Aero Modeller
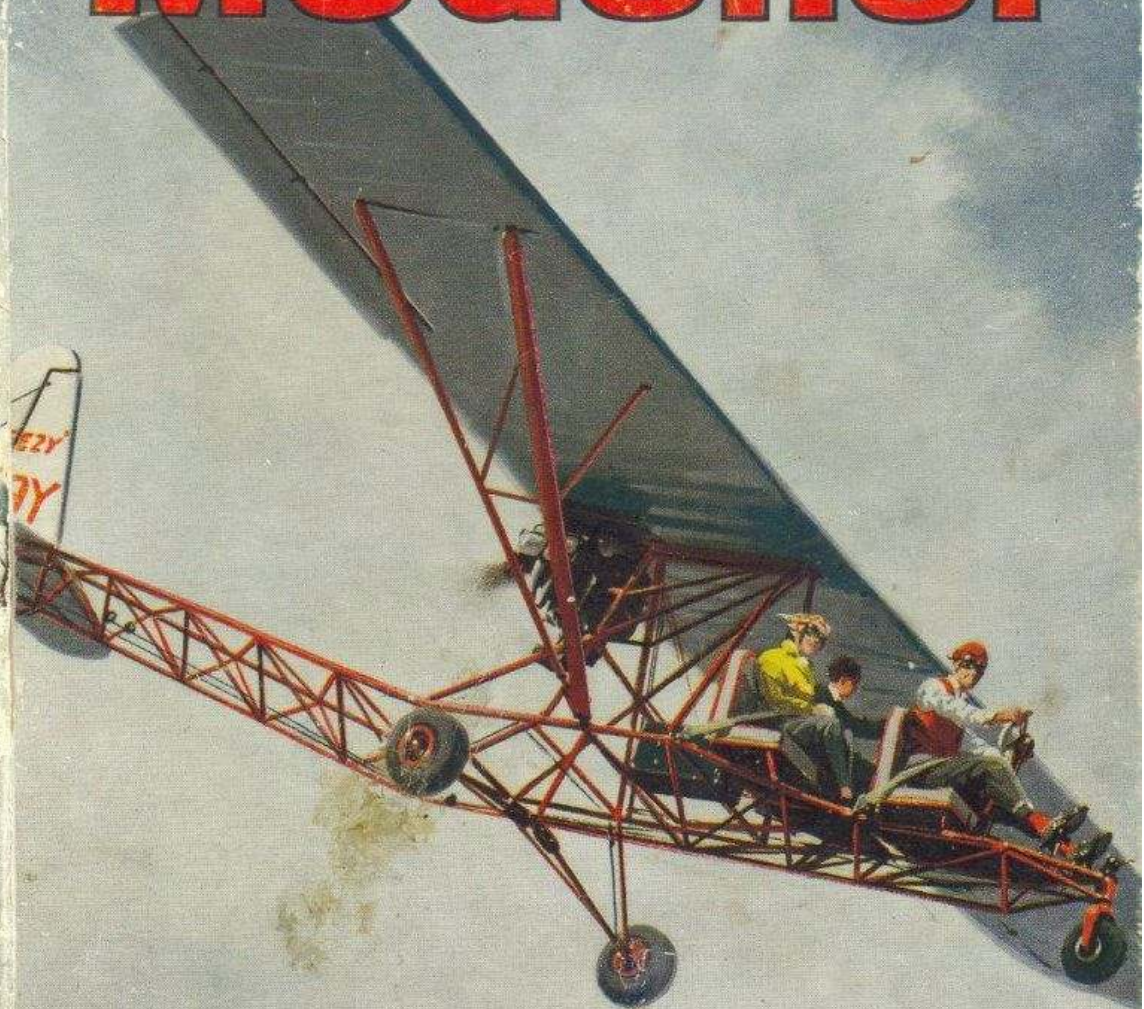
Annual
1968-69

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AEROMODELLER
ANNUAL 1968-69

A review of the year's aero-
modelling throughout the
world in theory and practice;
together with useful data,
and authoritative articles,
produced by staff and
contributors of the
AEROMODELLER

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

AEROMODELLER ANNUAL 1968-69

CONTENTS

INTRODUCTION

A YEAR of change—transition which some prefer to regard as progress, accepting the inevitable with a shrug and to which others more creative among us, rise in challenge. We see the arrival of new construction techniques, many forecast in earlier editions of this Annual series. The almost-ready-to-fly-solid-foam model becomes reality for industry. Superb scale models created for the film world—"Battle of Britain" in particular, show how the hobby reaches an approved maturity—dare we say adulthood ? Whereas a few years back, the elaborate scale model was a "sudden death" one-time project, it now performs endlessly, wheeling and cavorting precisely to the commands of its skilful pilot at the controls of sophisticated proportional radio equipment. Nothing—not even tha dream Spitfire, Lancaster, or early pioneer type seems to be "impossible" any longer.

Never was this more evident than at the 1968 Nats where thousands of SMAE members and their friends enjoyed the wonderful hospitality of the Royal Navy at Yeovilton. Interspersed with multi-aerobatic flights the scale models exhibited a degree of reliability and performance that was their weak point even a year ago. Return to a Royal Naval Air Station for the first time since 1952 must be rated the social success of the year. The hospitable West Country laid upen its hostelries, the huge airfield cleared its bright new concrete decks and for two glorious calm days, competition modellers had the time of their lives.

Yet out of this comes evidence of another change. Specialist interests in the fields of Radio Control, Free Flight and Control Line are inexorably drawing each class apart from the rest. Thus we find separatist elements, each regarding the other categories with an attitude ranging from indifference to outright antagonism. The common denominator Societies and Associations throughout the world have a tough time ahead in maintaining a co-ordinated effort. It is much to the credit of the Officers of the SMAE (each of them having broad interests all round with widespread aeromodelling activity) that they manage to satisfy the varied tastes of the characters who adopt the three modelling categories. For distinctly different characters they certainly are—the ardent, athletic free-flighters the blue-jeaned engine hungry control liners and the older, less nimble but tremendously enthusiastic radio controllers. Somehow the widening gaps of interest must be bridged if organised modelling is to succeed in its purpose.

The situation spreads further to International contests. Participation of a couple of dozen National Teams plus supporters and all the organising personnel at a World Championships produces an accommodation and financial problem of mammoth proportions. This is to some extent offset by income from spectators who provide the audience for "captive" performers in R/C or C/L events; but for Free Flight there is little chance of reimbursement. So for 1969 the prospect of repeating the triple (Rubber, Glider, Power) contests at one venue seems remote at time of writing. If matters proceed at the same pace of progress, the free flight championships will become isolated as the province of those Nations where Government support is forthcoming (Socialist States) or separated to reduce the commitments for the host countries. We hope that whatever happens, there will be no loss of continuity.

World Championships are bi-annual. As we go to press a British "private venture" team competes in Finland at the C/L Championships. The Indoor Champs take place at Rome in Italy during early October. West Germany is to be host to the World Championships for Radio Control next year (aided, we are informed, by a renowned brewery!) but Free Flight is out on a limb.

Meanwhile, technical developments proceed at a pace that at times baffles the poor lone-hand who can find his equipment out-moded overnight. This occurs in all branches but is most evident in engine design. Even the smallest of changes have produced incredible increases of power. So, as in years before, this Annual brings another "milestone" feature to reveal techniques hitherto the close-kept secrets of experts only. Coupled with the variety of other articles and the range of designs culled from the model press all over the World, we offer this year's content with confidence that it will inspire new ideas, and approaches to satisfy everyone . . . on to the next!

+3/16"

C.G. 75% from L.E.

Auto rudder line

3/32"

0° Hooks

3.7/8"

37.1/2"

DT line

Snuffer tube

Fuselage 1.1/4" to rear pylon tapering to 1/4" at L.E. of tailplane.

8° down

16 s.w.g. skid

Trim Right–Right

2.1/2"

42.1/2"

1.1/4"

Bulkhead 1/8" – 1/8" – 1/8" Ply sandwiched around skid

WING AREA: 215 sq. ins.
TAIL AREA: 87 sq. ins.
WEIGHT: 7–7½ oz.

3/16" soft block tip

1/8" x 1/4" balsa support (bottom only)

Double tissue wing centre section

1/16" aluminium tube

D/T hold–down hole

17"

6.1/4" x 1.3/4" x 1/8"

3/16" sq. wing runners

Top planked with 1/32"

3"

14"

1/4" x 1/2" hard balsa pylon support

A–A SECTION (HALF SIZE)

1/4" Alu. tube pylons

5"

1/16" sheet sides – top – bottom

3/16" sq.

STILETTO
½A power design
By BOB STALICK
U.S.A.

SCALE 1:10

8"

1/4" soft block tips

6.1/4"

3/16" sq. L.E. 1/16" x 1/8" balsa spars

1/8" sq. balsa spars

1/8" x 1/2" (Light) T.E.

1/16" x 1/8" balsa spars

1/8" sq. spruce spars

1/16" sheet

1/4" sq. balsa L.E.

1/16" sheet

1/8" x 1/2" medium balsa T.E.

WING AND TAIL SECTION (HALF SIZE)

1/4" ply

1/16" sheet

1/4" sheet

1/8" sq. pine

Block fairing

1/16" sheet

1/8" sheet

1/16" sheet

Beech dowel 5/32" dia.

1/16" sheet

25.1/2"

1/16" sheet

WING SECTION (HALF SIZE)

T.E. 5/16" × 5/8"

L.E. 1/8" × 3/8"

1/8" sq. spruce

4.3/8"

3/32" sq.

3/32" × 5/8"

1/16" sheet

5.1/2"

15.3/4"

Engine 0.8 – 1 c.c.

FINK

One-metre sports
R/C for up to 1 c.c.
By HERBERT
WILHELM
W. GERMANY

19.3/4"

3.1/2"

12°

14 s.w.g. wire

SCALE 1:6

5.15/16"

Flight Lieutenant Ray Lawrence runs the Triumph M/Cycle engine in his "Kuching Special" made while stationed in Borneo. Direct drive at 3 400 r.p.m. is a disadvantage, leading to poor airscrew efficiency. Weighing only 335 lbs. less pilot, the "Special" hopped a few times before enforced dismantling due to Service posting.

ONE STAGE FURTHER?

MAN CARRYING MODELS—*an old cliché is now spelled out loud and clear. Men that carry models can also make "models" to carry themselves.*

"Why bother with models" said a lightplane pilot at the Club bar, *"when for the same kind of money you can learn to fly the real thing"*. The statement is true as far as sophisticated radio control is concerned; but hardly typical. It does however, emphasise the growing attachment of model and full-size interests. Thousands of aeromodellers have the yearning to qualify as pilots. Many have gliding experience, a few own their personal aircraft or belong to Flying Groups.

We could name a couple of dozen well-known aeromodellers who have taken to cockpit flying in recent years—and even a few "reverse" cases where pilots have turned to aeromodelling! But that is not our purpose here, where we would like to introduce just five of the many original light aircraft designs which exemplify the emergent spirit of "making one's own". They have not been selected as examples for any particular reason, and the fact that the three American aircraft come from the same State of Illinois is not intended to indicate that this is a hot-bed of homebuilding. Any copy of "Sport Aviation", the monthly magazine issued by the Experimental Aircraft Association in the U.S.A. will provide a batch of new shapes produced in any of the U.S. States.

The ideal situation—one might refer to it as the easiest approach, is to accept existing components and power unit as purpose designed for lightplanes and so save time and effort in construction and certification. This was the means by which three professional pilots, Chuck Roloff, Carl Unger and Bob Lipofsky came to create the RLU-1 "Breezy" featured on the jacket of this Annual. They wanted a "puddle-jumper" for fair weather flying. A model was made in

Hang these on for size Gabriel! Ernie Sherry is "hooked". Eric Clutton acts as flight manager for the epic of the Dales—an experiment which proved that the pioneers of "hang flying" knew the right approach after all.

welding rod and in January '64 they decided to find a damaged Piper Cub wing and to order a factory re-built "zero-time" Continental aero engine. First flights on August 7th of the same year fulfilled all expectations. Since then, hundreds of passengers, have been carried on the rear bench. Despite the early-Sikorsky appearance, "Breezy" has an up-to-date performance. It carries on the theme of the Curtiss Junior, Kronfeld Drone, Kirby Motor Tutor, Dart Pup, etc.; but without the protection of a fuselage covering which would be desirable for keeping the crew dry in British air!

Breezy was not built on the cheap, it cost $3,400, of which the engine and prop accounted for almost half, radio and instruments another $800.

Cost of the certified aero engine and radio is beyond the pocket of the majority and so there is an immediate attraction for the converted motor cycle or car engine. Liquid cooling brings such a weight penalty that the range of choice is limited in the car field to the German Volkswagen series or the

Airfoil   Gottingen 535

No Dihedral
No Incidence

First Official Flight 3.11.63
(Triumph 5T 500cc M/Cycle engine)

A–A

Lawrance 37.5 b.h.p. radial

1° Washout

110 sq. ft

B–B   C–C

SPAN   22' 6"
CHORD   5'
LENGTH 17' 6"
HEIGHT   6'
TAILSPAN 9'
WHEELTRACK   4'

Max crusing speed 65 m.p.h.
Stalling Speed 36 m.p.h.

11.25 sq. ft

12 sq. ft

SCALE 1/72nd

F. R. E. D.
(Flying Runabout Experimental Design)
by E. Clutton & E. Sherry.

Landing run from 50'   530'

American Corvair. Motor cycle engines of the Harley-Davidson, Triumph, Douglas, Scott and J. A. Prestwich types have been employed for low powered single seaters. There are also the Ground Power Units or GPUs made by Lycoming, and Air Power Units such as the Lawrence radial—or thinking really "big"—the Rover APU Turbine. Major disadvantage is the lack of a propeller shaft reduction gearing. Most of these units develop full power in the 3–5,000 r.p.m. range and this is about twice as fast as needed for an efficient prop. So the next stage to be fully developed is that of satisfactory gear reduction, and many experimenters are currently working on this, particularly with the V.W.
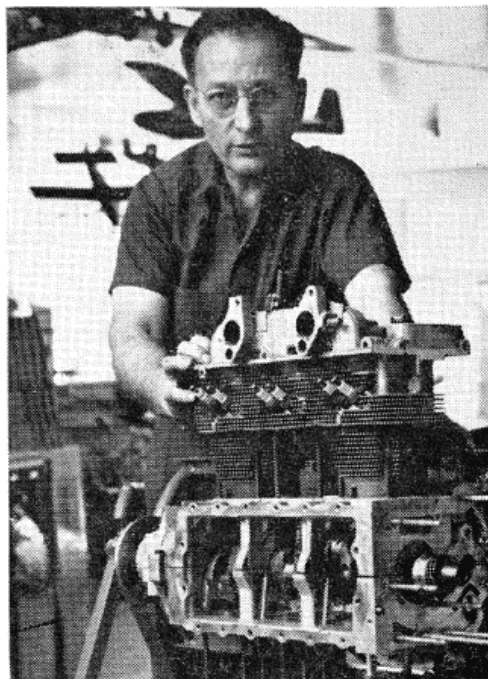
This is not to say that the direct drive VW is unsatisfactory, Mira Slovak's flight from Germany to California behind one proves its worth. The high r.p.m. can be turned to advantage, as with ex-St. Albans' club member Colin Rogers' much modded racing version of the Druine Turbulent which announced its approach five miles ahead like a Harvard. Fine pitch on an end-plated prop must make this the fastest VW airborne. Modeller, airline pilot and regular Aeromodeller correspondent from the U.S.A. Dick Stouffer forecasts as much as 160 m.p.h. out of his VW powered SK-1 which is a scaled up radio control design!

"Big Simpler" has been engineered by Emmet Kraus and incorporates many new features as the 3-view indicates on p. 16. Not the least is the comparative high loading and the Tee tail. The fuselage of this aerobatic design has accommodation for a suitcase—or a model.

Third of our examples from the U.S.A. could well be another blown-up model, for Ken Flaglor's "Scooter" has all the proportions of a "fun" design.

Above right: Harry Lange of Barrington, Illinois, U.S.A., is converting a Corvair car engine for his home-built Piel Emeraude. Modelling experience helps —see background of workshop with gliders and R/C models pendant.

Framework of the Clutton-Sherry F.R.E.D. long before it realised how many different engines it would have to bear on its nose! Latest is a geared V.W. driving a Gipsy engine prop! Gives STOL performance.
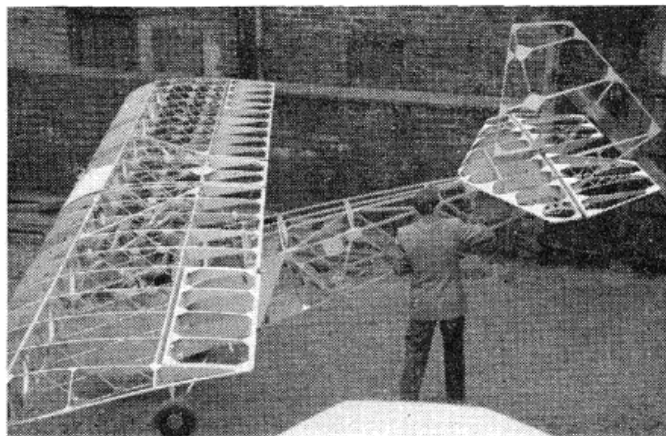
Italian modeller Bruno Militi designed, built and test flew his Hydro-Glider
at Rimini. Span is 28 feet, weight 170 lbs. less pilot and glide ratio 9:1.

It follows his "Cherokee" powered by Go-Kart engines, and flew first on the
18 h.p. of a Cushman Golf-Kart unit. Performance was marginal due to weight,
so inevitably, the VW was fitted, but the smallest version, not the latest which is
almost 50% bigger in capacity. Ken sells plans for this delightful ground
hugging flivver (almost a powered glider) and it won the award for "Most
Outstanding ultra-Light" at the 1967 EAA fly-in at Rockford. Wooden structure
can be completed in 40 hours, ribs are sawn from ply, assembled on spruce spars
and the fuselage has spruce longerons, leaving only the engine mounting in steel
tube for professional welding. Engine instruments are car type, and the landing
gear mainly ex Go-Kart.

Ray Lawrence is a modeller of many years standing, and whilst on duty
in the Far East in the R.A.F. created his "Kuching Special" from indigenous
materials in Borneo. Time was not on Ray's side and tests abandoned due to a
posting. (The airframe subsequently became a non flying Fokker DR.1 replica.)
Motor Cycle engine power was enough; but only just, for test hops and as Ray
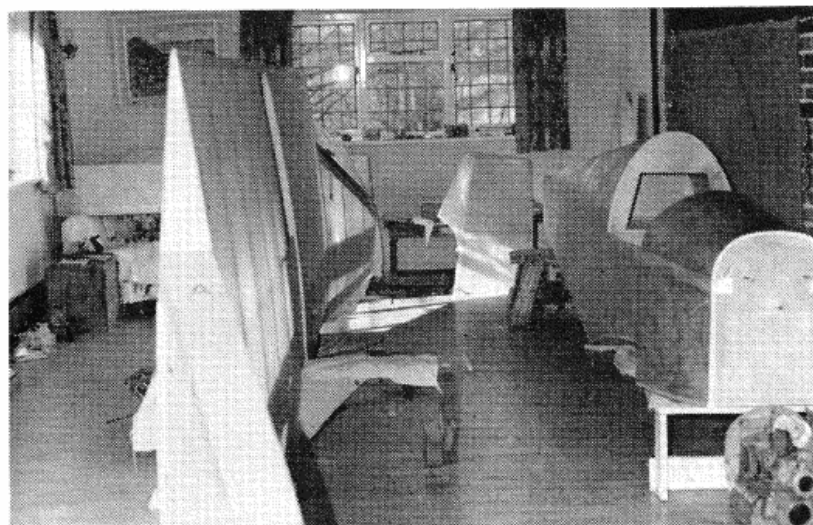
Member of West
Essex Aeromodel-
lers, R/C flier Bill
Cole chose a house
with a 23 ft. long
room to make his
Bebe Jodel D-9
indoors! Original
engine was to be
a Douglas Sprite
but now changed
to a V.W. Started
after a club session
last October, it
reached this stage
in March — some
people take longer
to make a model!
Bill was flying it
within a year of
starting.

states, the Triumph should really go to 6,000 r.p.m. to achieve peak power, so that the home carved prop wasn't even allowing the engine to get started up the b.h.p. curve. Ray's "big model" was much after the Luton Minor, Heath Parasol style, a popular arrangement which offers excellent visibility, "Umbrella" weather protection and centre of gravity position for the pilot. It was also chosen by Eric Clutton and Ernie Sherry for the F.R.E.D., but as this particular project has rather a colourful background, we'll hand over to Eric to tell his own story:
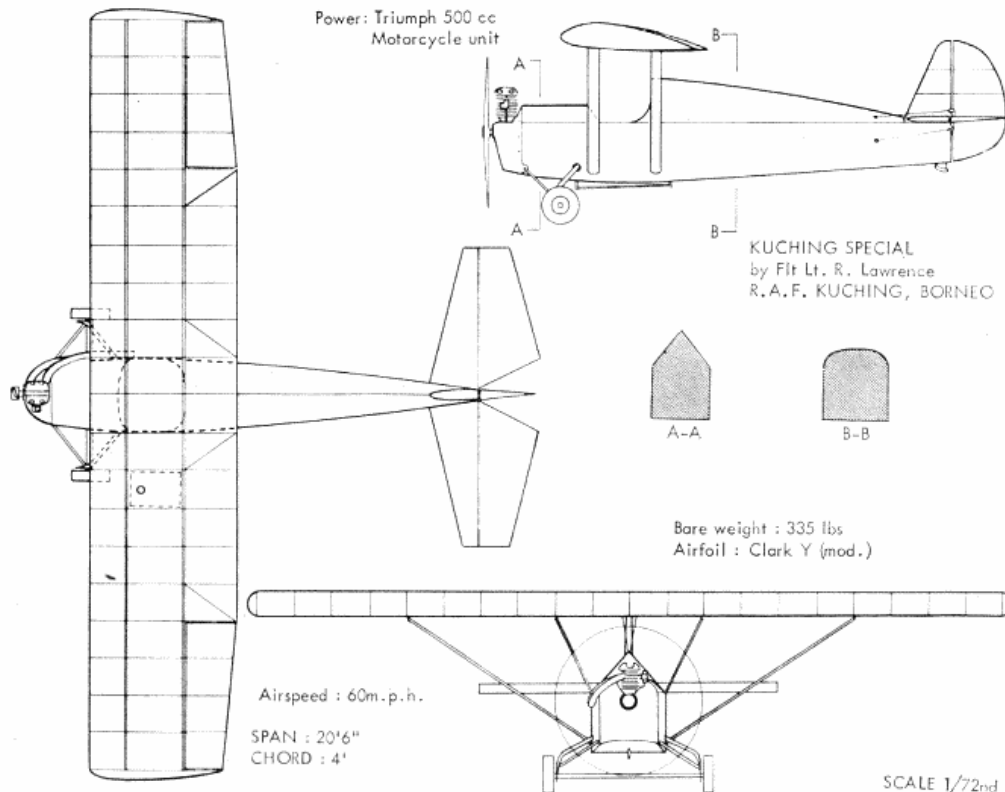
"Some years ago I became involved with AEROMODELLER's tame cartoonist, Ernie Sherry, in a project straight out of Jules Verne—or was it Walt Disney? A huge pair of wings were made to strap on our backs—a sort of latter day Lillienthal. I hasten to say that all this was Ernie's idea—I just went along for the laughs!

"We never actually got off the ground with these wings in spite of running down hills and being towed by a motor-cycle, but on one occasion my partner lifted both feet at the same time in sheer desperation. He did a nose dive into the heather and it took two of us to pull him out of the soft ground! Fortunately he was wearing a crash hat. Probably the funniest occasion was when we were in the Derbyshire hills with the wings. I had just run down a steep slope and then staggered back to the top looking like the angel Gabriel with 40 ft. wings sprouting from my shoulders. As I came over the brow of the hill (attired in wings, crash-hat and goggles) I could see that a large number of Sunday motorists had stopped by the roadside, wide-eyed at the sight I presented. The opportunity was too good to miss—I announced to all in a loud voice, *"It's a bit rough over Derby!"* I still wonder what sort of tales were told on the Monday.

Power: Triumph 500 cc Motorcycle unit

KUCHING SPECIAL
by Flt Lt. R. Lawrence
R.A.F. KUCHING, BORNEO

A–A   B–B

Bare weight : 335 lbs
Airfoil : Clark Y (mod.)

Airspeed : 60m.p.h.

SPAN : 20'6"
CHORD : 4'

SCALE 1/72nd

SPAN : 33' AREA 165 sq.ft.
LENGTH 22' 6" HEIGHT : 8' 6"
Bare weight : 700 lbs

BREEZY RLU-I 2/3 SEATER
by CHARLES ROLOFF, CARL UNGER & BOB LIPOSKY
Illinois U.S.A.

Charles Roloff's "Breezy" in photo opposite (and cover) shows how designers achieved object of creating a puddle-jumper for fresh air flying.

White wings
Red registration
Red fuselage tubing

Piper Cub PA 12 Wing

Power: Continental C-90

Airspeed : 75 m.p.h.
Stall : 30 m.p.h.

Landing Roll from 50' - 1100'

SCALE 1/72nd

"These wings were hilariously funny but not exactly a practical flying machine, so some thought was given to designing a proper glider. We worked out that several fairly high performance gliders could be scaled down to about 20 ft. wingspan if the pilot adopted a prone position (headfirst). I also did some drawings of a tandem wing glider.

"Perhaps fortunately these plans were forgotten when we acquired a spare motorcycle engine and it was decided to design a powered aeroplane. The eventual outcome was **FRED** (Flying Runabout Experimental Design) but of course we stood little chance of getting a motor-cycle-engined craft cleared for flight. We overcame this by finding a spot of our own, and after many trials and tribulations managed to get off the ground. The poor old Triumph 500 c.c. engine had to work mighty hard to haul Fred along and we got through three engines (one was still going strong) before giving up that idea.

"Our next engine was a Scott Flying Squirrel out of a Flying Flea. As a noise-maker this engine was superb, but it was deadly unreliable—the most memorable thing about it was the fact that it used Castor Oil for lubrication and the smell was gorgeous. After a session with this engine we would be sticky and smelly but we would feel like Sopwith Camel pilots (a moving experience!). This engine is now in the tender hands of the Shuttleworth Trust and is destined to be fitted to their Flying Flea so it will be back where it belongs!

"Our next engine was a Lawrence five-cylinder radial. This was the only one in the country and a really beautiful piece of equipment. Although it had been used to drive a generator it had obviously been designed from the outset as a genuine aero engine. It was rated at almost 40 h.p. and converting it to aircraft use took about three or four months of spare time. In the meantime Fred was largely rebuilt and steps taken to legalise the situation which involved some paper work and static proof loading of the whole aircraft. Proof loading consisted basically of turning the wings upside down and placing concrete blocks on them to a total weight of three and a half times that of the fully loaded aeroplane—approximately one ton in all! It is incredible how much weight a few scraps of plywood and spruce will support. We were so interested we did the test twice!
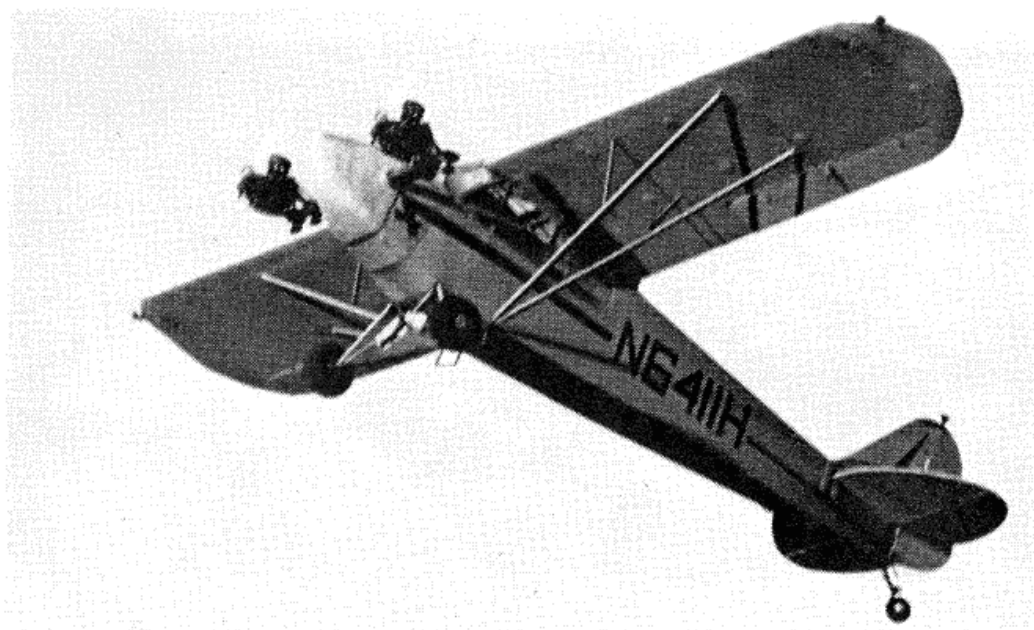
Nelson Twin Cub N6411H owned by Nelson Aircraft piloted by S. N. Siggins, Finleyville, Philadelphia. Powered by two Nelson 48 H.P. 2-stroke engines. A modified Piper Cub, the engines appear to be mounted to a large diameter tube, bolted or mounted to original firewall and a fibreglass fairing covers the original engine area.

Photo opposite reveals low ground clearance and overall height of the Flaglor "Scooter", plans for which are sold by Flaglor Aircraft, 1550 Sanders Road, Northbrook, Illinois 160062, U.S.A. price 25 dollars. Cost to build, less engine and instruments is £200.

Corcoran Glider N 7558U, built and flown by R. Stanley Corcoran, 500 Old Hickory Road, New Lennox, Illinois. Powered by two West Bend, 2-stroke engines of 8 h.p. each. Built in 1965. This most interesting prototype takes off and flies on a total of 16 h.p. The props are wide paddle blades of about 18–24 in. diameter in a pusher configuration. Note that the engines are simply mounted on a cantilever board attached to the top longeron of the basic fuselage.

U.S. photos by Dick Stauffer and Marion Davidson.
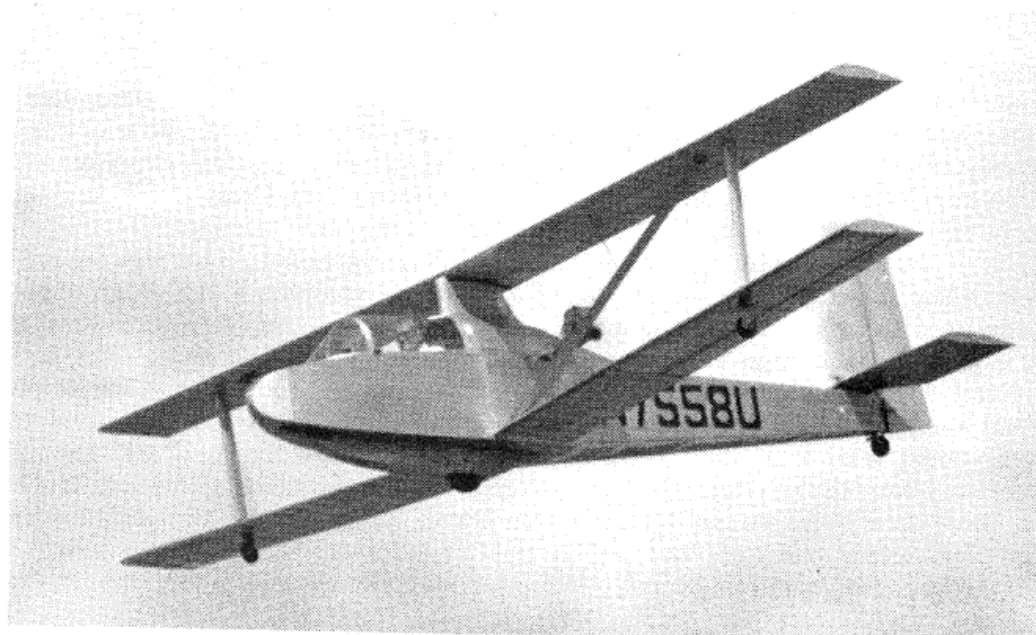
"Soon after completing these tests, disaster struck! The Lawrance engine was being run up when it stopped very suddenly—so suddenly in fact, that the complete hub assembly with prop shot off! A broken connecting rod was found to be the culprit and as this was about the only spare part we didn't have we were back to square one. After some thought it was decided to convert a Volkswagen engine for Fred, and a 1,500 c.c. unit was obtained from a somewhat beat-up motor car. This was converted to an aero engine—not just an ordinary engine, but one with a reduction drive! This engine has been an outstanding success, and as it swings a 6 ft. prop taken off the 90 h.p. engine

Power: Volkswagen 1192 cc

FLAGLOR SCOOTER
by KEN FLAGLOR
Illinois U.S.A.

SPAN : 27'10"
LENGTH : 15' 6"

Airfoil: NASA 23012

Bare weight : 390 lbs.

Max. Speed: 80 m.p.h.
Cruise : 65-70 m.p.h.
Stall : 34 m.p.h.

A-A   B-B   C-C

SCALE 1/72nd
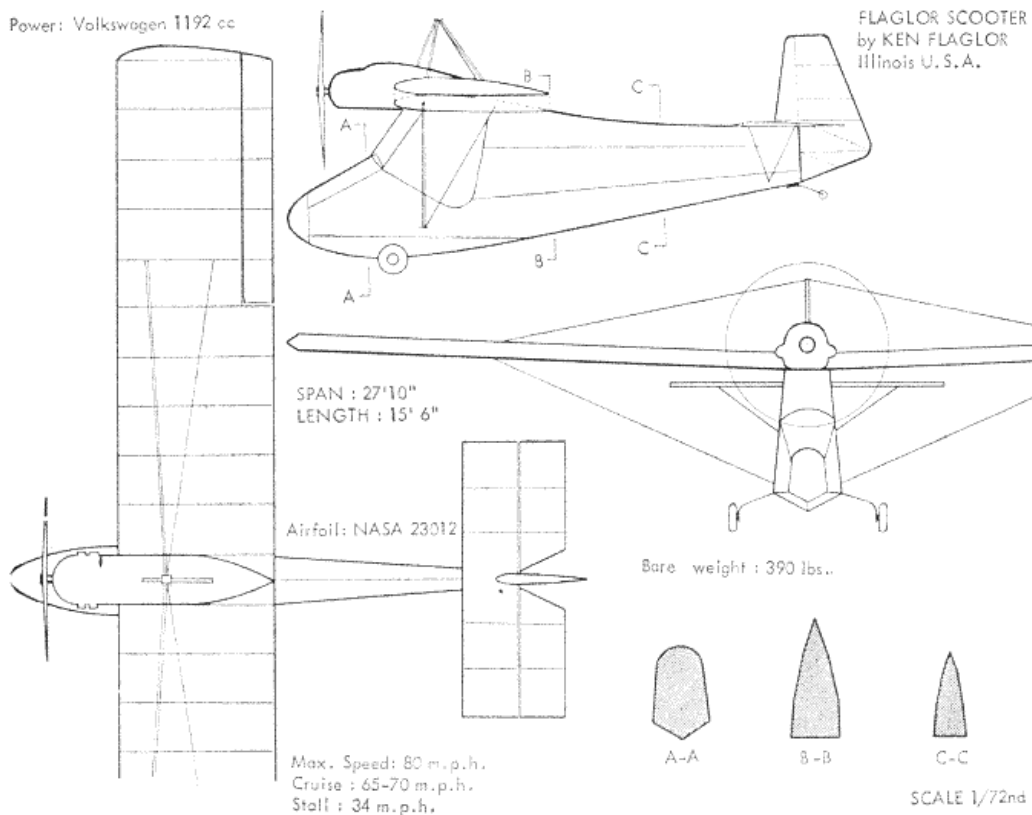
in an Auster, it has given Fred true STOL capabilities—almost VTOL in fact! As far as we know this is the only geared VW engine flying in an ultralight anywhere—we even beat our American cousins to it!

"This is probably the ultimate development as far as Fred is concerned— the wings and tail detach very simply in glider fashion and it take two people about twenty minutes to rig Fred ready for flight. This is a slight snag—the two people bit. A new design is on the way and this will be a low wing aeroplane with wings that can be folded by one man. It will then fit into a normal single car garage. The engine will naturally be a geared VW and the performance should be something extra special!

"Oh yes, I still manage to make toy aeroplanes as well—wouldn't be without them in fact. The strange thing is that I became involved in full size bui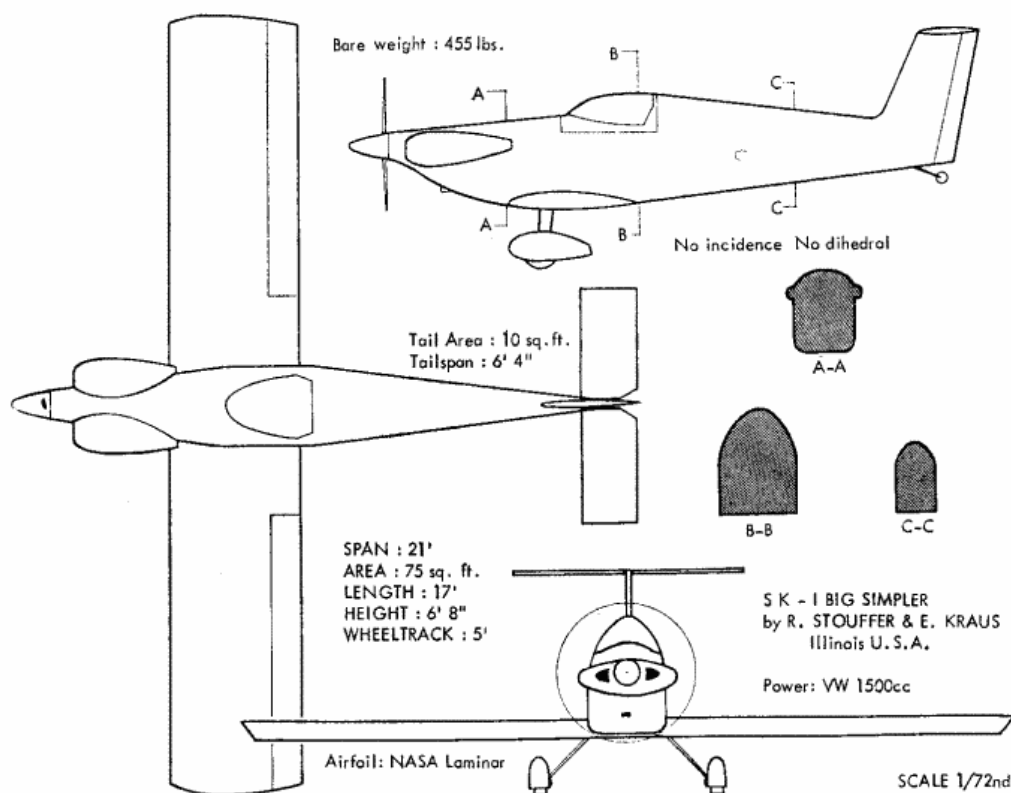lding through my modelling activities and because of my involvement in big stuff I can honestly say that my workmanship has improved and I now make better models.

"Building an ultralight is not all that difficult—if it was really difficult I couldn't do it, so if you are interested join the P.F.A. and have a go."

There are, of course, many other home-built designs flying around on "cooking" engine power. The Woody Pusher is a fine example in the U.S.A., and the many Turbulents and Jodels in Europe have become household names. Modellers who have the yearning to expand their interests are advised to contact the *Popular Flying Association*, 2 Waldens Park Road, Horsell, Woking, Surrey, or the *Experimental Aircraft Association*, European Office, 11 Stonehills House, Stonehills, Welwyn Garden City, Herts.

Bare weight : 455 lbs.

No incidence No dihedral

Tail Area : 10 sq. ft.
Tailspan : 6' 4"

A–A

B–B   C–C

SPAN : 21'
AREA : 75 sq. ft.
LENGTH : 17'
HEIGHT : 6' 8"
WHEELTRACK : 5'

S K – 1 BIG SIMPLER
by R. STOUFFER & E. KRAUS
Illinois U.S.A.

Power: VW 1500cc

Airfoil: NASA Laminar

SCALE 1/72nd

A

2.3/4" 4.5/8" 9.1/2"
Block formed
on 1/32" ply

14.1/2" 5"

1.1/2" 1.3/4"

8"

2.5/8" 4" 3.3/4"

2"

1.3/8"

2.3/4"

A

43"

1/4" x 1/16" balsa   1/16" sheet

WING SECTION (1/3RD SIZE)
(SECTION EPPLER 374)

Root rib

1/4" x 1/8" spruce   Brace

SECTION A-A (NOT TO SCALE)

3/32" Ribs
Sanded to symmetrical
section

1/2" block

Sides 1/32" ply
Evostick to
1/32" balsa

1/4" sq.

3/4" block

Dihedral brace
1/2" ply extends
to second rib.

1/4" dowel

24"

3.3/8"

1.3/4"

For 6 Channel:
Rudder,
Elevator,
Elevator trim.

3/8" sq. frame

4"   1"

33"

2.3/4"

2.1/2"

SUZIE QUE
Fully aerobatic multi R/C slope
soaring glider
By KEN BINKS, Eastbourne

4"

SCALE 1:10

3/4"   7.1/4"   1.1/4"

2"

C. G.

2½°

24¼"

32.5/8"

5°

WING – SECTION (Half size)

⅛" sq.

3/64"

⅛" sq.

Sheet 5/64"

1/8" × 3/8"

15"

3¾"

2⅜"

2⅜"

2⅜"

¾"

1.11/16"

7.3/16"

DORNIER Do-27
Semi-scale R/C sports for single
channel and ·8-1 c.c. engines
From JAPAN

SCALE 1:6

Fill in with 1/16" sheet
between 1/16 sq. stringers.
Top of fuselage from
formers A–B.

.008 celluloid

3/32" sheet

1/16" sheet

1/16" sq.

1/16" sq. stringers

1/16" sq.

1/16" sq.

N21P

Fill in between
stringer with 1/16"
sheet balsa

1/16" sq. stringers

16⅛"

Soft balsa

5.5/8"

A–A

B–B

L.E. 1/8" sq.

1/16" sq. spars

All formers are 1/16" sheet

3.9/16"

1/4" × 1/8" T.E.

2.3/16"

Soft balsa
cheek cowls

4¾"

4½"

Wing fillet ⅛" sq.

Soft balsa
spinner & nose

6½"

2⅛"

GRAY GHOST
Rubber scale
By HAROLD SWANSON
(Modernistic Models)
U.S.A.

Soft balsa tips

5" dia
prop

C–C

Sandwich landing gear wire
between 1/32" sheet balsa

Wheel covers 5/16" sheet
centres and 1/8" sheet sides

.032 dia. wire
landing gear

SCALE 1:4

LE MODELE REDUIT D'AVION, U.S.A.

The Fleet—2 As, 1 B, 2 Cs.

" 'SECRETS' OF ENGINE PERFORMANCE"
by GEORGE M. ALDRICH

JUST what advantage is there in keeping secrets? What advantage is there in not helping a fellow competitor? Well, if you really try hard you can get your event to the state speed modelling is today. By sharing ideas, not only are newcomers encouraged, but mistakes are avoided and the state of the art *progresses* much more.
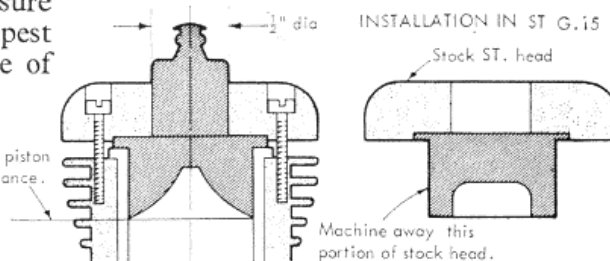
With the tips given here on engine work, plus the fuel formulae, it is possible to be very competitive. For example the Author has exceeded 190 m.p.h. four times with a stock Super Tigre .65. The only alteration to the engine was to "band" the head and taper the piston as described.

The following is a basic outline on how to prepare a glow engine. The comments apply to all high performance engines no matter what the event.

(I) *Dismantle* the entire engine completely, taking the following dimensions and writing them down for future reference as you go.

1. Piston depth in cylinder at T.D.C. measured from top flange of liner.

2. Exhaust timing—total time exhaust is open through B.D.C. (A plastic, full circle, protractor with a hole in the centre serves nicely.)

3. Depth that cylinder head extends into cylinder less gaskets.

4. Plug depth in head. Measure from surface of squish band or deepest extension into cylinder, to surface of plug.

Note: Remove ball bearings by heating crankcase over a gas flame. Avoid over-heating. Heat for a short period and tap case over a heavy cloth that will catch the bearing. A good heat gauge is to apply light oil to the bearings and heat until the oil just starts to smoke. Use a wooden dowel to push or tap bearings that won't come free.

½" dia   INSTALLATION IN ST G.15

Stock ST. head

.003 piston clearance.

Machine away this portion of stock head.

NOTE: This head when used on ST G.15 with E.D. Power Pipe gave clean 700 R.P.M. increase on F.A.I. fuel. Pipe length 11" ₵ cyl. to end of tail pipe. Exhaust timing 156° with 10° lead over intake.

(II) *Basic Fit*. Remember that the single most important aid to engine performance is the proper fit of all the parts. We are preparing to "custom fit" an engine. Something most manufacturers cannot afford.

1. Lap crankshaft to case with bearings removed using 600 grit valve grinding compound. (Area between the bearings.)

2. Bearing housings should be reworked to give a tight *HAND PUSH* fit. This is best done with 320 sandpaper on a dowel.

Note: These operations may not be necessary if your engine shaft spins completely free when the bearings are washed clean. However watch for shaft or bearing seizing when the engine is run the first time. The K. & B. engines do not require this step.

3. Wash these parts thoroughly several times with a solvent and finally with a dishwashing detergent to remove all grit.

4. Check the connecting rod. Obtain steel dowel pins about 2 in. long that will fit both the big and small end of the rod. By centring the two dowel pins in the rod accurate measurements can be made to be certain the two holes are parallel. The pins should be a light push fit.

5. Cylinder head—here is one of the best kept secrets—I have seen more than one engine jump 1,000 to 1,500 r.p.m. with this modification alone. The portion of the head that fits into the cylinder should be *no more than 0·001 undersize*. Refer to the diagram for details on "banding" a head. The best fit is a light hand fit or about the same as the piston! The plug depth is most important, as is the clearance between the head and squish band face (head clearance).

6. Piston and Cylinder Fit: Another well kept secret is the "tapering" of the piston. Refer to the chart for the proper dimensions. Note that only the very top of the piston is tapered. This is done to stop the piston from catching on the top edges of the ports when the engine is new and still tight. The piston is normally made from cast iron and will expand when hot and contract when it cools. But it will not contract back to its original shape or size. I have measured some 0·65 pistons and found them to be 0·004 out of round. That is, the piston is larger to the wrist (gudgeon) pin side. This one fact is the main reason for "Running-in" an engine and *not* disassembling it after it is run in. A small amount of lapping using 800 Grit Aluminium Oxide compound for 0·29 through 0·65 engines and 900 to 1,000 Grit for 0·15 size can shorten the amount of run in time—but proceed at your own risk. As the piston and cylinder become run in, there is a point where the piston stops "growing" and the unit becomes perfectly rated.

New G.15 Super Tigre 15s with exhaust casting to adapt to muffler or tuned exhaust showing insert type and Cox T.D. heads held by "false" head.
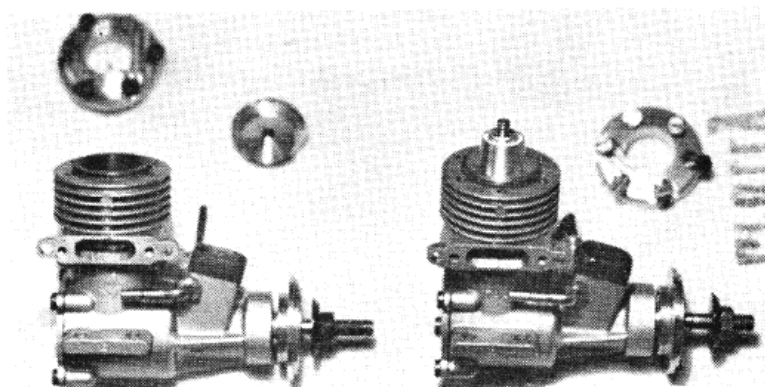
If you are to run only F.A.I. fuel (80–20) there is no need to taper the piston. However, when nitro fuels are used the heat is so much greater that this taper will disappear as the unit is run in. Regardless of what you have heard, the above is the difference between an average engine and the record setter *All Other Things Being Equal*.

7. Crankcase Modifications. Above all DO NOT POLISH THE TRANSFER PASSAGES. With a 2-stroke engine the piston serves as the "valves". And, at their normal operating speeds the piston opens *and* closes the ports so fast that it is hard for enough fuel to get into the cylinder. In view of the above I have been experimenting with both the H.P. 15G and ·61 engines. Directly opposite each of the three ports (two intakes, one boost) I have enlarged the by-passes in the crankcase as much as possible. To date the best with the H.P. 15G is 156·43 m.p.h. on the pylon.

What about the tuned exhaust system? Quite frankly I do not think competitive speed will last long if this system is used only by the select few. That is, until it is made readily available to all, there can be no real contest. However, some tests have been made with the tuned pipe—*i.e.*, E.D. pipe by Kevin Lindsey and one made by Curt Burrus, Bill Wheeler and the author (B. A. W. Speedteam). K. & B. and Super Tigre are to produce tuned exhausts.

Conclusions: (1) Using the "L" Section or Dykes ring quite a bit more piston clearance is necessary, a 0·60 *must* have up to 0·010 larger bore than piston fit due to higher operating temp. (2) Crankcase Pressure can be used. (3) A tuned pipe for nitro fuel must have slightly more volume than for F.A.I. fuel. *Example:* Larger major diameter and possibly shorter—depending on nitro content, air temp., etc. (4) There are so many variables that it will be quite some time before optimum performance is reached on a universal scale.

What do we have to look forward to? By the time you read this the new Super Tigre "ABC" engines should be established on the market. ABC stands for *A*luminium Piston, *B*rass, *C*hromed Liner. The secret here is closely matched coefficients of expansion between piston and cylinder materials. And, with the chrome plating it is virtually impossible to "stick" a piston. In fact you can take a new engine, mount it, and fly right off with the hottest of fuels!!! Imagine, no break in!

RATTLER 29   (HYBRID K. & B. AND S.T 29)

This engine "mix" has produced some really excellent speeds in the hands of such notables as Husted & Roy and Graham & Booker. H. & R. made their own casting but the basic set up is quite similar to the details given.
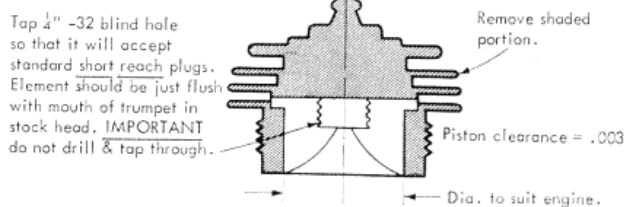
(I) **Basic hybrid consists of:**

1. K. & B. crankcase, backplate ass'y., front end ass'y.
2. Super Tigre 29 piston and cylinder, con rod, cylinder head.
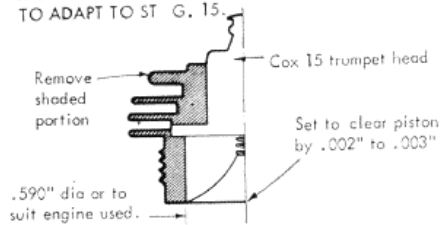
(II) **Modification of Parts:**

1. Piston tapered after lapping with 800 aluminium oxide compound.

2. Liner O.D. turned down to give light hand push fit into crankcase; or crankcase can be bored to accept the S.T. liner.
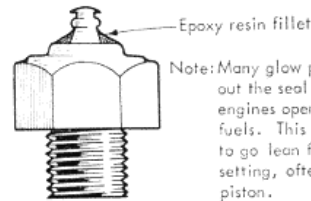

MODIFICATIONS TO COX 15 T.D. HEAD

Tap ¼" -32 blind hole so that it will accept standard short reach plugs. Element should be just flush with mouth of trumpet in stock head. IMPORTANT do not drill & tap through.

Remove shaded portion.

Piston clearance = .003

Dia. to suit engine.

MODIFICATION TO COX T.D. 15 GLOW HEAD
TO ADAPT TO ST G. 15.

Remove shaded portion

Cox 15 trumpet head

Set to clear piston by .002" to .003"

.590" dia or to suit engine used.

EXTRA SEAL ON STANDARD GLOW PLUGS.

Epoxy resin fillet

Note: Many glow plugs will blow out the seal when used in engines operated on Hi-Nitro fuels. This causes an engine to go lean from a perfect setting, often siezing the piston.

3. Crankcase machined to drop liner in case to give 0·278/0·280 piston depth A.T.D.C.

4. ST 29 Rod, big end drilled out and bushed to fit K. & B. shaft crankpin. Bronze bushing suggested. (H. & R. now use K. & B. rod.)
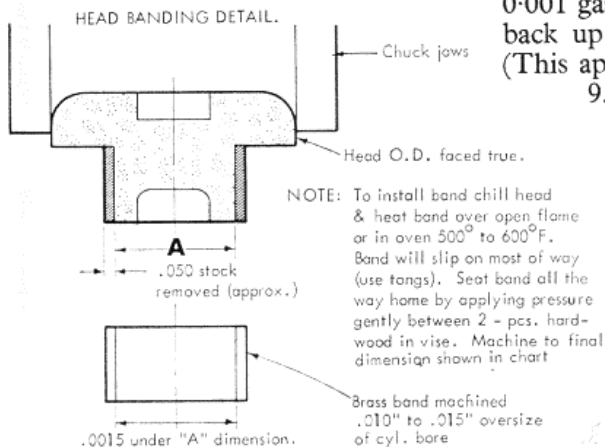
5. Rod must be thinned down on both sides to clear K. & B. rotor and crank throw (counter balance). Several mock assemblies are sometimes required to clear rod in order to remove only *just* enough material.

6. Backplate capped with a steel face and lapped square with rotor pin on glass plate, i.e. Super Tigre 0·29 RV.

7. Make a new rotor from either Phenolic sheet (paper base is best, rather than linen) or from aluminium 2024–T3 Bar Stock. Some mount rotor on 2 — 0·3125 O.D. × 0·1251.D. flanged ball bearings, to get really "fancy". Set all rotors as close as possible to backplate and still spin free—·0015" ideal, over ·004" too much clearance.

8 Cylinder Head banded to dimensions shown in chart for ST 29 RV. Set up to give approximately 0·010 piston/head clearance. Test run, adding 0·001 gasket each run until r.p.m. falls off; back up one gasket for proper clearance. (This applies to all engines.)

HEAD BANDING DETAIL.

Chuck jaws

Head O.D. faced true.

A

.050 stock removed (approx.)

NOTE: To install band chill head & heat band over open flame or in oven 500° to 600°F. Band will slip on most of way (use tongs). Seat band all the way home by applying pressure gently between 2 – pcs. hardwood in vise. Machine to final dimension shown in chart

Brass band machined .010" to .015" oversize of cyl. bore

.0015 under "A" dimension.

9. Most machine a completely new front end bearing housing though the stock K. & B. unit works well unless "kissed" in flight and will normally require replacement.

10. On test assembly it will be noted that the bottom lip of the exhaust port will be below the crankcase exhaust port opening. Grind or file the crankcase to fair this opening to the exhaust port.

Super Tigre 15 G Head with band installed and band as before installation.
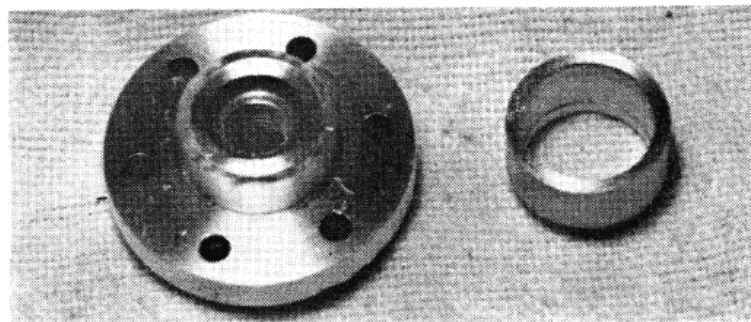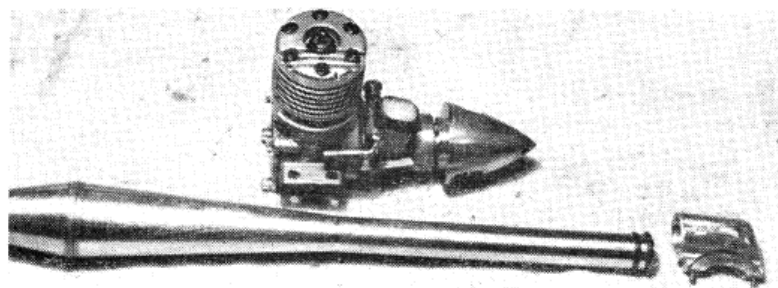
B.A.W. pipe for Super Tigre G.15 167° exhaust, 10° lead over intake. Bench tests show clean 23,500 on 7½ × 3¾″ rev-up 80-20 fuel.

11. Use *only* Rossi Needle valve assemblies. All the others available at this writing give inconsistent or touchy settings.

12. H. & R. used a trumpet head shape on their record setting engines. This is not an easy design to get top performance from. In fact, H. & R. had to go and get their best head back, as they sold it on an engine they had built up. They made impressions of its shape for duplication and still that one head was better. I have often wondered how well it fitted the liner. Dimensions on this head are approximately as follows:

Piston Clearance: 0·004 in. Plug depth: 0·125/0·130 in. Squish Band: $\frac{1}{16}$ total.

H. & R. use a fuel very much like the Ramm (called "Heat") formula which works well with the trumpet shape. It seems that high compression and high propylene oxide content work well together.

G. & B. use a fuel similar to the No. 3 formula except that they use an ingredient called low E.T. (Elapsed Time) which consists of: 65% Toluene, 12·5% Propylene Oxide, and 22·5% top skim of white gasoline distilate (called Lube Gas). The formula for this fuel is:
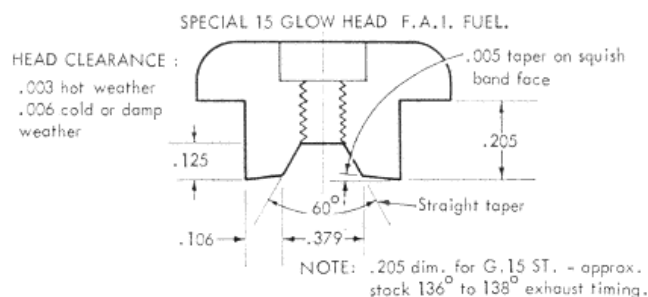
65% Nitro Methane, 9% S.B., 9% Poly (or all S.B.), 5% Low E.T., 7% Nitro Benzine, 5% Alcohol.

This formula can be altered to 70% N.M., cutting out all of the Alcohol.

A final note on the K. & B. crankcase. There have been several models made. The best style to use seems to be the latest with enlarged bypass. Some very good engines were built up on the original narrow transfer (bypass) case.
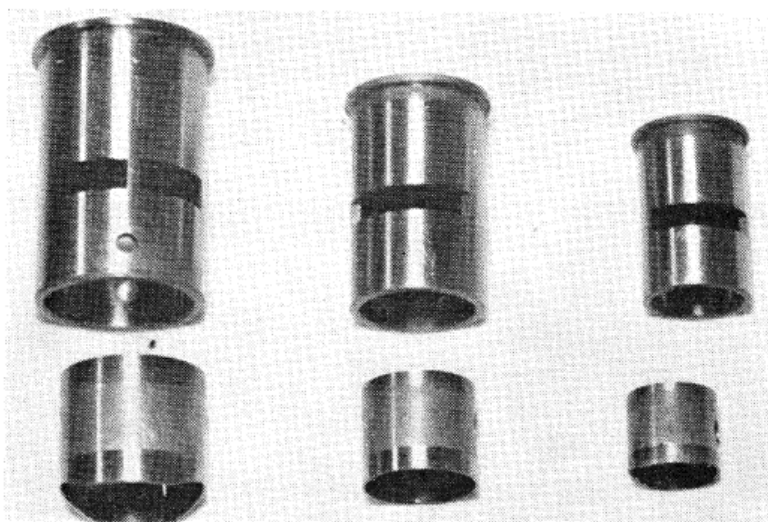
Left to right Super Tigre G.65, G.29, G.15 piston and cylinder assembly showing taper to top of pistons.

SPECIAL 15 GLOW HEAD F.A.I. FUEL.

HEAD CLEARANCE :

.003 hot weather
.006 cold or damp
weather

.005 taper on squish
band face

.125

.205

60°

Straight taper

.106

.379

NOTE: .205 dim. for G.15 ST. - approx.
stock 136° to 138° exhaust timing.

By building up a reinforcement of epoxy based aluminium compound around the top of the bypass on the outside the inside could be opened up to form a "storage chamber" opposite the intake port. "Blowing" the top off the case was not uncommon with these engines. Possibly this resulted in the H. & R. case. A good epoxy aluminium compound is made by the Devcon Corp., called Devcon F Aluminium Putty. The address is:
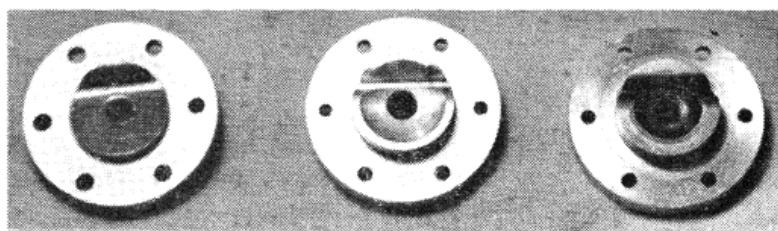
The Devcon Corp.,
Danvers, Mass.

Devcon Canada Ltd.,
Scarborough, Ontario.

Devcon Ltd.,
Theale, Berks., England.

Devcon De Mexico, S.A.,
Mexico 5, D.F.

Three styles of K. & B. 29 heads; left to right, wedge, Hemi with squish band. Note that baffle slot divides combustion chamber.

Super Tigre G21/29 "L" ring piston, liner and insert head assembly. Ring retainer web brazed into intake and exhaust ports. Honed true. chromed and re-honed. Piston material is D-132 aluminium—11% silicone for low expansion. Dykes ring is ductile iron. High nickel content permits ring to take a "set".
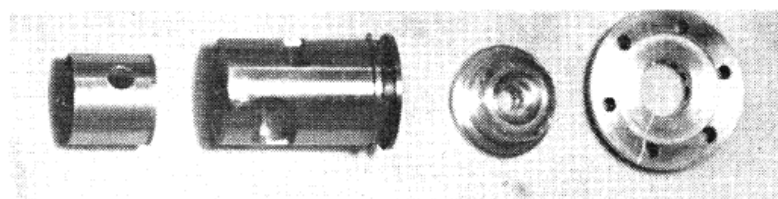
Prototype 3 E.D. Power Pipe on Rossi ·65 (bored ·970) chrome liner. E.D. Power Pipe on G.15 with Cox T.D. 15 plug/trumpet head. 20,400 best on 7½ × 3¾″ rev-up 80-20 fuel.
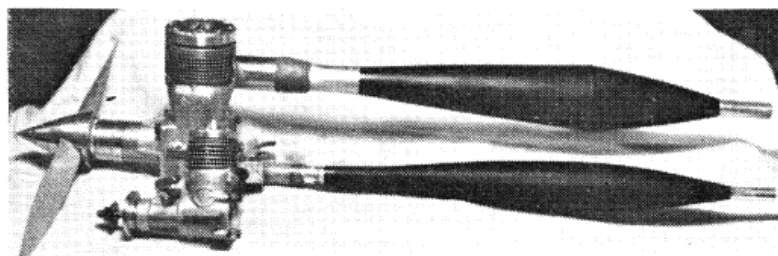
FUEL INGREDIENT GLOSSARY

AL   Methanol

N.M. Nitro Methane

P.O. Propylent Oxide—
(an igniter used to
"set off" N.M.) do
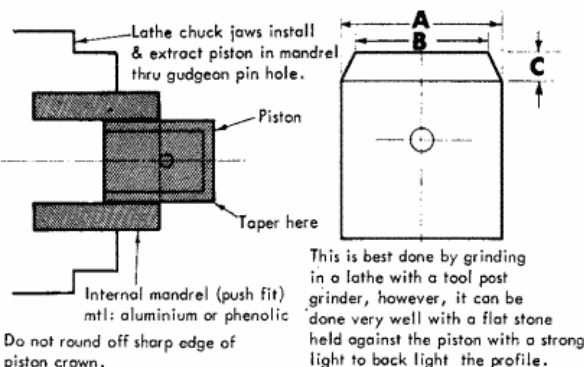not use with meth-
anol.

Poly Poly Oxide Oil
(Widget Racing
Supplies & Fuels,
P.O. Box 29, Concord, Calif.)

S.B. Epoxidised Soy Bean Oil (Archer, Daniels, & Midland Co., Decatur,
Ill., U.S.A.) 7·5% epoxidation important.

U.C. Ucon Oil (Union Carbide Chem. Co., 270 Park Ave., New York
10017.) (Union Carbide trademark for Polylefin Synthetic Oil)

C.O. Castor Oil AA or AAA.

N.B.—Nitro Benzene—(Do not get in open cuts or scratches—avoid
prolonged contact with skin.)

Diagram labels: Lathe chuck jaws install & extract piston in mandrel thru gudgeon pin hole. — Piston — Taper here — Internal mandrel (push fit) mtl: aluminium or phenolic — Do not round off sharp edge of piston crown. — This is best done by grinding in a lathe with a tool post grinder, however, it can be done very well with a flat stone held against the piston with a strong light to back light the profile.

Useful Formulae

(*1*) Break-in Fuel—50% N.M.; 20% Ucon 625, S.B. or Poly; 30% A.L.

(*2*) Basic Test Fuel   60% N.M.
       (K. & B. speed fuel)   20% Ucon 625, S.B., or Poly
                                20% A.L.

   Note: All engines should have several flights on this fuel before more nitro
        is used.

(*3*) Contest Fuel—Basic for many speed men
       65% N.M.; 9% C.O.; 9% Poly, Ucon 625, or S.B.—(Below 75°F use
       18% of any of these oils); 7% N.B.; 7% A.L.

   Note: This fuel can be varied by eliminating up to all of the A.L. and using
        as much as 72% N.M. This is good in high humidity and tempera-
        ture.

(*4*) Record "A" Fuel
       75% N.M.; 18% to 20% S.B., Ucon 625; 5% P.O.

(*5*) Top all-purpose fuel (Harry Roe "Top Hammer")
       72% N.M.; 18% Ucon 625; 10% P.O.

(*6*) Aldrich Best "C" Fuel
       72% N.M.; 8% Ucon 625; 10% P.O.; 10% Ucon 1800x.

(*7*) Ramm Fuel Formula
       65% N.M.; 17% P.O.; 18% Poly. *Notes:* Good Rossi 60 fuel. Very good
       for cool weather and well run-in engine. Tricky to set needle. Works well
       in high-compression engine, with trumpet head, as Husted & Roy's Rattler
       29.

(*8*) Hot weather Contest
       70% N.M.; 25% Poly, Ucon 625, S.B.; 5% P.O. *Note:* Very good for
       lapped larger engines.

PISTON TAPER DATA TABLE

Total Stock Removal	Eng. (Cu. In.)	A	B	C
0·0005	0·15–0·19	0·59050	0·5900	0·090
0·0015	0·20–0·35	0·74800	0·7465	0·125
0·0025	0·40	0·81000	0·8075	0·156
0·0035	0·60–0·65	0·94400	0·9405	0·250

Note: "A" is average dimension for engines of this size.

SUPER TIGRE SQUISH BAND DIMENSIONS
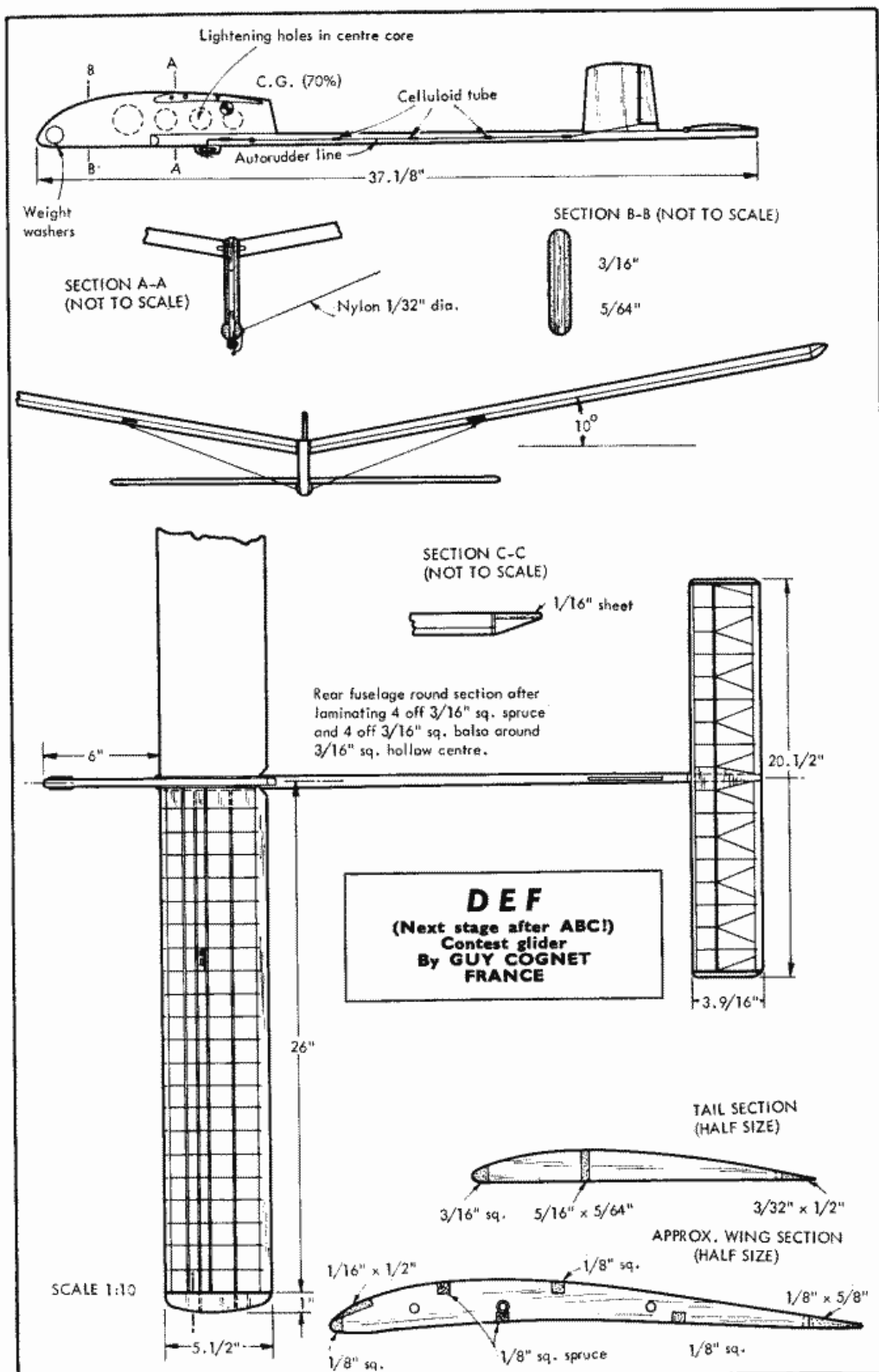
For Nitro-Methane Fuel

Eng. (Cu. In.)	A Plug Depth	B*	C	D*
0·15	0·090–0·105	0·213–0·207	0·110	0·0045–0·0100
0·29	0·128–0·130	0·270–0·265	0·150	0·0100–0·0150
0·40	0·130–0·135	0·1745	0·160	0·0120–0·015
0·60–0·65	0·160–0·166	0·289	0·181	0·021–0·025

SUPER TIGRE squish band head dimensions.
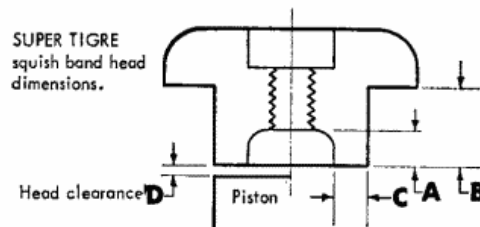
For F.A.I. Fuel

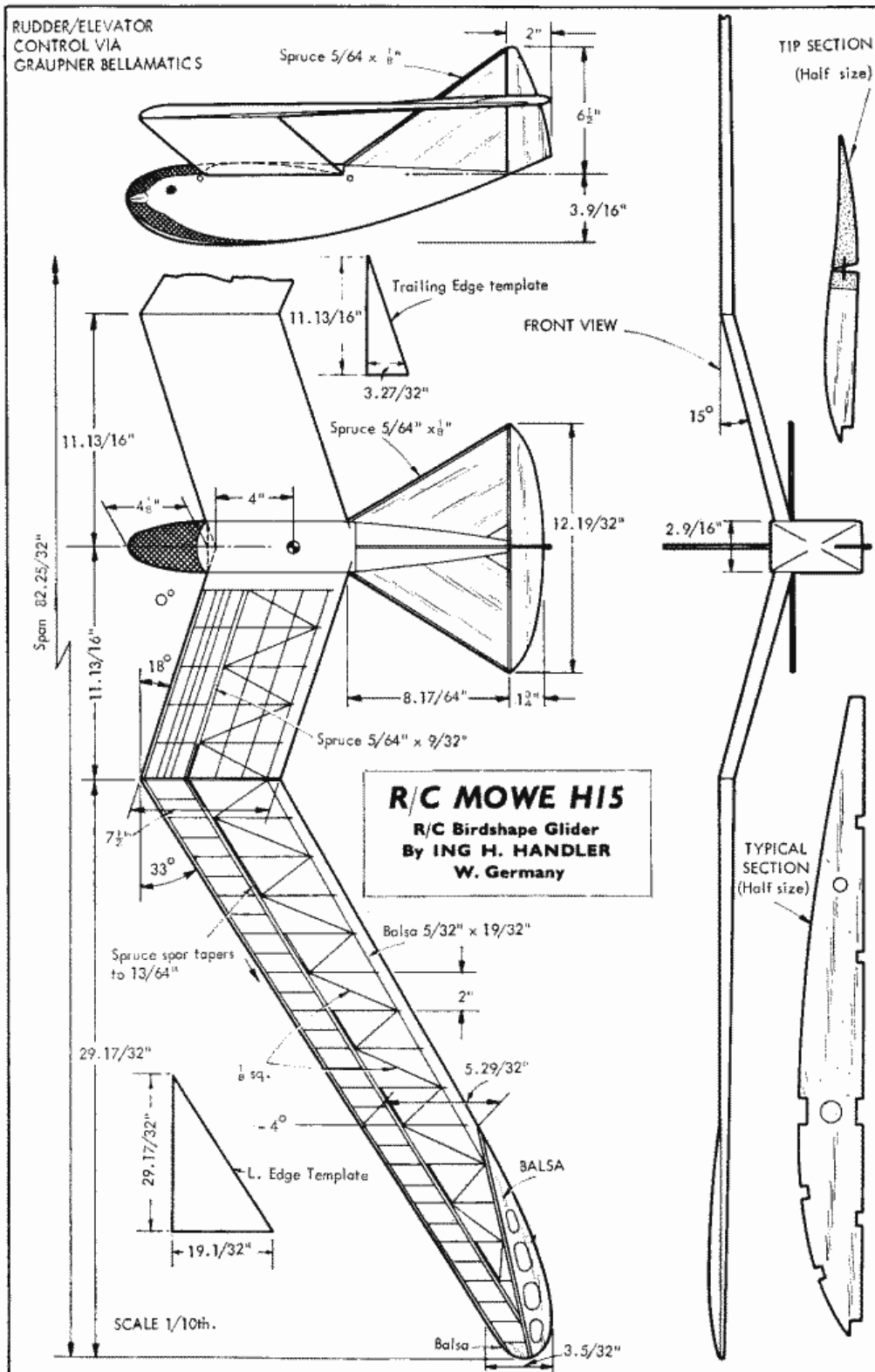| Eng. (Cu. In.)	A1	B1*	C1	D1*
0·15	0·078	0·206–0·210	0·110–0·106	0·003–0·006
0·29	0·125	0·275–0·272	0·150–0·155	0·005–0·008
0·40				
0·60–0·65	0·160–0·155	0·290–0·295	0·181	0·020–0·015

Notes: *For hot weather use less head clearance; for cold weather use more head clearance. *Example:* S.T. G.15 Air Temp 100° to 80°F 0·003 head clearance or air temp., 65°F to 75F° 0·006 head clearance on F.A.I. Fuel.

Lightening holes in centre core

C.G. (70%)

Celluloid tube

8

A

A

Autorudder line

B

B

37.1/8"

Weight
washers

SECTION A-A
(NOT TO SCALE)

Nylon 1/32" dia.

SECTION B-B (NOT TO SCALE)

3/16"

5/64"

10°

SECTION C-C
(NOT TO SCALE)

1/16" sheet

Rear fuselage round section after
laminating 4 off 3/16" sq. spruce
and 4 off 3/16" sq. balsa around
3/16" sq. hollow centre.

6"

20.1/2"

D E F
(Next stage after ABC!)
Contest glider
By GUY COGNET
FRANCE

3.9/16"

26"

TAIL SECTION
(HALF SIZE)

3/16" sq.   5/16" x 5/64"   3/32" x 1/2"

APPROX. WING SECTION
(HALF SIZE)

1/16" x 1/2"   1/8" sq.

SCALE 1:10

1/8" x 5/8"

1/8" sq.   1/8" sq. spruce   1/8" sq.

5.1/2"

C.G. 52%

1½"

D/T

3"

-1°

5/16" sq.

41¼"

Vernier incidence adjuster

Fuselage: 1/16 Ply box to 3 inch behind wings
3/32 sq. spruce in each corner aft
to rear. 1/16 light balsa cladding
with 1/16 balsa doublers on sides
and bottom forward of wing T.E.

1/16" ply ribs
first 3 bays

445.5 sq. inch
(projected)

76.5 sq. inch

28"

20½"

1"

3.1/2"

1ST CANADIAN 1967 TEAM TRIALS
2ND 1966 CZECH AUTUMN POSTAL CONTEST

23"

Model turns right

3⅜"

6½"

1"

7⅓"

15½"

MOUNTIE
1966/7 A/2 glider
represented Canada in '67 World
Championships
By ALAN RICHES, Vancouver

3/16" washout

TAIL SECTION (half size)

3/32 sq. spruce

L.E. 3/16" sq.

T.E. ¼" × 3/32"

Ribs 1/32"

5¾"

6"

SCALE 1:10

⅛" sq.

Ribs 3/32"

WING SECTION (Half size)

L.E. ½" × ⅜"

T.E. 1" × 5/32"

3/16" sq. spruce centre, balsa tips

CANADIAN MODEL AIRCRAFT

Sheet 13/64"   +3°   C.G. 72%   1/8" sq. Longerons

1/8" sq.

-1°

2 3/8" × 1 1/2"

.33 1/4"

SPAN 36 1/4"

.3 3/4"

0°

15 3/4" Dia.
15 3/4" Pitch

5° Right

6 1/8"

15"

14 1/4"

WING AREA 155 sq. ins.

1.3/16"

14.9/16"

BAMBOO 1/8" Dia.

20 swg

3.9/16"

TAIL AREA 50.22 sq. ins.

WEIGHTS

WING   ˙8465 oz.

FUSELAGE   1.0582 oz.

TAIL   .2469 oz.

PROPELLER   .4585 oz.

RUBBER   .3527 oz.

TOTAL   2.9627 oz.

MOTOR 10 Strands
   Pirelli 4mm

5.29/32"

19/32"

1968 COUPE D'HIVER
**Winner
MRA International
By J. GRIVEAU
France**

SCALE 1/8th

4.5/16"

1/4 × 1/8"

5/64" × 1/8"

WING SECTION (Full size)

1/16 × 1/2"

5/64" × 5/64"

5/64" × 5/64"

TAIL SECTION (full size)

5/16" × 5/64"

RUDDER/ELEVATOR
CONTROL VIA
GRAUPNER BELLAMATICS

Spruce 5/64 x 1/8"

2"

6½"

3.9/16"

TIP SECTION
(Half size)

FRONT VIEW

15°

11.13/16"

Trailing Edge template

3.27/32"

Spruce 5/64" x 1/8"

12.19/32"

11.13/16"

4 5/8"

4"

0°

Span 82.25/32"

11.13/16"

18°

Spruce 5/64" x 9/32"

8.17/64"　　1 3/4"

2.9/16"

R/C MOWE H15
R/C Birdshape Glider
By ING H. HANDLER
W. Germany

7½°

33°

Balsa 5/32" x 19/32"

2"

Spruce spar tapers
to 13/64"

1/8 sq.

5.29/32"

29.17/32"

-4°

BALSA

TYPICAL
SECTION
(Half size)

29.17/32"

L. Edge Template

19.1/32"

BALSA

SCALE 1/10th.

Balsa

3.5/32"

FIG 1

LENGTH OF FLOW PATHS

UPPER

LOWER

THE THEORY OF MODEL FLIGHT

ALL forms of flying machines which obtain lift by virtue of their motion through the air creating an *aerodynamic reaction* work on similar principles, whether full size aircraft or models. The term "model" is, in fact, a misnomer as far as functional behaviour is concerned as any model made to fly is, functionally, a small size aircraft. The principles involved, however, are *similar* rather than *identical*, which is one of the main reasons why the model designed for maximum performance is very different in appearance from full size aircraft. There are also other reasons for such differences—such as the difference in stability requirements between a free flight model and a piloted aircraft (full size or model); differences in power units (e.g. a rubber motor requiring a large diameter propeller for efficient working); and so on.

Originally model theory was based entirely on elementary full size theory, with the discrepancies explained on the basis of differences in efficiencies. This prevented any complete theoretical analysis of model aircraft design and performance having any reliable meaning, so that the successful design was evolved almost entirely on purely practical lines. To a large extent this is still true, although today there is much more knowledge of true model aerodynamics —or, more correctly, "small scale" aerodynamics. This has mainly been significant in the development of more efficient aerofoil sections for low speed working and in model sizes, but has also contributed useful knowledge on stability and control requirements.

The fact remains, however, that successful model design is still largely practical—either based on copying and trying to improve on established practice, or "cut and try" methods. Where "theoretical" solutions are offered to justify the results achieved, such theories often show more imagination than truth, and in some cases are definitely erroneous. Like the bumble bee—which any competent aerodynamicist can prove cannot possibly fly with such a high wing loading—good model design frequently ignores theory and flies quite well!

A knowledge of model flight theory is, however, very useful as it can indicate likely solutions to design problems and, in particular, indicate design layouts or methods likely to result in improved efficiency—and thus improved performance. The same limitation as with all true theory applies. To translate pure theory into practical design calculations a linking factor or "empirical

23600 OUNCES   FIG 2   ↑ LIFT 2·4 OUNCES
                              23597.6 OUNCES

23600 OUNCES   23600 OUNCES
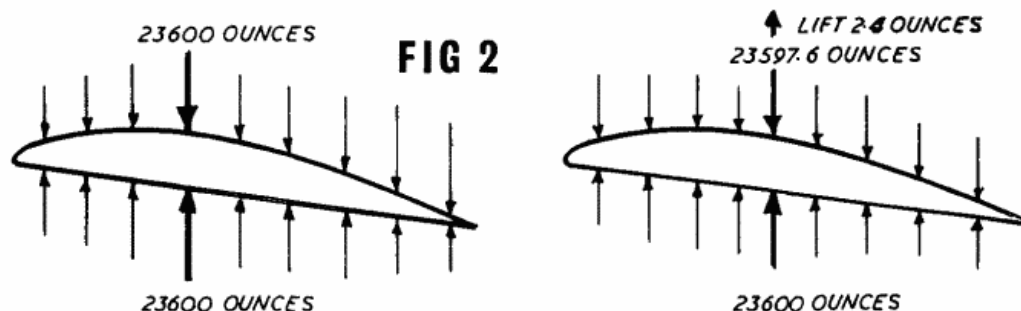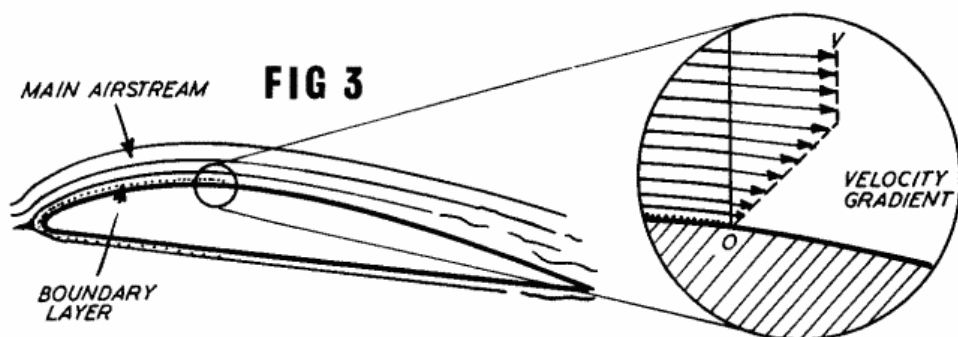
coefficient" is normally involved, which factor can only be obtained by practical tests. It is in this field particularly that model theory is lacking, although within the last decade some very useful data have been amassed relating to small scale aerofoil section performance.

Basically, aerodynamics is concerned with movement of air and its consequent reaction on shapes immersed in the air. Air itself has appreciable weight—approximately $1\frac{1}{4}$ oz. per cu. ft. of air—and if disturbed will generate reaction forces through its inertia. More important, the weight of air enveloping the earth is responsible for atmospheric pressure acting on anything immersed in the air; and anything which modifies this pressure will result in unbalance or reaction forces.

This offers a basic explanation of why an aerofoil section develops "lift". Air meeting the leading edge of a wing moving through it separates into two streams, one passing over the upper surface and one over the lower surface—Fig. 1. Due to the shape of the aerofoil section the airflow has farther to travel over the upper than the lower surface in order to meet up again at the trailing edge. It is a characteristic of airflow that when it is speeded up locally its *pressure* is reduced. Consequently, considering the aerofoil as a body immersed in the moving air, there is a reduction in pressure over the upper surface compared with the lower surface, and it is this pressure difference which is largely responsible for a "lift" force being generated.

Commonly this is erroneously referred to as a "suction" being developed over the upper surface of an aerofoil. In actual fact the reduction in pressure is normally quite low. Normal atmospheric pressure is 14·7 lb. per sq. in.* which means that a 100 sq. in. wing held stationary in air would be subject to a pressure on both sides of about 23,600 oz. Movement of the aerofoil through the air to bring about a pressure reduction of only *one ten thousandths* would result in an "unbalance" yielding nearly $2\frac{1}{2}$ oz. of lift—see Fig. 2. Pressure reductions achieved by aerofoils are, therefore, fairly minute—and certainly not of the order of "suction" forces.

Considering the airflow past an aerofoil (or any other body) more realistically, flow conditions take the form shown diagrammatically in Fig. 3. Whilst the main airstream is deflected initially and continues to flow past the section in a uniform manner the airflow adjacent to the surface is slowed up, and that immediately adjacent to the surface actually clings to the surface, forming what is known as the *boundary* layer. Thus however fast the aerofoil may be moving through the air there is a thin layer of air immediately adjacent to the surface which is dragged along with the aerofoil. Adjacent layers of air to the

* This pressure is actually the weight of a column of air 1 sq. in. in cross section extending upwards to the extreme height of the earth's atmosphere.

FIG 4

boundary layer progressively speed up, until at some little distance from the surface the main stream is flowing with constant velocity.

The boundary layer flow has a critical effect on the aerodynamic perform-ance of the aerofoil, for this governs the point at which the main airflow will tend to break away from the surface of the aerofoil. Thus with increasing angle of attack the boundary layer will tend to become increasingly unstable so that the point at which separation of the main flow takes place tends to move forwards—Fig. 4. This results in an increasingly disturbed wake (with increase in drag) as the angle of attack increases. Lift also increases, up to the point where the main airstream breaks away completely and the aerofoil is stalled.

At higher speeds and larger aerofoil sizes the boundary layer flow is turbulent (or virtually twisting over itself). This is actually a stable form of flow which is not readily disturbed and so a turbulent airflow will tend to cling to the aerofoil surface, gradually thickening until eventually it breaks way into dis-rupted flow producing also a complete breakaway of the main airstream—Fig. 5.

At much lower speeds the boundary layer flow is laminar, or virtually sliding over itself. In this condition it is very readily disrupted to produce an early breakaway of the main airstream and thus loss of performance as far as the aerofoil is concerned—i.e. less lift developed before the aerofoil stalls and a generally deeper "wake" of disrupted airflow and higher drag—Fig. 6.

The point at which the boundary layer flow changes from laminar to turbulent, and thus the aerofoil changes from relatively inefficient to efficient working, is governed by the airflow velocity and chord length, and also by the shape of the aerofoil section itself. The product of Velocity and (chord) Length is a measure of the *aerodynamic scale* of the aerofoil, normally referred to as the Reynold's number or RN which also takes into account the viscosity of the air. Arithmetically,

$$RN = 525 \times \text{velocity (ft/sec)} \times \text{length (in.)}$$

For convenience, however, the aerodynamic scale may simply be quoted in terms of *VL* (i.e. velocity in ft/sec *times* chord length). The point to watch in this latter case is that different authorities may use inches *or* feet for the chord length dimension, so that the corresponding *VL* values will differ by 12 times. Also *VL* values determined on metric units will be different from those determined on English units. The Reynold's number, on the other hand, is a dimensionless quantity and the same in both metric and English systems of units.

FIG 5

FIG 6
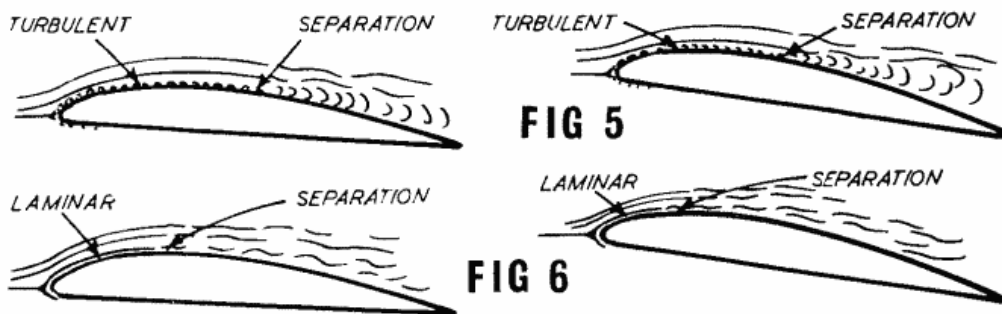
The aerodynamic scale value at which the boundary layer flow condition changes from laminar to turbulent is known as the critical RN (or critical *VL*) for that particular aerofoil. The change is not necessarily abrupt and operating slightly above the critical RN the flow may be transitional, so that the specification of critical RN is not always exact. Logically it should err on the low side to avoid the possibility of transitional conditions; although most usefull it should be the higher value consistent with the end of any transition range and where turbulent boundary layer flow is fully established. This may seem a quibble, but it is an important consideration when trying to establish aerofoil working at maximum efficiency (fully turbulent boundary layer flow).

The unfortunate thing from the model designer's point of view is that the wing chords and model flying speeds associated with normal free flight designs yield a Reynold's number *below* the critical value for conventional aerofoils. Thus the aerofoils are working with laminar boundary layer flow and lower efficiency, as explained above. This also renders useless any direct application of aerofoil data determined at higher Reynold's numbers, since such data relate to quite different boundary layer flow conditions and higher efficiencies. Nor is it possible to correct such aerofoil performance data for working at a different aerodynamic scale—except by guesstimate.

FIG 8

Gö 804

Fig. 7 A laminar aerofoil selected for Man-power and gliders. Re = Reynold's number.
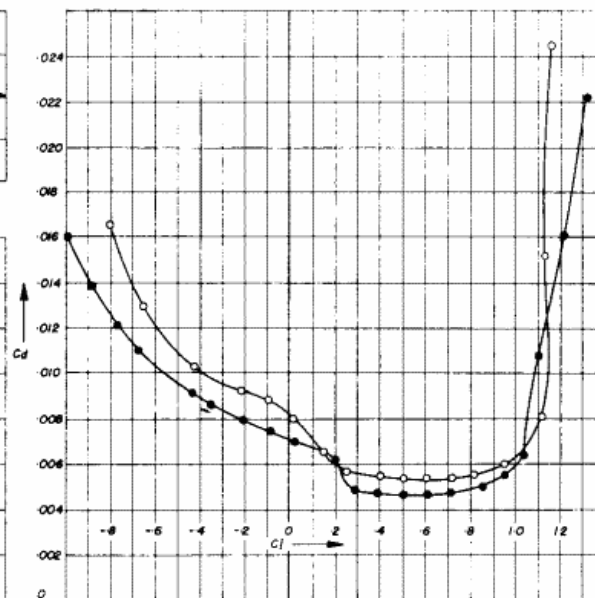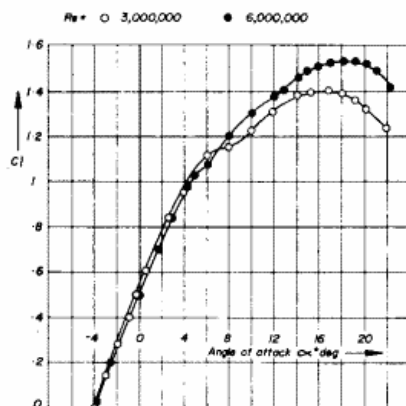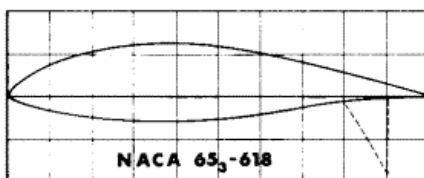
NACA 65₃-618
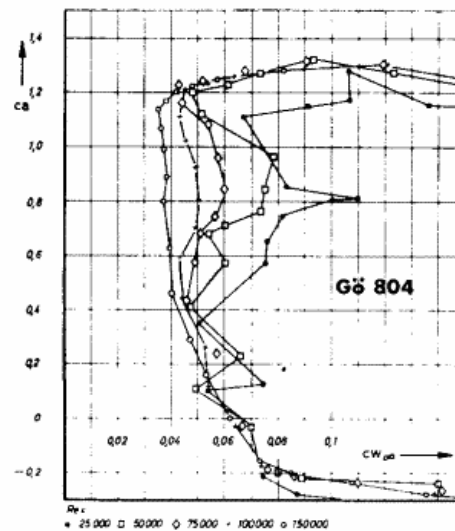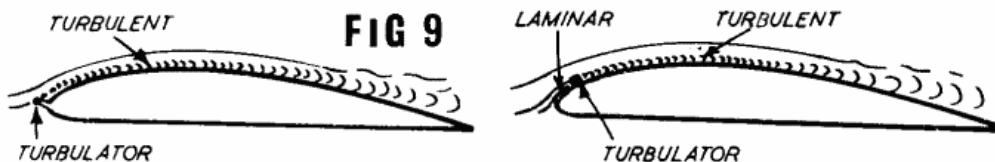
There are four basic ways of getting around this problem, viz:

(i) Developing suitable aerofoil sections on a "cut-and-try" basis, i.e. those which give suitable results when tried out.

(ii) Wind tunnel tests to establish comparative performance figures for different sections at appropriate Reynold's numbers.

(iii) Design of special aerofoil sections to operate efficiently with laminar boundary layer flow.

(iv) Design of special aerofoil sections with very low critical RN values so that they can be operated *above* the critical RN.

(v) Artificial means of improving laminar boundary layer flow conditions.

Method (i) is the most widely used and can give excellent results. It has no connection with theory, however, and will not be discussed further.

Method (ii) involves considerable cost, time and effort and is virtually beyond the scope of most individuals. There is also the point to be considered that the construction of a wind tunnel for testing at appropriate Reynold's numbers is no complete answer in itself unless *complete* corrections for tunnel effect are known and can be applied. Without correction, wind tunnel test figures can be highly inaccurate—this being a limitation of much earlier (full size) wind tunnel testing of the 1920–1936 era at Reynold's numbers which do lie in the "model" range. On the other hand, accurate wind tunnel testing is virtually essential to prove solutions for methods (iii) and (iv).
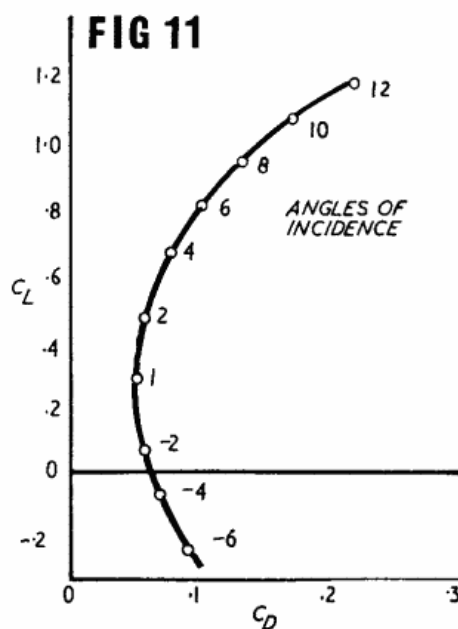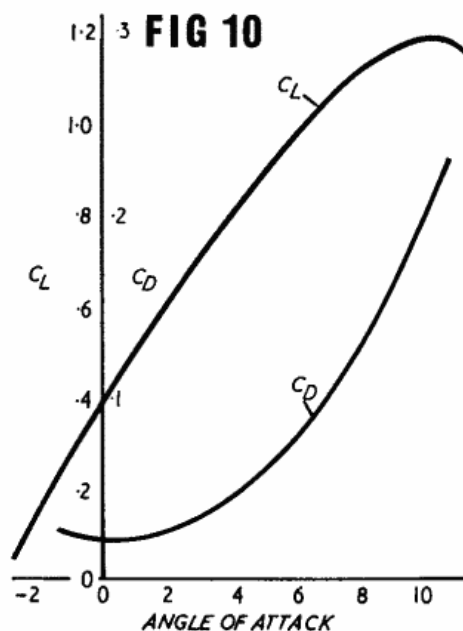
Method (iii) led, initially, to the development of mathematical sections similar to that of Fig. 7, the considerably modified forward shape aimed at maintaining laminar boundary layer flow over a substantial length of the section. Unfortunately this also substantially reduced the "lift" performance of such sections and they proved inferior to conventional "full size" sections such as RAF 32 and Clark Y operating below their critical RN. More modern sections of this type do, however, have a more satisfactory performance, although with no marked superiority over conventional and "cut-and-try" sections.

Method (iv) provides a rather more realistic approach for theoretical design, provided operating data can be verified. This has, in the main, produced thin and relatively heavily cambered sections mostly suitable for contest gliders— where maximum aerofoil efficiency is obviously desirable. Such section shapes, in fact, do not differ greatly from many evolved by cut-and-try methods, with the inference that these, too, probably have a low critical RN and a capability for operating with a turbulent boundary layer flow—Fig. 8.

The most worthwhile approach, in fact, would be extensive—and accurate—wind tunnel testing of both established and possible model aerofoil sections in order to establish their respective critical Reynold's numbers. Model design would then be based on achieving this figure in flight.

For example, given two aerofoils of similar performance but one with a critical RN of 100,000 and the other 60,000, calculations for minimum wing chord length required to achieve this operating RN with a flying speed of 15 m.p.h. would be

(a) Critical RN = 100,000: $l = \dfrac{100,000}{525 \times 22} = 8{\cdot}6$ in.

(b) Critical RN = 60,000: $l = \dfrac{60,000}{525 \times 22} = 5{\cdot}2$ in.

Method (v) solution is to artificially turbulate the boundary layer, which can be done either by mounting a thin wire immediately ahead of the leading edge in a suitable position, or adding a small strip projection to the top of the leading edge—Fig. 9. Both these devices are known as turbulators and do, in fact, provide part at least of the required solution. They are practical rather than theoretical solutions, however, and do not necessarily have the desired effect with all types of sections. They would appear to work best with thin and fairly heavily cambered sections which already have a fairly low critical RN.

Aerofoil characteristics are typically represented by a graph showing variation of lift coefficient (C_L) and drag coefficient C_D) with angle of attack— Fig. 10. The use of a coefficient renders the lift and drag characteristics specific to the section only, and not the actual size. Coefficient values, extracted from such a graph, can then be employed to calculate Lift or Drag according to the following basic formulas:

$$\text{Lift } = C_L \frac{\rho}{2} SV^2$$

$$\text{Drag} = C_D \frac{\rho}{2} SV^2$$

where S = wing area in sq. ft.
  V = velocity of airstream in ft./sec.
  ρ = mass density of air = $0{\cdot}00238$ (slugs per cu. ft.).

For model design purposes the air density is constant and so these formulas can be reduced to

Lift in *ounces* $= 0 \cdot 000132\, C_{\mathrm{L}}SV^2$ where area (S) is in *square inches*
Drag in *ounces* $= 0 \cdot 000132\, C_{\mathrm{D}}SV^2$ where area (S) is in *square inches*.

Given valid aerofoil data—i.e. data obtained at the same Reynolds number—lift and drag values for a particular wing can thus be calculated directly, knowing the airspeed (V); and the angle of attack (to find the appropriate value of C_{L} or C_{D} from the graph). Equally, the same basic equations can be used for a solution for any one unknown value, the others being known. This, in fact, is more usual. Thus knowing the speed at which a model flies in horizontal flight, the lift would obviously be equal to the weight, when the operating angle of attack of the wing could be determined.

Normally the operating angle of attack is determined by *trim*, but it is particularly useful to be able to check this by calculation as the angle of attack will govern the overall *efficiency* of the model at that trim. As a simple example, the ratio of Lift to Drag is a measure of the efficiency of the aerofoil, and a L/D curve is usually included on the graph of aerofoil characteristics. In such cases it will be seen that the maximum value of L/D normally occurs at a very low angle of attack. In practical terms, a trim which gives an operating angle of attack equivalent to L/D maximum is equivalent to the *flattest* gliding angle; or maximum lift with minimum drag for a speed model.

A more useful form for design purposes is to plot C_{L} against C_{D}, as shown in Fig. 11. This is known as a *polar* curve for the aerofoil. In this case the C_{L} (and C_{D}) value for maximum L/D would be given by drawing a tangent from the origin to the polar curve, as indicated—Fig. 12.

So far, however, the aerodynamic characteristics of the aerofoil only have been considered. The fuselage and tail surfaces will produce additional drag, modifying the overall result achieved, but in most cases it will be sufficient to assume that this drag remains fairly constant over the range of trim angles likely to be employed in flight. In that case the "extra to wing" drag can be rendered in terms of a simple coefficient, C_{DF}.

FIG 12

FIG 13

EXTRA TO WING DRAG COEFFICIENT
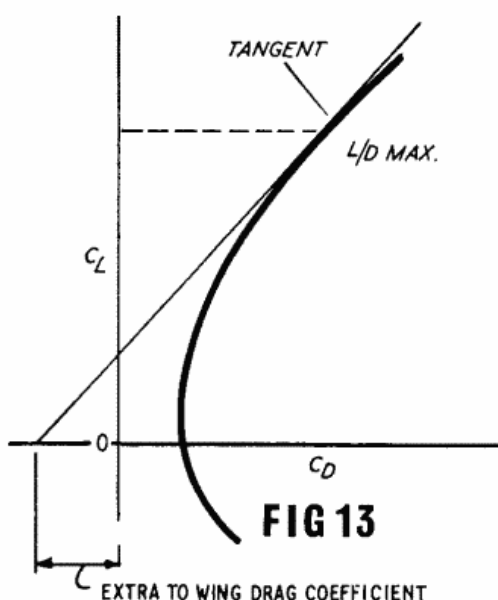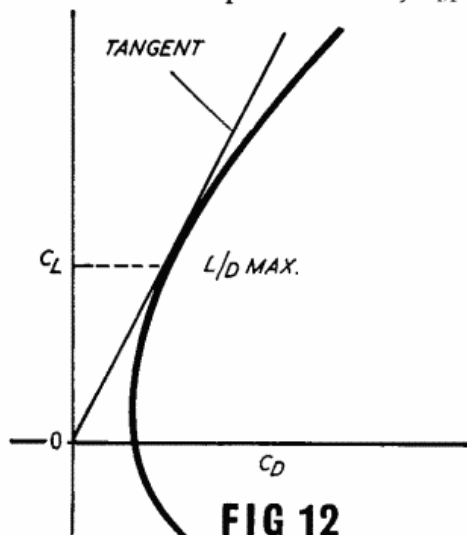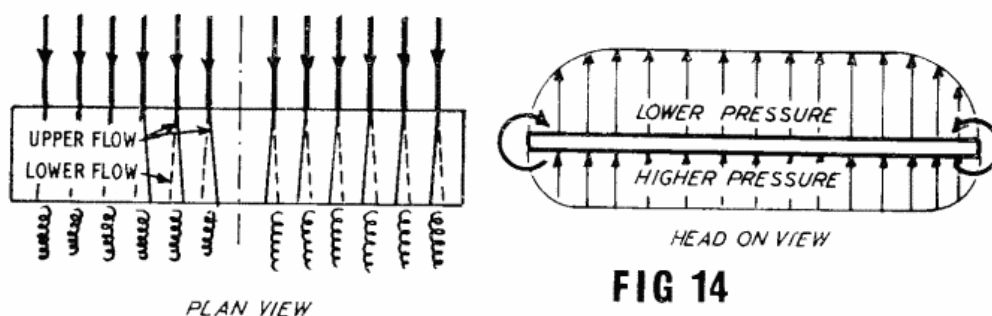
FIG 14

This is equivalent to an increase in wing drag coefficient of

$$\text{Drag coefficient increase} = \frac{A_F \times C_{DF}}{S}$$

where $A_F =$ cross sectional area of fuselage.

The effect as far as use of the tangent to the polar curve is concerned is to move the point from which the tangent line is drawn to the left of the origin by an amount equal to this additional drag coefficient increase—see Fig. 13. The actual value is hard to determine except by wind tunnel tests, but can usually be estimated with reasonable accuracy and any discrepancies countered by slight adjustment of trim.

One further correction remains to be made. Aerofoil characteristics, as presented, are either for a specific aspect ratio or corrected to infinite aspect ratio, equivalent to two-dimensional flow. The fact that the airflow will be three-dimensional on a working aerofoil modifies both the lift and drag by *induced* effects.

Basically, this is because under true operating conditions in free air there will be a tendency for the airflow over the upper surface of an aerofoil (lower pressure region) to spill inwards; and that over the lower surface (higher pressure region) to spill outwards. The joining of the two flows at the trailing edge will result in them rolling up into a series of vortices—Fig. 14. This will be even more marked at the tips where there will be a spillage of air round the tips from the higher to the lower pressure region and for most purposes three dimensional flow can be considered as generating one main inward rotating vortex at each tip.

Aspect ratio has the effect of modifying the strength of these vortices which both increase drag (add induced drag) and modify the effective angle of attack (since a proportion of the original angle of attack is rendered ineffective by vortex generation). The greater the aspect ratio the weaker the effect, and vice versa. Thus an increase in aspect ratio gives higher values of L/D due to the fact that the lift coefficient values are produced at smaller angles of attack. High aspect ratio is therefore desirable to minimise induced effects; but with a fixed wing area increasing the aspect ratio reduced the chord and at the same time lowers the operating Reynold's number of the wing, as well as introducing the problem of structural rigidity.

The change in angle of attack (Δa) for a difference in aspect ratios can be calculated from the formula

$$\Delta a \text{ (degrees)} = 18{\cdot}24 \left(\frac{1}{A_1} - \frac{1}{A_2} \right)$$

where $A_1 =$ the original aspect ratio
  $A_2 =$ the new aspect ratio.

A new polar curve for the design aspect ratio can be calculated on this basis—see Fig. 15.

Nominally a design rigging angle for the wings consistent with L/D maximum gives the most efficient set-up for free flight operation although this, or the actual *operating* angle of attack of the wings, may be modified by other requirements. This can be adjusted by trim governing the actual flying attitude of the model, although where the trim attitude is substantially different from the rigging attitude the original rigging angle may be modified. Thus, to take two extremes, the modern "multi" radio model is commonly rigged with zero angle of attack on the wings; whereas the free flight duration model, which operates at a high angle of attack, may have a fairly high rigging angle to start with to avoid flying with the fuselage pitched up excessively and probably increasing its drag value.

For duration requirements *power factor* is more important than L/D ratio since this governs the amount of power needed to sustain the model in flight. In practice this means maximum rate of climb from a given amount of power, and minimum sinking speed in gliding flight. Power factor is defined as $C_L^{1.5}/C_D$ and thus a new polar curve is required to optimum operating angle of incidence—see Fig. 16. Equally, merits of different sections for duration work can be assessed on their respective maximum values of $C_L^{1.5}/C_D$.

Note that whilst this analysis is directly applicable to gliders it does not necessarily hold true that this operating lift coefficient (operating angle of attack) can be maintained under powered flight. It can be approached by rubber models (after the initial burst of power), but power-on trim with power duration models normally has to be held to a much lower operating angle of attack for stability reasons: and in many cases lower than that for L/D maximum.

Modern theory disregards the traditional conception of a "centre of pressure" for the lift force shifting with the angle of attack in favour of analysis of longitudinal stability on the basis of the pitching moments involved. In turn this leads to the conception of a "neutral point" or axis about which stability is neutral. The static stability of any model is then measured by the distance between the neutral point and the centre of gravity. For free flight stability a

FIG 15

FIG 16
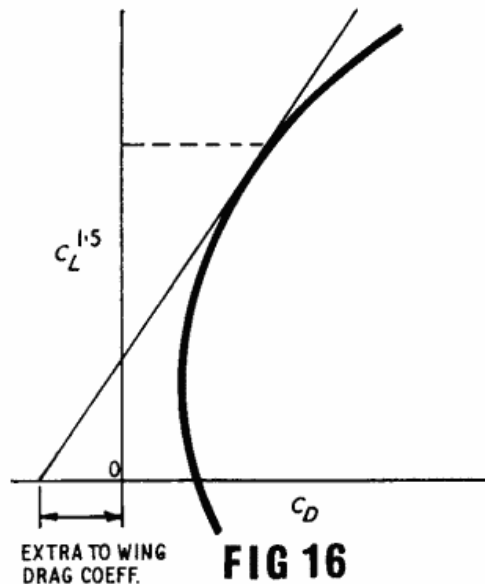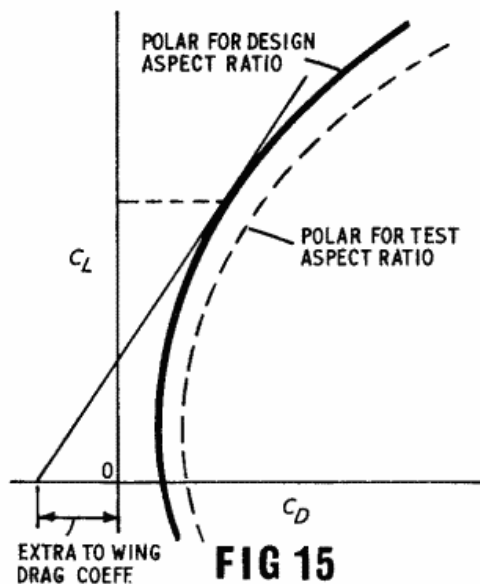
positive or nose-up pitching moment must be present at zero lift, the ratio of this to the static margin also governing the trimmed lift coefficient (or actual angle of attack) at which the model will fly. Anything which increases the zero lift positive pitching moment—such as a high mounted wing; or decreases the static margin—such as moving the centre of gravity farther aft—will tend to make the model trim at a higher lift coefficient. Wing lift also represents a positive pitching moment, so that as a general rule the higher the operating lift coefficient aimed at the less the stability of the system, calling for a larger static margin and good phugoid damping, such as given by large tail surfaces and less streamlined shapes. Lack of adequate damping is one reason why tailless models, for example, cannot be trimmed for "duration" performance comparable with orthodox types.

Spiral stability can also be analysed in terms of moments, although in this case moments due to pitch, yaw, sideslip and roll are all involved and the analysis becomes somewhat complex. Basically the rolling coefficients are:

(i) Rolling moment due to sideslip—C_{LB}
(ii) Yawing moment due to sideslip—C_{NB}
(iii) Rolling moment due to rate of turn—C_{LR}
(iv) Yawing moment due to rate of turn—C_{NR}

Stabilising (or unstabilising) effects of these are:

C_{LB} is negative and stabilising
C_{NB} is positive and unstabilising
C_{LR} is positive and unstabilising (usually)
C_{NR} is negative and stabilising

and for satisfactory stability $C_{LB} \times C_{NR}$ must be greater than $C_{LR} \times C_{NB}$. The degree of spiral stability is then dependent on how much $C_{LB} \times C_{NB}$ is greater than $C_{LR} \times C_{NB}$.

$\frac{1}{2}$A TUNED PIPE

by BARRY HOBKIRK

FOR the past several months I have been working on tuned exhaust pipes for $\frac{1}{2}$A speed and proto and have been receiving fairly good results. The idea was prompted mainly by the domination of tuned pipes at the 1967 U.S. Nationals.

In construction of the pipe the first change made to the standard TD 0·049 was addition of a collar around the exhaust ports. This was constructed from a reamed-out Babe Bee crankcase that seats over the TD cylinder between the crankcase and third cylinder fin. The first two fins have been lathed down to the cylinder base dia. Where the original Babe Bee cylinder would have been, I placed an old reamed out glowplug which holds the tube. I constructed a pipe, of 18,000 r.p.m. specifications and made several test flights. The model was doing 70–75, showing not much gain considering the stock TD alone did 75–80 previously. The difference was probably due to the added weight.

The next step was to eliminate the TD sub-piston induction by the use of the cylinder on the new Cox QZ engine that eliminates this but still retains the two flute bypass. This was tried in flight with the 18,000 r.p.m. pipe and results were again only 72–78 m.p.h. At this time I decided to raise the r.p.m. to 28,000 which ended in all types of results. The air speed jumped to 90 m.p.h. but takes
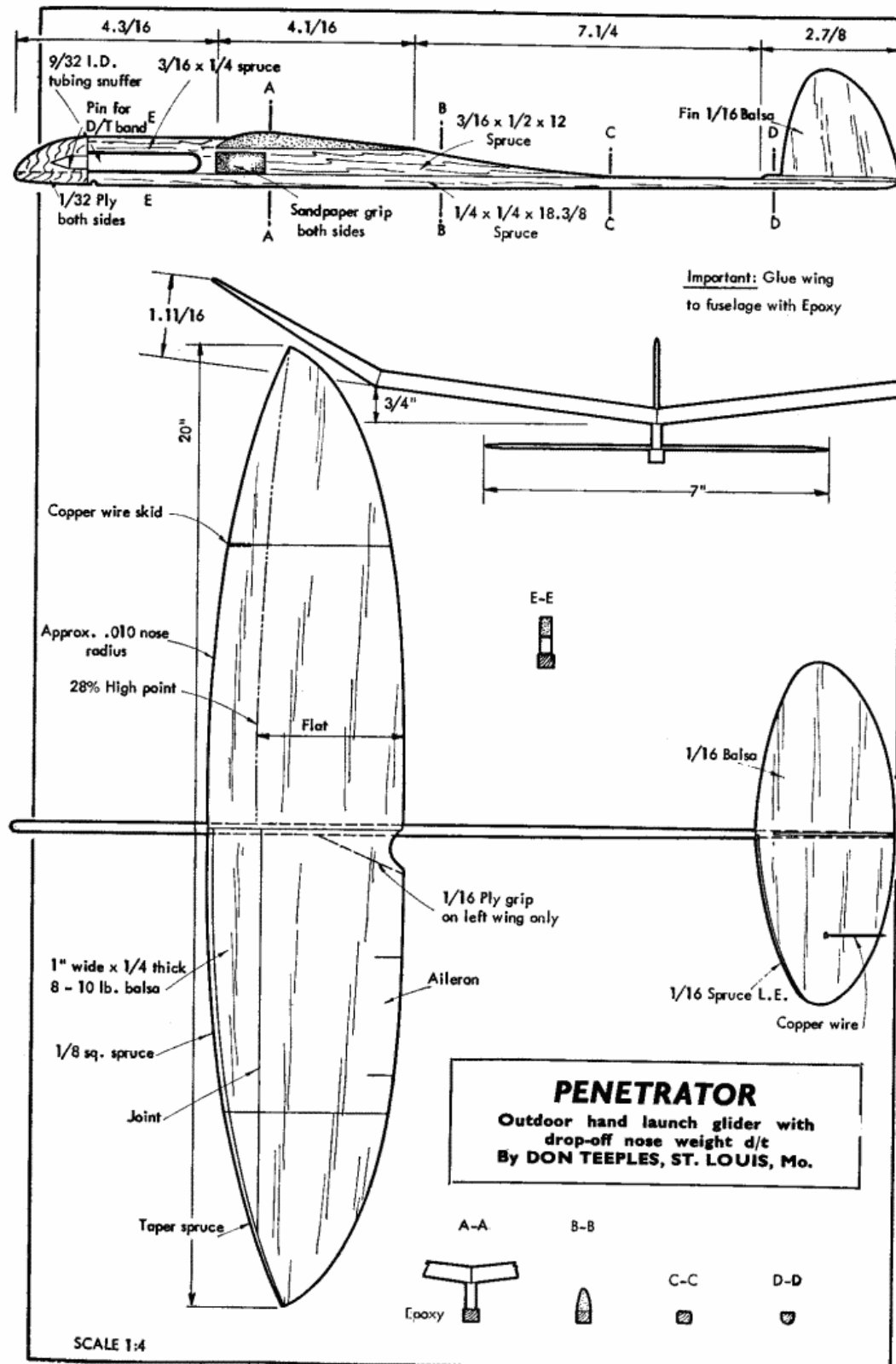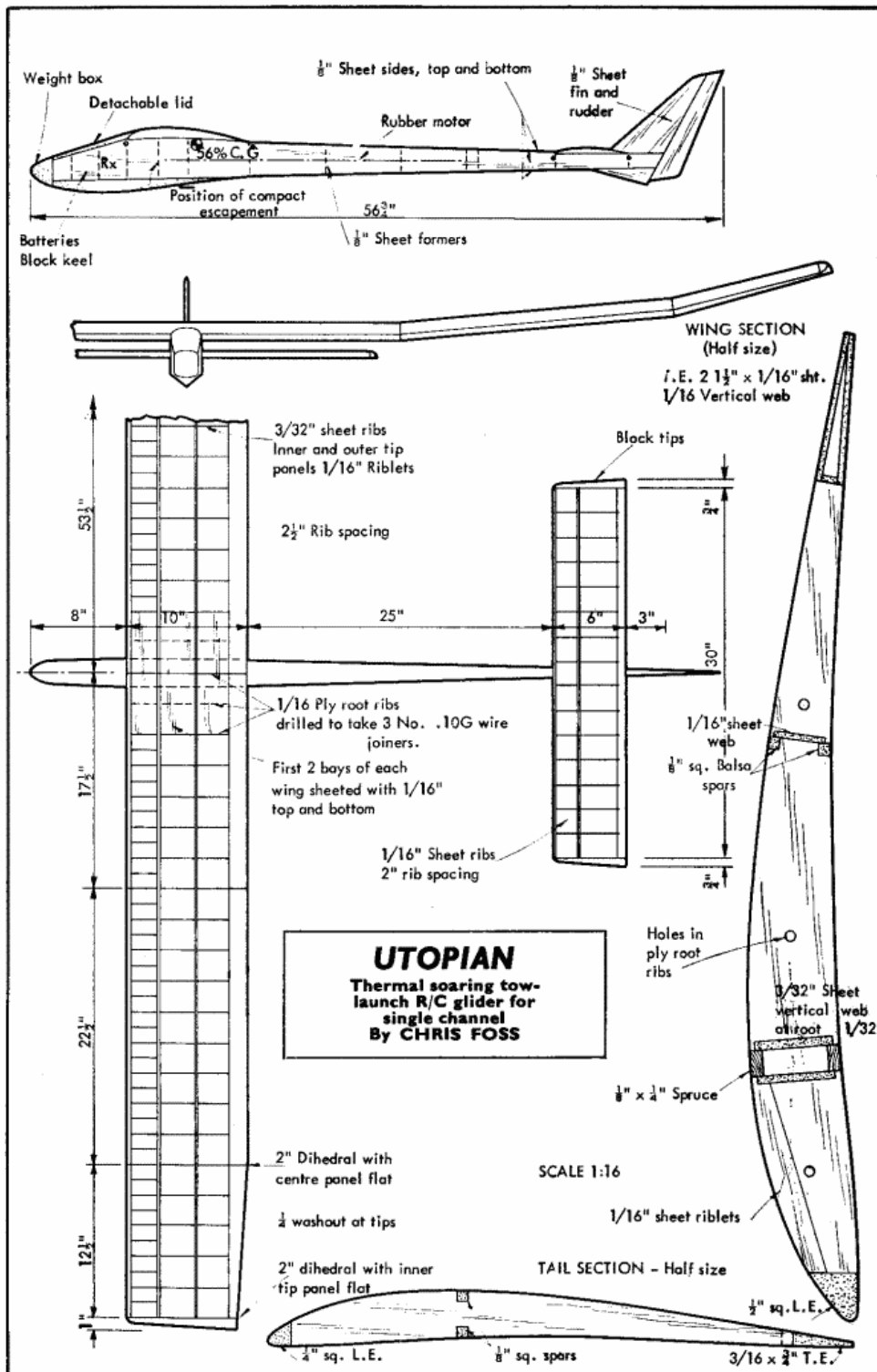
TAIL PIPE 0.81"

CONVERGING CONE 2.40"

5/32" I.D. BRASS

7/8"

DIVERGING CONE 3.26"

0.003 COPPER SHEET

SOLDER ALL JOINTS

HEADPIPE 2.09"

11/32" I.D. BRASS TUBE

SPACE HOPPER REED VALVE INTAKE 9/64" I.D.

TO TANK

TO FRONT INTAKE

REAM OUT GLOW PLUG 13/32 I.D.

COX NO. 6 CYLINDER

BABE BEE CRANKCASE

BORE TO 9/64" I.D.

7/8 ALUMINIUM SPINNER
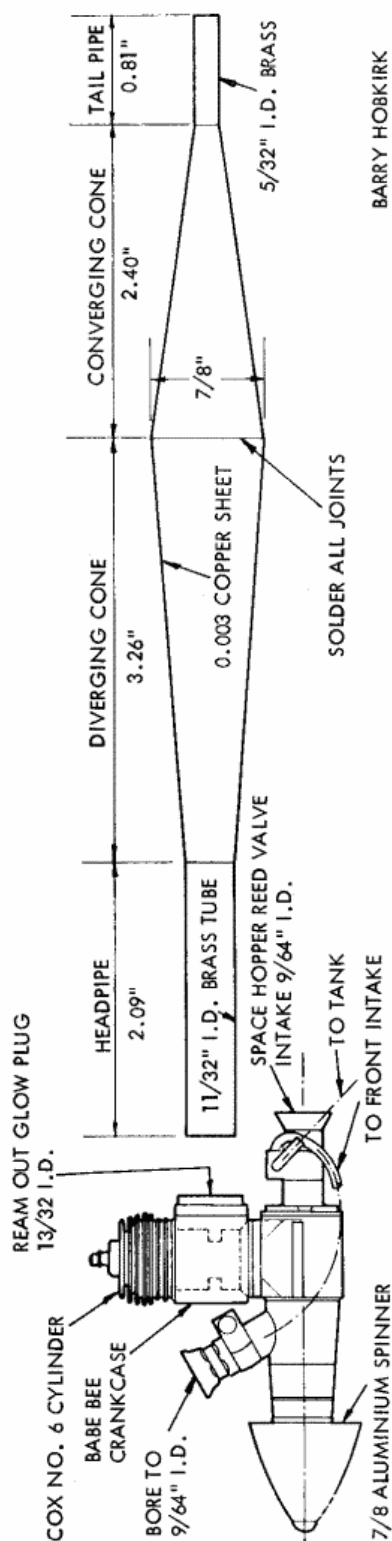
BARRY HOBKIRK

it out on the engine with broken con rods and crankshafts plus burning out numerous plugs and generally wearing out the engine. Even with these results the engine seemed to be lacking the 28,000 r.p.m. I tried several experiments with lengthening the venturi but the gain was only 2–3 m.p.h. and the length caused problems in cowlings being so close to the prop.

Next I was hoping to eliminate the front venturi completely by making a rear rotor setup. While running, the engine lost much power both by leakage by small parts and having to pull the rotor around. I then tried a reed valve intake similar to that on the Space Hopper but again the results were slow running much like a Babe Bee then purely by accident I was replacing the front rotor setup to test when I thought "Why not try both together?" I started the engine on the rear intake then opened the front. It went lean, then "kicked in" to a high pitched whine. On test flying, the engine was rather difficult to set at first because of the two carburettors but the trouble was overcome. The plane ranges in speed from 90 m.p.h. up with odd flights near 105 m.p.h., with the first "kick in" lap when the engine was cool at approximately 115 m.p.h. So far the heat has been the biggest problem. Best flights were made at 54°F on K & B speed fuel.

The pipe itself is now made from brass tubing and sheet copper to the specifications in the diagram. The headpipe tubing has been lathed down 0·010 in. to reduce weight. The coupling between the engine and the pipe is made from $\frac{3}{16}$ in. o.d. surgical tubing stretched over the end. There should be no leaks in the system as the pipe will not run efficiently. The r.p.m. the pipe is designed for is 28,000 but this will vary greatly (between 22–29,000) depending on the engine setting and weather conditions. The cooler it is the slower the pipe r.p.m. becomes. The pipe I am now using requires small air-speed to let the engine unwind before the pipe will "kick in" thus reducing the take-off speed that is required for proto starts but the high speed at the top end usually makes up for it. The proto times (between 85–95 m.p.h. from standing start) range greatly depending how long it takes the pipe to come in after take-off.

4.3/16   4.1/16   7.1/4   2.7/8

9/32 I.D.
tubing snuffer   3/16 x 1/4 spruce

Pin for
D/T band   E   A

1/32 Ply
both sides   E

Sandpaper grip
both sides

B   3/16 x 1/2 x 12
Spruce   C   Fin 1/16 Balsa   D

1/4 x 1/4 x 18.3/8
Spruce

Important: Glue wing
to fuselage with Epoxy

1.11/16

20"   3/4"

7"

Copper wire skid

Approx. .010 nose
radius

28% High point

Flat

E-E

1/16 Balsa

1/16 Ply grip
on left wing only

1" wide x 1/4 thick
8 – 10 lb. balsa

Aileron

1/16 Spruce L.E.

1/8 sq. spruce

Copper wire

Joint

PENETRATOR
Outdoor hand launch glider with
drop-off nose weight d/t
By DON TEEPLES, ST. LOUIS, Mo.

Taper spruce

A–A   B–B   C–C   D–D

Epoxy

SCALE 1:4

Weight box

Detachable lid

$\frac{1}{8}$" Sheet sides, top and bottom

$\frac{1}{8}$" Sheet fin and rudder

Rubber motor

56% C.G.

Rx

Position of compact escapement

$56\frac{3}{4}$"

$\frac{1}{8}$" Sheet formers

Batteries
Block keel

WING SECTION
(Half size)

i.E. 2 $1\frac{1}{2}$" × 1/16" sht.
1/16 Vertical web

3/32" sheet ribs
Inner and outer tip
panels 1/16" Riblets

Block tips

$2\frac{1}{2}$" Rib spacing

$53\frac{1}{2}$"

8"

10"

25"

6"

3"

30"

1/16 Ply root ribs
drilled to take 3 No. .10G wire
joiners.

First 2 bays of each
wing sheeted with 1/16"
top and bottom

$17\frac{1}{2}$"

1/16"sheet
web

$\frac{1}{8}$" sq. Balsa
spars

1/16" Sheet ribs
2" rib spacing

Holes in
ply root
ribs

UTOPIAN

**Thermal soaring tow-
launch R/C glider for
single channel
By CHRIS FOSS**

$22\frac{1}{2}$"

3/32" Sheet
vertical web
all root 1/32"

$\frac{1}{8}$" × $\frac{1}{4}$" Spruce

2" Dihedral with
centre panel flat

SCALE 1:16

$\frac{1}{4}$ washout at tips

$12\frac{1}{2}$"

1/16" sheet riblets

2" dihedral with inner
tip panel flat

TAIL SECTION – Half size

$\frac{1}{2}$" sq. L.E.

$\frac{1}{4}$" sq. L.E.

$\frac{1}{8}$" sq. spars

3/16 × $\frac{3}{4}$" T.E.

NOISE EXPLAINED

by P. NEWELL

"What annoys an oyster?"
"A noise annoys an oyster!"

THE purpose of this article is to ex-
plain in easily understood terms,
the technicalities of noise and its
measurement. Figures of noise meas-
urements are appearing in various
places and to the uninitiated these can
only be both confusing and misleading.
Do not be frightened off by the use of
mathematics, this has only been used
where it helps the explanation of noise
and to show how the decibel scale is
built up and used.

FIG. 1
SOUND INTENSITY

What is Sound?

Sound is vibrations in the frequency range that can be sensed by the
human ear, typically this is the range 20 c/s to 18 kc/s. The master vibrator
causes the air particles adjacent to it to be set in motion and the oscillations are
transmitted from one particle to the next thus transmitting the sound. The ear
then responds to the oscillating air particles causing the sensation of sound.

Sound Intensity

This is a measure of the sound energy transmitted in one second through
unit area perpendicular to the direction in which the sound is travelling, Fig. 1.
Under conditions of no wind the sound energy from a source is radiated uni-
formly in all directions, Fig. 2.

The energy is made up of the kinetic and potential energies of the air
particles. The kinetic energy is the energy due to the motion of the air particles
and the potential energy is the energy of a particle at any instant due to its dis-
placement, during the oscillation.

Mathematically the sound intensity is given by

$$I = \rho c V_p{}^2$$

where ρ = air density, c = velocity of sound in air, V_p = the root mean square
particle velocity. c and ρ are related by

$$c = \sqrt{\frac{k}{\rho}}$$

where k is dependent on atmospheric pressure.

If we assume V_p to remain constant the variation of sound intensity at a
given point due to variations in the ambient conditions may now be considered.

The density of damp air is less than that of dry air at the same pressure,
consequently sound travels faster in humid conditions. Thus it can be seen from
the formula, an increase in c causes an increase in I.

An increase in temperature causes an increase in c according to the
formula

$$c_t = c_0 \sqrt{1 + \frac{t}{273}}$$

WIND DIRECTION

FIG. 2
UNIFORM RADIATION OF ENERGY
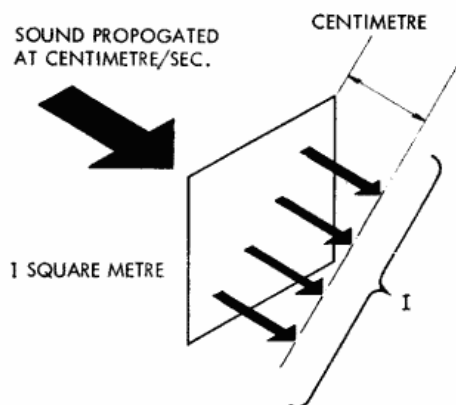
FIG. 3
EFFECT OF WIND ON
RADIATION OF ENERGY
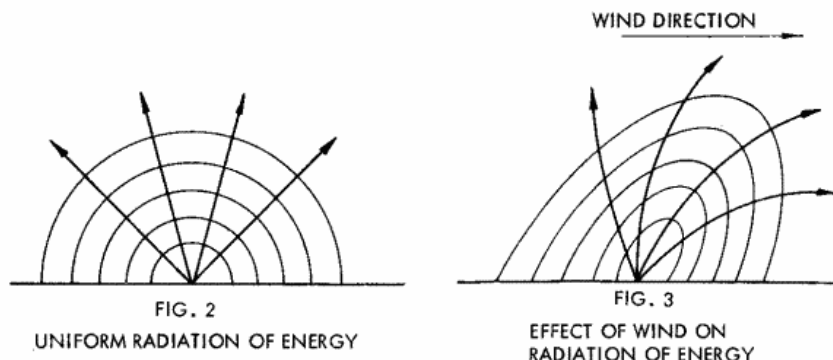
where c_t = velocity of sound at $t°c$, c_0 = velocity of sound at $0°c$, t = temperature in degrees centigrade.

Consequently an increase in temperature results in an increase in the sound intensity.

The effect of wind can be seen by comparing Figs. 2 and 3. From Fig. 3 it can be seen that at a given point downwind of a sound source the intensity is increased as the windspeed increases. Similarly upwind the sound intensity is decreased.

The effect of altering the distance from the source at which the sound is observed may be considered in the simple case of a source situated on the ground under ideal conditions as in Fig. 2. Consider the source to be radiating sound energy at the rate of E energy units per second. The observation point at a distance r from the source may be considered as being a point on the surface of a hemisphere radius r through which the energy is passing at E units per second. From our definition of sound intensity it can be seen that the intensity at our observation point is given by

$$I = \frac{E}{2\pi r^2}$$

the r^2 term indicating that sound intensity at a point falls off with the square of the distance of the point from the source.

The Decibel Scale for the Measurement of Sound Intensity

Direct sound energy measurements are difficult to obtain so a comparison scale is used. The sensation caused at the human ear by sound does not increase linearly with increases in sound intensity, but rather the relationship tends to be logarithmic. Hence the decibel scale used for sound level measurement is a logarithmic comparison scale.

The threshold of hearing, i.e. the lowest sound intensity that is just perceptible, is taken as the standard value for establishing the decibel scale. We will give this threshold intensity the symbol I_0. A tenfold increase in sound intensity is then defined as 1 bel and the following relationship exists

$$\log \frac{10 I_0}{I_0} = \log 10 = 1$$

Similarly a hundredfold increase in sound intensity is 2 bels, i.e.

$$\log \frac{100 I_0}{I_0} = \log 100 = 2$$

Thus for any sound intensity I the number of bels is given by

$$\log \frac{I}{I_0}$$

The bel is an inconveniently large unit to work with so we take one tenth of it as our standard unit. This smaller unit is the decibel (dB). The decibel scale is built up as follows:

$$
\begin{aligned}
I_0 &= 0 \text{ dB} \\
10 I_0 &= 10 \text{ dB} \\
100 I_0 &= 20 \text{ dB} \\
1,000 I_0 &= 30 \text{ dB} \\
10^{10} I_0 &= 100 \text{ dB}
\end{aligned}
$$

If we have a sound intensity I 1 dB above say $10^8 I_0$ dB we can calculate I in terms of I_0.

$$\log \frac{I}{10^8 I_0} = 0{\cdot}1 \qquad \therefore I = \text{antilog } 0{\cdot}1 \times 10^8 I_0$$
$$= 1{\cdot}26 \times 10^8 I_0$$

Thus 1 dB rise is an increase of 26% in sound energy irrespective of the original loudness of the sound. This happens to be about the minimum change that the ear can detect.

As shown above the intensity of sound decreases with the square of the distance from the source, hence doubling the distance reduces the intensity to 25%, and the change in decibels may be worked out as follows:

$$\log \frac{4I}{I} = \log 4 = 0{\cdot}6021$$

The change in decibels is therefore equal to 6·021 dB. The sound at the doubled distance is said to 6·021 dB down on the original sound intensity. Rounding this figure off to 6 provides a useful approximation for converting decibel figures for different distances.

FIG. 4

40dB CURVE REACHES PEAK AT 2.5 Kc/s

FREQUENCY RESPONSE OF EAR AT DIFFERENT SOUND INTENSITIES.
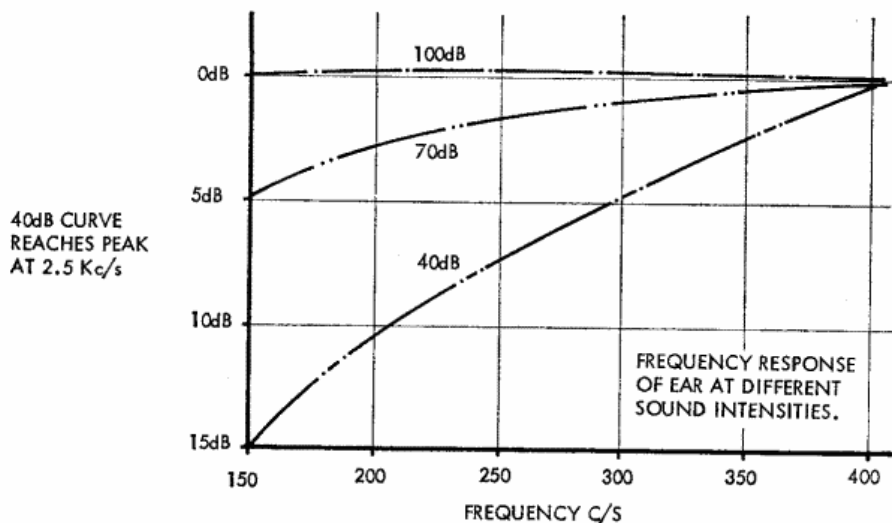
The Response of the Ear

In measuring noise annoyance levels a difficulty is introduced by the response of the ear. This varies both with frequency and the order of magnitude of the sound intensity. Fig. 4 illustrates the frequency response of the ear in the frequency range corresponding to engine speeds between 9,000 r.p.m. and 24,000 r.p.m. The single dot line represents a typical response at 100 dB, the double dot line the response at 70 dB, and the chain line the response at 40 dB.

100 dB is a typical noise reading obtained from an unsilenced 2·5 cm³ engine running at 19,000 r.p.m. and measured at a distance of 10 ft. If we assume the decreases in intensity to be due solely to distance, i.e. no obstructions such as trees and houses, then 70 dB would be the reading at a distance of 320 ft. and 40 dB the reading at approximately 2 miles. Thus in the range where the noise from such an engine could cause annoyance the response of the ear would approach the double dotted curve.

What this Means to the Model Flyer

It is safe to say that a noise becomes insignificant when the sound level has dropped to around 50 dB and for the example above this corresponds to a distance of 3,200 ft. Whether noises louder than this by only a small amount may be considered significant would depend upon other noises present, but for argument's sake we take 50 dB as a convenient figure. Let us now fit a silencer to our engine in the example above, typically the noise level at 10 ft. will drop to 90 dB. This corresponds to 10% of the sound intensity at 100 dB but although the drop will be quite noticeable it will not sound anything like the change it represents. This is because of the ear's response at these orders of magnitude. However our 50 dB level now occurs at a distance of 980 ft. so representing a considerable reduction in area over which annoyance could occur.

When obstructions such as trees exist between source and observer a considerable dampening effect is exerted on the sound. As a result flying areas surrounded by trees allow much shorter distances from populated areas to be used without causing any inconvenience to the public.

This article is by no means exhaustive and several generalisations have been made. However if in reading it you learned something about noise then its purpose has been achieved.

Note: All figures quoted are based on readings obtained using a Dawe Instruments Ltd. type 1408E sound level indicator.

A

A

+4°

4⅜" 1¼"

⅛"

6½"

3¼"

0°

37.5/8"

B

B

A

A

STANDARD AIRFISH
**Motor-Glider for R/C
all balsa structure
By ERICH JEDELSKY
W. GERMANY**

2.11/64"

18¼"

10"

72½"

3¼"

4⅛"

24.13/64"

3.35/64"

20 inch

1¾"

15

B - B (NO SCALE)

10

3.7/8"

A - A
(NO SCALE)

3.7/8"

5

12"

SCALE

0

4¾"

5.45/64"

WING SECTION
(NO SCALE)
15/64 x 1.7/8

⅛ sq. spruce

⅛ sq. spruce

L.E.
9/64
x 13/64
Spruce

Ribs 5/64"

T.E. 43/64 x ⅛"

TAIL SECTION
(NO SCALE)

3/16" sheet

1/16" sheet

Carve hatch from block

Fuselage sides 3/16" sheet with 1/32" ply doublers

3/8" sheet top block

1/2" triangular longerons

3/8" × 1/8"

1/4" sheet fin and rudder.

Top Flite nosegear

3" dia.

1/8" sheet bottom

Note: fuselage side is open frame with silk covering.

2.1/2" dia.

3"

Soft block tip.

HALF SIZE WING RIB

3/8" sq. leading edge

60"

3/8" × 1/4" rear spar

Rear spar doubler end here

1/4" spar top and bottom

Spar doubler ends here

7.3/4"

4"   2.1/2"

2.1/2" Spinner

23.1/2"

1/4" sheet elevators

Hardwood u/c mount

3.1/4"

1.5/8"

3/16" × 3/4" L.E and T.E

3/32" sheet

1/16" sheet covering

1.7/8"

3/32" sheet

KWIK-FLI III
1967 World R/C
Champion Enya 60
Engine. Kraft R/C
By PHIL KRAFT
U.S.A.

11"

1/8" x 1/4" Balsa planking

Block top

1/2" radius fillet

1/16" x 1/4" spruce

3/8" sheet

Hardwood

Side cheaks and chin intake from block balsa

1/16" Sheet fuselage sides

End of 1/8 doublers

45.1/2"

Block wing tips

Wing spars - spruce

1/4" hard balsa sheet L.E.

1/16" sheet

5.3/16"

14.1/2"

16.3/4"

7"

SCALE 1:10

1/8" sq.

A

A

Section A-A

Chin block

Elevators from 3/8" sheet balsa

1/8" x 3/8"

4.29/32"

Rx Aerial

All ribs cut out from 1/16 hard balsa sheet

3/8 Balsa sheet

21 9/64"

RIVETS
Scale R/C Pylon Racer
to "Goodyear" rules for
·40 engines
By JOE FOSTER, U.S.A.

Undercarriage detail

.080 hard aluminium

Jack Stafford wheelpants

2.3/64"

6.5/16"

HOME-BREW FOAM-PLASTICS

by E. HEIMANN

EVERY year the chemical industries produce many new synthetic materials often showing a considerable advantage if compared to conventional materials. Plastics again and again prove that they are no longer only replacements but now have many new uses in their own right. Today we cannot imagine a household, where at least one article made of plastic is being used, to say nothing of the extensive use of such synthetic materials in industrial work. Even sunken ships were recently lifted by pumping synthetic foam into them.

Model-makers, hobby-workers and do-it-yourself people long ago accepted and learnt to appreciate plastics, which can be processed without using expensive tools and equipment. A novel two-component foam resin should soon be available on the model market which can be simply and cleanly handled by everyone without making use of special skills. This resin exists in four different types and with their aid you can form simple structural parts like flower stands, boat-hulls, flower-pots etc. in a very simple pour-in-place process.

Both components are of a syrup-like consistency and have to be thoroughly mixed by means of a simple gadget, which can be easily made from a length of piano-wire with a twisted tin flap ($1\frac{1}{2}$ in. dia.) soldered to it. This ultra-simple tool fits your electrical drill revolving at 1,000–2,000 r.p.m. Make sure that the mixing proportion indicated by the manufacturer is carefully observed. According to the type of resin used mixing must be finished within 10 to 60 seconds (so called pot-life), because the resin is only liquid and ready for pouring in place for a short period. A slight warming and a simultaneous change of colour of the substance clearly indicate that the resin is mixed well enough and that the chemical reaction has started. It is now time for pouring the mixture into a mould covered with polythene (=polyaethylene) or aluminium foil or prepared with a coating of a special wax, which allows you to remove the hardened foam-body from the mould. During the following expansion-process a blowing agent is set free and makes the primary liquid resin rise just like leavened dough. Within 30 to 180 seconds (according to foam type chosen) a more or less rigid and compact foam body consisting of a great number of micro-gas-bubbles lying side by side but not being connected with each other (except FR-foam) originates. Its volume is 17 to 140 times as big as that of the originally mixed liquid resin. After further 4 to 10 minutes the surface of the foam has set (the foam cap is no longer sticky) and the whole moulding may now be carefully lifted out of its mould. This procedure is by no means complicated as the finished "cake" shrinks a little after setting.

The rigidity of our foam also depends on the working-temperature and also on the perfect mixture of the two components. Last but not least you can also mix a larger quantity of resin than necessary to fill the mould, which makes the foam set under pressure. Thus the specific weight of the finished foam moulding increases, but on the other hand this over-dosage secures a first class expansion of the foam in the mould and reduces or completely balances the shrinking effect.

The manufacturers recommend a 20% over-dosage of the resin, which results in an absolutely faultless filling of the mould and additional strength. This rule was also proved by our own tests. It is even possible to double the resin quantity needed for moulding a part (100% overdosage), so that the foam cannot expand to its full extent (due to the confined mould) and thus show a very high rigidity and toughness. When building the mould you must consider the pressure resulting from the restrained expansion, which may rise to a figure of about 690 p.s.i.

As the resin-foams described above do—opposite to "styrofoams"—not contain styrene, you can easily improve the solidity of a structural part made

Sequence of two-part foam polyurethane action. Top right, the chemicals with empty containers. Four photographs below, show in time sequence how the foam is formed, and expands rapidly, obscuring the clock in the brief cycle of events. The foam is soon workable in this "solid" state.
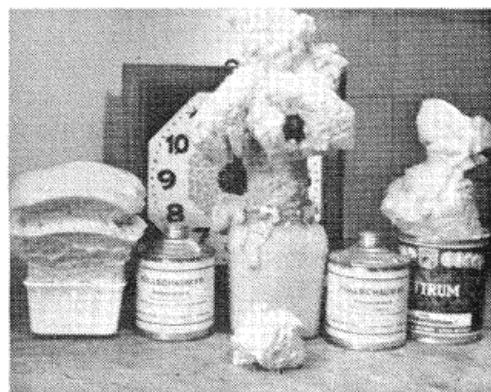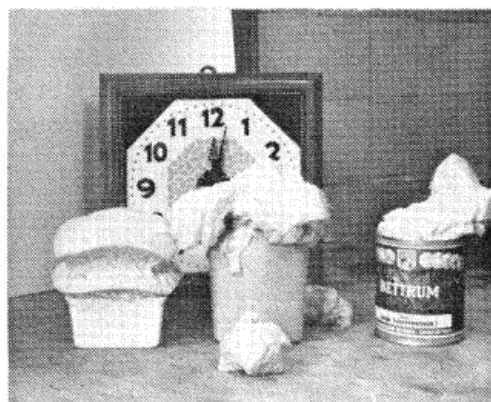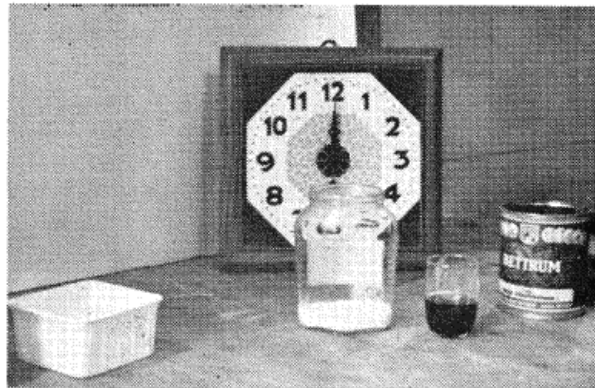
from expanded resin-foam by covering its surfaces with glassfibre without running the risk of distorting the foam by chemical influences of the polyester-resin.

Such a two-component-expanding-foam is extremely suitable for filling structural elements (i.e. fuselages of model aeroplanes or boats and other parts) made from glassfibre in order to achieve additional strength and durability. This filling-technique permits the reduction of the wall-thickness of the glassfibre skin by approximately one third. Thus the weight and consumption of material can be reduced, which is of great importance in the field of modelling. Moreover the filling of model fuselages or boat hulls with foam absorbs engine vibrations, and a radio control receiver embedded in foam in a flying model will even survive a spectacular prang without great harm. Owners of yachts or racing-boats may also like to prevent their models from sinking by filling cavities with rigid foam. Innumerable small gas-bubbles form a great core providing suffici-ent buoyancy, to prevent sinking if leaks occur in the hull.

The gas-bubbles are not connected together, so that the foam block cannot suck up water as a sponge does. According to manufacturer's information, an eight-days' total immersion test, showed only a water absorption of 0·4375 g per sq. in. As the volume/surface ratio of a boat is very advantageous, filling with foam gives unfailing security against sinking risks in the case of a leakage.

As all foam types tested show a very good adhesion to wood, tin, metal, stonework etc. and proved to be resistant against water, diesel-oil, petrol, diluted acids and electrolytes, alcohol and ether as well; they are really ideal substances for insulation purposes of all kinds. With regard to this, the excellent capability of withstanding temperatures ($-50°C$ to $+100°C$) is of great importance, too.

Hobby-workers and craftsmen find unlimited possibilities for this material. In connection with wood, plastics or metal reinforcements, even medium-size structural elements, such as roofs for your veranda or a small roof over your front door can be easily built from pour-in-place-foams (sandwich-construction). If you are a keen amateur-craftsman you can even build your own portable, battery-powered refrigerator for your Sunday-picnics or your summer-camping-trips.

TABLE I
Characteristics and Application of Voss Pour-in-Place-Foams

Type	Use	Mixing ratio	Pot-life	Expan-sion ratio	Time needed for expanding	Time needed for setting	Physical properties	Density lb./cu. ft.
HR	Structural ele-ments, floats, temperature insulation, model boats and aeroplanes	1 : 1	60 sec.	1 : 25	180 sec.	10 min.	Rigid, closed-cell structure	2·48
ZR	Moulded parts, handles etc.	1 : 1·5	15 sec.	1 : 17	45 sec.	4 min.	Tough, semi-rigid	3·72
ER	Flexible moulded parts	2 : 1	16 sec.	1 : 17	45 sec.	5 min.	Soft, flexible	3·72
FR	Packaging, fill-ing, modelling, insulation (very cheap)	1 : 1	50 sec.	1 : 140	30 sec.	10 min.	Soft, very light, open-cell structure	0·434
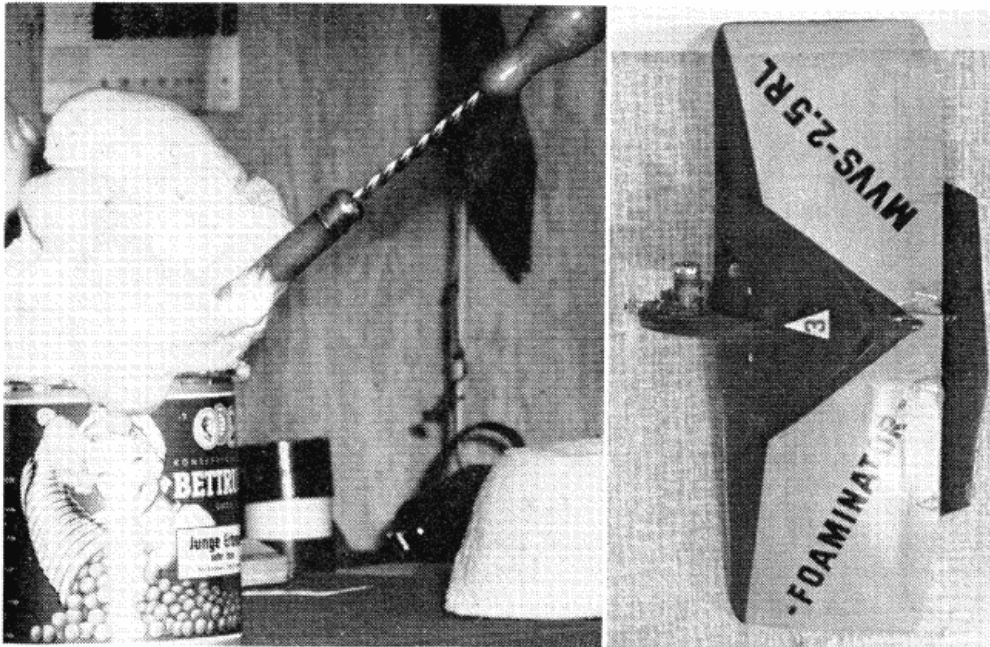
(A) Above: use of a whisk to agitate chemicals. Top right, this APS "Dominator" design is a balsa shell, filled with the two part foam material. The only serious difficulty with this foam-in-place method of structure filling, is that the pressure developed can be sufficient to burst the balsa sheet! Otherwise the "Foaminator" is extremely simple to make and exceptionally robust.

(B) Right: a cowl moulded with the two part chemical, the dark sector indicates an area on which plastic enamel was applied to show that the foam and the enamel are compatible.
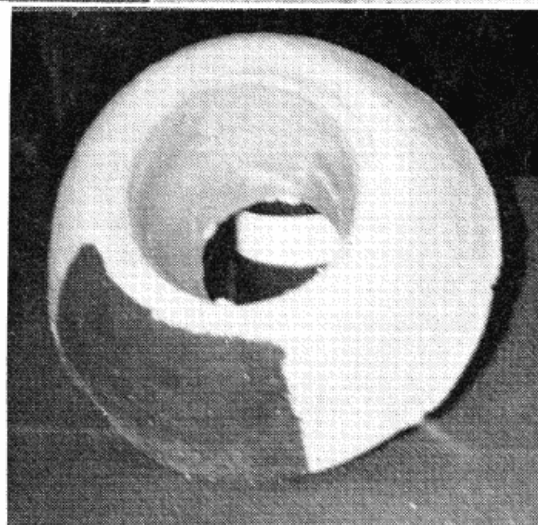
Mountains, landscape, tunnels or ramps for your model railway track are problems which can be quickly solved by using foam-plastics. Their fine noise-absorbing characteristics recommend them as silencing support for your model railway track-system. As the HR-type foam can also be cut and carved by means of a sharp knife or razor blade there are no limits for your inventive genius. The final smoothing and fininishing can be done with sandpaper.

Now some general hints for handling pour-in-place-foams. In order to achieve a faultless expansion of the foam and a homogeneous consistency, both components must be thoroughly mixed (but not in excess). The most convenient working temperature is between 20° and 35°C (metal moulds which dissipate heat rapidly should possibly be preheated). As all foam types stick very well to every kind of material (except polyaethylene), you should always wear an old

TABLE II
HR-Foam Compared to Different Insulating Materials

Material	K-factor	Coefficient of thermal conductivity	Density lb./cu. ft.
HR-foam	0·12	0·02	2·48
Styrofoam	0·22	0·03	2·48
P VC-foam	0·26	0·033	5·58
Phenolic resin foam	0·20	0·025	2·48
Iso-resin foam	0·20	0·025	2·48
Cork-board	0·32	0·04	15·50
Wood (soft)	1·20	0·15	31·00
Hardwood	1·90	0·23	49·60
Wood fibre	0·42	0·05	18·60
Mineral wool	0·24	0·03	6·20
Glass-wool	0·24	0·03	6·20
Insulated brick wall	2·40	0·40	74·40
Lime-brownstone wall	6·00	1·00	124·00
Cement-clinker wall	9·70	1·20	124·00
Cement plaster	6·50	0·80	124·00
Reinforced concrete	10·40	1·30	148·00
Slag concrete	4·80	0·60	80·60
Soil (sand or clay)	12·00	2·00	124·00
Tarmac	4·48	0·60	130·20

All data according to information from Messrs K.-W. Voss

overall and protect your hands with gloves when working with pour-in-place-foam. Above all the B-components of the foam types are toxic (they contain isocyanate). Therefore you should only use bigger quantities of foam in the open air. If you can only work in a room, take care that all windows are open and wear a filter mask against toxic gas. Hardened and set foam is no longer toxic, if the mixture prescribed by the manufacturer is faithfully carried out (±1%). Only under this condition the toxic element is entirely neutralised by

Most sophisticated of the foam-in-place model developments is the system used by film producers for models in destruction scenes. This Ju 87 Stuka is typical moulded completely with two part chemicals and very little reinforcement except a layer of ·003″ glassfibre. The Ju 87 is radio controlled, 72 in. span, weighs about 11 lbs. with Kraft KP6 R/C and Super Tigre ·71 motor. It also carries explosive detonation devices and an extra receiver. Who can deny that the film makers—and the modellers have succeeded in skilful deception?

When a crash occurs with a foam model the repair can be done in less than a minute! This severed wing shows that there is nothing, other than solid foam inside and that the clean break can be butt-joined with epoxy. Even the u/c leg is butted to the wing.
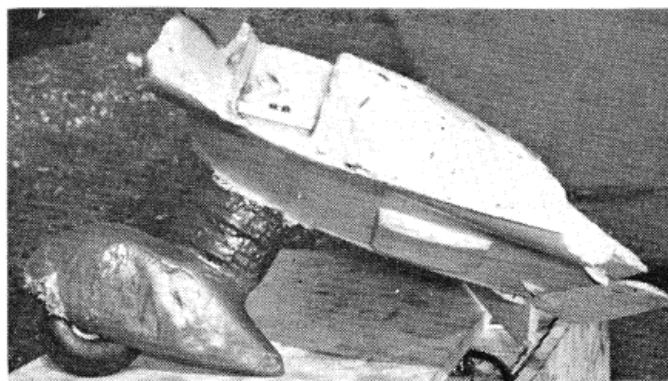
chemical reaction. Possible splashes of foam on your skin or elsewhere can be quickly removed with some alcohol or acetone—provided that you use it at once.

For industrial processing of these resin foams, where great quantities are being used, special spray guns, which automatically mix both components during the spraying-process are available.

Finally, we feel that the two-component pour-in-place-foams, which can be handled and processed without difficulties are a novel material with physical and chemical characteristics making them pre-eminent for a wide variety of purposes. The simple way of processing secures a maximum degree of success for the hobby-worker and craftsman.

SUPPLIERS

This feature is based upon the chemicals available on the Continent of Europe from Klaus-W Voss, Chem Fabrik, 2082 Uetersen, Esinger Steinweg 50, West Germany and sold as type KR (Rigid) and ER (Flexible) and ZR (Resilient).

In the U.S.A. many proprietary brands of foam in place chemicals are available. One which has been used for model work is "Minut-Foam".

Supplies in Great Britain are sold as "Coolag" through most Ships' Chandlers. In case of difficulty contact: Wren Nest Mill, High Street West, Glossop, Derbyshire.

The Baxenden Chemical Company Ltd. of Paragon Works, Baxenden, near Accrington, Lancashire (London Office—Clifton House, 83-117 Euston Road, London, N.W.1) have a range of foam plastics and are bulk suppliers to industry and research institutes. Marketed as "Glocel" (low density) and "Spandofoam" rigid polyurethane foam, the material is backed up by excellent descriptive literature on techniques, types of foam, applications, mixing and general properties.

5½" 4¾" 4¾" 3¼" 2¼"

A

Cooling air outlet

Wing weight 3½ ozs.

Lead-outs enclosed in wing

Best time 4.37 on 7 c.c. fuel

15¾"

39½"

GEMINI IV
F.A.I. Team racer
By
D. McNEILL
(Belfast)

SECTION A-A

Dural
crutch

4"

2"

41.5/8"

Sheet 13/64"

Engine 6 cc.

16g. Dural
undercarriage legs

1.5/8"

1.15/16"

2⅜"

55⅛"

2⅜"

9.3/4"

2° Right-thrust

10.1/2"

3"

3/4"

3⅛"

15¾"

4½"

3"

2¾"

22"

Balsa 1/4"

2⅜"

1.9/16"

Sheet
3/32"

2.5/8"

Tank

15/16"

VUM-18
Control-line stunt
with detachable wing
By
TIBOR VELLAI
HUNGARY
14th 1967
Criterium of Aces

3/8"

2"

4½"

1.3/8"

8.7/8"

5/8"

SCALE 1:10

14 1/4"
2.7/8"
1/4 sheet
7"
1/2" offset
5 1/8"
A B
A A
B B

A–A
(1/5 SIZE)

Balsa blocks

Fibreglass cowl

All ribs 3/32" sheet

C–C
(1/5 SIZE)

Balsa fairing

Veco differential horns with 1/16" dia. pushrods

1/8 sheet sides

3/8 sheet

5°

Flaps 1/4 sheet

nylon hinges used

14"

1/16 sheet

1/4 sheet

1/2 fin offset

2° offset

3" bellcrank

O.S. Max S35 plus 2" ext shaft

1/2" sq. L.E.

B–B
(1/5 SIZE)

Moulded canopy

3/8" x 1/2" Maple mount

1/16" sheet

1/16 Ply doublers

2.13/64"

Metal strap

Vent

1/8 Piano wire L.G.

1 3/4" dia. wheel

Rib 1/8"

Tailplane and elevator cut from 3/8" sheet. Hollow out, cement 3/32" ribs in place, then shape to airfoil section.

1/2 x 5/8 T.E.

25.13/64"

24.5/8"

1 1/2"

3.1/16

3"

NOVI III
Control-line stunt
5th US NATS 1967
By
DAVE GIERKE

SCALE 1:10

1.7/8"

9.5/8"

Wing tips cut from 1/2" sheet

TAILLESS
Open rubber
By
HENRY TUBBS
(Baildon)

6" 2"

12"

4"

Ribs in this area from 1/16" sheet

7.1/8"

T.E. 1/4 x 1/8"

13.1/2"

3rd Woodford 1966
2nd Midland Rally 1966
2nd H.T.C.T. Sept. 1966

Wing section "By eye"
1/8" under camber in centre,
flat below 5" chord.

1/32"

Ribs

Airframe 3.2 oz.
Rubber 2.5 oz.

L.E. 3/16" sq.

1/16"

1.1/2"

1⅜"

2.1/4"

1.1/8"

Approx. areas:

C/S   — 77½ sq. in.
Middle panels — 130 sq. in.
Tips   — 53 sq. in.

6"

3"

20" D.B. folder

1/2" washout

5"

Open lightweight fuselage
Longerons 3/32" sq.
Diagonals 1/16" sq.
Spacers   7/32" x 1/16"

Power: 8 strands Pirelli
        1/4" x 1/24"
Run: 2½ min. – 1300 turns

3

6

¼" incidence

1½" sq.

2"

12"

24"

2½"

Fuselage blue, except
cabin and strip (white).
Wing & tail yellow
Modelspan coloured black

Sheet 1/16

Spruce 1/16 x 1/8"

$2\frac{1}{4}$"

$2\frac{3}{8}$"

B

C.G.

$1\frac{3}{4}$" from L.E.

0°

$2\frac{1}{4}$"

C

D

2°

$1\frac{3}{8}$"

C'

D'

B

$2\frac{3}{4}$"

22.11/16"

Span $30\frac{3}{4}$"

A

A

$2\frac{3}{4}$"

$\frac{1}{8}$" dia.
dowel

A - A SECTION
(1:2)

SECTION D–D
(1:2)

1/16" sq.

Lead

$\frac{1}{8}$" sheet
balsa

1/8" Ply

$\frac{1}{8}$" sheet
balsa

Balsa
inset

5/64 x 5/32"

$11\frac{3}{4}$"

$5\frac{3}{4}$"

1/2"

$1\frac{3}{4}$"

$1\frac{1}{4}$"

$30\frac{1}{4}$ sq. ins.

$1\frac{3}{4}$"

B-B SECTION
(1:2)

8.5/8"

124 sq. ins.

Spruce
1/16 x 1/8"

1/8" Sheet
balsa

Tow hook
18 s.w.g.

2.5/8"

Weight: 3,74 oz.

C–C SECTION

$6\frac{3}{8}$"

QUAIL
30 inch Glider for
beginners
By
RADOSLAV CIZEK

Spruce

3/8"

SCALE 1:6

7/8"

Spruce 1/16" x 5/16"

Spruce 1/16" x 1/8"

WING SECTION
(1:2)

L.E. spruce
1/16" x 5/16"

$4\frac{1}{8}$"

Spruce
1/16" x 13/64"

$4\frac{1}{8}$"

Sheet 1/16" (All ribs)

A WORD ABOUT WARPS

by L. RANSON

BACK in the old days of flying, wings were too flimsy to spread out by themselves, cantilever fashion; they had to be hitched up by a whole network of tensioning wires. This primitive system, however, had one advantage: if the plane was not behaving in a pleasant, equilibrious manner—perhaps flying with one wing low, or pulling like mad to one side—then the rigger chappie would pull a few knowing strings to get the kinks out of the wings, and cows could sleep happily on the pastures.

Nowadays, however, in model as well as full size craft, the wing, once built, must find its own salvation. On full size craft various trim correctives are sufficient to counter any waywardness, but although the model world has not lagged behind in developing new structural techniques, the warping tendencies of our extremely light model wings are greater than those on full size craft, and often they call for quite drastic treatment.

Warps can occur for a variety of reasons: most of which the expert, who has experienced all the pitfalls, goes to great pains to eliminate (too great pains if he holds the wing too near the fire). Prevention being better than cure he tries to produce a structure that is light enough for the type of model but rigid enough to resist undue distortion when covered. In the case of the highly developed contest model this may only be achieved by a quite complex cross tensioned airframe in which the balsa is of a highly selected order. When building the structure he keeps tensions even by making each joint a nice secure fit, without jamming. And, perhaps most important of all, he covers the framework with an even spread of the fabric. More warps than enough are caused by a one sided covering pull, and a little care and observation at the time can save a lot of worry later. Over-doping is another hazard to avoid; a spectacular finish can lead to—well, a spectacular finish!

Notwithstanding all this warps will creep in. You will often find a degree or two of wash-out, that is trailing edge up twist, at the wing tips, but, if not excessive, this can prove a useful stabilising device in that it prevents premature wing tip stalling. Less to be desired is the span-wise twist, with wash-in on one wing and wash-out on the other, although, even this can be used to advantage if not excessive and going the right way. But, obviously no warp can be used to any good aeronautic effect if it is too exaggerated, and the inexperienced, not too careful builder is capable of some real anti-fly shockers, although it is fair to say that the beginner is not warp conscious simply because he has no experience of their quite alarming effects.

Perhaps the most disconcerting thing about warps is that they are not constant in their effect; this varies both with the *speed* of the model and its flight *attitude*. The influence may be quite mild at low speeds but extremely violent at high speeds. There are two main reasons for this: one is our old friend velocity squaring itself to the increase of speed, so that if you double the speed you quadruple the warp effect, and the other is whether at any one time the warpage is producing lift or drag.

Aileron down

Aileron up

Gives positive lift.
Wing rides up, but
if downward angle
exceeds critical
setting, lift is
destroyed rather
than increased.

Gives 'Negative' lift.
Wing drops

Combined effect is to roll
the aircraft to the left
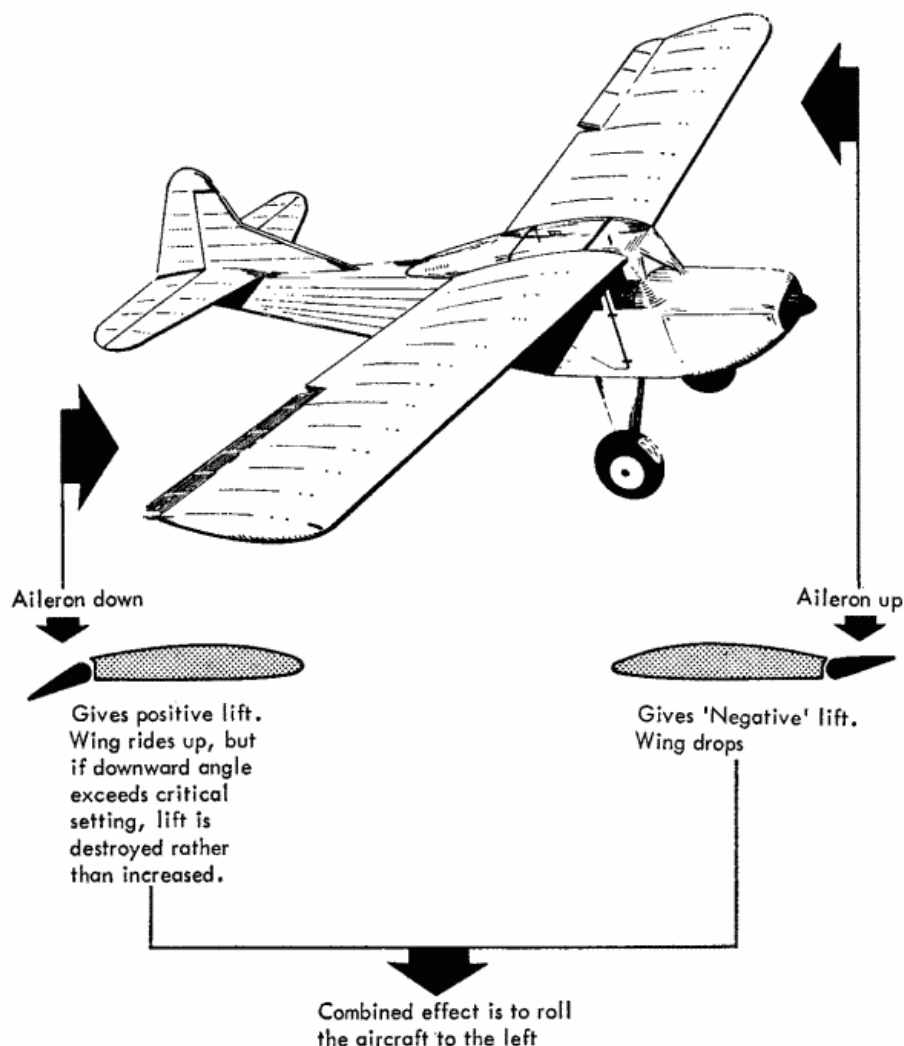
The warp is best tamed by knowing something of how it operates; the particular way it influences the flight trim. Perhaps the simplest way to demonstrate this is to relate it to the operating of wing ailerons. If, for instance, a pilot wants to bank his aircraft to the left (port) he trims the ailerons so that the left, or inboard aileron, is raised to give a negative incidence to the wing aerofoil and the right, or outboard aileron, depressed to give a positive incidence. Thus the left wing has less lift and the right wing increased lift, rolling the aircraft to the left.

If, therefore, you have a span-wise twist which raises the trailing edge on the left wing of your model (wash-out) and lowers the trailing edge on the right hand wing (wash-in), then this will tend to bank your model to the left. Or will do if the speed of the model is sufficient to create extra lift on the outer wing; otherwise the drag effect will pull the model the opposite way! This means that a warp may produce a marked pull one way under power, and yet turn it the other way on the glide.

This phenomenon is sometimes put to good effect by the expert as a trimming device. On power models, and even on rubber models, come to that, the power-on turn is critical. If the inboard wing tends to drop you get a roll on over effect which can easily terminate in a steep spiral. To counter this wash-in

is introduced into the wing that is on the inside of the turn—normally the right hand wing—so that this wing rides up against the turn and keeps the model in a safe posture. On the glide the drag effect produced by the warp gives the desired circling pattern.

If the deliberately induced warp demands a fine degree of control to make it work for you, then you may be sure that the casual warp can throw the model into all sorts of tantrums, leaving you with the baffling problem of a virtually untrimmable model. The expert, of course, can usually pull something out of his box of tricks to counter an intractable warp, but he usually ensures that no such warps exist, or, if they do occur, are speedily eliminated.

What to do about a warp? Well, it may sound crude, but holding the offending surface in front of an electric fire seems to be the most effective remedy. An electric fire is recommended because it gives out a constant heat. A doped wing is very inflammable and a tongue of flame could leave you with a few charred remains. Hold the wing with opposing pressure to the warp, just sufficiently close to the fire to get a fairly intense heat. A few seconds of such treatment is usually enough to expand and re-tension the covering. If possible the treated surface should be pinned flat to a board and left for a day or so to "set".

"Wash-in" – Gives Positive lift same as "Down" position on aileron, but only at higher speeds. At lower speeds – when model is gliding – drag will exceed lift.

"Wash-out" wing warp – Gives "Negative" lift same as "Up" position on aileron

Rolling tendency to left under power. Turn to the right on glide.

2°30

3/8"

3.9/16"   4½"   1.9/16"   7¾"   11.5/16"   2⅜"   ½"

5.29/32"

5/8"

3.35/64"

1°

10"   8.11/16"

1.9/16"

12.5/8"   13"

Block 1" x 5/8" x 7¾"

1.9/16"

Equipment : Grundig

1"
⅜"

2.9/16"

2"

3.5/32"

4.5/16"

1.3/16"

17¾"

1.3/16"

Weight ~ 42.4 oz.

22"

1.3/16"

5.29/32"

2¾"

IDRO OP23
Four channel R/C Waterplane for
·19-35 cu. in.
By PAOLO ORIGINI
ITALY

SCALE 1:10

1/16" sheet

5/8"

¼" sq.

19/32" sq.

WING SECTION (HALF SIZE) – 13% T/C

Double 1/16" sheet T.E.

28¾"

Ply 1 mm.

3/8" Hardwood

Celluloid 1/32nd.

Ply 1.5 mm.

3.1/16"

2.9/16"

Dural 1 mm.

1⅜"

C.G.

17½"

Wire 1.5

16 s.w.g.

NACA 0018 airfoil

Ply 1 mm.

Beech
wheels
1¼"

Mk 16 engine
1.6 cc. capacity

16 s.w.g.

10¼"

Tank capacity 30 cc.

Ply 0.4 mm.

Hardwood flap

Ply 1 mm.

Ply 1 mm.

2⅜"

3.9/16"

Pine 1/8 x 1/8

Pine 1/16 x 1/4

STRUZ
Control-line Trainer
By JERZY KACZOREK
and MAREK CYBULSKI
POLAND

Weight 12.3 oz.

1.9/16"

2⅜"

SCALE 1:5

⅛"

5⅛"

1"

5.3/4"

3° 30'

A

A

32.7/8"

2.5/8"

1.3/8"

51.1/4 span

4"

1"

4.7/8"

16.5/16"

43 sq. ins.

239 sq. ins.

19"

A A

1/8

15.3/4"

5/8"   2.7/8

3.3/8"

7/16"

10.5/8"

GAZELA
A/1 Class Glider
By MIROSLAV PETERKA
ZEHROVICE, CZECHOSLOVAKIA

half size sections

TAIL

1/8

1/16" sheet

WING

Scale 1:8

13/16"   2.13/16

3/16 x 1/4"

5/64 x 1/8 spruce

3/32 x 15/32"

CZECH

Tick off timer
for wing incidence
change

3/32" Aluminium

3/32 Ply skid

3/4"

19½"

Pattern: Right – left

Power: 16 strands 1/4 Pirelli
31 – 34 sec. prop. run

2"   1¾"

5⅛"

Solid soft
balsa tail
plug

6"   4⅛"

5/8" dia. at Tail L.E.

5½"

2"

244 sq. in.

Machined aluminium ring
1/16" aluminium jaws

Prop 21½ × 27"

Adjust pitch folder

Front of tail boom

Aluminized Mylar
reflective tape

1/32d
spring
wire

48.6 sq. in.

3/8"

WING CENTRE
SECTION

C.G. 75%

Epoxy

1" long
motor tube

Hole in
bulkhead

1.1/16"

4"   1"

26½"

16¼"

9⅛"

1.3/16"

3/8 o.d. × 1/32"
wall alumin. tube

NOSE BLOCK (HALF SIZE)

1/8 I.D. brass tube

3° right thrust

3/16 alum.
nose piece

1/32"
wire

1/32" wire

3.1/16"

Fuselage: 1¼ O.D. × .008
wall alu. tube re-enforce
Epoxied at end

19⅛"

4–40 setscrew
holds shaft

1/32#

13°

1/8"shaft

Right thrust in nose
plug (lathe turned)

Total area 292.6 sq. in.

Weight – 8.15 oz.

Steel
hinges

Machined
aluminium
prop hub.

1967 WAKE

High aspect ratio
By JIM PATTERSON
Granada Hills
California, U.S.A.

12"

13°

1/32"ribs

1/64"cover top
and bottom

WING AND TAIL
SECTION
(HALF SIZE)

1/8"sq.

1/2"

1/16" × 1/8" spruce
(balsa at tip)

1/32" ribs   1/32" top cover

3.15/16"

1/8 × 3/16"

SCALE 1:12

Wing – '55 Lindner section

1/16"soft web

1/64" bottom cover

SCATTER, U.S.A.

Timer

6.5/16
5/64
12.13/32

2.1/8"

5.1/2"
3.3/8"
5/8"d.

21.1/2"
1/32" sheet

19/32"
1.5/16"

16 strands 6 x 1 mm. Pirelli

48"

5.7/8"
5/8"

22" diameter
variable pitch

51 sq. ins.
(0.26 ozs.)

17.3/4"

9.7/8"   3"   60%
1"
26.3/4"

Dural tube 1.3/8"d.

1.3/16

1"

14.3/4"

226 sq. ins.
(1.76 oz.)

1967 TOP CZECH
WAKEFIELD
META-67
By MIROSLAV URBAN
Most MFC
CZECHOSLOVAKIA

3.1/8"

Weight 8.36 oz.

9.7/8"

TAIL   1/32 x 5/16"   1/32"
1/16" x 7/16"
1/32"
Balsa   Half size airfoils   WING

Scale 1:10

4.15/16"

1/16" dowel   16g wire   spruce 5/64 x 1/8"   spruce 5/64" sq.
Balsa

CZECH

A
4"
+3°
5.5/16"
2"
17"
C
C
4"
1"
1"
4"
1°
A
A
C

19/32"

B-B
C-C
3/4" dia.
1.1/4"
Balsa 1/32"

26"

72 sq. in.
11.27/64"
1.9/16"

45°
45°
30"

A-A

450 sq. ins.

2¾"
3.15/16"

6.19/64"

1.31/32"

25/32"

A/2 GLIDER
With Geodetic Wing
By TINO COSMA
MILAN, ITALY
19th 1967 World Champs

Weight: 14.66 ozs.

SCALE 1:10
ALL SECTIONS
HALF SIZE

TAIL SECTION
1.3/8"
1/16" x 1/8" spruce
1/8" x 25/64"
13/64" x 5/32"

WING SECTION
1.7/8"
25/32"
Balsa 5/32" x 1.3/16"
10.3/8"

2.1/16"
5.15/16"

Spruce 1/8" x 3/16"
Spruce 1/16" x 5/32"

SHORT CUTS AND BUILDING EFFICIENCY AIDS

by Martin Dilly

SOME of the following ideas may be new to you, and have either been evolved or else collected over the past 20 or so years of modelling. While some of them may seem too simple to be worthwhile, some sort of time and motion approach to model building can make the process a lot quicker and more efficient.

Tube bending When bending brass or aluminium tube thinner than about 14 s.w.g., the way to get a smooth kinkless bend is to slip a length of nylon monofilament of the right diameter into the tube; the bend can then be made either with a pair of round-nosed pliers or sometimes round the thumb. Remove the nylon and you have a perfect bend, even down to around $\frac{1}{8}$ in. radius. When bending brass tubing or working brass at all, bends can be safely made if the material is first annealed by heating to a dull red and then allowing to cool in air. Of course the operation is a lot easier if the bend is made at the end of the full length and then cut off afterwards; the quickest way to cut tubing of the sizes we usually use, is to roll it under a long-bladed balsa knife, at the same time moving the knife backwards and forwards. Don't forget to de-burr the end before fixing the tube in place; this is best done with a twist drill a bit larger than the tube diameter, twiddled between the fingers.

BALSA STRIP

STEEL STRAIGHT-EDGE

QUICK GUSSET PRODUCTION
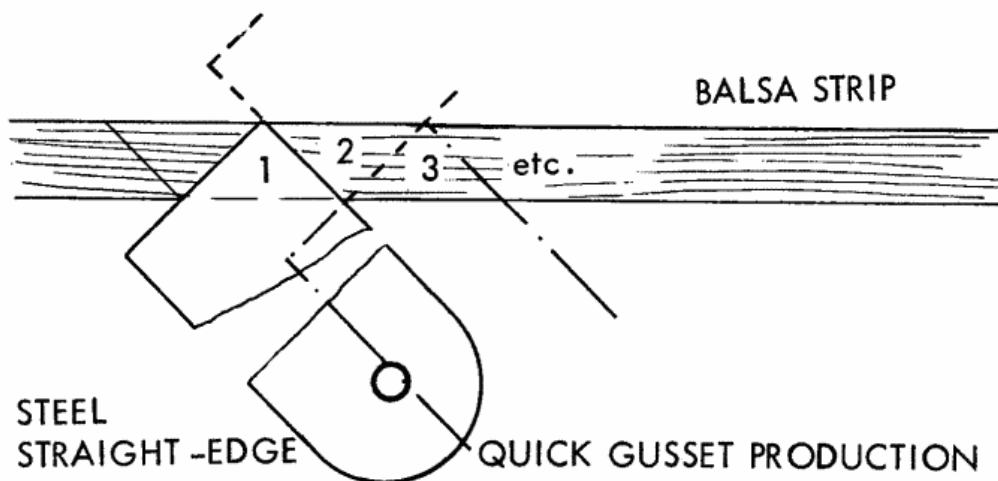
Gussets should have the grain running parallel to the diagonal side in order for them to be any use structurally. The quickest way to produce them is to cut a strip of balsa the right width (see diagram) and then use the square end of a steel straight-edge as a template to cut the gussets from the strip, turning the straight-edge through 90° after each cut.

Sanding is another use for the straight-edge; wrap the garnet paper round and you will then have a flat surface which can be renewed when the paper gets smooth simply by tearing off and exposing the layer beneath. In case you haven't yet discovered garnet paper, give it a try; it lasts far longer than glass-paper and gives a much sharper cut on balsa. One other use for it is trimming tissue; when you have covered a wing or fuselage side and are wondering how to make a neat job of removing the overlap, forget about razor blades or scissors and, holding a piece of fairly fine garnet paper at about 45° to the tissue-

covered surface, simply sand through the tissue along the edge of the structure, the surplus simply dropping away.

Pins   Removing these is always a fussy job, specially if you've knocked them into the board too energetically; the usual way is to pull them out with pliers, one at a time, transferring each one to the pin box. If you take a couple of pins between the thumb and fingers these will make a grip to put beneath the head of the ones in the board, which can then be pulled out neatly and quickly and held in the hand in quite a large bundle. It's a lot quicker than pliers!

Sheeting   When pieces of sheet have to be let into a structure, for instance round the nose of a rubber model, one of the difficulties is not to push the pieces too far in so they go below the edges formed by the longerons or spacers. The best way to do this is to run cement round the edges of the hole and then, after offering up one edge of the sheet, "wipe" the rest into the hole with a straight-edge. This will ensure that the inlay is perfectly flush with the surrounding wood.
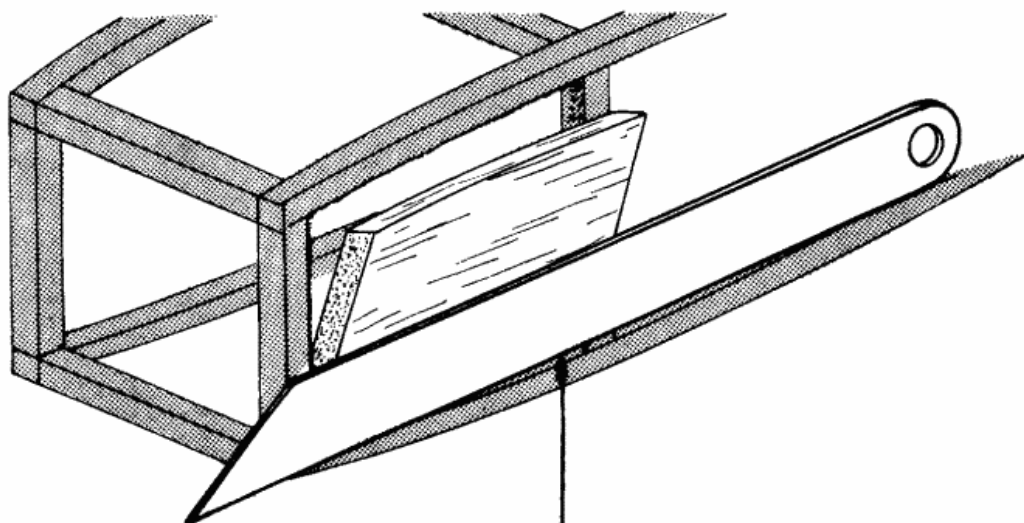
WIPE INLAY INTO PLACE BY MOVING STRAIGHT-EDGE IN DIRECTION SHOWN, AFTER LOCATING LOWER EDGE, AND CEMENTING EDGES OF RECESS.

Sheet Covering   Sometimes when covering a sheet-surfaced wing there is a tendency for wrinkles to form after the tissue is applied; this seems to be due to the pressure applied from the dope brush when doping the tissue on to the wood. A method to prevent this happening, that seems to work, is to ensure that the wing has a slight concave bow in it when the tissue is being doped on; this can be easily done by putting shallow blocks at each end of the wing so that when the doping is finished the wing will spring flat again and exert a slight tension on the tissue to pull the wrinkles out as the dope dries.

Dihedral Joints can be accurately sanded to fit by lining the joint end of the panel up with the edge of the building board, raising the tip and supporting at the correct angle and then using the edge of the board as a guide to sand the joint vertical. In order to prevent the spars being buckled and knocked out by the sanding operation, slip a spare rib in place to support the loose ends of the spars; this way their ends will be sanded to the correct angle together with the rest of the root.

WEIGHT IN OUNCES	6 lb.	8 lb.	10 lb. PER CU. FT.
36" X			
1/32 × 3"	.1875	.250	.312
1/32 × 4"	.250	.333	.417
1/16 × 3"	.375	.500	.625
1/16 × 4"	.500	.667	.833
3/32 × 3"	.563	.750	.938
3/32 × 4"	.750	1.00	1.25
1/8 × 3"	.750	1.00	1.25
1/8 × 4"	1.00	1.333	1.66
3/16 × 3"	1.125	1.50	1.875
3/16 × 4"	1.50	2.00	2.50
1/4 × 3"	1.50	2.00	2.50
1/4 × 4"	2.00	2.66	3.33
3/8 × 3"	2.25	3.00	3.75
3/8 × 4"	3.00	4.00	5.00
1/2 × 3"	3.00	4.00	5.00
1/2 × 4"	4.00	5.33	6.66

OUNCES

A
B
O

Brass or tinplate strap is secured to top corner with 8 BA bolt and nut. Weigher arms 7 in. long, bent at ends to form hooks, are fixed at X. Arm A is of 20 swg piano wire for heavy scale (A); arm B, 22 swg for lower weights—scale B. Scale, with sheet balsa weights tabled, can be traced or cut out and stuck to ply or hardboard backing.

When making the rounds of the model shops on the off chance of finding some good quality wood, a simple weigher is handy, to cut out guesstimating wood weights and comparing sheets with each other. This way one's stock of balsa can be kept complete without size and density gaps; the weigher shown is compact and quickly made. The wood is hung from the hook at the end of a suitable weigher arm with a rubber band; further arms or scale divisions can be added as required. If the wood is marked with its weight as soon as it is bought you will be able to select the correct grade of wood for the job in hand without re-weighing at home. The scale can be cut out and stuck direct to the backing.

40"

Tauri landing
gear

3/32" sheet sides, top and bottom,
over 3/16" sq. longerons and spacers

49.3/8"

Dihedral:

6° – For rudder control only
4° – For G.G. or Rem. Propo.
2-3° – For full house propo
with strip ailerons

Engines:

Max 10, Cox .09
for 7-8 oz. servo or
G.G. installation.

O.19 RC for high performance
or sports flying.

0.35 RC for heavy building.

8.1/4"

T.E. 1/16" x 1.7/16" x 22.1/2"

1/8" tip sheet

1/4" sheet

2-3° right
thrust

L.E. sheet
1/16" x 3" x 22½"

A-A SECTION
(HALF SIZE)

3/16" sq. fillet
(shaped)

Shaped block

1/16" sheet top and
bottom of tail over
1/8" sq. frame

1/16" x 1/4" cap strips

19"

5.5/8"

6"

HEADMASTER
Small multi-channel model
By KEN WILLARD
U.S.A.

Balsa block tip

ROOT SECTION (1/4 SIZE)

9"

1/2" x 3/8" L.E.

Spar doubler, extend to 2nd rib from centre

Spar

3/16" Ply

1/8" Ply

Shaped block

SCALE 1:10

18⅛"

3.17/32"

2⅛"

Propeller 6" x 8.11/16"

4¾"

15¾"

Engine: Rhythm 2.5

Span 39½"

2.3/4"

Scale 1:6

F.A.I. RACER
1967 Polish Nats
Winner—SW-24
By VALDEMAR
SALACH
POLAND

1967 First, Tern Hill Easter Meeting
1967 Second Cambridge Rally
1963 First and third, Airport Works Rally
1967 First and second, Wanstead Rally

1967 Second Finchley Gala
1967 First and second
Hayes Rally

WING SECTION
(Half size)

½" sheet

½ oz. tip weight

½" x ½" Bearer

Fuselage centre piece

½" x ⅛" spruce

⅜" x ¾" Balsa

16⅛"

Engine
Oliver Tiger

Ply horn

½" Back block

½" x 1⅛" Spruce

16.9/16"

WARLORD
Nats winning
combat (Duncker)
designed by
HEANOR M.A.C.

8½"

SCALE 1:6

FORCES ON AN OVERCORRECTED MODEL

LIFT

NO. 1 FORCE

MORE THAN 90°

LINES

WEIGHT (AS BEFORE)

No. 2 FORCE

LINE PULL (LARGER THAN BEFORE BECAUSE LIFT FORCE IS NEARER VERTICAL; ALMOST AS LARGE AS CENT. FORCE)

CENT. FORCE (AS BEFORE)

RESULTANT OF CENT. FORCE AND WEIGHT (AS BEFORE)

KEEPING CONTROL LINE TENSION

by G. READ

As we all know, our models only stay under control as long as the lines don't go slack, and we all know that the basis of their staying tight is our old friend centrifugal force. However, anyone who's had lines slack off during a loop strongly suspects that there is a bit more to it than plain centrifugal force. There is more to it, in fact quite a bit.

In fact, line tension is ensured in level flight by two things, aerodynamic reactions and a c.g. position ahead of the line pivot point, which together form the familiar set up we all know in any control line model.

When considering flight with the lines at an angle to the ground, we must consider the effect of other forces which modify things quite a bit. Take the case of a model directly overhead; here, centrifugal force is being opposed by the model weight. These two forces have a definite relationship, so reducing model weight is no help, as this will also reduce centrifugal force. Under these conditions, therefore, aerodynamic reactions such as fin offset must provide a greater proportion of our line tension than in level flight, so we must design accordingly.

It is during violent manoeuvring that we tend to run into trouble, because here further forces appear to affect line tension. We start by realising that all control line manoeuvring consists of upward or downward pitches of varying severity. Invariably an "outward turning" propeller is used; this acts as a gyroscope, and produces what are known as "precessive forces", which are really quite simple. If we look at the nose of the model, we see the propeller

LIFT = WEIGHT

LINE PULL = CENT. FORCE (EQUALS RESULTANT OF ALL 3 FORCES)

WEIGHT = LIFT
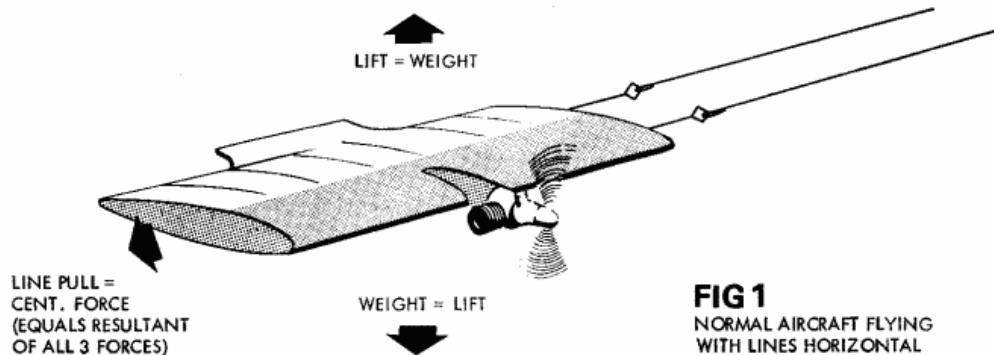
FIG 1

NORMAL AIRCRAFT FLYING WITH LINES HORIZONTAL

turning anticlockwise. If we apply down elevator, the nose goes down, and our precessive force will try to turn the aircraft to port (into the circle). Similarly, if we make the nose rise, it tries to turn to starboard, which is out of the circle. Here is the explanation of the lines slacking off in the second half of a loop: a loop is really an upward pitch followed by a downward pitch, so we have tight lines on the first half, as precession is acting to give an outward turn, but on the second half it is causing a force trying to turn the plane into the circle. Apart from ensuring that our design has enough stability in yaw to resist these forces, we can do nothing about them, except possibly to use the smallest and lightest airscrew we can get away with. It does show, though, that control line jobs have to have a certain amount of stability in yaw, which is possibly not widely known. Of course, in inverted flight, these effects are reversed, the upward pitch being when lines are likely to go slack.

Three simple design rules come out of this:

1. Establish minimum flying speed.
2. Arrange that centrifugal force MINUS model weight is sufficient to maintain line tension.
3. Allow a large safety margin to cover inward turning forces caused by precession.

LINE PULL (RESULTANT OF THE OTHER 3 FORCES – MUCH SMALLER THAN CENT. FORCE)

LIFT (INCLINED INWARD – SO GREATER THAN WEIGHT)

FIG 2
NORMAL AIRCRAFT FLYING HIGH

CENT. FORCE (ALWAYS HORIZONTAL)

WEIGHT (DIRECTLY DOWNWARD)
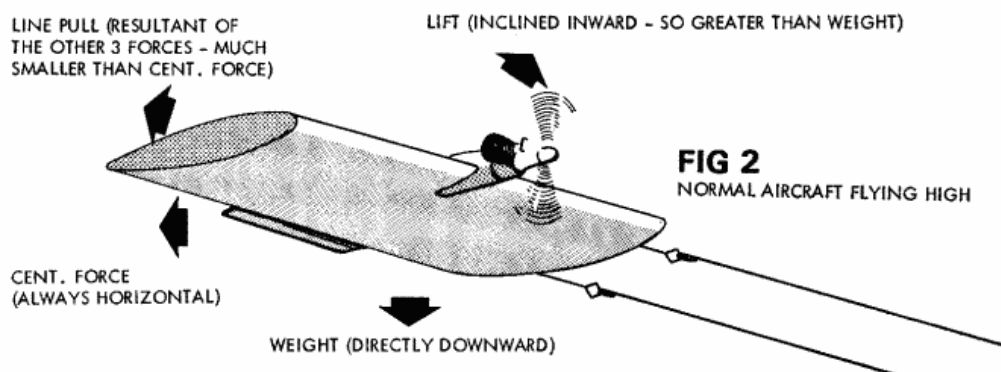
To get a real idea of the size of these forces would need some rather involved maths, so for most of us it's the usual "try and hope" routine, but at least it's nice to know what you're dealing with!

There is, however, a way of increasing line tension which may not be generally known, which is making the model fly "outer wing low". It works like this; in level flight with the lines parallel to the ground, lift equals weight and line pull equals centrifugal force, but as we go higher, and the lines are at an angle to the ground, conditions alter. Line pull becomes less than centrifugal force, and lift becomes greater than weight. This means a greater angle of attack at high line angles, so we get a drag increase. Power is constant, so we fly slower as we go higher, which reduces centrifugal force, so line tension drops.

If, however, we overcorrect for line weight by, for example, using too much tip weight, we'll fly outside wing low, and conditions change to our advantage. In level flight line pull becomes greater than centrifugal force. As we fly higher, lift can be less than before for the same angle between the lines and the ground, so we fly faster, and get a greater line tension. In fact, we get greater

FORCES ON A NORMAL MODEL

LIFT

No. 1 FORCE

90°

LINE PULL (RESULTANT OF No.1 AND No.2;
SMALL COMPARED TO CENT. FORCE

CENT. FORCE

No. 2 FORCE

LINES   WEIGHT

RESULTANT OF CENT. FORCE AND WEIGHT
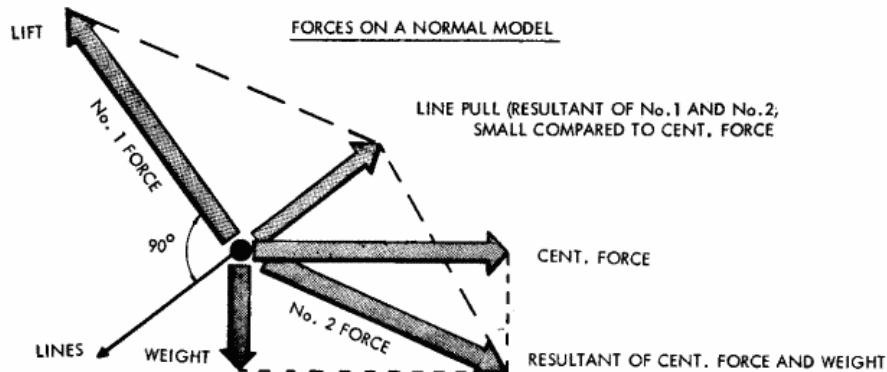
line tension not only from the greater speed, but from the arrangement of forces
we have produced as well. The amount of line pull increase is great in com-
parison with the amount the model has to be overcorrected and fly outer wing
low.

     This was all found out accidentally when a "Manx Cat" biplane combat
job was made and tried. I had given the thing too much tip weight, and it was
about 5° outer wing low when the lines were level with the ground. On trying
the things you usually do with combat wings it was puzzling as to where the
high pull came from, a pull that hardly varied at all no matter what you did.
Being a bit of a slide rule type, I just had to find out why, and eventually came
up with the answer, which proved to be the right one.

     There's not much in this for the chap who flies something really fast, as
then line tension isn't normally any problem, but it's worth using on slow models,
especially when weight and engine size are both small.

LINE PULL (RESULTANT OF THE
OTHER 3 FORCES - NOW LARGER
BECAUSE LIFT FORCE IS NEARER VERTICAL)

LIFT (MORE UPRIGHT THAN BEFORE, SO
NOT SO MUCH GREATER THAN WEIGHT)

SMALL ANGLE
GIVES CONSIDERABLE
PULL INCREASE

CENT. FORCE
(UNCHANGED)

FIG 3
OVERCORRECTED AIRCRAFT

WEIGHT
(DIRECTLY DOWN)

5/8"

1/4" sq.

5/16" sq. hard balsa

C.G.

Batteries   Receiver

5/16" sq. balsa.

.49 – 60
engine
with 5° downthrust

Wheels 4" dia.

46.1/4"

Clark Y
type aerofoil

12.3/4"

8.3/16"

16.3/4"

3.15/16"

1/16" sheet

3.15/16"

3/8" x 1"
L.E.

3.15/16"

STRUMPFMEISTER
Sport R/C design
By "LE PERROQUET"
FRANCE

3.15/16"

7/32" x 3/8"
spars

5/32" T.E.

33.7/8"

3.3/4"

7.3/32"

11.13/16"

11.13/16"

LE MODELE REDUIT D'AVION, FRANCE

+2°30   1¼" dia.   7/8" dia.   Weight 8.7 oz.   4"   -1°

4⅛"   5.29/32"   25.5/8"

38.7/8"

C.G. at 57% chord

Timer

11.13/16"   3¾"   9/16" dia.

1¼"   19¼"

460 sq. in.
(6.55 oz.)

60 sq. in.
(.4233 oz.)

3⅛"

Weight: 15.34 oz.

31½"

83⅜"

6.5/16"

1.9/16"

32"

9.9/16"

A/2 GLIDER
28th 1967 World Champs
By VALDEMARO LENSI
ITALY

10⅛"

5.29/32"   SCALE 1:10

3.9/16"

+3°

1.3/16"d.

1/32" Balsa tube tissue covered

-1°

13"

32.3/32"

9/16"d.

45.3/32"

5.15/16"

28.15/16"

19.5/16"

1.9/16"

3.15/16"

1/16" sq. balsa

1/16 x 3/32" spruce

3/32" x 3/8"

3/16" sq. balsa

1/16" x 1/8" spruce

TAIL

28.5/32"

1/16" sheet balsa

5/64" x 1/4" spruce

20°

1/4" x 5/16" balsa

8 s.w.g. dural tube

WING

1/8" x 3/4" balsa

78.3/16"

2°

10¼"

**THERMAL-
SENSITIVE
A/2 GLIDER**
By G. CATTANEO
and B. MURARI
ITALY

Adjustable
stop for
trim tab

Stop for
rudder

Tatone tick
off timer

4.1/2"

Batteries

Rubber escapement
drive

Switch

Yoke

Amplifier

Escapement relay

Torque rod

Approximate scale inches   0 1   10   20   30

1.9/16"

2.3/8"

21.9/16"

2.7/8"

FUSELAGE SECTION
(NOT TO SCALE)

4"

15.3/4"

4.7/8"

Plywood
facing

1.5/8" 1.5/16" 1.3/16

8"

CHICO
Beginners' glider kit
By AERO-BRAS
BRAZIL

1.3/4"

3"

6"

WING SECTION (HALF SIZE)

3/16" x 3/16"   1/6" x 3/16"

SCALE 1:5

2.1/2"

1/8" x 5/8"

3.9/16"

A

7.3/32"

+2½°

B

3¾"

19/32"

-½°

45°

10.13/16"

B

42.1/8"

79.9/16"

10.5/8"

5.29/32"

1.9/16"

Tow hook detail

Dural
14 s.w.g.

453.3 sq. ins.

72.5 sq. ins.

60%

C.G.

27.3/16"

20.15/32"

A-A SECTION

Ply 1/16"

B-B SECTION

1/8" Ply

1/8" Balsa

5/16"

1"

29.17/32"

3/4"

3/16" Balsa

3/4"

3.9/16"

ABREGO
A/2 glider
By JOSE RAMON PEREZ
SPAIN

Ply 1/16"

TAIL SECTION – HALF SIZE

3/8" × 3/32"

1/8"

3/8" × 3/32"

9.5/8"

1/16" sheet

Pine 1/8 × 1/8"

WING SECTION – HALF SIZE

Pine 1/8 × 1/8"

1/8" × 3/4"

SCALE 1:10

3.9/16"

5.29/32"

5/16" × 5/16"

Pine 1/8" × 3/16"

Steel 14 s.w.g.

1.7/8"
6.7/8"
25.9/32"
2.13/64" 1.2/4"
6.1/2"
1.3/16"
5.3/64"
2.3/16"
4.5/16"
25/64" x 5/16"
38.35/64"

4.3/4"
5/8"

2.3/8"
1.3/16"

Engine: Barbini B.38
Propeller: 6 x 6"

380.64 sq. ins.

113.94 sq. ins.

Weight: 17.637 oz.

8° right

18·1/2"

5.7/8"
6.1/2"

CHARYBDE & SCYLLA
French "monotype" design for 1 c.c. maxi-
mum engines. 2nd in 1967 French Champs.
By G. MATHERAT
GRENOBLE, FRANCE

SCALE 1:10

40.5/32"

ALL SECTIONS HALF SIZE

1/16" sheet
3/32" x 3/16"
3/32" sq.
TAIL SECTION
3/32" x 5/8"

3/64" sheet
3/32" x 3/16"
1/8" x 1/4"
1/8" x 11/16"

10.5/8"

3/32" x 3/16"
1/16" sheet
Piano wire 10 s.w.g.
WING SECTION
TIP
ROOT
3/16" x 3/4"

5.1/2"
6.7/8"
1/8" x 1/4"

A–A
(1:6)

WING SECTION – 1/4 SIZE

C.G. 30-40%

48¼"

B–B
(1:6)

C–C
(1:6)

9.5/8"
2° offset

11¾"

27"

For .40 to .65
engines

63½" wing span

Fuselage is planked
with 3/32" sheet balsa

Wing covered with
1/16" balsa

1.15/16"

8.5/8"

SCALE 1:12

**BELL P-39
AIRACOBRA**
Semi-scale R/C design
By FUJIO ARIGAYA
JAPAN

10"   4.7/8"   24⅜"   4.21/64"

+2°

5⅛"

FAI 3689

1.3/64"

6⅛"

Motor: Pirelli 1 x 6 – 12 strands

3⅜"

3.15/16"

1"

21⅜" dia.
25½" pitch

3.9/16"

39⅜"

1.11/32 dia.   1/32"   1/32"

1½"

16.5/16"

Weights :

Wing   –   35g
Fuselage –   87 + 19g
Tail   –   13g
Rubber   –   40g
Propeller –   71g
          _____
Total   –   265g

HYDRO-WAKE
1967 Italian Champion
By G. CATTANEO

3/64"

7½"

TAIL SECTION
(HALF SIZE)

1/8" sq.   3/64" sq.   1/16" x 3/64"

4.7/8"

3/64" sq   5/64" x 1/16"   1/16" x 3/8"

WING SECTION (HALF SIZE)   5/64" sq.

AR-67, ITALY

11"

1.3/16" dia.

41.5/8"

4"

WING SECTION (TIP)
Not to scale

5.1/2"

TAIL SECTION (HALF SIZE)

90.3 sq. ins.

14.7/8"

420.6 sq. ins.

Not to scale

3.9/16"

Weight:
14.1/2 oz.

29.1/2"

Detail of geodetic wing structure

**EXPERIMENTAL
A/2 GLIDER**
By TINO COSMA
ITALY

Flight
direction

Not to scale

8.5/8"

WING SECTION (ROOT)
(HALF SIZE)

SCALE 1:10

3.1/8"

5.15/16"

12°

Motorstick 1/4"d. 1/64" sheet
Boom 1/4"d. tapered to 1/16"d. 1/100" sheet

1/32" sq.

0°

3"

1/50" sq. outline

1/32" sq. × 3"

4"

Tungsten bracing

75%

1/16"d tapered to 1/32"d.

2 strands Dacron

2" 5.1/8" 5.1/8" 2" 11.1/4" 3"

Picket bracing is 2 strands Dacron

2"

Front view

.5"

x Compression ribs (x)

140 sq. ins.

6.3/4"

All spars 1/32" sq. tapered to 1/50" sq.

14.1/2"

CLASS II AMA INDOOR RECORD HOLDER
FAI 65 cm. class By
HARRY LERMAN
17 min. 46 secs.
U.S.A.

50 sq. ins.

Tail tips have 1/4" washout

8.3/4"

4.1/2"

x

5"

All ribs 1/64" × 1/32"

Prop section

3/16

6"

5/16" arc

Wing airfoil half size

1/64" Outline

1/16d tapering to 1/32d.

Scale 1/8 and 1/2

Propeller 18"d and 30"p.

SIMPLE
MICRO
Tissue covered indoor
By GUY COGNET
A.C. PIERRE TREBOD

3.7/8"   3.3/4"   3.3/4"   6.3/4"

1.3/8"   3/64" sq.

+3°   70% C.G.

3/64" sq.

Bind and cement   1/16" sq.

3/16" × 1/16"

0.5 wire

1.3/16" dia.

1/32" × 3/64

4"

1.3/4"

2° incidence

0.3 mm. alum. hinge for rudder offset

Rear fuse stick 1/8" sq.

1/16" sq.   Motor peg 0.5 mm. wire   1/32" sq.

5.1/2"   Bind and cement   3/16" × 1/16"

Paper tubes rolled and cemented

Bearing from 0.5 aluminium

Prop shaft 0.5 wire

1/32" × 3/64

8"

11.5/8"   3.5/16"

Cover with fine tissue non porous (Bamboo paper)

6.1/4"

N.B. Port wing larger spar than stbd.

2.3/8"
3.3/16"

C/S ribs to this chord
Tip ribs to this chord

1st rib
2nd rib

Ribs cut using template at 1/16" intervals

1 mm. ply template

1/64" Balso sheet

Sketch shows prop spar 'handed' cutaways

3.11/16"

Ribs and template : Half full size

4"

2.3/4"
3.3/4"

4" sheet

Rotation

32°   Shaft

1/8" sq.

Plan view of propeller

Propeller: Half full size

$\frac{3}{8}" \times \frac{1}{2}"$ Bearers

Root gusset

1/32" Ply fuselage sides

L.E. from $\frac{1}{4}"$ sq. spruce + $\frac{1}{4}"$ sq. hard balsa centre with $\frac{3}{8}" \times \frac{1}{4}"$ top and bottom tapering to $\frac{1}{2}"$ wide at tip.

C.G.

Nylon support strips

half size

Hard $\frac{1}{4}"$ T.E. Reinforcement

SECTION B-B

1/8" Ply booms

12.3/4"

$\frac{1}{2}"$ Sheet tip brace

Starboard tip rib $\frac{1}{4}"$ rock hard balsa

$\frac{1}{8}"$ Gusset at centre line

$\frac{1}{8}"$ Gussets top and bottom

Hard $\frac{1}{4}"$ T.E. Reinforcement

1/16" Sheeting

14"

$\frac{1}{8}"$ Gusset

1/16" sheeting

1/2"

9"

A

2" Bellcrank $\frac{3}{8}"$ throw

Two bellcrank mounts $\frac{1}{8}"$ ply

$1\frac{3}{8}"$

15.1/2"

$\frac{1}{8}"$ Ribs

KANIBLE
F.A.I. and S.M.A.E. combat for 2·5 c.c.
By JOHN DIXON
Feltham and Liverpool

B

SCALE 1:6

7.5/16"

TYPICAL RIB (HALF SIZE)

Power pack
solid block

3/16" hardwood dowel All moving
rudder

1/8" ply   1/16" sheet

Stiff spring

1/8" ply   Balsa doubler

1/8" sides

5/32"
dia.
wire
u/c.

Brass lug
silver soldered

7"

39.3/4"

All ribs 3/32" sheet

WING SECTION (NOT TO SCALE)

1/16" sheet   1/16" sheet

3/32" sheet balsa

8.3/4"

Ailerons top wing only   11.1/4"

48"

3/8" O.D. black
rubber tubing
around cockpit edge

Offset

19.1/2"

Super Tigre 60

WING AREA: 880 sq. ins.
POWER: .46 – .60
WEIGHT: 6 lbs dry

FOKKER DR-1
Multi R/C near scale
By BRYCE PETERSEN
U.S.A.

1/4" hard balsa

SCALE 1:10

-0°

+2°30"

3/16" Pylon

C.G ≈ 80%

Fuselage is 1/16" sheet
square box

4⅜" 2¾"

4"
1" 0°

3/32" Fin

2.5/8"

Tick off

Tatone mount

7"

326 sq. ins.

24½"

2"
1"

24½"

1¼" sq.

3½"

Ramrod style Tail Construction

4° Left

14"

SHORTHORN
½A power design
By BILL CHENAULT
Fort Worth, Texas
U.S.A.

2¾"

Weight: 7¼ - 9 oz.
Flight pattern: Right/right

10½" 4¾"

1.1/2"

3½"

7"

1"

1¼" 3½"

Ply pull-up key

3/16" sq.

1/16" sheet

1/16" x 7/16" tapers to 1/16" x 1/8"

TAIL SECTION

5/32" x ¾" T.E.

1/16" x 9/32"

1/16" x 1/8"

Turbulator thread
doped on

⅛" sq.

Basic Rib

¾" T.E. stock

⅛" x ½"

⅛" x 3/16"

Centre rib

1/8" x 1/4"

Casey Hornbeck Rib Mod.

3/16" x ⅜"

1/16" x 1/8" spars

1/32" web

⅛" sq.

1/16" Ribs

3/32" x ¼"

SCALE 1:10

40"

A   Engine timer cut out

+1¼"

$\frac{11}{8}$" Spruce

Fin 1/8" C-grain

B

3.13/64"

D.T.

A

−1°

$\frac{1}{8}$" Ply $\frac{1}{8}$" Spruce

Skid $\frac{1}{8}$" wire epoxy in

62½" (Flat)

B

4¾"

Pattern Left – Left

Wing weight 7.75 ozs.
Tail weight   1.5 oz.
Wing Area   575 sq. ins.

$\frac{3}{8}$"

Tatone radial mount

All ribs 3/32"

3/32" sheet top and bottom

G.15

1/32" Plywood over break

SCALE 1:10 & half size

$\frac{1}{8}$" sq. spruce

Fuselage weight 16.6 oz. (complete)

1¼"

FLY-OPIC
Top Canadian F.A.I. power
design 1967
By DON ELLIOTT
Vancouver, B.C.

Cover 1/16" sheet top and bottom

24"

19"

SECTION A – A (Half size)

3/16" Sheet tips

5½"

12¼"

$\frac{1}{8}$" Sheet

SECTION B – B (Half size)

$\frac{1}{8}$" Sheet sides

$\frac{1}{4}$" Pylon

$\frac{1}{8}$" sq. in corners

All ribs 1/16" light C-grain

TAIL SECTION (Half size)

6¼"

1/16" x 3/16" cap strip (bottom only)

$\frac{1}{8}$" x $\frac{3}{8}$"

1/16 x 3/8"

3/4 x 3/16"

7¾"

3/8" x 1/4" spruce

3/8" sq.

L.E. 3/32 x 7/8" sheet

WING SECTION (Half size)

L.E. $\frac{3}{8}$" x 5/16"

3/32" x ¼" Diags.   ¼" x $\frac{1}{8}$" Spruce   1/16" Gusset

T.E. 3/16" x 1"

CANADA

Escapement

Engine: Cox Tee Dee .51
(0.8 c.)

Battery box

B

1/8" dia.

4.5/8"

Ply 1/4"

1/64" Ply
over 1/8" balsa sheet
both sides and below

Webra Picco receiver

1/8" sheet

4.7/8"

2½"

B

30½"

SECTION B-B (1/4 FULL SIZE)

1/8" sheet

5/32" sq. pine

1/64" Ply

25/64"

18¼"

1½"

59°

Pine 5/32" × 3/8"

1/8" sq. pine
on L.E.

Nylon band

11"

Ply 1/8"

3.15/16"

Tank
20 cc. capacity

A

3.15/16"

A

4¼"

2⅜"

BIG BOSS
Mini R/C speed with
124 mph claim. By
ING F. W. WULLNER
GERMANY

5/16"

No dihedral on wing

23½"

A-A SECTION (HALF SIZE)

Pine 5/32" sq.
(sanded)

Sheet 5/32 balsa

C.G 85%

44.15/16"

Fibreglass cowl

Mod. Tatone

Finger grip for launching

D/T Fuse

3/8" Fin

Autorudder, left climb, right glide

1/4" Ply

Solid balsa laminations

B

B

A

A

Aluminium

5/32"

5° down

3/8" Fin

64½" (Flat)

7"

1½"

7" x 3½" Cox prop

8.5/16"

7" x 3½" Cox nylon prop

JAP tissue cover

ST G.15 engine

24"

28"

NEO NEMESIS
F.A.I. power design
By BILL GIESKING
"Magnificent Mountain Men"
Denver, Colorado

6¼"

17¾"

14½"

1⅜"

6⅞"

A – A

A – A SECTION
(Half size)

3/16"

¼"

B – B SECTION
(Half size)

⅛"

¼"

Laminated spar and L.E.

7.9/32"

1½"

⅛" sq.

Recommended outline

.018 wire

0.25 x 0.45 hard

1/20" Rib

3/32" hard ribs

1/20" thin to 1/32" tip

1/16" x 5/8" kicker

⅛" x ¼"

TAIL SECTION (Half size)

⅛" x 1½"

.018 wire

1/16" Riblet

1/16" Reinforce laminations

WING SECTION (Half size)

⅛" hard rib

1/16" cover

3/16" x 2"

5/16" x 5/8"

1/16" wire (12" top, 6" bottom)

(Chordwise)

Recommend ⅛"

SCATTER, U.S.A.

Some of the supplies used in working with epoxy. Two types of applicators are
in the foreground with the Binks air brush on the right.

*A feature extolling the virtues of new finishing and construction methods in the U.S.A., soon
to reach Europe.*

HOW TO USE EPOXY

by J. A. KLOTH

THE various epoxy compounds now on the market are a great breakthrough for
the model builder. Taking advantage of them often requires new techniques
and, in some cases, completely different approaches to construction. Some of the
basic advantages of epoxy are: greater strength of joints; warp-free structures;
epoxy docs not shrink while hardening; lighter weight of structures, *through
superior strength*; easier and more durable finishes; reduced cost of structure and
finish as *a little* epoxy *goes a long way*; stronger and more durable structures
when combined with glass cloth, nylon or silk; faster construction with shorter
"drying" times; and, easier and faster repairs.

Epoxies are sold in a variety of types and, of course, best results are ex-
perienced when the types are matched to the job they do best. I presently keep
four different types on hand. Formulas I and II by Hobby Poxy are the basic
types and cover most needs. These are both packaged to be mixed in a 1 to 1
ratio. Formula I instructions say to batch it 2 to 1 but further on state that this is
automatically accomplished by squeezing out and mixing equal length. Formula
II is mixed truly using equal parts. Sig markets an epoxy which is available in
several sizes, with cost ranging from 98 cents to $4.98. This type gives a "pot
life" or usable working time about half way between the 10 minutes of Formula
I and the 30 minutes of Formula II Hobby Poxy. It also mixes thinner than
Hobby Poxy and so penetrates deeper into the pores of the wood, resulting in a
better bond between pieces. The setting time also falls between that of Formulas
I and II. Formula I takes about 1 hour to harden fully, Sig about $1\frac{1}{2}$ hours and
Formula II 3 or 4 hours. The other type that I use is sold by Edar Plastics for
use primarily on boats. It is less expensive than Sig and Hobby Poxy and comes
in a variety of pot life and setting times. The primary uses of Sig and Formula I
are for construction, while the other two are for finishing and fibreglassing.

Another type used with good success is called Minut-Grip. This has a pot life of about 1 minute, cures hard in less than 15 minutes, and is excellent for field repairs.

Pot life and setting times are always approximate. Temperature and humidity cause variations. All types can be speeded by applying heat, while high humidity tends to slow it down. For best results, the temperature should be above 70° and the humidity below 70%. This also applies to epoxy paints.

Epoxy needs a slightly rough surface in order to bond properly. It will bond almost all materials together so long as the surfaces are not smooth. Metal to metal or metal to wood joints are better when reinforced with glass cloth or nylon. Attaching a wire landing gear to a profile fuselage can be rigidly reinforced by encircling the two struts and intervening wood with light soft wire. Fill in and around with epoxy and it will not come apart. Glass cloth over this joint will resist the best of explosives or even any of my normal landings.

Building structures requires a different approach than when using regular model cements. All pieces to be assembled are cut and approximately positioned. Do all gluing at one time. Mix small batches so that it is still rather thin when the batch is exhausted. This gives better penetration into the pores of the wood and, therefore, better joints. Small unwaxed paper plates and round toothpicks are ideal for mixing small batches and applying in tight corners. Use small amounts since less than the usual amount of model cement is needed, and any splashed over on to surfaces to be sanded will be difficult to remove later. It is best to have a slight pressure between pieces being bonded since it too causes deeper penetration and better joints. For structures built in the air, parts should be located and held in place with pins, clamps, rubber bands, tape or any other suitable means. Pins should be twisted before pulling out to break loose the bond between wood and pin, otherwise some of the surrounding structure might break. H.L.G. fuselages, solid balsa wings and tails and even whole structures can be repaired by coating the broken ends with epoxy and forcing the parts back together. The resultant joint is stronger than the material being joined. Although it is better to reinforce this type with glass cloth or nylon, this sometimes is not feasible and the bare joints are adequate. Building time can be reduced on new projects by planning the construction to take advantage of the shorter setting time of epoxy. I originally planned the whole of an evening's work so that the last half hour was spent gluing but, with greater experience, ways were found to make joints and do additional shaping after allowing 1 hour for setting time.

Epoxy eliminates the long delays required for solvents in normal model cements to evaporate. Warp-prone structures such as Free Flight wings and tails and stunt model wings can be removed from the building board or jig much sooner and construction can be resumed with a greater degree of confidence that they will remain true. Mixing a new batch over the residue of a prior batch will accelerate the hardening of the new batch.

At this point, let's concentrate on the removal of epoxy from hands, fingers, clothes and tools. Once epoxy is set, it is almost impossible to dislodge. Never wear good clothes when using it and, whenever possible, keep a jar of Epoxy Cleaner or Hobby Poxy Thinner on your workbench to dip into with tools or paper towels for removal of excess epoxy. Hands and fingers are best cleaned by first using one of these solvents on a paper towel. Keep seeking an unused spot on the towel to prevent spreading the epoxy over a greater area. Scrub well with soap and water and follow this with an application of a high lanolin type hand lotion. These solvents have an extreme drying property and
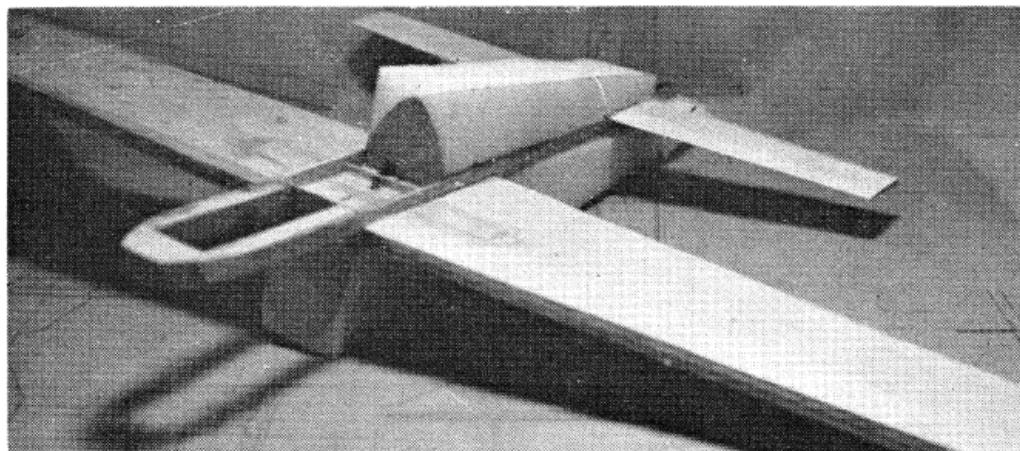
Styrofoam blocks glued to the frame of the author's unique
team racer construction 1/32 plywood bulkheads used as
shaping guides. Plans of model are beneath it.

the lanolin helps neutralise the epoxy still in your pores and under your finger-
nails. If not completely removed, epoxy will cause "skin reinforced epoxy" and
rough hands. Great care should be exercised to reduce epoxy contact with skin
to a minimum.

The "Easy-fill" method as propounded by the Pettit Company is a
wonderful way of finishing. However, some gaps are left in their processes that I
will attempt to fill, based on my experience.

It is absolutely necessary to force the epoxy into the pores of the wood
during the first coating of exterior finishes. Use a relatively stiff bladed, angled
handle artist's pallet knife. Start with small batches and work the epoxy into the
wood just as you would apply butter or jam to a slice of bread or toast. If a
batch starts to set, discard it and mix a new batch. Use small unwaxed paper cups
and discard them after each batch. These cups are inexpensive and a second
batch mixed in the same cup will start setting immediately, drastically reducing
the pot life. Start with no more than $\frac{1}{2}$ teaspoon of each of the two parts. Gradu-
ate to full teaspoons of each after experience is gained. A teaspoon of each can be
handled comfortably. The Sig epoxy with its thinner consistency works best for
the first coat. Use even smaller batches of this, since it has a shorter pot life. I
personally like it better because the wood absorbs it more easily and it is not
necessary to exert as much pressure when buttering. Good penetration of the
first coat will prevent chunks breaking out of the surface, leaving bare wood,
when scraping or filing later on. It is practically impossible to refill these areas.
Do any necessary reinforcing with glass cloth or nylon. Spread on a layer of
Formula II or "boat" epoxy, lay the reinforcing material over and work the
epoxy well into the pores. The reinforcing material will show up transparent
when it is properly filled. Be sure all air bubbles are worked out, so that they will
not show up later as pin holes. Attempt to feather out the epoxy around the
edges of the reinforcing material to provide a smooth contour. If using more
than one layer of reinforcing material, cut it smaller or larger than the previous
layers to eliminate abrupt changes in thickness. Follow with an overall coat of
epoxy, attempting to keep it as smooth as possible. Two coats are minimum,
but it is sometimes necessary to use more to build up contours, sanding to proper
shape later. Let the epoxy set up before attacking it again. Later, when more

experience is gained, you will find that certain areas can be shaped while the epoxy is still slightly soft, eliminating tedious filing or sanding.

To remove high spots use a wood rasp, metal files, Nos. 50 and 80 grit Aluminium Oxide Open-Coat Production paper. Care must be exercised to avoid damage to parts like leading and trailing edges. After the high spots are eliminated, change to No. 100 grit Garnet paper to roughen the whole surface. Sanding epoxy dry is normally tedious work. Attack it with 150 or 180 grit wet or dry paper used wet. This has several advantages. The paper lasts considerably longer, the "dust" ends up either on the paper towel used to wipe with or in the water dish, and the whole job goes much faster. Use caution because it cuts so fast you may go too far and expose bare wood. Seal the whole model before using the wet sandpaper or use extreme care to avoid wetting any bare wood. When all surfaces are reasonably smooth, switch to 320 grit paper, again wet, and bring the surface to an ideal smoothness. Brush on one coat of Pettit "Stuff" thinned to brushing consistency to accomplish a final filling. Sand again with the 180 and then the 320 wet paper. Sand off almost all of the stuff, leaving only what is necessary to provide a smooth surface. Wash off the sanding residue and set aside to dry overnight. After the model is completely dry, lightly sand with dry 320 paper. Wipe thoroughly with a tack rag and you are ready to paint.

Fillets can be formed in a variety of ways after the first coat of epoxy is applied. "Stuff", Plastic Balsa, epoxy batches about to set, glass cloth, fibreglass matt Cloth or matt cut into tiny pieces, or other filler materials, can be stirred into the batch, to thicken the consistency so that smooth fillets may be applied without running off before setting. Stuff and Plastic Balsa must be allowed to set while their solvents evaporate. This usually ranges up to 72 hours. Stuff must be applied in thin coats for it to harden throughly.

Shaping fillets also has a variety of different methods often depending upon their locations. Wrapping coarse sandpaper around dowels or coarse rat-tail files is good for preliminary shaping. Scraping is a good way to develop a

Model ready for fibreglassing. Note nylon line bulkheads and stringers, wire skids around wheel and under nose, glass cloth reinforcing wing-fuselage joint and around wing tip at skid.
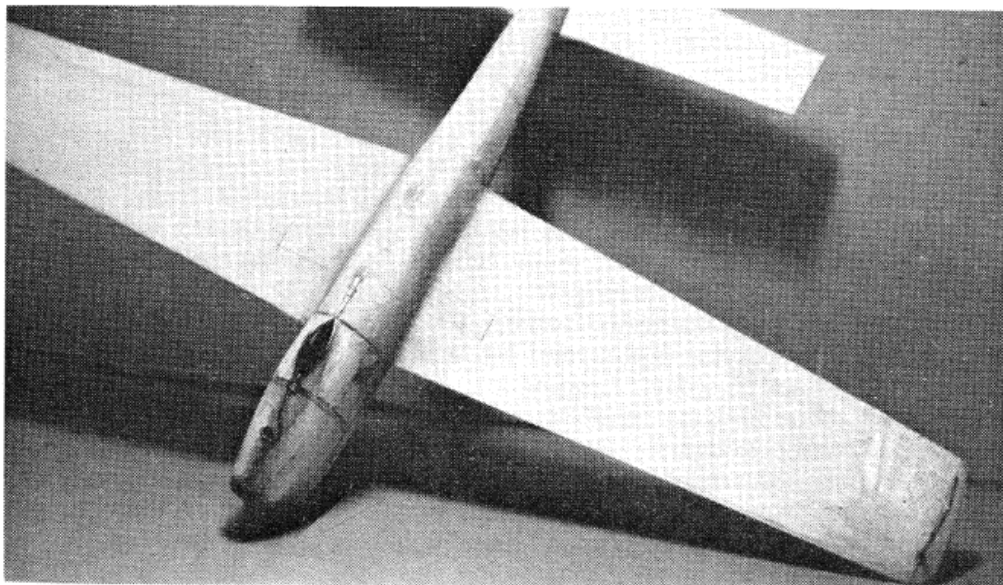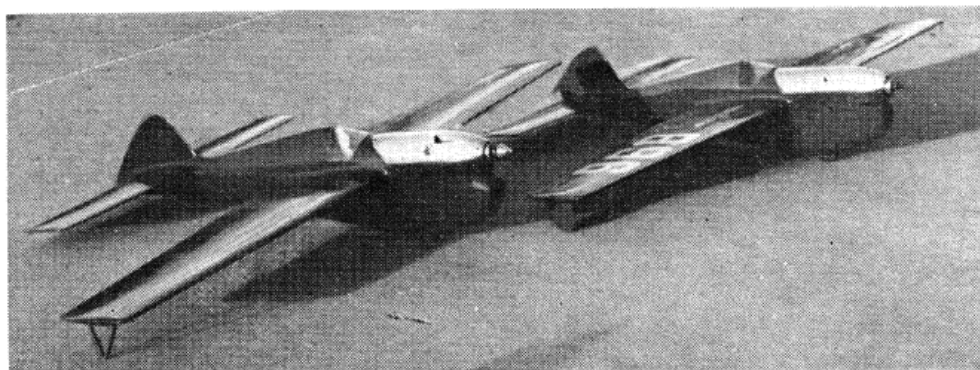
Two styrofoam and fibreglass bodied team racers ready to go flying. Near one has ETA Mk II, far one Supertigre G 20D. Both have recorded wins in local meets in Florida, U.S.A.

smooth contour. I file old Xacto knife blades or single edge razor blades to appropriate shapes and resharpen them with honing stones. Always try to keep the scraper perpendicular to the surface. Be sure you have no sharp corners on the scraper and avoid gouging into the surface which requires tedious refilling with epoxy. Finish up with the wet sandpaper just as on other surfaces. Valleys adjacent to fillets can be avoided by putting a strip of masking tape along the edges of the fillets to protect the surfaces. Sanding will erode the tape and it should be replaced when it gets too thin or damaged to protect the surface beneath.

Sanding with paper finer than 320 grit does not improve the final finish and may even be harmful. Epoxy paint needs a slight roughness for good bond. The paint acts like a filler/sealer and will fill these small marks, making the final finish like glass.

Painting with epoxy is best accomplished by spraying. Several brushed on finishes were tested but final appearances were less than desired. Wet sanding with 400 or 600 grit paper improved things but the finish still wasn't satisfactory. Some overtime pay came my way at an opportune time and allowed the purchase of a Binks No. 2 Air Brush and Compressor. This completely solved my finishing problems and to my way of thinking was well worth the cash outlay. Other types of small spray guns are available which will do the job equally well and at less cost.

Premix the two components of the paint at least 1 hour before using. Be sure to stir the colour component well before mixing to prevent pigments from settling out. Use unwaxed paper cups for small batches or small jars for larger planes. If the excess paint will be used within a few days or weeks, store the unused batches in the freezer. Some will be good several months later, but a couple of weeks is about the longest.

The mixed paint is thinned between 50–50 and 65–35 with thinner before spraying. Actual spraying is not hard but a little practice helps. Large areas require even passes of spray. Leading and trailing edges require extra paint, taking about twice as many passes as a flat area. It is not necessary to apply several coats. Mix enough for the entire job and continue spraying until good coverage is obtained. Apply a base coat of silver under the lighter colours in order to get uniform dense coverage. This is not necessary under the darker colours but it appears that red is not a "dark" colour in epoxy. The temperature and humidity again are important and the temperature should be above 65°F.

These factors affect the curing of the paint. High humidity will cause other problems like fouling of the jet and occasional blasts of water. The water causes little bubbles in the finish which can be quite exasperating. This is a particular problem when you live in Florida where a humidity reading of 50% is considered very low. Sprayed epoxy sets faster than brushed. Planes can be sprayed in the morning and flown in the afternoon. Setting in the hot sun helps. Brushed epoxy paint takes at least 24 hours to properly set. Hang the model in a dust-free area while it sets. In most cases, however, any dust that shows was on the plane before painting. Vacuum the plane well first and then go over it very carefully and thoroughly with a tack rag just before spraying. I have received many compliments on the finishes of my planes. Questioners of how I do it are surprised at how little effort and time is required compared to the older methods of finishing.

The fuselage of my new FAI Team Racer design is based on $\frac{1}{16} \times \frac{1}{2}$ balsa crutch members cemented to $\frac{1}{2}$ in. thick basswood blocks at the front. Several $\frac{1}{32}$ plywood bulkheads are glued in place. One forms the back of the cockpit, each one fore and aft of the recessed wheel compartment and several decks and walls to form the cooling air inlet and outlet ducts. The remainder of the fuselage is formed by approximately shaped styrofoam blocks epoxied in place. The styrofoam used is the small grain open cell type used for table decorations or Christmas tree ornaments. This is considerably cheaper than balsa and shapes faster and more easily when using the normal carving and sanding procedures. Ribs and stringers can be appropriately located and built in by grooving the foam and laying in heavy strings of glass cloth. Coat one section at a time with Formula II or boat epoxy. Lay several layers of glass cloth over it being sure to work out the air bubbles and pockets. Use 6 oz. glass cloth for the inner layers and finish up with 3 oz. cloth. After all the areas are covered, let it set and then finish it as in the Easy-Fill method. I embed $\frac{1}{16}$ in. and $\frac{3}{32}$ in. dia. music wire in appropriate spots to act as skids on Team Racers, since these take most of the beatings on landings. The engine and fuel tank compartments should be well sealed to keep fuel from getting back into the styrofoam. This is done by appropriate bulkhead location and well sealed joints. Fuel will dissolve styrofoam and leave a spongy structure. This will not be as much of a problem if you have included the extra stringers and bulkheads of string.

Cowls and other portions of structure may be shaped of styrofoam, glassfibre over this foam and then etch the styrofoam out with Acetone or thinner. Wire or string reinforcing can be enclosed in the glassfibre for extra strength. It isn't necessary to fabricate a mould to make up one of a kind parts. You can enjoy the strength and durability of glassfibre without all the excess work. Remember to shape the styrofoam undersize by the thickness of glassfibre you plan.

The glassfibre styrofoam structure is a simple, quick and inexpensive method of fabrication. Balsa is far more expensive than styrofoam and you eliminate the hollowing out of a balsa block structure. The foam is also shaped more easily than balsa.

I have barely scratched the surface of the epoxy world. Try it out and do some experimenting on your own. Follow the basic rules and you can't go wrong. It's the greatest thing to hit model building since the Glo-Plug.

$+2\frac{1}{2}°$

70% C.G.

$2\frac{3}{8}"$

8 Strands
Pirelli 6 x 1

4.5/16"

0°

$1\frac{1}{4}"$ dia.

1.3/16"

4.5/16"

25/32"

$17\frac{3}{4}"$

1"

$6\frac{1}{8}"$

21.11/16"

15"

4"

11.13/16"

1.3/16"

3"

COUPE D'HIVER
4th 1964, 3rd 1965, 23rd 1967, 9th 1968
in MRA International
By **BERNARD RAULIN**
France

7.7/8"

4.5/16"

13/64" x 15/64"
L.E.

5/64" sq.

5/64" x 5/32"

WING SECTION (Full size)

1/8 x 3/8" TE

5/64" sq.

Approx TAIL SECTION (Half size)

FRANCE

1" Dia.   +3°

Balsa 1/32"

2¾"

4⅛"

25/64" Dia

13"

31½"

3.5/32"

15½" Dia. Prop.

Motor: 6 strands 6 mm Pirelli
40 seconds run

14¼"

TAIL AREA 49.29 sq. in.

1"

15¾"

1.3/16"

1"

11.13/16"

COLIBRI
Coupe D'Hiver
2nd 1968 International
By ROBERTO GIOLITTO
Italy

3.5/32"

WING AREA 76.42 sq. in.
(approx.)

7⅞"

FUSELAGE
CROSS SECTION
(Half size)

TOTAL WEIGHT 2.89 oz.

SCALE 1/8th

4.5/16"

5/64"sq.

WING SECTION (Full size)

⅛ x 7/16" T.E.

L.E. ⅛ x 13/64"

5/64" x 5/32"

5/64"sq.

TAIL SECTION (Full size)

⅛" x ⅝" T.E.

L.E. ⅛" x 5/32"

3.7/8"

1.3/32"

1.3/8"

+3°

13/16"

19/32"

2.3/8"

3/32"

1"

0°

3.1/32"

1.27/32"

Araldite shaft to prop

Bead bearing

1/64" x 1/64"

ACTUAL SIZE

RIESENMUCKE
Indoor flysize model
By OTTO HOFFER
Flying weight 0·00338 oz!
Frame weight 0·0020456 oz!

Template length

2.1/4"

Overall span

25/32"

5

15°

11/32"

4

4"

13/16"

110°

3

10°

2.3/8"

Pinning points for assembly of
outline around template

20°

10°

1/16"

1.1/8"

9/16"

1/16"

38 s.w.g. steel wire hook
Araldited

Propeller

9/16"

blade profile

1/64" x 1/64"

38 s.w.g. steel
wire hook

9/32"

3/16"

5/32"

20% Collodion   *8% Castor Oil*

RIESENMÜCKE

Mighty Midge

Microfilm Miniature
by Otto Hoffer

Switzerland

Microfilm Mixture:

Clear Nitro lacquer	55%
Collodion	20%
Amyl Acetate	17%
Castor Oil	8%
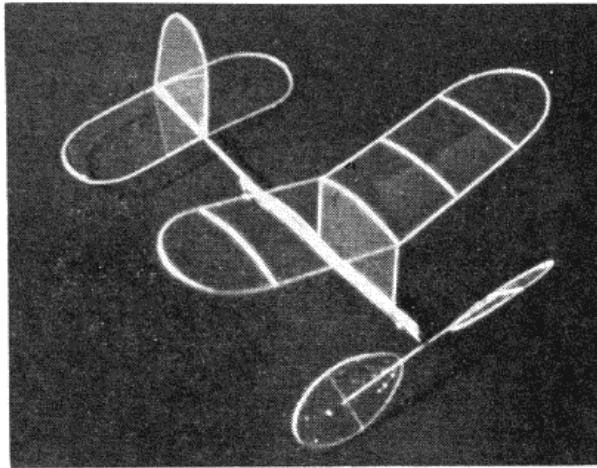
Making the Model is a test of skills. Weight ready to fly is *under 1/10th gram* including rubber motor ½ mm. square × 64 mm. long (hard to get! use shirring from haberdasher's with cotton covering removed). Drawing full size on plan. Note that prop is also microfilm covered. To cover wings and prop blade pour mixture on still water in bowl. Make a light wire lifting frame slightly larger than half span of wing. Place under microfilm floating on bowl. Lift and lower on to wing or other surface. That's it! Note to beginners: Try again and again if need be . . . very rewarding in the end.