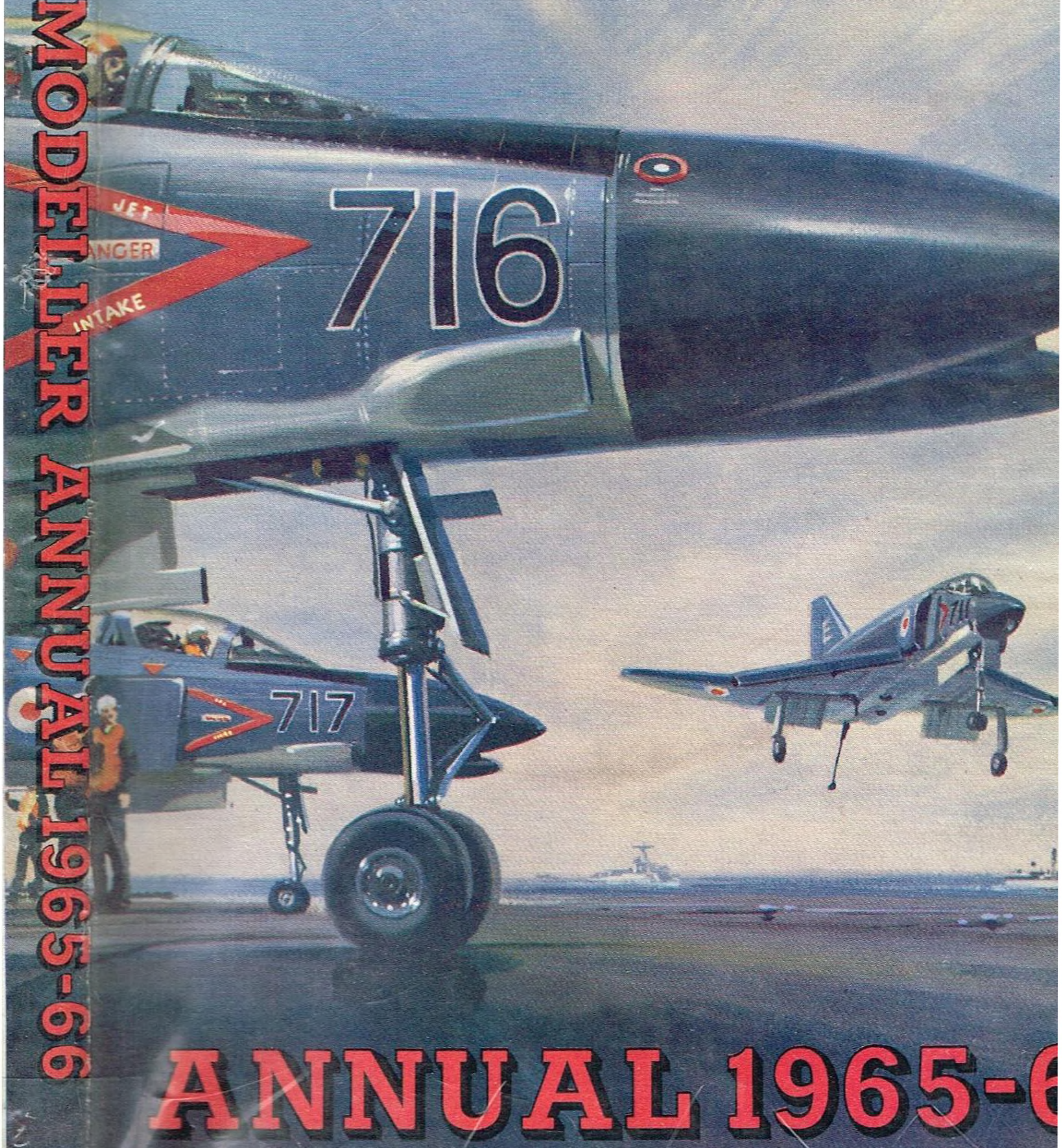
AERO MODELLER



ANNUAL 1965-6

AERO MODELLER ANNUAL 1965-66

AEROMODELLER ANNUAL 1965-66

AEROMODELLER ANNUAL 1965-66 once more sports an attractive Laurie Bagley dustjacket and cover featuring the McDonnell Phantom on an Aircraft Carrier in full colour. Contents have moved more towards special articles in this edition and amongst them we can strongly recommend Doug McHard's Engine Collecting masterpiece "History in the Making"; a curious oddity will be enjoyed in Water Rockets—yes! they really do go! Ever more popular radio control has a Basic Single Channel Control article. The design-theory fans have Modern Structures, Understanding Airfoil Data, Nomograms and Drag to keep them happy. More practical people will like Laminated Wakefield Props. More on the Continental "Standard" Construction method and Why Not Pushers? Ron Moulton presents a survey of Beginners' Models throughout the World.

A selection of model plans from the world's best published includes sailplanes, radio control designs, team racers, stunt and combat planes, Winter Cup models, Wakefields, in fact something of nearly everything, not forgetting a Cox-powered model Airship!

Two of the plans have been covered in some detail and full size drawings are offered through our plans service. The unusual "Dragonette" will be—we are confident—one of 1966's most seen flying models.

Statistical matter has always been an ANNUAL attraction. We provide results of all British S.M.A.E. events up to closing for press, and carry over balance from 1964; in addition pictures and results of World Championships are recorded, including 1965 Free Flight events. The new engines of the year are given a "potted" analysis.

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10/6

AEROMODELLER ANNUAL 1965-66

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

Compiled and Edited by
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and
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AEROMODELLER ANNUAL 1965-66

acknowledges with thanks the work of friends and contributors in this volume and the cream of the world's periodical and privately circulated literature which has been studied to provide this year's offering.

In particular we would thank MODELE MAGAZINE of France; R/C MODELER, AMERICAN MODELER, MODEL AIRPLANE NEWS of U.S.A.; ILMAILU of Finland; RASSEGNA DI MODELLISMO, of Italy; FLUG MODELL-TECHNIK of Germany; RADIO CONTROL TECHNIQUE of Japan . . . and our many correspondents throughout the world.

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CONTENTS

INTRODUCTION

Astronaught McDivitt and Gemini model

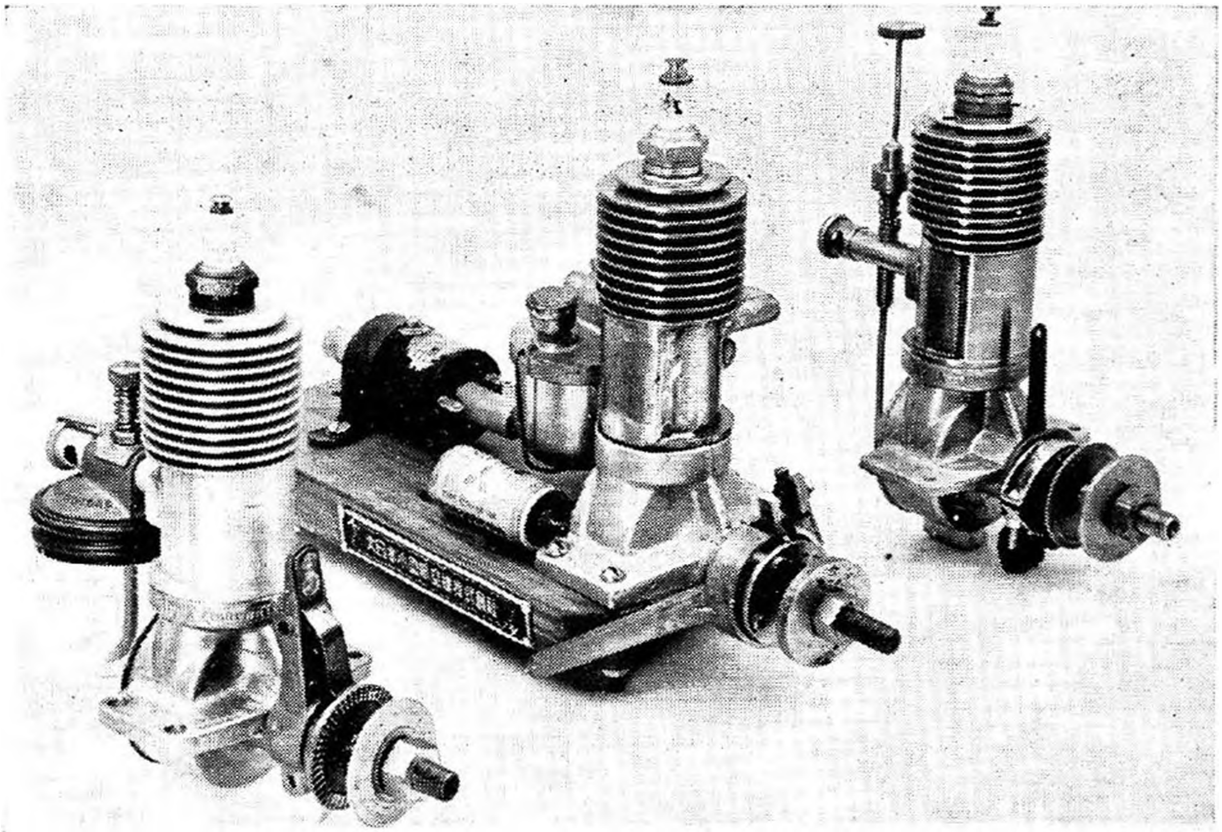
1965 has been very much a "Northerly" year. The British National Championships were held at the invitation of Squadron Leader W. A. Drinkell, A.F.C., D.F.C., R.A.F. close by Hadrian's historic wall across the extreme North of England at Newcastle. As an experiment it proved to be a great success. For the first time, aeromodellers were offered on-station accommodation, refreshments and entertainment facilities. Campers could find no fault and even the wind was kindness itself. It was a most happy meeting and one which sets a high standard for the future.

Then, in July, we journeyed to Finland. At Kauhava, on a latitude north of the Faroes, or the Yukon and Hudson Bay, a memorable World Championships concluded with the most exciting climax yet in the famous Wakefield contest. Young Dane Thomas Koster snatched victory from the seemingly sure grasp of the U.S.S.R.'s V. Matveev with scant seconds of the 8th round to spare, so providing further honours for the Scandinavians. Sweden scored a perfect 2700 seconds to gain the Wakefield team prize. Italy and the U.S.A. achieved the same in Power to tie in perfection, and, *three rousing cheers*—our British tacticians of the towlines, Messrs. O'Donnell, Tipper and Young, brought home the honour of being leading nation in Glider. Four of the nine British competitors were in the fly-offs.

This too, was the year of the Silencers,—and M.A.P. insurance. Each is slowly making its mark in protecting the future of our hobby whatever may have been said in those long hours of debate on the clubroom floors! It is also the year of scale modelling. When a minor event on May 9th was forced by circumstances to become a hangar-sheltered impromptu display it became a prototype of style for scale meetings that will surely be repeated. Support for the "bring and show" rally was tremendous, allowing all participants to reflect in the joys of mutual admiration of their models.

In other spheres, scale models have played a big part in the world of commerce. Radio controlled for film sequences, pre-programmed for dropping from helicopters to test the Concord and, as we were able to see in person at Paris during the Salon Aeronautique, used by Gemini astronauts to recall their multi-orbit mission. Colonel James McDivitt shows in our photo how he allowed his Gemini Spacecraft to drift in order to keep Colonel White in view during his spacewalk. The model of the capsule was essential to his lecture and reminds us of the booming interest in Model Rocketry that abounds in Europe. Alas our own Explosives Act precludes such activity in Great Britain but this volume contains an alternative suggestion.

For the cover theme artist Laurence Bagley illustrates the McDonnell F.4 Phantom II as intended for the Fleet Air Arm and with little licence predicts a colour scheme that will become familiar in the approaching year. With tip dihedral on the wing, anhedral on the tail and the general impression of having been designed upside down, the Phantom, like many a power model, belies its appearance with a shattering performance.



International influence. Two 9·9cc Brown Juniors flanking a Japanese "Inoue-Shiki" of 1942. The Brown—father of all commercial engines—was widely copied—a tribute to a basically sound design that remained in production almost unchanged from 1937 to 1946. Left above is the last of the line—a model "D" with transparent tank, cadmium plated cylinder and upright timer points. On the right is a 1937 Model "B" which originally came with a cylindrical metal tank. Between them, the interesting Japanese engine, although owing much to the Brown, nevertheless exhibits much original thought. The timer points are outside what looks like a dummy all-enclosed timer case. Notice the Japanese name plate on the wooden mounting block, and the Japanese spark plug.

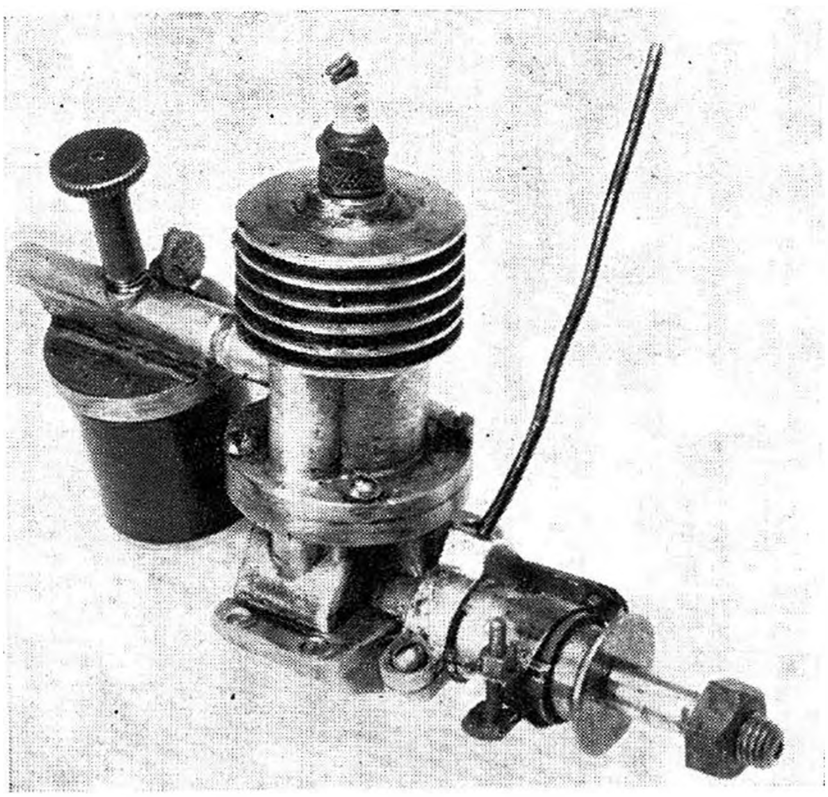
HISTORY IN THE MAKING

By Doug McHard . . . sometime professional model maker . . . R.A.F. Sergeant Instructor in Photography . . . Chief Photographer to M.A.P. Ltd. . . . Assistant Editor of "Model Aircraft" . . . Editor of "Triang Magazine" . . . popular TV broadcaster on model subjects . . . now Editor of "Meccano Magazine" and in passing, just about the cleverest manipulator of a soldering iron we know!

SCRAP MERCHANTS; Junkies; Old Retainers; call us what you will but we belong to an expanding group of enthusiasts who collect old model aircraft engines.

The reasons behind the rapidly increasing popularity of this pursuit are difficult to define, but one *could* say that it reflects the maturity of our hobby, it being now old enough to have its own historical relics. On the other hand, the inevitable pessimist might look upon it as a sign of decay, with the collections providing silent evidence of a once noisesome and bustling virility, now dead.

Perhaps both theories contain an element of truth, for although the helter-skelter post-war boom is long gone, model engine development continues at a high pitch. The ingenious, comic and sometimes "impossible" design stages that led up to today's ultra-efficient model power units have provided the inspiration and hardware for today's many fine engine collections.

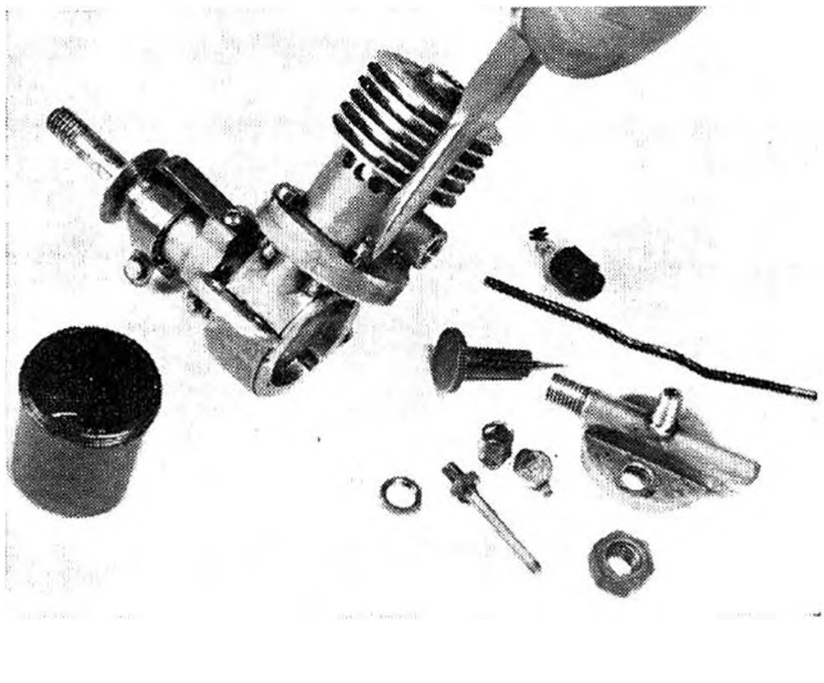


Look as this poor old 3·5 c.c. "Atlas"—encrusted with dirt, mixed screws (cheese and round head all chewed up), broken spark plug, oft bent advance/retard arm, rusty prop nut. But it's ideal collector's material because, although tatty, there's nothing that can't be restored to its original condition, and no missing parts, other than the prop washer.

The 'Atlas" big end is screwed to the crank web. Always use a screwdriver of the correct size when dealing with any screws. Grind the blade tip to a square section to fit the slot exactly. Tapered blades burr screws.

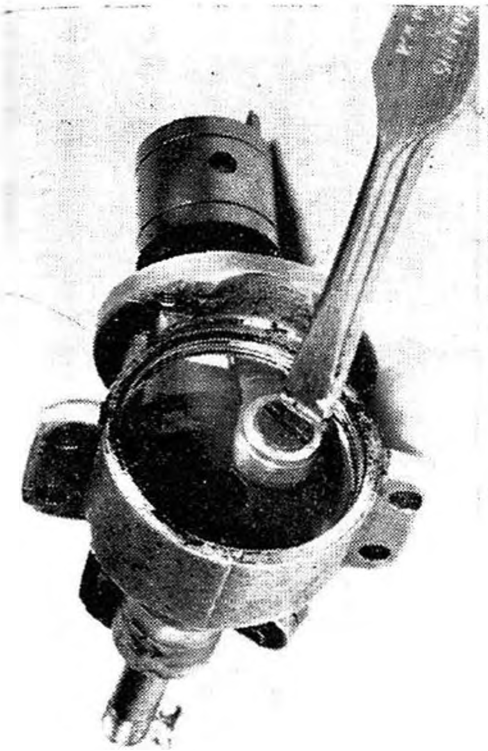
Although the first signs of engine collecting emerging as a hobby in its own right only became evident about six years ago, the enthusiasm, particularly of American collectors, is tremendous, and still increasing.

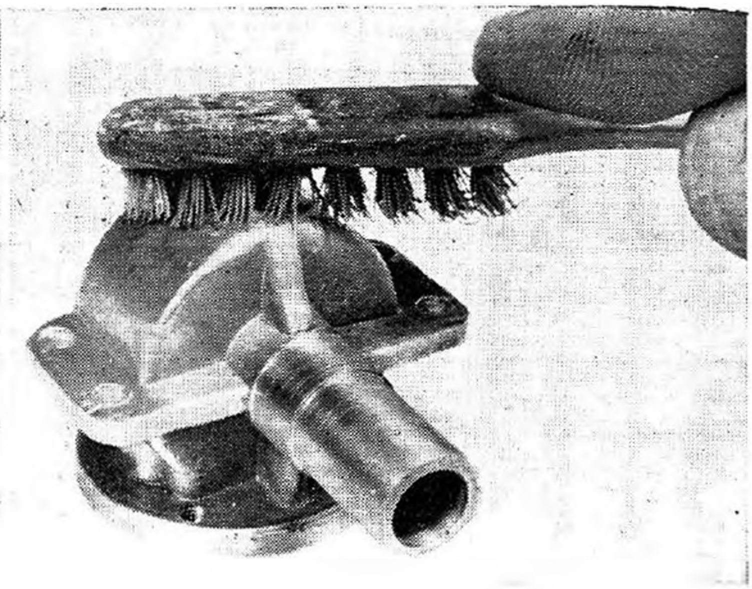
Already there is in America a well-established bi-monthly magazine—*The Engine Collector's Journal*, and a "Model Engine Collector's Association". Their research projects into the often fascinating development histories of both obscure and well-known engines are pursued with the enthusiasm of an archaeologist at a "dig". The obscure engines and facts unearthed, and design relationships revealed, make for an almost James Bond excitement—come to think of it, there *was* a James engine—11 c.c. made by the "Rice" of "Ohlsson & Rice" in 1938, and a Bond too—a bit smaller dating from 1946! Wonder if Ian Fleming was a collector?



First step is carefully to dismantle everything, accurately noting what goes where! Screws are probably standard items obtainable from engineers' supply or tool stores and damaged ones should be replaced with new ones wherever possible.

Sketch any parts that could be reassembled incorrectly. Position of piston baffle, bypass and exhaust sides. All metal parts should then be soaked in a jar of cellulose thinners. Don't put plastic tanks in though! Use a metal polish for these; it removes slight scratches and cleans at the same time.



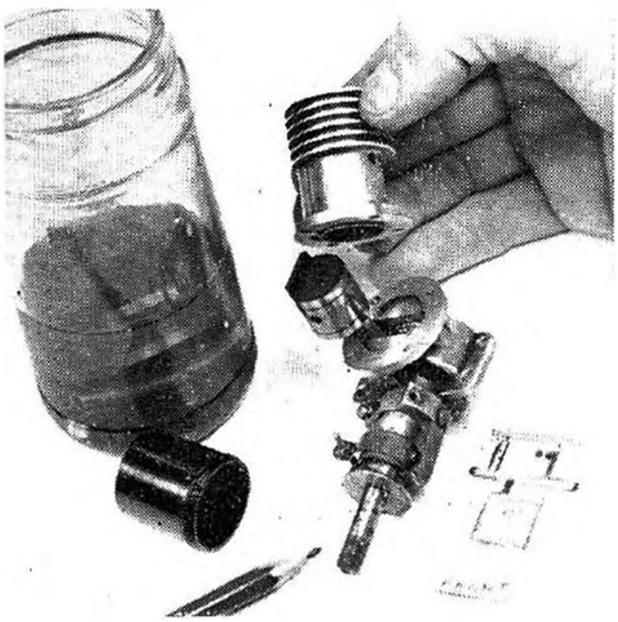


Clean up the parts with an old toothbrush, the bristles of which have been cut down as shown. Scrub vigorously and finally dip the part in clean thinners, then carefully wipe dry with a lintless cloth.

Most collections start in a pretty aimless way, the accumulation of as many engines as possible being the immediate object of the exercise. The would-be historian soon comes to realise, as the heap increases, that since it is impossible to collect *all* the many hundreds of engines ever produced, some rationalisation is required. This is the first step to putting things on a sound footing and marks the *real* beginning of the collection.

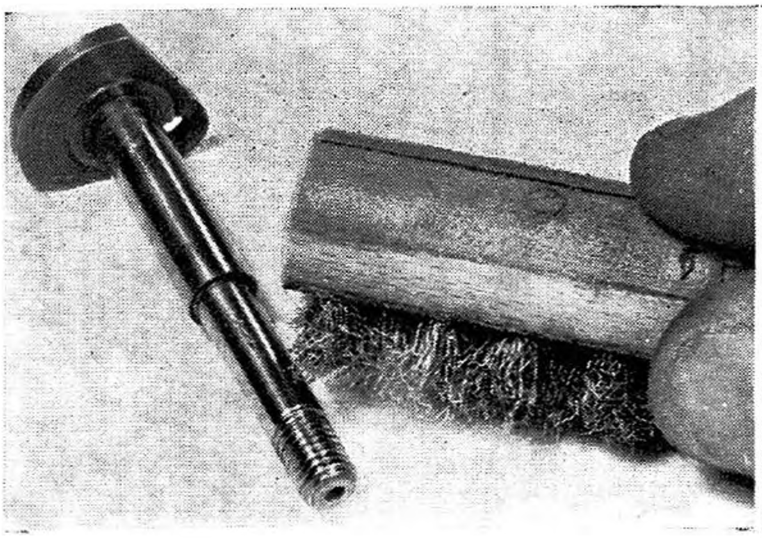
One may, for example, decide to base the collection on British petrol engines, or perhaps limit it to 2·5 c.c. diesels. Some restrict their scope by period—pre-1940 American engines for instance.

When one considers the hundreds of *manufacturers* who have each produced whole ranges of all sizes of engines in U.S.A., Britain, Japan, Germany, France, U.S.S.R., Poland, Hungary, Italy, etc., it is easy to appreciate the need for some kind of collecting "plan".



A well-known American enthusiast, John Krickel, claims to have an almost complete collection of American ½A glow motors. When he embarked on the project some seven years ago, he envisaged a collection of 25 motors—it now stands at over 160 units!

To complete his museum he had to buy several ready-to-fly plastics in which never-advertised types were fitted. Wen-Mac, Cox, Fox and Herkimer all at some time or other produced "specials" of this kind.

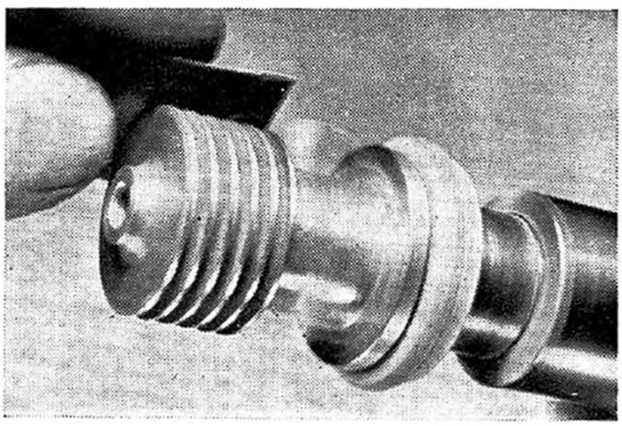


A brass suede-cleaning brush will clean up dirty screw threads on the crankshaft and make them shine again. Never use the brass brush on aluminium, or a steel brush, on *anything !*

De-coke the piston crown with Belco rubbing compound. It's soft enough not to damage the surface, yet will restore the finish admirably. Wash very thoroughly in clean thinners to make certain all abrasive is entirely washed off.

The following extract from a most interesting and amusing article which John Krickel wrote for the *Engine Collector's Journal* throws some light on the excitement and difficulties he experienced.

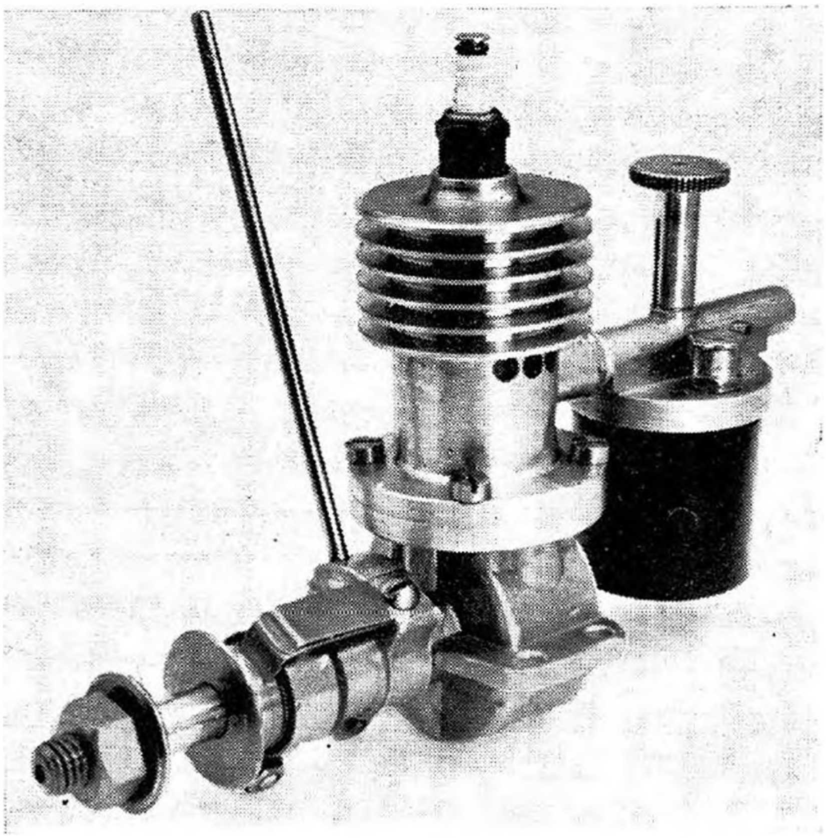
"Some engines became a real challenge; among them the 1956 *Athearn 'POGO' really haunted me. This fabulous little engine was redesigned by Fred Funn from the dies of the never-produced Anderson Spitfire* ·09 *'Hornet' for a plastic ready-to-fly toy by Athearn, the model railroad people. Only about* 1,000 *of these engines were made, and the Company decided not to go into the airplane business. This design was, in turn, reworked by Bill Atwood for Pagliuso (the tripod people) into the PAGCO XF-*9. *Going through the Montclair advertisement of used engines one day, I noticed they had a used 'PAGO' for sale. Smiling smugly at their misspelling of PAGCO, I tossed the ad. aside. Two days later, in the middle of the night, I sat up in the bed and yelled 'POGO'! I won't repeat what my wife yelled in return, but then you can't expect a woman to understand engine collectors anyhow. I hurriedly made out a cheque for* $3, *air-mailed it off, and waited. After a nervous ten days (what if there were some other ½A col-*



Never grip cylinders in chuck jaws but mount them on a length of screwed rod which matches the plug or compression screw thread.

With the cylinder securely chucked, and a wood disc (cotton reel end) interposed between chuck and cylinder skirt to prevent damage, clean and re-surface the fins (to remove plier jaw marks!) using No. 280 "wet or dry" paper. This will give a "turned" look and will avoid giving an unnatural polished surface which would not be authentic. Never try to *improve* on the original (it's often very easy and tempting) but try to recapture the appearance of the engine when new.

All the parts sparkling and ready to reassemble. Always apply a little oil to steel parts before assembly.

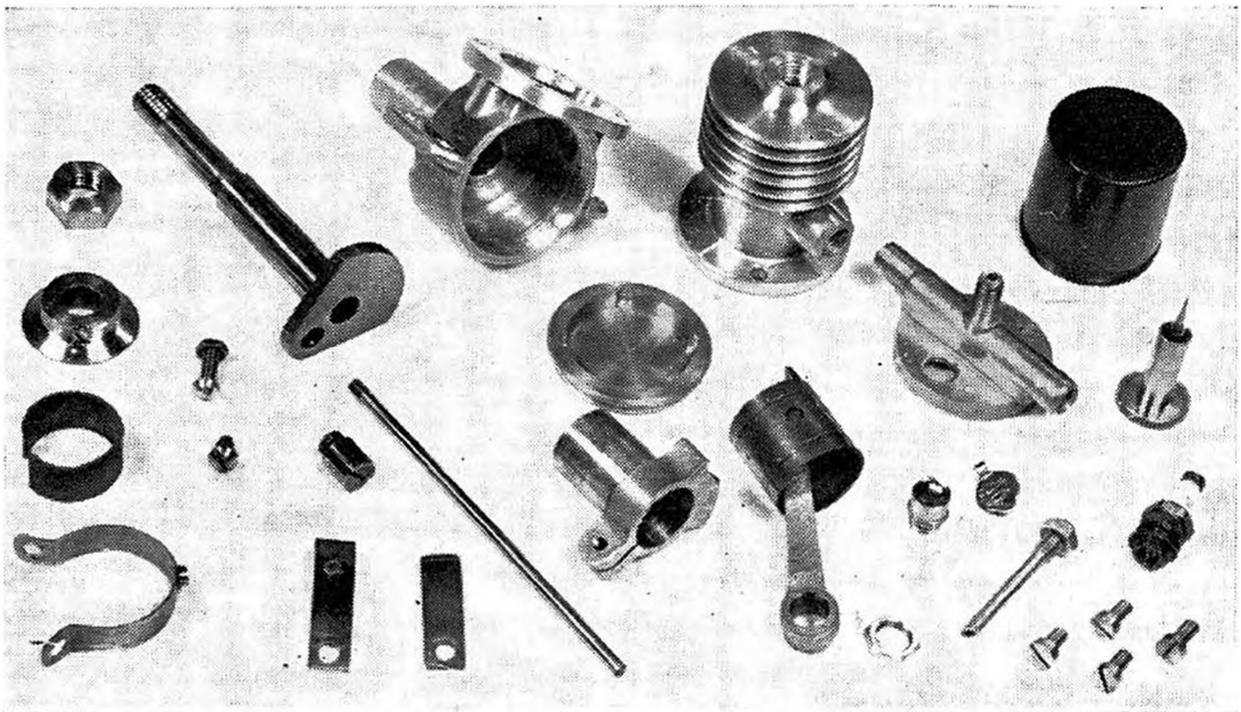


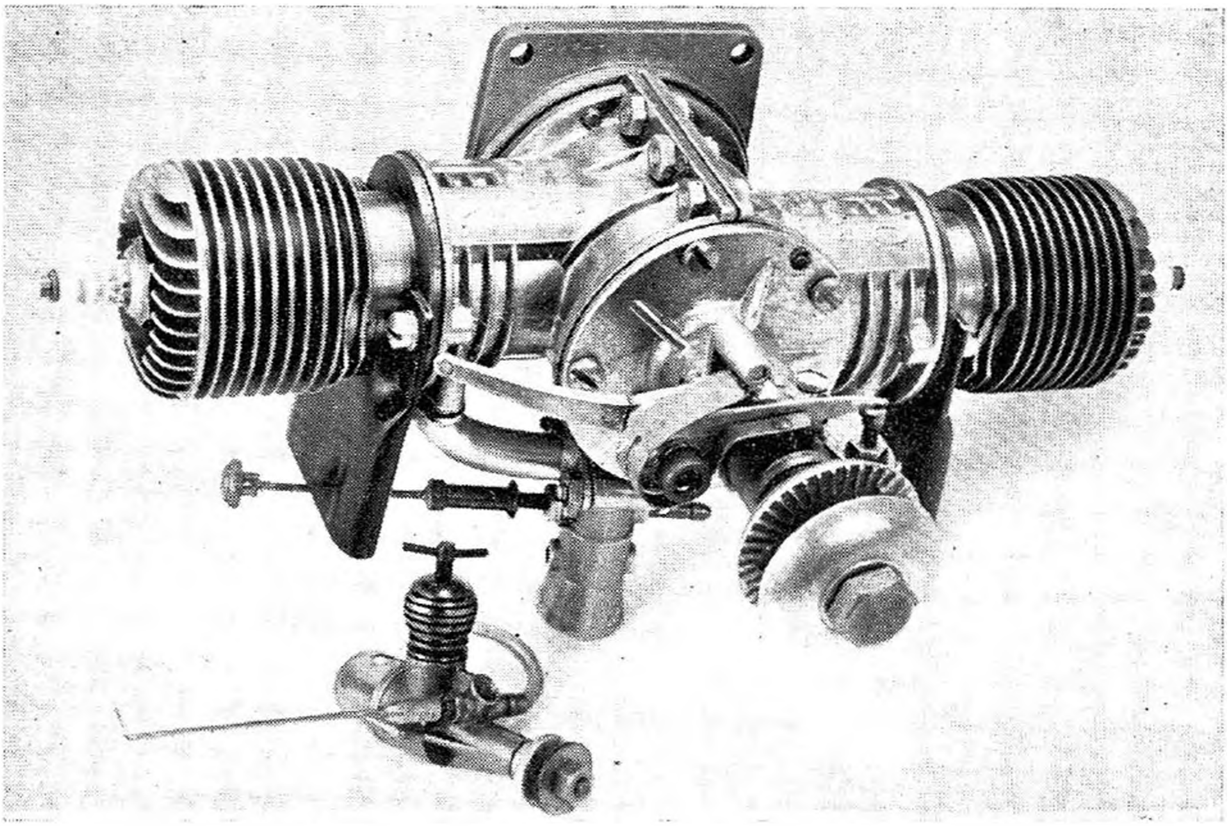
Good as new! A new timer arm was made from a length of silver steel rod, the end of which was threaded and screwed into the timer casting. Clean brass and copper parts with rubbing compound, which produces a natural lustre rather than a sparkle, dry, and then give a coat of clear polyurethene to prevent tarnishing. New screws, prop nut and spark plug complete the job. No internal reworking is needed for a static collection and should not be attempted by the amateur. But re-bores, or the fitting of new bearings to engines intended for use, can be carried out by specialists and are not expensive. Compare this photograph with the one on page 6.

lector in the country who had beaten me to it)? back came a brand new Athearn 'POGO' with part of the airplane still attached! A long search had ended.

"There have been some other real thrills, and some expensive headaches, too. To get a never-advertised McCoy '5', I had to order the engine by parts and assemble it. The darned thing cost me over $10, wholesale, but the little engine will always be one of my favourites. It's a real beauty."

There's a lot to be said for basing a new collection on recent and current (used) engines. They're easier to find, less in demand by existing collectors,

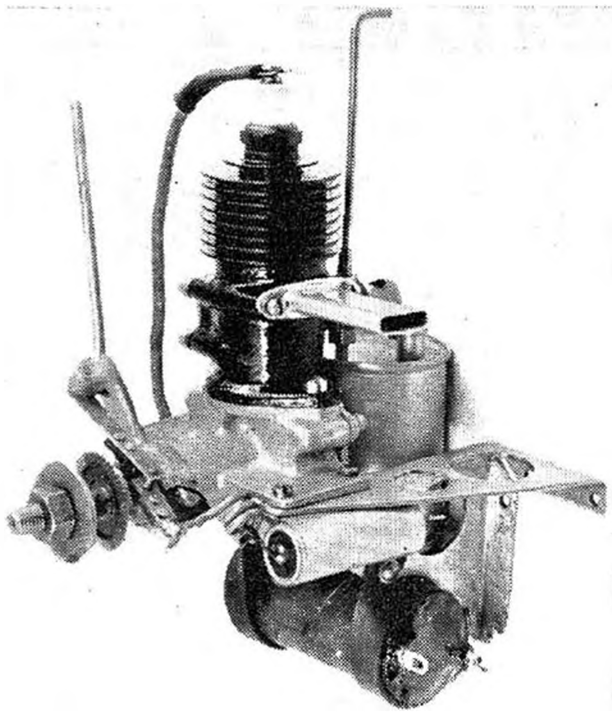




and therefore likely to be cheaper. Less interesting? Not at all! History is a continuous process and in twenty years time a good E.D. Bee will probably be as much sought-after as a pre-war Brown Junior is today. Yet Bees can still be picked up for a song.

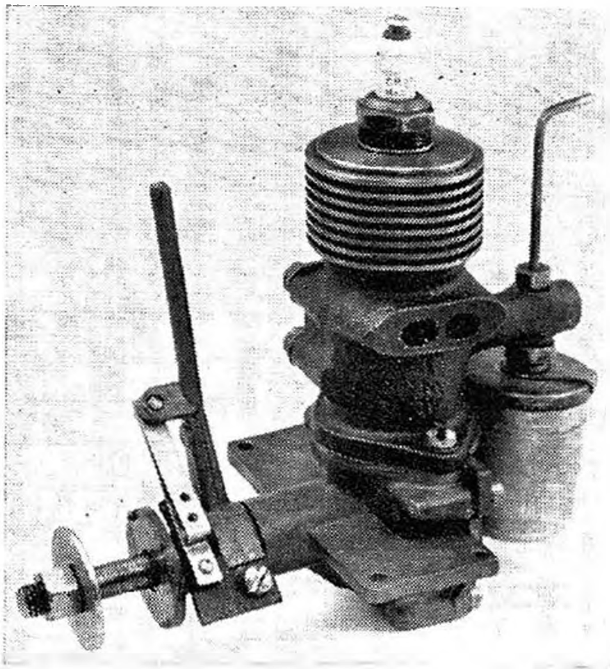
Recent model "used" engines are frequently of such low trade-in value that their owners often "junk" them or relegate them to some remote and dusty corner, where in a few years time they will no doubt be rediscovered to form the nucleus of another collection! Get in there NOW and restore them while most of the original spares are still available with which to return the engines to their "new" condition.

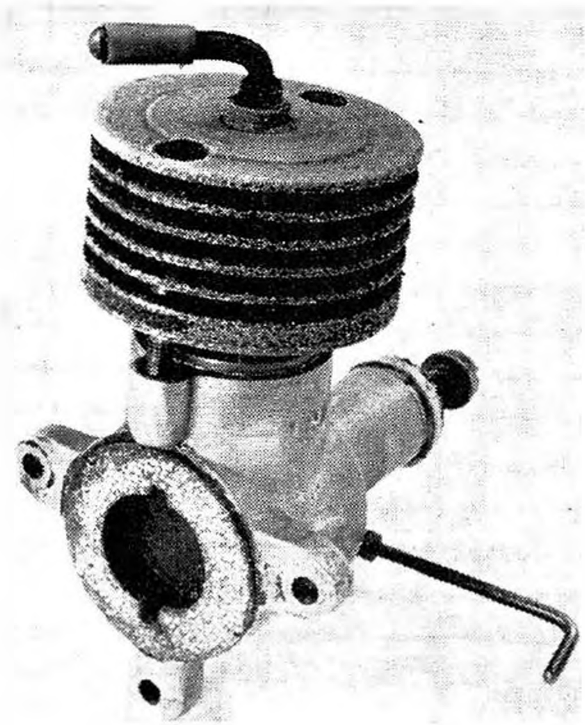
Don't refuse "duplicates" if they're reasonably priced, because as your collection grows, you will find that many of your most valuable additions are made as a result of "swaps" rather than straight purchases. The "system" much resembles the old cigarette card game, but now it's something like "A 'K. Vulture' and a 'Mills Mk. 1' for a 'Gwinn Aero Mighty Midget'!"



Of course, this process depends on personal contact being established with fellow collectors. What about the lone hand? How is he to expand his collection? The

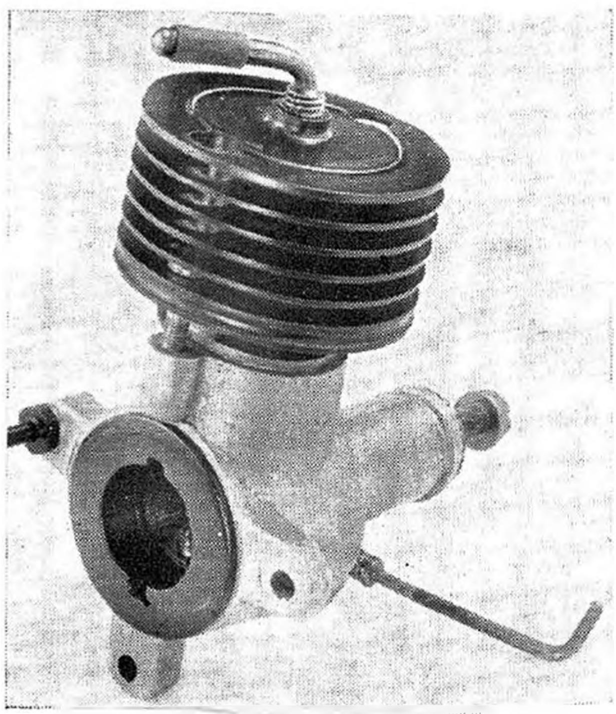
One of the biggest and one of the smallest engines ever to see large scale production, the massive 20 c.c. O.K. Twin and the little D.C. Bambi of just ·15 c.c. The 18 in. propeller of the O.K. was bigger than the wing-span of many Bambi powered models!



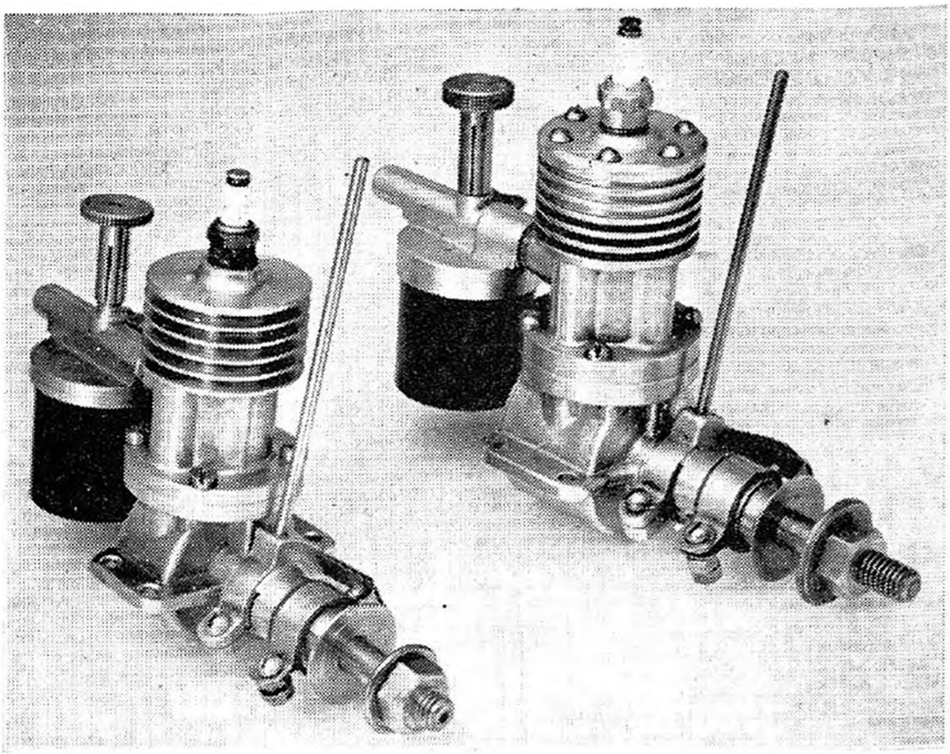


This is a "Sky Chief" of 1941, largely copied from the Dennymite but simplified, and of 8·6 c.c., it sold new for half the price. Most obvious difference was the very heavy cast iron cylinder. Piston was fitted with one ring—Dennymite had none. Compare this photograph with the one at the foot of page 10.

Damp plays havoc with magnesium, and the only cure for a bad case like this Czech A.M.A. 2·5 is physical removal of the corrosion. Cleaned parts may then be re-anodised or, if only required for show, may be sprayed with semi-matt cellulose as shown in the photo, right. Notice the display mounting stem threaded 6 BA on the far mounting lug.



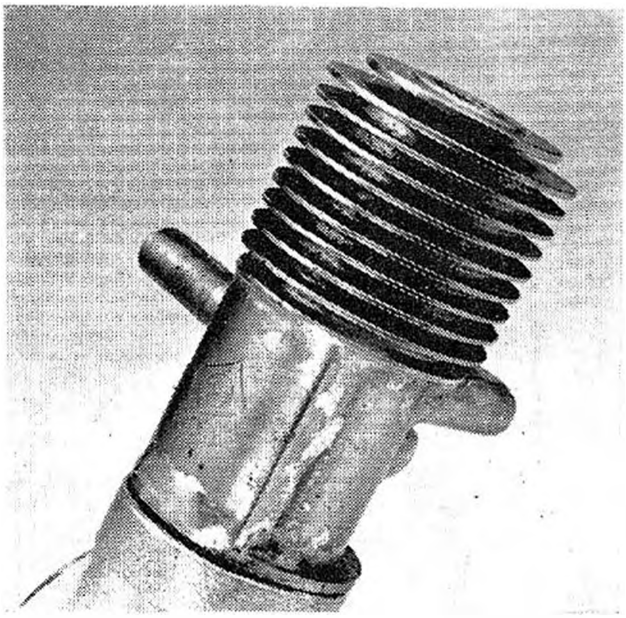
Pre-war engines were often supplied on alloy or wood mounts complete with mounted and wired coil and condenser. Here's a 1937 9·4 c.c. Dennymite "Skycharger" on such a stand. Glossy black cylinders, if in poor condition, are best restored with a heat and fuel resisting paint such as Valspar.



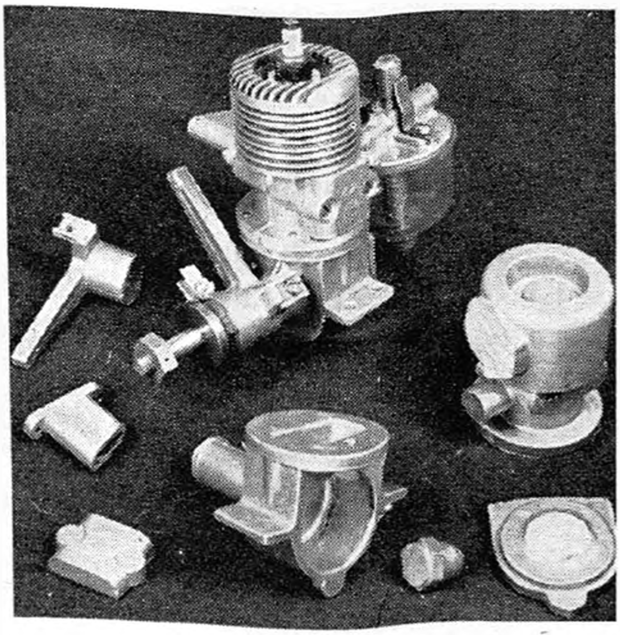
Family likeness. The similarities are unmistakable, some parts are even interchangeable between this Atlas 3·5 c.c. of 1946 and the 4 c.c. H.P. Mk. II of a year later. Reasons for such relationships which frequently occur in model engines often involves interesting detective work. Original price of the "H.P. was £8 2s. 6d. and the Atlas £7 10s. 0d —very expensive for their time and far above their present collector's value, even if in "as new" condition.

classified columns of the model press are useful here, but remember that there must be hundreds, nay, thousands of disused engines lurking in dusty attics and cupboards, belonging to once-active modellers who no longer read the model magazines. Some surprising "finds" have come to light as a result of a postcard in a local tobacconist's window. Local papers and the big circulation "buy and barter" publications should not be forgotten either.

Ex-modellers are often surprised to learn that what they considered to be so much sentimental junk, is actually of interest to someone—for *money*! Of course, there's the other type who will tell you that he paid £10 for his Super Cyclone back in '46 (in the motor famine) and therefore the engine must, by today's values, be worth at least £30! Move on quickly unless you've got a persuasive tongue!

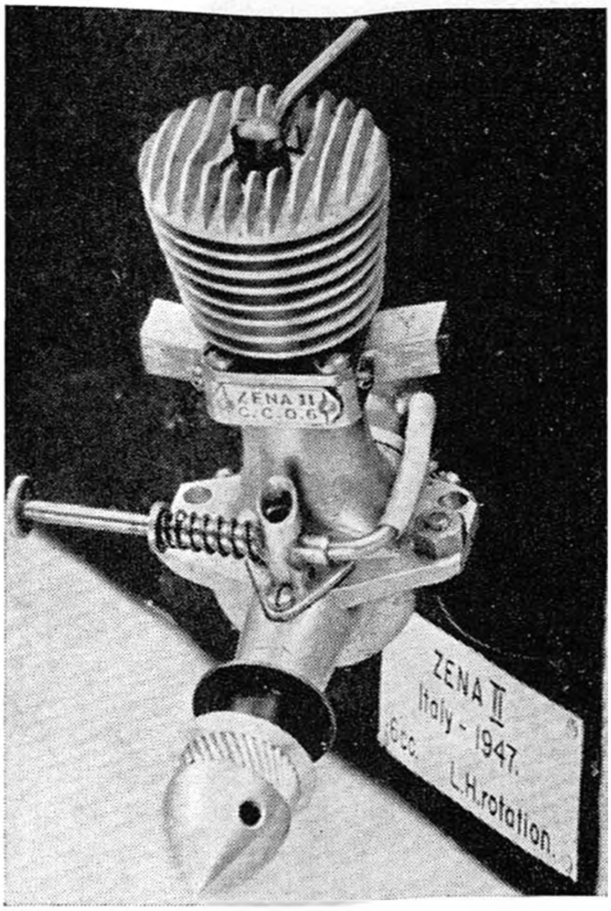


Cylinder parts of the Inoue-Shiki are crudely brazed together. The original engine was nickel plated (long since gone). An effective 'plating' job can be done on such brass parts by immersing them in an exhausted photographic fixing bath. Silver is deposited very quickly, the more exhausted the bath is, the faster the deposit builds up and it can be prevented from tarnishing by giving it a coat of clear Polyurethene varnish. It then looks very much like the original nickel.

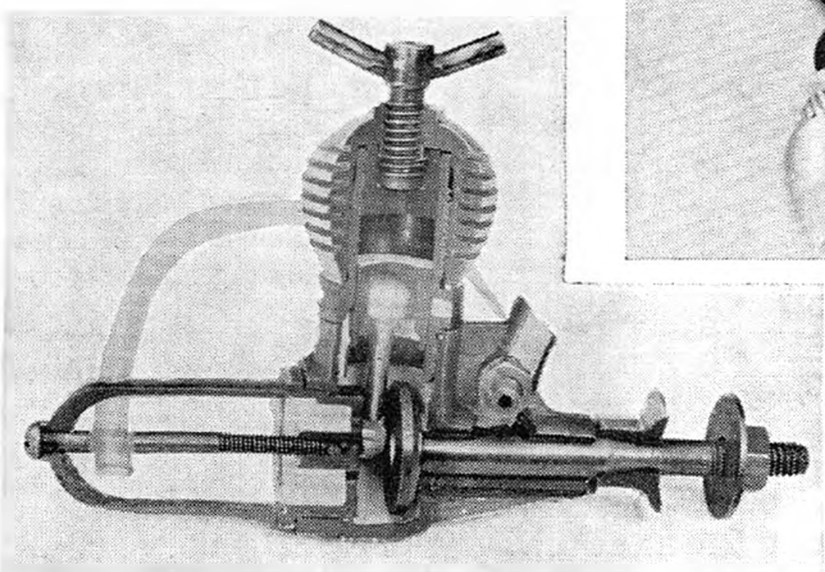


An interesting little "set piece" is made by displaying the basic castings needed to make an engine alongside the finished product. Here's the first post-war British engine to reach the market in any quantity—the Majesco 45 of 4·5 c.c., it cost £4 4s. 0d. new.

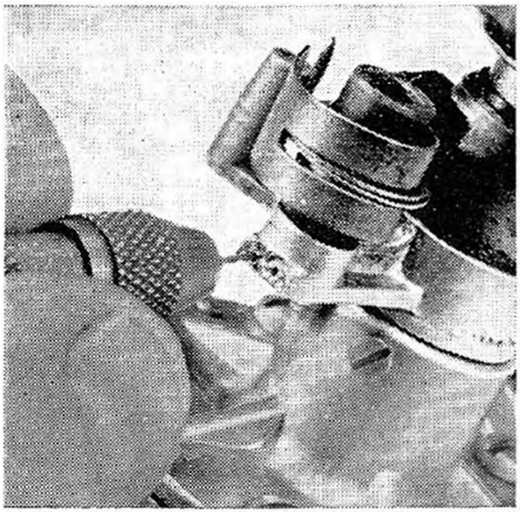
This of course, raises another interesting point. Just how much *is* an old engine worth? There are the inevitable few individuals and "sharp" traders who are trying to cash-in on the "antique motor market" and who will cheerfully ask £25 for a slightly tatty Brown Junior. Such inflated prices are out of all proportion to the engine's worth. Even so there *are* one or two—one might call them "Professional Collectors"—who will pay such prices—let them. It's much more exhilarating to "discover" an oldie for 10*s*. in a junk shop or complete a good "swap" deal, than to help to support this engine Black Market, even if it does mean waiting a little longer.

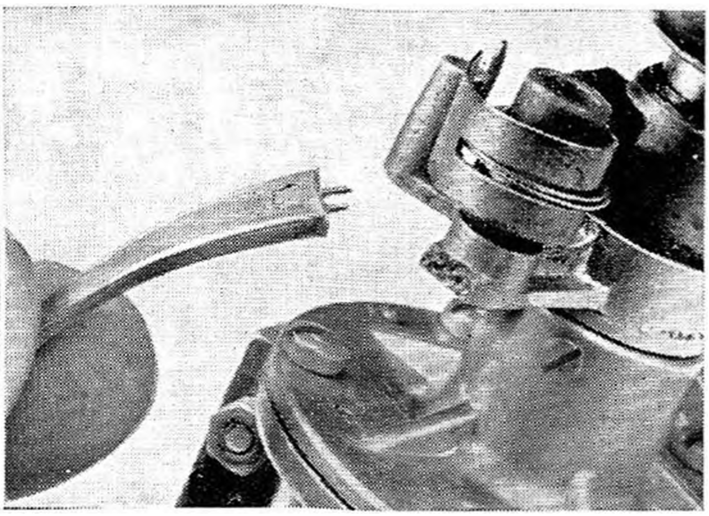


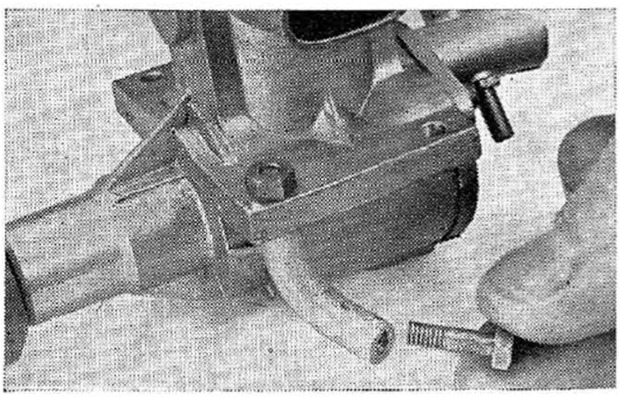
Section to show a small motor (Italian Zena ·6 c.c. diesel) mounted for showcase display with green baize facing to ¼ in. ply backing. The curved, black-painted mounting stem with its threaded ends is inconspicuous and efficient. Larger, heavier engines require more substantial support (see page 14). The simple stencilled data panel is light green card fixed with four brass brads.



Another eye-catching exhibit is a sectioned motor. This is a Frog 50 Mk. II of ·5 c.c. It is most impressive with the cut edges of its individual parts each identified with a different colour.







Repairing a broken O.K. Twin timer arm. Two matching holes are drilled in each part and steel pins inserted. The joint is completed with an epoxy adhesive such as Araldite—it's permanent!

Heavy engines like this 1946, 5 c.c. Italian Osam (Super Tigre) need quite substantial mounts. This one is made from ¼ in. diameter aluminium rod drilled and tapped 4 BA each end (after bending!).

There is no "Blue Book" of used engine prices as there is for used cars. The value of an old engine is whatever it is worth to the collector who *wants* it. For instance to a Frog collector who only needs a "1·75" to complete his range, a good 1·75 Mk. 1 in its original box *could* be worth its original purchase price or even more. From another collector it might only fetch a quarter of that, or less.

Generally speaking, only very occasionally will an old engine command more than its original 'new' cost. To do so, it would have to be a fairly rare one, in mint condition, absolutely complete, and probably in its original box.

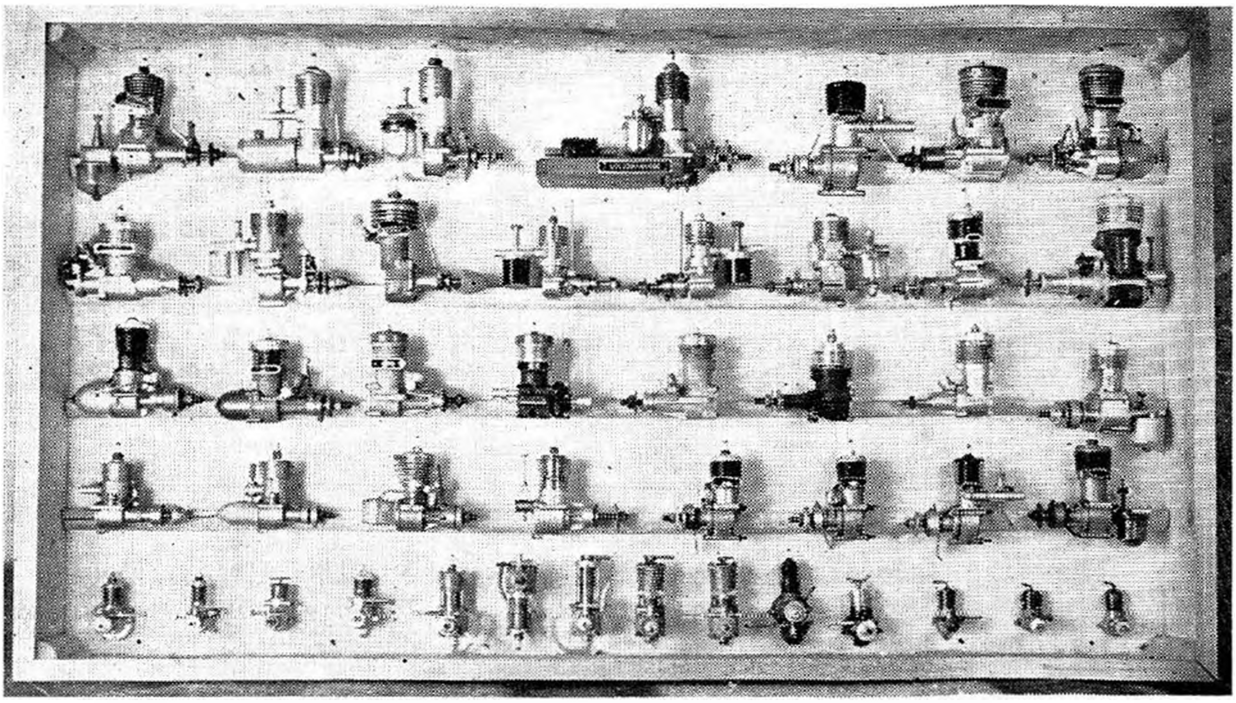
There are exceptions, of course, such as manufacturers' experimental development prototypes, short production run jobs and so on. It is paradoxical that the least successful engines (when new) often bring the highest prices from the collector. Such engines, *because* of their poor performance or unreasonably high price, usually went out of production pretty quickly, leaving comparatively few examples to be handed on; they are the Penny Blacks of the collecting game.

Consider the fact that in Britain alone, in the late '40s there were about a hundred engine manufacturers, ranging in size from one-man-bands to mass production lines. How many of their often crude, and sometimes quaint products, are now gone for ever? How many just waiting to be rediscovered?

Display

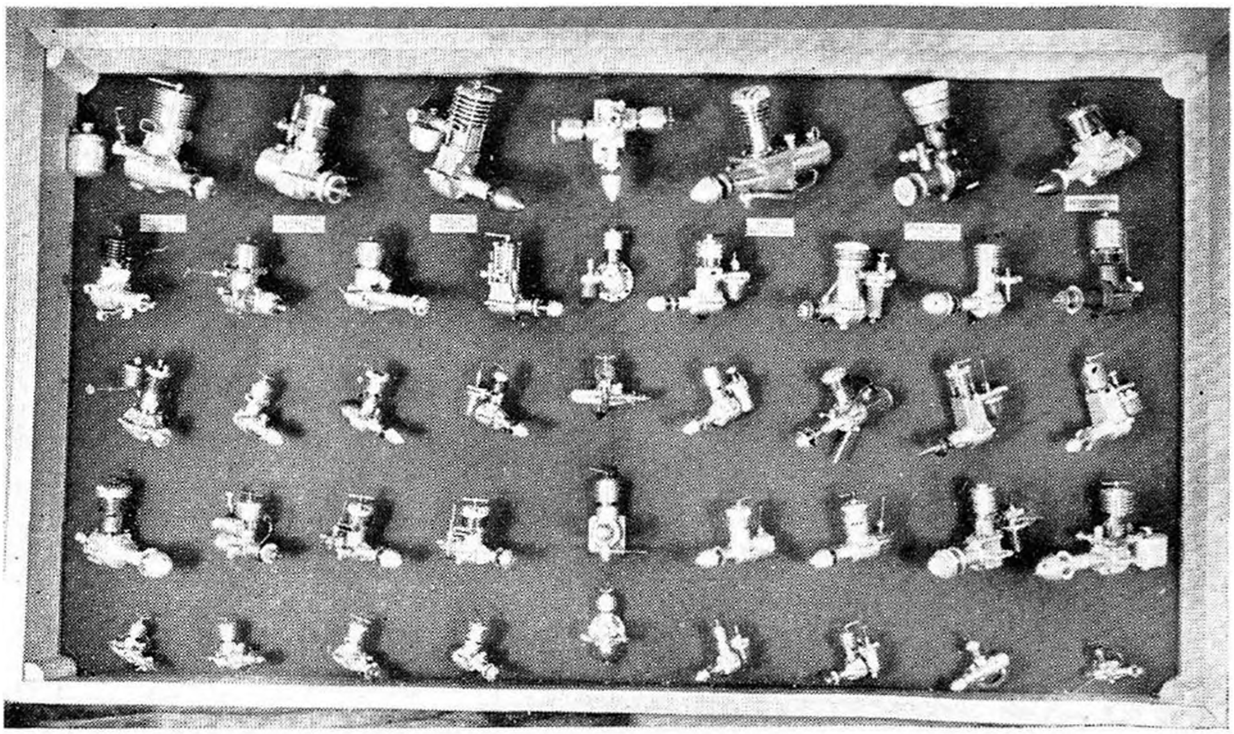
Once your collection starts to take shape, you will want to display it attractively. Such a display, besides being colourful and decorative in its own right, can also be very useful as a promotional exhibit at local model shows.

Such an engine display will frequently interest members of the public (and the Press) who otherwise find models rather boring. Favourite questions



Early attempt at a display cabinet. Half-round battens screwed from behind support rows of engines each arranged to "face the centre". Bottom row are radial mount jobs simply screwed to the back of the case. The display is rather "flat", uninspired and inflexible, but is quick and easy to produce.

My present type of case is baize lined with the engines each mounted on little "stalks" allowing great flexibility in display. The data tablets in this "Box of Diesels" are as yet incomplete. In damp conditions, a small muslin bag of Silica Gel in the bottom of the case will absorb moisture and prevent corrosion. All cases are, of course, glass-faced.



from such sources are "Don't tell me that's a REAL spark plug?" or (looking at the O.K. Twin) what sort of goliath would you put *that* one in?" The P.R. value of my own collection has already justified all the work put into it, even had it not been a labour of love!

I now mount my engines in 4 ft. x 2 ft. cases. Each engine being fixed to a little "stalk" on which it can be inclined and rotated to a variety of angles. The backs of the cases are lined with green baize and the front is faced with heavy glass retained with a 1 in. aluminium angle. Each engine has a little data plate stencilled beneath it showing name, country of origin, date of manufacture, capacity, and any particularly notable characteristic, such as "left-hand rotation" or "compression varied by rotating eccentric main bearing", etc. Additional details are kept on an index card, one of which is made out for every engine.

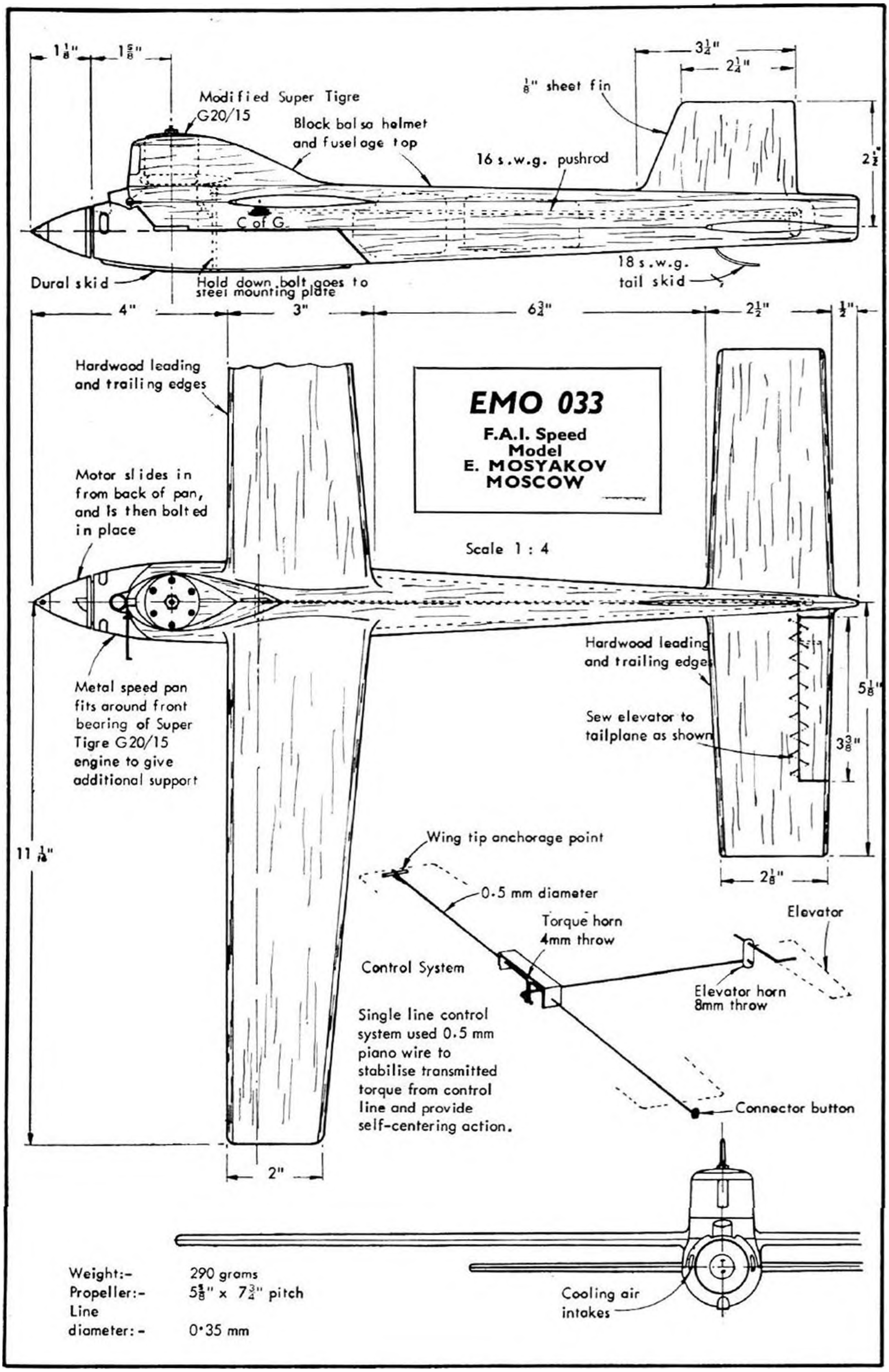
Models Too . . .

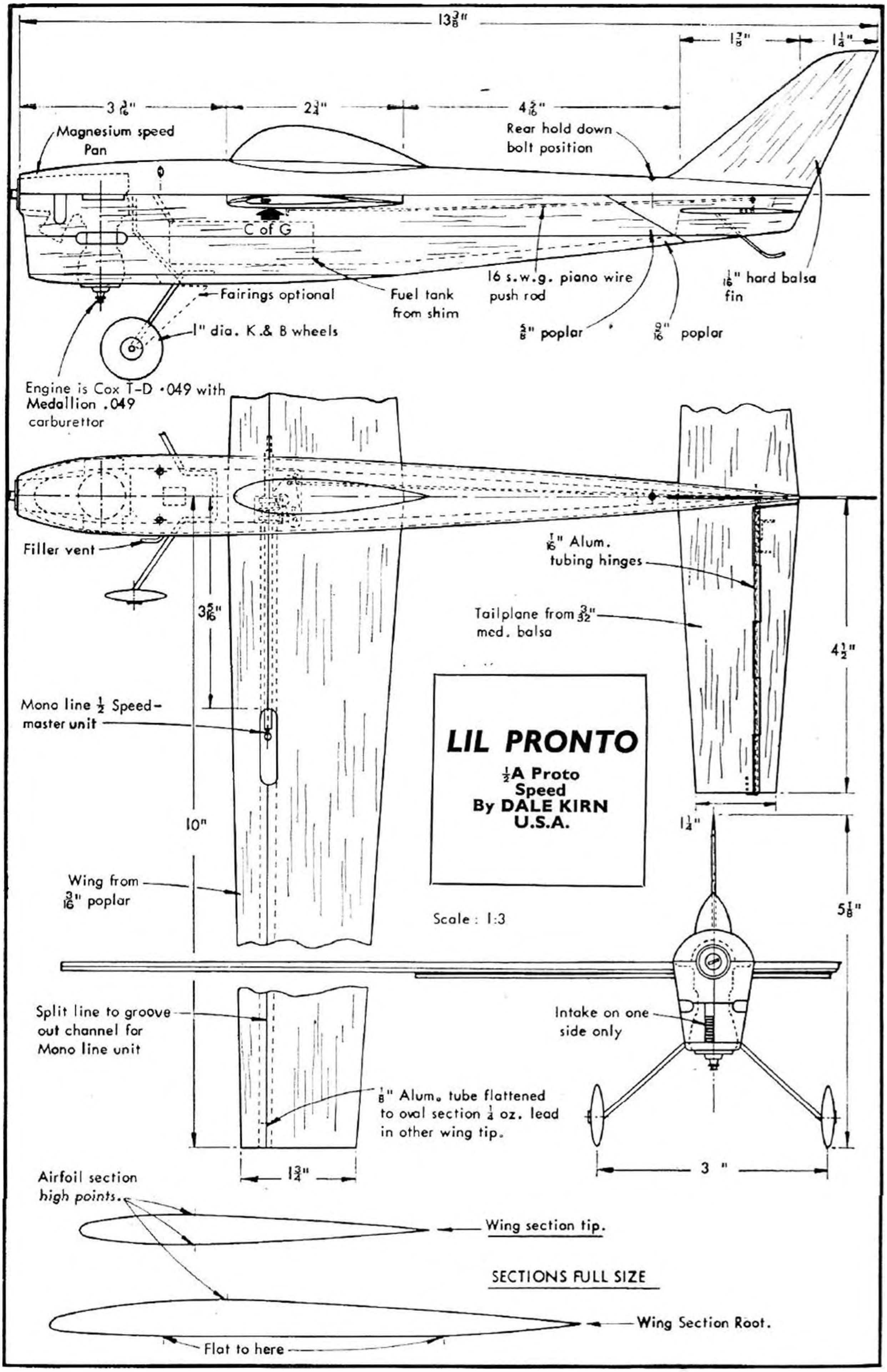
There is a rapidly increasing interest in all forms of "vintage modelling". Reproductions of big pre-war "gassies" continue to appear in ever greater numbers, while in America the "vintage contest" is flourishing.

Some of this activity undoubtedly stems from the interest in vintage engine collecting. Many owners of such collections are not content merely to sit and look at their loot. They want to get their engines airborne again and in doing so they are rediscovering the quite unique appeal and fascination of the pre-glow plug era. The good humour and comparatively leisurely approach to such a meeting is almost magically returning with the old models. It emphasises the sad way in which many modern events have developed into high pressure, backbiting, pot-hunting, litter-strewing marathons.

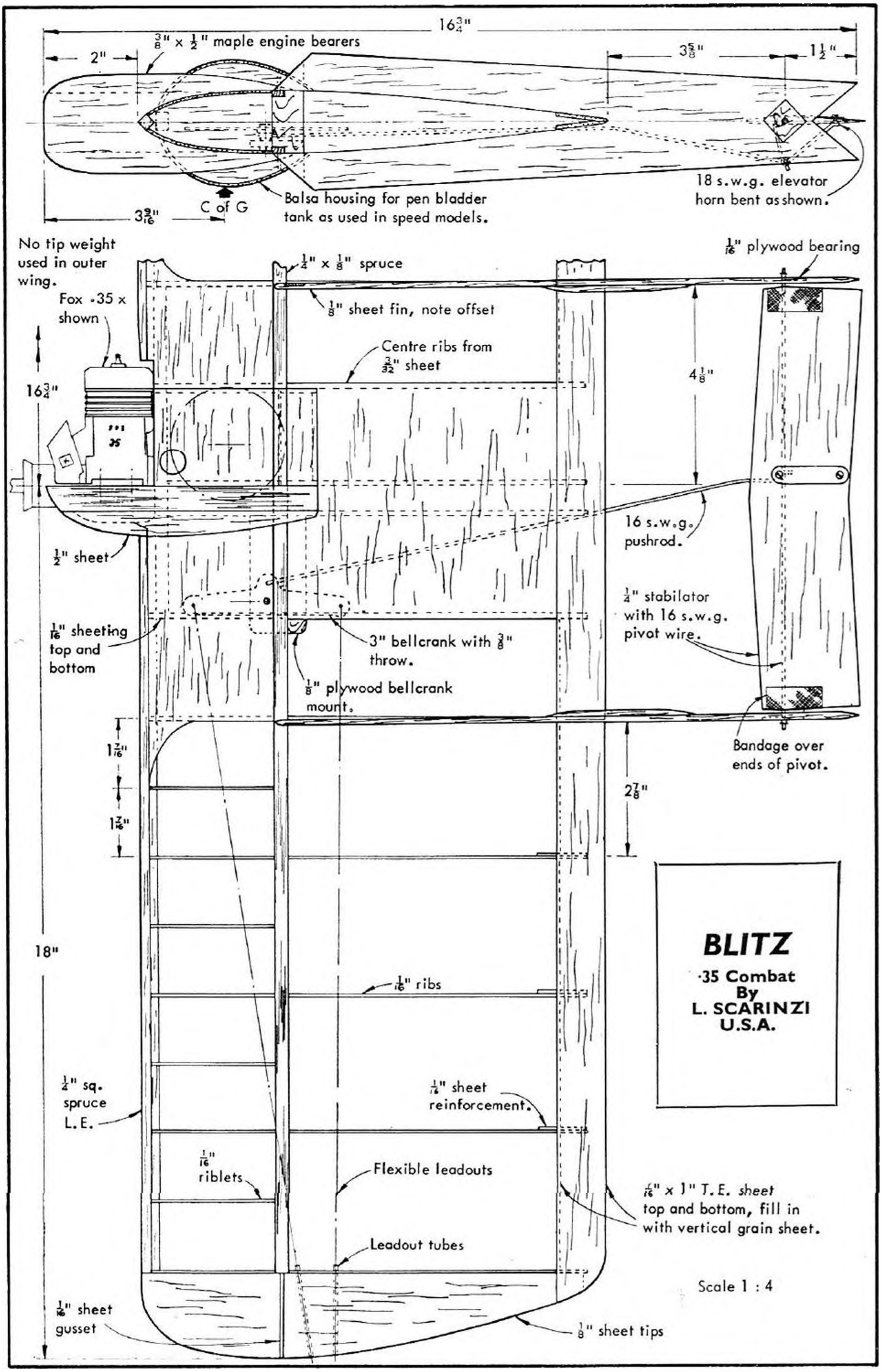
It would be nice to think that perhaps a vintage event could become a regular feature of our bigger meetings, when, perhaps some of the lost light-hearted sporting spirit of our *hobby* will rub off on those who have never wrestled with flat pen-cells, oiled-up points, and dry joints, or thrilled to the distinctive bark of a Brown Junior in full song—even with a muffler, it's unmistakable!

This is no nostalgic pipe dream—it's happening—and how gratifying to know that our engine collections are not just stuffy museums, but living things, once more performing a useful function for the good of aeromodelling past, present *and* future.


EMO 033
F.A.I. Speed Model
E. MOSYAKOV
MOSCOW
Scale 1 : 4
Modified Super Tigre G20/15
Block balsa helmet and fuselage top
1/8" sheet fin
16 s.w.g. pushrod
C of G.
Dural skid
Hold down bolt goes to steel mounting plate
18 s.w.g. tail skid
Hardwood leading and trailing edges
Motor slides in from back of pan, and is then bolted in place
Metal speed pan fits around front bearing of Super Tigre G20/15 engine to give additional support
Hardwood leading and trailing edges
Sew elevator to tailplane as shown
Wing tip anchorage point
0.5 mm diameter
Torque horn 4mm throw
Elevator
Control System
Elevator horn 8mm throw
Single line control system used 0.5 mm piano wire to stabilise transmitted torque from control line and provide self-centering action.
Connector button
Cooling air intakes
Weight:- 290 grams
Propeller:- 5 5/8" x 7 3/4" pitch
Line diameter:- 0·35 mm



AMERICAN MODELER, U.S.A.



BLITZ

·35 Combat
By
L. SCARINZI
U.S.A.

MODEL AIRPLANE NEWS, U.S.A.

UHU emblem at left symbolises this Company's efforts to encourage German Youth over the past ten years. At right are photographs of the Austrian kit for the Standard A/I Glider using Jedelsky Standard parts as in the article beginning page 128. Plans on page 30. Assembled model flies well.

CATCH 'EM YOUNG by Ron Moulton

Official plans for novice modellers are issued by Aero Clubs of many Nations. This survey examines the styles of approach for those who may care to take up the same useful means of aeromodeller recruitment.

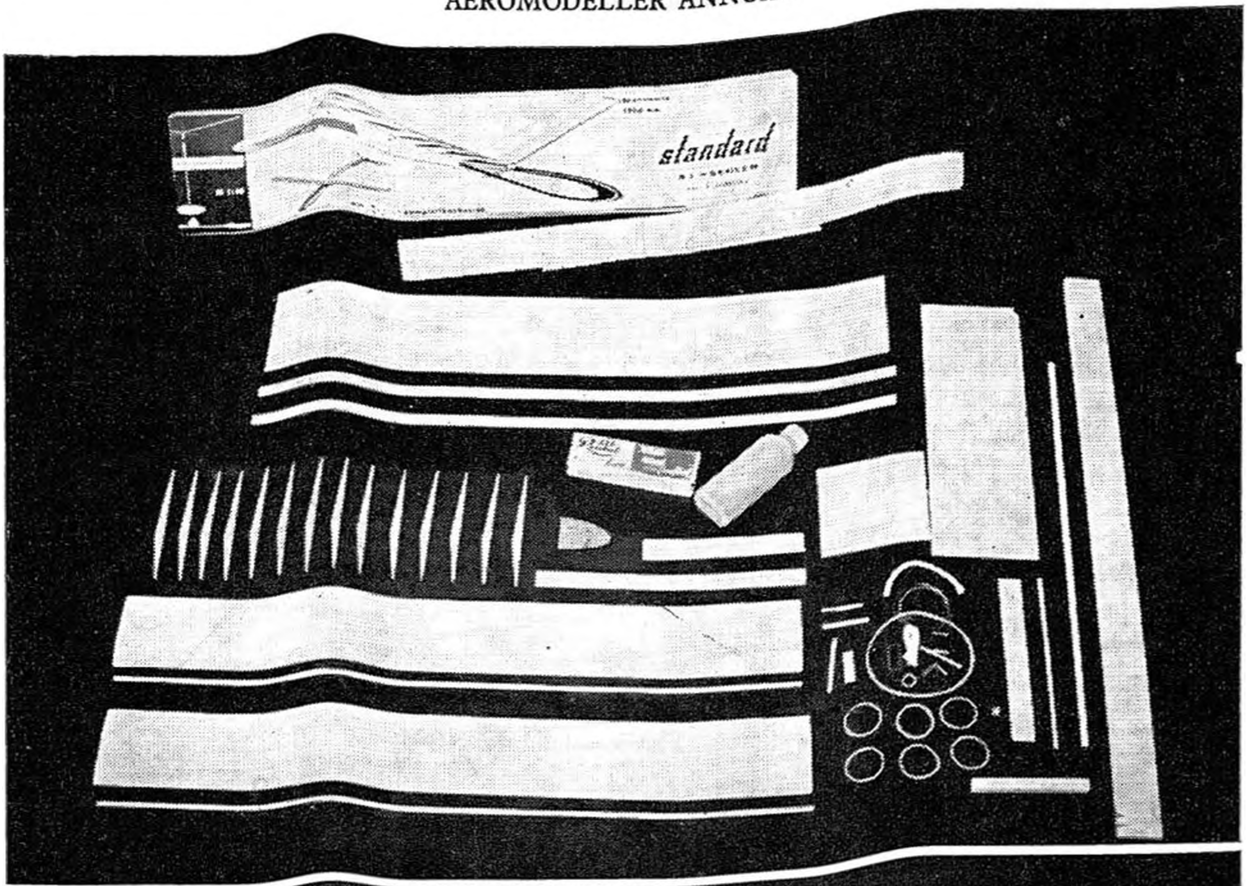
ASIDE from the much debated domestic problems associated with our hobby over the past few years such as the Silencer mandate, the cost of Proportional R/C gear, the garden, the smell of Polyurethane paint, flying fields, the family and of course those club dues . . . the most worrying concern has been that there are too few junior flyers around.

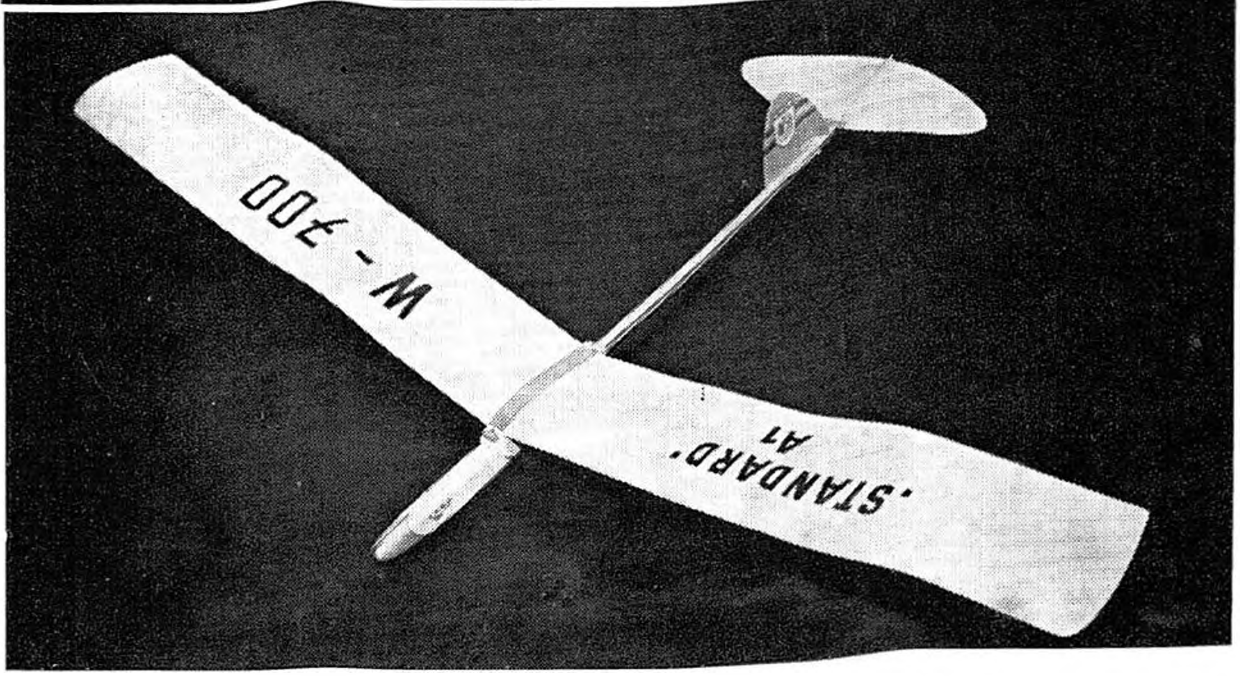
It is difficult to pinpoint reasons for this universal dilemma. The new generation does not appear to have aeronautical inclinations. Falling off in full-scale industry activities could be blamed. Fewer new types of exciting aircraft appear annually. They've become more specialised, more expensive, and so too has aeromodelling. The core of the hobby today belongs to an age group spread over those years of stimulated aero-activity from 1940 to 1956. This means that the majority of readers will have picked up their first aeromodelling enthusiasm in those 16 years. High proportion of those who took up the hobby subsequent to 1956 will have been strongly influenced by contact and instruction from the main group.

As people get older, have to work harder and take on greater responsibilities so also do they lose the time they used to spare in the interests of others. Thus the unfortunate newcomer of '66 will have to look harder than ever for one of the "oldie" hard core types to help him over the hurdles.

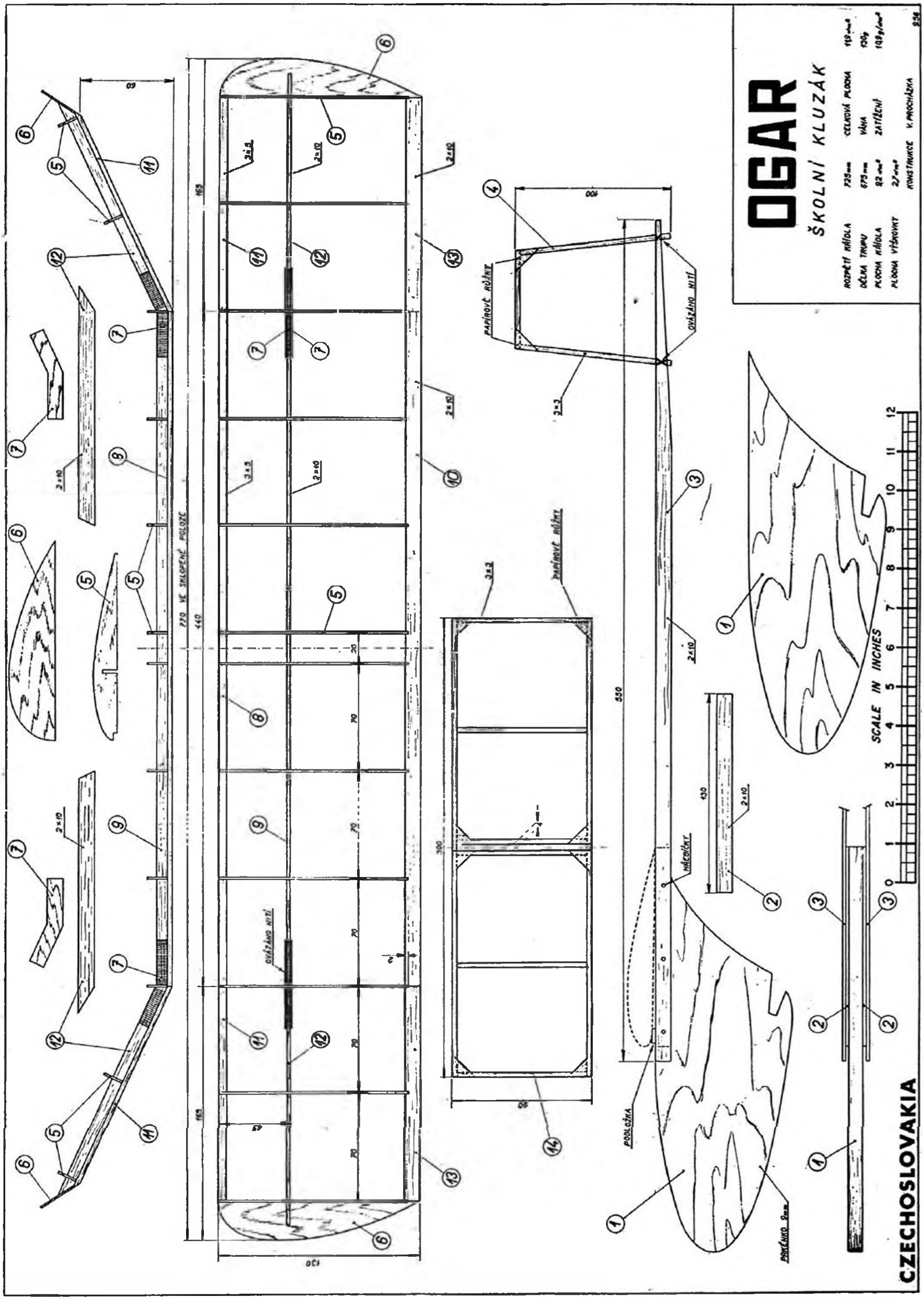
Gloomy as this picture may seem,—and it is certainly not exaggerated, being the result of long hours of discussion with youth leaders from all parts of the world,—there is a consolation that though numbers may fall off, standards of efficiency continue to rise.

A major contribution toward the loss of aeromodelling recruits in many Nations is the lack of general publicity. This falls squarely on the shoulders of the Aero Clubs. In most cases the Aero Clubs do absolutely no more than





accept the nomination of officials in their Models Commission or recognise an established Society as "official" and leave their efforts on behalf of youth at that. Since these are normally voluntary bodies, run by older modellers who freely give their time to administrate but who otherwise have to do a job of work, then there is a distinct limit of the amount of effort the Commission or Society can produce. Most of the administration is concerned with using a shoestring budget to satisfy the whims of the members with organisation of frequent contests. They simply do not have the time or resources to launch upon any planned printing programme or form of regulated instruction.

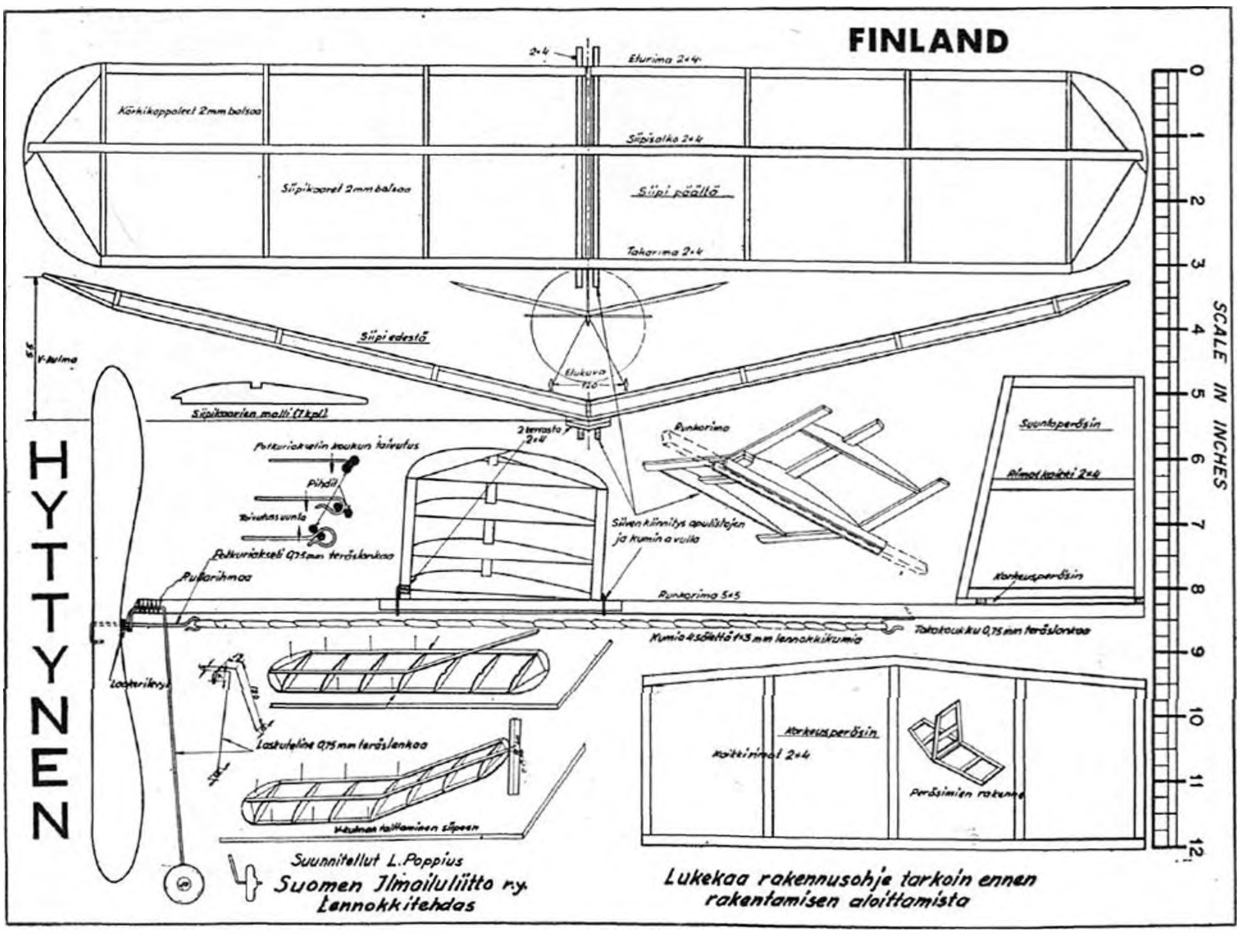

OGAR
ŠKOLNÍ KLUZÁK
ROZPĚTÍ KŘÍDLA 725 mm
DÉLKA TRUPU 675 mm
PLOCHA KŘÍDLA
PLOCHA VÝŠKOVKY
CELKOVÁ PLOCHA
VÁHA 130 g
ZATÍŽENÍ
KONSTRUKCE V. PROCHÁZKA
PAPÍROVÉ ROŽKY
OVÁZÁNO NITÍ
HÁČEK
PODLOŽKA
SCALE IN INCHES
0 1 2 3 4 5 6 7 8 9 10 11 12
CZECHOSLOVAKIA

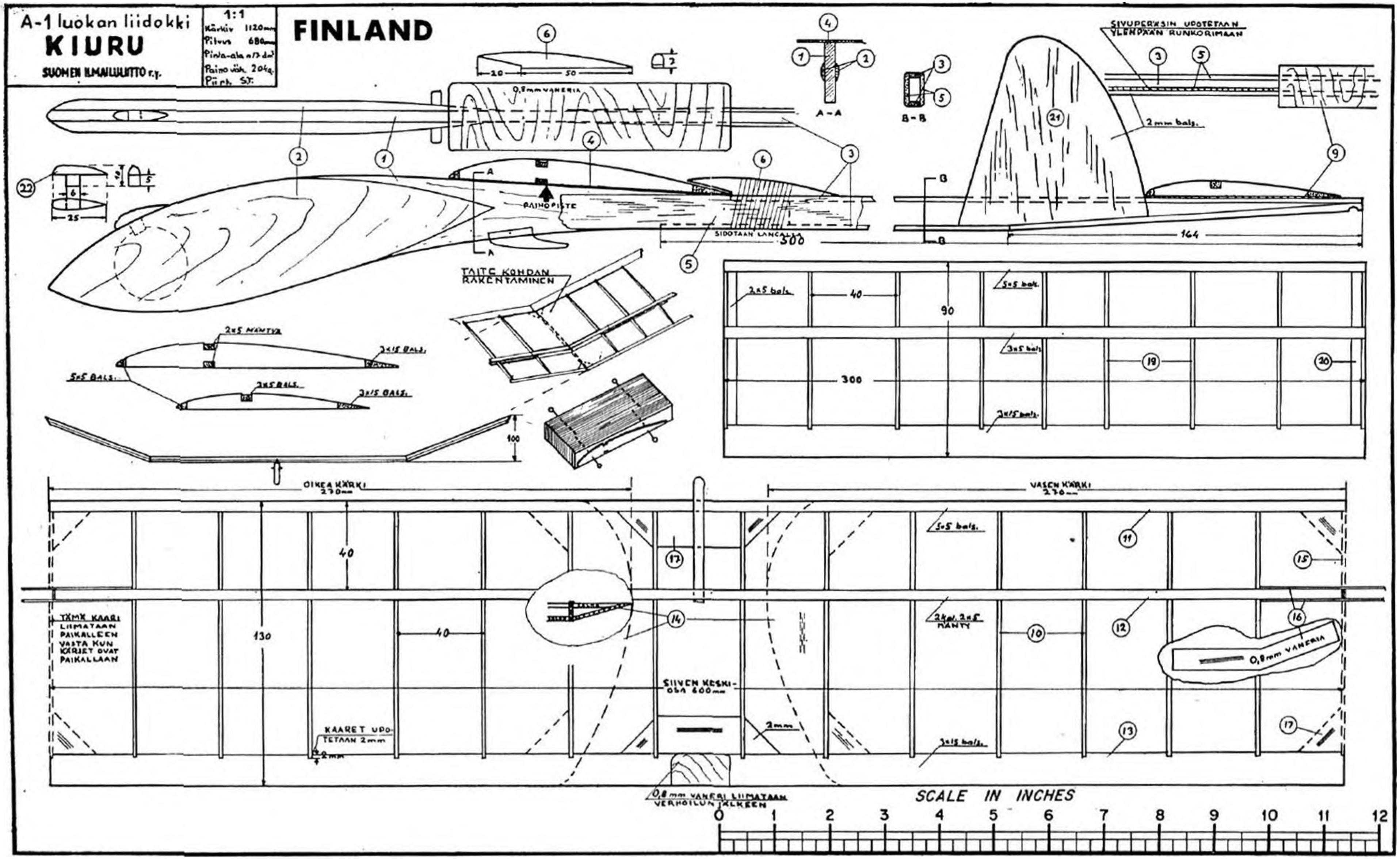
The exceptions are those Aero Clubs which appoint paid staff to look after aeromodelling as a recognised media for full scale aviation trainees.

Two important Committees have each recommended such action to two Governments in Great Britain, but like so many other deliberations produced as White Papers for Parliament, little or no action has ever been taken. The British aeromodellers are totally self dependent and cannot call upon the Royal Aero Club which recognises the Society of Model Aeronautical Engineers Ltd. as the Official Body in Great Britain, to provide office facilities or finance. While such a system has advantages of detached freedom to go one's own way, one can always see the better facilities for example in France, just across the Channel, where aeromodelling has a recognised status in local aero clubs. Airfield clubrooms welcome the local model club, grant field facilities in most cases and encourage the hobby. Take a model to a British lightplane centre and you are cast off to the gateway along with the Spotters and other enthusiasts. Of course if you are in any of the Socialist Republics, then your aeromodelling is a passport to all kinds of aero-sports. These States consider the hobby sufficiently important to give their representative teams for International events special training periods especially prior to departure for a World Championships where the team may be operating together in "training" for up to a month. But then, there are other disadvantages. . . .

Is there any hope that a scheme could produce a new flock of aeromodellers by means of commercial or official inducement?

Certainly there is. The only obstruction is the competition given by other similarly interested parties. Approach a National newspaper with a scheme to publish model glider plans and issue kits of parts at premium prices




A-1 luokan liidokki
KIURU
SUOMEN ILMAILULIITTO r.y.
1:1
FINLAND
0,8 mm VANERIA
PAINOPISTE
SIDOTAAN LANGALLA
300
A – A
B – B
SIVUPERÄSIN UPOTETAAN YLEMPÄÄN RUNKORIMAAN
2 mm bals.
164
TAITE KOHDAN RAKENTAMINEN
2×5 MÄNTYÄ
3×15 BALS.
5×5 BALS.
2×5 BALS.
2×5 bals.
5×5 bals.
3×5 bals.
3×15 bals.
90
40
300
OIKEA KÄRKI 270 mm
VASEN KÄRKI 270 mm
130
TÄMÄ KAARI LIIMATAAN PAIKALLEEN VASTA KUN KÄRJET OVAT PAIKALLAAN
SIIVEN KESKI-OSA 600 mm
KAARET UPOTETAAN 2 mm
2 mm
0,8 mm VANERI LIIMATAAN VERHOILUN JÄLKEEN
0,8 mm VANERIA
2 kpl. 2×5 MÄNTY
SCALE IN INCHES
0 1 2 3 4 5 6 7 8 9 10 11 12

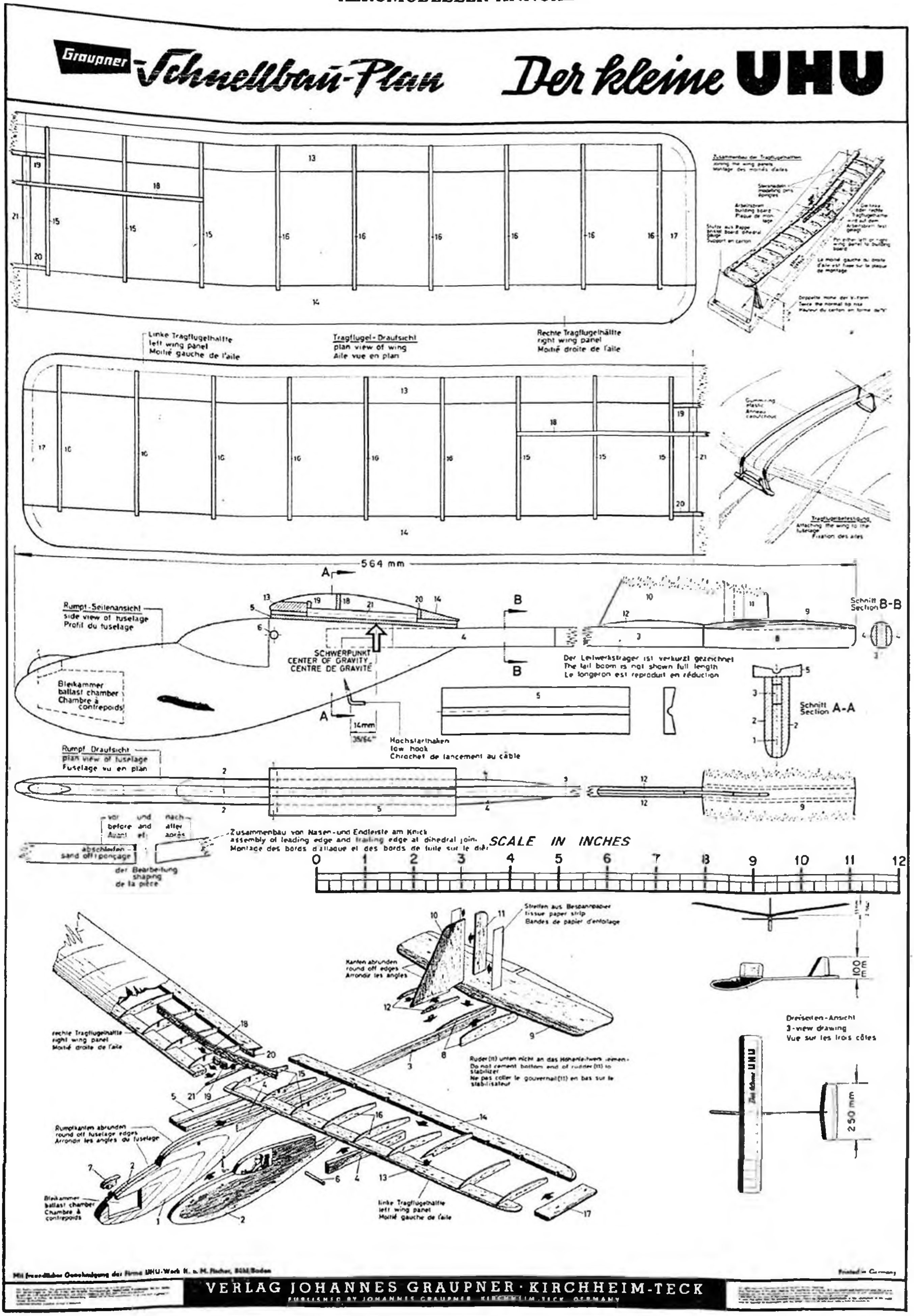
to gain some extra circulation in return and they'll soon tell you how much better a return of response they can get for far less effort *plus* large advertising revenue from a cycling feature, or something on angling. Go to educational authorities and present a workable aeromodelling scheme as part of the handicrafts training. The immediate question arises as to how to train the teachers? Such a problem may yet be overcome, we have slight expectations in this direction so do not discard the venture as anything less than hopeful. Then try that magic formula Television. Why not use the almighty "Gogglebox" to bring in new modellers? Mention a razor blade to the kiddies and you're off the air next week! Skirt around it as did Doug McHard in his fine series with ITV and offer free plans, and the studio will be aghast at the response. Tens of thousands of youngsters sent for Doug's little TV special. We wonder how many followed up with another?

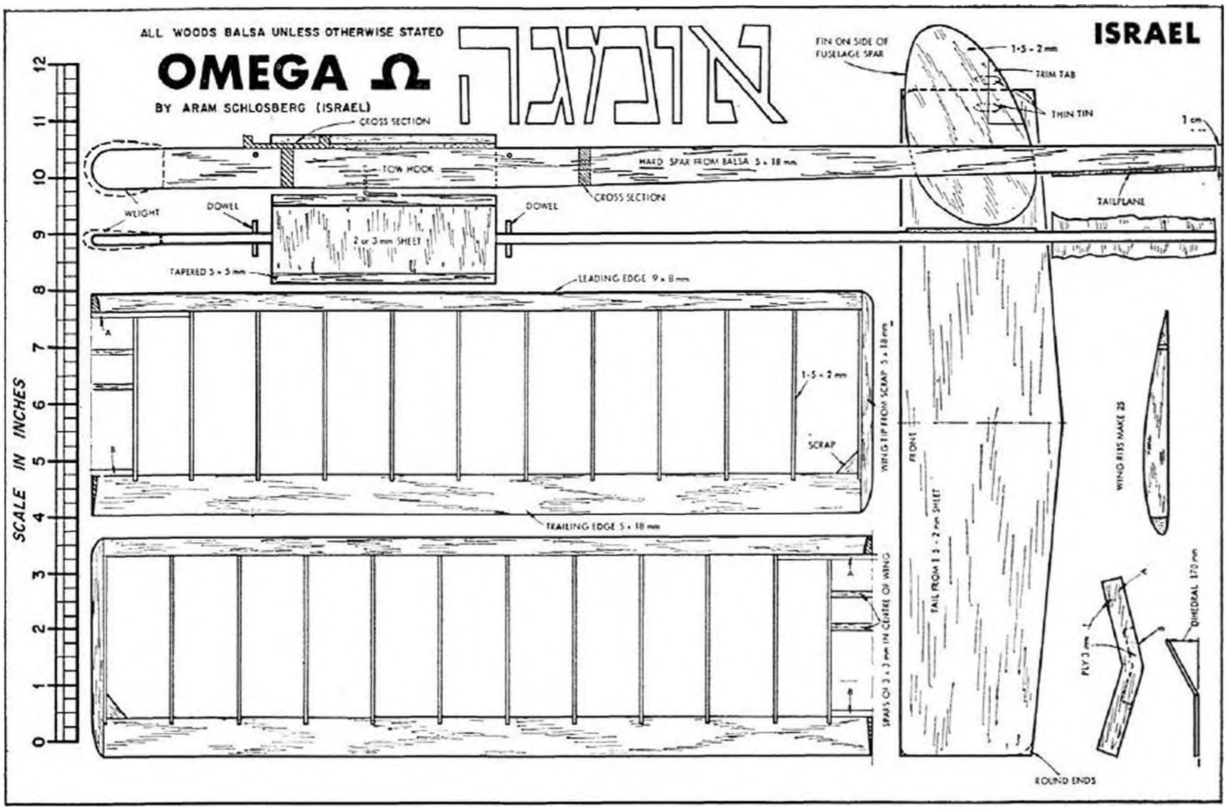
Once started, the scheme must never be allowed to die. That is why the Schools are the mcst attractive source of modeller supply. Given stretched out instruction, so permitting more than one design to be made, the youth has a chance to get a feeling for the hobby. Initial failure can turn into influential success and once bitten by the balsa bug, the new modeller carries on under his own enthusiasm.

Plans for suitable modelling programmes exist, *Aeromodeller Plans Service* can make up a range of from 3 to 20 different designs which will mould the modeller into a fully experienced flier from a simple start. All we need is to spread the word to the *un*converted!

How is it done in other Nations? We have published trainers from the U.S.S.R. in previous editions of this Annual. Issued through DOSAAF, a central aeronautical institution which administrates all civilian aero activities, many different plans and most comprehensive instruction books cover practically every possibility. The Soviet enthusiast has to make for himself many of the items we consider matter of fact "over-the-counter" purchases, and so the plans allow for use of common materials such as hardwoods and wire rather than all-balsa structures. The modeller has to use techniques which would be strange to those in other countries; but at least he has official encouragement. Obviously the volume of material issued must outweigh that of any other Nation. Yet the system does not appear to produce many new names in the contest sphere. The U.S.S.R. is represented time and time again by a small nucleus of experts, which is in direct contrast to many other far less populated Nations. The same could also be said of Hungary, Czechoslovakia and Poland to some extent where official instruction is supplied though on a smaller scale. Could it be that the builders of the *ab initio* designs remain as "sports fliers" and never assume a contest interest? Or is modelling material in these Nations in such short supply that only a few have the traditional materials available to construct the type of model that is Internationally competitive? For these reasons we shall never be able to truly assess the value of recruitment in Eastern Countries.

What then of the West? In the Americas, the Junior Problem is serious. With all possible facilities to hand from a vast commercial output of kit and engine manufacturers supplying a great network of retail outlets, the new generation is turning away from planes for other interests. Aside from isolated Club efforts to form instruction classes we know of no scheme outside the traditional American method of depending on salesmanship at retail and advertising level to halt the fall-off.


Graupner - Schnellbau-Plan
Der kleine UHU
Linke Tragflügelhälfte
left wing panel
Moitié gauche de l'aile
Tragflügel-Draufsicht
plan view of wing
Aile vue en plan
Rechte Tragflügelhälfte
right wing panel
Moitié droite de l'aile
564 mm
Rumpf-Seitenansicht
side view of fuselage
Profil du fuselage
SCHWERPUNKT
CENTER OF GRAVITY
CENTRE DE GRAVITÉ
Bleikammer
ballast chamber
Chambre à contrepoids
Schnitt B-B
Section B-B
Der Leitwerksträger ist verkürzt gezeichnet
The tail boom is not shown full length
Le longeron est reproduit en réduction
Schnitt A-A
Section A-A
14mm
Hochstarthaken
tow hook
Crochet de lancement au câble
Rumpf Draufsicht
plan view of fuselage
Fuselage vu en plan
vor und nach
before and after
Avant et après
abschleifen
sand off / ponçage
der Bearbeitung
shaping
de la pièce
Zusammenbau von Nasen- und Endleiste am Knick
assembly of leading edge and trailing edge at dihedral join
SCALE IN INCHES
0 1 2 3 4 5 6 7 8 9 10 11 12
Streifen aus Bespannpapier
tissue paper strip
Bandes de papier d'entoilage
Kanten abrunden
round off edges
Arrondir les angles
rechte Tragflügelhälfte
right wing panel
Moitié droite de l'aile
Ruder (11) unten nicht an das Höhenleitwerk leimen
Do not cement bottom end of rudder (11) to stabilizer
Ne pas coller le gouvernail (11) en bas sur le stabilisateur
Rumpfkanten abrunden
round off fuselage edges
Arrondir les angles du fuselage
Bleikammer
ballast chamber
Chambre à contrepoids
linke Tragflügelhälfte
left wing panel
Moitié gauche de l'aile
Dreiseiten-Ansicht
3-view drawing
Vue sur les trois côtés
100 mm
250 mm
VERLAG JOHANNES GRAUPNER · KIRCHHEIM-TECK
PUBLISHED BY JOHANNES GRAUPNER KIRCHHEIM-TECK GERMANY
Printed in Germany

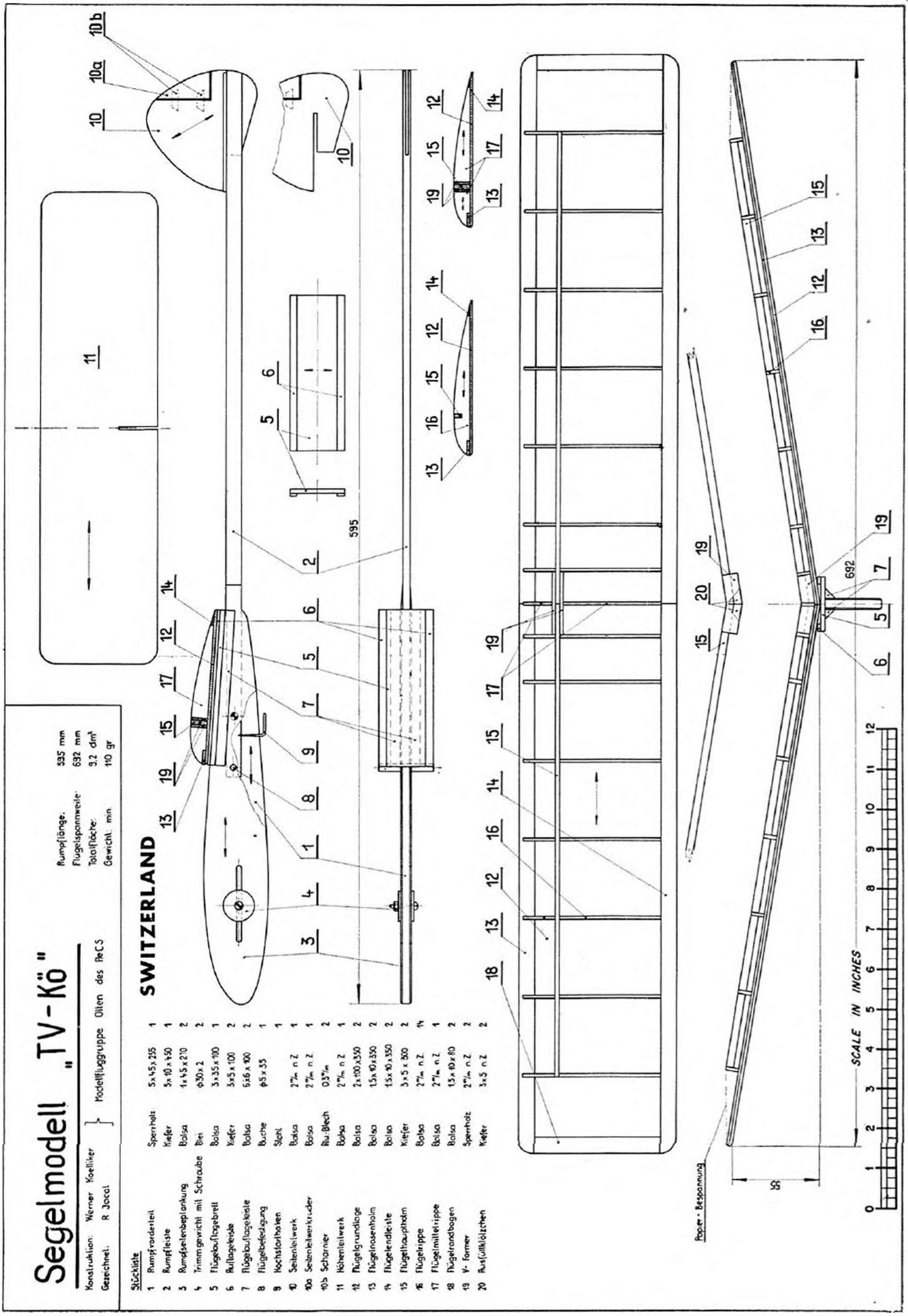


Here in Great Britain, we at *Aeromodeller* have tried our best with "Golden Wings" contests and club talks *etc*; but this is preaching to the converted. One has to spread the story over new ground. The Schools are the most fertile source and as mentioned before, we have hopes.

On the European Continent there are several really enterprising schemes, perhaps the most famous being that sponsored in West Germany by the UHU adhesive company. Inaugurated in 1955, the contest for "Der kleine UHU" calls in 1965 for five flights made at any time between July and October by a youth of 14 years or under. Sponsored by the glue manufacturers, run by the German Aero Club, and with kits available from retail sources at most reasonable rates, it is no wonder that the contest is a success. Moreover it gets a lot of TV time and instruction lessons have been run on TV showing how to make the little glider. Flights have a maximum duration set at three minutes each, have to be certified and also be made off a 50 metre line. Finalists get together at a youth centre for the deciding contest to see who wins the handsome prizes.

Model itself is a simple structure, not so very different from the general arrangement of trainer designs of 30 years ago. Wings are constant chord, the fuselage has a pod shaped nose and the tail surfaces are of sheet balsa.

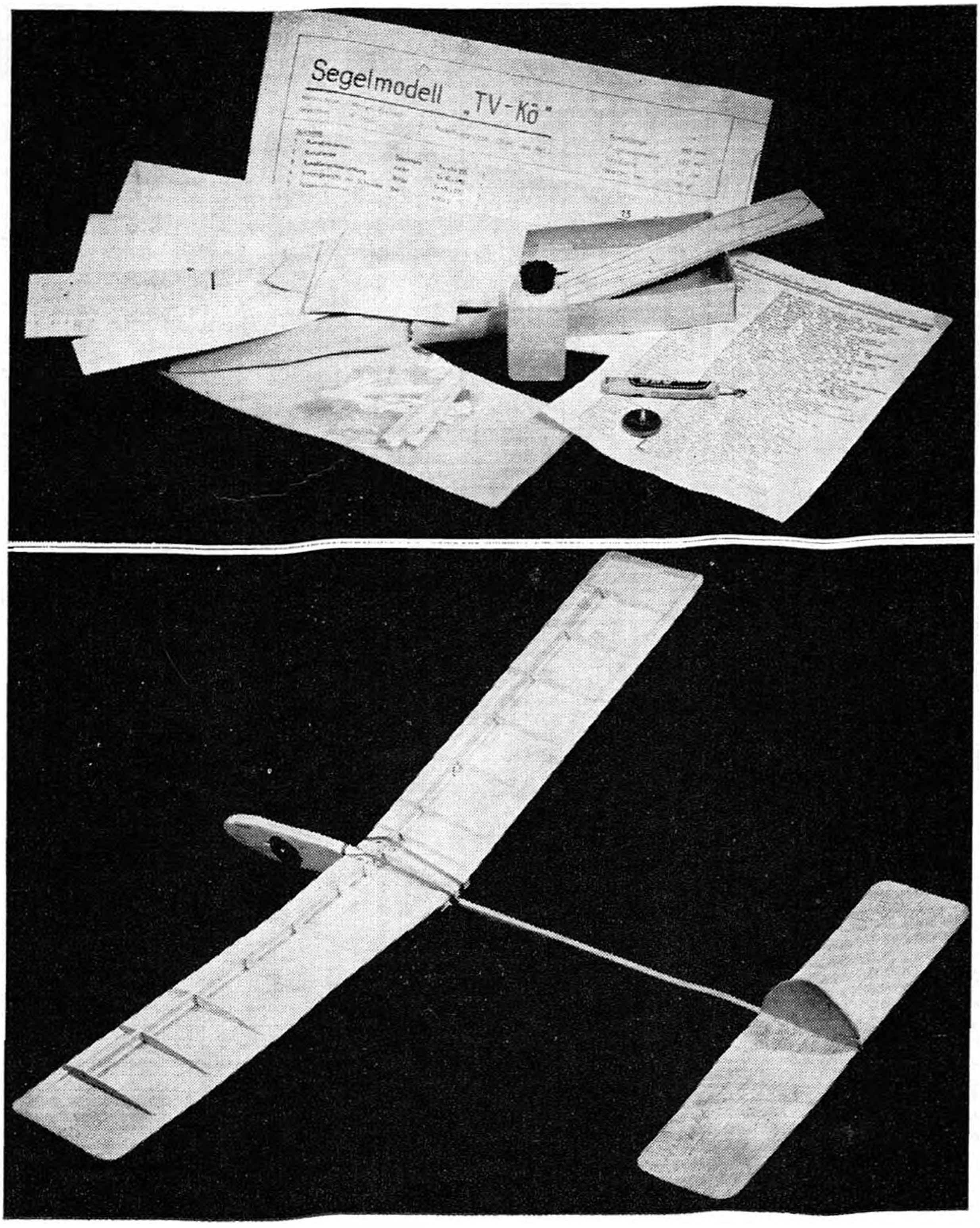
Success of this contest probably influenced the Swiss. They had a TV programme by W. Köelliker which centred upon a simple glider of about 28 inches span created by the Olten Club. Produced as a kit, the "TV-Kö" employs the same traditionally simple features of "Der kleine UHU" in construction with the exception that the wing is made up over a sheet balsa base, leaving only the top of the wing for tissue covering. We made up one of these "TV-Kö" models and it turned in a fine performance. Kit includes a noseweight, cement and dope. All you need that is outside the normal demands of the household is a fretsaw for the nose pod, but the Swiss always seem to have a fretsaw around

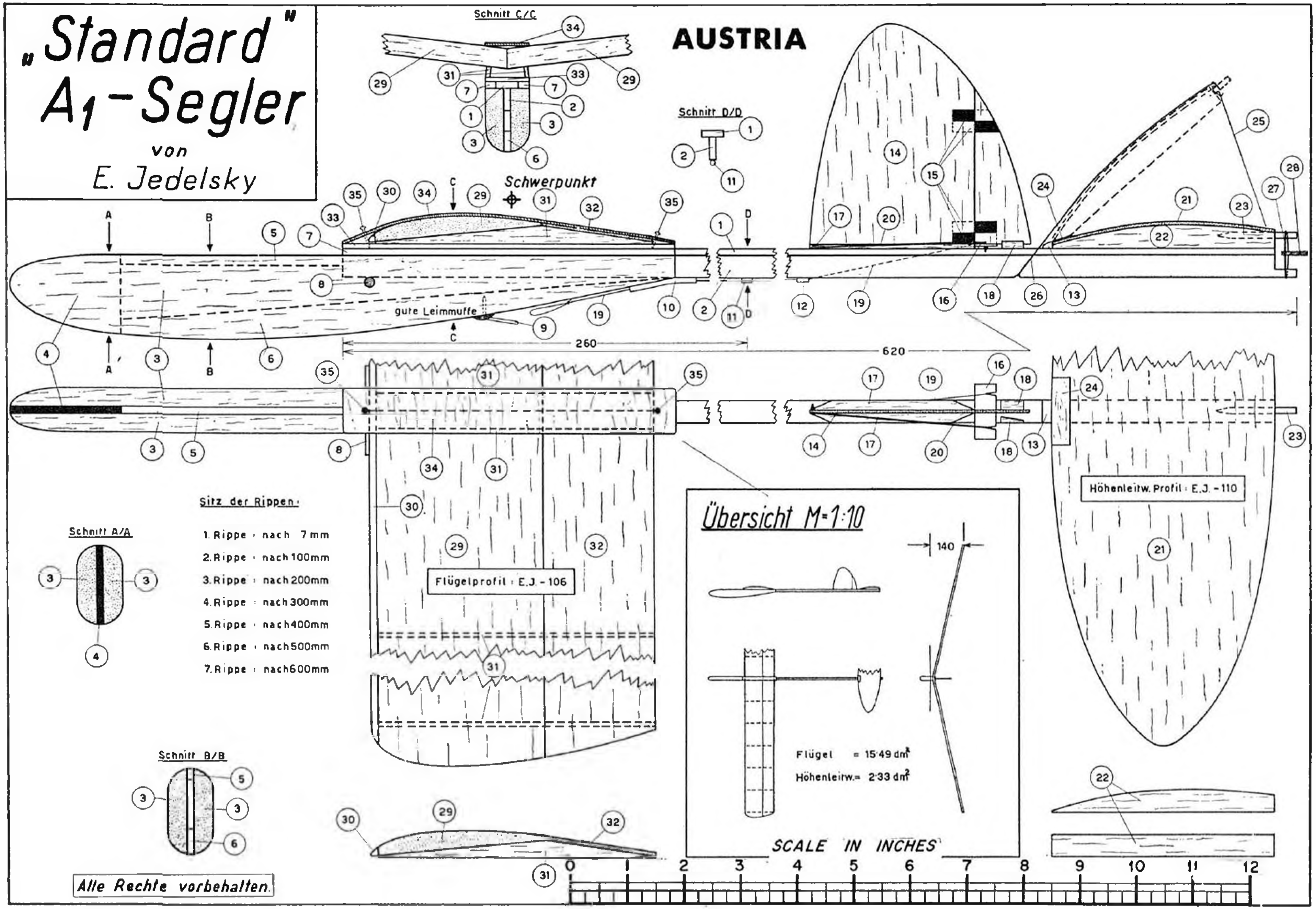

Segelmodell „TV-Kö"
Konstruktion: Werner Koelliker
Gezeichnet: R Jacol
Modellfluggruppe Olten des AeCS
Rumpflänge: 595 mm
Flügelspannweite: 692 mm
Totalfläche: 9.2 dm²
Gewicht: min. 110 gr
SWITZERLAND
Stückliste
1 Rumpfvorderteil Sperrholz 5x45x255 1
2 Rumpfleiste Kiefer 5x10x450 1
3 Rumpfseitenbeplankung Balsa 1x45x210 2
4 Trimmgewicht mit Schraube Blei φ30x2 2
5 Flügelauflagebrett Balsa 3x35x100 1
6 Auflageleiste Kiefer 3x5x100 2
7 Flügelauflageleiste Balsa 6x6x100 2
8 Flügelbefestigung Buche φ5x35 1
9 Hochstarthaken Stahl 1
10 Seitenleitwerk Balsa 2 mm n.Z. 1
10a Seitenleitwerkruder Balsa 2 mm n.Z. 1
10b Scharnier Alu-Blech 0.3 mm 2
11 Höhenleitwerk Balsa 2 mm n.Z. 1
12 Flügelgrundlage Balsa 2x100x350 2
13 Flügelnasenholm Balsa 1.5x10x350 2
14 Flügelendleiste Balsa 1.5x10x350 2
15 Flügelhauptholm Kiefer 3x5x300 2
16 Flügelrippe Balsa 2 mm n.Z. 14
17 Flügelmittelrippe Balsa 2 mm n.Z. 1
18 Flügelrandbogen Balsa 1.5x10x80 2
19 V-Former Sperrholz 2 mm n.Z. 2
20 Ausfüllklötzchen Kiefer 3x5 n.Z. 2
595
692
55
Papier-Bespannung
SCALE IN INCHES
0 1 2 3 4 5 6 7 8 9 10 11 12

for their other interests in Cuckoo Clocks. We understand that the introduction of TV publicity and production of the kit has strengthened the Swiss modelling movement considerably.

In Austria, the "Standard" construction methods devised by Erich Jedelsky have helped to remove many of the difficulties facing the beginner and make him or her more sure of a good start in the hobby. A feature on the methods appears elsewhere in this Annual and we featured the A/1 "Standard" as long

Swiss kit model in parts and assembled below. Note the uncovered upper wing surface, over which tissue is applied, and the solid sheet undersurface. See plan on page opposite.



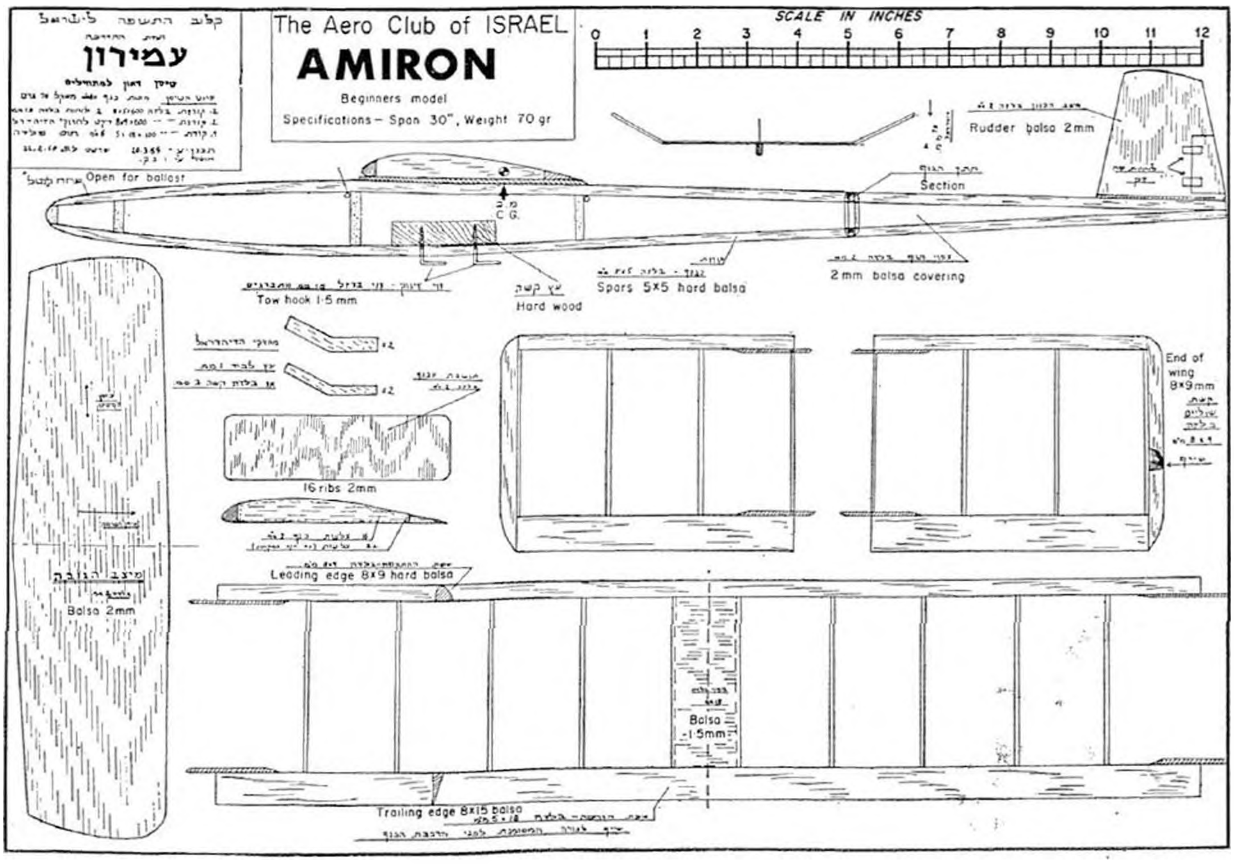

„Standard"
A1-Segler
von
E. Jedelsky
AUSTRIA
Schnitt C/C
Schnitt D/D
Schwerpunkt
gute Leimmuffe
260
620
Schnitt A/A
Schnitt B/B
Sitz der Rippen:
1. Rippe : nach 7mm
2. Rippe : nach 100mm
3. Rippe : nach 200mm
4. Rippe : nach 300mm
5. Rippe : nach 400mm
6. Rippe : nach 500mm
7. Rippe : nach 600mm
Flügelprofil : E.J. - 106
Höhenleitw. Profil : E.J. - 110
Übersicht M=1:10
140
Flügel = 15·49 dm²
Höhenleitw.= 2·33 dm²
SCALE IN INCHES
0 1 2 3 4 5 6 7 8 9 10 11 12
Alle Rechte vorbehalten.

ago as in the 1962/63 edition. Now the model is kitted by Czepa in Vienna, with profiled parts in balsa and spruce, cement, dope, and even rubber bands. Having an auto-rudder and a dethermaliser which is most essential, as it can be a two-minute model, the "Standard A/1" is a refined design which is frequently employed in youth competitions. For example, an event for school pupils held in 1964 was held in three classifications, A, B, and C. Grade C was for two flights with the pupil flying his own towline gliders of 3 ft. 6 in. to 5 ft. span, and then the five best made a total of five flights each to determine the winners. All these finalists used the "Standard A/1". In Class A, models were simple chuck gliders of up to 24 in. Class B was for 24 in. to 39 in. span towline gliders and they were of the all-sheet type, launched by the teachers. Durations of over a minute may not sound much to the experienced but to these youngsters, in a brisk wind, the impression is great. To us the impressive thing is the entry. 188 in Class A, 99 in Class B, and 58 in Class C, all between the ages of 10 and 14 years! Object lesson there!

In Finland, a range of official Aero Club designs covers all categories. We illustrate a couple of the more popular, and "Hyttynen" dates back over 25 years with an estimated construction total exceeding ten thousand. It remains popular in spite of a modernised version being introduced in more recent years. The Finns also have a fame for prowess with gliders and "Kiuru" designed as an A/1 by members of the club of the same name is a standard introductory model. Study the plans. There is a lot of plain commonsense in these Finnish Aero Club models and they have performance too.

Completing our collection are a couple of gliders from Israel. The Central Committee of the Aero Club of Israel, situated in Tel Aviv, gives every en-

Plan opposite also refers to article on page 128. Note use of Standard parts in this Austrian design. Below is one of two Israeli designs included in this survey of beginner models.

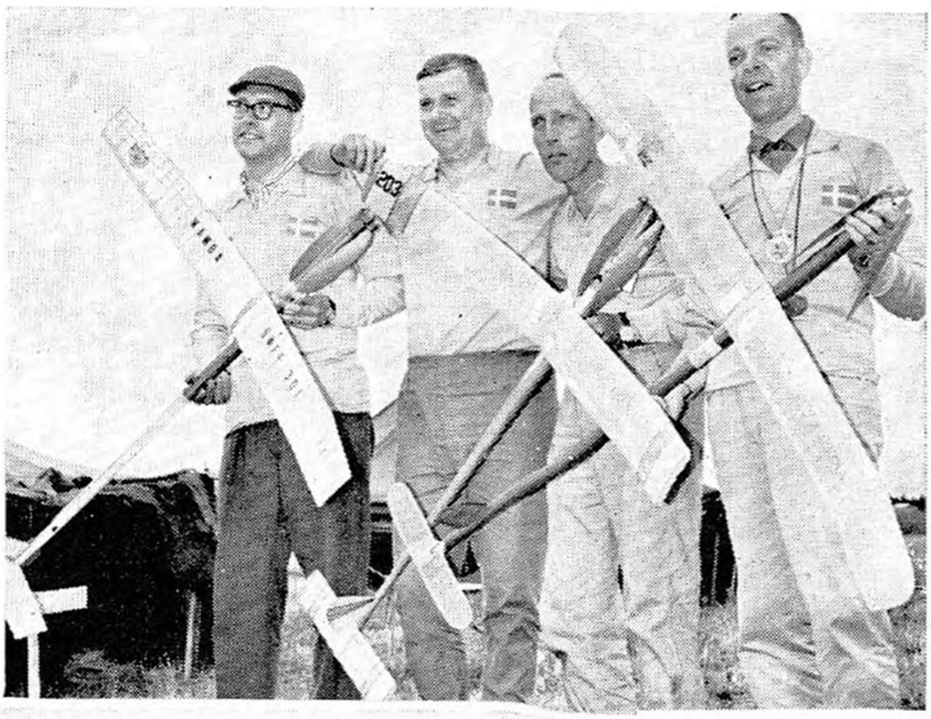


couragement to the aeromodeller. These two beginner designs are by experienced contest fliers and have been constructed in large numbers. "Amiron" is by Amos Yardeni and dates back to 1953. It can make flights of around a minute in proper trim. "Omega" is of 1962 vintage and was designed by Aram Shlossberg. It regularly makes two minutes. Materials may not necessarily be balsa, but the reader will note that the designs permit one to take advantage of whatever is available to the constructor.

These examples show what can be done, and indeed what has been done for many years in Nations with foresight enough to look after youthful interests in aeromodelling. In most cases they were obliged to develop their own approach for reasons of language and international economics. Now, we look to them for their experience in trying to foster interest in our own affluent society.

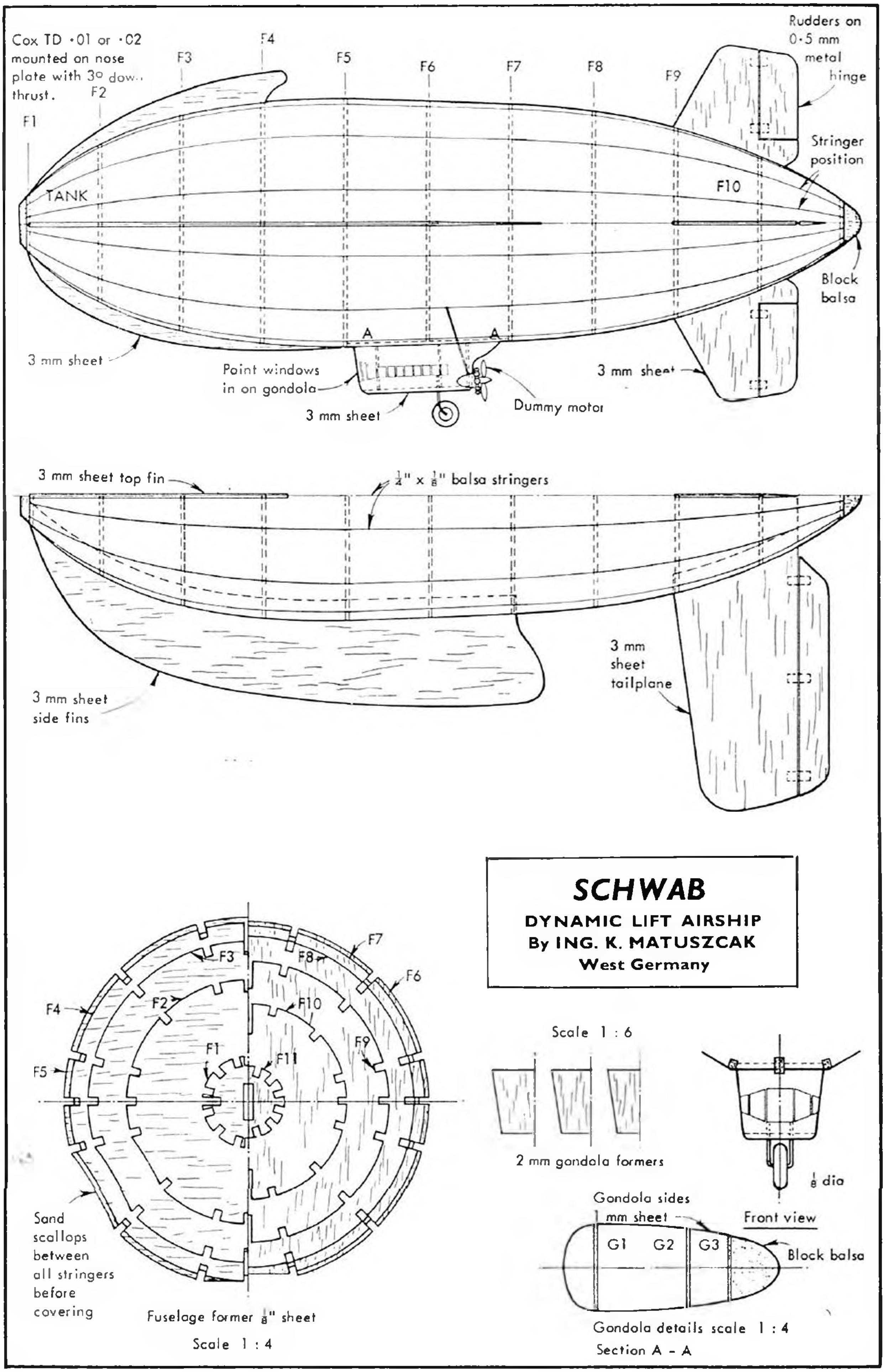
The formula is simple.

Add a spark of interest to a spot of instruction with a sound design and lots of after-sales service. Result, an *aero*, rather than an *error*modeller. Unfortunately, though we know the ingredients of the formula, there's far too little of each to spare these days!

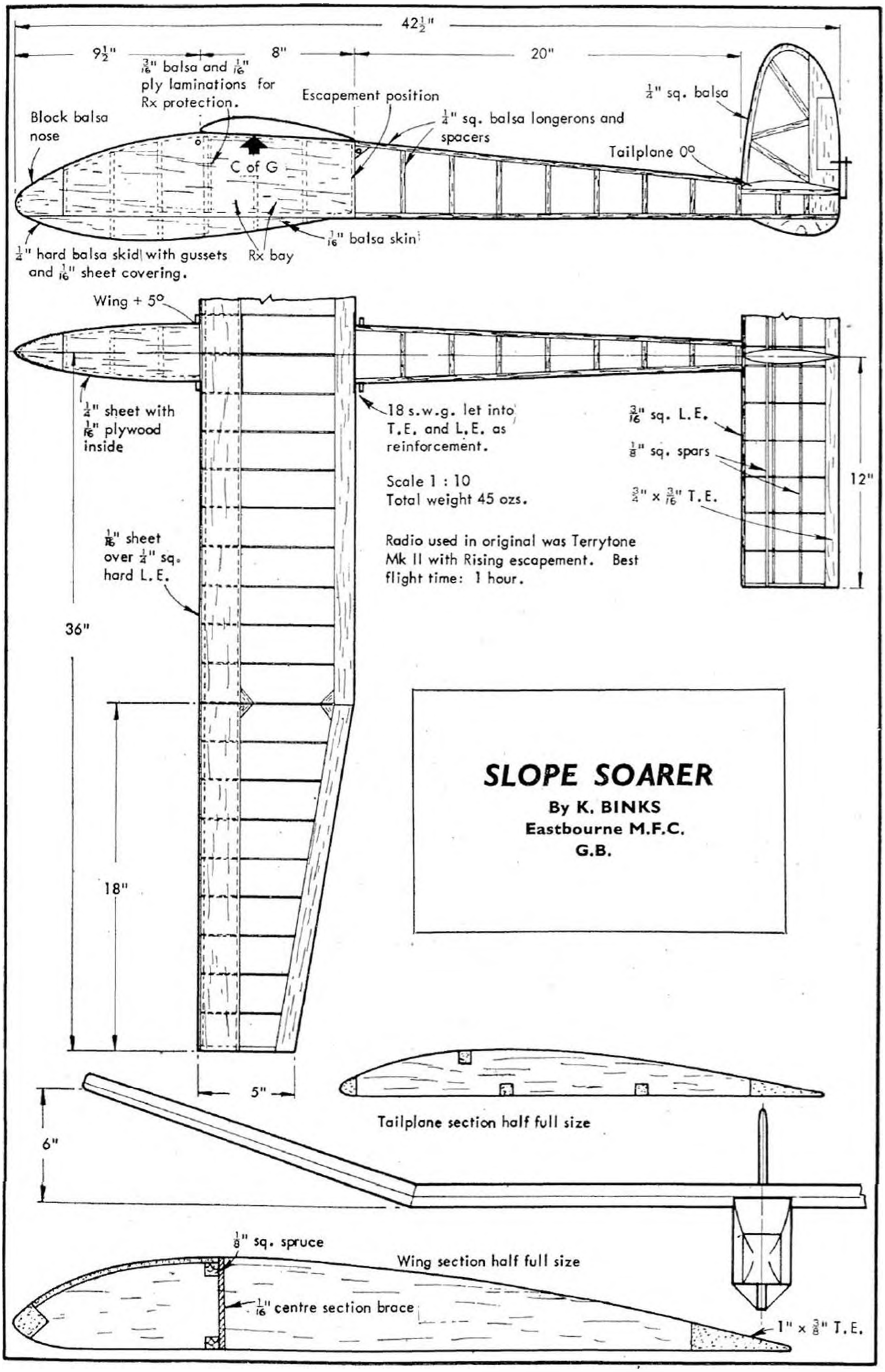


Invincible Wakefielders from SWEDEN. With a perfect score of 2,700 seconds they took the team trophy in the 1965 Wakefield contest. Left to right, Lennart Flodstrom, team manager Karl Ericsson, Rune Johanssen and Bengt Johanssen (not related). Their success was due to terrific modelling standards and fine tactics in thermal selection by the manager.

Tying with the team from the U.S.A. Carlo Lenti, Alberto Dal'Oglio (eventual winner) G. Barthel (team manager) and Gianfranco Grifoni of *ITALY* who made a perfect score for the 1965 World Power Championship at Kauhava, Finland.



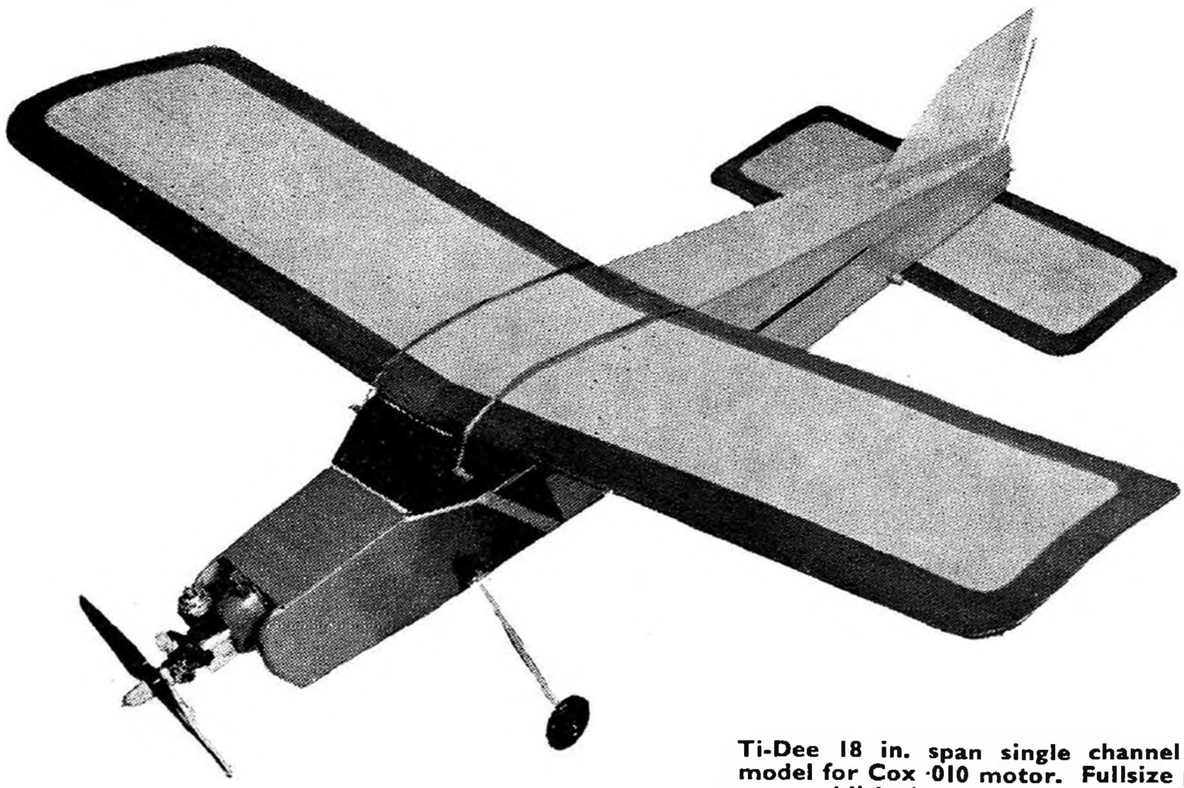
FLUG MODELL TECHNIK, GERMANY.



SLOPE SOARER

By K. BINKS
Eastbourne M.F.C.
G.B.

"SEA DOG" NEWSLETTER, GREAT BRITAIN



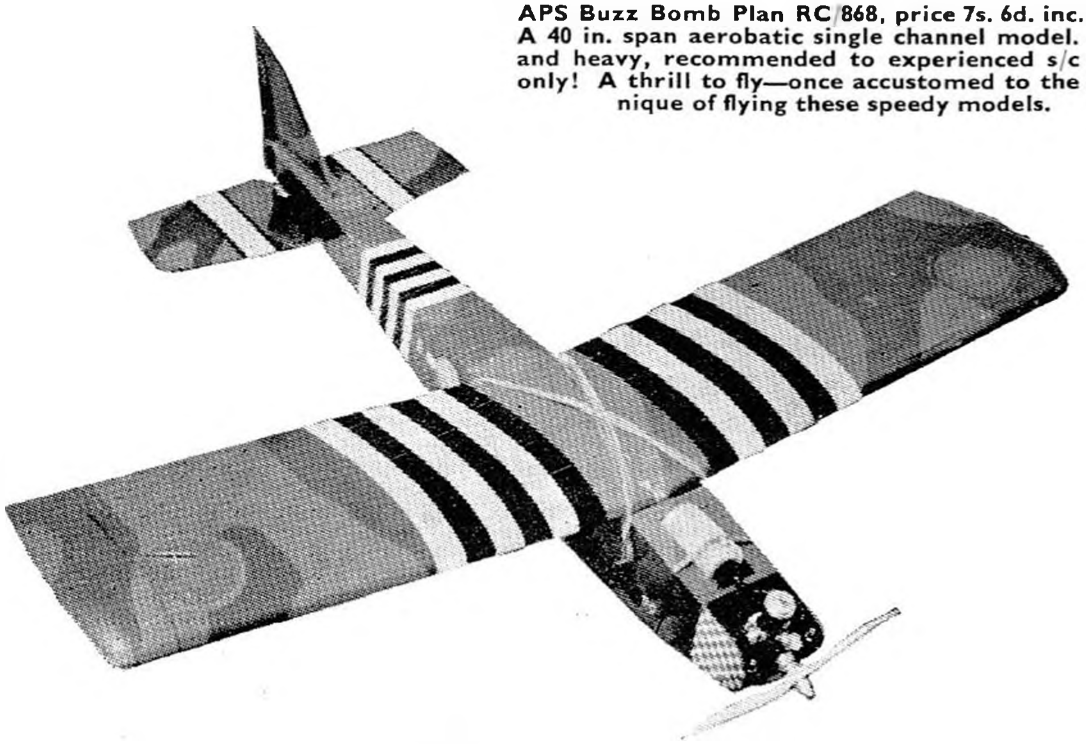
Ti-Dee 18 in. span single channel r/c model for Cox ·010 motor. Fullsize plan was published in our magazine *Radio Control Models & Electronics*, January 1964.

BASIC SINGLE-CHANNEL R/C

IN considering radio control, a basic truth has to be faced. The only real advantage which single-channel radio can offer is minimum cost. It is distinctly limited in the degree of practical control which it can provide, and also in scope for flying. Thus even with rudder only, two-channel control is better than single-channel; and for *complete* control, eight-channel coverage is required. However, the cost difference is so considerable that single-channel radio is by far the most popular in numbers (in Britain, at least). Also, by knowing the limitations and working accordingly, single-channel flying can be very satisfying. It also opens up scope for the radio control of very small models —in fact, it can cover virtually all practical free-flight model sizes from the smallest to the largest.

The basis of single-channel radio control is a single signal, so that "multiple" response can only be obtained by a sequence of signals. In practice the simple single-channel actuator provides two "sequence" positions, corresponding to right and left rudder positions, self-neutralising on release of signal. Thus control signals give *alternatively* right or left rudder. The *compound* actuator incorporates a slightly different action to give *selective* signalling, although it still works as a sequence device. Thus signal on (held) gives *right* rudder (normally) and signal "on-off-on and held" gives *left* rudder. This is better for operating as a flying control.

A "third" position can also be provided on a compound actuator, selected by a sequence signal (e.g., on-off-on-off-on and hold); or merely by a quick blip of the control signal. The first method provides a "hold" position for a control movement. The second method provides a means of switching a



APS Buzz Bomb Plan RC/868, price 7s. 6d. inc. post. A 40 in. span aerobatic single channel model. Fast and heavy, recommended to experienced s/c fliers only! A thrill to fly—once accustomed to the technique of flying these speedy models.

second actuator to operate an additional service on a change-over basis. Both forms of additional control service may be provided on a single compound actuator, but "quick-blip" switching always demands the use of a second actuator.

Theoretically, at least, it is possible to extend control service coverage by extending the available sequence of "signalled" positions, the primary actuator switching in a secondary actuator at a specified signal sequence which can then be signalled through its own sequence, even controlling further actuators in this manner. This is generally referred to as employing actuators (usually escapements) in "cascade".

In practice, extension of single-channel signalling to multiple services in this manner soon becomes unworkable, mainly due to the time lag involved and the difficulty of maintaining correct and virtually instantaneous "sequence" switching. The most reliable single-channel radio control—and the one which is easiest to fly—uses just a single actuator controlling one main control. Motor speed "change-over" control via "quick-blip" switching and a secondary actuator is also a practical proposition and well worth adding when the model is large enough to accommodate the additional weight and an engine of a size which can be fitted with an effective throttle. The third "hold" position on a compound actuator can also be used for selecting an elevator "trim" movement (usually known as trip elevator) *one way only*, at the expense of some loss of versatility and consistence of selection of the rudder control. The best advice which can be offered regarding any basic single-channel control system which attempts anything more ambitious is—forget it!

This means that with single-channel we have just one main control available, and the control invariably chosen is rudder. Rudder is a fairly violent control and so corrective action on release of control, plus an ability for the model to fly normally with the rudder neutral and no other control available, demands a certain amount of inherent "free flight" stability in the model design. As a result the typical "free flight" layout with high wing and fairly generous dihedral and moderate engine power makes the best layout for flying, slightly modified to meet "rudder response" requirements.

No model which does *not* have a certain amount of inherent free-flight stability will make a satisfactory single-channel radio model. The control available is really a displacement from a normal free-flight path, after which the model must recover on its own when the control is taken off. Models with marginal stability, like low wings, make poor single-channel models, although they approach the ideal layout for multi-channel radio where near neutral stability is required since *full* control coverage is available. This is also a pity since ailerons would be a more "moderate" control for turning than rudder, but ailerons are usually better on a low wing model than a high wing in this respect. Thus the "aileron only" rather than "rudder only" single-channel model is a better proposition as a low wing than a high wing. It is a type worth developing, but the present standard remains rudder as the primary control and the high wing layout.

The basic single-channel design layout has become more or less standardised over the years, scaled up or down according to the model size required. It owes much to the original "Live Wire" designs by de Bolt, although refined in detail and with a tendency to make fuselages slimmer as receiver-actuator installations have become more compact. These basic design proportions are summarised in the outline plan.

There are no real limits to model *size* which can be built to these proportions. With a sub-miniature receiver and lightweight escapement, the complete installed radio gear weight can be as low as 2 ounces. Thus a model of 18 in. to 20 in. span becomes a practical proposition powered by the smallest commercial size of engine (·010 glow). Equally the same proportions could be scaled up to a 10 or 12 footer, although there is not much point in building such large models merely for single-channel control—to say nothing of the transport difficulties involved. A nominal maximum size, therefore, would be of the order of 5 ft. span for powering by a 2·5 to 3·5 c.c. engine.

Small models have the advantage of being quick and easy to construct, cheaper as regards materials and engine cost, and less prone to crash damage than larger models. On the other hand they are really only suited to still air flying—or at least calm weather with a wind drift of not more than about 6-8 m.p.h. Larger models are less critical as regards trim, fly rather better and are easier to control. They can also be flown in breezy weather quite satisfactorily,

Simplex: simplest possible single channel r/c design with all sheet construction, including solid sheet wing. Span 36 in., for ·3 to ·8 c.c. (·020—·049 cu. in.) motor and lightweight r/c equipment. Fullsize plans appeared in *Aeromodeller* May 1964.

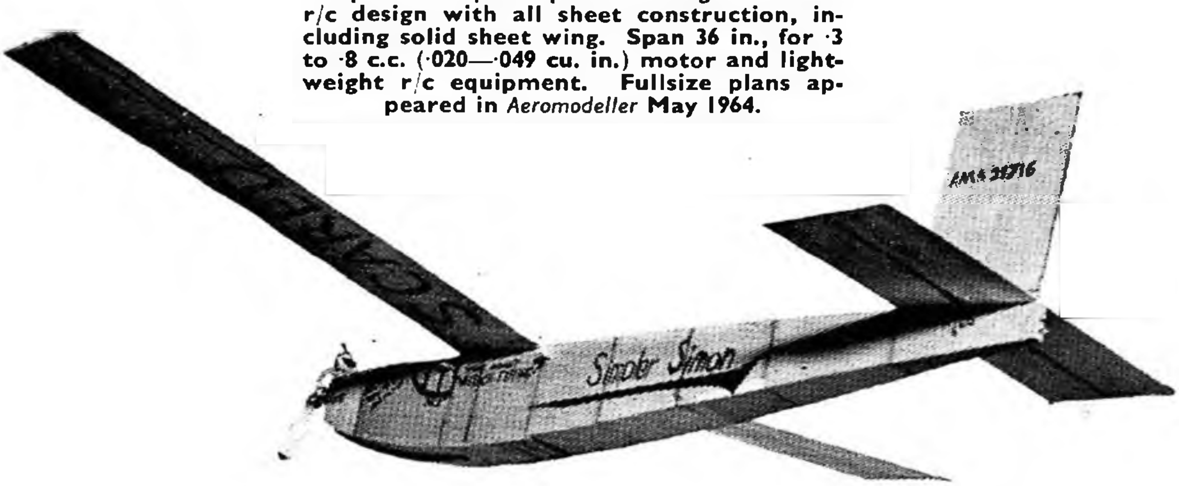


TABLE I DESIGN CONSIDERATIONS

	DESIGN FEATURE	KEY	VALUE Related to Semi-span (S) unless noted otherwise
DIMENSIONS VARIABLE WITH MODEL SIZE	Wing Span		2 S
	Wing Chord	C	·4 S
	Nose Length	N	S/3
	Tail Moment Arm	M	S/2
	Fuselage Length	L	approx. ·8 × span or 1·6S
	Fin Height	H	·25 S
	Base Chord at C/L	B	·35
	Tip Chord	E	·17 S or B/2
	Fuselage Depth: Above C/L	D1	·1 S
	Below C/L	D2	·085 S
	Tailplane Span	T	·8 S
	Root Chord	R	·26 S
	Tip Chord	G	·23 S
	Chord for parallel tailplane		·25 S
FIXED PROPORTIONS	Balance Point		·3 C (30% Chord)
	Wing Dihedral		8° min., 10° max., 8½° recommended
	Wing Rigging Incidence		+1½°
	Tailplane Rigging Incidence		0°
	Sidethrust		2° right, or as required
	Downthrust		3°-5°, as required
	Wing Section—Flat bottom		12½% thick min., 13½% recommended
	Tailplane Section		Flate plate or thin symmetrical
	Undercarriage position: Orthodox		Under Wing L.E.
	Tricycle		Main wheels ·55C back from L.E.

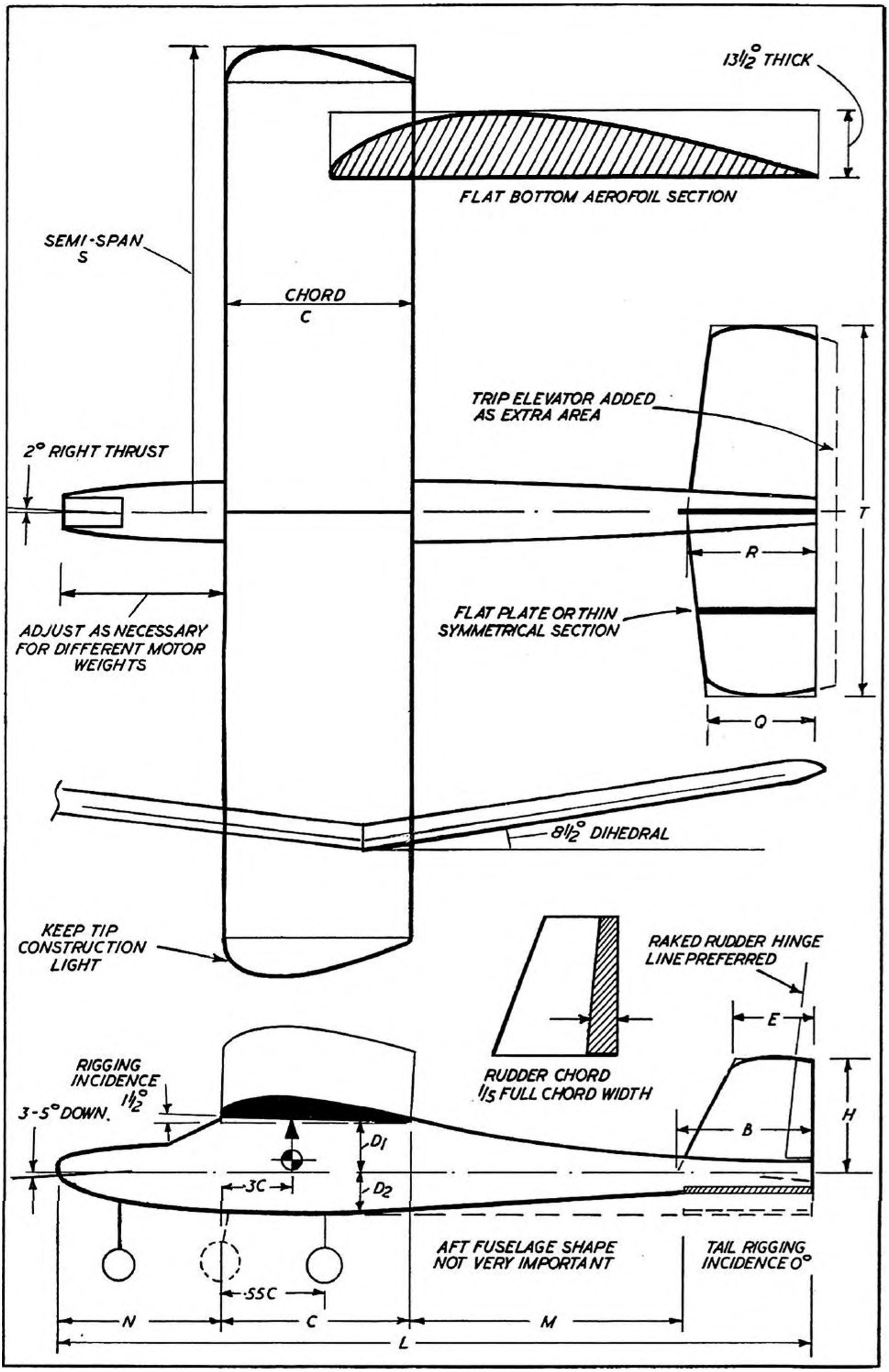
but not strong winds. No single-channel radio model is really suitable for flying in winds of more than about 15 m.p.h. as the best that can be done under such circumstances is usually to keep them heading into wind with little or no scope for manoeuvres as otherwise the model would drift too far downwind to make enough headway to land near the take-off point.

Basically, we would say, the 48 in. single-channel model with suitable engine power is about the best size; although a slightly smaller model will compare well for manoeuvrability fitted with lightweight radio. A larger model will tend to be sluggish by comparison and more limited in the scope of manoeuvres it can perform. The smaller model is trickier to fly and essentially a "still air" job. Typical recommendations are summarised in Tables I and II.

TABLE II SINGLE-CHANNEL MODEL SIZES

MODEL SPAN in.	ENGINE(S)	CONTROLS Rudder	Engine Speed	Trip Elevator	Escapement	Motorised Actuator
20	·010 Glow	X	N	P	X	NS
28	·020 Glow	X	N	P	X	NS
36	·049 Glow ·5 Diesel	X	N	S	X	NS
42	·049 Glow / ·8-1 c.c. Diesel	X	N	S	X	P
48	·09 Glow / 1·5 c.c. Diesel	X	X / P	P	S	X
54	·15 Glow / 2·5 c.c. Diesel	X	X	P	S	X
60	·19 Glow / 3·5 c.c. Diesel	X	X	P	S	X

X = Recommended installation
P = Possible but not generally recommended
S = Suitable
NS = Not suitable
N = Not practical


13½° THICK
FLAT BOTTOM AEROFOIL SECTION
SEMI-SPAN S
CHORD C
TRIP ELEVATOR ADDED AS EXTRA AREA
2° RIGHT THRUST
T
R
ADJUST AS NECESSARY FOR DIFFERENT MOTOR WEIGHTS
FLAT PLATE OR THIN SYMMETRICAL SECTION
Q
8½° DIHEDRAL
KEEP TIP CONSTRUCTION LIGHT
RAKED RUDDER HINGE LINE PREFERRED
E
RUDDER CHORD 1/5 FULL CHORD WIDTH
RIGGING INCIDENCE 1½°
3-5° DOWN.
H
B
D1
D2
·3C
AFT FUSELAGE SHAPE NOT VERY IMPORTANT
TAIL RIGGING INCIDENCE 0°
·55C
N
C
M
L

APS Schoolmaster plan RC/875 price 7s. inc. post. Span 39 in. for ·049 (·8cc) cu. in. A beginner's r/c model for s/c. Features all sheet covered wing for strength and rigidity. Designed by Ken Willard, best known of the ace American lightweight fliers.

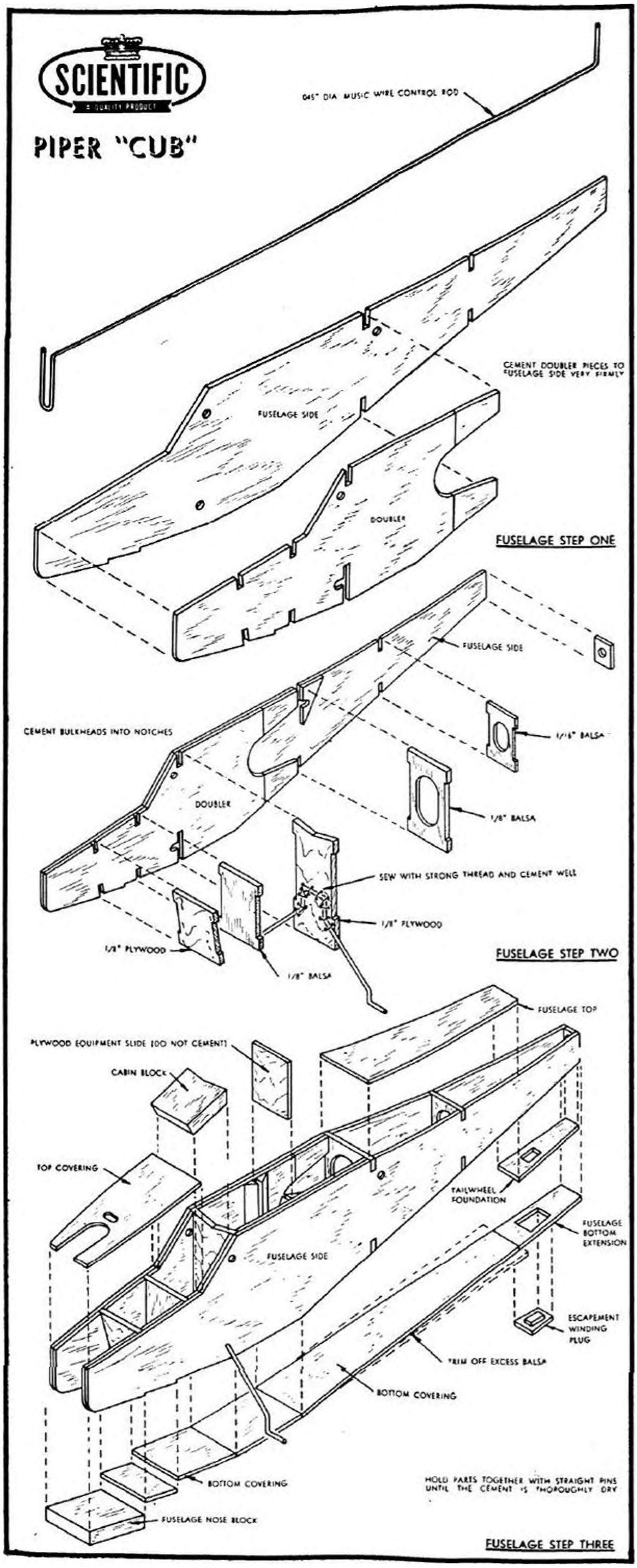
As regards engines, glow motors are generally to be preferred to diesels as being smoother running and less susceptible to changes in flight speed. In the larger sizes glow motors are also usually more responsive to simple throttle controls than diesels. On the other hand the diesel is the preferred type for sports flying in Britain and has the advantage of being a completely self-contained power unit requiring no starter battery and using fuels which do not demand fuel-proofing of conventional cellulose dopes and finishes. The fact that most modern receivers are of relayless type also makes the vibration question less critical—so choice of engine type is usually a matter of individual preference, or availability, in single channel model sizes.

On the airframe side, extensive use of sheet balsa construction is now usual, particularly for fuselages, making for strong and rigid structures which are quick and easy to build accurately. Built-up all-sheet wings are also coming into favour for spans up to 40 in.—see article on MODERN STRUCTURES. Structural design is seldom a critical factor but needs to be somewhat more robust than that of similar free-flight sports models. At the same time airframe weight should be kept reasonably light. Unnecessary "built-in strength" also means more built-in weight—and the heavier the model the harder it will hit in a crash! The main reason why the baby models survive crashes which would write off a larger model is that they are *light*.

Typical recommendations for construction are summarised in Table III. These data are allied to the typical model sizes previously analysed. For convenience of laying out a design outline dimensions for different sizes are worked out in Table IV. This should be all the information necessary to build a successful single-channel radio control model of any size within the range covered.

For single-channel radio an escapement is usually preferred for the actuator as being cheaper and lighter than motorised actuators, as well as (usually) faster in operation. An escapement should always be chosen on *performance* rather than price. An escapement which does not work reliably is *quite useless*. Pay what is necessary to get an escapement which really is reliable—it will be the cheapest of the lot in the long run. After all, the life of the engine, model and receiver is really in the hands of the escapement once the model is airborne.

Motorised actuators can only be accommodated in the larger models although modern units of this type have been reduced to only 2 ounces in weight. They are to be preferred as an engineering solution, but only a proportion of relayless receivers will operate a motorised actuator satisfactorily. Most will not develop enough output current for driving the actuator motor, or are subject to interference from the motor. The vast majority of single-channel radio flying is still done with escapements, although motorised actuators are undoubtedly coming more to the fore, together with suitable receivers to match. Use only a combination *known* to work—i.e., if in doubt as to the ability of a receiver to work a motorised actuator, use an escapement. Even then there is still the chance of some interference between escapement and receiver, but this can be overcome by bonding the escapement to the output linkage (i.e., by soldering a suitable length of flexible wire between the body of the escapement and the wire link).



Detail from Scientific Kit (U.S.A.) shows sheet structure applications.

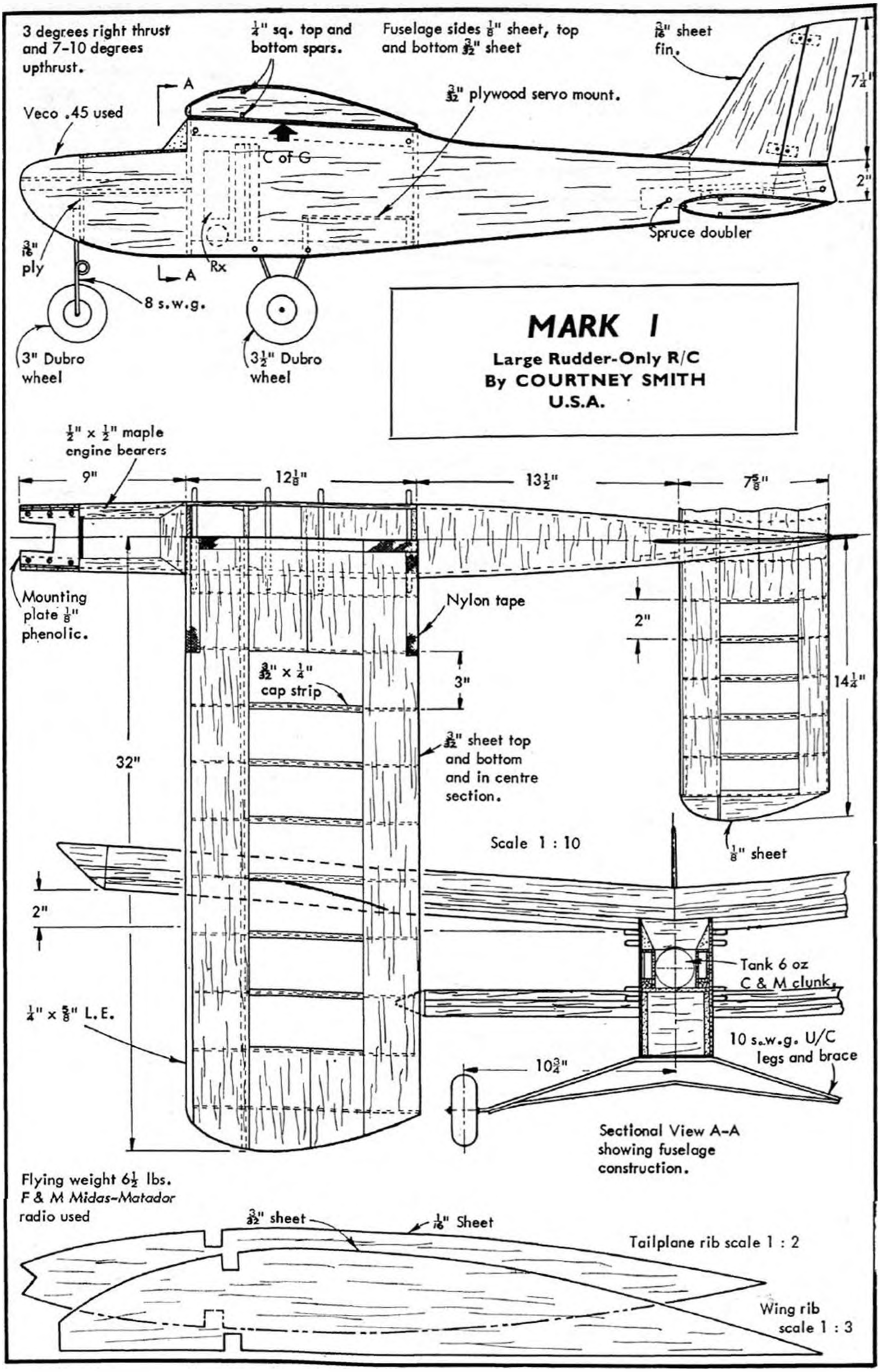
TABLE III STRUCTURAL DESIGN

STRUCTURE	SPAN (inches)						
	20	28	36	42	48	54	60
Fuselage: Sheet box	X	X	X	X	X	X	X
Built-up, tissue covered	S	S	S	S			
Built-up, nylon covered				S	S	S	S
Glass fibre moulding	NS	NS	NS	NS	NS	NS	S
Wings: Built-up, tissue covered	S	S	S	S	S	S	S
Built-up, nylon covered	NS	NS	NS	NS	NS	S	X
All-sheet	X	S	S	S			
All-sheet, tissue covered	S	X	X	S			
Built-up, sheet balsa skinned	NS	NS	NS	NS	NS	S	S
Expanded Polystyrene			S	S	S		
Expanded Polystyrene—balsa skinned						S	S
Tailplane: Built-up, tissue covered	S	S	S	S	X	X	S
Built-up, nylon covered	NS	NS	NS	NS	NS	S	X
Solid sheet	X	X	X	X	S		
Fin: Built-up, tissue covered					S	X	X
Solid sheet	X	X	X	X	X	S	S

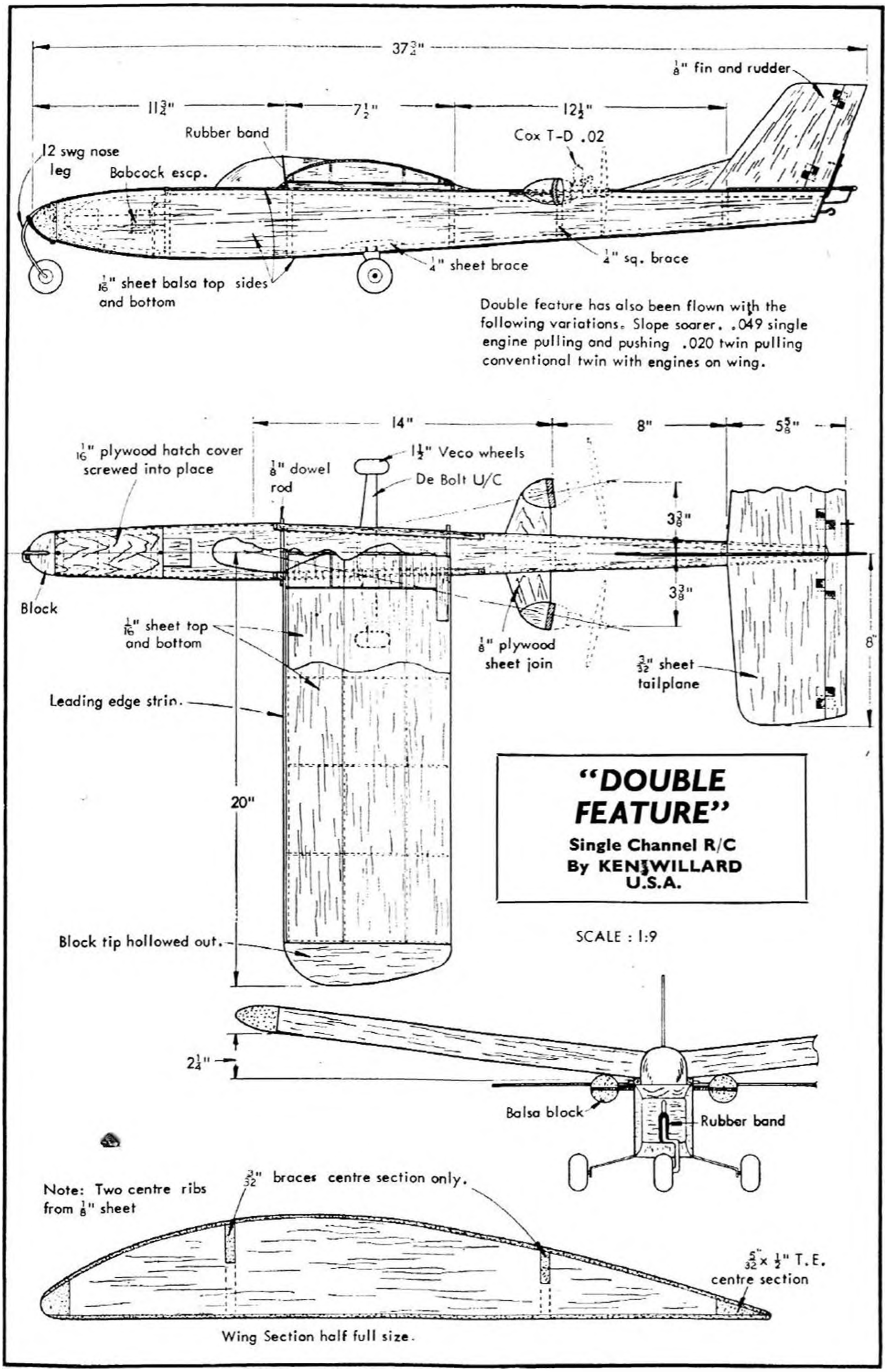
X = Recommended S = Suitable NS = Not suitable

TABLE IV WORKED OUT DIMENSIONS FOR SINGLE-CHANNEL MODELS
(Adjusted as necessary)

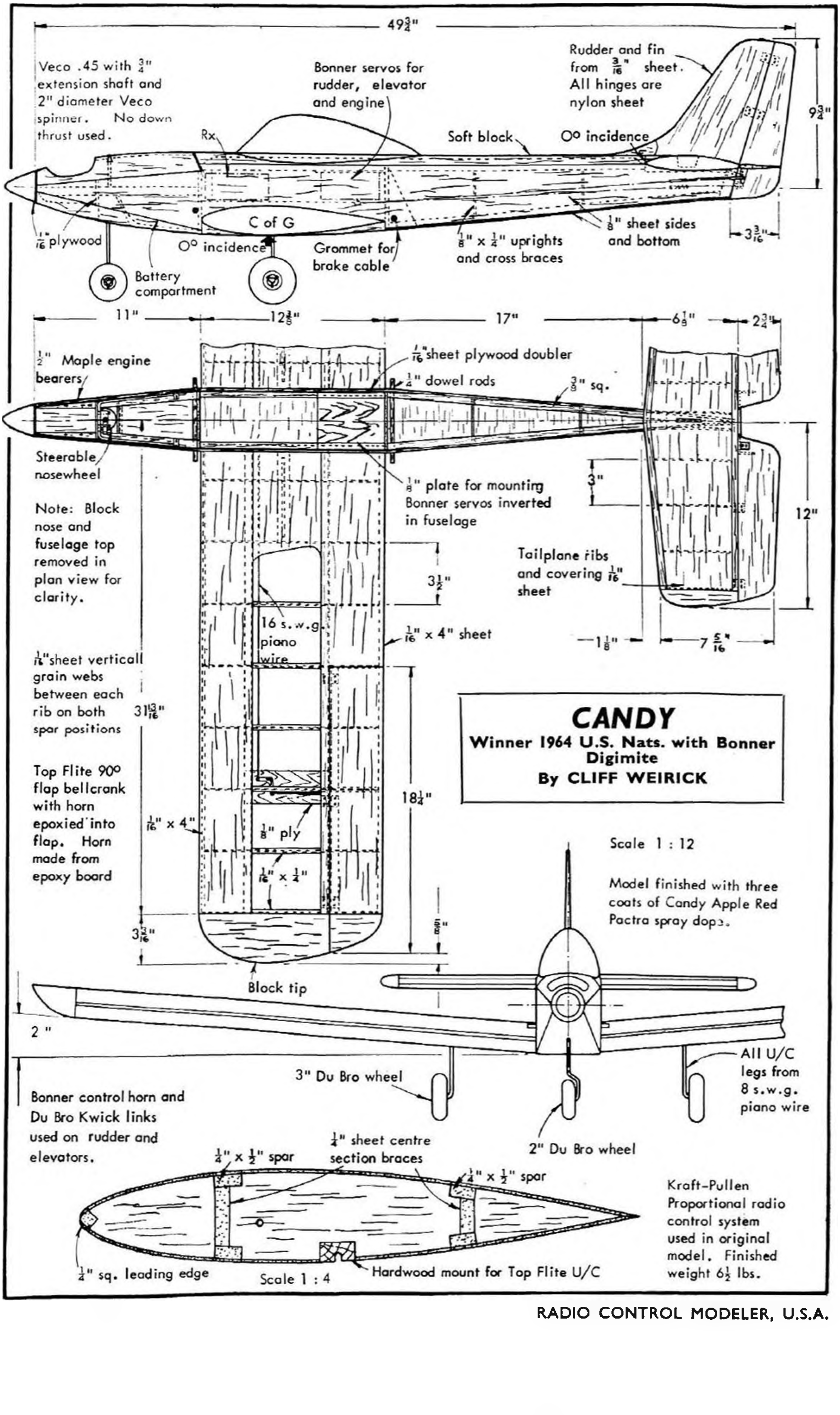
LAYOUT DIMENSIONS (See Basic Plan)	SPAN (inches)						
	20	28	36	42	48	54	60
Semi-span S	10	14	18	21	24	27	30
C	4	5½	7·2	8·4	9½	10½	11
N	3-3¼	4-4½	5½-6	6½-7	8	9	10
M	5	7	9	10½	13½	12	15
L	16	22½	29	34	38	42	46
H	2½	3½	4½	5¼	6	6¾	7½
B	3	4·2	5·4	6·3	7·2	8·1	9
E	1½	2·1	2·7	3·15	3·6	4	4½
D_1	1½	1½	2	2¼	2½	3	3½
D_2	1¼	1¼	1½	2	2	2¼	2½
T	8	11¼	14½	17	19	22	24
R	2·6	3·65	4·7	5½	6¼	7	7¾
Q	2·3	3·2	4·2	4·8	5½	6¼	7
Chord for Parallel Chord Tailplane	2·5	3¼	4½	5¼	6	6¾	7½



RADIO CONTROL MODELER, U.S.A.



RADIO CONTROL MODELER, U.S.A.

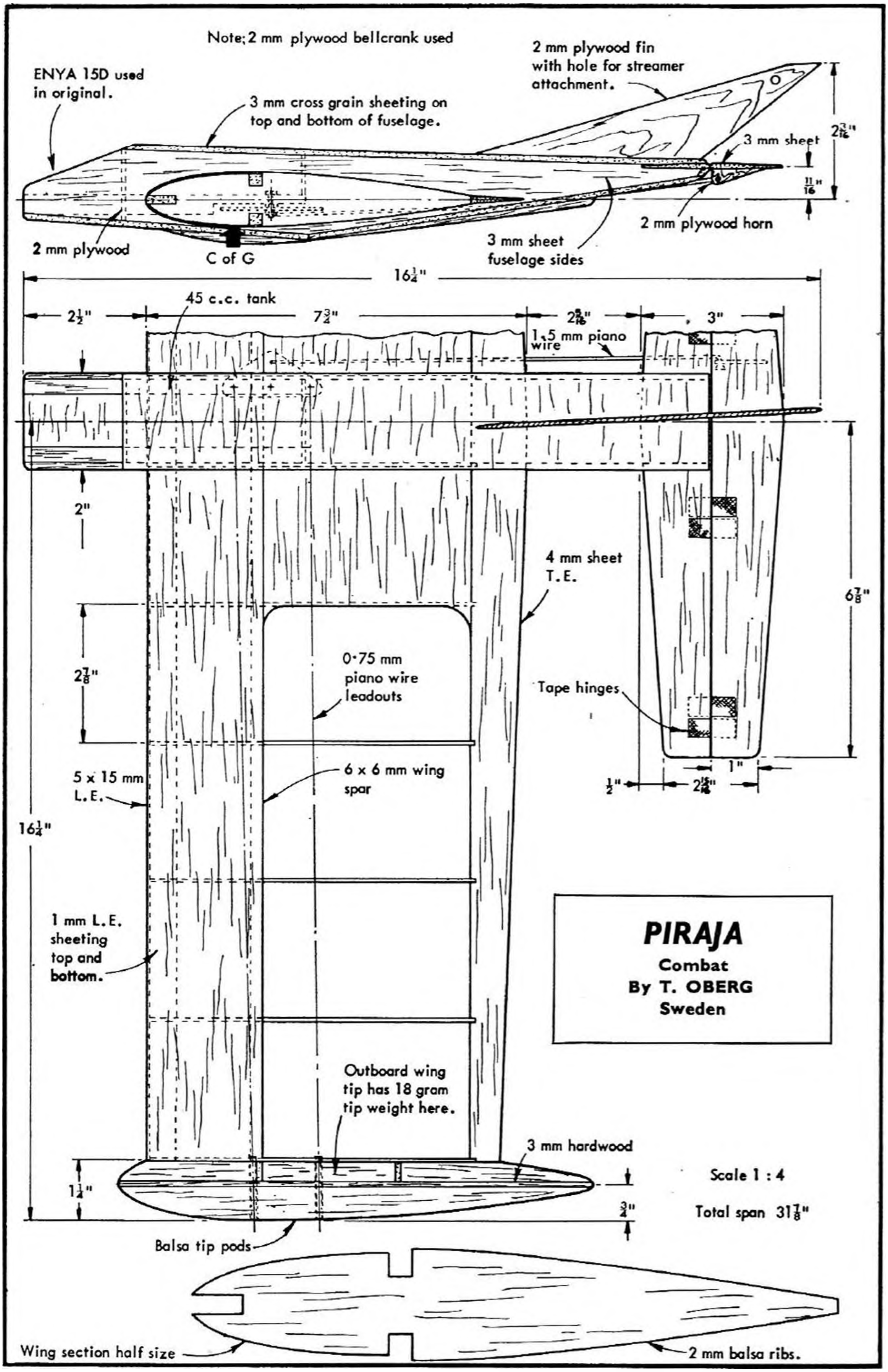


CANDY

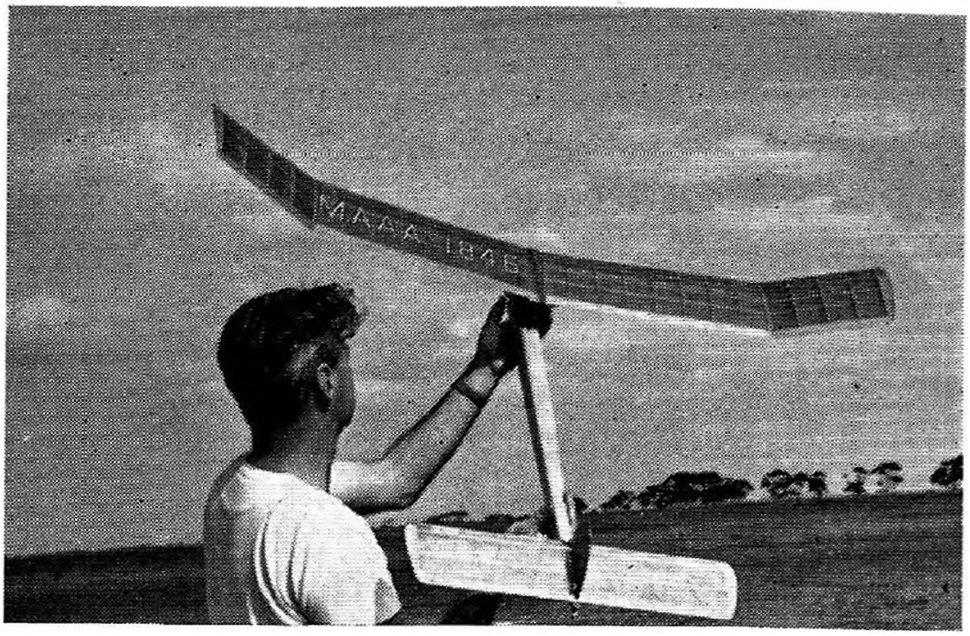
Winner 1964 U.S. Nats. with Bonner Digimite

By CLIFF WEIRICK

RADIO CONTROL MODELER, U.S.A.



MODELL FLYGNYTT, SWEDEN



MINICANO

by FORD LLOYD (Australia)

GENERAL layout of this Australian ½A power duration design was influenced by the American "Fly Rod" but the airfoil section, areas, etc., are the result of studying Harry Conovers ½A article in the 1960 Christmas issue of *Aeromodeller*, plus experiences with F.A.I. models.

From the very start, the original model was non-critical to fly, and very easy to adjust, provided the surfaces are true, and the weight watched carefully.

The first one was flown in the 1961-62 Australian Nats, and although it was lost on the second flight, had sufficient margin to clinch the event, using an ancient design with an A.M.10 for the third flight as a reserve.

Next success was at the 1962 Victorian State Championships; when it won all three places the winning time was a ratio of 27, or 3 min. maxes off about 7 sec. engine runs!

At the 1963 Nats, designer Ford Lloyd placed 2nd, after two very good flights (the first was a max.: off 7 secs. in dead calm conditions). He knocked the tail with his hat on launching in the third round, and the turn tightened up and didn't get the usual height.

The weights of the various parts are as follows:

Fuselage complete with K.S.B. timer, Tee Dee 051 and 5½ in. × 4 in. Tornado nylon, 5½ oz.

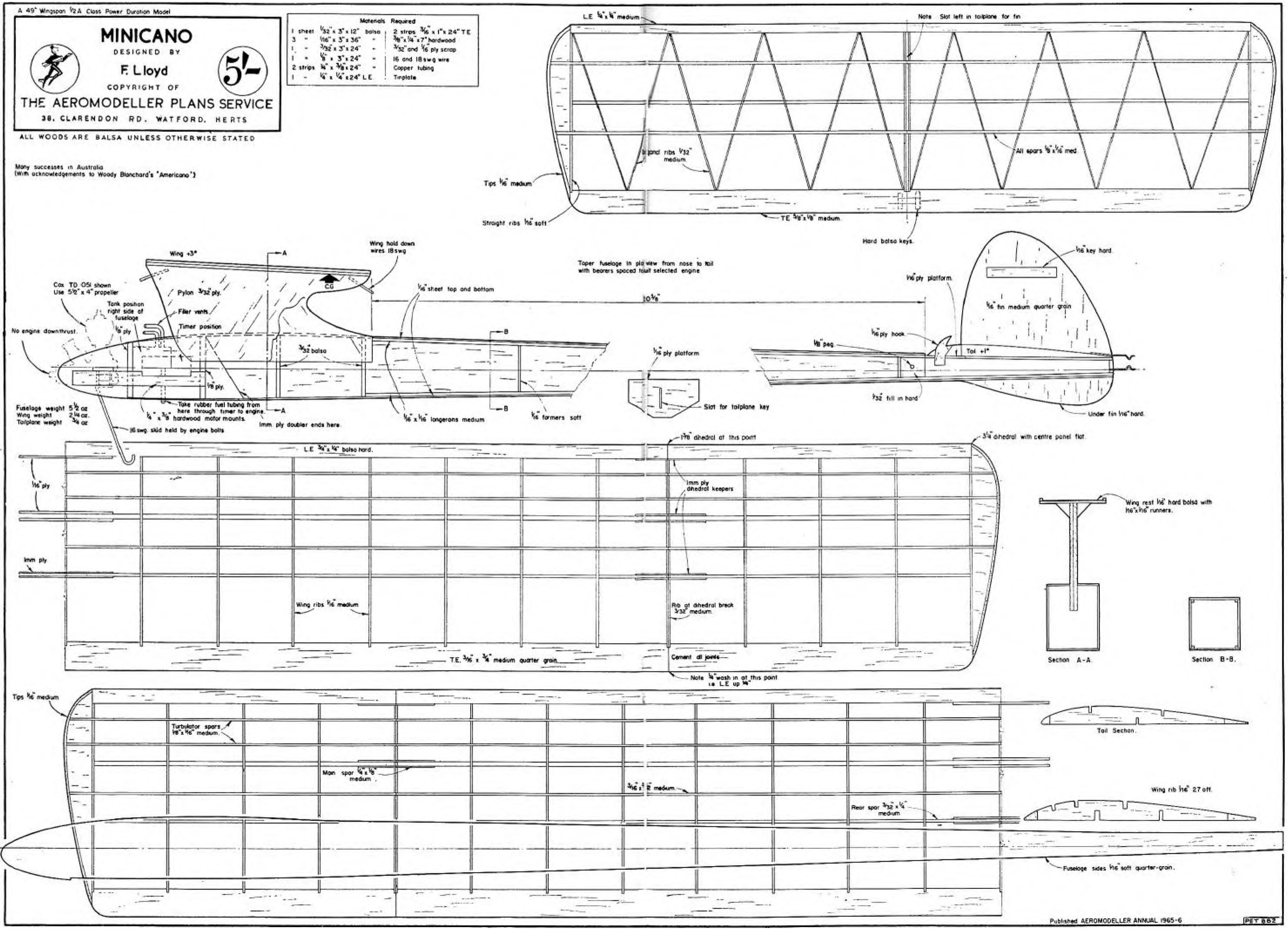
Wing 2¼ oz., tailplane ¾ oz.

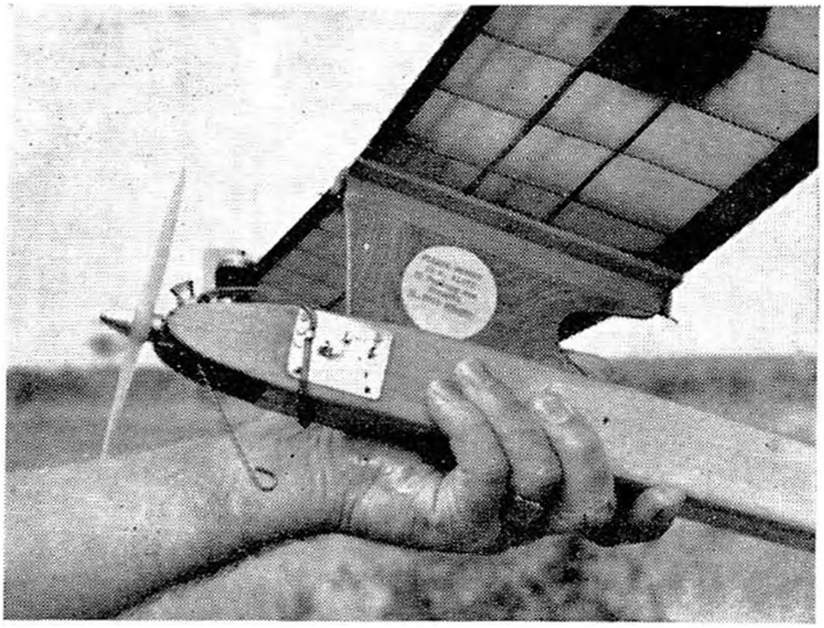
Weight could be further reduced by smaller wood sizes, and selecting all woods carefully, but Ford personally prefers a model with a slight reserve of strength, to cope with rough conditions.

Construction is straightforward and any modeller with limited experience would have no trouble building this model.

The wings and tailplane are covered with red lightweight Modelspan, and the fuselage with yellow, the entire fuselage and tank compartment are coated with polyurethane lacquer as a fuel-proofer.

Plan overleaf: Text continued on page 50


A 49" Wingspan 1/2A Class Power Duration Model
MINICANO
DESIGNED BY
F. Lloyd
5/-
COPYRIGHT OF
THE AEROMODELLER PLANS SERVICE
38, CLARENDON RD., WATFORD, HERTS
ALL WOODS ARE BALSA UNLESS OTHERWISE STATED
Many successes in Australia
(With acknowledgements to Woody Blanchard's "Americano")
Materials Required
Fuselage weight 5 1/2 oz
Wing weight 2 1/4 oz.
Tailplane weight 3/4 oz
No engine downthrust.
Wing +3°
Pylon 3/32" ply.
Filler vents
Timer position
CG
Wing hold down wires 18 swg
1/16" sheet top and bottom
1/16" x 1/16" longerons medium
1/16" formers soft
Imm ply doubler ends here.
16 swg. skid held by engine bolts
Taper fuselage in plan view from nose to tail with bearers spaced to suit selected engine
10 3/8"
1/16" ply platform
Slot for tailplane key
1/8" peg
1/16" ply hook
Tail +1°
3/32" fill in hard
1/16" key hard
1/16" fin medium quarter grain
Under fin 1/16" hard.
L.E 1/4" x 1/4" medium
Note Slot left in tailplane for fin
All spars 1/8" x 1/16" med.
Tips 1/16" medium
Straight ribs 1/16" soft
TE 5/8" x 1/8" medium.
Hard balsa keys.
L.E. 3/4" x 1/4" balsa hard.
1/16" ply
Imm ply
1 3/8" dihedral at this point
3 1/4" dihedral with centre panel flat.
Imm ply dihedral keepers
Wing ribs 1/16" medium
Rib at dihedral break 3/32" medium.
T.E. 3/16" x 3/4" medium quarter grain
Cement all joints
Note 1/4" wash in at this point i.e. L.E up 1/4"
Wing rest 1/16" hard balsa with 1/16" x 1/16" runners.
Section A-A.
Section B-B.
Tips 1/16" medium
Turbulator spars 1/8" x 1/16" medium.
Main spar 1/4" x 1/8" medium
Rear spar 3/32" x 1/4" medium
Tail Section.
Wing rib 1/16" 27 off.
Fuselage sides 1/16" soft quarter-grain.
Published AEROMODELLER ANNUAL 1965-6
PET 882



Trimming: all adjustments are right-right and with the C.G. in the right place and wash-in as indicated in the right wing panel, the climb should be steep and to the right, so that when the motor cuts, the model will slide into a right-hand glide, the climb pattern can be controlled with slight right thrust or bending the rudder to the right, the glide circle is established by tail tilt, the tail being tilted parallel to the starboard inner wing section.

The name Minicano is derived from the "Americano" design of Woody Blanchard. The designer became known Americano Lloyd, so when he built this small model, he naturally called it a Mini-cano.

LAMINATED WAKEFIELD PROPS. 1964/65

by MIKE WOODHOUSE

I FIRST tried my hand at laminating props. two years or so ago basing my ideas on articles in the *N.A. News* and *Model Aircraft*. It was not until Geoff Lefever joined the Norwich Club that I made any usable props. Geoff's ideas helped to convince me that these types of props. were worth-while. Firstly a summary of the pros and cons is, I think, in order.

For:

1. *Quicker* to make. (More experiment in sizes can therefore be made).
2. *Stronger*. Control of strength is easier by wood selection and if wished slight cross graining of laminations can be attempted.
3. Greater *accuracy* and *similarity* of blades, less material is used and the bottom surface is finished during moulding to the former, thickness is controlled by the number of laminations, final shaping can be checked by comparing the glue lines on each blade.
4. *Cheaper*. Sheet is more economical to use than block and a greater selection of grades can be made.
5. *Easier* to make, once the former is made this should be well made. Mine are made by the method developed by Geoff Lefever.

Against:

1. *Weight*. This *can* be kept down to that of a normal type of block carved type, with care in wood selection.
2. *Warping* tendencies can be eliminated by careful gluing (do not use a glue that "pulls", cascomite is very good for laminating) an accurate former and sufficient ageing before removal.

3. Probably the biggest suspicion against these types of props. is the idea "that if it's not carved from block it's not right". The only way to satisfy this query is to build one and try it. I'm personally convinced they are not just as good but far better.

To summarise: the only way I believe, to make a success, is to satisfy the following:

1. A well made and accurate former. 2. Use only soft wood.
3. Use a non-shrinking glue.

Construction of Props.

Former

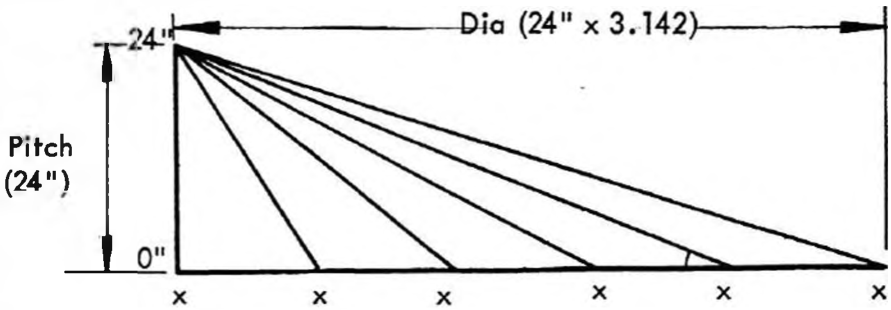
Pitch is calculated in normal manner, my own preference is pure geometric pitch no extra flare in or out.

Cement formers on lines marked. *NOTE:* fix with *front* of former on *forward* line.

When set plank with $\frac{1}{8}$ in. × $\frac{1}{4}$ in. (soft), first strip will need trimming to fit base board.

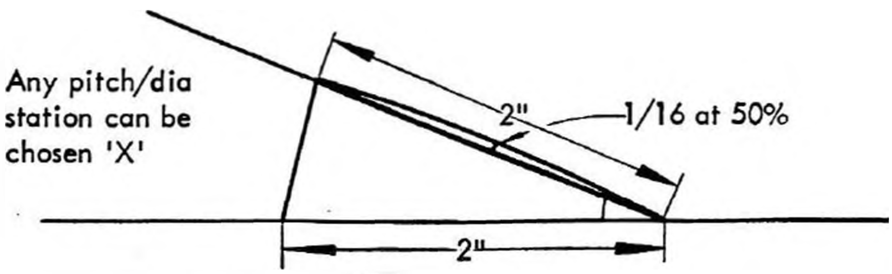
When set carefully sand and finish with sanding sealer. Then polish with wax to prevent sticking.

NOTE: Finished former will appear to be curved in all planes.

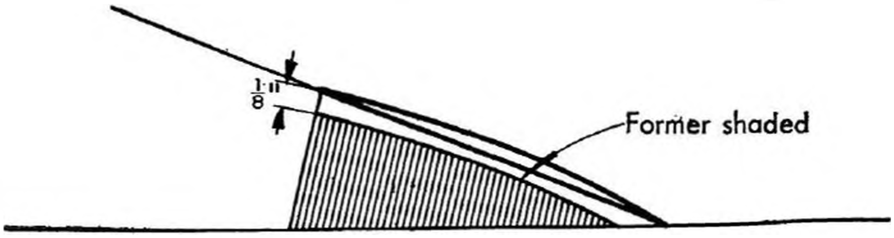


Former planed from above thus:-

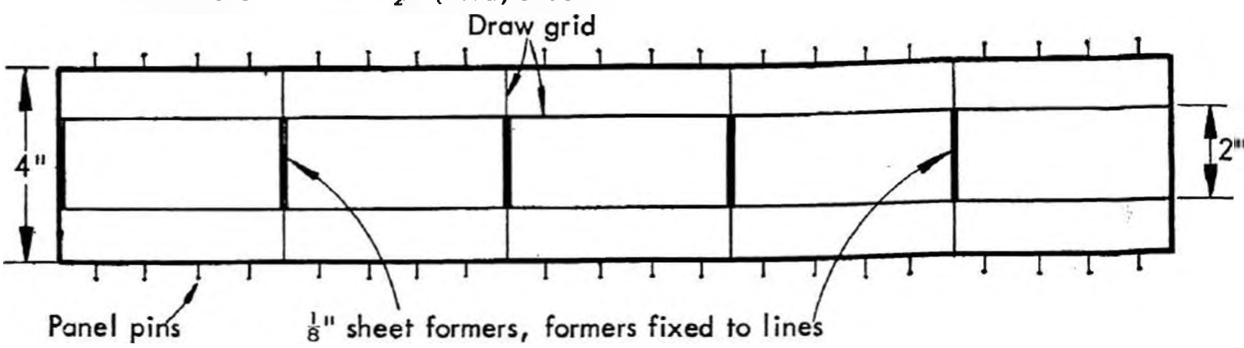
Draw 'X' in say 6 positions including both Dia extremes



Requisite number of formers cut from $\frac{1}{8}$" (hard) sheet.

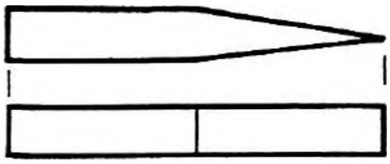


Make base as below from $\frac{1}{2}$" (hard) sheet



Prop.

1. Cut 8 laminations of $\frac{1}{32}$ in. sheet to the shape of the prop. outline.
2. Stick 4 lams, together with "CASCOMITE".
3. Place on former with T.E. touching base board and tip at correct diam. station. (For 2 in. wide blade narrower chord raise T.E. to suit).
4. Secure with rubber bands using panel pins as an aid.
5. Check all is well and the blade is fully home on the former and leave two/three days.
6. When dry remove and trim to finished outline.

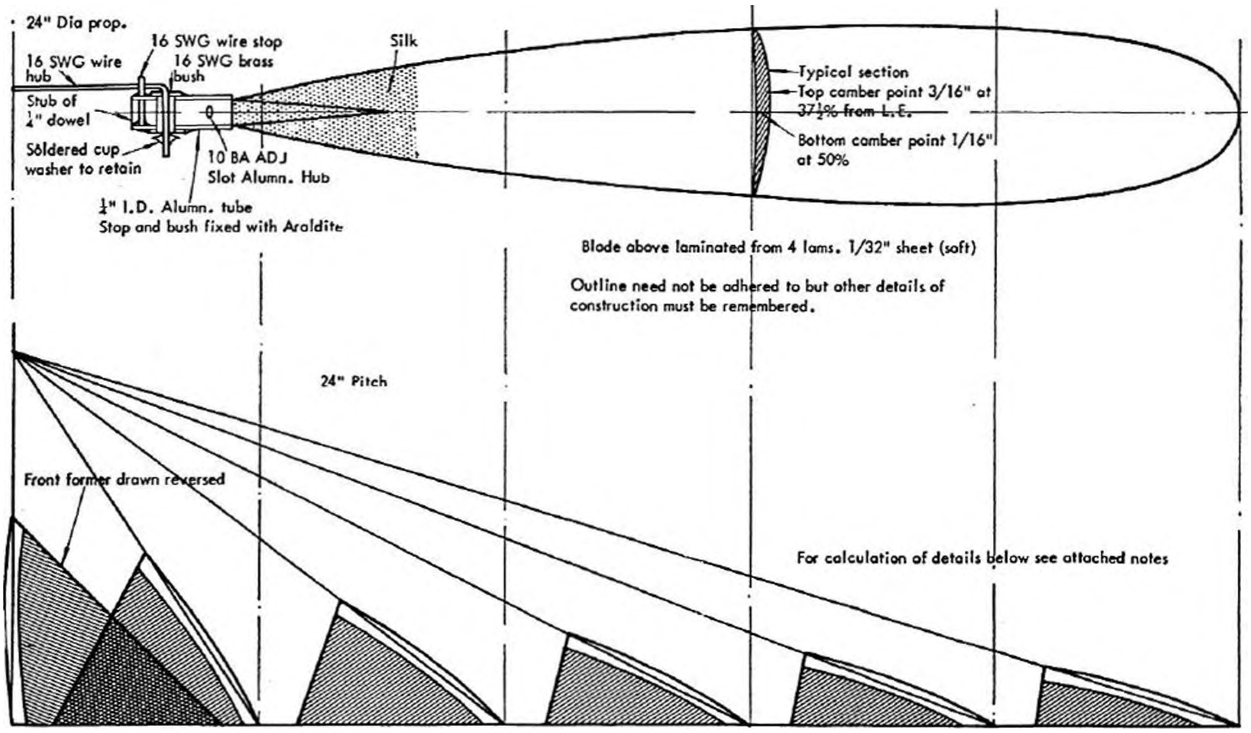


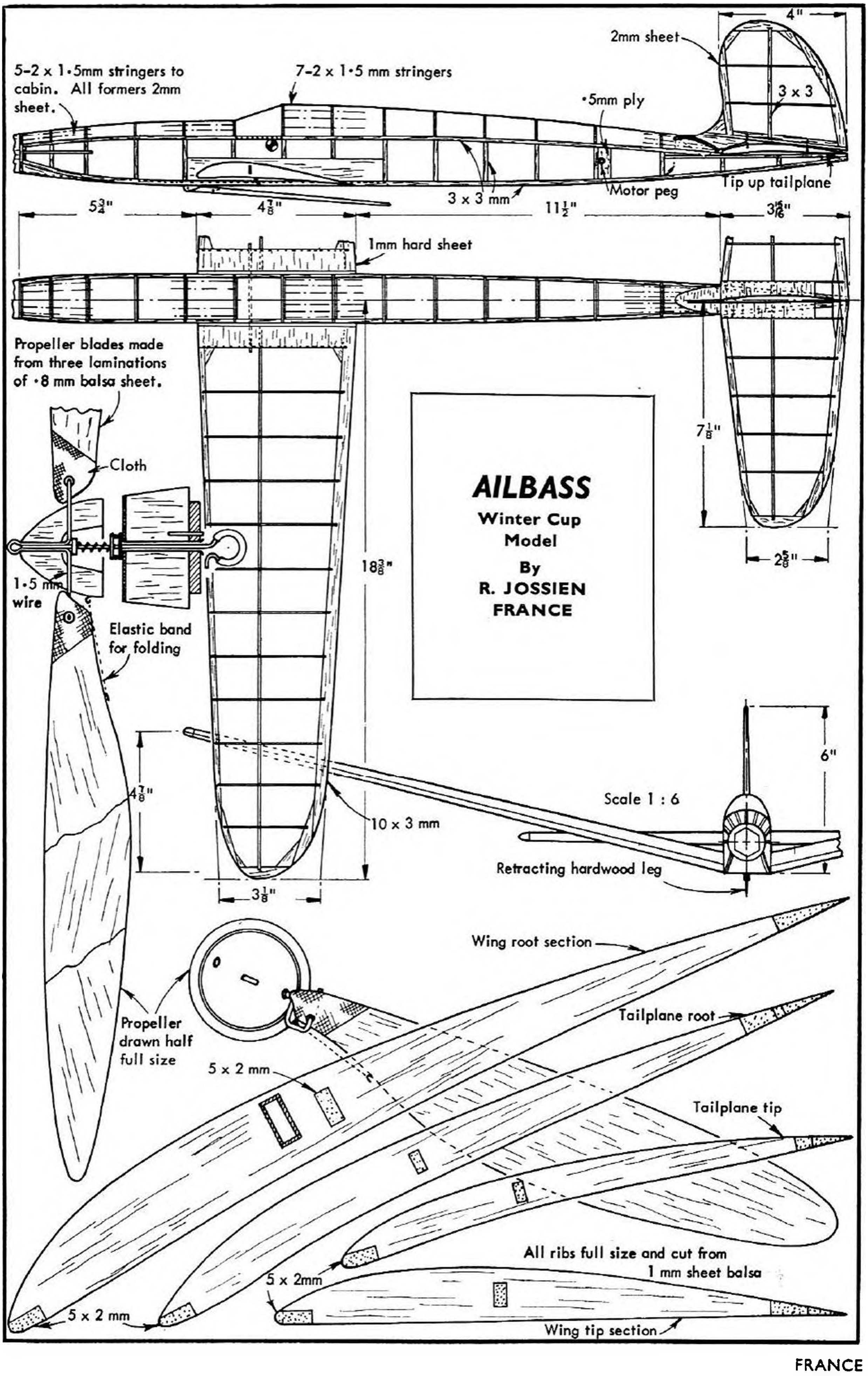
Hub

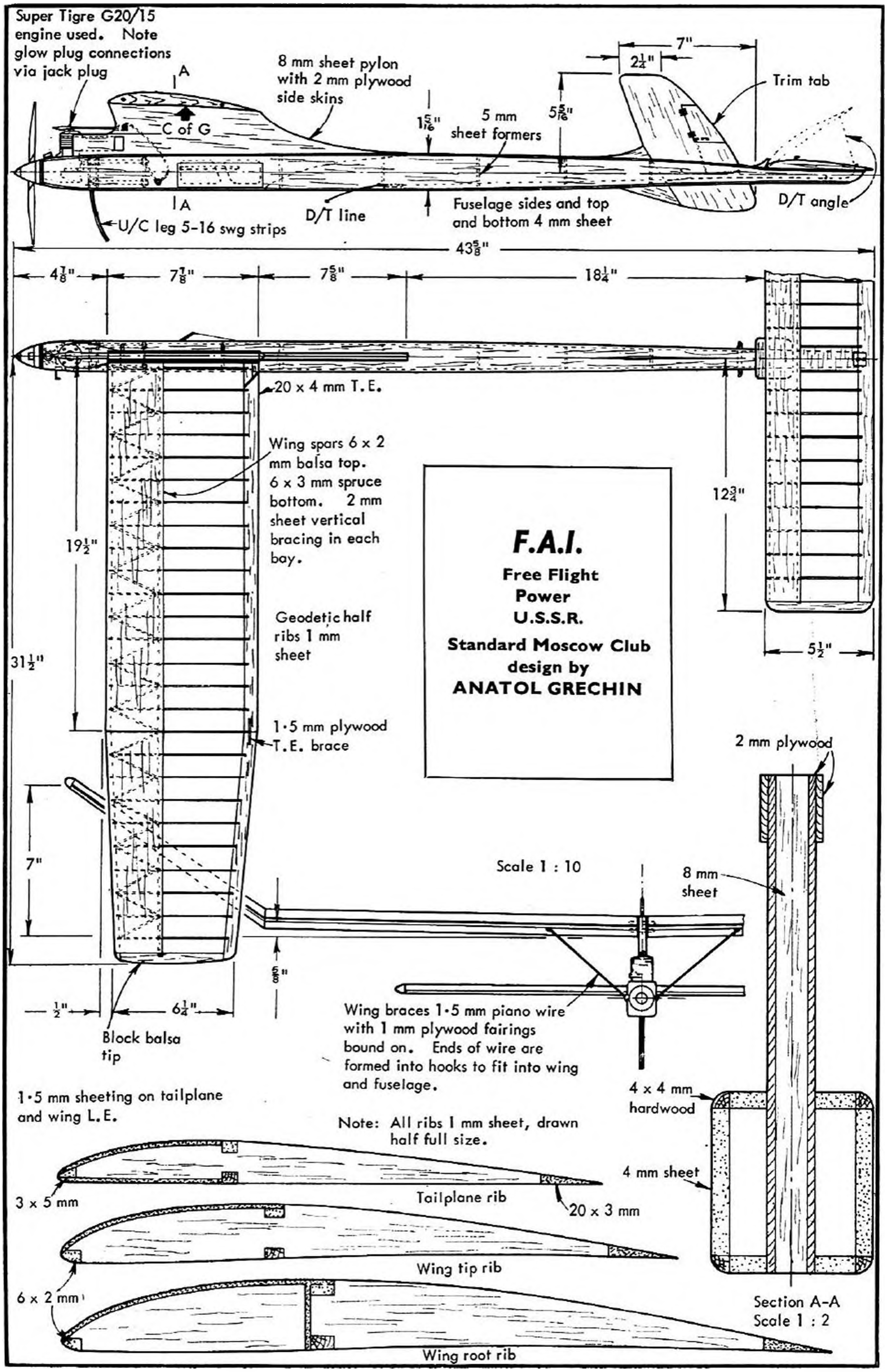
1. Cut two 3 in. lengths of $\frac{1}{4}$ in. dowel, shape $1\frac{1}{2}$ in. of each dowel thus:
2. Cut vee-shaped notch in blade root to take dowel.
3. Fix dowel (pre-cemented) to blade carefully checking (by use of former) that dowels are correctly aligned. They will not fit in square but appear to be angled up and back.
4. When set, cut away excess dowel and sand and shape blades in normal manner; by watching the contour lines of glue more exact similarity of blades can be assured.
5. The portion of blade fixed to the dowel can then be silked.
6. Finish lightly sanding blades, cover with lightweight modelspan, give several coats of 50/50 dope/thinner sanding lightly between each.

The alloy section of the hub is made from $\frac{1}{4}$ in. inside diam. tubing 16 s.w.g. brass bushed and 16 s.w.g. wire stops are Araldited together. The dowels are placed in the roots and drilled for 10 B.A. bolts to enable adjustment.

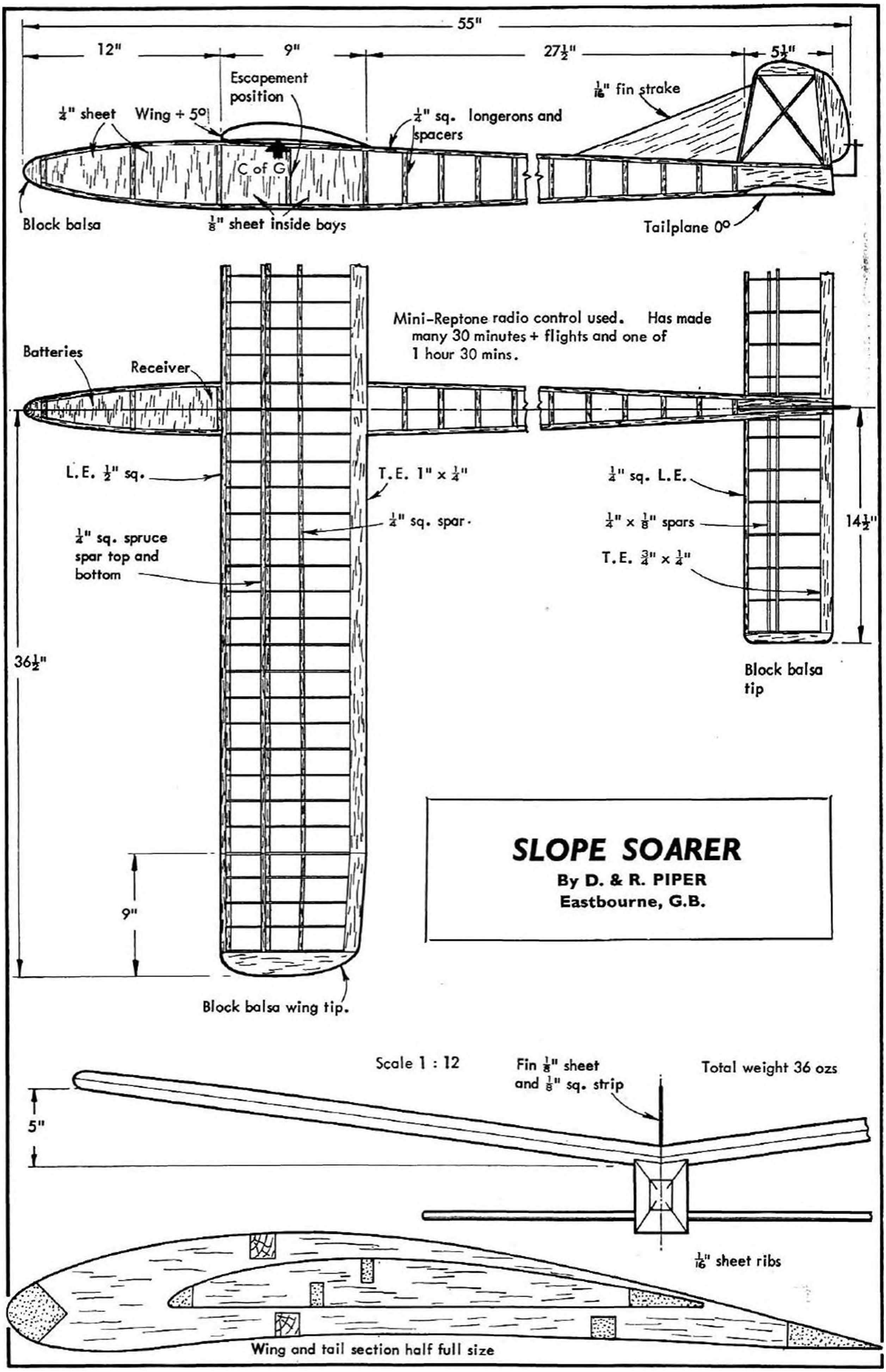
Finally the roots are soldered to wire arms and the whole prop. assembly. is carefully balanced.



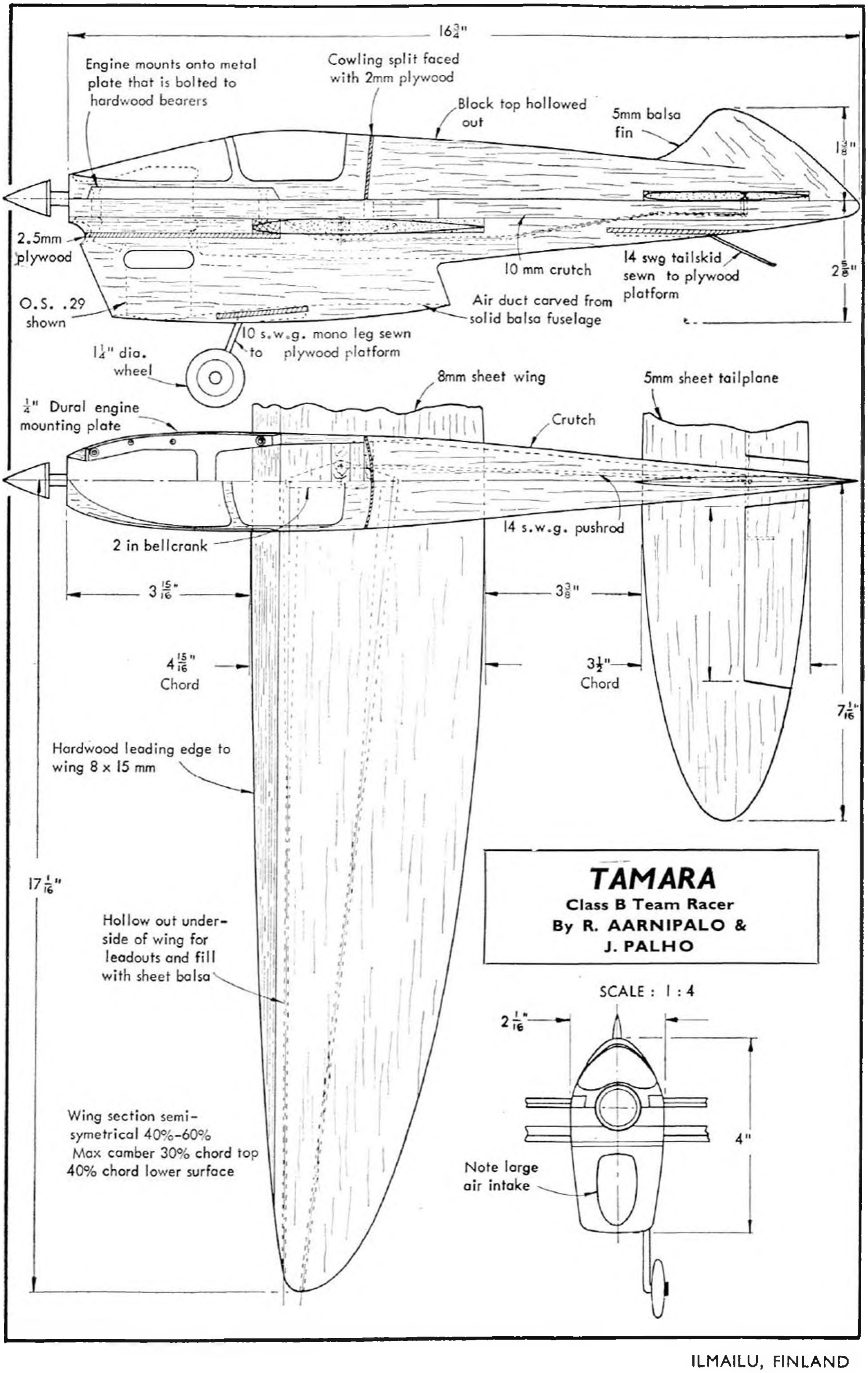

5-2 x 1·5mm stringers to cabin. All formers 2mm sheet.
7-2 x 1·5 mm stringers
2mm sheet
4"
·5mm ply
3 x 3
3 x 3 mm
Motor peg
Tip up tailplane
5¾"
4⅞"
11½"
3 5/16"
1mm hard sheet
Propeller blades made from three laminations of ·8 mm balsa sheet.
Cloth
1·5 mm wire
Elastic band for folding
AILBASS
Winter Cup Model
By
R. JOSSIEN
FRANCE
7⅛"
2⅝"
18⅜"
4⅞"
10 x 3 mm
3⅛"
6"
Scale 1 : 6
Retracting hardwood leg
Wing root section
Tailplane root
Propeller drawn half full size
5 x 2 mm
Tailplane tip
All ribs full size and cut from 1 mm sheet balsa
5 x 2mm
5 x 2 mm
Wing tip section



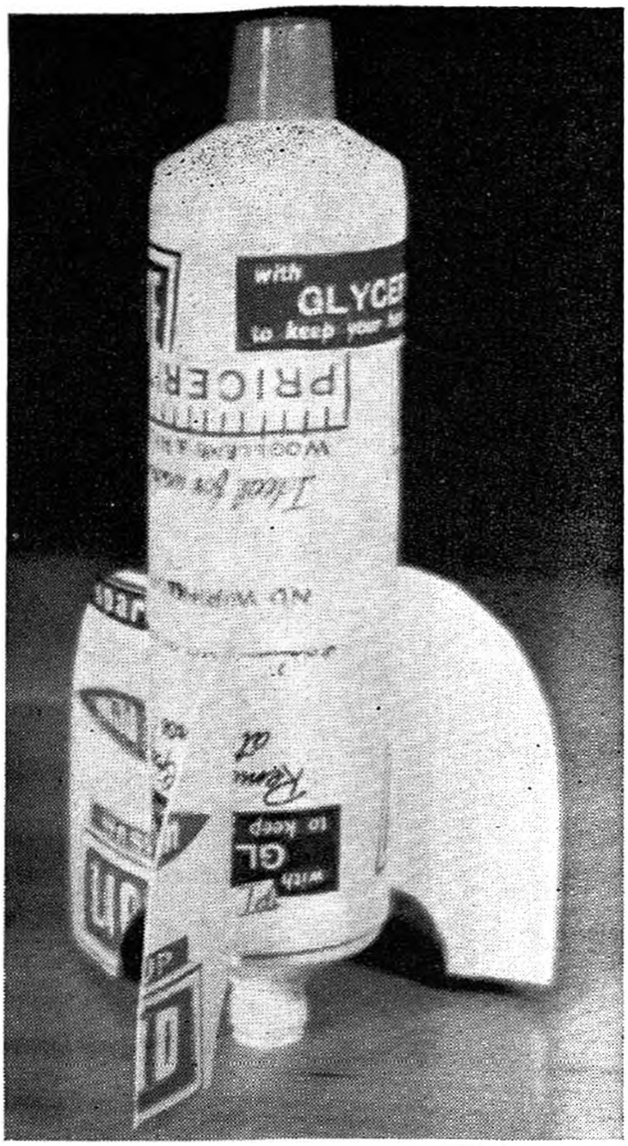
F.A.I.
Free Flight
Power
U.S.S.R.
Standard Moscow Club
design by
ANATOL GRECHIN
Super Tigre G20/15 engine used. Note glow plug connections via jack plug
8 mm sheet pylon with 2 mm plywood side skins
C of G
A
A
U/C leg 5-16 swg strips
D/T line
5 mm sheet formers
Fuselage sides and top and bottom 4 mm sheet
Trim tab
D/T angle
7"
2¼"
5 5/16"
1 5/16"
43⅝"
4⅞"
7⅞"
7⅝"
18¼"
20 x 4 mm T.E.
Wing spars 6 x 2 mm balsa top. 6 x 3 mm spruce bottom. 2 mm sheet vertical bracing in each bay.
Geodetic half ribs 1 mm sheet
1·5 mm plywood T.E. brace
19½"
31½"
7"
12¾"
5½"
½"
6¼"
⅝"
Block balsa tip
Scale 1 : 10
Wing braces 1·5 mm piano wire with 1 mm plywood fairings bound on. Ends of wire are formed into hooks to fit into wing and fuselage.
1·5 mm sheeting on tailplane and wing L.E.
Note: All ribs 1 mm sheet, drawn half full size.
2 mm plywood
8 mm sheet
4 x 4 mm hardwood
4 mm sheet
Section A–A
Scale 1 : 2
3 x 5 mm
Tailplane rib
20 x 3 mm
Wing tip rib
6 x 2 mm
Wing root rib



"SEA-DOG" NEWSLETTER, GREAT BRITAIN



ILMAILU, FINLAND



Water Rockets

This rocket, powered by water, will fly to 100 ft. or more altitude. It can be made in a few minutes from these materials:

(a) two polythene bottles—any type will do as long as they are similar.

(b) a cork to fit the bottles.

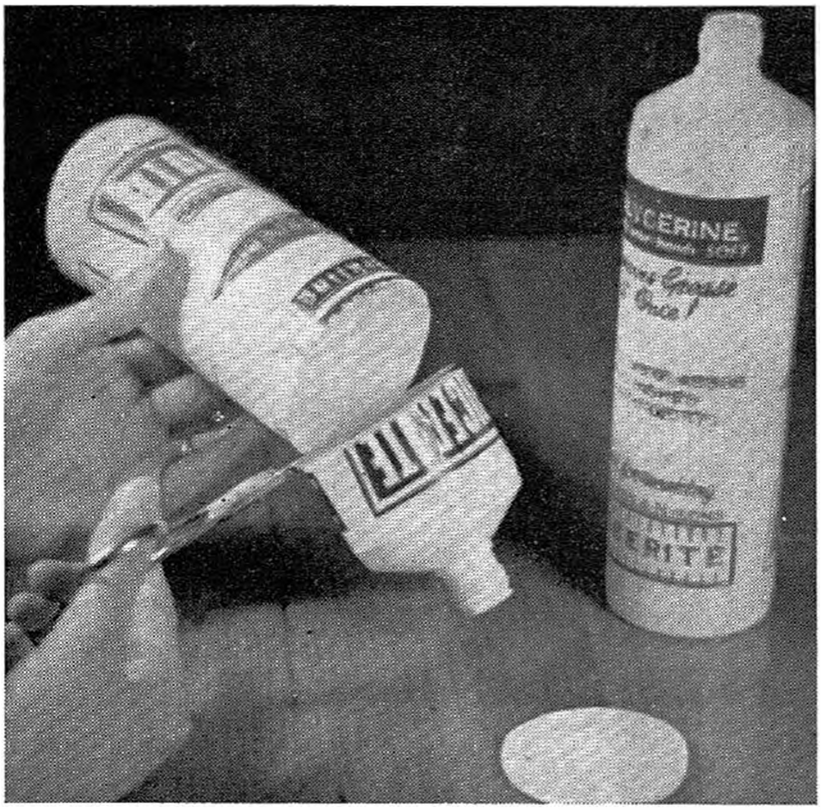
(c) a piece of copper or glass tubing about 3 in. long and about $\frac{3}{8}$ in. diameter.

(d) 18 in. of plastic tubing to fit over the copper or glass tubing.

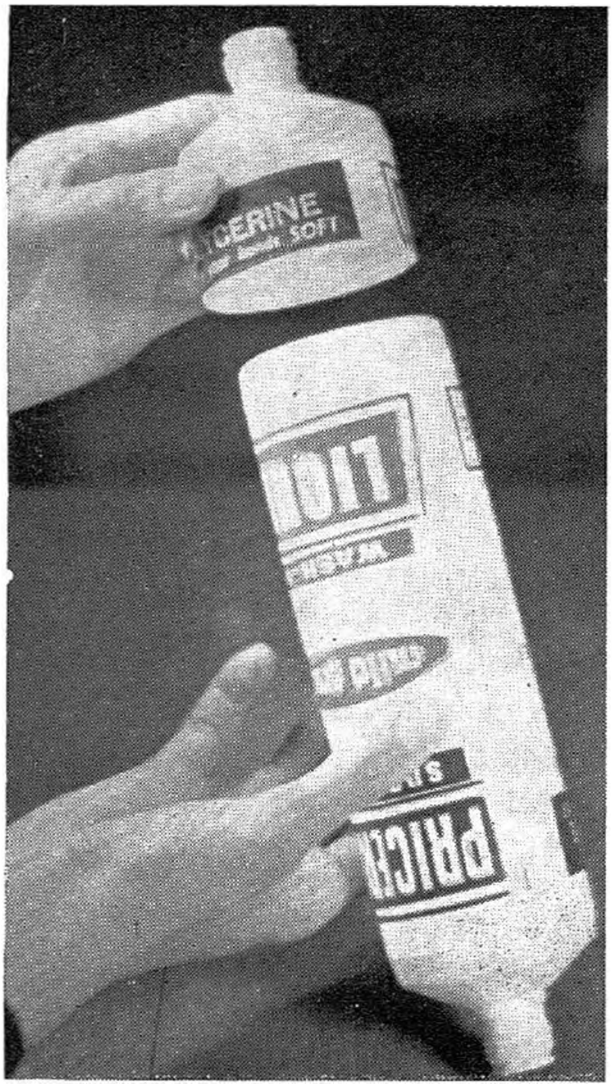
(e) a football pump connector.

(f) some thin string.

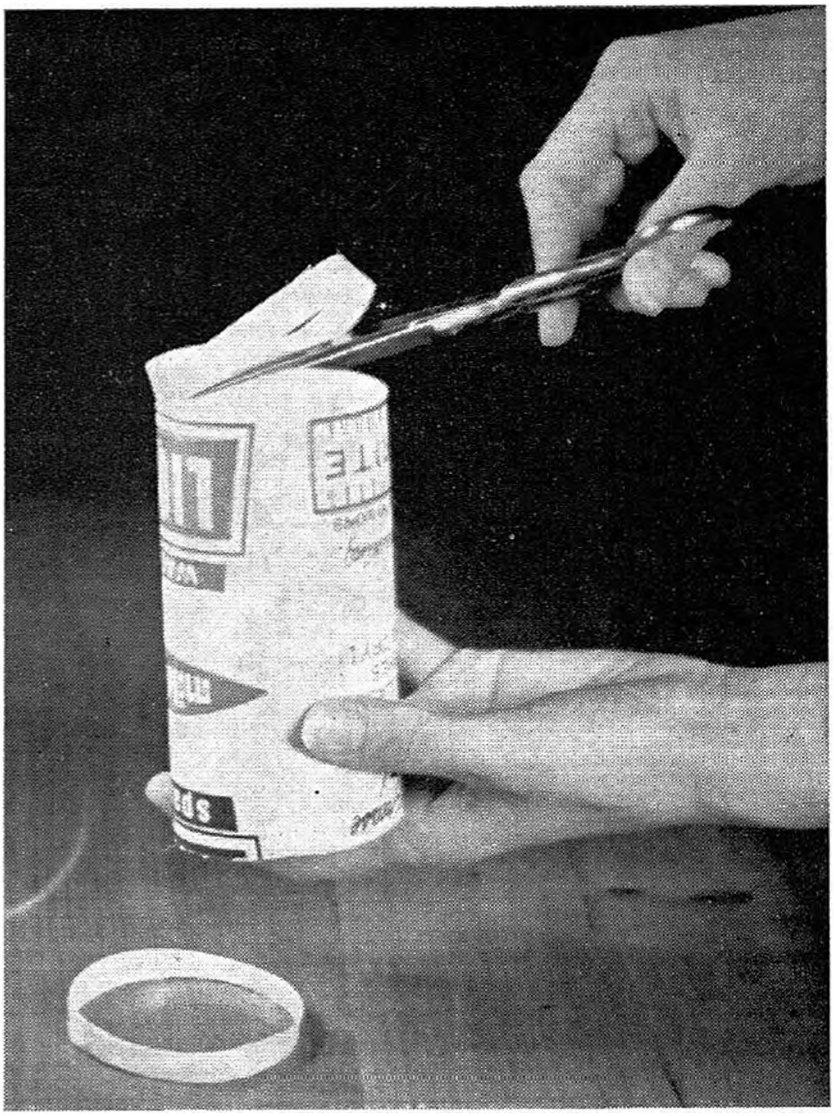
You will need a cork borer or drill to make a hole in the cork for the copper or glass tube. You will also need a pair of scissors.



Cut the top from one of the polythene bottles about 2 in. from the shoulder. Cut the bottom from the same bottle as close to the end as possible.

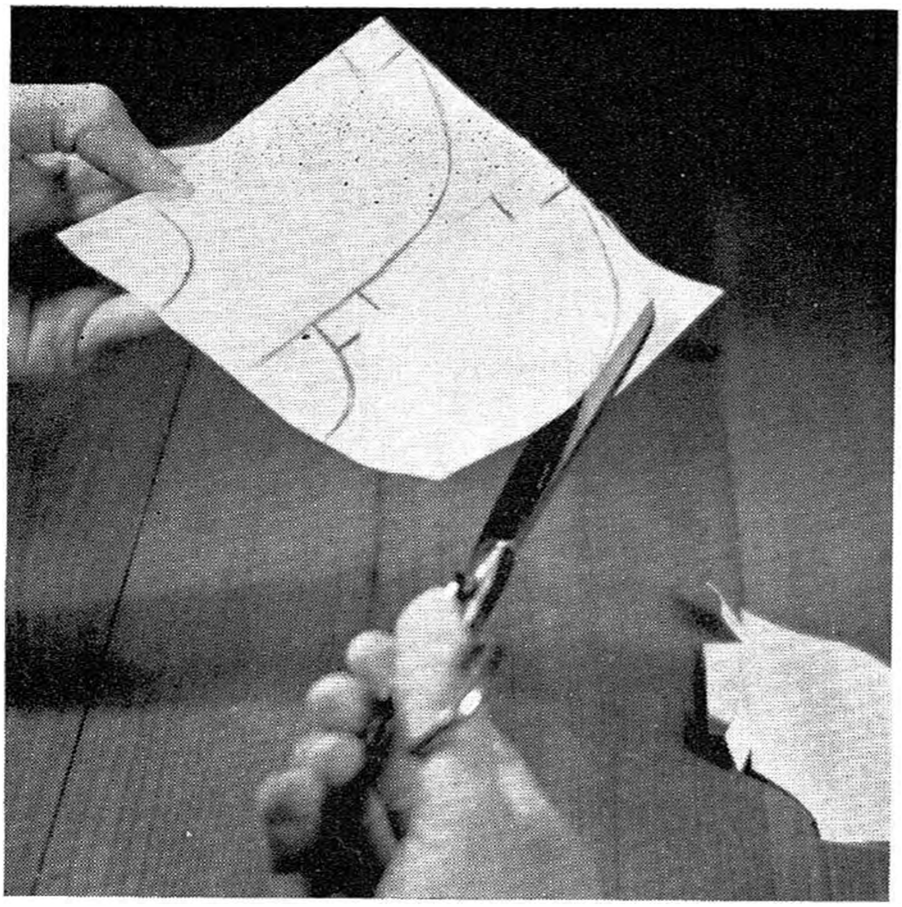


Slide the loose top on the bottom of the other bottle.

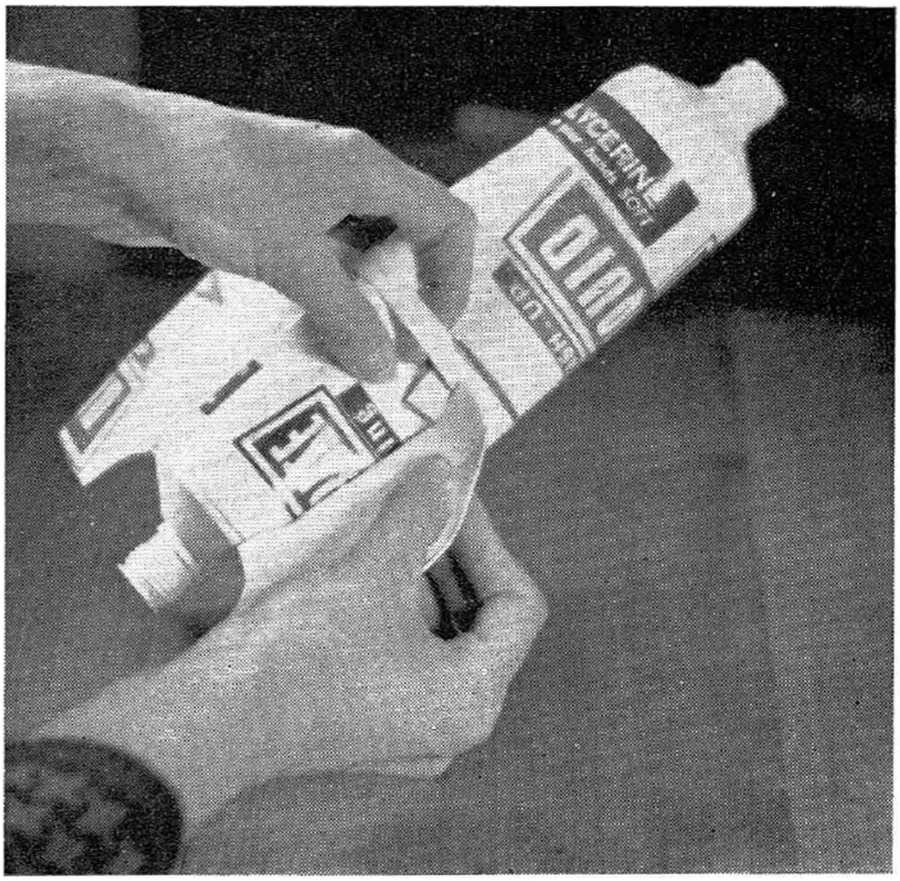


Cut two ½ in. deep rings from the cylinder left from the first bottle.

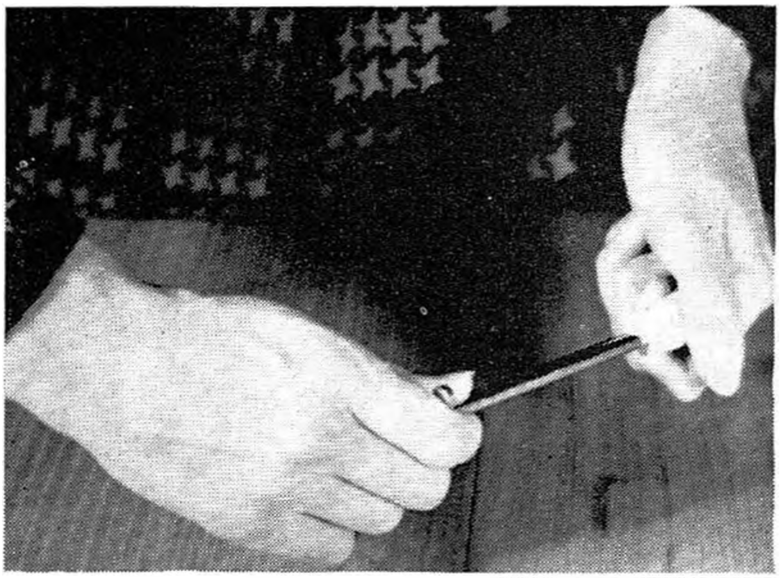
Slip the rings onto the second bottle which now forms the body of the rocket. Place one halfway along the bottle and the other at the shoulder.



Take the cylinder remaining from the first bottle and cut it length-ways to form a sheet. Divide this into three, and draw the shape of the fins. The exact shape is not critical but care should be taken to cut along all the solid lines shown, forming tabs to fit under the rings on the body of the rocket.

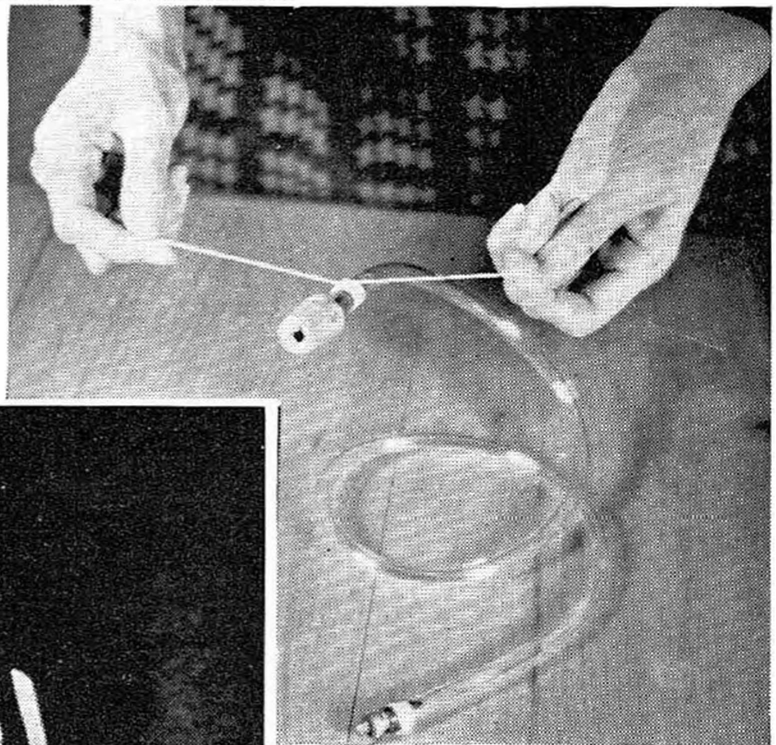


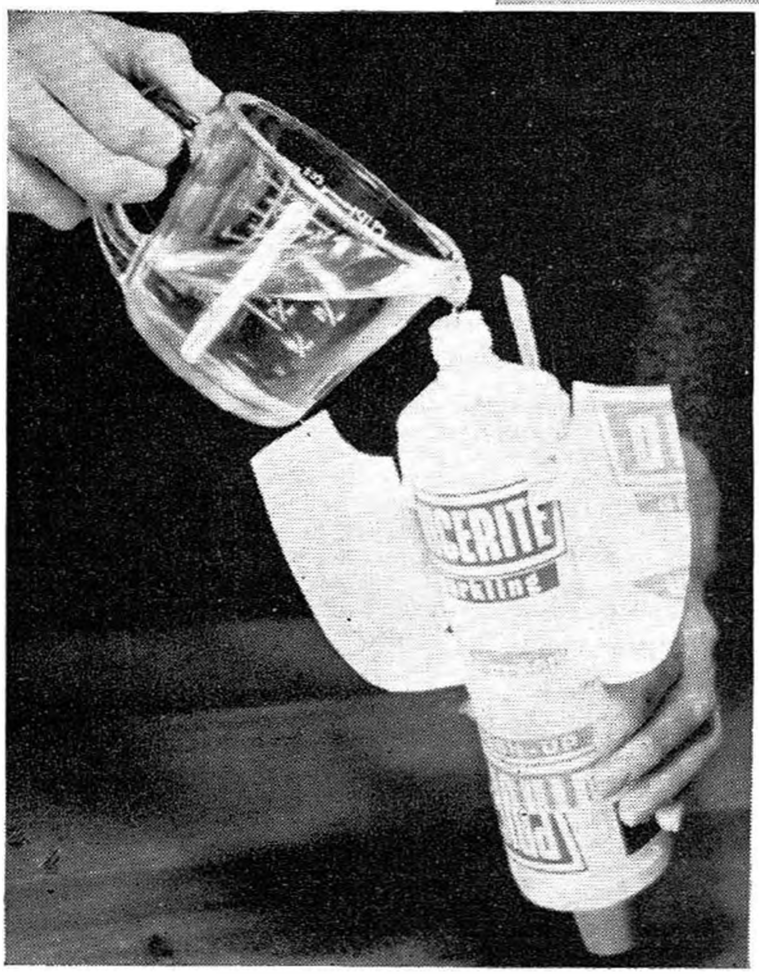
Bend the tabs at right angles to the fin and fit to the rocket body using the rings as shown.



Bore a hole in the cork for the copper or glass tube.

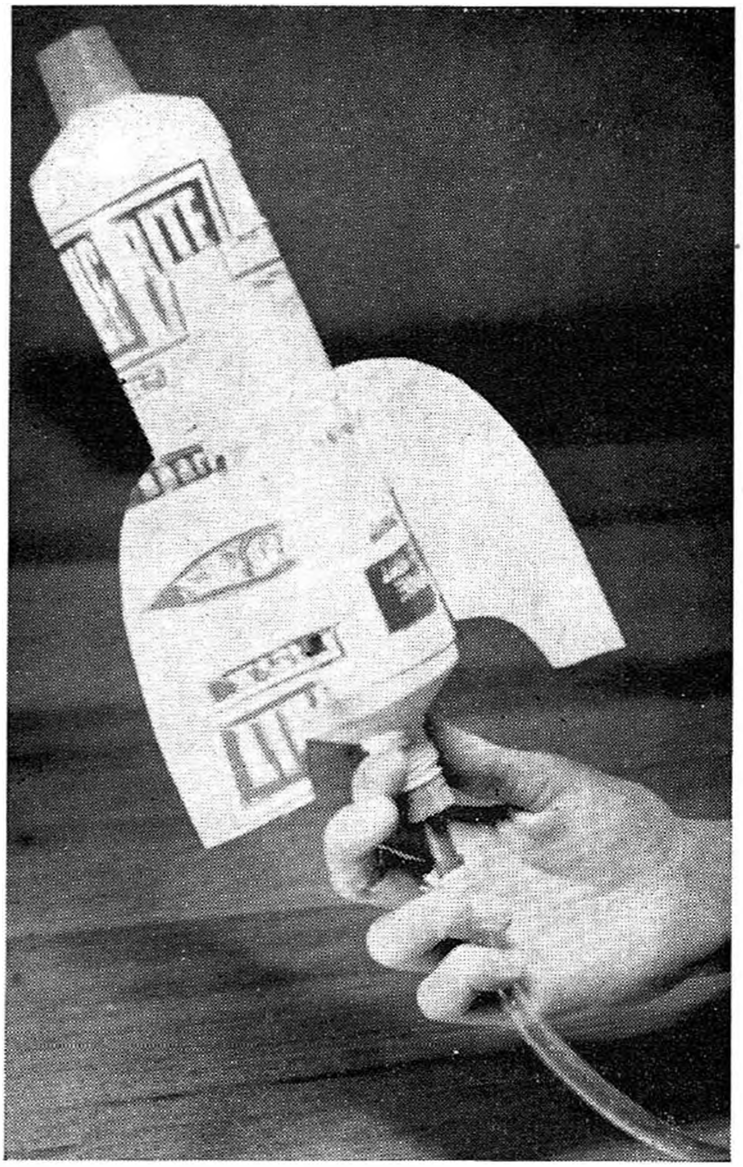
Fit the plastic tubing on the copper tubing and insert the football pump connector in the other end of the plastic tubing. Bind each end with twine.



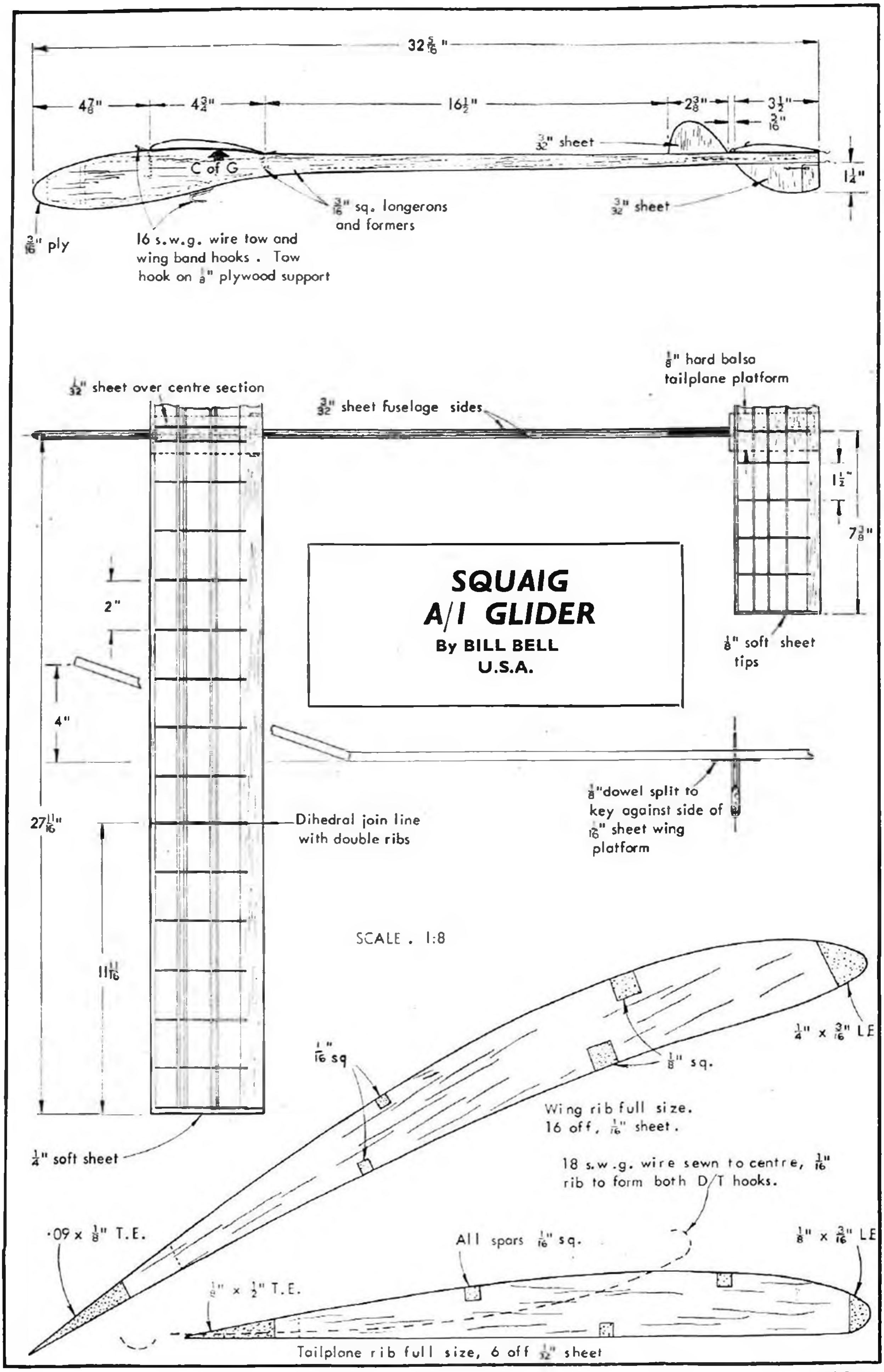


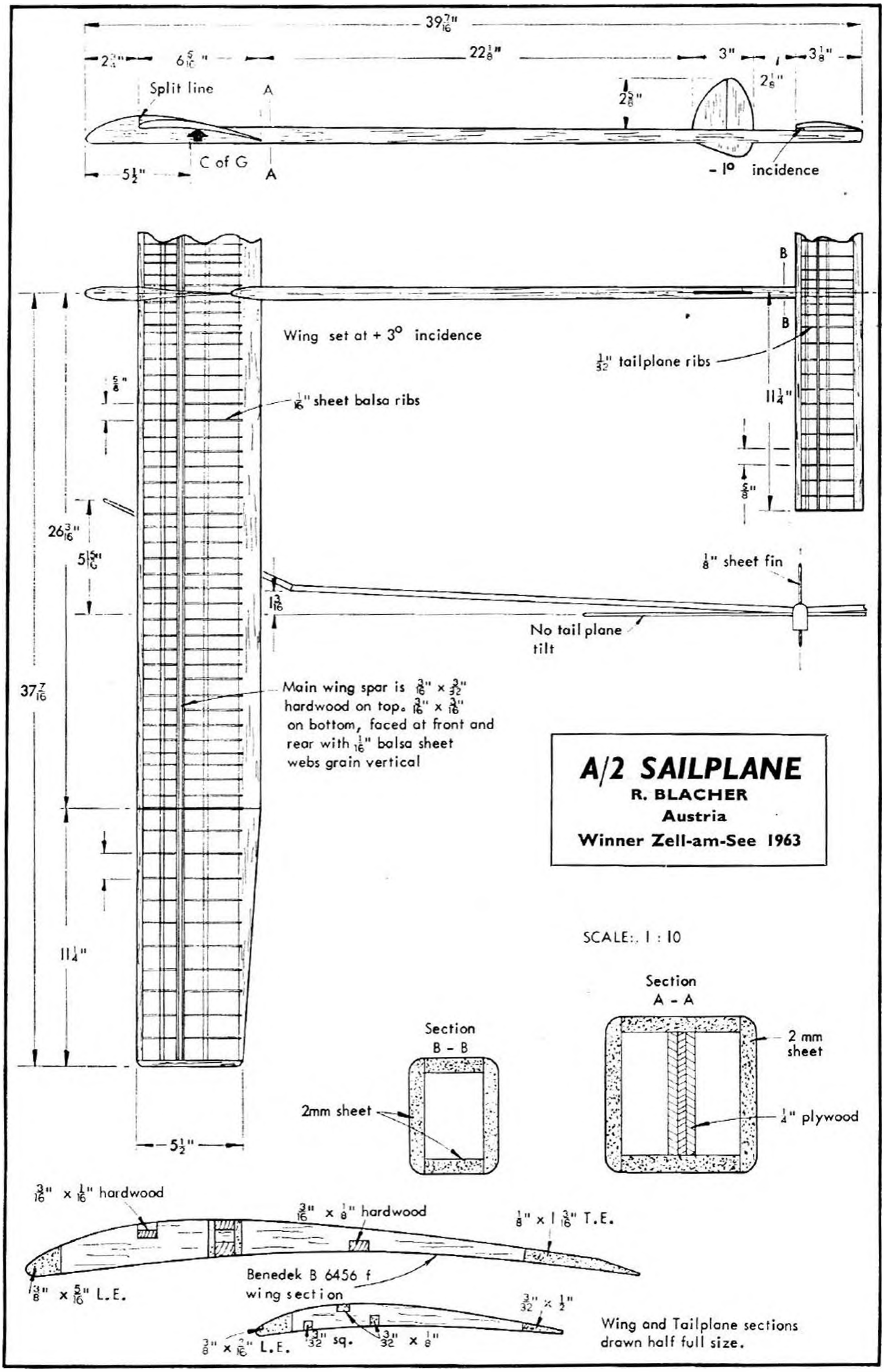
1/3 fill the rocket with water.

Insert the cork, with tubing and pump attached, and hold the rocket for launching as shown.

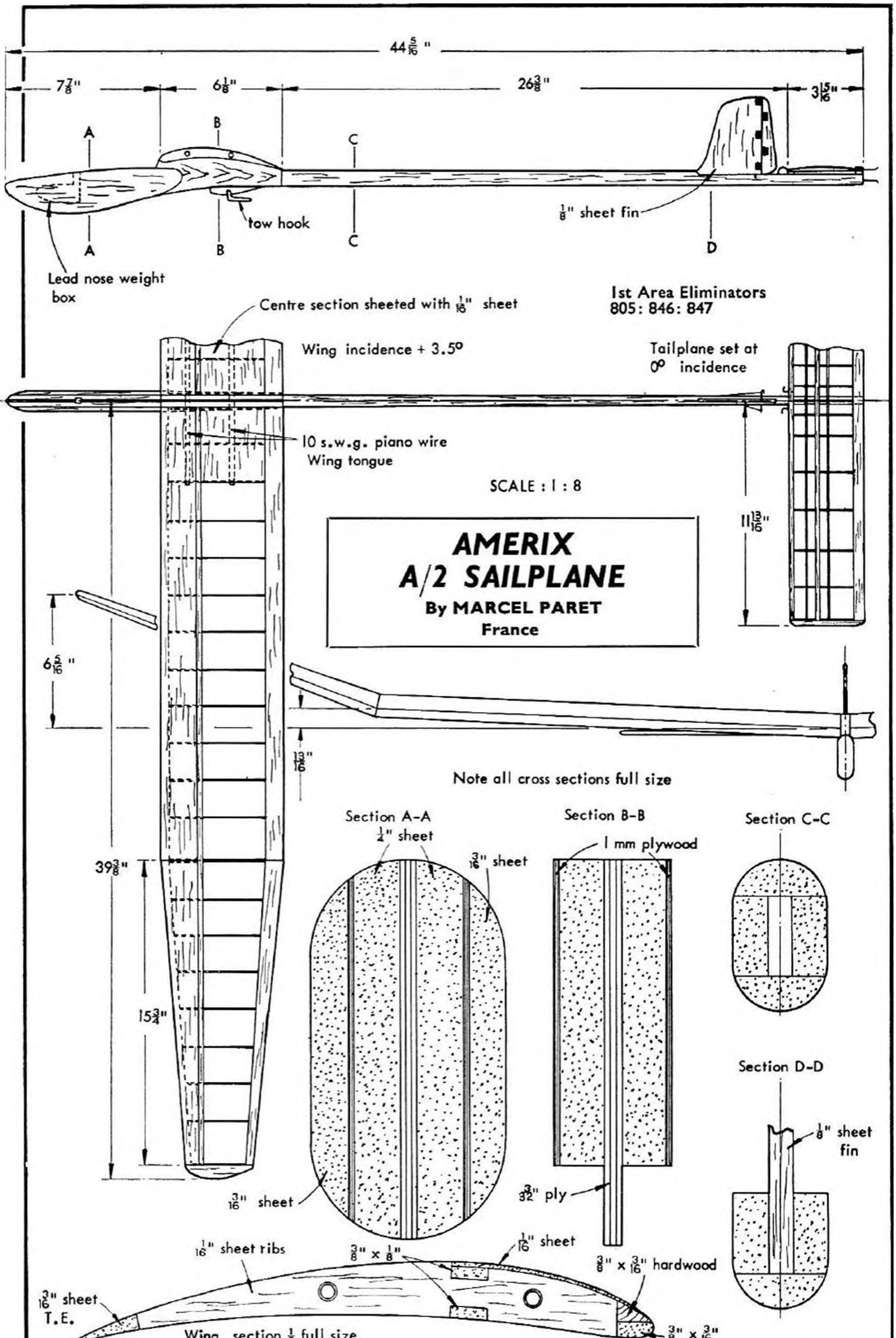


An assistant pumps with a bicycle pump until the pressure builds up sufficiently to blow the cork out of the bottle—The water is forced out and the rocket flies off. Altitudes of well over 100 ft. and horizontal distances of 200 ft. have been achieved.

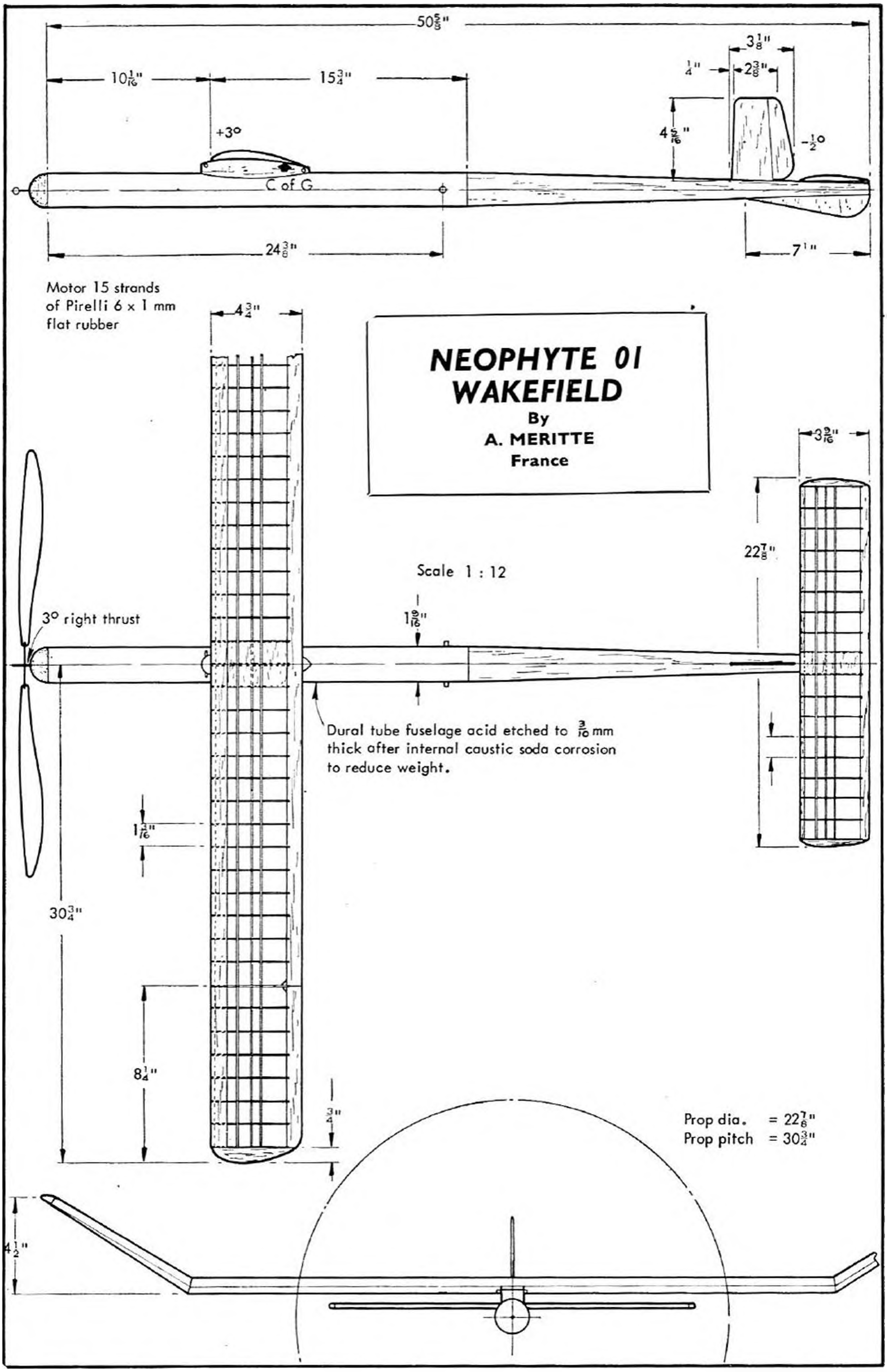

32 5/16"
4 7/8"
4 3/4"
16 1/2"
2 3/8"
3 1/2"
3/16"
3/32" sheet
C of G
1 1/4"
3/16" sq. longerons and formers
3/32" sheet
3/16" ply
16 s.w.g. wire tow and wing band hooks. Tow hook on 1/8" plywood support
1/8" hard balsa tailplane platform
1/32" sheet over centre section
3/32" sheet fuselage sides
1 1/2"
7 3/8"
SQUAIG
A/1 GLIDER
By BILL BELL
U.S.A.
1/8" soft sheet tips
2"
4"
27 11/16"
Dihedral join line with double ribs
1/8" dowel split to key against side of 1/16" sheet wing platform
SCALE. 1:8
11 11/16
1/4" x 3/16" LE
1/16" sq
1/8" sq.
Wing rib full size. 16 off, 1/16" sheet.
1/4" soft sheet
18 s.w.g. wire sewn to centre, 1/16" rib to form both D/T hooks.
·09 x 1/8" T.E.
All spars 1/16" sq.
1/8" x 3/16" LE
1/2" x 1/2" T.E.
Tailplane rib full size, 6 off 1/32" sheet



MODELE, FRANCE



MODELE, FRANCE



MODELE, FRANCE

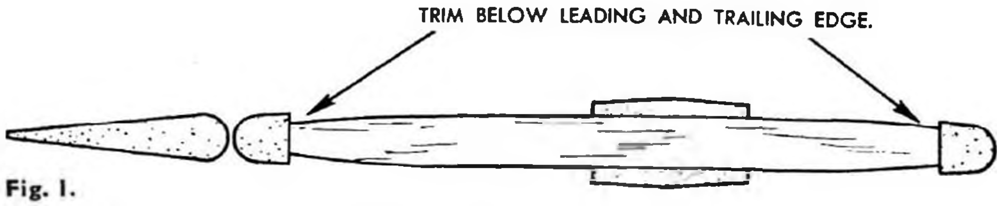


Fig. 1.

MODERN STRUCTURES

THE essence in modern model airframe design is generally towards basic simplicity and ease of construction. This is largely a reflection of the change in contest model specifications and model performance requirements. Thus whereas performance was largely dependent on lightweight structures, placing a premium on balsa selection and minimum spar sizes, etc., weight is seldom regarded as a critical factor in modern designs. Suitable minimum weights for satisfactory flying performance, or to meet contest specifications, can be met by medium balsa grades rather than meticulous selection and disposition of light and ultra-light stock; and structures as a whole can be made more rugged. This has led to structural designs which a decade ago would have been regarded as excessively heavy, or even poor design. Yet they serve the purpose admirably on the modern model.

A typical example is the form of built-up tailplane structure widely favoured on modern radio control models—Fig. 1. This first came into prominence with the Smog Hog, since when it has become almost a standard for medium and large size R/C models. While not a particularly light structure—or one which always give a pleasing surface when nylon covered—it is simple, strong and rigid and entirely satisfactory as a functional structure.

Another modern trend is the increasing use of all-sheet construction for free-flight models, particularly R/C models. While it was logical enough to utilise sheet-sided fuselages, the trend has now developed towards all-sheet wings as providing a satisfactory, lightweight structure up to a span of 40 in. or more—Fig. 2. This is a true stressed skin structure in which the need for a mainspar can be eliminated entirely, provided the aspect ratio is kept to a low or moderate figure. If the same form of construction is applied to a high aspect ratio wing a mainspar is usually necessary and the wing weight increased for a given area.

For proper weight control, however, it is necessary to select the sheet grade carefully, favouring lighter grades throughout as far as possible. Total (finished) wing weight can then be estimated fairly closely from the sheet density used on the basis of a total sheet area used of twice the wing area plus an additional allowance for leading edge, ribs and any internal stiffeners necessary, including wing joiners and cementing up. The latter can represent anything between 10 and 30 per cent additional weight, but the wing weight in the main will be determined by the balsa sheet density. Since this can range from 6 to 16 lb. per cubic foot, all-sheet wing weights can vary by as much as 300 per cent! (see Table I).

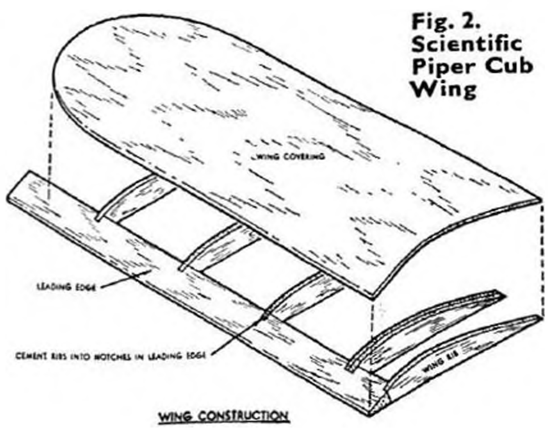


Fig. 2. Scientific Piper Cub Wing

TABLE I WEIGHT OF BALSA SHEET

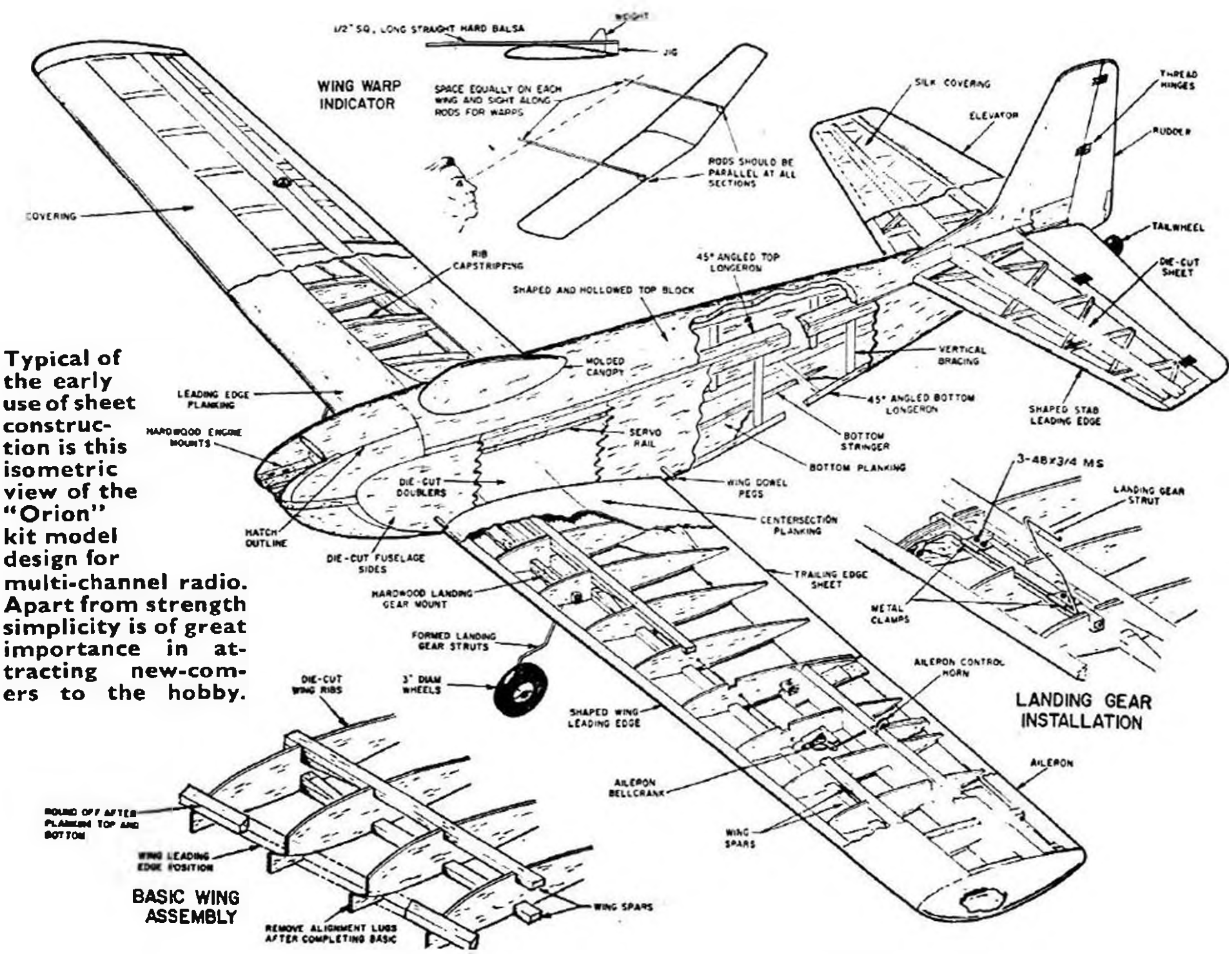
SIZE	BALSA DENSITY Pounds per cubic foot					
36″ ×	6	8	10	12	14	16
SHEET 1/32″ × 2″	·125	·167	·271	·250	·291	·333
3″	·1875	·250	·3125	·375	·4375	·500
4″	·250	·333	·417	·500	·583	·667
1/16″ × 2″	·250	·333	·417	·500	·583	·667
3″	·375	·500	·625	·750	·875	1·000
4″	·500	·667	·833	1·000	1·167	1·333
3/32″ × 2″	·375	·500	·625	·750	·875	1·000
3″	·5625	·750	·9375	1·125	1·3125	1·500
4″	·750	1·000	1·250	1·500	1·750	2·000
1/8″ × 2″	·500	·667	·833	1·000	1·167	1·333
3″	·750	1·000	1·250	1·500	1·750	2·000
4″	1·000	1·333	1·667	2·000	2·333	2·667
3/16″ × 2″	·750	1·000	1·250	1·500	1·750	2·000
3″	1·125	1·500	1·875	2·250	2·625	3·000
4″	1·500	2·000	2·500	3·000	3·500	4·000
1/4″ × 2″	1·000	1·333	1·667	2·000	2·333	2·667
3″	1·500	2·000	2·500	3·000	3·500	4·000
4″	2·000	2·667	3·333	4·000	4·667	5·333
3/8″ × 2″	1·500	2·000	2·500	3·000	3·500	4·000
3″	2·250	3·000	3·750	4·500	5·250	6·000
4″	3·000	4·000	5·000	6·000	7·000	8·000
1/2″ × 2″	2·000	2·667	3·333	4·000	4·667	5·333
3″	3·000	4·000	5·000	6·000	7·000	8·000
4″	4·000	5·333	6·667	8·000	9·333	10·667

Note: 36″ × 4″ sheet = 144 sq. in. Therefore weight of 36″ × 4″ sheet = weight per square foot in that thickness and balsa density.

Normally a density of 6 to 8 lb. per cu. ft. would be chosen for all-sheet wings, with a minimum thickness necessary for stiffness of about 1/20 in. for a 20 in. model, increasing to 3/32 in. sheet thickness for a 40 in. span wing. Wing weight can then be estimated directly from Table II where sheet density is reduced to weights per 100 sq. in. surface area. Thus, for example, estimated weight of a 200 sq. in. wing in $\frac{1}{16}$ in. thick sheet would be:

(*i*) 2 × 200/100 × ·337 = 1·348 plus 25%, say = 1·685 ounces in 6 lb. balsa
(*ii*) 2 × 200/100 × ·580 = 2·32 plus 25%, say = 2·90 ounces in 10 lb. balsa
(*iii*) 2 × 200/100 × ·925 = 3·7 plus 25%, say = 4·625 ounces in 16 lb. balsa

A further chance of weight control is offered by balsa "cut" selection. Thus stiff quarter-grain sheet for the lower surface would enable the thickness to be reduced (e.g., by sanding down standard sheet). It is more advisable to use thicker sheet but lighter density for the upper surface since this is the



Typical of the early use of sheet construction is this isometric view of the "Orion" kit model design for multi-channel radio. Apart from strength simplicity is of great importance in attracting new-comers to the hobby.

surface area most likely to buckle or be sanded through, particularly at rib positions, when finally sanding down.

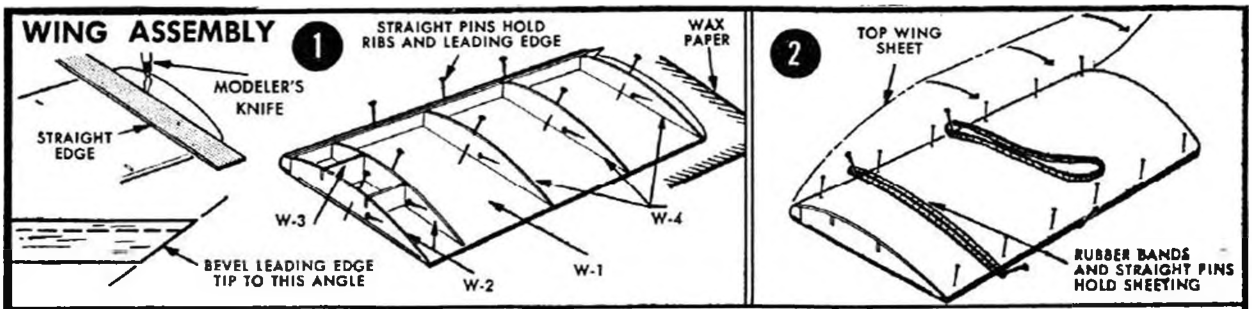
This also raises the important point that with all-sheet construction for wings as much "finish-sanding" as possible should be done *before* assembly. The smooth surface will be roughened and require further sanding after doping, but this can be reduced to very light sanding just to get the surface smooth again. It is virtually impossible to reduce wing weight by sanding *after* assembly as unsupported areas (between ribs) will simply bow away from the sanding block so that very little wood is removed; and the supported areas over the ribs are readily sanded right through.

All-sheet wing construction simplifies building to a degree. Having selected suitable bottom sheets, the wing plan can be drawn directly onto this

TABLE II BALSA SHEET WEIGHT—OUNCES PER 100 SQ. IN.

SHEET THICKNESS inches	BALSA DENSITY Pounds per Cubic Foot					
	6	8	10	12	14	16
1/32	·168	·232	·290	·348	·405	·463
1/20*	·278	·370	·465	·556	·648	·740
1/16	·337	·463	·580	·695	·810	·925
3/32	·505	·695	·870	1·04	1·22	1·39
1/8	·694	·925	1·16	1·39	1·62	1·85

* Sanded down from 1/16 in. sheet

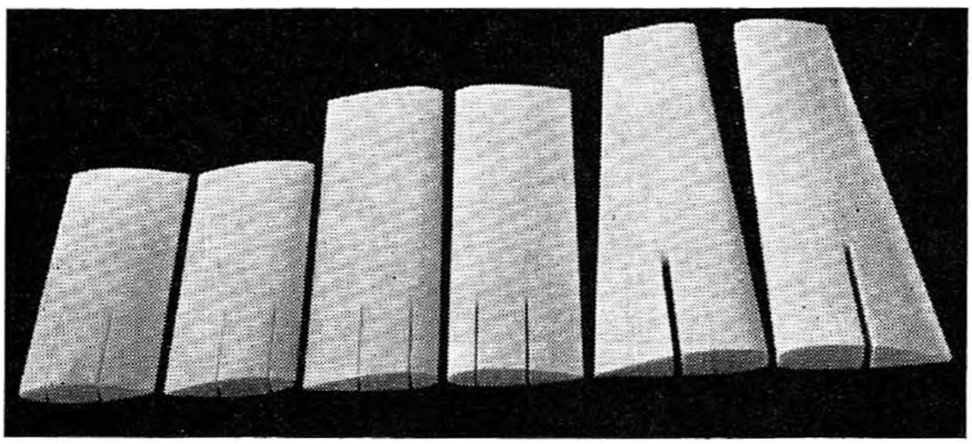


(1) Pin bottom sheeting to flat board. Glue shaped leading edge to sheeting. Cut taper at tip of leading edge and then glue wing ribs and braces into notches. (2) Glue top sheeting to wing leading edge and hold with pins. Then bend over and glue to wing ribs and at trailing edge. Hold in place with pins and do not remove from board until glue has thoroughly dried.

sheet and the ribs and leading edge cemented in place, followed by the top sheet. Solid trailing edge reinforcement is only needed on the larger sizes, and then not always. The weakest point is the centre joint and the design must be arranged so that wing joiners or dihedral keepers distribute the stress as far as possible. With accurate workmanship, however, it is surprising how strong an unbraced joint can be with all-sheet construction, particularly if the external joint line is bound round with nylon tape cemented in place. Other parts which can usually do with external reinforcement by tape are the leading and trailing-edge points, particularly the latter, where the retaining bands pass over the edge.

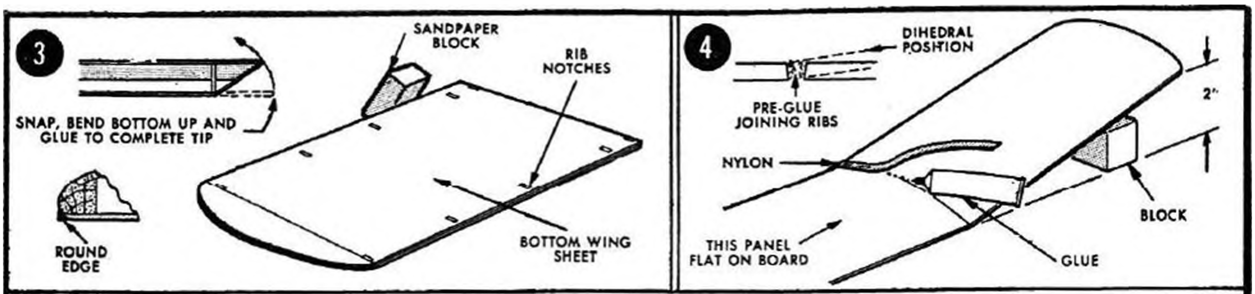
PVA is often preferred to balsa cement as an adhesive for all-sheet construction, and its slower setting properties are particularly useful in dealing with relatively large panels. Balsa cement is generally to be preferred for attaching external binding strips, however, and can equally well be used throughout the structure. In this case setting time should not be underestimated. Cement drying inside the wing structure may take much longer than usual to set, simply because the solvents cannot evaporate off so rapidly. If removed from the building board too soon, distortion can result as these internal cement joints finally set and contract. Strongly contracting cements will also tend to pull thin top sheeting down over ribs, resulting in a "starved horse" appearance.

Slight warps which may be present in the original sheet will be straightened out by pinning down during building, and the finished assembly should be more than rigid enough to resist any locked in stresses resulting. As a matter of principle, though, the careful modeller would prefer to work with perfectly flat sheet.



Expanded polystyrene wings in a variety of shapes which are now available commercially. Slots are provided to take wing spars. Supplied by Ives of Yeovil.

Two sets of wing construction diagrams from instructions provided in kit for Topflite "Schoolboy" at top of pages show all-sheet construction sequence.



(3) Finish tips by bending up along score line on underside of bottom sheet. Glue bent up tip portion to top wing sheeting. When dry, sand to smooth streamlined edge. (4) Take the two finished panels and trim off all remaining excess. Butt-join the wing panels together with the correct dihedral. Cement nylon to the centersection and apply several coats of glue. When thoroughly dry smooth-sand the entire wing.

Sanding is both a "cure" and a "cause" for warps in sheet balsa—and in balsa spars, etc. Sanding on one side of sheet—or one face of strip lengths—will tend to produce a curl in the direction of the sanded surface. Reduction in thickness by sanding should therefore be done on both surfaces of the sheet, not just one side. Similarly, sanding on *one* side can often be effective in taking out a warp in a sheet or strip length.

Warp-free sheet is even more important in the case of "solid" tailplanes (or fins). Normally quarter-grain stock would be chosen for such components in any case, as being the most rigid type of cut and the one least likely to warp. The original sheet, however, may well have become warped during machining, particularly in the lighter grades, in which case it may not be possible to true it up satisfactorily. This is often put down to incomplete "kilning", or improper storage. In many cases, however, it is a direct result of the finishing technique employed, particularly with American stock.

This is because the original sheet has been cut to a nominal (oversize) thickness and then finished to final size by passing through a sander. In this case, one surface is merely given a "lick" to smooth (if sanded at all), and all the thickness necessary to reduce to final size taken from the other surface as below. The result is very often a badly warped sheet. It is usually impossible to take out this warp by sanding the opposite face without reducing the thickness too much. Thus the only solution is to replace the warped sheet.

The alternative modern structure which is finding increasing favour for R/C work is solid construction in expanded polystyrene. This is produced commercially either as finished mouldings (in kits) or solid slabs which can be "carved" to shape, the best technique for cutting and carving being a hot wire (a suitable resistance wire mounted in a frame like a bow string and heated by a low voltage battery). Carved forms are normally limited to wings, and to a lesser extent tail surfaces.

Expanded polystyrene can be produced in densities ranging from as low as 2 lb. per cubic foot up to 10 lb. per cubic foot. A typical figure for model mouldings and slabs is 4 lb. per cubic foot, which makes it lighter in solid form

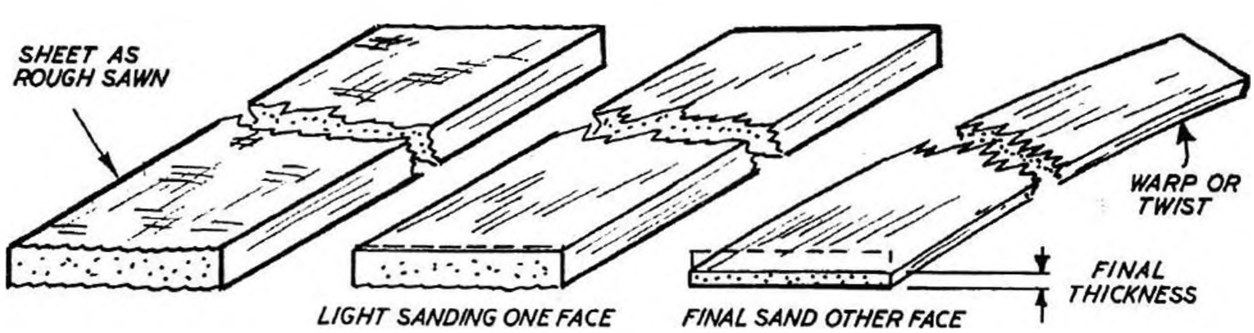


TABLE III WEIGHT OF BALSA BLOCK

	BALSA DENSITY LB./CU. FT.					
	6	8*	10	12	14	16
BLOCK 1″ × 1″	2·0	2·667	3·333	4·0	4·667	5·333
1½″	3·0	4·0	5·0	6·0	7·0	8·0
2″	4·0	5·333	6·667	8·0	9·333	10·667
2½″	5·0	6·667	8·333	10·0	11·667	13·333
3″	6·0	8·0	10·0	12·0	14·0	16·0
1½″ × 1½″	4·5	6·0	7·5	9·0	10·5	12·0
2″	6·0	8·0	10·0	12·0	14·0	16·0
2½″	7·5	10·0	12·5	15·0	17·5	20·0
2″ × 2″	8·0	10·667	13·333	16·0	18·667	21·333
2½″	10·0	13·333	16·667	20·0	23·333	26·667
3″	12·0	16·0	20·0	24·0	28·0	32·0
2½″ × 2½″	12·5	16·667	20·833	25·0	29·166	33·333
3″	15·0	20·0	25·0	30·0	35·0	40·0
3″ × 3″	18·0	24·0	30·0	36·0	42·0	48·0
4″	24·0	32·0	40·0	48·0	56·0	64·0

* **Note: Typical expanded Polystyrene mouldings have approximately half of this solid weight.**

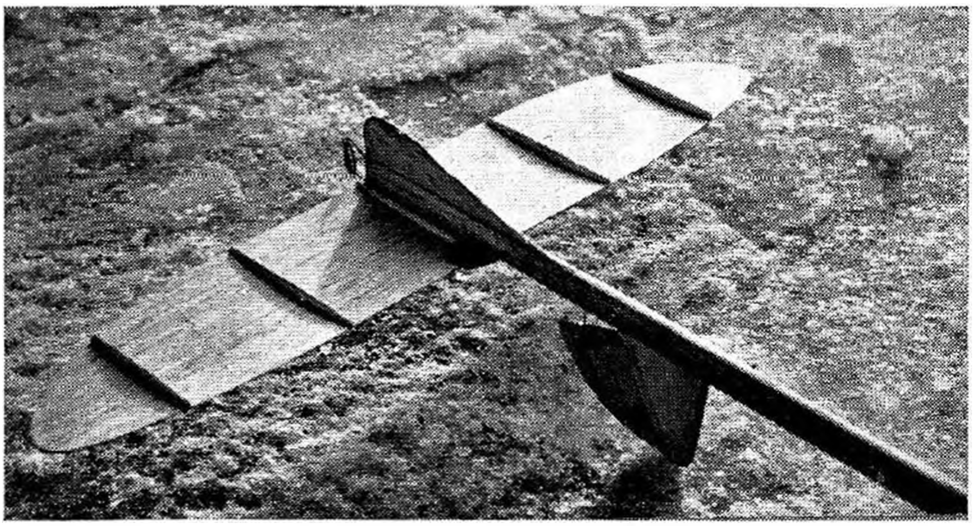
that the lightest grade of balsa—see Table III. It has to be used as a solid form, however, and is best "skinned" in any case. This can be tissue covering in the case of smaller panels (e.g., wings up to about 44 in. span and tail parts); or sheet balsa or hardwood veneer skinning for larger wings. In the latter case "skinning" is virtually essential to overcome the limited "brittle strength" of the core material.

The particular advantage of expanded polystyrene as an airframe material is that complete wing panels can be speedily and easily carved from slabs. It is very difficult to get a good surface finish other than by moulding, however, and surface *protection* is essential to resist the solvent action engine fuels have on the material. Weight will be higher than that of a built-up or all-sheet balsa wing of the same size because the core must be solid. Its chief advantage is time saving in building, therefore, rather than any structural advantage. This is further emphasised by the availability of commercial wing mouldings to suit standard R/C designs—e.g., Taurus, etc.—the cost of such panels usually comparing favourably with a *kit* for a similar built-up balsa structure.

There are other expanded plastics which can be used in a similar manner, some of which have superior properties as regards surface finishing, ease of bonding, and mechanical strength. In general, however, other materials with superior mechanical properties have a higher density and thus impose a weight penalty. Some, however, show distinct possibilities at a density of 5 to 6 lb. per cubic foot and should become more prominent. At this density level, though, weight is becoming directly comparable with "solid" balsa construction in ultra-light stock.

Glass fibre mouldings are well established as a modern structural material, although with a limited application to aeromodelling because of their weight.

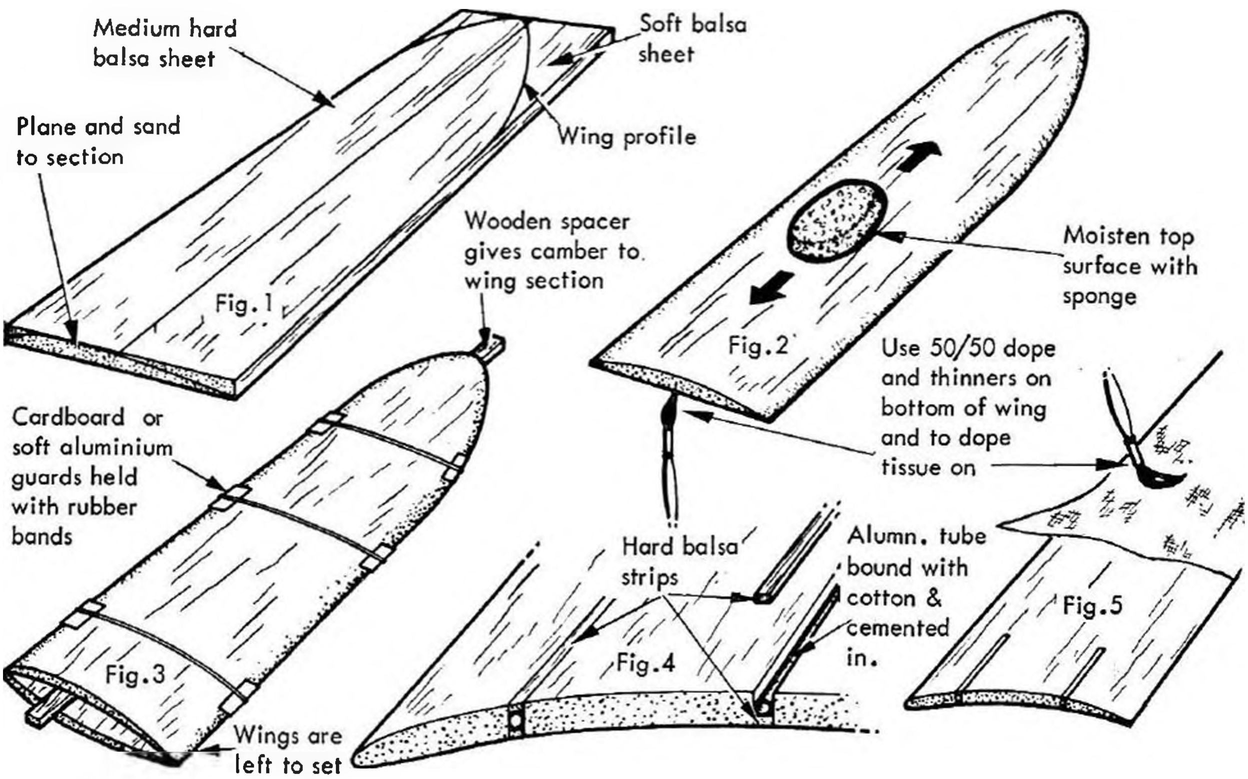
Single surface sheet tailplane on the APS Glider design "Mini-Egal"—shown inverted. Note how ribs hold the camber and an elliptical shape is chosen to minimise natural tendency to warp with this type of structure where no spar is employed.



Its main scope is for commercial mouldings where a sufficient number of individual mouldings can be produced off a master pattern to justify the time and cost spent in producing the master. Weight and cost are the chief limitations—plus the fact that it requires a considerable amount of effort, skill and experience to produce really first-class work in the material. Its main application to airframes is virtually limited to fuselage shell mouldings for R/C and control

Simple Sheet Wings in stage by stage construction.

(1) Cement two sheets together by stage construction. Shape to profile and section.
(2) Dope bottom; moisten top with water.
(3) Strap together to dry with wood camber spacer between.
(4) Slot for aluminium tubes to take wire wing retainers.
(5) Dope and cover with light tissue.



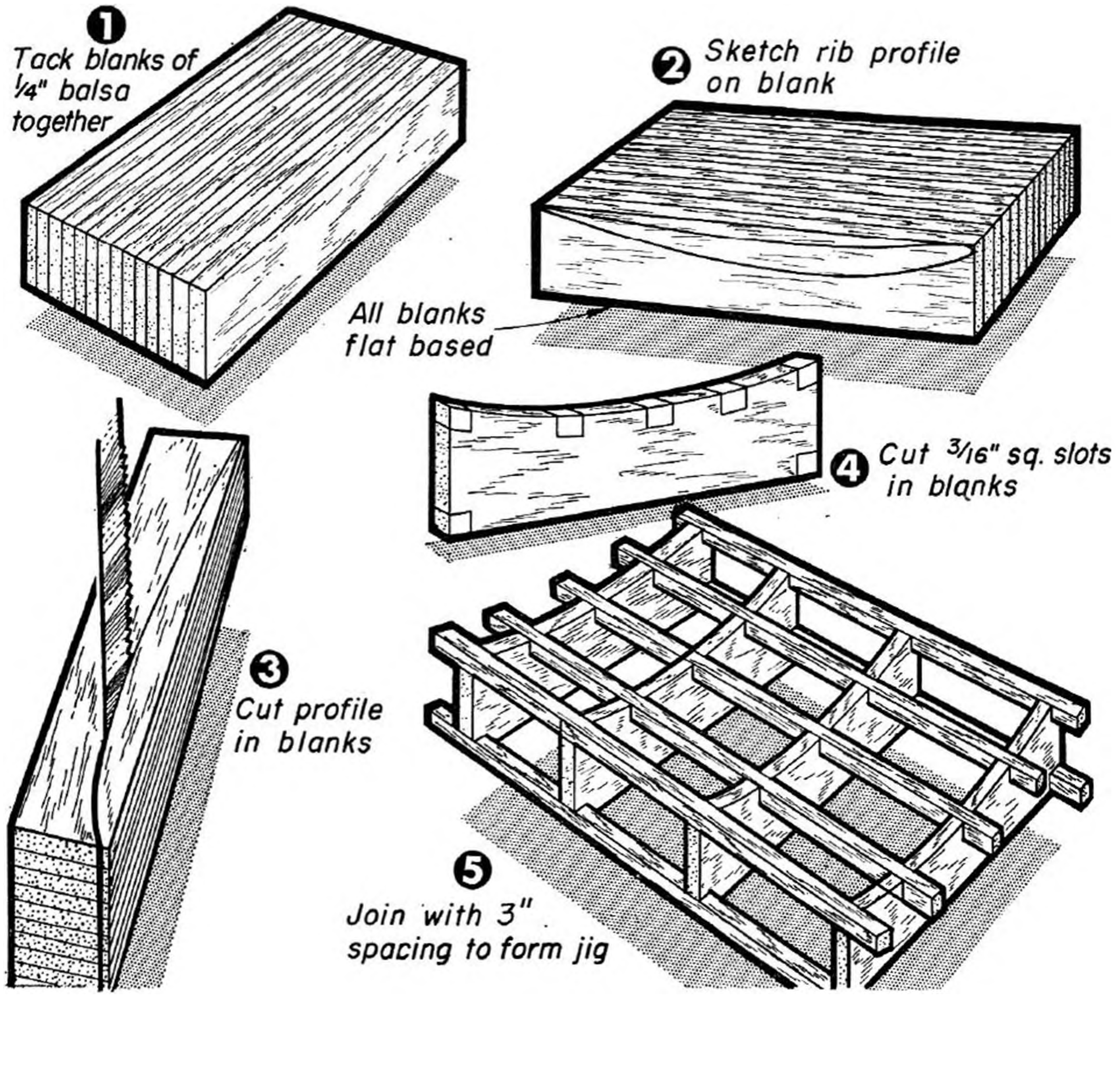
line types, although it is also a good material for making individual fairings, such as cowlings.

Built-up tissue or nylon covered structures still remain the standard choice for almost all "performance" models other than control line speed and Team Racers, largely because this is still the only form of construction which allows a large area wing of adequate strength to be built down to minimum weight—and performance is always a function of total weight. Design then follows orthodox forms. There have been no particular advances in this direction other than detail improvements and the best source of data for any new design is a study of plans of models of similar size and type.

Probably the most "scientific" approach to built-up structural design in the modern model is seen in the A/2 glider where aspect ratios are high and wind sections thin. This places a premium on good design to ensure adequate strength in bending coupled with sufficient rigidity to avoid twisting or flutter without producing too heavy a structure. Particular attention should also be paid to introducing anti-warp features in such wings.

Strangely enough "anti-warp" structures are still in the minority, particularly geodetic or "X" rib configuration which produces the most rigid of

Jig building of sheeted wings, shown diagramatically. An interesting and quick method which appeared in the South African Model Aircraft Association Newsletter.



all wing or tail frames as regards twisting. Warps are by far the most common cause of trimming troubles on high powered models and duration designs trimmed to very fine limits, yet still conventional type structures are used which can—and do—warp.

Wing structures with large sheeted areas—e.g., sheeted leading edges and built-up sheet trailing edges—are generally inherently rigid and so are themselves anti-warp structures. Thus warping or twisting is unlikely to be a problem with larger radio control models, unless a warp is accidentally built into the structure during assembly (usually as the result of removing from the building board at too early a stage). Lighter structures, however, are very prone to warp unless rigidly braced internally, although any induced warp will normally tend to become "permanent" after a period of time. Thus recommendations are often made that a wing and tailplane should be "aged" after covering and doping to take up any permanent set which may develop before the model is trimmed. With conventional shrinking dopes the "ageing" period, during which the dope may still be contracting, can ıange up to two weeks. A true anti-warp structure is far more reliable in this respect and does not need any ageing at all before it can be used.

By and large, therefore, conventional structural design has not advanced at all over the past decade or so and this is a field which could certainly do with some new thoughts for lightweight structures—or even a study of what has been done in the past when ultra-lightweight airframe construction was the rule for contest work rather than the exception. One still, for instance, finds elementary mistakes pursued—such as covering one side only of a light frame (e.g., a flat section built-up tailplane for a small R/C model). This is almost bound to warp—upwards, at least, if the frame itself is rigidly braced. Covering *both* sides would give it anti-warp properties.

ABSOLUTE WORLD RECORDS

Duration (New Zealand)

I. B. Barber, 9th October, 1960 ... ... 9 hours 4 minutes

Distance in a straight line (U.S.S.R.)

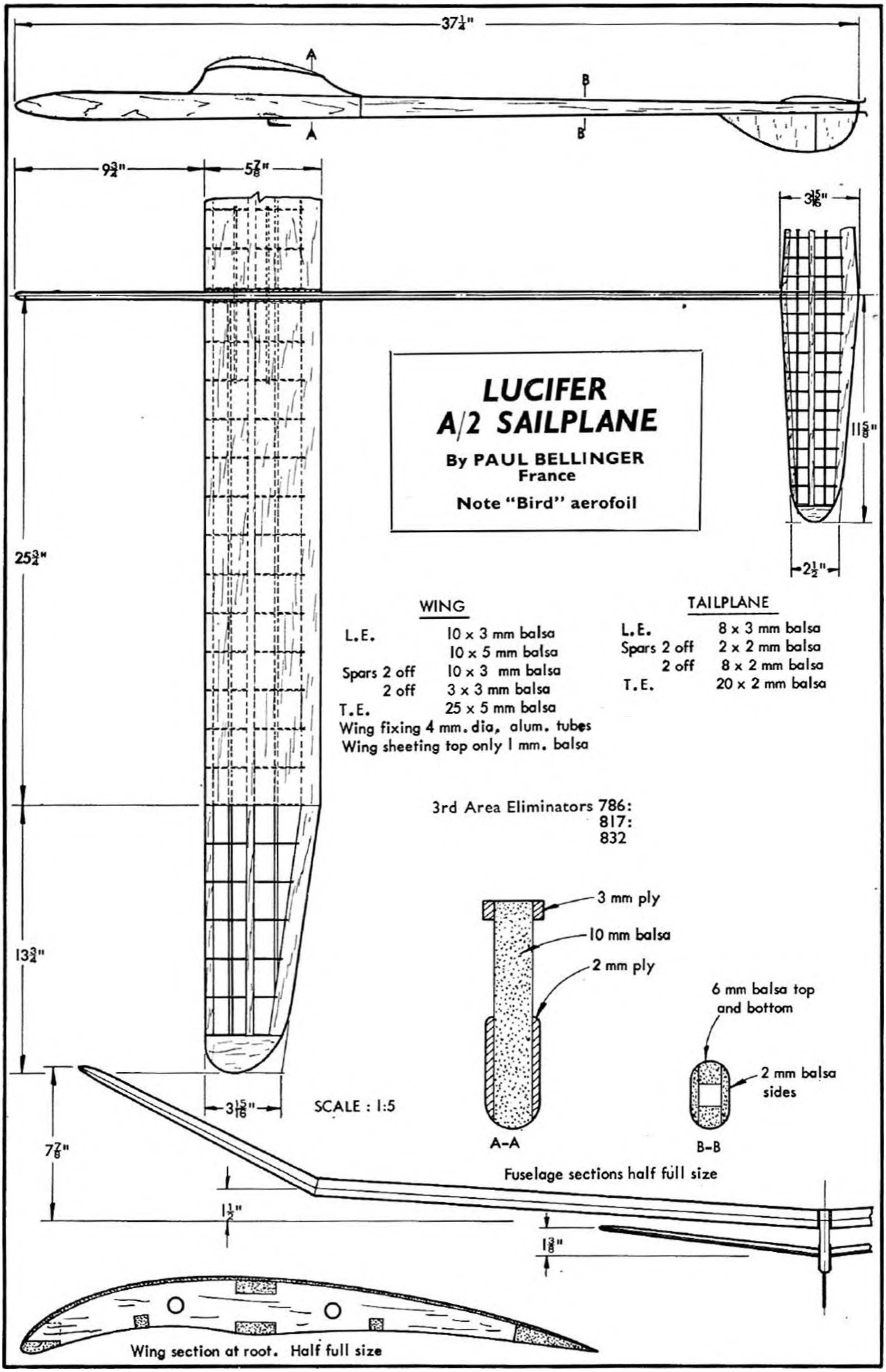
E. Boricevitch, 14th August, 1952 ... ... 378,756 km.

Altitude (U.S.S.R.)

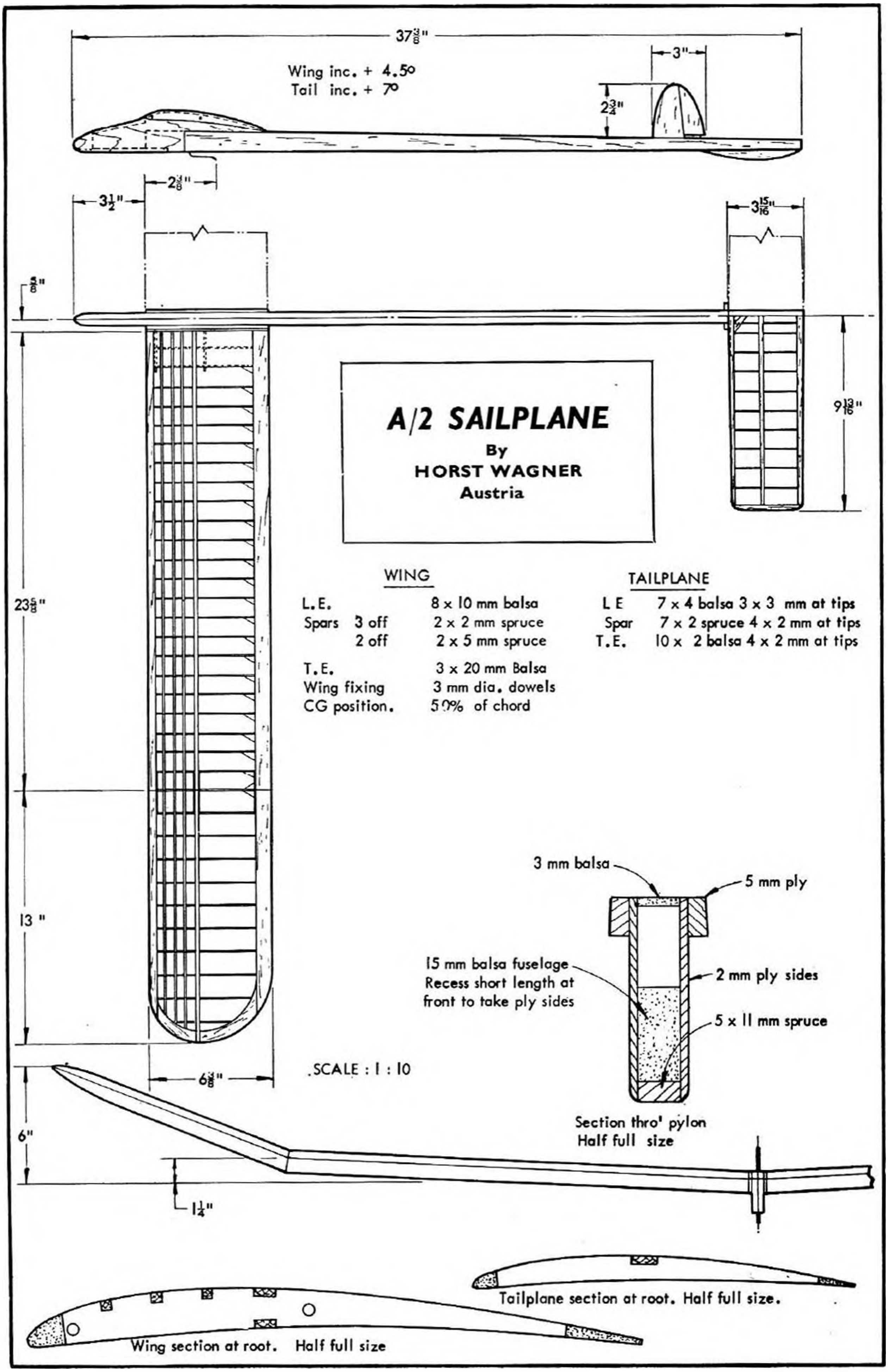
G. Lioubouchkine, 13th August, 1947 ... ... 4152 m.

Speed (Italy)

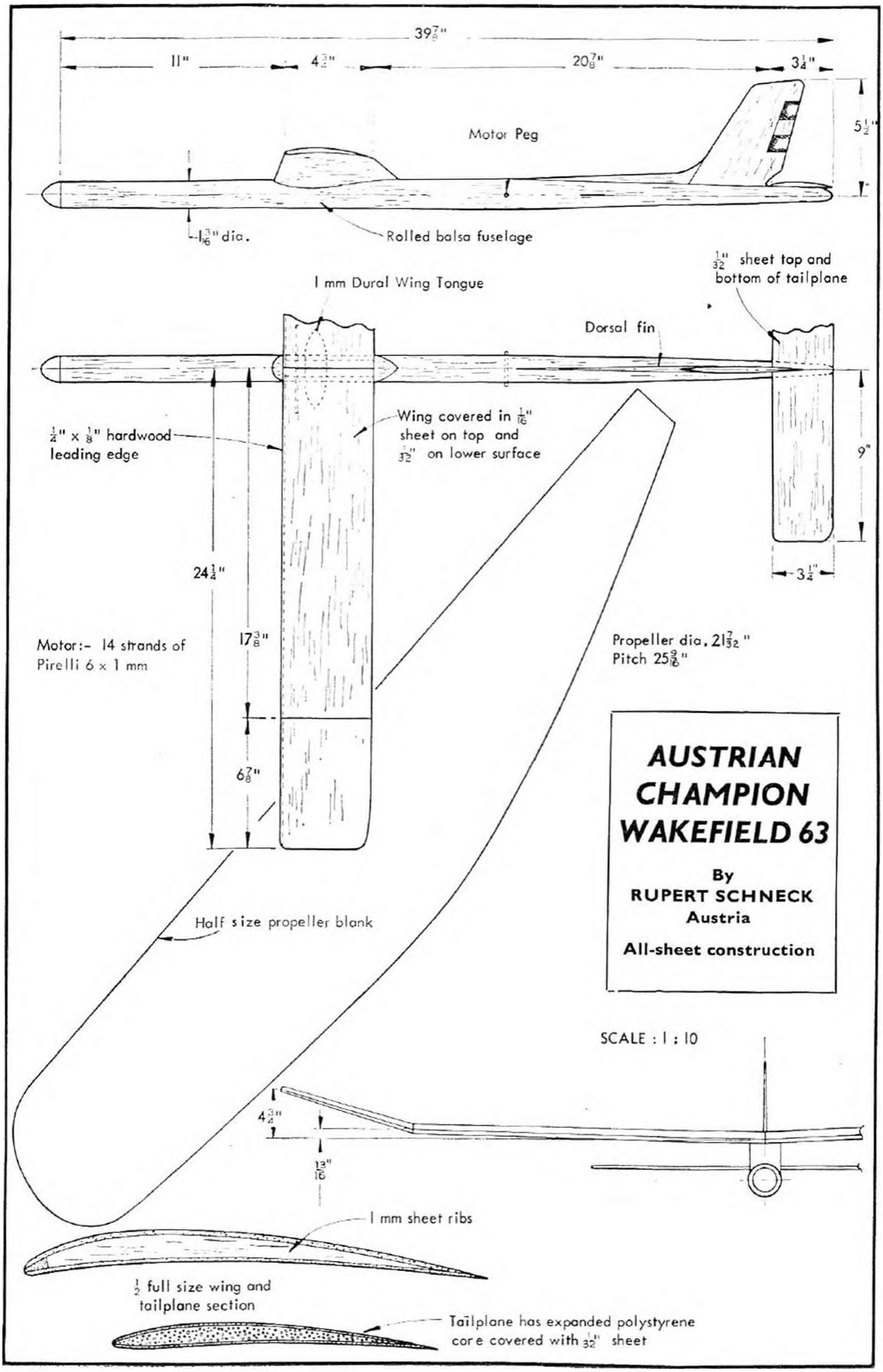
E. Zanin, 26th April, 1964 ... ... 327 km/h.



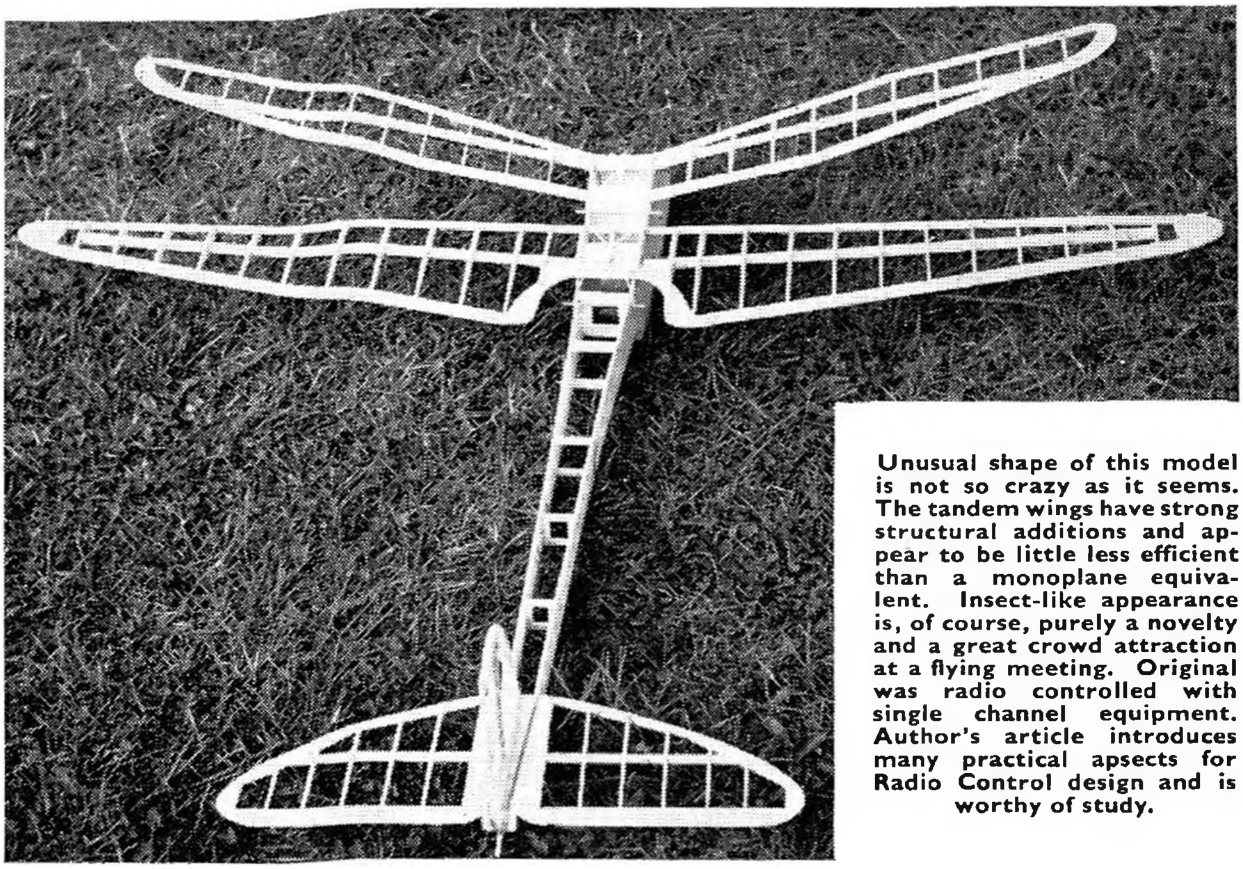
MODELE, FRANCE



MODELE, FRANCE



MODELE, FRANCE



Unusual shape of this model is not so crazy as it seems. The tandem wings have strong structural additions and appear to be little less efficient than a monoplane equivalent. Insect-like appearance is, of course, purely a novelty and a great crowd attraction at a flying meeting. Original was radio controlled with single channel equipment. Author's article introduces many practical apsects for Radio Control design and is worthy of study.

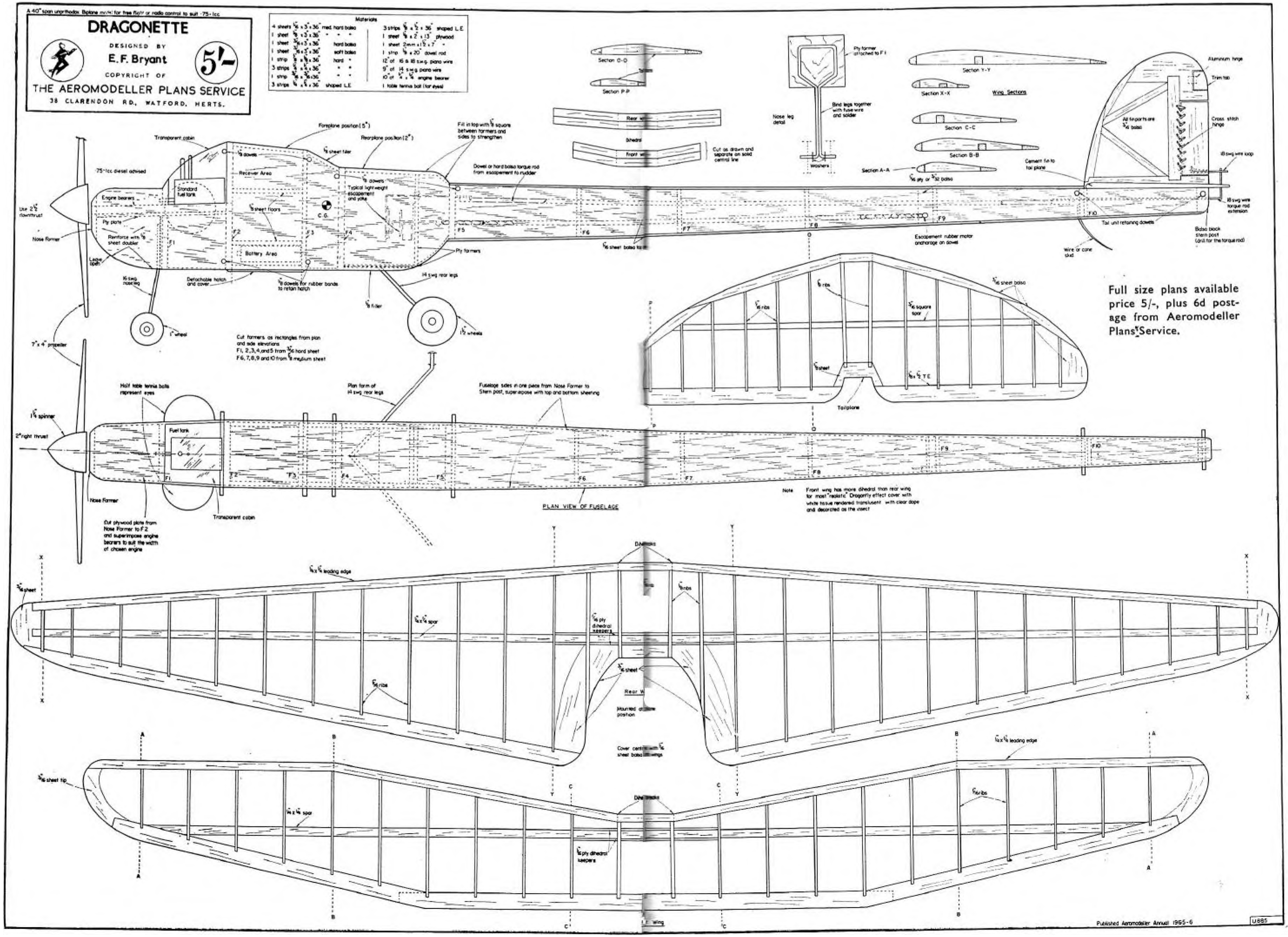
DRAGONETTE

by E. F. BRYANT

(A 40-inch span unorthodox biplane for free-flight or single channel radio control, suitable for engines of ·75 c.c. to 1 c.c. capacity)

THE original model of this type, called "Dragon Fly", was inspired by the sight of one of these magnificent insects gliding silently and effortlessly over the still waters of a canal one hot, dry summer afternoon. The author, who was supposed to be fishing, was so impressed by this performance that he determined to try to reproduce it in model form. Accordingly, the largest dragon fly to be found was sacrificed to the cause, pinned to the drawing board, and scaled up as accurately as possible. Nature's perfection having been suitably modified, the result was a model of some 42 inches span, which although almost impossible to build, flew extremely well and realistically. Powered by a worn out Taifun Hobby of ·98 c.c. capacity, the model flew regularly on calm evenings over the Wiltshire countryside, attracting much attention and, on one occasion, raising the local unorthodox record by some 2 or 3 minutes. After completing well over 40 hours, it was finally broken up when its owner was posted overseas.

The next model in the series was much smaller and the fuselage much modified to make construction easier, and to facilitate the installation of radio gear. Built and flown in Aden, it was a diminutive 22 inches span, powered by a new E.D. Baby ·46 c.c., and controlled by a C. & S. 501 receiver and an O.S. lightweight escapement. Over the desert sands it was found that the wing loading proved too high and this particular model was difficult to fly. It did, however, show that the type could be made suitable for rudder only radio control, before eventually meeting its fate in the shape of a very solid goalpost on the sports ground of Steamer Point.


A 40" span unorthodox Biplane model for free flight or radio control to suit ·75-1cc
DRAGONETTE
DESIGNED BY
E. F. Bryant
5/-
COPYRIGHT OF
THE AEROMODELLER PLANS SERVICE
38 CLARENDON RD., WATFORD, HERTS.
Materials
Section O-O
Section P-P
Section Y-Y
Section X-X
Wing Sections
Section C-C
Section B-B
Section A-A
Aluminium hinge
Trim tab
Cross stitch hinge
Foreplane position (5°)
Rearplane position (2°)
Transparent cabin
·75-1cc diesel advised
Standard fuel tank
Engine bearers
Ply plate
Nose Former
Receiver Area
Battery Area
C.G.
Ply formers
Detachable hatch and cover
1" wheel
1½" wheels
7" x 4" propeller
Cut formers as rectangles from plan and side elevations
Half table tennis balls represent eyes
Fuel tank
2° right thrust
Transparent cabin
PLAN VIEW OF FUSELAGE
Tailplane
Full size plans available price 5/-, plus 6d postage from Aeromodeller Plans Service.
Published Aeromodeller Annual 1965-6

Back in England once more, the design was again revised, and a return to almost the original size proved to be the right answer. An experimental model of 40 inches span was built, using the original wing and tail plans, but with a fuselage designed expressly for the use of radio. A tricycle undercarriage was tested and found to be a great improvement for take off and landing. The model, however, this time powered by a ·76 c.c. Merlin, showed a depressing tendency to tighten up on turns, ending up in a hair-raising spiral dive. This was not at all what was wanted, so more midnight oil was burnt until the cause was determined and rectified. Alterations to wing tips, rib sections and C.G. position, with attendant revision of incidence angles completely cured the troubles and the result was "Dragonette".

Dragonette is meant only as a "fly-for-fun" model, but it must be pointed out that it is capable of very sustained flights and free-flight versions could well carry some form of dethermaliser, as well as the owner's name and address. The radio controlled version, with its heavier load, will fly a little faster, but if lightweight gear is used will compete on almost equal terms with its free-flight counterpart.

Whichever version is flying, however, it is certain to attract attention from the young and old, and even the hard-bitten multi-man will be seen to stand and watch its realistic flight.

Construction

Construction is orthodox throughout and no difficulty will be found by those who have previously built powered models. It is, however, necessary to build carefully and to choose the materials with care in order to get the best results.

"Beefing up" of the components is not recommended, since any significant addition to the designed weight will seriously affect the performance, although gussets of sheet balsa may be used appropriately even when not shown on the plan.

Silk or nylon should *not* be used for covering.

Fuselage

Choose two sheets of $\frac{1}{16}$ in. balsa as similar as possible for the fuselage sides and carefully trace the profile onto them from the plan. Particular care must be taken at the wing and tail platform areas, since these determine the incidence angles which are fairly critical. Mark former and engine bearer positions at the same time.

Pin or "spot-cement" sides together, sand to exact shape and drill holes for dowels. Cut all fuselage formers from balsa sheet as shown on the plan, noting that all from F.5 backwards must have cut-outs to allow for the torque rod and escapement rubber.

(For free-flight versions these formers can be left solid).

Lay the starboard fuselage side over the plan, pin down and cement in Formers 2, 3, 4, and 5. Check for squareness with set-square or template and leave to set.

Cut the "floors" for receiver and batteries as shown on plan, cement them into position and allow to set thoroughly.

Next place the port fuselage side over the formers already in place, cement well into position and leave to dry.

While this section is drying the engine platform can be cut from plywood as shown on the plan and the bearers cut and drilled for the particular engine to be used. Do not forget the side-thrust, which is determined at this stage. Bolt holes for the engine should be drilled $\frac{1}{64}$ in. oversize to allow for small adjustments when flying. The bearers should be fixed to the ply platform with an adhesive such as "Evostik" or "Bostik".

When the fuselage section is dry the tail ends can be drawn together and the remaining formers cemented in aft of the wing area. The tail post is carved from scrap block or laminated sheet. Check for twist and set aside to dry.

Next cut and drill the doublers for the rear rubber motor peg and cement them and the tailplane holding dowels into position.

Note. The rear rubber motor peg is *not* cemented in.

Now draw the forward ends of the fuselage sides in and fix the engine platform and bearers into position, again using the "Evostik", and taking care to allow for the correct down-thrust. The doublers are now added to the nose, below the engine, as are the lower part of Former 1 and the nose former.

All remaining dowels are cemented into position at this stage, checking for correct alignment and adjusting if necessary.

The fuselage is now ready for the installation of any radio gear and since this may be of various types, it would be pointless to describe any particular one here. Suffice it to say that the centre of gravity should be carefully watched during the installation.

The landing gear is now made up as on the plan, the piano wire being sewn to the ply formers with strong thread or silk and well cemented afterwards. Gussets for local strengthening may be added, but not overdone, as the undercarriage formers are cemented into place. Wheels are now checked for correct alignment and completely free running. No other spring is necessary, the natural spring of the wire being sufficient.

Top and bottom decking can now be added to the fuselage, leaving the spaces at the front wing platform which allows access to the receiver compartment and below the engine, which allows for drainage and gives access for adjustments to thrust.

Since the rubber for the escapement is wound by inserting a finger into the fuselage and turning the crank on the escapement, a space should also be left at the rear wing platform, but it may be considered easier to make a little door in the side of the fuselage at the appropriate place for this operation. If this is to be done, now is the time to do it.

Note. The rubber could also be wound from the rear, in which case a space should be left below the rear motor peg.

Cut the table tennis ball accurately in half and cement the halves in the position shown on the plan. These will represent the eyes of the dragon fly.

Note. An interesting possibility is the use of the "eyes" as fuel tanks.

If a metal type fuel tank is used it will sit on the back of the engine platform, but this again will depend on the engine and tank to be used. In any case, the top part of Former 1 is now glued in place. The whole fuselage can now be sanded down lightly and prepared for finishing. A covering of lightweight tissue over the fuselage will add little weight but considerably increase the strength, besides giving a good surface for colour dope if this is to be used. If tissue is applied it should be given two coats of clear dope, thinned by 25% and *very* lightly rubbed down. This apart from colouring completes the fuselage.

Fin and Rudder

The unit is built up on the plan from $\frac{3}{16}$ in. sheet balsa, then sanded to a streamlined section. The rudder area shown should be adhered to and, for both free-flight and radio versions, the trim tab is very desirable. It can be fashioned from the wood or, more easily from a scrap of aluminium foil.

When sanded smooth, the unit is covered with lightweight tissue, given two coats of thinned dope and one coat of varnish.

The rudder itself is cross-stitched to the fin to form the hinge and its movement should be restricted to $\frac{3}{16}$ of an inch either side of neutral.

Wings

The construction here is orthodox, following normal simple practice, but special care is needed when fitting joints to ensure that stresses are not created through force fitting any parts.

Spars are tapered, as shown on the plan, from the centre section to the wing tip rib. Dihedral keepers are fixed to the spars with "Evostik" adhesive, before commencing the building of the wing. The ribs are best made by the "sandwich" method, templates of the largest and smallest ribs being of ply and the rectangles of $\frac{1}{16}$ in. sheet pinned between them. Carving and sanding to shape is made easy by this method.

Note. In the case of the foreplane, because of the peculiar plan form, it will be found easier to make the ribs in two lots, one lot inboard of the trailing edge angle, and the other for those outboard.

Spars can now be pinned over the plan and the ribs, tips and leading and trailing edges cemented on. Centre sections of both wings are covered with $\frac{1}{16}$ in. sheet, and the whole framework carefully sanded smooth.

Both wings are covered with lightweight tissue, water doped, then given two coats of the thinned clear dope and a final coat of copal varnish. It should not be necessary to pin the wings down during the doping process, although they should be carefully checked for warps after the dope has dried.

No wash-in or wash-out is intended in the design and the performance will suffer badly if warps are present.

Tailplane

As for the wings, the construction is simple and orthodox. Ribs are again made by the "sandwich" method, while the leading edge is cut from $\frac{1}{16}$ in. sheet. The centre section is sheeted both top and bottom, the sheet on the bottom being inlaid to bring it flush with the ribs. Covering and finishing is the same as for the fin and rudder.

Fin and rudder can now be cemented to the tailplane, care being taken to make sure it is in accurate alignment. A dowelled joint will add considerably to the strength and rigidity of the joint, but once again the weight must be carefully watched. Small fillets of tissue can be used to neaten the joint between the two units.

Landing Gear

The tricycle gear on this model ensures good take-off characteristics and reduces longitudinal strains on the fuselage during landings. Its construction is straightforward and is described in the text on the fuselage. The tiny skid at the rear of the fuselage is optional, but has been found to prevent the tail scraping the ground on a bouncy landing.

Colouring and Finishing

In order to keep the weight down, colour dope or paint is used only on the fuselage.

The designer's models have had a bright, multi-coloured fuselage, with flying surfaces of white, pale blue, or yellow, the translucent effect produced by varnish or banana oil being particularly desirable. Coloured dopes can be used on the fuselage, although good enamel paints are easy to apply and have a natural resistance to diesel fuels.

The "eyes" can be painted in a variety of ways, probably the brighter the better.

As a final touch, don't forget your name and address, printed boldly and clearly, with a note that there will be a reward for the finder!

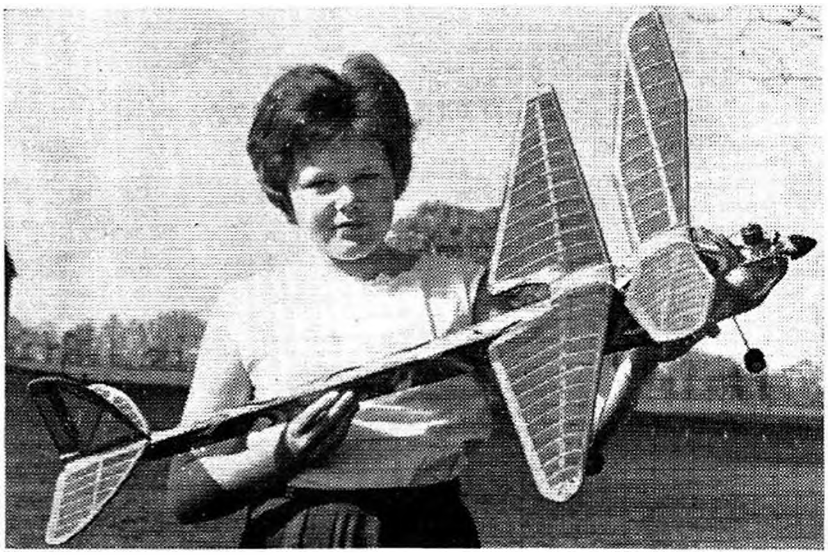
Flying

As has been said previously this is not a heavy weather model, so do choose a really calm day for the first flights.

If possible, find a place with really short grass, or even better, a tarmac or concrete surface to do the test gliding. Long grass will only cause the model to nose over when landing and tissue repairs will have to be carried out before the model has done one flight. Prior to any flying at all, it is wise to carry out the following checks.

1. Check that the C.G. is correct. If necessary adjust by the addition of small amounts of "Plasticine" to nose or tail.
2. Check all surfaces for warps, particularly the foreplane and tailplane. If a warp is very slight it may be rectified by simply twisting the component in the opposite direction, preferably in front of a source of *gentle* heat. In any case, this component must always be suspect and the subject of careful checking before subsequent flights.
3. Check that the wings and tail are adequately fixed to the fuselage. Models often crash because the wing or tailplane move in flight.

Complete Dragonette shows the author's white, blue and yellow colour scheme for extra realism. Fuselage is gaily painted and has half section of table tennis balls appropriately painted as eyes on either side of the nose cowling. Plans for the model on earlier pages can be enlarged or alternately Aeromodeller Plans Service can supply full size dye-line prints, price 5/-, plus 6d postage.



4. Check that the trim-tab is in the neutral position.

Now, if all is well, hold the model above the head at arm's length in a straight and level attitude, and walk into wind, increasing speed until the model can be felt to be lifting. Note the speed. Next, face into wind and launch the model in a slightly nose-down attitude at what you estimated the speed to be in the previous test and observe what happens. The model should leave the hand in a long, straight, shallow glide, without deviating or soaring.

Note. When only a few inches from the ground there may be a tendency for the nose to lift, but this is presumably due to ground effect and can be disregarded.

If the model turns very slightly to the right, this is satisfactory for a free-flight version, but if for radio control, the turn must be completely corrected with the trim tab. For free flight, the pattern is right-right, and on no account should a left turn be introduced. Should the model appear to be nose heavy, correct by adding tiny bits of weight to the tail, but this condition is most unlikely and weight should only be added after the C.G. has been re-checked. If there is a tendency to stall, the tailplane may be packed up at the leading edge, but no more than $\frac{1}{32}$ in. Adding weight to the nose is preferable, but a re-check of the incidence angle of the foreplane is also indicated.

When the glide is completely satisfactory, tank up for about one minute engine run, undercompress the engine to slow it down and launch into wind.

If free-flying, the aimed at pattern should be a slow climbing turn to the right, followed by a smooth transition to glide when the engine cuts and a flat glide, also to the right.

For radio control, naturally, the pattern should be a straight climb, followed by an equally straight glide.

From now on, any deviations can only be corrected by altering the direction of engine thrust, in the usual manner. Increasing the power will result in a much steeper climb, but when properly trimmed, this model is unlikely to stall.

Dragonette is not a high speed model and will perform best at more modest speeds, besides looking more realistic.

With radio controlled rudder, it will perform flick loops with ease, after a spiral dive, and can be rolled, with judicious use of a light wind. Take-offs are a joy to watch, and its ability to fly slowly and stably at low altitude make it a real pleasure to fly.

AEROMODELLER NOMOGRAMS

The four following nomograms, specially prepared for the Aeromodeller Annual, have been designed both to cover a number of standard formulas and also provide instantaneous conversion of dimensions, areas, weights and loadings from English to metric units, and vice versa.

In all cases, the complete nomogram solution is found by connecting two known values with a straightedge or straight line and reading the corresponding value of the third (unknown) value at the intersection on that scale. Conversions are read directly off individual scales.

Use and scope of the nomograms are described under the following headings.

Nomogram 1. Bore—Stroke—Displacement

To find cylinder displacement for known values of bore and stroke, connect bore value to stroke value on the appropriate scales and read off displacement on the centre scale.

Example: to find the displacement of a cylinder of ·59 in. bore and ·54 in. stroke. Answer: 2·42 c.c. or ·1476 cu. in.

Note: both bore and stroke can be entered either in inches or millimetres; and displacement read in cubic inches or c.c.

To convert inches to millimetres, or vice versa, read off corresponding values directly from the Bore or Stroke scales.

To convert c.c. to cu. in., or vice versa, read off corresponding values on the Displacement scale.

Nomogram 2. Chord—Span—Area

This nomogram gives the area of a rectangular shaped wing, knowing the chord and span. In the case of a straight tapered wing, the mean or average chord value should be used.

This nomogram is also useful for investigating the various combinations of chord and span which give a required area.

Chord may be entered either in inches or millimetres; and span in inches or decimetres. The area can be read in square inches or square decimetres (or both).

To convert inches to millimetres, and vice versa, read off corresponding values direct from the Chord scale.

To convert inches to centimetres, and vice versa, read off corresponding values on the Span scale.

To convert square inches to square decimetres, and vice versa, read off corresponding values on Area scale.

Nomogram 3. Line Length—Time—Speed

This nomogram can be used for finding the speed of a control line model flown on any line length, reducing the observed time for any given number of laps to time per lap (i.e., divide total time by number of laps timed).

Example: to find the speed when the time is 2·8 seconds per lap on 35 ft. lines. Answer: 53·6 m.p.h.

To convert feet to metres, or vice versa, read corresponding values directly off the Line Length scale.

To convert speed in m.p.h. to kilometres per hour, or vice versa, read corresponding values directly off Speed scale.

Nomogram 4. Weight—Area—Loading

By connecting the known weight (in ounces or grams) to the area (in sq. inches or sq. decimetres), the corresponding loading can be found on the centre scale.

Example: to find the wing loading when the model weight is 24 ounces and the wing area 360 sq. in. Answer: 9·33 ounces per square foot.

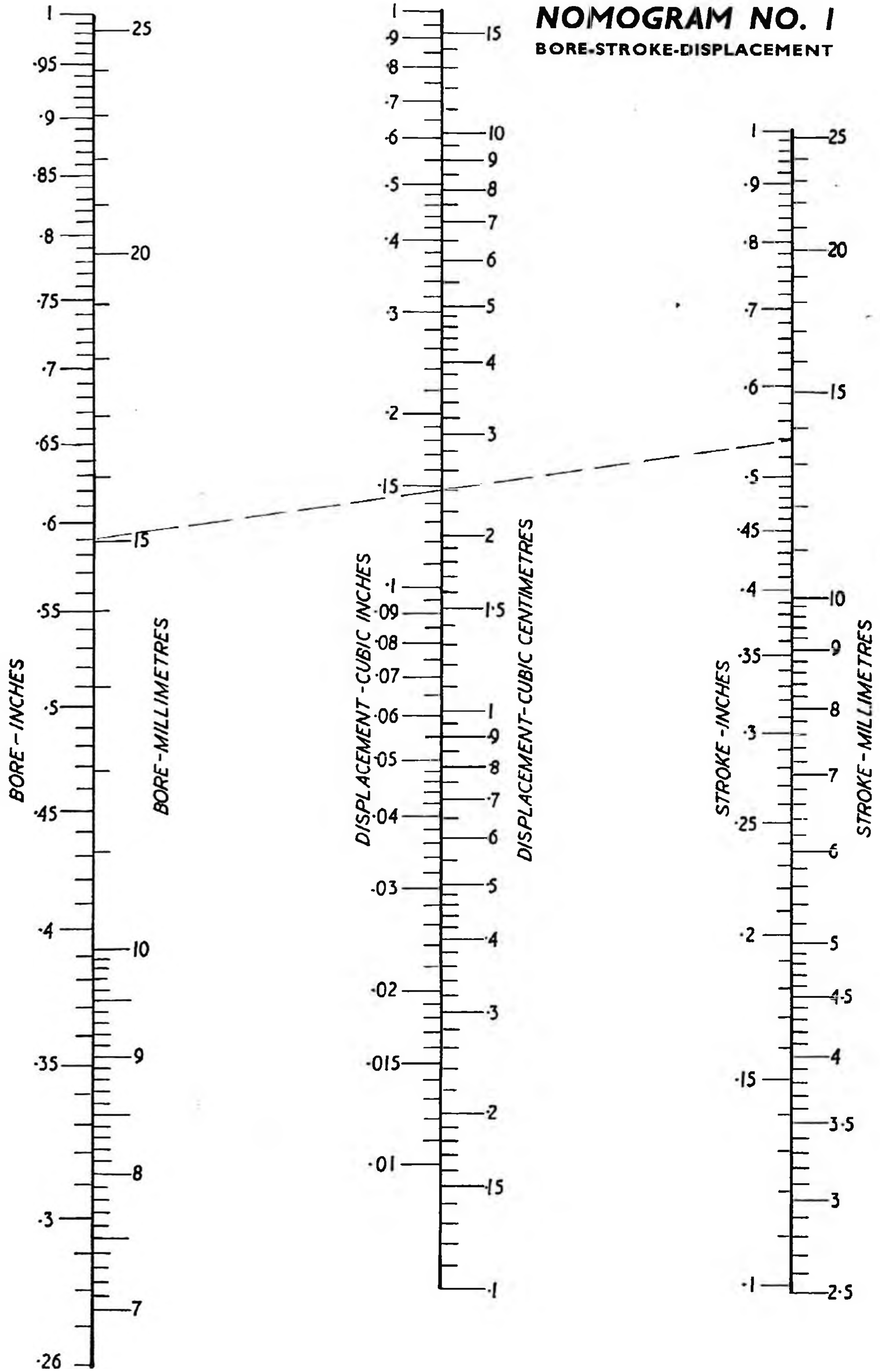
To convert weight in ounces to weight in grams, or vice versa, read corresponding values directly off Weight scale.

To convert area in sq. inches to area in sq. decimetres, or vice versa, read corresponding values directly off the Area scale.

To convert loading in ounces per sq. ft. into loading in grams per sq. decimetre, or vice versa, read corresponding values directly off the Loading scale.

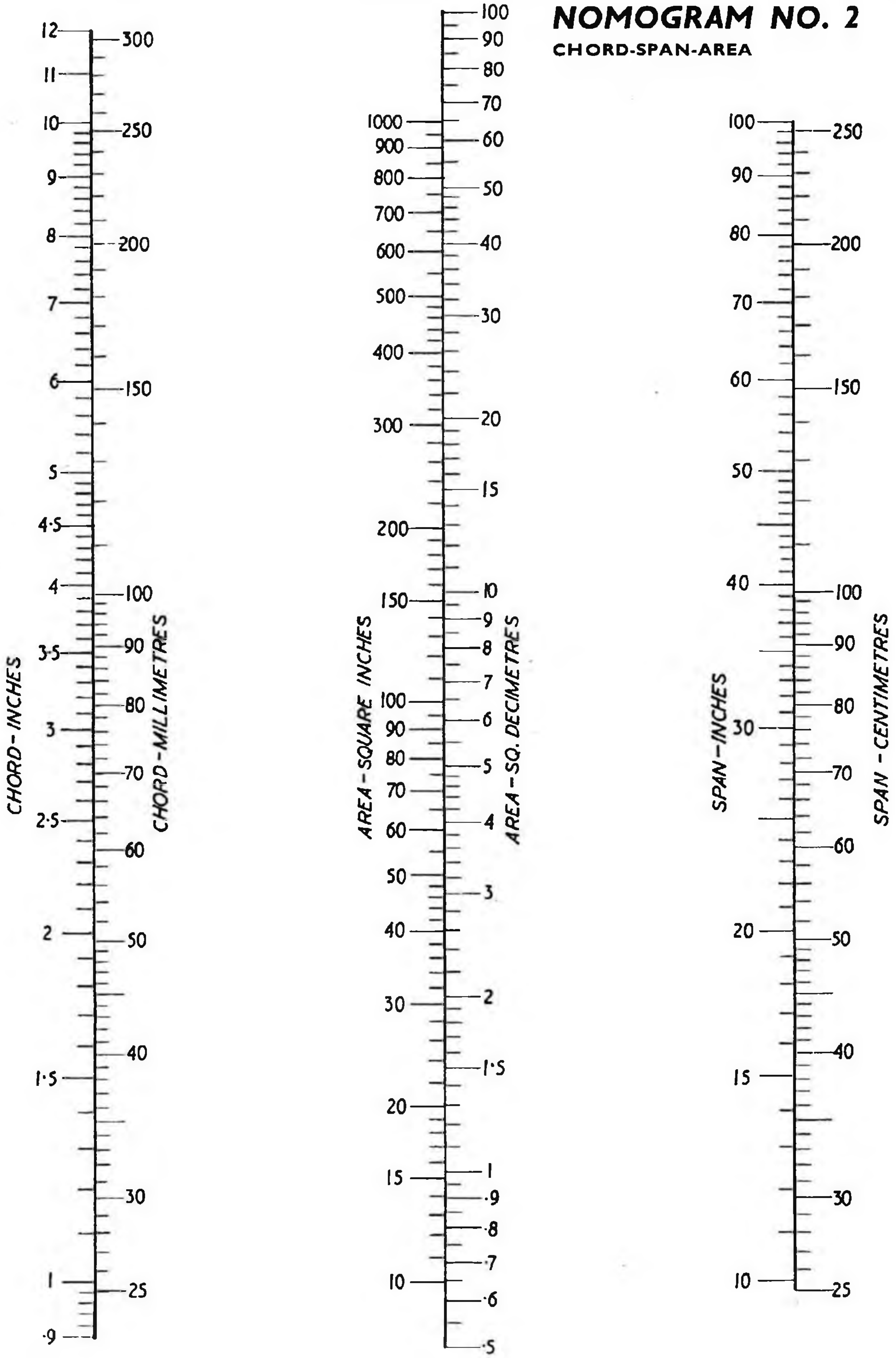
NOMOGRAM NO. 1

BORE-STROKE-DISPLACEMENT

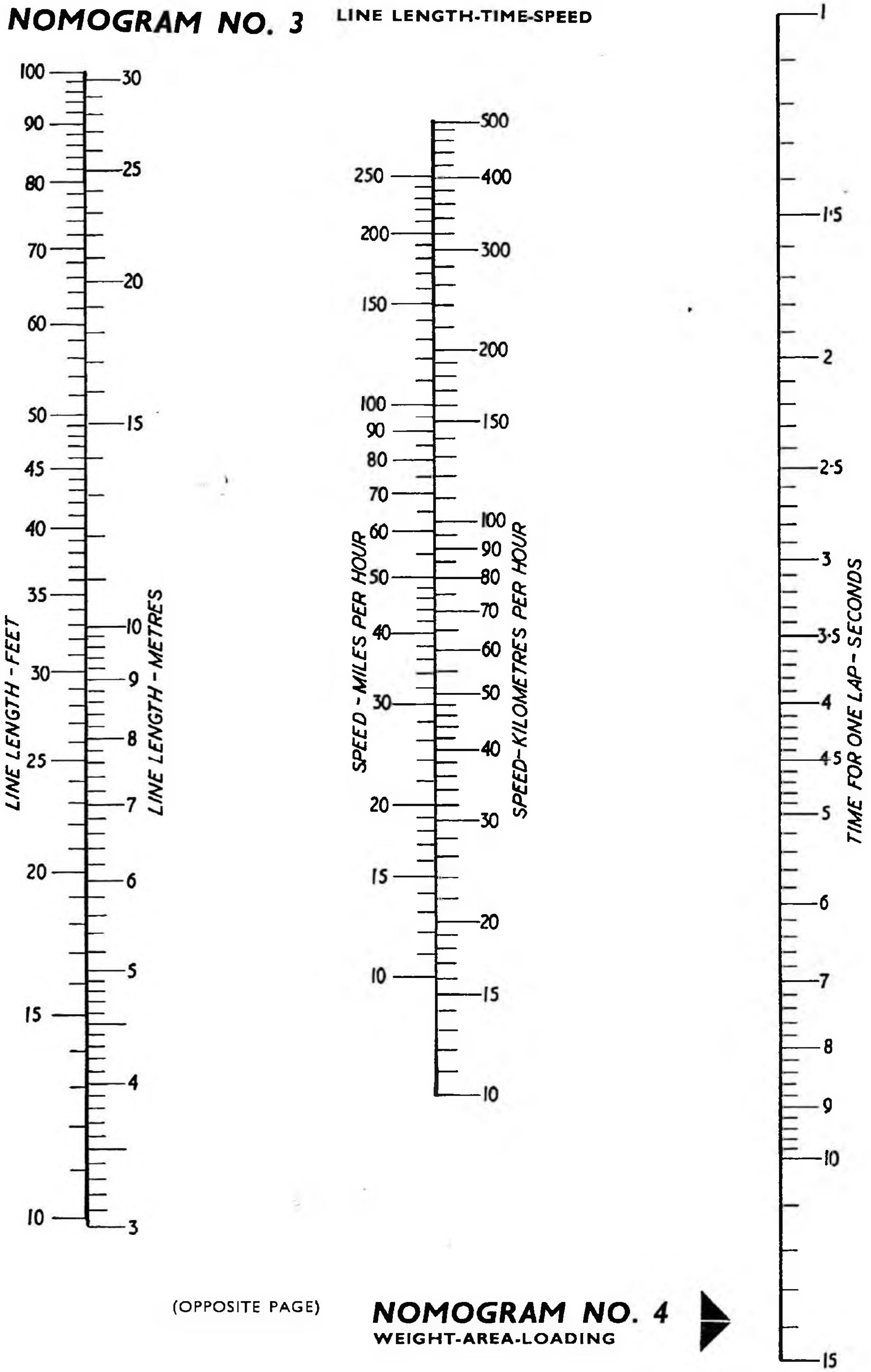


NOMOGRAM NO. 2

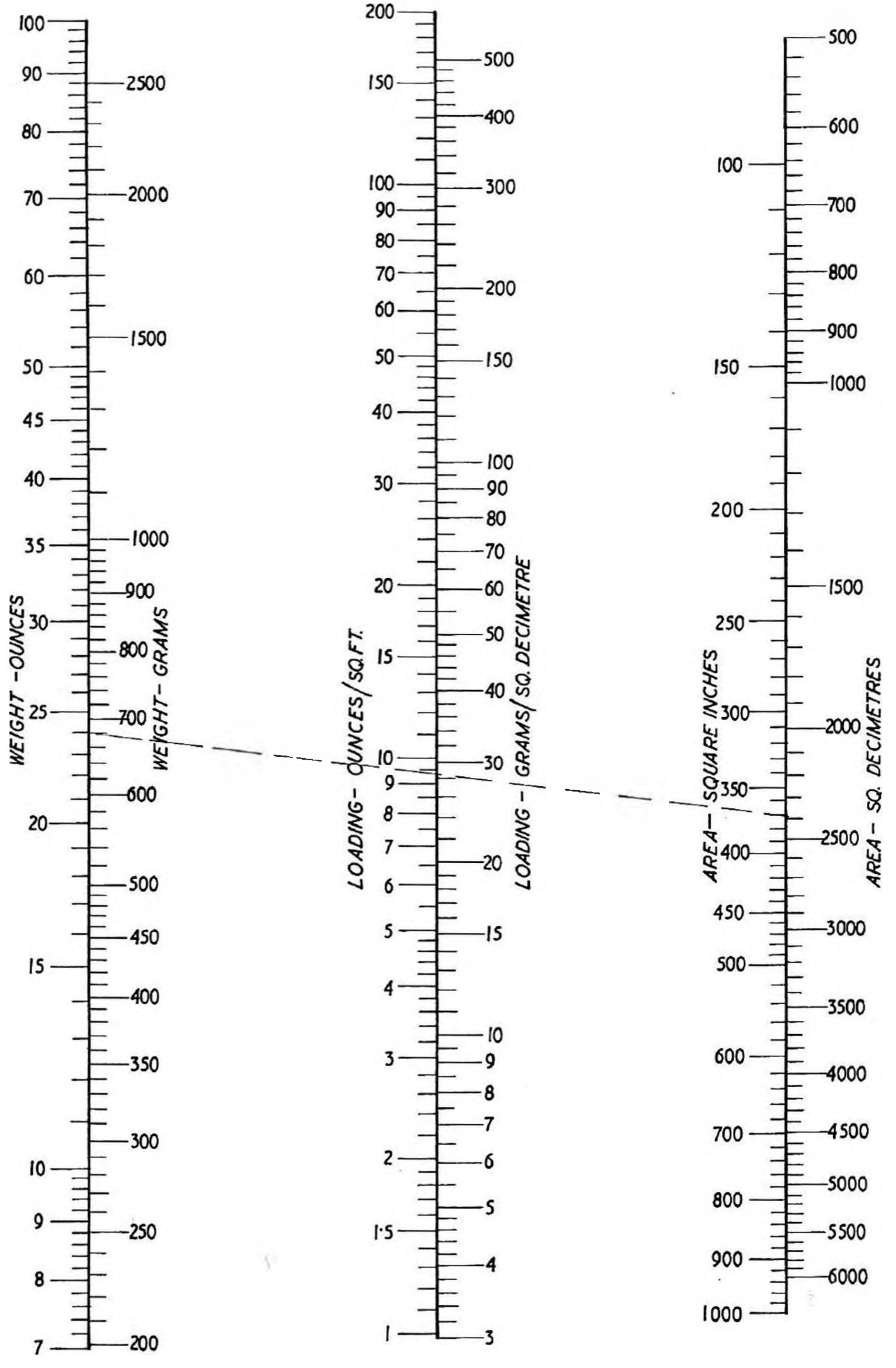
CHORD-SPAN-AREA

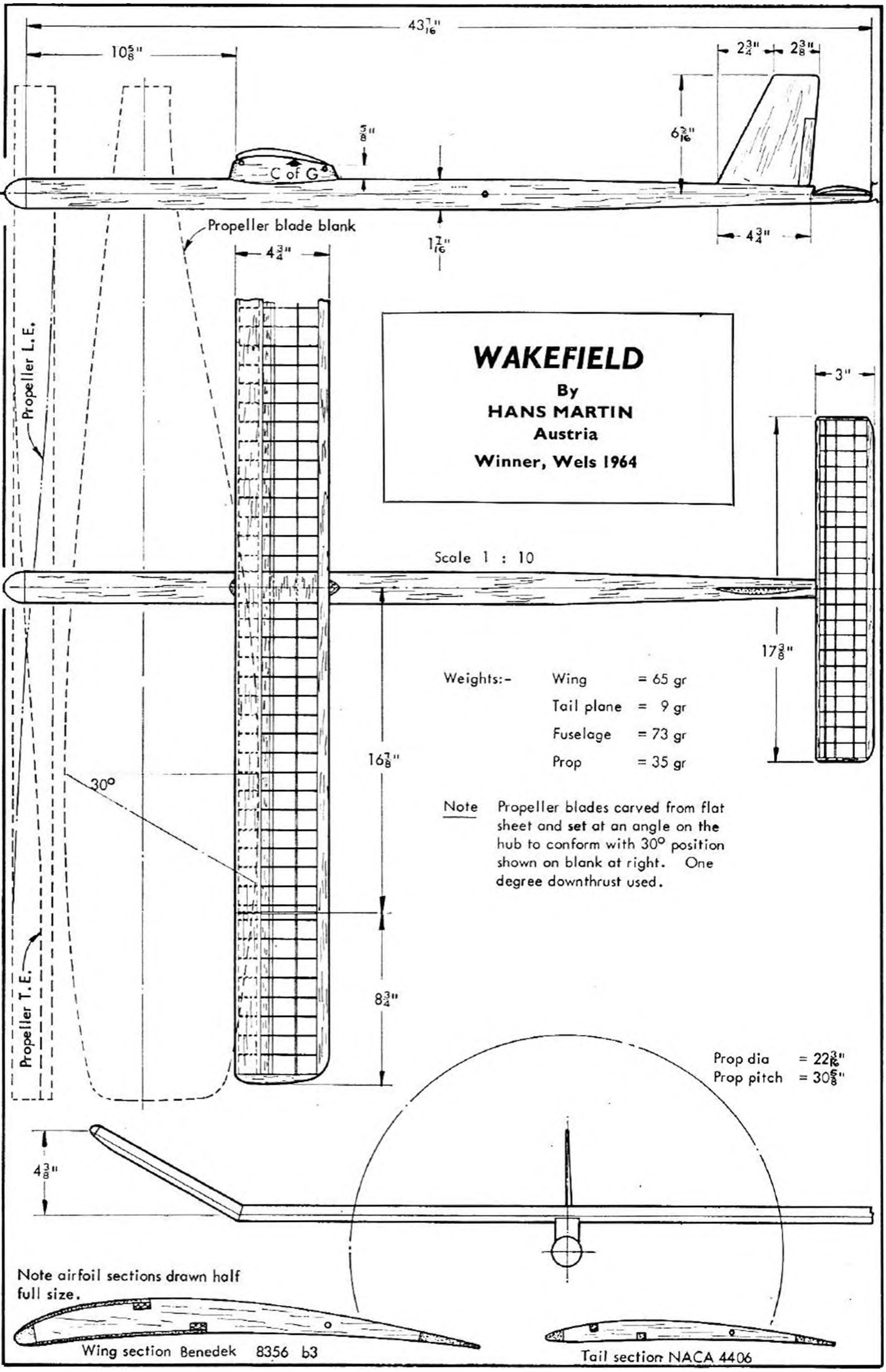


NOMOGRAM NO. 3 LINE LENGTH-TIME-SPEED



(OPPOSITE PAGE) NOMOGRAM NO. 4 WEIGHT-AREA-LOADING


WEIGHT -OUNCES
WEIGHT- GRAMS
100 90 80 70 60 50 45 40 35 30 25 20 15 10 9 8 7
2500 2000 1500 1000 900 800 700 600 500 450 400 350 300 250 200
LOADING- OUNCES/SQ.FT.
LOADING - GRAMS/SQ. DECIMETRE
200 150 100 90 80 70 60 50 40 30 20 15 10 9 8 7 6 5 4 3 2 1·5 1
500 400 300 200 150 100 90 80 70 60 50 40 30 20 15 10 9 8 7 6 5 4 3
AREA— SQUARE INCHES
AREA - SQ. DECIMETRES
100 150 200 250 300 350 400 450 500 600 700 800 900 1000
500 600 700 800 900 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000



MODELE, FRANCE

WHY NOT PUSHERS?

PUSHERS are generally regarded as unorthodox models with, in consequence, an inherently inferior performance to equivalent models with a tractor layout. This assumption is based largely on the fact that pusher designs have been relatively undeveloped and in consequence the potential performance of the type has not been realised in any category. Theoretically, at least, the pusher layout, properly applied, should have *better* efficiency than a tractor. That is to say, given a particular model specification, the potential performance of the pusher is higher than that of the tractor, although the solution of practical problems involved may impose penalties offsetting likely gains.

The basic theoretical considerations involved in producing an "optimum" design layout involve comparisons of parasitic and induced drag for various alternative layouts, together with available lift coefficients. From such data the theoretical or maximum potential performance can be worked out—but since such data normally involve estimates or approximations rather than exact figures, performance calculation ends up rather as a "guesstimate".

As far as free-flight models are concerned, at least, potential performance is usually developed and improved by practical considerations, such as the ratio of rubber to airframe weight in the case of rubber models; power loading and wing loading in the case of power duration models; and power loading, stability margins and inertia forces in the case of fully aerobatic radio control models. Gliders we can ignore because these are not applicable to "pusher" or "tractor" configurations, although it is interesting to note that the efficiency of the canard may well compare with, or exceed, that of the conventional layout—and the theoretical efficiency of the canard may well be worth considering together with pusher propulsion in the case of power models.

Hank Cole, for example, who originated the long fuselage Wakefield design under the old (unrestricted rubber) rules adopted this particular layout largely because his preliminary theoretical performance estimates showed the potential performance some 15 per cent better than a conventional layout, which could be boosted to some 20 to 25 per cent with a pusher propeller (although the latter was not considered a practical solution to apply). The canard layout, by Cole's analysis, showed a 10 per cent improvement over the conventional layout, with a further improvement if considered as a pusher.

Theory can only indicate. It is the practical results achieved which count. Departure from a conventional, well-tried and proven layout introduces new problems as regards stability, as well as modifying structural design requirements. Not the least, trimming may also be affected. In the case of free-flight models there is a distinct difference between the potential performance of any design and the actual performance achieved by trimming—this difference completely demonstrated by the performance of a model trimmed by an experienced contest flyer and the same design flown by an inexperienced or less skilled modeller. Unconventional layouts introduce more "unknowns" in trimming, especially if the stability problem is not fully worked out in the design. Playing it safe, the actual performance achieved may never approach

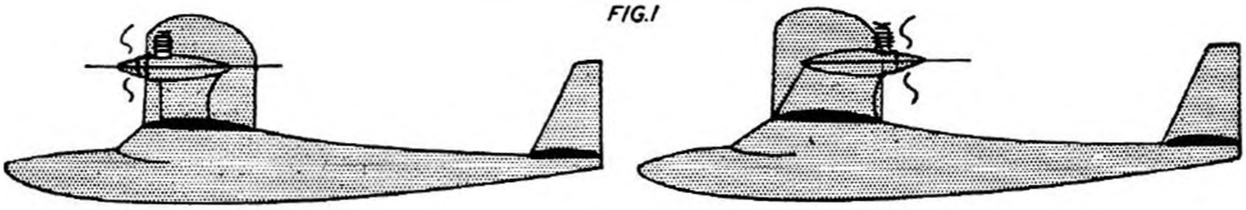


FIG. 1

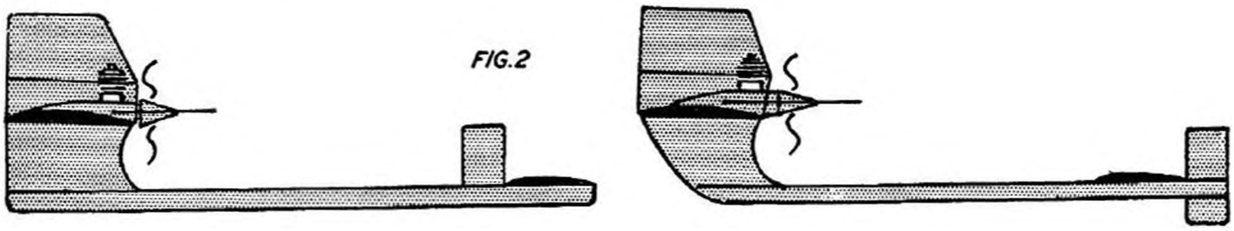


FIG. 2

the true potential—or perhaps marginal stability may make it impossible to "trim to the limit" for maximum performance.

Let's start, therefore, with a layout which should not pose these additional problems—the auxiliary sailplane. This type offers considerable scope for sports flying, and in particular for radio control work. The usual method of conversion to auxiliary power is to mount a relatively low powered engine (for the size of model) on a pylon secured to the wing centre section. The configuration adopted is almost invariably tractor—Fig. 1. With the same engine, performance *should* be improved by mounting the power unit as a *pusher*. What is more, since the power used is often marginal with such auxiliary sailplanes, the difference in performance should show up readily, without aggravating any stability problems. The answer to those who doubt the statement is—try it and see.

Actually the comparison is not quite as simple as that. The pusher layout will necessarily carry the motor weight farther aft, calling for more nose ballast to trim. Thus applied to a standard auxiliary glider layout the pusher configuration has to carry a certain weight penalty, although the effect on performance should be negligible. What is likely to be more important is the effect of the propeller having to push rather than pull. This means a special pusher airscrew to use with conventional engine rotation, plus the fact that no standard production engines are *designed* to accommodate reverse thrust loads on the crankshaft. The fact that the crankshaft is being pushed inwards all the time by pusher (propeller) thrust can reduce the motor performance—drastically in some cases, but perhaps almost negligibly so in others.

Running the engine the other way (clockwise rotation) does not answer the "reversed crankshaft thrust" problem, although it does open up a far wider field for choice of readily available propellers. Engines with symmetrical timing —e.g., the three-port two-stroke or those with reed valve induction—will run equally well in either direction of rotation. Other types *may* run "backwards" as well as "forwards", but will not run nearly as well in the opposite direction unless specifically timed for running clockwise. Ultimate development of high performance pushers, therefore, really demands the development of special "pusher" engines. This becomes more and more significant as we consider applying the pusher layout to high performance types, such as power duration models and control line speed models.

Frankly it seems unlikely that the pusher layout could beat the conventional tractor-pylon layout for power duration. The logical approach would have to be the high thrust line layout—Fig. 2—which, although it has achieved some marked success with a tractor propeller, is still not as good as the conventional tractor-pylon for all-out performance. Any attempt to lower the thrust line to a "conventional" position either imposes severe structural problems and weight penalty (as well as destroying some of the "pusher" advantage in placing part of the model still in the slipstream); or results in a layout which presents an entirely new set of stability problems to be solved—Fig. 3. On the other hand, there is some evidence to support the thought that the second layout with *canard* configuration could have an extremely favourable performance potential —if the stability problems could be solved for the high power loadings which would have to be employed for comparable performance.

Practical investigation into the possibilities of the pusher layout have at least been started for high-performance radio controlled models. Dennis Allen's "Cyrano" design is noticeably faster on a Merco 61 than a conventional layout of similar size—which can only mean that the layout has less overall drag, i.e., is more efficient aerodynamically. The main problem with this particular model appears to be one of control of attitude in landing, aggravated by the long "wheelbase" of the original undercarriage. Certainly the layout is promising enough to warrant further development, as undoubtedly it will. The general form also illustrates the answers to some of the practical problems of accommodating engine weight and necessary propeller clearance at the tail end of the model.

Weight "at the wrong end" is, in fact, probably the biggest argument against pushers for free-flight models. Aircraft designs, model or full size, nearly always tend to come out "tail heavy" and accommodating weights aft only aggravates this basic problem. If accommodated by moving the wing aft, this reduces the tail moment arm—Fig. 4. If accommodated by extending the fuselage forwards or added nose ballast—Fig. 5—this increases the total weight,

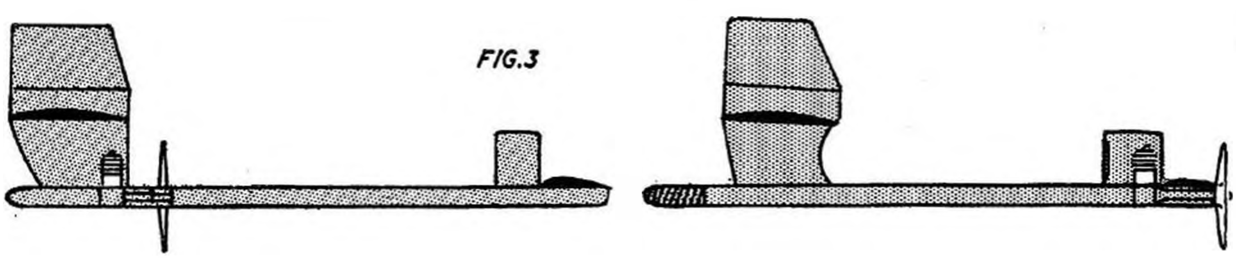


FIG.3

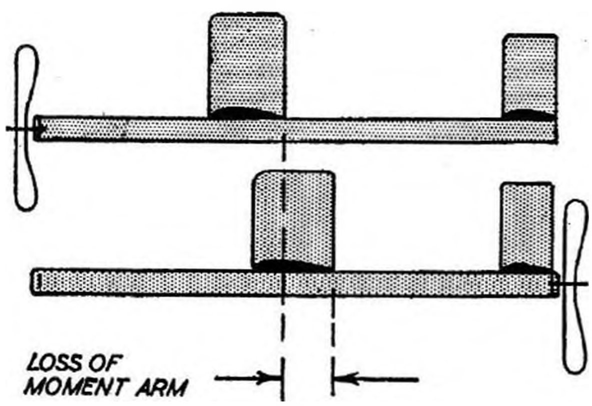


FIG. 4

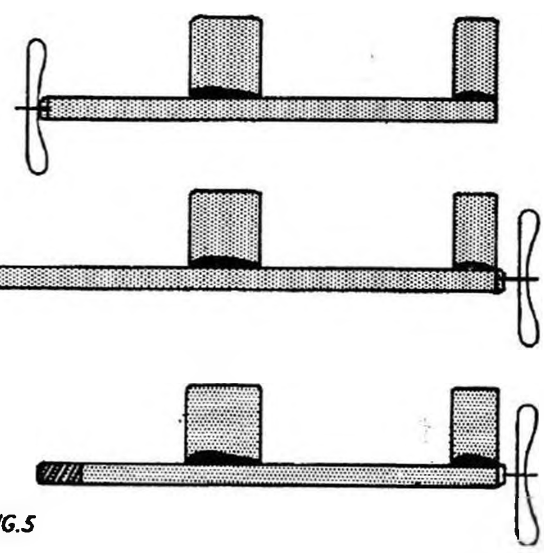
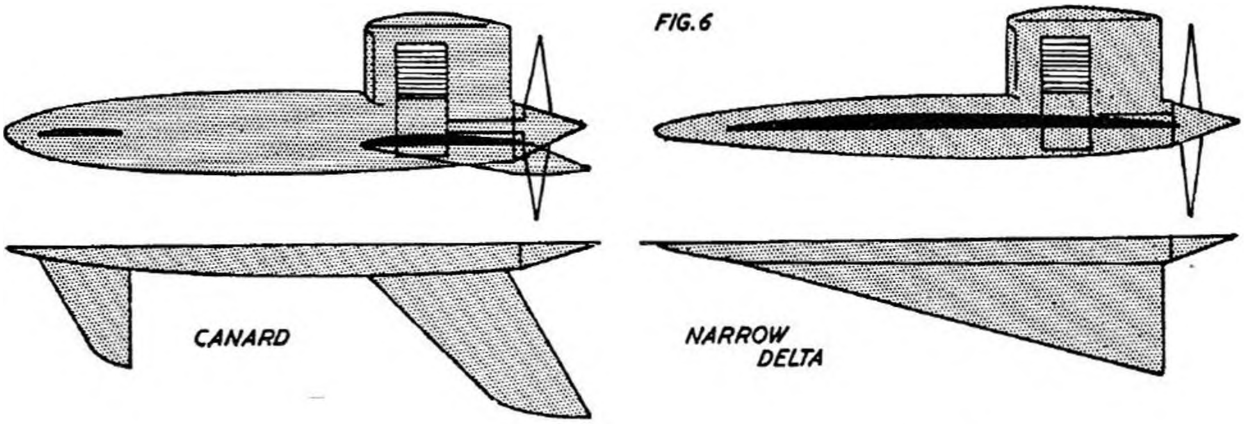
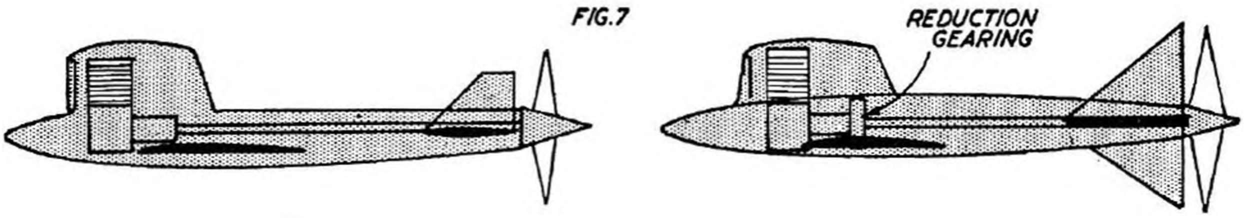


FIG.5



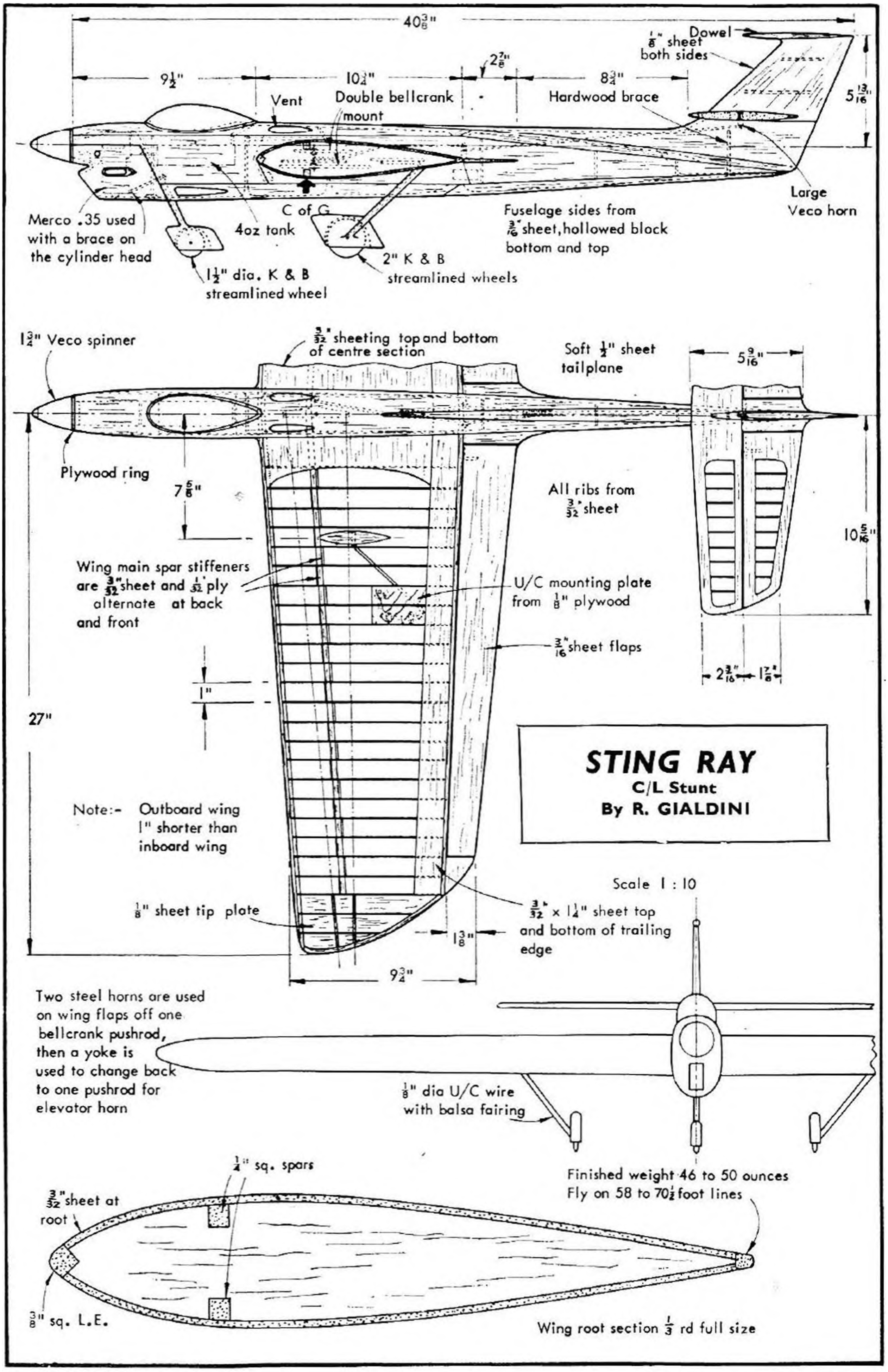


and in the former case also increases the fuselage wetted area and resulting parastic drag. Any of these solutions mitigates against realising the full gains which might be available with a pusher.

In the case of a control line speed model we might be on to a better proposition, although to our knowledge no model of this type has yet been tried as a serious proposition. Rather than a conventional layout, which would need a lot of ballast weight forward, the canard pusher seems the logical approach—Fig. 6. On the basis of a preliminary design estimate this *could* have a performance approaching 10 per cent better than a conventional layout for the same thrust available.

Yes, a pusher-canard on monoline might well be worth developing! Alternatively, for the engineering-minded modellers, turn the engine the other way round in a conventional layout and drive a pusher propeller through an extension shaft—Fig. 7. Either type should go faster than a conventional layout, if the engine is up to the mark, enabling that extra inch or so to be utilised on the prop. pitch. We wish we had the time to try!

As to why a pusher layout should be more efficient than a tractor layout, there are two main contributory factors. The first is that the slipstream of a tractor airscrew passing over such airframe components as lie behind it (i.e., the fuselage and usually part at least of the tail group) increases the drag of these components. The second is that the presence of these physical bodies in the slipstream tends to reduce the thrust developed by the propeller. Thus with the slipstream projected into "clean" and unrestricted air, as in the case of the pusher, the propeller is slightly more efficient (i.e., has a higher thrust coefficient), and the overall drag coefficient of the preceding body (i.e., fuselage) is slightly reduced. Overall result, an increase of anything up to 10 to 15 per cent in aerodynamic efficiency with a given powered layout—in theory, at least. In practice, as we have already noted, there are plenty of little practical difficulties which can cut back this potential gain, especially if one considers pushers only as an alternative "version" to conventional layouts. This may be all right for sports flying where absolute performance is not at a premium; but for most benefits the whole design has to be conceived and developed *as* a pusher from the start.



AMERICAN MODELER, U.S.A.

UNDERSTANDING AEROFOIL DATA

BASICALLY an aerofoil section is simply a specific "shape", the outline of which can be most accurately given in the form of a table of ordinates. This enables the exact outline to be plotted and drawn out in any size required, which is obviously a much more accurate method than attempting to scale up just an outline drawing of the section.

The "size" is always determined by the length of *chord* of the aerofoil, measured from the extreme point of the leading edge to the extreme trailing edge. All subsequent dimensions for plotting an aerofoil of this chord length are then calculated as a *percentage* of this chord dimension.

The first step in plotting an aerofoil is, therefore, to draw a horizontal straight line and mark on this the actual chord length. This chord length is then sub-divided into a number of "stations"—always ten equal parts representing 10, 20, 30, 40, etc. per cent of the chord length; plus closer spaced stations between 0 and 10 per cent (usually at 1¼, 2½, 5 and 7½ per cent). This is to provide more accurate plotting of the nose section of the aerofoil, where the change in curvature is usually greatest.

Having sub-divided the chord into these number of stations, a vertical line is then drawn at each—Figs. 1 and 2. It is then simply a matter of referring to the table of ordinates to plot the height of the section at each station in turn. These heights, referred to as "ordinates", are given for both upper and lower

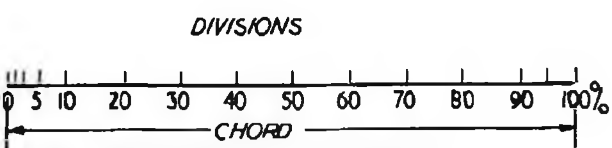


FIG. 1 DRAW CHORD LINE & SUBDIVIDE

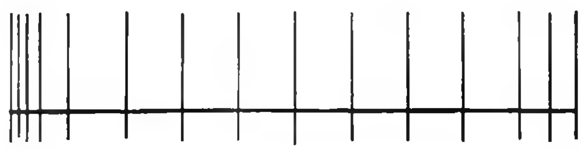


FIG. 2 ERECT PERPENDICULARS

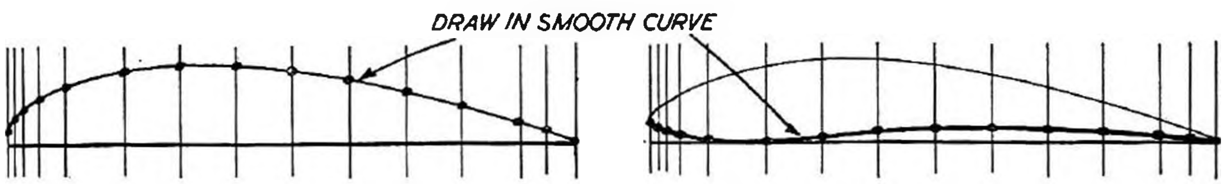


FIG. 3 PLOT UPPER ORDINATES

FIG. 4 PLOT LOWER ORDINATES

ORDINATES AS PUBLISHED

ST.	0	1·25	2·5	5	10	20	30	40	50	60	70	80	90	95	100
U	3·42	5·56	6·52	7·84	9·72	11·92	12·98	13·10	12·46	11·06	9·10	6·56	3·60	1·98	0·00
L	3·42	1·96	1·50	·88	·30	0·00	·30	·70	1·10	1·46	1·60	1·46	·92	·52	0·00

STATIONS AND ORDINATES AS CALCULATED FOR 5 in. CHORD

ST	0″	·0625″	·125″	·25″	·5″	1″	1·5″	2″	2·5″	3″	3·5″	4″	4·5″	4·75″	5″
U	1·71	2·88	3·26	3·92	4·86	5·96	6·49	6·55	6·23	5·53	4·55	3·28	1·80	·99	0·00
L	1·71	·98	·75	·44	·15	0·00	·15	·35	·55	·73	·80	·73	·46	·26	0·00

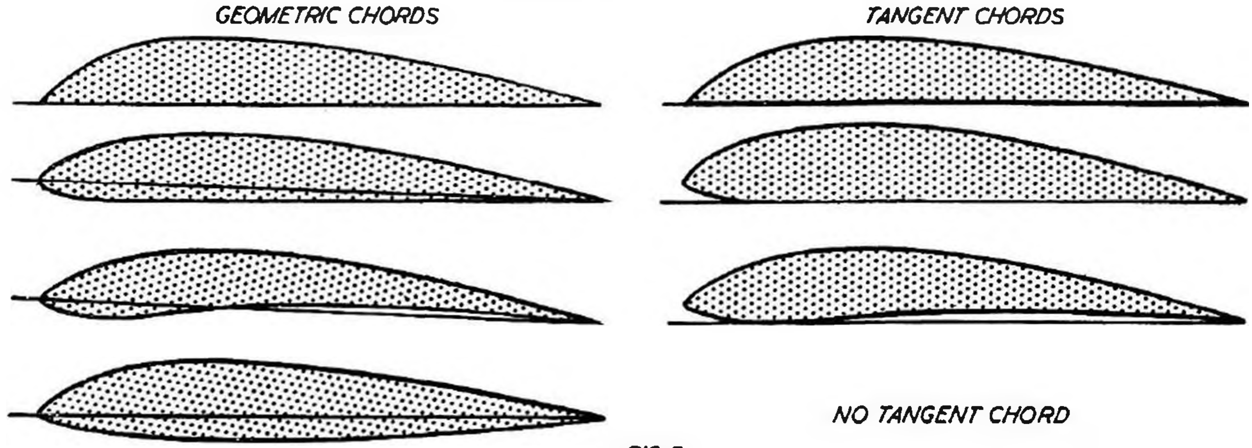


FIG.5

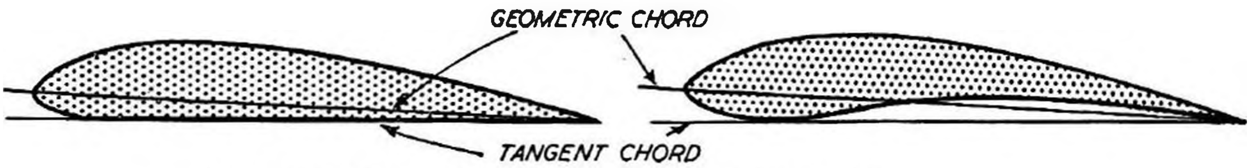


FIG.6 SECTIONS OF THESE FORMS HAVE TWO CHORD LINES

as a percentage chord figure. Merely multiply by the actual chord figure and that is the actual section height at that particular station. Fig. 3 shows these calculations applied to a 5 in. chord for plotting the upper surface; and Fig. 4 the lower surface plotting. It is then only necessary to connect all the plotted points with a smooth curve to complete drawing out the section to the size (chord length) required.

A section plotted in this way will be clearly defined as regards its *chord line*. This will be the original line drawn in starting to plot the section from its table of ordinates. In the case of an undercambered section this chord line may lie within the section or the section, as plotted, virtually rest on the chord line, touching at just the trailing edge and some other point on the undersurface—Fig. 5. With a flat bottom section the chord line will form the bottom of the section, while with bi-convex and symmetrical sections the chord line will always come within the section.

If we had just a drawing of the section to start with and no table of ordinates to check against, then the position of the chord line will only be apparent with bi-convex or symmetrical sections. It can be found by drawing a line from the trailing edge to the extreme leading edge, when it would be correctly called the *geometric chord*. In the case of an undercambered section, however, there are two possible chord lines—the geometric chord line (from trailing edge to leading edge), or a line from the trailing edge just touching the bottom surface—Fig. 6. The latter is known as the tangent chord and, with such shaped sections, is obviously more convenient to use for rigging purposes than the geometric chord.

The fact that an undercambered section may have two different chord lines, differing by several degrees in attitude, can be confusing in interpreting aerofoil test data. Thus the performance of an aerofoil is related to its angle of attack, or angle which the chord line makes with the direction of the airstream. This implies the chord line as defined by the table of ordinates for that section. This may, in the case of undercambered sections, be the geometric chord or the tangent chord, depending on how the section was originally plotted.

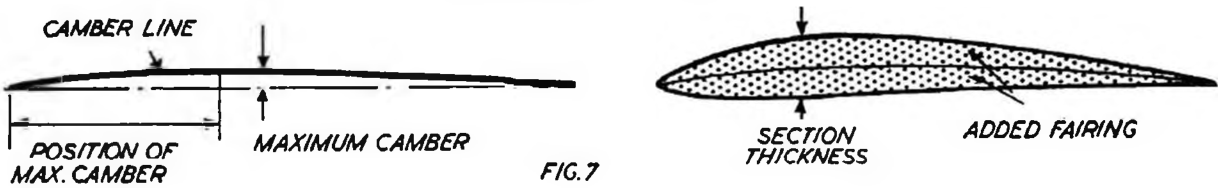


FIG. 7

A section is also defined by its "middle thickness line" or, as it is more usually called, its camber line—see Fig. 7. Many sections are, in fact, evolved on the basis of adding a symmetrical fairing of different thickness and proportions around a series of different camber lines. The amount of camber (height of camber line) and position of the point of maximum camber affects the basic aerofoil characteristics, further modified by the superimposition of different "fairings".

Many of the well-known NACA series of aerofoils are evolved on this basis. The four-digit series are amongst the earliest of this type where the first digit represents the amount of camber (maximum height of camber line); the second digit the position of maximum camber; and the third and fourth digits the thickness of the superimposed fairing—all in percentage chord. Thus NACA 4412 has a mean line (camber line) with a 4 per cent camber located at 40 per cent chord position, and a (fairing) thickness of 12 per cent of the chord. The symmetrical sections evolved on this basis have a straight camber line so that the first two digits become "0". The last two then give the section thickness (per cent chord)—*e.g.*, 0008, 0012, 0018, etc., equivalent to 8 per cent, 12 per cent and 18 per cent, etc., thickness respectively.

The later five-digit NACA series used a slightly different system, the first digit designating the camber in terms of the relative magnitude of the design lift coefficient; the next *two* digits indicating *twice* the maximum camber point in per cent chord; and the last two the section thickness. Thus NACA 23012 has a design lift coefficient of 0·3, a maximum camber at 15 per cent chord, and a section thickness of 12 per cent. Later series become a little more complex, incorporating a series number and other design characteristics, but with thickness still defined by the last two digits. There is no particular value in attempting to learn the coding, unless specifically interested in aerofoils, when complete data can be found in NACA Report No. 824, published in 1945.

Numerous other aerofoil sections have also been developed as "families", and even more as individual sections. In most cases the description is purely

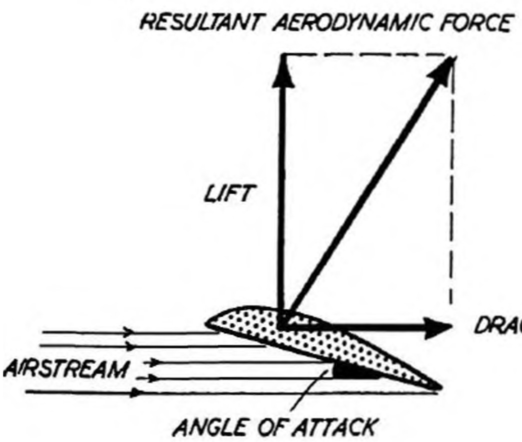


FIG. 8

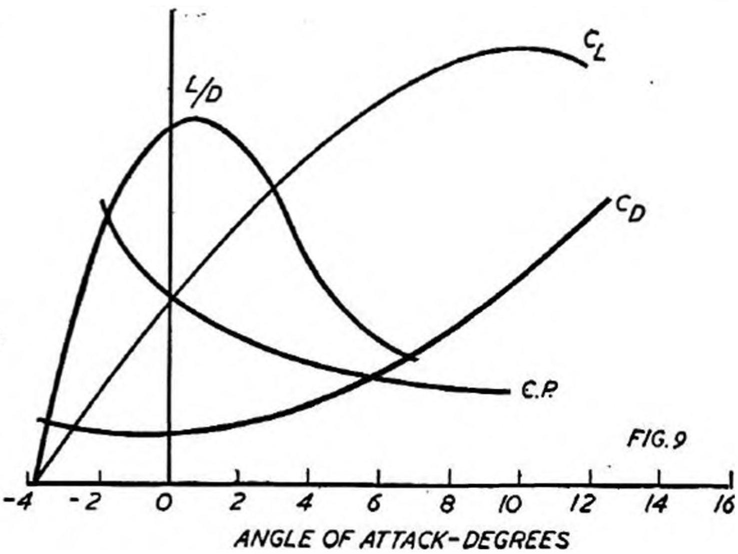
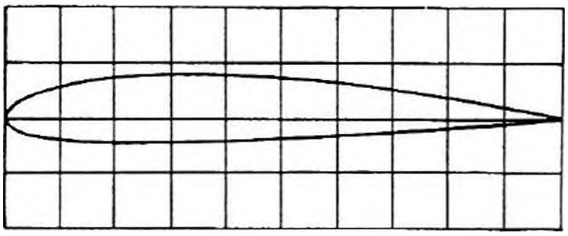


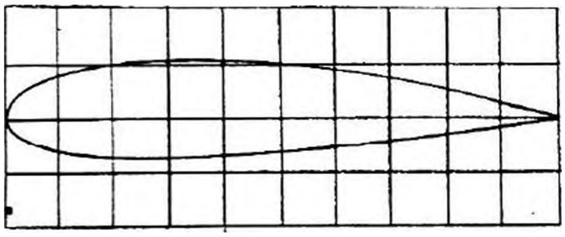
FIG. 9



NACA 2412

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	-----	0	0
1.25	2.15	1.25	−1.65
2.5	2.99	2.5	−2.27
5.0	4.13	5.0	−3.01
7.5	4.96	7.5	−3.46
10	5.63	10	−3.75
15	6.61	15	−4.10
20	7.26	20	−4.23
25	7.67	25	−4.22
30	7.88	30	−4.12
40	7.80	40	−3.80
50	7.24	50	−3.34
60	6.36	60	−2.76
70	5.18	70	−2.14
80	3.75	80	−1.50
90	2.08	90	−.82
95	1.14	95	−.48
100	(.13)	100	(−.13)
100	-----	100	0

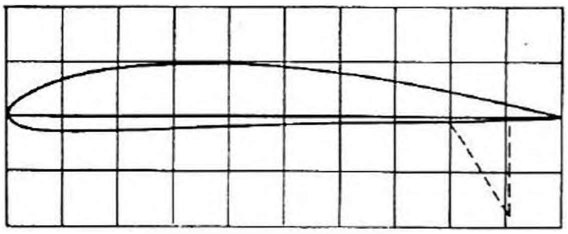
L. E. radius: 1.58
Slope of radius through L. E.. 0.10



NACA 2418

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	-----	0	0
1.25	3.28	1.25	−2.45
2.5	4.45	2.5	−3.44
5.0	6.03	5.0	−4.68
7.5	7.17	7.5	−5.48
10	8.05	10	−6.03
15	9.34	15	−6.74
20	10.15	20	−7.09
25	10.65	25	−7.18
30	10.88	30	−7.12
40	10.71	40	−6.71
50	9.89	50	−5.99
60	8.65	60	−5.04
70	7.02	70	−3.97
80	5.08	80	−2.80
90	2.81	90	−1.53
95	1.55	95	−.87
100	(.19)	100	(−.19)
100	-----	100	0

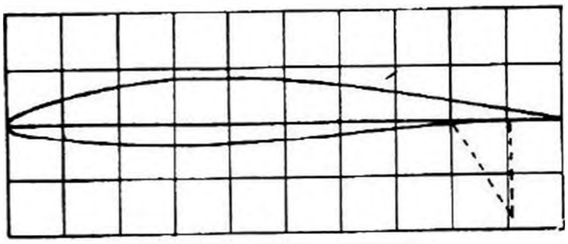
L. E. radius: 3.56
Slope of radius through L. E.: 0.10



NACA 4412

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
1.25	2.44	1.25	−1.43
2.5	3.39	2.5	−1.95
5.0	4.73	5.0	−2.49
7.5	5.76	7.5	−2.74
10	6.59	10	−2.86
15	7.89	15	−2.88
20	8.80	20	−2.74
25	9.41	25	−2.50
30	9.76	30	−2.26
40	9.80	40	−1.80
50	9.19	50	−1.40
60	8.14	60	−1.00
70	6.69	70	−.65
80	4.89	80	−.39
90	2.71	90	−.22
95	1.47	95	−.16
100	(.13)	100	(−.13)
100	-------	100	0

L. E. radius: 1.58
Slope of radius through L. E.. 0.20



NACA 64_1-412

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.338	1.064	.662	−.864
.569	1.305	.931	−1.025
1.045	1.690	1.455	−1.262
2.264	2.393	2.736	−1.649
4.738	3.430	5.262	−2.166
7.229	4.231	7.771	−2.535
9.730	4.896	10.270	−2.828
14.745	5.959	15.255	−3.267
19.772	6.760	20.228	−3.576
24.805	7.363	25.195	−3.783
29.842	7.786	30.158	−3.898
34.882	8.037	35.118	−3.917
39.923	8.123	40.077	−3.839
44.963	7.988	45.037	−3.608
50.000	7.686	50.000	−3.274
55.032	7.246	54.968	−2.866
60.059	6.690	59.941	−2.406
65.078	6.033	64.922	−1.913
70.090	5.293	69.910	−1.405
75.094	4.483	74.906	−.903
80.089	3.619	79.911	−.435
85.076	2.722	84.924	−.038
90.055	1.818	89.945	.250
95.027	.919	94.973	.345
100.000	0	100.000	0

L. E. radius: 1.040
Slope of radius through L. E.: 0.168

[Stations and ordinates given in percent of airfoil chord] nominal, comprising a name (indicating origin) and a code number or letter. Any such complete study is of academic rather than practical interest. As far as application is concerned it is the performance of the aerofoil which counts, not the name.

Specific performance can be analysed by wind tunnel testing, using a test wing of suitable proportions mounted in an airstream of known velocity and measuring the aerodynamic reaction generated over a range of angles of attack. Specifically, the aerodynamic reaction will be a single force, which at positive angles of attack which will be inclined upwards and backwards, as shown in Fig. 8. Both the magnitude and direction of this force will vary with the angle of attack of the aerofoil, and the apparent origin of the reaction will shift forwards or backwards along the length of the aerofoil with changing angle of attack.

Rather than measure the single force it is easier, and more convenient, to measure its upward component vertical to the direction of the airstream as a Lift force; and the other component at right angles (parallel to the airstream) as a Drag force. The change in position of the force can then be analysed separately in terms of Centre of Pressure position.

The actual Lift force will vary with the aerofoil shape and angle of attack, the area of the wing being tested and the dynamic air pressure (expressed mathematically as $\frac{1}{2}$ × mass air density × (airspeed)^2). Grouping the aerofoil characteristics as a single factor and calling it a Lift Coefficient we can write

Lift = Lift coeff × Area × $\frac{1}{2}$ × air density × (airspeed)^2

or in symbols

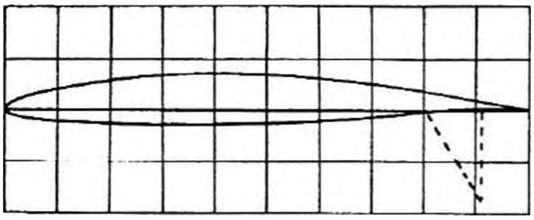
$$L = C_L \, S \frac{\rho}{2} V^2$$

(the letter "*S*" is preferred to "*A*" for surface area, to distinguish from "*A*" for cross sectional area).

Now in a wind tunnel test, every factor is either measured (*i.e.*, Lift and airspeed) or known (*i.e.*, area and air density). Thus each individual test measurement made at a particular angle of attack enables the Lift coefficient to be found *for that aerofoil section* at each angle of attack. The results can then be plotted in the form of a curve of C_L against angle of attack—Fig. 9. In just the same way the Drag force can be measured and reduced to a Drag Coefficient (C_D) plotted against angle of attack. These two together, in fact, define the working characteristics of the aerofoil over its normal operating range from zero lift to the stall.

At the same time other data can be plotted on the same graph—notably the centre of pressure movement with angle of attack; and the nominal efficiency of the aerofoil expressed as the ratio of Lift to Drag (L/D). The four curves then form a complete set of standard aerofoil characteristics.

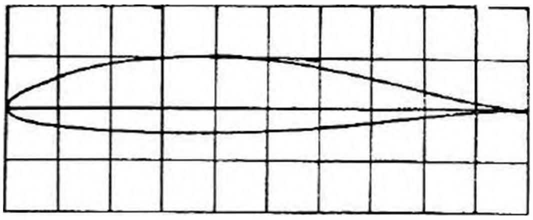
From such data one can calculate the performance of a wing employing that particular section, simply by finding the lift coefficient and drag coefficient at the particular operating angle of attack intended and substituting in the basic formula together with wing area, air density and airspeed. However, this is an over-simplification of the problem as there are other hitherto unmentioned variables involved. The first, and the most significant, of these additional variables is that the characteristic values for C_L and C_D as determined by test are valid only at that particular aerodynamic "scale". Aerodynamic scale is defined as the product of chord length and airspeed and called the Reynold's Number. In the case of a model aerofoil the Reynold's Number may be as low



NACA 65-410

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.372	.861	.628	−.661
.607	1.061	.893	−.781
1.089	1.372	1.411	−.944
2.318	1.935	2.682	−1.191
4.797	2.800	5.203	−1.536
7.289	3.487	7.711	−1.791
9.788	4.067	10.212	−1.999
14.798	5.006	15.202	−2.314
19.817	5.731	20.183	−2.547
24.843	6.290	25.157	−2.710
29.872	6.702	30.128	−2.814
34.903	6.983	35.097	−2.863
39.936	7.138	40.064	−2.854
44.968	7.153	45.032	−2.773
50.000	7.018	50.000	−2.606
55.029	6.720	54.971	−2.340
60.053	6.288	59.947	−2.004
65.073	5.741	64.927	−1.621
70.085	5.099	69.915	−1.211
75.090	4.372	74.910	−.792
80.088	3.577	79.912	−.393
85.076	2.729	84.924	−.037
90.057	1.812	89.943	.226
95.029	.937	94.971	.327
100.000	0	100.000	0

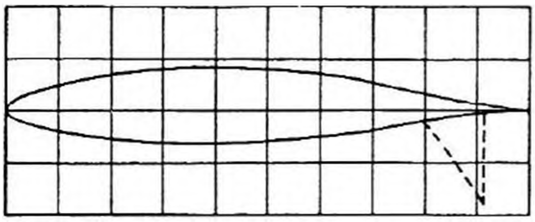
L. E. radius: 0.687
Slope of radius through L. E.: 0.168



NACA 65(216)-415 $a=0.5$

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.244	1.238	.756	−.960
.469	1.498	1.031	−1.110
.930	1.947	1.570	−1.359
2.121	2.837	2.879	−1.801
4.564	4.175	5.436	−2.411
7.044	5.208	7.956	−2.832
9.540	6.073	10.460	−3.169
14.561	7.465	15.439	−3.673
19.608	8.518	20.392	−4.022
24.669	9.315	25.331	−4.267
29.742	9.900	30.258	−4.428
34.825	10.279	35.175	−4.5[illegible]7
30.916	10.467	40.084	−4.523
45.019	10.438	44.981	−4.446
50.153	10.131	49.847	−4.251
55.263	9.512	54.737	−3.940
60.305	8.645	59.695	−3.521
65.308	7.575	64.692	−2.995
70.281	6.373	69.719	−2.409
75.237	5.152	74.763	−1.848
80.180	3.890	79.820	−1.278
85.117	2.639	81.883	−.723
90.062	1.533	89.938	−.305
95.020	.606	94.980	−.030
100.000	0	100.000	0

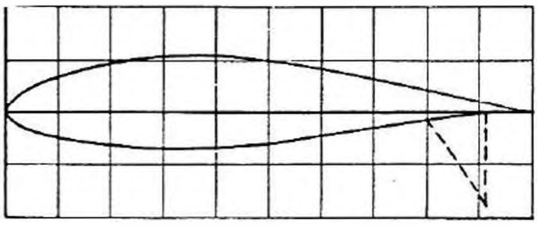
L. E. radius. 1.498
Slope of radius through L. E. 0.233



NACA 65₂-215

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.406	1.170	.594	−1.070
.645	1.422	.855	−1.282
1.132	1.805	1.368	−1.591
2.365	2.506	2.635	−2.134
4.848	3.557	5.152	−2.925
7.342	4.380	7.658	−3.532
9.841	5.069	10.159	−4.035
14.848	6.175	15.152	−4.829
19.863	7.018	20.137	−5.426
24.882	7.658	25.118	−5.868
29.904	8.123	30.096	−6.179
34.927	8.426	35.073	−6.366
39.952	8.569	40.048	−6.427
44.976	8.522	45.024	−6.332
50.000	8.271	50.000	−6.065
55.021	7.815	54.979	−5.625
60.039	7.189	59.961	−5.047
65.053	6.433	64.947	−4.373
70.062	5.572	69.938	−3.628
75.065	4.638	74.935	−3.848
80.063	3.653	79.937	−2.061
85.055	2.649	84.945	−1.303
90.040	1.660	89.960	−.626
95.020	.744	94.980	−.112
100.000	0	100.000	0

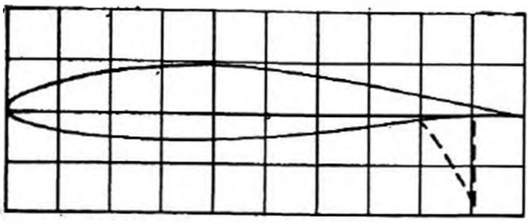
L. E. radius: 1.505
Slope of radius through L. E. 0.084



NACA 65₃-418

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.278	1.418	.722	−1.218
.503	1.729	.997	−1.449
.973	2.209	1.527	−1.781
2.181	3.104	2.819	−2.360
4.639	4.481	5.361	−3.217
7.123	5.566	7.877	−3.870
9.619	6.478	10.381	−4.410
14.636	7.942	15.364	−5.250
19.671	9.061	20.329	−5.877
24.716	9.914	25.284	−6.334
29.768	10.536	30.232	−6.648
34.825	10.[illegible]44	35.175	−6.824
39.884	11.140	40.116	−6.856
44.943	11.091	45.057	−6.711
50.000	10.774	50.000	−6.362
55.051	10.1[illegible]8	54.949	−5.818
60.094	9.408	59.906	−5.124
65.126	8.454	64.874	−4.334
70.146	7.368	69.854	−3.480
75.154	6.183	74.846	−2.603
80.147	4.927	79.853	−1.743
85.127	3.638	84.873	−.946
90.092	2.3[illegible]0	89.908	−.282
95.046	1.120	94.954	.144
100.000	0	100.000	0

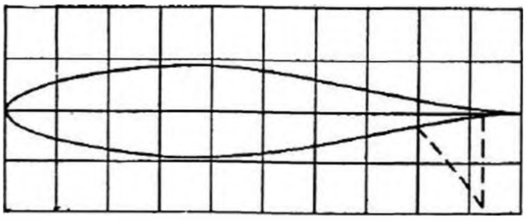
L. E. radius 1.96
Slope of radius through L. E. 0.168



NACA 64_2-415

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.299	1.291	.701	−1 091
.526	1 579	974	−1.299
996	2.038	1.504	−1.610
2.207	2.883	2.793	−2.139
4.673	4.121	5.327	−2.857
7.162	5.075	7.838	−3.379
9.662	5.864	10.338	−3.796
14.691	7.122	15.319	−4.430
19.714	8.066	20.286	−4.882
24.756	8.771	25.244	−5.191
29.803	9 260	30.197	−5.372
34.853	9 541	35.147	−5.421
39.904	9.614	40.096	−5.330
44.954	9.414	45.046	−5.034
50.000	9.016	50.000	−4.604
55.040	8.456	54.960	−4.076
60.072	7 762	59.928	−3.478
65.096	6.954	64.904	−2.834
70.111	6.055	69.889	−2.167
75.115	5.084	74.885	−1 504
80.109	4.062	79.891	−.878
85.092	3.020	84.908	− 328
90.066	1 982	89.934	086
95.032	976	94.969	288
100.000	0	100.000	0

L. E. radius. 1.590
Slope of radius through L E 0.168



NACA 64_3-018

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
50	1.428	50	−1.428
75	1.720	.75	−1.720
1.25	2.177	1.25	−2.177
2.5	3.005	2.5	−3.005
5.0	4.186	5.0	−4.186
7 5	5.076	7.5	−5.076
10	5.803	10	−5.803
15	6.942	15	−6.942
20	7.782	20	−7.782
25	8.391	25	−8.391
30	8.789	30	−8.789
35	8.979	35	−8.979
40	8.952	40	−8.952
45	8.630	45	−8.630
50	8.114	50	−8.114
55	7.445	55	−7.445
60	6.658	60	−6.658
65	5.782	65	−5.782
70	4.842	70	−4.842
75	3.866	75	−3.866
80	2.888	80	−2.888
85	1 951	85	−1.951
90	1 101	90	−1.101
95	400	95	− 400
100	0	100	0

L. E. radius: 2.208

as 100,000 or less; and with a full size wing 5,000,000 or more. Basically, therefore, aerofoil test data are only directly applicable if the Reynold's Number of test is the same as that of the projected design—and there is no method of "correcting" C_L and C_D values from one Reynold's Number to another.

The other big snag is that wind tunnel testing represents an artificial operating condition which may considerably modify the airflow over the aerofoil and produce measured figures which are peculiar to that particular test condition. To a large extent such errors can be allowed for and corrected, but only when the degree of error-forming conditions is known. A large amount of earlier wind tunnel test data at Reynold's Numbers which would have been useful for model work are useless because of quite unknown (and therefore uncorrectable) error factors, with actual errors running as high as 100 per cent or more. Thus only data which are fully corrected for "tunnel effect" are reliable.

Even with this worked out there is still another correction to be made. Measurement must be conducted on a model wing of limited span, usually with an aspect ratio of 5 to 6. It is an aerofoil characteristic that the drag generated is partly due to profile shape and surface area and partly as a by-product of lift. The latter part of drag, known as induced drag, varies with the aspect ratio—*i.e.*, progressively gets less as the aspect ratio is increased. To eliminate induced drag effects entirely, therefore—*i.e.*, to eliminate the test aerofoil span as a factor—test data must be corrected to correspond to a wing of infinitely high span. In applying such data to a practical wing of some finite span, therefore, the induced drag for that particular aspect ratio has to be calculated and added to the corrected (profile) drag as read from the graph of C_D plotted against angle of attack.

When comparing characteristic curves of different aerofoils, the best that can be said is that tests of different sections *from the same source* should provide reliable relative values at similar Reynold's Numbers; but comparison of tests from *different* sources can be highly unreliable. The model designer is in an even worse position for it does not even follow that good relative comparisons above will still hold true at much lower Reynold's Numbers, where there tends to be a general degradation and levelling out of all aerofoil characteristics. Many of the most successful model aerofoil sections, in fact, are entirely practical ones, developed (or just simply drawn out) on a basis of known or assumed camber and thickness requirements. This leads to generalisations developed through practical experience, such as thin, undercambered wings being best for A2 gliders; slightly thicker sections but still undercambered for rubber-duration models; thick symmetrical or near-symmetrical sections for aerobatic R/C models; and so on. Although designers may make a particular point of employing a specific "name" section, the performance is seldom very different from a "rule of thumb" section of similar proportions. At model speeds, in fact, it seems that proportions (camber and thickness) are more significant than specific outline curves.

Reduced to basics, the Lift Coefficient of any aerofoil section should, theoretically at least, show a directly proportional change with angle of attack, *i.e.*, a straight line C_L curve—Fig. 10. The actual shape of the section will then largely affect the *slope* of this curve. Thus a high lift section (*e.g.*, a well cambered section) will show a steeper curve and a higher peak lift. The "peak lift" or stall condition is a phenomenon which just happens. It occurs much earlier at model speeds than at higher Reynold's numbers and, in fact, the whole curve tends to be "degraded" both as regards slope and peak C_L. This is largely because separation of the airflow occurs much more easily, and thus earlier. Aerofoil efficiency is further reduced by the fact that corresponding C_D values are higher for the same angles of attack, so the L/D curve is very much lower and may peak at an almost "unusable" value (*i.e.*, very low angle of attack)—Fig. 11.

This is well established in practice. The L/D ratio in gliding flight is the same as the angle of glide—only in the case of a complete aircraft the drag of the fuselage and tail is also added to wing drag in arriving at an overall L/D ratio.

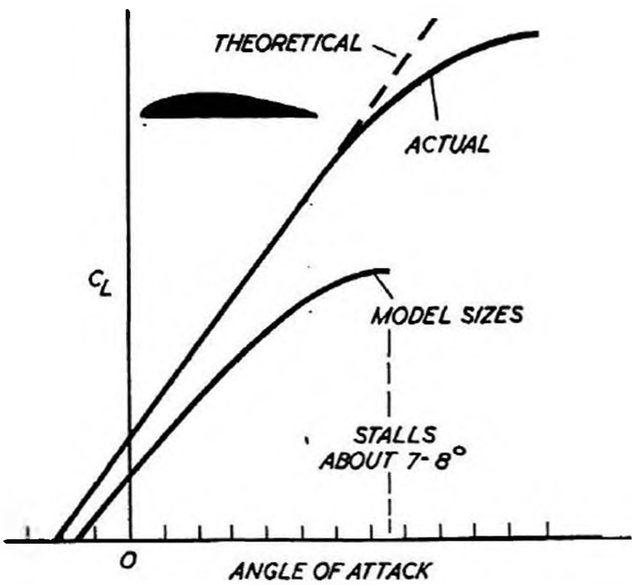


FIG. 10

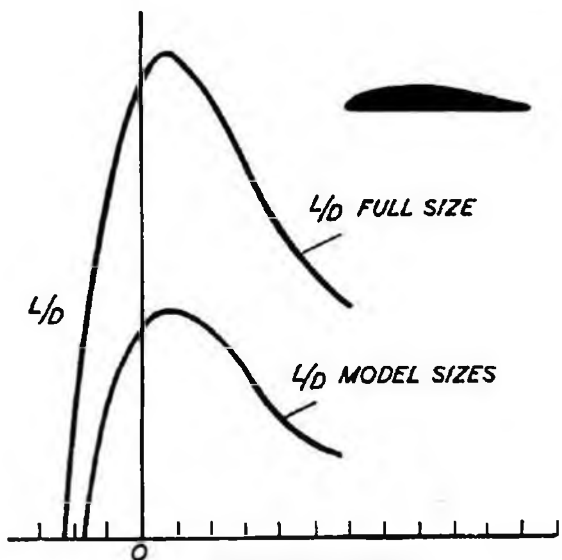


FIG. 11

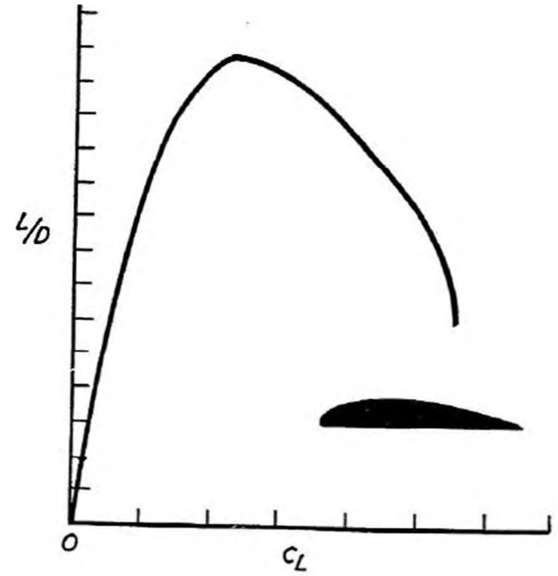


FIG. 12

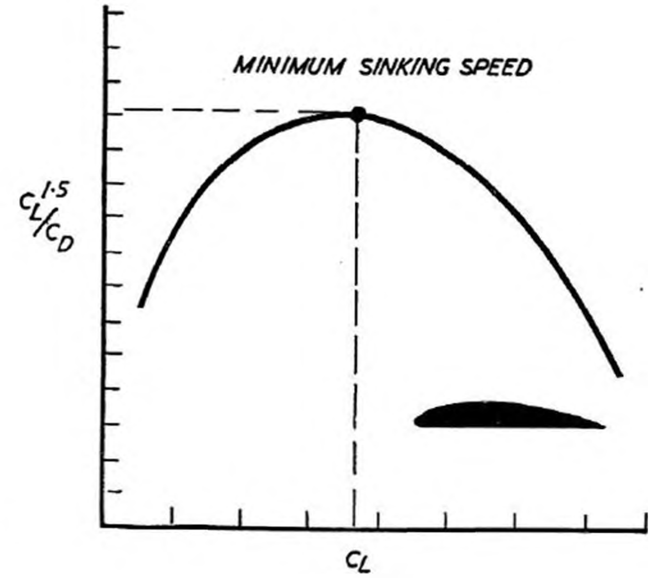


FIG. 15

For flattest gliding angle the aircraft is then trimmed to fly with the wing at the angle of attack corresponding to L/D maximum. In the case of a full size sailplane this L/D ratio (and hence flattest gliding angle) can be as high as 50 : 1. Models can rarely approach one-quarter of this value, even with the most refined of special "low speed" aerofoil sections. A 50 : 1 1/D ratio, if achievable, would give an A2 glider a still air duration of something like 5 minutes from a 150 feet high launch flying at about 15 m.p.h. Maintaining equivalent "full size" aerofoil characteristics could probably add as much as 50 per cent further still air duration trimmed for minimum sinking speed!

Although the L/D curve gives specific values for aerofoil efficiency at particular angles of attack it does not show the relationship of lift to drag over the trimming range. Thus maximum L/D may occur at a very low angle of attack, which would mean a very fast flying trim to produce enough lift at the correspondingly low value of C_L concerned. For further evalutation, therefore, aerofoil characteristics may be replotted in other forms, such as L/D against Lift Coefficient—Fig. 12; and C_L against C_D—Fig. 13. The latter type of curve is often called the polar diagram for the aerofoil (or computed for the complete

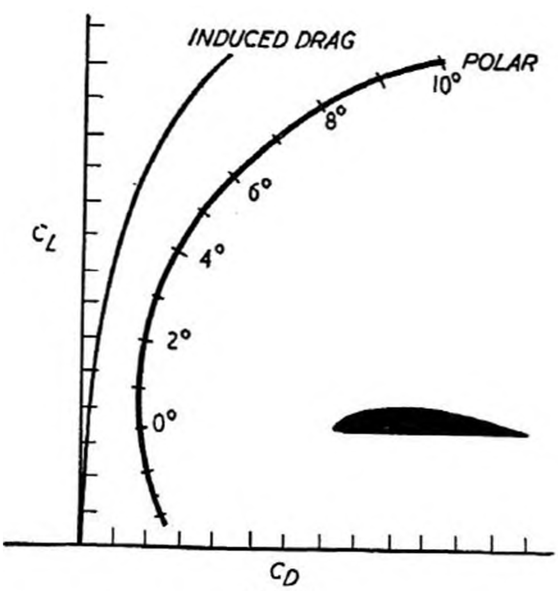


FIG. 13

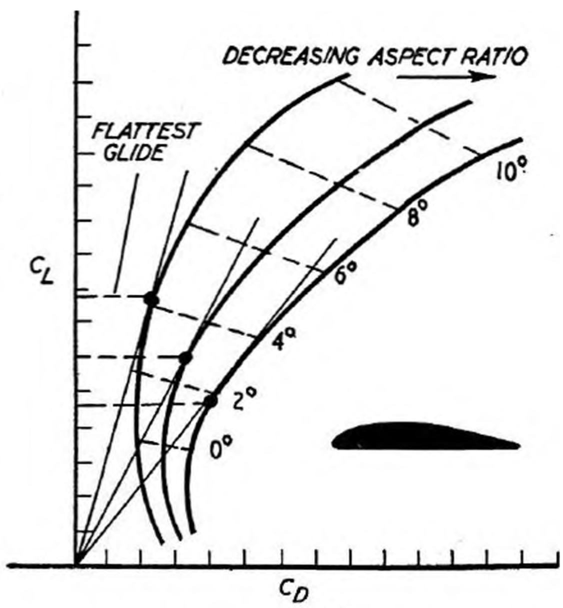
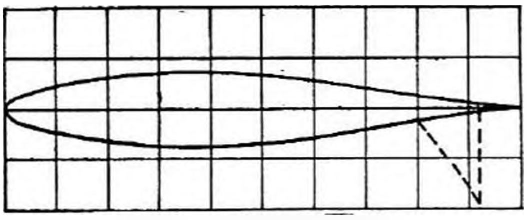


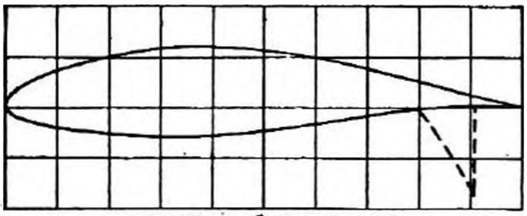
FIG. 14



NACA 64_2-015

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.50	1.208	.50	−1.208
.75	1.456	.75	−1.456
1.25	1.842	1.25	−1.842
2.5	2.528	2.5	−2.528
5.0	3.504	5.0	−3.504
7.5	4.240	7.5	−4.240
10	4.842	10	−4.842
15	5.785	15	−5.785
20	6.480	20	−6.480
25	6.985	25	−6.985
30	7.319	30	−7.319
35	7.482	35	−7.482
40	7.473	40	−7.473
45	7.224	45	−7.224
50	6.810	50	−6.810
55	6.266	55	−6.266
60	5.620	60	−5.620
65	4.895	65	−4.895
70	4.113	70	−4.113
75	3.296	75	−3.296
80	2.472	80	−2.472
85	1.677	85	−1.677
90	.950	90	−.950
95	.346	95	−.346
100	0	100	0

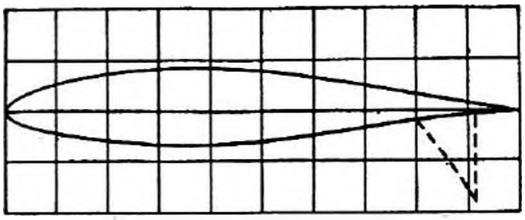
L. E. radius: 1.590



NACA 64_3-618

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
150	1.534	850	−1.234
359	1.885	1.141	−1.465
805	2.452	1.695	−1.810
1.982	3.518	3.018	−2.402
4.417	5.093	5.583	−3.197
6.895	6.312	8.105	−3.768
9.395	7.322	10.605	−4.220
14.427	8.937	15.573	−4.899
19.486	10.153	20.514	−5.377
24.560	11.065	25.440	−5.695
29.645	11.698	30.355	−5.866
34.735	12.065	35.265	−5.885
39.827	12.163	40.173	−5.737
44.917	11.915	45.083	−5.345
50.000	11.423	50.000	−4.805
55.071	10.730	54.929	−4.160
60.129	9.870	59.871	−3.444
65.171	8.870	64.829	−2.690
70.196	7.754	69.804	−1.922
75.203	6.544	74.797	−1.174
80.191	5.270	79.809	−.494
85.161	3.963	84.839	.075
90.115	2.646	89.885	.456
95.056	1.344	94.944	.552
100.000	0	100.000	0

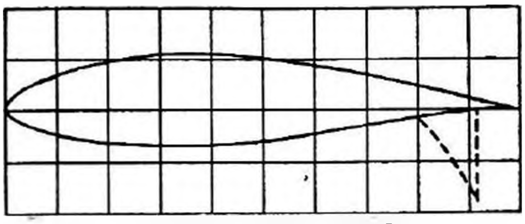
L. E. radius: 2.208
Slope of radius through L. E.: 0.253



NACA 64_2-215

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.399	1.254	.601	−1.154
.637	1.522	.863	−1.382
1.122	1.045	1.378	−1.731
2.353	2.710	2.647	−2.338
4.836	3.816	5.164	−3.184
7.331	4.661	7.669	−3.813
9.831	5.356	10.169	−4.322
14.840	6.456	15.160	−5.110
19.857	7.274	20.143	−5.682
24.878	7.879	25.122	−6.089
29.901	8.290	30.099	−6.346
34.926	8.512	35.074	−6.452
39.952	8.544	40.048	−6.402
44.977	8.319	45.023	−6.129
50.000	7.913	50.000	−5.707
55.020	7.361	54.980	−5.171
60.036	6.691	59.964	−4.549
65.048	5.925	64.952	−3.865
70.055	5.085	69.945	−3.141
75.058	4.191	74.942	−2.401
80.055	3.267	79.945	−1.675
85.046	2.349	84.954	−1.003
90.033	1.466	89.967	−.432
95.016	.662	94.984	−.030
100.000	0	100.000	0

L. E. radius: 1.590
Slope of radius through L. E.: 0.084



NACA 64_3-418

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.263	1.508	737	−1.308
.486	1.840	1.014	−1.560
.950	2.370	1.550	−1.942
2.152	3.357	2.848	−2.613
4.609	4.800	5.391	−3.536
7.095	5.908	7.905	−4.212
9.595	6.823	10.405	−4.755
14.617	8.277	15.383	−5.585
19.657	9.366	20.343	−6.182
24.707	10.176	25.293	−6.596
29.763	10.730	30.237	−6.842
34.823	11.037	35.177	−6.917
39.885	11.093	40.115	−6.809
44.945	10.820	45.055	−6.440
50.000	10.320	50.000	−5.908
55.047	9.635	54.953	−5.255
60.086	8.799	59.914	−4.515
65.114	7.841	64.886	−3.721
70.131	6.784	69.869	−2.896
75.135	5.654	74.865	−2.074
80.127	4.477	79.873	−1.293
85.108	3.294	84.892	−.602
90.077	2.132	89.923	−.064
95.037	1.030	94.963	.234
100.000	0	100.000	0

L. E. radius: 2.208
Slope of radius through L. E.: 0.168

aircraft using the overall drag coefficient instead of the aerofoil drag coefficient). This polar curve, extracted from aerofoil data, would be corrected for the aspect ratio of the design wing—Fig. 14.

To investigate minimum sinking speed trim and performance, $C_L^{1.6}/C_D$ can be plotted against C_L, as in Fig. 15. The value of C_L corresponding to the maximum value of $C_L^{1.5}/C_D$ is then the design trim C_L, from which follows the required flying speed—assuming valid aerofoil data used throughout.

For those who wish to work out design problems on published aerofoil data (and remembering the many limitations discussed above), the more important formulas and usage are summarised in the Table on page 116.

SELECTED NACA SERIES AEROFOILS

Illustrations and Ordinate tables are provided for some of the lesser known aerofoils.

Radio control—single channel

A flat-bottom section with fairly generous thickness is usually the best practical solution, with thickness not less than 12½ per cent or more than 15 per cent. NACA 2421 or 2424 plotted as the upper half only would be suitable, but not necessarily any better than Clark Y or similar sections.

Radio control—intermediate multi

Bi-convex sections of fairly generous thickness are recommended—*e.g.*, NACA 2412, 2415, 2418, 64_2215, 64_2415.

Radio control gliders

Sections developing rather higher lift coefficients are to be preferred, such as 64_1412, 64_2415, 65-410 for models intended to have an aerobatic performance. Otherwise, duration type sections can be used.

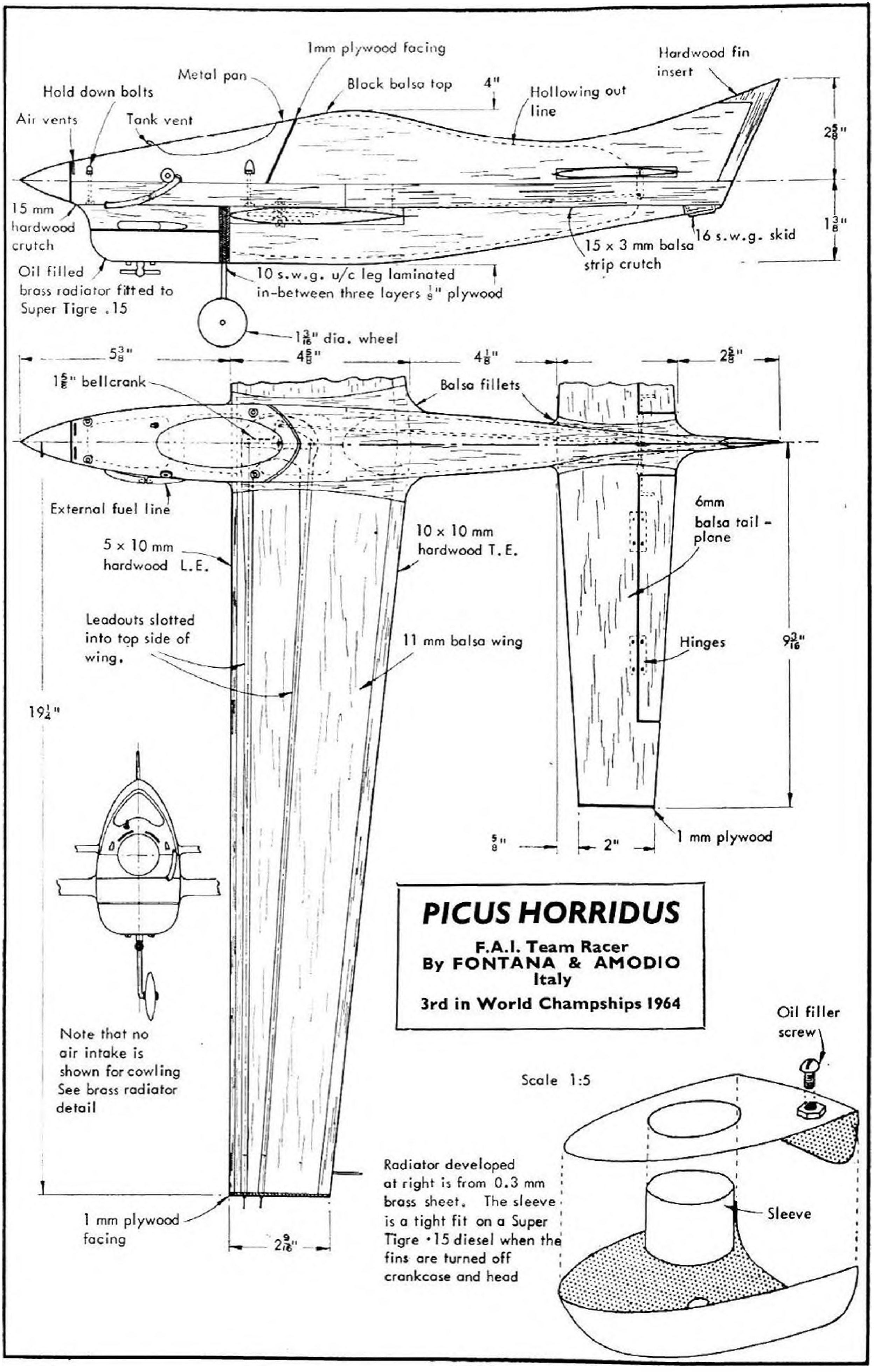
Radio control—multi; and Control Line stunt

The NACA four-digit symmetrical sections are to be recommended with 15 to 18 per cent thickness—*e.g.*, 0015 and 0018. There appears to be little advantage in going to greater thickness. Other sections which could produce good results are: 64_3218, 64_3418, 64_3618, 65(216)-415 (less suited for inverted flying), 64_2015, 65_2-215, 64_2-415, 64_3-018, 64_3-118, 65_3418.

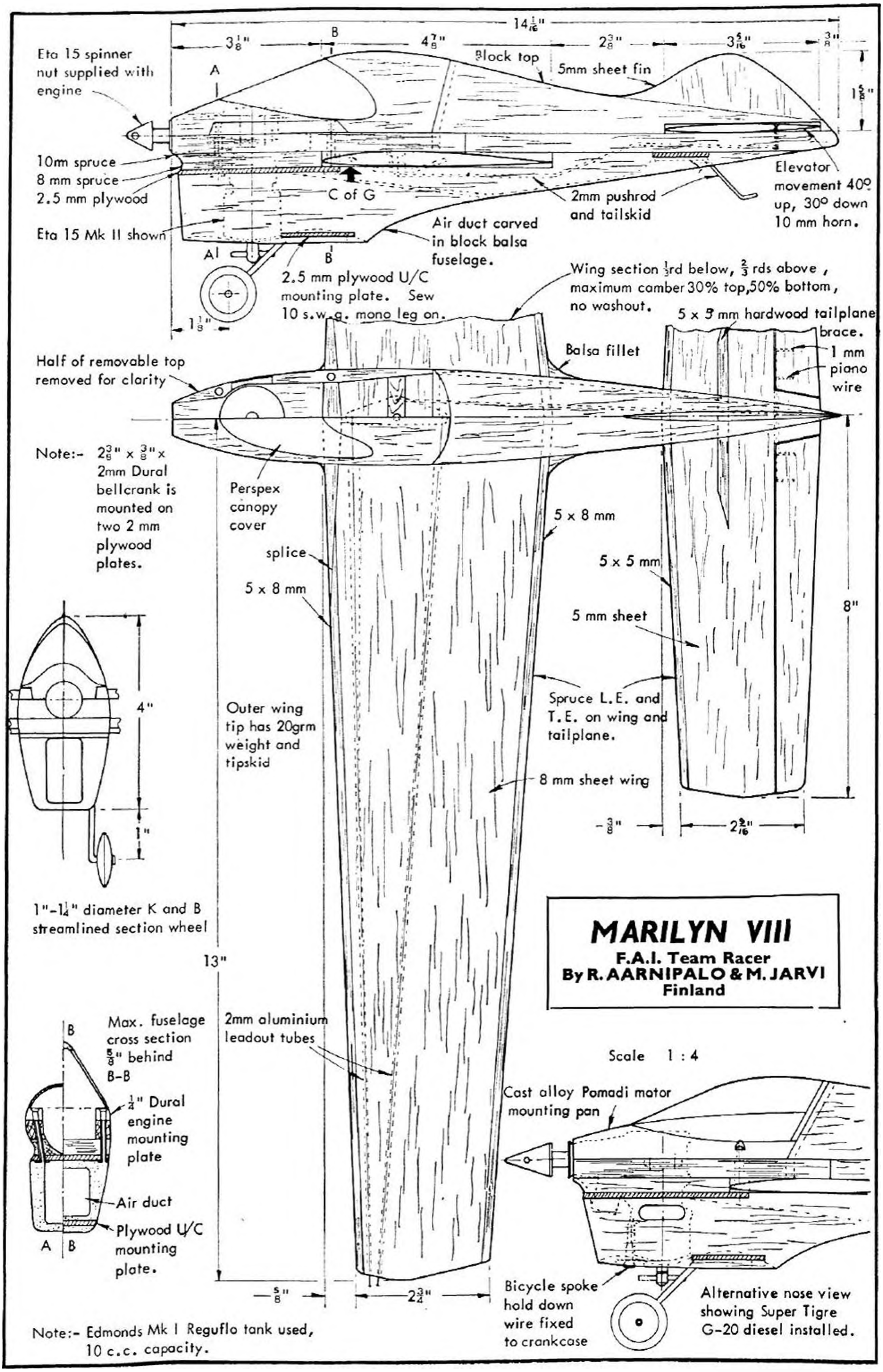
Duration model sections

Sections of moderate thickness with generous camber are recommended. The greatest degree of undercamber can be accommodated on gliders (with correspondingly thinner sections). Marked undercamber on power duration model wings is likely to lead to power-on trimming troubles.

Recommended NACA sections:
Rubber—4409, 4410, 4412, 6409, 6509.
Glider—6309, 6409, 6509.
Power—4309, 4409, 4210.



MODELLISMO, ITALY



ILMAILU, FINLAND

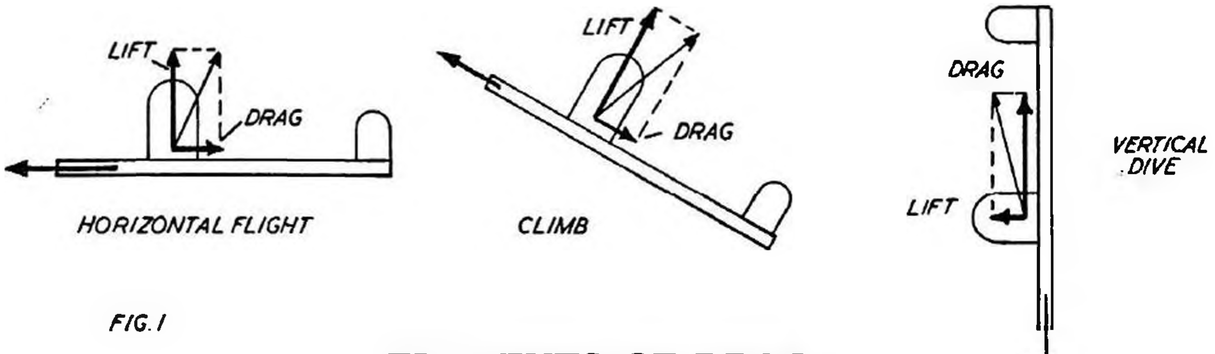


FIG. 1

ELEMENTS OF DRAG

THE essence of sustained flight is motion or movement through the air, except for certain highly specialised cases well beyond the scope of models. Motion in turn implies the use of power to produce movement and, since useful results are never obtained for free, a reaction or opposition to movement which the power has to overcome. In the case of all moving vehicles this is a drag force; and in the case of aircraft, models or full size, aerodynamic drag.

In fact, any type of aircraft flying through the air develops only a *single* aerodynamic force, compounded as the result of "lifting" forces which may be present due to the shapes involved, and "drag" forces generated as the result of motion. It just happens to be far more convenient to consider these as separate Lift and Drag forces and related in attitude to the direction of the air-stream or flight path. This is quite different to saying that Lift acts vertically upwards and Drag horizontally, as is sometimes erroneously assumed—see Fig. 1. In a vertical dive, for example, Lift is acting *horizontally* and Drag *vertically*—a fact which has led to failures in vertical dives by early full size aircraft with the wing initially breaking *forwards* because of the high loads imposed on them by high fuselage drag!

Normally drag is an unwanted force. In the case of a powered aircraft the higher the drag the greater the thrust or engine power needed to maintain a particular speed or flight attitude. In the case of a glider the ratio of lift to drag governs the *gliding angle*—Fig. 2—and the higher the drag the steeper the glide path will be.

Drag, basically, is of two types—*parasitic* drag which is a function of the shape of the various components involved; and *induced* drag which is an inescapable part of lift production. Parasitic or profile drag is applicable to all parts of the aeroplane. Induced drag is a feature only of wings or other lifting surfaces.

Profile drag can be reduced by streamlining and the respective efficiencies of various shapes in this respect can be expressed in terms of their equivalent drag coefficients. This relates the drag factor to the shape, when the actual drag for any size ofthat shape and for any airspeed can be calculated from the basic formula

$$\text{Drag} = \text{Drag coefficient} \times \tfrac{1}{2}\,\text{air density} \times (\text{airspeed})^2$$

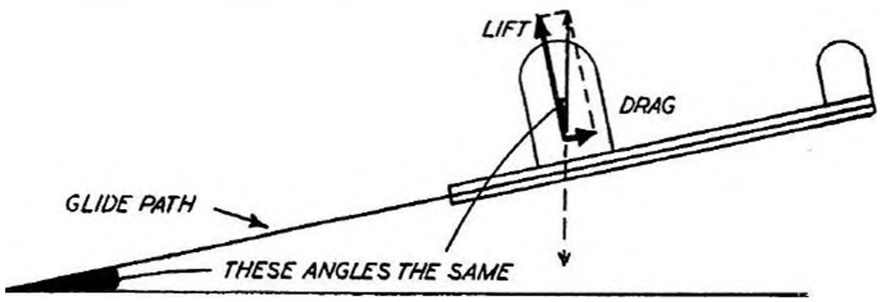
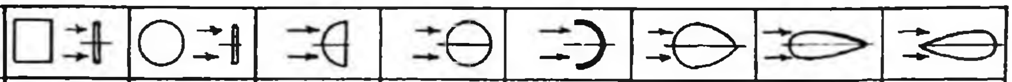


FIG. 2



SHAPE	(shape 1)	(shape 2)	(shape 3)	(shape 4)	(shape 5)	(shape 6)	(shape 7)	(shape 8)
RELATIVE DRAG	4 TO 5	2·5 TO 3·5	2·5	2	7	2	1	2

This is essentially similar to the "Lift" formula described in the article on aerofoils.

Drag coefficients vary enormously for different shapes, some typical values being shown in Table above. Unfortunately the drag coefficient is not a constant for any given shape but varies considerably with actual size and airspeed and what holds good for larger sizes flying at fairly high speeds (*e.g.*, full size aircraft) is certainly not true for models. There is far less difference in drag coefficients and all tend to be higher in value. Thus the finer points of streamlining become far less important, except for models which do realise quite high flying speeds.

As a generalisation, in fact, it can be said that for airspeeds below about 40 m.p.h. the effect of streamlining is largely negligible. This is because at low speeds the air displaced by the body moving through it has plenty of time to establish a reasonable flow path without being violently disrupted. Thus a blunt entry or blunt exit shape may not show a very much higher drag than a fully streamlined one at low speeds; although at high speeds the two flow patterns would be considerably different—Fig. 3. On the other hand, at low speeds the airflow pattern will be less well established, breaking away much earlier to give a wider and more turbulent wake—Fig. 4. This is a characteristic of both model bodies (fuselages) and wings, accounting for the lower lift and earlier stall in the latter case.

Profile drag can be considered as being caused by the friction of the air molecules rubbing against the body surface and the disturbed wake caused by parting the airflow. The properly streamlined shape aims at producing the minimum wake by disturbing the air gently, as it were, and allowing it to close in again as the body tapers away from its widest point. The fineness ratio of length to thickness which will perform this function best is strictly dependent on the product of body length and airspeed.

In model sizes, and at model speeds, the streamlined form is likely to fall down on two scores. In a fuselage it has to be fairly long, which for a reasonable streamlined form calls for a fairly large cross section. This may well result in a comparatively large wake because of the early separation of the airflow at low speeds. Thus although the theoretical drag coefficient may be one-fifth of that of a "square" or flat plate section a pure stick fuselage of one-fifth the (streamlined body) cross section may, in fact, produce less wake—Fig. 5. Further, the *overall* drag of the stick fuselage will almost certainly be con-

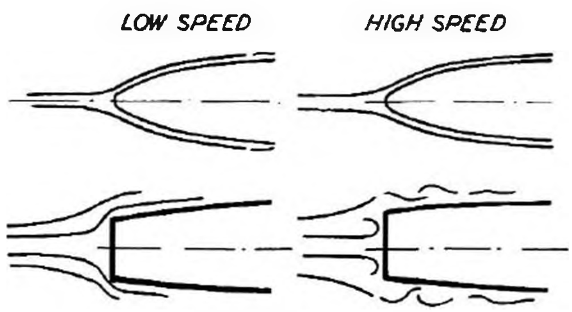


FIG. 3 ENTRY FLOW

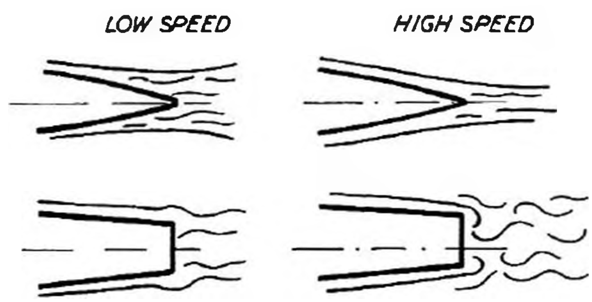
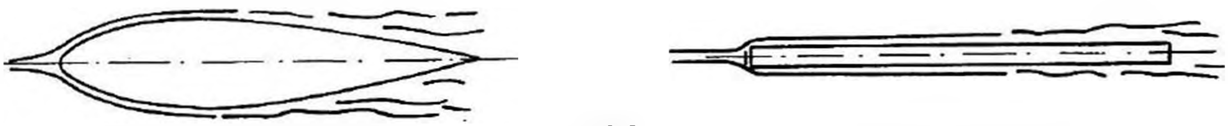


FIG. 4 EXIT FLOW



STREAMLINED FUSELAGE FIG. 5 STICK FUSELAGE

siderably less because of the much lower surface area or "wetted area" swept by the airstream.

Basically, therefore—and since we are dealing with largely unknown values of drag coefficients at model speeds—the logical method of "streamlining" a model fuselage is to reduce it to a minimum cross section and minimum wetted area (surface area). It is then possible to add appendages, such as a pylon for mounting the wing, and still end up with considerably less wetted area and total drag than a fully streamlined shape. The additional attraction is that such simple shapes are much easier to construct and can generally be made lighter for equivalent strength. The fully streamlined model flying at under 30 m.p.h. may score on appearance, but gain little or nothing in performance. And this speed range covers virtually all rubber, glider and free flight power models. In such cases it does not even seem necessary to avoid bad entries, such as "flat-plate" noseblocks or even a blunt pylon leading edge.

The profile drag of the wing is basically a feature of the aerofoil section chosen and, despite the claims often advanced for special low speed sections, will not be very different for sections of similar camber and thickness. The only likely gains here are with regard to induced drag, directly related to the wing aspect ratio. Increasing the aspect ratio can result in an appreciable reduction in induced drag for the same amount of lift developed—the theoretical change in *induced* drag coefficient being equal to $\cdot 318\ C_L^2 \left(\frac{1}{AR_1} - \frac{1}{AR_2}\right)$ where AR_1 and AR_2 represent the two aspect ratios considered.

Saving in this respect is likely to be highest in the case of gliders trimmed for minimum sinking speed, and thus operating at high C_L values. This is also born out in practice where most high performance gliders, such as modern A2 types, do normally employ high aspect ratio wings. The difficulty, both aerodynamic and structurally, is in deciding just how much the chord can be reduced to give the highest practical aspect ratio. Reducing the chord tends to decrease the aerofoil section efficiency (less lift and more drag). Structurally high aspect ratios mean design problems in producing sufficient strength in bending and resistance to twisting without increasing wing weight unduly.

With other types of free flight models the structural disadvantages and low chord dimensions of high aspect ratio wings are normally avoided. Certainly the possible gain in induced drag reduction does not seem worth-while chasing at the expense of other desirable characteristics. In some instances, however, induced drag effect can become noticeable. Thus a particular free flight sports model with a low aspect ratio built-up sheet balsa wing (a characteristic form for this type of wing) was found to be very "marginal" in performance on a certain engine. Refitted with a wing of similar construction and weight but higher aspect ratio it exhibited a much better power reserve (*i.e.*, lower overall drag) with a noticeable improvement in rate of climb. Thus possible savings in induced drag should not be entirely ignored with "minimum power" sports models or the smaller R/C models.

Many modellers tend to confuse drag coefficient and "effect". Thus a model fitted with a thin wing section may be found to fly faster than expected, when the wing is immediately claimed to be of "low drag" type. Certainly the section may have a low drag coefficient, but equally its lifting power may also be low, calling for greater speed to generate the required lift. The *total* drag at the increased flying speed will be the same as that for a higher lift, higher drag section flying more slowly, if the power available is the same. Its performance as a duration model would be that much poorer as a consequence, since a higher proportion of the *total* drag is purely parasitic.

Similar confusion also arises over the effect of *weight* on drag and performance, many aeromodellers finding it difficult to appreciate that for a given design the *lighter* the model the *faster* it can be made to fly on a given power. This is in apparent contradiction to the fact that increasing the weight (and thus the wing loading) will make a model fly faster—the real answer in this case being that the model *has* to fly faster to develop the extra lift to support the extra weight. Arranging for a model to fly at its maximum speed is quite another thing, as this is basically a matter of *trim.*

The most direct method of calculating maximum speed in horizontal flight is to calculate theoretical speed for maximum thrust against parasitic drag, and then apply a correction for induced drag. In other words, for a starting point an overall drag coefficient for the aeroplane is calculated or assumed. Since thrust will equal drag, then thrust can be substituted for drag in the "Drag" formula, *i.e.*

$$\text{Thrust} = C_{DO} \times \text{equivalent size factor} \times \tfrac{1}{2} \text{ air density} \times (\text{speed})^2$$

Speed is the unknown in this equation, all other values being known. Hence speed can be calculated for the available thrust.

In practice, overall drag would normally be computed separately for the fuselage (parasitic drag) and wings (profile drag only), but the result is the same. You end up with a figure for maximum speed for a given thrust, assuming that all the drag is parasitic. A correction must then be applied to account for the fact that there will also be *induced* drag since to sustain the aircraft in horizontal flight the wings must develop lift. Such corrections can be plotted graphically—*e.g.*, see Fig. 6—enabling the reduction in maximum speed due to the effects of

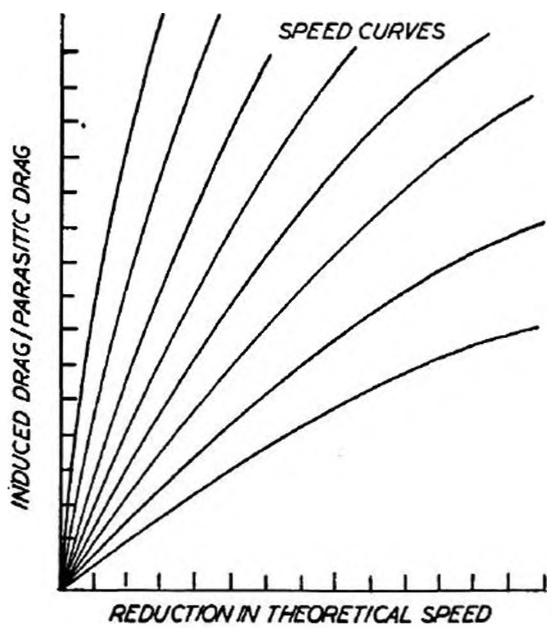


FIG. 6

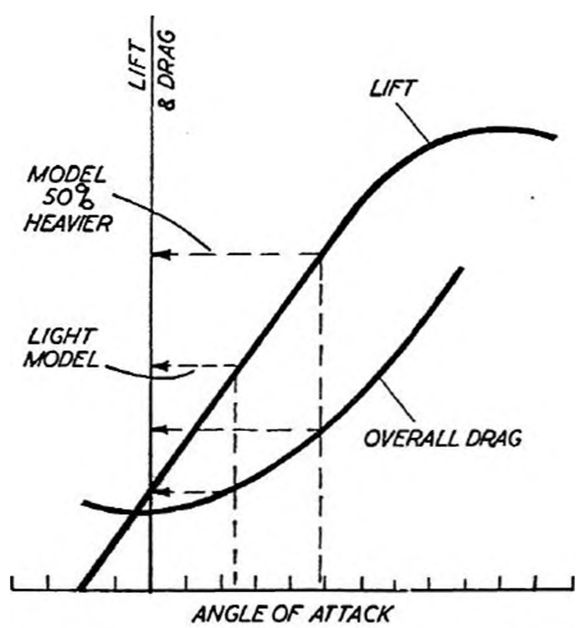


FIG. 7

induced drag to be read off at any level of induced drag (usually expressed in terms of the ratio induced drag to parasitic drag at a particular speed).

The significance of this correction is that the higher the ratio induced drag : parasitic drag the greater the speed correction, as is to be expected. In more simple terms, since induced drag is generated by lift the greater the lift required the higher the induced drag and thus the greater the loss of speed over the theoretical figure calculated on the basis of parasitic drag only. This is the same thing as saying that the greater the weight of the aircraft the greater the lift required, and thus the lower its maximum speed.

This can also be explained diagrammatically with reference to the Lift and Drag curves for the design (*i.e.*, strictly speaking the lift curve for the wings presented together with a total drag curve). Assuming two models identical in everything but weight, the greater the weight the greater the lift required. To achieve this the heavier model will have to fly with the wings at a higher angle of attack—Fig. 7. This means that its drag will be higher as a consequence, hence it will require more power (thrust) to fly at the same speed than the lighter model which can fly at a lower angle of attack.

This form of diagram explains the effect of weight on speed quite clearly, but it does not give the comparative effect. It will only show that the heavier model will require more power to fly at the same speed, or the lighter model less power to fly at the same speed with the logical assumption that given the *same* thrust it will fly faster. Analysis on the basis of induced drag correction, as in Fig. 6, does enable the loss of speed due to lift required to be determined directly.

This also leads to a number of interesting design points regarding speed model wings. Thus increasing the wing aspect ratio has the effect of offsetting the effect of increasing weight. In other words, the heavier the model the more it can benefit from a high aspect ratio wing, and vice versa. Also the choice of wing section is quite important. Very thin "low drag" sections may be all very well from the point of view of reducing parasitic drag but can pay a considerable penalty in induced drag if their lift characteristics are poor. Thick sections are equally to be avoided, both on account of their higher parasitic drag and considerable changes in induced drag with small changes in angle of attack. Carried to extremes, a strongly lifting undercambered section would be very tricky to control trimmed out to the exact angle of attack required to support the model's weight at maximum speed. Thus reducing wing area (to reduce parasitic drag) and using a better "lifting" section is not a solution for speed wings. The answer has to be a compromise between all the requirements.

Drag, in some cases, can be helpful. Thus it is now commonly accepted that thick bi-convex aerofoil sections are best for highly aerobatic radio control models. Actually this is merely a practical "rediscovery" of a fact established long ago with control line stunt models. Thicker sections are known to give less drastic changes in flight speed with changing model attitude, and thus make for smoother manoeuvres and ease of control—this being put down to the higher drag of thicker sections.

In point of fact it is the complete aerofoil characteristics rather than the section drag which are responsible. Thin wing sections have to undergo a more drastic change in angle of attack to produce the same changes in lift as thicker wings and thus make for less smoothness in manoeuvres as well as greater speed changes. Symmetrical sections of moderate thickness (*e.g.*, 12 to 15 per cent) are much more moderate in reaction. Drag is still quite low at zero or very small angles of attack, but good lift is developed at quite low positive (or negative) angles of attack. Increasing the section thickness to 18 per cent or more will mainly add drag rather than increase lift coefficients and so virtually have the effect of applying a "braking" action on flying speed at very low angles of attack (*e.g.*, in a dive).

FORMULAS

VALUE	FORMULA
Lift (L)	$C_L \frac{\rho}{2} S V^2$
Drag (D)	$C_D \frac{\rho}{2} S V^2$
Flying speed (V)	$\sqrt{\frac{2W}{\rho C_L S}}$
Stalling speed (V_{MIN})	$\sqrt{\frac{2W}{\rho C_{Lmax} S}}$
Reynold's number	$6{,}300 \times V c$
Gliding angle	C_L / C_{DO}
Induced drag coefficient C_{Di}	$\frac{C_L^2}{\pi AR}$
Total drag coefficient (wings)	$C_D + C_{Di}$
Change in angle of attack due to aspect ratio.	$18{\cdot}24\ C_L \left(\frac{1}{AR_1} - \frac{1}{AR_2}\right)$
Maximum speed V_M	$V_P - \triangle V$

SYMBOLS

C_L = Lift coefficient.

C_D = Drag coefficient.

C_{DO} = Overall Drag Coefficient.

ρ = ·00238.

V = Speed in ft./sec.

W = All-up weight, lb.

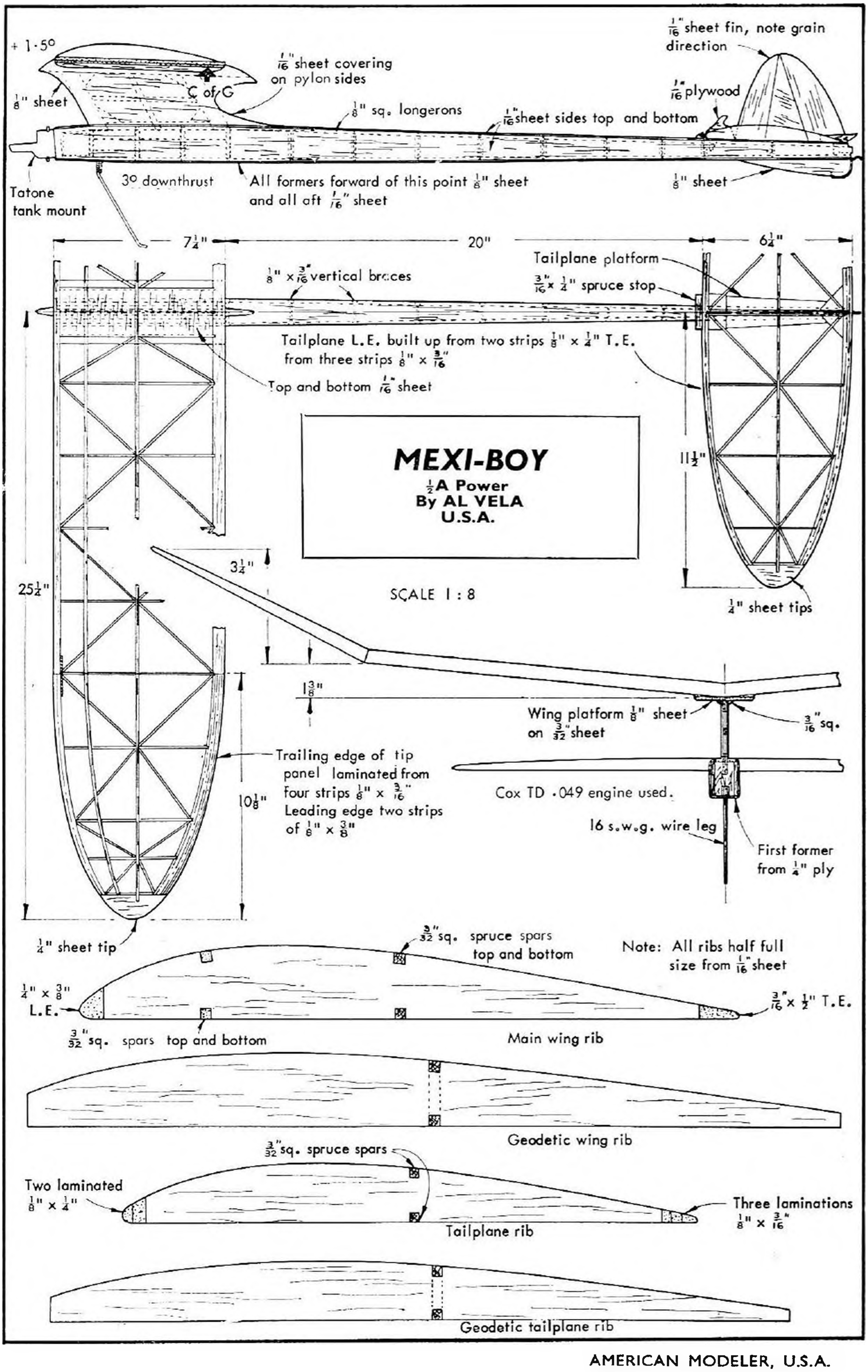
S = Surface area, sq. ft.

C = chord, feet.

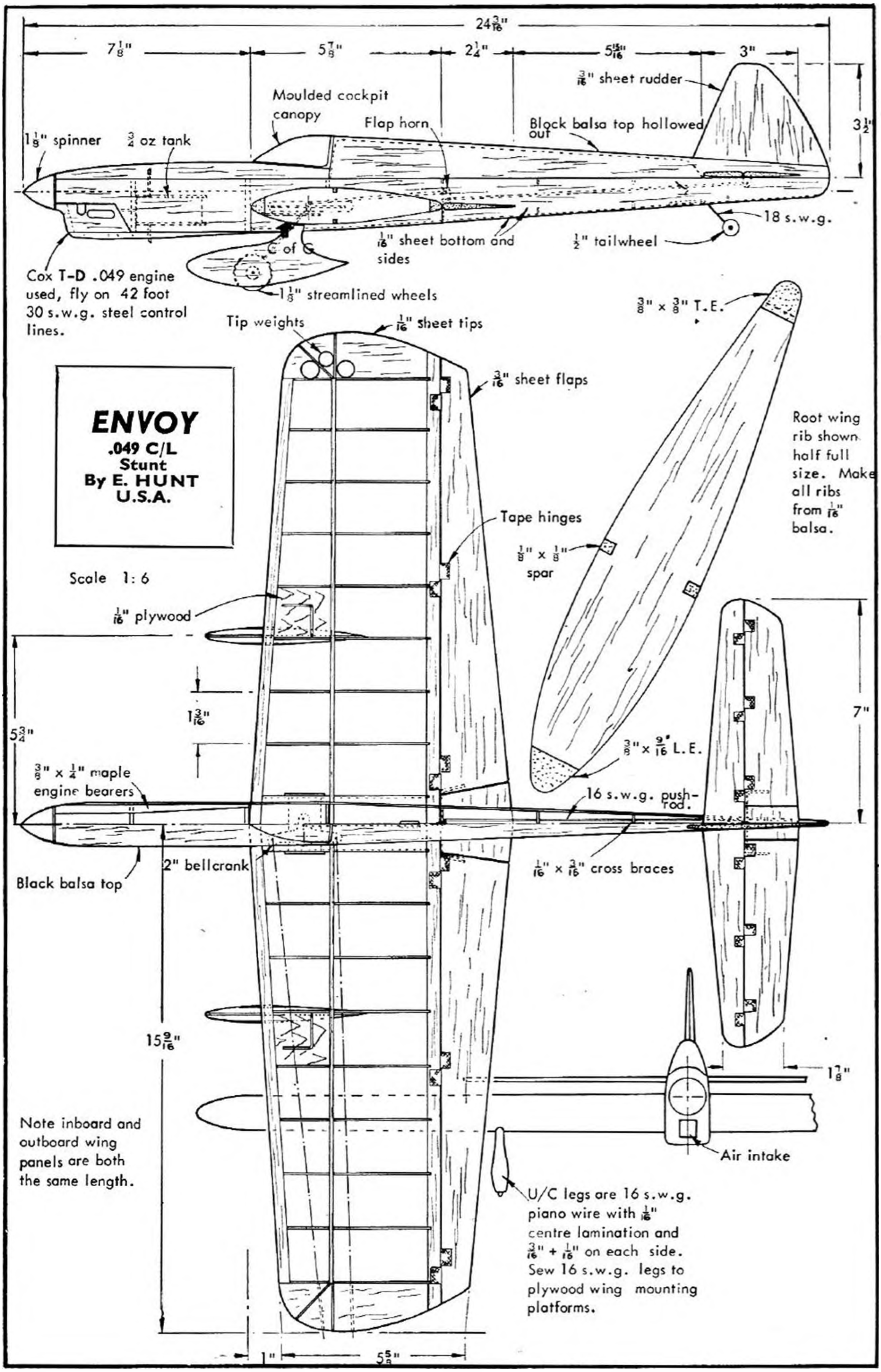
AR = aspect ratio.

V_P = Maximum speed for zero induced drag (infinite aspect ratio)

$\triangle V$ = Speed correction for aspect ratio.



AMERICAN MODELER, U.S.A.


24 3/16"
7 1/8"
5 7/8"
2 1/4"
5 15/16"
3"
3/16" sheet rudder
3 1/2"
Moulded cockpit canopy
Flap horn
Block balsa top hollowed out
1 1/8" spinner
3/4 oz tank
18 s.w.g.
C of G
1/16" sheet bottom and sides
1/2" tailwheel
Cox T-D .049 engine used, fly on 42 foot 30 s.w.g. steel control lines.
1 1/8" streamlined wheels
Tip weights
1/16" sheet tips
3/8" x 3/8" T.E.
3/16" sheet flaps
ENVOY
.049 C/L
Stunt
By E. HUNT
U.S.A.
Root wing rib shown half full size. Make all ribs from 1/16" balsa.
Tape hinges
1/8" x 1/8" spar
Scale 1: 6
1/16" plywood
1 3/4"
7"
5 3/4"
3/8" x 9/16" L.E.
3/8" x 1/4" maple engine bearers
16 s.w.g. push-rod.
2" bellcrank
Black balsa top
1/16" x 3/16" cross braces
15 9/16"
1 7/8"
Air intake
Note inboard and outboard wing panels are both the same length.
U/C legs are 16 s.w.g. piano wire with 1/16" centre lamination and 3/16" + 1/16" on each side. Sew 16 s.w.g. legs to plywood wing mounting platforms.
1"
5 5/8"

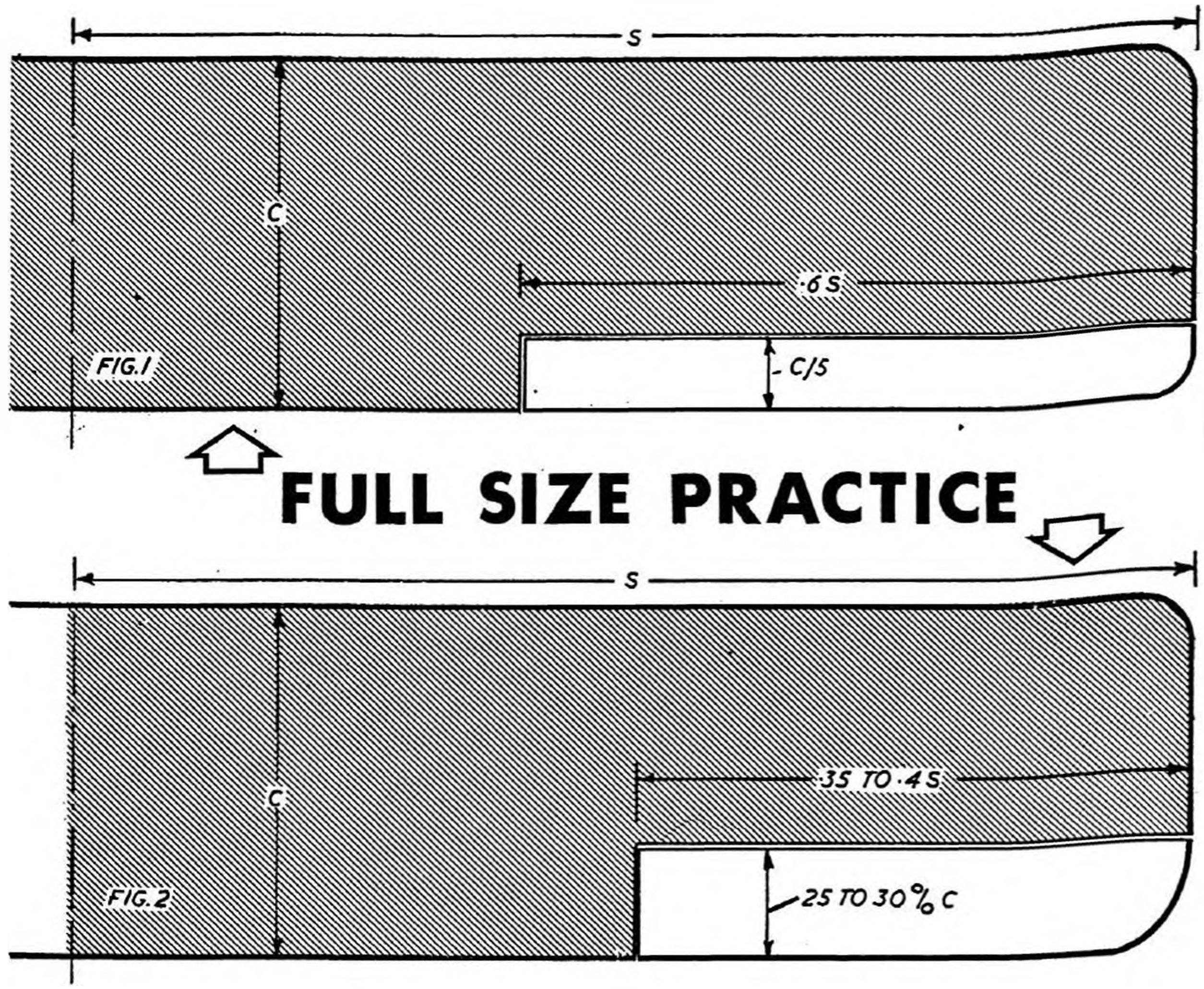
ABOUT AILERONS

AILERONS are undoubtedly the most satisfactory method of providing lateral control on all normal aircraft, model or full size. Thus the scope of the radio control model opened up enormously as soon as reliable multi-channel equipment enabled ailerons to be included as an additional service. Ailerons however, represent an *extension* of the control system, and not a "complete" control. In order of significance the controls become rudder, engine speed, elevators and then ailerons.

Ailerons are not a complete "substitute" for rudder control and *both* are normally required for complete control coverage. In practice, however, rudder control is very little used in "multi" pilotage, although it is still retained as essential for take-off and spinning. Attempts to substitute "ailerons" for "rudder" as the primary control with limited coverage—*e.g.*, single-channel—have generally proved unsatisfactory as not offering *enough* control at critical times, although this was usually a result of design limitations as much as limitations of ailerons as a "complete" control. Thus the typical single-channel model layout, with high wing configuration and a certain reserve of inherent or automatic stability is not a suitable subject for "aileron only" control. The more neutrally stable low wing "multi" configuration, however, may prove controllable under ailerons only as used widely by the Japanese. Generally speaking, though, the more satisfactory the performance in this respect the more "marginal" the overall stability which is necessary for safe flying with just a single control.

The addition of further controls, particularly elevators, helps to overcome this. Thus ailerons, elevators and engine speed can offer "complete" control where a full aerobatic performance is not required, such as a pylon racer. This can offer a more economic solution than normal "full house" multi, but places a considerable premium on model design and piloting ability. A further solution is to *couple* ailerons and rudder as a single service, *i.e.*, both operating together when switched by a single signal (car). With normal "multi" this saves two channels, but the overall result is necessarily a compromise. A better method would be to provide "switching out" of alternative services so that rudder and ailerons can be operated independently by the *same* control signals (same two channels). This is a perfectly practical system which can provide virtually "full house" coverage on only six channels, although lacking the very useful elevator trim feature provided by 10 channels. It is even more attractive with proportional systems (where trim is available on the proportional channels) by reducing the number of proportional channels required, and thus considerably reducing the expense of the equipment. Coupled aileron and rudder, in fact, was originally developed to overcome the limitations of dual proportional compared with 8- or 10-channel "bang bang" multi. With constant coupling (both services paralleled) this still has limitations, but these can be reduced to a minimum by "switching out".

The basic fact is that any extension of control to approach or achieve full control demands the use of ailerons and aileron design, as far as models are concerned, is something which has "happened" on a cut-and-try basis as regards proportions and movements. Some basic knowledge of aileron behaviour



can save a lot of wasted time in arriving at a satisfactory solution, and in particular in avoiding inherent limitations which are a feature of aileron behaviour, unless corrected. The fact that ailerons "work" in providing a means of lateral control is not enough, for lateral control is closely coupled in effect to directional control, with one strongly affecting the other. Thus aileron design must be considered alongside model design, and the performance required from the aileron movement.

Normally a model with zero dihedral can be expected to be unstable laterally. Without dihedral, however, the rudder can be an almost independent directional control, producing turns with very little bank. Such turns, however, will be characterised by skidding during entry and sideslipping on recovery, these effects increasing both with the amount of rudder movement and the abruptness with which rudder control is applied. Adding dihedral to the wing produces a powerful banking effect with rudder turns, with a corresponding tendency to nose down at the same time as rolling into the banked attitude. Thus the rudder-only model has to compromise between enough dihedral for lateral stability and as little dihedral as possible to prevent excessive rolling and nosing down in turns.

With ailerons, the rolling moment for banking is produced directly and may produce either a complete roll or just enough displacement in roll to induce a banked turn, depending on the severity of the aileron action. Just how this will affect movement in other planes depends on the overall design characteristics. Interaction can vary from very slight—*e.g.*, the model will roll without loss of directional stability or height—to complete instability resulting from excessive aileron forces.

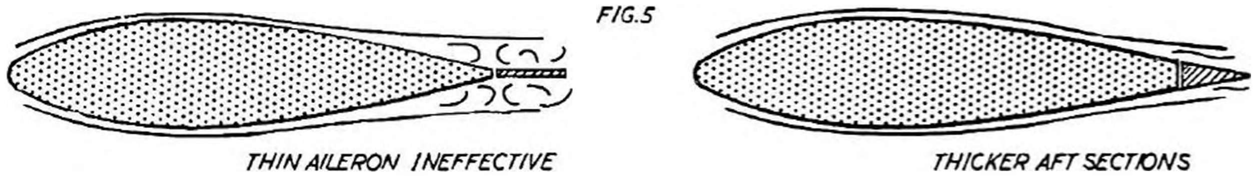
The latter—or, equally, tendencies toward instability—is normally caused by lack of directional stability. Thus good lateral control also demands good directional control, or adequate wing dihedral and sufficient fin area to match. Dihedral has a very powerful effect on lateral stability and apparent lateral control, so much so that excessive dihedral will tend to reduce the effectiveness of ailerons, calling for excessive aileron areas or movements. Thus apart from their own individual characteristics, aileron effectiveness is more closely linked to dihedral than any other single design factor.

In general terms, "optimum" dihedral for "optimum" aileron control will be lower than that required for normal free flight stability. Thus in the case of a high wing configuration about 3 to 4 degrees dihedral is a typical "optimum" figure; very slightly more in the case of a shoulder wing layout increasing to 6 to 8 degrees in the case of a low wing layout. These are, of course, purely general recommendations but do appear to give satisfactory results with conventional design outlines. Higher dihedral angles will tend to reduce the effectiveness of ailerons as a control; and lower figures may well tend to induce instability following aileron movement. The basic "cut and try" method of developing a fully aerobatic "multi" model is, in fact, to progressively reduce dihedral to improve aileron performance until a point is reached where undesirable instability starts to show up due to lack of dihedral—the "optimum" dihedral figure then being selected as a little greater than the critical value.

In the case of full size low to medium speed aircraft the most effective aileron is usually about 10 to 12 per cent of the wing area with a chord of 20 per cent of the wing chord and span 60 per cent of the wing semi-span—Fig. 1. Wider chord, shorter span ailerons are sometimes preferred where aileron movement or area can be reduced slightly—Fig. 2. Narrower chord ailerons are not usually employed on full size designs without some good reason since increased movement is usually necessary. The one common recommendation is that the aileron should be mounted near the tip, with some designers preferring to carry them right to the tip. In the case of a fairly thick aerofoil section there is also some increase in aileron effectiveness if the wing is thinned towards the tip (especially on a tapered wing) and washout incorporated. In the case of biplanes there is also the interesting point that better control is realised by using ailerons on both upper and lower wings rather than one on wing only *e.g.*, on the lower wing only on the basis that the upper wing of a biplane will always stall first). This is because deflection of one aileron on a biplane wing can modify the airflow over the other wing in a manner to produce an opposite reaction, thus reducing the effectiveness of the aileron.

Initially, at least, "model" ailerons followed more or less full size proportions, inset in the wing, but with a tendency towards increased chord. Fig. 3 shows typical proportions for a high wing R/C model. The modern trend is almost entirely towards the full span strip aileron (except for scale models) as providing better control response and also being much easier to make and fit—Fig. 4. It does not follow that because they appear to work better strip ailerons are more efficient than inset ailerons. Aerodynamically they are probably not, and not every experienced R/C designer accepts them at best. They can, in fact, be extremely inefficient if of narrow chord and fitted to the trailing edge of a very thick wing where they are operating in the wing wake—Fig. 5. On the

FIG. 5



other hand they present far less problems in fitting than inset ailerons and, being invariably of sheet balsa construction, can be tried with different areas, if necessary. Fig. 4 shows typical strip aileron proportions, a taper from root to tip being desirable. The strip aileron should also be fairly thick in section for best results rather than a simple flat plate "flap".

Where the strip aileron generally scores is that it has less adverse yaw effect than tip-mounted inset ailerons. Normal aileron movement will result in a rolling moment from the greater lift produced by the downgoing aileron. At the same time the extra drag of this aileron will tend to yaw the model in the opposite direction to that required to complete a smooth turn—Fig. 6. It will also be appreciated that since the downgoing aileron increases the angle of attack of the wing at that region it is possible to stall an aileron at low flying speeds simply by applying downward movement. The result in this case is likely to be a roll in the opposite direction to that required—*i.e.*, loss of aileron control on approaching a stalled flight attitude.

Logically, therefore, downward aileron movement should be limited to a minimum required to give the required rate of roll. It does not matter how much the opposite aileron is raised, although the rising aileron will be less effective than the downgoing one in inducing the roll. Thus, usually, a differential aileron movement is employed, with more "up" movement than "down". This can readily be provided for on the aileron linkage—Fig. 7. Typical values for model work are 30 degrees "up" and 20 degrees "down" as a maximum—less where more moderate aileron control response is required. If more aileron power is required it would be better to increase aileron chord or area (or both) rather than down movement.

An alternative solution is to *shape* the aileron to provide a compensating effect when displaced, the most widely adopted of this type being the Frise aileron—Fig. 8. Here the aileron is shaped like a complete aerofoil section with

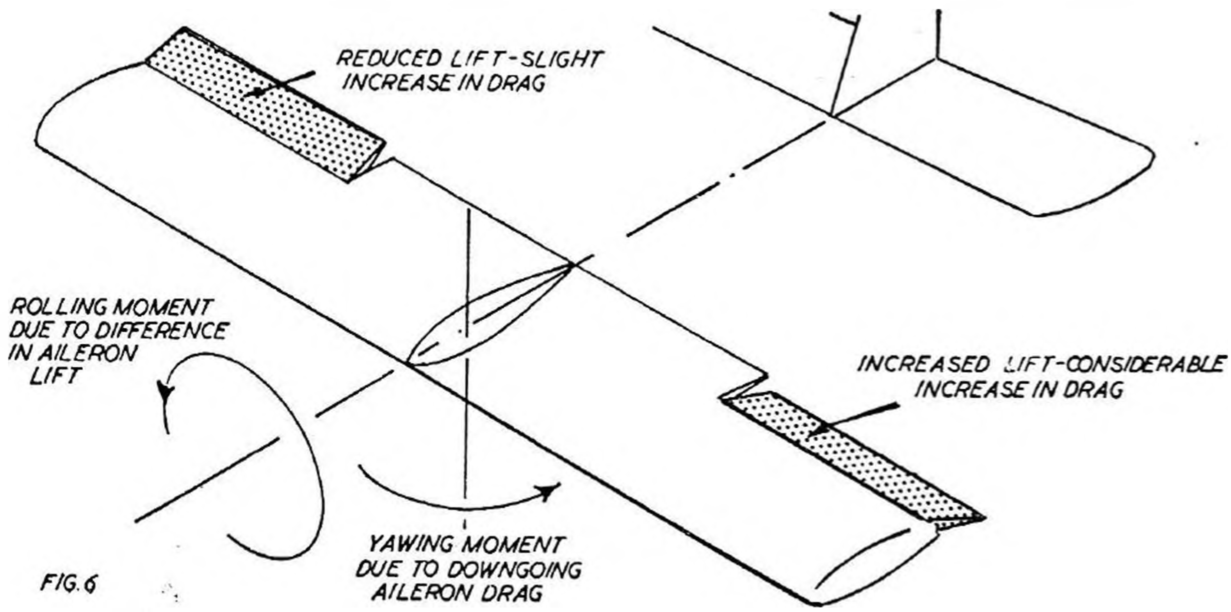
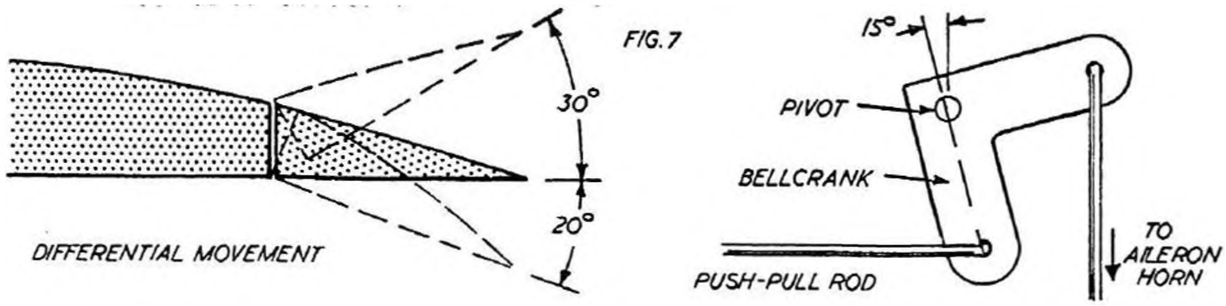
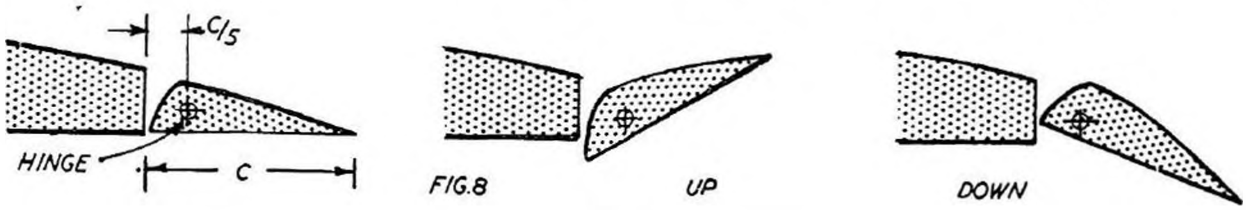
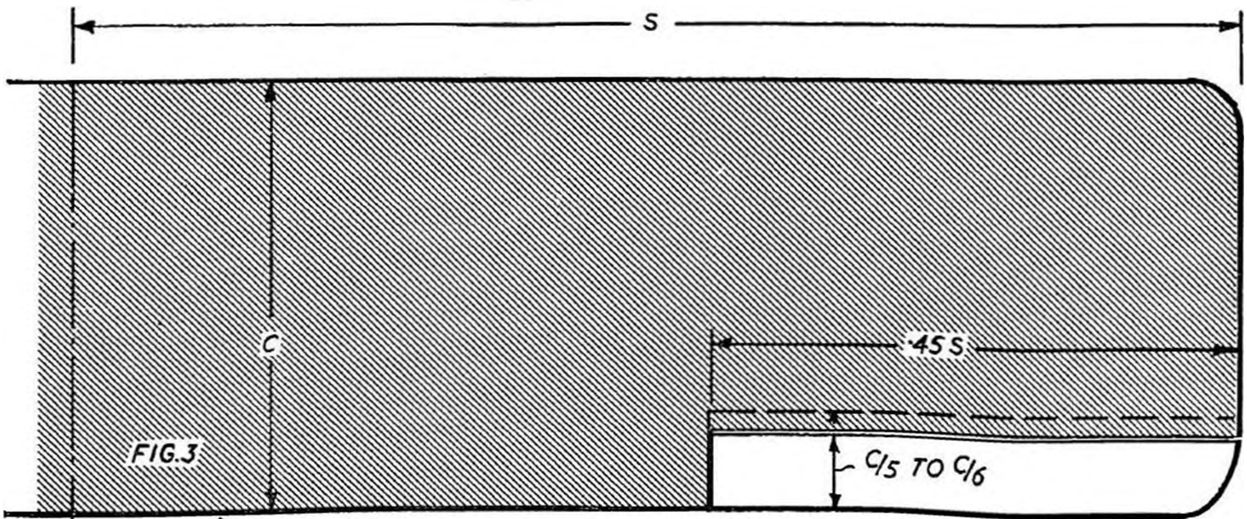


FIG. 6

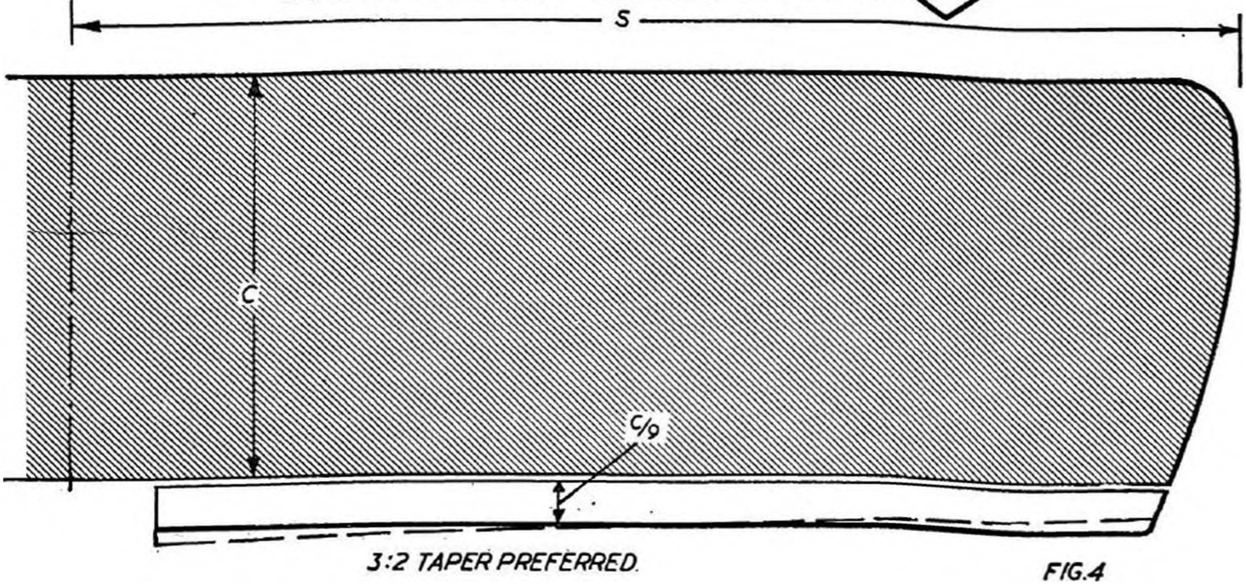


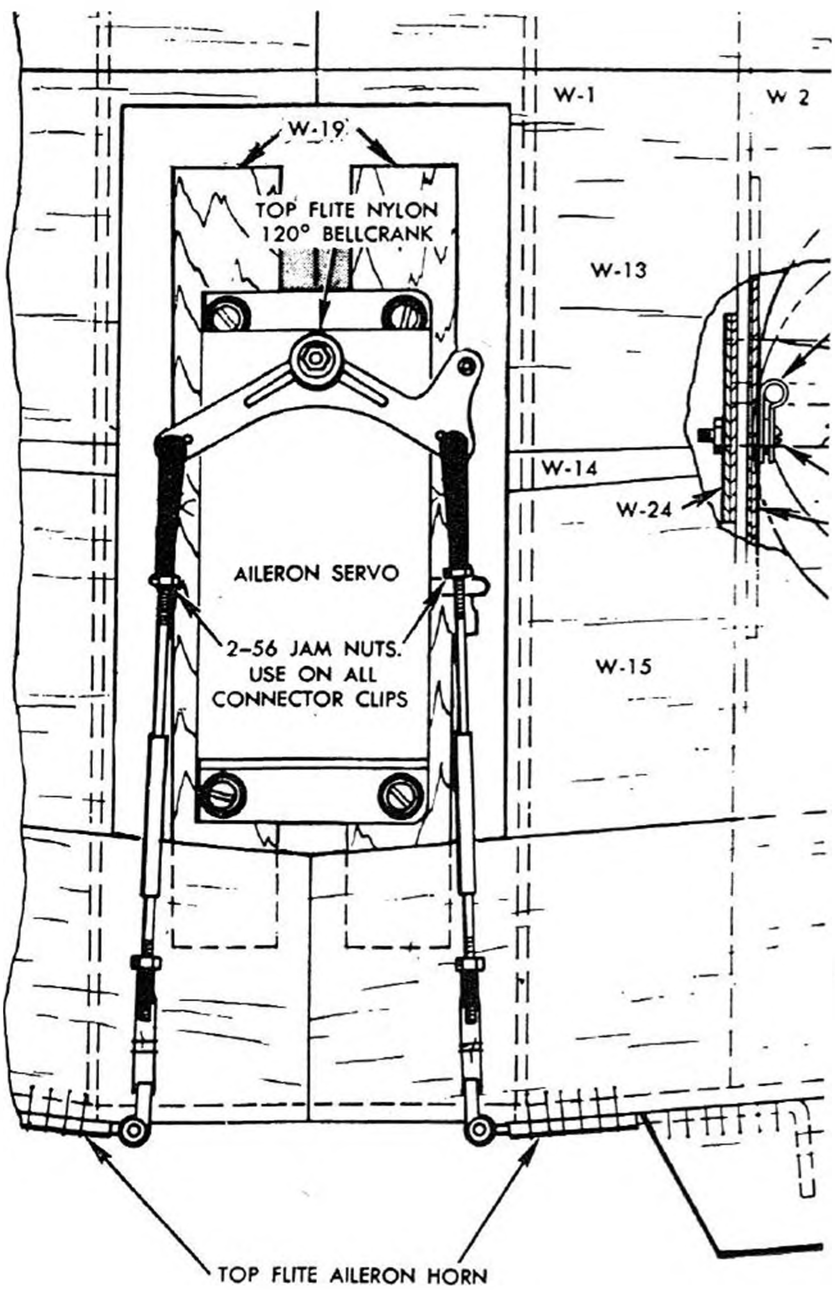


the leading edge lining up with the bottom of the main wing section in the neutral position. When displaced, the leading edge always remains within the depth of the main wing section over the full range of "down" movement, but *emerges* from the wing section on the "up" movement. Thus the drag of the upgoing aileron is automatically increased to counteract the yawing moment induced by the opposite downgoing aileron.



MODEL DESIGN

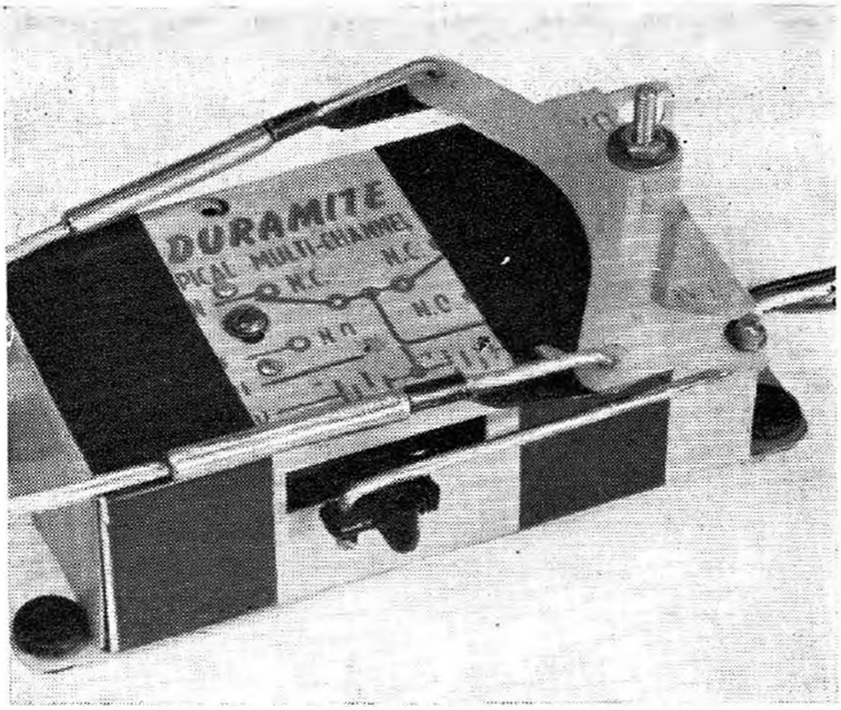




Detail from the TopFlite drawing for the Kazmirski "Taurus" design indicates how the Bonner aileron servo is linked to the strip ailerons with TopFlite 120 degrees bellcrank. This is mounted directly to the Transmite case and two Dubro links are used to connect to the vertical horns at the root ends of the ailerons. Adjustment is then possible in an infinite number of positions with turnbuckle effect on each aileron pushrod, and additional adjustment on the primary motion of the servo output arm.

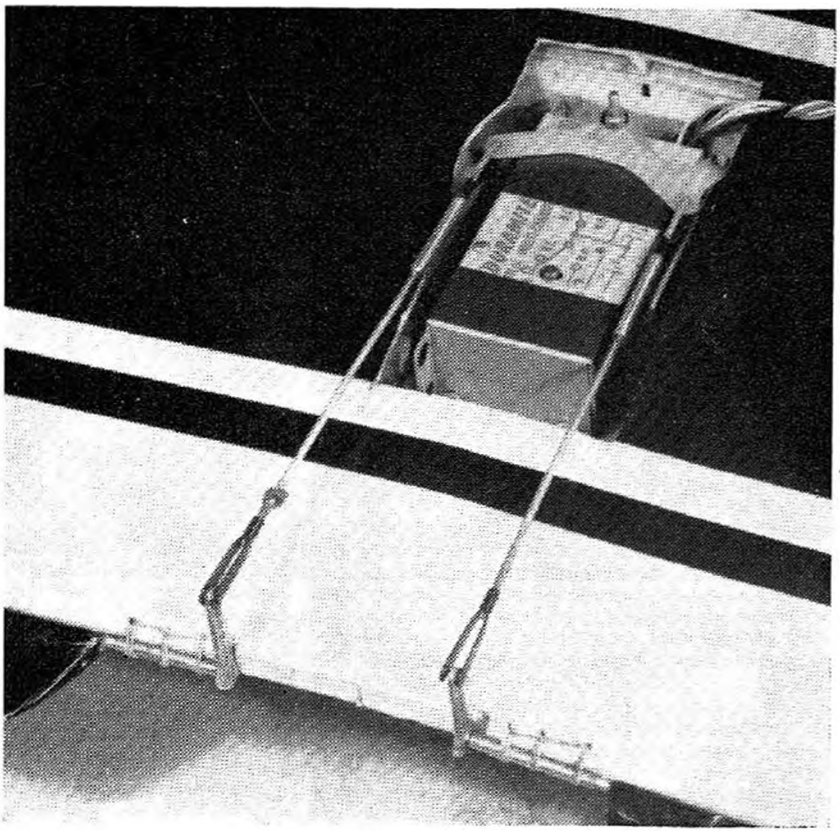
The Frise aileron is also balanced, *i.e.*, it pivots about a point distant from its leading edge, requiring lower forces to move it. The hinge point is normally about 20 per cent of the aileron chord back for complete balance. Moving the hinge point farther aft is undesirable as producing over-balance, and also reducing aileron effectiveness since only the part aft of the hinge line is "effective" area.

On models the operating forces required for consistent aileron operation are not excessively high and well within the capabilities of conventional motorised servos. The aerodynamic balancing of ailerons is, therefore, seldom necessary or significant. It is far more important to install free hinges and linkage movements, with an absolute minimum of free play. Thus it is usually quite unnecessary to have to think of applying static or aerodynamic balance to strip ailerons. Where Frise type ailerons are installed the fact that aerodynamic balance is inherent is incidental. The main thing here is that the position of the pivot point back from the leading edge is necessary for the required movement.



The TopFlite 120 degrees nylon bellcrank mounted on top of a converted Duramite illustrating the two aileron pushrods and the primary motion from the servo output. In this case no provision has been made for adjustments at the servo.

Deliberate attempts to produce very "light" aileron movements by aerodynamic balance can, in fact, have adverse effects if marked overbalance is produced. If aileron flutter does occur on models it is more likely to be due to slackness or lack of elastic stiffness in the control linkage than aerodynamic effects. Equally, the more sophisticated types of ailerons, such as slotted ailerons, etc., are quite unnecessary on models. For inset ailerons, the plain aileron with differential movement, or the Frise aileron with or without differential movement, will normally be perfectly satisfactory. Alternatively, use strip ailerons, preferably with differential movement—see Table I. If aileron control



Installation in a "Taurus" shows the TopFlite system for strip ailerons. In this case with adjustment on the Kwik Link connectors to the aileron horns only.

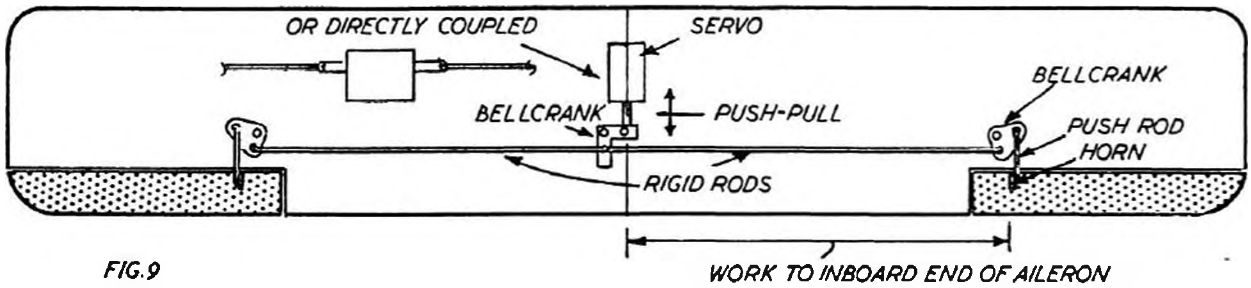


FIG. 9

response is not adequate within the conventional range of movement and aileron size, then the cause almost certainly lies elsewhere in the design.

On the mechanical side, the aileron servo is invariably mounted in the wing centre section connected to the hinged ailerons via suitable push-pull linkage. With inset ailerons this linkage has to extend along a considerable length of the span, normally employing a piano wire push-pull rod linking the respective bellcranks—Fig. 9. This is more or less standard practice, although the weight of wire (usually 16 swg.) can be quite considerable. Balsa push-pull rods with bound-on wire end fittings make a lighter installation, but require larger clearance holes in the ribs. The latter system also has the advantage of being more rigid (*i.e.*, has elastic stiffness). Wire rods can bow under "push" movements, unless supported at intervals in bushings.

With strip ailerons a very simple hook-up is often adequate, especially on the smaller models. Provided the servo has a linear (push-pull) output this movement can be connected directly to the two aileron horns via flexible stranded wire running in slightly oversize rigid metal tubing—Fig. 10. The elastic stiffness of such a system is governed by the stiffness of the "free" length of stranded wire—*i.e.*, the length emerging from the tube ends at the limits of movement. Obviously such "free" lengths should be reduced to an absolute minimum and the size of stranded wire selected to give adequate stiffness over this free length.

With larger models more rigid movements are usually preferred and proprietary fittings provide the simplest answer. Thus the *Tauri* system has formed the basis for "Top Flite" components and a well-proven linkage—Fig. 11. It is important that such systems should incorporate a means of differential adjustment of aileron positioning both to simplify setting up and also to make further "trim" or total movement adjustments, should these be found necessary or desirable.

Although ailerons are normally considered to be a single control service with conventional "bang bang" multi, there are advantages in extending the coverage. Thus an additional servo could be used to provide aileron "trim" for trimming out the model directionally or holding a particular degree of turn. There is even more advantage, however, is providing two separate ranges of total movement, selectable independently. Thus small movement could be

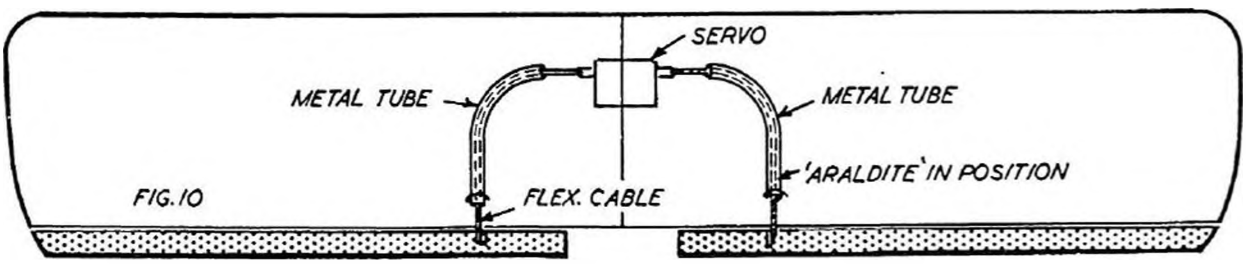
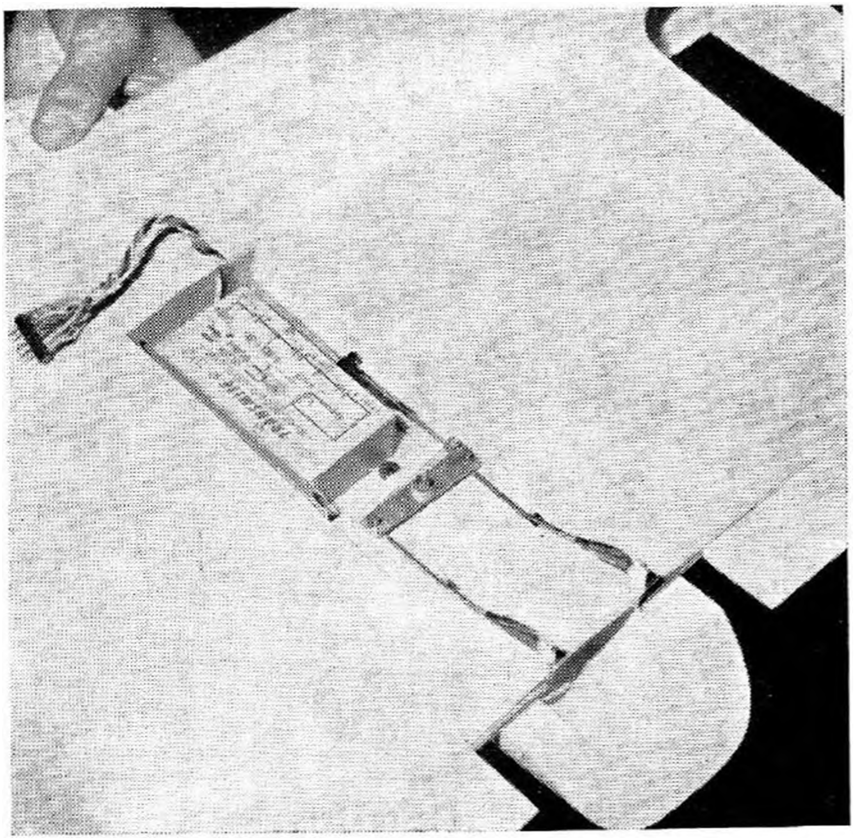


FIG. 10



Installation of a Bonner Transmite in a Veron "Concord" showing a detached Bellcrank mounting and two Kwik Link connectors to the aileron horns. This reduces the overall depth of the wing installations and can avoid strain on the servo case.

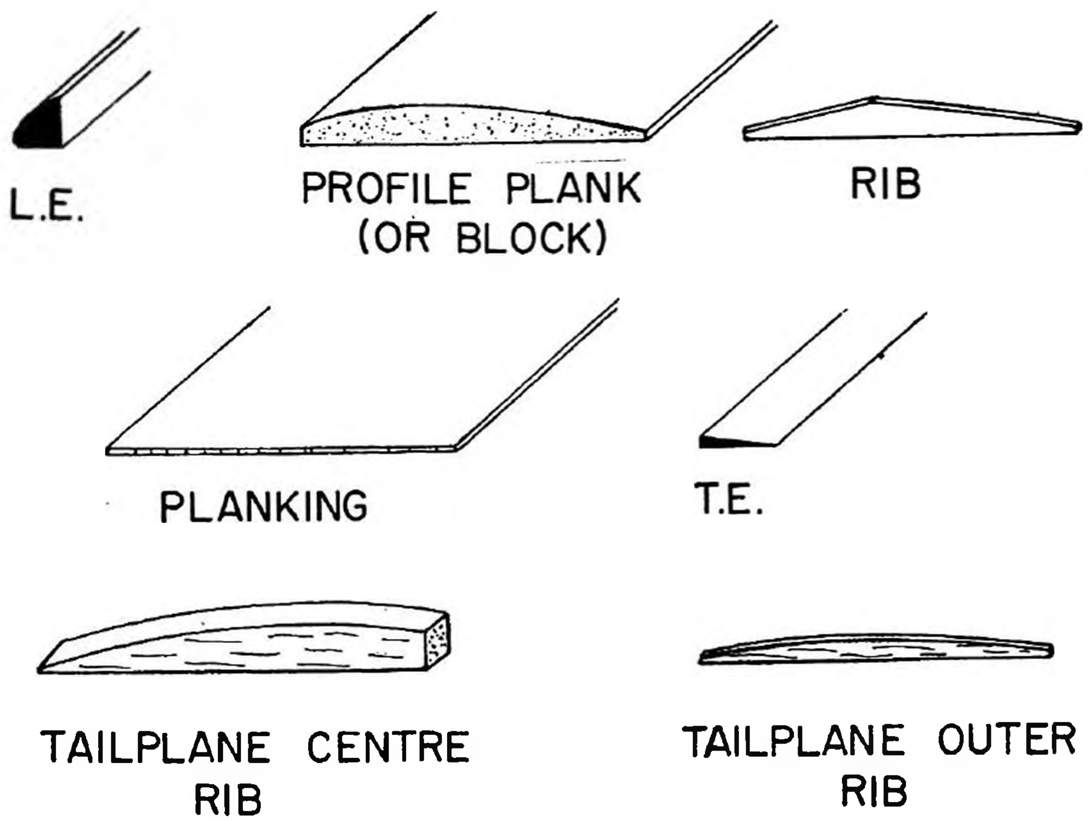
selected for smooth turns, and large movement for snap rolls, etc. Such a system could provide virtually the same coverage and smoothness of control as proportional aileron movement, at a much lower equipment cost except that 12-channel gear is needed. It is, in fact, only in aileron control that "proportional" shows a possible advantage over "bang-bang" multi.

TABLE I—AILERON MOVEMENT

TYPE	AREA % WING	MAXIMUM MOVEMENT* UP	DOWN
INSET	8	30	25
	10	30	20
	12	30	15
	15	25	15
STRIP	10	30	25
	11	30	20
	12	30	20

* Note: This is the maximum design movement. Provision should be made to adjust actual movement, adopting the lowest aileron movement (particularly "down") which gives the required response.

STANDARD CONSTRUCTION ELEMENTS



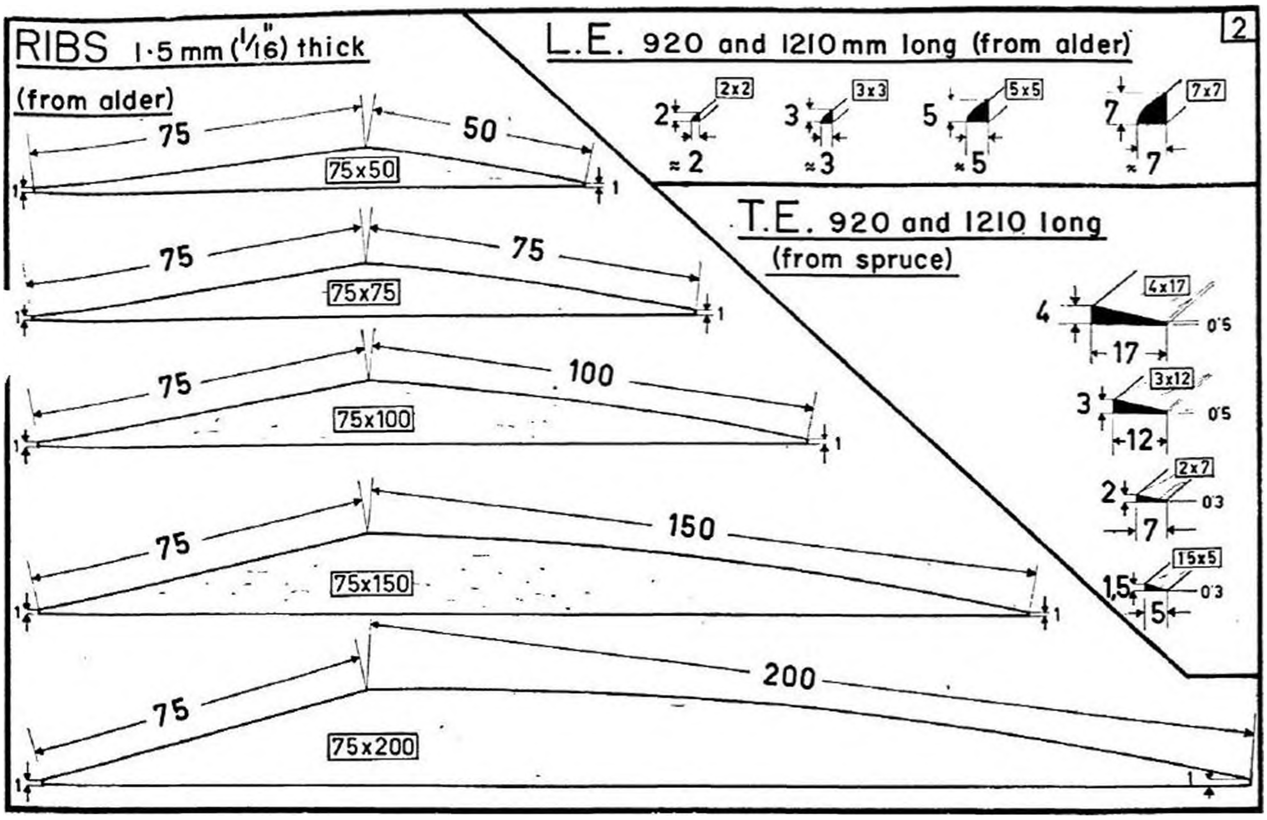
AEROMODELLING WITH STANDARD PARTS

"Standard"-Construction does for aeromodelling what Meccano has done for the general model builder in supplying parts which can be built up into an infinite number of components.

By Erich Jedelsky, who has done so much to promote this modern constructional method.

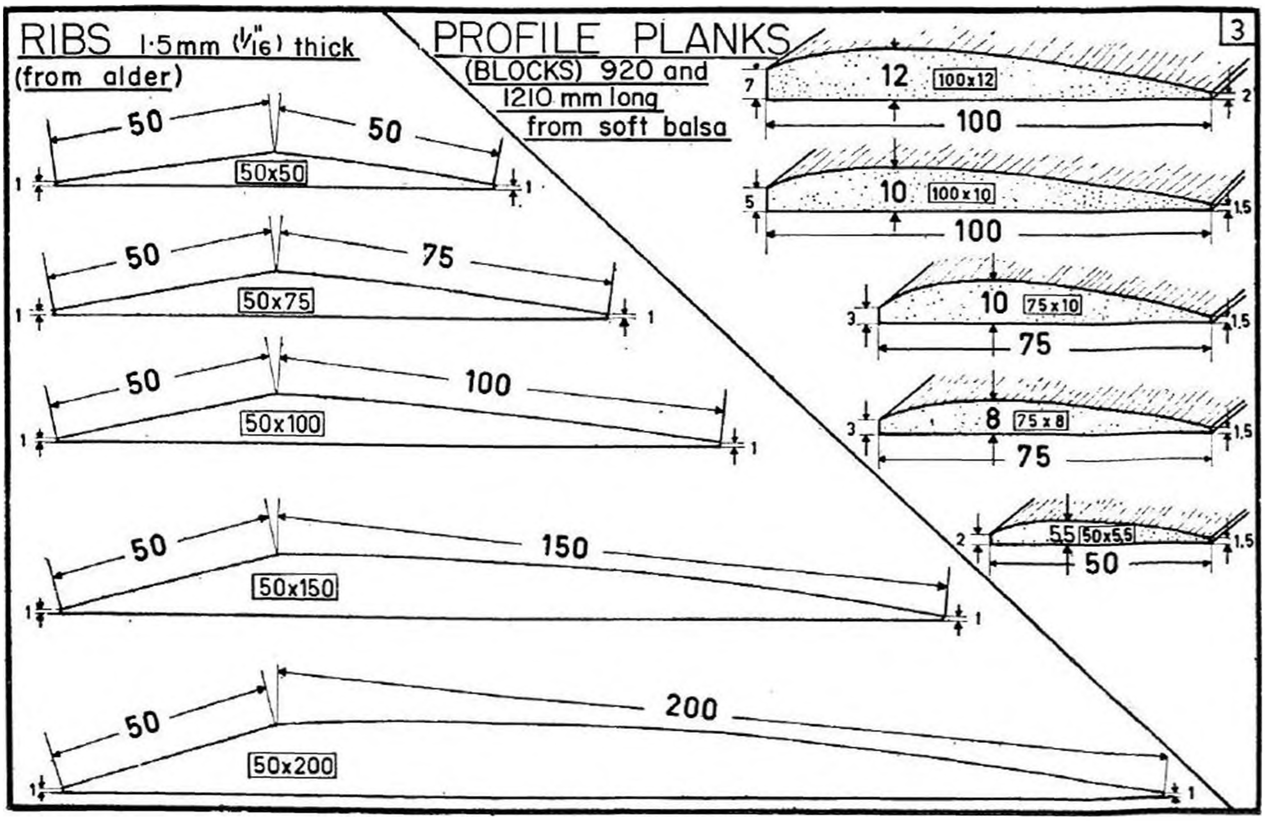
AFTER three years of development and practical testing of production facilities, machines, tools, *etc.* and wood-materials, an assortment of "Standard"-parts is obtainable in Austria, Germany and Switzerland, all of good quality and made to close tolerances. Object of "Standard"-Construction is the quick assembly of finished parts.

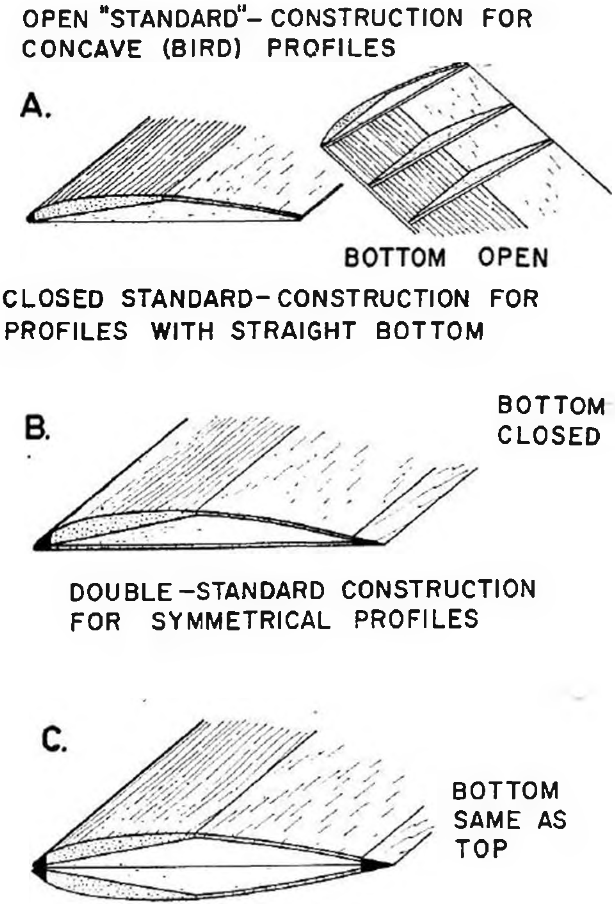
Modern modelling must be quick, simple and require a minimum of tools, if it is to have a general appeal. In the very early days of modelling, stringers, longerons and ribs had to be split off a bamboo cane. By contrast modern techniques demand prefabricated parts that click together. No architect dreams of making his own bricks, windows, doors, floors, *etc.* Modelling too, must be the better if finished parts in a variety of sizes are on the market, and can be relied upon to interlock accurately. The modeller can use them in any combination he chooses to produce his own design. This is now possible with "Standard"-Construction which can take its place with other well-known names in the unit construction field.

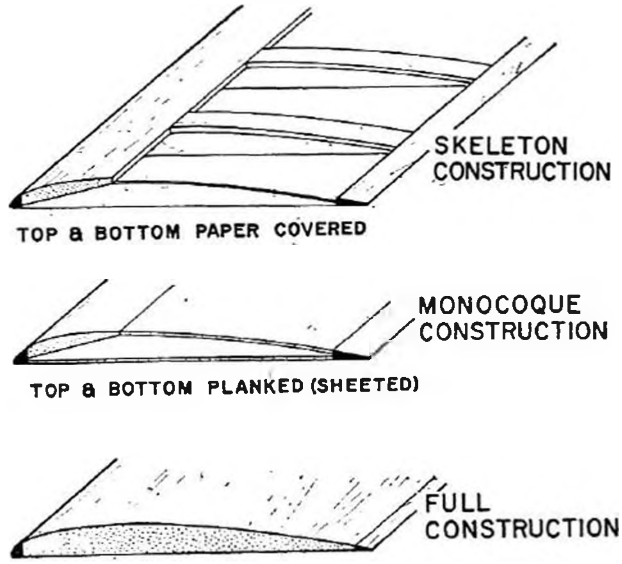


Thoroughly tested Construction:

Ten years of testing was needed to find the right size and shape of parts and to prove its worth during practical flying in competition and for sport, so as to reach the best solution for all branches of modelling. They are detailed in drawings 2 and 3 on this page.

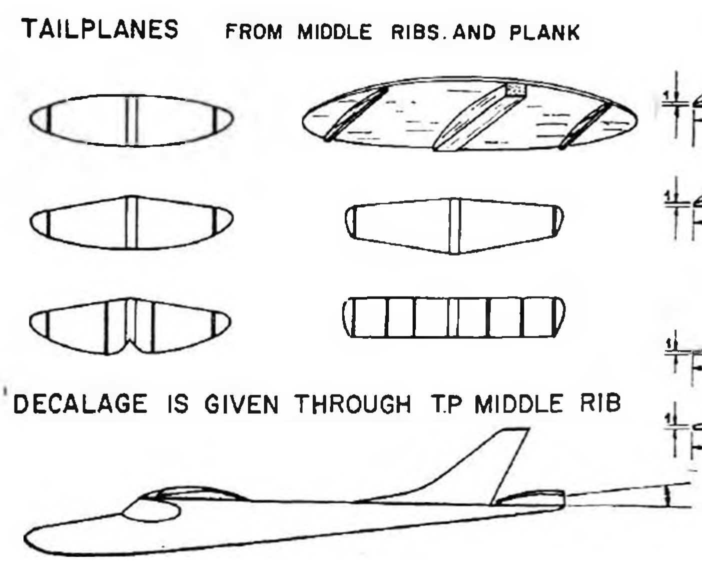


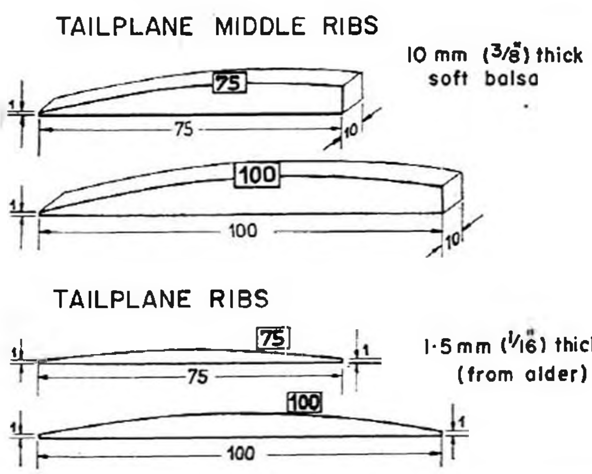




Drawing 4 at left and Drawing 5 above show Standard construction methods while Drawings 6 and 7 opposite illustrate the way to make a tapered wing with various standard rib lengths in a set. Note sequence of assembly.

Illustrations 1-9 on these pages show the standard parts and how they are employed for all types of model, free flight, control line, radio control or slope soaring glider. Tapered wings are possible and tailplanes can be single cambered surface with middle ribs shaped to obtain negative incidence. Successes of the system are already considerable. On first appearance in 1953 at Bremen in a Flying Wing contest a prize was won for construction design In 1963, after 10 years of use, a World Champion (G. Erichsen) used the system for one of his two A/2 Gliders and more recently Angus McDonald's New Zealand model flown proxy by Martin Dilly came 10th in the 1965 World Championships. Standard construction has International appeal. APS designs, *Mini-Egal*, *Daedalus* etc., employ it and these details of the commercially available parts will now be an aid to standardisation of the "STANDARD" system.

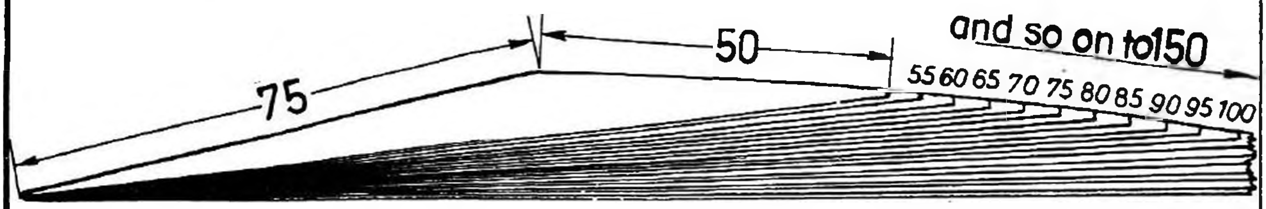




Drawings 8 (left) and 9 (above) show curved plate tail units and means of obtaining negative incidence.

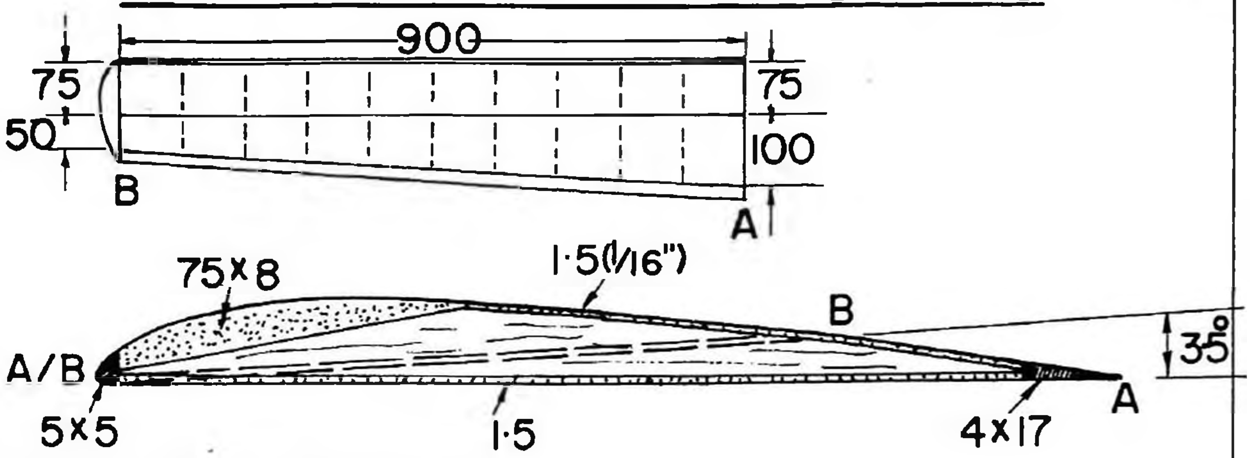
6

TAPERING RIB SET. Shown in 5mm steps over a range from 125mm to 225mm



7

EXAMPLE OF A R/C - Motorised glider wing



WING CONSTRUCTION

(1) ELEMENT LOWER PLANKING TOGETHER

(2) CEMENT ON T.E.

(3) CEMENT ON RIBS

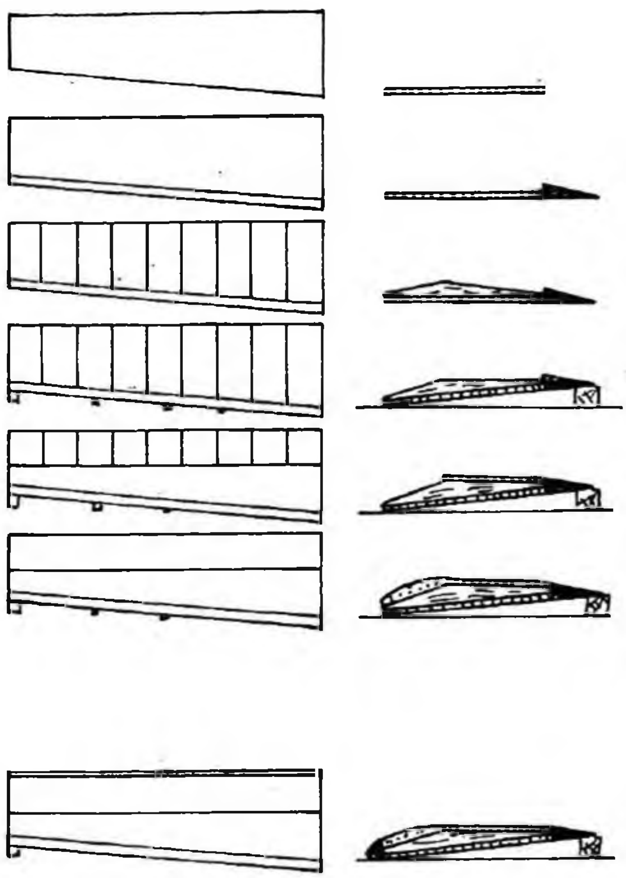
(4) BLOCK UP FOR WASHOUT

(5) PUT ON UPPER PLANKING

(6) CEMENT ON PROFILE BLOCK

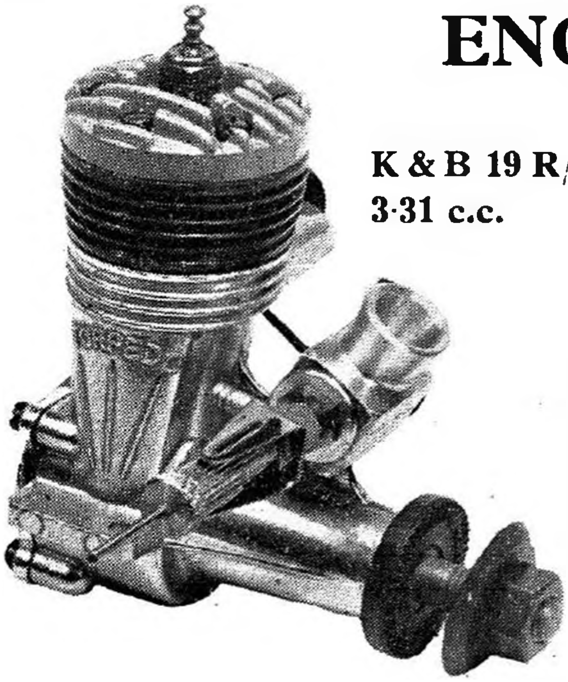
(7) LEAVE TO DRY !

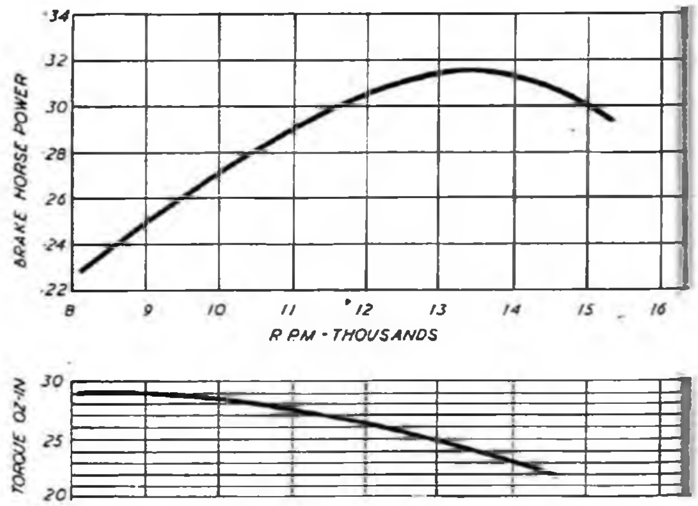
(8) CEMENT TO L.E.



ENGINE ANALYSIS

K & B 19 R/C 3·31 c.c.





Specification

Displacement: 3·31 c.c. (·201 cu. in.
Bore: ·641 in.
Stroke: ·620 in.
Bare weight: 6⅝ oz.
Max. power: ·317 b.h.p. at 13,400 r.p.m.
Max. torque: 20 oz-.in. at 9,000 r.p.m.
Power rating: ·096 b.h.p. per c.c.
Power/weight ratio: ·048 b.h.p. per oz.

Material Specification

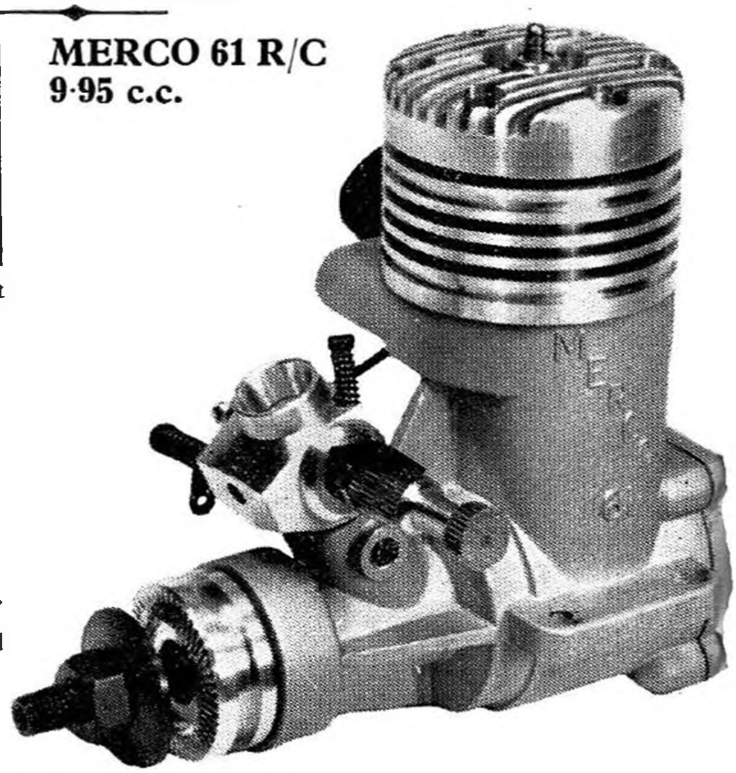
Crankcase: light alloy pressure die casting.
Cylinder: mild steel.
Piston: cast iron.
Cylinder head: light alloy pressure die casting.
Crankshaft: hardened steel.
Main bearing: bronze bush.
Connecting rod: light alloy forging.
Propeller driver: steel.
Throttle unit: aluminium body with steel barrel; steel throttle arm and exhaust flap.
Spraybar assembly: brass.
Crankcase rear cover: light alloy pressure die casting.

Propeller—R.P.M. Figures

Propeller dia. × pitch	r.p.m.
10 × 3½ (Top Flite)	10,800
9 × 4 (Top Flite)	12,500
9 × 6 (Top Flite)	10,200
8 × 6 (Top Flite)	12,200
9 × 4 (Keil Kraft)	13,000
9 × 6 (Keil Kraft)	9,500
9 × 6 (Frog nylon)	11,200

Fuel: 70/25 methanol/castor with 5 per cent nitromethane.

MERCO 61 R/C 9·95 c.c.



Propeller—R.P.M. Figures

Propeller dia. × pitch	r.p.m.
12 × 6 (Tornado)	10,700
12 × 5 (Tornado)	11,800
11 × 6 (Tornado)	12,300

Fuel: 70/25 methanol/castor with 5 per cent nitromethane.

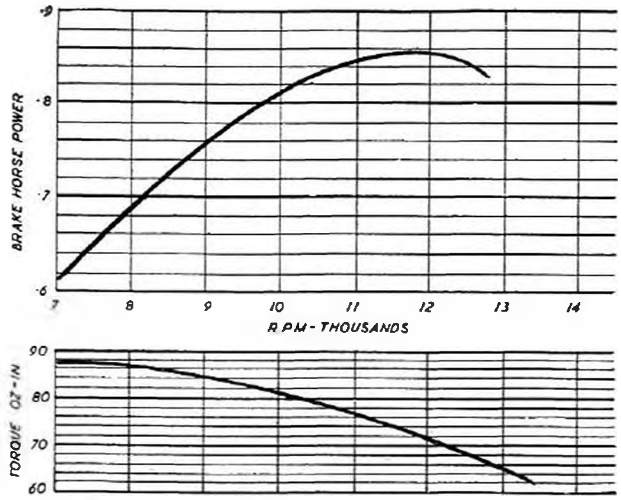
Specification

Displacement: 9·95 c.c. (·607 cu. in.).
Bore: ·938 in.
Stroke: .875 in.
Weight: 12$\frac{11}{16}$ oz.
Max. power: ·86 B.H.P. at 11,800 r.p.m.
Max. torque: 88 oz.-in. at 7,200.
Power rating: ·0865 B.H.P. per c.c.
Power/weight ratio: ·068 B.H.P. per oz.

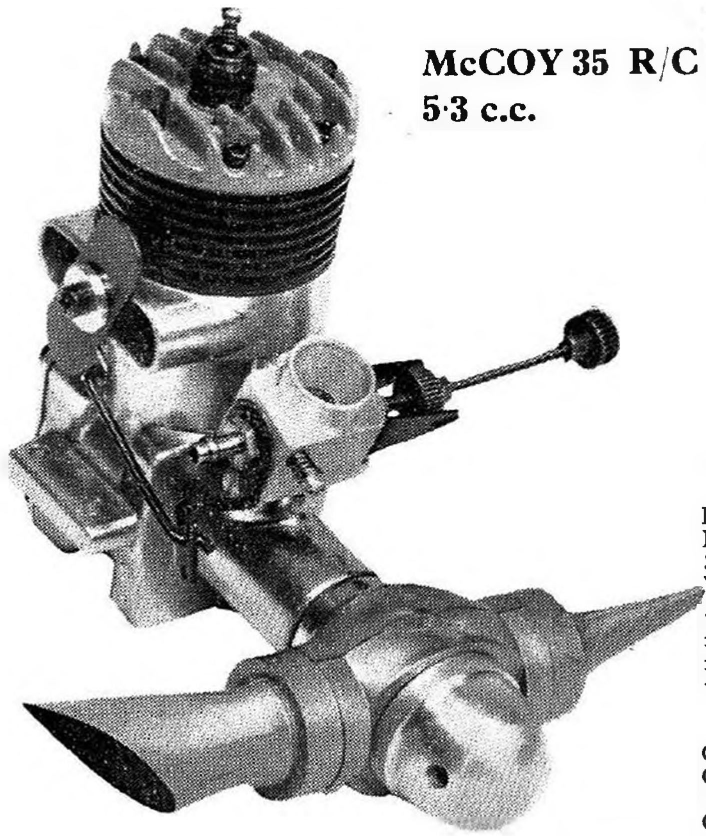
Material Specification

Crankcase: pressure die cast L.33 light alloy. Sand blast finish.
Cylinder liner: EN 1A steel, case hardened, ground and honed.
Cylinder jacket: turned dural.
Cylinder head: turned dural.
Piston: light alloy with two cast iron rings.

Connecting rod: light alloy RR 56 forging.
Crankshaft: EN 1A steel, case hardened and ground.
Main bearings: ½ in. ballrace (rear), 8 mm. ballrace (front).
Crankcase back cover: pressure die cast L.33 alloy Sand blast finish.
Gudgeon pin: EN.1A steel, hardened and ground.
Carburettor unit: turned dural body and barrel valve: brass spraybar.
Propeller driver: turned dural, split collet fitting.
Exhaust flap: throttle arm and link; black-finished steel.



McCOY 35 R/C 5·3 c.c.



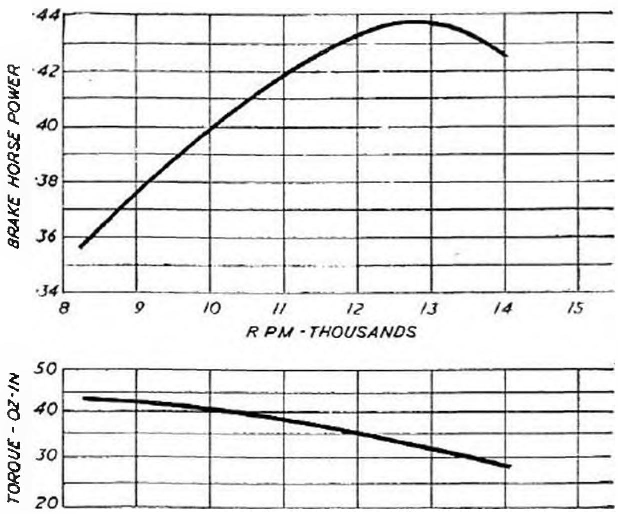
Very nearly every major model engine has been duly covered in our columns over the years. New engines are very frequently only slightly modified versions of ones which have previously been tested. This accounts for the shorter number presented here. A 16-page booklet, dealing with all the engines currently in production, or still available, is available from our offices, price 1s. 6d. including postage.

Specification

Displacement: 5·362 c.c. (·327 cu. in.).
Bore: ·775 in.
Stroke: ·743 in.
Weight: 7⅞ oz.
Max. power: ·438 B.H.P. at 12,700 r.p.m.
Max. torque: 44 oz.-in. at 8,400 r.p.m.
Power output: ·082 B.H.P. per c.c.
Power/weight ratio: ·056 B.H.P. per oz.

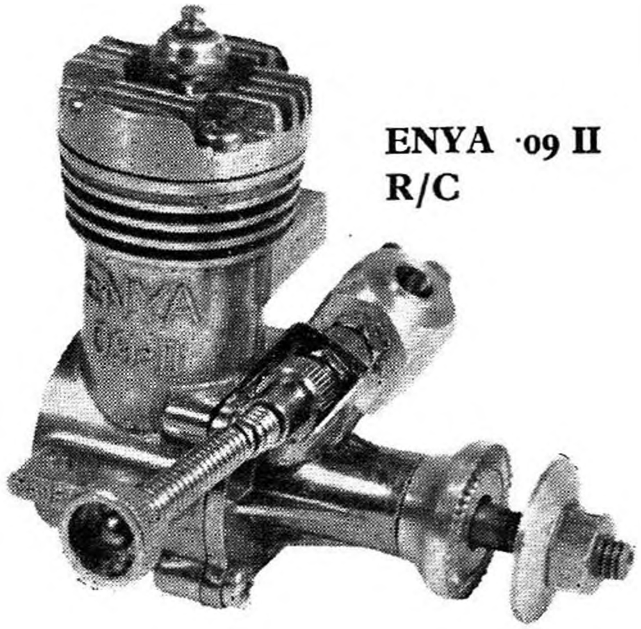
Material Specification

Crankcase: pressure die cast light alloy.
Cylinder: leaded steel (unhardened) with integral fins.
Cylinder head: light alloy pressure die casting (stove enamelled red).
Piston: lightweight cast iron.
Connecting rod: light alloy forging
Main bearing: cast iron bush.
Crankshaft: hardened steel.
Gudgeon pin: silver steel.
Propeller driver: light alloy pressure die casting.
Crankcase backplate: light alloy pressure die casting.
Throttle body: aluminium.
Throttle barrel: aluminium.
Spraybar assembly: brass with steel needle and spring steel ratchet spring.



PROPELLER—R.P.M. FIGURES	
Propeller dia. × pitch	*r.p.m.*
11 × 4 (Tornado nylon)	10,900
10 × 6 (Tornado nylon)	11,200
10 × 6 (Frog nylon)	10,800
11 × 4 (Trucut wood)	10,000
11 × 4 (Top Flite nylon)	10,700
10 × 6 (Top Flite nylon)	10,900
9 × 6 (Top Flite nylon)	11,500

Fuel used: Mercury 45.



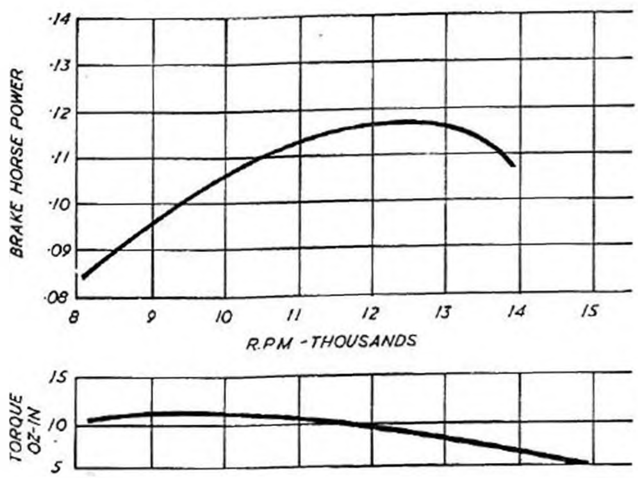
ENYA ·09 II R/C

Specification

Displacement: 1·60 c.c. (·0978 cu. in.).
Bore: ·500 in.
Stroke: ·498 in.
Weight: 5 oz.
Max. power: ·118 B.H.P. at 12,750 r.p.m.
Max. torque: 11·5 oz.-in. at 9,500 r.p.m.
Power rating: ·074 B.H.P. per c.c.
Power/weight ratio: ·023 B.H.P. per oz.

Material Specification

Crankcase unit: light alloy pressure die casting.
Cylinder liner: leaded steel (unhardened).
Piston: cast iron.
Con. rod: light alloy forging.
Crankshaft: hardened steel.
Main bearing: plain, bronze bush.
Front bearing unit: light alloy pressure die casting.
Cylinder head: light alloy pressure die casting.
Throttle unit: brass barrel in light alloy body.
Needle valve assembly: nickel plated brass.
Propeller driver: light alloy.
Propeller shaft thread: ·192 in. diameter.



PROPELLER—R.P.M. FIGURES

Propeller dia. × pitch	*r.p.m.*
6 × 4 (Top Flite)	14,300
7 × 4 (Top Flite)	11,700
7 × 6 (Top Flite)	10,200
8 × 4 (Top Flite)	10,500
8 × 6 (Top Flite)	8,500
8 × 4 (D-C nylon)	10,200
7 × 6 (K-K nylon)	10,200
7 × 4 (K-K nylon)	11,600

All figures are with throttle fitted.
Fuel used: Mercury 45.

The GREAT BRITISH TEAM—or so it says on the back of the van. Team manager Dave Posner, David "Happy" Tipper, John O'Donnell and Tony Young flew well worn but highly trimmed A/2 Gliders to win the 1965 World Championship. A great honour for the old country and a tribute to the British competition stanstards which developed the tactical techniques they used, to lead the event from start to finish.

WORLD FREE-FLIGHT MODEL CHAMPS — FULL RESULTS INCLUDING ROUND BY ROUND TEAM TOTALS

Held at KAUHAVA, FINLAND, July 7-12

A/2 GLIDER RESULTS

	Name	*Nation*	1	2	3	4	5	*Total*
1	Anton Bucher	Switzerland	180	180	180	180	180	900
				Fly-off +		240	282	
2	**John O'Donnell**	**Great Britain**	180	180	180	180	180	900
				Fly-off +		240	152	
3	Kjell Bentzen	Norway	180	180	180	180	180	900
				Fly-off +		240	143	
4	Gunnar Kalen	Sweden	180	180	180	180	180	900
				Fly-off +		240	122	
5	Gerard Klomp	Netherlands	180	180	180	180	180	900
				Fly-off +		240	122	
6	Stefan Hubert	Czechoslovakia	180	180	180	180	180	900
				Fly-off +			210	
7	**David Tipper**	**Great Britain**	180	180	180	180	180	900
				Fly-off +			193	
8	Thomas Kongsted	Denmark	180	180	180	180	180	900
				Fly-off +			122	
9	Herbert Schmidt	W. Germany	180	157	180	180	180	877
10	Angus McDonald (*Proxy* M. Dilly)	New Zealand	180	180	180	180	153	873
11	Moshe Goldberg	Israel	180	146	180	180	180	866
12	Ivan Horejsi	Czechoslovakia	138	180	180	180	180	858
	Vasilev Simonov	U.S.S.R.	180	180	180	180	138	858
14	Ari Hietanen	Finland	134	180	180	180	180	854
15	John Swallow	South Africa	134	180	180	180	175	849
16	**Anthony Young**	**Great Britain**	180	140	166	180	180	846
17	Rimas Shourna	U.S.S.R.	154	146	180	180	180	840
18	Oldrich Prochazka	Czechoslovakia	180	119	180	180	180	839
19	Johan Schreiner	E. Germany	180	117	180	180	180	837
20	Juri Sokolov	U.S.S.R.	180	180	180	116	180	836
21	M. Corbin	France	180	135	180	156	180	831
22	Markku Tahkapaa	Finland	180	180	180	110	166	816
	Jorgen Larsen	Denmark	180	121	180	180	155	816
24	Theo van't Rood	Netherlands	170	112	180	180	173	815
25	Ugo Acuto	Italy	180	129	180	154	157	800
26	Hans Maassen	Netherlands	180	180	145	180	107	792
27	Fritz Gaensli	Switzerland	180	180	180	180	69	789
28	Pierre Lommer	Luxembourg	97	180	180	180	145	782
29	Dieter Ducklauss	E. Germany	180	109	132	180	180	781
30	Paolo Dapporto	Italy	180	60	180	165	180	765
31	Paolo Soave	Italy	180	113	101	180	180	754
32	Aimar Mattano	Argentina	114	180	143	180	127	744
33	Giora Herzberg	Israel	180	180	68	180	132	740
34	Peter Allnut	Canada	180	73	180	180	119	732
	Dale Wilson	U.S.A.	99	180	180	180	93	732
36	Robert Rowe	South Africa	141	169	97	180	142	729
37	Jack McGillivray	Canada	180	180	92	95	180	727
38	Josef Bucher	Switzerland	180	58	180	180	126	724
39	Inge Sundstedt	Sweden	180	180	69	114	180	723
40	Richard Nagler	W. Germany	180	180	130	55	175	720
	Knut Andersson	Sweden	180	56	155	180	149	720
	Karoly Fischer	Hungary	180	108	180	114	138	720
43	M. Braire	France	180	180	145	57	155	717
	John Foley	Canada	86	180	164	107	180	717

	Name	Nation	1	2	3	4	5	Total
45	Albrecht Oschatz	E. Germany	101	74	180	180	180	715
46	David Anderson	Australia	180	86	180	180	67	693
47	Heinz Geiger	W. Germany	100	180	108	180	111	679
	M. Bolland	France	180	86	180	53	180	679
49	Per Grunnet	Denmark	106	110	180	95	180	671
50	Brian Glenny (*Proxy* P. Lawson)	New Zealand	180	140	93	74	170	657
51	Peter Visser	South Africa	40	153	180	180	66	619
52	Asmund Skard	Norway	180	64	118	76	180	618
53	Abraham Kiflawi	Israel	180	84	80	180	88	612
54	Norm Ingersoll	U.S.A.	86	145	140	70	158	599
55	Hugh Langevin	U.S.A.	121	180	180	35	78	594
	J. Thomson (*Proxy* C. Hayward)	New Zealand	180	101	72	180	61	594
57	Norbet Mertes	Luxembourg	42	114	180	130	63	529
58	Torsten Strang	Finland	59	155	99	66	148	527
59	Joseph Ewen	Luxembourg	46	60	—	85	42	233

A/2 TEAM RESULTS

	Rounds	1	2	3	4	5
1	**Great Britain**	540	1040	1566	2106	2646
2	Czechoslovakia	489	977	1517	2057	2597
3	U.S.S.R.	514	1020	1560	2036	2534
4	Netherlands	530	1002	1507	2047	2507
5	Switzerland	540	958	1498	2038	2413
6	Denmark	466	877	1417	1872	2387
7	Sweden	540	956	1360	1834	2343
8	East Germany	461	761	1253	1793	2333
9	Italy	540	842	1303	1802	2319
10	West Germany	460	977	1395	1810	2276
11	France	540	941	1446	1712	2227
12	Israel	540	950	1278	1818	2218
13	Finland	373	888	1347	1703	2197
	South Africa	315	817	1274	1814	2197
15	Canada	446	879	1315	1697	2176
16	New Zealand	540	961	1306	1740	2124
17	U.S.A.	306	811	1311	1596	1925
18	Luxembourg	185	539	899	1294	1544
19	Norway	360	604	902	1158	1518
20	Argentina	114	294	437	617	744
21	Hungary	180	288	468	582	720
22	Australia	180	266	446	626	693

F.A.I. POWER RESULTS

	Name	Nation	1	2	3	4	5	Total
1	Alberto Dall'Oglio	Italy	180	180	180	180	180	900
					Fly-off + 240			
2	M. Bourgeois	France	180	180	180	180	180	900
					Fly-off + 239			
3	Eugene Verbitski	U.S.S.R.	180	180	180	180	180	900
					Fly-off + 227			
4	Benno Schlosser	W. Germany	180	180	180	180	180	900
					Fly-off + 223			
5	Victor Onufrienko	U.S.S.R.	180	180	180	180	180	900
					Fly-off + 212			
6	**George French**	**Great Britain**	180	180	180	180	180	900
					Fly-off + 203			
7	Vladimir Hajek	Czechoslovakia	180	180	180	180	180	900
					Fly-off + 190			
8	Robert Cherny	U.S.A.	180	180	180	180	180	900
					Fly-off + 173			
9	Carlo Lenti	Italy	180	180	180	180	180	900
					Fly-off + 163			

	Name	*Nation*	1	2	3	4	5	*Total*
10	Jorma Kumpulainen	Finland	180	180	180	180	180	900
					Fly-off + 159			
11	Nils Erik Hollander	Sweden	180	180	180	180	180	900
					Fly-off + 153			
12	A. Landeau	France	180	180	180	180	180	900
					Fly-off + 152			
13	Andras Meczner	Hungary	180	180	180	180	180	900
					Fly-off + 142			
14	James Robinson	U.S.A.	180	180	180	180	180	900
					Fly-off + 128			
15	Gianfranco Grifoni	Italy	180	180	180	180	180	900
					Fly-off + 120			
16	Henry Spence	U.S.A.	180	180	180	180	180	900
					Fly-off + *over-run*			
17	Valentin Mozirski	U.S.S.R.	180	180	180	164	180	884
18	Birger Bulukin	Norway	180	162	180	180	180	882
19	Brian Eggleston	Canada	180	180	180	160	180	880
	Torbjorn Johannessen	Norway	180	180	180	168	172	880
21	Niels Christensen	Denmark	157	172	180	180	180	869
22	**Peter Manville**	**Great Britain**	164	180	180	164	180	868
23	Ferenc Csizmarik	Hungary	141	180	180	180	180	861
24	Don Elliot	Canada	132	180	180	180	180	852
25	Paul Lagan (*Proxy* D. Welch)	New Zealand	180	180	164	165	158	847
26	Raymond Hewitson (*Proxy* P. Bayram)	New Zealand	180	180	180	125	180	845
27	Gyula Simon	Hungary	180	180	180	140	153	833
28	M. Fernandez	France	180	170	141	180	160	831
29	Rudolf Schenker	Switzerland	180	163	180	180	108	811
30	Pieter Broerse	Netherlands	99	180	180	180	167	806
31	Hans Friis	Sweden	180	180	120	180	143	803
	Karl-Heinz Rieke (*Proxy* H. Seelig)	W. Germany	180	171	180	94	178	803
33	Martin van Dijk	Netherlands	180	180	122	180	129	791
34	**Michael Gaster**	**Great Britain**	180	130	180	180	112	782
35	Fritz Schneeberger	Switzerland	180	53	180	180	180	773
36	Zdenek Malina	Czechoslovakia	180	180	165	63	180	768
37	Josef Blazek	Czechoslovakia	180	91	180	133	180	764
38	Lasse Laxman	Finland	90	180	180	170	142	762
39	Harry Winn (*Proxy* D. Hipperson)	New Zealand	180	180	170	104	127	761
40	Rolf Kammer	E. Germany	180	136	163	180	98	757
41	Peter Visser	South Africa	180	180	175	133	58	726
42	Joachim Benthin	E. Germany	180	180	152	180	—	692
43	John Swallow	South Africa	114	102	180	180	107	683
44	Robert Rowe	South Africa	—	165	180	180	123	648
45	Peter Spring	Switzerland	25	119	180	180	136	640
46	Seppo Haapalainen	Finland	134	173	180	26	114	627
47	Carl-Erik Auner	Sweden	14	180	180	180	67	621
48	Norbert Czeranowsky	W. Germany	152	94	68	64	180	558
49	Eolo Carlini	Brazil	—	180	148	125	94	548
50	Michael Segrave	Canada	180	69	—	180	104	533
51	Julian Falecki	Poland	121	108	7	180	109	525
52	Ferd Kraemer	Luxembourg	54	66	76	66	60	322
53	Oyvind Liberg	Norway	31	69	—	116	—	216

TEAM RESULTS: F.A.I. POWER

		Rounds 1	2	3	4	5
1	Italy	540	1080	1620	2160	2700
	U.S.A.	540	1080	1620	2160	2700
3	U.S.S.R.	540	1080	1620	2144	2684
4	France	540	1070	1571	2111	2631
5	Hungary	501	1041	1581	2081	2594

	Name	*Rounds* 1	2	3	4	5
6	**Great Britain**	524	1014	1554	2078	2550
7	New Zealand	540	1080	1594	1988	2453
8	Czechoslovakia	540	991	1516	1892	2432
9	Sweden	374	914	1394	1934	2324
10	Finland	404	937	1477	1853	2289
11	Canada	492	921	1281	1801	2265
12	West Germany	512	957	1385	1723	2261
13	Switzerland	385	720	1260	1800	2242
14	South Africa	294	741	1276	1769	2057
15	Norway	391	802	1162	1626	1978
16	Netherlands	279	539	941	1301	1597
17	East Germany	360	676	991	1351	1449
18	Denmark	157	329	509	689	869
19	Brazil	0	180	329	454	548
20	Poland	121	229	236	416	525
21	Luxembourg	54	120	196	262	322

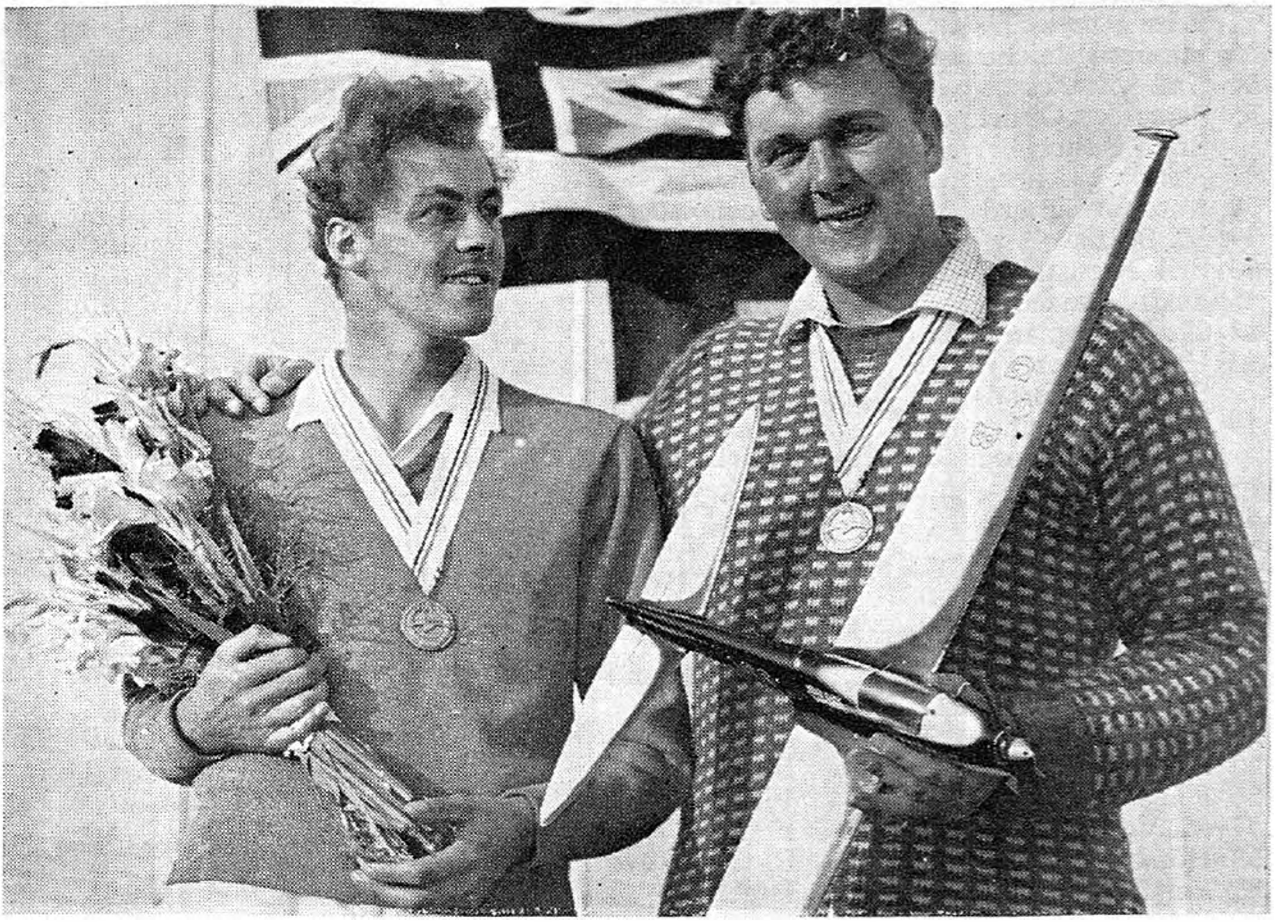
WAKEFIELD RESULTS

	Name	*Nation*	1	2	3	4	5	*Total*
1	Thomas Koster	Denmark	180	180	180	180	180	900
			Fly-off +	240	300	360	257	
2	Vladimir Matveev	U.S.S.R.	180	180	180	180	180	900
			Fly-off +	240	300	360	217	
3	Bengt Johansson	Sweden	180	180	180	180	180	900
			Fly-off +		240	300	196	
4	Lennart Flodstrom	Sweden	180	180	180	180	180	900
			Fly-off +				229	
5	Rune Johansson	Sweden	180	180	180	180	180	900
			Fly-off +				221	
6	Jurgen Horn	W. Germany	180	180	180	180	180	900
			Fly-off +				218	
7	Frank Parmenter	U.S.A.	180	180	180	180	180	900
			Fly-off +				212	
8	Egert Oskamp	Netherlands	180	180	180	180	180	900
			Fly-off +				200	
9	**Alan Armes**	**Great Britain**	180	180	180	180	180	900
			Fly-off +				188	
	Julije Merory	Yugoslavia	180	180	180	180	180	900
			Fly-off +				188	
11	Vilim Kmoch	Yugoslavia	180	180	180	180	180	900
			Fly-off +				183	
12	Masahiro Itoh	Japan	180	180	180	180	180	900
	(*Proxy* Jan-olle Akesson)		*Fly-off* +				174	
13	Vladyslav Niestoj	Poland	180	180	180	180	178	898
14	Karel Rys	Czechoslovakia	180	180	176	180	180	896
15	Kurt Sager	Switzerland	180	178	180	180	176	894
16	Ronald Magill	New Zealand	180	172	180	180	180	892
17	Johan Schulten	Netherlands	180	180	171	180	180	891
18	Emil Fresl	Yugoslavia	180	180	180	170	180	890
19	Sergio Legnani	Italy	180	180	164	180	180	884
	Arthur Macauley (*Proxy* R. Godden)	New Zealand	180	166	180	178	180	884
21	John Lenderman	U.S.A.	180	163	173	180	180	876
22	Gunter Rupp	W. Germany	180	180	155	180	180	875
	Vladimir Zviakin	U.S.S.R.	180	180	180	180	155	875
	Vincenzo Scardicchio	Italy	155	180	180	180	180	875
25	Michael Segrave	Canada	180	152	179	180	180	871
26	Joachim Loffler	E. Germany	180	180	180	148	180	868
27	Erik Jorgensen	Norway	180	144	180	180	180	864
28	Jerzy Kosinski	Poland	143	180	180	180	180	863
	Giovanni Cassi	Italy	180	180	143	180	180	863
	Jack McGillivray	Canada	147	180	180	176	180	863
31	Daniel McDonald	U.S.A.	135	180	180	180	180	855

	Name	Nation	1	2	3	4	5	Total
32	Fritz Strzys	E. Germany	180	180	180	180	133	853
33	Manfred Reichenbach	W. Germany	180	123	180	180	180	843
34	Gad Minikes	Israel	160	180	135	180	180	835
35	Peter den Ouden	Netherlands	180	180	180	115	177	832
	Erich Rohrer	Switzerland	159	143	170	180	180	832
37	Karoly Fischer	Hungary	180	127	180	180	164	831
38	Antonin Simerda	Czechoslovakia	180	107	180	180	180	827
39	M. Boiziau	France	180	180	102	180	180	822
40	Erik Nienstaedt	Denmark	180	139	140	180	180	819
41	Esko Hamalainen	Finland	180	180	98	180	180	818
42	Chaim Kaplan	Israel	154	180	119	180	180	813
34	Urs Schaller	Switzerland	180	180	89	180	180	809
	Stanislav Zurad	Poland	180	150	119	180	180	809
45	Reino Hyvarinen	Finland	98	180	168	180	180	806
	Frantisek Dvorak	Czechoslovakia	180	150	116	180	180	806
	Rone Koen	Turkey	180	86	180	180	180	806
48	**Bruce Rowe**	**Great Britain**	180	89	180	180	169	798
	Robert Rowe	South Africa	145	180	156	180	137	798
50	**John O'Donnell**	**Great Britain**	111	180	180	144	180	795
51	Vladimir Zapachni	U.S.S.R.	93	180	180	150	180	783
52	Karl-Erik Widdel	Denmark	171	130	117	180	180	778
53	Brian Roots (*Proxy* B. Halford)	New Zealand	111	180	120	180	180	771
54	M. Degieux	France	50	166	180	180	180	756
55	Luis Serrano	Brazil	180	106	163	126	180	755
56	Pentti Aalto	Finland	162	95	126	180	180	743
57	M. Valery	France	110	180	92	180	180	742
58	Horst Kubiak	E. Germany	133	84	154	180	180	731
59	Yair Shmueli	Israel	121	109	139	180	138	687
60	Peter Visser	South Africa	121	110	127	147	180	685
61	John Swallow	South Africa	133	107	130	180	129	679
62	Henrik Dahl	Norway	130	85	100	180	180	675
63	Cordon Hilliam	Canada	102	124	175	55	180	636
64	Joseph Glodt	Luxembourg	53	60	89	165	180	547

WAKEFIELD TEAM RESULTS

	Rounds	1	2	3	4	5
1	Sweden	540	1080	1620	2160	2700
2	Yugoslavia	540	1080	1620	2150	2690
3	U.S.A.	495	1018	1551	2091	2631
4	Netherlands	540	1080	1611	2086	2623
5	Italy	515	1055	1542	2082	2622
6	W. Germany	540	1023	1538	2078	2618
7	Poland	503	1013	1492	2032	2570
8	U.S.S.R.	453	993	1533	2043	2558
9	New Zealand	471	989	1469	2007	2547
10	Switzerland	519	1020	1459	1999	2535
11	Czechoslovakia	540	977	1449	1989	2529
12	Denmark	531	980	1417	1957	2497
13	**Great Britain**	471	920	1460	1964	2493
14	E. Germany	493	937	1451	1959	2452
15	Canada	429	885	1419	1830	2370
16	Finland	440	895	1287	1827	2367
17	Israel	435	904	1297	1837	2335
18	France	340	866	1240	1780	2320
19	South Africa	399	796	1209	1716	2162
20	Norway	310	539	819	1179	1539
21	Japan	180	360	540	720	900
22	Hungary	180	307	487	667	831
23	Turkey	180	266	446	626	806
24	Brazil	180	286	449	575	755
25	Luxembourg	53	113	202	367	547



Don Haworth and Dick Place complete with prize-winner's bunch of flowers, gold medals on neck ribbons and their "Super Nova" F.A.I. Racer. World Champions in their class, these Wharfedale clubsters use an Eta 15 in this single-stop racer.

WORLD CHAMPIONSHIPS FOR CONTROL-LINE MODELS

Held at Budaors, Hungary, July 28th - August 2nd, 1964

TEAM RACING

					Final	
1	**Place-Haworth**	**Great Britain**	0	4 : 35·0	4 : 51·2	Eta 15 II
2	Trnka-Drazek	Czechoslovakia	5 : 17·0	4 : 23·7	4 : 58·4	M.V.V.S.-TR
3	Fontana-Amodio	Italy	5 : 19·0	4 : 33·8	5 : 06·8	Super Tigre G.20D
4	Fabre-Favre	France	4 : 40·2	0		Eta 15 II
5	O. Sundell-G. Sundell	Finland	4 : 47·9	4 : 45·4		Oliver Tiger
6	Gelmann-Bulkin	U.S.S.R.	4 : 46·3	4 : 49·6		Start
7	Zolotoverch-Kobets	U.S.S.R.	4 : 46·3	0		Super Tigre G.20D
8	**Humphrey-Turner**	**Great Britain**	4 : 46·9	5 : 05·2		Eta 15 II
9	Bjork-Rosenlund	Sweden	4 : 49·0	5 : 15·6		Oliver Tiger
10	Burke-Jones	U.S.A.	4 : 49·4	5 : 08·1		Eta 15 II
11	Sapovalov-Radchenko	U.S.S.R.	4 : 49·4	5 : 11·2		Super Tigre G.20D
12	Schluchter-Fromm	W. Germany	4 : 52·0	5 : 08·2		Oliver Tiger
13	Schliewa-Wamper	W. Germany	4 : 54·0	4 : 58·8		Eta 15
14	Purgai-Katona	Hungary	0	4 : 59·0		Moki—TR6
15	Alseby-Hagberg	Sweden	5 : 01·1	6 : 10·8		Eta 15 II
16	Mohai-Toth	Hungary	5 : 03·3	5 : 10·9		Moki—TR 6
17	Raatikainen-Torttila	Finland	5 : 08·0	7 : 16·8		Oliver Tiger
18	**Nixon-Ellis**	**Great Britain**	5 : 09·9	5 : 23·0		Eta 15 II
19	Stoyl-Rachkov	Bulgaria	5 : 10·3	5 : 52·2		Super Tigre G.20D
20	Ch. Gafner-M. Gafner	Switzerland	6 : 20·3	5 : 11·0		Oliver Tiger
21	Varjacic-Kmoch	Yugoslavia	5 : 14·8	0		O/D
22	Marcelli-Fabbri	Italy	5 : 15·3	5 : 16·5		Super Tigre G.20D
23	Aarnipalo-Jarvi	Finland	5 : 18·0	5 : 36·4		Eta 15 II
24	Fischer-Meusburger	Austria	5 : 18·3	7 : 20·8		Oliver Tiger

25	Fischer-Frigyes	Hungary	5 : 24·9	0	Moki—TR6
26	Brandt-Soule	U.S.A.	5 : 26·9	0	Eta 15 II
27	Hartinger-Neckar	Czechoslovakia	0	5 : 28·8	M.V.V.S.%TR
28	Zube-Willberg	E. Germany	5 : 31·0	0	Oliver Tiger
29	I. Lultchev-L. Lulchev	Bulgaria	5 : 34·7	0	Super Tigre G.20D
30	Kroff-Russ	Austria	5 : 35·0	0	Oliver Tiger
31	D. Lutkat-H. Lutkat	W. Germany	5 : 35·7	0	Oliver Tiger
32	Ivanek-Spoljaric	Yugoslavia	5 : 37·5	0	Oliver Tiger/Eta 15 II
33	Meyer-Saser	Sweden	6 : 41·2	5 : 41·1	Oliver Tiger
34	P. Hasling-O. Hasling	Denmark	5 : 55·7	5 : 47·0	Super Tigre G.20D & Oliver Tiger
35	Tomaszewski-Rachwal	Poland	6 : 25·1	5 : 59·0	M.V.V.S.-TR
36	Pinotti-Hagel	Sweden	6 : 00·5	0	Super Tigre G.20D
37	Martense-Koningshoven	Holland	7 : 54·9	6 : 01·3	Eta 15 II
38	Wilke-Wolf	E. Germany	0	6 : 01·8	Moki TR 6
39	H. Kominek-R. Kominek	Austria	0	6 : 05·4	Bugl.
40	Kacibo-Kacanski	Yugoslavia	7 : 07·6	6 : 10·0	Oliver Tiger
41	Mainhardt-L. Jentsch	E. Germany	6 : 25·2	6 : 15·3	Moki TR 6
42	Svensson- Geschwendtner	Denmark	0	6 : 17·2	Oliver Tiger & Eta15
43	Vlaitvhev-Vaszilev	Bulgaria	6 : 24·0	7 : 07·6	Super Tigre G.20D
44	Pudelko-B. Sawe	Poland	6 : 37·0	6 : 26·5	Eta 15 II
45	B. Bador-D. Bador	France	6 : 27·5	6 : 30·4	Micron 15D
46	Nenin-Creola	Belgium	0	6 : 28·0	Oliver Tiger
47	Patriarche-Challe	Belgium	0	6 : 53·2	Eta 15 II
48	Vanderryken-Vanderbeke	Belgium	6 : 53·6	0	Super Tigre G.20D
49	Gurtler-Klemm	Czechoslovakia	0	7 : 05·3	M.V.V.S. TR
50	Ehlers-Jensen	Denmark	7 : 26·2	0	Super Tigre G.20D

Four others did not complete a race.

STUNT

						Total	
1	J. Sirotkin	U.S.S.R.	1,049·3	1,052·3	876	2,101·6	M.V.V.S. 5·6
2	J. Kari	Finland	988	1,018·0	1,053·0	2,071·0	Veco ·35
3	R. Gialdini	U.S.A.	975	1,003·6	1,024·3	2,027·9	Merco ·35
4	G. Egervary	Hungary	970	996·6	1,023·3	2,019·9	Veco ·35
5	J. Gabris	Czechoslovakia	986·6	901	1,031·3	2,017·9	M.V.V.S. 5·6
6	L. McFarland	U.S.A.	1,020·6	976·6	975	1,997·2	K. & B. ·45
7	L. Van Den Hout	Holland	994·0	982	990·6	1,984·6	Veco ·45
8	G. Masznyik	Hungary	963·0	960	1,003·0	1,966·0	Moki ·35
9	R. Gieseke	U.S.A.	965·3	963	989·6	1,954·9	Fox ·35
10	H. Sviatkin	U.S.S.R.	838	976·3	960·0	1,936·3	O/D
11	E. Kondratenko	U.S.S.R.	991·3	943	943·3	1,934·6	O/D
12	H. Turk	Austria	909	975·0	941·6	1,916·6	Fox ·35
13	J. Trnka	Czechoslovakia	944·3	951·6	915	1,895·9	M.V.V.S. 5·6
14	T. Vellai	Hungary	848	938·3	954·0	1,892·3	Moki ·35
15	K. Seeger	W. Germany	954·0	936·6	935	1,890·6	Fox ·35
16	J. Bartos	Czechoslovakia	927	930·0	960·6	1,890·6	M.V.V.S. 5·6
17	J. Bonnet	France	815	913·3	926·3	1,857·6	Fox ·35
18	P. Pattiala	Finland	898	948·6	902·0	1,850·6	Veco ·35
19	O. Sundell	Finland	880	942·3	907·6	1,849·9	Merco ·35
20	A. Kaminski	W. Germany	847	919·6	902·3	1,821·9	Fox ·35

Mr. Sugar, official of the Hungarian Aero Club congratulates Juri Sirotkin (U.S.S.R.) on gaining the World Championship in C/L Aerobatics. Yugoslav and U.S.S.R. onlookers admire the fine black and white finish on "Spacehound"—which is available through APS as plan CL 846 price 10s. Engine is an M.V.V.S. 35.

For the remainder only better two scores are shown

21	G. Sbragia ...	... Italy ...	... 908·0	908·0	1,816·0	Fox ·35
22	E. Mothwurf	... Austria ...	... 923·3	885·3	1,808·6	O.S. ·35
23	H. Hedinger	... Switzerland	... 896·0	904·0	1,800·0	Fox ·35
24	W. Bagalini ...	... Italy ...	... 896·3	903·3	1,799·6	Super Tigre ·35
25	M. Souliac ...	... France ...	... 906·6	884·3	1,790·9	Fox ·35
26	A. Svenson ...	... Denmark	... 865·0	916·6	1,781·6	Merco ·35 & O.S. ·35
27	P. Tupker ...	... Holland ...	... 862·0	872·3	1,734·3	Fox ·35
28	K. Stover ...	... W. Germany	... 861·6	867·6	1,729·2	Fox ·35
29	M. Vanderbeke	... Belgium ...	... 923·3	804·0	1,727·1	Veco ·35
30	M. Fricke ...	... E. Germany	... 844·0	873·3	1,717·3	M.V.V.S. 5·6
31	R. Lauron ...	... France ...	... 851·6	843·3	1,694·9	Veco ·35
32	J. Bredenhoff	... Holland ...	... 819·6	856·0	1,675·6	O.S. Max ·35
33	W. Goulbier...	... E. Germany	... 808·3	726·3	1,534·6	Enya ·35
34	S. Marinov ...	... Bulgaria ...	... 741·6	779·3	1,520·9	Fox ·35
35	Kazmierowski	... Poland ...	... 781·3	728·0	1,509·3	Fox ·35
36	Kaiser ...	... Austria ...	... 719·6	734·3	1,456·9	Fox 35
37	Kujawa ...	... Poland ...	... 712·3	733·0	1,445·3	Fox ·35
38	A. Milanov ...	... Bulgaria ...	... 730·0	664·0	1,394·0	Fox ·35
39	Salanthë ...	... Switzerland	... 732·6	660·0	1,392·6	Fox ·35
40	Jankov ...	... Bulgaria ...	... 616·6	758·0	1,374·6	McCoy ·35
41	P. Cohen ...	... Belgium ...	... 675·6	647·0	1,322·6	Fox ·35
42	Buisch ...	... E. Germany	... 608·6	688·6	1,297·2	Enya ·35
43	G. Golignon	... Belgium ...	... 539·6	590·0	1,129·6	Fox ·35
44	C. Söderberg	... Sweden ...	... 442·0	—	442·0	Merco ·29

SPEED (M.P.H.)

1	W. Wisniewski	... U.S.A. ...	... 138·0	—	141·1	K. & B. ·15 RS
2	G. Krizsma	... Hungary ...	... 135·5	131·1	139·8	Koki S—3
3	G. Lee ...	... U.S.A. ...	... 138·6	138·6	138·9	K. & B. ·15 RS
4	J. Sladky ...	... Czechoslovakia	... 138·6	138·0	—	M.V.V.S. 2·5 R.L.
5	W. Carpenter	... U.S.A. ...	... 136·1	136·7	—	K. & B. ·15 RS and Super Tigre G.15
6	I. Toth ...	... Hungary ...	... 126·8	133·0	136·7	Moki S—3
7	E. Mosyakov	... U.S.S.R....	... —	136·1	134·2	Super Tigre G.20/15G
8	M. Sebestyen	... Hungary ...	... 129·3	136·1	134·2	Moki S—3
9	A. Prati ...	... Italy ...	... —	135·5	—	Super Tigre G.15
10	J. Magne ...	... France ...	... 132·4	133·4	—	Super Tigre G.20/15G
11	G. Ricci ...	... Italy ...	... 125·5	133·6	133·6	Super Tigre G.15
12	R. Meibach	... W. Germany	... 129·3	133·0	127·4	Super Tigre G.20/15G
13	N. Turkin ...	... U.S.S.R....	... 128·0	—	133·0	Start
14	Z. Pech ...	... Czechoslovakia	... 130·5	128·0	126·8	M.V.V.S. 2·5 R.L.
15	H. Freundt	... Austria ...	... 130·5	—	—	Bugl. 2·5G
16	A. Malik ...	... W. Germany	... 121·5	129·3	126·8	Super Tigre G.20/15G
17	J. Valo ...	... Finland ...	... 118·7	129·3	—	Super Tigre G.20/15G
18	P. Natalenko	... U.S.S.R....	... 126·8	128·0	—	Start
19	R. Grandesso	... Italy ...	... —	—	128·0	Super Tigre G.15
20	R. Dolejs ...	... Czechoslovakia	... —	126·8	109·4	M.V.V.S. 2·5 R.L.
21	R. Ekholm	... Finland ...	... 124·3	114·3	125·5	Super Tigre G.20/15G
22	J. Frohlich	... W. Germany	... —	125·5	124·3	Super Tigre G.20/15G
23	**K. Lindsey**	... **Great Britain**	... 121·8	—	124·9	Super Tigre G.15
24	E. Purice ...	... Rumania ...	... 119·3	124·9	—	Super Tigre G.20/15G
25	A. Rachwal	... Poland ...	... 118·7	—	124·3	Super Tigre G.20/15G
26	D. Ehlers ...	... Denmark	... 118·1	111·9	122·4	Super Tigre G.20/15G
27	**R. McGladdery**	... **Great Britain**	... 113·2	114·3	122·4	Super Tigre G.15
28	S. Purice ...	... Rumania ...	... —	122·4	118·7	Super Tigre G.20/15G
29	O. Kjellberg	... Sweden ...	... —	—	122·4	Hybrid (K. & B.—S/T—Cox)
30	M. Polster ...	... E. Germany	... 121·1	—	81·4	O/D
31	J. Verbaere	... France ...	... —	121·2	120·6	Super Tigre G.20 (Mod)
32	K. Raschkov	... Bulgaria ...	... —	113·71	121·2	Super Tigre G.20/15G
33	K. Jensen ...	... Denmark	... —	—	118·7	Super Tigre G.20/15G
34	R. Desloges	... France ...	... —	115·0	—	O/D
35	H. Fieldler...	... E. Germany	... 112·5	108·7	107·5	Super Tigre G.20/15G
36	K. Heinsius	... Holland ...	... —	103·2	111·9	Super Tigre G.15
37	I. Vassilev ...	... Bulgaria ...	... —	—	111·9	Super Tigre G.20/15G
38	**B. Jackson**	... **Great Britain**	... —	—	111·9	Super Tigre G.20/15G
39	L. Meinhardt	... E. Germany	... —	105·6	107·5	Moki
40	S. Skotneczny	... Poland ...	... —	103·2	—	M.V.V.S.
41	G. Tinev ...	... Bulgaria ...	... 100·7	—	—	Super Tigre G. 20/15G
42	O. Piwko ...	... Poland ...	... —	—	90·1	M.V.V.S.
43	N. Gluysen	... Belgium ...	... —	80·8	—	Super Tigre G.15
44	G. Golingnon	... Belgium ...	... —	64·7	—	K. & B ·15 R

Five others did not complete the flight.

K & B engine development engineer, Bill Wisniewski and his 1964 "Pink Lady"—World Championship winning speed model at 141.1 m.p.h. Model is beautifully finished in a delicate shade of pink, and has (naturally) a K & B 15RS series 64 engine modified with Boost port and known as the "Wart".

Team Positions—TEAM RACING

1	U.S.S.R.	14 : 21	8	Austria	16 : 58
2	**Great Britain**	14 : 30	9	Yugoslavia	17 : 01
3	Finland	15 : 11	10	Bulgaria	17 : 08
4	W. Germany	15 : 21	11	E. Germany	17 : 47
5	Hungary	15 : 26	12	Denmark	19 : 30
6	Sweden	15 : 50	13	Belgium	20 : 14
7	Czechoslovakia	16 : 56			

Team Positions—STUNT

1	U.S.A.	5,980	9	Austria	5,182·1
2	U.S.S.R.	5,972	10	E. Germany	4,549·1
3	Hungary	5,878·2	11	Bulgaria	4,289·5
4	Czechoslovakia	5,804·4	12	Belgium	4,179·5
5	Finland	5,771·5	13	Italy	3,615·6
6	W. Germany	5,441·7	14	Switzerland	3,192·6
7	Holland	5,394·5	15	Poland	2,954·6
8	France	5,343·4			

Team Positions—SPEED

1	U.S.A.	416·3	10	Bulgaria	339·9
2	Hungary	412·6	11	Poland	317·5
3	U.S.S.R.	397·1	12	Finland	254·8
4	Italy	397·1	13	Rumania	247·3
5	Czechoslovakia	395·8	14	Denmark	241·1
6	W. Germany	387·7	15	Belgium	145·4
7	France	369·7	16	Austria	130·5
8	**Great Britain**	359·2	17	Sweden	122·4
9	E. Germany	341·8	18	Holland	111·9

Scale B-17 bomber was an ambitious project by Bristol R/C M.A.C. members, Norris, Harrison and Alexander. 1/12th scale it has two K & B engines and two dummy propellers. Decorated in "The Body" marking after the War Lover film

CONTEST RESULTS

Results of most S.M.A.E. Contests for balance of 1964 season are included in this report to complete records. Those 1965 events which have been decided before going to press are also included and will be completed in next year's AEROMODELLER ANNUAL.

SCOTTISH GALA—June 21st, 1964—R.N.A.S. Abbotsinch.

Rubber		
1 R. Firth	Sheffield S.A.	9 : 00
2 H. Tubbs	Baildon	8 : 52
3 J. O'Donnell	Whitefield	8 : 41
Glider		
1 R. Godden	Cambridge	9 : 00
2 D. Wiseman	York	8 : 34
3 R. Firth	Sheffield S.A.	7 : 30
Power		
1 D. Wiseman	York	7 : 45
2 W. Lee	Tees-side	7 : 43
3 J. Moseley	Baildon	7 : 27
Combat		
1 I. G. Coutts	Larkhall Orbiters	
2 Scurfield	Tynemouth	
½A T/R		
1 S. Boyd	Forfar	9 : 38
2 G. Low	Forfar	10 : 10
3 A. McIntyre	Glasgow Hornets	13 : 32
F.A.I. T/R		
1 J. Reid	Dumbarton	9 : 39
2 F. Hampson	Leigh	11 : 37
3 K. Crozier	Hamilton	118 laps
B.T/R		
1 Yates/Hampson	Leigh	7 : 06
2 D. Gordon	Glasgow Hornets	8 : 00
3 Lorimer	T.R.E.O.	9 : 43

AEROMODELLER TROPHY—Multi R/C—July 26th, 1964—*Centralised.*

	Round 1	Round 2	Total
1 C. Olsen	1644	1666	3310
2 S. Foster	1594	1682	3276
3 G. Franklin	1317	1431	2740
4 J. Wingate	1342	1239	2581
5 G. Ford	1168	1110	2278
6 J. Bickerstaffe	1088	1136	2224

NORTHERN GALA—September 6th, 1964—R.A.F. Church Fenton.

Caton Trophy—Rubber		
1 H. Tubbs	Baildon	9 : 00+7 : 38
2 B. Picken	Wigan	9 : 00+6 : 11
3 T. Stoker	Baildon	9 : 00+6 : 00
Hamley Trophy—Power		
1 J. O'Donnell	Whitefield	9 : 00+3 : 50
2 T. Stoker	Baildon	9 : 00+3 : 19
3 Illsley	Lincoln	9 : 00+0 : 15
C.M.A. Cup—Open Glider		
1 C. Morris	St. Albans	9 : 00+3 : 12
2 A. Young	St. Albans	9 : 00+3 : 10
3 J. O'Donnell	Whitefield	9 : 00+2 : 20
PAA Load		
1 D. Hipperson	Croydon	9 : 00
2 R. Stott	Baildon	7 : 00
3 J. Rowley	Tynemouth	3 : 25
Radio Control		
1 S. Foster	Lincoln	3,870
2 J. Bickerstaffe	Rugby	3,120
3 Strafford	—	2,815
Budapest Trophy—½A T/R		
1 Balch/Cooper	Feltham/Hayes	8 : 42·4
2 A. Dell	Feltham/Hayes	9 : 28·2
3 Long/Davy	Wharfedale	9 : 43·6
Wharfedale Trophy—F.A.I. T/R		
1 Long/Davy	Wharfedale	9 : 49·9

2 Place/Haworth	Wharfedale	9 : 54·0
3 Nixon/Ellis	Hinkley	12 : 20

Eta Trophy—B T/R

1 Dugmore/Bell	Novocastria	6 : 27·3
2 Yates/Hampson	Leigh	6 : 56·9
3 Hardcastle/Skitt	Wolves	8 : 18·6

Combat

1 D. Balch	Feltham/Hayes
2 L. Scurfield	Tynemouth

Stunt

1 D. Day	Wolves	1,141
2 T. Jolley	Kidderminster	1,129
3 H. Dowbekin	Horwich	1,029

RUSH TROPHY GALA—September 13th, 1964—R.A.F. Ouston

F.A.I. T/R

1 Place/Haworth	Wharfedale	9 : 49·5
2 Nixon/Ellis	Hinkley	10 : 41
3 Turner/Humphrey	Wharfedale	

Class B T/R

1 Yates/Hampson	Leigh	7 : 39
2 J. Horton	Wharfedale	8 : 30·9
3 Place/Haworth	Wharfedale	10 : 45

Combat

1 L. Scurfield	Tynemouth
2 T. Lee	Wharfedale

Multi R/C

1 P. Wilson	Jesmond
2 P. Huntley	—

Power

1 T. Stoker	Baildon	9 : 00
2 D. Wiseman	York	8 : 53
3 D. White	York	8 : 10

Rubber

1 D. Wiseman	York	9 : 00+4 : 05
2 T. Stoker	Baildon	9 : 00+3 : 48
3 R. Pollard	Tynemouth	9 : 00+3 : 23

Glider

1 D. White	York	8 : 14
2 R. Swinden	Tees-side	6 : 44+2 : 40
3 G. Abbott	York	6 : 44+2 : 23

KEIL TROPHY—Open Team Power—October 18th, 1964 (*Area Centralised*)

1 York	36 : 00+14 : 55
2 Wallasey "A"	35 : 27
3 Croydon	35 : 25

FARROW SHIELD—Open Team Rubber—October 18th, 1964 (*Area Centralised*).

1 York	36 : 00+18 : 39
2 Tynemouth	36 : 00+13 : 56
3 Birmingham	35 : 21

Nats Rubber winner Brian Day (Walsall) holding smart yellow tissue covered open model. Made 7:09 in the 22 man fly off.

NORTHERN AREA F.A.I. RALLY—October 25th, 1964 (*Centralised*).

Rivers Trophy—F.A.I. Team Race

1 Laurie/Wallace	Novocastria	4 : 50
2 Long/Davy	Wharfedale	5 : 10·3
3 Turner/Humphrey	Wharfedale	5 : 21·3

Sheffield Shield—Control Line Stunt

1 G. Higgs	Norwich	1072	1137
2 T. Jolley	Kidderminster	1060	1132
3 H. Dowbekin	Norwich	998	1045

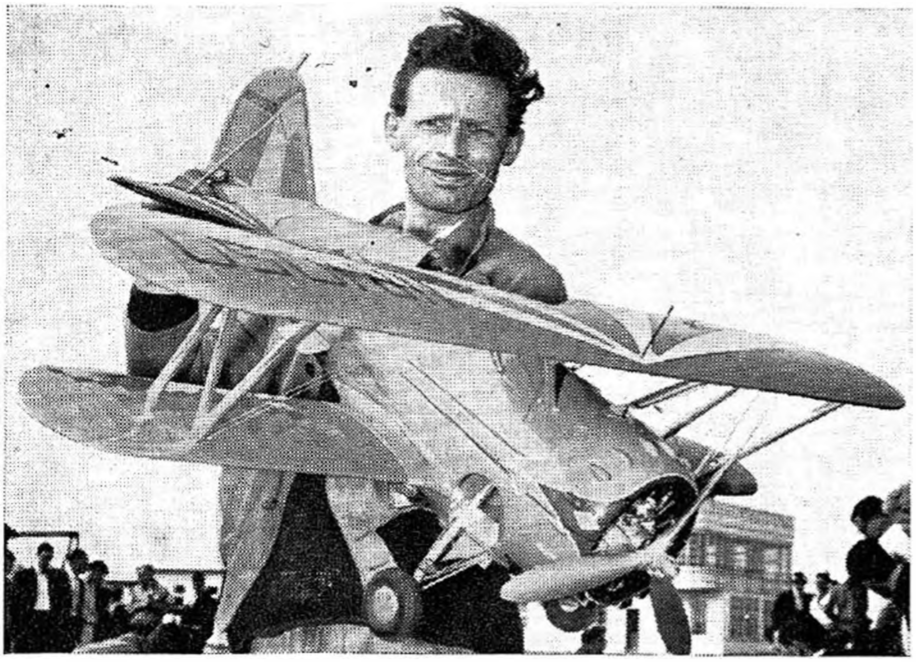
Combat

1 R. Hillyard	Wharfedale
2 A. Kelly	Tynemouth
3 L. Scurfield	Tynemouth

GUTTERIDGE TROPHY—F.A.I. Rubber—November 1st, 1964 (*Area Centralised*)

1 J. Shaw	Sheffield S.A.	15 : 00+3 : 30 +2 : 40
2 J. O'Donnell	Whitefield	14 : 56
3 F. Boxall	Brighton	14 : 53

Nats Control Line scale winner Tony Day (Handsworth) with his 1/6th scale Beagle Airedale, has Super Tigre 46, servo actuated brakes, and Roberts Flight Control on Flaps, Throttle Lights and Elevator, also detailed interior.



Pete Ball's (Wanstead W'H'K's) magnificent Nats 2nd place control line scale Grumman Gulfhawk with sprung U/C opening luggage hatch, sliding cockpit canopy and scale dummy engine to match the silver foil covered three blade propeller. A Merco 49 R/C lifted and flew this 5½ lb. orange white and blue beauty.

HALFAX TROPHY—F.A.I. Power—November 1st, 1964 (*Area Centralised*).

1 S. Savini	Wallasey	15 : 00
2 A. Anderton	Norwich	15 : 00
3 G. French	Essex	15 : 00

QUICKSTART TROPHY—½A Power—November 1st, 1964 (*Area Centralised*)

1 A. Young	St. Albans	9 : 00+4 : 10
2 M. Brown	Maidenhead	9 : 00+2 : 57
3 A. Moss	Whitefield	9 : 00

S.M.A.E. CUP—A2 Glider—November 1st, 1964 (*Area Centralised*).

1 J. Baguley	Hayes	15 : 00+2 : 14
2 E. Drew	Bristol & West	14 : 49
3 D. Tipper	St. Albans	14 : 25

1964 SENIOR CHAMPIONSHIP F/F

1 R. Godden	Cambridge	319 mins.	45 secs.
2 D. Wiseman	York	317 mins.	17 secs.
3 J. O'Donnell	Whitefield	307 mins.	33 secs.

PLUGGE CUP (*Area Centralised*).

1 York	1438·3
2 Whitefield	1356·6
3 St. Albans	1335·6

CONTROL LINE TEAM TRIALS FOR INTERNATIONAL CRITERIUM OF ACES, BELGIUM—(Hemswell May 23rd *Centralised*)

Team Racing		
Place/Haworth	Wharfedale	5 : 1·6
Dell/Balch	Feltham/Hayes	5 : 5·0
Turner/Hughes	Wharfedale	5 : 6·0
Speed		
K. Lindsey	Hayes	124·3 m.p.h.
R. McGladdery	Hayes	121·1 m.p.h.
B. Jackson	Worksop	119·0 m.p.h.
Combat		
B. Bumstead	Northwood	
P. Smith	Outlaws	
M. Davies	Outlaws	
Stunt		
M. Reeves	West Essex	676
J. Mannall	Lincoln	1008

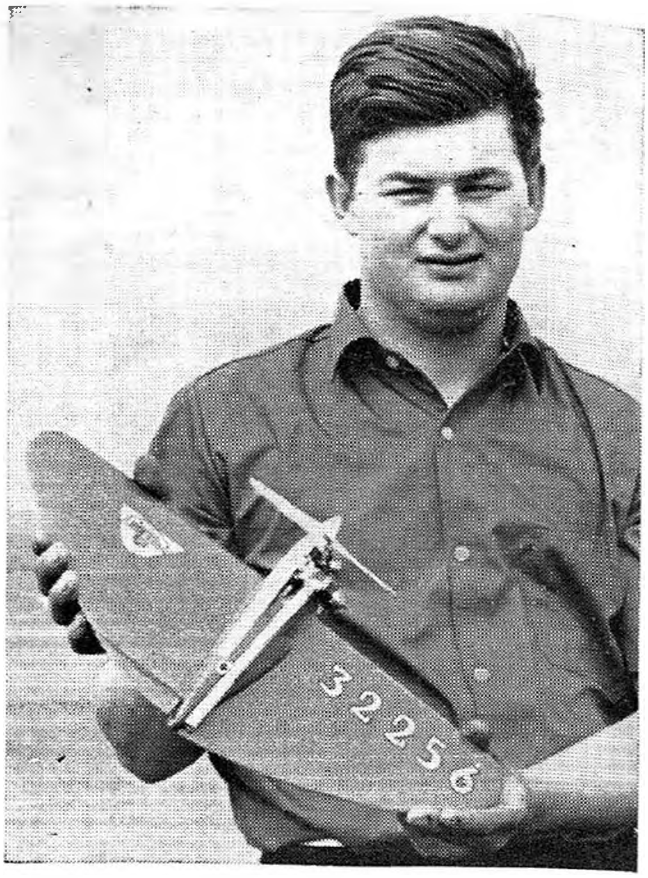
Team Manager Kevin Lindsey (Hayes)

FREE FLIGHT TEAM TRIALS FOR WORLD CHAMPIONSHIPS AT KAUHAVA, FINLAND—(Hemswell Sept. 19-20th, Oct. 10-11th 1964 *Centralised*)

Wakefield		1st Trial	2nd Trial	Total
1 G. Lefever	Norwich	13:14	14:25	27:39
2 B. Rowe	St. Albans	12:25	15:00	27:25
3 D. Morley	Lincoln	14:01	13:21	27:22
4 A. Armes	Hayes	12:37	14:19	26:56
5 J. O'Donnell	Whitefield	11:46	15:00	26:46
6 R. Godden	Cambridge	12:42	13:57	26:39
Glider				
1 D. Tipper	St. Albans	14:21	13:16	27:37
2 A. Young	St. Albans	10:54	14:09	25:03
3 J. O'Donnell	Whitefield	10:53	13:46	24:39
4 A. Wisher	Croydon	11:57	12:10	24:07

John West (Brighton) power winner with this Super Tigre G.15 powered modified Dixilander, originally designed by George Fuller. Made 3:50 in the man fly off.

Bill Bessant (Southampton) winner of Nats all-in speed with his Cox TD.09 unconventional all wing model. Note the tuned length silencer, model made 98:6 m.p.h.



5 R. Godden	Cambridge	11:06	12:20	23:26
6 E. Black	Scotmac	9:30	13:37	23:07
Power				
1 J. Savini	Wallasey	13:46	14:58	28:44
2 M. Gaster	Surbiton	12:47	14:51	27:38
3 P. Manville	Bournemouth	12:46	14:51	27:37
4 D. Posner	Surbiton	12:33	14:32	27:05
5 G. French	Essex	11:34	15:00	26:34
6 D. Wiseman	York	11:40	14:16	25:56

Radio Control (Second Trials)

	1st	2nd	3rd	Best 2 Flts.
1 S. Foster Lincoln	1505·0	1684·5	1814·0	3498·5
2 C. Olsen C/M	1654·0	1707·5	1694·5	3402·0
3 F. v. d. Bergh Bromley	227·5	1709·0	1661·5	3370·5
4 P. T. Waters South Wales	1707·0	1471·0	1634·5	3341·5
5 G. Pike Nottingham	1219·0	1469·0	1490·0	2959·0

FROG SENIOR CUP—Open Power—March 21st, 1965 (*Area Centralised*).

1 V. Taylor	St. Albans	9 : 00+2 : 15
2 G. Cornell	Croydon	9 : 00+1 : 53
3 J. Bailey	Bristol & West	8 : 36

K. & M.A.A. CUP—F.A.I. Glider—March 21st, 1965 (*Area Centralised*).

1 J. Baguley	Hayes	15 : 00+2 : 19
2 R. Salmon	York	15 : 00+2 : 08
3 P. Newall	Surbiton	15 : 00+1 : 22

GAMAGE CUP—Open Rubber—April 11th, 1965 (*Area Centralised*).

1 R. Paveley	Hornchurch	7 : 44
2 C. King	Cambridge	7 : 15
3 A. Wells	Hornchurch	6 : 46

PILCHER CUP—Open Glider—April 11th, 1965 (*Area Centralised*).

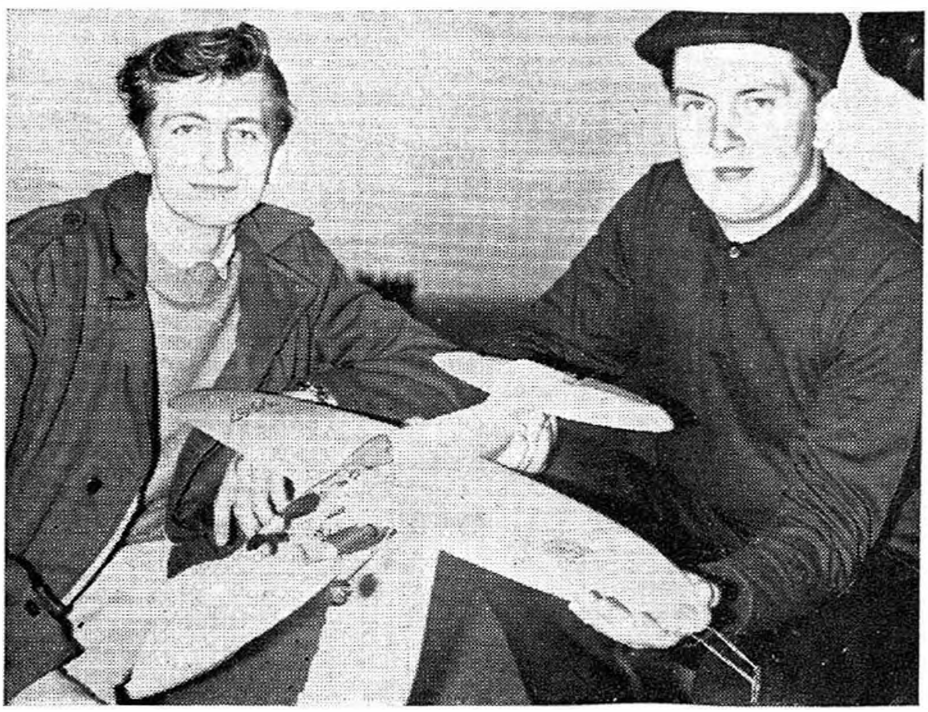
1 J. Bailey	Bristol & West	6 : 45
2 M. Bayram	Lincoln	6 : 30
3 M. Dilly	Croydon	6 : 15

C/L CONTEST—April 11th, 1965, Hayes

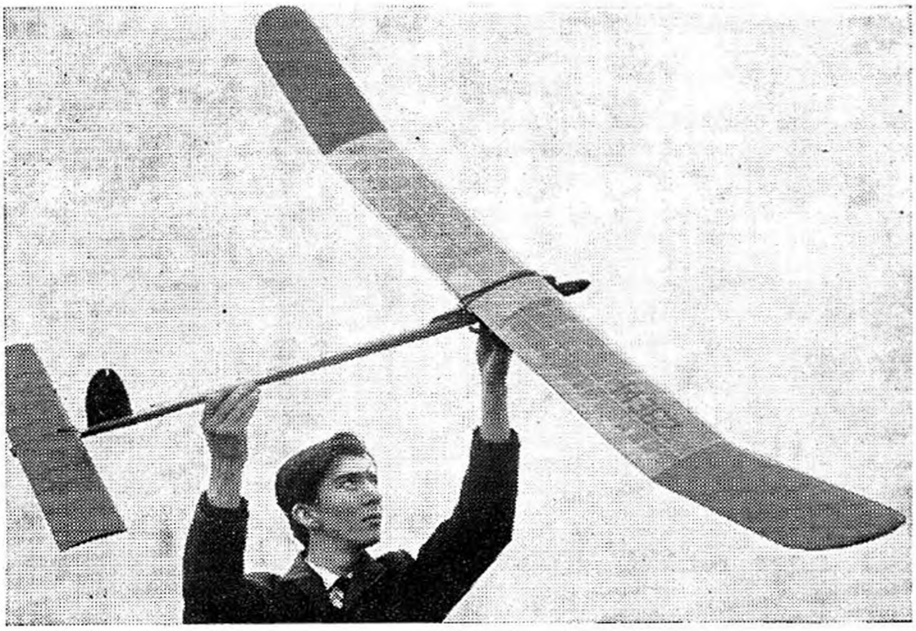
Class 1—Speed		
1 I. W. Bessant	Southampton	92·8 m.p.h.
Class 2—Speed		
1 B. Jackson	Worksop	107·1 m.p.h.
Class 4—Speed		
1 J. Hall	West Essex	136·4 m.p.h.
Class 5—Speed		
1 I. Roffey	Brixton	94·4 m.p.h.

F.A.I. Team Racing

1 Allen/Bedford	Wanstead W'H'Ks	11 : 46
2 Hutchinson/Peake	Feltham	12 : 25
3 Gillhespey/Goddard	St. Albans	12 : 42



Nats F.A.I. Team Race winners Peart / Kirton (Novocastria). Oliver Tiger powered low aspect ratio and metal engine mounting pan. A home made double sided silencer was used.



Nats Glider winner Wilf Trotter (N. Kent Nomads) displays his short nosed model with steeply cambered wing section and drooped trailing edge.

F.A.I. Combat

1	R. Sibbald	Sidcup
2	R. Wilkens	Sidcup

NORTH WESTERN AREA EASTER MEETING—April 18th-19th, 1965—R.A.F. Ternhill.

Open Glider—99 *entries*

1	D. Coffin	Southampton	4 : 37
2	K. Smith	Croydon	3 : 47
3	D. Wiseman	York	2 : 59

Open Rubber—48 *entries*

1	G. Tideswell	Baildon	9 : 00
2	J. O'Donnell	Whitefield	8 : 47
3	H. Tubbs	Baildon	7 : 15

Open Power—56 *entries*

1	P. Manville	Bournemouth	9 : 00
2	D. Miller	Cambridge	7 : 19
3	S. Savini	Wallasey	6 : 31

½APower—24 *entries*

1	D. Wiseman	York	5 : 52
2	G. Head	Lee Bees	5 : 47
3	M. Brown	Maidenhead	5 : 02

Tailless—12 *entries*

1	J. Pool	York	1 : 32
2	G. Tideswell	Baildon	0 : 59

Combined F.A.I.—54 *entries*

1	H. Tubbs	Baildon	6 : 32
2	S. Savini	Wallasey	6 : 16
3	D. Coffin	Southampton	3 : 47

½A Team Racing—30 *entries*

1	Turner/Nixon	Wharfedale
2	Dell/Balch	Feltham
3	Neal	Hatfield

F.A.I. Team Racing—34 *entries*

1	Turner/Davy	Wharfedale	11 : 12
2	Franklin/Ives	Wanstead W'H'Ks	11 : 37
3	Nixon/Ellis	Hinckley	13 : 40

B Team Racing—15 *entries*

1	Yates/Hampson	Leigh	8 : 13·5
2	Laurie/Wallace	Novocastria	9 : 57·2
3	Skitt/Hardcastle	Wolves	10 : 03·2

Combat—91 *entries*

1	S. Holland	Northwood
2	B. Bumstead	Northwood
3	J. Downey	Worthing

C/L Stunt—17 *entries*

1	H.Dowbekin	Horwich	1040
2	D. Day	Wolves	828
3	M. Mayne	Fareham	632

C/L Scale—2 *entries*

1	S. Perry	Wolves	432
2	A. C. Day	Birmingham	430·5

Free Style R/C—15 *entries*

1	B. Deniel	Doncaster	102
2	B. Purslow	LARCAS	92
3	A. Thomas	Sutton Coldfield	92

Multi F.A.I. R/C—17 *entries*

1	E. Johnson	CM	1529
2	B. Purslow	LARCAS	1400

ALL SCALE MEETING—May 9th, 1965—R.A.F. Hemswell.

Super Scale Trophy—Free Flight

				Pts.
1	D. Clements	Maidenhead	Fokker Spinne	415
2	D. McHard	C/M	Dixon Nipper	411
3	T. Manley	Blackburn Aircraft	F2B	405

Control Line

				Pts.
1	B. Ball	Wanstead W'H'Ks	Curtiss P6c	460
2	S. Perry	Wolves	Hawker Henley	410
3	A. Day	Handsworth	Fokker D.7	375

FARROW SHIELD—Open Team Rubber—May 16th, 1965 (*Area Centralised*).

1	Baildon "A"	36+23·33
2	Tynemouth	36+15·22
3	York	35·48

WHITE CUP—Open Power—May 16th, 1965 (*Area Centralised*).

1	Payne	Northampton	9 : 00+3 : 36
2	Doncaster	Baildon	9 : 00+2 : 48
3	Wannup	Wallasey	8 : 50

FROG JUNIOR CUP—Open Rubber/Glider—May 16th, 1965 (*Area Centralised*).

1	Brown	Northampton
2	Whitehead	York
3	Sunderland	Thirsk

BRITISH NATIONAL CHAMPIONSHIPS—June 6th-7th, 1965—R.A.F. Ouston

C/L Speed—All classes

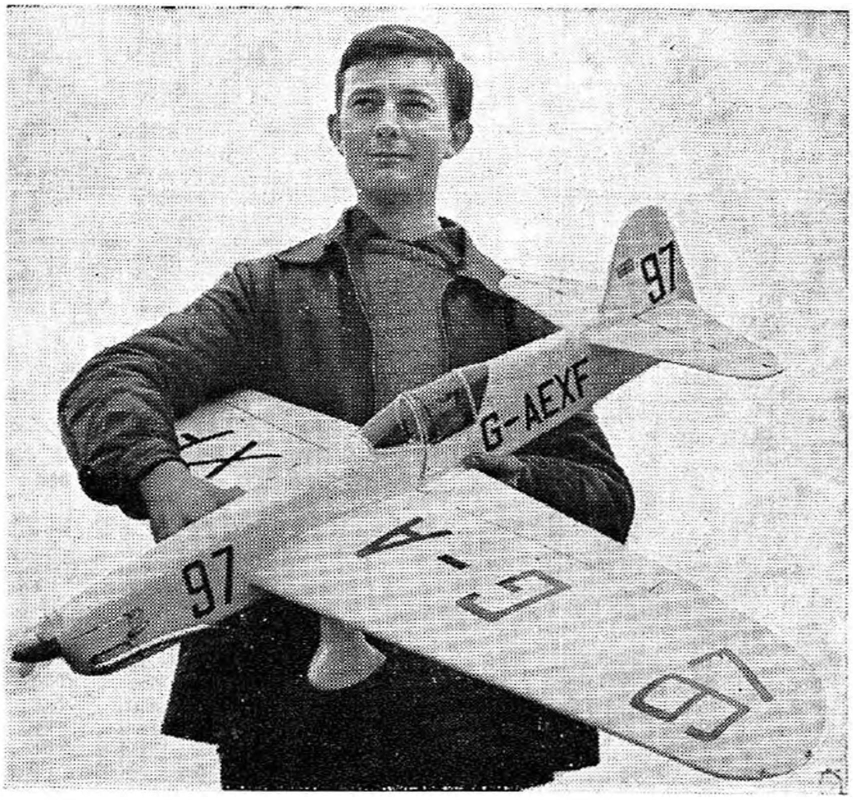
		Handicap %	m.p.h.	class
1	W. Bessant, Southampton	100	98 : 6	1·5 c.c.
2	R. Gould, R.A.F.M.A.A.	83	128 : 5	5 c.c.
3	G. Head, Lee Bees	82	81 : 6	1·5 c.c.
5	I. Roffey, Brixton	79	131 : 6	5 c.c.

Women's Cup—Open R/G/P

1	S. Horton	Crawley	8 : 35
2	G. Stott	BAC Warton	8 : 28
3	K. Allen	Brighton	7 : 52

Thurston Cup—Open Glider

1	W. Trotter	Nomads	9 : 00+3 : 62
2	G. Martin	W. Coventry	9 : 00+2 : 23
3	U. Wannup	Wallasey	9 : 00+2 : 25



Semi scale Mew Gull stunter by Mick Reeves (West Essex) was an exceptional example nice scale lines. Fox 35 powered with home made silencer. Fully detailed cockpit includes a pilot.

R.A.F.M.A.A. Trophy—$\frac{1}{2}$A Team Race

		Heat	Final
1 B. Turner	Wharfedale	4 : 43	9 : 06
2 L. Davy	Wharfedale	4 : 43	9 : 13
3 A. Jackson	Feltham	4 : 44	—

S.M.A.E. Trophy—Multi Control R/C

	1	2	Total
1 G. Foster	1573	1765	3338
2 F. Knowles	1462	1782	3244
3 D. Read	1476	1603	3079

Houlberg Trophies—for Individual Champions

Senior		Pts.
1 D. Wiseman	York	192
2 G. Head	Lee Bees	178
3 D. White	York	173
Junior		
1 K. Taylor	E. Grinstead	34
2 C. Tippler	Leicester	16

Combat

1 D. Sizmur	Northwood
2 N. Tidey	Worthing
3 M. Morris	Northwood

R/C Scale

	Flight	Scale and W'm'ship	Total
1 D. Thumpston CM DH9	299	361	660
2 D. Bryant Bromley Miles Satyr	198$\frac{3}{4}$	307	505$\frac{3}{4}$
3 A. Lalley Bromley Corsair F4U	220$\frac{1}{2}$	283	503$\frac{1}{2}$

Gold Trophy—C/L Aerobatics

		Pts.
1 G. Higgs	Horwich	1047
2 T. Jolley	Redditch	938
3 M. Dowbekin	Horwich	916

Sir John Shelley Cup—Open Power

		Fly-off times
1 J. West	Brighton	9 : 00 + 3 : 50
2 D. Posner	Surbiton	9 : 00 + 2 : 35
3 M. Green	Lincoln	9 : 00 + 2 : 22

Davies "A" Trophy—F.A.I. Team Race

		Final
1 Peart/Kirton	Novocastria	11 : 02
2 Turner/Hughes	Wharfedale	11 : 04
3 Balch/Dell	Feltham/Hayes	11 : 09

Knokke No. 2 Trophy—C/L Scale

		1	2	Total
1 A. J. Day Auster-Beagle	Handsworth Airedale	71	437	508
2 B. P. Ball Grumman Gulfhawk	Wanstead	89	401	490
3 D. W. Nelson Matra-Moynet Jupiter	Derby C'Liners	110	280	396

F.A.I. GALA—July 4th, 1965—R.A.F. Hemswell

Halfax Trophy—Power

1 R. Monks	Birmingham	13 : 37
2 J. West	Brighton	12 : 46
3 R. Baggott	Birmingham	11 : 43

S.M.A.E. Cup—Glider

1 G. Skinner	Cambridge	14 : 30
2 A. Wisher	Croydon	14 : 10
3 A. Wells	Hornchurch	14 : 06

Gutteridge Trophy—Wakefield

1 L. Barr	Hayes	13 : 42
2 D. Hipperson	Croydon	13 : 17
3 J. Allan	Brighton	11 : 57

F.A.I. Team Race

1 Turner/Hughes	Wharfedale	4 : 54	11 : 18
2 Allan/Bedford	Wanstead	5 : 06	11 : 58
3 Green/Knight	Wanstead	5 : 07	12 : 35

C/L Aerobatics

1 D. Day	Wolverhampton	992 + 1008
2 J. Mannall	Lincoln	798 + 926
3 M. Reeves	West Essex	858 + 521

Combat

1 S. Holland	Northwood
2 G. Johnson	C/M

Aeromodeller Trophy—Multi R/C

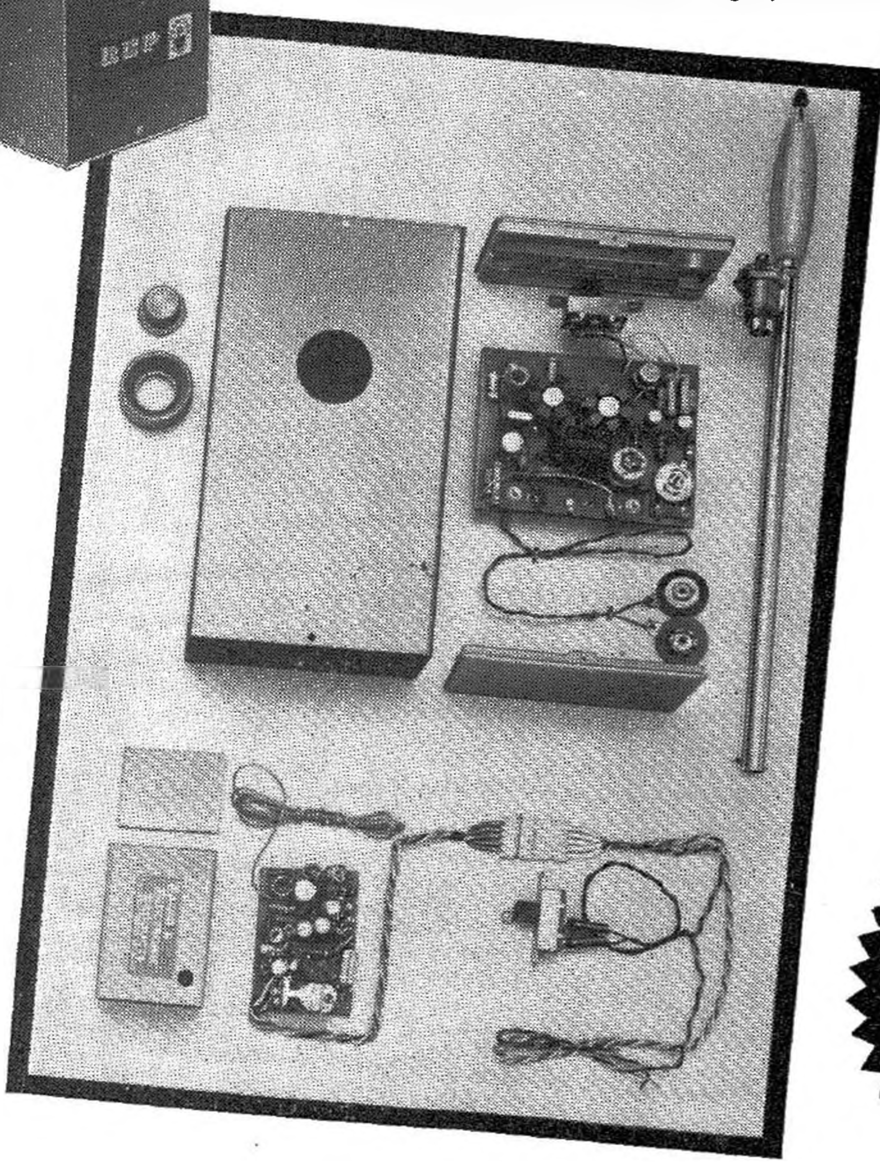
1 P. Rogers	High Wycombe	2631
2 F. Knowles	Surrey	2517
3 D. Read	Derby	2472

Free Flight Scale

1 T. Manley	Blackburn Aircraft	Bristol Fighter	533
2 J. Palmer	Wanstead	Sopwith Triplane	480
3 R. Jarvis	Wanstead	Sopwith Snipe	420

Control Line Scale

1 B. Ball	Wanstead	Grm. Gulfhawk	527
2 S. Perry	Wolverhampton	Hawker Henley	443
3 R. Ivans	C/M	Hampden	409



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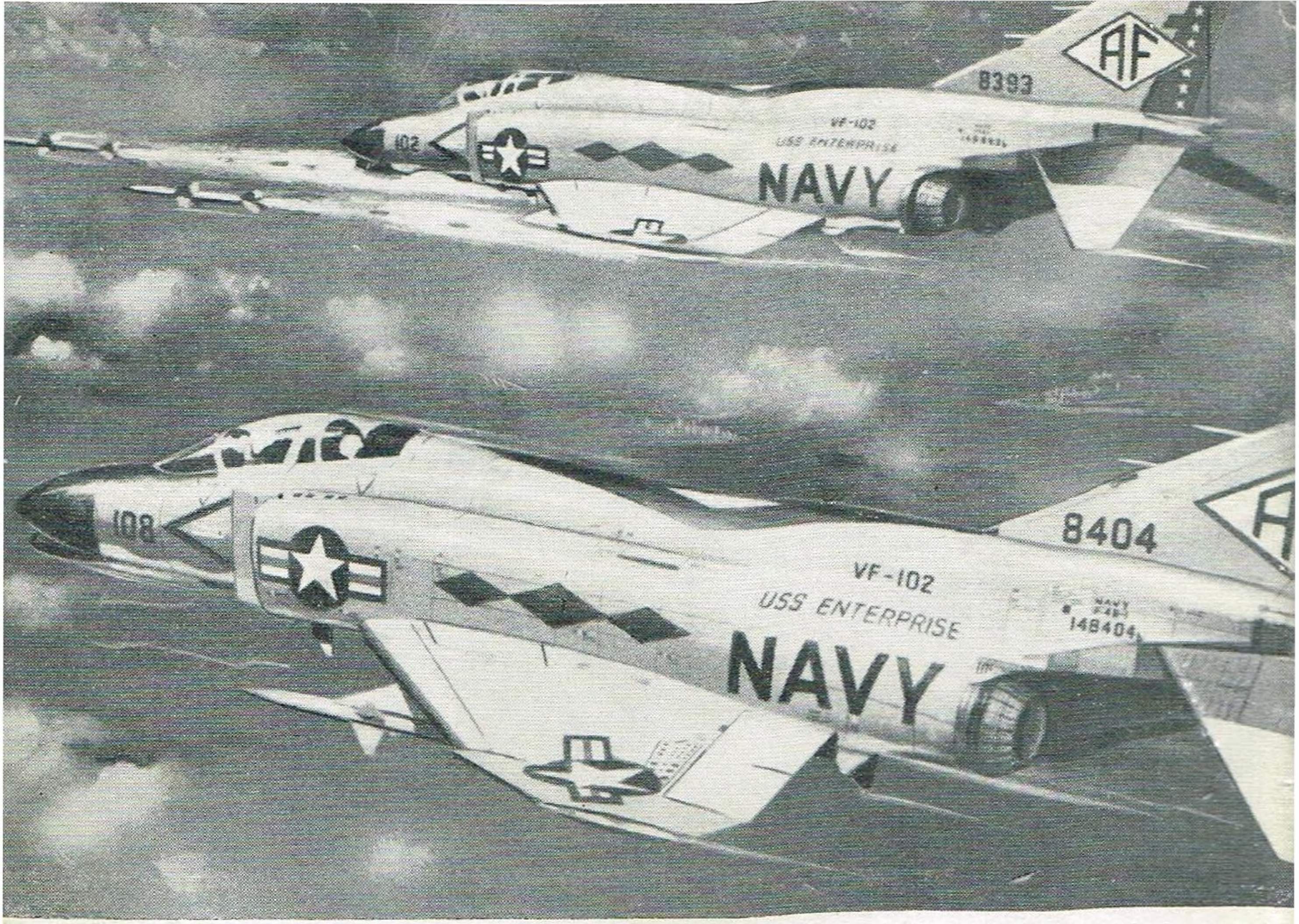
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