a fairly high angle of attack to contribute reasonable lift. To minimise downwash effects it is desirable to remove the tailplane from the

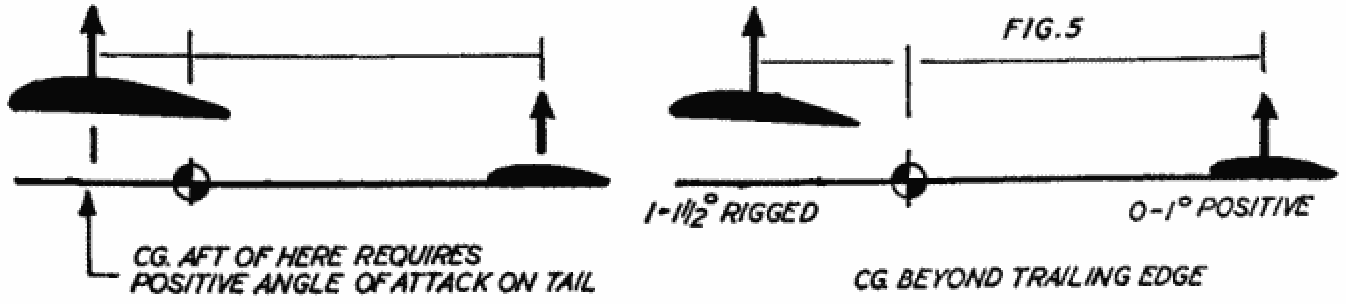


wing as far as possible—*e.g.*, on a long moment arm; or take advantage of some other design feature which is favourable to an aft CG position—*e.g.*, a pylon-mounted wing. The two may be combined—*e.g.*, pylon-mounted wing and long moment arm. In such cases it may well be possible to establish a balance point aft of the wing trailing edge, although 66 per cent to 100 per cent of the chord is more usual—Fig. 5.

Recovery following a momentary nosing down is then largely given by the drag of the high mounted wing. Stall recovery is usually poor because wing drag opposes recovery and tail lift is relatively ineffective at this attitude. Thus having stalled, the model may go into a relatively prolonged dive before pulling out. Downthrust requirements, on the other hand, are usually reduced to a minimum since the tailplane rigging angle is often positive to the thrust line to start with.

A particular point to bear in mind is that with a design layout intended for an aft CG position to balance, re-trimming with a forward CG position will drastically reduce the efficiency of the set-up and may, in some circumstances, even make it "untrimmable". Thus forward movement of the CG would have to be compensated by adding negative incidence to the tailplane. This would put the tailplane at a negative incidence to the thrust line, calling for a substantial amount of downthrust to compensate for power-on trim. The resulting slip-stream may now even produce unstabilising effects on the pylon and wing centre section. Equally, a model correctly designed for a normal forward CG position (*e.g.*, 40 to 45 per cent chord) will tend to become increasingly difficult to trim and suffer a marked loss of stability if balanced with an aft CG position. The balance point, or permissible CG range, is thus an integral feature of any design layout.

As a generalisation, the common tendency with all free flight models is to arrive at a final trim which is more *under-elevated* than is desirable for maximum performance; and with radio controlled models to arrive at a trim which is more *over-elevated* than desirable. This usually applies particularly to glide trim. The average modeller is usually content to stop at what he finds is a safe



power-on trim at an early stage without having fully worked out the best glide trim. He then dare not rework the glide trim for fear of upsetting the power-on trim again. The real answer is to establish the glide trim *completely* first and then finally work on power-on trim, whatever the type of model. If this does not work out properly it may be necessary to readjust the balance and rigging angles and work right through again. Getting a model to fly is easy. Getting it to fly well is a little harder. Getting it to fly at its best can be quite a difficult process.

A model as built will normally tend to work out tail heavy, mainly because not enough attention is given to material selection and weights of tail end components. It *pays* to built light for the tailplane and fin, and keep the rear end of the fuselage structure as light as possible. The ideal model structure would have all the weight concentrated around the centre of gravity and would be easier to trim, fly better and be more stable (and more manoeuvrable in the case of an R/C model).

In general it will pay to start trimming by adding ballast or shifting interior weights to bring the balance point to the design position or at least very near it, because of the effect on stability margin as determined by the design layout. All the adjustment can then be done by adjustment of rigging incidences, and downthrust and sidethrust as required. To save adding more weight it may even be preferable to alter the wing position, if practicable, to bring the CG in line with the design balance point. This was the original method of trimming used on model aeroplanes and is still one of the most effective methods of all. Virtually all modern designs, however, have a fixed wing position and so in following, or modifying, a plan, it is very important not to depart from material specifications, *etc.*, which could throw out the original balance of weights. Even better, try to lighten the tail end if possible. You are then more likely to end up with a more or less correct balance point.

Before flying, rigging angles should be checked. The actual angles relative to the fuselage datum are largely unimportant, except for the tailplane incidence relative to the thrust line. It is the longitudinal dihedral angle or difference in rigging incidences between the wing and tailplane which really count. A suitable "datum" for measurement is a straightedge (*e.g.*, a length of strip) strapped to the bottom of the tailplane, as shown in Fig. 6. Measurement of wing incidence can then be taken from this datum to the wing leading and trailing edge. This is the true or geometric incidence of the wing (relative to the tailplane). More commonly the *tangent chord* of the wing is used for measurement, represented by a straightedge laid along the underside of the wing. Either can be used.

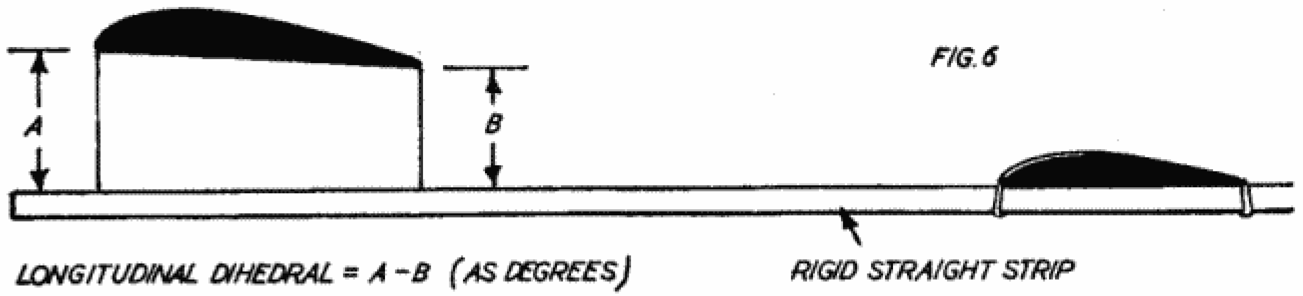


FIG. 6

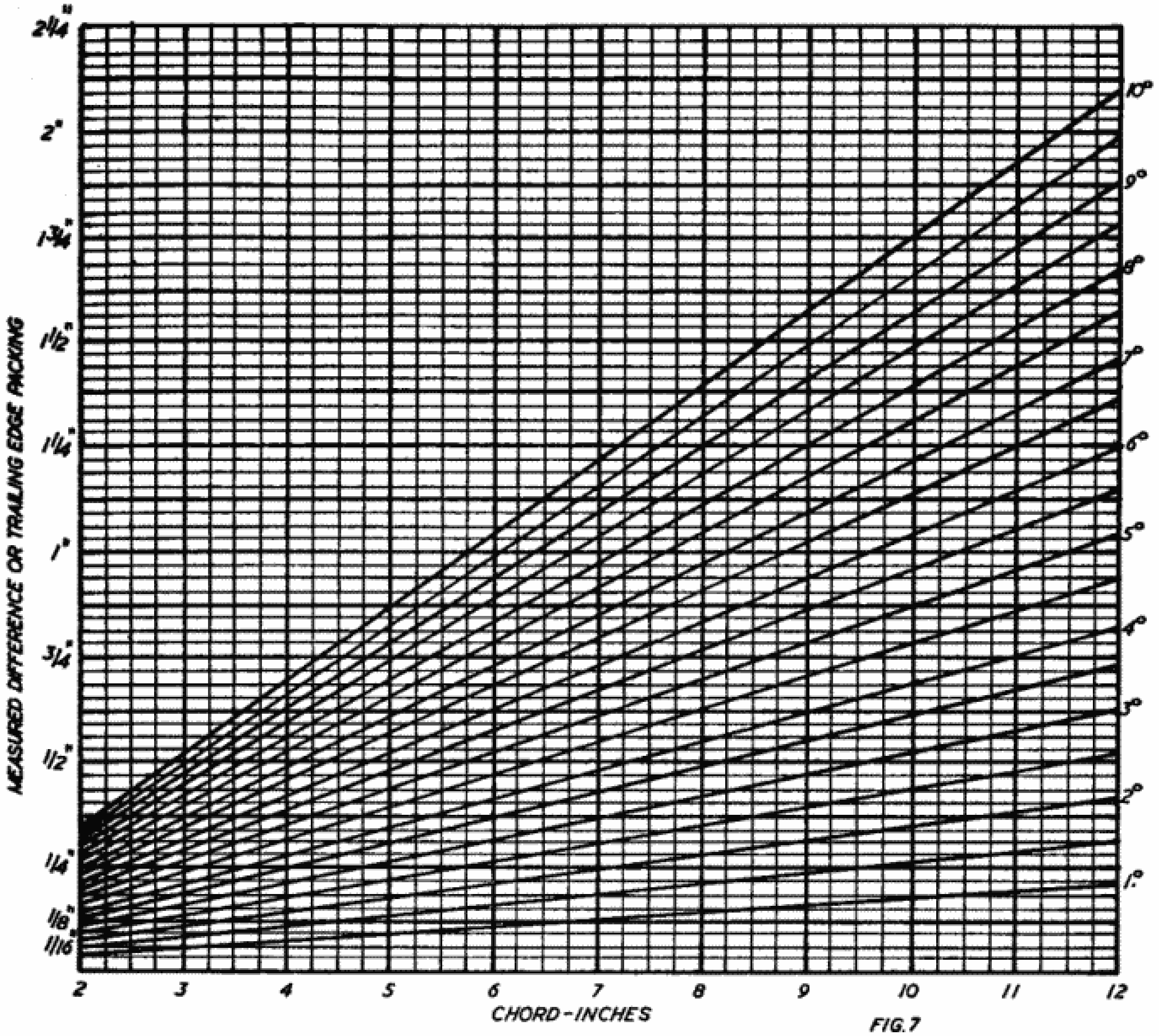


FIG. 7

An alternative method of measurement is to stand the assembled model on a flat, horizontal surface and prop up to a suitable angle (*e.g.*, to give the tailplane an attitude equivalent to zero incidence, parallel to the table top). The attitude of the wing geometric chord or tangent chord can then be measured at the leading and trailing edges; and the same for the tailplane, if not horizontal. Fig. 7 can then be used to translate measurement into degrees.

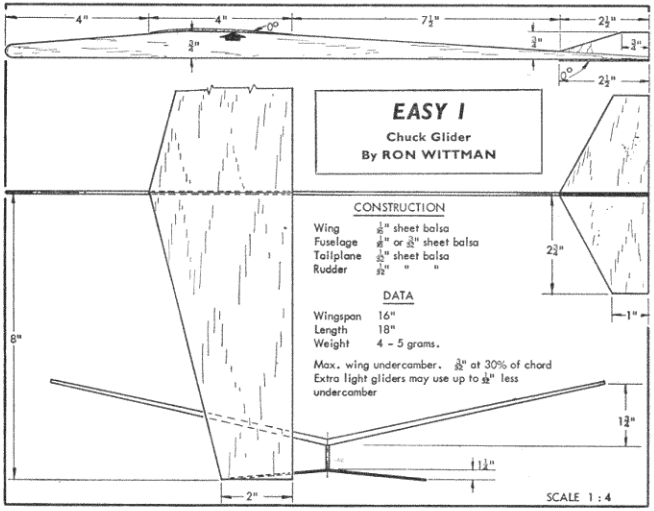
Although acceptable longitudinal dihedral is related to the design layout, the following general figures can be used as a guide.

Balance point % chord	*Typical longitudinal dihedral (degrees) Shoulder—or high wing*	*Pylon wing*
33	3½-4	—
35	3 -3½	—
40	3	—
45	2½-3	—
50	2½	2½
60	1½-2	2
70	—	1½

Any marked deviation from this is likely to mean that the rigging incidences are wrong and need correcting before attempting to fly the model. For example a 4 degrees longitudinal dihedral associated with a 60 per cent chord CG position will almost certainly lead to a stall on the initial flight. Table I will be useful to judge the thickness of packing required to affect an angular change with different chord lengths.

Since trimming is outside the scope of this present article we will assume that the model has now been trimmed and is flying satisfactorily, but with some limitations. As a typical example, the model may have a marked tendency to zoom (a common failing with rudder-only models on coming out of a turn). It is apparently over-elevated, but correction by adding positive incidence to the tailplane (or decreasing the negative incidence) may result in definite under-elevation. This indicates that the balance point was wrong to start with and should be moved farther *aft*, retrimming by increasing the tailplane (positive) incidence, or decreasing the wing incidence (with packing under the trailing edge).

Radio models, in particular, benefit from tailplane trim *plus* adjustment of the CG to arrive at an optimum set-up, although most modellers are loath to shift internal gear once fitted. The extra effort is almost invariably worth it. It is not worth 'compensating' for a poor balance position by other trimming techniques, as this will only result in a set-up less efficient and pleasing to fly than it could be.



INDOOR NEWS & VIEWS, TEXAS, U.S.A.

ENGINE ANALYSIS

WEBRA PICCOLO ·78 c.c.

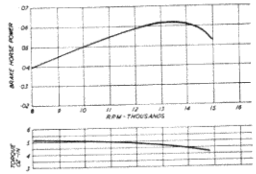
Material Specification

Crankcase unit: light alloy pressure die casting
Cylinder: hardened steel
Cylinder jacket: anodised dural
Crankshaft: hardened steel
Piston: cast iron
Contra piston: cast iron
Connecting rod: dural
Crankcase end cover: turned dural
Propeller driver: turned dural
Spraybar assembly: nickel plated brass
Crankcase bearing: plain

British Agents:
MODEL AIRCRAFT (BOURNEMOUTH) LTD.
Price: £3/8/6 (including Purchase Tax)

Specification

Displacement: ·78 c.c. (·047 cu. in.)
Bore: ·415 in. (10·5 mm.)
Stroke: ·354 in. (9 mm.)
Bore/stroke ratio: 1·17
Weight: 1·6 ounces
Max. B.H.P.: ·062 at 13,500
Max. torque: 5·2 ounce-inches at 9,000 r.p.m.
Power rating: ·08 B.H.P. per c.c.
Power-weight ratio: ·039 B.H.P. per ounce



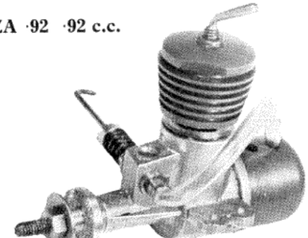
ZA ·92 ·92 c.c.

Specification

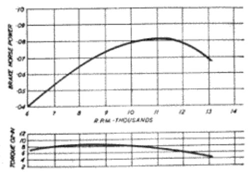
Displacement: ·9262 c.c. (·062 cu. in.)
Bore: ·438 in.
Stroke: ·375 in.
Weight: 2 ounces
Max. power: ·082 B.H.P. at 11,800 r.p.m.
Max. torque: 9 ounce-inches at 8,500 r.p.m.
Power rating: 0·089 B.H.P. per c.c.
Power/weight ratio: 0·041 B.H.P. per ounce

Material Specification

Crankcase: light alloy pressure die casting
Cylinder: hardened EN202 steel
Crankshaft: hardened EN32 steel
Main bearing: Manganese bronze bush
Piston: cast iron
Contra piston: cast iron
Connecting rod: Hiduminium
Cylinder jacket: turned dural (anodised red)
Tank: turned dural (anodised red)
Spraybar: brass
Back cover: turned dural
Propeller driver: dural



Manufacturers:
DE-ZE-LUX DEVELOPMENTS LTD., 231 High St., Brentford, Middlesex
Retail price: £2/9/2 (including P.T.)



PROPELLER—R.P.M. FIGURES

Propeller dia. × pitch	*r.p.m.*
9 × 4 (Top Flite)	5,950
6 × 4 (Top Flite)	13,000
7 × 4 (Top Flite)	10,250
8 × 4 (Top Flite)	9,400
8 × 4 (Trucut)	9,200
7 × 4 (Trucut)	10,100
7 × 6 (K-K nylon)	8,300
8 × 4 (K-K nylon)	8,550
7 × 4 (K-K nylon)	10,600
6 × 4 (K-K nylon)	12,900

Fuel: Mercury No. 8

WEBRA RECORD

R/C 1·5 c.c.

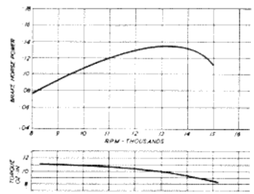
Specification

Displacement: 1·47 c.c. (·09 cu. in.)
Bore: ·472 in.
Stroke: ·512 in.
Weight: 3¼ ounces
Max. power: ·134 B.H.P. at 13,000 r.p.m.
Max. torque: 11 ounce/inches at 9,000 r.p.m.
Power rating: ·09 B.H.P. per c.c.
Power/weight ratio: ·041 B.H.P. per ounce

Material Specification

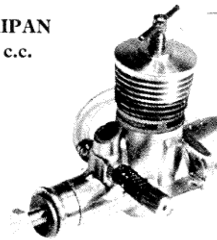
Crankcase: light alloy pressure die casting
Cylinder: hardened steel
Cylinder jacket: dural
Piston: cast iron
Contra piston: cast iron
Crankshaft: hardened steel
Connecting rod: dural forging
Spraybar assembly: nickel plated brass
Crankcase end cover: turned dural
Main bearing plain

British Agents:
MODEL AIRCRAFT (BOURNEMOUTH) LTD.
Price: £4/4/1 (including Purchase Tax); £3/14/5 (without throttle)



TAIPAN

1·5 c.c.



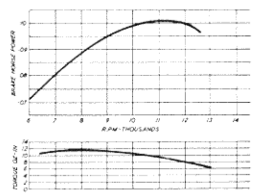
Specification

Displacement: 1·517 c.c. (·0925 cu. in.)
Bore: ·511 in.
Stroke: ·453 in.
Weight: 3¾ ounces
Max. power: ·101 B.H.P. at 11,000 r.p.m.
Max. torque: 11·6 ounce/inches at 7,800 r.p.m.
Power rating: ·067 B.H.P. per c.c.
Power/weight ratio: ·027 B.H.P. per ounce

Material Specification

Crankcase: light alloy die casting (L33 alloy)
Cylinder: mild steel, hardened
Piston: Meehanite
Contra piston: Meehanite
Cylinder jacket: aluminium alloy
Crankshaft: 3 per cent nickel steel, hardened
Connecting rod: aluminium alloy
Crankcase back cover: aluminium alloy
Tank: aluminium alloy
Spraybar: brass

Manufacturers:
GORDON BURFORD & Co., 40 Belfast St., Grange, South Australia
Retail price: £3/3/- (Sterling)



PROPELLER—R.P.M. FIGURES

Propeller dia. × pitch	*r.p.m.*
7 × 6 (Top Flite)	10,200
8 × 6 (Top Flite)	8,400
9 × 4 (Top Flite)	8,350
8 × 4 (Top Flite)	9,800
7 × 4 (Top Flite)	11,500
8 × 4 (Trucut)	9,600
8 × 4 (K-K nylon)	9,900
7 × 6 (Trucut)	9,750
7 × 4 (K-K nylon)	11,300
8 × 6 (K-K nylon)	7,400

Fuel: Mercury No. 8

JENA 2 c.c.

Specification

Displacement: 1·97 c.c. (·12 cu. in.)
Bore: ·548 in. (13·9 mm.)
Stroke: ·512 in. (13 mm.)
Bare weight: 5 ounces
Power output: ·238 B.H.P. maximum at 13,800 r.p.m.
Max. torque: 22 ounce/inches at 9.500 r.p.m.
Power rating: ·12 B.H.P. per c.c.
Power/weight ratio: ·0475 B.H.P. per ounce

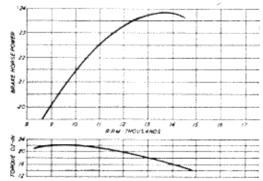
Material Specification

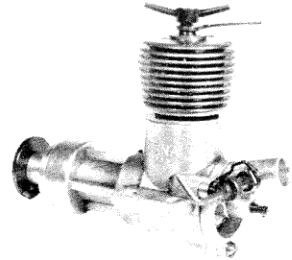
Crankcase: light alloy pressure die casting
Cylinder (liner): hardened steel

Crankshaft: hardened steel
Piston: cast iron
Contra piston: hardened steel
Connecting rod: light alloy pressure die casting
Cylinder jacket: turned dural (anodised blue)
Crankcase back cover: light alloy pressure die casting
Rotor disc: light alloy pressure die casting
Main bearings: two lightweight ball races
Propeller driver: dural
Propeller shaft: 4 mm. steel screw (metric thread)

Models and Variants

Jena 2 c.c. DNR: diesel, normal head, rotary disc induction
Jena 2 c.c. DNK: diesel, normal head, reed valve induction
Jena 2·5 c.c. DNR: diesel, normal head, rotary disc induction
Jena 2·5 c.c. DKR: diesel, small head, rotary disc induction
Jena 2·5 c.c. DNK: diesel, normal head, reed valve induction
Jena 2·5 c.c. DMK: diesel, small head, reed valve induction





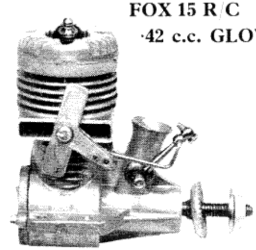
PROPELLER—R.P.M. FIGURES

Propeller dia. × pitch	*r.p.m.*
9 × 6 (Trucut)	9,400
9 × 4 (Trucut)	11,400
9 × 5 (Stant)	10,000
9 × 4 (Stant)	10,800
8 × 4 (Stant)	13,200
9 × 6 (Frog nylon)	10,200
8 × 6 (Frog nylon)	11,000
8 × 6 (Top Flite nylon)	11,200
9 × 4 (Top Flite nylon)	11,300

Fuel: Mercury No. 8

FOX 15 R/C

·42 c.c. GLOW

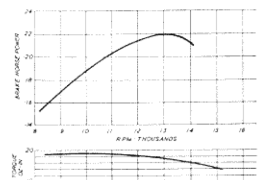


Specification

Displacement: 2·42 c.c. (·1476 cu. in.)
Bore: ·590 in.
Stroke: ·540 in.
Weight: 3¾ ounces
Max. power: ·22 B.H.P. at 13,000 r.p.m.
Max. torque: 19 ounce/inches at 10,000 r.p.m.
Power rating: ·091 B.H.P. per c.c.
Power/weight ratio: ·059 B.H.P. per ounce

Material Specification

Crankcase unit: pressure die cast light alloy
Crankcase back cover: pressure die cast light alloy, attached by two screws
Cylinder liner: leaded steel (unhardened)
Piston: cast iron
Cylinder head: light alloy pressure die casting
Connecting rod: light alloy
Crankshaft: alloy steel, hardened and ground to finish
Main bearing: bronze
Throttle: rotating spraybar in brass; unit retained by spring circlip

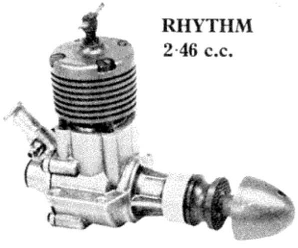


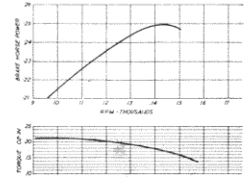
PROPELLER—R.P.M. FIGURES

Propeller dia. × pitch	*r.p.m.*
8 × 6 (Top Flite nylon)	10,200
9 × 4 (Top Flite nylon)	10,500
8 × 4 (Top Flite nylon)	13,200
7 × 4 (Top Flite nylon)	14,900
8 × 4 (Trucut)	13,000
9 × 4 (K-K nylon)	10,800
8 × 4 (K-K nylon)	12,800
7 × 6 (K-K nylon)	12,400

Fuel used: Mercury 45

RHYTHM
2·46 c.c.





Specification

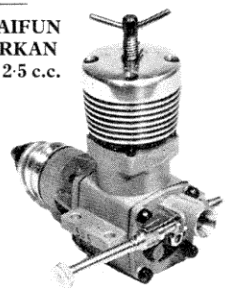
Displacement: 2.46 c.c. (·15 cu. in.)
Bore: ·552 in. (14 mm.)
Stroke: ·630 in. (16 mm.)
Bare weight: 6½ ounces
Max. power: ·25 B.H.P. at 14,400 r.p.m.
Max. torque: 21·5 ounce/inches at 9,800 r.p.m.
Power rating: ·1 B.H.P. per c.c.
Power/weight ratio: ·038 B.H.P. per ounce

Material Specification

Crankcase unit: light alloy gravity die casting, machined faces and machined internally for ball race housings, transfer port clearances and connecting rod clearance
Cylinder liner: hardened steel ·6985 in. o/d (top and bottom, above and below exhaust ring)
Piston: cast iron, shallow conical frustum top
Gudgeon pin: silver steel approx. ·165 in. diameter
Connecting rod: machined from dural
Crankshaft: hardened steel (solid)
Drum valve: hardened steel, ·3735 in. o/d drum
Main bearings: Standard 7 mm. ball race (rear;) lightweight 6 mm. ball race (front)
Cylinder jacket: turned dural, anodised purple
Propeller driver: turned dural, anodised purple, brass split collet
Spinner nut: turned dural, anodised purple
Crankcase back cover (integral drum valve housing and intake tube): light alloy gravity die casting
Spraybar: brass

Propeller—R.P.M. Figures	
Propeller dia. × pitch	*r.p.m.*
9 × 6 (Frog)	10,500
8 × 4 (Frog)	12,900
9 × 4 (KK)	11,600
8 × 4 (KK)	13,000
9 × 4 (Top Flite)	11,000
8 × 6 (Top Flite)	11,100
8 × 4 (Top Flite)	13,600

TAIFUN ORKAN
2·5 c.c.



Specification

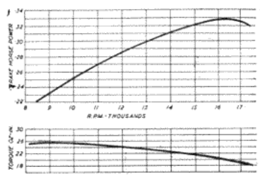
Displacement 2·48 c.c. (·151 cu. in.)
Bore: ·552 in.
Stroke: ·591 in.
Weight: 6⅛ ounces
Max. power: ·328 B.H.P. at 16,400 r.p.m.
Max. torque: 25·5 ounce-inches at 9,500 r.p.m.
Power rating: ·132 B.H.P. per c.c.
Power/weight ratio: ·0535 B.H.P. per ounce

Material Specification

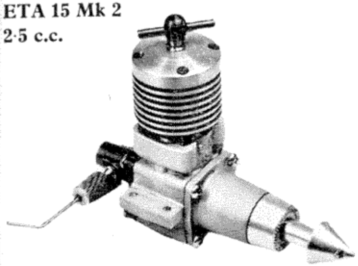
Crankcase: light alloy pressure die casting
Cylinder liner: hardened steel
Piston: cast iron
Contra piston : cast iron
Connecting rod: light alloy
Crankshaft: hardened steel
Bearings: two ball races
Prop. driver: dural
End covers: light alloy pressure die castings
Induction: plastic rotor (rear disc)
Spraybar: brass
Needle valve: steel with brass thimble

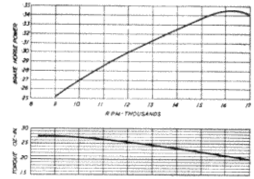
Propeller—R.P.M. Figures	
Propeller dia. × pitch	*r.p.m.*
10 × 3½ (Top Flite nylon)	10,200
9 × 4 (Top Flite nylon)	12,100
8 × 4 (Top Flite nylon)	15,100
7 × 4 (Top Flite nylon)	17,200
7 × 6 (Top Flite nylon)	15,000
9 × 4 (KK nylon)	12,600
8 × 6 (KK nylon)	11,800
8 × 4 (KK nylon)	14,300
7 × 4 (KK nylon)	17,400
8 × 4 (Frog nylon)	14,200
7 × 6 (Frog nylon)	15,200
6 × 4 (Frog nylon)	22,000 plus

Fuel: 50:30:20 paraffin, ether, castor plus 4 per cent amyl nitrate



ETA 15 Mk 2
2·5 c.c.





Specification

Displacement: 2·5 c.c. (·152 cu. cm.)
Bore: ·560 in.
Stroke: ·620 in.
Bare weight: 6¼ ounces
Max. power: ·345 B.H.P. at 16,400
Max. torque: 27·5 ounce-inches at 9,000 r.p.m.
Power rating: ·137 B.H.P. per c.c.
Power/weight ratio: ·055 B.H.P. per ounce

Material Specification

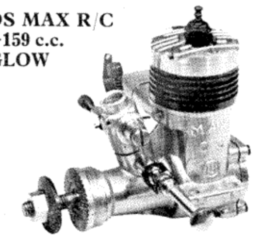
Crankcase: light alloy die casting
Front cover/bearing housing: light alloy pressure die casting
Rear cover: light alloy pressure die casting
Cylinder: hardened steel (investment casting)
Piston: Meehanite
Contra piston: Meehanite
Crankshaft: forged alloy steel, hardened and ground
Bearings: ½ in. Hoffman ball races (front and rear)
Propeller driver: turned dural, collet fitting
Cylinder jacket: turned dural, anodised light blue
Jet assembly: nickel plated brass. Nickel plated needle thimble, "blued" spring steel ratchet lock
Compression screw: steel, chemically blacked
Spinner nut: turned dural

Manufacturers:
ETA Instruments Ltd., 289 High Street, Watford
Price: £5/15/- plus £1/1/7 P.T.

Propeller—R.P.M. Figures	
Propeller dia. × pitch	*r.p.m.*
9 × 4 (Trucut)	12,000
8 × 6 (Trucut)	11,500
8 × 4 (Trucut)	15,500
10 × 6 (Frog)	9,250
9 × 6 (Frog)	11,000
8 × 4 (Frog)	14,800
9 × 4 (K-K)	13,200
8 × 6 (K-K)	12,700
8 × 4 (K-K)	15,200
10 × 3½ (Top Flite)	10,500
9 × 6 (Top Flite)	9,900
9 × 4 (Top Flite)	12,300
8 × 6 (Top Flite)	12,400
8 × 4 (Top Flite)	15,500

Fuel: paraffin, 50 per cent; ether, 30 per cent; castor oil, 20 per cent; plus 3 per cent amyl nitrate

OS MAX R/C
3·159 c.c.
GLOW



Specification

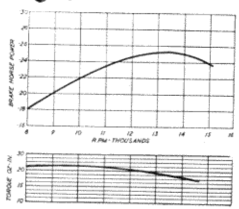
Displacement: 3·159 c.c. (·193 cu. in.)
Bore: ·6535 in. (16·5 mm. nominal)
Stroke: ·575 in. (14·5 mm. nominal)
Bare weight: 5¾ ounces
Max. power: ·254 B.H.P. at 13,300 r.p.m.
Max. torque: 22·5 ounce-inches at 9,500 r.p.m.
Power rating: ·0805 B.H.P. per c.c.
Power/weight ratio: ·043 B.H.P. per ounce

Material Specification

Crankcase: pressure die cast light alloy incorporating lower cylinder and stub exhaust

Propeller—R.P.M. Figures	
Propeller dia. × pitch	*r.p.m.*
8 × 6 (Frog nylon)	10,300
10 × 6 (Frog nylon)	7,900
9 × 6 (Frog nylon)	10,100
9 × 4 (K-K nylon)	11,900
8 × 6 (K-K nylon)	11,000
10 × 4 (K-K nylon)	9,400
10 × 3½ (Top Flite nylon)	9,500
9 × 4 (Top Flite nylon)	11,200
9 × 6 (Top Flite nylon)	9,100
8 × 6 (Top Flite nylon)	10,800
8 × 4 (Top Flite nylon)	13,800

Fuel: 75/25 methanol castor plus 5 per cent nitrobenzene



Cylinder: mild steel, turned with integral fins, blued
Piston: cast iron
Connecting rod: dural (machined)
Cylinder head: light alloy pressure die casting
Crankshaft: hardened steel
Gudgeon pin: hollow silver steel
Back cover: light alloy pressure die casting

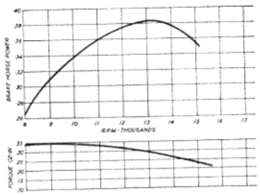
OLIVER TIGER MAJOR 3·5 c.c.

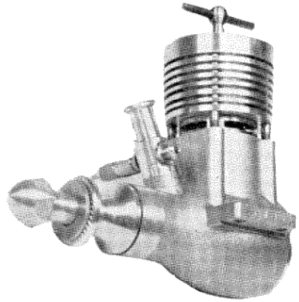
Specification

Displacement: 3·47 (·212 cu. in.)
Bore: ·620 in.
Stroke: ·705 in.
Bare weight: 6 ounces
Collector ring: $\frac{5}{16}$ ounce
Max. power: ·386 B.H.P. at 13,200 r.p.m.
Max. torque: 35 ounce-inches at 9,000 r.p.m.
Power rating: ·112 B.H.P. per c.c.
Power/weight ratio: ·0643 B.H.P. per ounce

Material Specification

Crankcase: gravity die casting in LAC 113 B light alloy
Cylinder: EN 32 steel, fully hardened
Crankshaft: EN 36 Nichrome heat treated and ground
Piston: Meehanite
Connecting rod: turned from RR 56 light alloy, bronze little end bearing
Cylinder jacket: turned dural
Main bearings: $\frac{3}{8}$ in. (rear) and $\frac{1}{4}$ in. dia. ball races (front) Hoffman L. J.
Propeller driver: turned dural
Crankcase back cover: turned dural (threaded to screw in)
Contra piston: Meehanite
Spraybar: brass





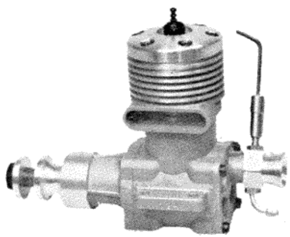
Manufacturers:
J. A. Oliver, "Four Acres", Ringwood Road, Ferndown, Dorset
Price: £5/15/- plus £1/3/2 P.T. Collector and Silencer fitted £1. Collector separate, unmachined 12/6

Propeller—R.P.M. Figures	
Propellers dia. × pitch	r.p.m.
11 × 4 (Top Flite nylon)	9,600
10 × 6 (Top Flite nylon)	9,900
9 × 6 (Top Flite nylon)	10,800
9 × 4 (Top Flite nylon)	13,500
8 × 6 (Top Flite nylon)	13,300
8 × 4 (Top Flite nylon)	15,200
12 × 6 (K-K nylon)	8,500
12 × 4 (K-K nylon)	9,100
11 × 6 (K-K nylon)	8,900
11 × 4 (K-K nylon)	10,400
10 × 6 (K-K nylon)	10,100
10 × 4 (K-K nylon)	12,600
9 × 6 (K-K nylon)	10,500
9 × 4 (K-K nylon)	13,500
8 × 6 (K-K nylon)	12,800
8 × 4 (K-K nylon)	14,700
9 × 6 (Frog nylon)	12,200

MOKI S-4 5 c.c. GLOW

Specification

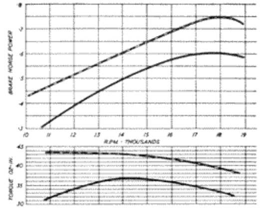
Displacement: 4·94 c.c. (·302 cu. in.)
Bore: ·7485 in. (19 mm.)
Stroke: ·685 in. (17·4 mm.)
Weight: 9 ounces
Max. power: ·6 B.H.P. at 17,800 r.p.m. on 75:25 methanol:castor fuel; ·75 B.H.P. at 18,000 r.p.m. on 50 per cent nitromethane; 23 castor; 25 methanol fuel
Max. torque: 36·5 ounce-inches on 75:25 methanol: castor fuel; 43·5 ounce-inches on 50:25:25 nitro; castor; methanol fuel
Power rating: ·122 B.H.P. per c.c. on 75:25 methanol: castor fuel
Power/weight ratio: ·067 B.H.P. per ounce on 75:25 methanol:castor fuel



Material Specification

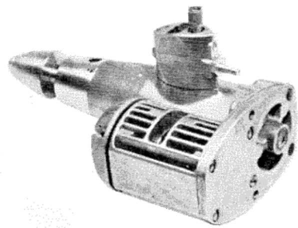
Crankcase unit: light alloy pressure die casting
Cylinder liner: alloy steel (unhardened)
Crankshaft: nickel-chrome steel, hardened
Piston: cast iron
Connecting rod: dural
Front assembly: light alloy pressure die casting fitted with two ball races (9 mm. rear, 6 mm. front)

Propeller—R.P.M. Figures		
Propeller dia. × pitch	r.p.m. 75:25 methanol: castor fuel	50 nitro; 25 castor; 25 methanol
10 × 6 (Top Flite)	9,400	11,000
11 × 4 (Top Flite)	9,000	
9 × 6 (Top Flite)	10,400	12,300
8 × 6 (Top Flite)	14,500	16,600
9 × 6 (Keilkraft)	10,200	12,100
9 × 4 (Keilkraft)	15,300	17,000



Rear assembly: light alloy pressure die casting fitted with a laminated phenolic rotor disc
Intake tube: turned dural
Jet tube and needle assembly: brass, steel needle
Cylinder head: turned dural
Propeller driver: turned dural

AERO 35 5·82 c.c. GLOW



Propeller—R.P.M. Figures	
Propeller dia. × pitch	r.p.m.
10 × 6 (Top Flite)	10,000
12 × 6 (Top Flite)	8,600
9 × 6 (Top Flite)	11,000
8 × 6 (Top Flite)	13,300
10 × 6 (K-K nylon)	10,200
9 × 6 (K-K nylon)	10,800
8 × 6 (K-K nylon)	13,200
10 × 6 (Frog nylon)	10,200
9 × 6 (Frog nylon)	12,300

Fuel: 70:30 methanol/castor oil

Manufacturers:
Acro Research, 51 Gt Arrow Avenue, Buffalo 16, N.Y., U.S.A.

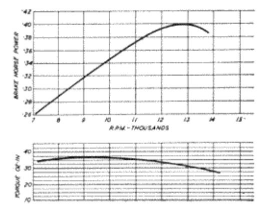
British Agents:
Performance Kits Ltd., Sandy, Beds

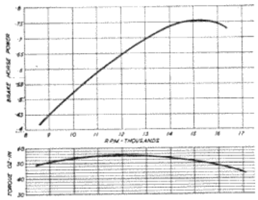
Specification

Displacement: 5·82 c.c. (·355 cu. in.)
Bore: ·815 in.
Stroke: ·680 in.
Weight: 9½ ounces
Max. power: ·40 B.H.P. at 12,800 r.p.m.
Max. torque: 36 ounce-inches at 9,000 r.p.m.
Power rating: ·069 B.H.P. per c.c.
Power/weight ratio: ·042 B.H.P. per ounce

Material Specification

Crankcase: light alloy pressure die casting, incorporating cylinder
Cylinder liner: mild steel
Piston: light alloy with two cast iron piston rings
Rocking con rod: high tensile steel (casting or forging) with hardened and ground plain and ball ends: hardened steel pivoted little end piston bearing
Main bearings: two ball races
Crankshaft: composite construction
Prop driver and prop shaft: dural
Cylinder head: light alloy pressure die casting
Rear cover: light alloy pressure die casting; bronze spherical shell bearing with screw adjustment for rocking con. rod ball end
Intake: light alloy pressure die casting; steel needle valve; dural fuel pipe connector
Assembly: crankcase and cylinder as integral unit with fitted liner; cylinder head attached by four screws; back cover attached by six screws (sealing on gasket); intake casting attached to crankcase by two screws; prop driver attached to crankshaft by hardened socket screw





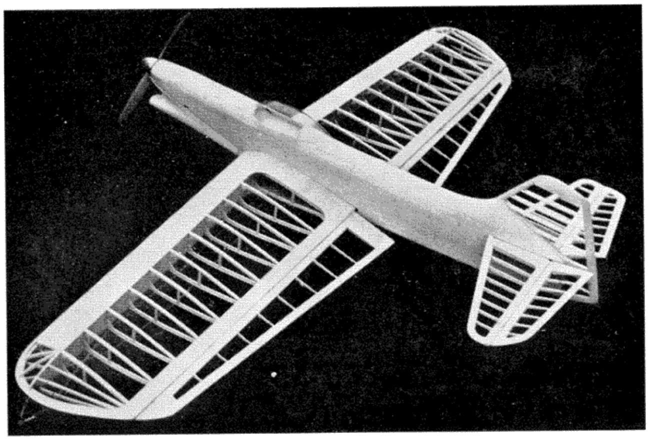
FOX 40BB
6·49 c.c. GLOW

PROPELLER—R.P.M. FIGURES	
Propeller *dia.* × *pitch*	*r.p.m.*
9 × 6 (Top Flite)	14,200 (15,300 on Fox *Blast*)
10 × 6 (Top Flite)	12,400 (13,200 on Fox *Blast*)
9 × 7 (Top Flite)	13,300
8 × 6 (Keilkraft)	16,800
9 × 6 (Keilkraft)	13,300
9 × 7 (Keilkraft)	13,600
9 × 6 (Frog nylon)	15,300

Fuel: 30 per cent nitromethane
All B.H.P. curve figures extracted on Fox *Blast* fuel (50% nitro)

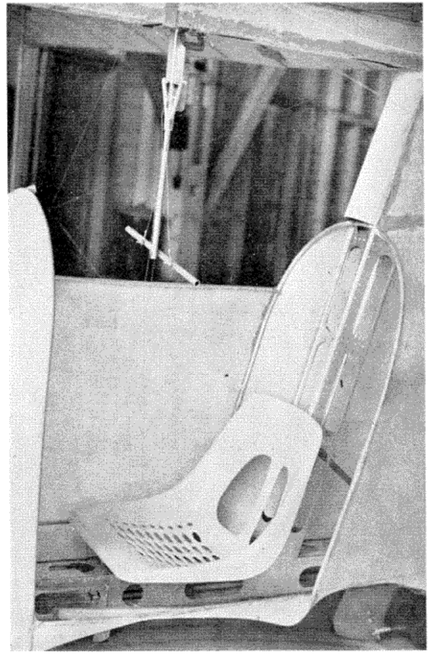
Specification

Displacement: 6·49 c.c. (·394 cu. in.)
Bore: ·800 in.
Stroke: ·790 in.
Weight: 8 ounces
Max. power: 76 B.H.P. at 15,600
Max. torque: 55 ounce-inches at 12,000 r.p.m.
Power rating: ·117 B.H.P. per c.c.
Power/weight ratio: ·095 B.H.P. per ounce



Paul Tupker's "Twister" outsize stunter (drawings on p. 107) with Fox 59 has novel cowl intake using two tubular shapes; combined "Ares" and "Nobler" wing construction; metal surface hinges, and a detachable wing for easier transportation.

Close-up detail of the pilot's seat and pendant lightweight control gear on the Canadian man-powered Biplane made at Calgary, Alberta, by Maurice Laviolette and Alvin Smolkowski. Other photographs will be found on page 63. Note the main member of the fuselage, fabricated in metal, which supports the seat, and beneath which, the lower mainplane is attached.

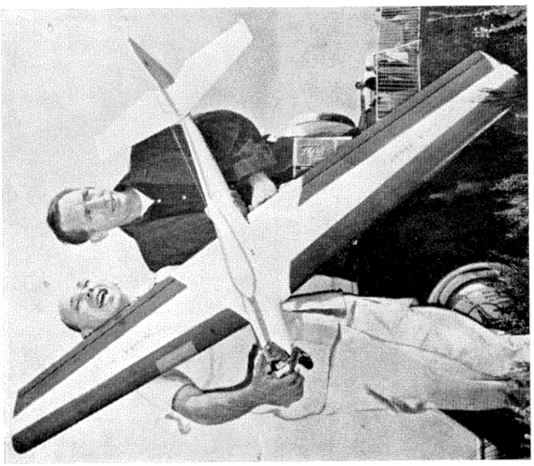


MUSCLE POWER

(*continued from page 63*)

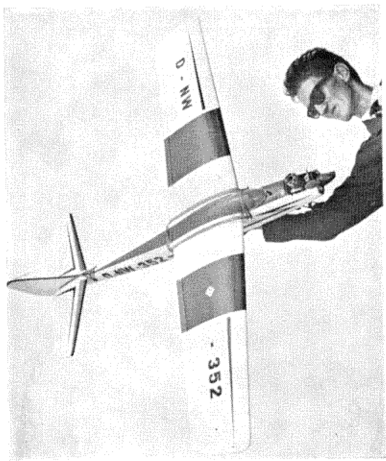
prop. size worked out to 16 ft. diameter, but the group settled for a 10-foot tractor, just like an enlarged Wakefield model type, and indeed a magnificent piece of work by expert model designer Martin Pressnell. Driven by cable with 2 in. spaced steel balls, the single prop. is pylon mounted with allowance for thrust adjustment. The wing has a laminar section, a solid spar and is mounted high to minimise body interference and risk of landing damage. Control on the elevator is of a positive position type, relieving the pilot of all static load (and feel!) and his instrumentation is red light for "too fast" and another for "too slow". Leaning heavily on aeromodelling techniques, "Mayfly" has suffered unfortunate delays in her metalwork supplies but remains one with a considerable chance of success in the Kremer challenge. It introduces metalized covering for the top surfaces (Meculon) and has Melinex on the undersides.

We came in with the ornithopter, and leave with the thought that it is by no means a forgotten approach. The Farnborough M.P. Ornithopter Club is working on such a project that could well confound all the scepticism and truly prove that the birds have the best system!



Dr. Ralph Brooke of Seattle and Orbit R/C proprietor Bob Dunham of Los Angeles with the former's World Championship winning R/C model at Genk, Belgium. Veco 45 R/C engine, Orbit proportional controls, Glass Fibre fuselage.

WORLD CHAMPIONSHIP RESULTS



Fritz Bosch with his Telecont 9-channel-equipped FB 37 co-world champion model. Wing is styrene foam. Super Tigre 56 engine. Fritz has given many a spectacular display with this model.

3rd WORLD RADIO CONTROL CHAMPIONSHIP Held at Genk, Limburg, Belgium, August 21st/26th, 1963

1	R. Brooke	U.S.A.	1924	1806	1798	3730	*AMA-NUSA L/W*	*Veco 45 R/C*	*Orbit Prop.*
	F. Bosch	Germany	1724	1812	1968	3780	**O/D Shoulder/W*	*Super Tigre 56BB*	*Telecont 9*
3	E. Kazmirski	U.S.A.	1670	1503	1760	3430	*Taurus*	*Veco 45 R/C*	*Orbit 10 Sht.*
4	P. Louis	Belgium	1608	1607	1783	3391	*Taurus*	*Veco 45 R/C*	*Orbit 10 Sht.*
5	G. Nelson	U.S.A.	600	1556	1800	3356	*Cumulus*	*Veco 45 R/C*	*Oorbit Prop.*
6	C. Culverwell	S. Africa	1661	1576	1667	3328	*Taurus*	*Veco 45 R/C*	*Kraft 10 Sht.*
7	**F. Van den Bergh**	**G.B.**	1543	1625	1653	3278	*Sky Dancer L/W*	*Merco 49*	*Orbit 10 Sht.*
8	Ch. Teuwen	Belgium	1409	1541	1530	3071	*Taurus*	*Veco 45 R/C*	*Orbit 12 Sht.*
9	P. Marot	France	1503	1327	1537	3040	*Taurus*	*Veco 45 R/C*	*Radio Pilote*
10	H. Tom	Canada	1470	1329	1552	3022	*Taurus*	*Veco 45 R/C*	*Ace—Kraft 10*
11	J. P. Gobeaux	Belgium	1470	1227	1527	2997	*Taurus*	*Veco 45 R/C*	*Orbit S/Regen*
12	P. Stephansen	Norway	1360	1173	1596	2956	*O/D Shoulder/W*	*Merco 49*	*Quadruplex*
13	M. Chercover	Canada	1474	1480	1204	2954	*Taurus*	*Veco 45 R/C*	*Orbit 12 Sht.*
14	J. Connacher	S. Africa	1444	1452	1177	2896	*Taurus*	*Veco 45 R/C*	*Kraft 10 Sht.*
15	H. Schumacher	Germany	1364	1233	1487	2851	*VAT 69 L/W*	*Super Tigre 56BB*	*Polyton*
16	M. Malherbe	S. Africa	1425	1334	1370	2795	*Sultan L/W*	*Veco 45 R/C*	*Orbit 10 S/Region*
17	W. Hitchcox	Canada	1430	823	1350	2780	*Taurus*	*Veco 45 R/C*	*Min-X 12*
18	P. Bignon	France	1242	1017	1326	2468	*Caravelle*	*Veco 45 R/C*	*Orbit 10 Sht.*
19	E. Corghi	Italy	1238	1186	1208	2446	*X-16*	*Super Tigre 56BB*	*Controlaire*
20	F. Plessier	France	980	1053	1208	2261	*O/D Shoulder/W*	*K & B 45*	*Grundig 8 (Mod.)*
21	R. Dilot	Sweden	198	972	1233	2205	*Taurus*	*K & B 49*	*Bramco 10 (Mod.)*
22	P. Eliasson	Sweden	1086	807	1116	2202	*Mustfire L/W*	*Merco 49*	*Kraft 10 Sht.*
23	V. Tonnesen	Norway	858	559	1294	2152	*O/D Low/W*	*Merco 49*	*Orbit 10 Sht.*
24	T. Van Vliet	Netherlands	433	004	1138	2142	*Taurus*	*Veco 45*	*Orbit 10 Sht.*
25	N. Kramer	Netherlands	1048	328	1039	2087	*Taurus*	*OS 49 R/C*	*Kraft 10 Sht.*
26	O. Mantelli	Italy	1073	888	796	1961	*F/T Stormer*	*Super Tigre 56BB*	*Ecktronics 10*
27	H. Gast	Germany	1211	732	571	1943	*O/D Shoulder/W*	*Super Tigre 56*	*Telecont 9*
28	**H. Brooks**	**G.B.**	—	237	1502	1739	*Soraco L/W*	*Veco 45*	*F & M 10 Sht.*
29	C. Sauthier	Switzerland	639	696	1042	1738	*O/D Low/W*	*Merco 45*	*F & M 10 Sht.*
30	**C. Olsen**	**G.B.**	—	1559	175	1734	*Uproar S/W*	*Merco 49*	*REP 10*
31	G. Hormann	Austria	805	816	874	1690	*O/D Shoulder/W*	*Super Tigre 40*	*OMU 10*
32	R. Aebi	Switzerland	158	460	1143	1603	*Nimbus 2*	*Super Tigre 56*	*O/D Prop.*
33	J. Levenstam	Sweden	619	880	428	1499	*Viscount*	*Merco 49*	*Kraft 10 Sht.*
34	W. De Mulder	Netherlands	950	536	107	1486	*Taurus*	*Veco 45 R/C*	*D.C Tx. Controlaire Rz.*
35	P. Reinas	Finland	643	532	735	1378	*Uproar*	*K & B 45*	*Orbit 10 Sht.*
36	F. Mortensen	Denmark	409	588	618	1206	*Taurus*	*O S 49 R/C*	*Kraft 12 Sht.*
37	A. Matthey	Switzerland	—	643	23	666	*Taurus*	*Merco 49*	*Kraft 12 Sht.*
38	V. Miliani	Italy	119	546	—	665	*Taurus*	*K & B 45*	*Orbit 10 Sht.*
39	J. Sederholm	Finland	120	120	82	240	*Uproar S/W*	*Merco 49*	*F & M 10 Sht.*

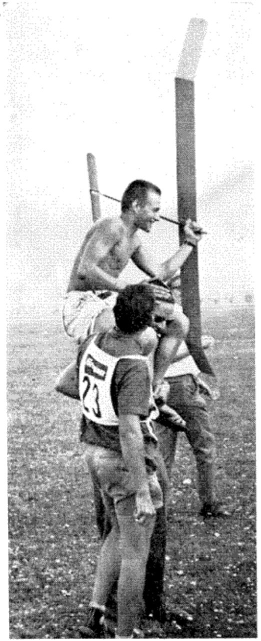
* *Flights with less than 2 per cent. difference, counted as equal first.*

FLY-OFF

R. Brooke	U.S.A.	1928 points—Champion of the World
F. Bosch	Germany	1856 points

WORLD R/C CHAMPIONSHIP TEAM POSITIONS

1. U.S.A.	10.516 pts.	5. Germany	8.574 pts.	9. Netherlands	5.715 pts.
2. Belgium	9.459 pts.	6. France	7·869 pts.	10. Italy	5.072 pts.
3. South Africa	9.019 pts.	7. **Great Britain**	**6.751 pts.**	11. Switzerland	4.007 pts.
4. Canada	8.756 pts.	8. Sweden	5.906 pts.		



Joachim Loffler of East Germany proudly holds the much-admired Lord Wakefield Trophy after prize-giving at Wiener-Neustadt.

Chaired by fellow West German teamsters, Gerd Erichsen holds his sheet construction glider which won World A/2 Champs.

Top four in power, Galbraith and Dall'Oglio standing, Laxmann and Frigyes kneeling, ready for a tremendous fly-off. Results page 142.

WORLD CHAMPIONSHIPS FOR FREE FLIGHT MODELS

Held at Wiener-Neustadt, Austria, August 13th/15th, 1963

A/2 GLIDER RESULTS

	Name	*Nation*	1	2	3	4	5	*Total*
1	G. Erichsen	W. Germany	180	180	180	180	180	900
2	E. Avory	Canada	180	180	180	180	171	891
3	B. Modeer	Sweden	180	180	168	180	180	888
4	E. Nicolaas	Netherlands	171	180	155	180	180	866
5	P. McQueen	Canada	180	177	145	180	168	862
6	B. Roschin	U.S.S.R.	136	180	180	180	180	856
7	V. Simonov	U.S.S.R.	142	180	180	180	180	850
8	L. Lultchev	Bulgaria	147	162	180	180	180	849
9	P. Soave	Italy	126	180	180	180	180	846
10	A. Riflawi	Israel	173	120	180	180	178	831
10	I. Zlatev	Bulgaria	168	180	180	180	123	831
12	F. Polak	Netherlands	110	180	180	180	180	830
13	A. Koval	U.S.S.R.	104	180	180	180	177	821
14	A. Schlosberg	Israel	92	180	180	180	180	812
15	T. Van't Rood	Nethlerands	179	180	156	180	116	811
16	M. Benedik	Yugoslavia	171	180	180	88	180	799
17	F. Gaensli	Switzerland	175	180	165	91	180	791
18	G. Foucart	Belgium	180	180	180	157	92	789
18	S. Maupetit	France	87	180	180	180	162	789
20	A. Franke	E. Germany	180	180	123	123	180	786
21	O. Prochazka	Czechoslovakia	180	180	124	180	119	783
21	B. Hansen	Denmark	180	180	76	180	167	783
23	J. Michalek	Czechoslovakia	128	127	165	180	180	780
24	F. Weyrauther	W. Germany	78	180	180	180	157	775
25	F-J. Meister	W. Germany	111	180	180	121	180	772
26	I. Alm	Sweden	45	180	180	180	180	765
27	A. Heitanen	Finland	106	156	180	180	141	763
28	N. Hopley	New Zealand	180	39	180	180	180	759
29	M. Lesobre (*proxy* Bourgeois)	France	107	180	171	180	118	756
29	U. Acuto	Italy	180	65	180	180	151	756
31	E. Hopper	U.S.A.	80	144	180	180	160	744
32	J. Larsen	Denmark	180	140	98	180	145	743
32	C. Boscarol	Italy	180	106	180	115	162	743
34	N. Ingersoll	U.S.A.	180	19	180	180	180	739
35	**M. Burrows**	**Great Britain**	142	180	54	180	178	734
36	S. Paulin	Yugoslavia	129	180	114	180	129	732
37	**C. Jackson**	**Great Britain**	113	180	143	180	112	728
38	**J. Baguley**	**Great Britain**	152	180	78	180	136	726
39	M. Hlubocky	Czechoslovakia	174	180	58	180	131	723
40	D. Ducklauss	E. Germany	122	134	157	163	145	721
41	J. Waanaen	Finland	124	180	180	65	170	719
41	O. Zitkon	Austria	95	180	180	180	84	719
43	M. Doyle	Ireland	160	180	180	110	87	717
44	P. Lauridsen	Denmark	77	180	148	180	120	705
45	M. Koller	Austria	108	180	154	137	118	697
46	A. Gogorcena	Spain	112	161	78	180	161	692
47	W. McGarvey	New Zealand	74	180	180	149	93	676
48	W. Thomson	Canada	130	65	180	113	180	668
49	F. Solakovic	Yugoslavia	105	180	105	180	94	664
50	J. Jauquemart	Luxembourg	69	179	180	89	139	656
51	R. Blacher	Austria	139	120	127	180	89	655
52	M. Da Silva Amado	Portugal	180	180	142	48	85	635
53	S. Costa	Portugal	163	74	143	100	151	631
54	W. Haller	Switzerland	159	180	71	103	115	628
55	R. Verdren	Belgium	82	117	180	180	60	619
56	K. J. Butz	E. Germany	120	69	180	91	154	614

	Name	Nation	1	2	3	4	5	Total
56	A. Frost...	U.S.A....	147	59	180	115	113	614
58	L. Braire	France...	123	180	97	26	180	606
59	J. Feron...	Belgium	84	46	180	146	130	586
60	P. Thompson	Ireland	56	115	126	180	108	585
61	R. Skold	Sweden	113	50	113	180	126	582
62	J. O'Sullivan	Ireland	89	65	180	134	105	573
63	K. Abadjiev	Bulgaria	165	150	69	140	44	568
64	E. Malkin	New Zealand	38	70	180	136	128	552
65	G. Herzberg	Israel	113	81	180	36	141	551
66	B. Pereira	Portugal	94	93	176	156	21	540
67	F. Meyer	Switzerland	118	27	42	180	130	497
68	W. Bjorn	Finland	108	87	57	69	141	462
69	M. Thies	Luxembourg	43	60	42	161	146	452
70	N. Mertes	Luxembourg	26	58	180	33	103	400
71	P. G. Lengomin	Spain	112	95	24	46	119	396

TEAM RESULTS A/2 GLIDER

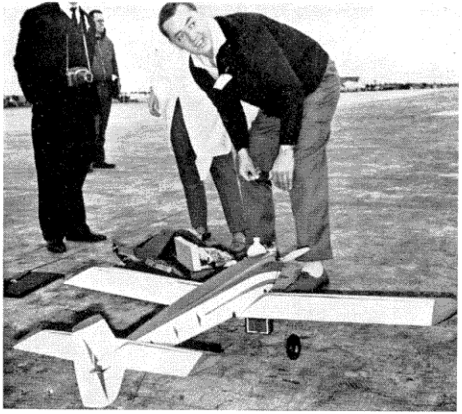
1	U.S.S.R.	2527	13	France	2151
2	Netherlands	2507	14	E. Germany	2121
3	W. Germany	2447	15	U.S.A.	2097
4	Canada	2421	16	Austria	2071
5	Italy	2345	17	Belgium	1994
6	Czechoslovakia	2286	18	New Zealand	1987
7	Bulgaria	2248	19	Finland	1944
8	Sweden	2235	20	Switzerland	1916
9	Denmark	2231	21	Ireland	1875
10	Yugoslavia	2195	22	Portugal	1806
11	Israel	2194	23	Luxembourg	1508
12	**Great Britain**	**2188**			

F.A.I. POWER RESULTS

	Name	Nation	1	2	3	4	5	Total	
1	E. Frigyes	Hungary	180	180	180	180	180	900	Moki S-3
		Fly-off +		210	240	270			
	L. Laxmann	Finland	180	180	180	180	180	900	Super Tigre G20
		Fly-off +		210	240	233			
	D. Galbreath	U.S.A.	180	180	180	180	180	900	Super Tigre G20
		Fly-off +		210	240	223			
	A. Dall'Oglio	Italy	180	180	180	180	180	900	Super Tigre G20
		Fly-off +		210	201	—			
5	A. C. Sereno	Portugal	180	180	178	180	180	898	Super Tigre G20
6	**G. R. French**	**Great Britain**	180	180	180	180	166	886	Cox 15 Spl.
7	K. Keinrath	Austria	164	180	180	180	180	884	Bugl 15.
8	K. Braasch	East Germany	162	180	180	180	180	882	Oliver Tiger
9	**M. H. Green**	**Great Britain**	180	161	180	180	180	881	Cox 15 Spl.
10	B. Bulukin	Norway	160	180	180	180	180	880	Super Tigre G20
11	A. Meczner	Hungary	180	158	180	180	180	878	Moki S-2
12	I. Henry (*proxy* V. Jays)	New Zealand	180	180	156	180	180	876	Cox TD Spl.
13	V. Hajek	Czechoslovakia	176	180	159	180	180	875	MVVS 58/G
14	F. Grifoni	Italy	180	180	180	153	180	873	Super Tigre G20
15	Y. Joostens	Belgium	180	180	155	180	172	867	Cox Spl.
16	S. Pimenoff	Finland	161	180	180	180	161	862	Super Tigre G20
16	Z. Malina	Czechoslovakia	180	180	180	142	180	862	MVVS 58/G
18	Z. Merkez	Yugoslavia	180	180	180	180	135	855	Super Tigre G20
19	K-H Rieke	West Germany	180	180	180	180	130	850	Super Tigre G20
19	T. Van Dijk	Netherlands	130	180	180	180	180	850	Super Tigre/Rossi
19	P. Broerse	Netherlands	180	180	130	180	180	850	Super Tigre/Rossi
22	R. Kammer	East Germany	180	126	180	180	180	846	Schlosser 2.5
23	D. Surry	Canada	120	180	180	180	180	840	Super Tigre G20
24	J. Warnock	U.S.A.	130	180	163	180	180	833	Super Tigre G20

Soviet Union team which won the National prize in World A/2 glider champs all used Sokolov designs after the "master's" leadership. Sokolov is second from left.

	Name	Nation	1	2	3	4	5	Total	
25	B. Filimonov	U.S.S.R.	180	111	180	180	180	831	Super Tigre G20
26	V. Pecorari	Italy	180	133	180	180	152	825	Cox 15 Spl.
27	M. Bourgeois	France	150	136	178	180	180	824	Super Tigre G20/D
28	F. Spearman	U.S.A.	134	149	180	180	180	823	Super Tigre G20
29	A. Gorgocena	Spain	180	163	118	180	180	821	Super Tigre G20
30	G. Simon	Hungary	180	180	129	180	151	820	Moki S-3
31	K. Bajc	Austria	180	180	180	180	94	814	Cox Spl.
32	**D. S. Posner**	**Great Britain**	180	180	112	180	160	812	Cox Spl.
33	J. Cerny	Czechoslovakia	144	123	180	180	180	807	MVVS 58/G
34	R. Hagel	Sweden	147	112	180	180	180	799	Super Tigre G20
35	H. Beck	West Germany	180	165	148	180	116	789	Super Tigre G20
36	A. C. Leite	Portugal	180	180	180	162	86	788	Super Tigre/Rossi
37	R. Rudolph	West Germany	175	125	124	180	178	782	Cox Spl.
38	R. Zimmer	France	180	146	87	180	180	773	Cox Spl.
39	H. Raulio	Finland	144	180	85	180	180	769	Super Tigre G20
40	P. Lagan (*proxy* P. Buskell)	New Zealand	135	180	180	111	158	764	Cox TD 15
41	T. Wiegers	Netherlands	180	119	157	128	172	756	Enya 15D
42	V. Kmoch	Yugoslavia	127	117	147	180	180	751	Super Tigre G20
43	R. Bekkelund	Norway	180	180	180	—	180	720	Eta 15D
44	J. Foley	Canada	136	115	101	180	180	712	OS Max Spl.
45	R. Schenker	Switzerland	78	79	179	180	180	696	Own engine
46	F. Kraemer	Luxembourg	180	62	180	180	85	687	Cox TD 09
47	S. Agner	Denmark	180	180	100	113	102	675	Cox TD 15
48	J. O'Sullivan	Ireland	85	85	180	180	136	666	Cox TD 09
49	U. Carlsson	Sweden	180	180	134	124	25	643	Super Tigre G20
50	M. Doyle	Ireland	111	124	90	180	132	637	Cox TD 15
51	A. Lundin	Sweden	180	85	59	126	180	630	Super Tigre G20
52	I.Sverdrup	Norway	26	180	156	80	180	622	Cox Spl.
53	N. Christensen	Denmark	107	28	116	180	180	611	Cox TD 15
54	M. Zupanski	Yugoslavia	—	180	171	105	154	610	Super Tigre G20
55	E. Eng	Switzerland	140	157	79	131	86	593	Cox TD 09
56	H. J. Benthin	East Germany	150	111	101	80	144	586	Schlosser 2·5
57	A. Schlosberg	Israel	40	180	117	180	46	563	Super Tigre G20



Frank van den Bergh established himself as top British R/C pilot using his well-worn models, Merco 61 powered and Orbit R/C equipped. One later version had two Merco 61 engines!

Below right, the Master of Power, Erno Frigyes from Budapest, Hungary and his world famous "Taltos" (Pegasus) design with Moki S-3 engine. World Champion in 1963, he also became European Champ in 1964 at 11th Criterium, held in Yugoslavia.

	Name	*Nation*	1	2	3	4	5	*Total*	
58	J. Scott ... (*proxy* J. McGillivray)	... Canada ...	... 76	169	180	103	31	559	Oliver Tiger
59	M. Scott (*proxy* K. Glynn)	... New Zealand	... 161	180	37	50	120	548	Cox TD 15 & Spl.
60	A. Schiller	... Switzerland	... 180	124	180	9	—	493	Cox TD 15 & Spl.
61	M. J. Soares	... Portugal	... 93	180	135	—	82	490	Super Tigre G20
61	C. Guilloteau	... France ...	... 107	81	86	76	140	490	Super Tigre G20/D
63	O. Ebner	... Austria ...	... 127	147	76	9	—	359	Cox TD 15
64	E. Nienstaedt	... Denmark	... 130	93	8	—	—	231	Cox TD 15

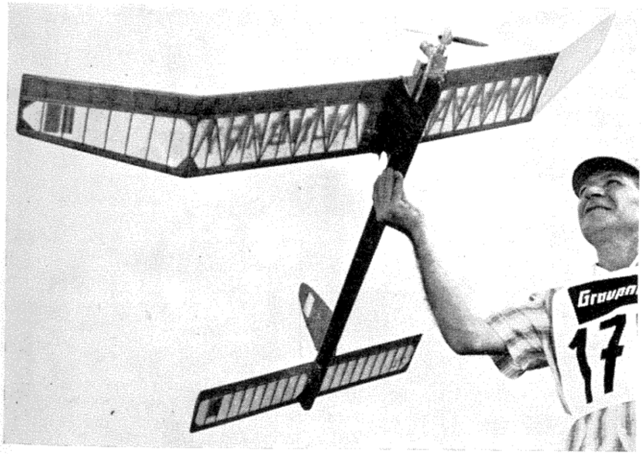
F.A.I. POWER TEAM PLACINGS

1 Italy	2598	11 Yugoslavia	2216
1 Hungary...	2598	12 New Zealand	2188
3. **Great Britain**	2579	13 Portugal	2176
4 U.S.A.	2556	14 Canada	2111
5 Czechoslovakia	2544	15 France	2087
6 Finland	2531	16 Sweden	2077
7 Netherlands	2456	17 Austria	2052
8 West Germany	2421	18 Switzerland	1782
9 East Germany	2314	19 Denmark	1517
10 Norway	2222		

WAKEFIELD RESULTS

	Name	*Nation*	1	2	3	4	5	*Total*
1	J. Loffler	E. Germany	180	180	180	180	180	900
			Fly-off +		210	240	243	
1	A. Hakanson	Sweden	180	180	180	180	180	900
			Fly-off +		210	240	186	

	Name	*Nation*	1	2	3	4	5	*Total*
1	B. Murari	Italy	180	180	180	180	180	900
			Fly-off +		210	232	—	
1	H. Wagner	Austria	180	180	180	180	180	900
			Fly-off +		185	—	—	
5	R. Sundin	Sweden	180	162	180	180	180	882
6	E. Melentiev	U.S.S.R.	180	180	161	180	180	881
7	A. Petiot	France	156	180	180	180	180	876
7	J. McGillivray	Canada	180	180	177	180	159	876
9	S. Galgoczi	Hungary	180	180	180	150	180	870
10	A. Mabille	Belgium	149	180	180	180	180	869
11	**J. O'Donnell**	**Great Britain** ...	161	180	180	161	180	862
12	V. Zapachni	U.S.SR.	172	180	142	180	180	854
13	E. Fresl	Yugoslavia	180	165	180	144	180	849
14	G. Cassi	Italy	158	180	151	178	180	847
14	R. Koen	Turkey	180	180	180	180	127	847
16	J. Schulten	Netherlands	180	180	142	180	164	846
17	P. Aalto...	Finland	180	171	180	134	180	845
18	J. Meyer	Switzerland	121	180	180	180	180	841
19	W. Pulik	E. Germany	180	180	180	118	180	838
20	J. Merory	Yugoslavia	116	180	180	180	180	836
21	C. Hewel	W. Germany	180	154	180	141	180	835
22	K. Kongsberg	Denmark	180	180	113	180	180	833
23	A. Alinari	Italy	125	180	164	180	180	829
24	V. Kmoch	Yugoslavia	180	121	180	169	178	828
25	P. Den Oden	Netherlands	125	180	180	162	180	827
26	G. Krizsma	Hungary	180	180	180	105	180	825
27	R. Eisen	W. Germany	167	180	115	180	180	822
28	R. Liechti	Switzerland	180	171	180	120	162	813
29	D. Kneeland	U.S.A....	180	180	180	89	180	809
30	S. O'Connor ... ... (*proxy* Eigner)	Australia	180	180	144	141	160	805



Name	Nation	1	2	3	4	5	Total
31 M. Segrave	Canada	180	125	180	180	133	798
32 Ono A. (*proxy* Haiden)	Japan	94	160	180	180	180	794
33 W. McGarvey	New Zealand	180	128	180	120	180	788
34 L. Purgai	Hungary	180	180	64	180	180	784
35 L. P. Riffaud	France	162	137	150	180	154	783
35 E. Nienstaedt	Denmark	145	180	98	180	180	783
37 L. Tlapak	Austria	180	180	62	180	180	782
38 A. McCauley (*proxy* R. Magill)	New Zealand	180	180	75	180	164	779
39 R. G. McGlashan	Canada	180	180	51	180	180	771
40 E. Kasley	Bulgaria	115	180	180	113	180	768
41 K-E. Widell	Denmark	147	171	82	180	180	760
42 M. Rohlena	Czechoslovakia	175	180	94	128	180	757
43 C. Hermes	U.S.A.	180	91	180	105	180	736
44 J. Gabris	Czechoslovakia	158	180	134	98	161	731
45 L. Muzny	Czechoslovakia	137	116	180	132	165	730
46 A. Rodriques	Portugal	136	180	82	180	128	706
47 C. Rothenberger	Switzerland	180	180	170	22	137	699
48 N. E. Hollander	Sweden	157	154	68	139	180	698
49 E. Hamaleinen	Finland	180	98	180	111	128	697
49 F. Strzys	E. Germany	153	180	59	125	180	697
51 **D. Latter**	**Great Britain**	180	180	59	96	180	695
52 M. Carlos	France	112	180	76	131	155	654
53 M. Reichenbach	W. Germany	170	180	60	105	122	637
54 F. Breith	Austria	76	136	180	64	180	636
55 S. Nevenkin	Bulgaria	109	67	180	99	180	635
55 S. Cannizzo	U.S.A.	30	180	138	149	138	635
57 C. Merseburger	Spain	135	91	60	180	162	628
58 K. Omura (*proxy* Hlavka)	Japan	158	180	105	103	77	623
59 T. Owada (*proxy* Schneck)	Japan	139	180	65	118	119	621
60 L. Serrano	Brazil	149	95	180	56	134	614
61 N. Burger	Netherlands	126	141	42	180	117	606
62 **B. Rowe**	**Great Britain**	116	66	116	155	142	595
63 B. Storgards	Finland	88	92	80	123	180	563
64 J. Malkin (*proxy* E. Malkin)	New Zealand	78	121	180	63	116	558
65 A. G. Martinez	Spain	87	5	180	103	171	546
66 M. F. Sousa	Portugal	84	101	180	62	105	532
67 A. Mirtschev	Bulgaria	173	74	6	88	149	490
68 A. C. Sereno	Portugal	80	180	180	—	—	440

WAKEFIELD TEAM RESULTS

1	Italy	2576	11	W. Germany	2294
2	Yugoslavia	2513	12	Netherlands	2279
3	Sweden	2480	13	U.S.S.R.	2218
4	Hungary	2479	14	U.S.A.	2180
5	Canada	2445	15	**Great Britain**	2155
6	E. Germany	2435	16	New Zealand	2122
7	Denmark	2376	17	Finland	2105
8	Switzerland	2353	18	Japan	2038
9	Austria	2318	19	Bulgaria	1893
10	France	2313	20	Portugal	1678

CONTEST RESULTS

Results of S.M.A.E. Contests for balance of 1963 season are included in this report to complete records. Those 1964 events which have been decided before going to press are also included and will be completed in next year's Aeromodeller Annual.

SCOTTISH GALA—August 4th, 1963—R.N.A.S Abbotsinch

Open Glider (*C.M.D. Trophy*) 27 *entries* 24 *flew*

1 J. Hanson	Wallasey	7:37
2 D. Petrie	Montrose	7:30
3 D. Millachip	Wallasey	7:18

Open Power (*K.L.M. 3rophy*) 20 *entries* 17 *flew*

1 R. Robertson	Aberdeen	9:00 + 3:00.5
2 F. Ballardie	Prestwick	9:00 + 1:35
3 P. Bayram	Lincoln	8:47

Open Rubber 17 *entries* 11 *flew*

1 D. Morley	Lincoln	9:00 + 9:47
2 G. L. Roberts	Lincoln	9:00 + 9:32
3 R. Pollard	Tynemouth	9:00 + 9:05

F.A.I. Team Race 27 *entries* 11 *flew*

1 J. Reid	Dumbarton	10:57.5
2 R. Rae	Dumbarton	13:13
3 G. Lowe	Forfar	Disqualified

Class B Tean Race 10 *flew*

1 J. Horton	Wharfedale	7:20.2
2 B. Harris	Prestwick	7:37.7
3 R. Yates	Leigh	rtd. 109 laps

Mono Radio Control (*Ripmax Trophy*) 2 *entries*

1 R. Scott	L.A.R.C.A.S.	797	697
2 K. Hall	Kirkcaldy	543	452

WHITE CUP—Open Power—July 28th, 1963 (*Decentralised*) 18 *flew*

1 P. Woodhouse	Shefield S.A.	+5:59
2 J. West	Brighton	+5:27
3 E. Jepson	Rotherham	+5:10
4 D. Welch	Brighton	+5:05
5 M. Bayram	Lincoln	+4:51
6 R. Salmon	York	+4:37

FROG JUNIOR TROPHY—Open Rubber/Glider—July 28th, 1963 (*Decentralised*) 9 *flew*

1 J. McNammee	Wallasey	8:41
2 F. Ballardie	Scotmac	8:21
3 A. Abbs	Norwich	7:51

C.M.A. CUP—Open Glider—August 18th, 1963 (*Area Centralised*) 37 *flew*

1 B. Spencer	Ashton	8:07
2 U. Wannop	Edinburgh	7:34
3 P. Manville	Bournemouth	7:17

F.A.I. RUBBER—August 18th, 1963 (*Area Centralised*) 10 *flew*

1 R. Wells	Hornchurch	13:40
2 H. Tubbs	Baildon	10:09
3 B. Picken	Wigan	9:01

KEIL TROPHY—Open Team Power—August 18th, 1963 (*Area Centralised*)

1 Prestwick	29:46
2 Brighton	23:57
3 Whitefield	19:45

C/L CONTEST—R.A.F. Debden—August 18th, 1963

Class 1 Speed 2 *entries*

1 J. Barclett	Colchester	80:18 *m.p.h.*

Class 2 Speed 1 *entry*

1 W. Kelsey	Brixton	129:3 *m.p.h.*

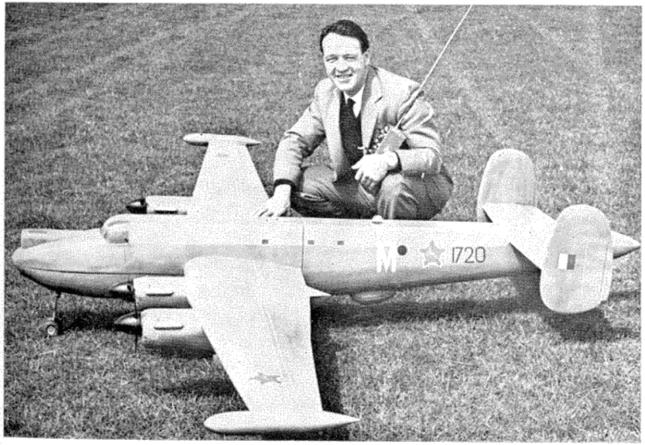
Class 3 Speed 2 *entries*

1 N. Butcher	Croydon	115:9 *m.p.h.*
2 S. Moxham	Colchester	94:78 *m.p.h.*

Class 4 Speed 6 *entries*

1 R. Gould	F.A.S.T.E.	136:3 *m.p.h.*
2 W. Kelsey	Brixton	130:0 *m.p.h.*
3 R. Tilbury	C.M.	101:2 *m.p.h.*

Dave Walker's 122 in. span Avro Shackleton has four K. & B. ·19's and weighs 16½ lb. One-piece wing detaches with upper forward fuselage. (Photo: H. Brooks)



Class 5 Speed 3 *entries*

1 M. Billington	Brixton	160:9 *m.p.h.*
2 I. Roffey	Brixton	150:1 *m.p.h.*

FARROW SHIELD—Team Rubber—September 15th, 1963 (*Area Centralised*) 24 *flew*

1 Bristol and West	34:59
2 York	34:55
3 Brighton	34:52
4 Lincoln A.	34:33
5 St. Albans	34:21
6 Norwich	34:07

FROG SENIOR CUP—Open Power—September 15th, 1963 (*Area Centralised*) 53 *flew*

1 G. French	Essex	9:00+4:33
2 V. Jays	Surbiton	9:00+4:20
3 M. Bayram	Lincoln	9:00+3:56
4 G. Lowe	Wallasey	9:00+3:46
5 P. Manville	Bournemouth	9:00+3:25
G. Stringwell	Rotherham	9:00+3:25

S.M.A.E. CUP—FAI Glider—September 17th, 1963 (*Area Centralised*) 72 *flew*

1 A. G. Young	St. Albans	15:00+44:10
2 M. J. Woodhouse	Norwich	15:00+16:36
3 A. Wisher	Croydon	15:00+16:11
4 C. Jackson	Surbiton	15:00+15:31
5 W. H. McGarvey	Stevenage	15:00+10:10
6 J. Blount	Croydon	15:00+ 4:47
7 M. Burrows	St. Albans	15:00+ 1:25
8 D. Latter	C.M.	15:00+ 0:14

M.E. TROPHY—Team Glider (Open)—October 6th, 1963 (*Area Centralised*) 35 *flew*

1 Bristol and West	32:12
2 Northern Heights	30:49
3 Hayes	30:17
4 St. Albans	28:16
5 Northampton	26:50
6 Timperton	25:52
Norwich (A)	25:52

FLIGHT CUP—Open Rubber—October 6th, 1963 (*Area Centralised*) 42 *flew*

1 W. McGarvey	Stevenage	+7:02
2 D. R. Woods	St. Albans	+5:49
3 T. Faulkner	Luton	+5:35
4 H. Tubbs	Baildon	+5:05
5 R. Godden	Cambridge	+5:02
6 D. Wiseman	York	+4:21

FAI POWER—October 6th, 1963—17 *flew*

1 J. West	Brighton	15:00+11:24
2 P. Welch	Brighton	15:00+ 6:37
3 P. Manville	Bournemouth	15:00+ 3:25
4 D. Cook	Canterbury	14:31
5 V. Jays	Surbiton	14:27
6 G. French	Essex	14:26

PLUGGE CUP

1 Brighton	1240.723 points
2 Whitefield	1077.695 „
3 St. Albans	1066.227 „
4 Bristol and West	955.619 „
5 Norwich	774.706 „
6 York	685.870 „

Senior Champion: J. O'Donnell (Whitefield).
Junior Champion: A. Abbs (Norwich).

K. & M.A.A.—A/2 Glider—March 22nd, 1964 (*Area Centralised*) 125 *entries*

1 D. Wooton	Hayes	14.23
2 R. Amor	Essex	14.22
3 M. Burrows	St. Albans	14.19
4 D. Millachip	Wallasey	14.11
5 A. Wells	Hornchurch	14.01
6 A. Abbs	Norwich	13.56

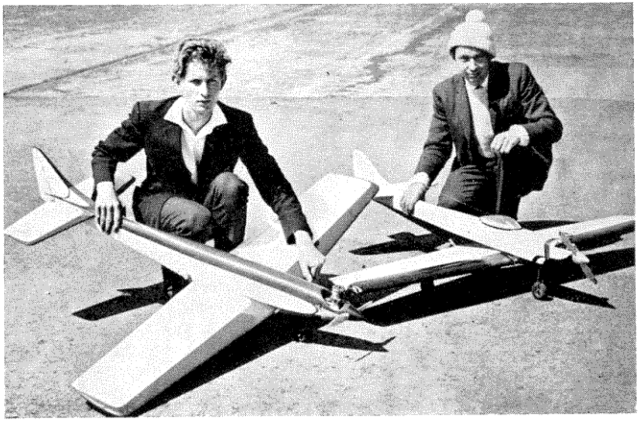
F.A.I. RUBBER—March 22nd, 1964 (*Area Centralised*) 42 *entries*

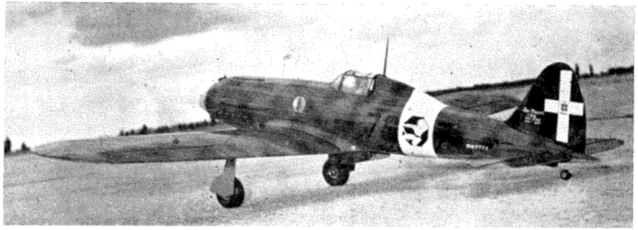
1 B. Rowe	St. Albans	15.00
2 G. Lefever	Norwich	14.20
3 B. Halford	Norwich	13.48
4 D. Morley	Lincoln	13.37
5 A. Ames	Hayes	13.22
6 C. Pittard	B.A.C. Warton	13.20

FROG SENIOR SUP—Open Power—March 22nd, 1964 90 *entries*

1 M. Gaster	Surbiton	9.00+5.18
2 R. Cummings	Bristol & W.	9.00+4.03
3 R. Monks	B'ham	9.00+4.02
4 M. Dilly	Croydon	9.00+3.54
5 D. Posner	Surbiton	9.00+3.39
6 K. Glynn	Surbiton	9.00+3.10

New names in multi R/C. Left: George Bradley with Scorpio original, 68 in. span, Super Tigre '56. Right: Stuart Forster with Nimbus II, Super Tigre '56. Both from Lincoln and using F. & M. 10 radio gear.





Dennis Bryant's magnificent Macchi 202 scale radio model. Weighing 6½ lb. with F. & M. 10 channel gear and Veco .45 R/C engine it was superbly finished.

PILCHER CUP—Open Glider—August 19th, 1964 (*Area Centralised*)

1 R. Amor	Essex	9:00
2 J. Hannay	Wallasey	8:21
3 R. Brownson	Timperley	8:04
4 F. Barnett	Leics.	8:02
5 G. Hutton	Wallasey	7:54
6 M. Dilly	Croydon	7:52

F.A.I. POWER—April 19th, 1964 (*Area Centralised*)

1 M. Green	Lincoln	+ 2:22
2 J. Parrott	Whitefield	+ 0:47
3 D. Wiseman	York	14:42
4 J. Toohey	Lincoln	14:35
5 S. Savini	Wallasey	14:29
6 J. Taylor	York	14:10

GAMAGE CUP—Open Rubber—April 15th, 1964 (*Area Centralised*)

1 D. Wiseman	York	+6:21
2 D. Wolstenholme	E. Lancs.	+6:14
3 H. Tubbs	Baildon	+5:49
4 D. White	York	+5:00
5 T. Chambers	Tees-side	+4:27
6 R. Monks	B'ham	+4:20

C/L MEETING—R.A.F. Tern Hill—April 19th, 1964 (*Centralised*)

Stunt

1 G. Higgs	Norwich	1,177
2 D. Day	Wolves	1,088
3 M. Cole	Norwich	960

F.A.I. T/R

1 Place/Howarth	Wharfedale	5:6.2
2 Davy/Long	Wharfedale	5:16.4
3 Cooper/Allen	West Essex	5:56.6

½A T/R

1 L. Davy	Wharfedale	4:40
2 J. Turner	Wharfedale	4:49
3 R. Place	Wharfedale	5:05

Speed—Class 1

		m.p.h.
1 James	Rolls-Royce	65.8

Speed—Class 2

1 K. Lindsey	Hayes	108
2 R. McGladdery	Hayes	107
3 J. Farnsworth	Sheffield	101

Speed—Class 3

1 R. Lindsey	Hayes	115.3

Combat

1 Dalton	Sutton-in-Ashfield
2 De Ville	Derby

CONTROL LINE TEAM TRIALS FOR HUNGARY WORLD CHAMPIONSHIP—May 3rd, 1964

Team Racing

Place/Howarth	Wharfedale	4.36.5
Turner/Humphrey	Wharfedale	5.14
Nixon/Ellis	Hinckley	5.35.5

Speed

Lindsey	Hayes	112 m.p.h.
Jackson	Worksop	109 m.p.h.
McGladdery	Hayes	106 m.p.h.

Stunt

Name

Team Manager: Norman Butcher

1964 NATIONAL MODEL FLYING CHAMPIONSHIPS—May 17th/18th 1964—R.A.F. Barkstan Heath

Super Scale Trophy Free Flight (20 *entries*)

	Flight	Scale	Total
1 J. Simmance, Wharfedale — Sopwith Schneider	253	382	635
2 N. Taylor, Boscombe DN — Luton Minor	159	148	317

Knokke No. 2 Control-Line (14 *entries*)

	Flight	Scale	Total
1 J. Mackie, R.A.F.M.A.A. — Sopwith Camel	62	416	478
2 B. P. Ball, Wanstead Whks. — Curtiss Hawk P6E	64	361	425
3 R. Ivans, Walsall — Hawker Fury	103	258	361
4 A. C. Day, Handsworth — Fokker D.VII	39	306	345
5 D. D. Nelson, Derby — Stearman PT13D	100	217	317
6 H. J. Carter, C.M. — Great Lake Spcl.	51	220	271

Radio Control Scale (16 *entries*)

	Flight	Scale	Total
1 J. Morton, Bristol — D.H. 82 Tiger Moth	898	84	982
2 D. Bryant, Bromley — Miles Sparrowhawk	446	339	805
3 D. Thumpston, C.M. — Sopwith 1½ Strutter	307	399	706
4 D. Bateman, Luton DMAC — Bristol Scout D	184	211	395
5 B. Denial, C.M. — D.H. 60 Gypsy Moth	217	150	367
6 A. G. Devonshire, C.M. — D.H. 60 Gypsy Moth	231	63	294

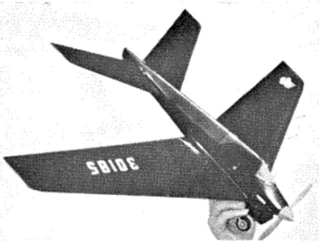
Sir John Shelley Cup—Open Power (243)

1 P. Bayram	Lincoln	9:00+3:46
2 C. Pittard	BAC Warton	9:00+2:13
3 N. Willis	Essex	9:00+0:04
4 D. Thorne	Stevenage	8:54
5 D. England	Leicester	8:45
6 K. Harrison	Tees-side	8:40

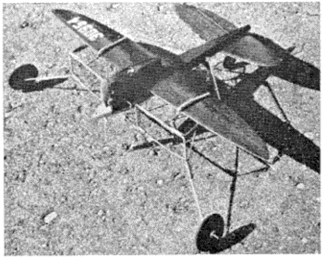
Thurston Cup—Open Glider (269)

Twenty-two competitors returned perfect 9:00 scores. The following are first six fly-off times in the fourth flight.

1 P. Newell	Surbiton	6:17
2 G. French	Essex	5:51
3 D. Wiseman	York	5:37
4 W. Trotter	Nomads	5:31
5 B. Halford	Norwich	5:05
6 A. Wells	Hornchurch	4:56



Swept wing F.A.I. team racer by Atkinson and Crofts qualified for semi-finals at Nationals with 4:34 using at Eta 15 engine.



Winning F.A.I. speed model at Nationals by B. Jackson of Worksop. Model is Launerdale design and Super Tigre G.20 powered.

Model Aircraft Trophy—Open Rubber
Thirteen competitors returned perfect 9:00 scores. The following are fly-off times in the fourth flight. (149 *entries*)

1 J. O'Donnell	Whitefield	5:08
2 E. Thorpe	Lincoln	3:46
3 D. Reece	C.M.	3:12
4 D. White	York	3:06
5 J. Blount	Croydon	3:03
6 R. Monks	Birmingham	3:03
7 R. Bow	Bristol & W.	2:38
8 T. Chambers	Stockton	1:53
9 R. Leppard	Chichester	1:34
10 N. Elliott	Croydon	0:08
Three did not return a fourth flight.		
11 D. Wolstenholme	E. Lancs.	9:00
11 D. Wiseman	York	9:00
11 A. Wells	Hornchurch	9:00

Short Cup—Pay Load (34 *entries*)

1 G. Lowe	Wallasey	6:54
2 D. Hipperson	Croydon	6:31
3 A. Mussel	Farnham	5:51
4 G. Kent	Watford Wfrs.	4:56
5 G. Pepperil	Stevenage	4:18
6 G. Head	Portsmouth	3:56

Gold Trophy (34 *entries*)
Control-Line Aerobatics

1 T. Jolley	Whitefield	1,148
2 D. Day	Wolves	1,060
3 G. Higgs	Horwich	1,051
4 J. Perry	C.M.	1,006
5 R. Place	Wharfedale	958
6 J. Mannal	Lincoln	955

35 entered.

Lady Shelley Cup—Tailless 21 *flew*

1 J. Poole	York	9:00
2 D. Woods	St. Albans	7:49
3 H. Tubbs	Baildon	6:44
4 D. Reece	C.M.	5:53

Women's Cup—Combined Rubber/Glider/Power 9 *flew*

1 Mrs. S. Miller	Cambridge	Power	7:03
2 Mrs. S. Horton	Crawley	Rubber	6:43
3 Mrs. R. Jepson	Rotherham PG	Power	6:38
4 Mrs. D. Wootton	Hayes	Glider	5:31

Combat (*Restricted to* 128 *entries*) Final Score

1 S. Holland, Northwood	Oliver Tiger II	+5
2 N. Tidey, Worthing	Rivers Silver Arrow	−12

S.M.A.E. Trophy Multi-Control R/C

1 F. Van Den Bergh	Bromley	3,604
2 G. Bradley	Lincoln	3,398
3 C. Olsen	C.M.	3,237
4 S. L. Foster	Lincoln	3,136
5 P. T. Waters	South Wales	2,951
6 G. Franklin	Larks	2,659
7 R. Brown	Lees Bees	2,655
8 G. Pike	C.M.	2,558
9 D. G. Brogan	C.M.	2,410
10 F/O Denny	R.A.F.M.A.A.	2,365
11 E. Johnson	C.M.	2,358
12 J. Morton	Bristol	2,186

Speed—Class 1 (1.5 c.c.) (*Total* 95 *in all classes*)

		m.p.h.
1 D. E. Coffin	Southampton	81.33
2 J. Kallend	Spring Park	72.15
3 J. Lucas	Spring Park	71.68
Class 2		
1 W. Kelsey	Brixton	128.5
2 P. Drewell	Sidcup	125.7
3 I. Roffey	Brixton	117.0
Class 3 (F.A.I.)		
1 B. Jackson	Worksop	113.0
2 D. Bird	Brixton	104.0
3 I. Roffey	Brixton	108.0

Pete Ball from Wanstead Warhawks with second place Curtis Hawk P.6E, from A.P.S. In foreground Graham Malyon's ·35 Gee Bee racer from Wanstead. P.6E has O.S. ·29 and provision for three-line control.

Class 4 (5 c.c.)

1 J. Hall	West Essex	141.6
2 R. Gould	F.A.S.T.E.	139.8
3 R. McGladdery	Hayes	130.0
Class 5 (10 c.c.)		
1 Thorney/Allen	Whitefield	140.0

Class 6 (Jet) No flight times recorded

R.A.F.M.A.A. Cup (60 *entries*)
Team Race Class 1A 1.5 c.c.

	Semi Final	10 mile Final
1 Place/Howarth, Oliver Tiger Cub Wharfedale	4:48.6	9:15
2 Turner/Humphries, Oliver Tiger Cub Cambridge/Wharfedale	5:04.1	9:49.4
3 Ball/Malyon, Oliver Tiger Cub Wanstead Warhawks	5:34	17 laps

Davies 'A' Trophy (96 *entries*)
Team Race Class 'A' (F.A.I.)

	Semi-Final	20K.m. Final
1 Long/Davey, ETA 15 II Wharfedale	4:35	9:15
2 Pert/Kinton, Oliver Tiger III Novocastria	5:21	11:00
3 Wallace/Laurie, ETA 15 II Novocastria	5:03.5	40 laps

Davies 'B' Trophy (28 *entries*)
Team Race Class 'B' 5 c.c.

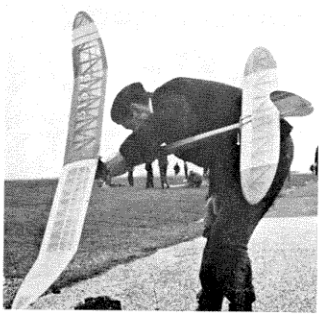
	Semi Final	10 mile Final
1 Dugmore/Bell, ETA 29 Novocastria	3:50.3	7:16.7
2 Yates/Hampton, ETA 29 Leigh	3:36.4	7:46.4
3 Allen/Cooper, ETA 2.6 West Essex	4:06.5	10:22.9

R/C MULTI—Woburn Abbey—June 14th, 1964 17 *entries* (*Centralised*)

1 G. Bradley	Lincoln	3250 pts.
2 P. T. Waters	S. Wales R/C Soc.	3110 pts.
3 S. L. Foster	Lincoln	3067 pts.
4 J. Morton	Winchester	2723 pts.
5 R. W. Payne	Surrey R/C	2498 pts.
6 R. O. Yates	N.L.S.M.E.	1982 pts.

FLIGHT CUP—Open Rubber—May 31st, 1964
(*Area Centralised*)

1 L. Barr	Hayes	9:00+4:27
2 B. Day	Walsall	9:00+4:04
3 D. Morley	Lincoln	9:00+3:50
4 A. Wells	Hornchurch	9:00+3:42
5 L. Burrows	Blackheath	9:00+3:39
6 J. Bailey	Whitefield	9:00+3:11
J. Blount	Croydon	9:00+3:11



Faitel III F.A.I. power model by Joe Savini of Wallasey. With Super Tigre G.20 Joe took first place in the Six Nation International Contest at Wels in Austria.

WHITE CUP—Open Power—May 31st, 1964
Area Centralised)

1 J. Taylor	York	9:00+5:30
2 G. Lowe	Wallasey	9:00+3:55
3 P. Manville	Bournemouth	9:00+3:48
4 V. Jays	Surbiton	9:00+3:03
5 T. Payne	Northampton	9:00+——
6 P. Bayram	Lincoln	8:50
7 P. Buskell	Surbiton	8:49

C/L at TOPCLIFFE, nr. THIRSK—May 31st, 1964. F.A.I. Combat (11 *entries*)

1 Wilson	Tynemouth
2 Spence	Wharfedale
3 Secker	Wharfedale
Scurfield	Tynemouth

F.A.I. TEAM RACE (10 *entries*)

1 Long/Davy	Wharfedale	9.32
2 Place/Haworth	Wharfedale	10.21
3 Atkinson/Crofts	Derby	11.17

½A TEAM RACE (5 *entries*)

1 Davy/Long	Wharfedale	10.17
2 Place/Haworth	Wharfedale	10.34
3 Turner/Humphrey	Wharfedale	163 laps

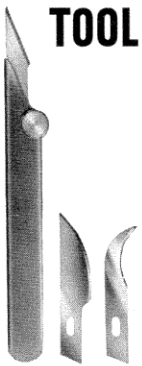
Winning F/F scale model at Nationals by John Simmance. Sopwith Schneider had immaculate finish and flew well.

You'll do a better job with Swann-Morton TOOLS

Made with the same precision and to the same quality as Swann-Morton's famous surgical blades, these inexpensive cutting tools are equally useful to the skilled craftsman and the amateur handyman. Their flat handle design ensures a safe, firm grip and prevents accidental rolling when laid down.

The Swann-Morton

CRAFT TOOL



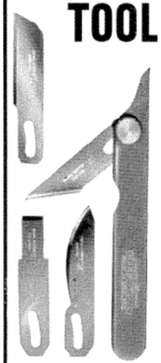
- Does all light and medium cutting jobs
- Ideal for intricate work
- 3 different blades available

TOOL (plus 2 blades) 2/6

Set of 6 spare blades 2/6

The Swann-Morton

HANDI-TOOL



- With new heavy duty blades
- Safe 'stow-away' handle
- 4 interchangeable blades

TOOL (complete with 4 blades) 5/-

Set of 6 spare blades 3/-

TRADE ENQUIRIES ONLY TO:

Swann-Morton

(SALES) LTD · PENN WORKS · SHEFFIELD 6 · ENGLAND

JOHN W. BAGNALL LTD.

Modelcraftsmen's Supplies

18 SALTER STREET, STAFFORD

Est. 1936 Phone 3420

Radio Control Aircraft

Railways

Boats

Cars, etc.

Kits and Accessories

CALDMORE MODELS

For all your Model requirements

All British Kits & Engines and many Foreign ones in stock

RADIO CONTROL

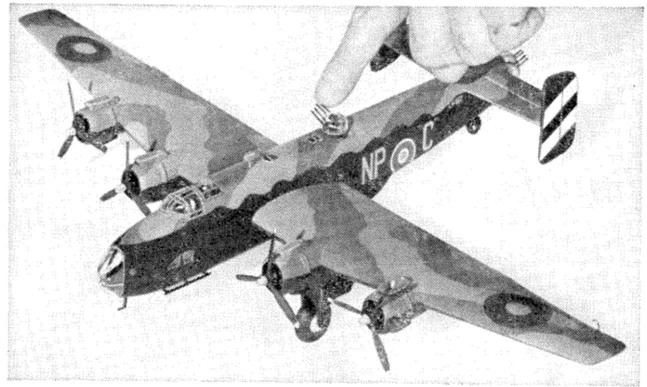
Main Agents for Grundig and MacGregor. F. & M. Orbit. Citizenship. Kraft. Bonner. Dubro & Topflite Accessories. Williams WWI. Wheels & Pilots.

Repairs - Overhauls - Spares
Second-hand Engines

S. H. GRAINGER

108 CALDMORE ROAD
WALSALL, Staffs.

Phone: 23382



. . . even the guns elevate!

This Airfix 1/72nd scale Halifax bomber is loaded with realistic detail. 16¾" span, fully crewed, 122-part kit 7/6. It's typical of the realism you get with Airfix models. They're just like the real thing! More than that, though, Airfix give you constant scale, so that the models of every series are proportionately right; and a great ever-increasing range—there are 13 series now, with over 200 kits. At prices from 2/- to 17/6 Airfix are great on value too.

For endless modelling fun—make it Airfix.

JUST LIKE THE REAL THING! **AIRFIX** **CONSTANT SCALE CONSTRUCTION KITS**

From model and hobby shops, toy shops, and F. W. Woolworth

STOP PRESS !

WATCH THIS SPACE

In Airfix advertisements in many magazines the latest Airfix productions are regularly announced in this space. Watch out for them—and remember, whichever models you choose you can always rely on constant Airfix.

Constant scale . . . constant attention to detail . . . top value. That's Airfix

A162E

GET YOUR CATALOGUE

32 pages of models. From your dealer - only 9d

W. E. HERSANT LTD.

AVIATION BOOKS

New and second-hand English and Foreign

Agents for Morgan Aviation Books, publishers of the "Famous Aircraft" series.

A selection of naval and armour items also stocked.

WE BUY BOOKS

Write for lists, or call.

228 Archway Rd., Highgate
LONDON N.6.

Telephone: MOUntview 3869

REMCON ELECTRONICS LTD.

Manufacturers of Multi-Channel R/C Kits and Servos.

Stockists of all Modellers requirements.

Call or write, we are always pleased to help.

SAE brings you our latest price list.

4a Broadway Bexleyheath
KENT

Tel.: DAN 2055

For all that's best in aircraft and boats

MODERN MODELS LTD.

49-51 LOWFIELD STREET
DARTFORD, KENT

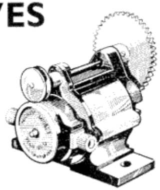
PHONE 24155

RADIO CONTROL
GRUNDIG, MacGREGOR
F. & M., R.E.P.

KITS AND ACCESSORIES BY ALL LEADING MAKES

POWER FOR MINIATURE DRIVES

Operates off Torch Battery



Precision Built

World Famous

"MIGHTY MIDGET" ELECTRIC MOTOR

Develops great power for its size. Armature speed 4-6000 RPM. C'shaft 650-1000 RPM. Current consumption less than flashlight bulb. Over one hour continuous running on tiny battery. Suitable for 3-6v D.C. O'all height $1\frac{1}{8}$".

From Model Shops and Stores.

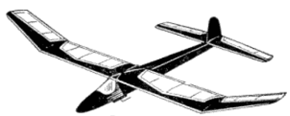
VICTORY INDUSTRIES (Raceways) LTD.
GUILDFORD, Surrey

KEILKRAFT

BRITAIN'S LEADING MODEL AIRCRAFT KITS

KEILKRAFT *Snipe*

For flying ability and ultra-smart appearance these Keilkraft kits are unsurpassed. Record flights are being made with them by modellers all over the country!



KEILKRAFT *Conquest*

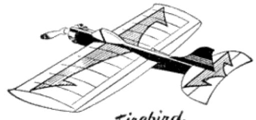
They all contain DIE-CUT PARTS for quick and easy building

SNIPE 40" span free flight model for the new 049 glowmotors and ·5 diesels **22/1**

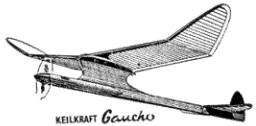
CONQUEST 30" span towline glider for beginners. Easy to fly **9/-**

FIREBIRD 32" span control line stunt model for 2·5 to 3·5 c.c. motors **27/11**

GAUCHO 44" span contest model for 1 to 1·5 c.c. motors **24/5**



KEILKRAFT *Firebird*

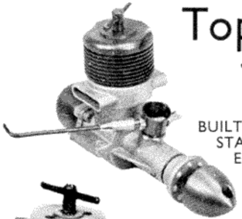
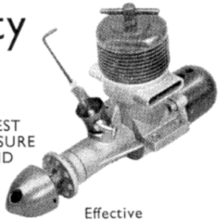


KEILKRAFT *Gaucho*

THERE ARE OVER 100 KITS IN THE KEILKRAFT RANGE
See them at your local model shop

The Greatest Name in model kits

KEILKRAFT


MODEL SHOP DIRECTORY

LONDON

*Airfix Products Ltd.,
Haldane Place,
Garratt Lane,
S.W.18.

Blackburn Models Ltd.,
146 Merton Road,
WIMBLEDON, S.W.19.

W. E. Hersant Ltd.,
228 Archway Road,
HIGHGATE, N.6.

H. A. Blunt & Sons Ltd.,
133 The Broadway,
MILL HILL, N.W.7.

Jones Bros.,
56 Turnham Green Terrace,
CHISWICK, W.4.

Model Aircraft Supplies Ltd.,
29 Old Kent Road,
S.E.1.

BERKSHIRE

Reading Model Supplies,
1 Hosier Street,
READING.

CHESHIRE

Hewitts (Knutsford) Ltd.,
25-29 King Street,
KNUTSFORD.

ESSEX

Chelmsford Model Co. Ltd.,
204 Moulsham Street,
CHELMSFORD.

*E. Keil & Co. Ltd.,
Keilkraft Works,
Russell Gardens,
Wick Lane,
WICKFORD.

GLOUCESTERSHIRE

The Model Hangar,
71 Cricklade Street,
CIRENCESTER.

HAMPSHIRE

Precise Model-Kraft,
80 Southampton Road,
EASTLEIGH.

Robin Thwaites Ltd.,
The Hobby Shop,
28 Arundel Street,
PORTSMOUTH.

Tip Top Model Aircraft Stores,
10 Kingston Road,
PORTSMOUTH.

HERTFORDSHIRE

H. A. Blunt & Sons Ltd.,
38 Fretherne Road,
WELWYN GARDEN CITY.

ISLE OF MAN

*Marown Engineering,
Union Mills,
DOUGLAS.

KENT

H. E. Hills & Son,
481-483 Bromley Road,
Downham,
BROMLEY.

MODEL SHOP DIRECTORY

Modern Models Ltd.,
49-51 Lowfield Street,
DARTFORD.

LANCASHIRE

Ashton Model Supplies,
201 Old Street,
ASHTON-UNDER-LYNE.

The Model Shop (Nelson) Ltd.,
57 Railway Street,
NELSON.

The Modellers Mecca,
(Harry Welch Ltd.),
85 Church Street,
PRESTON.

LINCOLNSHIRE

Russell Models,
Model Centre,
LINCOLN.

NORFOLK

Universal Suppliers Ltd.,
(Aero and Boat Modelling Department),
27 Norwich Street,
FAKENHAM.

NOTTINGHAMSHIRE

Russell Models,
Model Centre,
Ryton Street,
WORKSOP.

STAFFORDSHIRE

Dunns,
65 Lower High Street,
CRADLEY HEATH.

John W. Bagnall Ltd.,
18 Salter Street,
STAFFORD.

Caldmore Models,
(S. H. Grainger),
108 Caldmore Road,
WALSALL.

The Handicraft Centre,
491 Dudley Road,
WOLVERHAMPTON.

Models & Hobbies,
19 St. Johns Street,
WOLVERHAMPTON.

SURREY

Remcon Electronics Ltd.,
4A Broadway,
BEXLEYHEATH.

Bondaglass Ltd.,
5A South End,
CROYDON.

E. Pascall (Guildford) Ltd.,
105 Woodbridge Road,
GUILDFORD.

Victory Industries Ltd.,
Barfax Works,
Worplesdon Road,
GUILDFORD.

Heset Model Supplies,
61 Brighton Road,
SOUTH CROYDON.

Whitewoods,
103 Brighton Road,
SURBITON.

SUSSEX

Planet Models and Handicrafts,
108 The Hornet,
CHICHESTER.

Major R. J. McNeill,
The Eastbourne Model Shop,
185B Langney Road,
EASTBOURNE.

*Plantation Wood Ltd.,
Commerce Way,
LANCING.

WILTSHIRE

Hobby's Corner (Swindon) Ltd.,
24 Fleet Street,
SWINDON.

WORCESTERSHIRE

A. N. Cutler,
7 Bridge Street,
WORCESTER.

YORKSHIRE

*W. R. Swann & Co. Ltd.,
Swann Morton Sales Ltd.,
Penn Works,
SHEFFIELD 6.

SCOTLAND

Caledonia Model Company,
478 Argyle Street,
GLASGOW, C.2.

WALES

Bud Morgan,
22 Castle Arcade,
CARDIFF.

OVERSEAS

Gorrie's,
604 Stanley Street,
Woolloongabba,
Brisbane,
AUSTRALIA.

North York Hobbies & Crafts,
1910 Avenue Road,
Toronto 12, Ontario,
CANADA.

* Manufacturers and/or Wholesalers only