AERO MODELLER

ANNUAL 1961-2

AEROMODELLER ANNUAL 1961-1962 (Cover Missing)

Cover Added 20/10/13

1961

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Outstanding Czech achievement! This 40 in. span MIG-15 built by J. Urban and K. Vary is powered by a Czech Tyrska pulse jet, weighs just over 4 lb., and flies control line at around 80 m.p.h. Owing to location of high tailplane an ingenious control method was designed, which changes from conventional push pull rodding forward of the fin to Bowden cables which thus negotiate the awkward angle up to the elevators. It is interesting to record that the designers have dedicated their model to Russian cosmonaut Juri Gagarin.

INTRODUCTION

THE STRUGGLE AHEAD

A DANGEROUS portent in the aeromodelling sky demands vigorous steps by both trade and user interests. We refer to the menace of noise, that is driving aeromodellers from their established haunts even farther afield. Local authorities are withdrawing permissions granted, or refusing to consider convenient sites for local flying by reason of objections raised by residents under the powers given by the Noise Abatement Bill. It is vital that the trade provide silencers at once, and that modellers use them! Unless this is done forthwith these drastic curtailments of flying enjoyment will continue. Let us hope that in 1962 this will be a priority in every engine manufacturer's programme.

A pleasanter sight in the sky, for those few able to see it, was the magnificent first-ever orbit in space by Russian aeromodeller Juri Gagarin. In the wonderful years ahead we are sure many other names will become world famous for ever more adventurous voyages, and, as is so usual amongst aerial pioneers, they will have developed their interest and skill through aeromodelling. But, above all, in considering such important values of aeromodelling, there is a yet more pertinent reason for following this hobby—it's great fun!

The disappointment at not having Scampton for this year's Nationals was tempered by the great success of the meeting at R.A.F. Barkston Heath, which attracted the largest ever entry and attendance. Camping facilities were splendidly handled by Springpark M.A.C. again with a record attendance, so that, what with parking and programme revenue, the S.M.A.E. hon. treasurer Harry Barker was as delighted as the other hard-worked officials.

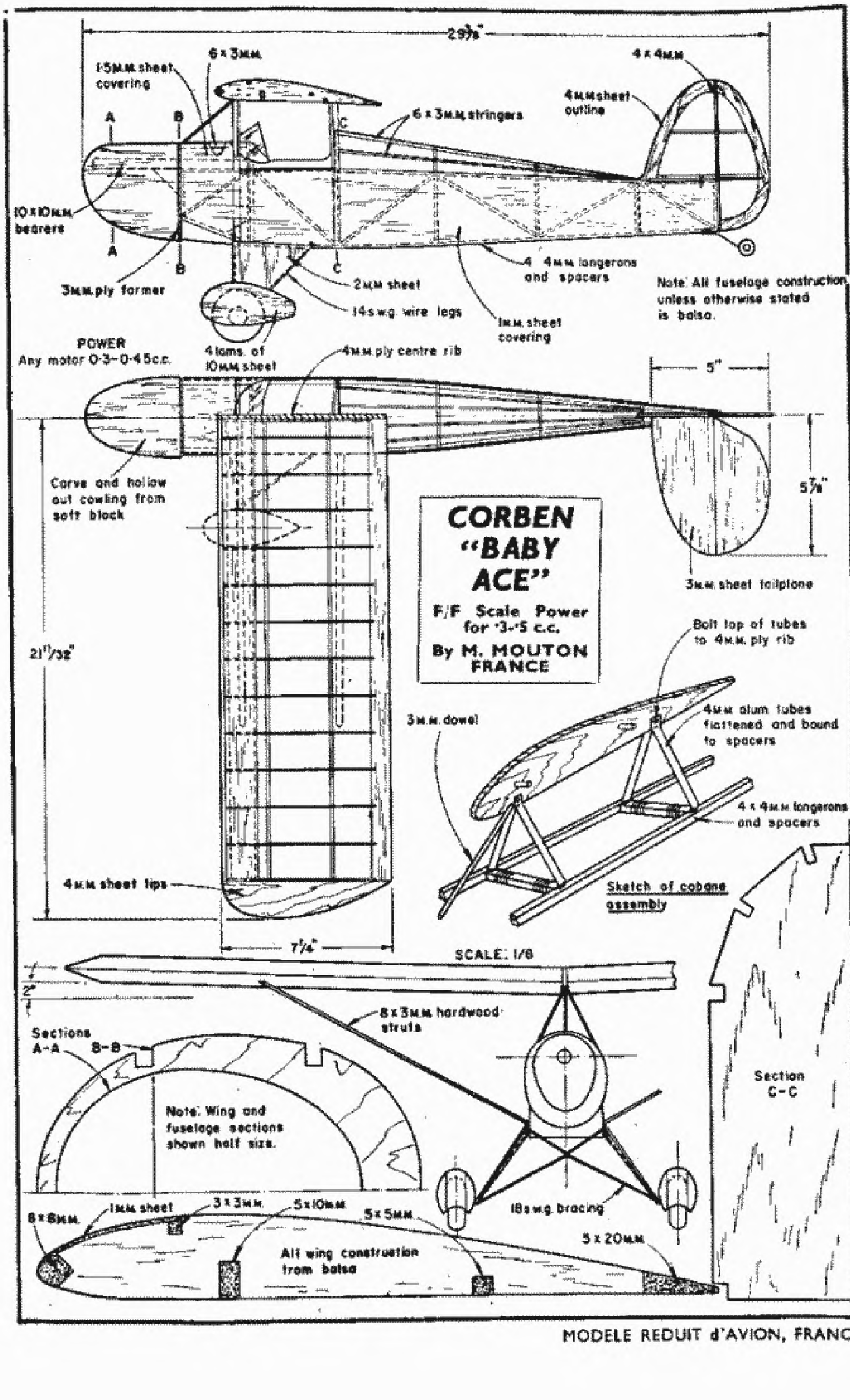
As we go to press our first Indoor World Championships in the Cardington Balloon Hangar have yet to take place, but if the times of 30 minutes plus recorded at our team trials mean anything some new world records may be confidently expected. Whilst very much an "experts only" occasion the fascination of the ultra light microfilmies extends far wider than the limited few who dare to practise this side of the aeromodelling art.

The model trade has enjoyed a steady though unsensational year with little in the way of new developments, unless we mention the first British ready-to-fly plastic model shown at the Toy Fair, but as yet not in circulation. We are happy to note, however, that every one of the "big" kit manufacturers has now produced a high grade radio control model in their range, thus, belatedly, admitting the existence of what has so long been our Cinderella. (A black mark here to the S.M.A.E. for deleting single control from the Nationals this year!)

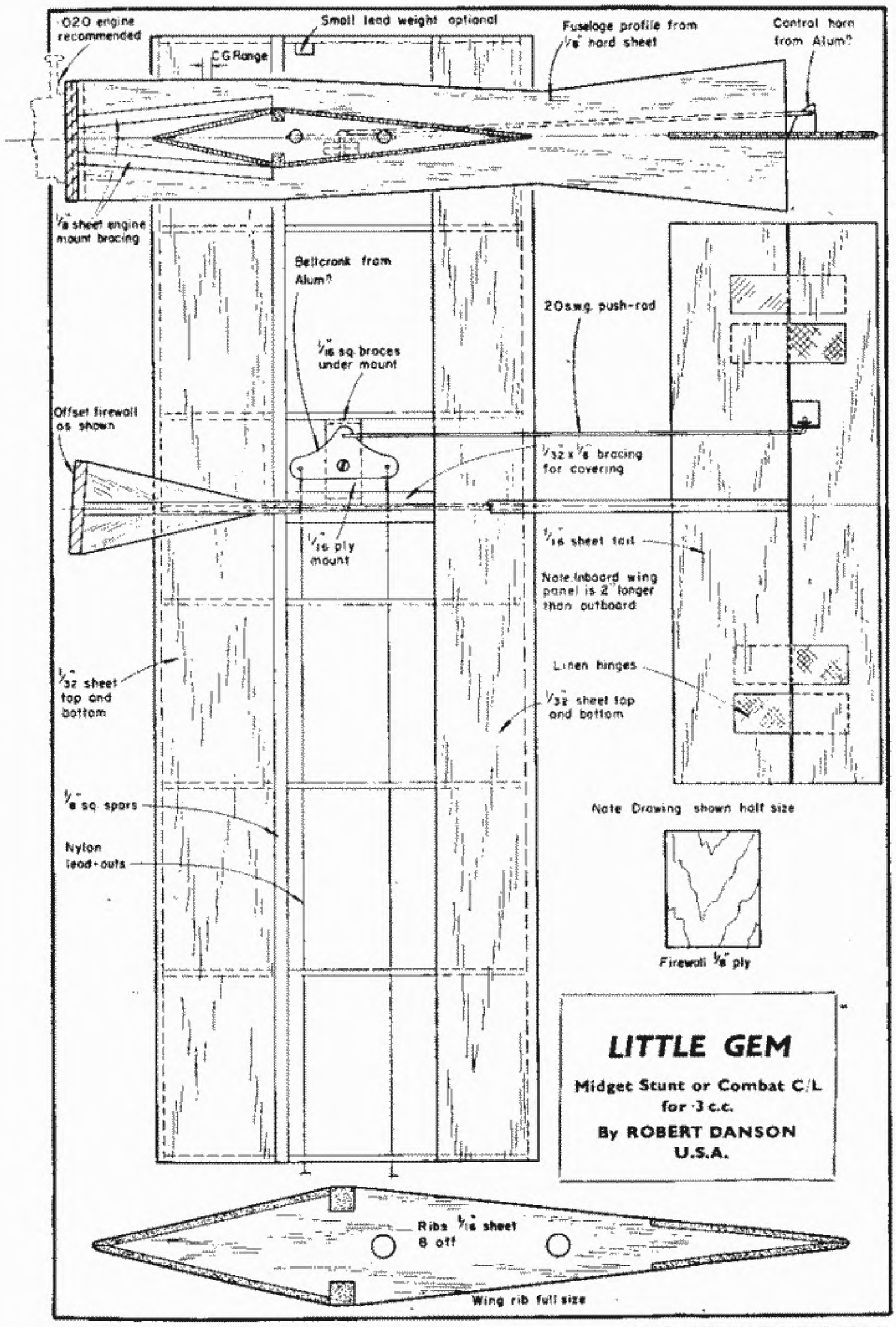
Our own baby—"Radio Control Models & Electronics" has been going from strength to strength, and is now happily filling a need amongst r/c enthusiasts. At the same time a number of new firms in the modelling field are catering for the needs of r/c constructors with simple receiver and transmitter kits and a growing range of accessories, of which the non-mechanical relay device is the most interesting.

We must also congratulate both B.B.C. and I.T.V. for their enterprise in offering aeromodelling and radio control programmes, even, in one precious instance, outside the Children's Hour! More of these please in 1962!

"AEROMODELLER ANNUAL" this year offers a slight change of style, in that we have bound copies with our dust cover theme, thus providing a more colourful volume. Inside we hope the mixture pleases; we have thoroughly enjoyed its preparation, we hope you, our readers, will have just as much fun within its pages.



MODELE REDUIT d'AVION, FRANCE

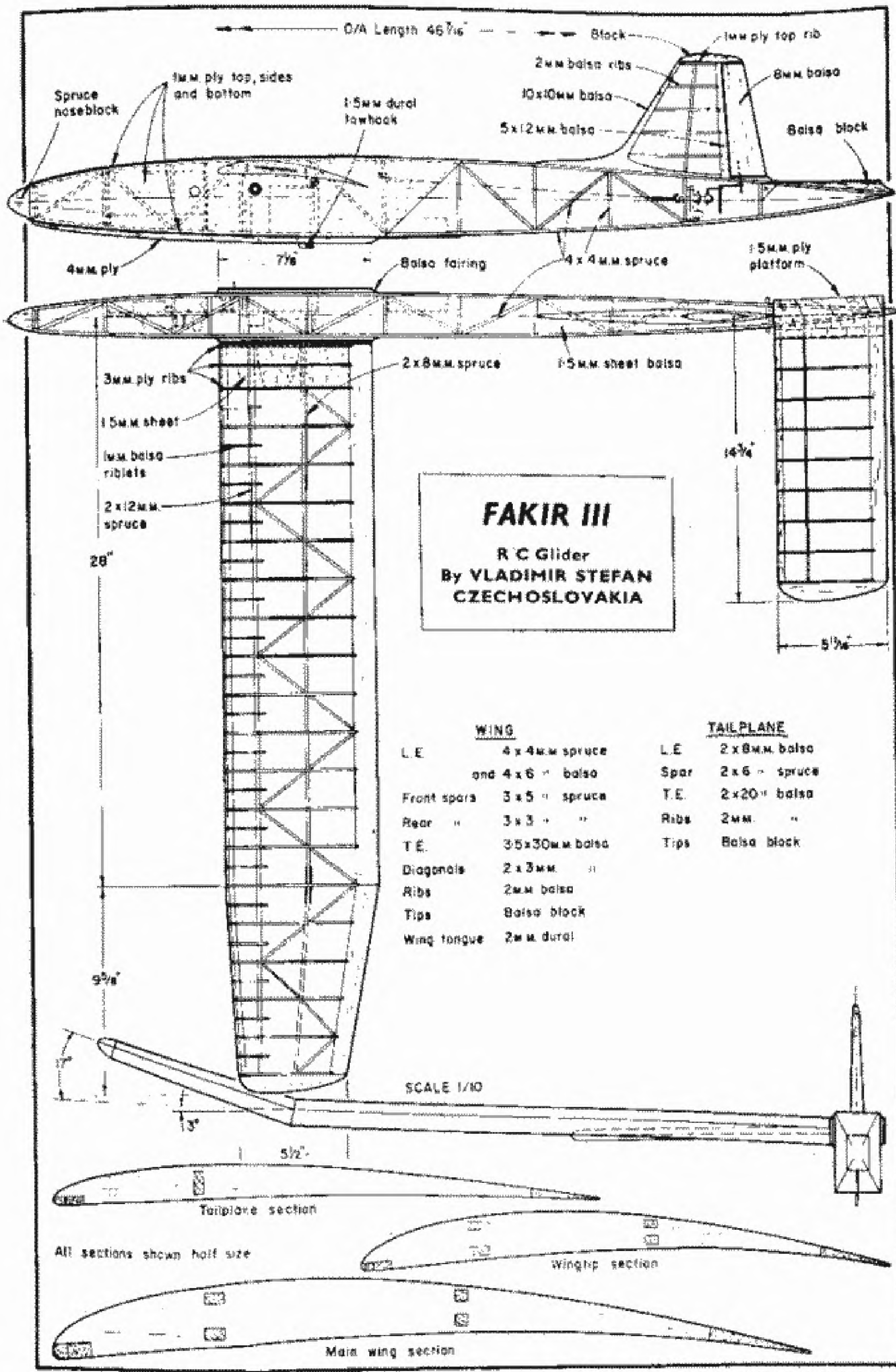


LITTLE GEM

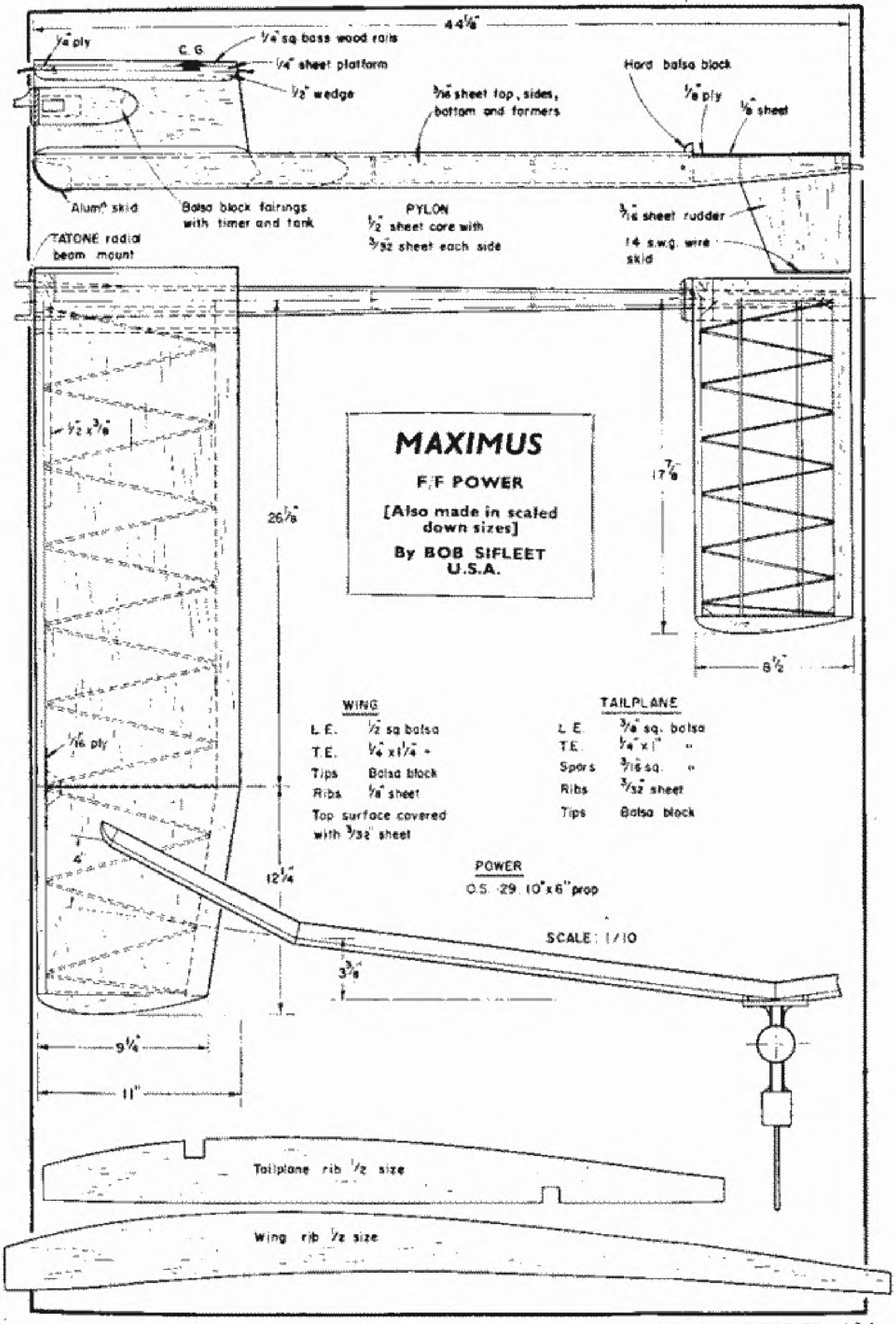
Midget Stunt or Combat C/L for ·3 c.c.

By ROBERT DANSON U.S.A.

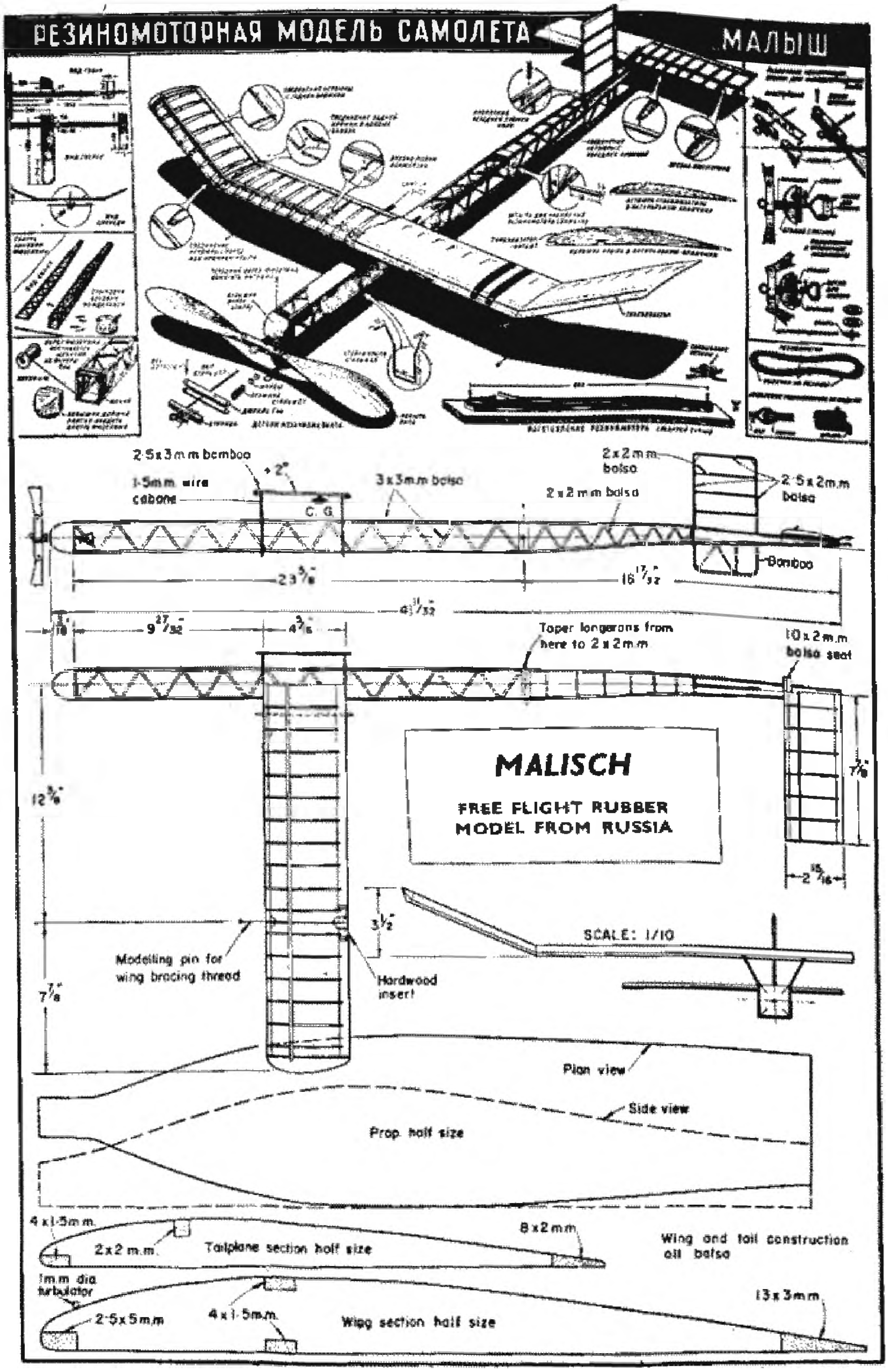
MODEL AIRPLANE NEWS, U.S.A.



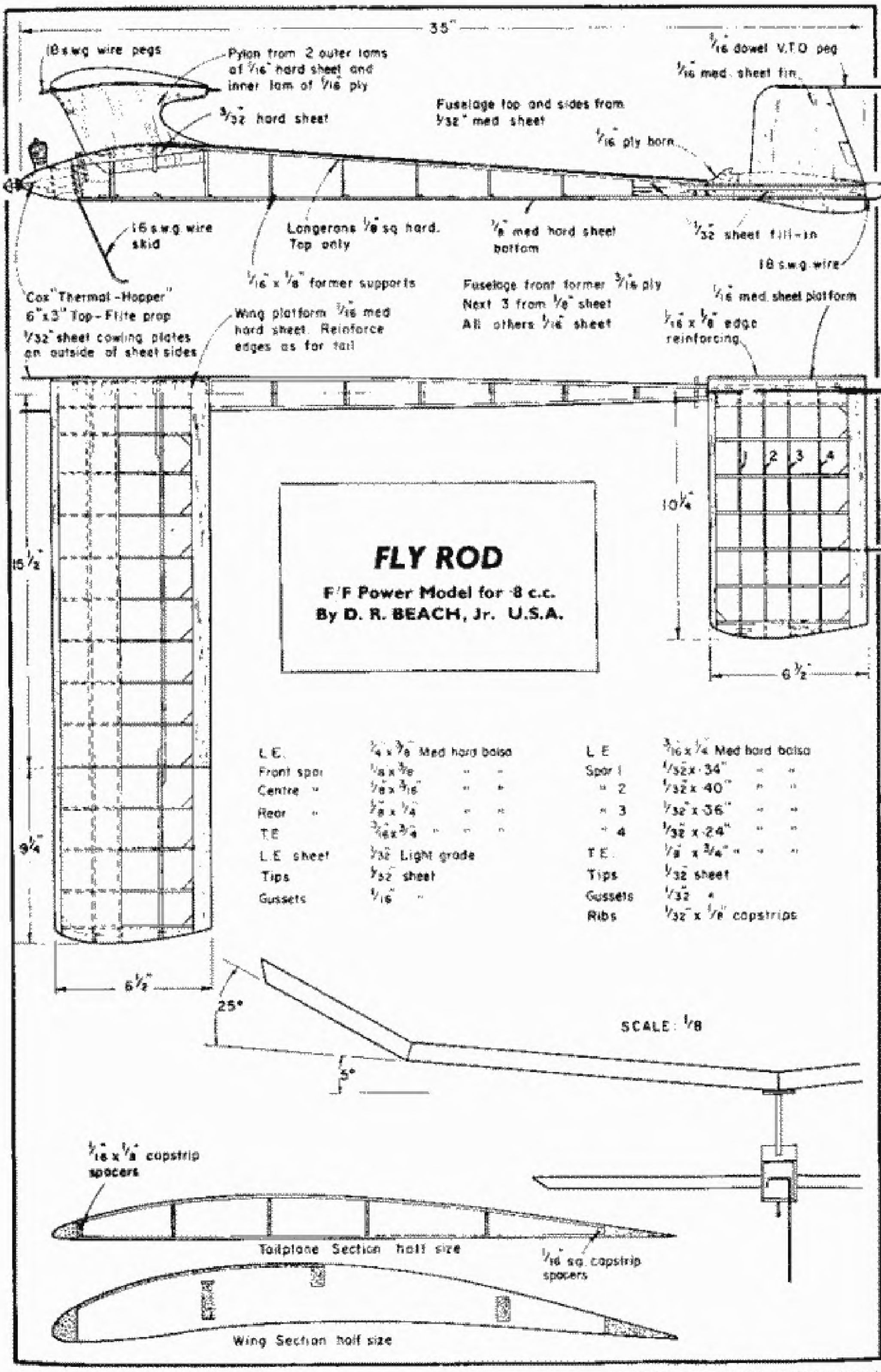
LETECKY MODELAR, CZECHOSLOVAKIA



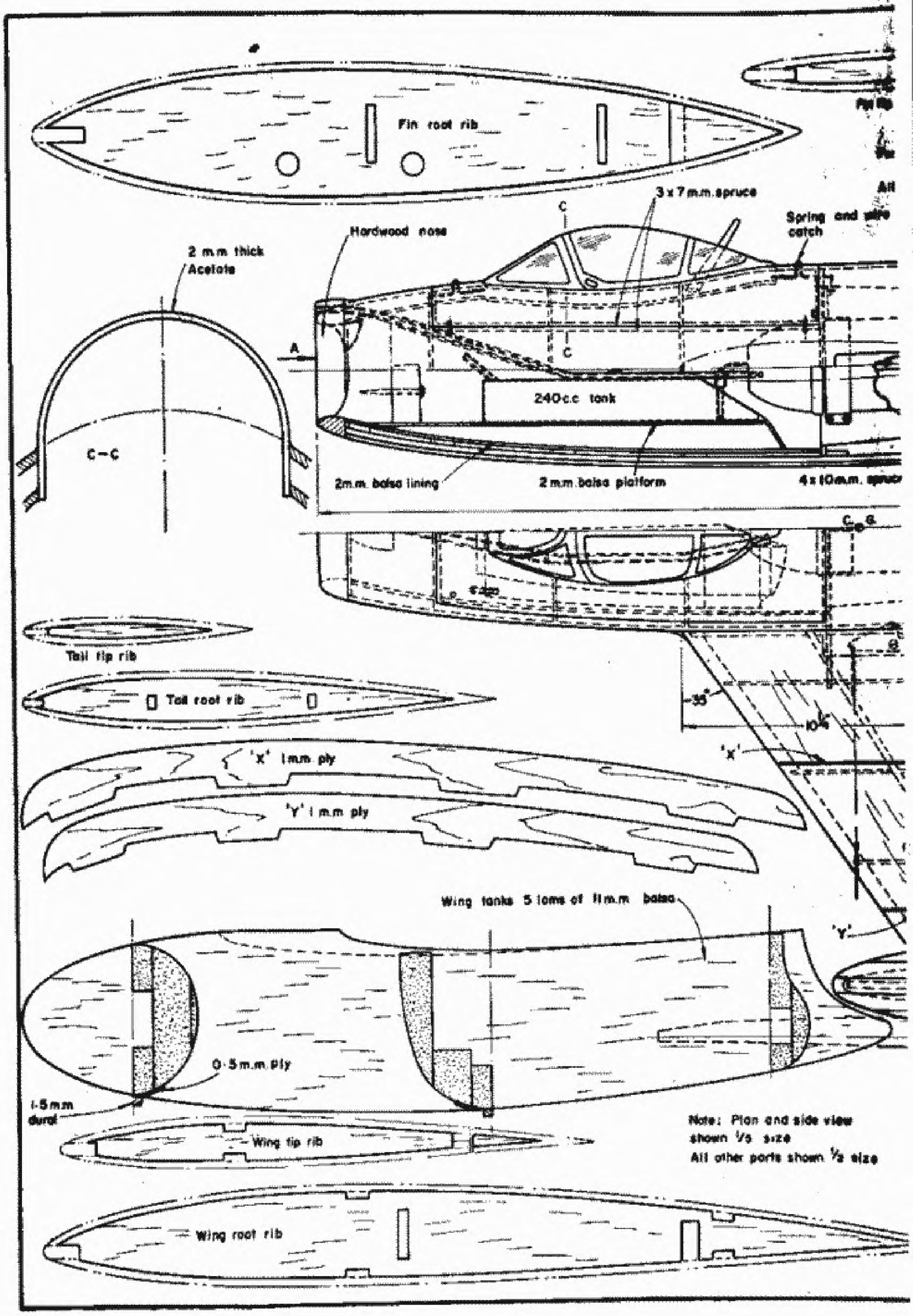
AMERICAN MODELER, U.S.A.

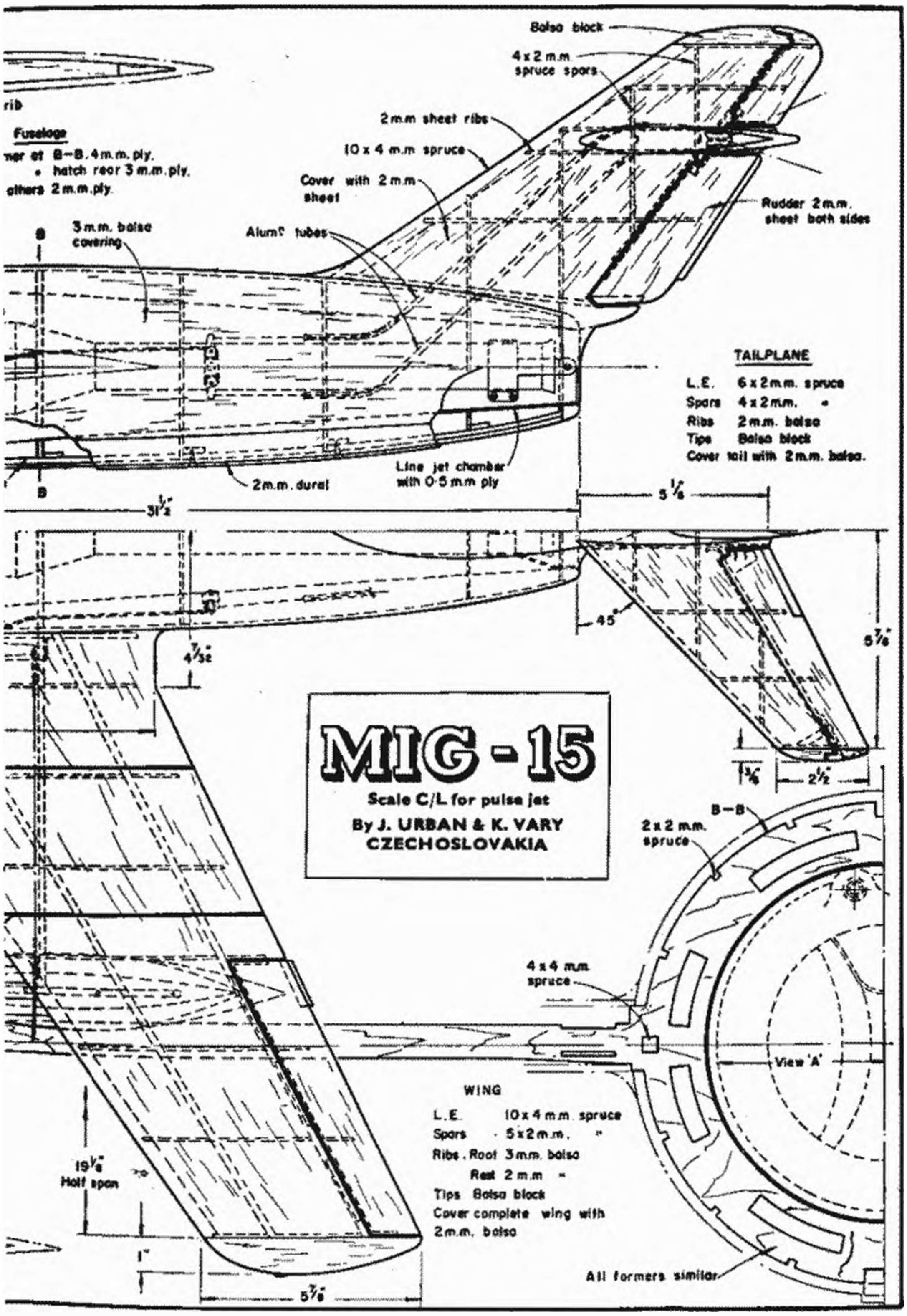


RODINY KRILA, U.S.S.R.

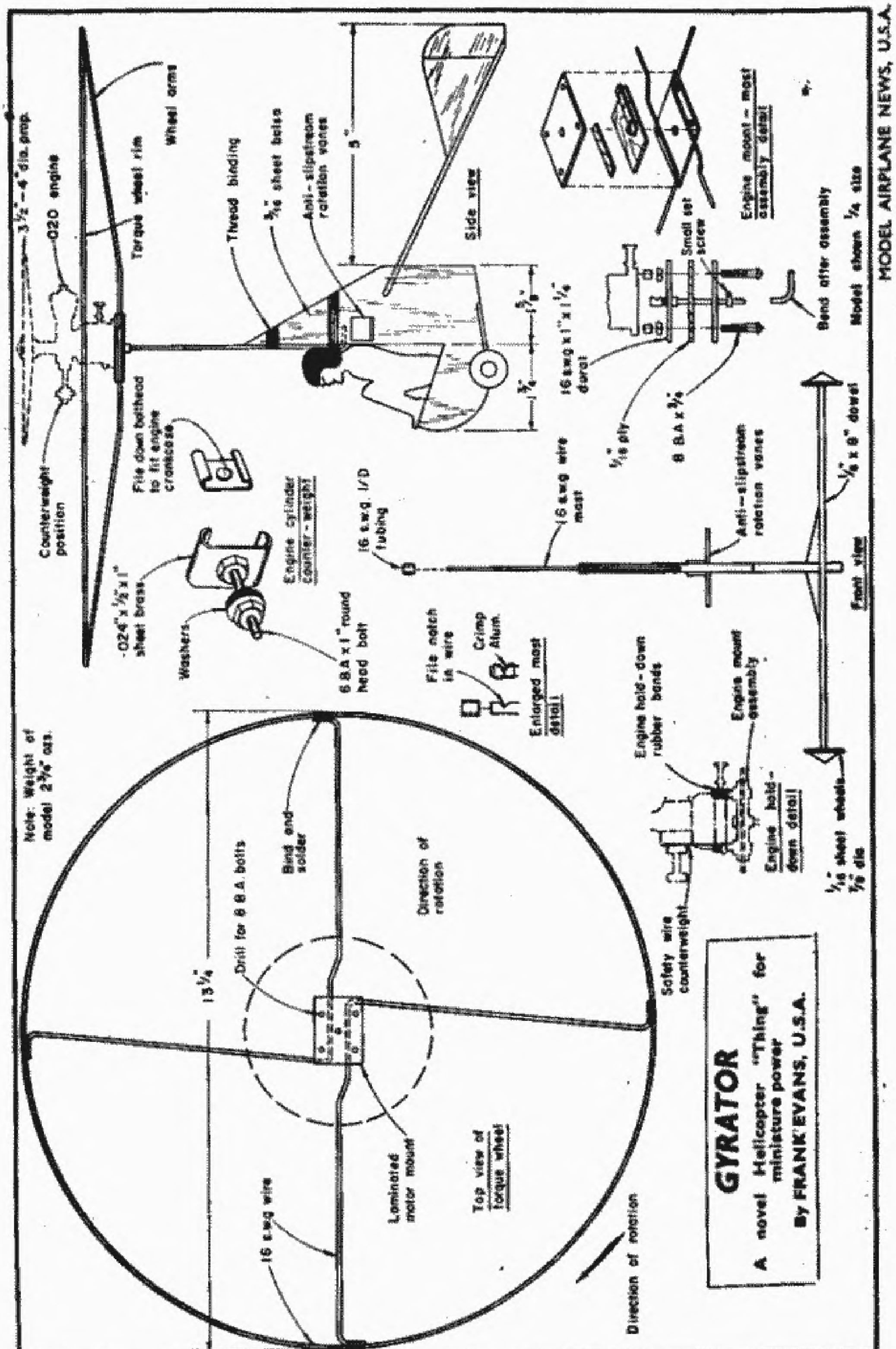


MODEL AIRPLANE NEWS, U.S.A.

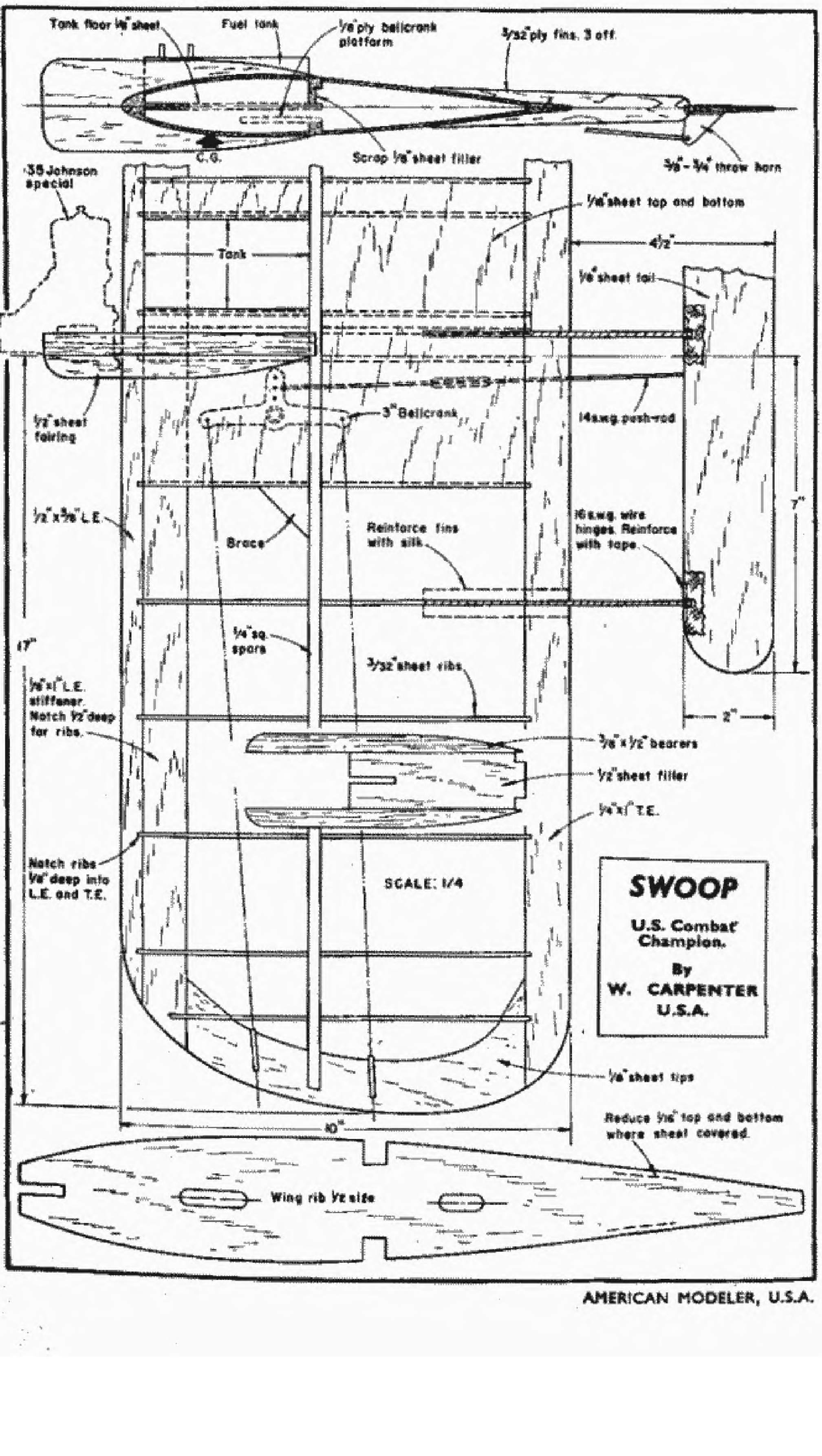

Fin root rib
Fin tip
3 x 7 m.m. spruce
Spring and wire catch
Hardwood nose
2 m.m. thick Acetate
C–C
240c.c. tank
2 m.m. balsa lining
2 m.m. balsa platform
4 x 10 m.m. spruce
Tail tip rib
Tail root rib
'X' 1 m.m. ply
'Y' 1 m.m. ply
35°
10¼"
'X'
'Y'
Wing tanks 5 lams of 11 m.m. balsa
0·5 m.m. ply
1·5 m.m. dural
Wing tip rib
Wing root rib
Note: Plan and side view shown 1/5 size
All other parts shown 1/2 size



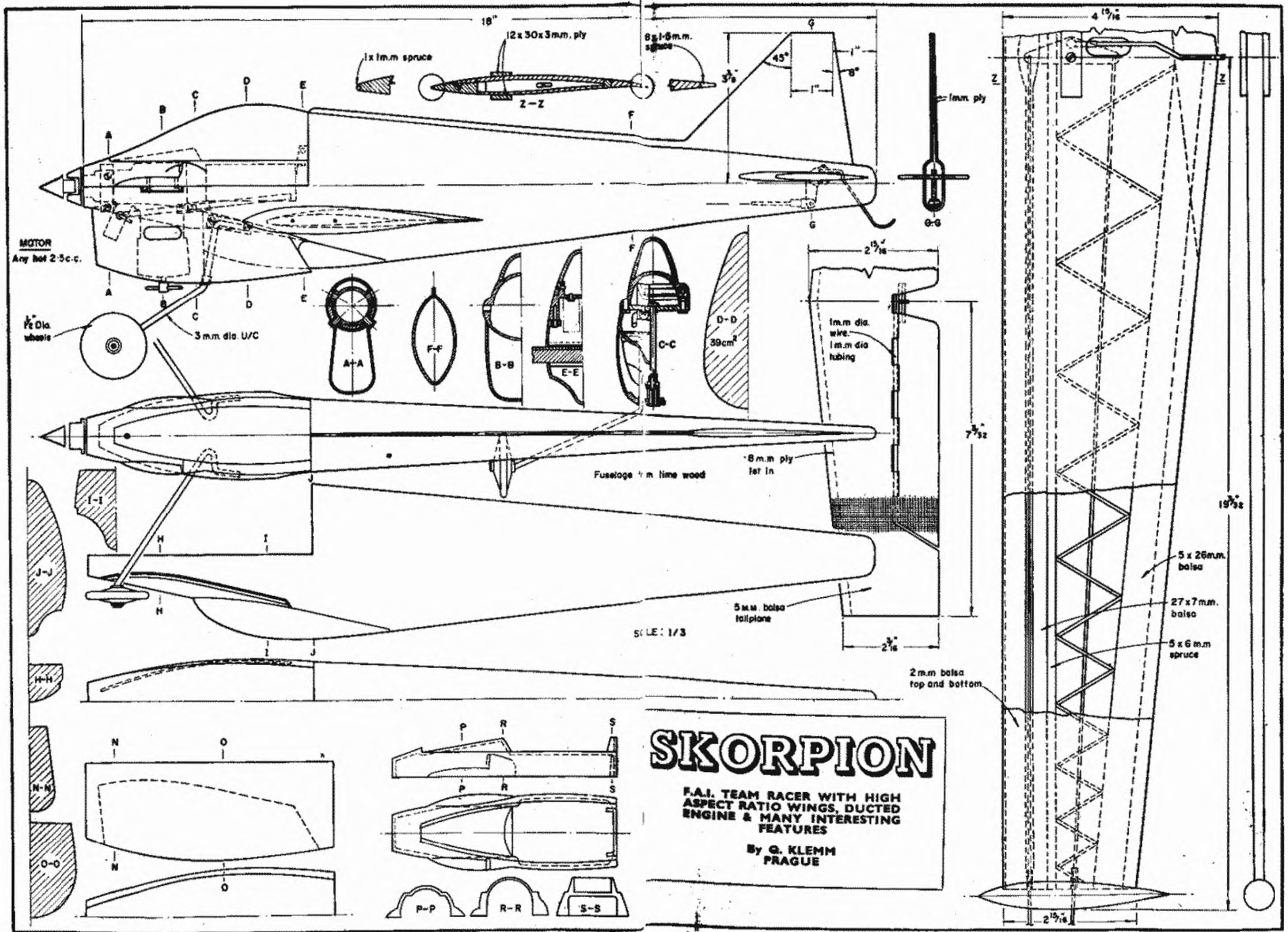
LETECKY MODELAR, CZECHOSLOVAKIA



3½"-4" dia. prop.
·020 engine
Counterweight position
Torque wheel rim
Wheel arms
Thread binding
3/16" sheet balsa
Anti-slipstream rotation vanes
5"
Side view
File down bolthead to fit engine crankcase
·024"x½"x1" sheet brass
Washers
6 B.A x 1" round head bolt
Engine cylinder counter-weight
16 s.w.g. I/D tubing
16 s.w.g. wire mast
16 s.w.g x 1" x 1¼" dural
1/16 ply
8 B.A x ¾
Small set screw
Engine mount - mast assembly detail
File notch in wire
Crimp Alum.
Enlarged mast detail
Anti-slipstream rotation vanes
⅛ x 8" dowel
Front view
Bend after assembly
Model shown ¼ size
MODEL AIRPLANE NEWS, U.S.A.
Note: Weight of model 2¾ ozs.
Drill for 8 B.A. bolts
13¾"
Bend and solder
Direction of rotation
Laminated motor mount
Top view of torque wheel
16 s.w.g wire
Direction of rotation
Engine hold-down rubber bands
Engine mount assembly
Engine hold-down detail
Safety wire counterweight
1/16 sheet wheels ⅞ dia
GYRATOR
A novel Helicopter "Thing" for miniature power
By FRANK EVANS, U.S.A.



AMERICAN MODELER, U.S.A.



SKORPION

F.A.I. TEAM RACER WITH HIGH ASPECT RATIO WINGS, DUCTED ENGINE & MANY INTERESTING FEATURES

By G. KLEMM
PRAGUE

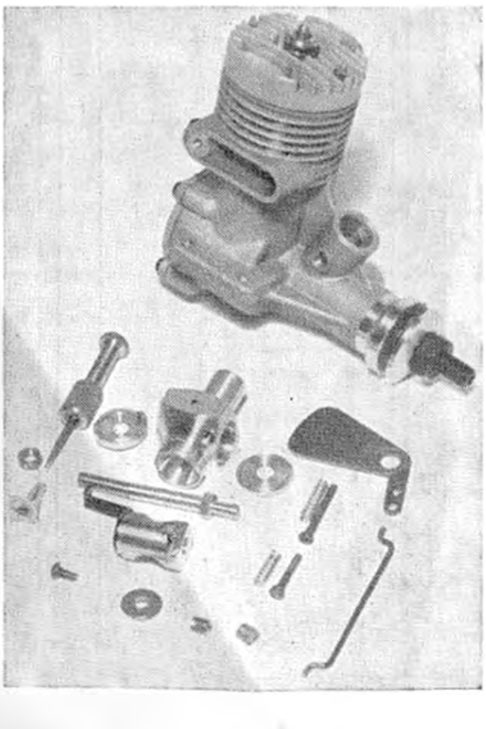
LETECKY MODELAR, CZECHOSLOVAKIA

ENGINE SPEED CONTROL

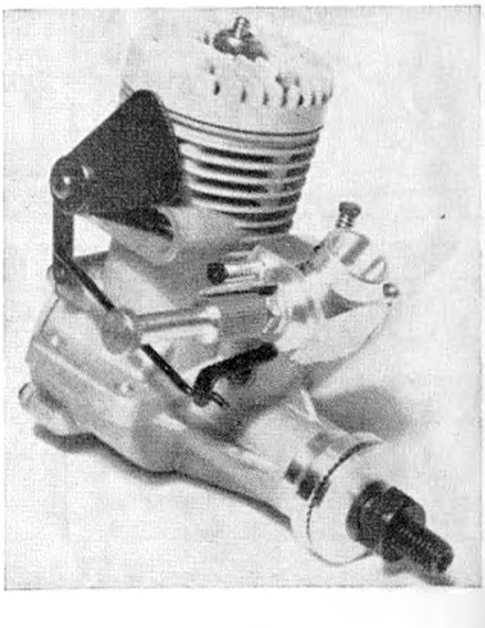
By R. G. Moulton

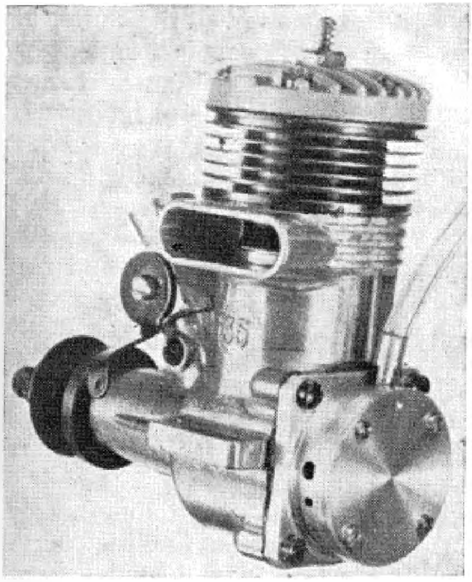
THREE years ago in the ANNUAL, this author summarised the methods by which desirable engine speed control could be obtained. The decisive finding in that article of the 1958/9 edition was as follows: "*Undoubtedly the ideal would be to couple exhaust and intake controls*".

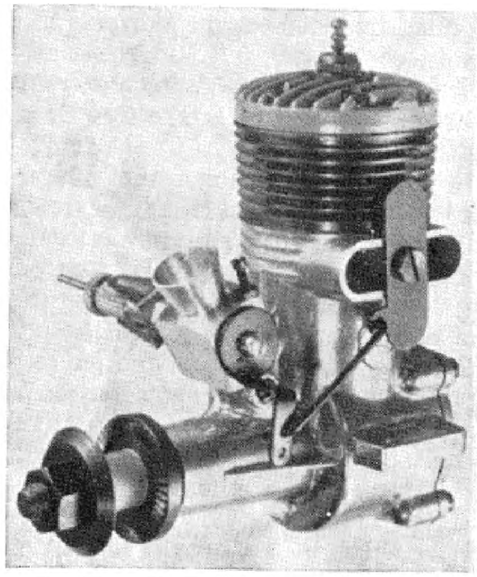
No sooner had those words appeared in print than the enterprising Japanese Ogawa Company produced the first O.S.35 Multispeed, soon to be followed by the K & B 45 in the USA, then the Veco 35 and a subsequent string of other types. All fitted with the coupled control, and now universally adopted by modellers the world over, these might still be regarded as crude and elementary approaches in a further three years after more development has taken place. There are still many avenues to explore, the great snag is that engines are produced on slim profit margins and no manufacturer can afford endless time on experiment unless his existing sales line is threatened. Consequently it may well take three years or even much more before we see any "streamlining" of speed control and a more scientific approach.

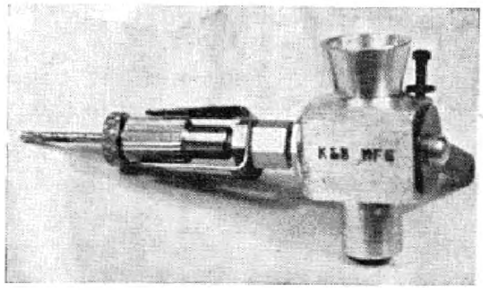


The Merco 35 with speed throttles dismantled at left and assembled at right, showing the "chopper" action of exhaust valve and neat body of intake which has airbleed control.









The K & B Company of Los Angeles, under the direction of John Brodbeck, produces engines of fine quality. Above is a 35 to which a vacuum servo pump has been added by F. Rising as a modification for the German Stegmaier radio control system. The engine is otherwise the standard R/C model with intake throttle only as at right. Not obvious is the Tee feed for fuel to the carb, so avoiding the rotation of the fuel feed pipe with the choke. Top right is the famous 45, most widely used of all R/C engines and one which established the standards by which others are judged.

We have learned in the intervening years how the idiosyncracies of variant speeds and fuel/air mixtures can be as frustrating as were the old coil ignition set-ups with the first petrol-fuelled aero engines. An engine may well have performed as desired on the bench, yet in the airframe it cuts out as soon as the servo switches the speed control. Glowplugs fail to glow, engines start to reject fuel instead of inhaling it, and worst of all, an engine might be completely tamed with perfect control through its high to low range yet have lost so much of its peak power that it is no longer adequate for the job.

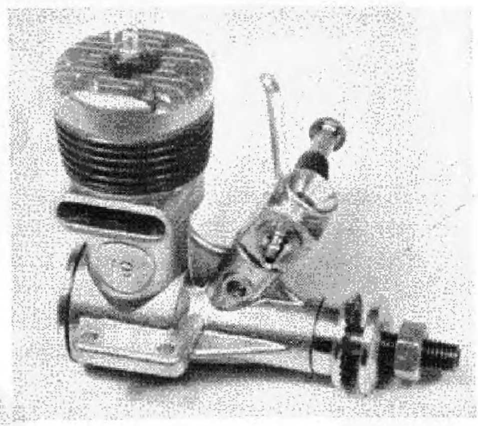
The tendency has therefore been towards a demand for the larger capacity engine of no more than a moderate output but with sufficient reliability to justify its position on the front of an expensive piece of radio-controlled machinery. Makers have been influenced into a rash of ·45 ·49 ·51 or ·56 cu. in. sizes to cope with the demand.

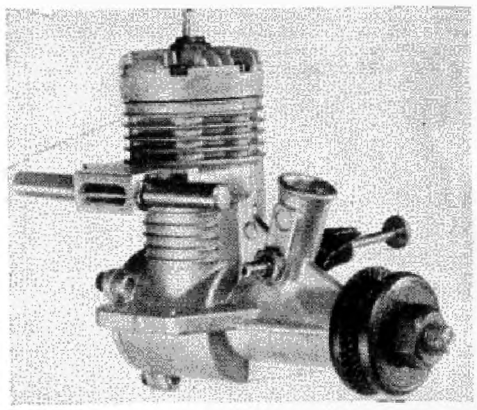
Some engines are exceptional in their degree of control, others are sensitive to throttle position changes and offer little in the way of a range of speeds between the ultimate high and low. A lot depends on the operator, more on the fuel, and a great deal on the control linkage from the servo or actuator. It is simply not just a matter of mounting the units in place on the airframe and expecting it to work to perfection without need of adjustment.

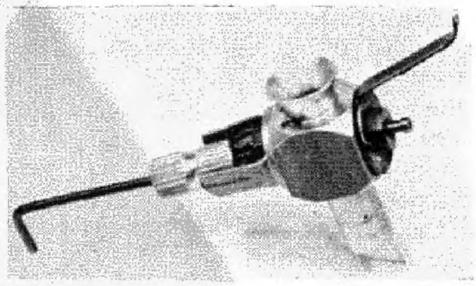
The charm of the two-stroke engine is its utter simplicity. When it is ignited by incandescent glowplug in the head, it throws away all the clutter of coils, condensers and batteries, and becomes a neat self-contained and fairly clean operating unit. But try to control its speed by fuel/air mixture change through exhaust or intake throttle and immediately that means of ignition is affected.

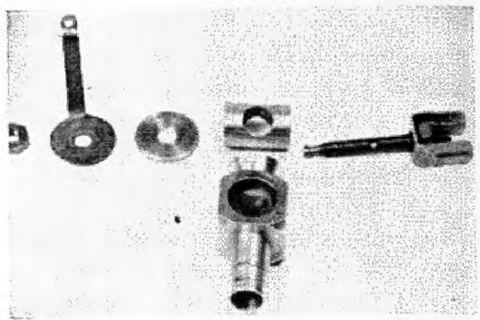
We should first realise how the glowplug keeps an engine going. First it is boosted by short circuit for the low speed start. The wire becomes red hot, and compressed fuel mixture is locally ignited when it achieves the ideal gaseous state. This means that one can introduce fuel directly into the upper cylinder as a starting primer, and by turning the shaft over, the natural scavenging action of the two stroke will eventually sort out the right upper cylinder fuel content for the start. With widely ported engines this happens within a few flicks of the propeller; but if an engine has an exhaust restrictor that does interfere with natural scavenging, the start is likely to be prolonged. Hence it is always advisable to open up an engine to the full-speed settings for the manual start from zero revs per minute.

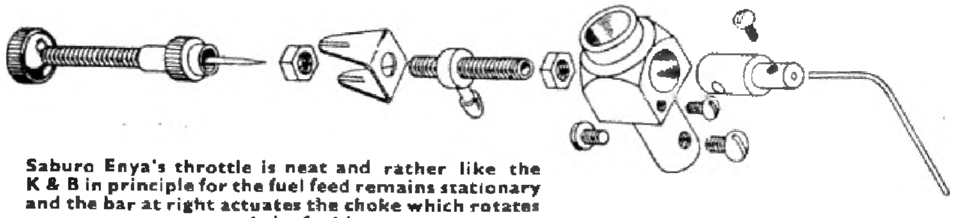
The engine now has to draw in its fuel through the controlling needle valve which meters out the fuel/air mixture, and after induction into the crankcase, the gaseous mix is transferred by pressure from below and suction from above, into the hot chamber which wants to explode it into a power stroke. If the needle valve setting happens to be on the open side of ideal, then the engine will run "rich" and slow, with smoky exhaust and evidence of excess fuel from the exhaust port. If it is set "lean" then the engine will speed up, and starve itself, running hot in the process.











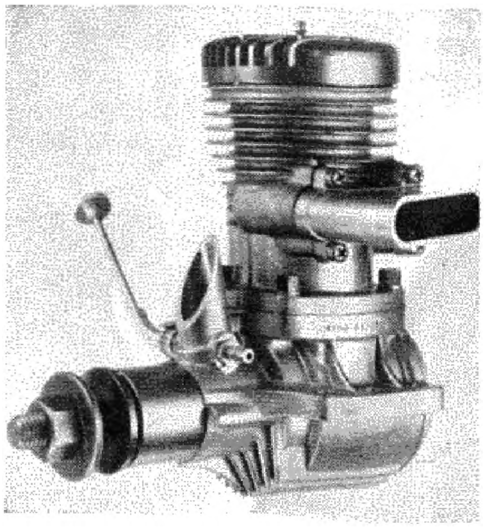
Saburo Enya's throttle is neat and rather like the K & B in principle for the fuel feed remains stationary and the bar at right actuates the choke which rotates around the fuel jet.

In the first case, the excess fuel may stop the engine by putting the fire out in the upper cylinder. This is because a rich mixture will physically cool the plug element while the same rich mixture also *needs* an increase in element temperature to achieve more complete combustion.

Assuming that the metering jet control is set ideally, the engine will be running at peak r.p.m. on the propeller load applied if the exhaust and intake are free of all obstruction. What happens when exhaust restriction is applied is that we are limiting the flow of gases through the engine. Back pressure prevents the normal transfer to take place from the crankcase and in turn, less fuel is inducted. Yet the port restriction compensates for the weakened fuel/air mixture and so the engine does not become overlean and keeps running right down to almost complete eclipse of the exhaust port. In some cases it does appear that the port is entirely covered but close examination usually shows that the port cover is pushed by pressure away from its seat and in effect is vibrating at the r.p.m. rate.

The great disadvantage of such control is that sudden opening of the exhaust after a long run at full closed setting may stop the engine. It has been suggested that this is because some engines will run so lean and hot on exhaust restriction that the fuel ignites under compression alone, and does so in such a state that the plug can lose its heat and lose its glow ; but the author does not subscribe to this view. It is more likely that pre-ignition does take place, the element getting very hot in the process, and sudden induction of a richer mixture quenches the plug. Moreover, the two-stroke takes its own time to

Left are two really good 19 size engines, at far left the Gordon Burford Glo-Chief from Australia with intake throttle as an accessory and at right, the Fox 19 with exhaust control only by means of rotating rod in the port. Neither has the low speed of coupled throttle engines but each is a good example of the merits of the two different approaches. At bottom is the Bramco American throttle, sold as an accessory and very widely used. Parts display the plain hole through the choke, see text for modification detail.



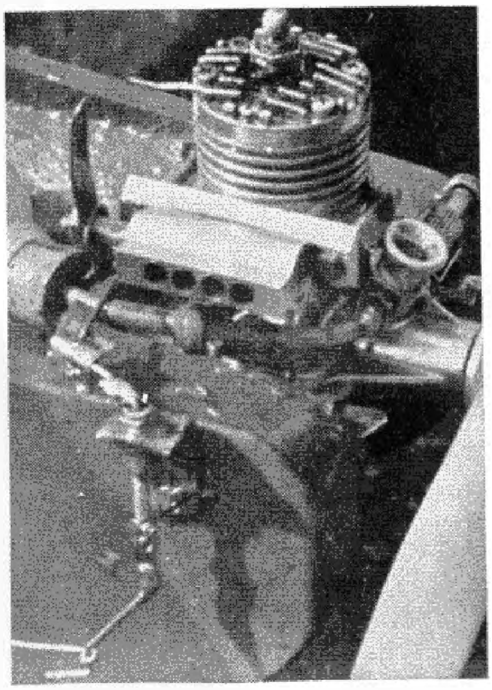
sort out its internal bothers and if disturbed, may get through several hundred revs before achieving a clean run again. If the exhaust restriction is suddenly removed, the transfer action is called upon for increased work and in turn has to draw upon more fuel from the intake. This is why coupled throttles are the answer to the problem for they serve to bridge the gap and provide the right venturi effect for the desired r.p.m.

The intake throttle serves to control the fuel/air mixture by reducing the amount of air and so richening the mix for low speed, or opening to full venturi throat for normal or full speed. Again, a sudden change in either direction may put the fire out, particularly when opening up from rich mixture when the plug is subjected to quench cooling by excess fuel, to normal mix which calls for a hot element. This is where the exhaust valve is so valuable in that it retains the heat in the upper cylinder when the engine is set for low speed and restricts the volume of enriched fuel/air supplied by the closed intake throttle.

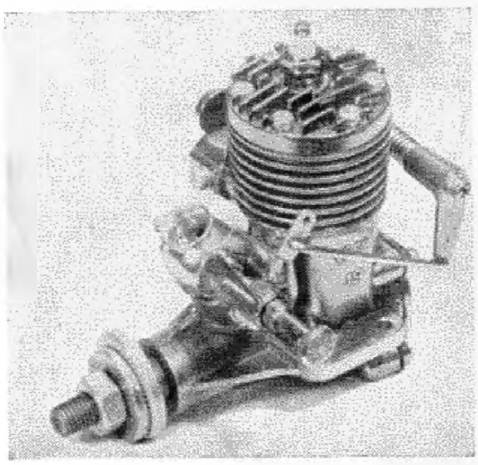
But even then, the juggling of settings for each valve in combination with the other is not easy and apart from absolute cleanliness in the fuel which must have top grade oil content, the glowplug itself needs to have a standard of reliability to operate through the speed range.

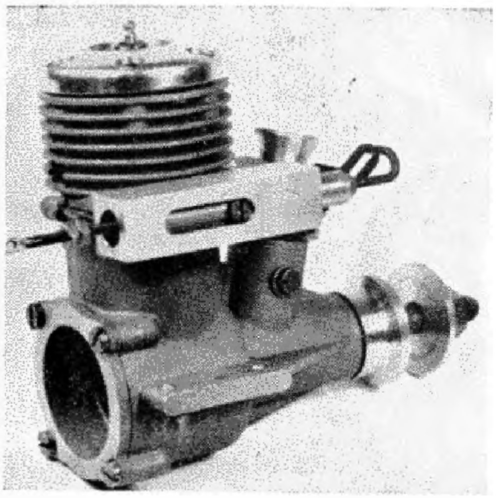
Shielded plugs help. Some are far better than others and it is usual for those with greatest amount of shielding to be the most reliable yet hardest for starting. Those with bars across the face must be checked for clearance from the piston. If any is to be singled out for reliability we should mention Veco, Ohlsson and Johnson plugs as being good samaritans for the figures obtained in tables with this article.

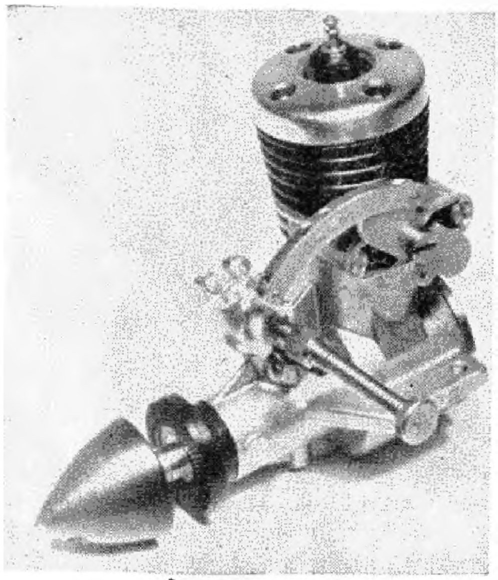
What we could really do with, is a refinement in control of the glowplug heat itself. If present-day knowledge of transistor circuitry could be applied to develop a variable glowplug heat control unit, we would be on the way to having



The Veco 19 is one of the most satisfying of all the smaller controlled engines and has always been a favourite. At left is an early plain version to which a Roto-Valve exhaust choke has been fitted. At right is the standard version for R/C with coupled controls.







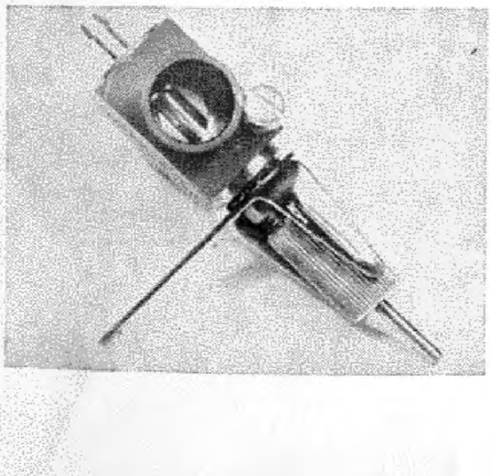
Coupled controls at left on the Super Tigre 51 and at right on the Taifun Bison 19. It is significant that although the push-pull action on the Italian Super Tigre was much valued, the manufacturers have turned to "Chopper" action exhaust control control in order to minimise power losses.

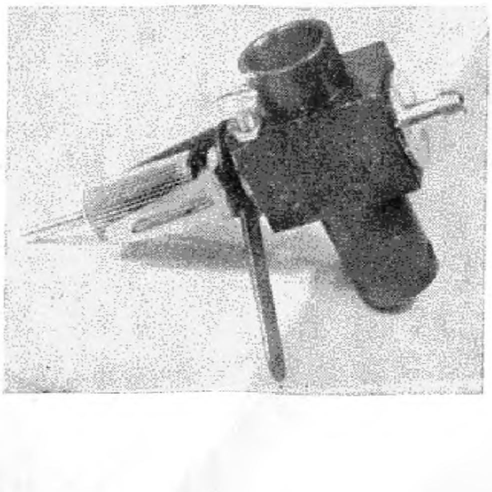
speed control through ignition timing. A larger glowplug might be used, more akin to an electric oven "quick-ring" whereby the leading part of the plug would always retain heat and avoid failure of combustion, and the balance of the wound spiral element have increased incandescence as required. Maybe that is a pipe-dream ; but at least it is a thought worth remembering.

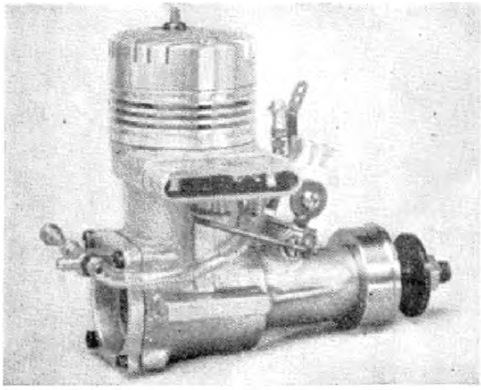
Then the throttles we use are extraordinarily crude, the most advanced at the time of writing being the Johnson Auto-Mix from the USA, an example of which was loaned to us by one importer, Harry Brooks of Southern Radio Control in Brighton.

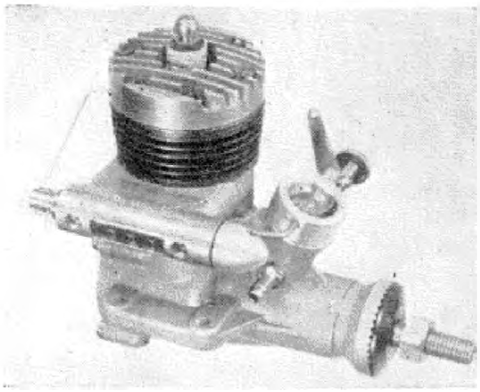
Now this is interesting as the throttle barrel itself is arranged with a helical groove and locating pin so that as the operating arm is moved, the barrel moves laterally as well as radially. Since the barrel also carries the needle valve control with it, then the needle is also moved away from or towards its seat. This means that the fuel to air ratio is as near constant as the simplicity of the machining allows. The engine will two-stroke constantly throughout the

Most advanced of current throttles is the Johnson Auto-Mix which has a choke that moves in and out in unison with the needle valve. View down the spout shows quarter throttle position and at right, the slightly larger than normal body and extension to fit in the Johnson 36.





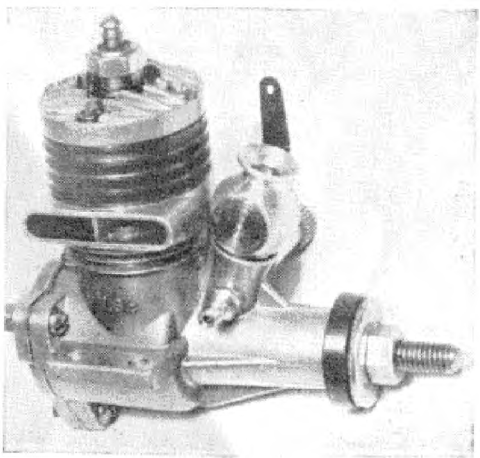




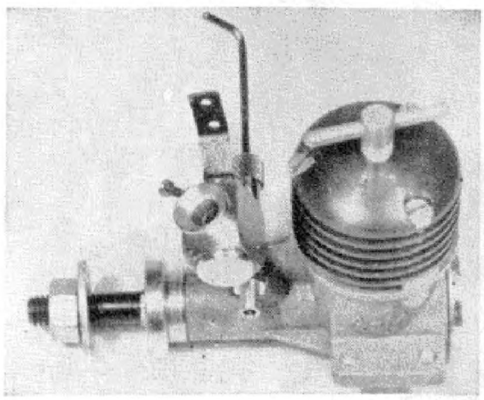
greater part of its speed range, and there are no back pressure loads on connecting rod bearings as the exhaust valve is not considered necessary.

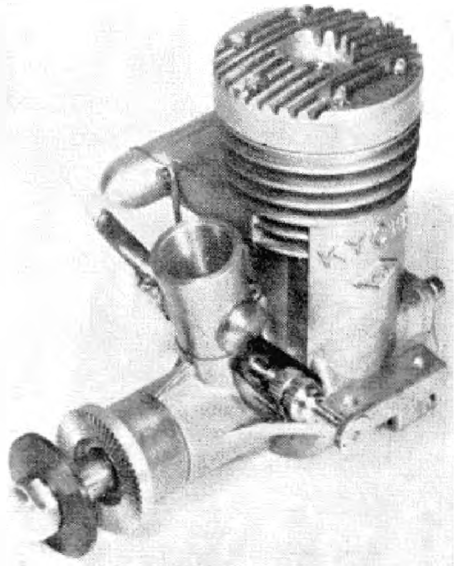
By adoption of the idea from full scale engines, the carburettor air bleed has also given the same effect on, for example, the Merco 35 and the Taplin Twin which are paragons of controllability in our experience. These have screw control for the idling jet as well as screws for limiting the physical movement of the throttle.

Many modellers overcame the shortcomings of earliest simple throttles of the Bramco type by first filing a Vee into one side of the hole through the barrel so that at slow setting there was still a respectable air induction. A 60° jeweller's file could be applied a few strokes at a time between bench checks so that the engine slows to the point where it still keeps going when opened suddenly and if one overdoes this, then a simple remedy is to work on the other side of the barrel to balance things back a little and so recover reliability. The notch is as good as a non-controllable air bleed, but the ideal is to tap in a 10 or 12 BA set screw so that it blanks a $\frac{1}{64}$ in. hole in the side of the carburettor body and which will feed air in below the main entry. In other words, set the barrel at slow speed and drill so that the hole to atmosphere leads straight on to the needle jet area in the middle of the barrel.



O.S. ·09 glowplug "Pet" at left and the British Allen-Mercury 15 diesel at right have intake chokes above the needle valve as common features. Surprisingly, the diesel has a wider range of control.





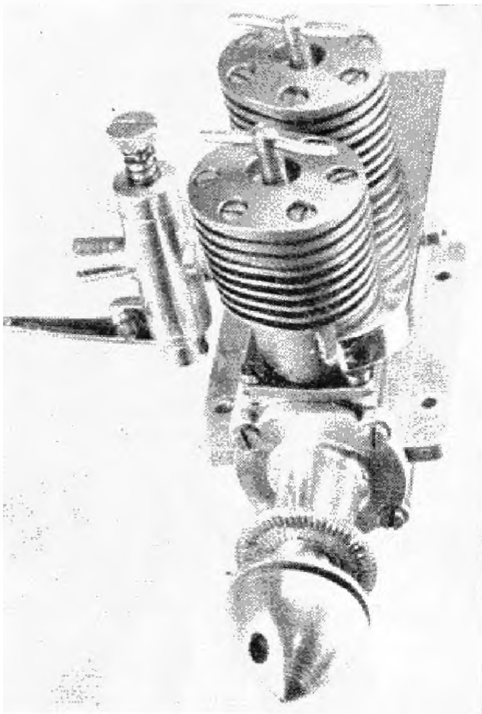
In the two-stroke world, Japanese engines are held in high esteem and the O.S. 49 at far left has advanced features. Remote needle valve control on rear of engine serves the fuel feed to the rear of throttle which also has an airbleed control. Behind airscrew is a counter weight for balancing and inside the exhaust stack is a butterfly choke, all coupled to the intake. Next is the well established O.S. 35 Multispeed with rotary bar in the exhaust and a simple flapper in the intake. At right is the Kyowa 45 which also has an intake flapper and a rotary exhaust valve, but no balancing weight, which it needs for low speed operation.

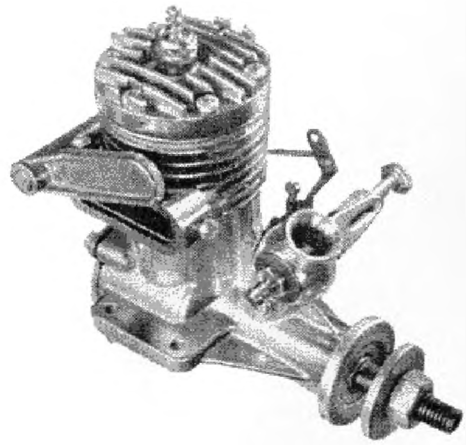
Alternatively, where a throttle is an adaptation for a standard engine, the normal means of retention is by means of set screws through the original needle valve holes. Do not use these ; but instead, fit a two-part Dooling or ETA needle valve assembly and use this to control an airbleed.

Not all engines have the needle valve control integral with the barrel of the throttle and employ a needle valve which is independent and below a flap as on the Kyowa 45 or OS 35. The effect is more or less the same and as these and other engines have exhaust control as well, they do not call for any test to see if the separated intake units are inferior. What is desirable is that the needle valve and throttle should move freely and not have to rotate the feed pipe from the tank as was the case on first examples. The K & B Company who are always so alert to such refinements of design, produced a tee fitting which is admirable and overcame this movement drag.

It is not generally appreciated that the linkage to the escapement or servo must be completely free. When running in the airframe the two-stroke of larger than 5 c.c. capacity is a real vibration producer, so much so that for the 45 and 49 engines from K & B in the USA and OS in Japan, special devices are used to balance out the reciprocating parts. If any vibration is present then the weak point is the linkage and possible seizure of the push-pull action which is common, may result. Always use stout push rods, always allow for adjustments and do keep it simple, especially at fairleads where the rods pass through the main bulkhead into the body of the model. This is very important when the clockwork escapement by Fred Rising is used, not that the power is limited ; but simply the radius of pawl movement is small and if there is any drag on the rod it may "hang up" and overload the spring. There is nothing more annoying than being stuck in low speed a long way from base on an otherwise perfectly functioning model.

The diesel does react fairly well to exhaust control : but very good results are obtainable from a flapper in the carburettor intake, as shown in the Allen-Mercury 15. This is a very fine unit for 36 in. to 54 in. span models, offering a good range of speed control with utter reliability, much better in fact than any





Two of the nicest to control, at left the Taplin Twin Mark one 7 c.c. diesel with best of all the throttles and at the right of it is the Veco 35 with chopper action exhaust control and couple carburettor intake throttle.

of the ·09 glowplug engines of nearly the same capacity. Diesels tend to be more messy, but why not Araldite an exhaust duct bent from thin aluminium, on to the crankcase? The author's has served well.

Using an escapement with four pawls one can have the blessing of three set speeds, Slow, Medium, Fast and back again through Medium to Slow. This allows Fast for take off, Medium for the cruise and Slow for the landing. With a trim type servo on two channels of multi-channel operation, one can employ the full range of speed control in larger models. We shall not delve into the radio controlled selection of engine speeds, that is a subject unto itself but summarise now, a few bench running impressions and tables of figures which have been gleaned over the past three years since the original article appeared.

We deal first with the engine which is the very epitome of ideal speed control, the :-

Taplin Twin 7 c.c.

Requires very careful tuning for synchronous compression of the cylinders, an art soon learned. Symptom of bad comp settings is the tendency to stop rotation and begin oscillatory action at extreme low speed. Needle is insensitive, throttle arm delightfully in command of r.p.m. Airbleed ideal for slow settings. Exhaust is treacly, use a pipe to the fuselage base, or lower.

OS Max 35

Is gasket failure prone on long low speed runs. Has excellent control, and speed range, being best with a plug that brings the element low in the compression chamber.

Veco 35

Delightful to handle, stops abruptly when the slow speed ideal setting is passed, runs hot and needs the Veco shielded plug for best results. Has good reliability but one must sacrifice some low speed revs due to tendency to reject fuel with blow back at low limit.

Merco 35

As fine on control as it is handsome to the eye. Smooth in speed change, clean running and the easiest of all to adjust. Better on 12 in. or less propeller diameters.

HIGH-LOW FIGURES (10 c.c.-6 c.c.)

for throttled engines, all figures being the mean of four readings and to the level of consistency, not ultimate speeds

ENGINE	SPEED CONTROL	14 × 6	13 × 8	12 × 6	12 × 5	12 × 4*	10 × 6†
Anderson Spitfire 61	None—included for output comparison	6,600	7,600	9,200	10,000	10,500	—
Taplin twin 7 c.c.	Air-bled throttle	5,600 1,750	6,000 1,900	6,400 2,400	6,750 2,500	7,650 2,500	— —
K & B 45‡	Coupled throttle exhaust	6,200 1,900	6,800 1,900	7,600 2,000	7,900 2,450	8,750 2,500	— —
K & B 35 R C	Throttle only	— —	— —	7,500 4,200	7,750 4,500	8,900 3,800	— —
OS Max 35 R C	Coupled throttle exhaust	5,400 41,000	5,900 4,200	8,200 4,750	8,400 4,500	9,250 5,100	12,000 6,100
Super Tigre 35	Bramco throttle	— —	6,000 4,250	8,200 5,000	8,450 5,000	9,300 5,000	— —
Veco 35 R C	Coupled throttle exhaust	5,000 3,400	6,000 3,400	7,800 3,000	8,200 3,000	8,600 3,700	11,400 4,600
Fox 35 R C	Exhaust control only	— —	5,700 3,100	7,750 3,300	8,000 4,000	8,200 4,200	— —
Merco 35 R C	Coupled throttle exhaust	— —	— —	8,150 2,800	8,400 2,900	9,300 2,950	11,000 4,200

* These figures also for 11 × 6. † This prop Frog nylon, others PAW wooden

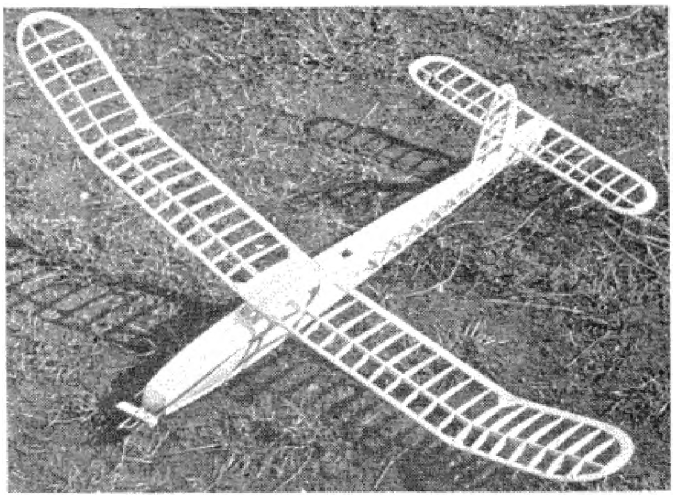
‡ Early production model, new improved approximately 12 per cent.

ENGINE	SPEED CONTROL	12 × 6§	12 × 5§	12 × 5	12 × 4§	11 × 6§
MERCO 49 Prototype first test	Coupled throttle/exhaust	10,000/ 4,300	11,000/ 4,300	1,000/ 4,300	11,600/ 6,000	11,400/ 5,500

§Tornado nylon propellers

HIGH-LOW (3·5 c.c. - 2·5 c.c.)

ENGINE	SPEED CONTROL	10 × 6	10 × 4	9 × 6	9 × 4
Veco 19 R C	Coupled throttle exhaust	8,800 3,400	10,600 3,500/	10,200 3,500	11,800/ 4,000
Fox 19 R C	Exhaust control only	9,000 5,250	10,400 5,500	9,600 6,200	11,500 6,800
Taifun Bison 19	Coupled throttle exhaust	8,400 3,600	10,000 3,800	9,600/ 3,8000	11,950 4,200
Glo-Chief 19 R C	Throttle only	8,500 3,500	9,900 3,700	10,300 4,500	12,200 5,000
Enya 15D-II	Throttle only	8,400 3,000	9,750 3,500	10,000 3,800	11,100 4,500



"WINTER CUP" MODEL

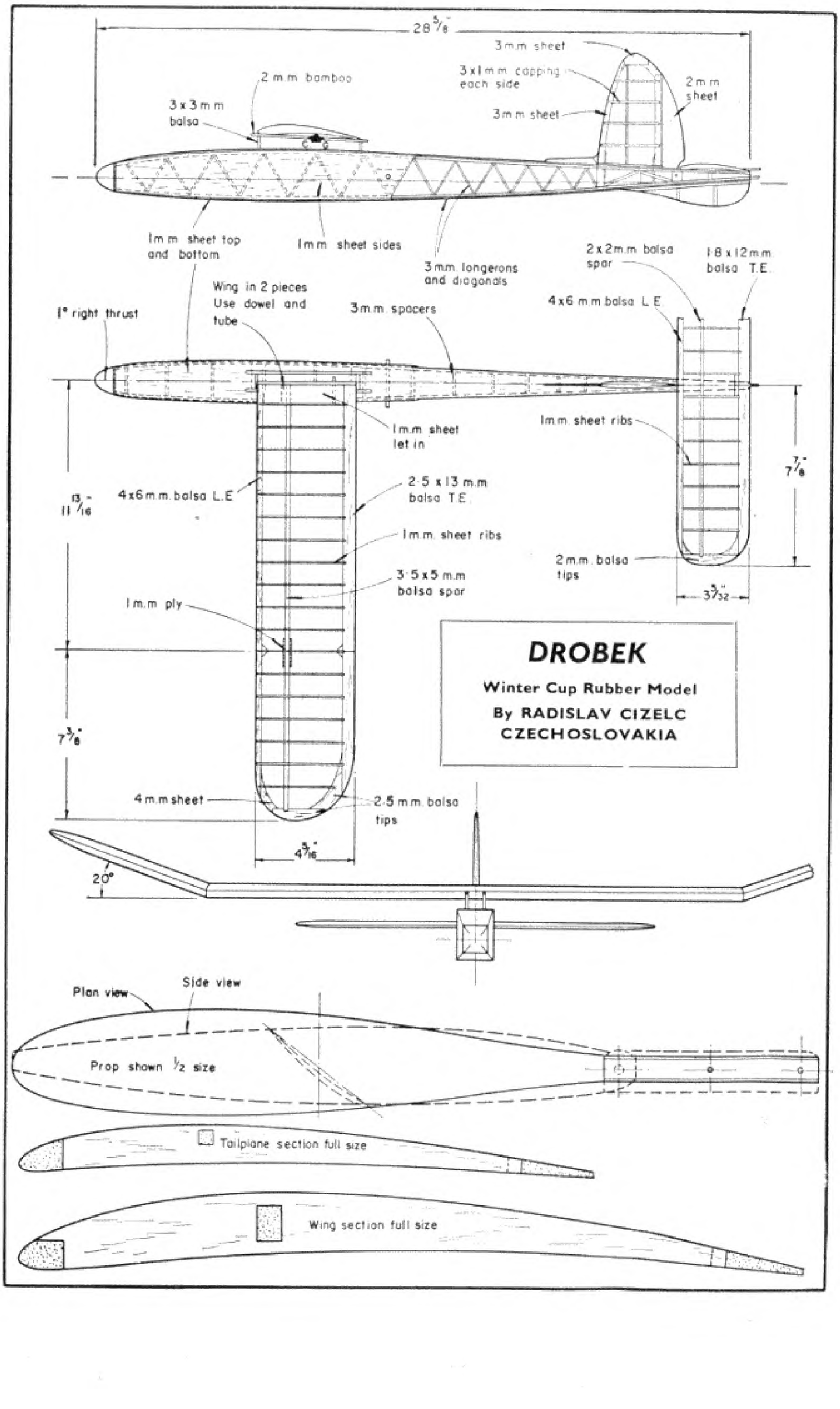
UNDER various names the miniature rubber class evolved by Maurice Bayet of *Modele Reduit d'Avion* in 1939 has been taken up by Finland, Italy, Belgium and Czechoslovakia, whilst in France today some 3,000 models to his "Winter Cup" formula are in active use as against something like fifty or so Wakefield models. An annual event towards the end of February each year regularly attracts over one hundred participants, and the contest has now been held (excluding the war years) eighteen times. Is there something in this for us?

Let us look at the extremely simple formula (reminiscent of wartime "Flight" Cup formula: 5 oz. all up, including 1 oz. rubber, wing area not exceeding 144 sq. in.). Minimum weight, ready to fly: 80 gms. (2·82 oz.). Maximum weight of lubricated rubber: 10 gms. (0·352 oz.). Minimum Cross-section of largest X-section: 20 sq. cm. (3·1 sq. ins.). R.O.G. compulsory, holding model by wing and prop tips. Three flights obligatory, limited to 120 seconds each. (Other countries following the formula have adapted it to current F.A.I. rules, omitting R.O.G. and in some cases minimum cross-section rule.)

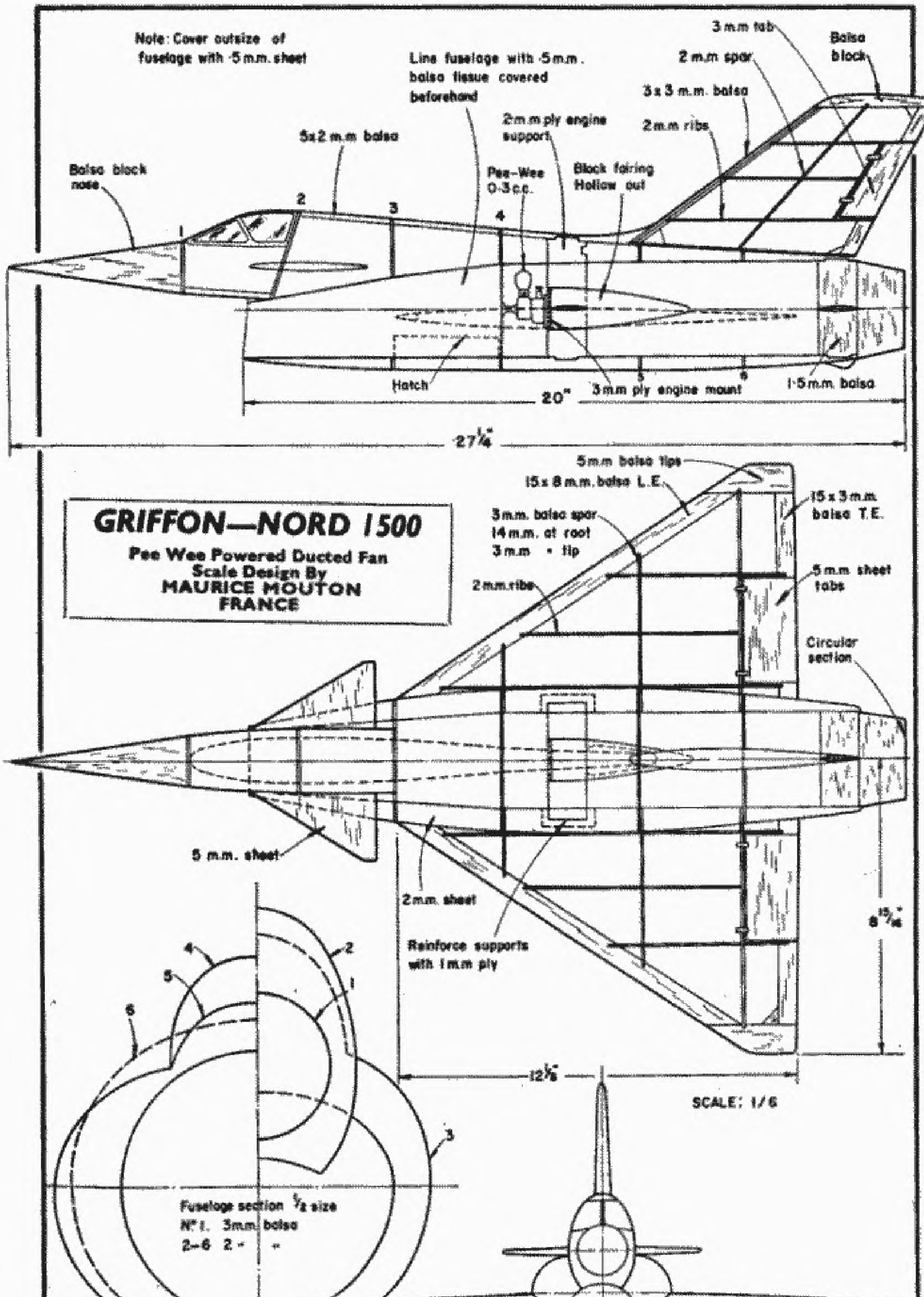
It looks something of a teaser! The low rubber allowance means light construction, and it is surprising therefore that it should be flourishing as a *Junior* Rubber class in some of the countries which have copied the basic requirements. However, 3,000 Frenchmen can't be wrong, and winning times of 1959 and 1960 in France were 118·8, 120, 58·6 total 297·4 (110 entries 105 starters) and 120, 120, 105·6 total 345·6 (138 entries 127 starters 96 scorers). Significant is the fact that out of 230 contestants no one in the two years noted achieved a three-flight max., nor were there any fly-offs. This suggests that time of year limited "lucky" flights by absence of thermals, and that two minute max. allowed is not as easy to achieve as the experts over here might think. Also, and this we feel is a "bull point", it is an event which does not require a vast space in which to fly. We need more small field events and believe this is one for a start.

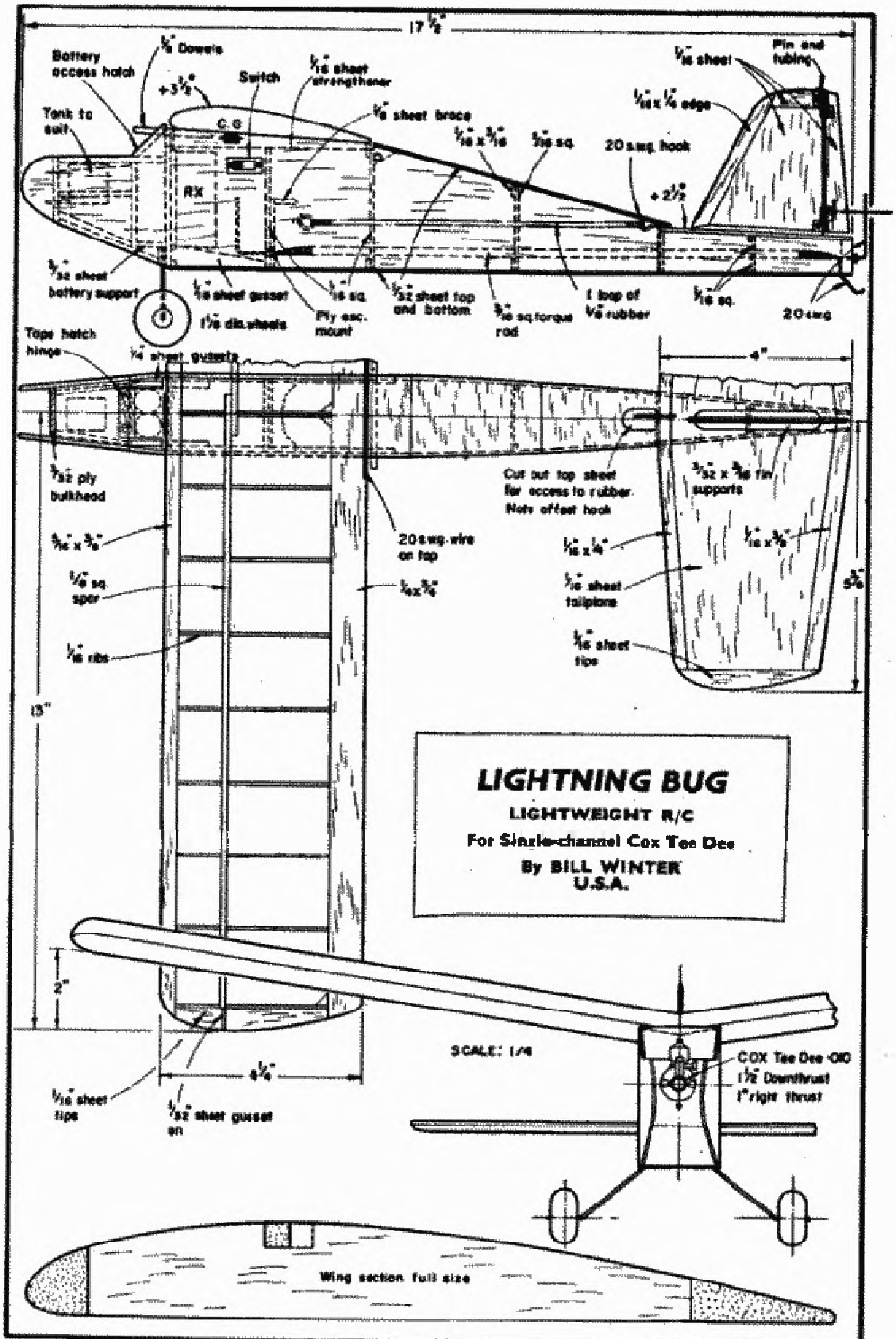
Aeromodeller will be featuring some suitable designs in the next few months, since we would like to accept a magazine/international challenge from our friends M.R.A. in France. Meanwhile, we offer an exclusive design by that well-known Czech all-rounder Radislav Cizek. His *Drobek* on the next page follows the no u/c style but has enough of interest to start you thinking. All up weight of *Drobek* is 106 gms. (min. 100), prop. is a folder—you need all the freewheeling glide you can get—and fuselage construction is light but robust, with a fairly short rubber length between hooks.

Going to have a go? And the best of Gallic luck. . . .



28 5/8"
3 m.m. sheet
3 x 1 m.m. capping each side
2 m.m. sheet
3 m.m. sheet
2 m.m. bamboo
3 x 3 m.m balsa
1 m.m. sheet top and bottom
1 m.m. sheet sides
3 m.m. longerons and diagonals
2 x 2 m.m. balsa spar
1·8 x 12 m.m. balsa T.E.
Wing in 2 pieces Use dowel and tube
1° right thrust
3 m.m. spacers
4 x 6 m.m. balsa L.E.
1 m.m. sheet let in
1 m.m. sheet ribs
7 7/8"
11 13/16"
4 x 6 m.m. balsa L.E.
2·5 x 13 m.m. balsa T.E.
1 m.m. sheet ribs
2 m.m. balsa tips
3·5 x 5 m.m. balsa spar
3 5/32"
1 m.m. ply
DROBEK
Winter Cup Rubber Model
By RADISLAV CIZELC
CZECHOSLOVAKIA
7 3/8"
4 m.m. sheet
2·5 m.m. balsa tips
4 5/16"
20°
Plan view
Side view
Prop shown 1/2 size
Tailplane section full size
Wing section full size


Note: Cover outsize of fuselage with ·5 m.m. sheet
Line fuselage with ·5 m.m. balsa tissue covered beforehand
3 m.m tab
Balsa block
2 m.m spar
3 x 3 m.m. balsa
2 m.m ply engine support
2 m.m ribs
5x2 m.m balsa
Balsa block nose
Pee-Wee 0·3 c.c.
Block fairing Hollow out
Hatch
20"
3 m.m ply engine mount
1·5 m.m. balsa
27¼"
5 m.m balsa tips
15 x 8 m.m. balsa L.E.
15 x 3 m.m. balsa T.E.
3 m.m. balsa spar 14 m.m. at root 3 m.m " tip
2 m.m. ribs
5 m.m sheet tabs
Circular section
GRIFFON—NORD 1500
Pee Wee Powered Ducted Fan
Scale Design By
MAURICE MOUTON
FRANCE
5 m.m. sheet
2 m.m. sheet
Reinforce supports with 1 m.m ply
12⅝"
SCALE: 1/6
Fuselage section ½ size
N° 1. 3 m.m. balsa
2–6 2 " "



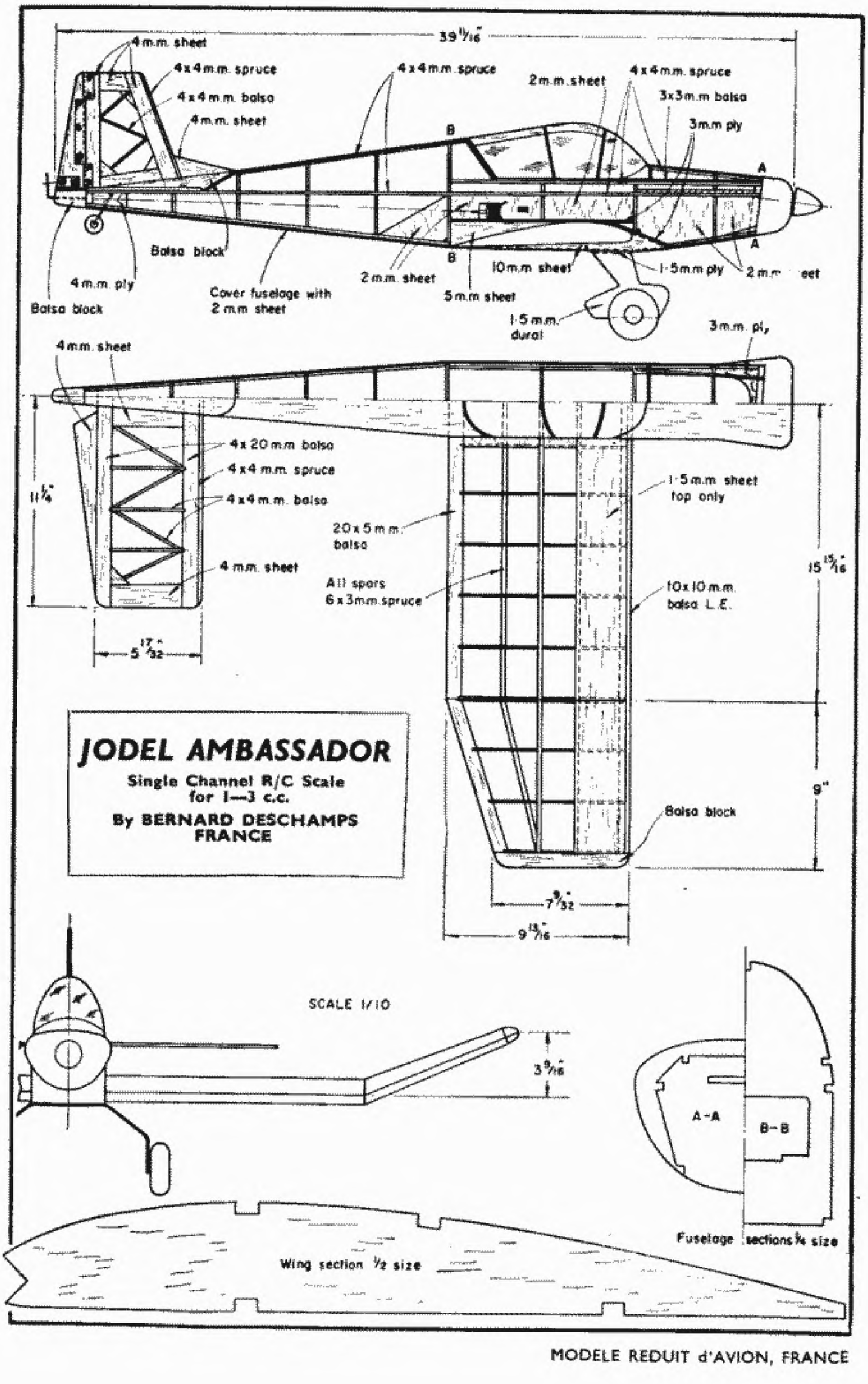
LIGHTNING BUG

LIGHTWEIGHT R/C

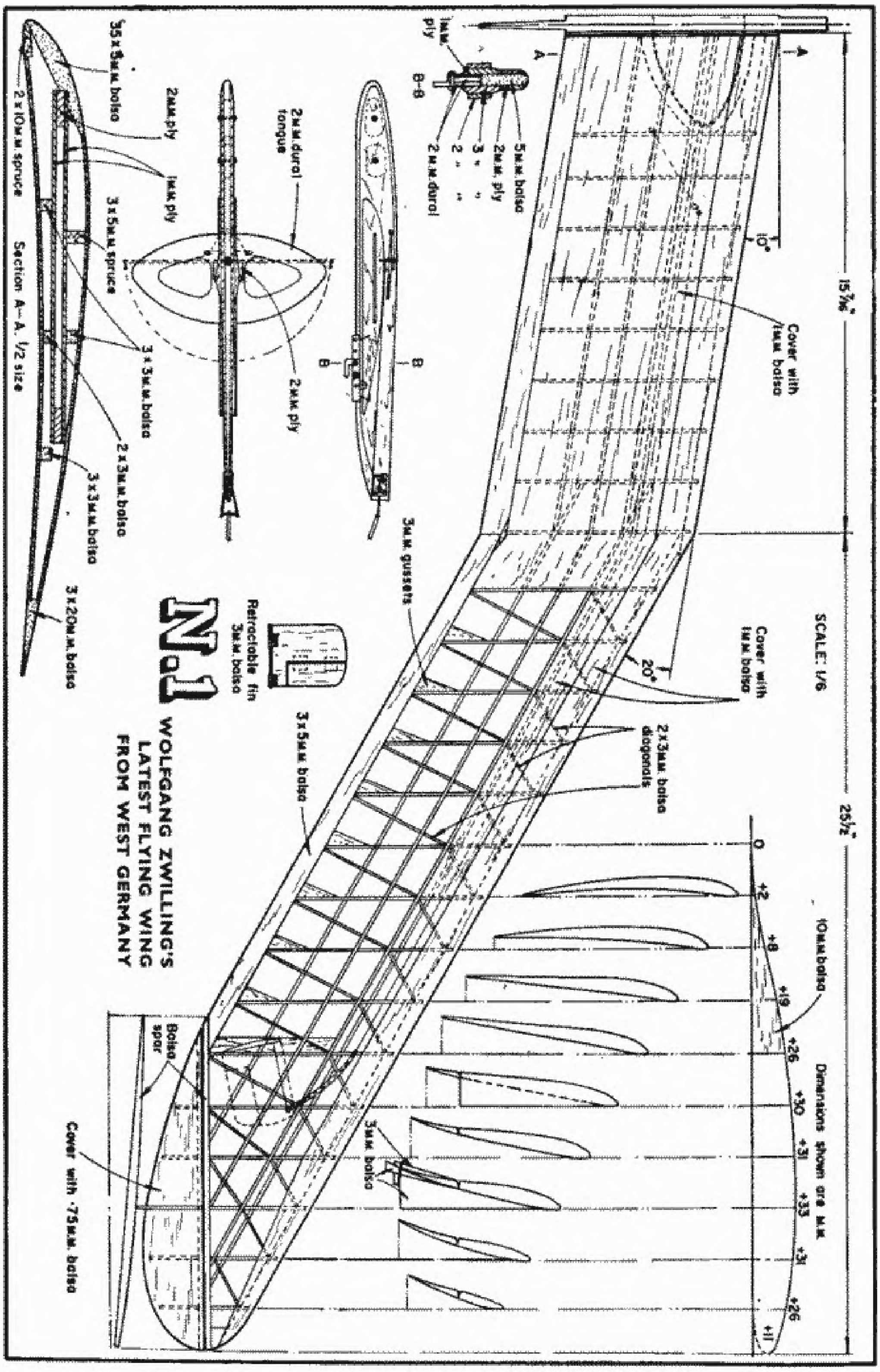
For Single-channel Cox Tee Dee

By BILL WINTER U.S.A.

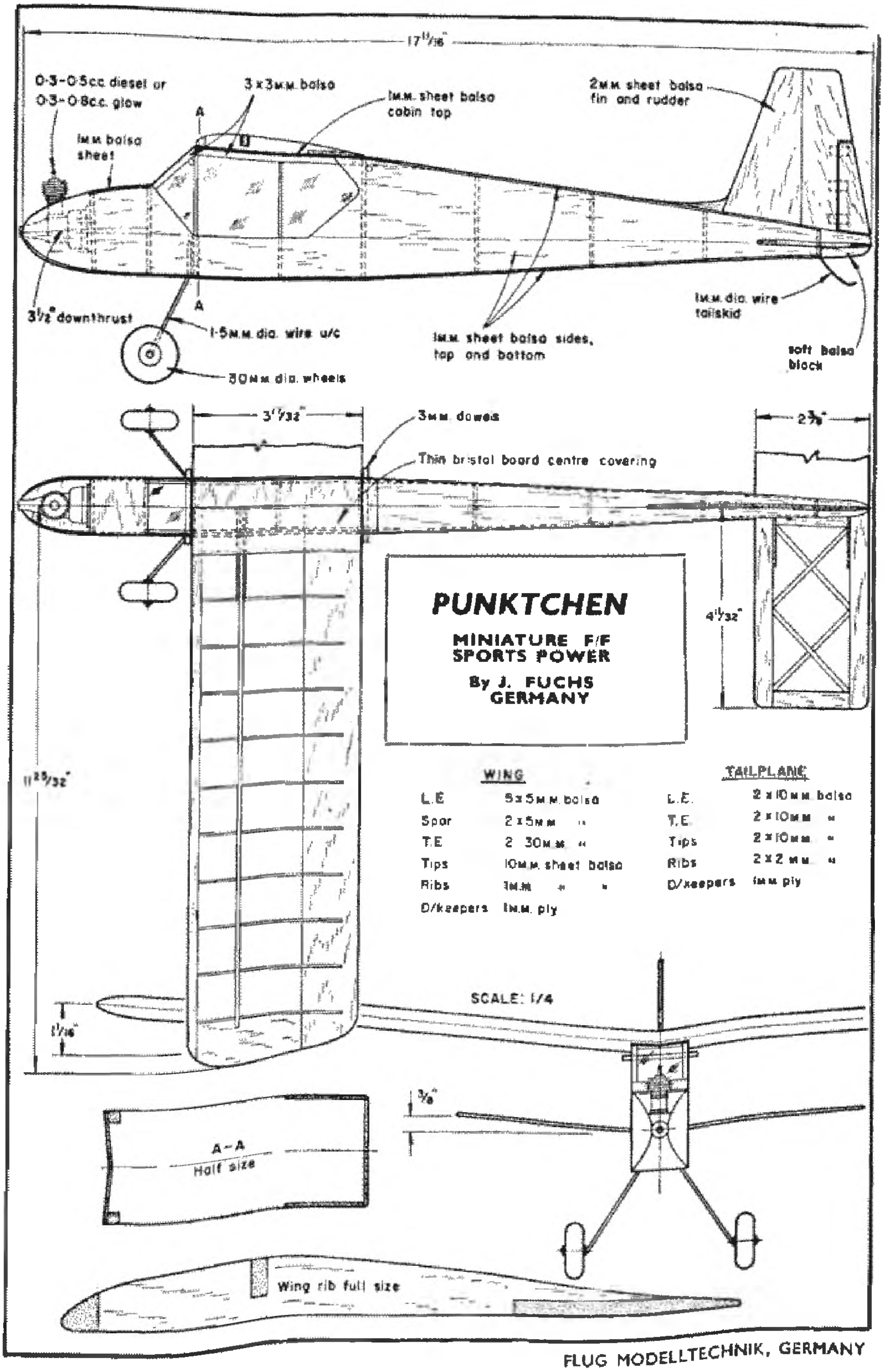
MODEL AIRPLANE NEWS U.S.A.



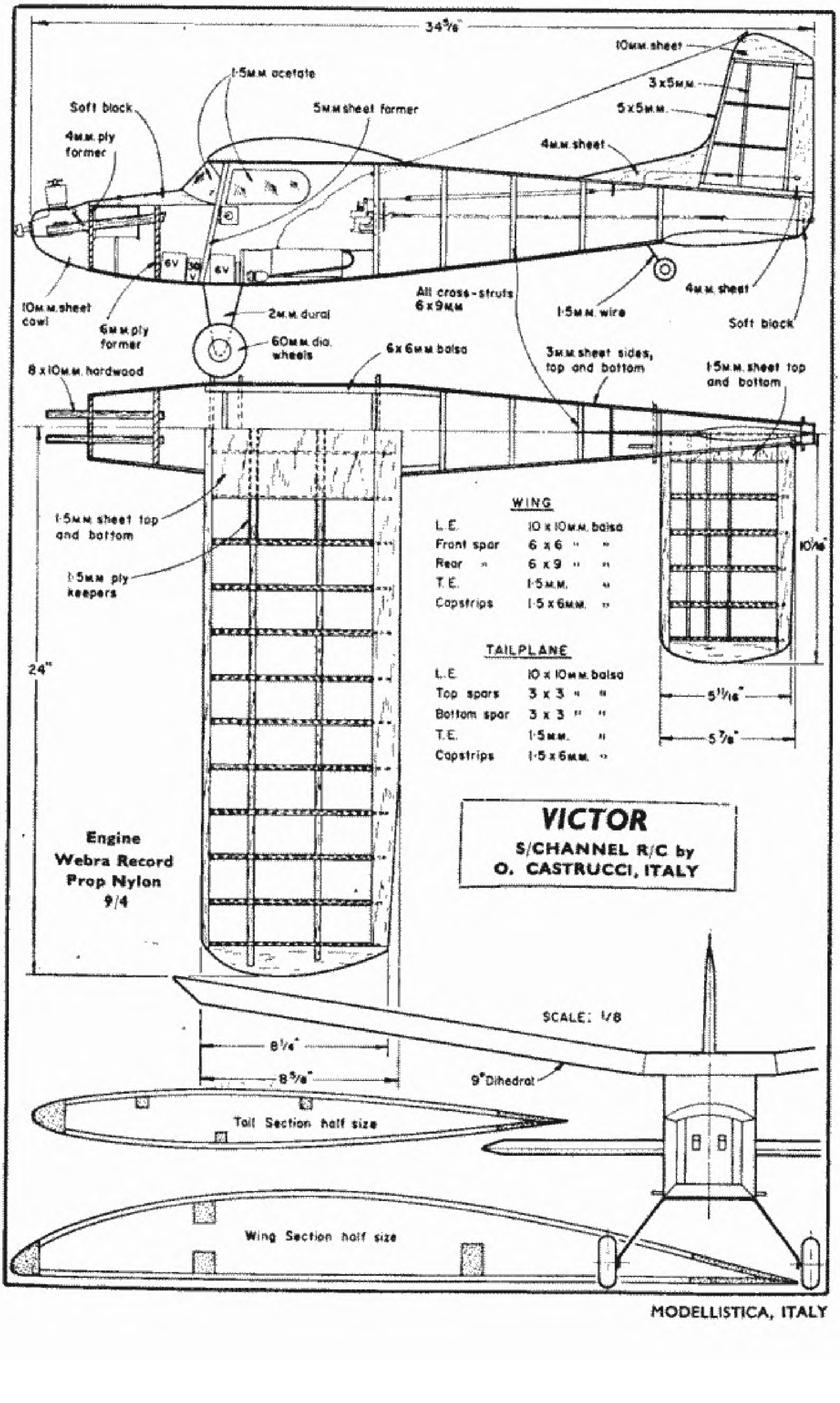
MODELE REDUIT d'AVION, FRANCE



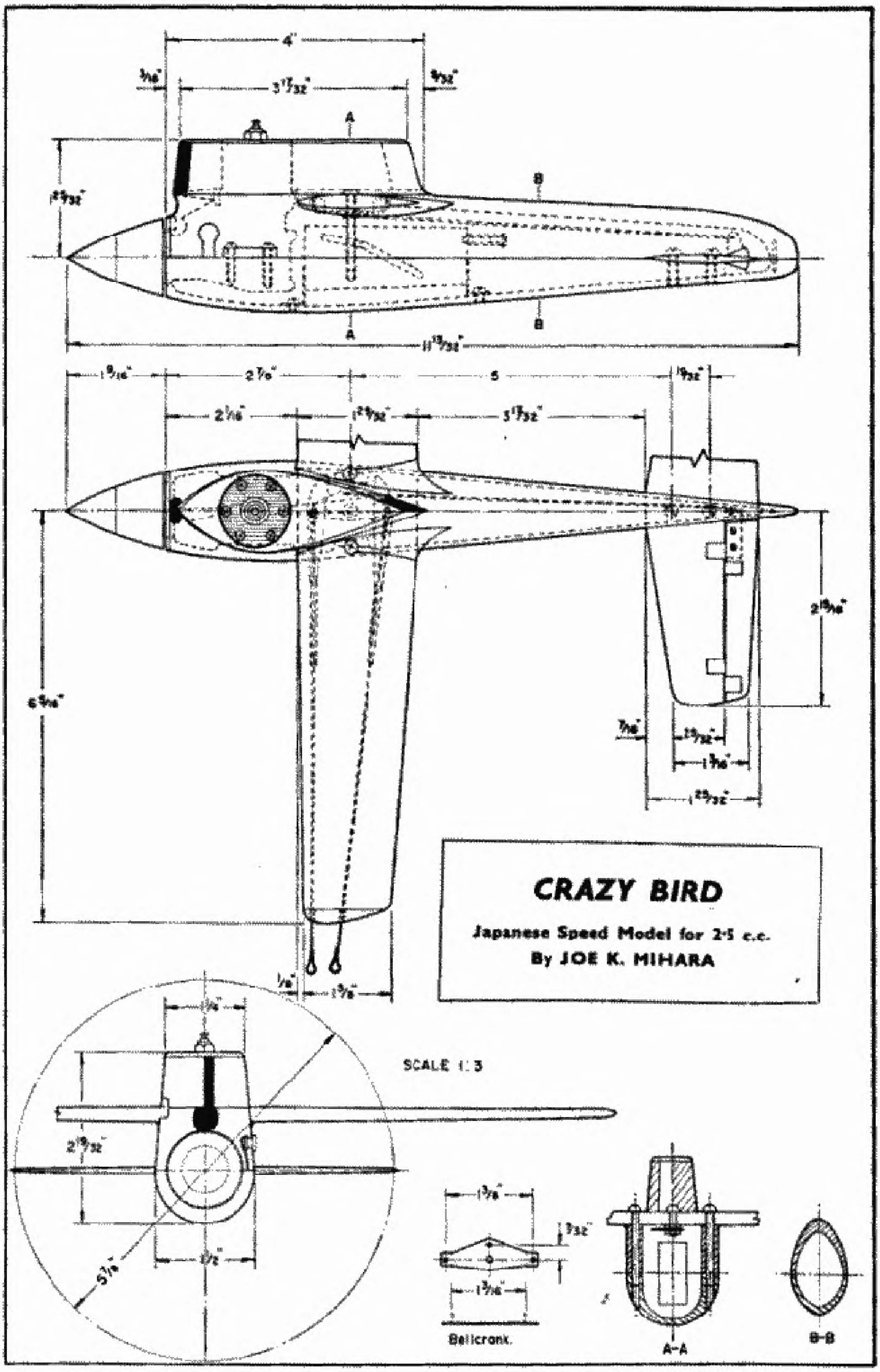
MECHANIKUS, W GERMANY



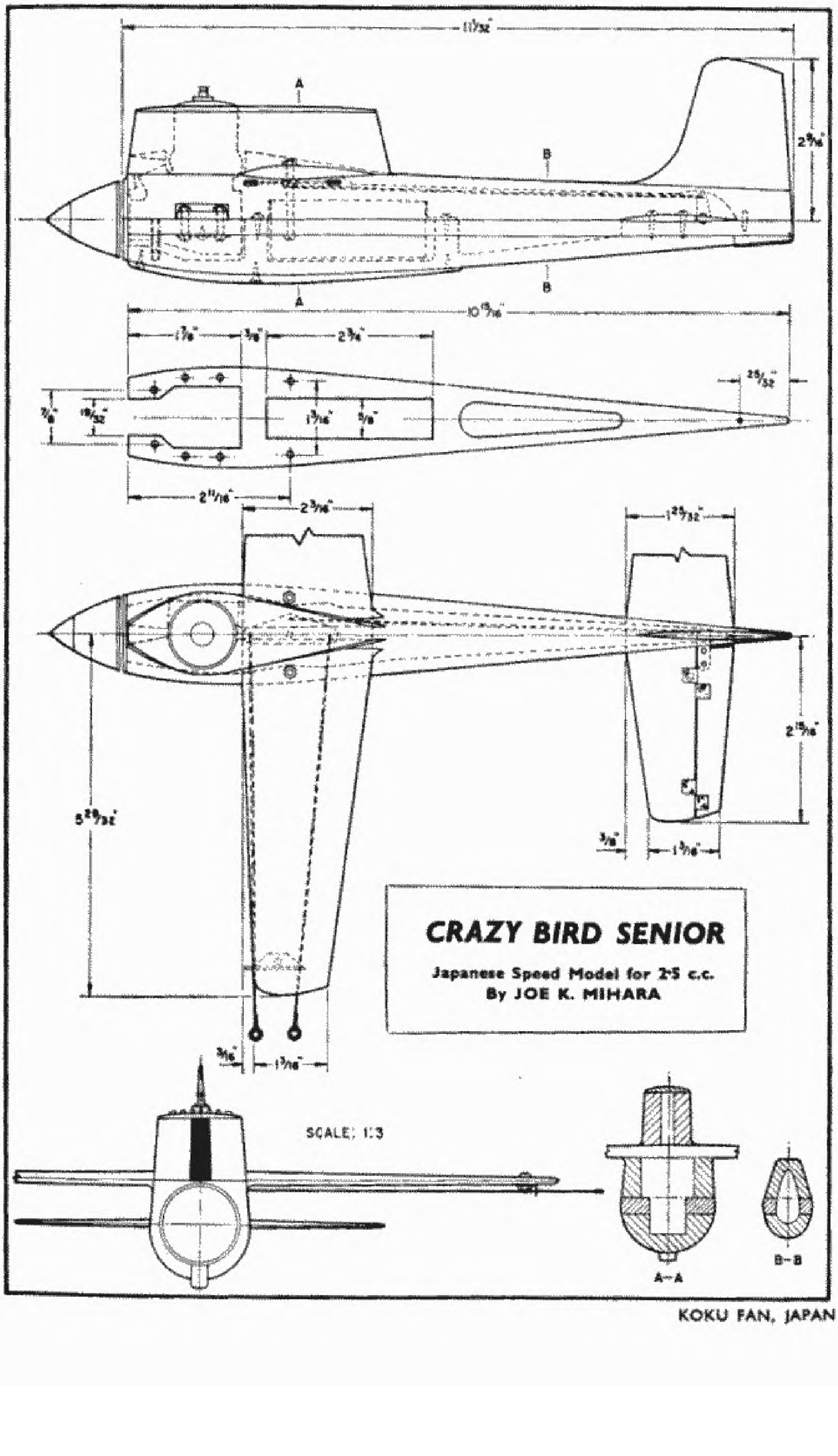
FLUG MODELLTECHNIK, GERMANY



MODELLISTICA, ITALY



KOKU FAN, JAPAN



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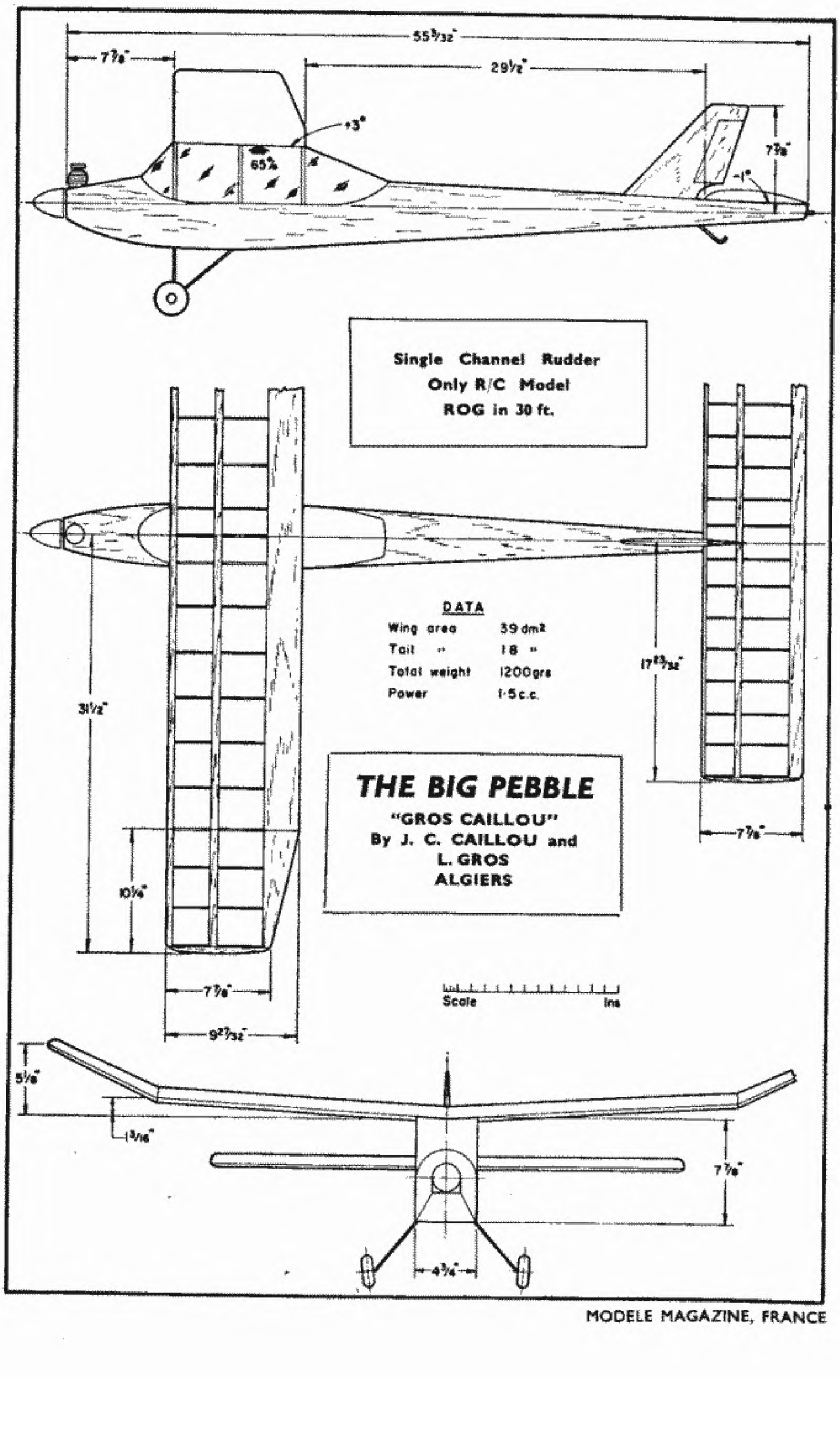
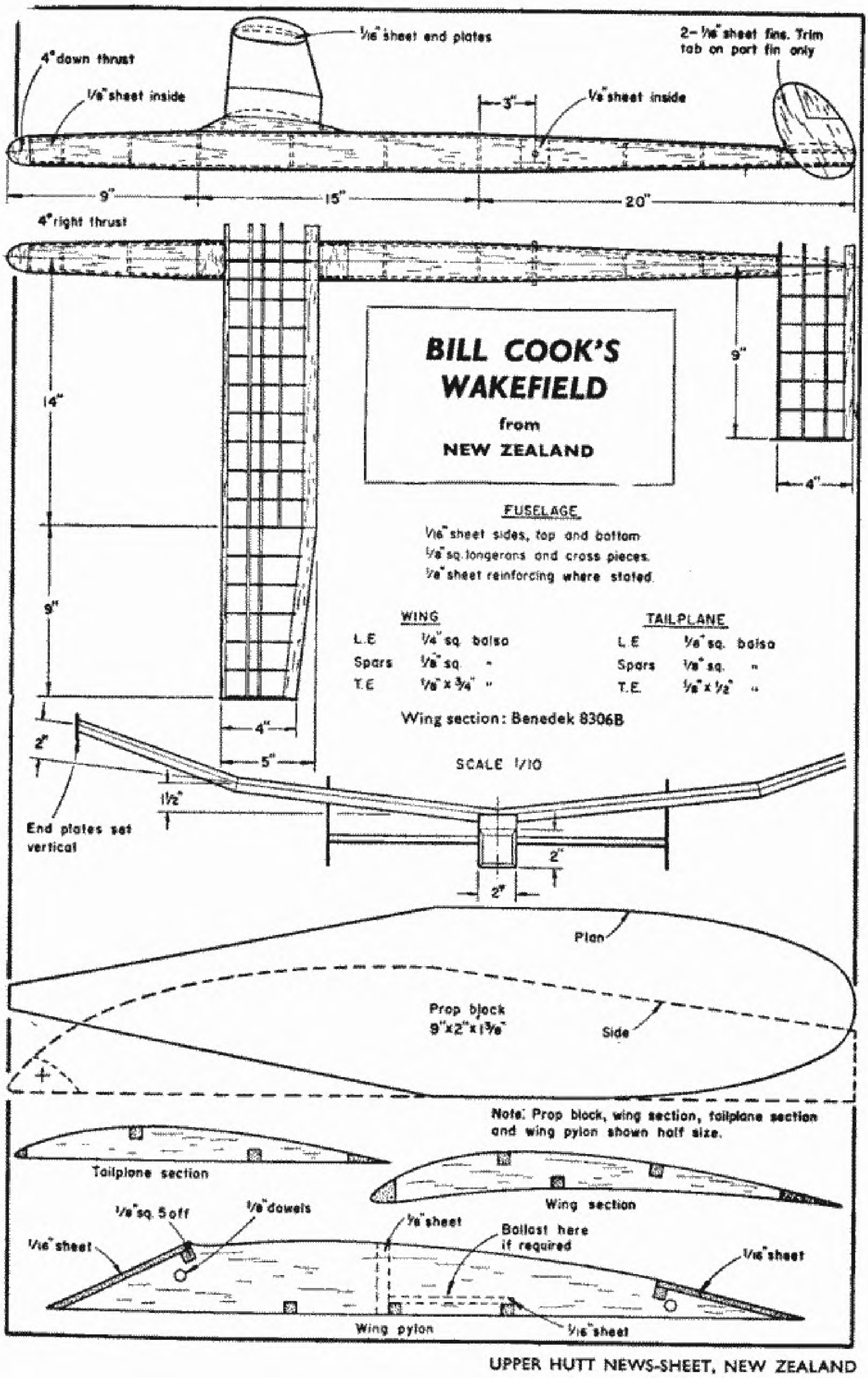
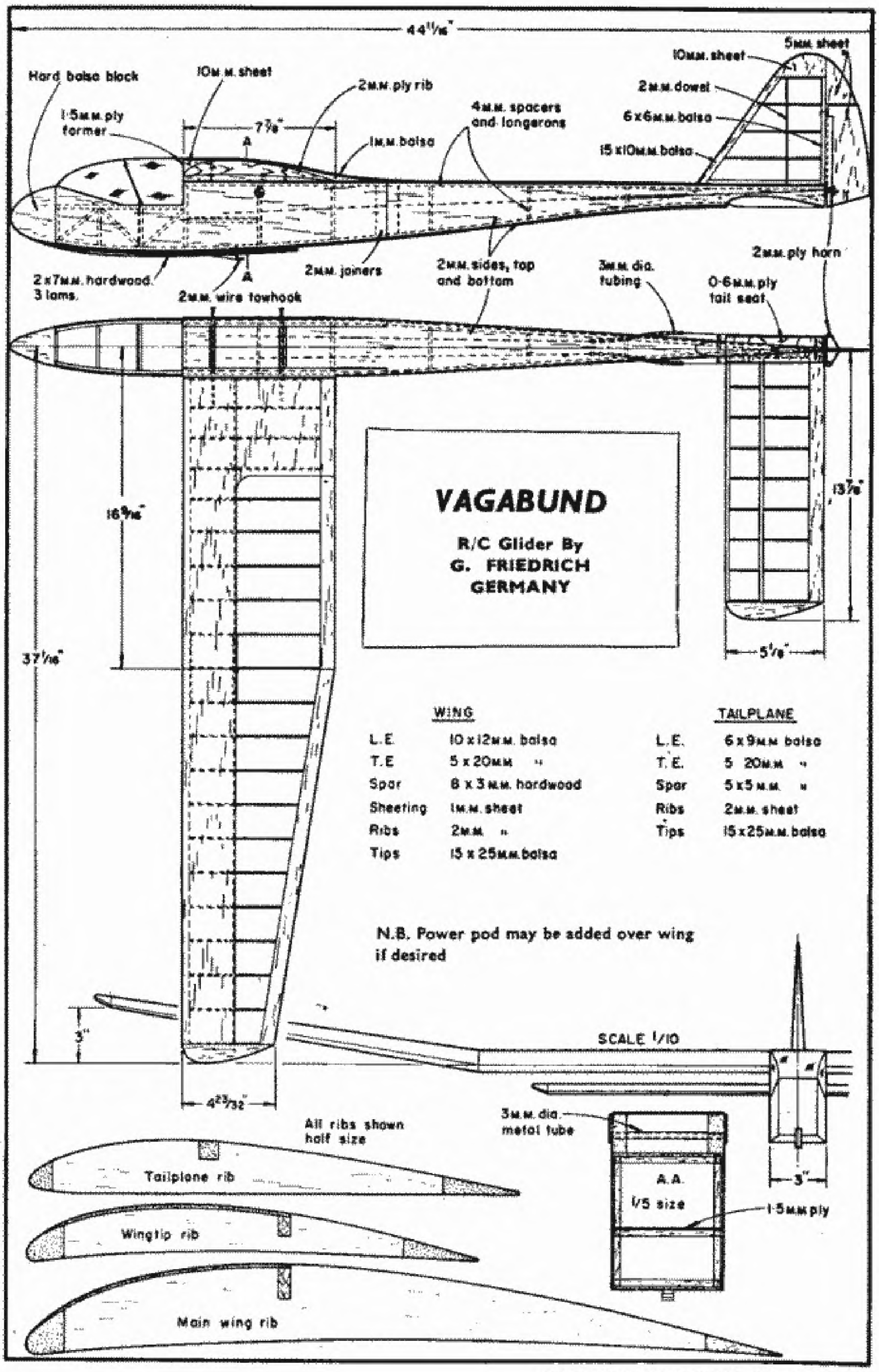


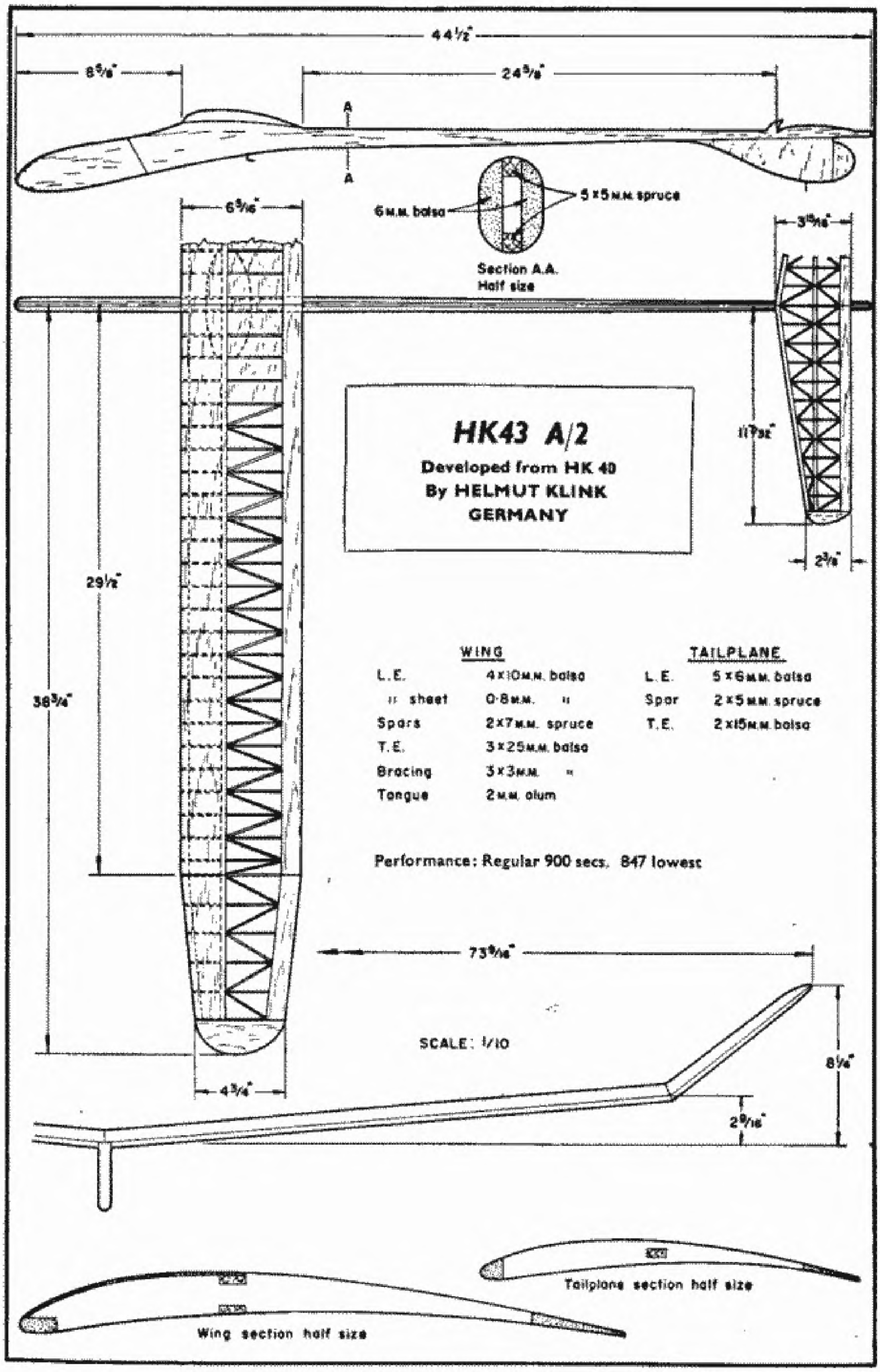
MODELE MAGAZINE, FRANCE



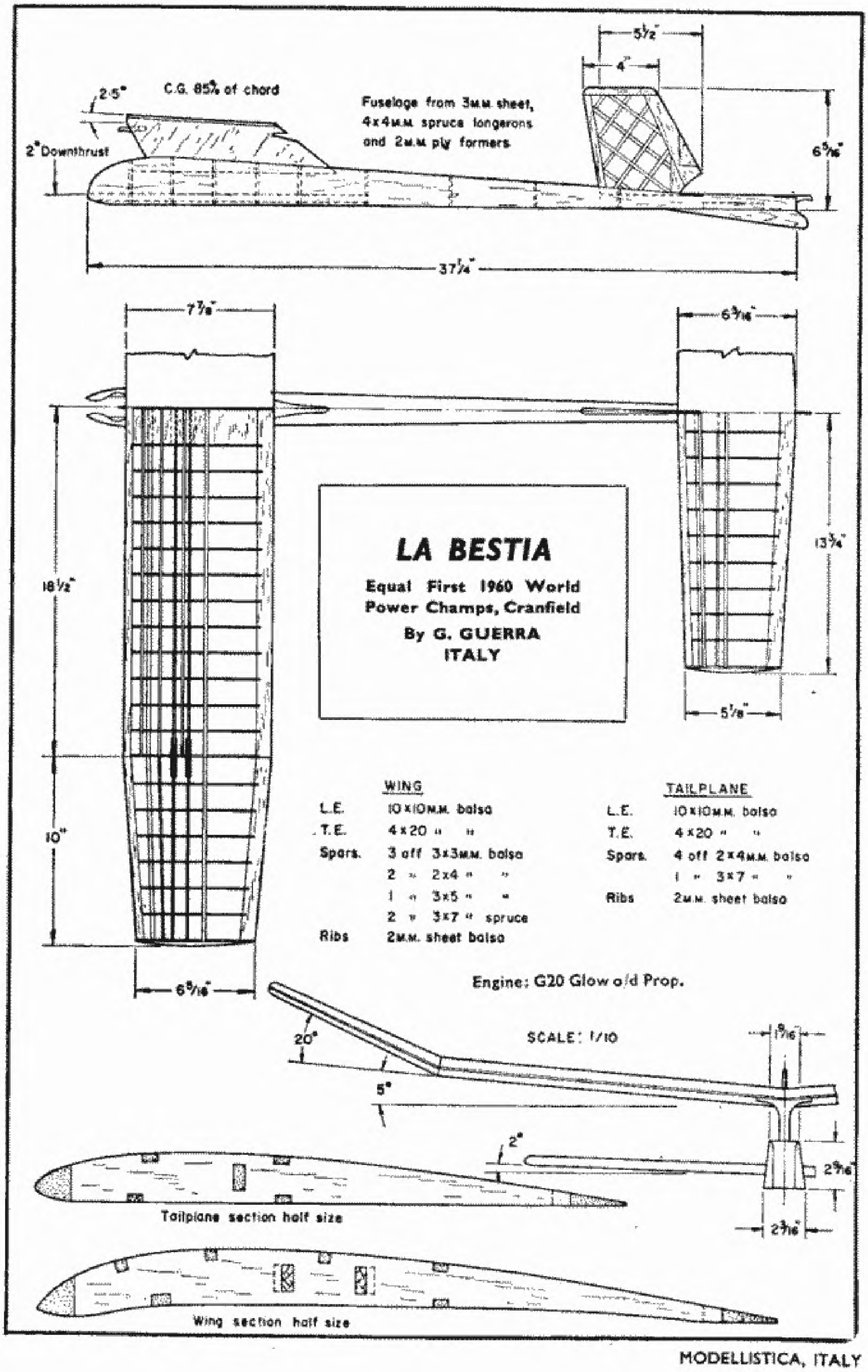
UPPER HUTT NEWS-SHEET, NEW ZEALAND



FLUG MODELLTECHNIK, W. GERMANY



MECHANIKUS, W. GERMANY



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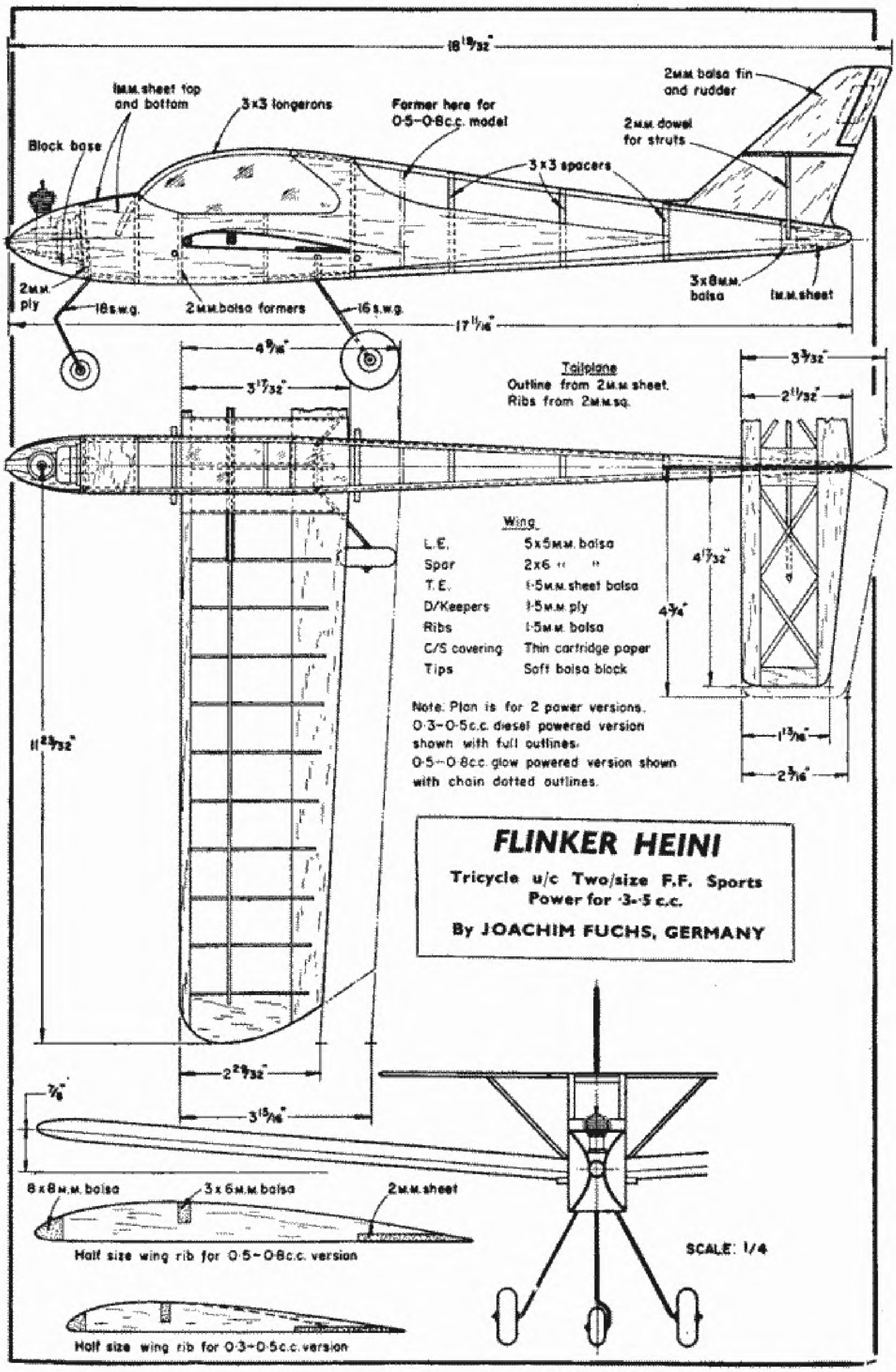
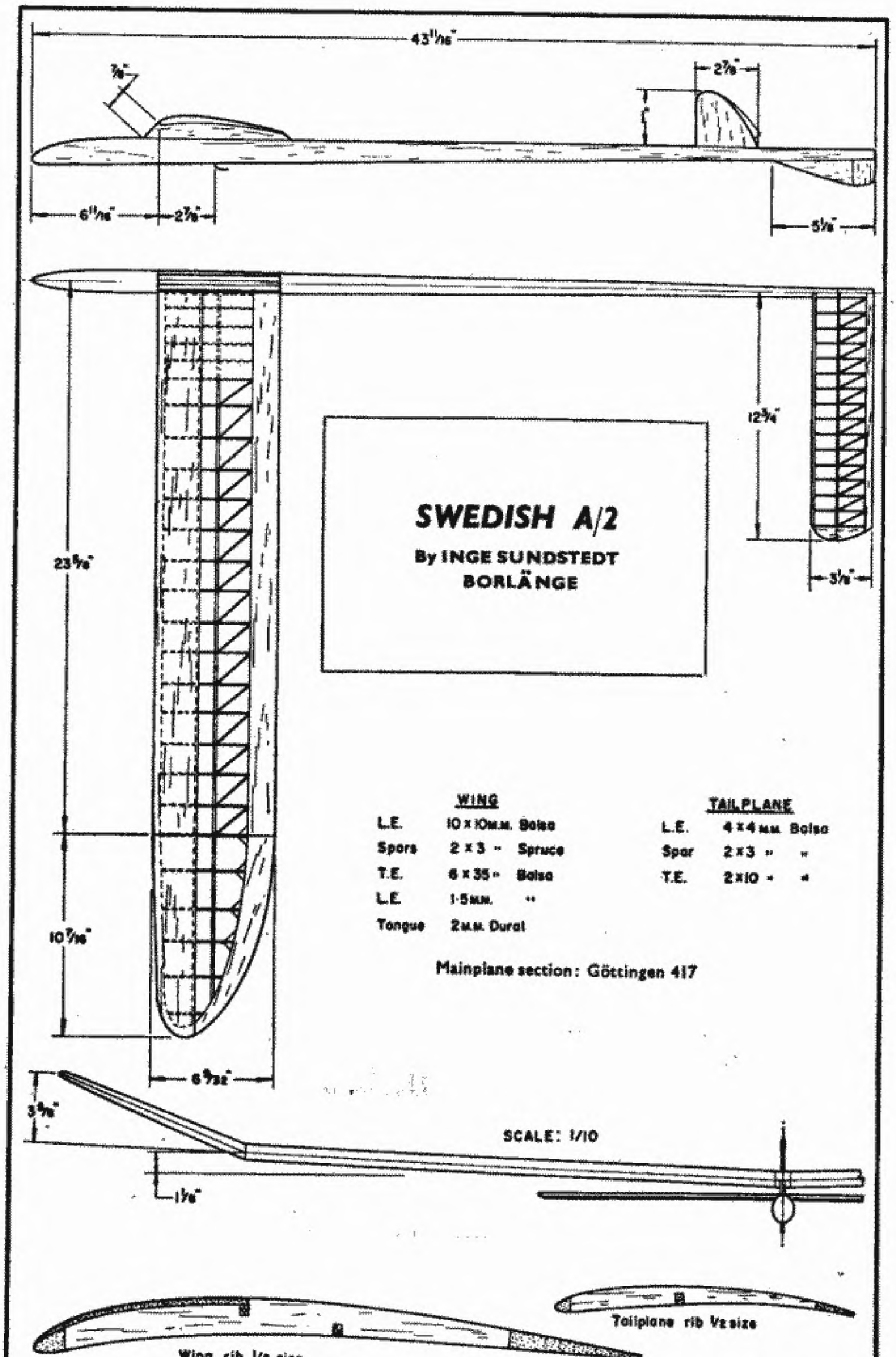
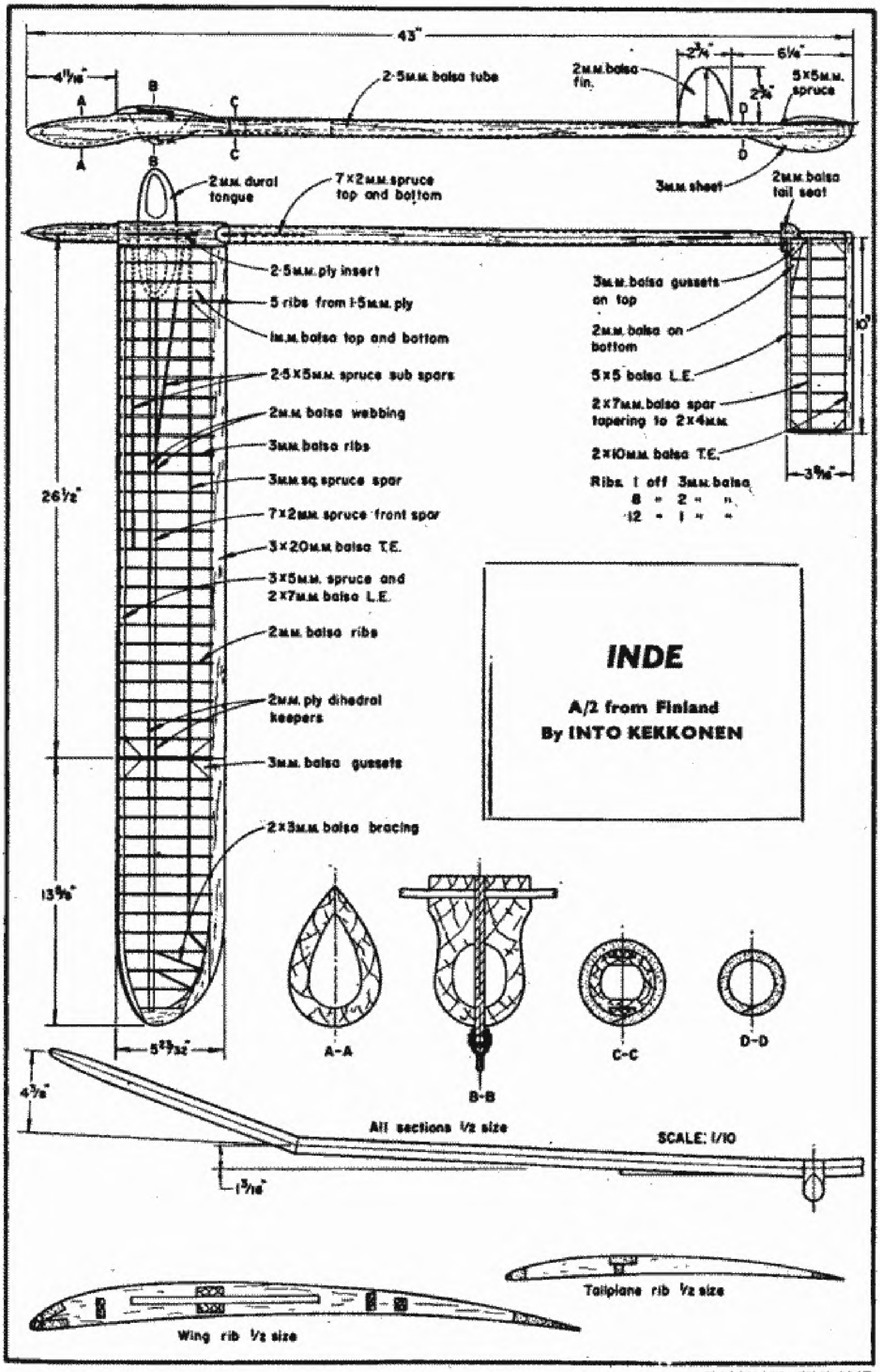


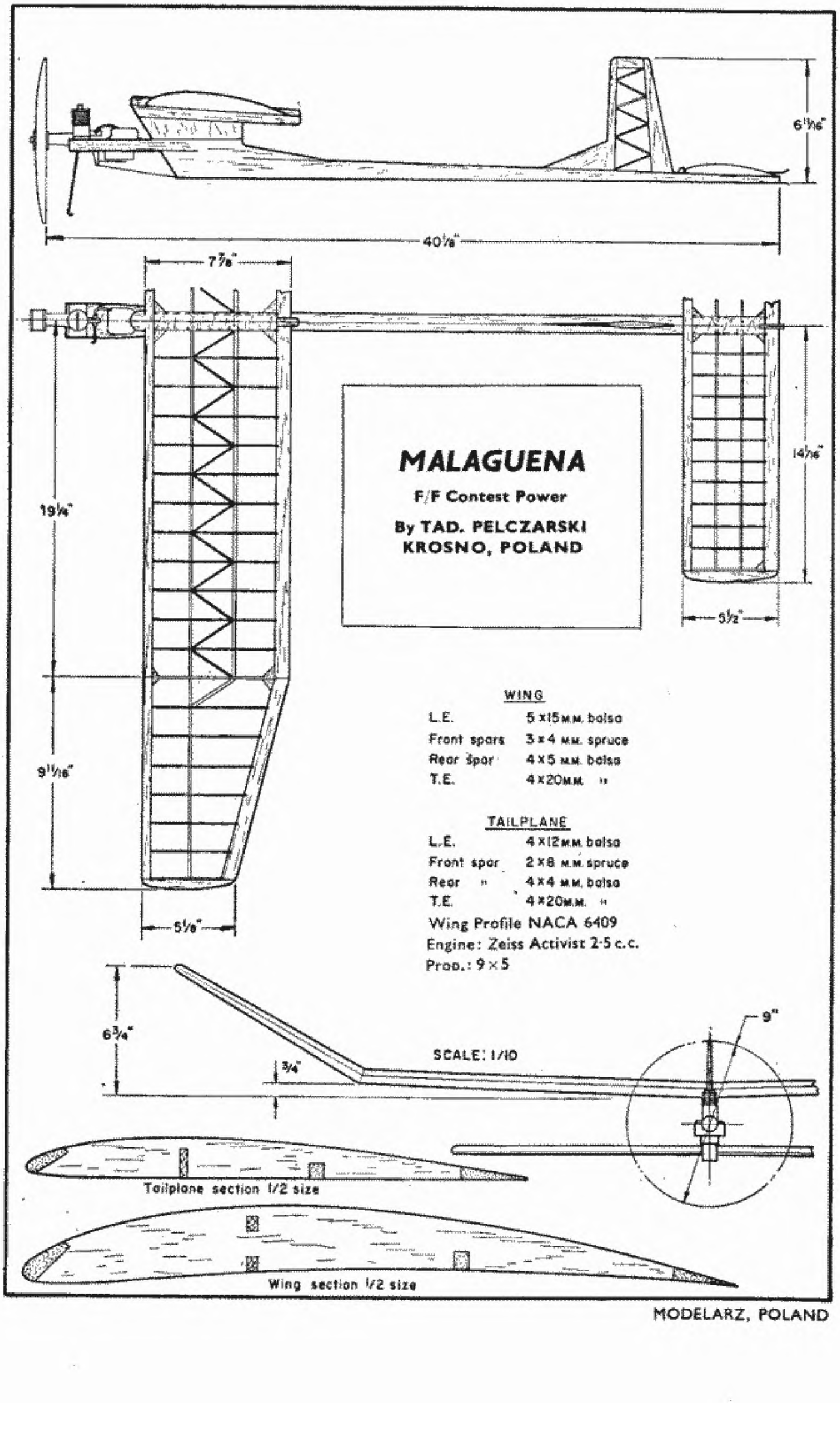
FLUG MODELLTECHNIK, W. GERMANY



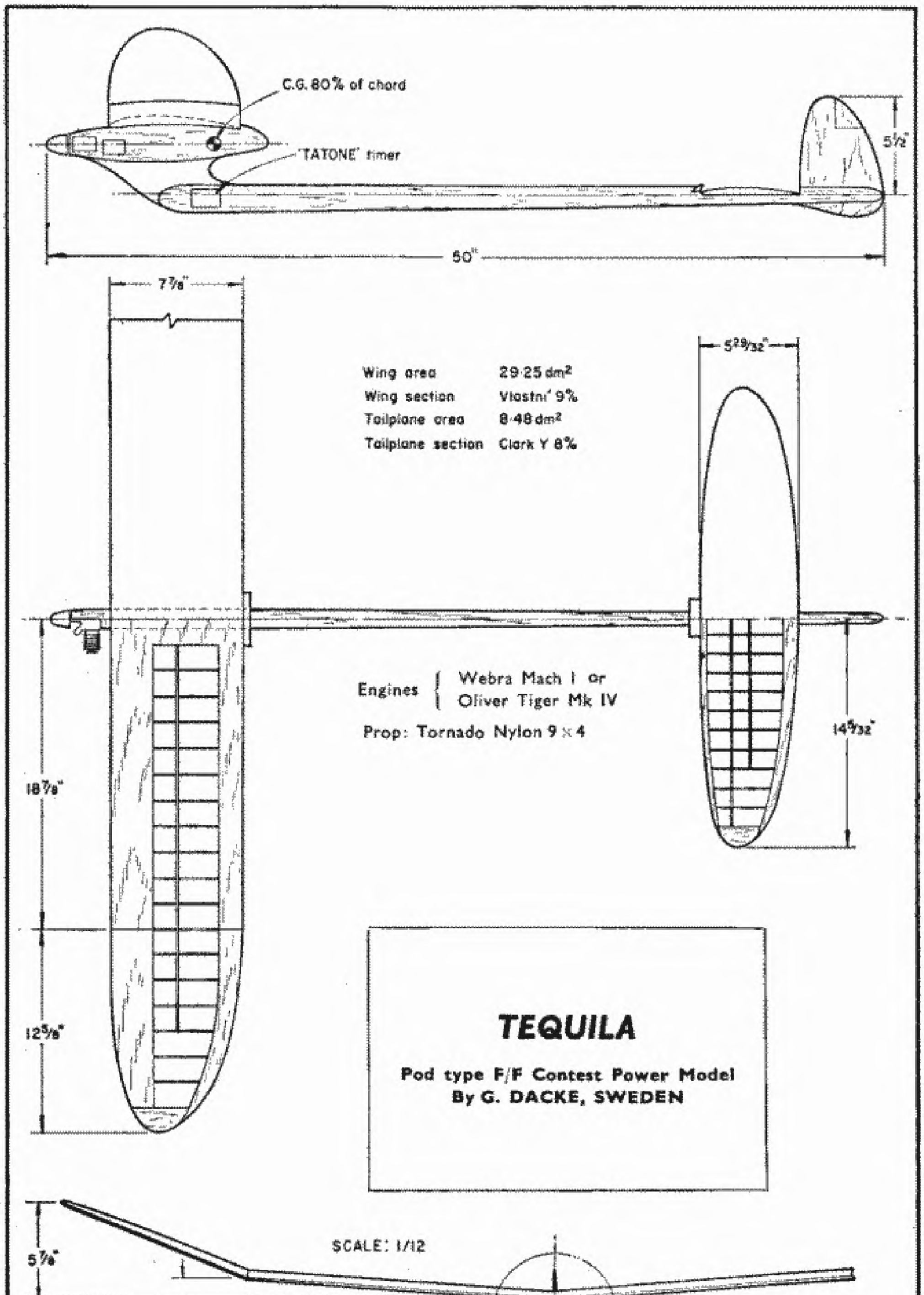
MODELFLYGBLADET, SWEDEN



ILMAILLU, FINLAND



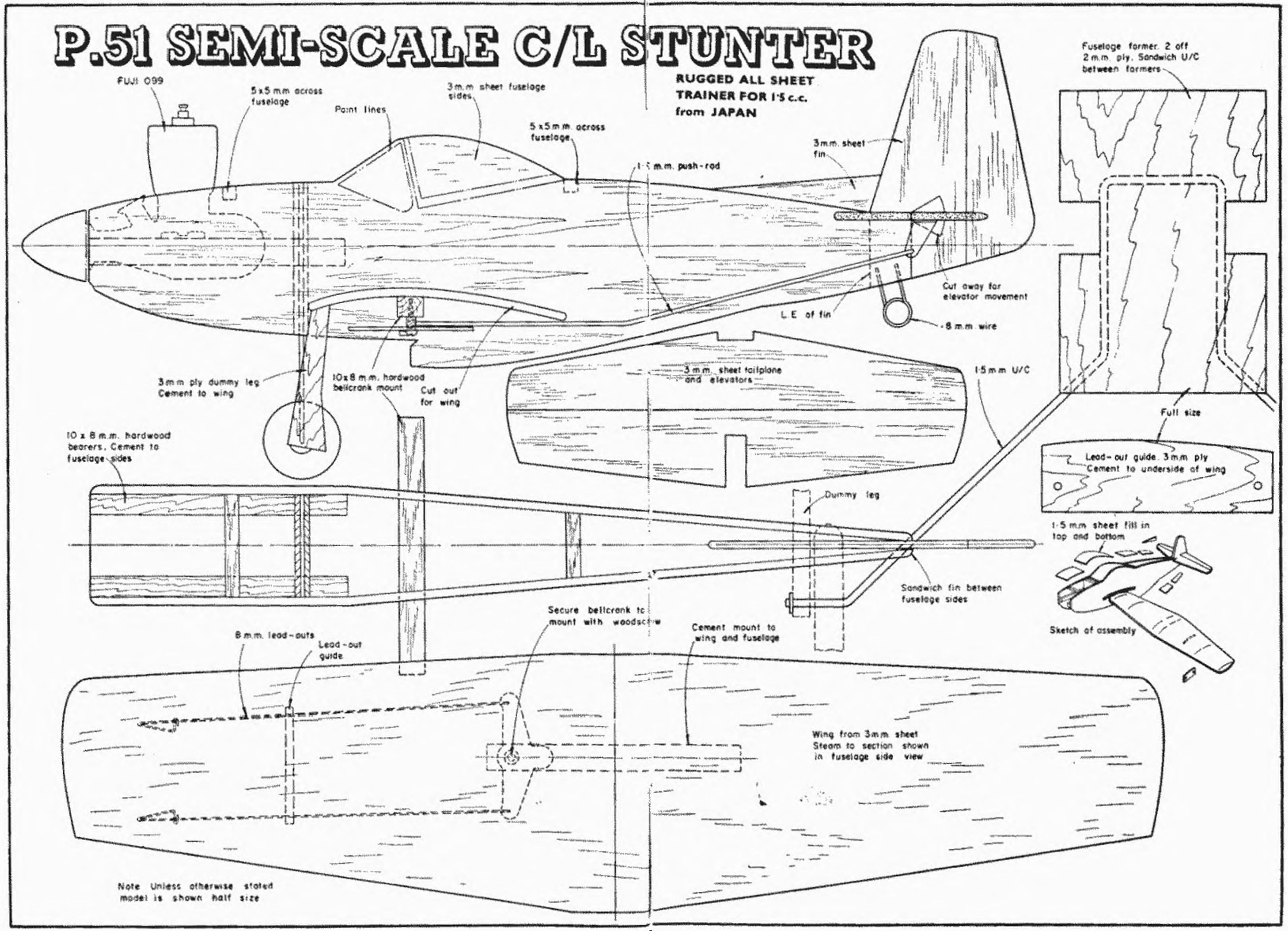
MODELARZ, POLAND



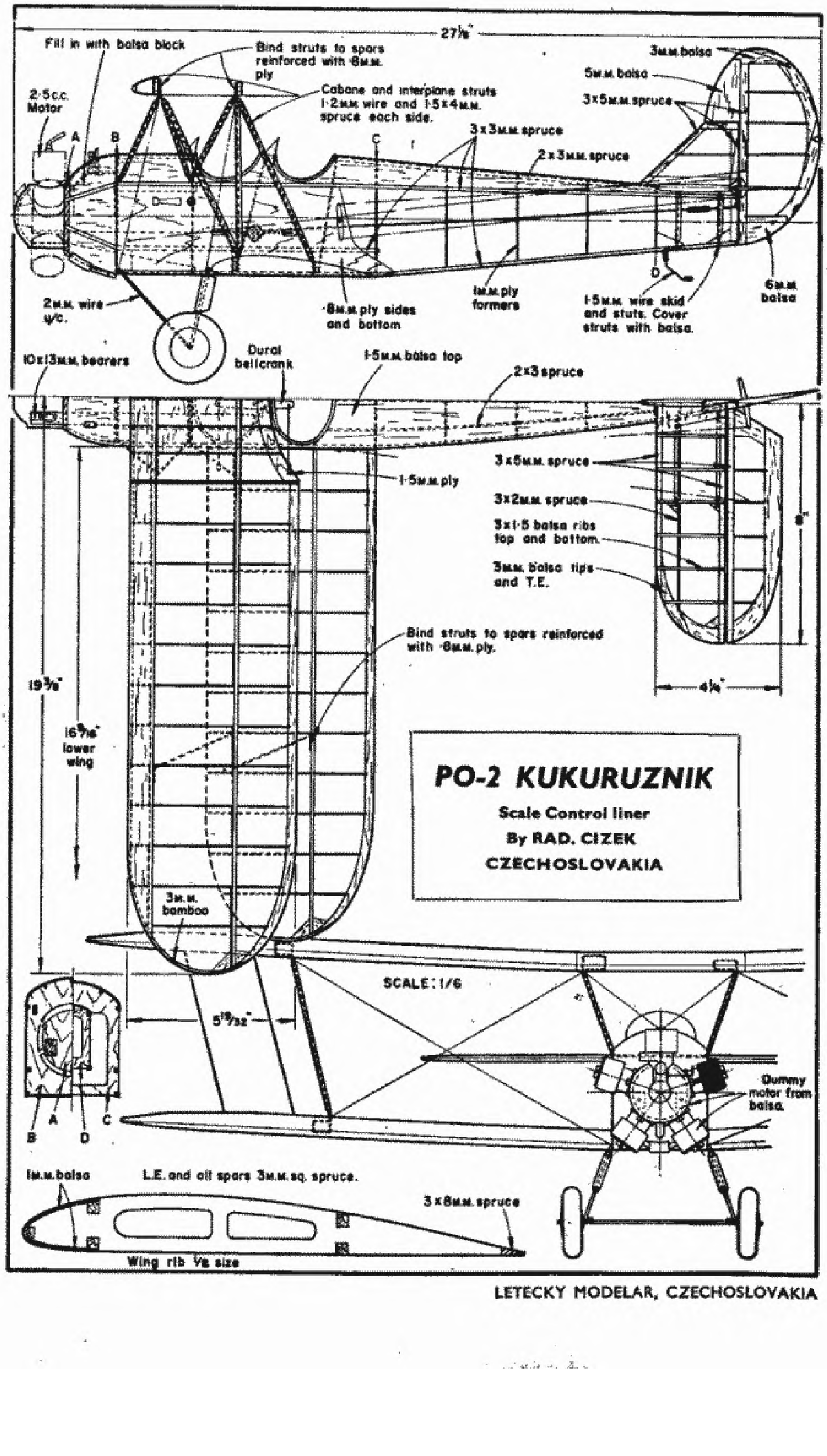
MODELLISTICA, ITALY

P.51 SEMI-SCALE C/L STUNTER

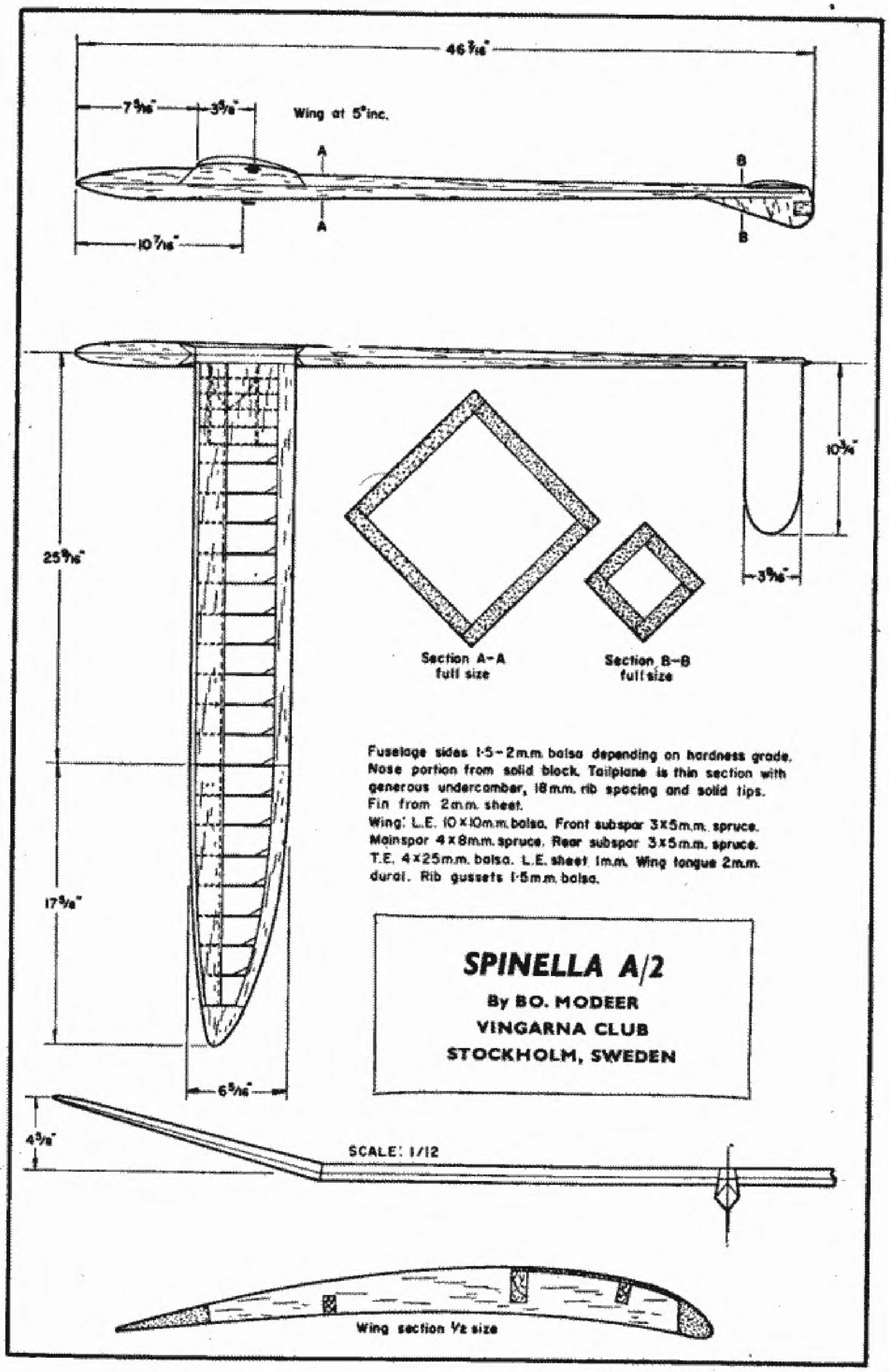
RUGGED ALL SHEET TRAINER FOR 1·5 c.c. from JAPAN



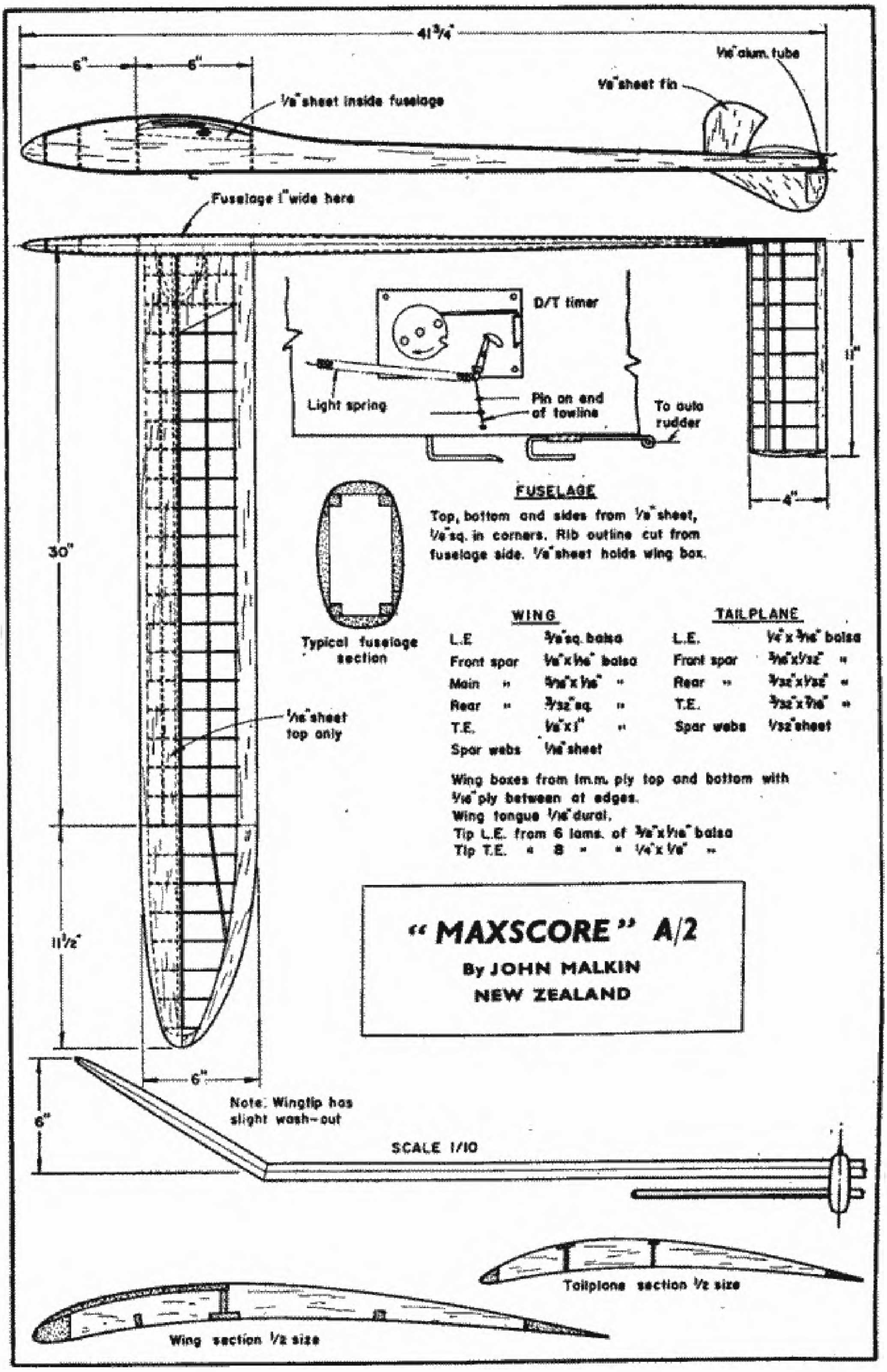
KOKU FAN, JAPAN



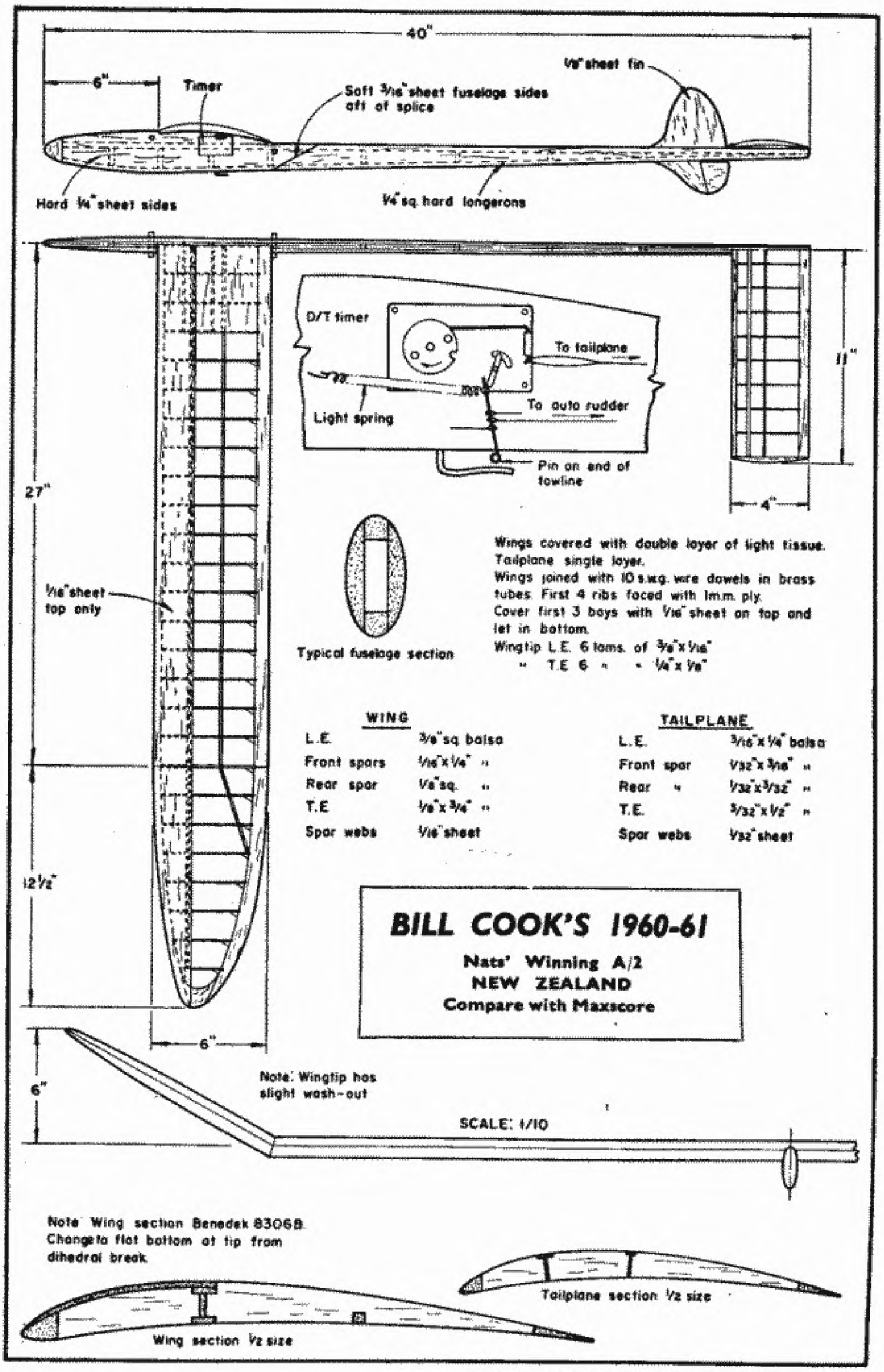
LETECKY MODELAR, CZECHOSLOVAKIA



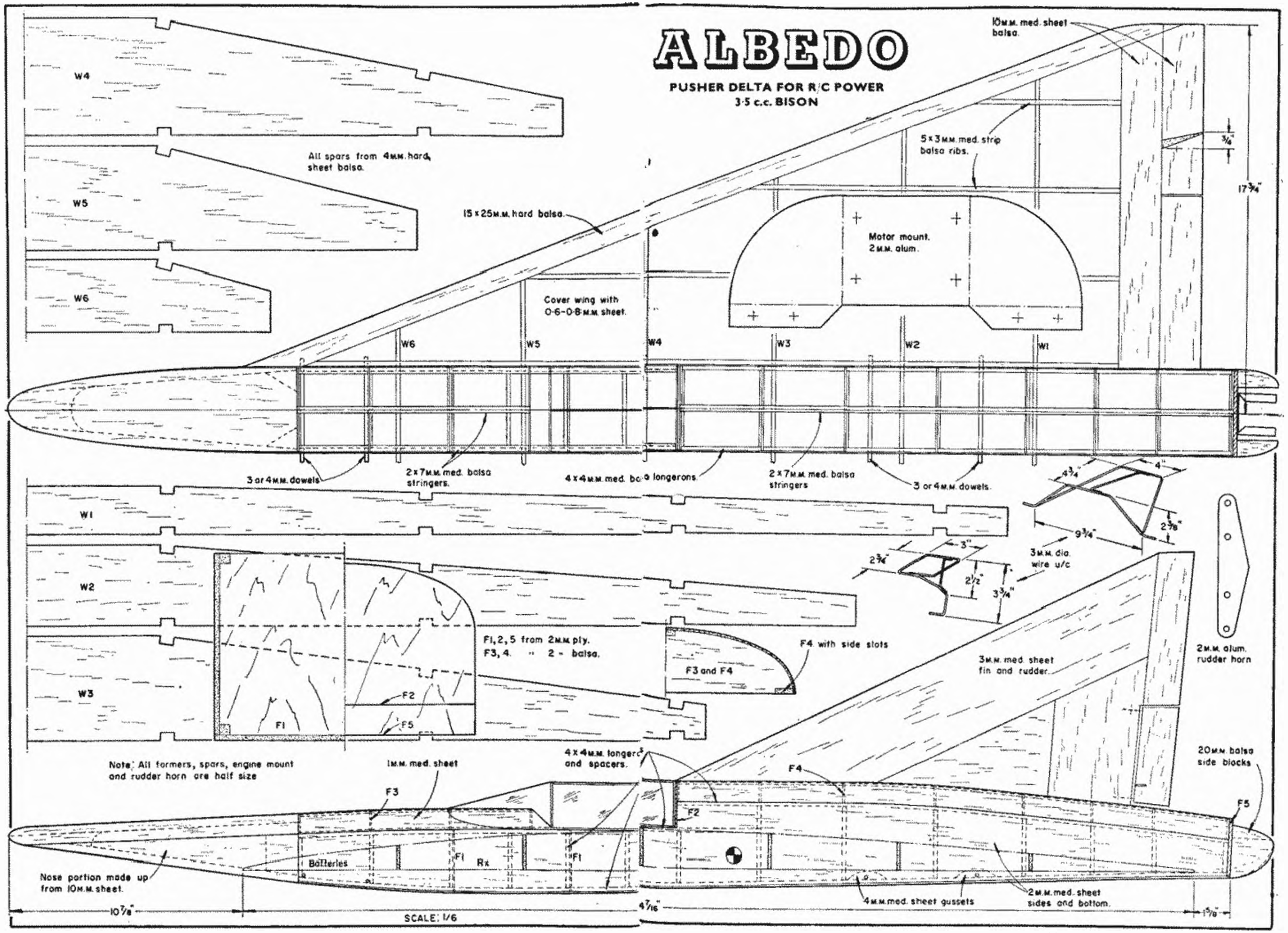
MODELFLYGBLADET, SWEDEN



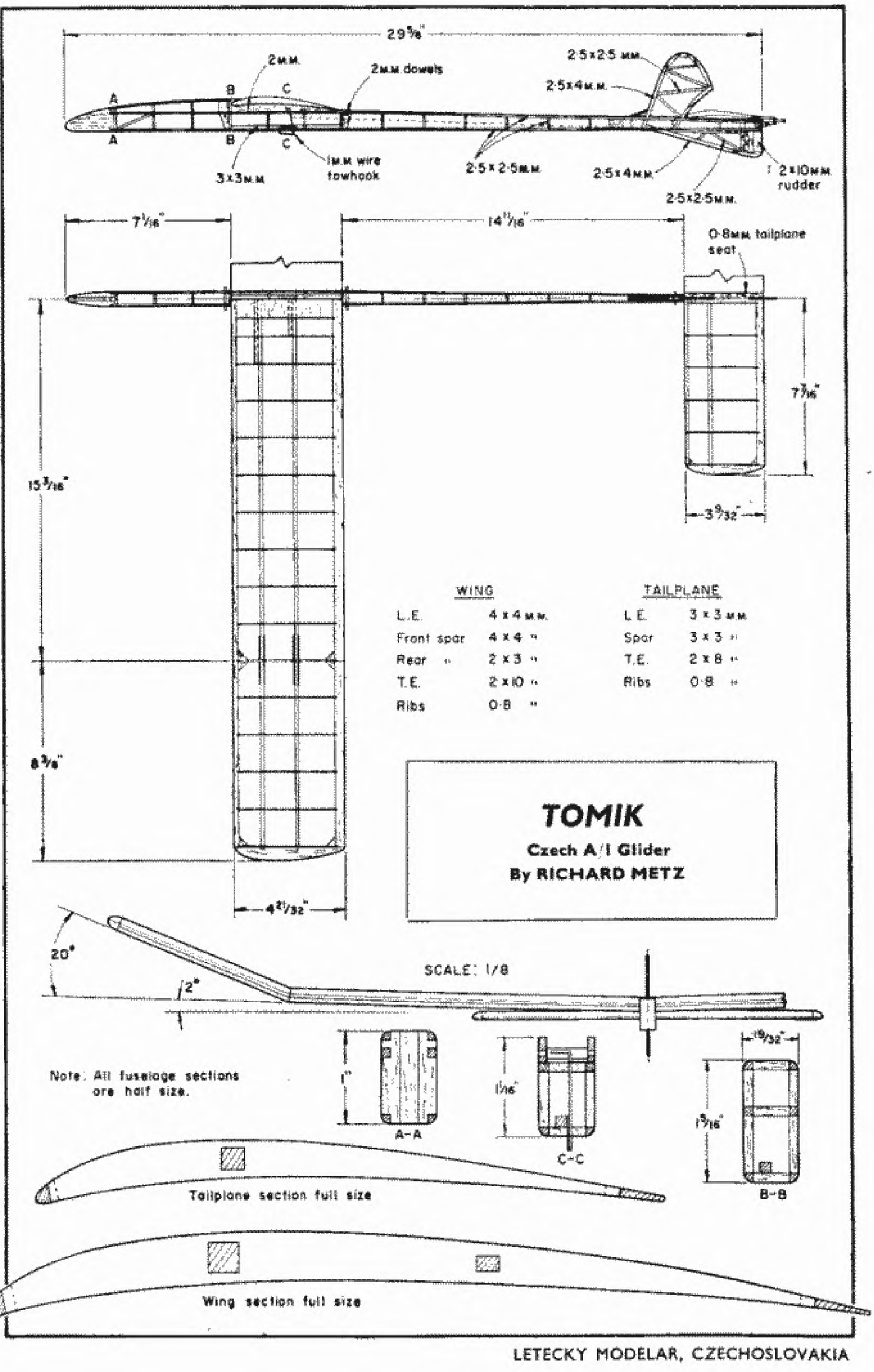
UPPER HUTT NEWS-SHEET, NEW ZEALAND



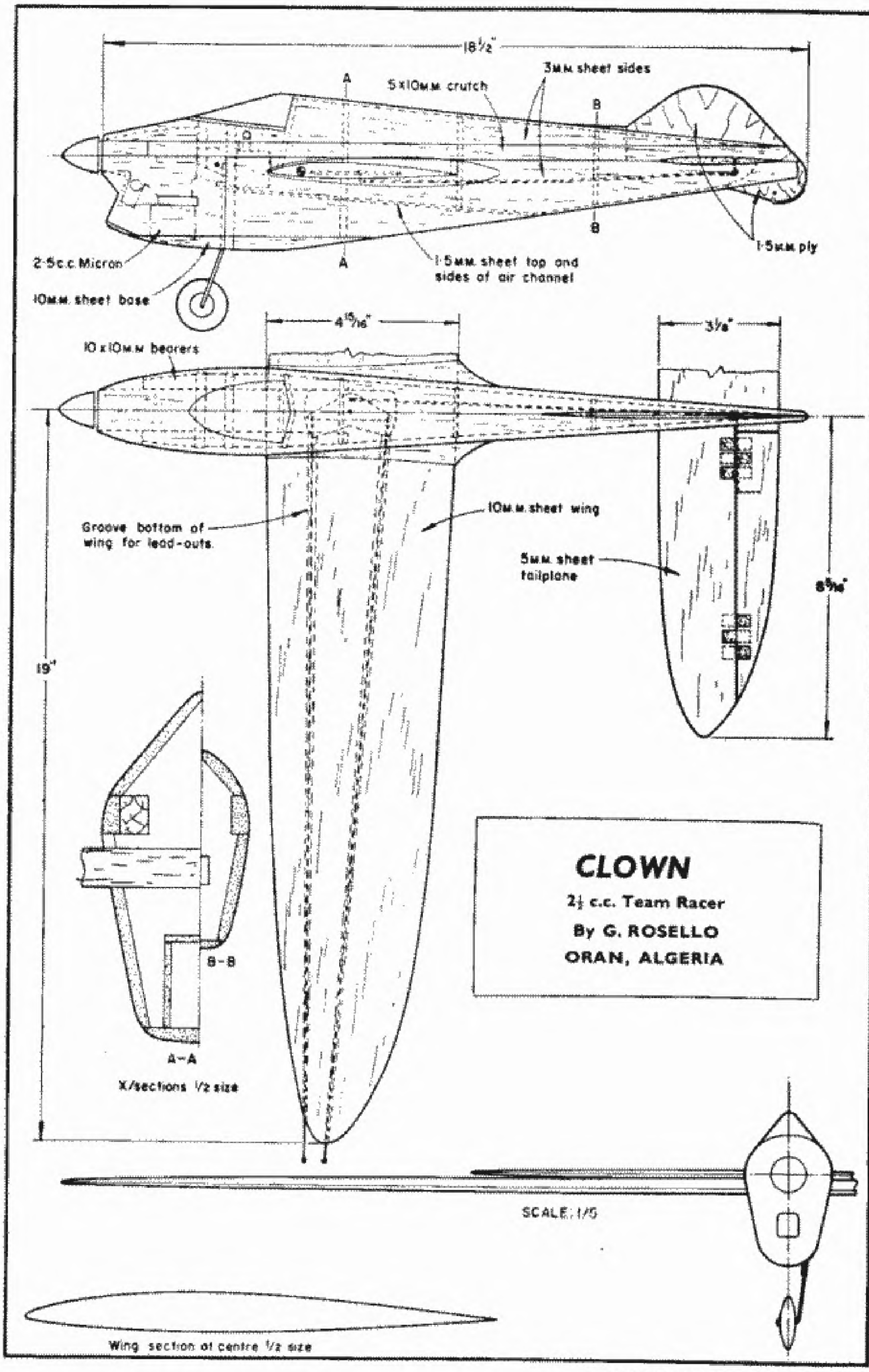
UPPER HUTT NEWS-SHEET, NEW ZEALAND



FLUG MODELLTECHNIK, W. GERMANY



LETECKY MODELAR, CZECHOSLOVAKIA



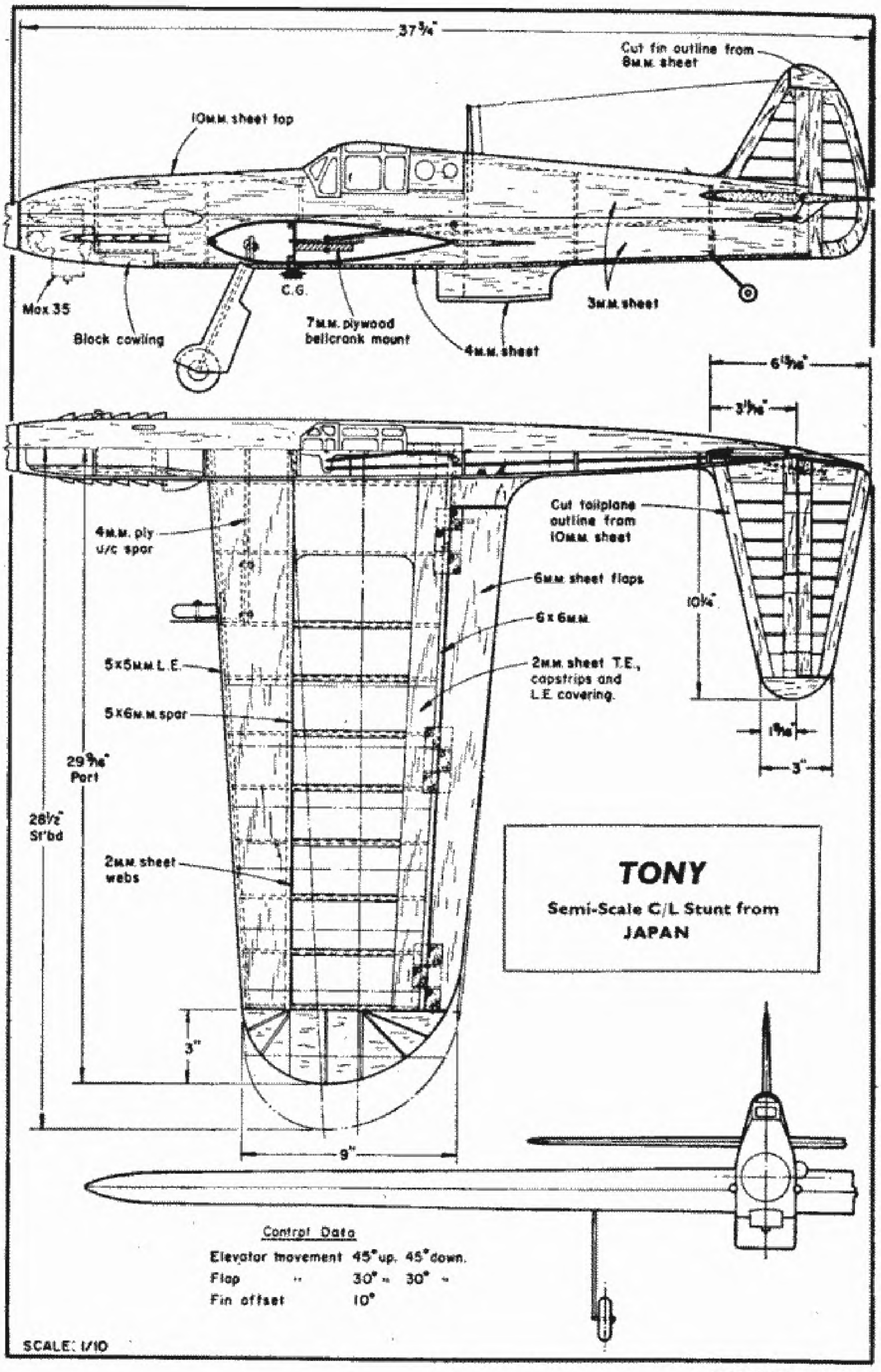
CLOWN

2½ c.c. Team Racer

By G. ROSELLO

ORAN, ALGERIA

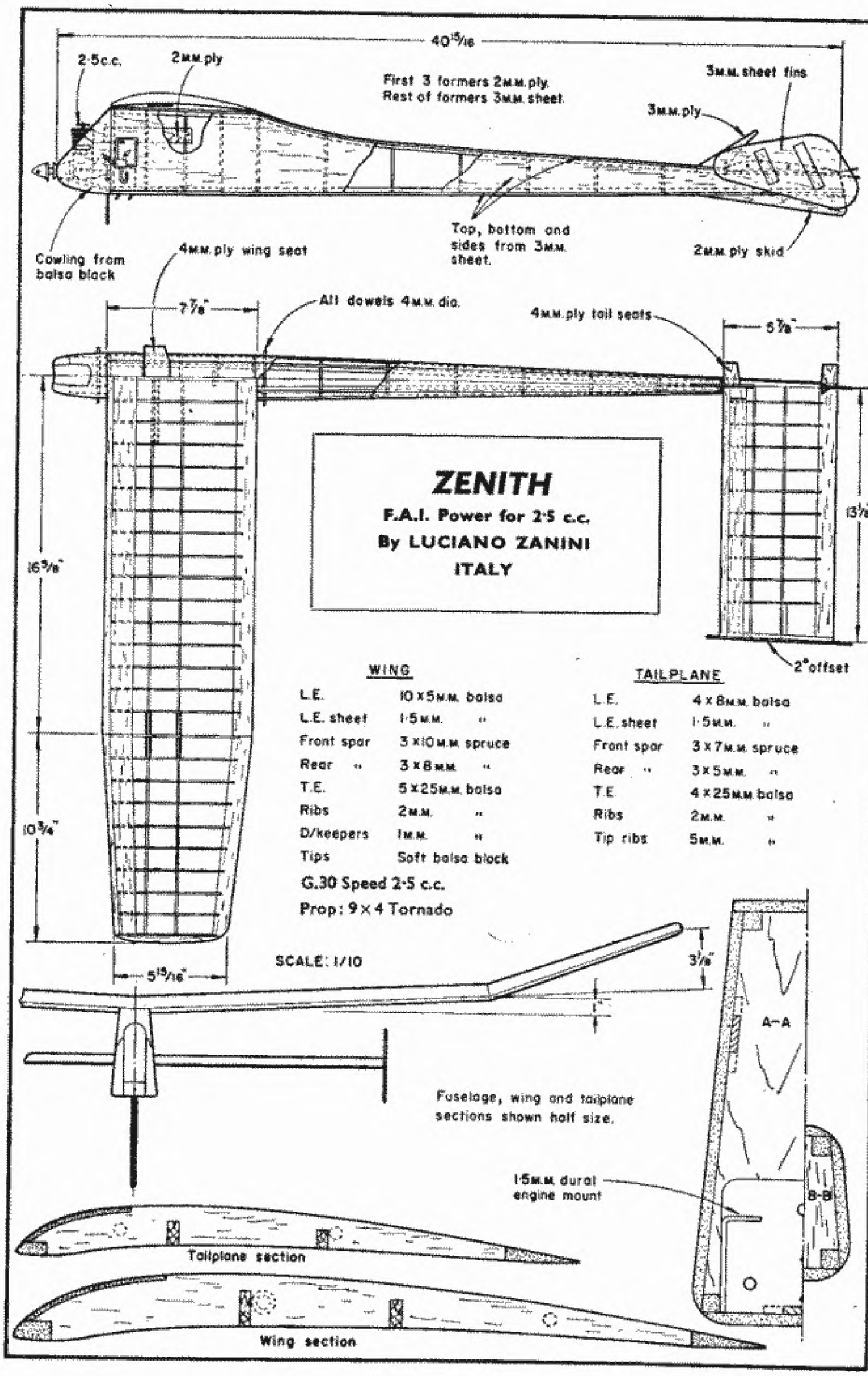
MODELE MAGAZINE, FRANCE



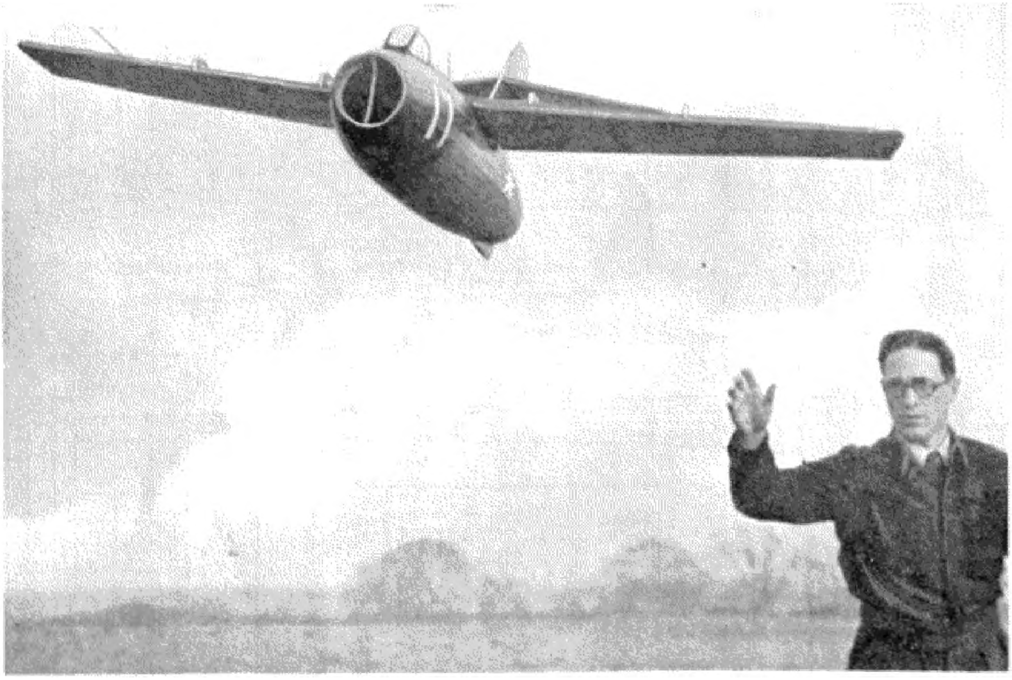
TONY

Semi-Scale C/L Stunt from JAPAN

KOKU FAN, JAPAN



MODELLISMO, ITALY



Phil Smith hand launches his Lavochkin ducted fan model, which was the first kit model of this type to be offered to the public. Hundreds of successful replicas have been flown all over the world.

FANORAMA

SIMULATION of the modern jet aircraft in flight is undoubtedly one of the most exciting branches of aeromodelling. Free flight with pulse jets is impossible because of the high injury risks involved together with absence of insurance cover. Smaller, safer, Jetex-propelled models are limited in size, weight and duration of flight. There remains the ducted fan formula, and this has been the basis of nearly every noteworthy successful model attempt in the *genre* for a number of years.

Younger enthusiasts may be surprised to learn that the first successful examples of this kind were produced for an electric powered model, that was, in fact, designed and built by Sqn.-Ldr. Peter Hunt for the AEROMODELLER Dorland Hall Exhibition as long ago as 1947. This centrifugal fan type flew a tethered model of the then new Vampire throughout the exhibition at a vast expense in burnt-out electric motors, which seldom enjoyed more than a twenty-minute flying life owing to the need for a damaging overload during take-off! (The backroom boys were engaged whole-time rebuilding motors.)

This was very much an experts only field, and it was not until 1951 that Veron's Phil Smith produced the first commercially available variant for use with free flight diesel-powered models. Scale prototype chosen was the Russian Lavochkin jet, which appeared in kit form. Fan or impeller was a slotted dural disc, the blades of which were bent in to provide a multi-blade drive in a tunnel, very much like a cylinder-type vacuum cleaner. In spite of the need for careful building to fairly close weight tolerances a large number of kits were made up and flown by newcomers to this method of flying, so that the

P.E.N. semi-scale line-up: Front Lavochkin 44 in. span 3¾ lb., Fox 35 combat. Second row, left to right, Scimitar, 34 in. span 38 oz., Os Max 15; Scimitar, 39 in. span 3¼ lb., Fox 19. Back row, left to right, Javelin, 36 in. span 40 oz., Cox Olympic 2 5 c.c.; Scimitar, 34 in. span 38 oz., Fox 15. All r/c designed by either Norman Kite or Stan Sarll.

P. E. Norman with his semi-scale version of the Lavochkin, Fox 35 powered, and, to date, his fastest, largest, toughest, most powerful ducted fan model. It offers a striking contrast to Phil's 5 c.c. model opposite.

designer could be well satisfied that he had put over the idea in an easily understood form.

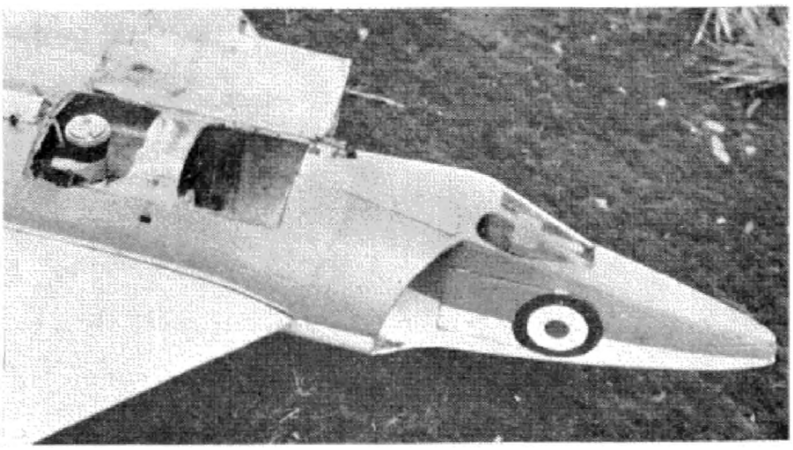
Phil's success interested that stalwart power-modeller P. E. Norman, who embraced the system wholeheartedly, and from that day to this has marched parallel with him in study and development of the technique. We must thank P.E.N. for a great deal of original work on the built-up type of impeller. This type has now superseded the metal disc type almost entirely, and is the basis of the only commercially available impellers for modellers available throughout the world, the Veron "Imp" Impellers.

Pete Norman's work has always been robust, and he was not content with the light construction of the earlier models. Using fibreglass, bonded resin plywoods and other stout materials he produced exciting bombshells guaranteed to make life exciting for the casual Sunday stroller on Epsom Downs, his usual habitat. Particularly dear to him was the urge to fly his models at scale speeds. This meant ever smaller, more heavily loaded, models with their own special problems of control.

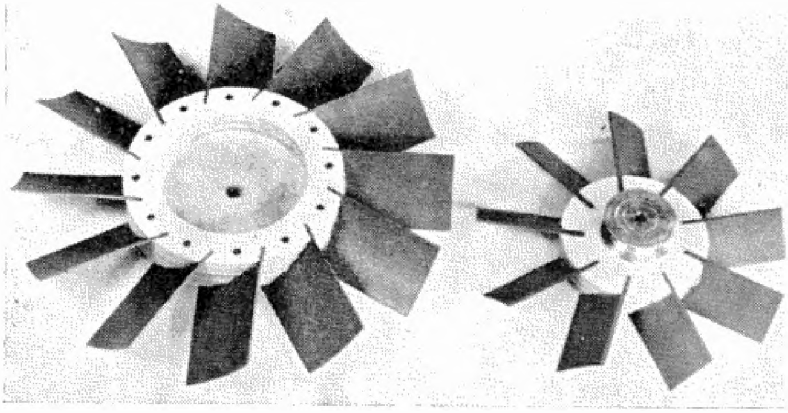
Work on this aspect led to introduction of small downthrust chutes near the end of the jet tube and the study of the effects of flight trim tabs honeycombed across the annular ring.

The "circus" had by then grown to such proportions that further effective development could only be made with the assistance of radio control. Here P.E.N. is fortunate to have interested r/c boffins such as Norman Kyte and more recently Sqn.-Ldr. Sarll, whose Sarll-Rising equipment is now used exclusively in the Norman models. Designs are available in A.P.S. service for those intent on making a start, but we would state without equivocation that this is definitely not a beginner's job!

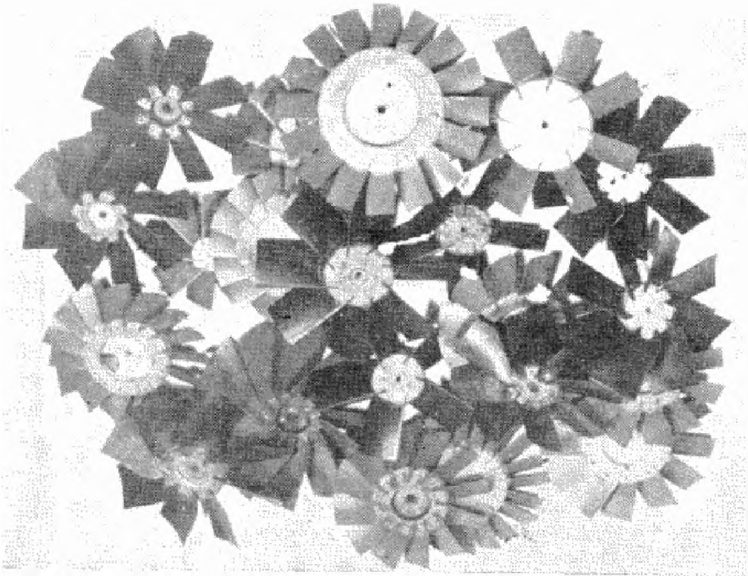
Phil Smith's parallel work has followed a very different pattern. He could not be content with building flying models. His models must be such that *others* could do likewise fairly easily. For that reason it is only fair to say that for every shiny kit on the dealers' shelves representing a successful version of this ideal, there are at least two prototypes on Phil's shelves that could not pass this critical demand. These models all flew in Phil's hands, but for one reason or another offered problems too great to be left to the unknown enthusiasts who might wish to build them.



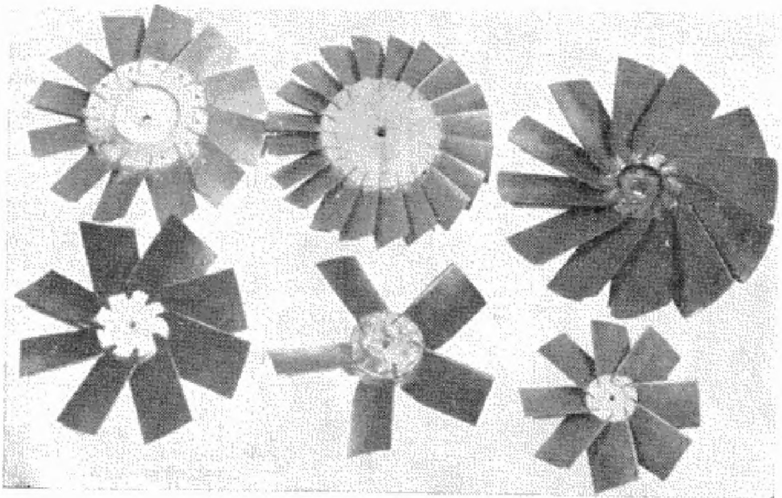
P. E. Norman's semi-scale Scimitar, showing bifurcated intake. Radio is under roundel hatch; batteries in hatch over cabin. Escapement is fitted in fin root. Power—Cox Olympic 2.5 c.c.



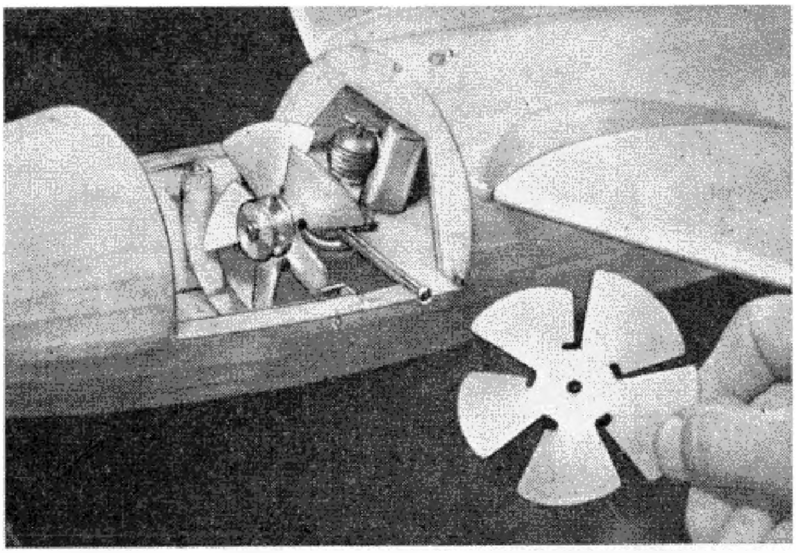
Nine and twelve bladed Imp Impellers, as now produced to Phil Smith's design by Model Aircraft, Bournemouth under the Veron trade-mark, ready for use by the "average" modeller.



Fans wholesale! A mixture from P. E. Norman's workshop showing some of the wide assortment with which he has, from time to time, experimented. Not all of them have proved successful needless to say!



Here are some of the most interesting ones, ranging from five to twenty blades—which are probably the extreme limits of practical value in model sizes.

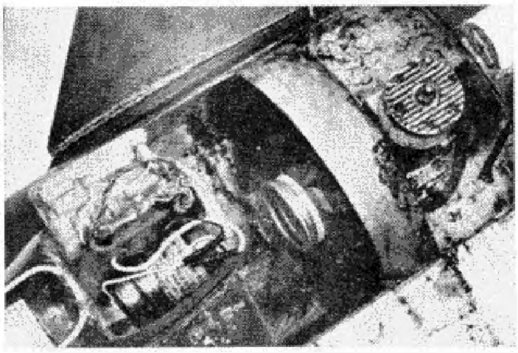


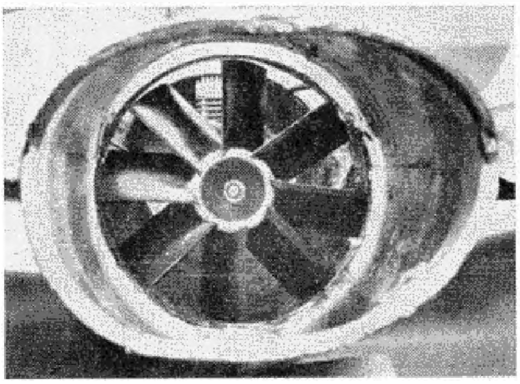
Left: Close-up of the original type Imp impeller made of a light alloy pressing which the buyer then bent up into the desired shape—now superseded by boss and blade type.

Right: Two of Phil Smith's interesting experimental designs. Top right, Hunter for 5 to 9 c.c. and, lower right, Skyray for the same power. Notes on them appear in text.

Several are illustrated, and we give some of the designer's own comments. Of his *Skyray* he says: "Designed for ·5 to ·9 c.c. diesels with 'A' impellers. Weight 9½ oz., 'Dart' powered. Scale areas made it too fast. Area needs enlarging to reduce loading by half. Otherwise a lovely little flyer." An experimental *Hunter* (a model that we particularly liked when we saw it at Bournemouth) occasioned: "For ·5 to ·9 c.c. and "A" type impeller again. Weight 10¾ oz. Flew well but the low aspect ratio and ultra sweepback caused it to fly persistently nose-up irrespective of balance and incidence. Moral: when modelling scale jets, choose designs with little sweepback—or reduce it in planform and choose a prototype with plenty of area."

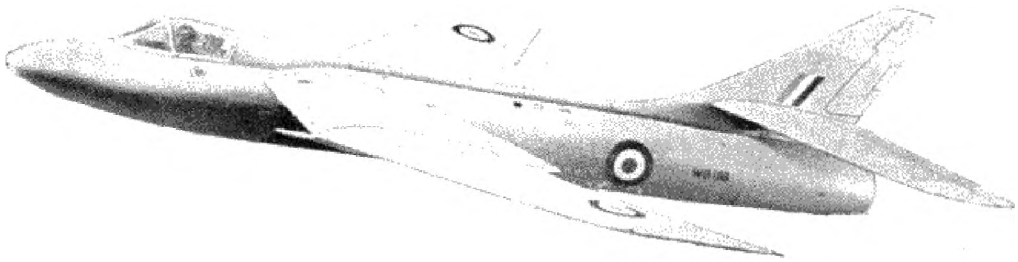
A *Super Sabre F*.100 was built for control line flying, specification being ED 2·46, Type "E" (40 in.) impeller, complete with u/c weight 22 oz. Of this he says: "A purely experimental model. It showed up one feature of ducted fan scale models that had been overlooked! At low speeds the elevator was of no control whatever—due to the fact that there was no

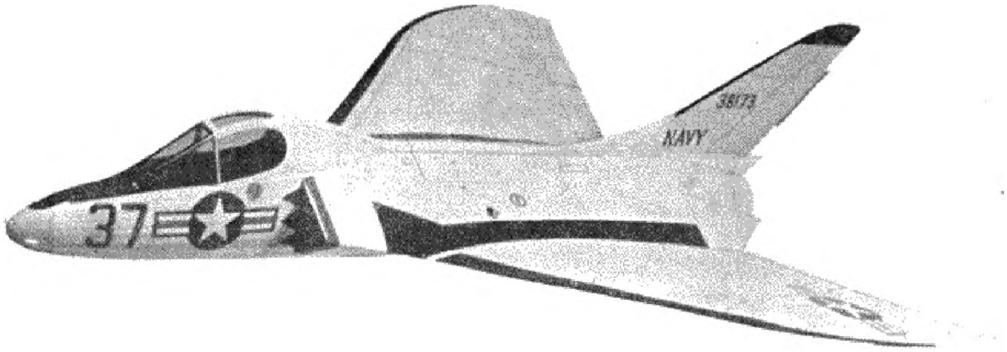




Above left: Engine installation, showing clever use of a serrated rim bottle top bolted to engine for cord starting. Below left Impeller of the Norman semi-scale Lavochkin intake and fan.

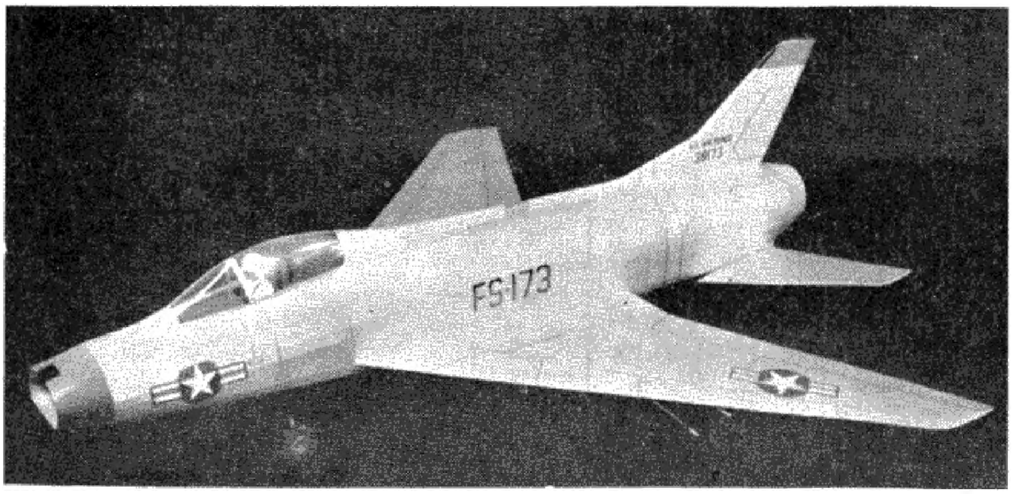
Right: Another Phil Smith experiment, this time a Super Sabre for control line flying, which proved instructive though not practical as a kit design.





slipstream. Only when the model was in full flight did it become controllable, the point was getting it there ! The only answer is sheer brute power, the more the better—and that of course, is unfeasible commercially !" [Sheer brute power is just what P.E.N. has so often put into his models with outstanding success.—*Ed.*]

Of the successful *Fairey Delta II*, Phil says : "Whereas the LA.17 and Sabre used hexagon ducting the F.D.2 was our first kit to use "pre-bonded" sheeting. Tissue was doped to one side of soft sheet balsa ($\frac{1}{16}$ in.), as it dries it aids curvature naturally ; these are then laminated over formers, using cement or Aerolite 305. The result is a strong tubular self-rigid ducting *very easy to construct*. The rear ducting is single pre-bonded $\frac{1}{32}$ in. sheet with formers and stringers, tissue covered. Weight complete (1 c.c. to 1·49 c.c.) 20-22 oz."



We hope some of this background story will encourage more aeromodellers to try their hand at ducted fan propulsion. The more the merrier. We have included several tables of general information based on data that has appeared in French, German and Polish magazines, which have published a series of articles on the subject.

TABLE I TYPICAL SPECIFICATIONS

C.C.	Power B.H.P.	Weight ozs.	Wing loading in ozs./ft.	Wing surface in sq. ins.	Span (ins.)	
					Normal	Delta
·5	·03–·04	7–9	9–11	110	24	20
1	·07–·1	12–16	10–13	155	28	24
1·5	·12–·15	16–21	12–14	190	32	26
2·5	·17–·26	21–26	13–18	235	35	28
5	·3–·6	32–40	14–20	310	40	33
	·5–·8	40–54	14–20	400	48	40

N.B. This table is based on successful model experience but should be taken as a guide only.

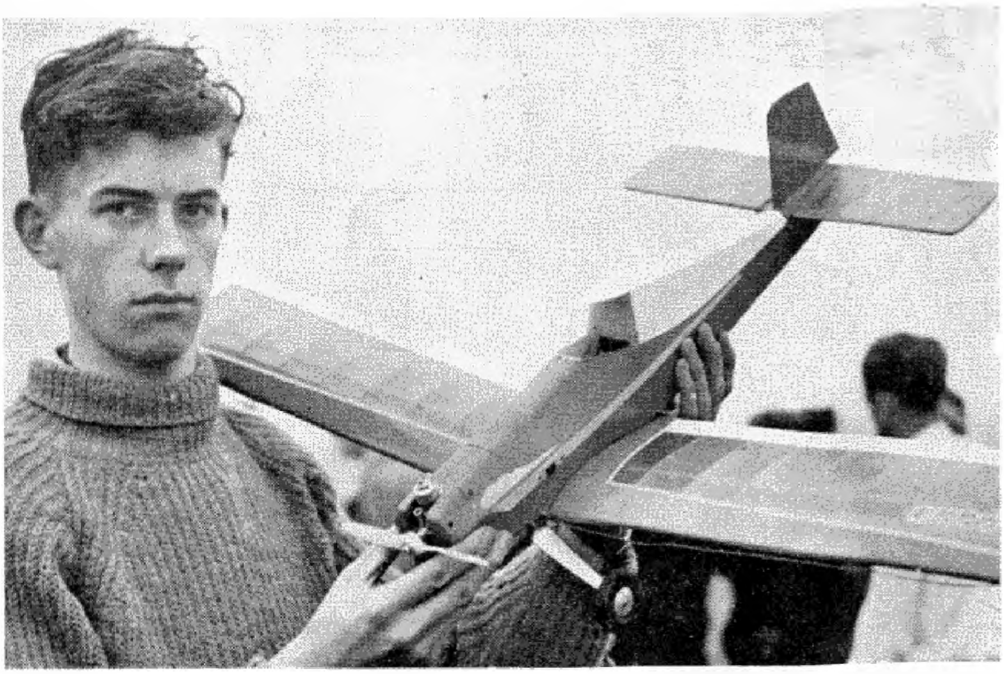
TABLE II(a) IMPELLER (8-blade fan) AND POWER SELECTION

Capacity in C.C.	Power B.H.P.	R.P.M. X 1000	Fan Dia. ins.	Typical Engine	
·5–·8	·03	10	3¼	E.D. Baby D.C. Dart A.S. 55 D.C. Bantam	Frog ·049 A.M. ·049 Frog 80
1	·07 ·1	10 13	4 3½	E.D. Bee DC Spitfire Cox ·049	Holland Hornet A.M. 10
1·5	·12 ·14	10 13	4¼ 4	P.A.W. 1·5 E.D. Hornet A.M. 15	Oliver Tiger Cub Frog 150
2·5	·17 ·22 ·26	10 13 15	4½ 4 4	A.M. 25 E.D. Racer Oliver Tiger ETA 15 P.A.W. 249	Frog 2·49 D.C. Rapier Fox 15 Cox 15 K & B 15
5	·3 ·6	10 15	5 4¾	Frog 500 ETA 29 McCoy 29 K & B 29	Fox 29 Veco 29 Merco 29 Etc.
7	·8	10 15	5 6½	K & B 35 Fox 35	Merco 35 Veco 35

Based on 8-bladed fan

TABLE II(b) VERON "IMP" IMPELLER RANGE

Type	Dia. ins.	No of Blades	Engine size recommended in c.c.
A	3	9	·5–·9
B	3½	12	1
C	3¼	12 (thick section)	1 (Racing types)
D	3¾	12	1·49–2
E	4½ { 4/4¼ 4½	12 12	2·49 3·5



C. Dowsett of Esher built this Ted Strader design "Westwind" for r/c with a Kraft Rx. Power is AM 049. Note neat leaf-type u/c retained by rubber bands.

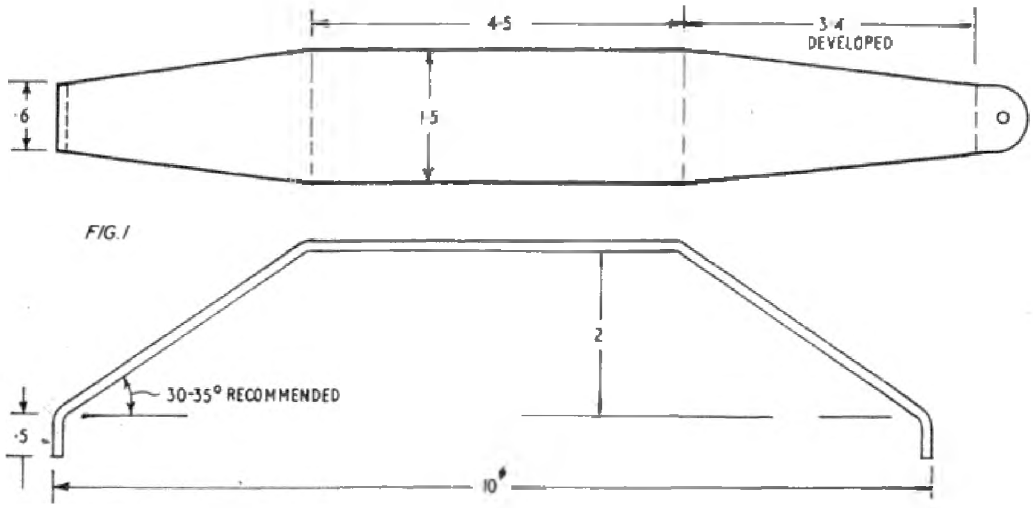
LEAF-TYPE POWER MODEL UNDERCARRIAGES

THE conventional bent-wire cantilever undercarriage has proved generally practical for power models of all types, whatever its limitations on the score of appearance, although it tends to be too flexible for satisfactory landings with heavy models and large models or which land at fairly high speeds. These, in the main, cover all the radio control models from about 48 in. span upwards where the cantilever leaf-type undercarriage has become established as more or less a standard (but not without its own limitations). This type of undercarriage is also applicable to control line models for better appearance and, in fact, originally evolved from the scale-type undercarriage developed for team racers.

The leaf-type sheet-metal undercarriage can be made reasonably light, strong and springy by suitable choice of material. Experience has shown that only a relatively narrow base is required for adequate anchorage, provided there is a good width of fuselage for fixing. Fig 1. shows typical proportions. Nor is an excessively wide track called for in undercarriage design although optimum track is also bound up with undercarriage position, relative to the centre of gravity of the whole machine.

The other factor controlling the weight of the sheet-metal undercarriage is the thickness of the sheet required. This, in turn, is dictated almost entirely by the type of metal used—not in terms of metal density, since aluminium and light alloys have roughly the same specific weight, but in the bending strength given by the sheet metal.

Aluminium is *quite useless* for such undercarriages. It is far too soft and readily bent, even in comparatively gentle landings—and a rough landing will virtually wipe the landing gear back around the fuselage. Dural is a general



term used to describe a whole range of copper-containing light alloys characterised by the fact that they "age-harden" and are relatively brittle in such a condition. Thus to be bent to a suitable shape such an undercarriage blank has to be annealed or softened by heat treatment.

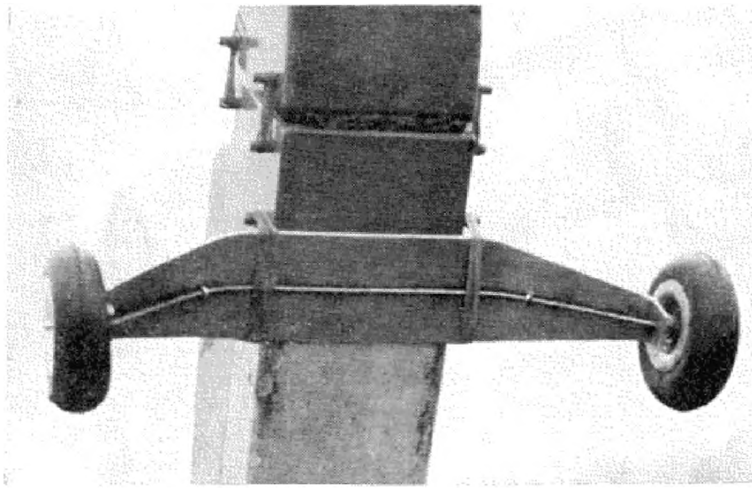
The classic "workshop" method of arriving at a suitable temperature for annealing is to coat the metal surface with ordinary yellow soap rubbed on and heat until the soap turns dark brown. Then quench by plunging into water. The metal will remain soft, after cooling, for up to 24 hours or more. Within this time it can be bent to shape without fear of cracking and then left to recover full strength.

Unfortunately, a whole variety of alloy sheet may be obtained under the name "dural" and the majority of such materials are not strong or "springy" enough to make a suitable leaf-type undercarriage without being excessively thick (and thus heavy). Many, too, never fully recover their original properties after softening and allowing to age-harden again and need a specific heat treatment to achieve maximum strength. The amateur aeromodeller, therefore, is in considerable difficulty in (*i*) finding the best type of alloy and (*ii*) ensuring maximum "spring" strength after softening and bending to shape. Even kit manufacturers run into similar difficulty, as can be seen from the somewhat excessive thickness of metal they may have to employ.

Where the original alloy sheet is hard and springy but fails to recover fully its "spring" strength after softening and bending, age-hardening can sometimes be improved by putting the part to "soak" at a low temperature in the family" fridge" (preferably in the freezer). This certainly works in the case of aluminium-magnesium-silicon alloys, although these are generally of lower strength than the copper-containing aluminium alloys ("dural"). Other light alloys may require just the opposite treatment in that hardening can be accelerated by gentle heating—*e.g.*, in boiling water (but higher temperatures with certain alloys). Soaking them at low temperatures will delay hardening.

The correct material choice is a "double heat treatment" alloy. All the strong aluminium alloys are hardened by heat treatment, the initial heat

A wide leaf-type u/c reinforced with piano wire, which in turn serves also as axles for the wheels, as well as adding strength and springiness to possibly inadequate light alloy sheet.



TYPICAL SIZES FOR WIRE LEGS

Model Span in.	Weight	Wire Dia. s.w.g.
up to 30	up to 8	16
30 to 40	12 to 18	14
40 to 50	24 to 32	14 to 12
50 to 60	over 2lb.	10
60 to 72	up to 6-7lb.	10 or 8 (1/8 in. or 5/32 in.)

5/32 in. wire dia. is recommended for nosewheel legs or tricycle undercarriages on large radio control models.

treatment consisting of heating them to a temperature of about 500 deg. C. and then quenching. In this condition they are in their softest condition. "Single heat treatment" alloys will then age-harden naturally if left, reaching maximum strength in about 5 days. A "double heat treatment" alloy, on the other hand, only achieves its maximum hardness after further heat treatment which involves soaking for several hours at a certain temperature. With some alloys this temperature may be as low as 100 deg. C. and with the others as high as 250 deg. C. After such artificial hardening the alloy is very hard and strong and resistant to deformation. The aluminium-zinc-magnesium alloys are the strongest of the lot.

A clue as to the type of alloy is often given by its resistance to bending in the normal state. If it can be bent fairly readily it is almost certainly a "single heat treatment" alloy for these retain a certain amount of ductility after ageing. It will also almost certainly be too "bendable" to make a good undercarriage, even if left quite thick. If the original sheet can only be bent with extreme difficulty, or cracks almost as soon as a bend is developed, it is most likely a "double heat treatment" alloy. It will need softening, as previously described, to bend to shape and may require further heat treatment to regain its original strength and springiness.

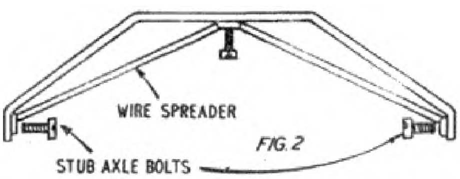


FIG. 2

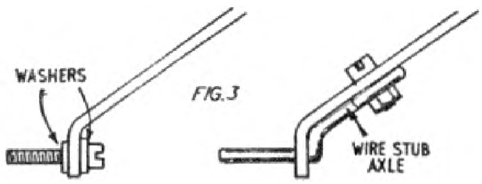
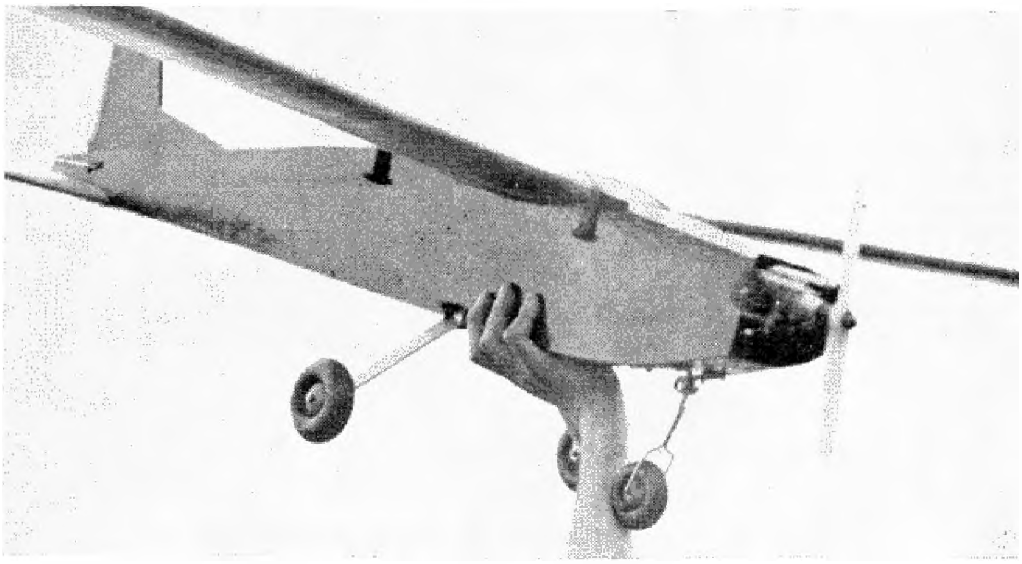


FIG. 3



Uproar Mk II with tricycle u c. Narrow leaf-type u c for rear wheels provides excellent lateral springing.

Where a suitable alloy is not obtainable, or where the leaf undercarriage proves too prone to bending—a steel wire spreader may be incorporated, as shown in Fig. 2. This is not a good design either from the point of view of drag or weight, but can render an otherwise too soft undercarriage usable.

Originally undercarriages of the leaf-type employed a steel bolt for a stub axle, mounted directly through the end of each leg. Although suitable for smaller, lighter models, this is not entirely satisfactory since the head of the bolt presents a relatively small bearing area, even if backed up with washers. Also unless the retaining nut is definitely soldered to the bolt (or an elastic stop nut used), that on the left-hand side of the undercarriage will always tend to unscrew via rubbing contact with the wheel hub. Wire stub axles mounted as shown in Fig. 3 are therefore often preferred.

Whether this type of undercarriage should be mounted permanently to the bottom of the fuselage (*i.e.*, bolted through to a suitable strong point, usually in the form of a plywood base), or lashed on with rubber bands is debatable. The latter method allows the undercarriage to be knocked off in a heavy landing, rather than tearing away the fuselage fixing and has more points in its favour than against. It is certainly becoming more or less standard practice on radio control models.

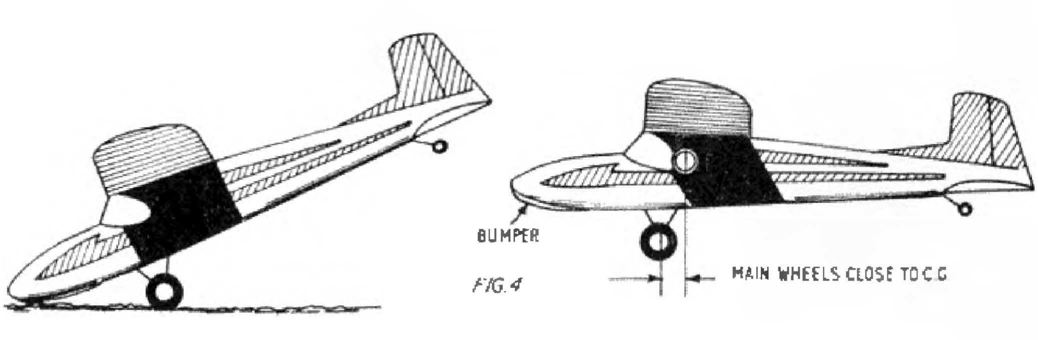
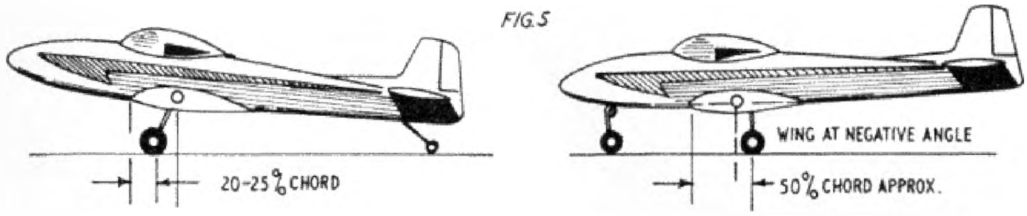


FIG. 4

FIG. 5



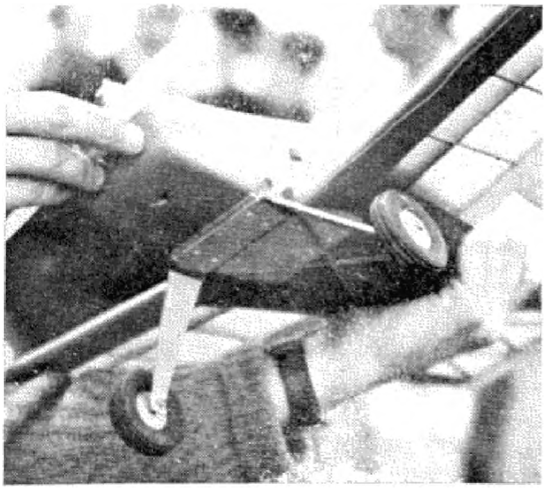
The modern trend with radio control aircraft undercarriage design is to mount the wheels well back and only a little in front of the centre of gravity—Fig. 4—which improves both take-off and ground handling characteristics. In such a position, too, only a minimum track is required for adequate ground stability—*e.g.*, approximately one sixth of the wing span. The chief disadvantage is that a badly controlled landing, or one on rough ground, can tip the model forwards so that, momentarily at least, the lower part of the engine cowling is acting as a ground skid. A suitably placed wire skid or nose "bumper" would not be out of place to take care of such possibilities and protect the lower cowling finish.

The other limitation of the leaf-type undercarriage as a "standard" for radio control models in particular is that it cannot readily be applied to low wing layouts. The required wheel position would mean an undercarriage fixing point on the bottom of the wing itself—see Fig. 5—which would be undesirable on a number of counts. For this reason the cantilever wire undercarriage is usually retained on low wing designs, mounted so as to embody

PROPERTIES OF TYPICAL LIGHT ALLOY SHEET

B.S. Designation	Metal or Alloy	Composition	Condition	Ultimate Tensile Stress lb. sq. in.	Elongation* % on 2 in.
IA, IB, IC	Aluminium	99.8 to 99%	Soft	4-5	35
		Aluminium	Half Hard	6-7.5	8
			Hard	8	5
H 10	H T Alloy	Magnesium—Silicon Type	Single-heat treatment	13	15
			Double-heat treatment	19	8
H 14	H T Alloy	"Dural"	Single-heat treatment	24	15
HC 14	Alclad	Aluminium Clad "Dural"	Single-heat treatment	24	15
H 15	H T Alloy	"Superior Dural"	Single-heat treatment	24	15
			Double-heat treatment	26	5-8

* The higher this figure the more ductile or "bendable" the alloy
H T-Heat treatable



Underside of Dowsett's Westwind, showing how leaf-type u c is bolted to ply plate to facilitate attachment to fuselage and provide added strength.

torsion springing. Vertical shock loads are carried directly by the wing structure, calling for a suitable strong point anchorage, but the method has proved extremely practical in use.

Nosewheel undercarriages represent an entirely different design case, but here again the placement of the main wheels still requires to be near the centre of gravity (although this time behind it and roughly at 50 per cent chord) so that the leaf-type undercarriage is still not a proposition for low-wing layouts. Wire is a logical choice for the nosewheel leg and preferably double thickness. Fabricated steerable nosewheel legs flange mounted on to a ply panel in the fuselage have, however, proved quite practical provided the model is fully controllable during landing (*i.e.*, can be flared out properly) and the unit not subject to "crash" loads. In general, however, a stout bent-wire nosewheel leg is to be preferred, incorporating coil springing.

SELECTING BALSA

BALSA lumber, as a raw material, is a highly variable commodity which may range in density from as low as 4 lb/cu. ft. up to 20 lb/cu. ft. or even more in weight. This is largely because the rate of growth of the balsa tree can vary so much in different years, depending on the seasonal rainfall. Unlike most other trees which may take a century or more to mature, balsa trees are ready for cutting in about 6 to 7 years, during which time they have grown to a height of about 60 ft. with an average trunk diameter of something like 18 in. Each year's growth is therefore considerable, and differences in annual rainfall can lead to variations in density throughout a log, as well as other possible "faults". Hence the selection and grading of balsa lumber is a most important aspect of providing suitable material for aeromodelling use.

The majority of such balsa is selected from the middle grades although quite obviously there will be a fairly wide density range covered. For well over a quarter of a century aeromodellers have specified and selected balsa as "hard", "medium", "soft", etc., and grade selection does play an important part in both weight and strength control. Mostly, however, this form of grading has been purely arbitrary and what one aeromodeller (or retailer) may call "soft", another would classify as "light medium"; and so on. There is no overall standard in this respect. The following figures are, however, typical of the bulk of cut balsa sheet, strip and block available in this country. These are all the more interesting in view of the fact that they differ from previous standards by various aeromodelling authorities and are also somewhat heavier ratings than those adopted in America.

TABLE I. WEIGHTS OF SINGLE SHEETS OF BALSA

SHEET 36"×3"× → (LB/CU.FT.)	1/32"	1/16"	3/32"	1/8"	3/16"	1/4"	3/8"	1/2"
ULTRA LIGHT	UNDER 3/16	UNDER 3/8	UNDER 9/16	UNDER 3/4	UNDER 1 1/8	UNDER 1 1/2	UNDER 2 1/4	UNDER 3
LIGHT 6	3/16	3/8	9/16	3/4	1 1/8	1 1/2	2 1/4	3
MEDIUM SOFT (7 → AV. → 9)	1/4	1/2	3/4	1	1 1/2	2	3	4
MEDIUM (→ 12)	3/8	3/4	1 1/8	1 1/2	2 1/4	3	4 1/2	6
HARD (→ 16)	1/2	1	1 1/2	2	3	4	6	8
EXTRA HARD	OVER 1/2	OVER 1	OVER 1 1/2	OVER 2	OVER 3	OVER 4	OVER 6	OVER 8

Very light or ultra-light—6 lb./cu. ft. and under
Light—6 to 7 lb./cu. ft.
Medium-soft—7 to 9 lb./cu. ft.
Medium—9 to 12 lb./cu. ft.
Hard or heavy—over 12 lb./cu. ft.
Extra hard—over 16 lb./cu. ft.

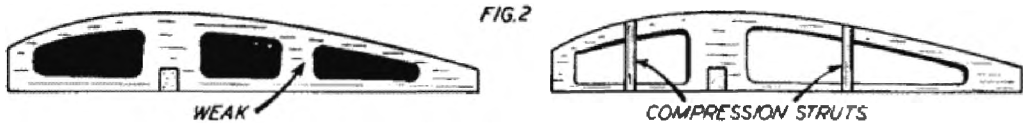
Weights of balsa sheet and strip consistent with these ratings are detailed in Tables I and II. There are no overall rules as to the best choice of grade (density) for specific purposes since this is affected by the material *sizes* employed. Thus the larger the section, usually, the lighter the grade desirable. For

TABLE II. NUMBER OF 36 IN. LENGTHS PER OUNCE

SECTION → (LB/CU.FT.)	1/16" SQ	3/32" SQ	1/8" SQ	1/8"×1/16"	3/16" SQ	1/4" SQ	1/4"×1/8"	3/8"×1/8"	1/2"×1/4"	1"×1/4"
ULTRA LIGHT	OVER 128	OVER 57	OVER 32	OVER 64	OVER 14	OVER 8	OVER 16	OVER 11	OVER 4	OVER 2
LIGHT (6 → 7)	128	57	32	64	14	8	16	11	4	2
MEDIUM SOFT (AV. → 9)	96	43	24	48	11	6	12	8	3	1 1/2
MEDIUM (→ 12)	64	28	16	32	7	4	8	5	2	1
HARD (→ 16)	48	21	12	24	5	3	6	4	1 1/2	3/4
EXTRA HARD	UNDER 48	UNDER 21	UNDER 12	UNDER 24	UNDER 5	UNDER 3	UNDER 6	UNDER 4	UNDER 1 1/2	UNDER 3/4

FIG. 1

FIG. 2



example, a typical "box" fuselage for a power model could be constructed with $\frac{3}{16}$ in. square longerons and spacers or $\frac{1}{4}$ in. square throughout. The use of a heavy grade balsa in the former case and medium soft in the latter would give similar overall strength and weight. Using light or soft wood with the $\frac{3}{16}$ in. square construction, however, could produce a fuselage which was too weak; and using heavy $\frac{1}{4}$ in. square a fuselage which was much too heavy. Some designers prefer to work with smaller sections and denser wood; others with more generous sections and much lighter wood.

As far as strip sizes go (used for longerons, stringers, spacers and spars), only wing mainspars really demand hard or extra hard grade and even then mostly in the case of power models. Medium grade is probably most suited in the case of smaller models, unless the spar section is small. Medium grade should be suitable for "box" fuselage longerons. Hard is only really necessary where the cross section of the longeron is a little on the small side for the length of fuselage. Medium is certainly satisfactory for spacers.

Wing leading and trailing edges are a different matter again. In modern designs these tend to be of fairly generous section and are all too frequently overweight as a result of choosing too dense a grade of balsa. The denser the leading edge, too, the more the chance of one leading edge working out appreciably heavier than the other and the greater the necessity of matching the two lengths for weight. In general, medium-soft should be adequate for all leading edges unless of very small section—*e.g.*, square section set diagonally without leading edge sheeting. In this case medium grade would be preferable.

The trailing edge is an unfortunate section in that it is relatively narrow and wide, yet requires to exhibit maximum stiffness in bending. The answer is *not* a hard grade of balsa but the selection of quarter-cut stock to achieve stiffness. This applies equally well to solid sections and built-up trailing edges. A medium grade should be entirely adequate in the first place (medium-soft on a large section), and medium-soft in the case of built-up trailing edges.

Leading edge sheeting is another part where the *cut* of the balsa is important. Here the wood needs to be readily bendable across the width of the sheet to conform easily to the curvature required. True quarter-cut sheet which may appear advantageous because of the extra stiffness offered is not satisfactory and may even split in being bent to quite a gentle curve. This is also an excellent example where a thicker, lighter grade of balsa is usually superior to a thinner, heavier grade. Six pound density $\frac{1}{16}$ in. sheet, for example, will only weigh the same as 12 pound $\frac{1}{32}$ in. sheet but can be smoothed down without fear of rubbing through at rib positions, or giving a "starved horse" effect due to sagging of the sheet between ribs after covering and doping.

The most common fault in choosing leading edge sheeting is selecting far too heavy a grade. Medium-soft should be perfectly adequate, or even light grade. As with the leading edge, too, the weights of the sheet should be matched for each wing half. Although not applicable to material selection as such, leading edge sheeting should be pre-finished by sanding perfectly smooth *before* cementing in place. Final sanding can then be restricted to cleaning up at the edges and joints.

Ribs are another item all too often cut from unnecessarily hard and heavy sheet. Quarter-sawn sheet is invariably the best choice and the grade can usually be quite light—*e.g.*, medium-soft. Ribs are not heavily loaded and further weight can be saved, if necessary, by punching or cutting out lightening holes.

The use of lightening holes in ribs, however, is often misunderstood A considerable amount of stock must be removed from the section before there is any appreciable saving in weight. A few punched holes may look effective and "realistic"—Fig. 1—but the actual saving in weight over a whole set of wing ribs may be negligible. To give a real saving in weight very drastic cutting out is called for, preferably using well rounded punch corners to maintain maximum strength in the remaining wood. Where the rib is large and deep some vertical bracing may be required to prevent crushing of the reduced section and in this case separate cemented-on compression struts would be preferable—Fig. 2. The main control in rib weight—and on thick section wings the ribs can account for a considerable proportion of the frame weight—is still the balsa density chosen.

This question of weight saved by simple cut-out can best be illustrated by a simple example—Fig. 3—which is the sort of lightening which can be applied to compression or tension members (*e.g.*, a rib) not called upon to carry bending loads. It can also be applied to stiffening webs between spar members carrying bending loads when the grain of the webs should be vertical, or diagonal. For simplicity a simple rectanglar shape is assumed, with equal circular cut-outs. Cut-outs are spaced one half their diameter in from top and bottom edges, and ·75 × diameter in from the ends, consistent with avoiding undue weakening of the member.

The area of the basic member is 10 in. × 2 in.=20 sq. in. The area of a 1 in. circular cut-out is ·7854 sq. in. Six such cut-outs can be accommodated so that the total cut-out area (or stock removed) is 6 × ·7854=4·7124 sq. in. Although it may look more, this is less than one quarter of the total volume (23·6 per cent), which represents the weight saving obtained. It would probably be more usual to space the individual cut-outs even more widely, or make them of smaller diameter, when the weight saving would be less again. Six ½ in. diameter cut-outs, for example, would represent a weight saving of only 5·8 per cent.

The tailplane is the least critical of all the airframe components as regards strength. Almost invariably it is made much stronger and heavier than it need be, representing weight in completely the wrong place. Very seldom does any new *design* work out nose-heavy. Almost invariably the reverse is true. Even when corrected on, say, a finalised kit design or magazine plan, the chances are that subsequent models built from the kit or plan will tend to work out tail heavy because of variations in wood density—the variation usually being upwards (in density). With the tailplane having the longest lever arm about the centre of gravity, wood density for the tailplane is the most critical of the lot.

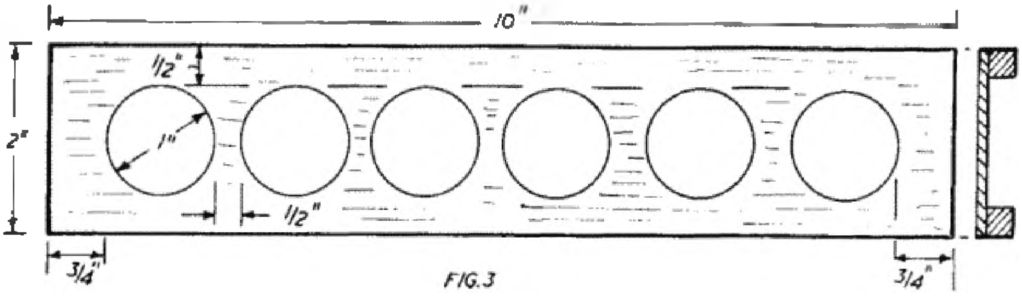


FIG. 3

Another point here is that the most successful designers normally aim to produce the lightest possible tailplanes, consistent with suitable strength and torsional rigidity. When such a design is turned into a kit, or detailed on a plan, some variations will be inevitable. Suppose, for example, the designer specifies medium-soft for the tailplane wood. In actual fact the wood used on the prototype and particularly selected may have been light grade—say 6 lb./cu. ft. Kit wood may err on the heavy side of the medium-soft range, which could give a 1·5 times increase in frame weight. A modeller buying wood for building from the plan may choose what he considers light wood in the "medium" range and virtually double the frame weight. The result may not be too drastic, but it will upset the original design balance and perhaps call for ballast to trim.

Many aeromodellers—contest flyers, in particular—often feel the need for an "in-between" size of sheet thickness (and sometimes in strip sizes). Thus on a particular design, $\frac{1}{32}$ in. may appear too weak for wing ribs, and $\frac{1}{16}$ in. too heavy. The intermediate size—$\frac{1}{24}$ in.—would seem just right. This, however, is not really a valid demand although quite a high proportion of sheet stock for kit model ribs, etc., in $\frac{1}{24}$ in. thick because this is a useful size for the very reason just mentioned. In the case of kits, however, there is not the same chance for *close*, individual selection of material grades.

Basically, the answer to this particular problem is—if $\frac{1}{32}$ in. is considered too thin for adequate buckling strength, then the standard $\frac{1}{16}$ in. thickness will be quite a suitable choice, rather than an "intermediate" size. It will certainly have the required stiffness. If it is selected from quarter-cut stock it will give this thickness in a very light grade so need be no heavier, and could even work out lighter, than random grade $\frac{1}{24}$ in. thick stock. To cut down weight still further, if necessary, the extra thickness means that it is somewhat more rigid than it need be, so stock can be removed to lighten. The main point is that since $\frac{1}{16}$ in. sheet is a standard stock size, selection of a suitable grade and cut is far easier than obtaining $\frac{1}{24}$ in. to special order and where, in any case, final selection will be limited to the relatively few "special" sheets.

Table III offers a useful method of comparing the relative *volumes* of different standard strip sizes ; and thus either comparative weights in the same density of balsa, or the difference in density required to achieve similar weights in changing from one wood size to another. The table shows, for example, that $\frac{1}{8}$ in. sq. (16 units) has roughly twice the volume of $\frac{3}{32}$ in. sq. (9 units), although this is not readily apparent just thinking in terms of "square" sizes. To use the larger section to give greater local strength would, therefore, necessitate using wood of nearly half the original density unless a weight increase is regarded as inevitable. If this additional stiffness is necessary, most probably it could be

TABLE III
RELATIVE VOLUMES OF STRIP SECTIONS
SQUARE SECTIONS

SIZE	1/16″ sq.	3/32″ sq.	1/8″ sq.	5/32″ sq.	3/16″ sq.	1/4″ sq.	3/8″ sq.	1/2″ sq.
RELATIVE VOLUME	4	9	16	25	36	64	144	256

RECTANGULAR SECTIONS

Size	1/8″ × 1/16″	1/8″ × 3/32″	3/16″ × 1/16″	3/16″ × 3/32″	1/4″ × 1/16″	1/4″ × 3/32″	1/4″ × 1/16″	3/8″ × 1/16″	3/8″ × 3/32″	3/8″ × 1/8″
Relative Volume	8	12	12	18	16	24	32	24	36	48

3/8″ × 3/16″	3/8″ × 1/4″	1/2″ × 1/16″	1/2″ × 3/32″	1/2″ × 1/8″	1/2″ × 3/16″	1/2″ × 1/4″	1/2″ × 3/8″	3/4″ × 1/8″	3/4″ × 1/4″	1″ × 1/4″
72	96	32	48	69	96	128	192	96	192	256

TABLE IV
WEIGHT OF BALSA—OUNCES PER CUBIC INCH

Density lb/cu.ft.	5	6	7	8	9	10	11	12	13	14	15	16
oz./cu.in.	·04630	·05556	·06482·	·07407	·08333	·09259	·1019	·1111	·1204	·1296	·1389	·1481

achieved by increasing one dimension only—*e.g.*, using 1/8 in. × 3/32 in. in the case of the example just quoted. Here the volume increase is only 12—9=3 units and more or less within the range of dropping one grade in weight.

The classic example of "volume saving" (and thus weight saving) by exaggerating one dimension in the direction of maximum strength required and reducing the other dimension to a minimum is the so-called diagonal longeron construction on box fuselages—Fig. 4. Longerons 1/8 in. square can be replaced by 3/16 in. × 1/16 in.; longerons 3/16 in. square by 5/16 in. × 3/32 in.; and longerons 1/4 in. square by 3/8 in. × 1/8 in. to give similar, if nor greater overall strength, although there is some loss of local strength on the unsupported runs (*i.e.*, between spacer stations). The saving is approximately 25 per cent, as shown in the diagram, and in practice is usually higher since similar "reduced" sizes are usually employed for the spacers.

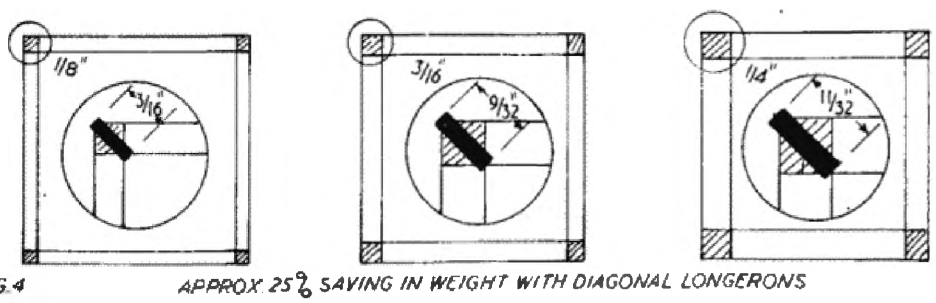
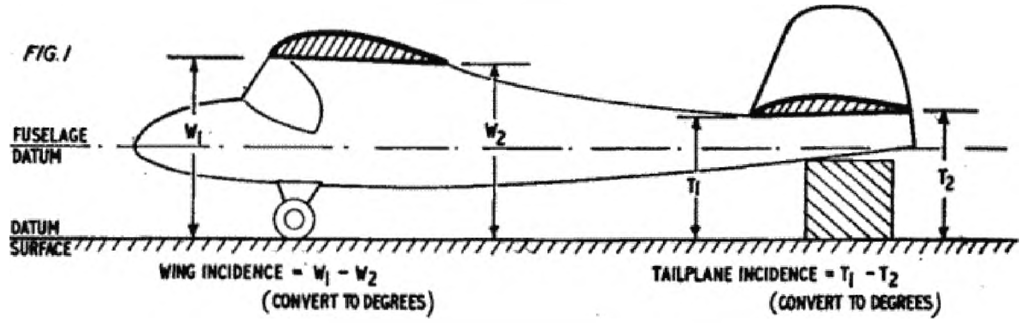


FIG. 4 APPROX 25% SAVING IN WEIGHT WITH DIAGONAL LONGERONS

FIG. 1



MEASUREMENT OF RIGGING ANGLES

INITIAL rigging angles are invariably built into the design of a model but are seldom final. Usually the tailplane incidence is adjusted by means of packing under the leading or trailing edge. Sometimes, but far less usually, the wing incidence also requires adjustment to counter a design fault, or to assist trimming. Power-duration models, for example, may be more amenable in some cases to trimming by adjustment of wing incidence rather than tailplane incidence; or both wing and tailplane incidence adjusted as an alternative to adding downthrust to the engine.

Initial rigging angles are set when drawing up the fuselage plan, where they can readily be measured in degrees. Any subsequent adjustment is almost invariably done using an arbitrary scale, leaving the final rigging angle unknown. One invariably speaks of adding "so much packing", for instance, rather than adding a fraction of a degree positive (or negative) to the tailplane to trim. It is possible when trimming by "packing sizes" to reduce the longitudinal dihedral to a dangerous degree, or conversely to increase it to an excessive—and therefore inefficient—value without knowing. Checking the final rigging angles established in terms of degrees is therefore a wise precuation. Such a check is also recommended when initially rigging the model, before test flying, in order to ensure that it conforms to plan requirements and that no variations have crept in during construction.

A rigging check may be carried out directly, using a protractor and a plumb bob. Although the principle involved is accurate, such a method may be awkward to use and also read inaccurately. Direct measurement is best using a rule to find the leading and trailing edge heights above a common datum (*e.g.*, a table top) with the assembled model supported so that its nominal datum line (*e.g.*, the fuselage centre line) is parallel to that datum surface—see Fig. 1. Using Tables A or B the difference in heights between the leading and trailing edge measurements for the wing (or tailplane) can then be translated in terms of degrees rigging angle.

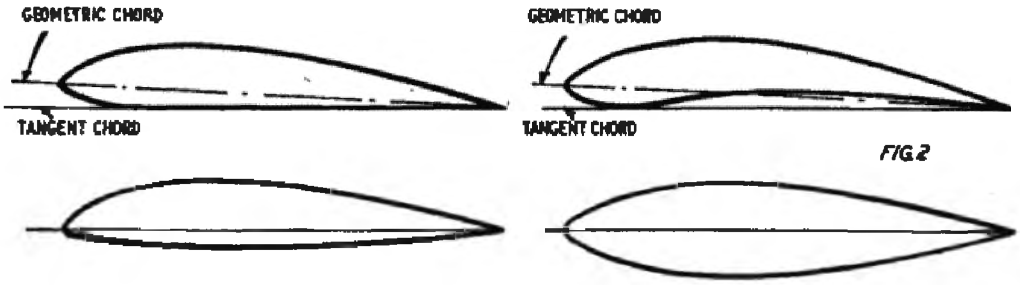


FIG. 2

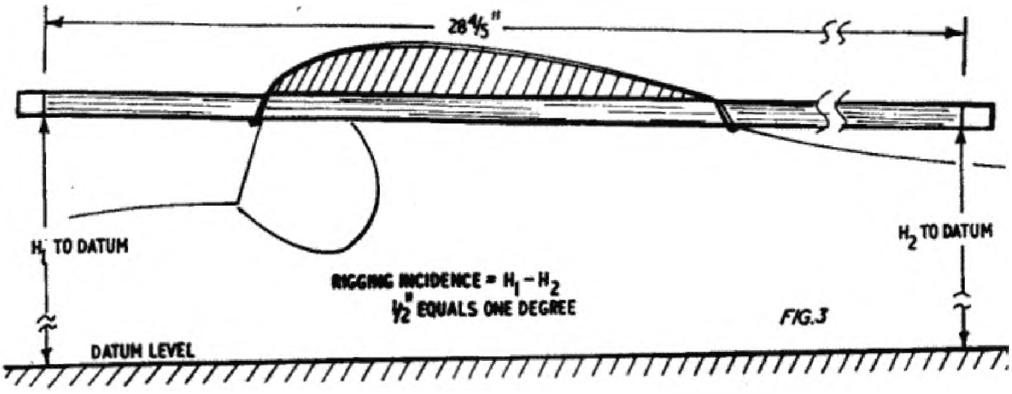


FIG.3

There are two possible points to measure to in determining leading edge height on an aerofoil—the physical leading edge itself, or the height of the tangent to the lower surface—see Fig. 2. The first represents the true geometric datum line of the aerofoil section, but the *exact* position of the leading edge point is not always obvious. Thus the *tangent* datum is invariably preferred for rigging angle measurement. In the case of sections with upswept leading edges or undercambered sections, this is represented simply by holding a flat strip of balsa against the bottom of the wing section and measuring to the strip.

The tangent datum cannot be used in the case of bi-convex and symmetrical sections. In such cases the true geometric datum must be employed and, to assist measurement, the leading edge points should be carefully and accurately marked on the section at the point where a rigging angle check is to be made.

Instead of direct measurement of leading and trailing edge height and referring to tables to find the appropriate value in degrees for the chord concerned, a rigging stick is often preferred. This is suitable only for *tangent* measurement and consists simply of a suitable length of straight balsa strip of sufficient section to remain rigid when strapped to a wing (or tailplane) with a rubber band, as in Fig. 3. The model itself is supported on a flat surface with its datum line parallel to that surface, as before.

Height measurements are then made to marked points on the rigging stick which can then be translated directly into degrees regardless of the chord of the wing (or tailplane) and without reference to tables. Measurements are made to the height of the rigging stick (top or bottom, as most convenient, but the *same* in both cases) at each of the marked points. If the distance between the marks is 28·8 in., then each ½ in. of difference measurement represents one degree in angle. Angular rigging can thus be estimated very rapidly and accurately, provided the rigging stick is not bowed. A 1¾ in. difference in heights, for example, would represent 3½°.

Where a rigging stick of this length is not convenient to use a shorter

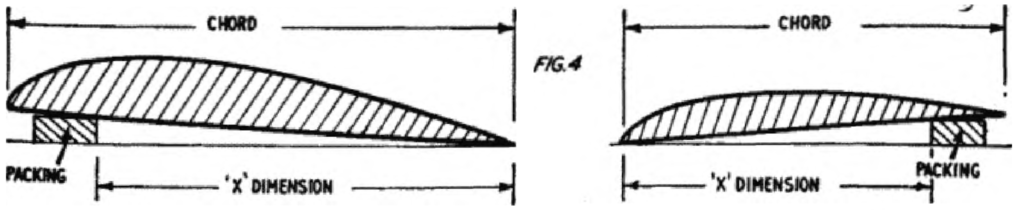


FIG.4

TABLE A
DEGREES FOR GIVEN PACKING THICKNESS OF CHORD

PACKING THICKNESS / CHORD →	3	3½	4	4½	5	5½	6	7	8	9	10	11	12
1/32	37′	31′	27′	24′	22′	20′	18′	16′					
1/16	1° 14′	1° 2′	54′	48′	43′	39′	36′	31′	27′	24′	22′	20′	
3/32	1° 51′	1° 30′	1° 21′	1° 12′	1° 6′	1° 0′	54′	48′	42′	36′	32′	30′	27′
1/8	2° 28′	2° 5′	1° 48′	1° 36′	1° 26′	1° 19′	1° 12′	1° 1′	54′	48′	43′	39′	36′
3/16	3° 42′	3° 6′	2° 42′	2° 24′	2° 9′	2° 0′	1° 48′	1° 36′	1° 24′	1° 12′	1° 6′	1° 0′	54′
1/4	4° 57′	4° 9′	3° 37′	3° 12′	2° 52′	2° 37′	2° 24′	2° 3′	1° 48′	1° 36′	1° 26′	1° 18′	1° 12′
3/8	7° 25′	6° 14′	5° 24′	4° 48′	4° 18′	4° 0′	3° 36′	3° 12′	2° 48′	2° 24′	2° 10′	2° 0′	1° 48′
1/2	9° 44′	8° 18′	7° 15′	6° 25′	5° 45′	5° 15′	4° 48′	4° 7′	3° 35′	3° 12′	2° 52′	2° 37′	2° 24′
5/8	12° 20′	10° 25′	9° 0′	8° 0′	7° 10′	6° 35′	6° 0′	5° 5′	4° 30′	4° 0′	3° 35′	3° 15′	3° 0′
3/4		12° 28′	10° 48′	9° 36′	8° 36′	8° 0′	7° 12′	6° 24′	5° 36′	4° 48′	4° 20′	4° 0′	3° 36′
1				12° 50′	11° 32′	10° 29′	9° 36′	8° 13′	7° 11′	6° 23′	5° 45′	5° 13′	4° 47′

ALL MEASUREMENTS IN INCHES

length (*e.g.*, 15 in.) can be used, measured off with 14·4 in. between marks. In this case each ¼ in. difference in measurement will represent 1°. A shorter rigging stick than this size is not recommended for accurate work. Equally a longer rigging stick than 30 in. (with 28·8 in. between marks) is not recommended owing to the tendency for longer lengths to bow and thus give false readings.

Notes on the use of the Tables appear on page 82.

TABLE B
I/CKING THICKNESS EQUIVALENT TO DEGREES RIGGING

DEGREES / CHORD →	3	3½	4	4½	5	5½	6	7	8	9	10	11	12
½	·0263	·0305	·0348	·0392	·0435	·0479	0526	·0610	·0696	·0784	·087	·0958	1052
1	·0525	·0610	·0700	·0784	·0875	·0958	·1050	·1219	·1400	·1568	·175	1916	·2100
1½	·0786	·0914	·1048	·1276	·1310	·1437	·1572	·1829	·2096	2352	·262	·2874	·3144
2	·1047	·1220	·1396	·1568	·1745	·1916	·2094	·2438	·2792	·3136	·349	·3832	·4188
2½	·1308	·1525	·1744	·1960	·2180	·2395	·2616	·3048	·3488	·3920	·436	·4790	·5232
3	·1568	·1829	·2092	·2351	·2620	·2874	·3138	·3658	·4184	·4703	·523	·5748	·6276
3½	·1830	2233	2440	2744	3055	·3553	·3660	·4268	·4880	·5487	·610	·6706	·7320
4	2091	·2440	·2792	·3136	·3490	·3832	·4182	·4876	·5584	·6272	·698	·7664	·8364
4½	2355	2745	·3140	3528	·3925	·4311	·4710	5486	·6280	7056	·765	·8622	·9420
5	·2616	3050	3488	3920	·4360	·4790	5232	·6095	·6976	·7840	·872	·9580	1·046
6	·3135	·3658	·4180	·4702	·5225	·5748	·6270	·7315	·8360	·9405	1·045	1·150	1·254

ALL MEASUREMENTS IN INCHES

TABLE C
CHORD SPACING "X" FOR EXACT RIGGING ANGLES

PACKING → / DEGREES	1/32	1/16	3/32	1/8	3/16	1/4	3/8	1/2	5/8	3/4	1
1/2	3·58 3 37/64	7·17 7 11/64	10·75 10 3/4	14 34 14 11/32							
1	1·79	3·58 3 37/64	5·37 5 3/8	7·17 7 11/64	10·74 10 3/4	14·32 14 11/32					
1 1/2		2·39 2 25/64	3·58 3 37/64	4·78 4 25/32	7·16 7 11/64	9·95 9 61/64	14·32 14 11/32	19·1			
2	(29/32)		2·69 2 11/16	3·58 3 37/64	5·37 5 3/8	7·16 7 11/64	10·74 10 3/4	14·32 14 11/32	17·90 17 29/32		
2 1/2	(23/32)			2·865 2 55/64	4·30 4 19/64	5·73 5 47/64	8·595 8 19/32	11·46 11 29/64	14·32 14 11/32	17·19 17 3/16	
3	(19/32)				3·585 3 37/64	4·78 4 25/32	7·17 7 11/64	9·56 9 9/16	11·95 11 61/64	14·34 14 11/32	
3 1/2	(33/64)				3·07 3 1/16	4·095 4 3/32	6·14 6 9/64	8·19 8 3/16	10·29 10 19/64	12·285 12 9/32	
4		(29/32)		(1 51/64)	2·69 2 11/16	3·58 3 19/32	5·37 5 3/8	7·17 7 5/32	8·98 9	10·74 10 3/4	14·34 14 11/32
4 1/2	(13/32)			(1 19/32)		3·19 3 3/16	4·785 4 25/32	6·38 6 3/8	7·99 8	9·57 9 9/16	12·75 12 3/4
5	(23/64)			(1 7/16)		2·865 2 7/8	4·30 4 5/16	5·73 5 3/4	7·175 7 3/16	8·595 8 19/32	11·47 11 15/32
6	(19/64)						3·585 3 19/32	4·784 4 25/32	5·980 6	7·176 7 3/16	9·567 9 9/16
7	(1/4)						3·077 3 1/16	4·103 4 3/32	5·130 5 1/8	6·153 6 5/32	8·206 8 3/16
8		(7/16)		(29/32)			(2 11/16)	3·593 3 19/32	4·490 4 1/2	5·385 5 3/8	7·185 7 3/16
9		(13/32)				(1 19/32)		3·196 3 3/16	4·00 4	4·794 4 25/32	6·392 6 3/8
10	(5/32)	(5/16)		(23/32)		(1 7/16)		(2 7/8)	3·585 3 19/32	4·305 4 5/16	5·758 5 3/4

Table A

This gives the angular difference in degrees produced by standard size packing inserted under the leading edge (positive angular addition) or trailing edge (negative angular addition, for a range of different chord sizes.

Example : What change in rigging incidence is produced by inserting $\frac{1}{8}$ in. thick packing under the trailing edge of a 6 in. chord tailplane?

Answer : the corresponding table figures shows that this is equivalent to adding 1° 12 min. negative incidence to the tailplane.

Note: this assumes that the tailplane is so mounted that packing is inserted *under* the trailing edge. In the case of underslung tailplanes where packing is inserted between the *upper* surface of the tailplane and its mount an *opposite* change is produced (*i.e.*, trailing edge packing adds positive incidence; and leading edge packing negative incidence).

Table B

This table gives exact packing thicknesses (and nearest fractional equivalents, where applicable) required to produce specific incidence changes over a range of chord sizes.

Table C

This table gives values for the *distance* at which standard sizes of packing should be inserted relative to the tangent chord line to give exact angular changes —see Fig. 4. These data are of particular value where it is desired to produce an exact angular change in rigging rather than an arbitrary change given by a certain thickness of packing.

Example : It is required to produce an exact $1\frac{1}{2}$° change (increase in positive incidence) on an 8 in. chord wing. Find a suitable size of packing and its location.

Reference to Table C shows that $\frac{3}{16}$ in. packing will produce a $1\frac{1}{2}$° change at 7·16 in. Thus the $\frac{3}{16}$ in. packing would be inserted so that the "X" measurement in Fig. 4 is 7·16 in. That is the back edge of the packing should come 8—7·16=·84 in. behind the leading edge. This, of course, is applicable only to a flat bottom section.

Note : In the case of Tables A and B, values have been calculated on the assumption that the packing has no width—*i.e.*, the packing is equivalent to raising the leading edge (or trailing edge) by an amount equivalent to the exact thickness of the packing. This enables Tables A or B to be used for conversion of rigging measurements as in Fig. 1 directly into degrees. The difference that may be involved when applied to packing inserted under a wing or tailplane is small enough to be negligible since packing width is usually small.

POPULAR EQUIVALENT MOTOR SIZES

Note that the American sizes as quoted by manufacturers are usually nominal—thus a "29" may, in fact, approach ·299 cu. in. capacity, equivalent to 4·9 c.c. For *exact* conversion multiply *actual* displacement of engine concerned (cu. in.) by 16·39.

AMERICAN CU. IN.	·02	·049	·099	·15	·19	·23	·29	·35	·45	·49	·60
C.C.	·3	·8	1·6	2·5	3·2	3·75	4·75	5·75	7·5	8·0	10·0

Dennis Thumpston of Sutton Coldfield M.A.C., pioneer scale r/c club with his Sopwith 1½ strutter, a delightful medium for the modeller. Power is a Rivers Silver Streak, r/c is single channel using Wright Relaytor system.

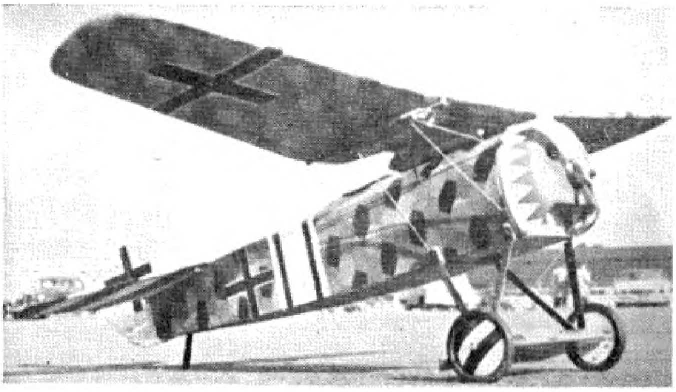
SCALE RADIO CONTROL

To a high proportion of aeromodelling enthusiasts, the flying scale model is the ultimate type. A high proportion of beginners, in fact—especially the younger enthusiasts—choose a flying scale design for their first model, usually with very indifferent or even disastrous results on the flying side. The limitations of the flying scale model are chiefly bound up with the difference in degree of inherent (or automatic) stability associated with a full-size aircraft design (which is pilot controlled) and that of a basic *model* design, with differences in geometry further aggravated by "scale effect". Basically, the latter is a lowering of efficiency of aerodynamic surfaces with decreasing size and flying speed.

As regards *free flight* flying scale models this usually results in an overall reduction in automatic stability below the level which is usually necessary for satisfactory model flight. This can be offset to some extent by a suitable choice of prototype—*i.e.*, a full-size design layout which itself possesses a fair degree of inherent stability. The stability margin can also be improved by modification to geometry—increased tail areas, increased dihedral, etc.—which, while departing from true scale geometry, may have to be accepted to achieve satisfactory flying results.

In other words, necessary model design requirements are built into the original scale layout without seriously detracting from appearance—although such differences may be very obvious to the expert. A further alternative is "automatic pilot" type of control, usually via a weighted pendulum linked to a suitable control surface (usually the rudder). This aims, as far as possible with simple mechanisms, to put back the missing "pilot" control into the scale design so that little or no exaggeration of desirable "model" design features need be incorporated to spoil true scale outlines or appearance. Pendulum controls can be quite efficient in this respect, but never completely efficient. They have definite limitations in that they are not able to distinguish between a sideslip and a bank, for example, so they can never be regarded as entirely reliable. On the other hand, properly applied, they can make an otherwise unsatisfactory design layout (one with marginal stability) a flyable proposition.

Unless possessing typical "model" stability, however, the free flight scale model is basically a calm weather flyer. All its stability problems are



A Fokker D.VIII by D. J. Bannister of Glevum M.A.C. for proportional control. Engine is Merco 29.

exaggerated in gusty conditions and under such circumstances it is usually unwise to attempt to fly. There is also the fact to consider that scale models have also received considerably more attention—and time spent on them—in the matter of finish and detail, all of which work can be ruined by a crash. The scope of free flight scale is, therefore, definitely limited. The control line scale model is much less limited since stability and control problems are minimised and the former usually non-existent except that in certain full-size designs the horizontal tail surface area is inadequate in model. As a result there is a lack of longitudinal stability causing the model to "hunt", with resulting loss of control. This is particularly true of certain World War II fighters such as the Tempest and Typhoon, and the Messerschmitt Me 109.

Radio control appears, on the face of it, to offer a complete answer to control and stability problems for free flight scale and produce an all-weather flyer. Certainly it offers tremendous scope in this direction but it, too, is not without its limitations. At the same time the radio-controlled scale model is a type which is rapidly gaining popularity so that such limitations as do exist may be overlooked by the newcomer.

Modern multi-channel radio equipment has reached such a state of reliability that the fully controllable flying scale model flown via rudder, elevator, ailerons and engine controls (with other additional services available, such as flaps, elevator trim, steerable nosewheel, etc.) *is* a practical proposition. The fully aerobatic "freelance" radio control designs, for example, may possess marginal or even zero inherent stability and have thus to be piloted virtually all the time via the controls available—something which has become more or less standard practice during the past year or so. It thus follows that any model which is not definitely *unstable* can be flown readily and satisfactorily with the right type of equipment, and equipment of high reliability.

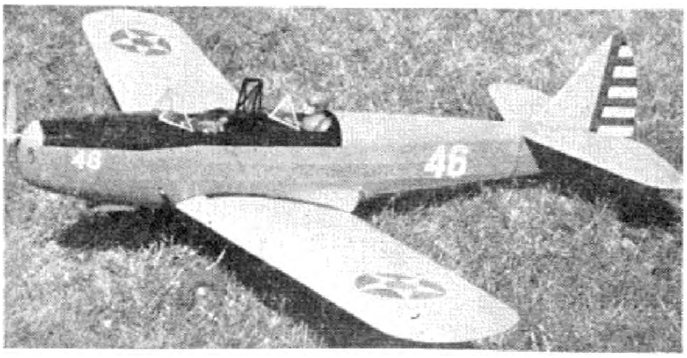
It does not follow that *all* multi-channel radio equipment is immediately suitable for such work. The operating efficiency or reliability factor may still be suspect in some cases. There is also the question of the *type* of control offered by advance radio control equipment.

Almost all consistently successful multi-control systems to date have been based on non-proportional or "bang-bang" control movement (with the exception of motor control and elevator trim which are essentially secondary controls and non-critical). That is to say, two positions only are provided for the control surface—fully deflected (right or left, or up and down)—with a self-neutralising action when the control signal is withdrawn. This is quite distinct from full-size practice where control movements are fully proportioned with respect to the pilot's actual movement of the control column or rudder pedals.

The fully proportional control system is a proposition with model radio control, with a number of workable designs and methods available. The additional complication introduced may or may not detract from the reliability factor, depending on the standard and quality of the design. Working efficiency and reliability, however, are not the major factors in model control. By detaching the pilot from the model so that he operates from a ground base distant from the model, there is an inherent time lag between the pilot *appreciating* any movement of displacement of the aircraft and carrying out any further control movement necessary. It is very much more difficult to maintain full control all the time from a ground station offering fully proportional control—and at times even impossible.

For general application to flying scale models, therefore, proportional control systems may have distinct practical limitations. Also this type of gear is less developed—and therefore readily available in fully proven form (particularly in this country). Theoretically it is the ideal solution, especially as it should eliminate the "jerkiness" often associated with "bang-bang" controls and requires little or no stability margin inherent in the aircraft design in order to recover from manœuvres when the controls are neutralised. On the other hand, conventional on/off self-neutralising controls for rudder, elevator and ailerons are much safer and easier to operate—and less training is needed to acquire the necessary piloting skill. Also, allied to a suitable design layout, virtually similar flying results can be achieved. In other words, fully proportional controls do not necessarily permit of *more* manœuvres, more *smoothly* performed. In practice, the very opposite can be true due to a tendency to over-control and the difficulty of obtaining synchronisation of control movement with demand. That is not to condemn proportional control systems as such, but merely to emphasise that this apparently highly desirable form of control sets particular problems of its own which are still further aggravated by any attempts at simplifying the system. Fully proportional controls, in other words, are not the complete answer.

The *current* answer to successful radio-control scale flying is conventional multi-channel systems with motorised actuators for a fully comprehensive control system enabling virtually any full-size prototype to be selected, provided that, in model size, it is not distinctly unstable. While it is theoretically possible to fly an unstable model under comprehensive multi-control systems, this represents too exacting a demand in practice. Also if the instability is



J. A. Mountain, Kidderminster, built this P.T. 19. Power is A.M.15., Rx E.D.I. with proportional control. Tx is own design.

The ubiquitious A.P.S. Cessna 172 design as built by P. J. Anderson of Wigsley M.A.C. Hill Rx. operates a Rising escapement. Power is A.M. 35 and Tx. R.E.P. printed circuit type.

catastrophic so that once initiated it tends to build up (*e.g.*, in a spin) there may be complete loss of control where no counter action is effective.

As a general rule, therefore, it would be advisable to avoid prototypes which could tend to be unstable. In particular this refers to designs with very small tail surfaces (both horizontal and vertical), low wing models with very little dihedral, and any full-size aircraft known to have "vicious" characteristics. Where slight modifications may be attempted it should be remembered that these may affect other parts of the layout. A slight increase in dihedral, for example, would call for an increase in fin area to balance. A difference in centre of gravity position between model and full-size craft could also have a drastic effect on tail surface efficiency. In the main, full-size aircraft balance is consistent with a "non-lifting" tail (although the tailplane is used as a trimming control) and models should adopt a similar forward centre of gravity position.

Lack of dihedral itself is no limitation for a successful radio-control model (although an essential feature for automatic stability on any free flight model). Nor is a low wing layout necessarily "critical" or difficult to control. Whereas a low wing layout may not have enough inherent stability for safe free flight characteristics, it is a perfectly satisfactory layout for radio control *provided* there are enough control services available. Low wing models, for example, are not particularly good for rudder-only control, mainly because the rudder tends to be relatively ineffective as a control with small movements—and too chaotic in action with large movements. It is a characteristic of a well-trimmed radio-control low-wing model, too, that it can be trimmed "zeroed out" or very nearly so, so that it approaches neutral stability and stays in any particular attitude into which it is put. Thus it can be flown without the "stepping" motions often characteristic with high wing designs where controls have to be blipped to hold a particular manœuvre—*e.g.*, a climb—unless a separate trim control is available.

Given this type of neutral stability, response with a normal "on/off" control movement can be as smooth as with fully proportional control. If a separate trim control is also available (virtually only required for the elevator), smooth upright and inverted flight trim is readily obtainable holding level, climbing or diving. It should be noted that such trim controls are usually "inched" or progressive and thus in this instance approximate to "proportional" controls with the correct "stopping" position judged by experience, and the actual behaviour of the model.

Complete Multi-channel Controls

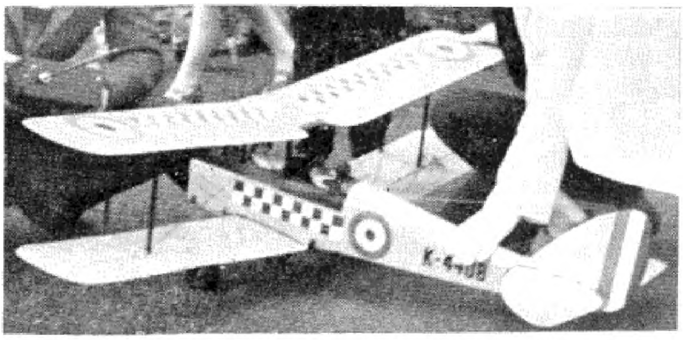
The coverage required for *complete* control embraces five different main controls and normally calls for ten-channel equipment arranged as follows:

(*i*) Rudder—right, left and self-neutralising (two channels).
(*ii*) Elevator—up, down and self-neutralising (two channels).
(*iii*) Motor speed—slow to fast, either sequence (fast to slow, slow to fast, and so on) or, preferably, progressive with positive limiting positions (fast and slow). It is strictly *necessary* to be able to find either "fast" or "slow" with *positive* switching action. Intermediate speeds are less important and can easily be "inched" on or off. "Selective" motor speed, fast or slow, calls for one or two channels. Progressive motor control calls for two channels.
(*iv*) Ailerons—up and down, self-neutralising (two channels).
(*v*) Elevator trim—restricted movement with "progressive" control (two channels).

Further additional controls may be desirable on a scale model, such as:

(*a*) Steerable nosewheel—right, left and self-neutralising (utilising rudder control channels). This is applicable only to tricycle undercarriage layouts. On conventional two-wheel undercarriages the tailwheel can be pivoted and mechanically linked to the rudder for ground steering control. In both cases the necessary movement can be obtained by utilising the rudder control channels.
(*b*) Wheel brakes—on or off. Again in the case of a normal undercarriage with tailwheel, a tailwheel brake can be arranged to operate via an elevator control (*e.g.*, linked to up elevator movement). A similar linkage can be connected to elevator movement or elevator trim for tricycle wheel brakes.
(*c*) Wing flaps—down and retracted (one channel) or progressive (two channels).
(*d*) Retractable undercarriage—up and down (with suitable locking in both positions).

Demands (*c*) and (*d*)—and any others, such as parachute or bomb dropping gears, etc.—can be regarded as secondary controls and therefore not



Elegant Gipsy Moth, with 10-channel Orbit Rx., Enya 19 engine, built and flown by J. R. Morton of Bristol.
APS Plan 135 price 10/- has R/C details, span 60½ in.

TABLE I. MAIN AND SECONDARY CONTROLS

	CONTROLS (In order of importance)	OPERATION VIA		PREFERRED ACTION	
		Single-channel	Multi-channel	Single-channel	Multi-channel
MAIN CONTROLS	(*i*) Rudder	Escapement or* *Fast servo*	Motor servo	S/N† selective (sequence)	S/N on-off
	(*ii*) Elevators	Escapement/servo*	Motor-servo	S/N selective (sequence)	S/N on-off
	(*iii*) Engine speed	Escapement	Escapement/servo or motor-servo	S/N selective (sequence)	Progressive‡
	(*iv*) Ailerons	not suitable	Motor-servo	—	S/N on-off
	(*v*) Elevator trim	not suitable	Motor-servo	—	Progressive‡
SECONDARY CONTROLS (order arbitrary)	(*a*) Steerable nosewheel	not suitable	Rudder link	—	as rudder
	(*b*) Wheel brakes	not suitable	Elevator or Elevator Trim link	—	on-off
	(*c*) Flaps	not recommended	I channel and motor servo	—	on-off
	(*d*) Retractable under-carriage	if required recommend dethermaliser timer operation (for (*d*) to (*f*))	I or 2 channels and motor servo	mechanical tripping (for (*d*) and (*e*))	on-off
	(*e*) bomb dropping		can be obtained through sequence switching or escapements on spare channel (for (*e*) and (*f*))		switch tripping (for (*e*) and (*f*))
	(*f*) other "novelty" services				

* Escapement operation is usually best for rudder owing to faster operation. Elevators require more power than is normally given by a rubber driver escapement and are preferably driven by a motor-servo controlled by the escapement.
† S/N—self neutralising ‡ With limiting end positions.

normally chosen at the expense of the other main controls (*i*) to (*v*) which are responsible for ensuring optimum flying performance and control. Demands (*a*) and (*b*) however are merely a matter of mechanical solution using main control movements—*i.e.*, rudder movement also operating steering and elevator movement wheel brakes. Of the main controls only (*iii*) motor control can be cut down to one-channel operation thus freeing one additional control channel on ten-channel equipment; or giving three further channels on twelve-channel equipment for operating the secondary services from (*a*), (*d*), etc. Such secondary services should *never* take precedence over the main control demands. It is more important to have the model fully controllable in flight than it is to achieve full "working scale" realism.

Restrictive Multi-channel Operation

The main controls detailed above are listed in order of importance. Rudder is an essential control though with the complete range (*i*) to (*v*) used comparatively little in flight, turning being more readily and safely initiated with ailerons. The only control service which can be regarded as an "extravagance" is elevator trim and so this could be dispensed with to provide a comparable flight performance on eight-channel equipment. One channel could also be derived spare from (*iii*) for operating a secondary control.

Since rudder control is *essential*, a further saving can be effected by dispensing with ailerons, reducing the number of channels required for adequate flight control to five or six. This implies that all turns and "rolling" control are largely determined by rudder and does place more demands on the flying characteristics of the model. In other words, cutting down the basic controls to rudder, elevator and motor calls for an overall design which is somewhat more stable. The controls available may not be sufficient to pull a neutrally stable model out of a "catastrophic" instability condition initiated, say, by over use of rudder. The turning characteristics of a particular design may also be particularly bad, tending to rollor side slip smartly even on "blipped" rudder action.

Restricted to five- or six-channel operation, therefore, the preferably scale prototype becomes one which normally makes a good free flight model (*e.g* , a high wing layout with generous tail surface areas). It need not, however, be necessary to exaggerate "stability" features as would be necessary with a free flight model. Flight pattern will be somewhat more limited—its stability to roll following a spiral dive, for example, being dependent on the spin characteristics of the design rather than on control, but it should still be quite safe to fly, even in rough weather. Elevator control will give necessary penetration and also enable the landing approach to be controlled—assuming always, of course, that the piloting is competent.

Reducing to four-channel equipment prototype choice is even more restricted. Also there is a considerable difference of opinion as to the best combination of controls to use. Rudder remains an essential control, which accounts for two channels. Elevator is an invaluable control in rougher weather in particular; but motor speed is also equally useful. Provided the model *design* is suitable, rudder and motor provides the most *scope* with three- or four-channel systems; although rudder and elevator could be a better combination on a scale model which is not over-powered and is not intended to be aerobatic.

TABLE II. MULTI-CHANNEL RADIO SYSTEMS

EQUIPMENT	MAIN CONTROLS (see Table I	AVAILABLE CHANNELS PER SECONDARY CONTROLS	SCALE PROTOTYPE
12-channel	All	2 or 3*†	Virtually unrestricted
10-channel	All	1 possible*†	
8-channel	All except elevator trim	1 if two-speed motor used*†	Virtually unrestricted but low wing or possibly biplane preferred
	As for 6-channel	2 or 3*†	Design with some dihedral high wing preferred
6-channel	recommended: (*i*) Rudder (*ii*) Elevators (*iii*) Engine	1 using two-speed engine*†	High wing monoplanes or designs with generous dihedral and tail areas
	alternative: (*i*) Rudder (*ii*) Elevators (*iii*) Ailerons	None*†	Designs with reasonable margin of inherent stability
4-channel	recommended: (*i*) Rudder (*ii*) Engine	1 using two-speed motor*	Designs with good free flight stability
	alternative: (*i*) Rudder (*ii*) Elevator	None*†	As above, with relatively low power
3-channel	(*i*) Rudder (*ii*) Motor	None*	High wing layout preferred with good free flight stability

* Steering (nosewheel or tailwheel) available via linkage to rudder movement.

† Brakes available via elevator movement and suitable linkage.

In either case it is necessary now to adopt a design which is positively stable, or modify the full-size layout accordingly. In other words, when controls are neutralised the model must revert to stable free flight trim from whatever attitude it was in beforehand. To be on the safe side, this means that the only satisfactory prototypes in this case are those which make satisfactory free flight models, unless flying is always to be restricted to calm conditions. In the latter case the stability requirements are less exacting, but the model will still require to have positive inherent stability as the only certain means of being able to recover from mis-handling of the controls.

Single-channel Operation

Very much the same considerations apply with single-channel operation. The basic requirement is a model which is stable in free flight so that it will recover to a normal flying attitude when all controls are neutralised. Coverage of all the basic control requirements for flying a neutrally stable model through sequence switching is only possible on paper or the test bench—not in practice. Two controls are as many as can be handled properly via sequence switching, and three at the most if the third control function is non-critical (*e.g.*, motor speed).

At best, therefore, with single-channel equipment one is restricted to rudder and elevator, and possibly motor control also available. The rudder is the essential and main control and where elevator control is also obtained through cascaded escapements, elevator trim rather than complete up and down elevator movement is to be preferred as a recommendation. Loss of a "trim" control in switching is likely to be less drastic than complete loss or mis-selection of a main and more powerful control.

In all such cases, the controls must be regarded as an addition to *a model which has good free flight characteristics*. Any complication of the mechanical movements possible from single-channel operation will, in general, lower the safety factor of the whole and quite possibly detract from the value and efficiency of the main or critical controls by making them difficult to select or slow to be selected. It can also be stated as a general rule that with single-channel systems and restricted control functions self-neutralising controls are imperative where applied to rudder and elevators. Proportional rudder or proportional elevator without a self-neutralising action can be virtually unflyable. The only "safe" system is one which allows the model to revert to a normal free flight model in case of difficulty in maintaining control. Nevertheless, various pulse systems continue to be used and developed to give proportional rudder (and in some cases other controls as well), in attempt to supply "multi-channel" coverage with simpler and far less expensive equipment. They can also give good results if the operator is experienced enough to handle them, and is not harassed by trying conditions such as rough weather. Despite the obvious attraction of lower cost, however, they cannot and do not rival multi-channel equipment either in scope or reliability.

Probably the best known, and most attractive, of the single-channel pulse systems is "simpl-simul" or "Galloping Ghost", as it is known in this country. This involves a motor drive and continuous cycling of the rudder and elevators through their full range of movement. Proportional control is provided by causing the control drive to dwell in a particular position. To do this the transmitter output is modified via a suitable control box mechanically or electrically arranged to pulse the transmitter signal at a variable *rate* (usually governing elevator movement) and with a variable pulse *length* (governing rudder position). The necessary pulse switching can be connected to a joystick-type lever for manual control purposes. The result is a reasonable full-proportional control response on rudder and elevator which, theoretically at least, provides all that is necessary to control a neutrally stable model.

Results achieved in practice vary enormously. Some "Galloping Ghost" systems are highly successful with the operator having no difficulty in maintaining control. Others are completely unsatisfactory, emphasising all the inherent disadvantages previously described with regard to fully proportional controls plus other unknown factors which seem to introduce a definite instability. So far, at least, the system seems to have been most successful on models with good free flight stability and least successful on models with marginal or no inherent stability. One hesitates, therefore, to recommend the system for general use for simplified scale radio control, although this may well be a fruitful field for further development by the more expert who is prepared to work on and eliminate failings or limitations which may show up in practice.

One such system which has showed considerable promise is dual-proportional coupled aileron-rudder which offers, theoretically at least, almost complete "aerobatic" control coverage. Its particular attraction as far as scale models is concerned is that it gives satisfactory control with about half the dihedral needed for normal "free flight" stability requirements, such as demanded by simpler on/off control systems. Lack of dihedral is, of course, one of the main "unstabilising" features of a true scale outline applied to models requiring free flight stability.

The same consideration does, of course, extend to almost all "proportional" control systems, which makes them so attractive and often causes their limitations to be overlooked. Discounting operational snags the success of any such system is almost entirely bound up with the servo performance.

TABLE III SINGLE-CHANNEL RADIO SYSTEMS

SWITCHING	SERVICES	REMARKS
*Simple escapement	Rudder only	S/N typeselective sequence preferred
*Compound escapement	recommended: Rudder Engine speed	via second escapement
	possible: (1) Rudder (2) Elevator trim	via second escapement
*Cascaded escapment	possible: Rudder Elevators Engine others	More than two *main* services cannot be handled efficiently. Rubber powered escapements are not suitable for operating elevators or ailerons
Pulse-proportional controls	Proportional rudder motor	Proportional rudder not recommended for aircraft possible as a record centre
	Proportional rudder-Elevator	The "poor man's multi" but not a foolproof system
	Proportional rudder-ailerons	Simulates "multi" action with good possibilities for further development

Note: * These require a careful choice of prototype (or modifications to the full-size design proportions) so that the model should possess good inherent free flight stability. In particular, it is important that the model should not develop vicious tendencies in turns.

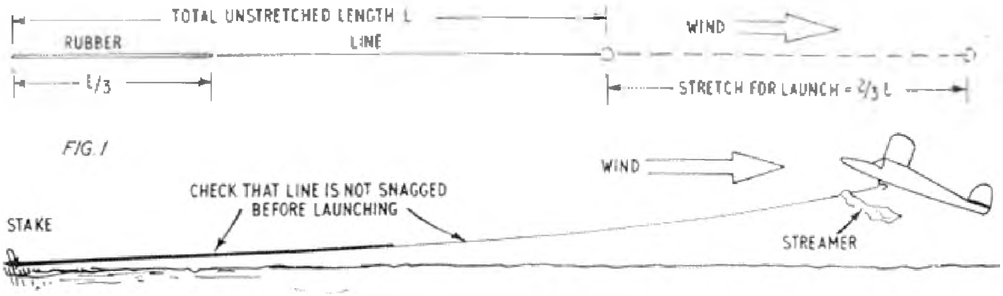


FIG. 1

GLIDERS FOR FUN

PRACTICALLY all the articles ever published on glider and sailplane design and flying have been concerned with contest types and their performance. Yet the glider is equally suited to "Sunday flying", just for fun, as well as offering considerable scope for experiment. Above all, a glider or sailplane is the most inexpensive of all model aircraft to operate. It costs nothing at all for fuel or motors; or if you adapt it for auxiliary power this represents a minimum investment for the size of model involved.

One apparent limitation with towline gliders is that two people are required for launching—one to handle the towline and carry out the actual launch and an assistant to release the model. What is so often overlooked these days is that the old-fashioned catapult launch can be nearly as effective as a normal tow launch in the matter of height gained before release—and it can be used with large models as well as small ones. It is a method of carrying out single-handed "high start" glider launches and—by proper selection of catapult rubber size—is even safer than a normal running tow.

The ideal proportions for a catapult are shown in Fig. 1, from which diagram the method of launch should be obvious. The line consists of one-third of its length of rubber strip and two-thirds normal towline (*e.g.*, linen thread, terylene or nylon line, as preferred). It is extended merely by walking down-wind until the rubber has been stretched to not more than three times its original length, the model hooked on and released. Provided the model is suitably trimmed for tow launching, and the catapult rubber section correct, the result should be a foolproof launch every time.

The chief fault is trying to use too strong a rubber in the line. The best section can only be decided by experiment, for this will vary both with total catapult length and the size and weight of the model. For a 100 to 150 ft. (total) line length, for example, $\frac{1}{8}$ in. flat strip rubber should be adequate to launch 36 in. to 48 in. span gliders weighing 5 to 8 ounces. It will probably be too powerful for smaller models, where $\frac{1}{16}$ in. square rubber is usually adequate. A larger, heavier model may require $\frac{3}{16}$ in. strip, or even $\frac{1}{4}$ in. strip. Also increasing the total line length will tend to call for a slightly powerful rubber. Catapult line lengths up to 300 ft. can work quite successfully, provided the ground is relatively free from obstructions which could snag the line. Unlike a normal tow launch where the line is free of the ground from the moment of launch the end of the catapult line nearest the stake tends to remain on the ground until the model has achieved a reasonable height, especially when using a very long line.

Faults are readily identified, and the cure obvious. If the model climbs too sharply or too fast and slips off the line prematurely, the rubber is too strong. Either decrease the rubber section or, if this is not practicable, increase the rubber length. If the model does not climb, then the rubber is too weak. By far the most usual fault is too strong a rubber as often quite a large model will launch successfully to the full height of the line on only $\frac{3}{8}$ in. rubber.

The fault may, of course, lie with the design or trim of the model, as in conventional tow launching. If the model pulls to one side on a catapult launch, almost certainly it is the fault of the model which needs trimming for straight flight, or warps need taking out of the wing. If the tow hook is too far forward, a glider will never achieve maximum height on the line, whatever the method of tow launching. If the tow hook is too far aft the model will tend to weave and usually pull off to one side for a premature launch. The latter can also be due to a design fault (lack of directional stability) or warps again. A weak catapult is much more tolerant than a running tow launch, with the elastic nature of the line applying automatic "correction" to gusts, etc., and even to a launch started slightly out of wind.

The model itself can easily be "proved", or adjusted as necessary on a 100 ft. (total) catapult before trying on a longer length. The aim should be to get the model up to the full (unstretched) length of the line so that it is almost coming over the top of the stake when it releases itself. This will not normally be possible if there is any appreciable wind, even with a really good towline glider design, because the higher wind resistance of rubber strip, compared with thread, will usually cause it to bow backwards with some resulting loss of height—Fig. 2. Part of this loss may be compensated by stretch remaining in the rubber length on release, however.

Incidentally, although a "single-handed" method of launching, the catapult launch also makes simultaneous launching of two or more models possible, which can be a lot of fun for sport flying. Line tangles are comparatively rare, even when adjacent models are released close together. It is

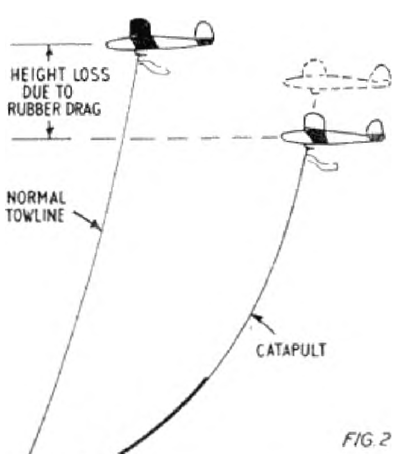


FIG. 2

The spirit of Sunday flying! Nothing could be more carefree than this—no noise—no crowds—just us and the model, plus it is hoped an adequate picnic lunch!

even possible for *one* operator to launch two models simultaneously, each on its own catapult—although this can be a little hectic at times !

The only other method of unassisted launching—hand launching—has definite limitations, except for "chuck" gliders. The "chuck" glider should never be despised as a type for flying for fun. A good design, properly constructed and trimmed, and with a good launching technique mastered, can give extremely long flights, even fly-aways. Often, too, when the wind is far too strong for safe flying with built-up tissue-covered models, a larger size of chuck glider can come into its own and take full advantage of the soaring opportunities given by gusts.

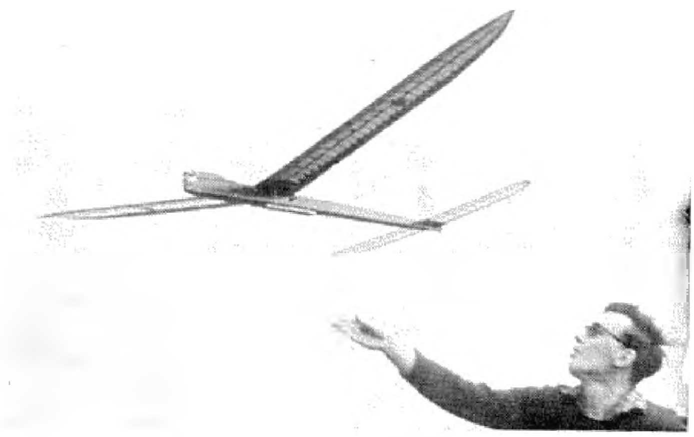
Successful soaring flights following hand launching from the top of a slope demand a specialised type of model—usually a fairly large one with a relatively high wing loading. Most conventional towline glider designs, and especially the smaller ones, will make little or no headway against the wind, lose height and turn back into the slope. Various forms of steering control—*e.g.*, vane controls and compass steering—can be used in an attempt to maintain a straight-out course, but these have their limitations. The model must also be large and heavy enough to achieve penetration against the wind, otherwise it will never reach soaring air.

The real answer to slope soaring is a large model, fairly fast flying, with radio control. Rudder control will be necessary to keep the model on course. Elevator control, or at least an elevator trim control, is also highly desirable, mainly as a method of being able to increase or decrease flying speed. It is possible to use rudder control to produce "down elevator effect" by blipping the rudder from side to side, but this demands some considerable skill to carry out properly. It is too easy to "lose" the model in a turn, for example, and not be able to work back again from the resulting downwind position.

The performance and handling characteristics of almost any model glider or sailplane are almost directly related to size. The larger the model, in general, the more efficient it tends to become, the better it flies and the more stable it is during launching (assuming that there are no design or construction faults present). A 6 or 8 ft. span glider is reckoned a big model, but a 10 or 12 footer is even more fun.

The main disadvantages are that a big model costs more in materials, takes longer to build and can be particularly troublesome to transport to and from the flying field. It may, for example, be necessary to have the fuselage in two plug-together halves to make it transportable at all. For anyone who wants to get the maximum pleasure and satisfaction out of glider flying for fun, however, the big model really is the answer. There are no kits available of models of this size, but there are a number of published plans (*e.g.*, Sunspot—10 ft. span; Thermalist—11 ft. 5 in. span; Peres I—10 ft. span; Fillon's Champion—9 ft. 3 in. span; Leprechaun—8 ft. 7 in. span—AEROMODELLER Plans Service). Such plans are worth a study, even if an "own design" of similar size is contemplated, if only to get a check on suitable material sizes.

The large glider also represents an excellent "platform" for aerial photography. As regards camera-carrying ability, size is not all that important since there are a variety of small, lightweight cameras which could be fitted into smaller models. The large model, however, tends to be that much more steady in flight. Also in the inexpensive camera range (under £2) there are many suitable for 120 size film (2¼ in. square or 3¼ by 2¼ in. negatives) or the slightly smaller 127 film with really excellent lenses. The combination of a



J. Dumble launches Peter Thornton's r/c glider at Ivinghoe Beacon slope soaring meeting. R.E.P. Rx.

reasonable lens and a large negative size can produce better results than the much more expensive sub-miniature cameras. It does, however, need the larger models to accommodate such a size and weight of camera in the fuselage.

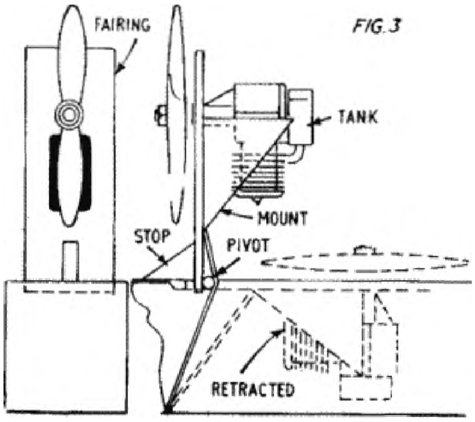
For all practical purposes, simple aerial photography is restricted to one shot per flight, presetting the camera, as necessary and tripping the shutter via a suitable delayed action. This can be a clockwork timer, a standard dethermaliser timer, or just a simple burning fuse "timer" as employed on the simpler dethermaliser systems. A further solution is to use a simple single-channel radio control hook-up operating the camera shutter. This, of course, has the advantage that the picture can be shot when the model is in the best position, as judged from the ground. There need not be an expensive installation, either, for many modellers have single channel radio control equipment of which the reliability is too suspect for normal radio control use (*e.g.*, it may be too susceptible to engine vibration). It would be perfectly suitable for camera operation and such equipment is often available second-hand at nominal prices.

Simple radio control "triggering", or delayed action timers, also give scope for novelty items, such as releasing parachutes from the model at height; or even the release of a smaller glider carried "pick-a-back" on the larger machine. The latter, in particular, lends itself to considerable experimental development.

One such possibility is a powered "tug" mounted on top of a glider to form a trimmable combination "biplane". The combination is launched under power and climbs to a suitable height. When the motor stops, separation of the two takes place, the tug descending in a fairly steep glide to be recovered while the glider component is free to continue its flight from the "high start" it has received.

A straightforward method of producing separation would be to use a timer to cut the tug's engine and at the same time operate the release mechanism to free the two separate aircraft. This would let the glider component fall free while the tug was still under power (the time-operated cut-out taking a second or so to bring the engine to a stop). Separation after the tug's engine had stopped might be more difficult to achieve cleanly as the glider component would normally have the better glide and thus tend to lift against the tug, even when detached.

Another unusual combination which has been tried in full size practice but not with models, as far as we are aware, is line-astern linkage of two or



more gliders via towlines. Whether such a string could be launched successfully is questionable, but provided the faster flying model was always linked in front of a smaller, slower one it could work. When tried with full size gliders during the war a violent up and down "wave" motion built up in the train which became virtually uncontrollable!

Auxiliary power for gliders is usually quite easy to arrange, mounting the engine on a tripod or similar structure fixed to the wing centre section. Preferably a pusher arrangement should be used. Apart from the fact that "pusher" propellers are not readily available, the majority of small engines are not designed to accommodate backward thrust loads (as they would be driving a pusher propeller tending to push the crankshaft back into the crankcase). With this limitation just mentioned, reed valve engines will run equally well with either direction of rotation and so can be used as "pushers" with ordinary propellers, simply by starting them "backwards".

Some of the smaller sizes of gliders provide excellent "vehicles" for adapting to auxiliary power via the smallest sizes of glow motors—*e.g.*, the ·2 c.c. glow motor can provide enough thrust to fly a 30 to 36 in. span lightweight glider; and a ·5 c.c. motor a 48 in. to 60 in. span lightweight glider.

Ingenuity can be extended to designing the auxiliary motor mount so that it is hinged. In the open position it is then held upright when the motor is running by propeller thrust. When the motor stops, air pressure on the mount causes it to fold backwards, thus retracting the power plant into the fuselage—Fig. 3. Suitable spring locking could be provided where the spring (or rubber band) is not effective in the open (upright) position but after suitable backward movement when retracting takes over and pulls the mounting unit down snugly and holds it in place.

Some other experiments with gliders which we have always been meaning to get down to, but have not yet found the time, include—

(*i*) Employing a "blown" wing with air circulated over the upper surface via suitable skin slots fed from a small electric motor driven pump.
(*ii*) Suction slots or perforated surfaces on wings, with suction provided either by a small electric motor pump or a venturi (even incorporating the venturi as part of the fuselage).
(*iii*) The possible virtue of a fully flexible trailing edge to initiate "Katzmyer" effect in turbulent air and negative drag forces.
(*iv*) Pendulum controlled wing flaps for "automatic pilot" longitudinal trim.
(*v*) Power driven (electric motor) rotating cylinder wing leading edge for high lift, non-stall wing.

And, of course, there is always the firework "banger" in the fuselage of an old model scheduled for its last flight. Lit from a suitable length of dethermaliser fuse, this can be quite a showpiece, especially as the shattered fuselage will usually catch alight (if tissue covered). Just make sure, before arranging such a display, that the remains cannot land where they could start a fire.

COMPASS STEERING, AND SIMILAR DEVICES

COMPASS steering for gliders to provide an "automatic pilot" control to hold them on a straight course—*e.g.*, to keep them headed into wind when slope soaring—enjoyed a considerable popularity in Continental Europe some fifteen years or so ago. It has been practically forgotten since because it did have many limitations—yet there were claims for considerable success with the system.

Compass steering is one of those theoretical solutions which look so effective when sketched out on paper—and almost impossible to make work effectively in practice. The idea is so simple. If a compass is mounted in the fuselage, when the model swings off course the compass needle will retain its normal north-south heading. The relative movement of the two can then be used to complete a switching circuit to provide compensatory rudder movement, via a suitable servo, to bring the model back on course.

Such a system is sketched in Fig. 1, using a robot arm mounted on the compass magnet so as to move with it, but also capable of being adjusted in position, relative to the magnet, to align on a "course" setting independent of the actual north-south attitude assumed by the compass needle. Any "swing" of the fuselage relative to the robot arm is thus a swing off course and brings the robot arm against one or other contact, energising the servo motor in the appropriate corrective direction.

The main snag is that the earth's magnetic field is a relatively weak field and even the strongest magnet used as a compass needle is readily displaced and will take some time to settle down to a constant north-south heading. Even the relative movement of the pivot will set the needle oscillating and so an ordinary "freely pivoted" compass needle is a quite hopeless proposition as a control device. It will spend more time "hunting" about a settled position than remaining on a constant heading, with repeated momentary switching of the servo system.

The apparent answer is a heavily damped compass which will eliminate most of the "hunting". The resulting response to being displaced will, however, be very slow—and perhaps too slow to apply any correction through the servo switching before the model has completed a 180° turn. The heavily damped compass has, however, given satisfactory results in certain circumstances. The inevitable time lag in applying correction has even been claimed as an advantage in inducing a tacking motion, which is highly desirable when slope soaring.

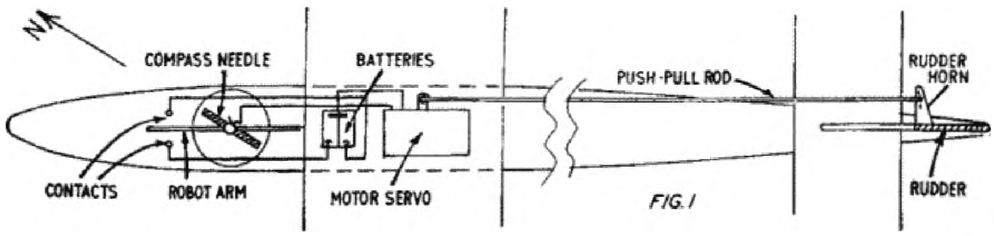
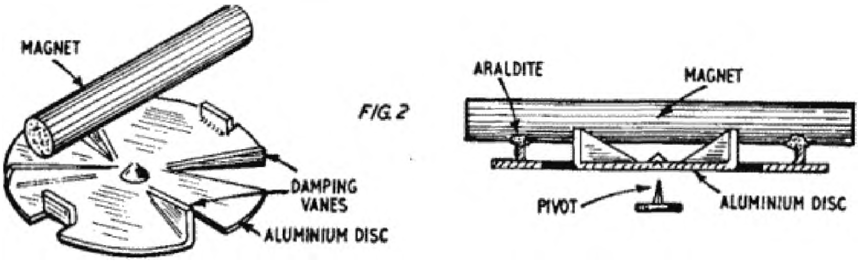


FIG. 1

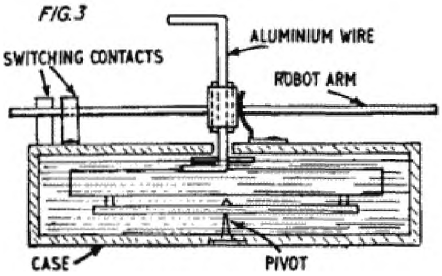


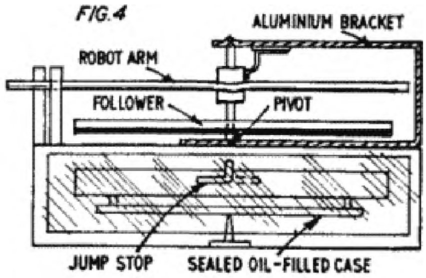
No commercial compass is likely to be suitable for the job of "automatic pilot". Those which have suitable damping are either too expensive or far too bulky to consider. Starting point, therefore, would be a high-energy bar magnet (*e.g.*, Alnico or Alcomax), preferably in rod form. Mounting is then a particular problem since these materials cannot be drilled. A simple solution would be to glue to a thin aluminium base, as in Fig. 2, using Araldite, the base also being dimpled to provide suitable a pivot. Magnet position can be adjusted for balance when gluing up.

The complication of gimbal mounting does not appear worthwhile as introducing yet another motion requiring damping. On the assumption that the model will hold a basically steady flight path when needing control, a simple pivot mount should be adequate. It will bind if the model is excessively displaced—but under such a disturbance the compass control would hardly be effective anyway. Suppose we just finish off the compass assembly as in Fig. 3, gluing on a light aluminium wire to carry the robot arm and finally enclosing the needle assembly in a watertight box almost completely filled with thin oil. It will be virtually impossible to provide a seal where the wire extension emerges from the oil-filled case—so this will be a source of leakage should the unit be overturned. But it should be a satisfactory, simple design to "prove" the possibilities of this form of control.

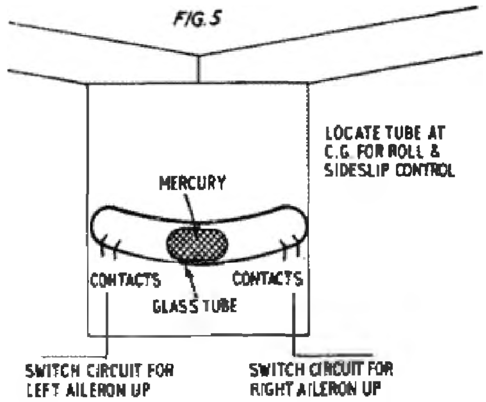
A completely sealed case can be used, if preferred. Here a soft iron "follower" is pivoted immediately above the magnet but outside the case—see Fig. 4. This carries the spindle for the robot arm independent of the actual magnet movement but is coupled to it via the magnetic attraction between magnet and follower arm.

In both cases the robot arm should be insulated from the wire spindle but should pick up its electrical connection via a light brush at the centre. The insulation can be a short length of plastic tube, which also provides the necessary friction grip on the wire spindle. Copper wire should be used for the contact arm, and cleaned regularly. The individual contacts can be mounted on the fuselage structure or directly on the case (insulated from it if a metal case).





The remainder of the hook-up then follows conventional radio control practice using a self-centring motor-driven servo, which will normally require two servo batteries. Simpler types may use spring self-centring when only one battery may be required. A rubber driven escapement *cannot* be used since this will be unable to differentiate between "right" or "left" rudder requirements as signalled by the appropriate contacts.



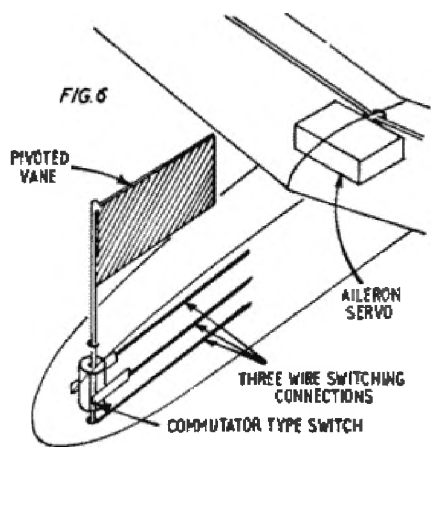
The servo itself, of course, is also subject to some operating delay or the time taken to achieve full travel which, together with a response lag from the compass swing itself may make the control ineffective. Good inherent directional stability in the model, in fact, is essential to give the compass a chance to work at all.

Some alternatives to compass steering are worth mentioning although they again have their limitations. It is just unfortunate that there is no *simple* and effective way of producing an "auto pilot"; and the more elaborate gyro control which *would* work would not be a practical proposition from the point of view of time and trouble spent on it. Radio control would be a simpler, and more effective answer here.

A pendulum operated linkage connecting to rudder (or ailerons) is another "theoretical" possibility on the basis that in a sideslip or yaw the inertia of the pendulum bob would cause it to remain in its original position and thus displaced relative to the (new) position of the fuselage. This displacement is translated, via linkage, into corrective control movement.

Although pendulum control has been applied quite successfully as an "auto pilot" on flying scale models it is seldom, if ever, likely to be a practical proposition as a means of directional control for gliders. Its behaviour at most times is, in any case, unpredictable.

Somewhat similar limitations apply to the mercury switch device—Fig. 5. This presupposes that in a bank or sideslip the mercury will fall to the lower side of the shallow U-tube to complete an electrical circuit switching a servo motor and applying corrective control. The inertia of the mercury will result in a response lag whilst lack of damping can lead to oscillatory switching and over-correction with "lag". Further, of course, all such systems which rely on weight effects are inoperative in a correctly banked turn since in such a turn centrifugal force exactly balances any "inward" force due to gravity. Thus in a correctly banked turn the mercury blob would remain in the centre of the tube. However, most momentary displacements of the model from a normal



flight path will initiate a roll or sideslip so that side forces may be available to overcome the inertia of the mercury. Located at the centre of gravity inertia effects due to yaw can be eliminated. If the switch is mounted forward of the centre of gravity, yaw control would require *opposite* connections. The best position for the switch would therefore appear to be at the centre of gravity or *behind* it.

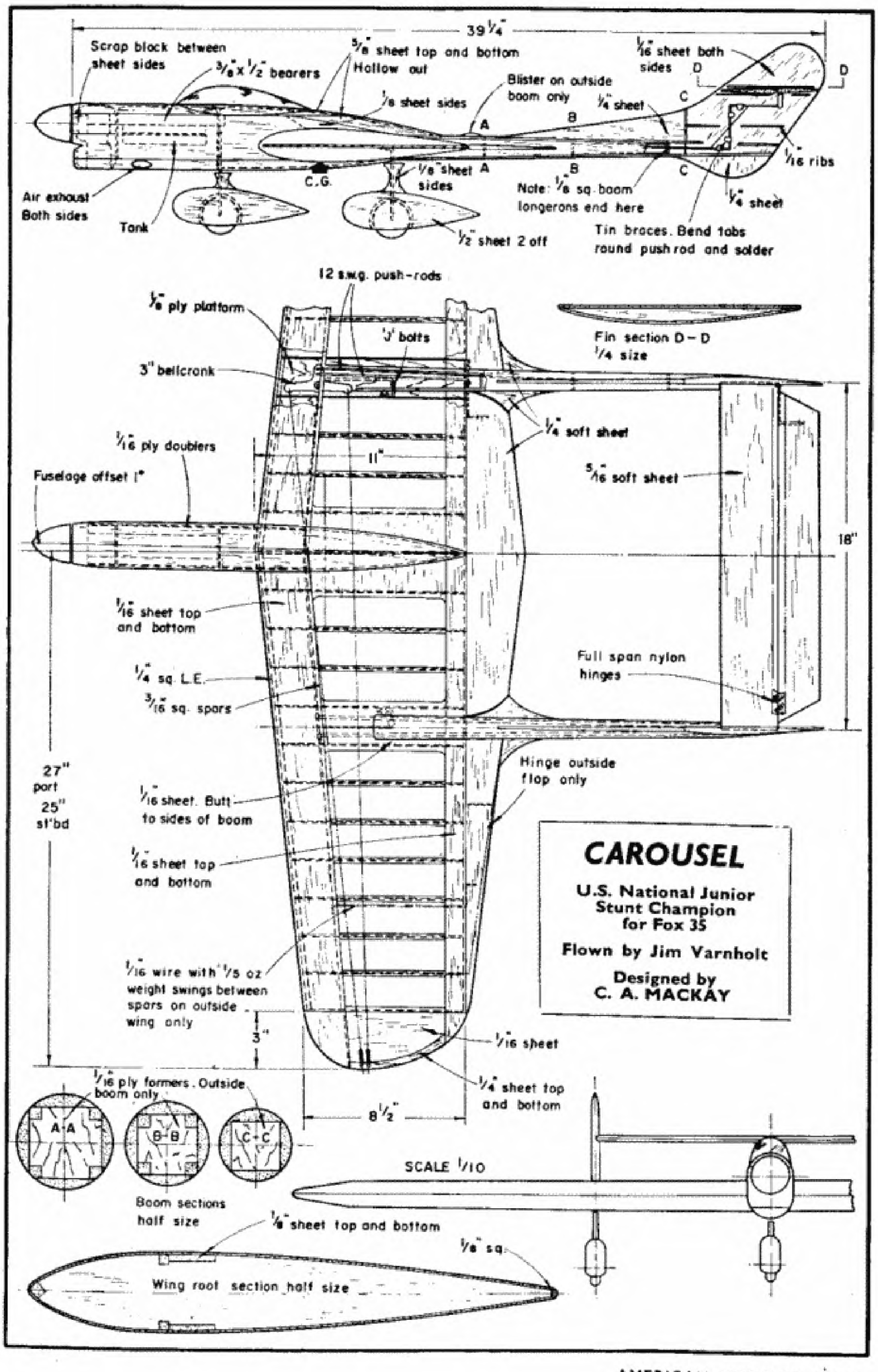
Another device which has appeared from time to time is "vane" steering although this is quite distinct in operating principle from vane steering as applied to a model yacht. A yacht operates relative to a fixed wind direction and the vane can be set to "hold" a course accordingly. A model aeroplane creates its own "wind direction" which in normal flight is "fore and aft" *irrespective of whether the model is flying upwind, downwind or crosswind.* This inherent wind direction *over the model* is only modified momentarily by gusts, or any unstable movement of the model (*e.g.*, yawing, rolling or sideslipping). A vane on a model, therefore, does not act as a "weathercock" relative to the apparent or prevailing wind direction. It will normally point fore and aft when the model is in flight, except if the model is caused to yaw or sideslip.

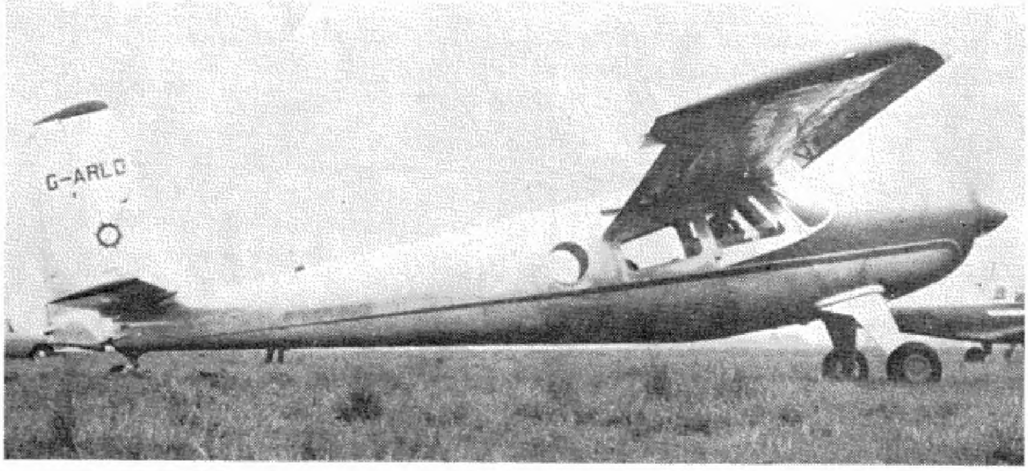
Under such circumstances the vane will pivot so that the trailing edge is "left behind", as it were, which movement relative to the fuselage can be used to apply correction. Mechanical power available from the vane will be very low and so it can only be used for electrical switching controlling a motor-servo, as with compass steering. In general, too, it is better with such system to link the servo to differential *aileron* movement rather than rudder as the corrective control surface.

Various other schemes have been tried operating on "sidewind" forces, but all remain relatively undeveloped. These include hinged outer wing panels, which can either apply automatic correction by increasing dihedral on the "inner" side in a sideslip, or be linked to compensating aileron movement; hinged tip fins ; and even a windmill vane mounted in the fuselage or fin. In the latter case the windmill is only energised when there is any airflow from the side, *i.e.*, the model is yawed or skidding relative to its normal flight path. All such devices—and this includes compass control—are interesting to experiment with, but none is capable of giving positive, consistent "auto pilot" control under all conditions.

CONVERSION TABLE SQ. CM. TO SQ. INCHES

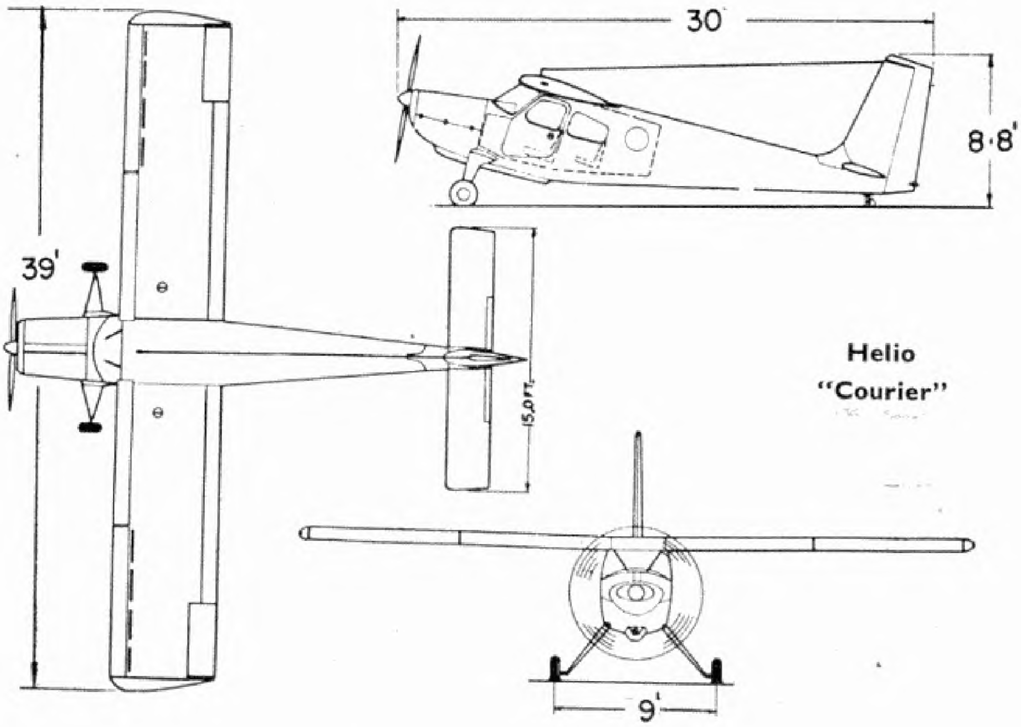
CM^2	0	1	2	3	4	5	6	7	8	9
0	—	·155	310	·465	·620	·775	·930	1·085	1·240	1·395
10	1·550	1·705	1·860	2·015	2·170	2·325	2·480	2·635	2·790	2·945
20	3·100	3·255	3·410	3·565	3·720	3·875	4·030	4·185	4·340	4·495
30	4·650	4·805	4·960	5·115	5·270	5·425	5·580	5·735	5·890	6·045
40	6·200	6·355	6·510	6·665	6·820	6·975	7·130	7·285	7·440	7·595
50	7·750	7·905	8·060	8·215	8·370	8·525	8·680	8·835	8·990	9·145
60	9·300	9·455	9·610	9·765	9·920	10·075	10·230	10·385	10·540	10·695
70	10·850	11·005	11·160	11·315	11·470	11·625	11·780	11·935	12·090	12·245
80	12·400	12·555	12·710	12·865	13·020	13·175	13·330	13·485	13·640	13·795
90	13·950	14·105	14·260	14·415	14·570	14·725	14·880	15·035	15·190	15·345


39 1/4"
Scrap block between sheet sides
3/8" x 1/2" bearers
5/8" sheet top and bottom
Hollow out
1/8 sheet sides
Blister on outside boom only
1/4" sheet
1/16" sheet both sides
1/16" ribs
1/4" sheet
Air exhaust Both sides
Tank
C.G.
1/8" sheet sides
Note: 1/8 sq. boom longerons end here
1/2" sheet 2 off
Tin braces. Bend tabs round push rod and solder
12 s.w.g. push-rods
1/8" ply platform
'J' bolts
3" bellcrank
Fin section D-D 1/4 size
1/4" soft sheet
1/16" ply doublers
Fuselage offset 1"
11"
5/16" soft sheet
18"
1/16" sheet top and bottom
1/4" sq. L.E.
3/16" sq. spars
Full span nylon hinges
27" port
25" st'bd
1/16" sheet. Butt to sides of boom
Hinge outside flap only
1/16" sheet top and bottom
CAROUSEL
U.S. National Junior Stunt Champion for Fox 35
Flown by Jim Varnholt
Designed by C. A. MACKAY
1/16" wire with 1/5 oz weight swings between spars on outside wing only
3"
1/16" sheet
1/16" ply formers. Outside boom only
1/4" sheet top and bottom
8 1/2"
A-A
B-B
C-C
SCALE 1/10
Boom sections half size
1/8" sheet top and bottom
1/8" sq.
Wing root section half size

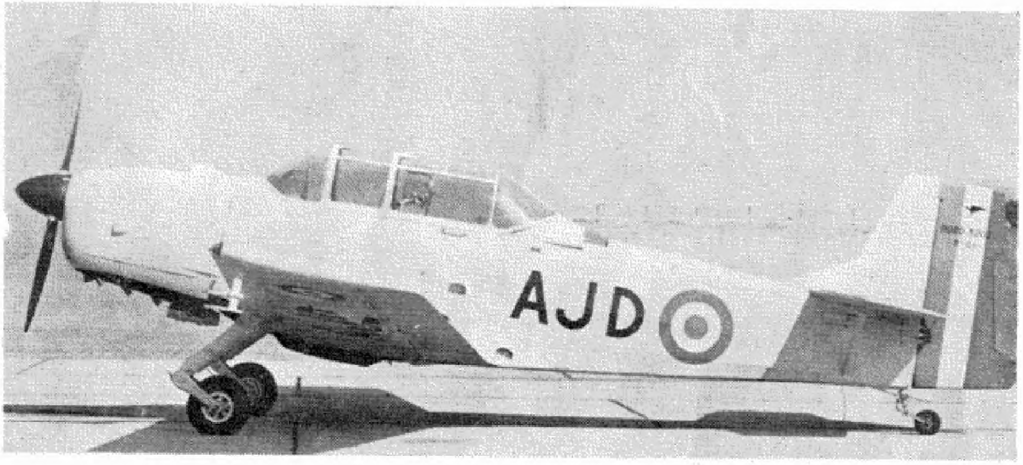


PROTOTYPES FOR FLYING SCALE MODELLERS

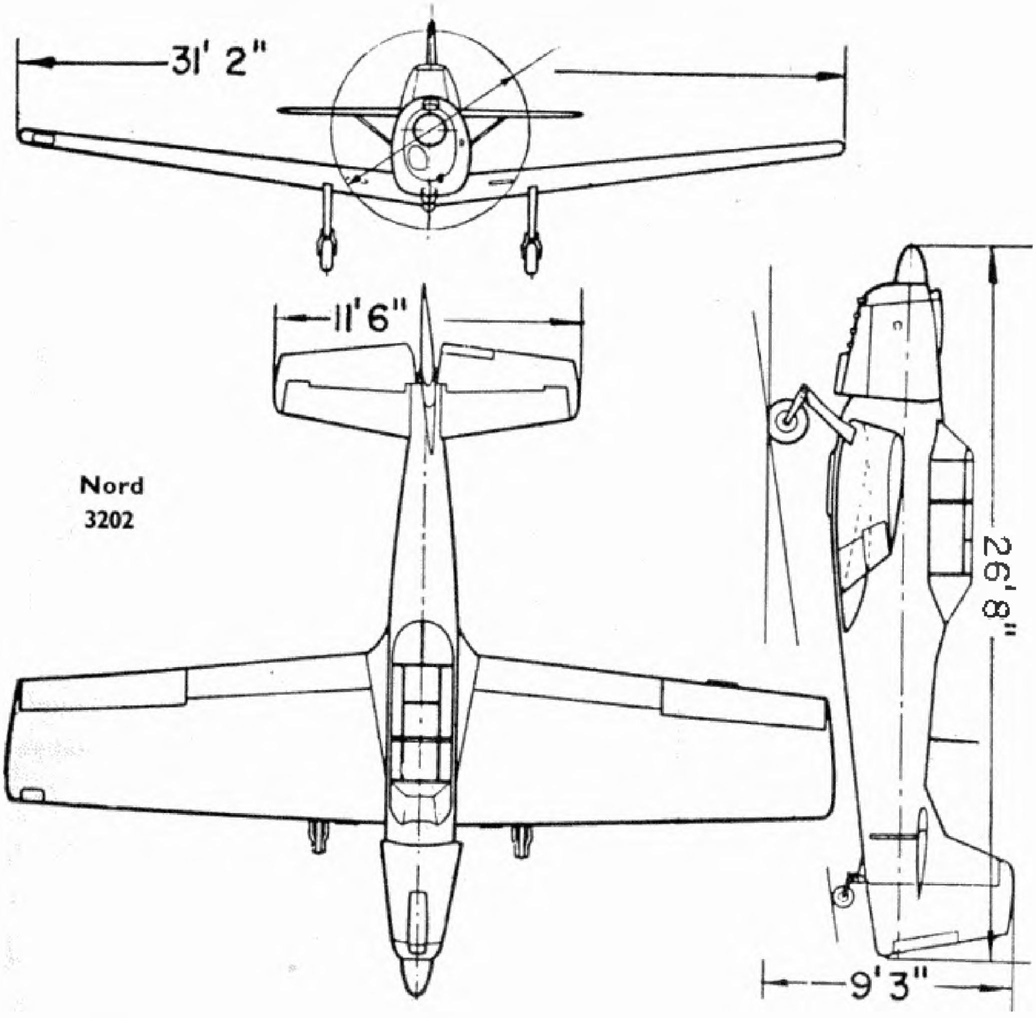
The Courier is a remarkable short take-off and landing aircraft, now being distributed in Great Britain. It is perfect for a larger type scale radio control model, although it would require an increase in tail area for safety and stability.



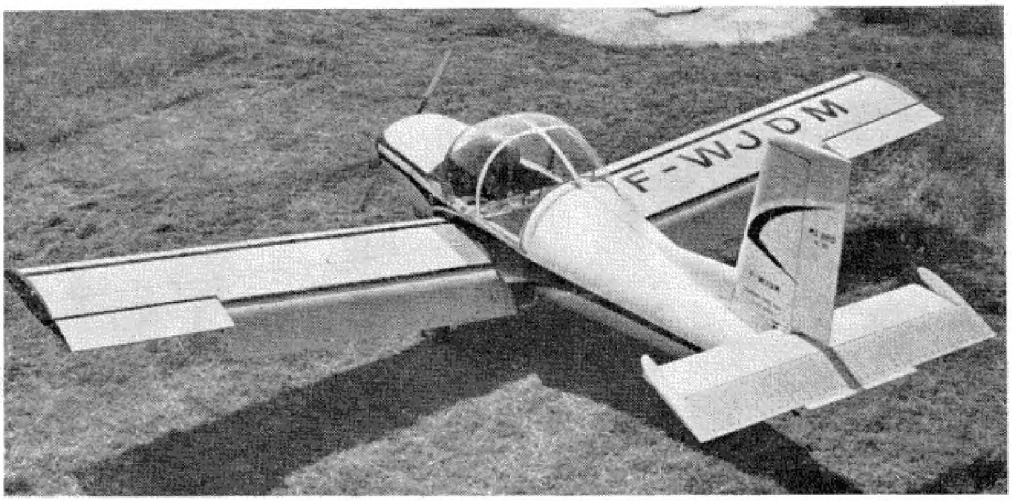
Helio "Courier"



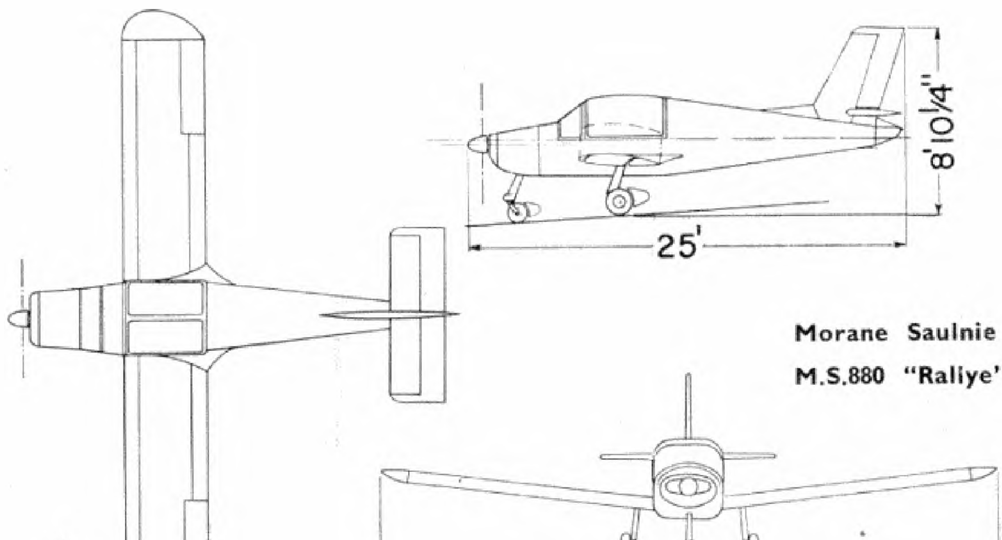
The all-yellow latest French pistoned engine trainer which is fully aerobatic and has the great advantage of a forward mounted undercarriage. Is ideal as a subject for control line aerobatics, moreover it incorporates scale rudder offset!



Nord
3202

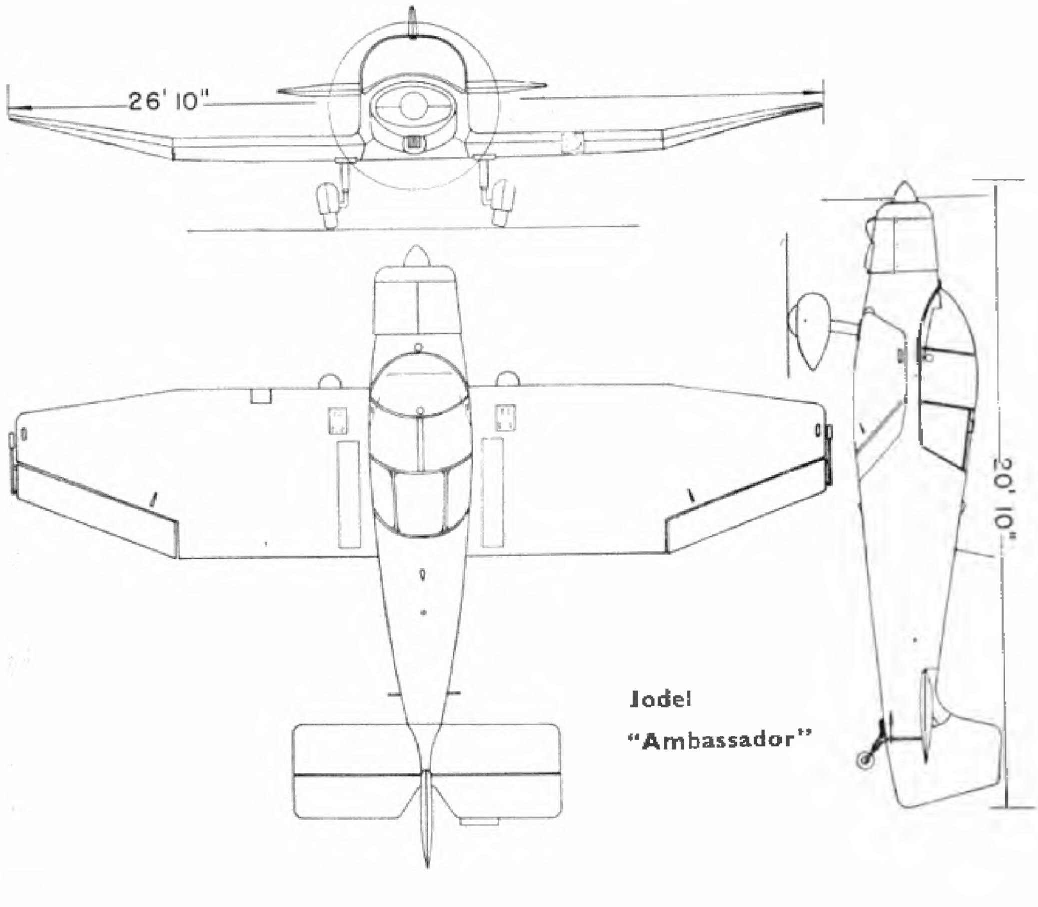


A lovely subject for radio control or sport is the M.S. 880 Rallye now in mass production for world wide distribution. The photograph shows a prototype before the fin was swept as illustrated in the drawing below. Generous dihedral and other proportions make it a fine scale subject which would be quite easy to reproduce.

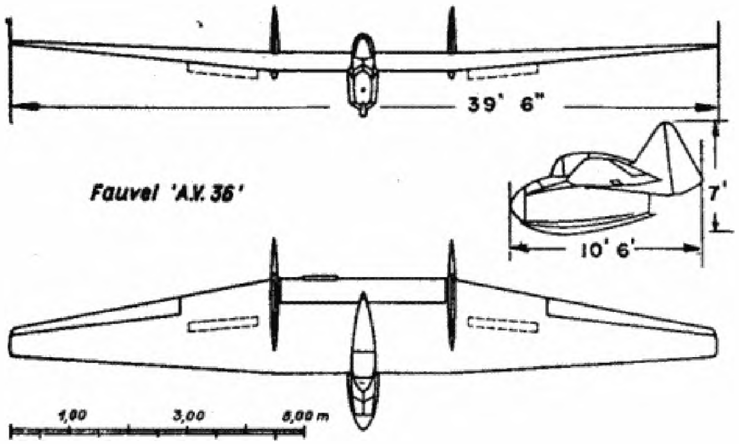


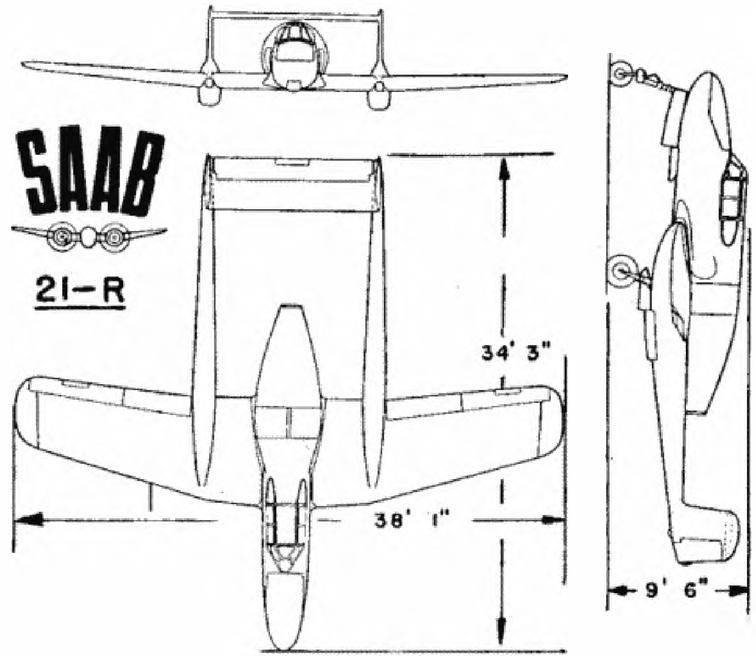
Morane Saulnie M.S.880 "Raliye"

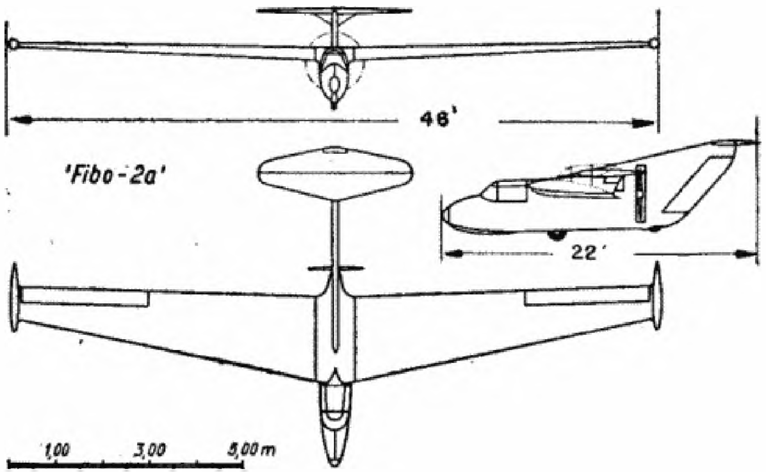
Most common of all French home built aircraft are the designs by M. Joly and his son-in-law M. Delemontez, known as the Jodel Series. Some are made professionally, as for example the Ambassador seen here. Ideal proportions for free flight or radio control are actually the result of the designer having a keen interest in aeromodelling.



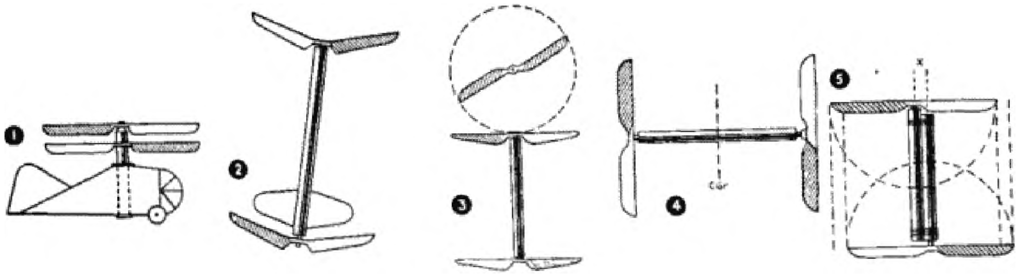
Jodel "Ambassador"







Three interesting subjects for the modeller with a notion for experiment. Top left, the French tailless sailplane which has been made in large numbers and is said to be extraordinarily pleasing to fly. We would suggest that any model should incorporate generous wash-out at the wing tips. At left, the German Fibo has its propeller in a slot in the fin, and is in effect a powered sailplane. There is no reason why this same arrangement should not work satisfactorily on a sports type model, provided strong booms are used to support the tail structure. Above, the Swedish fighter started life with a piston engine, and could therefore be built either for Jetex as illustrated, or with a pusher model aero engine.



WATTEYNE ON MODEL HELICOPTERS

M. Andre Watteyne of Brussels enjoys a worldwide reputation for his many years' work on the subject and this article is a digest of a considerably longer paper dealing with his own and other people's experiments.

THERE are only two sorts of helicopters :

(1) Slow, with flexible blades, consuming much power.

(2) Fast, rigid blades type, using little power.

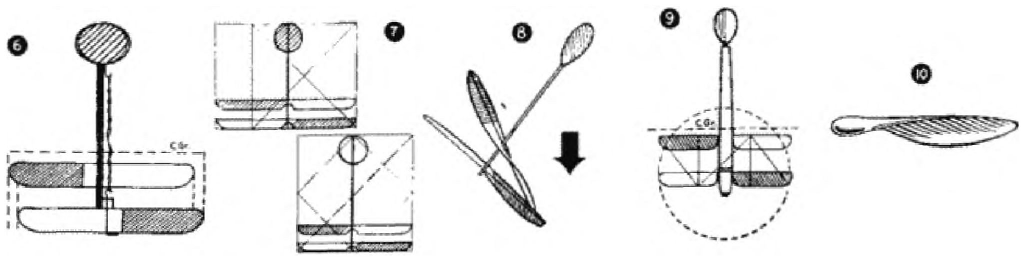
Let us consider these two types from their model aspects only. We can look at the two methods and decide which offers the greatest possibilities for us ; assess the degree of success that has so far attended semi-scale models, though it must be admitted that true scale models of existing helicopters have almost non-existent stability ! On semi-scale models, it has been said of British designs that (1) Flights are short; (2) If the climb is stable, the descent is not.

Fig. 1 shows a rubber-powered type with two rigid contrarotating motors in order to eliminate "contratorque" (contrary coupling of one of the rotors). Fuselage is short and limits length of flight since each rotor accounts for half the turns. Stable in climb, since lateral surface of fuselage resists transverse swaying due to airstreams directed downwards. This effect is lost during descent with slow rotors. Note the C.G. position. Model heels over on its side and slides helplessly to the ground.

Another rigid bi-rotor system has been used by MacCarthy and Parnell Schoenky with a very long fuselage (Fig. 2). This fuselage holds a large number of turns. The model is derived from the French design by Launoy and Bienvenu. When its fuselage is lengthened beyond a certain proportion relative to rotor diameter it tends to spiral in the climb when rubber motor begins to bunch. Here rotor diameter is relatively small. Additional fixed fins reduce fuselage turning. Descent again is clumsy. Autorotation would not solve the problem but only brake descent to a degree that would make small fins inoperative.

In the case of the square model, *i.e.*, diameter equal to length, when rotor blades are set at positive angles of incidence of 10°, 15° or 28° model will rise well as long as rotor-axes are rigid and their rotation planes remain parallel. But as model slows, it loses its vertical position and drifts to one side until it is horizontal. This shows that the lateral surfaces of the rotors are equally balanced on each side of the C.G.

I built a small model of this type (Fig. 5) and in order to increase duration I stuck two fuselages together, each turning a rotor at 28° positive, but was never able to get stable flights. I retained one fuselage only, with a rotor at each end. Flights were then regular, with the progressive heeling over already noted.



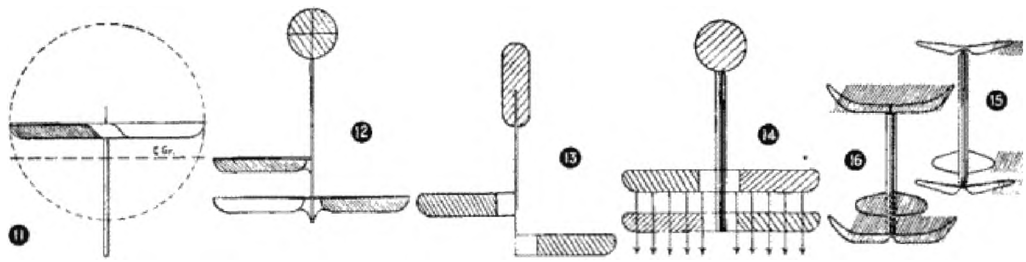
Rene Neuteleers, who introduced me to model helicopters, has some noteworthy models. With a very light reed framework, rotors fixed to it with thin copper wire, and ball bearings, all turns without friction. A small fin on a free axis is mounted over the fuselage. The blades turn slowly and machine climbs vertically without rocking to about 200 ft., floats at that height for a few seconds, and returns slowly, but progressively faster to ground, still vertical thanks to the swivelling fin. (Fig. 6) Neuteleers' models are light, compact, and not overlong, almost a square in fact, or a rectangle lying on its larger side. Another of his models nearly won the Helicopter Club of France's event in 1946, and I saw this stop turning when still some 20 ft. from the ground. It did not remain vertical, but the lateral surface of the blades was greater than that of the upper fin (Figs. 7 & 8).

I had entered my own Vega, plans of which have appeared in several countries in this contest (Fig. 9). It was an "upright rectangle" heavily rubbered for duration and achieved some 150 ft. on this occasion (against Neuteleers' 60 ft.). During its still air flight it swayed regularly, why I do not know. Then as motor ran out with the model still 60 ft. up it descended rapidly. I am told that at one point it actually caught a thermal and climbed. Later I found out that the swaying was caused by slight side winds on the fin and flexibility of the steel wire rotor mounting.

In view of this I developed a more rigid rotor mounting which maintained rotors in an absolutely parallel plane, thus eliminating swaying. My models were always more heavily loaded than Neuteleers', so that they had to climb higher to equal his times. My model "Robur" with flexible rotor mounting made overbalanced flights, but when this was corrected made up to 49 second flights. This machine had undercambered rotor blades as against Vega, which had Clark Y wing section.

Let us consider the seed (Fig. 10). It has (1) a single blade; (2) the mass of the seed is heavy compared with the weight of the wing; (3) the wing is centred like a model flying-wing glider by the weight of the vein in its leading edge (4) when the wing is cut free from the seed it floats away like a tiny glider.

The heavier the weight the faster it rotates, and the faster it goes the slower it falls. Two stuck together fall more rapidly than one; if three are stuck

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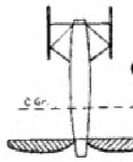
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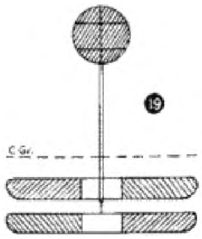
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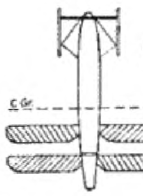
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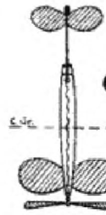
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at 120° they are more stable, but the single wing always descends slowest. Note also that is has a flexible trailing edge and sometimes in drying takes on under-camber which still further slows descent. There are constructional difficulties in imitating this type in models, but experiments have been made and a measure of success achieved.

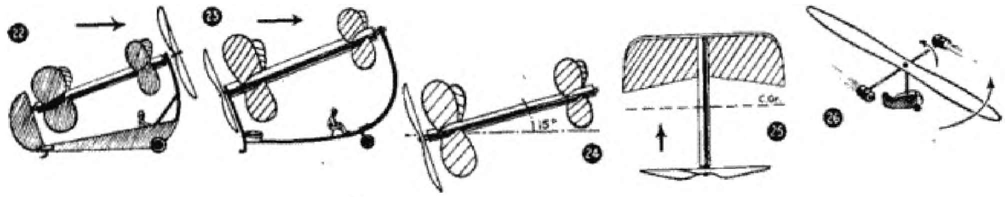
Whereas models developed in England usually have rotors with blades at a small pitch (Fig. 11), Neuteleers and other Continental experimenters go up to 28° or 30° to the four blades of two rotors. Contrary to belief, these blades do not come loose in flight owing to a reduction in the speed of rotation. So far no American modeller appears to have used the Neuteleers layout in contests. Its wonderful stability is due to :

(1) Placing of C.G. above (*i.e.*, in front of) the rotors.
(2) Constant parallelism between planes of rotation of rigid motors.
(3) Stabiliser in the shape of small fin.
(4) Good grip by widely pitched rotors during descent.
(5) Parallel reactions of rotors in opposite direction to pull of gravity at all points of swept circle.

The machine is auto-stable when one blade is removed (Fig. 12) and is equally stable if a blade is removed from each of the rotors (Fig. 13), but in this case the head-fin must be fixed and not free. The machine is remarkably steady in vertical flight.

MacCarthy and Parnell Schoenky models have long fuselages which have enabled them to clock 85 seconds and 100 seconds o.o.s. (Fig 15.) In the case of MacCarthy (Fig. 16) this is due to small diameter of rotors and length of fuselage, with Schoenky rotors are proportionately larger, but as the model is lighter rate of rotation is less. Great care has been taken to obtain a very large lateral surface to blades.

Until now no successful descent under autorotation with pitch-changing of blades has been achieved by a rubber powered model. Several approaches have been made, including a model with a balloon located in place of the head-fin in a design by R. Damhet in 1938 (Fig. 17). Slow descent however negatives value of the headfin, and by reason of further experiments, I concluded that stabiliser lift had to be preserved. I therefore fixed two parallel fins to Robur (this was in 1958, Robur has endured some twelve years !) I put rotor in negative position, left the lower rotor to simplify matters, started it rotating with blades at minus 2° and released machine from 20 ft. up. Very rapid rotation followed with slow descent but absolutely vertical with no spiralling. A further test with side wind blowing showed some swaying, but this was quickly righted (Fig. 18). It was clear that a machine able to change to negative pitch at the end of its vertical flight, could by virtue of its slow-autostable descent be well placed to catch any thermals. This theory was advanced in an article at the time, but



the plan was omitted, and much of the message lost thereby. Next stage must be to fit a fuse to permit this change in angle at the right moment.

Fig. 19 shows how the Neuteleers model has developed, from 1922 to 1946. The Vega's rate of descent was 15 ft. per sec. but in 1958 Robur descends at only 5 ft. per sec. (Fig. 20.) I have never seen any model described with so slow a descent rate. There is only the Jeticopter, a model with two Jetex motors and flexible blades which comes down at about 3 ft. per sec. under autorotation. We have spoken only of rubber powered models with high power at take off and slowly decreasing power. The position is different with i.c. powered models, where rate is constant.

Position of rotors with varying speeds is of interest. With the Aerien, a commercial model of about 1909 (Fig. 21), we have a high pitched rotor located in front of a propeller-rotor set at a lower pitch and turning relatively fast. At the end of the fuselage two small fins are set at high positive incidence. At the lower end of the fuselage an airscrew of wire and silk is placed. The model is wound via the propeller which has an opposite pitch to that of the fuselage-mounted fins. In flight the fuselage spins but provides an oblique and regular climb. Although heavily loaded it flies nimbly and with remarkable stability under power. On descent, however, with no prop dis-engagement provided, it flops anyhow with complete lack of stability.

In 1937 Damhet followed this layout with a revolving aerofoil stabilising it with an undercarriage fitted with an aircraft type empennage. (Fig. 22.) Developing the theme he produced a butterfly type stabiliser (V-shaped) type (Fig. 23) and then I tried the model with its u/c removed, launching it obliquely as I had seen Aerien launched long before, when instead of flying at 45° it immediately corrected itself and arrowed up to 50 ft. The motor began to run down and it swung nose forward first, then stabilised obliquely about 15° above horizontal, to produce a time of around 45 sec. for 600 turns. Finally as last runs finished it landed with fuselage nose down beyond horizontal.

It seems that with sufficient initial thrust of a propeller a whole aerofoil can be tilted upwards and fly vertically. I found this when I experimented with seaplane models a few years ago. In most cases, however, the model's C.G. is above the propeller or active rotor.

I have seen a model (built by Paul Poncellet Junior) that combined the attributes of both Aerien and the Rototos (Fig. 25). Two flexible wings at the end of the fuselage take a little negative incidence by virtue of fuselage rotation; then below it is a balsa propeller, alas, with too flexible a mounting, which detracted from stability. Properly built this model would have flown perfectly.

In Fig. 26 we have a Jeticopter, with two Jetex motors mounted on an arm perpendicular to the rotor blades. Blades are mounted flexibly on a 45° hinge to cut out precession. When the Jetex motors run out, the blades turn more slowly and rise into a V-shape, but as the hinge is set at 45° their positive position becomes negative, and descent is slow. Like the sycamore seed "propeller" the Jeticopter is stable because its centres of surface area and gravity are close together, and suppleness of blades gives it a flight free of jolting and swaying.

There are a few motorised model helicopters. Stability is their main trouble, since a turning rotor produces drift. Insufficient attention has been given to C.G. Virtually the only successful one is that built by Debrel, in which centres lie at the same point, and propeller is coupled to motor via a universal joint. A cabin-type fuselage slung beneath the engine aids stability, but serves no other purpose. Three typical models are shown in Figs. 27, 28, 29.

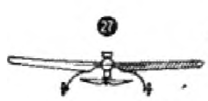
Gearing down demands heavy devices as a means of reducing speed and I am not considering it. My layout is all of proven component ideas. From the top, there is a two-finned stabiliser fixed to fuselage and turning with it. Fuselage has two- or three-bladed rotor at its base. A two- or three-wheels u/c strengthens attachment of blades to fuselage. C.G. is adjusted by position of motor and fuel tank. Major problem is the nature of the universal joint (Fig. 30).

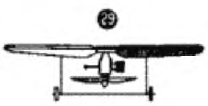
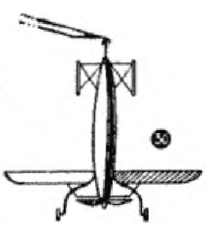
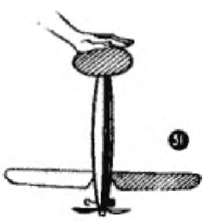
A bamboo rod fixed in a small holder enables ground manipulation to be simple. The model, running, is held down until release is judged ideal, when the handle is withdrawn and model lifts from its wheel and skids. A timer or fuse frees blades in a negative position at a predetermined time, cutting off fuel and stopping motor.

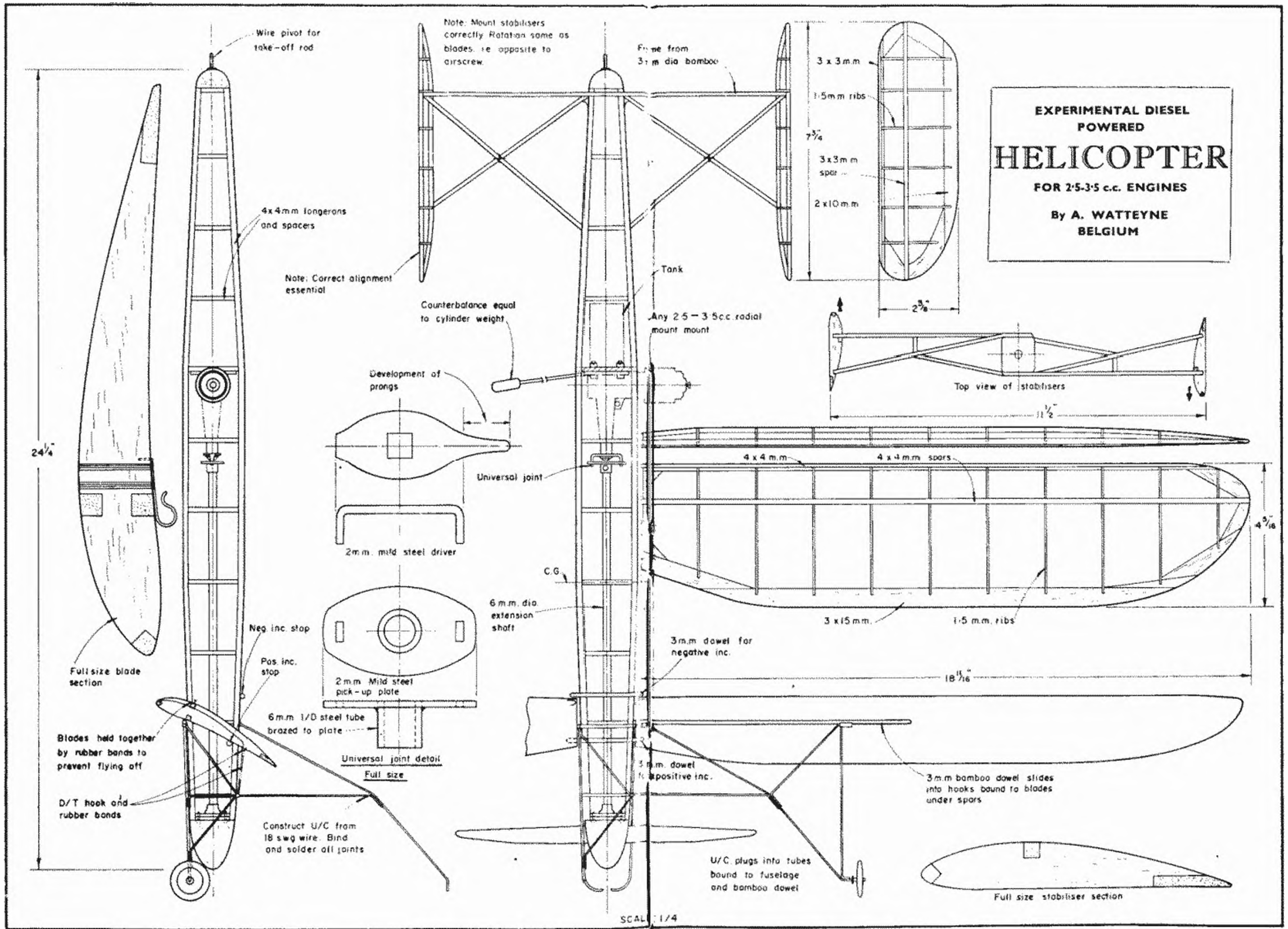
A final model (Fig. 31) has a bi-rotor of 65 cm. diameter. Its 1 c.c. engine is fixed under the fuselage, and on top is a Neuteleers' type fin. Held down by a hand the model remained upright under power, but when hand was released it toppled over. To achieve flight it was necessary to move the engine nearer the C.G. and drive via an extension shaft.

However, we now have two good helicopters—rubber and power driven—and look forward to considerable trouble-free experimentation, secure in the knowledge that these models will return under autorotation. Next stage is to proceed to cross-country as opposed to vertical flight with these models.

EDITORIAL NOTE. *On the following pages appears M. Watteyne's conception of a suitable motorised model helicopter. This must be accepted as a purely experimental project. In re-drawing from the designer's original plan we have necessarily made some simplifications, and have made minor changes where our experience shows that materials specified would be insufficiently robust. It is the author's earnest hope, however, that interested enthusiasts throughout the world will press on with experiments along these lines, and he will be very happy to correspond with like-minded aeromodellers. Letters should be addressed to him direct: M. Andre Watteyne, 79 Rue Roosendaal, Bruxelles-Forest, Belgium.*




EXPERIMENTAL DIESEL POWERED
HELICOPTER
FOR 2·5-3·5 c.c. ENGINES
By A. WATTEYNE
BELGIUM
Wire pivot for take-off rod
Note: Mount stabilisers correctly. Rotation same as blades, i.e. opposite to airscrew.
4x4 m.m. longerons and spacers
Note: Correct alignment essential
Counterbalance equal to cylinder weight
Development of prongs
Universal joint
2 m.m. mild steel driver
C.G.
6 m.m. dia. extension shaft
Neg. inc. stop
Pos. inc. stop
2 m.m. Mild steel pick-up plate
6 m.m. I/D steel tube brazed to plate
Universal joint detail
Full size
Full size blade section
Blades held together by rubber bands to prevent flying off
D/T hook and rubber bonds
Construct U/C from 18 s.w.g. wire. Bind and solder all joints
24¼"
Tank
Any 2·5 – 3·5 c.c. radial mount mount
3 x 3 m.m.
1·5 m.m. ribs
7¾
3x3 m.m. spar
2 x 10 m.m.
2⅝"
Top view of stabilisers
11½"
4 x 4 m.m.
4 x 4 m.m. spars
4 5/16"
3 x 15 m.m.
1·5 m.m. ribs
3 m.m. dowel for negative inc.
18 11/16"
3 m.m. dowel for positive inc.
3 m.m. bamboo dowel slides into hooks bound to blades under spars
U/C plugs into tubes bound to fuselage and bamboo dowel
Full size stabiliser section
SCALE 1/4

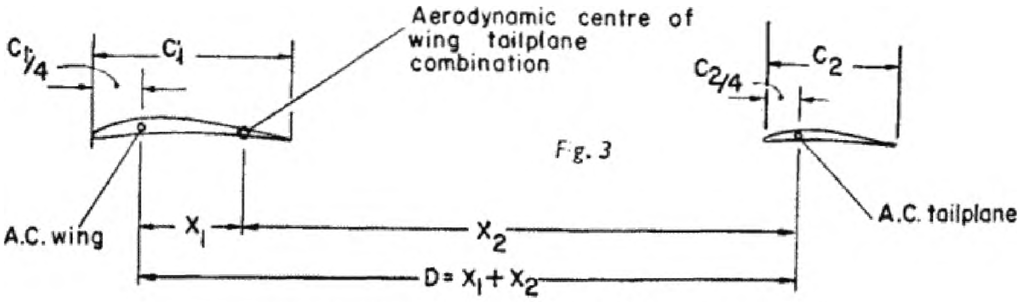


Fig. 3

GLIDER C.G. LOCATION

Estimating the optimum location of the centre of gravity of model Sailplanes, using the method evolved by Beuermann.

Juste Van Hattum who presents this interesting theoretical approach has enjoyed an international reputation as a model aerodynamicist for over thirty years, and has produced some of the prettiest small model glider designs of the postwar years.

ONE of the more difficult elements of model sailplane design is the estimation of the degree of longitudinal stability the model will possess. Longitudinal stability is dependent on various factors and generally assumed to be allied to the area of the tailplane in relation to the area of the wing and the distance between the two. This, however, is only a very rough yardstick, which fails to provide really accurate results. Neither will empirical methods provide a satisfactory answer.

Beuermann has established a method which enables the designer to calculate with a high degree of accuracy the location of the Aerodynamic Centre, or Neutral Point, of the wing—tailplane combination. From the result obtained one can make a reasonably accurate indication concerning the optimum location of the centre of gravity of the complete model.

In the following survey and examples, the deductions which have led to the formulæ used are omitted and only a guide will be given for carrying out the actual calculations.

Data Required

The following data of the design must be available in order to carry out calculations ; compare these with Fig. 1.

Area of wing	A_1 sq. in.	Area of tailplane	A_2 sq. in.
Span of wing	s_1 sq. in.	Span of tailplane	s_2 sq. in.
Chord of wing	c_1 sq. in.	Chord of tailplane	c_2 sq. in.
Aspect Ratio of wing	Λ_1 sq. in.	Aspect Ratio of tailplane	Λ_2 sq. in.

Correction factor c, about which more later.

The following data relating to the aerofoils used must be available:

Maximum camber, expressed in percentages of the chord. Location of the maximum camber, also in percentages of the chord.

It will be noted that the majority of the data will already be available as a result of normal design procedure. This means that the total available horizontal area is split up into the area of the wing and tailplane as a logical first step.

Formulæ Used

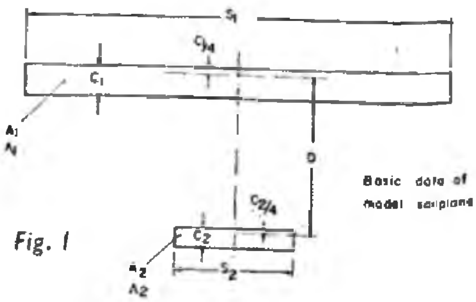


Fig. 1

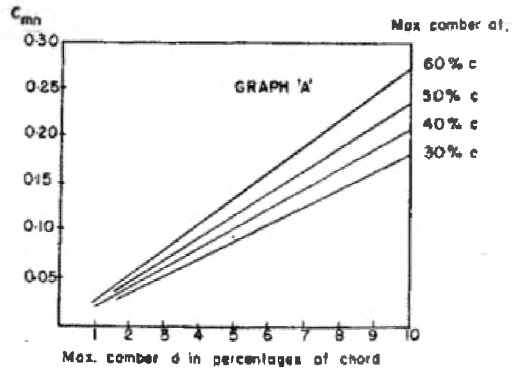
There is an understandable reluctance amongst aeromodellers to use formulæ. In view of this I would like to point out that, in order to keep pace with the progress of designers in most countries, we shall have to tackle design more scientifically. Moreover, the present method employs formulæ as simple tools to achieve the desired result. They may look formidable, but will soon be seen to be no more than an exercise in simple arithmetic.

$$x_2 = \frac{C_{mN1} \cdot A_1 \cdot c_1 + C_{mN2} \cdot A_2 \cdot c_2}{A_2 \cdot \triangle C_{a\,\min}} \qquad \ldots (1)$$

$$x_1 = \frac{A_2 \cdot c \cdot x_2}{A_1} \qquad \ldots (2)$$

In these formulæ we have the factors C_{mN1}, C_{mN2}, $\triangle C_{a\,\min}$ and c, a correction factor which have to be determined. We shall take them in that order.

C_{mN} is the moment coefficient of the aerofoil used. The value for this coefficient can be found from graph *A* as follows :

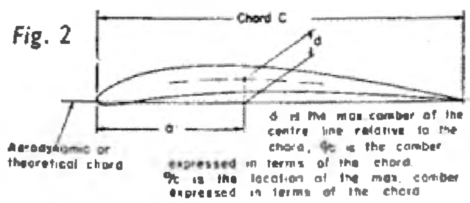


Determine the maximum camber of the aerofoil, *d*, relative to the aerodynamic chord, as shown in Fig. 2, then find the location of the maximum camber in terms of chord. Suppose we find that the maximum camber is 6 per cent at 40 per cent chord, we apply these data to graph *A*.

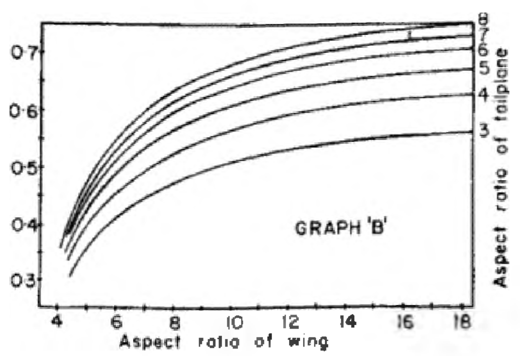
Read off on the horizontal scale the camber, then run a vertical line to the line which gives the location of the maximum camber, next read off the corresponding value for C_{mN}.

In this case you will see that the value for C_{mN} is 0,125.

Fig. 2



$\triangle C_{a\,\min}$ is taken by Beuermann equal to 0,17 in order to achieve optimum longitudinal stability. (When the value exceeds 0,17 the stability is less, when it is lower the stability is greater. This should be understood as virtually meaning that a higher value may lead to lack of stability, while a lower value may lead to excessive stability; it is therefore not advised to choose an appreciably lower value as margin of safety, for this is decidedly not the case, as the model will tend to over-correct.)



c is a correction factor, depending in magnitude on the aspect ratios of wing and tailplane. The value can be found in graph *B*, which will need no explanation.

Calculating the optimum distance between wing and tailplane, the AREAS being given.

In most cases the ratio between the areas of wing and tailplane have been decided by the designer. This is especially so in cases when the total available area is laid down by the contest rules, such as in the case of the A2 and A1 classes of model sailplanes.

When we consider Fig. 3, we want to find the distance *D*, which is made up of x_1 and x_2. In this calculation we use the following data, taken from an actual design :

$A_1 = 450$ sq. in.	$A_2 = 79$ sq. in.
$s_1 = 79$ in.	$s_2 = 21{\cdot}8$ in.
$c_1 = 5{\cdot}7$ in.	$c_2 = 3{\cdot}63$ in.
$\frac{c_1}{4} = 1{\cdot}43$ in.	$\frac{c_2}{4} = 0{\cdot}91$ in.
$\Lambda_1 = 14$	$\Lambda_2 = 6$

$$\text{Hence } \frac{A_2}{A_1} = 0{\cdot}176$$

c is found from Graph *B* to be 0·68.

The aerofoil chosen for the wing is the same as has already been discussed and $C_{mN1}=0{\cdot}125$. The aerofoil for the tailplane has a maximum camber of 5 per cent of the chord at 40 per cent and C_{mN2} is found from Graph *A* to be 0·11. We take $\triangle\ C_{a\ \min}$ equal to 0·17.

Now we can substitute all these values in formula (1) :

$$x_2=\frac{0{\cdot}125\ .\ 450\ .\ 5{\cdot}7+0{\cdot}11\ .\ 79\ .\ 3{\cdot}63}{79\ .\ 0{\cdot}17}$$

$$=\frac{321+31{\cdot}5}{13{\cdot}4}$$

$$=26{\cdot}3 \text{ in.}$$

We calculate x_1 from formula (2) :

$$x_1=\frac{79\ .\ 0{\cdot}68\ .\ 26{\cdot}3}{450}$$

$$=3{\cdot}14 \text{ in.}$$

From these two results follows that $D=x_1+x_2=29{\cdot}44$ in.

We see that we have established the optimum distance between wing and tailplane, related to the quarter-chord lines. It is now a simple calculation to find the distance between the trailing edge of the wing and the leading edge of the tailplane. It is 23·58 in.

The Aerodynamic Centre or Neutral Point of the complete model is found to be located at a position 3·14 in. behind the A.C. of the wing. Since the latter lies at quarter-chord behind the nose of the aerofoil, the A.C. of the model is located at 0,25+55=0·80 of the chord. (80 per cent.)

The distance between the location of the Centre of Gravity with respect to the location of the A.C. model is shown as the Static Margin.

The C.G. will have to be in front of the A.C. model if longitudinal stability is to be assured.

Beuermann and others co-operating with him, have found that a good average, as shown by a large number of existing designs, is a location of the C.G. about 15 per cent of the chord ahead of the A.C. model.

In our example the C.G. could lie at about 80—15=65 per cent of the chord.

This is all there is to it, and given the main data of the model—which should be available at the design stage—the entire work generally takes less than twenty minutes, especially when one has had some practice.

Practice will show that the exact location of the C.G. may have to be slightly adjusted for optimum performance. However, these deviations are quite small and may range from such extremes as 10 per cent to 20 per cent of the chord ahead of the A.C. model and generally less. This means that in some rare cases tests will have to be conducted with varying C.G. positions over 10 per cent of the chord, which in the case of the average A2 would not be more than 0·3 or 0·4. It is clear that this method greatly lessens the time needed for flying tests and also the risk of a bad crash when flying with a G.G. position which might lead to dangerous flying characteristics.

It remains for the designer to choose the angles of incidence of wing and tailplane, or rather of the rigging angles. The most successful procedure would be to design for a difference in rigging angles of 2° to 3°, combined with the calculated location of the C.G. and conduct careful experiments with C.G. locations first, following this up with changes in the difference in rigging angles, in order to see whether improved performance may be obtained. One should remember that in general two changes at the same time are undesirable, but one fact may lead to an exception to this rule:

The smaller the distance between the C.G. and the A.C. model, the smaller should also be the difference between the rigging angles. Therefore, if the C.G. is moved forward and the rigging angles remain the same, one should expect the model to show diving tendencies and, similarly, it would show stalling tendencies when the C.G. is moved back while the rigging angles again are kept unchanged.

Apart from the use of Beuermann's method during the design stage, it can also be used to investigate the degree of stability of existing designs, which may be a very enlightening exercise.

We now use the formula:

$$x_1 = \frac{A_2 \cdot c \cdot D}{A_1 + A_2 \cdot c} \qquad \dots (3)$$

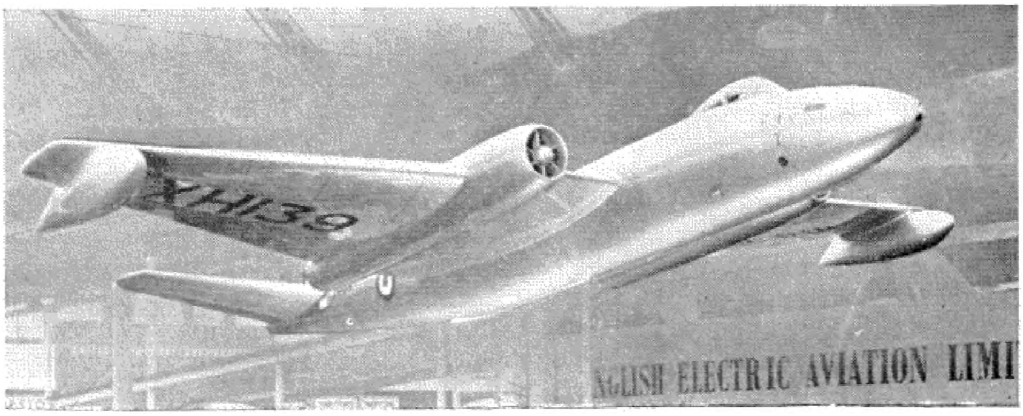
Since we know all the factors (D can be measured, of course), x_1 will provide x_2 by means of formula (2), slightly modified:

$$x_2 = \frac{x_1 \cdot A_1}{F_2 \cdot c}$$

Having found x_2 we can now calculate the value for $\triangle C_{a\ min}$ from a simple modification of formula (1), which we leave to the reader to carry out.

We now know that if for $\triangle C_{a\ min}$ a value is found greater than 0·17, say 0·23, the model concerned will possess a small degree of longitudinal stability. It may be a very good model in some respects, but probably not easy to trim and fly.

On the other hand, if a value of, say, 0·14 is found, that model will have a high degree of longitudinal stability and will probably tend to over-correct. That may be all right in a simple model, but it will not lead to top performance.



English Electric *Canberra* 1/12th scale. All wood construction with fully detailed cockpit. Made and finished in three weeks ! (By Mastermodels Ltd.)

GETTING A PROFESSIONAL FINISH

Laurie Barr, Founder and Managing Director of Mastermodels Ltd., Britain's leading aeronautical model makers, reveals the way to achieve that professional finish. Apart from his business interests, Laurie is a successful contest modeller, well known for power, Wakefield, Jetex and "kingsize" gliders.

THE difference between a really good finish and average, is largely a question of technique, and how keen the desire of the model maker is to produce this finish. Another factor is the critical standard you apply to the finished work, and you will find that each succeeding finish will be more critically regarded than the last, and through this analysis, coupled with high ambition, your standard will improve beyond measure.

The technique is easy enough to understand, and is only a question of applying a base, or platform on the surface to be painted, and the building up, and levelling off in between coats of paint, until a flawless sink-proof state is reached. On to this is applied a perfect coating of the gloss finish which is only just thick enough to stand hard abrasive polishing (or burnishing as the professionals call it) to the point where a perfect glass-like surface results without patches of the undercoat "grinning" through, to show a lack of depth in colour or body. After this a further improvement can be achieved by waxing or using silicones.

Apart from reaching perfection standards in all phases of the operations, the really super finish is seen as different from those which have had excessive coats at each stage, including the final coating of gloss, and which shows in some indefinable way as rather treacly. It is true that excess paint will act as an insurance against going through any of the coats, and at the early stages of learning the art, something can be said for it, at least results of a reasonable standard will be reached. However, if you have taken to heart the point in paragraph 1, about ambition and critical standards, your next finish will doubtless be more refined.

The following chart shows clearly (I hope), the average sort of make up in a finish to be applied to a well-prepared surface, such as English lime wood, for which there is no real substitute for most kinds of solid model making. The formula shown has no magic about it, nor is there any real need to stick slavishly to it, you should with expanded experience and confidence find short cuts, and variations which will suit your ideas better.

For the first coat I would recommend the use of sanding sealer, of the kind that you can buy in most model shops. There are (and Pros do use them on certain occasions) various synthetics, but the amateur would be well advised to leave them alone until a good proficiency is reached with cellulose enamels used throughout.

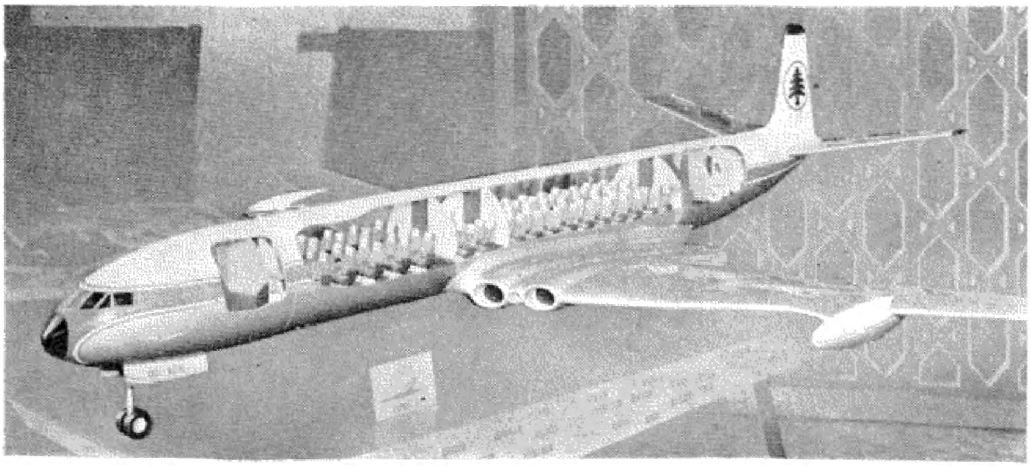
The sanding sealer, acts as a stopper in the sink that seems to be at the bottom of every hole or cavity, be it grain or otherwise, in wood. The sealer's purpose is to place a lining around the hole, and it has a certain amount of resistance to the solving action of the subsequent coats of paint, and at the same time should have good "keying" properties to both the wood and the following primers and undercoats, etc. It is in this "keying" action that synthetics suffer most, and this is not surprising since they are made of totally different materials from cellulose enamels.

Having put on a number of even coats of sealer, the work should be lightly de-whiskered with fine Garnet paper of about 5/0 grade.

The next coats to be applied are the primers, the purpose of which is to consolidate the foothold made by the sealer, and start on the business of filling in the grain. Primers have a lot of "body", that is to say they have a high percentage of filling materials in them, that try to stay where they are put without too much movement or shrinkage. One to three coats are usual (according to your experience with the type of surface to be painted, use more if in doubt). At this stage you can still rub down with 5/0 or 7/0 Garnet paper (the higher the number, the finer the grade), or you can start using "wet and dry" abrasive flatting paper, grade 220 is about right at this stage.

Having arrived at a fairly even surface, the next coats to be applied are the undercoats. This is further to improve the filling of the grain, so that when you have reached the last undercoat but one, all traces of grain should have completely disappeared. Again one to three coats are usual, giving a very thorough flatting down with 320-400 grade wet and dry at least twice in between the coats. It can be said that the final finish can only be as good as the condition of the surface at the last of the undercoats. For all coloured work, the final undercoat must be matt white, as only this will give a true tone re-

D.H. *Comet* 4C Composite model of wood, metal and plastic. (By Mastermodels Ltd.)



flection to the top gloss coating. The gloss finish to be put on should be of fairly thin consistency, but unless you have lost all traces of grain, and allowed ample time for the last undercoat to dry right out before applying the gloss, it will surely penetrate all the other coatings, and raise the grain with its solving action due to the thinners content being high.

With care and patience, a fairly good standard can be reached up to the undercoating stage by using a brush but the final gloss coat *must* be applied with a spray gun of at least 25 lbs. per sq. in. pressure. There are people who can do a fair job with a brush, but they are few and far between, and in any case the sort of critical standard we are concerned with would not tolerate anything less than perfection.

I do not think you can get away with less than three coats applied evenly and thinly, for if we are to burnish up the hardened surface with abrasive polish, there is the danger of rubbing right through to the undercoat. If this does happen, go back to putting on another undercoat, flat down and increase the gloss coating in number of coats from last time.

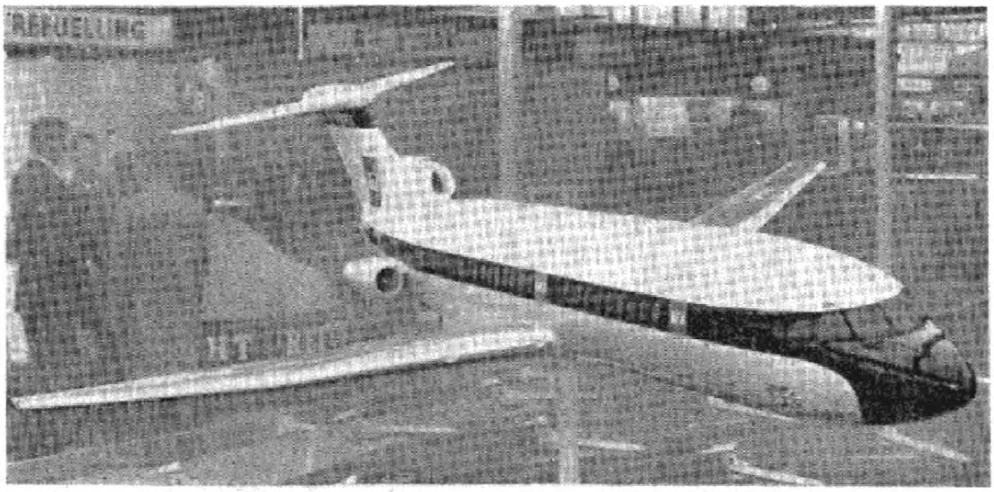
For burnishing, you can use a medium grade compound to start with, finishing with fine grade, but I suggest you start your experience with the fine. I usually use Hendon C, but if this is not available, a good substitute is metal polish. Use mutton cloth, and gauge the amount of burnish you have arrived at, by the amount of paint that has transferred from the model to the polishing cloth through the cutting action of the polish.

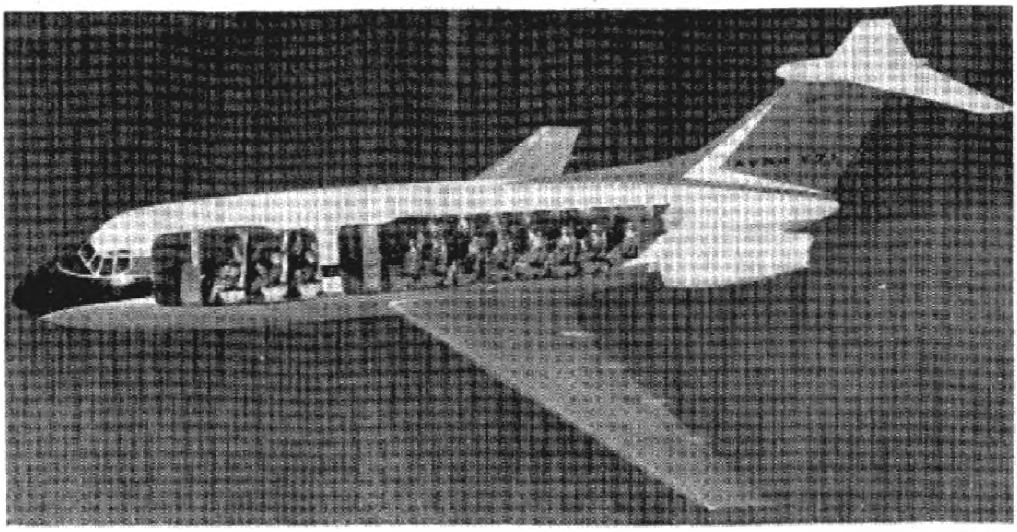
Hints Department

Although wet and dry paper is so called, use wet. For wet flatting down, lubricate the paper with either, soap and water, white spirit, or paraffin. When masking a line or motif, do not use motor body type which has a crinkly crepe backing, as this will leave a ragged edge next to the line. The sort to use is the shiny kind known as cellulose tape (that's what it is made from, although not always used for this purpose).

Try to construct your model with the problems of finishing in mind. Separate as many pieces as is convenient, without detracting from the appearance of the model.

B.A.C 121 *Trident*. 1/12th scale in B.E.A. livery, wood construction. (By Mastermodels Ltd.)





Avro 771. Finish on wings permits detailed passengers to be reflected thereon in original photo. 1/12th scale, wood and plastic construction. (By Mastermodels Ltd.)

Always strain the gloss paint before using. Use an old silk stocking.

During the last undercoats, it is a good idea to put on the surface prior to flatting, a speckle of some dark colour (cellulose), so that as you flat you have a visual guide to where you have been, as well as indicating where stopper is needed, for any holes will show as a dark mark that requires stopper if flatting cannot remove it.

Commence stopping at the primer stage, you should not have to do stopping at the undercoating.

Good luck with the finishing. If you ever reach No. 16 on the chart I shall be pleased to hear from you!

STEPS TO A PROFESSIONAL FINISH

STAGE	OBJECT	TREATMENT
1 Sanding sealer 2 Sanding sealer 3 Sanding sealer	Grain disappears	Paper off whiskers 5/0 Garnet
4 Primer filler 5 Primer filler 6 Primer filler		Paper off with 5/0 to 7/0, or use 320 grade wet or dry. All stopping complete at this stage if possible
7 Undercoat 8 Undercoat 9 Undercoat	No flaws	Two flattings 320/400 grade wet or dry. Speckle surface to be flatted with dark colour prior to flatting
10 Gloss colour finish 11 Gloss colour finish 12 Gloss colour finish	Perfect application Keep edges wet	No treatment required
13 Burnish 14 Polish	Final finish	Metal polish—apply effort evenly Wax or silicone
15 Camera 16 Exhibition	Record Prizes	

FINISHING SCHEDULES

Cellulose dopes have been the standard type of finish for model aircraft in this country for the past thirty years. Butyrate dopes were introduced in America within the last decade as being proof against glow fuels—which cellulose dopes are not—and are now also manufactured in Britain. However, British "fuelproof" dopes are not necessarily butyrate and may require a specific finishing schedule. Thus "Humbrol" fuelproof colour dopes can *only* be applied over Humbrol butyrate clear shrinking dope; and the *clear* butyrate in this case is *not* fully fuelproof.

All butyrate dopes—or those classified as "butyrate"—should be regarded as incompatible with cellulose dopes. Thus where butyrate dopes are employed they should be used throughout a finishing scheme from the first to final coat. If stages involving the use of sanding sealer are incorporated, the sealer should also be of butyrate type. Butyrate dopes, and butyrate-type dopes, applied over an initial coating of ordinary *cellulose* dope may fail to adhere and thus subsequently peel off.

Cellulose dopes may be broadly classified as:

Clear glider dope: a strong shrinking dope (clear or colourless, although perhaps imparting a slightly yellow colour to white tissue).

Clear tautening dope: normal clear model dope with marked shrinking properties.

Banana oil: a clear non-shrinking cellulose dope.

Coloured dopes: usually non-shrinking.

To render cellulose dope finishes impervious to softening attack from engine fuel a final coat of *fuel proofer* is normally required—and is essential in the case of glow motor fuels. Types and formulations of fuel proofer vary considerably, the two-part mixtures (activated by a catalyst which is added immediately before use) generally having the best fuel-resistant properties. Some of the modern marine finishes (polyester and polyurethane) would be well worth investigating for fuelproof finishes on control line models. These are available both as clear "varnishes" and coloured lacquers. These finishes should be regarded as incompatible with other finishes, as with butyrate dopes, and recommended sealers, etc., used with them.

The following typical finishing schemes are appended as a general guide. The type of finish and the quality of the finish will vary depending on whether the model is primarily a contest type (where a "functional" finish is more important than appearance), or aimed at displaying a high standard of finish. It should be remembered, however, that a high standard of finish is consistent with good workmanship, and thus should logically be applied to the initial finishing of *every* model.

Lightweight tissue-covered free flight (rubber or glider)

One coat overall 50/50 clear model dope/thinners

then fuselage: two to four coats 50/50 clear dope, depending on strength of framework.

Wings: two to three coats 50/50 clear dope.

Tailplane: one coat 50/50 clear dope.

Note: stains may be used in the clear dope to strengthen and "fix" the colour of the tissue. Colour dopes should not be used, except for trim (and then only sparingly applied).

Waterproofing scheme: one coat overall of banana oil.

C/L and F/F Power (heavyweight tissue)

(Also heavyweight tissue covered fuselages on gliders or rubber models.)

One to two coats 60/40 clear model dope overall

then fuselage: three to six coats 50/50 clear dope plus up to 10 per cent colour dope to strengthen tissue colour.

Wings and tail: three to four coats 50/50 clear dope plus up to 10 per cent colour dope.

Final treatment (diesel power): none necessary, but coat of fuel proofer or banana oil may be applied.

(Glow power): overall coat of fuel proofer.

Power models—Silk or Nylon covered

One or two coats of clear glider shrinking dope to fill pores

then fuselage: three to six coats 33/33/33 clear model dope/thinners/colour dope.

Wings and tail: three to four coats 50/50 clear dope plus up to 10 per cent colour dope.

Final treatment: as above.

Alternative scheme for Power Models

Two to four coats butyrate shrinking dope, as required

then one coat overall butyrate colour dope (or butyrate-type fuelproof dope). One further coat butyrate colour dope on fuselage.

DOPE SELECTION CHART

TYPE OF MODEL / FINISH →		CLEAR GLIDER DOPE	CLEAR MODEL DOPE	COLOURED DOPE	BANANA OIL	FUEL PROOFER	BUTYRATE DOPES	POLYESTER FINISH
RUBBER	SMALL		Normal choice		May be used			
	LARGE		Normal choice		May be used			
GLIDER	SMALL		Normal choice		May be used			
	LARGE	May be used	Normal choice		May be used			
F/F POWER	DIESEL		Normal choice			May be used	May be used	
	GLOW		Normal choice			Normal choice	Normal choice	
RADIO CONTROL	DIESEL	May be used	Normal choice	May be used		May be used	May be used	
	GLOW	May be used	Normal choice	May be used		Normal choice	Normal choice	
CONTROL LINE	DIESEL	May be used	Normal choice	May be used		May be used	May be used	May be used
	GLOW	May be used	Normal choice	May be used		Normal choice	Normal choice	May be used

NORMAL CHOICE — MAY BE USED — NOT SUITABLE OR NOT REQUIRED (blank)

Superior Power Model Finish

Before covering: dope airframe and sand smooth; one coat sanding sealer on airframe and sand smooth.
Two to three coats clear shrinking dope (glider dope on silk or nylon, model dope on tissue).
One to two coats 50/50 clear model dope overall.
One coat sanding sealer overall, then rub down.
Two to three coats 33/33/33 clear dope/thinners/colour dope.
* Flat and then polish.
Final treatment: one coat overall of fuel proofer

* This stage may be omitted

Notes

In all cases application of dope by *spraygun* is always to be preferred to brush painting, especially for the final coats.

When doping porous covering material (particularly silk and nylon) care must be taken not to apply excessive dope in localised areas so that the dope runs through and forms "weep" lines on the inside surface.

Where a spraygun is not available, "flow" application of clear dope is usually better than brushing on. In this case a lint-free pad or small piece of plastic sponge is used to flow the dope on to the surface to be covered with a sweeping motion. This can, however, lead to "weeping" on porous coverings.

SELECTION OF COVERING MATERIALS

POSSIBLE applications of the wide range of covering materials available for model aircraft are summarised in the Selection Table. These do not include all possible materials; nor does the absence of a "suitability" key against a particular material mean that it *cannot* be used for such an application. In general, however, use of the materials outside the range shown by the Selection Chart may lead to a poor or unsatisfactory performance. This Selection Chart should be studied in conjunction with the separate notes on the different materials.

Jap. tissue

A lightweight tissue with good strength properties but tends to become somewhat brittle with age, and also if excessively doped. Does not over-tauten with dope or absorb too much dope so specifically recommended for covering small, light frameworks.

The majority of Jap. tissue is of constant weight (grade), although there are different thicknesses produced. Thinner Jap. tissues may be classified as "lightweight" or "extra light". A somewhat similar form of very thin lightweight tissue, basically produced as "condenser tissue" is also sometimes sold under the name of Jap. tissue. This latter grade is really suitable only for ultra-light indoor models.

Modelspan tissues

These are tough paper tissues, now generally available with "wet strength" properties. That is to say the tissue does not become excessively weak when wetted, allowing for easier manipulation when covering. "Wet strength" tissue may be "moulded" to shape when covering, working with dampened tissue.

Lightweight Modelspan is somewhat lighter than standard Jap. tissue but absorbs a greater weight of dope and requires more dope to fill the pores. It also shrinks more than standard Jap. tissue when doped. Heavyweight Modelspan shrinks too much on doping for application to weak structures.

COVERING SELECTION CHART

TYPE OF MODEL		JAP. TISSUE	LIGHTWEIGHT MODELSPAN	HEAVYWEIGHT MODELSPAN	BAMBOO PAPER	LIGHTWEIGHT JAP. SILK	SILK MEDIUM WEIGHT	NYLON CHIFFON	NYLON MEDIUM WEIGHT
SMALL RUBBER		Normal choice	Suitable						
MEDIUM & LARGE RUBBER	WINGS	Particularly recommended	Suitable						
	TAIL	Particularly recommended	Suitable						
	FUSELAGE	Suitable	Suitable	Normal choice		Suitable			
GLIDER	SMALL	Suitable	Normal choice						
	MEDIUM	Suitable	Normal choice	Normal choice		Suitable		Suitable	
	LARGE		Suitable	Normal choice	Suitable	Suitable		Suitable	
F/F POWER	UP TO 36" SPAN	Suitable	Normal choice						
	36"-48" "		Suitable	Normal choice		Suitable		Suitable	
	OVER 48" "			Normal choice	Suitable	Suitable		Particularly recommended	
RADIO CONTROL	30"-36" SPAN		Normal choice	Suitable					
	36"-48" "			Normal choice	Suitable	Suitable		Suitable	
	48"-60" "			Normal choice	Suitable	Suitable	Suitable	Particularly recommended	
	60"-72" "			Normal choice	Suitable	Normal choice	Suitable	Particularly recommended	Suitable
	OVER 72" "			Suitable	Suitable	Suitable	Normal choice	Particularly recommended	Particularly recommended
CONTROL LINE (BUILT UP WINGS)	UP TO 24" SPAN	Suitable	Normal choice						
	24"-30" "		Suitable	Normal choice					
	30"-36" "			Normal choice		Suitable		Particularly recommended	
	OVER 36" "			Normal choice		Suitable	Suitable	Particularly recommended	Suitable

Legend: SUITABLE (hatched) — NORMAL CHOICE (cross-hatched) — PARTICULARLY RECOMMENDED (solid black)

Bamboo paper

A tough, heavy paper made from bamboo pulp, this covering material was quite popular pre-war for large power models. It is currently in use again in America but very little in this country. Its main virtue is cheapness.

Silkspan

Silkspans were the first of the specially made "tough" tissues developed for model aircraft covering and originated in America. They were also the first of the wet-strengthened tissues. Various types of paper are supplied in America under this name, classified as "lightweight" or "heavyweight". They can be regarded as virtually identical in application to the two grades of "Modelspan" although true "lightweight" Silkspan is somewhat intermediate in weight and strength between "lightweight" and "heavyweight" Modelspan.

Other tissues

Various other papers and "paper fabrics" appear from time to time as covering materials. Some may offer definite advantages—e.g. increased strength or strength/weight, but generally have some limitations, such as unfavourable shrinkage, rough surface, excessive dope absorption, etc. "Viscotex" is a paper fabric which has excellent strength and impact resistance and may be regarded as an inexpensive substitute for nylon or silk.

Silk covering

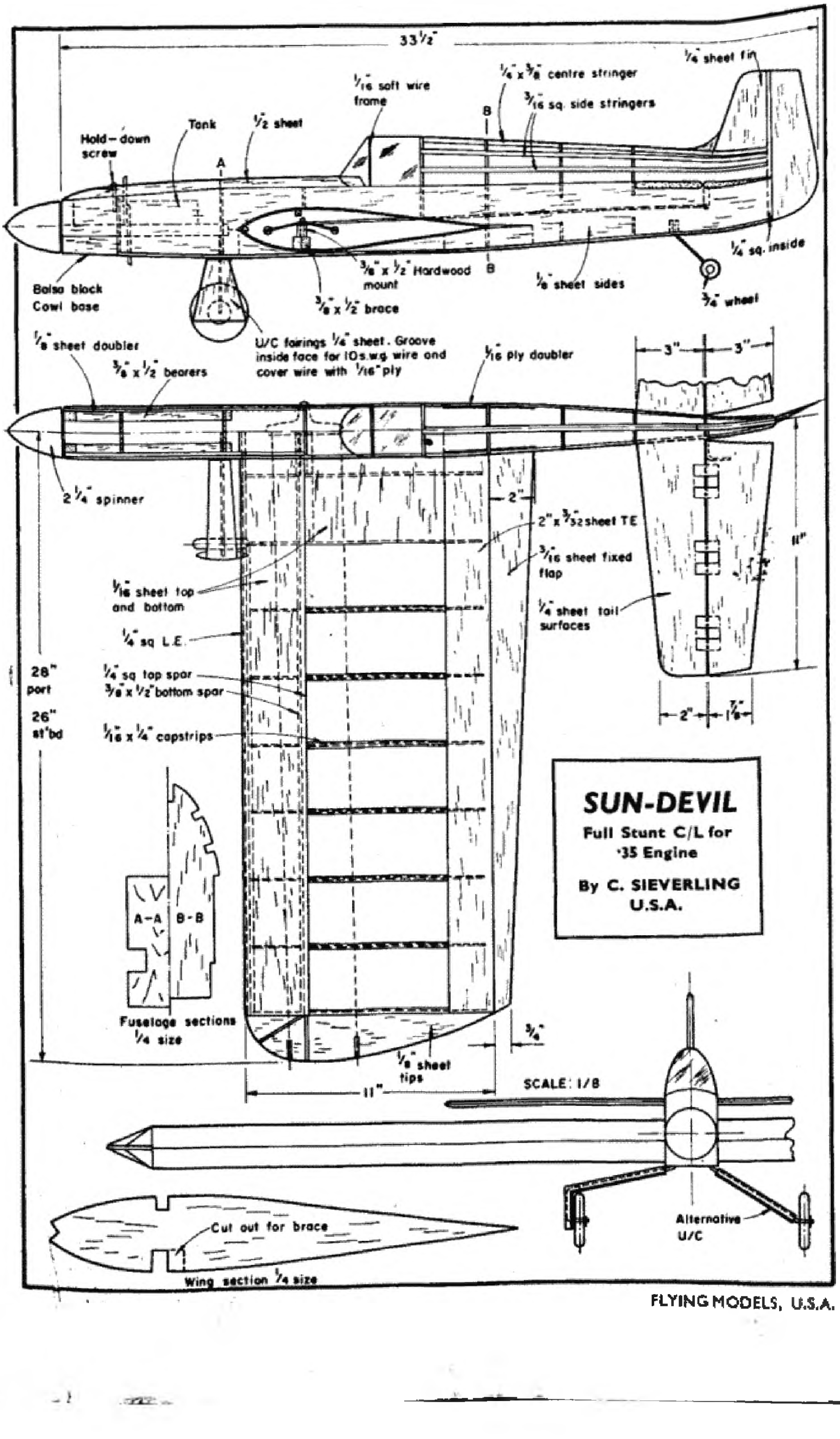
There are numerous grades of silk fabrics which can be used as covering materials. Extremely lightweight silks tend to have a very open weave and need an excessive amount of dope to fill. The lightweight quality generally classified as Jap. silk is about the minimum weight practical (approx. 1 oz. per sq. yd.) and a generally excellent covering material. Whilst strong it does, however, become brittle with age or with excessive doping. Heavier grades of silk offer superior strength and durability, but will still go brittle with age. Nothing heavier than "medium weight" should be considered. Ex-government parachute silk may be "medium weight", but a considerable proportion is also "heavyweight".

Nylon fabrics

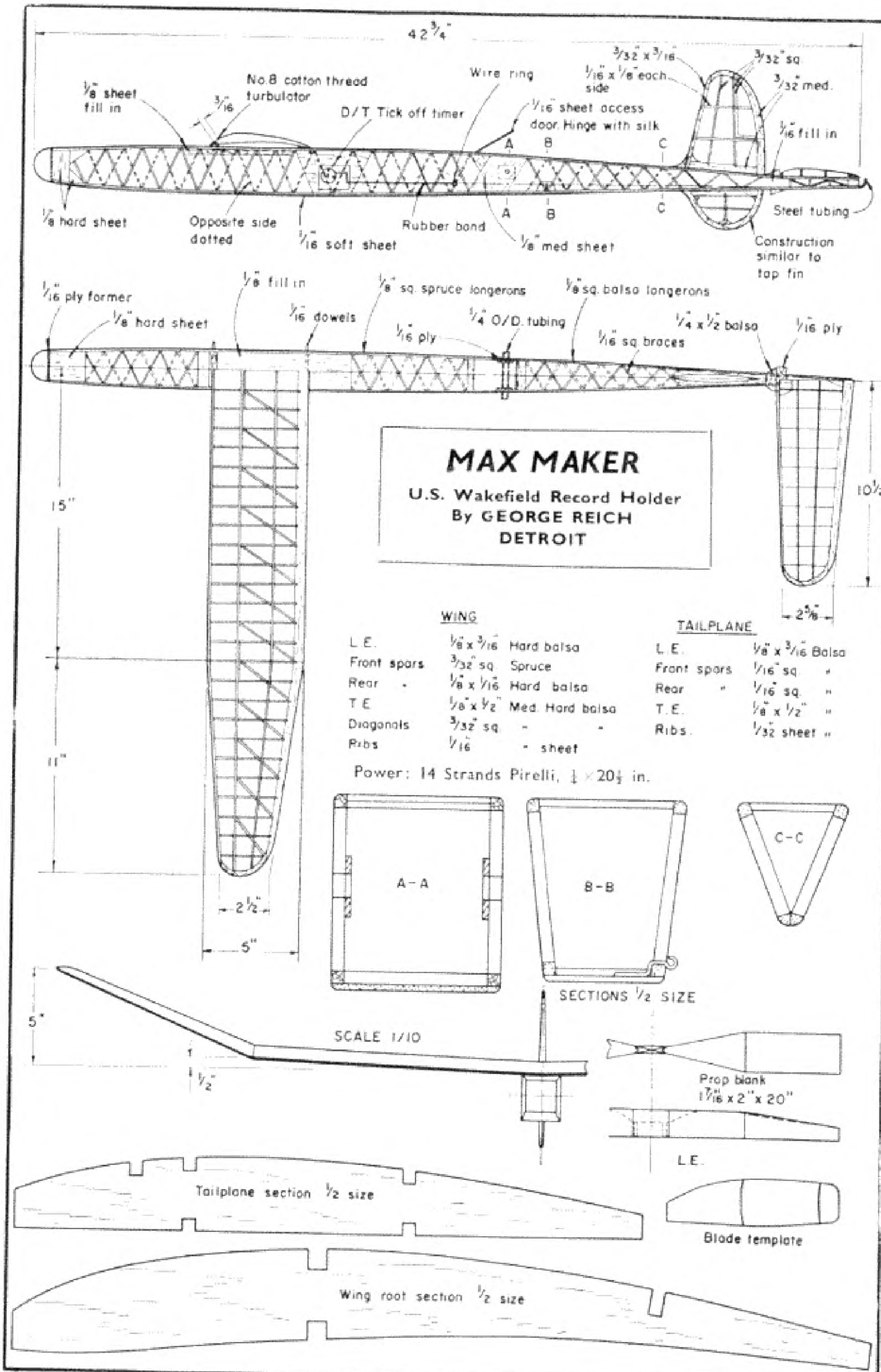
Plain nylon fabrics are produced in a variety of weights, some unnecessarily heavy for model work. A weight of 2 ounces per sq. yd. gives adequate strength for the largest size of model although 4 ounce nylon is sometimes used. Parachute nylon is usually "heavyweight" by model standards.

Nylon chiffon is a lighter fabric and generally strong enough for all normal applications. Again its weight may vary, according to manufacture and thickness, but usually averages about 1½-2 ounces per sq. yd.

Not all nylon chiffon is pure nylon. Some material marketed under this general name may be a mixture of nylon and terylene; and some even terylene. In general, however, all make excellent covering materials with maximum strength and resistance to splitting or cracking. Nylon covering does not appear to get brittle with age or excessive doping. It is also better than silk strips for "bandage type" reinforcement or bindings, and preferable to silk for covering larger power models or models subject to fairly rough usage. Nylon covering may also be applied with advantage over sheet-balsa fuselages to give a considerable increase in strength.



FLYING MODELS, U.S.A.

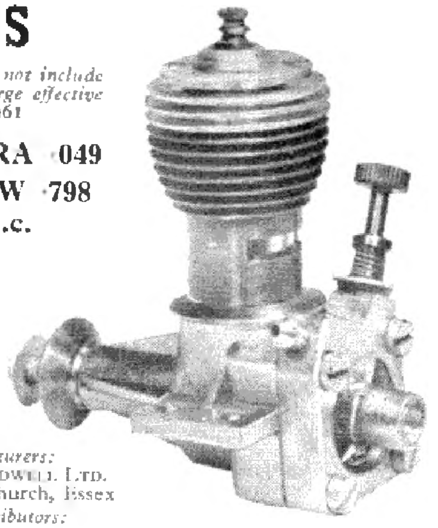


MAX MAKER
U.S. Wakefield Record Holder
By GEORGE REICH
DETROIT
42 3/4"
1/8" sheet fill in
No. 8 cotton thread turbulator
3/16
D/T Tick off timer
Wire ring
1/16" sheet access door. Hinge with silk
3/32" x 3/16"
1/16" x 1/8" each side
3/32" sq.
3/32" med.
1/16" fill in
1/8 hard sheet
Opposite side dotted
1/16" soft sheet
Rubber band
1/8" med sheet
Steel tubing
Construction similar to top fin
1/16" ply former
1/8" hard sheet
1/8" fill in
1/16" dowels
1/8" sq. spruce longerons
1/16" ply
1/4" O/D. tubing
1/8" sq. balsa longerons
1/16" sq. braces
1/4" x 1/2" balsa
1/16" ply
15"
11"
2 1/2"
5"
10 1/2"
2 5/8"
WING
L.E. 1/8" x 3/16" Hard balsa
Front spars 3/32" sq. Spruce
Rear " 1/8" x 1/16" Hard balsa
T.E. 1/8" x 1/2" Med. Hard balsa
Diagonals 3/32" sq. " "
Ribs 1/16" " sheet
TAILPLANE
L.E. 1/8" x 3/16" Balsa
Front spars 1/16" sq. "
Rear " 1/16" sq. "
T.E. 1/8" x 1/2" "
Ribs 1/32" sheet "
Power: 14 Strands Pirelli, 1/4 × 20 1/2 in.
A-A
B-B
C-C
SECTIONS 1/2 SIZE
5"
1/2"
SCALE 1/10
Prop blank 1 7/16 x 2" x 20"
L.E.
Tailplane section 1/2 size
Blade template
Wing root section 1/2 size

ENGINE ANALYSIS

Prices quoted do not include the P.T. surcharge effective July 1961

COBRA ·049 GLOW ·798 c.c.



Specification

Displacement: ·798 c.c. (·0487 cu. in.)
Bore: ·406 in.
Stroke: ·376 in.
Bare weight: 1¾ ounces
Max. power: ·052 B.H.P. at 15,000 r.p.m.
Max. torque: 4·3 oz. in. at 9,000 r.p.m.
Power rating: ·065 B.H.P. per c.c.
Power/weight ratio: ·047 B.H.P. per ounce

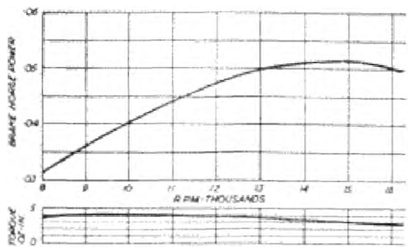
Material Specification

Crankcase: L.M.2 light alloy die casting
Cylinder and Piston: High tensile heat treated steel
Cylinder head: Dur. aluminium (incorporating glow element)
Crankshaft: High tensile heat treated steel
Connecting rod: machined from dural, ball and socket little end
Crankcase backplate: L.M.2 light alloy die casting
Induction: reed valve (hard beryllium copper alloy)
Propeller shaft: ¼ in. nominal diameter screw

Manufacturers:
John Rodwell Ltd.,
Hornchurch, Essex
Sole distributors:
E. Keil & Co. Ltd.,
Wickford, Essex
Retail price: £1/19/6

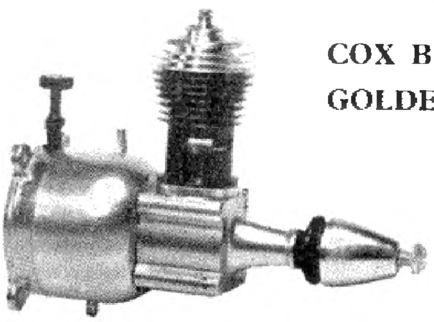
PROPELLER—R.P.M. FIGURES

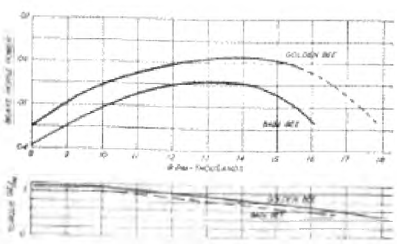
Propeller dia. × pitch	r.p.m.
6 × 4 (Davies-Charlton nylon)	13,600
5½ × 3½ (Davies-Charlton nylon)	16,500
6 × 4 (Top Flite)	12,000
6 × 3 (Top Flite)	14,200
5½ × 4 (Top Flite)	14,500
5½ × 3 (Top Flite)	15,500
7 × 4 (Top Flite)	8,400
6 × 4 (K-K nylon)	11,500
6 × 3 (K-K nylon)	13,200
5½ × 4 (K-K nylon)	13,500
5 × 4 (K-K nylon)	14,800
5 × 3 (K-K nylon)	16,200
7 × 4 (K-K nylon)	9,000
7 × 6 (K-K nylon)	7,000
6 × 3 (Trucut)	9,900
6 × 4 (Trucut)	9,400
6 × 4 (Stant)	9,800

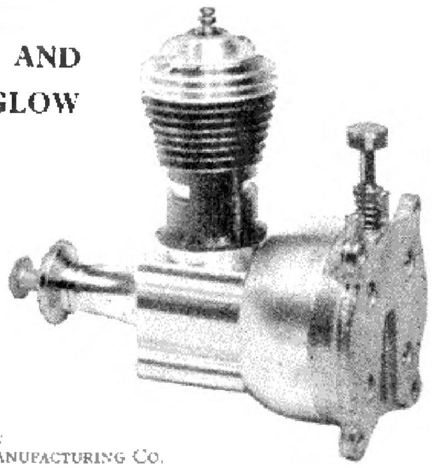


Fuel: 160-25-15 methanol, castor, nitromethane

COX BABE BEE AND GOLDEN BEE GLOW ·81 c.c.







Manufacturers:
L. M. Cox Manufacturing Co.,
Santa Ana, California, U.S.A.

British agent:
A. A. Hales,
26 Station Close, Potters Bar, Middlesex
Retail prices in G.B.: Babe Bee, £2/2/6; Golden Bee, £3/13/3

Specification

Displacement: ·81 c.c. (·0494 cu. in.)
Bore: ·4057 in.
Stroke: ·382 in.
Bare weight:
  Babe Bee—1¾ ounces
  Golden Bee—1⅞ ounces
Max. Power:
  Babe Bee—·056 B.H.P. at 13,000 r.p.m.
  Golden Bee—·0625 B.H.P. at 14,000 r.p.m.
Power rating:
  Babe Bee—·069 B.H.P. per c.c.
  Golden Bee—·077 B.H.P. per c.c.
Power/weight ratio:
  Babe Bee—·032 B.H.P. per ounce
  Golden Bee—·033 B.H.P. per ounce

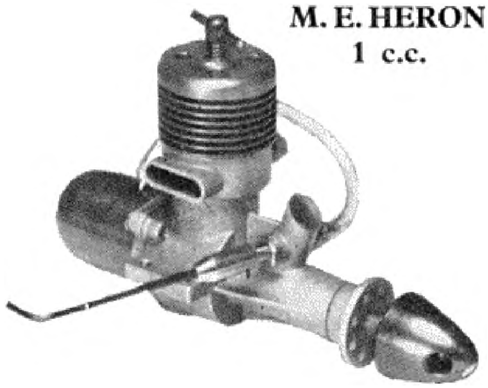
Material Specification

Crankcase: machined from extruded section light alloy
Cylinder: mild steel, black finish
Piston: hardened steel
Connecting rod: hardened steel
Crankshaft: hardened steel
Cylinder head: turned dural
Main bearing: plain
Induction: reed valve
Tank: turned dural
Tank backplate: light alloy pressure die-casting
Finish:
  Babe Bee—bright (tumbled) crankcase, plain metal tank
  Golden Bee—"Gold" anodised crankcase and tank
Fuel used: Keilkraft Record Nitrex

PROPELLER—R.P.M. FIGURES

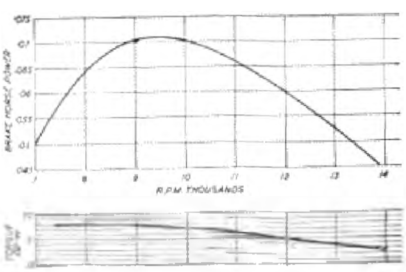
Propeller dia. × pitch	r.p.m.
COX GOLDEN BEE	
7 × 4 (Keilkraft nylon)	9,500
7 × 6 (Keilkraft nylon)	7,600
6 × 4 (Keilkraft nylon)	12,200
6 × 3 (Keilkraft nylon)	14,300
5¼ × 4 (Keilkraft nylon)	14,300
5 × 4 (Keilkraft nylon)	16,000
5 × 3 (Keilkraft nylon)	17,500
	18,000
6 × 4 (Top Flite)	13,400
7 × 4 (Top Flite)	9,500
6 × 3 (Top Flite)	15,200
5¼ × 4 (Top Flite)	15,200
5¼ × 3 (Top Flite)	16,200
6 × 4 (Stant)	11,000
7 × 4 (Stant)	9,800
8 × 4 (Stant)	8,000
5¼ × 3½ (Davies Charlton)	17,600
6 × 4 (Davies Charlton)	14,800
6 × 4 (Frog nylon)	14,000
7 × 4 (Frog nylon)	10,000
COX BABE BEE	
5 × 3 (Keilkraft nylon)	16,200
5 × 4 (Keilkraft nylon)	14,800
7 × 4 (Top Flite)	9,000
6 × 4 (Top Flite)	13,000
6 × 3 (Top Flite)	14,400
5¼ × 4 (Top Flite)	14,500
5¼ × 3 (Top Flite)	15,700

M. E. HERON 1 c.c.



Specification

Displacement: ·97 c.c. (1,059 cu. in.)
Bore: ·424 in.
Stroke: ·420 in.
Bore/Stroke ratio: 1·01
Bare weight (with tank): 2·4 ounces.
Max. B.H.P.: ·072 at 9,500 r.p.m.
Max. torque: 8 ounce-inches at 8,500 r.p.m.
Power rating: ·079 B.H.P. per c.c.
Power/weight ratio: ·03 B.H.P. per ounce



PROPELLER—R.P.M. FIGURES

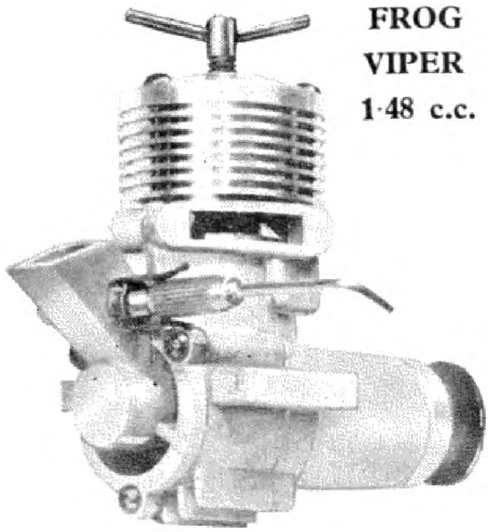
Propeller dia. × pitch	r.p.m.
8 × 4 (Trucut)	8,000
7 × 3 (Trucut)	11,000
7 × 6 (Trucut)	7,500
6 × 6 (Trucut)	9,000
6 × 4 (Trucut)	11,000
6 × 3 (Trucut)	11,800
7 × 5 (Trucut)	9,000
6 × 4 (Stant)	11,400
7 × 4 (Stant)	10,200
8 × 4 (Stant)	8,000
7 × 6 (Frog nylon)	8,800
7 × 4 (Frog nylon)	10,000
6 × 6 (Frog nylon)	11,500
6 × 4 (Frog nylon)	13,000
6 × 4 (Davies-Charlton nylon)	13,500

Fuel used: Mercury No. 8. A.P.S. Power Coding D

Material Specification

Cylinder: Meehanite
Crankcase: Light alloy pressure die casting
Rear cover: Light alloy pressure die casting
Crankshaft: Case hardened BSS EN 34 steel
Main bearing: Meehanite bush
Contra piston: Meehanite
Piston: Meehanite
Conrod: Machined from L.64 high tensile light alloy
Spraybar: Brass
Cylinder jacket: Turned from dural, anodised red
Fuel tank: Turned from dural, anodised red
Prop. driver: Light alloy die casting
Spinner nut: Turned from dural, anodised red

Manufacturers:
MAROWN ENGINEERING LTD.
  Glen Vine, Isle of Man
Retail price: £2/13/6 including P.T.



FROG VIPER 1·48 c.c.

Specification

Displacement: 1·48 c.c. (·09 cu. in.)
Bore: ·500 in.
Stroke: ·460 in.
Bore/stroke ratio: 1·09:1
Bare weight: 4¼ ounces
Max. power: ·161 B.H.P. at 14,800 r.p.m.
Max. torque: 14 ounce-inches at 9,500 r.p.m.
Power rating: ·109 B.H.P. per c.c.
Power/weight ratio: ·039 B.H.P. per ounce

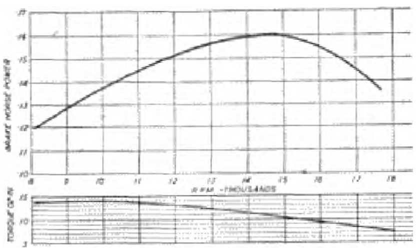
Material Specification

Crankcase: light alloy pressure die-casting, vapour-blast finish
Cylinder: case hardened mild steel
Piston: cast iron
Contra piston: mild steel
Crankshaft: case hardened steel
Bearings: two Muller lightweight precision ball races (¼-in. base)
Induction: Rotary drum valve (rear mounted)
Cylinder jacket: turned dural (threaded insert for compression screw)
Propeller driver: turned dural

PROPELLER—R.P.M. FIGURES	
Propeller dia. × pitch	*r.p.m.*
9 × 6 (Frog nylon)	8,000
8 × 4 (Frog nylon)	11,400
7 × 6 (Frog nylon)	13,200
7 × 4 (Frog nylon)	15,000
6 × 4 (Frog nylon)	19,000 +
9 × 4 (Top Flite)	9,100
8 × 6 (Top Flite)	9,000
8 × 4 (Top Flite)	11,700
7 × 6 (Top Flite)	12,200
7 × 4 (Top Flite)	13,700
9 × 4 (K-K nylon)	9,500
8 × 6 (K-K nylon)	8,900
8 × 4 (K-K nylon)	11,000
7 × 6 (K-K nylon)	11,300
7 × 4 (K-K nylon)	15,000
9 × 4 (Trucut)	8,700
8 × 4 (Trucut)	11,500
*7 × 4 (Trucut)	14,900
7 × 6 (Trucut)	10,400
6 × 9 (Trucut)	11,000

**This 7 × 4 propeller is new and will not agree with original 7 × 4 figures published, the original test propeller being of incorrect pitch*

Fuel used: Frog Powamix diesel fuel



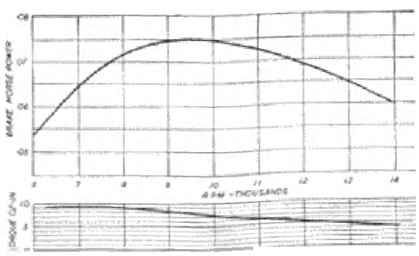
Spraybar: brass
Propeller shaft: 3 BS steel screw

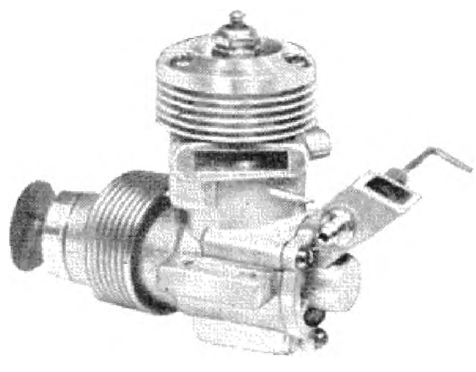
Manufacturers:
INTERNATIONAL MODEL AIRCRAFT LTD.
Retail price: £4/0/3

FROG VENOM GLOW 1·48 c.c.

Specification

Displacement: 1·48 c.c. (·09 cu. in.)
Bore: ·500 in.
Stroke: ·460 in.
Bore/stroke ratio: 1·09:1
Bare weight: 3¾ ounces
Max. power: ·075 B.H.P. at 10,000 r.p.m.
Max. torque: 9 ounce-inches at 7,500 r.p.m.
Power rating: ·05 B.H.P. per c.c.
Power/weight ratio: ·02 B.H.P. per ounce





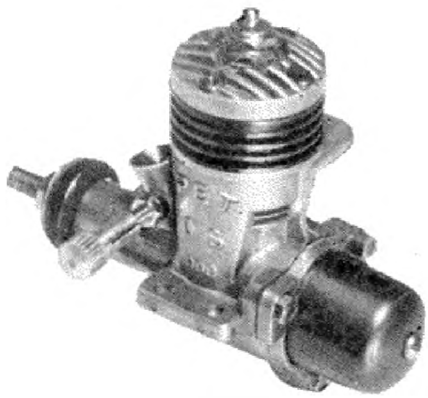
Material Specification

Crankcase: light alloy pressure die-casting
Cylinder: case hardened mild steel
Crankcase: case hardened steel
Propeller shaft: 3 BA steel screw
Piston: cast iron
Cylinder jacket (integral head): turned dural
Glow plug: A.M. 2-volt
Bearings: plain
Induction: rear induction via drum valve

Spraybar: brass
Starter spring: 7 turns 1 in. diameter 16 s.w.g. steel wire

Manufacturers:

INTERNATIONAL MODEL AIRCRAFT LTD.
Retail price: £2/8/0

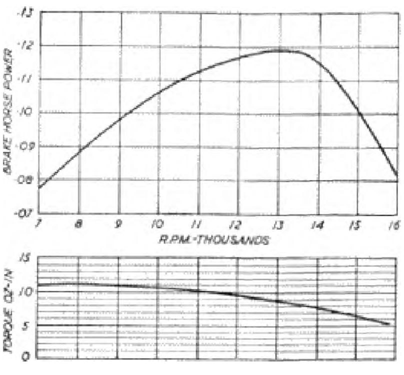


Specification

Displacement: 1·615 c.c. (·098 cu. in.)
Bore: ·529 in.
Stroke: ·448 in.
Bore/stroke ratio: 1·18 in.
Bare weight: 3½ ounces (with throttle)
Max. power: ·119 B.H.P. at 13,500 r.p.m.
Max. torque: 11 ounce-inches at 11,000 r.p.m.
Power rating: ·074 B.H.P. per c.c.
Power/weight ratio: ·034 B.H.P. per ounce

Material Specification

Crankcase: Light alloy pressure die-casting
Back cover: Light alloy pressure die-casting
Cylinder: Unhardened steel
Cylinder head: Light alloy pressure die-casting
Piston: Cast iron



PROPELLER—R.P.M. FIGURES	
Propeller dia. × pitch	*r.p.m.*
9 × 6 (Frog)	6,600
8 × 4 (Frog)	8,500
7 × 6 (Frog)	10,000
7 × 4 (Frog)	10,400
6 × 4 (Frog)	13,800
7 × 4 (Top Flite)	10,000
8 × 4 (Top Flite)	9,300
7 × 6 (Top Flite)	9,250
7 × 4 (K-K nylon)	10,600
7 × 6 (K-K nylon)	9,000
8 × 4 (K-K nylon)	9,400
8 × 4 (Trucut)	9,300
7 × 4 (Trucut)	10,700

Fuel: Frog Redglow

OS PET 09 GLOW 1·615 c.c.

Gudgeon pin: Silver steel
Crankshaft: Hardened steel
Propeller driver: Steel
Crankshaft nut: 2 B.A.
Spraybar: Brass
Throttle: Brass barrel in aluminium housing
Glow plug: Japanese (2-volt) with idling bar

Manufacturers:

OGAWA MODEL MFG. CO. LTD.
Hiranobaba, Higashisumiyoshi, Osaka, Japan
Retail price: £2/7/6 including P.T.

PROPELLER—R.P.M. FIGURES	
Propeller dia. × pitch	*r.p.m.*
7 × 4 (Frog nylon)	11,800
9 × 6 (Frog nylon)	6,500
8 × 4 (Frog nylon)	9,800
8 × 6 (Frog nylon)	7,000
6 × 4 (Frog nylon)	15,500
6 × 4 (Stant)	13,500
7 × 4 (Stant)	11,000
8 × 4 (Stant)	9,600
9 × 4 (Stant)	7,000
9 × 4 (Trucut)	7,500
8 × 6 (Trucut)	7,800
8 × 4 (Trucut)	10,200
7 × 5 (Trucut)	10,800
7 × 4 (Trucut)	12,300
7 × 3 (Trucut)	13,500
6 × 4 (Trucut)	14,000
6 × 3 (Top Flite)	16,800
6 × 4 (Top Flite)	15,500
7 × 4 (Top Flite)	12,000
7 × 6 (Top Flite)	10,500
8 × 4 (Top Flite)	10,500
9 × 4 (Top Flite)	8,300

Fuel: straight methanol/castor oil blend

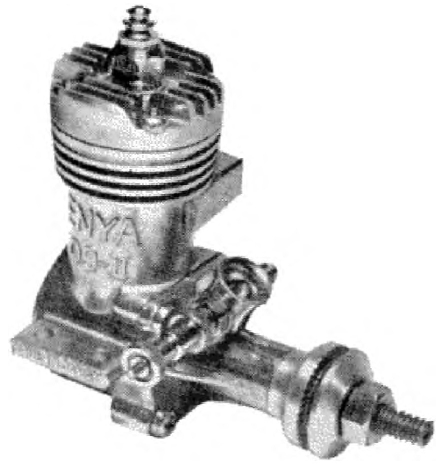
ENYA 09-11 GLOW 1·6 c.c.

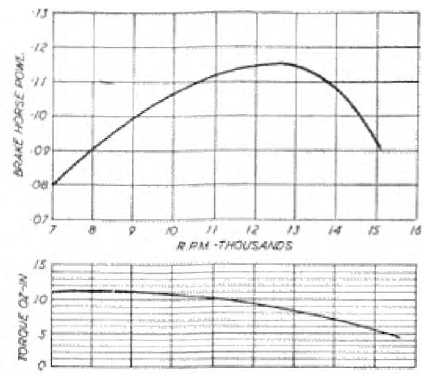
Specification

Displacement: 1·60 c.c. (·0978 cu. in.)
Bore: ·500 in.
Stroke: ·498 in.
Bore/stroke ratio: 1·0
Bare weight: 3½ ounces
Max. power: ·115 B.H.P. at 12,800 r.p.m.
Max. torque: 11 ounce-inches at 8,000 r.p.m.
Power rating: ·072 B.H.P. per c.c.
Power/weight ratio: 1·033 B.H.P. per ounce

Material Specification

Crankcase unit: Light alloy pressure die-casting
Cylinder: Cast iron
Piston: Cast iron
Front bearing: Bronze, in light alloy die-cast housing
Propeller driver: Dural
Propeller shaft thread: ·191 in. diameter
Spraybar: Nickel plated brass
Glow plug: Japanese (2-volt)





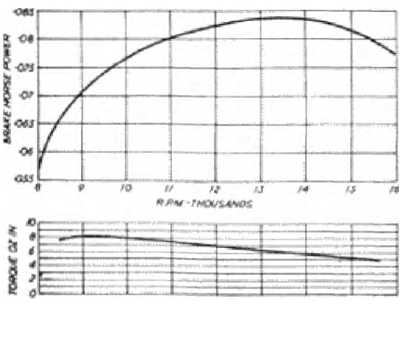
FOX 09 GLOW 1·639 c.c.

Specification

Displacement: 1·639 c.c. (·099 cu. in.)
Bore: ·530 in.
Stroke: ·453 in.
Bore/stroke ratio: 1·17 Bare weight: 3 ounces
Max. power.: ·084 B.H.P. at 14,000 r.p.m.
Max. torque: 8 ounce-inches at 9,000 r.p.m.
Power rating: ·051 B.H.P. per c.c.
Power/weight ratio: ·028 B.H.P. per ounce

Material Specification

Crankcase: light alloy pressure die-casting
Cylinder: mild steel
Piston: hardened steel
Crankshaft: hardened steel
Bearing: plain
Connecting Rod: machined from steel (ball and socket little end)
Head: light alloy (incorporating glow plug as integral unit)

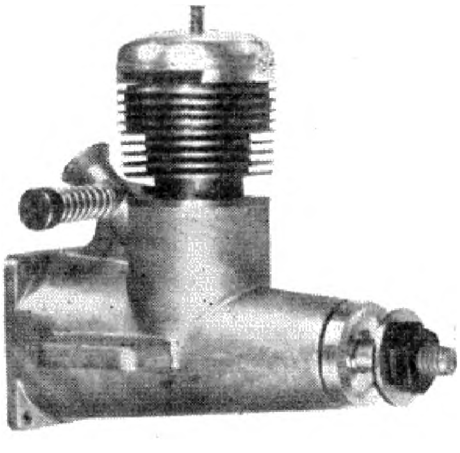


Manufacturers:
Enya Manufacturing Ltd.,
553 Arai-machi, Nakamo-ku, Tokyo, Japan
Retail price: £3/4/7

Propeller—R.P.M. Figures	
Propeller dia. × pitch	*r.p.m.*
7 × 4 (Frog nylon)	12,000
8 × 4 (Frog nylon)	10,000
8 × 6 (Frog nylon)	7,000
6 × 4 (Frog nylon)	15,000
9 × 4 (Trucut)	7,800
8 × 4 (Trucut)	10,500
7 × 5 (Trucut)	10,500
7 × 4 (Trucut)	12,200
7 × 3 (Trucut)	13,300
6 × 4 (Trucut)	13,300
6 × 4 (Top Flite)	14,800
7 × 4 (Top Flite)	11,800
7 × 6 (Top Flite)	10,400
8 × 4 (Top Flite)	10,600
9 × 4 (Top Flite)	8,200

Fuel: Straight methanol/castor oil blend

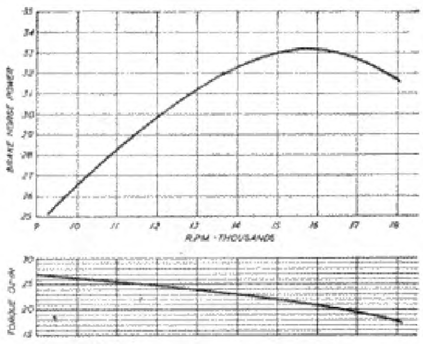
Note: Performance is improved slightly (4–5 per cent.) with an A-M glow plug, as compared with the Japanese standard plug on straight fuels.



Manufacturers:
Fox Manufacturing Co Inc.,
5305 Towson Avenue, Fort Smith, Arkansas, U.S.A.

Propeller—R.P.M. Figures	
Propeller dia. × pitch	*r.p.m.*
7 × 4 (Frog nylon)	10,000
6 × 4 (Frog nylon)	15,200 (14,500)*
8 × 4 (Trucut)	8,800
8 × 3 (Trucut)	9,400 (9,200)*
7 × 4 (Trucut)	10,800
7 × 3 (Trucut)	12,600 (12,000)*
6 × 4 (Trucut)	12,700
6 × 3 (Trucut)	13,400 (13,000)*

Fuel used: 25 per cent. nitromethane content in standard methanol/castor fuel
*straight methanol castor fuel



Propeller dia. × pitch	r.p.m.
9 × 6 (Frog nylon)	10,600
8 × 4 (Frog nylon)	13,800
8 × 6 (Frog nylon)	11,500
11 × 4 (Top Flite)	8,800
10 × 6 (Top Flite)	8,800
10 × 3½ (Top Flite)	10,100
9 × 7 (Top Flite)	9,000
9 × 6 (Top Flite)	9,800
9 × 4 (Top Flite)	12,000
8 × 4 (Top Flite)	14,800
9 × 7 (K-K nylon)	9,000
9 × 6 (K-K nylon)	9,300
9 × 4 (K-K nylon)	12,700
8 × 6 (K-K nylon)	11,900
8 × 4 (K-K nylon)	14,400
9 × 4 (Trucut)	11,500
8 × 6 (Trucut)	11,300
7 × 9 (Trucut)	11,500
8 × 4 (Trucut)	14,600
7 × 6 (Trucut)	11,500
7 × 4 (Trucut)	17,000
6 × 9 (Trucut)	14,600

Table title: PROPELLER—R.P.M. FIGURES

Fuel used: D-C "Quickstart" diesel fuel

ENYA 15D MARK II 2·443 c.c.

Specification

Displacement: 2·443 c.c. (·149 cu. in.)
Bore: ·589 in. Stroke: ·547in.
Bare weight: 6¼ ounces
Max. power: ·332 B.H.P. at 15,000 r.p.m.
Max. torque: 27 ounce-inches at 9,000 r.p.m.
Power rating: ·135 B.H.P. per c.c.
Power/weight ratio: ·053 B.H.P. per ounce

Material Specification

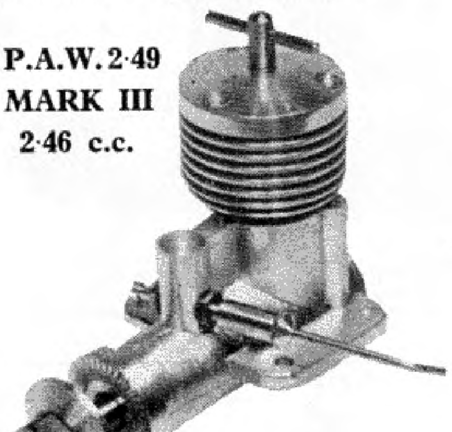
Crankcase unit: pressure die-cast light alloy
Cylinder: mild steel
Crankshaft: hardened steel
Piston: cast iron Contra piston: cast iron
Connecting rod: light alloy casting with bronze bushings
Cylinder jacket: turned dural
Spraybar: brass, nickel plated
Bearing: one 11·5 mm. ballrace at rear; bronze bush (front)

Manufacturers:
ENYA METAL PRODUCTS LTD. Tokyo, Japan
Retail price £6/1/3 inc P.T.

Table title: PROPELLER—R.P.M. FIGURES

Propeller dia. × pitch	r.p.m.
9 × 6 (Frog nylon)	10,400
10 × 6 (Frog nylon)	8,600
8 × 4 (Frog nylon)	14,000
11 × 4 (Top Flite)	8,000
10 × 6 (Top Flite)	8,600
10 × 3½ (Top Flite)	10,000
9 × 7 (Top Flite)	8,800
9 × 6 (Top Flite)	9,300
9 × 4 (Top Flite)	12,000
8 × 6 (Top Flite)	11,700
8 × 4 (Top Flite)	14,300
7 × 6 (Top Flite)	15,000
9 × 4 (Trucut)	10,800
8 × 4 (Trucut)	14,500
7 × 9 (Trucut)	11,100
6 × 9 (Trucut)	14,700
7 × 4 (Trucut)	16,800
9 × 6 (Trucut)	9,800
8 × 6 (Trucut)	11,200
9 × 7 (K-K nylon)	8,800
9 × 6 (K-K nylon)	9,000
9 × 4 (K-K nylon)	12,400
8 × 6 (K-K nylon)	12,000
8 × 4 (K-K nylon)	14,400
7 × 6 (K-K nylon)	14,000
7 × 4 (K-K nylon)	16,700

P.A.W. 2·49 MARK III 2·46 c.c.



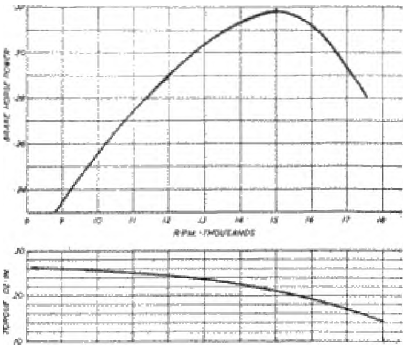
Specification

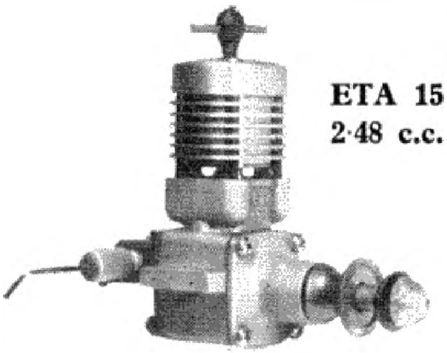
Displacement: 2·46 c.c. (·15 cu. in.)
Bore: ·595 in.
Stroke: ·535 in.
Bore/stroke ratio: 1: 1·09
Weight: 5 ounces
Max. power: ·318 B.H.P. at 15,000 r.p.m.
Max. torque: 26 ounce-inches at 9,000
Power rating: ·129 B.H.P. per c.c.
Power/weight ratio: ·0635 B.H.P. per ounce

Material Specification

Cylinder: fully heat-treated high tensile steel
Piston: Meehanite
Crankshaft: high tensile steel, fully hardened
Connecting rod: hiduminium
Bearings: Ransome & Marles ball race (rear), Meehanite bush (front)
Crankcase: light alloy gravity die-casting
Cylinder jacket: turned dural
Propeller: driver dural
Spraybar: brass

Manufacturers:
PROGRESS AERO WORKS,
Chester Road, Macclesfield
Retail price £4/18/0





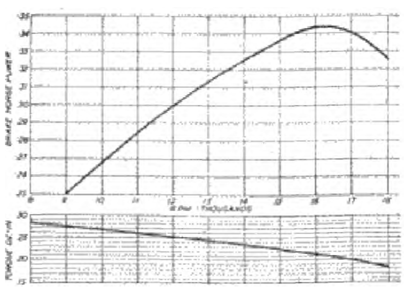
ETA 15
2·48 c.c.

Specification

Displacement: 2·48 c.c. (·15 cu. in.)
Bore: ·558 in.
Stroke: ·620 in.
Bore/stroke ratio: 1·1:1
Bare weight: 5¾ ounces
Max. power: ·345 B.H.P. at 16,000 r.p.m.
Max. torque: 28·5 ounce-inches at 8,000 r.p.m.
Power rating: ·153 B.H.P. per c.c.
Power/weight ratio: ·06 B.H.P. per ounce

PROPELLER—R.P.M. FIGURES	
Propeller dia. × pitch	*r.p.m.*
11 × 4 (Trucut)	8,800
10 × 6 (Trucut)	8,600
10 × 4 (Trucut)	9,000
9 × 6 (Trucut)	9,800
9 × 4 (Trucut)	11,900
8 × 6 (Trucut)	11,500
8 × 4 (Trucut)	15,400
10 × 6 (Frog)	9,200
9 × 6 (Frog)	10,800
8 × 4 (Frog)	14,600
9 × 6 (Keil)	9,300
9 × 4 (Keil)	13,000
8 × 6 (Keil)	12,600
8 × 4 (Keil)	15,000
7 × 6 (Keil)	18,000
9 × 5 (Stant)	10,400
9 × 4 (Stant)	11,800
11 × 4 (Top Flite)	8,600
10 × 3½ (Top Flite)	10,400
9 × 6 (Top Flite)	9,800
9 × 4 (Top Flite)	12,200
8 × 6 (Top Flite)	12,400
8 × 4 (Top Flite)	15,300

Fuel used: 50 per cent. paraffin, 30 per cent. ether, 20 per cent. castor oil, 3 per cent. amyl nitrate.



Material Specification

Crankcase: Light alloy die-casting
Front cover/bearing housing: Light alloy die-casting
Rear cover/rotor housing: Light alloy die-casting (anodised black)
Cylinder: EN.8 steel investment casting, hardened, ground and honed
Piston: Meehanite
Contra piston: Meehanite
Connecting rod: Dural
Crankshaft: 8 per cent. tungsten steel, hardened and ground
Main bearings:
⅜-in. heavy duty ball race (rear)
⅜-in. light duty ball race (front)
Propeller driver: dural (collect lock) (anodised red)
Cylinder jacket: dural, anodised light blue
Needle valve: jet and needle housing brass, nickel plated: nickel plated thimble and spring ratchet lock
Compression screw: hollow, light alloy (anodised black)

Manufacturers:
ETA INSTRUMENTS
289 High Street, Watford, Herts.
Retail price: £5/1/0 plus 18/11 P.T.

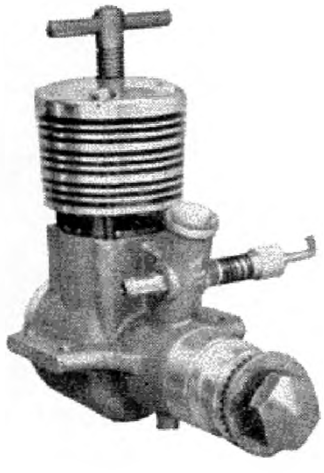
RIVERS SILVER STREAK II
2·49 c.c.

Specification

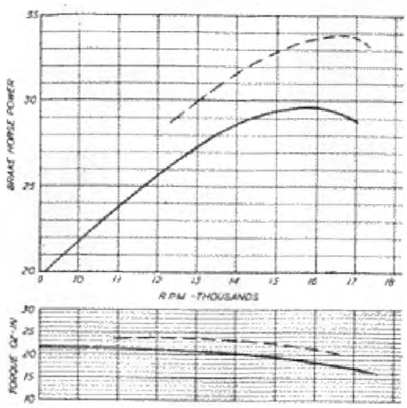
Displacement: 2·49 c.c. (·152 cu. in.)
Bore: ·5782 in.
Stroke: ·5782 in.
Max. power Mark II: ·296B. H.P at 16,000 r.p.m.
Max. power tuned version: 34 B.H.P. at 16,500 r.p.h.

Material Specification

Crankcase: light alloy gravity die-casting
Cylinder: hardened steel, stress relieved
Cylinder jacket: dural, turned



Piston: Meehanite, ground and honed
Contra-piston: Meehanite, ground and honed
Crankshaft: 85-ton steel, hardened on journals, tempered on crank pin and threaded length
Bearing sleeve: hardened steel
Bearings: rollers (sleeve and rollers forming an integral twin roller race assembly)
Connecting rod: DTD 363 dural
Spraybar assembly: brass, 4 B.A.
Propeller driver (hub): machined from dural



Manufacturers:
A. E. RIVERS (SALES) LTD.
North Feltham Trading Estate, Faggs Road Feltham, Middlesex
Retail price: Mark II standard—£6/5/8. Tuned version—£8/15/7

SUPER TIGRE G.20 D. 2·982 c.c.

Specification

Displacement: 2·982 c.c. (·1514 cu. in.)
Bore: ·591 in. (15 mm.)
Stroke: ·552 in.
Bore/stroke ratio: 1·07
Bare weight: 6 ounces
Power output: ·322 B.H.P. at 15,000 r.p.m.
Max. torque: 27·7 ounce-inches at 8,500 r.p.m.
Power rating: ·13 B.H.P. per c.c.
Power/weight ratio: ·059 B.H.P. per ounce

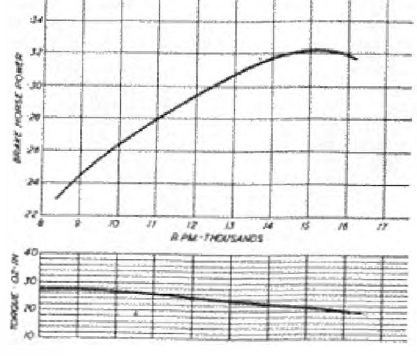
Material Specification

Crankcase: light alloy pressure die-casting
Cylinder liner: hardened steel
Contra piston: cast iron
Piston: cast iron
Connecting rod: machined from dural
Crankshaft: hardened steel, 5 mm. metric propeller shaft thread
Propeller driver: turned dural mounted on collet
Main bearings: one 10 mm. ball race (rear) one 5 mm. ball race (front)
Cylinder head: turned dural
Back cover: light alloy die-casting
Spraybar: brass—threaded steel needle screwing this internally tapped tube with external friction lock

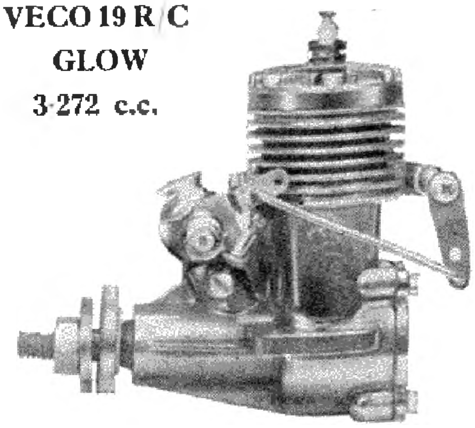
PROPELLER—R.P.M. FIGURES

Propeller dia. × pitch	*r.p.m.*
9 × 6 (Frog nylon)	11,000
8 × 4 (Frog nylon)	13,800
10 × 3½ (Top Flite nylon)	10,300
11 × 4 (Top Flite nylon)	8,400
9 × 4 (Top Flite nylon)	12,000
8 × 6 (Top Flite nylon)	12,000
8 × 4 (K-K nylon)	14,000
8 × 6 (K-K nylon)	11,700
9 × 4 (Trucut)	11,500
8 × 4 (Trucut)	14,800
7 × 9 (Trucut)	11,400
7 × 6 (Trucut)	14,000
9 × 4 (Semo nylon)	11,300
9 × 6 (Semo nylon)	10,200

Manufacturers:
MICROMECCANICS SATURNO, Bologna
Retail price: (in Italy) L.8,900. Test engine purchased ex-stock H. J. NICHOLLS LTD., £5/18/1 including P.T.



VECO 19 R/C GLOW
3·272 c.c.



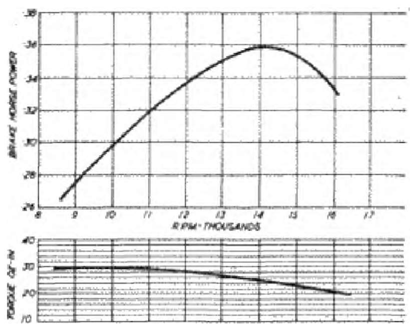
Specification

Displacement: 3·272 c.c. (·1995 cu. in.)
Bore: ·634 in.
Stroke: ·632 in.
Bore/stroke ratio: 1·0
Bare weight: 6 9/16 ounces
Max. power: ·395 B.H.P. at 14,000 r.m.p.
Max. torque: 30 ounce-inches at 9-10,000 r.p.m.
Power rating: ·11 B.H.P. per c.c.
Power/weight ratio: ·055 B.H.P. per ounce

Material Specification

Crankcase: light alloy pressure die-casting
Cylinder head: soft steel
Piston: hardened steel
Crankshaft: hardened steel
Connecting rod: light alloy pressure die-casting
Main bearing: phosphor bronze bush
Cylinder head: light alloy pressure die-casting
Glow plug: ceramic body, 1·5 volt element
Barrel throttle: light alloy and nickel plated brass
Exhaust flap: light alloy die-casting, spring loaded

Manufacturers:
VECO PRODUCTS CORP.,
Burbank, California, U.S.A.
Retail price: £6/15/0



PROPELLER—R.P.M. FIGURES	
Propeller dia. × pitch	*r.p.m.*
8 × 4 (Frog nylon)	14,400
9 × 6 (Frog nylon)	11,200
10 × 6 (Frog nylon)	9,000
10 × 3½ (Top Flite nylon)	11,000
9 × 4 (Top Flite nylon)	13,000
9 × 6 (Top Flite nylon)	10,400
9 × 4 (K-K nylon)	13,450
9 × 6 (K-K nylon)	9,600
10 × 6 (Trucut)	9,000
10 × 4 (Trucut)	10,000
9 × 4 (Trucut)	12,800
9 × 4 (Semo nylon)	11,800
9 × 6 (Semo nylon)	10,900
8 × 6 (Semo nylon)	10,900
8 × 4 (Semo nylon)	13,000

Fuel used: standard glow mixture plus 7 per cent. nitromethane

GLO-CHIEF 19
3·3 c.c.

Specification

Displacement: 3·30 c.c. (·1994 cu. m.) in.
Bore: ·640 in.
Stroke: ·620 in.
Bore/stroke ratio: 1·03
Bare weight: 6½ ounces
Max. power: ·31 B.H.P. at 13,800 r.p.m.
Max. torque: 28 ounce-inches at 9,000 r.p.m.
Power rating: ·094 B.H.P. per c.c.
Power/weight ratio: ·0505 B.H.P. per ounce

PROPELLER—R.P.M. FIGURES	
Propeller dia. × pitch	*r.p.m.*
8 × 4 (Frog nylon)	13,800
9 × 6 (Frog nylon)	10,500
8 × 4 (Top Flite nylon)	14,800
9 × 4 (Top Flite nylon)	12,200
10 × 3½ (Top Flite nylon)	10,200
8 × 4 (K-K nylon)	13,900
8 × 6 (K-K nylon)	11,800
9 × 4 (K-K nylon)	12,500
9 × 6 (K-K nylon)	9,500
9 × 6 (Semo nylon)	10,000
9 × 4 (Semo nylon)	11,200
8 × 6 (Semo nylon)	10,100

Fuel used: standard glow fuel mixture with 7 per cent. added nitromethane

Note: all performance figures related to engine run with standard intake and spraybar.

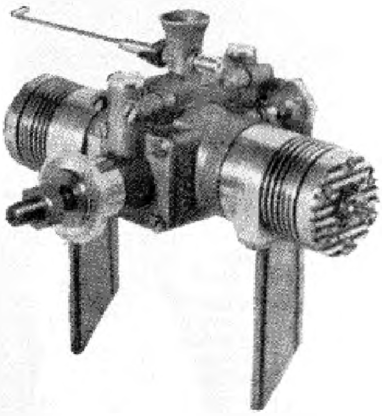
Material Specification

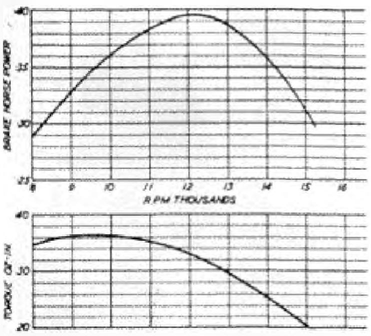
Crankcase: L.33 light alloy gravity die-casting
Cylinder: leaded steel (integral finning)
Cylinder head: turned alloy, anodised gold
Piston: Meehanite
Connecting rod: dural
Crankshaft: hardened 3 per cent. nickel-steel

Gudgeon pin: silver-steel
Propeller driver: turned dural
Backplate: turned dural
Spraybar: brass
Main bearing: cast-iron bush

Manufacturers:

GORDON BURFORD & CO. LTD.,
91 Beach Street, Grange, Australia
Retail price in Australia: Standard £A5/9/6; Two-speed £A5/19/6

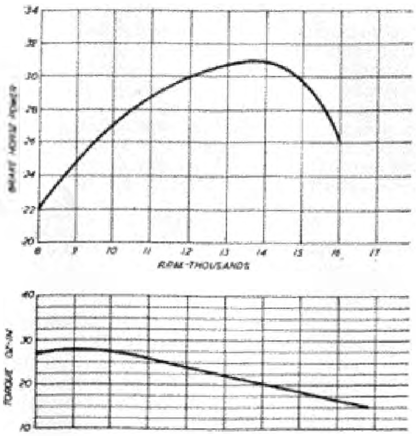




ENGINE ANALYSIS

A "potted" analysis of engines recently tested by AEROMODELLER always appears in the ANNUAL. A more extensive report dealing authoritatively with every note-worthy newcomer, or old friend in new guise is a regular monthly feature of AEROMODELLER.

An additional leaflet of interest to engine addicts is also available from AEROMODELLER PLANS SERVICE at Watford under the title of: "Engine Data Sheet" Ref. E/700. Price 2/6, which gives a précis of information on many of the engines tested by us over the past ten years.



D.C. TORNADO 5 c.c. TWIN

Specification

Bore: ·567 in.
Stroke: ·585 in.
Displacement: 4·972 c.c. (.303 cu. in.)
Weight: 10 ounces
Max. power: ·397 B.H.P. at 12,200 r.p.m.
Max. torque: 36·2 ounce-inches at 9,500 r.p.m.
Power rating: ·08 B.H.P. per c.c.
Power-weight ratio: ·04 B.H.P. per ounce

Material Specification

Crankshaft: EN.351 steel
Crankcase: LM.2 light alloy die casting
Crankcase end covers: LM.2 light alloy die castings
Piston: hardened steel
Gudgeon pin: silver steel
Cylinder liners: Leadloy (soft) steel
Cylinder jackets: aluminium)
Cylinder heads: aluminium
Radial mount: aluminium
Propeller driver: aluminium
Connecting rod: RR.56 forging)
Bearings: plain (in end covers)
Spraybar assembly: brass (steel jet needle and thimble with ratchet spring lock)
Spinner nut: aluminium

Manufacturers:

DAVIES CHARLTON LTD.
Hills Meadow, Douglas, Isle of Man
Retail price: £11/12/0 including P.T.

PROPELLER—R.P.M. FIGURES	
Propeller dia. × pitch	*r.p.m.*
12 × 4 (Trucut)	8,000
11 × 4 (Trucut	9,900
10 × 8 (Trucut)	7,500
10 × 6 (Trucut)	10,000
9 × 8 (Trucut)	7,000
9 × 6 (Trucut)	11,000
9 × 4 (Trucut)	12,800
10 × 6 (Frog nylon)	10,200
9 × 6 (Frog nylon)	12,000

Fuel used: D-C "Quickstart" Glowfuel

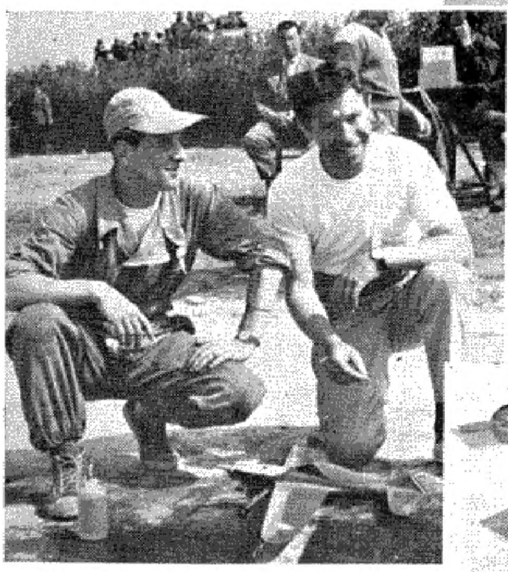
Note: bench running performance was not consistent with high-pitch propellers (8 in. pitch or greater on diameters up to 10 in.: 6 in. pitch on 11-12 in. diameters). High-pitch propellers should therefore be avoided for running-in, nor are they recommended for flying.

WORLD CONTROL LINE CHAMPIONSHIPS

Hungary, 8/11th Sept 1960

Olympics-type dais for Team Race Victors! Gordon Yeldham in Place 1, Rudi Beck of Hungary to his right in Place 2 and Klemm, Czechoslovakia in Place 3, with team members in foreground.

Right: Louis Grondal with Fox 35 in Nobler is 1960-1 World Stunt Champion. HPA is for "Herstal Petit Aviation" and cap is an A.M.A. souvenir!



Left: Team Race winners at Budapest with fastest heat time of 4:35, Leitzman and Nery Bernard.

Ugo Rossi and "New Devil" (available through A.P.S.) with Super Tigre G20 Jubilee Glow engine and pressure feed, which achieved a speed of 236 k.p.h.

1960 WORLD CONTROL LINE CHAMPIONSHIPS, Budaörs, Hungary Sept 8/11th

TEAM RACING—(Heat Times)

1.	Bernard—Lietzmann (Belgium)	6:18	**4:35**
2.	Bjork—Rosenlund (Sweden)	**4:39**	4:49
3.	**Yeldham—Taylor** (Gt. Britain)	**4:45**	—
4.	**Davy—Long** (Gt. Britain)	**4:57**	5:05
5.	Kun—Azor (Hungary)	**5:00**	5:03
6.	Beck—Frigyes (Hungary)	5:19	**5:01**
7.	Szkripcenko—Kontratenko (U.S.S.R.)	5:36	**5:03**
8.	Rossi—Stevanato (Italy)	5:46	**5:04**
9.	Klemm—Gurtler (Czechoslovakia)	**5:09**	5:51
10.	Bugl—Billes (Austria)	—	**5:18**
11.	Drazek—Trnka (Czechoslovakia)	5:24	**5:19**
12.	Macon—Grondal (Belgium)	6:07	**5:28**
13.	Szirotkin—Skurszkij (U.S.S.R.)	**5:30**	9:01
14.	Edwards—Edwards (U.S.A.)	**5:38**	6:02
15.	**Smith—Balch** (Gt. Britain)	**5:38**	6:54
16.	Veronesi—Lavazza (Italy)	**5:49**	5:53
17.	Soderberg—Rosenlund (Sweden)	—	**5:52**
18.	Simon—Kelen (Hungary)	**5:53**	5:59
19.	Roggl—Kirchert (Austria)	**6:03**	6:20
20.	Votypka—Komurka (Czechoslovakia)	6:56	**6:09**
21.	Post—Lutkat (Germany)	—	**6:12**
22.	Enquist—Kjelberg (Sweden)	6:28	**6:21**
23.	Schnorrenberg—Lenzen (Germany)	7:05	**6:23**
24.	Oswald—Malik (Germany)	—	**6:46**
25.	Paunov—Topalov (Bulgaria)	**6:50**	7:06
26.	Dolgner—Burke (U.S.A.)	**6:55**	9:30
27.	Aubertin—Follete (Monaco)	7:42	**6:56**
28.	Rosello—Fabre (France)	**7:02**	—
29.	Vlajosev—Tinev (Bulgaria)	**7:06**	7:17
30.	Cantelli—Amerio (Italy)	—	**7:10**
31.	Watts—Adams (U.S.A.)	**7:27·8**	7:31
32.	Fanica—Georgescu (Rumania)	**7:41**	7:48
33.	Bador—Souliac (France)	—	**8:22**
34.	S. Purice—F. Purice (Rumania)	9:54	**9:42**

Non-qualified:
Mircsev—Racskov, Bulgaria; Niemi—Jaaskelainen, Finland; Goyvaerts—Pierre, Belgium; Schnurer—Neusburger, Austria; Georgesou—Lupulescu, Rumania; Hoglund—Ruokalahti, Finland; Babicsev—Krasznoruckij, U.S.S.R.; Justin—Raatikainen, Finland.

TEAM RESULTS

1.	**Gt. Britain**	920	4.	Sweden	1012
2.	Hungary	954	5.	Italy	1083
3.	Czechoslovakia	997	6.	Germany	1161
			7.	U.S.A.	1200

AEROBATICS

		Total	Best Flight
1.	Grondal L. (Belgium)	2071·2	1048
2.	Still R. (U.S.A.)	2066·6	1062
3.	Palmer B. (U.S.A.)	2056·3	1040
4.	Wooley S. (U.S.A.)	2043·0	1042
5.	Dr. Egervary G. (Hungary)	1996·2	1015
6.	Lietzmann G. (Belgium)	1965·6	986
7.	Macon G. (Belgium)	1965·2	994
8.	Sirotkin (U.S.S.R.)	1963·9	989
9.	**Warburton F. L.** (Gt. Britain)	1954·2	982
10.	Compostella L. (Italy)	1952·0	1018
11.	Ordogh L. (Hungary)	1950·6	996
12.	Seeger K. (Germany)	1945·3	959
13.	Horrocks B. J. (Australia)	1931·9	985
14.	**Brown R.** (Gt. Britain)	1912·6	956
15.	Trnka J. (Czechoslovakia)	1893·9	969
16.	Doring U. (Germany)	1892·9	949
17.	Gabris J. (Czechoslovakia)	1883·9	942
18.	Herber M. (Czechoslovakia)	1859·2	939
19.	Kondratenko E. A. (U.S.S.R.)	1842·3	921
20.	Masznyik G. (Hungary)	1837·3	926
21.	Contini F. (Italy)	1819·6	921
22.	Ruokolahti P. (Finland)	1817·9	916
23.	Souliac M. (France)	1805·3	952
24.	Orsini C. (Italy)	1802·3	845
25.	Sundell O. (Finland)	1800·2	860
26.	Oswald G. (Germany)	1764·6	893
27.	Tautyko A. N. (U.S.S.R.)	1757·9	891
28.	**Day D. J.** (Gt. Britain)	1650·3	849
29.	Soderberg C. (Sweden)	1637·3	840
30.	Bador B. (France)	1574·6	787
31.	Bugl P. (Austria)	1538·6	843
32.	Rogl F. (Austria)	1434·2	732
33.	Glaser A. (Austria)	1402·2	767
34.	Raulio H. (Finland)	1245·2	669
35.	Bartoli C. (Monaco)	1230·9	715
36.	Kujawa S. (Poland)	1223·6	626
37.	Fabre L. (France)	1044·6	531
38.	Walicki J. (Poland)	996·3	526
39.	Novaro H. (Monaco)	986·6	598
40.	Csoma G. (Rumania)	941·9	488
41.	Nowakowszki J. (Poland)	825·6	462
42.	Ariton G. (Rumania)	756·9	443
43.	Silek K. (Rumania)	630·9	324

TEAM RESULTS

1.	U.S.A.	6·265·9	9.	Finland	4·863·3
2.	Belgium	6·002·0	10.	France	4·424·5
3.	Hungary	5·784·1	11.	Austria	4·375·0
4.	Czechoslovakia	5·636·7	12.	Poland	3·045·5
5.	Germany	5·602·8	13.	Rumania	2·329·7
6.	Italy	5·573·9	14.	Monaco	2·217·5
7.	U.S.S.R.	5·564·1	15.	Australia	1·931·9
8.	**Gt. Britain**	5·517·1	16.	Sweden	1·637·3

2·5 c.c. Speed (K.P.H.)

		km/h I	km/h II	km/h III
1.	Rossi U. (Italy)	219	227	**236**
2.	Wisniewski W. (U.S.A.)	**230**	219	0
3.	Pech Z. (Czechoslovakia)	213	213	**227**
4.	Nightingale J. (U.S.A.)	**227**	213	0
5.	Koci J. (Czechoslovakia)	213	213	**226**
6.	Lauderdale B. (U.S.A.)	**222**	174	204
7.	Stefano O. (Italy)	**220**	213	0
8.	Sladky J. (Czechoslovakia)	208	213	**219**
9.	Beck R. (Hungary)	**215**	208	0
10.	Rossi C. (Italy)	0	**213**	211
11.	Krizsma G. (Hungary)	**209**	208	209
12.	Natalenko V. T. (U.S.S.R.)	196	200	**204**
13.	Vasilchenko M. (U.S.S.R.)	192	**202**	200
14.	Toth I. (Hungary)	0	**202**	192
15.	Gaevsky O. K. (U.S.S.R.)	**200**	0	197
16.	Jaaskelainen K. (Finland)	0	0	**195**
17.	Kjellberg O. (Sweden)	0	181	**188**
18.	Martinelle B. (Sweden)	**180**	180	162
19.	Roselli G. (France)	0	171	**179**
20.	Ziegler G. (Germany)	**165**	**175**	0
21.	Racskov K. (Bulgaria)	162	0	**173**
22.	Vlajcsev A. (Bulgaria)	167	**171**	0
23.	Tinev S. (Bulgaria)	153	**169**	160
24.	Purice E. (Rumania)	**154**	147	135
25.	Bugl P. (Austria)	0	**154**	0
26.	Rakosi T. (Rumania)	128	134	**150**
27.	Enquist C. E. (Sweden)	0	**148**	0
28.	Marcu V. (Rumania)	0	0	**124**

TEAM RESULTS

		km/h			km/h
1.	U.S.A.	679	7.	Bulgaria	513
2.	Czechoslovakia	672	8.	Rumania	428
3.	Italy	669	9.	Finland	195
4.	Hungary	626	10.	France	179
5.	U.S.S.R.	606	11.	Germany	175
6.	Sweden	516	12.	Austria	154

Beautiful Spitfire VIII c/l model by B. F. Brown to a scale of 1½ in. to the foot, powered with ETA 29 VIc, pressure tank and full cockpit detail. Favourite for Knokke Trophy at Nats. after scale judging, but take-off performance not up to looks and it failed to leave the ground.

CONTEST RESULTS

Results of S.M.A.E. Contests for balance of 1960 season are included in this report to complete records. Those 1961 events which have been decided before going to press are also included and will be completed in next year's AEROMODELLER ANNUAL.

NORTHERN HEIGHTS GALA—June 26th, 1960—R.A.F. Halton.

Queen Elizabeth Cup—F.A.I. Power *pts.*

1 French, G.	Essex	521
2 Knight, D.	St. Albans	450
3 Mack, B.	C.M.	415

De Havilland—Open Power

1 Fuller, G.	St. Albans	5·27
2 Eggleston, B.	Baildon	5·02
3 Miller, A. M.	E.R.G.S.	4·33

Flight Cup—Open Glider

1 Simpkin, A.	Mkt. Harborough	5·06
2 Cameron, G.	Baildon	4·25
3 Thorpe, E.	Derby	4·02

Fairey Cup—Open Rubber

1 Elliott, N.	Men of Kent	6·04
2 Tubes, H.	Baildon	5·04
3 Berryman, J.		5·29

Thurston Trophy—Helicopter *pts.*

1 Poole, D.	Birmingham	260
2 Botting, R. E. A.	St. Albans	236
3 Dukes, B.	Birmingham	99

½A Contest

1 Webb, C.	Watford Wayfarers	4·37
2 Pinckert		3·22
3 Wisher, A.	Charlton	2·46

R.A.F. Review Cup—R/C Spot Landing

1 Dumble, M.	A.R.C.C.	15 ft. 4 in.
2 Miller, S. A.	Luton	28 ft. 6 in.
3 Neville, D.		41 ft. 0 in.

"AEROMODELLER" Trophy—Gala Champion

Thorpe, E. Derby

R.A.F. M.A.A. CHAMPIONSHIPS—July 2nd/3rd, 1960—R.A.F. Debden.

Victor Ludorum: Byrd, P.O.
Champion Station: R.A.F. Cranwell.

Radio Control *pts.*

1 Andrew, Flt-Lt. D.	Edinburgh U.A.S.	195
2 Goodchild, S.A.C.	Shawbury	85

Free Flight Scale

1 Fernyhough, A.C.	Weeton	57

Combat

1 Phin, S.A.C.	Cranwell	

Team Race "A"

1 Chappell, A. A.	Locking	6 : 31

Team Race "B"

1 Johnson, Major G.	Feltwell	11 : 16

F.A.I. Power

1 Channon, Sgt.	Scampton	360 + 3 : 30
2 Byrd, P.O.	Melksham	360 + 2 : 14

Open Power

1 Sharp, S.A.C.	Marham	360 + 4 : 56
2 Colling, L.A.C.	Norton	360 + 2 : 07
3 Byrd, P.O.	Melksham	360 + 1 : 51

A/2 Glider

1 Everitt, S.A.C.	Leconfield	5 : 56
2 Macmillan, S.A.C.	Colerne	5 : 45

Open Glider

1 Byrd, P.O.	Melksham	5 : 56
2 Gallagher, J.T.	Cranwell	5 : 15

Free Flight Scramble (One hour)

1 Funnell, A.A.	Halton	33 : 05
2 Byrd, P.O.	Melksham	31 : 42
3 Colling, L.A.C.	Norton	26 : 09

Wakefield (Thurston Trophy)

1 Elliott, N.	C.M.	360 + 6 : 16
2 Fuller, G.	St. Albans	360 + 4 : 27

Open Rubber

1 Anderton, S.T.	Swanton Morley	360 + 5 : 04
2 Sharp, S.A.C.	Marham	360 + 2 : 25
3 Parker, Flt-Lt.	Lindholm	360 + 2 : 15

Jetex

1 Franklin, Flt-Lt.	Cranwell	4 : 34

TWENTY-FIRST CLWYD SLOPE SOARING CONTEST—July 3rd, 1960.

Gosling Trophy *(Best time of the day)*

O'Donnell, J.	Whitefield	10 min. 32 sec.

Open

1 O'Donnell, J.	Whitefield	10 min. 32 sec.
2 Cole, J.	Surbiton	4 min. 30 sec.
3 Henshall, B.	Heswall	3 min. 57 sec.

Nordic

1 Shenton, E.	Ashton	6 min. 13 sec.
2 Cole, J.	Surbiton	4 min. 49 sec.
3 Wyatt, C.	Ashton	4 min. 2 sec.

Junior

1 Hibbert, F.	Chester	3 min. 47 sec.
2 White, A.	Chester	3 min. 34 sec.
3 Rickett, O.	Chester	2 min. 11 sec.

Radio

1 Knowles, F.	Reigate	2 points error
2 King, C.	Cambridge	5 points error
3 Mountain, J.	Kidderminster	7 points error

ENFIELD CONTROL LINE RALLY—July 10th, 1960

Class A (T/R)		
1 Smith	High Wycombe	5 : 20·6
2 Yeldham	Belfairs	5 : 21·9
3 Davy	Wharfedale	6 : 34·8
4 Long	Wharfedale	6 : 42·5
Class B (T/R)		
1 Lucas	West Essex	7 : 8·2
2 Whitbread	West Essex	8 : 9·8
3 Pasco	Thornaby	8 : 46·1
Combat		*pts.*
1 Tribe	Northwood	+ 17
2 Johns	Weston Controliners	+ 7
3 Copeman	Kenton	− 9
Stunt		*pts.*
1 Brown	Lees Bees	961
2 Day	Birmingham	950
3 Falcolner	Montrose	832

Speed—Handicap

1 Gibbs	Hornchurch (class 2)		
	200·0 k.p.h.	113·6% Handicap	
2 Stephens	Belfairs	(class 4)	
	220·8 k.p.h.	102·2% Handicap	
3 Drewell	West Essex (class 6)		
	250·0 k.p.h.	100·8% Handicap	

1960 P.A.A. RALLY—June 25th/26th, 1960—R.N.A.S. Abbotsinch

P.A.A. Load Junior Jet		
1 Parsons, R. A.	Prestwick	0 : 52
P.A.A. Load Gas		
1 Done, J.	Wallasey	7 : 42
2 Angel, R.	Wallasey	7 : 09
P.A.A. Clipper Cargo		*oz.*
1 Yates, D.	Wigan	21
2 Taylor, R.	Glasgow S.A.	8
Combat		
1 Blair, C.	S.A.S.M.C.	
U/R Glider		
1 O'Donnell, J.	Whitefield	9 : 00
2 Black, E.	Glasgow	6 : 44
U/R Rubber		
1 O'Donnell, J.	Whitefield	9 : 00 + 6 : 25
2 Owston, B.	Glasgow	9 : 00 + 5 : 10
3 Barnes, J. E.	Liverpool	9 : 00 + 4 : 56
U/R Power		
1 McPherson, I.	Glasgow	9 : 00 + 1 : 30
2 Carruthers, J.	Glasgow	9 : 00 + 0 : 00
Team Race "A"		
1 Pasco, T.	Thornaby	5 : 40
Team Race "B"		
1 Pasco, T.	Thornaby	8 : 54
Radio Control		*pts.*
1 Fraser, R.	Kirkcaldy	2359

AREA CENTRALISED—July 24th, 1960
Flight Cup (unrestricted Rubber) (70 *entries, five returned no score*)

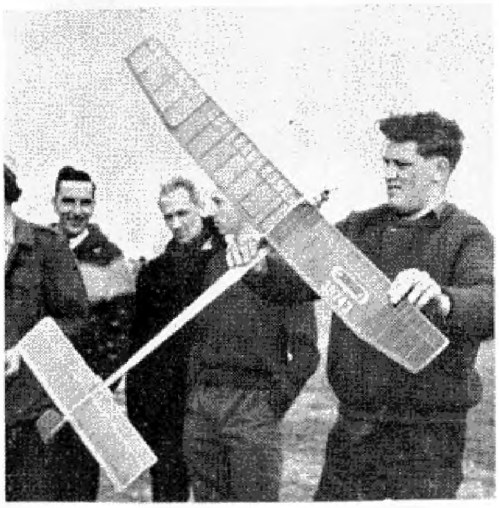
1 Turner, M.	Cheadle	12·00 + 5·02
2 Poole, D.	Birmingham	12·00 + 4·53
3 Wisher, A.	Croydon	12·00 + 4·09
4 Greave, D.	Leamington	12·00 + 3·12
5 Fuller, G.	St. Albans	11·55
6 O'Donnell, J.	Whitefield	11·20

AREA CENTRALISED—July 24th, 1960—Team Glider
Model Engineer Cup (Team Glider) (58 *competing teams*)

1 Cheadle	28·57
2 Baildon	25·21
3 Birmingham	24·47
4 Bournemouth	24·15
5 English Electric	24·12
6 Timperley	23·42

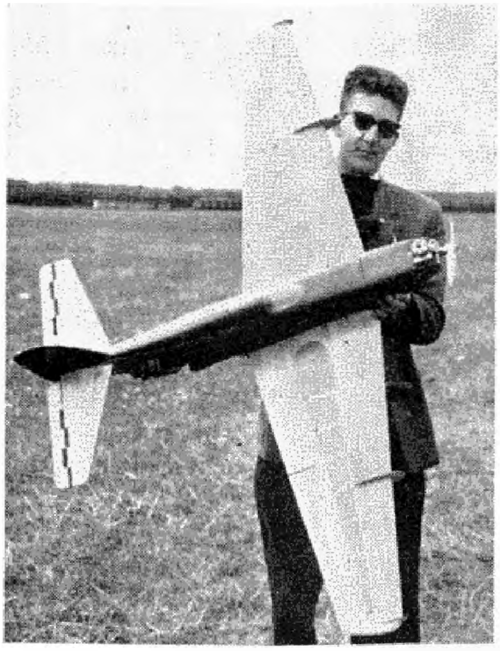
WAKEFIELD & A/2 PRACTICE TRIALS—July 16th/17th, 1960—R.A.F. Wigsley

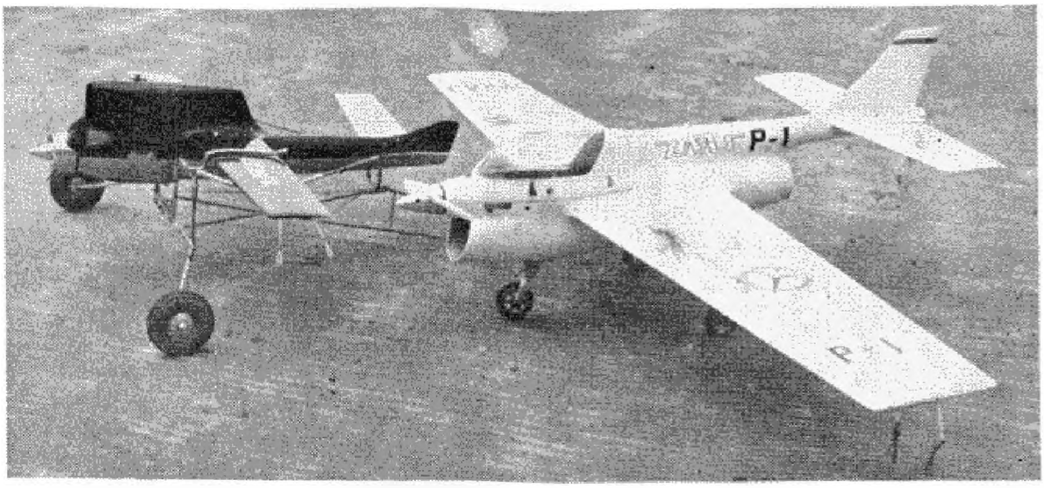
Wakefield—(20 *entries*)		
1 Greaves, D.	Leamington	13 : 44
2 Tubbs, H.	Baildon	11 : 30
3 Roberts, G. L.	Lincoln	10 : 58
4 Latter, D.	C.M.	9 : 19
5 Boxall, F. H.	Brighton	9 : 18
A/2 (27 *entries*)		
1 Tyrell, B. L.	C.M.	11 : 12
2 Lawson, P.	Baildon	11 : 08
3 Robinson, A. M.	Tees-side	10 : 53
4 Billings, D.		10 : 40
5 O'Donnell, J.	Whitefield	10 : 05
6 West, J.	Brighton	10 : 04



Al Wisher of Croydon with ½A Cox Thermal Hopper model which reached fly-off stage in Nationals F/F Power event.

Paul Rogers with his unusual r/c model, note wingfences. Dekatone r/c, Super Tigre 51 power. Only "Dad" is missing to complete this well-known father-and-son team.





Ex-Hungarian modeller Paul Pomadi of Nuneaton built the elegant ETA 15 powered "ducted" Dolphin teamracer of fibreglass construction. Speed model is for ETA 29.

MODEL ENGINEER CUP (Team Glider)—July 24th, 1960. *Area centralised.* (58 *teams*)

1	Cheadle	28 : 57
2	Baildon...	25 : 21
3	Birmingham	24 : 47
4	Bournemouth ...	24 : 15
5	English Electric	24 : 12
6	Timperley	23 : 42

FLIGHT CUP (U/R Rubber)—July 24th, 1960. *Area centralised* (70 *entries*)

1	Turner, M.	Cheadle	12 : 00 + 5 : 02
2	Poole, D.	Birmingham	12 : 00 + 4 : 43
3	Wisher, A.	Croydon	12 : 00 + 4 : 09
4	Greaves, D.	Leamington	12 : 00 + 3 : 12
5	Fuller, G.		11 : 55
6	O'Donnell, J.	Whitefield	11 : 20

DEVON RALLY—August 14th—Woodbury Common, Exmouth

Power			
1	Young, A.	St. Albans	9·00
2	Manville, P.	Bournemouth	8·22
3	Manville, J.	Bournemouth	4·37
Rubber			
1	Wisher, A.	Croydon	9·00
2	Leppard, R.	Croydon	7·39
3	Morgan, S.	Cardiff	6·21
Glider			
1	Flaherty, R.	Cardiff	8·26
2	Leppard, R.	Croydon	7·53
3	Manville, P.	Bournemouth	7·14
Radio Control Multi			*pts.*
1	Johnson, E.	A.R.C.C.	1,208
2	Singleton, J.	A.R.C.C.	1,195
3	Waters, P.	Port Talbot	638
Radio Control Single			*pts.*
1	Wear, B.	S.W.R.C. FS.	26
2	Simmonds, C.	Bournemouth	22
3	Peacock, G.		4
Combat			
1	Hitchcock, J.	West Hants	
2	Witts, A.	West Hants	

SIDCUP CONTROL LINE RALLY—August 14th, 1960

A T/R				
1	Balch, D.	Hayes	5 miles	5 : 5
2	Cornell, G.	Croydon		5 20
F.A.I. T/R				
1	Smith, M.	High Wycombe	10 km.	5 : 7
2	Dew, D.	Ecurie Endeavour		5 : 21·4
B T/R				
1	Taylor, C.	West Essex	10 miles	7 : 13
2	Tuthill/Walker	Enfield		7 : 16
Combat				
1	Tribe	Northwood		
2	March	Dagenham		
Stunt				
1	Brown, R.	Lees Bees		
2	Day, D.	Birmingham		

AREA CHAMPIONSHIPS (Rubber, Glider, Power)—August 21st, 1960—R.A.F. Wigsley

1	Midland area ...	Total 102 : 12
2	Northern area ...	Total 91 : 06
3	North Western	Total 89 : 21
4	East Midland area	Total 81 : 50
5	South Midland area ...	Total 81 : 38

NORTHERN GALA—September 4th, 1960—R.A.F. Rufforth

Caton Trophy (U/R Rubber) (63 *entries*)			
1	Poole, D.	Birmingham	12·00 + 7·32
2	Tubbs, H.	Baildon	12·00 + 6·46
3	Wannop, U. A.	C.M.	12·00 + 6·33
4	Roberts, G. L.	Lincoln	12·00 + 6·03
5	Picken, B.	Wigan	12·00 + 5·54
6	Elliott, N.	C.M.	12·00 + 5·47
7	O'Donnell, J.	Whitefield	12·00 + 5·25
8	Pollard, R. C.	Tynemouth	12·00 + 4·54
9	Turner, M.	Cheadle	12·00 + 3·56
10	Lennox, R.	Birmingham	12·00
U/R Glider (103 *entries*)			
1	Cameron, G.	Baildon	9·00 + 2·10
2	Proctor M. (Jnr.)	Baildon	9·00 + 1·37
3	Hutton, G. M.	Wallasey	8·42
	Carter, N. (Jnr.)	Cheadle	8·42
Hamley Trophy (U/R Power) (107 *entries*)			
1	Smith, T. W.	English Electric	12·00 + 6·10
2	Castell, G.	Letchworth	12·00 + 5·05
3	Eggleston, B.	Baildon	12·00 + 4·42
4	Gray, B.	Wakefield	12·00 + 4·23
5	Illsley, D.	Birmingham	12·00 + 4·08
6	Spurr, A. W.	Tees-side	11·58
P.A.A. Load. (15 *entries*)			
1	Collinson, A.	Baildon	4·53
2	Muller, P.	Surbiton	3·55
3	Farrar, A.	Wakefield	3·40

Aeromodeller Trophy (Multi R/C)

		pts.
1 Olsen, C. H.	C.M.	4,146
2 Fraser, R.	Kirkcaldy	317·5

U.K. Challenge Match. *(England beat Scotland by two points)*

	Scotland	**England**
Rubber:	35·27	45·15
Glider:	27·03	21·10
Power:	28·35	41·31
Class ½A		
1 Nixon, D. W.	Hinckley	10 : 20·8
2 Sleight, R.	Hayes	12 : 38·5
3 Laurie, A.	Novocastria	13 : 28·7
4 Norton	Chorlton	15 : 6·2
Class A (T/R)		
1 Haley, Bill	Thornaby	6 : 4·2
2 Pasco, Tom	Thornaby	6 : 26·5
3 Wallace, A.	Stanley	6 : 49·9
Class B (T/R)		
1 Haley, Bill	Thornaby	8 : 15
2 Watson, John K.	Thornaby	8 : 48·2
3 Orewell, P.	West Essex	9 : 2·2
4 Bowden, J.	Chorlton	10 : 7·5
Best Heat Times. *(Semi-final.)*		
½A Nixon, D. W.	Hinckley	4 : 38·4
A Watson, John K.	Thornaby	5 : 12·0
B Drewell, P.	West Essex	3 : 21·2

SOUTH MIDLAND RALLY—August 28th, 1960—Cranfield

Power		
Fuller, G.	St. Albans	9 : 00 + 6 : 21
French, G.	Essex	9 : 00 + 6 : 00
Sleight	Hayes	9 : 00 + 5 : 42
½A Power		
Bishop	Small Heath	8 : 05
French, G.	Essex	8 : 04
Newall, P.	Woking	7 : 01
"B" T/R		
Taylor, C.	West Essex	6 : 48
Drewell, P.	West Essex	6 : 54
Walker	Enfield	7 : 08
Combat		
Tribe, P.	Northwood	
Pratt, R.	Northwood	
R/C Multi		*pts.*
Olsen, C.	C.M..	1459
Rogers, P.	A.R.C.C.	1427
Johnson, E.	A.R.C.C.	1047
Glider		
Ferror, G.	N. Heights	9 : 00
Wright, J.	Peterborough	8 : 50
Eccles, C.	Croydon	8 : 42
Rubber		
Thorpe, E.	Derby	9 : 00 + 7 : 05
Barnes, J.	Liverpool	9 : 00 + 6 : 01
Robert, G.	Lincoln	9 : 00 + 5 : 45
"A" T/R		
Bassett, M.	Endeavour	5 : 08
Nixon, D.	Hinckley	5 : 24
Rivers, G.	Hayes	——
Stunt		*pts.*
Warburton, F.	Bolton	1134
Christopher, D.	Weston	1123
Davy, D.	Birmingham	1121
R/C Single		*pts.*
Wood, B.	North London	46·5
Marsh, G.	Sutton Coldfield	46·5
Dumble, J.	West Essex	45·5
Chuck Glider		
Burrow, M.	St. Albans	2 : 48

INTERNATIONAL TAILLESS—September 17th/18th 1960—Terlet, Holland

Glider		
1 Osborne, J.	Holland	483
2 Zwilling, W.	Germany	450
3 Fiks, G.	Holland	366
4 Hack, W.	Germany	329
5 Kool, P.	Holland	276
6 Wilke, K.	Germany	243
7 ten Hagen, G.	Holland	195
Power		
1 Langfet, W.	Germany	444
2 Wehmann, L.	Germany	423
3 Wassenaar, W.	Holland	331
Rubber		
1 Schenk, H.	Germany	431

One of modeldom's "characters" S/Tech. Andy Anderson piles on the turns of his unmatched tip wings rubber entry at the Nats. Sorry we cannot also show his recovery transport!

"Fuel Baron" R. Lucas of West Essex Aeromodellers with fast "B" Team racer. With 110 m.p.h. plus, 7 min. is regularly beaten in finals by this type of entry in the right hands.

SOUTH COAST GALA—September 27th, 1960—R.A.F. Tangmere

"A" Team Race (28 *entries*)

1 Smith, M.	High Wycombe	4 min. 39 sec.
2 Yeldham, G.	Belfairs	5 min. 12 sec.

Combat (39 *entries*)

1 Tribe, P.	Northwood
2 Copeman, G.	Kenton

Open Glider (76 *entries*)

1 Baguley, J.	Hayes	8 : 32
2 Hinds, S.	Wallasey	7 : 06
3 Bird, G.	R.A.F. Melksham	7 : 03

Open Power (55 *entries*) (12 in fly-off)

1 Posner, D.	Surbiton	9 : 00 + 6 : 00
2 Young, A.	St. Albans	9 : 00 + 5 : 12
3 Fuller, G.	St. Albans	9 : 00 + 5 : 03

Open Rubber (31 *entries*) (10 in fly-off)

1 North, R.	Croydon	9 : 00 + 5 : 40
2 Boxall, F.	Brighton	9 : 00 + 5 : 35
3 Elliott, N.	C.M.	9 : 00 + 5 : 01

Tailless Glider (8 *entries*)

1 Marshall, J.	Hayes	5 : 18
2 Gates, G.	Southern Cross	3 : 57
3 Kay, J.	Hayes	2 : 53

½A Power (16 *entries*)

1 Young, A.	St. Albans	8 : 22
2 French, G.	Essex	8 : 03
3 North, R.	Croydon	7 : 30

Radio Control (13 *entries*)

	pts.
1 Rogers, P.	2833
2 Johnson, E.	2814
3 Morton, J.	1246

Chuck Glider (14 *entries*)

1 Fathers, A.	Abingdon	2 : 12
2 Young, A.	St. Albans	2 : 00
3 Strachan, W.	Exmouth	1 : 30

FARROW SHIELD (Team Rubber)—October 9th, 1960. *Area centralised.* (16 *clubs entered.*)

1 Leamington	34 : 41	4 St. Albans	25 : 24
2 Norwich	30 : 08	5 Stevenage	24 : 4
3 Essex	29 : 19	6 Baildon	16 : 42

Individual scores

1 Pressnell, M.	Essex	10 : 09
2 Wiggins, E.	Leamington	9 : 55
3 Anderton, A.	Norwich	9 : 42
4 Hains, M. J.	Stevenage	9 : 21
5 Barnacle, E.	Leamington	9 : 15
6 Willis, N.	Essex	8 : 56

Plugge Cup (*Final placings*)

	pts.
1 St. Albans	1336·88
2 Baildon	1222·927
3 Essex	1201·018

TEAM RACING—October 9th, 1960. *Area centralised.*

½A. (22 *entries*)

1 Cornell, G.	Croydon	10 : 06·2
2 Bassett, D. M.	Ecurie End	11 : 27·5
3 Feilder, G.	Croydon	12 : 23·3

F.A.I. (28 *entries*)

1 Smith, N.	Hayes	4 : 47·2
2 Rivers, G.	Hayes	4 : 47·8
3 Long, K.	Wharfedale	4 : 55

B (13 *entries*)

1 Steward/Taylor	West Essex	7 : 08·6
2 Drewell, P.	West Essex	8 : 26·6
3 Harris, B.	Prestwick	8 : 49

FROG SENIOR CUP (U/R Power)—October 16th, 1960. *Decentralised.* (130 *entries*) (20 in fly-off)

1 Smith, T. W.	Eng. Elec.	12 : 00 + 8 : 10
2 Carter, A.	Liverpool	12 : 00 + 7 : 45
3 Knight, D.	St. Albans	12 : 00 + 7 : 29
4 Buskell, P.	Surbiton	12 : 00 + 7 : 00
5 Ambrose, N.	Ipswich	12 : 00 + 6 : 11
6 Castell, G.	Letchworth	12 : 00 + 5 : 50

Senior Champion

O'Donnell, J. Whitefield. Total time 206 min. 2 sec

Junior Champion

Birks, J. Chorlton. Total time 62 min. 18 sec.

C.M.A. CUP (U/R Glider)—October 16th, 1960. *Decentralised.* (166 *entries*)

1 Allsop, C. M.	C.M.	9 : 00 + 6 : 35
2 Crisp, A. J.	Abingdon	9 : 00 + 6 : 06
3 Barr, L.	Hayes	9 : 00 + 3 : 00
4 Rabjohns, G. W.	Southern Cross	9 : 00 + 2 : 20
5 Wyatt, C.	Ashton	8 : 58
6 Tyrell, B.	C.M.	8 : 54

EAST LANCS. M.A.C. WINTER RALLY—January 15th, 1961—Walton Spire, Lancs.

Rubber

1 Wisher, A.	Croydon	9 : 00 + 3 : 10
2 North, J.	Croydon	7 : 20
3 O'Donnell, J.	Whitefield	7 : 17

Power

1 Manville, P.	Bournemouth	9 : 00
2 Garnett, —.	East Lancs.	7 : 43
3 Shaw, J.	Oldham	7 : 43
4 Bailey, J. D.	Whitefield	6 : 37

Glider

1 O'Donnell, J.	Whitefield	8 : 41
2 Chadwich, J.	Ashton	8 : 09
3 Verity, P.	East Lancs.	7 : 06

Radio

1 Whittaker	Cheadle
2 Donahue	Kersal

Chuck Glider

1 Young, A.	St. Albans	3 : 25
2 Yates, D.	Wigan	1 : 42·5

GAMAGE CUP (Unrestricted Rubber)—March 5th, 1961. *Decentralised.* (78 *entries*)

1 Wharrie, A.	Norwich	12 : 00 + 9 : 03
2 Tideswell, G.	Baildon	12 : 00 + 6 : 15
3 Lennox, R.	Birmingham	12 : 00 + 5 : 59
4 Poole, D.	Birmingham	12 : 00 + 5 : 13
5 Thorbon, B.	St. Albans	12 : 00 + 5 : 02
6 North, J.	Croydon	12 : 00 + 3 : 38
7 Thorpe, E.	Derby	12 : 00 + 2 : 51
8 Leppard, R.	Croydon	12 : 00 + 2 : 39
9 Greaves, D.	Leamington	12 : 00 + 2 : 39
10 Barnes, J.	Liverpool	11 : 47
11 Amor, R.	Essex	11 : 46
12 O'Donnell, J.	Whitefield	11 : 31
13 Crossley, P.	Blackheath	11 : 30
14 Anderton, A.	Norwich R.A.F.	11 : 26
15 Nelson, W.	Sheffield	11 : 26

PILCHER CUP (**Unrestricted Glider**)—**March 5th, 1961.** *Decentralised.* (163 *ntries*)

1	Jackson, R.	Littleover	9 : 00 + 4 : 20
2	Crisp, A.	Abingdon	9 : 00 + 3 : 55
3	Laxton, D.	C.M.	9 : 00 + 2 : 50
4	Aitkenhead	Clevum	9 : 00 + 2 : 20
5	Young, F.	Birmingham	9 : 00 + 2 : 15
6	Richards, C.	Hayes	9 : 00 + 1 : 15
7	Simpkin, A.	Market Harborough	9 : 00 + 0 : 56
8	Tootell, W.	R.A.F.	9 : 00
9	Illsley, D.	Birmingham	8 : 57
10	Lavender, B.	Brentwood	8 : 55
11	Flaherty, R.	Cardiff	8 : 42
12	Birks, J.	Chorlton	8 : 41

WHITE CUP (**Unrestricted Power**)—**March 5th, 1961.** *Decentralised.* (120 *entries*)

1	Petty C.	Walsall	12 : 00 + 12 : 50
2	Monks, R.	Birmingham	12 : 00 + 6 : 48
3	Simeons	St. Albans	12 : 00 + 6 : 46
4	Thorpe, E.	Derby	12 : 00 + 5 : 17
5	Miller, D.	Cambridge	12 : 00 + 5 : 02
6	West, J.	Brighton	12 : 00 + 4 : 25
7	Draper, R.	Coventry	12 : 00 + 4 : 05
8	Ambrose, N.	Ipswich	12 : 00 + 3 : 57
9	Penberton, P.	Abingdon	12 : 00 + 3 : 35
10	Spurr, A.	Tees-side	12 : 00 + 3 : 35
11	Posner, D.	Surbiton	12 : 00 + 3 : 16
12	Savini, S.	Liverpool	12 : 00
13	Crisp, A.	Abingdon	11 : 57
14	Fuller, G.	St. Albans	11 : 41
15	Male, J.	Portsmouth	11 : 40
16	Lowe, G.	Liverpool	11 : 36
17	King, C.	Cambridge	11 : 35
18	Glazin, J.	Ipswich	11 : 34
19	Petrie, D.	E. Montrose	11 : 32
20	French, G.	Essex	11 : 32

GUTTERIDGE TROPHY (**First Wakefield Eliminator**)—**March 19th, 1961.** *Area centralised.* (47 *entries*)

1	Robert, G.	Lincoln	14 : 04
2	Monks, R.	Birmingham	12 : 47
3	Nicholson	Canterbury	12 : 35
4	Poole, D.	Birmingham	12 : 02
5	Lefever, G.	C.M.	11 : 39
6	Chambers, T.	Tees-side	11 : 33

K.M.A.A. CUP (**First A/2 Eliminator**)—**March 19th, 1961.** *Area centralised.* (206 *entries*)

1	Dallimer, G.	Stevenage	13 : 08
2	Hinds, S.	Wallasey	12 : 58
3	Henshall, B.	Heswall	12 : 38
4	Challen, T.	Northern Heights	12 : 26
5	Burrows	St. Albans	12 : 05
6	Wiggins, E.	Leamington	11 : 49

BRITISH NATIONAL CHAMPIONSHIPS—May 21st/22nd, 1961—R.A.F. Barkston Heath

Speed (**F.A.I. Class 2 5 c.c. Standard Fuel**)

			m.p.h
1	Tribe, P./Copeman, G.		108
2	Drewell, P.	W.E.A.	106·5
3	Jays, V.	Surbiton	99·9

Class 2 (**5 c.c.**)

1	Johnson, G.	F.A.S.T.E.	144·3
2	Hall, J.	Belfairs	143·4
3	Taylor, R.	Brixton	140·7

Class 3 (**10 c.c.**)

1	Gibbs, R.	Brixton	162
2	Johnson, G.	F.A.S.T.E.	160·9
3	Drewell, P.	W.E.A.	159·7

Combat

Semi-Finals:

Healey, P. (Weston)/Kendrick, M. (W. Bromwich)

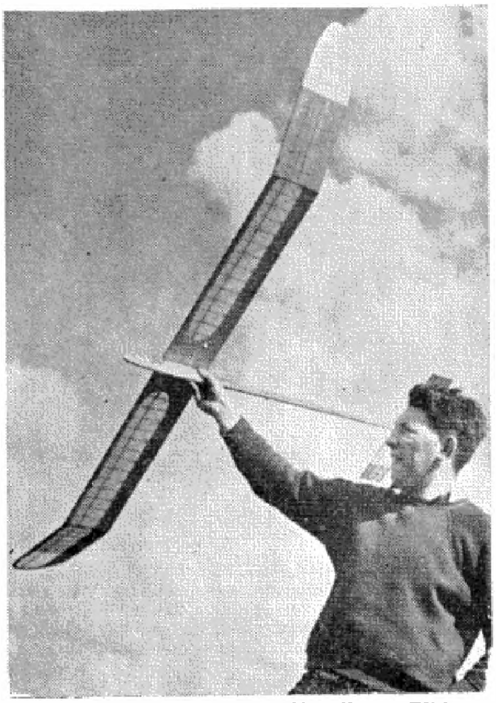
Benoy, J. (Kenton)/John, J. (Weston)

Finals:

Benoy, J. beat Healey, P.

Knokke Trophy (**C/L flying scale**)

			pts.
1	Day, A. C. *Fokker DVII*	West Bromwich	86



Ray Monks "Modeller of the Year" won Glider at the Nats. with his latest A/2 featuring flexible wings for good tow characteristics

Dave Day of Wolves with "Pedagogue" Gold Trophy entry (6th). Powered Merco 35, finished black, and — appropriately — Dayglo orange letters.

2	Wheldon, P. *Aichi* 99 "*Val*"	Blackheath & Halesowen	84
3	Nelson, D. D. *Ta 152H*	Derby C/L	82
4	Perry, S. B. *Hawker Fury*	Clevum	78
5	Noble, A. *Boeing F4B-4*	Leicester	72
6	Hemmings, J. *D.H. 88 Comet*	Blackheath & Halesowen	72
6	Hawkins, Dr. M. F. *Ta 152H*	C.M.	72

Thurston Cup (Open Glider)

1	Monks, R.	Birmingham	9 : 00 + 5 : 15
2	Carter, M.	Chorlton	9 : 00 + 2 : 52
3	Freeston, G.	Sheffield	9 : 00 + 1 : 20
4	Laxton, D.	C.M.	9 : 00 + 0 : 58
5	Wells, A.	Hornchurch	8 : 57
6	Francis, P.	Peterborough	8 : 45

Super Scale Trophy (Free Flight Scale)

			pts.
1	Simmance, J. *Sopwith Snipe*	Northwood	94
2	Bridgwood, J. *Stinson L-1 Vigilant*	Doncaster	93
3	Evans, A. W. *Savoia Marchetti* 55	Mill Hill	89

R.A.F. M.A.A. Trophy (½A Team Race)

			10 miles Final	5 miles heat
1	Atkinson, J.	Debdenairs	9 : 00	4 : 27
2	Calvert, A.	Feltham	9 : 00	4 : 32
3	Ellis, M.	Hinckley	9 : 20	4 : 45
4	Cornell, G.	Croydon	9 : 45	4 : 35

Davies "A" Trophy (F.A.I. Team Race)

			Final	Fastest Heat
1	Long, K.	Wharfedale	4 : 52·5	4 : 48
2	Edmonds, R.	High Wycombe	5 : 02	4 : 41
3	Hall, J.	Belfairs	5 : 03·1	4 : 43

Davies "B" Trophy (5 c.c. Team Race)

1	Yeldham, G.	Belfairs	6 : 42
2	Lucas, R. E.	West Essex	7 : 17
3	McNess, J.	West Essex	7 : 36

Gold Trophy (Control Line Aerobatics)

			pts.
1	Horrocks, B.	Wolves	579
2	Brown, R. E.	Lee Bees	548
3	Warburton, F.	Bolton	547
4	Christopher, D.	Weston	541
5	Jolley, T.	Whitefield	524
6	Day, D.	Wolves	501

Lady Shelley Cup (Free Flight Tailless)

1	James, H.	Maidenhead	5 : 58
2	Moore, L.	C.M.	5 : 06
3	Mutch, G.	Heswell	4 : 52

Short Cup (Payload)

1	Fuller, G.	St. Albans	8 : 00
2	O'Donnell, J.	Whitefield	7 : 26
3	Knight, D.	St. Albans	7 : 11
4	Glynn, K.	Surbiton	5 : 45
5	Swinden, R.	Tees-side	4 : 37
6	Mussell, A.	Farnham	3 : 18

Sir John Shelley (Open Power)

Following made 12 min.

			Fly off times
1	Monks, R.	Birmingham	11 : 58
2	McClave, K.	East Lancs.	9 : 37
3	Smith, T.	English Electric	7 : 27
4	Lee, W.	Novocastria	6 : 07
5	Wisher, A.	Croydon	5 : 24
6	Spurr, A.	Tees-side	4 : 23
7	Morgan, S.	Cardiff	3 : 36·5
8	Cook, D.	Canterbury Pilgrims	3 : 17
9	Dilley, M.	Croydon	3 : 15
10	Bickerstaff, J.	Rugby	1 : 33
11	Picken, B.	Wigan	Overrun
12	Gray, R. B.	Baildon	Did not fly

Model Aircraft (Open Rubber)

Following made 12 min.

			Fly off times
1	Turner, J.	Chorlton	9 : 10
2	Barr, L.	Hayes	9 : 01
3	Roberts, G.	Lincoln	8 : 10
4	Harris, J.	Blackheath	7 : 55
5	Leppard, R.	Croydon	7 : 28
6	Morley, D.	Lincoln	6 : 28
7	Boxall, F.	Brighton	6 : 21
8	Elliott, N.	Croydon	4 : 30
9	Poole, D.	Birmingham	3 : 42
10	Anderton, A.	R.A.F. M.A.A.	3 : 37
11	Clampitt, J.	Bristol Aces	2 : 59
12	Brownson, R.	Timperley	1 : 46

S.M.A.E. CUP (Multi R/C)

			Tota
1	Van den Bergh, F.	Bromley	3808·75
2	Olsen, C.	A.R.C.C.	3368·00
3	Rogers, P.	High Wycombe	3214·00
4	Johnson, E.	A.R.C.C.	3064·00
5	Walters, P.	Port Talbot	2439·5
6	Singleton, J.	A.R.C.C.	2411·5

INDOOR TEAM TRIALS—July 9th, 1961 (World Championships Team Trials) Cardington, Beds.

1	Read, P.	Birmingham	94 : 02
2	Draper, R.	Coventry	88 : 40
3	Parham, R.	C.M.	85 : 48
4	Monks, R.	Birmingham	81 : 30
5	Barr, A.	Coventry	61 : 15
6	Wade, S.	C.M.	61 : 04

WOMEN'S CUP—April 9th, 1961 Unrestricted Rubber Glider *Area decentralised. (12 entries)*

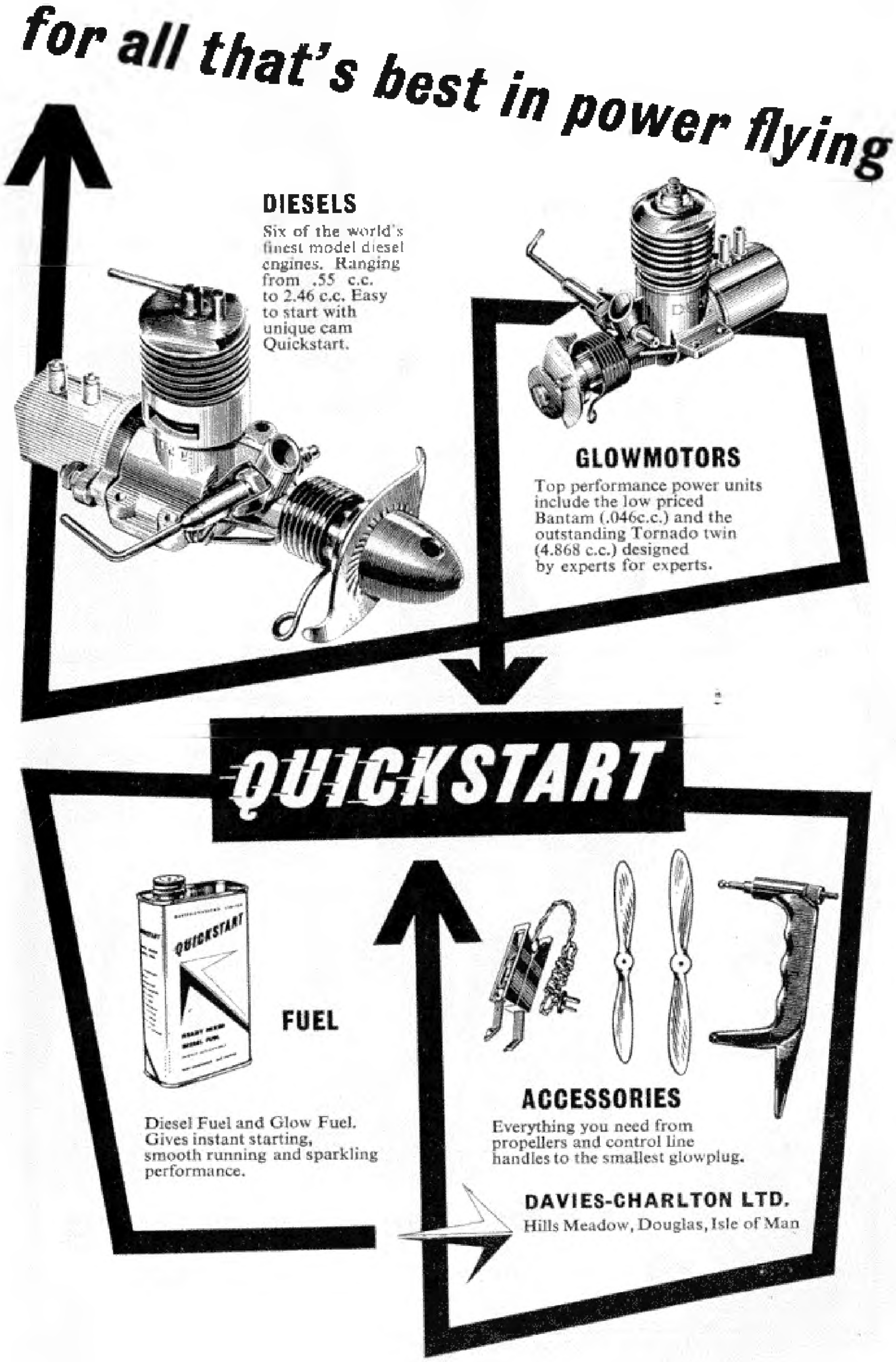
1	Giggle, M. Mrs.	C.M.	5 : 57
2	Picken, B. Mrs.	Wigan	5 : 52
3	Scott, G. Mrs.	English Electric	5 : 18
4	Roberts, G. Mrs.	Five Towns	4 : 16
5	Allsopp, S. Miss	Cambridge	4 : 09
6	Glynn, B. Mrs.	Surbiton	3 : 58
7	Mosedale, Y. Miss	Essex	3 : 13
8	Filtness, M. Mrs.	Chester	3 : 00
9	King, P. Mrs.	Essex	1 : 25
10	Willis, S. Mrs.	Essex	0 : 27

S.M.A.E. CUP—April 6th, 9161. F.A.I. Glider Eliminator. *Area decentralised. (173 entries)*

1	Harper, D.	Glevum	14 : 21
2	Cook, D.	Canterbury	13 : 51
3	Halford, B.	Norwich	13 : 34
4	Boxall, F.	Brighton	12 : 54
5	Partridge, D.	Croydon	12 : 52
6	Hiscock, F/O	R.A.F. Melksham	12 : 51
7	Sleight	Hayes	12 : 49
8	Spencer, B.	Chorlton	12 : 47
9	Oliver, K.	Foresters	12 : 35
10	Cooper, B.	N. Heights	12 : 12
11	Bryd, G.	Melksham	12 : 09
12	Jackson, C.	Surbiton	12 : 05

JETEX TROPHY—April 9th, 1961. Jetex. *Area decentralised (14 entries)*

1	Donnell, J.	Whitefield	37 : 35
2	Wiggins, E.	Leamington	18 : 21
3	Smeed, S.	Surbiton	16 : 60
4	Dowling, B.	Watford W.	11 : 80
5	Kent, G.	Watford W.	11 : 76
6	Pressnell, M.	Essex	7 : 79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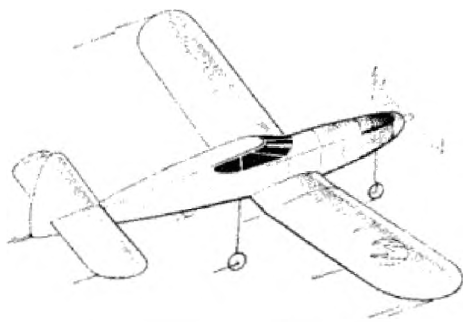

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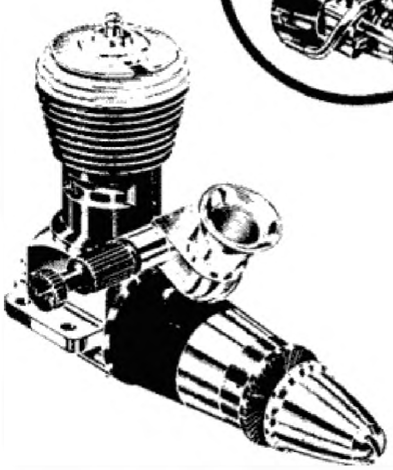

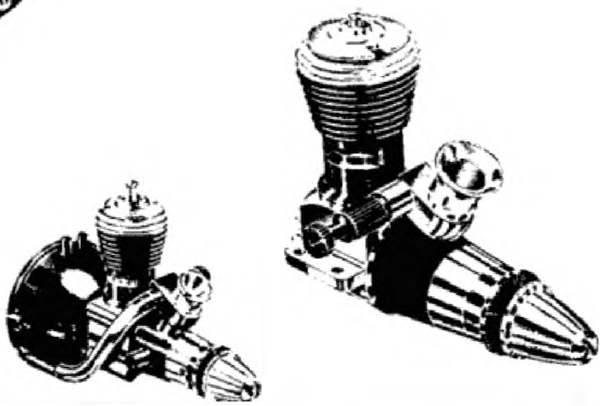

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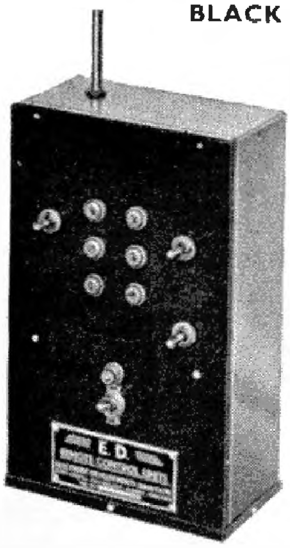

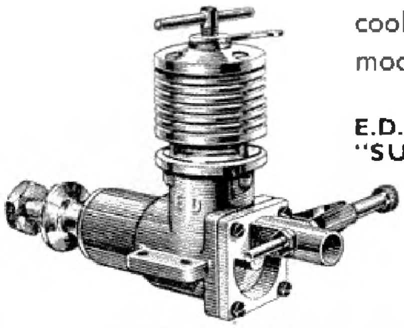

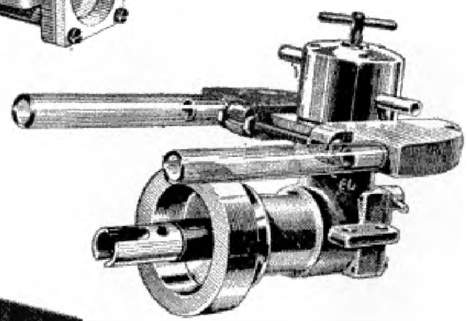

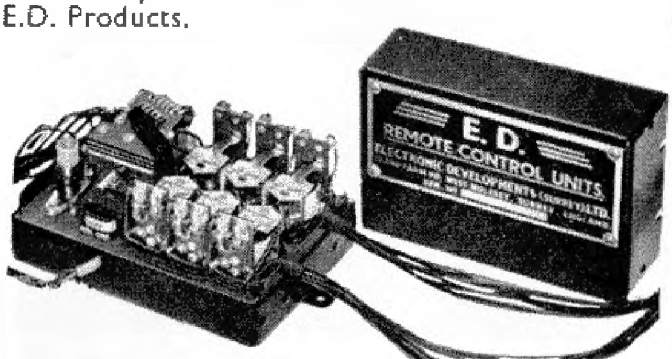
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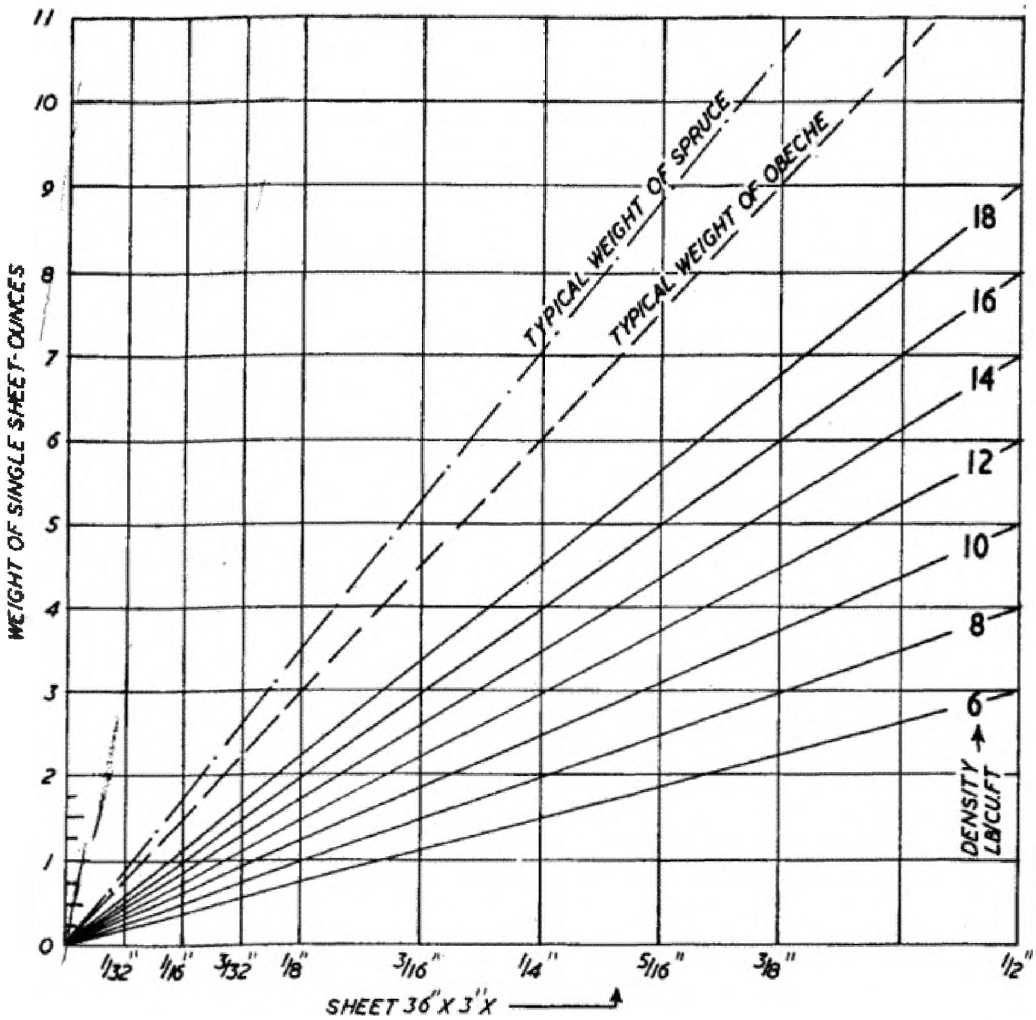

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