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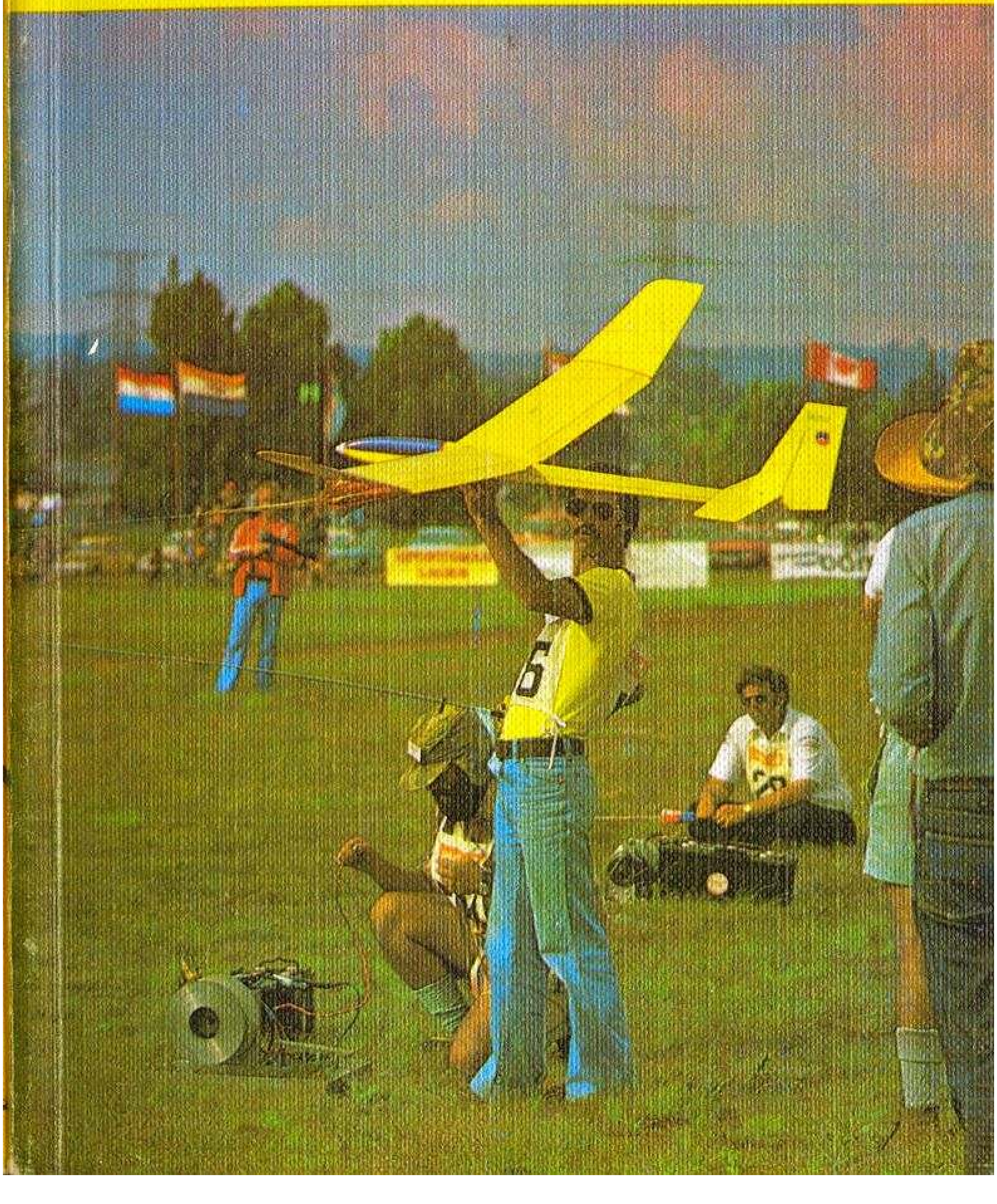
Aero Modeller Annual 1977~78



AEROMODELLER ANNUAL 1977–78

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

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A. A. P. Lloyd

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INTRODUCTION

ON THIS SAME page in the 1974 edition of the *Aeromodeller Annual*, we concluded with the remark "Their skills are well known (referring to the Russians) but the 1974 Soviet International in East Germany saw North Koreans almost sweep the board, a foretaste for exciting 1975." Well, we don't have to over-emphasise what happened in 1975 at the Free Flight World Championships and now we report for 1977 absolute confirmation that the North Koreans are capable of sweeping the board completely. Surely, it should not be long before this emergent nation in the aeromodelling world makes its own bid for a World Championships, and what a crisis that would create!

There must be many modellers who have wondered why the North Koreans' rapid climb to success in four short years of International Contest modelling should ever have taken place. It is a matter of technique in flying and long practice which has given the Koreans such success. One does not obtain first and third places in the Wakefield so easily.

In just the same way, Tom Koster's supreme effort in at last capturing the individual World Championships for Power Models (he won Wakefield in 1965) must be recognised as the pinnacle of his remarkable long career in International modelling. A pioneer of intricate systems devised to improve flight performance, Tom was also the principal instigator behind the Denmark-based Championships. His contribution to the organisation was well-rewarded by this first place and it was a triumphant leadership in a supreme fly-off with 17 of the world's finest power duration modellers.

In South Africa, the first-ever Championships for Thermal Soaring Radio Controlled Gliders took place near Pretoria.

The South African Contest was remarkable from many points of view. Firstly, it was won by a standard commercial kit using relatively elementary radio control systems, as marketed by the Cox Company of the U.S.A. Skip Miller's expertise in skilfully riding the thermals using the most clever of tactics deservedly gave him the first place, and it was a great pleasure to have local man, Frikkie Roos chase him into second place, just ahead of our own Sean Bannister, who had what was generally regarded as the most attractive individual design on the field. Secondly, the South Africans had to fight a political battle to gain recognition and to solicit the attendance; all the more credit to them for having 12 nations participate in the event. Thirdly, they were relatively inexperienced in the organisation of such meetings, and here they deserve the greatest of compliments for a meeting that was exemplary in every way.

In America, the U.S.A. had taken on at short notice, the World Championships for radio control aerobatics. The meeting at Springfield is now claimed by many to have been the greatest ever held for the class, since it was started many years ago at Dubendorf near Zurich, in Switzerland. Hanno Prettner was the winner. Undoubtedly so, too. Already the victor at the famous Las Vegas Invitational Meeting in October 1976, and the winner of many European events, also the demonstrator of aerobatics in South Africa, Hanno and his father are true ambassadors of the sporting spirit of aeromodelling. The fine character of this young expert radio controlled flyer has made him the idol of many. There is no arrogance with Hanno. One should also take note of another rising star among the aerobatic aces, namely Ivan Kristensen of Canada, who got himself up to fourth place, below Wolfgang Matt and Dave Brown of the U.S.A., to interrupt what was otherwise a U.S.A. team domination with three places out of the first six. America has always led in radio control aerobatic technique and this was in many ways a restoration after a slight relapse.

For Britain this has been a most eventful Jubilee year with celebrations taking place throughout the length and breadth of the country. So it would not be out of place for us to look back to the beginning of that 25-year period and check the 1952 records for interests' sake.

The Annual of that year reveals a fascinating situation. 1952 was a year of innovation. This page of the *Aeromodeller Annual* was headed "There's always something new" and what was new for that year was: Control Line Carrier Deck Flying; Phil Smith's development of Ducted Fans for Commercial Kits; and the very beginnings of reliable radio control.

The designs in the 1952 Annual came from a galaxy of talent. Vic Smeed's "Queen of Hearts" Power Design which had won the 1952 contest for the Queen Elizabeth cup was among them. The designer's names—Ledertheil, Lerat, Saffek, Everitt, Cole, Bilgri, Struhl, Ehling, Fletcher, Husicka, and so on, still have a great ring of reputation attached to them. It's pleasant to know that they are still with us and moreover still actively engaged in aeromodelling. In those days we incorporated potted engine analysis as part of the Annual, and it is fascinating to note that engine prices were averaging £2.50p for the ever popular ·5 and ·75 c.c. diesels. The Wakefield Contest was still being run to 5 minute maximums and Arne Blomgren was the victor for the year. And the very beginnings of A/2 glider took place under the banner of the "Swedish Glider Cup" with Bora Gunic of Yugoslavia the winner over the famous Germans Hacklinger and Saamann.

1952 was a year in which future patterns were determined. Albeit we did not recognise so at the time. One is left to consider whether the content of this Annual is a foretaste of the next 25 years.

As is our normal custom, we have specially selected "milestones" for your enjoyment. Each is indicative of a trend to come, the most important of which is quite obviously in radio control and in silent flight in particular.

Silencing is absolutely critical. The public enquiry at Bromley, near London, will have determined the future pattern of local administration in this respect. Silencer investigations are continuous. We have been using silencers ourselves for almost all of the last 25 years. But that does not mean we know everything about silencers—there is a lot to be learned and the tables produced in this issue will be of considerable interest. Man-powered aircraft also hover on the "silent flight" scene and having fostered m.p.a. so frequently in previous editions, this year's Annual now provides details of the incredibly successful STORK from the students of Nihon University, Tokyo.

Then we also cover the carrier deck scene, a section of control line flying yet to gain a full grip on the enthusiasm of British modellers. Because we witnessed such different techniques at the Canadian Nationals and because we feel there is much to be learned in the U.K. on the whole subject of carrier deck, we have reproduced Harry Higley's feature. Control liners would do well to study the contents.

Finally, the selection of drawings. Once again, Pat Lloyd has applied his masterly skills in reproducing designs which we have culled from the world's model press. They are dimensioned and scaled for the first time to the metric system so that there should be a minimum of difficulty in enlarging any of them or using them for inspiration. We hope that you like the selection and that it meets your particular interest in the fascinating subject.

ON THE COVER

Typical scene at Zwartkop, near Pretoria, South Africa, during the first ever World Championships for Radio Controlled Thermal Soaring models. Local flyer, Frikkie Roos is about to release his second place winning design. Called "Jonathan", it uses British-made Skyleader equipment.

THE CHANGING SCENE

Some comments on R/C soaring

by Geoff W. Dallimer

"Radio Control Models & Electronics" columnist

SEVERAL years of development have brought radio control thermal soarers to a fine degree of perfection in contests where *duration* is the main criterion. Indeed the ancestry of many of the more successful designs can be traced back to free flights models were duration was the *only* object. The requirement to land an R/C model within 12 metres or less of a target has led to improvements in the handling characteristics both in pitch and span, and to a limited extent, to the appearance of various forms of life spoilers.

During this time the rudder has been the major directional control surface often combined with a polyhedral wing to produce a stable and efficient model. Ailerons, when applied to high aspect ratio wings have proved counter-effective, whilst the hinge gap is essentially a source of drag, thus reducing efficiency.

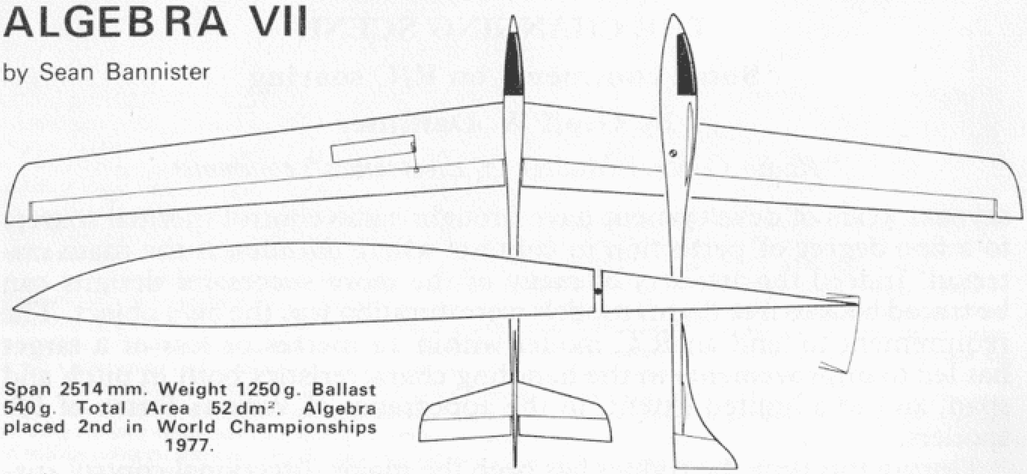
Both all-flying tailplanes and conventional elevators have been used for pitch control; the imprecise neutral of the one being counterbalanced by the slot losses in the other! The effect of fuselage weight on pitch control has become acknowledged and efforts made to keep the aft end of the fuselage light; this in turn has led to smaller tailplanes becoming practical with a corresponding reduction in drag.

The size of models has varied between 2440 mm (8 ft.) and 4880 mm (16 ft.) span although about the 3352 mm. span (10 ft.) mark has become the norm for average conditions with the larger, lighter models being preferred on calm days.

Author collects data from South African Roy Spavins, on his 2,740 mm. span "Yellowbird" which is Skyleader equipped at the 1977 World Championships for R/C Thermal Soaring. Behind is the curved wing "Hobie Hawk" which is also just rudder/elevator controlled. This first ever World Championships for the class produced several of the trends outlined in Geoff's feature.

ALGEBRA VII

by Sean Bannister



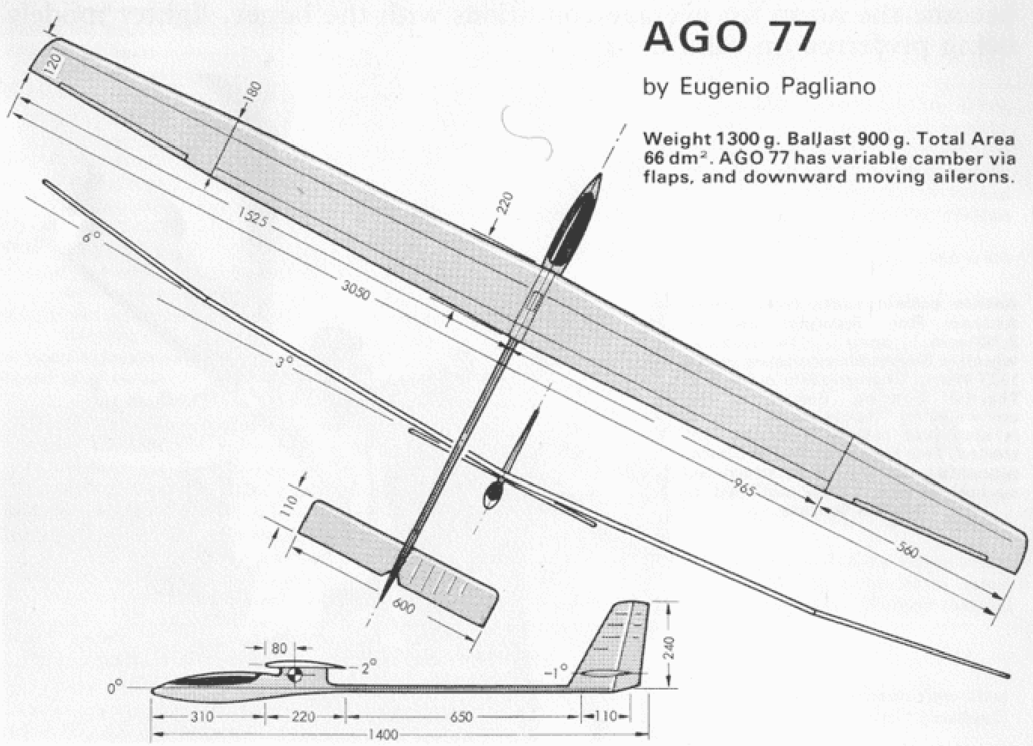
Span 2514 mm. Weight 1250 g. Ballast 540 g. Total Area 52 dm². Algebra placed 2nd in World Championships 1977.

Progressively, the contest rules have been refined and for duration events are now fairly stable, the previous formulae of three flights to a maximum of 6 minutes being more recently replaced by a 10-minute slot period in which the competitor flies as long as possible. Scores for each "slot" of six competitors being normalised relative to the "slot" winner who receives 1000 points. 50 bonus points are usually awarded for landing within a 12·5 metre target circle. Six competitors fly in each slot simultaneously—one on each of the six "spot" frequencies, and in 1978 one can expect to see twelve spot frequencies in use at meetings. The launching of models by hand towing with a 150 metre line has become universal although a few competitors have persisted with a bungee launch system and with the wider availability of "surgical rubber" bungee tubing this

AGO 77

by Eugenio Pagliano

Weight 1300 g. Ballast 900 g. Total Area 66 dm². AGO 77 has variable camber via flaps, and downward moving ailerons.

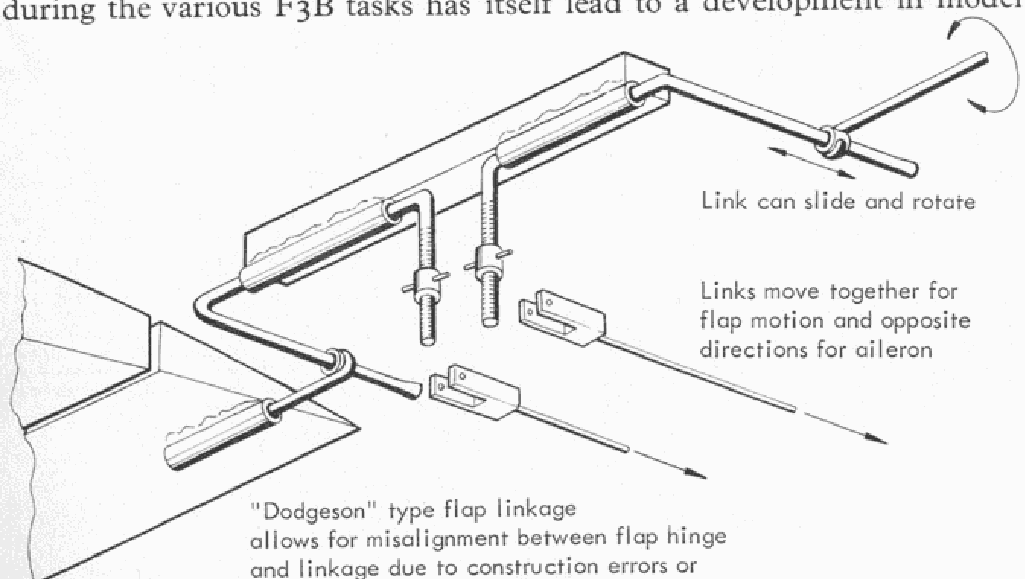


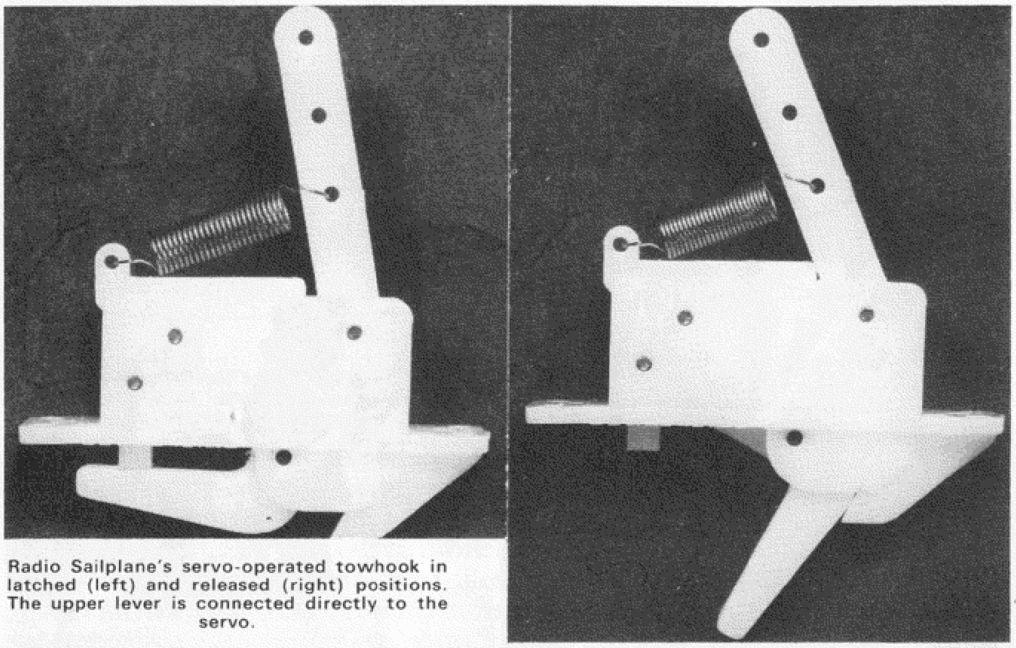
Eugenio Pagliano and pylon mounted wing on AGO 77; Seam Bannister launching Algebra VII, drawings opposite.

method has become very competitive to the point where it is quite likely to be banned!

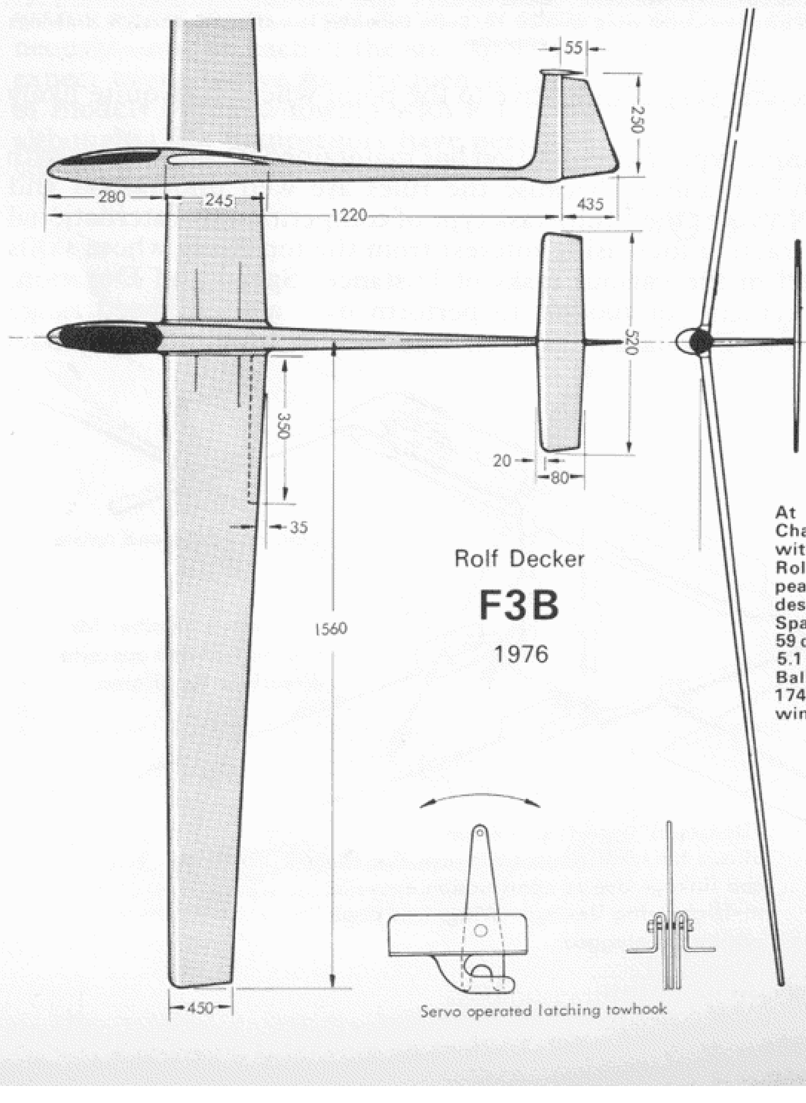
This simple type of competition has maintained its pupularity with competitors and organisers because the rules are well understood and simple to use. However the Multi-task type of competition to International F3B rules is attracting increasing interest from the top flyers whose skills are better tested in the various tasks of Distance, Speed and Duration.

A requirement for models to perform over a wide speed range during the various F3B tasks has itself lead to a development in model





Radio Sailplane's servo-operated towhook in latched (left) and released (right) positions. The upper lever is connected directly to the servo.



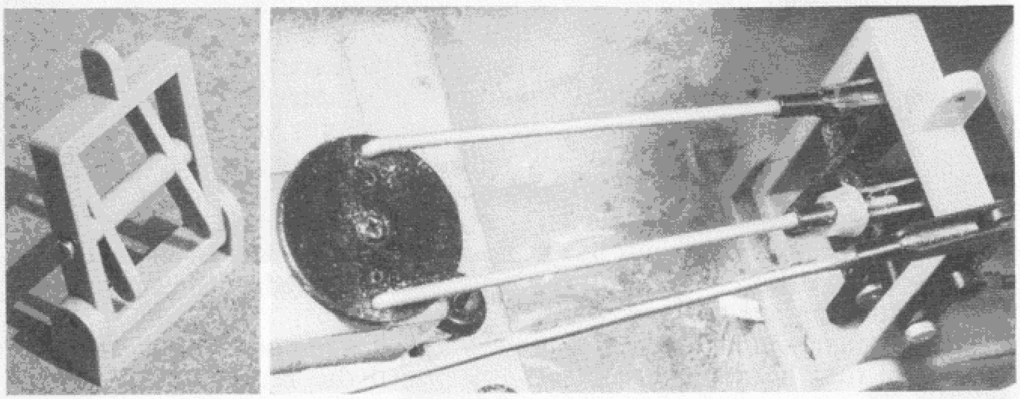
At right, the World Champion, Skip Miller with his "Aquila" and Rolf Decker, the European pacemaker with design drawn at left. Span is 3120 mm., Area 59 dm^2, with tail only 5.1 dm^2, Weight 1700 g. Ballast 700 g. Eppler 174 and 180 aerofoils on wing, NACA 009 on tail.

design. The need for the models to lift a large amount of ballast in the Speed task has encouraged the use of flaps, either quarter or full span, whilst the large number of turns required in the distance task has brought about a renewed interest in ailerons on the gliders. Here the gain in manoeuvrability during Distance and Speed tasks is balanced against the loss of performance in the duration task, thus the designer ponders the trade-off of one factor against another. Where flaps are added to a model they are often utilised as ailerons too, being given the hybrid name "Flaperons"! Both electronic and mechanical mixers have been developed to enable two different control servo's to be connected to the same flying control surface (see photographs).

Similarly most leading models are now fitted with servo-operated towhooks that hold the towline captive until the required moment of release. These are useful in avoiding accidental release of the towline during hand towing and are particularly effective in both hand tow and bungee launching when used to "spring" the model from the top of the line thus gaining extra height.

As modellers have added ballast to increase the flying speed during Speed and Distance tasks they have found that Duration times are not reduced as much as might be expected, so that now more heavily loaded models i.e. wing loadings between 24 and 36 g/dm² are used in duration contests. This enables models to be flown in winds much stronger than would have been the case say 5 years ago, with little deterioration in performance.

This improvement has been achieved largely in the choice of aerofoil sections and removal of drag forming protrudences such as wing retain-



Mechanical Mixer (left) with application for vee tail (right).

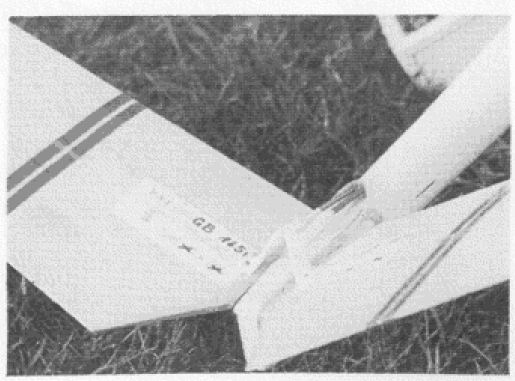
ing band dowels and the like. Airfoils have progressed from under-cambered high lift sections through flat bottom "Clark Y" types to the modern range of semi-symmetrical sections such as those designed by Eppler *(see opposite)*.

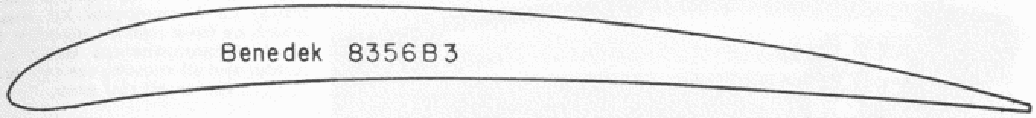
Evolution, to misquote Darwin, is a continuous process and this is very apparent in our R/C gliders, progressing as they have from 15 g/dm^2 converted F/F models to 30 g/dm^2 specialist designs. Now models are closer in appearance to modern full size gliders and use similar construction methods.

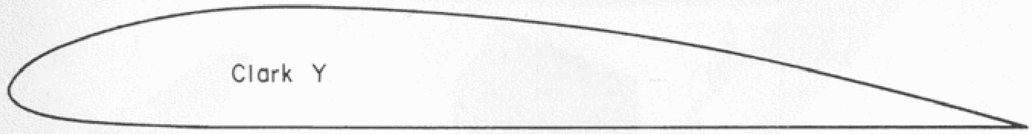
The use of fibre glass moulding for the fuselage has enabled designers to reproduce smooth flowing lines, whilst the thinner wall thickness of a moulding compared with built-up balsa structures has brought about a slimming of external shape without reducing interior space. Generally the strength of fibre glass fuselages is significantly better than those produced from Thermoplastic ABS materials although of course the latter have a cost advantage.

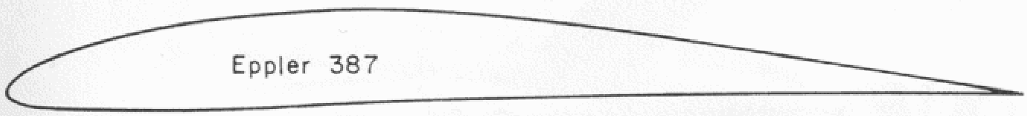
Despite the use of styrofoam for wing cores in many models including gliders it has been less successful in the higher aspect ratio wings where

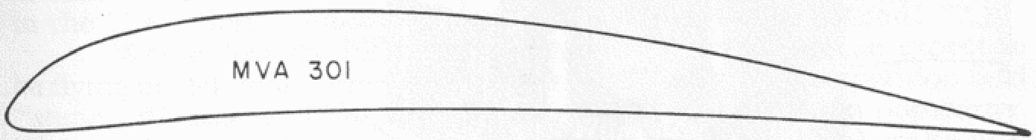
Electronic Mixer (left) with two servos on Vee tail (below) in author's "Wildflecken".

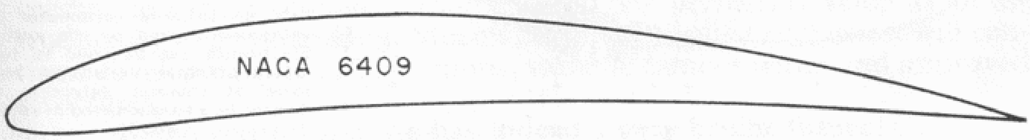






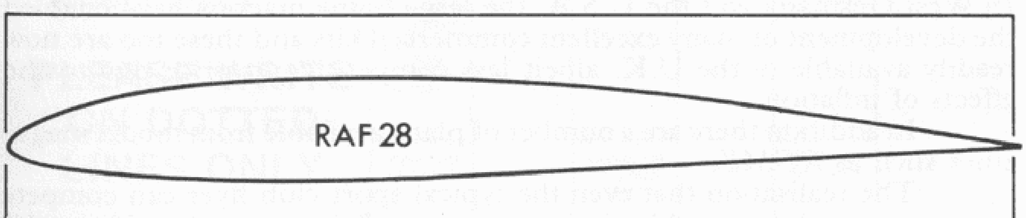




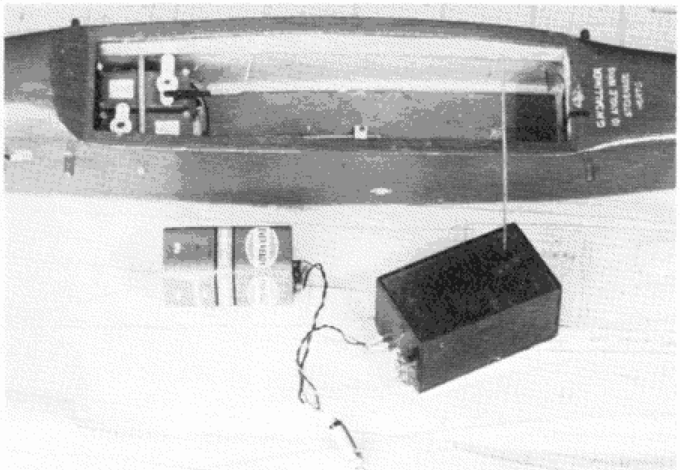


light weight is of importance. The traditional balsa rib construction remains popular but with detail improvements such as spars stiffened with carbon fibre or steel wire. "Open" structures are less often used now due to their tendency to flutter, particularly when covered with the shrink plastic type covering films. The change to all sheet flying surfaces has also offered the chance to more accurately reproduce the required airfoil section, although little practical improvement seems to arise from this point!

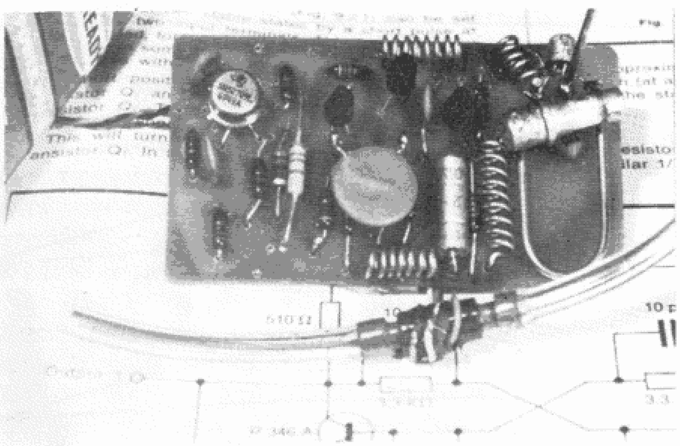
In the search for improved performance various stabiliser configurations have been tried, both conventional hinged elevators and "all flying" tailplanes, whilst the alternative "V" and "T" methods of mounting the control surfaces have been explored without significant or measurable im-



Sta.	0	1.25	2.5	5	7.5	10	15	20	25	30	40	50	60	70	80	90	95	100
Upr.	0	1.45	2.1	3.13	3.9	4.46	5.36	6.0	-	6.7	6.72	6.25	5.4	4.32	3.03	1.63	0.89	0
Lwr.	0	-1.25	-1.65	-2.2	-2.53	-2.75	-3.05	-3.2	-	-3.12	-2.86	-2.5	-2.1	-1.6	-1.1	-0.63	-0.43	0



Opposite: Mike O'Reilly's (Australia) LS 1 semiscale kit model which he flew to fifth place in the World Championships using only rudder and all-moving tee tail. Note the small tail area.



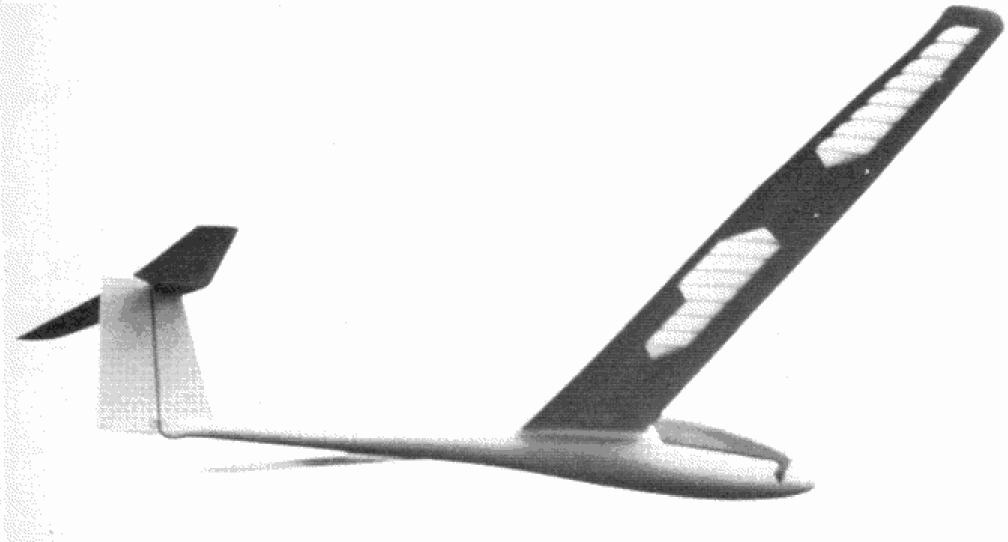
Left, an airborne variometer development tested by the author. Electronics can be used to telemeter pressure variations, as a form of thermal detection indicated by a tone emitted in an earphone.

provement. Perhaps it is important that alternative configurations do not produce significant change in performance so that modellers can have variety in design and appearance without penalty!

On the commercial side of soaring there have been tremendous advances in the availability of kits, plans and specialist accessories for the soaring enthusiast. Few other branches of the hobby have such a wide choice available to them. Most of the major kit manufacturers offer a range of soarers for both slope and flat field operation, whilst in addition there are a number of smaller manufacturers producing part kit packages (e.g. fibre glass fuselage moulding plus plan and hardware) for the enthusiast. In West Germany and the U.S.A. the large home markets have enabled the development of many excellent commercial kits and these too are now readily available in the U.K. albeit less competitive in price due to the effects of inflation.

In addition there are a number of plans available from model magazines such as *RCME*.

The realisation that even the typical sport club flyer can compete in contests with reasonable chance of success flying a standard kit model has brought the level of entries in R/C soaring events to an all time high. Indeed often entry lists are closed months before the event! No other type



of radio control class has enjoyed such competition activity and indeed in the U.K. there is often a choice of contests on each weekend!

Where does the future lie? The club "sport" flyer can expect to be flying models more scale-like in apperance, and on the competition field "stand-off" scale and full scale glider contest will increase in popularity. The development of a smaller class of 2550 mm. span (100 in.) is also proceeding as a more economic approach and will perhaps develop as an introductory step into soaring. Meanwhile the dedicated enthusiast will continue development of airfoil sections, variable camber wings and improved structures.

Radio control soaring has indeed a very bright future!

Below: the score card used at the first World Championships indicates performance in Duration, Distance and Speed sections of a single round. Other organisers apply different forms of score card to cater for each separate task but this is a good guide for clubs.

OFFICIAL NO.

FREQUENCY ....

RESERVE FREQUENCY ......

PLEASE WRITE ON DOTTED LINES ONLY

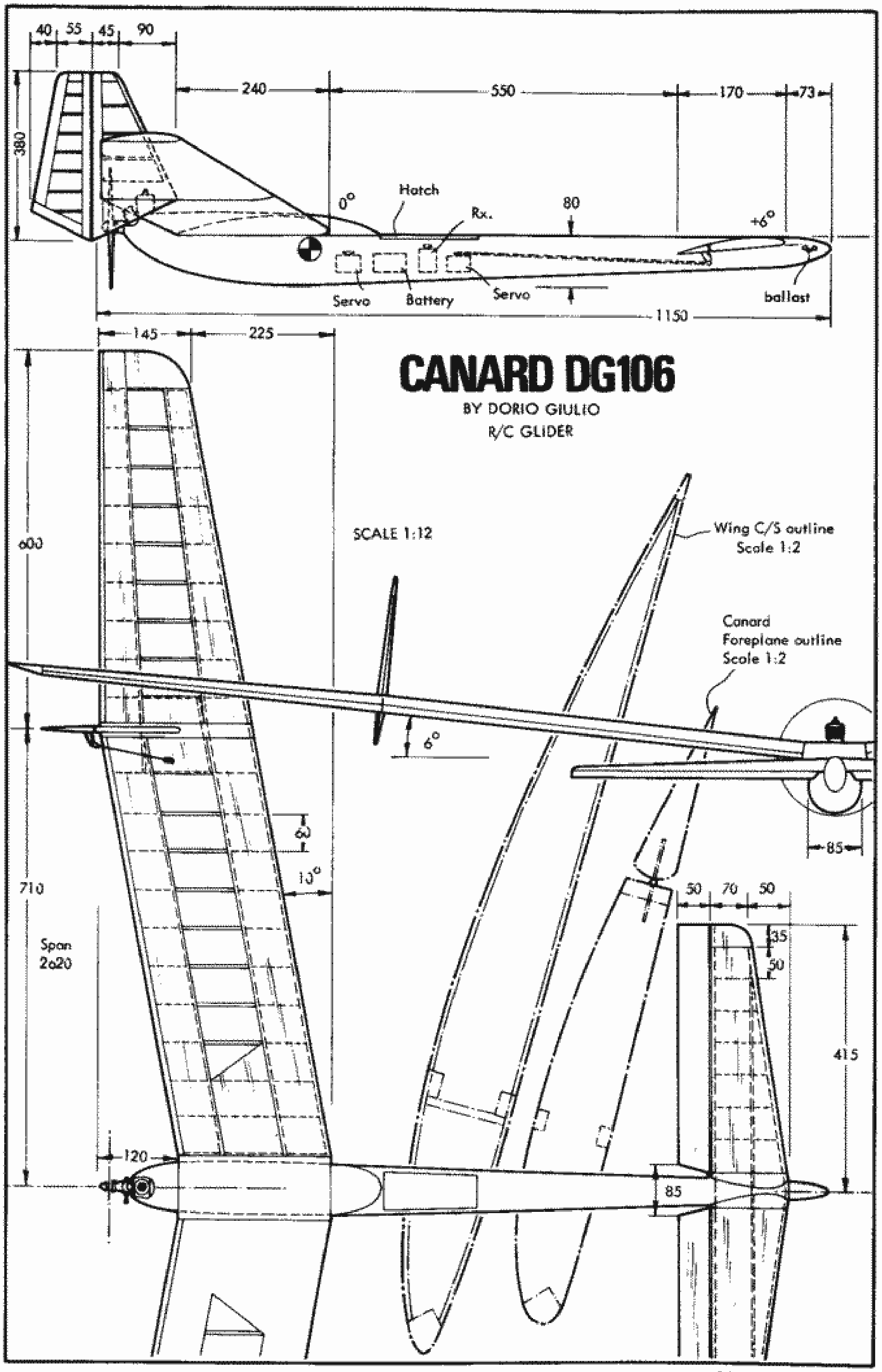
COUNTRY ....

SURNAME

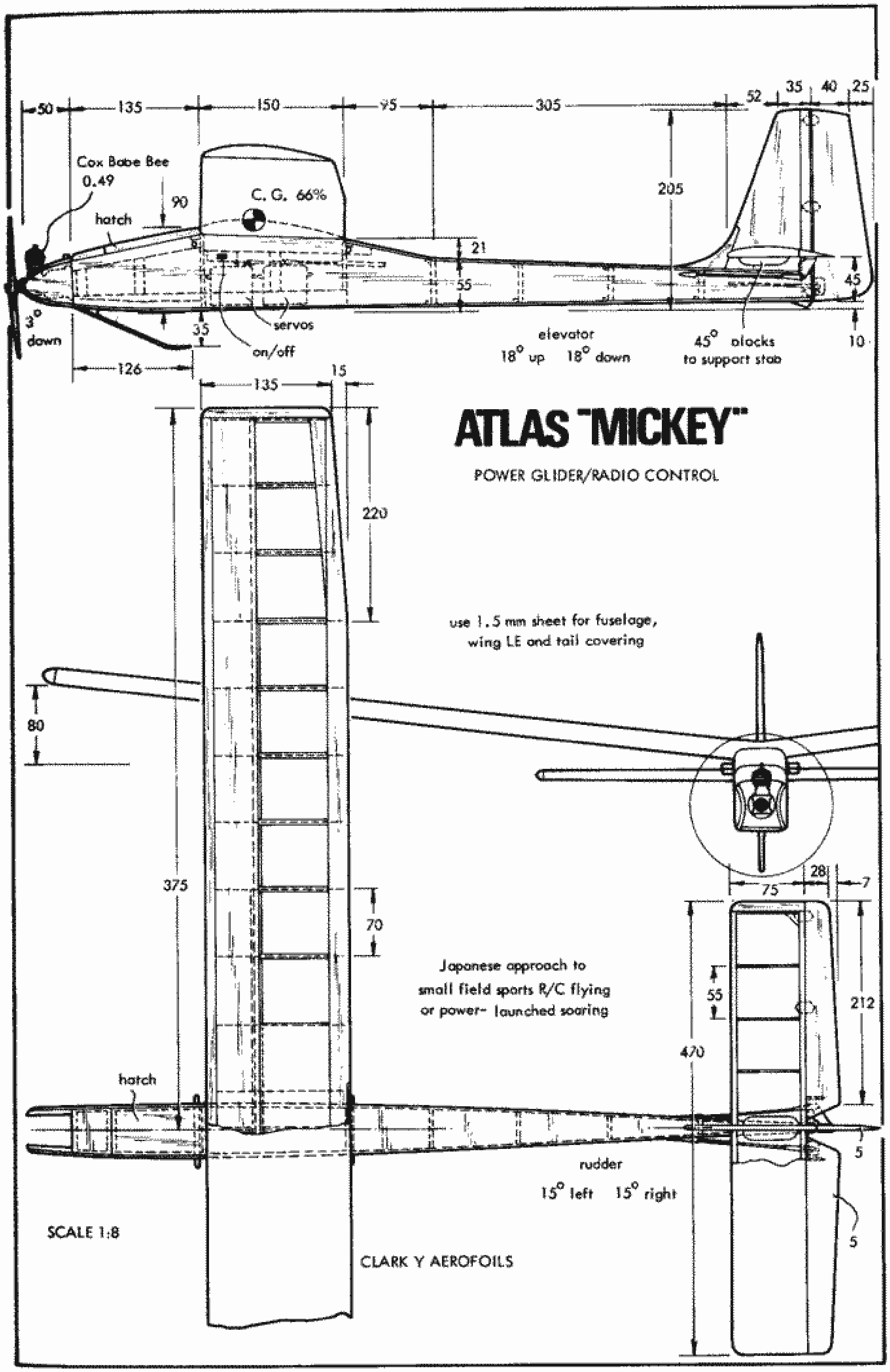
DURATION	LAPS	SPEED
MINUTES	NO. OF LAPS COMPLETED WITHIN 4 MINUTES (TO NEAREST TENTH OF A LAP)	MEASURED FLIGHT FROM BASE A TO BASE B TO BASE A (TO NEAREST TENTH OF A SECOND)
SECONDS		
DISTANCE FROM SPOT (TO NEAREST METRE BEYOND NOSE OF MODEL)		
SIGNATURE OF TIMER	SIGNATURE OF TIMER	SIGNATURE OF TIMER

INITIAL

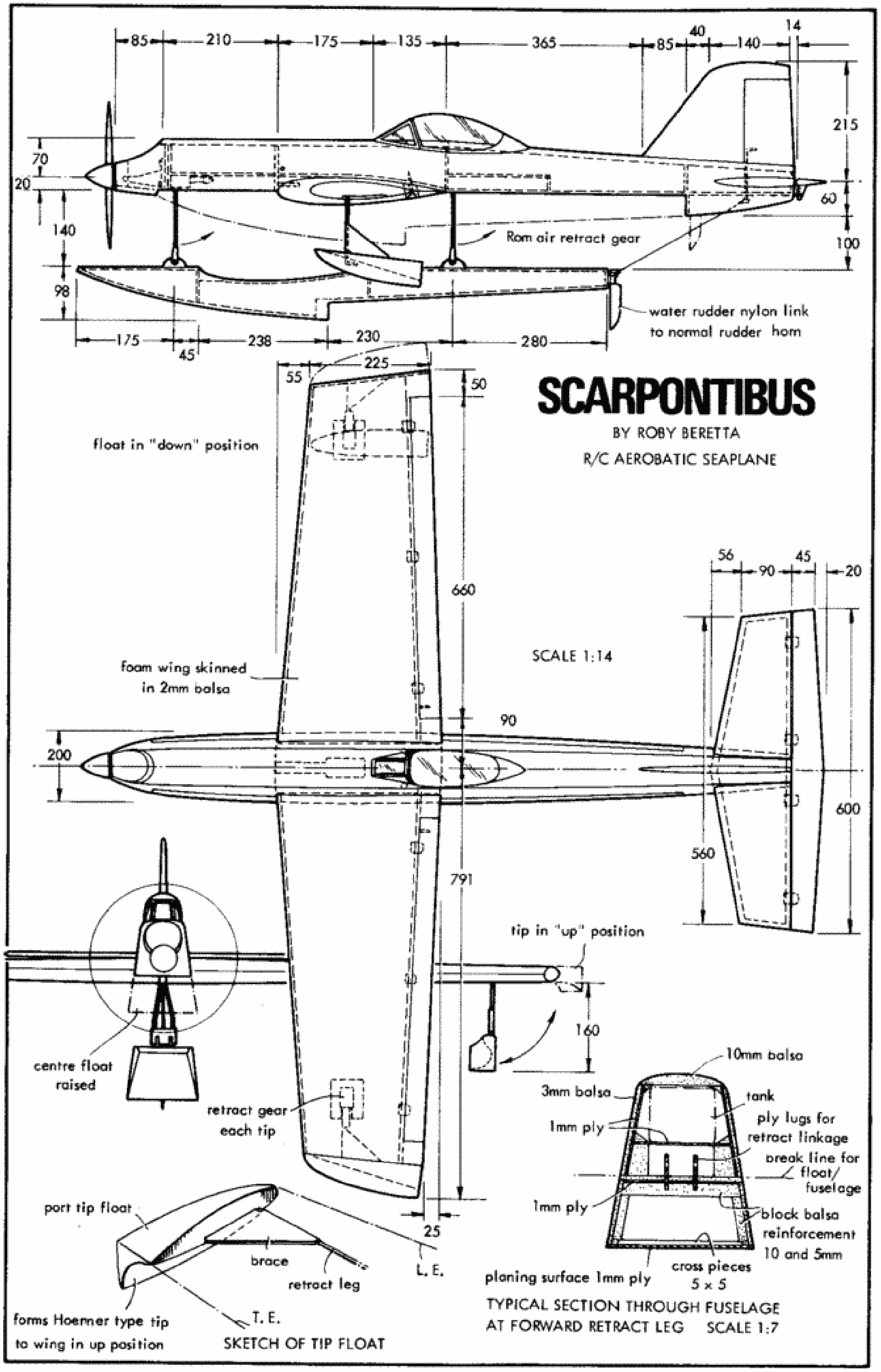
ROUND NO. ....



MODELLISTICA ITALY



R/C TECHNIQUE JAPAN



RASSEGNA TECNICA DI AEROMODELLISMO ITALY

CHANGES IN AMERICAN C/L STUNT DESIGN, INCLUDING THE DAZZLER 40

by Dave Rees

(From "Flying Models", U.S.A.)

A significant feature on the newest techniques in stunt models

THE CHANGE in the rules for appearance judging in control-line stunt that took effect 2 years ago, came as somewhat of a jolt to the regular stunt fliers. Having spent so much time learning to make semi-scale stunters look like the Gnat and Talon, the elimination of the realism and originality categories swept all that away.

The model itself now being worth only 3·1% out of a possible 650 points, meant that realism became less important, and performance everything. All that is needed for the future is a simple lightweight, precision aerobatic mechanism. Once the fact is accepted that a stunt model does not have to resemble anything, just a well built model, the whole outlook changes. Anything that is not absolutely necessary to the performance of the A.M.A. pattern can be omitted. Overall weight is bound to be reduced, and construction will be made less difficult at the same time.

However, don't neglect finishing techniques. As planes become simpler and more functional in appearance, they require more splashy paint jobs in order to avoid looking stark and uninteresting. The blinding polished finishes will be even more important than before, and without ink lines, there is nothing to hide those tiny flaws. Assuming that the functional approach is on the way in, and realism is on the way out, how does one design a stunter to keep up with the trend? The first objective is to get rid of all preconceived ideas, and to start from scratch, being concerned with only what is truly essential. If you have ever flown in competition, you know what is necessary and what is likely to give trouble. The following are some concepts which work well.

Upright Engine Mounting

A good place to start with in a powered model is position of the engine. Most stunters today have inverted engines, because it looks more nearly realistic. Another reason of lesser importance is the wing placement, which must therefore be below the thrust line to keep the vertical centre of gravity in the right place. All of which allows the landing gear to be shorter, again to increase the realistic short-legged look.

Forget all this.

After flying one for a season, the conclusion is that there is no more convenient position in which to mount a model engine than upright. While it is not impossible to flood an upright engine, you really have to work at it, and chances of a backfire blowing off the spinner are reduced by about 50%. Another nice feature of most stunt engines is the exhaust stack, which faces the outside of the circle when mounted upright. All the oil is thrown outboard, so only one wing needs to be wiped off after each flight. The needle valve will still be inboard, which means you won't have to reach around a hot muffler or exhaust to make adjustments with the engine running. Still another advantage is the engine noise being on the opposite side of the fuselage from the flyer. The effect has a calming and smoothing influence on some pilots. You will use the same glow plug all season, too. To break off one on an upright engine, you really have to make a big mistake.

Dazzler Design

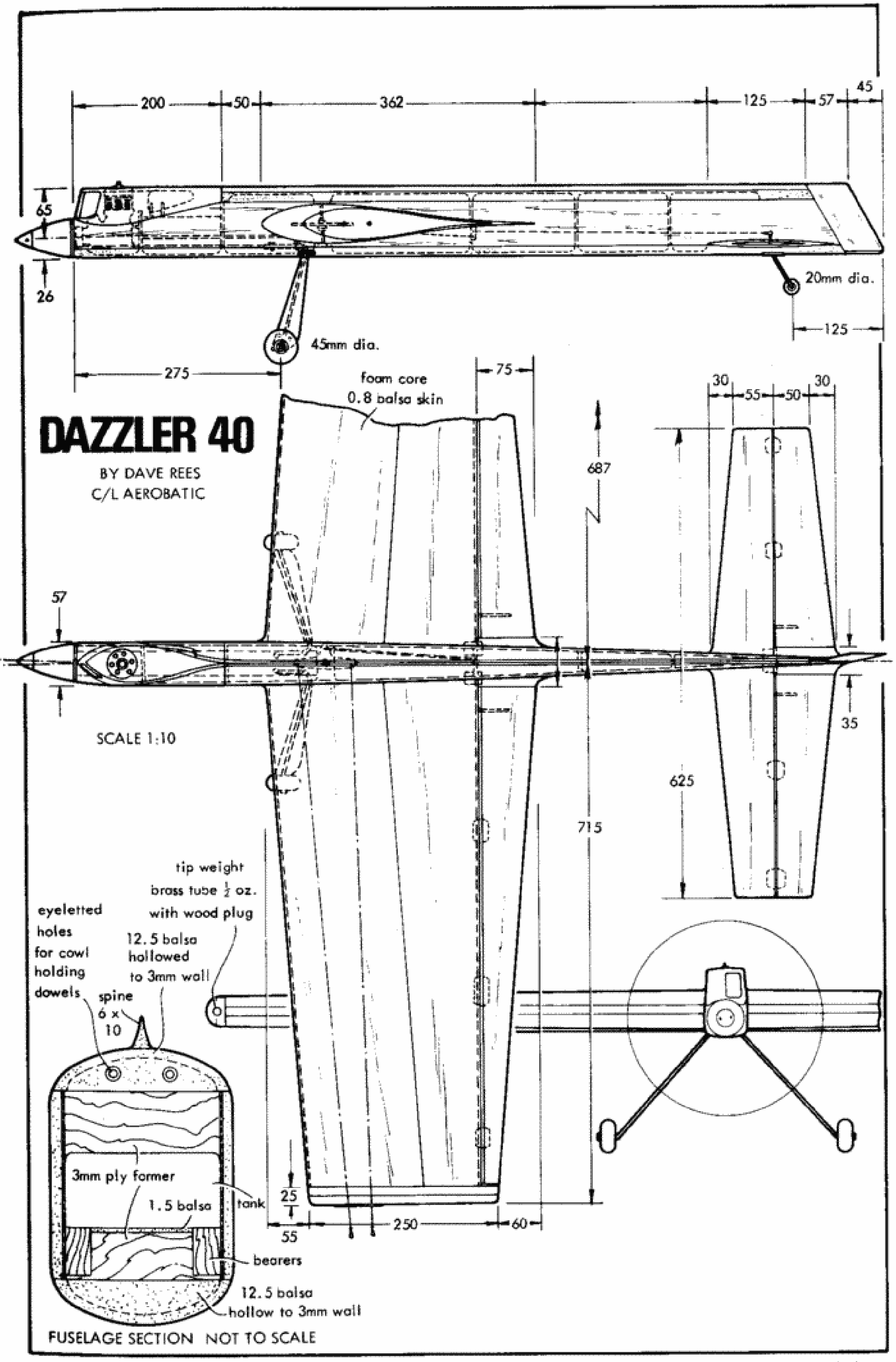
The engine I used was the original OS Max 40S stunt engine. For those fortunate enough to still have one, a 4 oz. tank will do nicely. If a new OS Max 40 is used without venturi modification, a 5 oz. tank will be required, because this hotter engine gulps more fuel in return for the extra power. The tank shown on the plans is 4oz., so the last plywood bulkhead will have to be moved rearward to allow room for a 5 ouncer.

Uniflow type tank with muffler pressure were used. Arrange the vents to protrude through the cowl opening. The OS muffler was the earlier type, installed with a cowling.

Helical Flow Cowling

Rat Racers and Speed event flyers have for years been designing the lower drag cowlings for upright engines, so their expertise was borrowed here. Only trouble was the size of the cooling openings, which needed to be larger for the slower precision aerobatics event. A lot of cowls have scoop designs which simulate those of aircraft. A few short tests with cigarette smoke will show that the airflow within the slipstream is helical in a counter clockwise direction when viewed from the front of the plane. This helix undoubtedly straightens out when the model is flying faster, but it is a safe assumption that the air immediately behind the prop is not moving straight back along the axis of the fuselage. Also remember the whole model is not flying straight, but around an arc as determined by the flying lines. Again the air does not enter the scoop axially, but at a slight angle. For both these reasons the opening in the cowl should be moved inboard slightly to induct the most air for cooling. The exit port should be on the opposite side, thereby taking advantage of an area of lower pressure to improve hot air scavenging. Remember to always make the exit opening of somewhat larger area than the inlet, because of the lower pressure drop across the exit. The intent of this design is to achieve greater efficiency with a lower drag opening, so that the model drag is reduced.

A wide-spread landing gear mounted in the wings does give a model a realistic rakish look, but unless designed very carefully, they are often short and stiff, making landings look choppy instead of the smooth swoosh of longer gear. Being a solid backer of foam wings for stunt models, and after several seasons of flying with a wing mounted gear, I find their attachment unreliable. The common type of slotted block, glued in the foam is too easily torn out on a landing obstruction. I have endeavoured to mount this gear to the strongest member available, the motor mounts, and as close to the centre of gravity as possible for the best absorption of landing shocks. The wings are therefore removed from the loads of landing altogether and can be cored out completely to a very thin foam wall thickness. There is then a net weight saving, plus no landing gear trouble throughout a long season of flying. Caution: never bend 10 gauge piano wire sharply. You wouldn't want a leg to break off from overstressing after mounting the gear permanently. Bend the wire around a $\frac{1}{4}$ in. diameter rod or larger.



DAZZLER 40
BY DAVE REES
C/L AEROBATIC
SCALE 1:10
200
50
362
125
57
45
65
26
20mm dia.
125
45mm dia.
275
foam core
0.8 balsa skin
75
30
55
50
30
687
57
35
625
715
tip weight
brass tube ½ oz.
with wood plug
eyeletted
holes
for cowl
holding
dowels
12.5 balsa
hollowed
to 3mm wall
spine
6 x
10
3mm ply former
1.5 balsa
tank
bearers
12.5 balsa
hollow to 3mm wall
25
55
250
60
FUSELAGE SECTION NOT TO SCALE

Cover exit holes through wood with oval eyelets so no ragged edges show. Remember, points still count for workmanship.

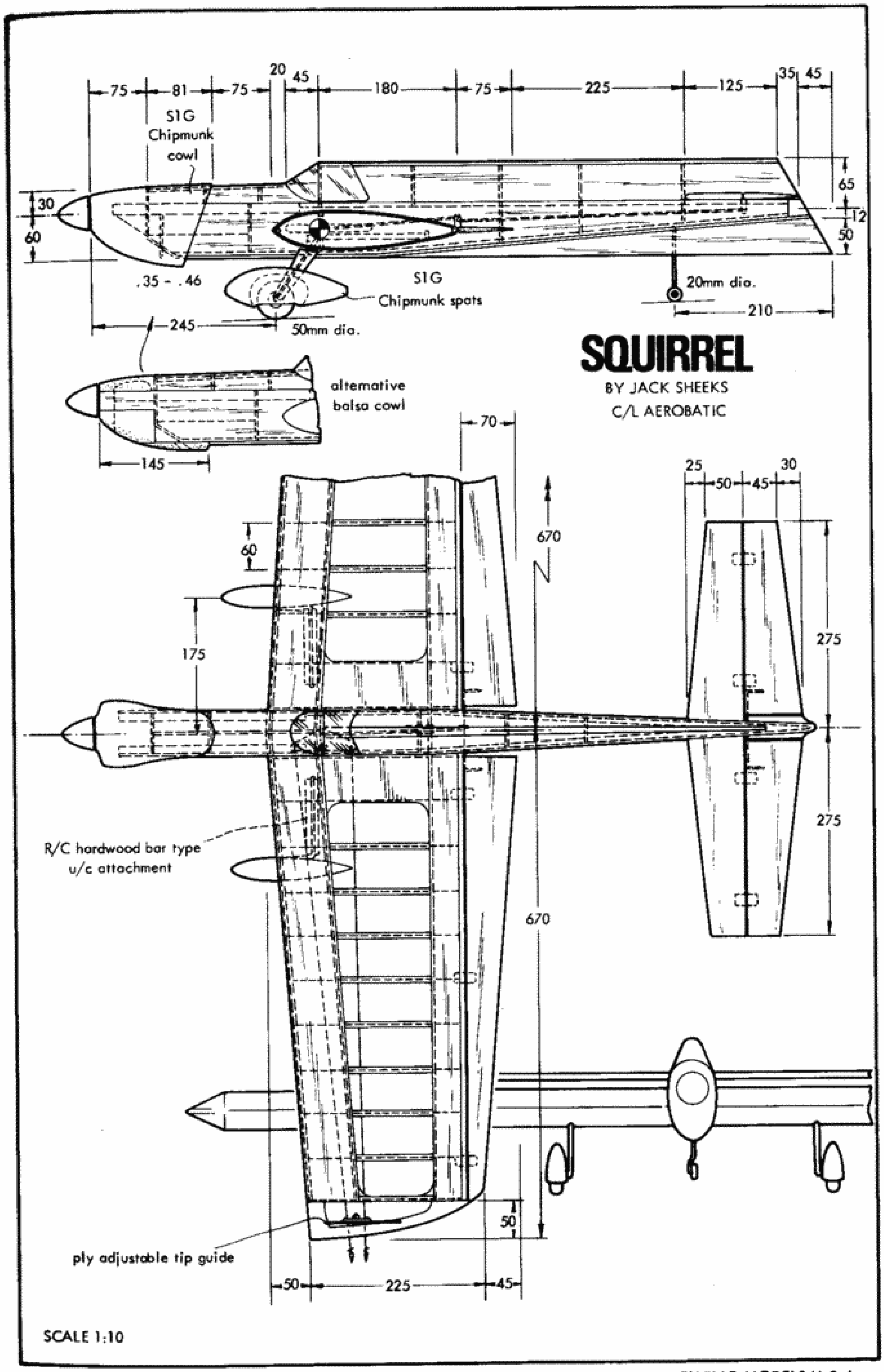
The wheels I have specified will give the best possible landings. For years the stunt community has been using thin racing wheels, probably because they have a low drag profile and are more easily installed in wheel covers. Aside from being heavy, they tend to make the landing more choppy and noisy. If you are now using slims, try the semi-pneumatic type just as an experiment. You will find your landings silent and soft with a distinct tendency to stick to the paving and not lift off again. Your landing point score should improve as a result.

While I'm on the subject of landing gear, I may as well make a few predictions on retracts for stunters. I don't think they will become part of the action for a while yet. With the trend toward functionality, they are just too much to fuss with and give trouble. Again "realism" is the category retracts fit into. Unless the overdesigned units being offered by the industry can be improved, they won't find much use on control line stunters. The whole works should weigh 2 oz. or less before I could justify their installation against the increased performance due to wheels-up flying. This means 2 oz. additional to the weight of the gear and wheels now in use.

Position of the landing gear is much more critical to good ground handling than realised. For a long while I used tricycle landing gear on semi-scale stunters, but when I switched to the single wheel with tip outriggers on the Dazzler I, I suddenly found I couldn't land or take off any more. After first blaming flying inabilities, then blaming the single wheel arrangement, I realized that the wheel was just too far ahead of the centre of gravity. Even with the very best landing approach, the touchdown would always result in a bounce. How much it bounced was determined by how well I gauged the flareout above the ground. The Dazzler 40 gear position should allow more control over both landings and takeoffs. I don't recommend the single wheel arrangement however. After using it for a season, I found that, while it was probably the lightest set-up possible, it had a nasty habit of catching the outboard wheel slightly on take-off. This tipped the nose down sufficiently to instantly change the 11–6 Rev-up to a 9–8.

I know I'm going to get a lot of flak about "flying razor blade" fuselage shape, but you do tend to get used to it after a while. You must admit that, with the exception of the cowling, there are very few fuselages easier than this one. There aren't even any blocks to buy, just ½ in. sheets top and bottom. I personally find it helpful in square manoeuvres to have a long straight silhouette to line up with the ground. I believe it helps the judges, too. But beware: if you are off on your angles, or blow a turn, everyone watching within two miles will know it. A Nobler has a much shorter rounded shape and is harder for an inexperienced judge to score correctly.

Oh yes, what about that missing rudder? Well, you don't need it for control-line flying. All that is required is sufficient lateral area with its centre of pressure (centroid of area) behind the centre of gravity. Most fuselages supply these requirements adequately without a rudder. Think of a rudder as something to foul up an otherwise perfect inverted landing.


75
81
75
20
45
180
75
225
125
35
45
S1G
Chipmunk
cowl
30
60
65
12
50
.35 - .46
S1G
Chipmunk spats
20mm dia.
210
245
50mm dia.
SQUIRREL
BY JACK SHEEKS
C/L AEROBATIC
alternative
balsa cowl
145
70
25
50
45
30
670
60
175
275
275
R/C hardwood bar type
u/c attachment
670
50
ply adjustable tip guide
50
225
45
SCALE 1:10

Not that the fuselage is only as deep as necessary to enclose the engine outline. Build the fuselage by sliding both completed sides onto the completed wing to avoid entry cut-outs and doubles. A stronger, straighter fuselage will be the result, with less tendency to stress crack. Be sure to extend the $\frac{1}{32}''$ plywood doublers in one piece several inches past the wing trailing edge, to prevent cracks at the highly stressed hinge point. Another high stress area that has a tendency to crack is where the front of the top block joins the sides. Make an internal fillet here for 2 in. back on both sides, before the lower block is glued on last. Apply masking tape to the wings near the fuselage while sanding the blocks so the wings are not marked.

The method of mounting the tailwheel is somewhat different than the wire-sewing type. Take the end of a piece of 16 s.w.g. diameter music wire and heat it until red hot with a torch. Quickly bend it into a loop around a $\frac{1}{8}''$ diameter rod. Through this loop fit a short screw with a washer and nut bolting it fast to a small piece of $\frac{1}{16}''$ thick plywood the width of the fuselage at that point. Bend the rest of the gear as shown and epoxy the whole assembly to the centre of the elevator before the lower block goes on. Leave the block solid in the elevator area, and glue in place, covering the slot with a nylon pushrod exit guide after painting.

Notice that the fuselage begins to taper immediately after the tank compartment. This gives an overall look of slenderness, but the maple motor mounts must be sanded to a slight curve at the rear before epoxying them to the $\frac{1}{32}''$ thick plywood fuselage doubler.

Nylon flap hinges are favoured but some trouble has been experienced retaining them in the wing trailing edges due to their tapered sides. The following method is used.

Slot the trailing edges with a slot cutter before gluing them to the foam wing cores. Then glue them to the wings and trim to the shape of the cores using a razor plane. Next epoxy all six hinges in place. Holding the wings up to the light, heat a straight pin over a candle and push it through the foam at the holes in the hinges. This will produce neat, hard edged holes in the foam at each hinge. Cut some short lengths of $\frac{1}{16}$ in. square balsa, and white glue (PVA) or epoxy them through the holes, keeping all flush with the surface. Now skin the wings in the normal manner leaving nothing showing. Hinges installed this way will break before pulling loose from the wings.

The wingtip weight is externally adjustable at the field by removing the hardwood nose plug and inserting lead into the wing tip tube. Remember that you already have the equivalent of some tip weight, since the $\frac{3}{8}$ in. i.d. brass tube weighs $\frac{1}{2}$ oz. and the unhollowed tip block accounts for between $\frac{1}{4}$ and $\frac{1}{2}$ oz. also. To install, sharpen the inside of the $\frac{3}{8}$ in. power hand drill. Using the slowest speed, drill the tube straight into the tip block as shown. Usually the balsa core will twist off and come out when the tube is withdrawn. If not, reinsert the tube, and drill out the core with a long $\frac{3}{8}$ in. drill bit in the centre of the tube. Epoxy the tube in place and make a small fillet around the front. $\frac{3}{8}$ in. diameter lead balls can be purchased from a gun store specializing in muzzle loader supplies. $\frac{3}{8}$ in. diameter lead rod can be cut into $\frac{3}{4}$ in. lengths of about $\frac{1}{2}$ oz. each on a lathe. If neither are available, drill some $\frac{3}{8}$ in. lengths of about $\frac{1}{2}$ oz. holes in a block of pine and pour melted lead into them. When cool knock them out and sand slightly until they fit. The balance of the space in the tube should be filled with lengths of balsa to prevent rattling in flight.

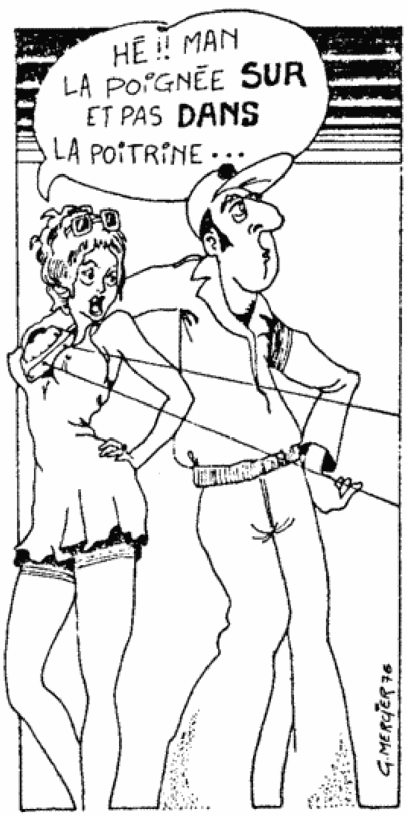
Finish

The finish used is similar to most non-polyester methods. The following coat outline may prove helpful in ordering paints.

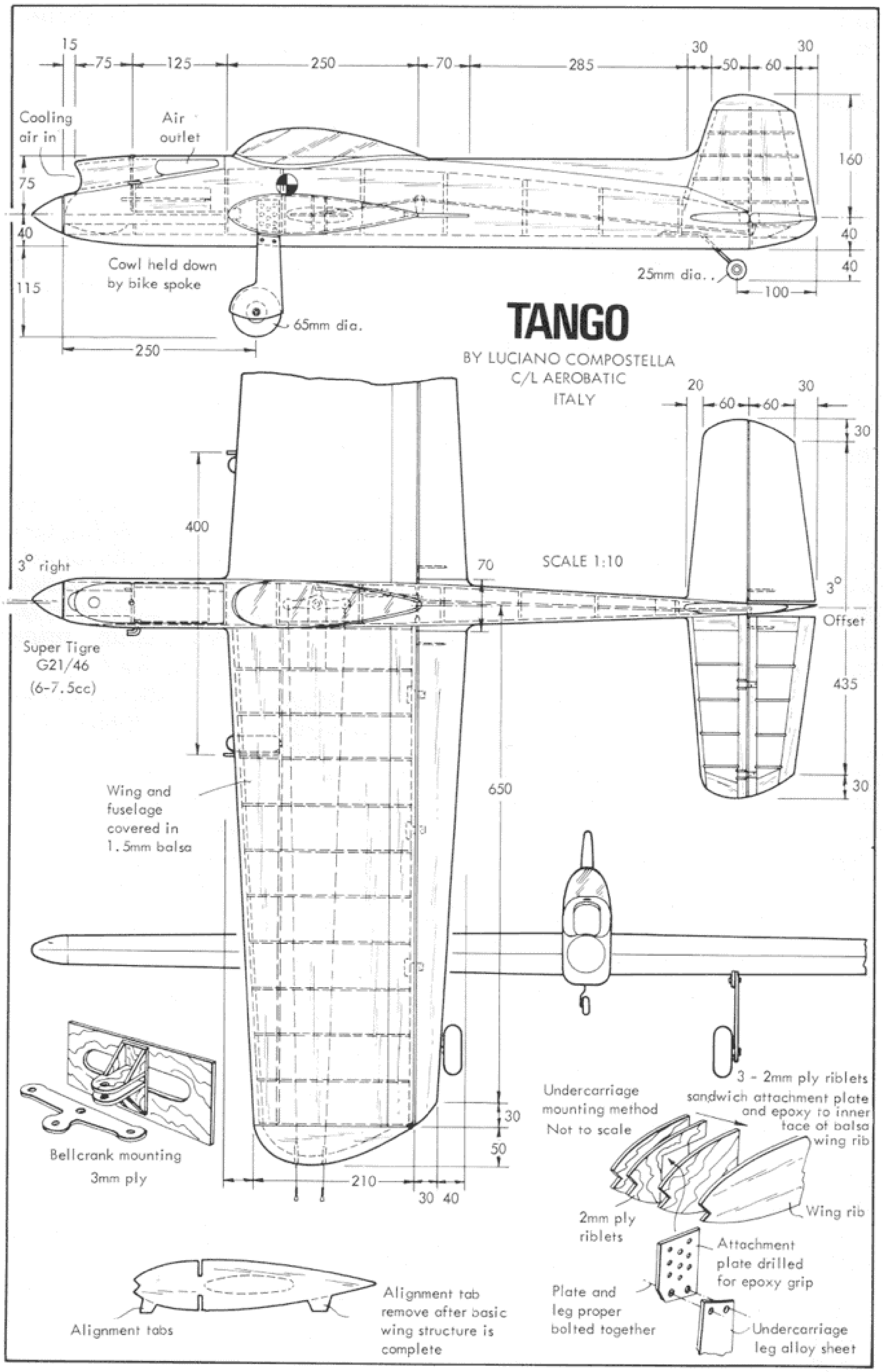
(*a*) Three coats Aero Gloss clear, brushed—(1 pint)
(*b*) Epoxolite fillets applied.
(*c*) Cover entire woodwork with 00 Silkspan using Aero Gloss clear, brushed—(4 oz.).
(*d*) Two coats Aero Gloss Balsa Filler coat, sanding each smooth with 400 paper, spray application—($\frac{1}{2}$ pint)
(*e*) Four coats Aero Gloss Swift White, sprayed—($1\frac{1}{2}$ pints)
(*f*) Apply all Aero Gloss trim colours and lettering, airbrush.
(*g*) Sixteen coats Sig Lite Coat clear, sprayed—(2 quarts and 2 quarts thinner)
(*h*) Sand entirely 600 paper, wet.
(*i*) Polish with white rubbing compound.

Last of all before waxing, cement the eyelets and leadout guides in place, using a clear epoxy. Wax the entire model with Lemon Pledge.

A very good flyer has said that it was difficult to tell, with this model, whether there was a right handed flyer flying inverted, or a left handed flyer flying upright. So it might be a good idea to paint the underside of the plane a different colour than the top, using the "green side up" principle!

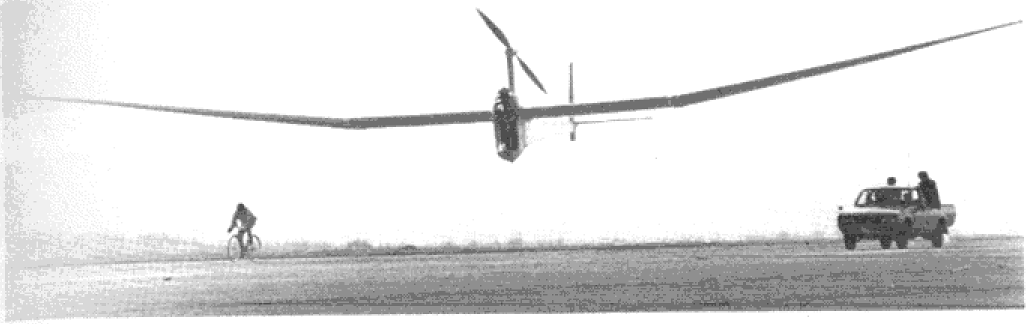


From "Le Modele Reduit d'Avion"—where else?



15
75
125
250
70
285
30
50
60
30
Cooling air in
Air outlet
75
40
115
160
40
40
Cowl held down by bike spoke
25mm dia.
100
65mm dia.
250
TANGO
BY LUCIANO COMPOSTELLA
C/L AEROBATIC
ITALY
20
60
60
30
30
400
3° right
70
SCALE 1:10
3°
Offset
Super Tigre G21/46 (6-7.5cc)
435
30
Wing and fuselage covered in 1.5mm balsa
650
Undercarriage mounting method Not to scale
3 - 2mm ply riblets sandwich attachment plate and epoxy to inner face of balsa wing rib
30
50
Bellcrank mounting 3mm ply
210
30 40
Wing rib
2mm ply riblets
Attachment plate drilled for epoxy grip
Plate and leg proper bolted together
Undercarriage leg alloy sheet
Alignment tabs
Alignment tab remove after basic wing structure is complete

AVION - SPAIN



Stork B making the record flight on January 2nd 1977.

DEVELOPMENT OF MAN-POWERED AIRCRAFT IN NIHON UNIVERSITY

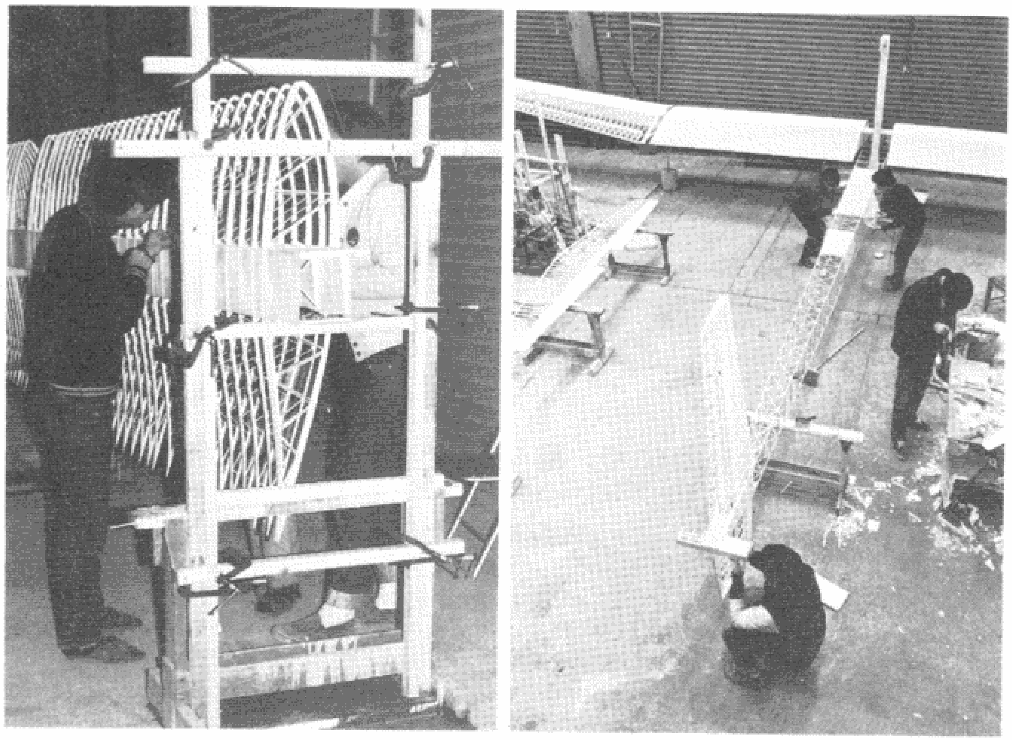
by Professor Hidemasa Kimura, (*Japan*)

THE IDEA of developing Japan's first man-powered aircraft as a students' project was conceived by Nihon University in 1961 soon after the news of successful flights of Britain's Sumpac and Puffin was received. At that time, theses on man-powered aircraft were in short supply, even in Britain which pioneered the man-powered concept. Very little reference material, such as detailed design data, was available. It was therefore decided to take up the development of man-powered aircraft as the graduation thesis of senior students of Nihon University's Mechanical Engineering Department, thereby building up the experience step by step.

April 1963 marked the beginning of the first year of research. The theme selected was the source of power for the machine—human power. A device to measure the power generated when man steps on the pedal was manufactured on an experimental basis. A variety of experiments were conducted with the device, using students. The experiments definitely served to establish the characteristics of man as a power-generating organ.

The second year was devoted to operations research to determine the optimum airframe dimensions, weight, aerodynamic characteristics and other factors to make man-powered flight possible. The basic form of the airframe was defined on the basis of the research. The third year marked a transition to detail design and manufacturing. The long-awaited first M.P.A. was rolled out in February 1966. The machine was expected to be able to lift off the ground but not to sustain flight. As a token of modesty, the equipment was christened the Linnet, a little bird whose flying performance is considered rather unimpressive. Nihon University at that time did not have a runway of its own. Consequently, airframe assembly and test flights were carried out at Chofu Airfield.

On February 25th, 1966, the Linnet, with Munetaka Okamiya at the controls, lifted its wheels off the ground for the first time. The following day, the bird flew 15 metres, marking Japan's first successful steady flight of man-powered aircraft. The Linnet thus achieved the distinction of the world's fourth man-powered aircraft, following the Sumpac, Puffin I and Puffin II.



Assembly at Nihon University, the delicate structure explains the light weight.

Because of his aerial feat, Okamiya became the first Japanese who was able to walk on the ground, swim at sea and fly in the air using his own power. He chalked up the longest flight record of 41 metres in later test flights.

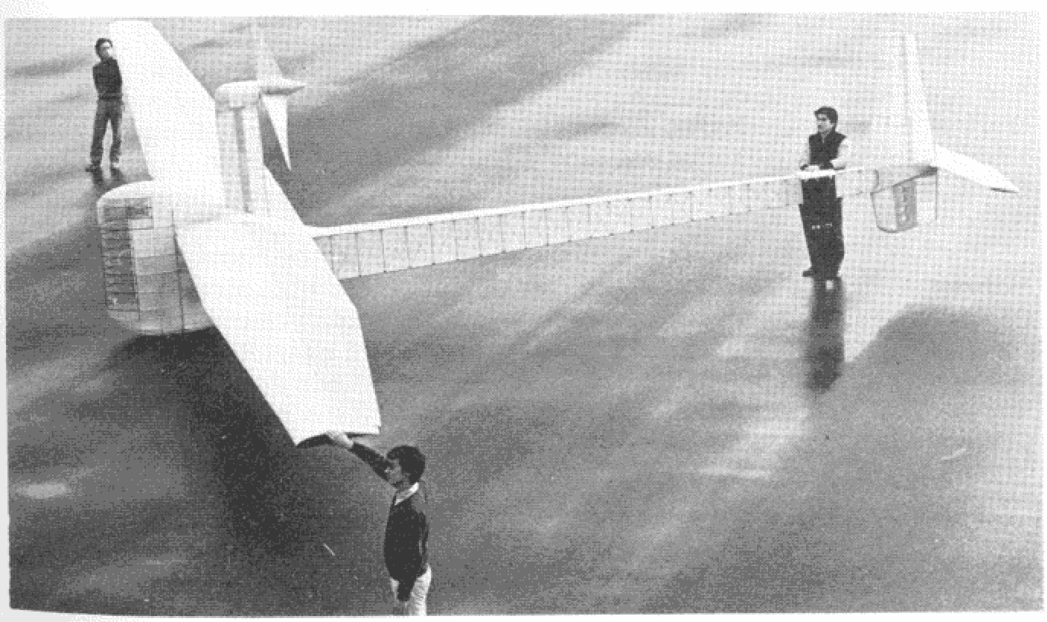
Following the initial flight programme trial-manufacture of subsequent models continued at a pace of one new machine almost every year, except for the period during which the university was embroiled in faculty-student disputes. The Linnet series was built up to the fifth model, using more or less the same basic form. The last model, however, remained unfinished. Such a series of research efforts had most satisfactory education effect on the students but did not produce any remarkable progress in the performance of man-powered aircraft—the longest flying record being on 91 metres registered by the Linnet II.

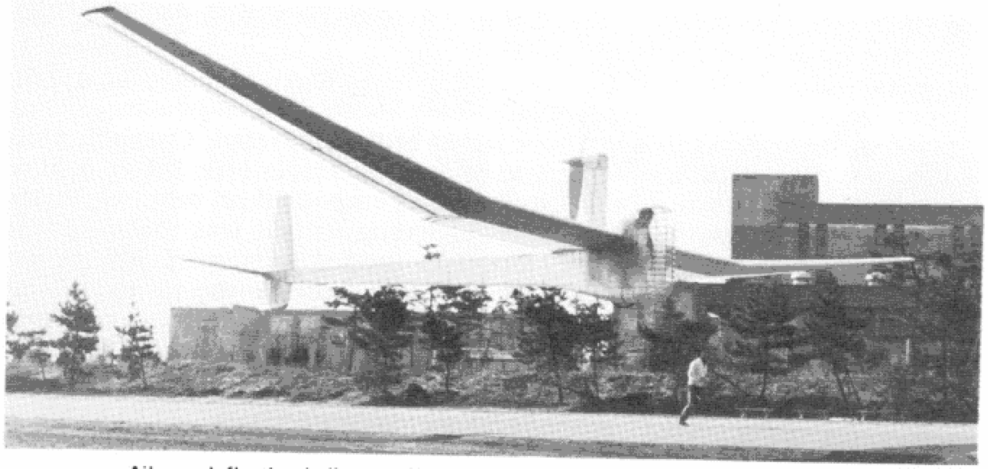
In spite of that, the team became confident that man-powered aircraft, which had hitherto been a nebulous entity, are flyable without fail, once built with their own hands. This was a great reward. Such accomplishment, of course, was made possible by the extraordinary efforts and dedication of the students. It turned out that building man-powered aircraft was not as easy a job as was manageable in the realm of a personal hobby. The key to the reasonable success of every flight of the Linnet series was the weight reduction of the airframe. In effecting the reduction, the team came to realise that use of styrene paper as the outer cover of the airframe would do the trick. This proved to be a particularly effective contributing factor. The outer cover is a thin sheet made by rolling styrolresins to a thickness of about 0·5 mm. Such material is light and effective in enhancing the rigidity of the airframe. It is also smooth in outer surface finish, a quality which is far superior to that of Melinex the surface of which slackens like a wet paper screen. There is a legend that use of styrene paper for the outer covering dawned on a student when he saw sashimi (raw fish) being sold in a wrapper made of that material. Combined use of styrene paper with *washi* (Japanese paper) produces even better results.

The basic form of the Linnet series embodied an original beauty which remains unparalleled. What was wrong with it was that a torque shaft measuring about 4 metres long was needed to transmit the power of the pilot from the pedals to the propeller because the propeller was located at the tail end. The vibration of the shaft, which was witnessed in the initial phase of the programme, was solved by increasing its outer diameter. The shaft, however, could not be elongated beyond reasonable limits. This made it impossible to elongate the moment arm of the tail. (The tail volume of the horizontal tail was 0·305 for the I model and 0·334 for the II model). Such structural deficiency brought on insufficient longitudinal stability, which demanded constant attention from the pilot to the maintenance of longitudinal trim. It was not easy to attend to the delicate manoeuvring of the aeroplane while pedalling with both feet at full power, simultaneously. There were many cases in which the machine hit the ground prematurely as a result of a loss of leg power caused by excessive demand for piloting. The pilots for the past series of man-powered flights were chosen from among holders of private pilot licenses.

In 1972, a well-equipped runway, 620 metres in length and 30 metres in width, was completed along with a hangar in the precincts of the Narashino School of Nihon University's Science and Engineering Department. The research base for man-powered aircraft was moved over

Covered with "gan hishi" Japanese paper, the newly built Stork in pristine condition.





Aileron deflection indicates effective control on Stork, flying at Narashino.

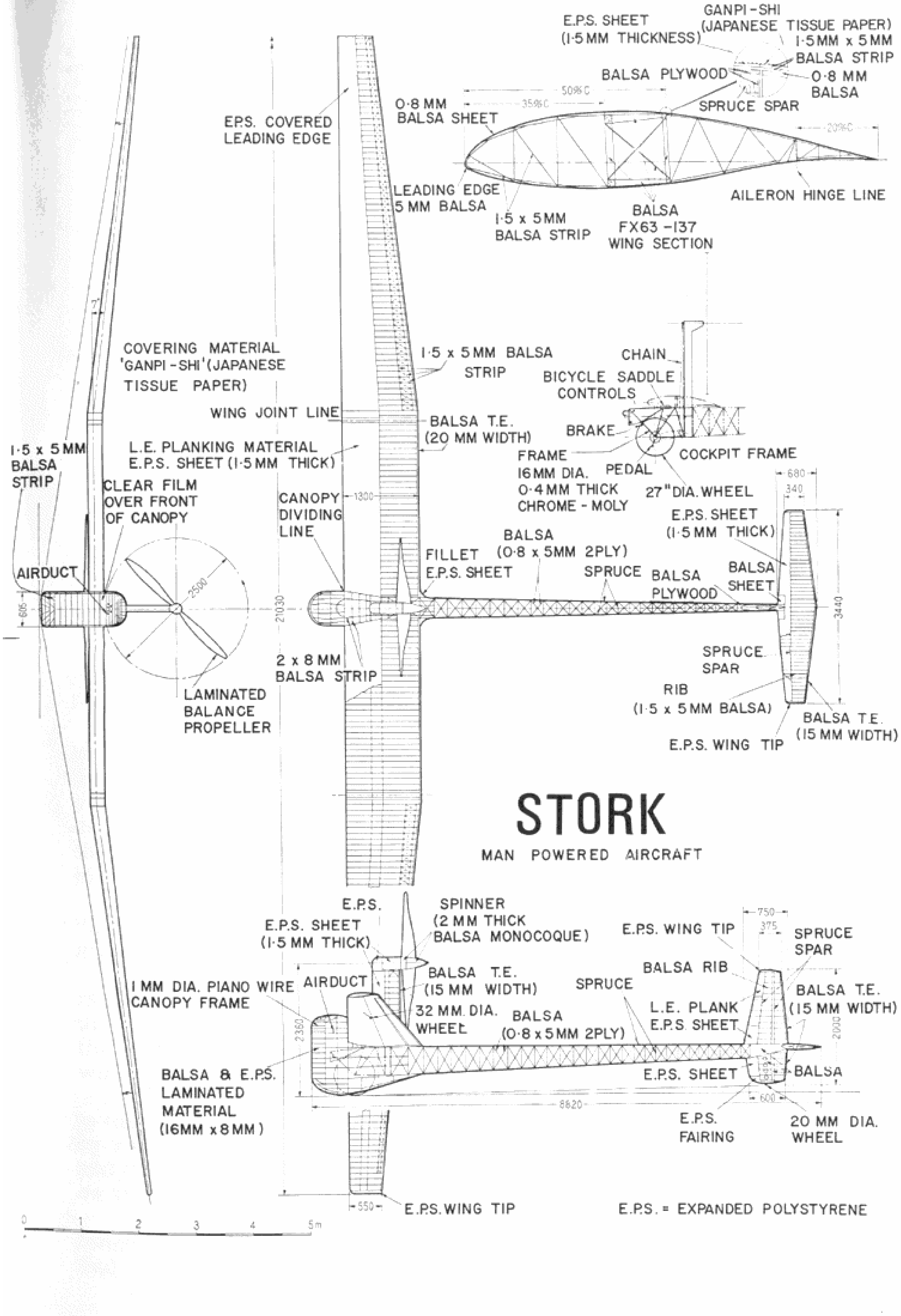
there. At the same time, design changes were incorporated. The new series was named the Egret, which was supposed to fly better than the Linnet.

Major improvements incorporated in the Egret series featured introduction of the belt drive to shorten the power transmission system. This was made possible by putting up a pylon for the propeller right behind the cockpit, as seen in the Sumpac and Jupiter. In keeping with the belt drive, the rear fuselage was elongated and the moment arm was increased for greater longitudinal stability. (The tail volume for the Egret III was 0·421.)

The II and III models of the Egret series demonstrated much more stabilised flight characteristics and came out with far better records than the Linnet series. The only exception was the I model which was destroyed on the ground by gusty winds, an accident which rendered full-scale testing out of the question.

The 1975 student team was composed wholly of enthusiasts who had been helping their seniors with the manufacture of man-powered aircraft since their freshman days. The team had an expert designer as its leader named Junji Ishii. Professor Kimura decided that he could entrust them with the task of undertaking drastic model changes. The new design was christened with the name of the Stork, which is something of a flier.

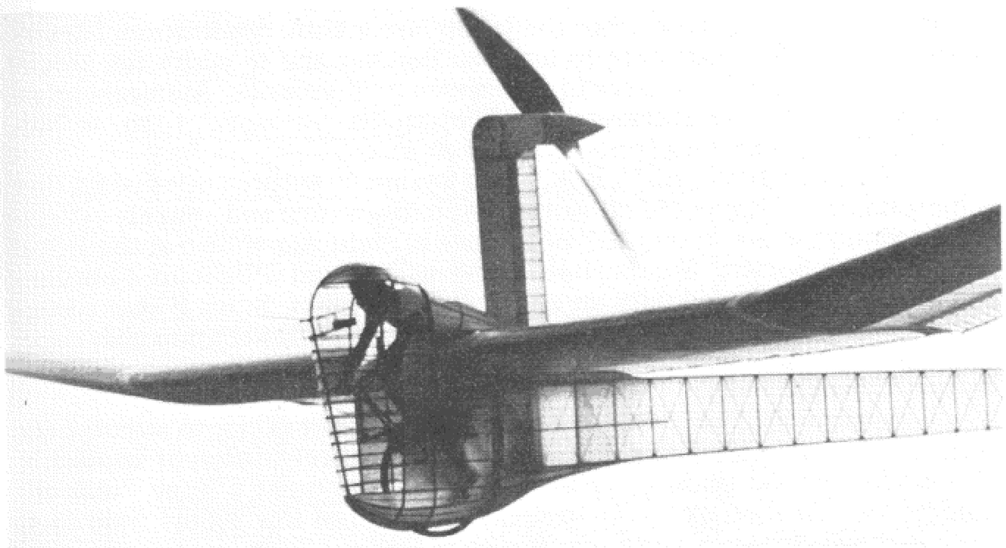
Compared with the Egret, the main target of the Stork was directed at further weight reduction and greater airframe engineering precision (which equates itself with improved aerodynamic characteristics). To achieve these objects, whole-hearted efforts were exerted and exhaustive studies pursued. The left and right wings were made detachable to facilitate the transport of the airframe on the street. This resulted in a weight penalty of about 2 kg. as compared with the conventional one-piece wing. Nevertheless, an overall weight reduction was successfully achieved in terms of an empty weight of 36·0 kg., an incredible figure, while preserving satisfactory rigidity. It is worth noting that in addition to the hitherto used foam plastic panel, *gan hishi* (a Japanese paper) was used for the outer covering of the various parts of the airframe. Most important of all, this


E.P.S. SHEET (1·5 MM THICKNESS)
GANPI-SHI (JAPANESE TISSUE PAPER)
1·5 MM x 5 MM BALSA STRIP
BALSA PLYWOOD
0·8 MM BALSA
SPRUCE SPAR
0·8 MM BALSA SHEET
E.P.S. COVERED LEADING EDGE
LEADING EDGE 5 MM BALSA
1·5 x 5 MM BALSA STRIP
BALSA
FX63-137 WING SECTION
AILERON HINGE LINE
COVERING MATERIAL 'GANPI-SHI' (JAPANESE TISSUE PAPER)
1·5 x 5 MM BALSA STRIP
CHAIN
BICYCLE SADDLE
CONTROLS
WING JOINT LINE
BALSA T.E. (20 MM WIDTH)
BRAKE
L.E. PLANKING MATERIAL E.P.S. SHEET (1·5 MM THICK)
FRAME 16 MM DIA. 0·4 MM THICK CHROME-MOLY
PEDAL
COCKPIT FRAME
27" DIA. WHEEL
1·5 x 5 MM BALSA STRIP
CLEAR FILM OVER FRONT OF CANOPY
CANOPY DIVIDING LINE
E.P.S. SHEET (1·5 MM THICK)
BALSA (0·8 x 5MM 2PLY)
FILLET E.P.S. SHEET
SPRUCE
BALSA PLYWOOD
BALSA SHEET
AIRDUCT
2 x 8 MM BALSA STRIP
LAMINATED BALANCE PROPELLER
SPRUCE SPAR
RIB (1·5 x 5 MM BALSA)
BALSA T.E. (15 MM WIDTH)
E.P.S. WING TIP
STORK
MAN POWERED AIRCRAFT
E.P.S.
SPINNER (2 MM THICK BALSA MONOCOQUE)
E.P.S. SHEET (1·5 MM THICK)
E.P.S. WING TIP
SPRUCE SPAR
BALSA RIB
1 MM DIA. PIANO WIRE CANOPY FRAME
AIRDUCT
BALSA T.E. (15 MM WIDTH)
SPRUCE
32 MM. DIA. WHEEL
BALSA (0·8 x 5MM 2PLY)
L.E. PLANK E.P.S. SHEET
BALSA T.E. (15 MM WIDTH)
BALSA & E.P.S. LAMINATED MATERIAL (16MM x 8MM)
E.P.S. SHEET
BALSA
E.P.S. FAIRING
20 MM DIA. WHEEL
E.P.S. WING TIP
E.P.S. = EXPANDED POLYSTYRENE

MAN-POWERED AIRCRAFT OF NIHON UNIVERSITY

	Aircraft	Linnet I	Linnet II	Linnet III	Linnet IV	Egret I	Egret II	Egret III	Stork I
	Date of first flight	26 Feb. 66	19 Feb. 67	26 Mar. 70	13 Mar. 71	28 Feb. 73	30 Oct. 73	16 Nov. 74	12 Mar. 76
	Maximum distance flown (m.)	43	91	31	60	34	154	203	595
Dimensions (m.)	Wing span (m.)	22·30	22.30	25·30	25·30	22·70	22·70	23·00	21·00
	Length O.A. (m.)	5·60	5·80	5·86	5·80	7·40	7·71	7·70	8·85
	Height O.A. (m.)	4·185	3·52	4·14	4·14	2·29	3·66	3·70	2·40
	Tailplane span (m.)	5·40	5·40	5·80	5·91	4·00	5·00	4·70	3·44
Areas (m^2)	Wing, gross	26·0	26·0	30·2	30·2	28·5	28·5	28·5	21·7
	Ailerons, total	2·20	2·20	—[1]	—[1]	1·90	3·11	2·40	2·52
	Fin	0·97	0·97	1·55	1·55	0·75	1·04	1·01	0·81
	Rudder	0·46	0·46	0·45	0·45	0·50	0·56	0·76	0·35
	Stabilizer	2·18	2·18	—[2]	2·33	—[2]	1·98	2·13	—[2]
	Elevators	1·46	1·46	3·40	1·55	3·30	1·32	0·70	1·71
Wing	Aerofoil section	NACA63_3-1218	NACA63_3-1218	NACA8418-8415	NACA8418	FX61-184	FX61-184	FX61-184	FX61-184/FX63-137
	Wing thickness %	18·0	18·0	18.0 ~ 15·0	18·0	18·4	18·4	18·4	18·4 ~ 13·7
	Aspect ratio	18·5	18·5	21·2	21·2	18·1	18·1	18·6	20·3
	Taper ratio	3:1	3:1	3:1	3:1	2·5:1(O.W.)	2·5:1(O.W.)	2:1(O.W.)	2·36:1(O.W.)
	Dihedral	3°	3°	6°	6°	6°(O.W.)	6°(O.W.)	6°(O.W.)	7°(O.W.)
Propeller	Diameter (m)	2·70	2·70	3·00	3·00	2·70	2·70	2·70	2·50
	r.p.m.	160	200	12·5	125	180	180	120	210
	Speed of aircraft (m./s.)	8·2	8·0	7·6	7·7	8·5	9·6	9·8	8·6
Weights	Weight empty (kg.)	50·6	44·7	49·8	55·0	57·0	55·7	61·1	35·9
	Flying weight (kg.)	108·6[3]	102·7[3]	107·8[3]	113·0[3]	115·0[3]	113·7[3]	119·1[3]	93·9[3]
	Wing loading (kg./m^2)	4·18	3·95	3·57	3·74	4·04	3·99	4·18	4·33
Weight (kg.) breakdown	Wing	22·83	19·23	22·0	N.A.	25·3	24·0	33·0	19·9
	Tail unit	4·03	3·23	3·1		3·0	3·0	2·8	1·0
	Control system	0·86	0·96	1·0		5·0	4·7	2·9	} 7·4 (Control system, Fuselage, Undercarriage)
	Fuselage	11·90	12·68	12·0		11·5	15·0	} 15·0 (Fuselage, Undercarriage)	
	Undercarriage	2·55	2·55	3·5		3·0	3·0		
	Propeller	} 4·78 (Propeller, Transmission)	1·03	1·3		1·2	1·0	1·4	1·0
	Transmission		3·66	5·5		5·0	5·0	6·0	5·6
	Miscellaneous	3·65	1·36	1·4		3·0	—	—	—

opposite
Churei pedals Stork B on one of many long flights at the Shimofusa air base, the coarse propeller pitch is a characteristic of Man-Powered Aircraft.



truly outstanding achievement deservedly owes to Ishii's design policy which was attentive to every inch of the airframe and allowed not a single gram of excess weight. The Stork featured a longer moment arm than the Egret series (horizontal tail volume: 0·535), use of the chain drive, instead of the belt, for power transmission (the belt caused trouble because it often got out of place while in driving operation as a result of deflection of the shaft) and a system for driving the wheel while taxing. In the Linnet and Egret series, only the propeller was driven.

On March 14th, 1976 the Stork, with Kazuhiko Churei as pilot, achieved a glorious new flying record of 446 metres. The way the bird flew comfortably at an altitude of 2 to 3 metres gave it the distinctive style of its own, strikingly similar to the British Jupiter. With the successful debut of the Stork, the man-powered aircraft of Nihon University reached the level of their British counterparts for the first time in their 10-year history.

Continuing the success tests, Churei went on to make an unofficial flight of 650 metres on May 10th, and built up an enviable record of many flights over 600 metres in length, leading up to the first 180° turn on June 4th. Flying at a banking angle of 10°, at a height of 3 metres and turn radius of 30 metres, Churei demonstrated the ease of control coordination in the refined design of Stork. Takashi Kato made some flights in between those by Churei and was to be the new pilot for the next phase of tests with Stork B, starting 24th November.

Changes to the aircraft were waxing of the wing leading edge back to the rear spars, increased rigidity of the welded steel tube cockpit area by addition of balsa bulkheads, which improved transmission efficiency and the movement of the elevator was decreased in proportion to "twist" on the pilot's control bar.

By January 4th, 1977 Stork B version had made 43 flights, nine longer than 800 metres and one which became a new record for distance and duration.

Flying over the 2200 metre runway at Shimofusa Naval Air Base, Kato made an unofficial 2074·9 metre flight which lasted 4 minutes 43 seconds. Official observers from the Japan Aeronautic Association, Messrs Watanake and Yagasaki were on hand on January 2nd to verify the official record flight of 2093·0 metres in 4 minutes 27·8 seconds. Meteorological conditions were: temperature 5° centigrade, pressure 1019 m/bar, humidity 29% and wind velocity 0–0·1 m/m.s.

Through 1977, the M.P.A. world anxiously awaited news of further achievement. A film record of Stork completing a turn and actually reversing direction for the second half of a figure of eight was shown at the Royal Aeronautical Society Symposium in Man-Powered Flight in February 1977 and was rewarded with an appreciative ovation. Stork B was recognised as the most advanced Man-Powered Aircraft flown up to that time.

In the U.S.A.

Meanwhile Paul MacCready decided at short notice to attempt the seemingly impossible Kremer course with an entirely different approach. His modelling and gliding experience led him to make a huge "indoor" model—no less than 95 ft. (35 metres) span and of low aspect ratio (9.5) so that the area became 1000 sq. ft. (93 m.^{2}).

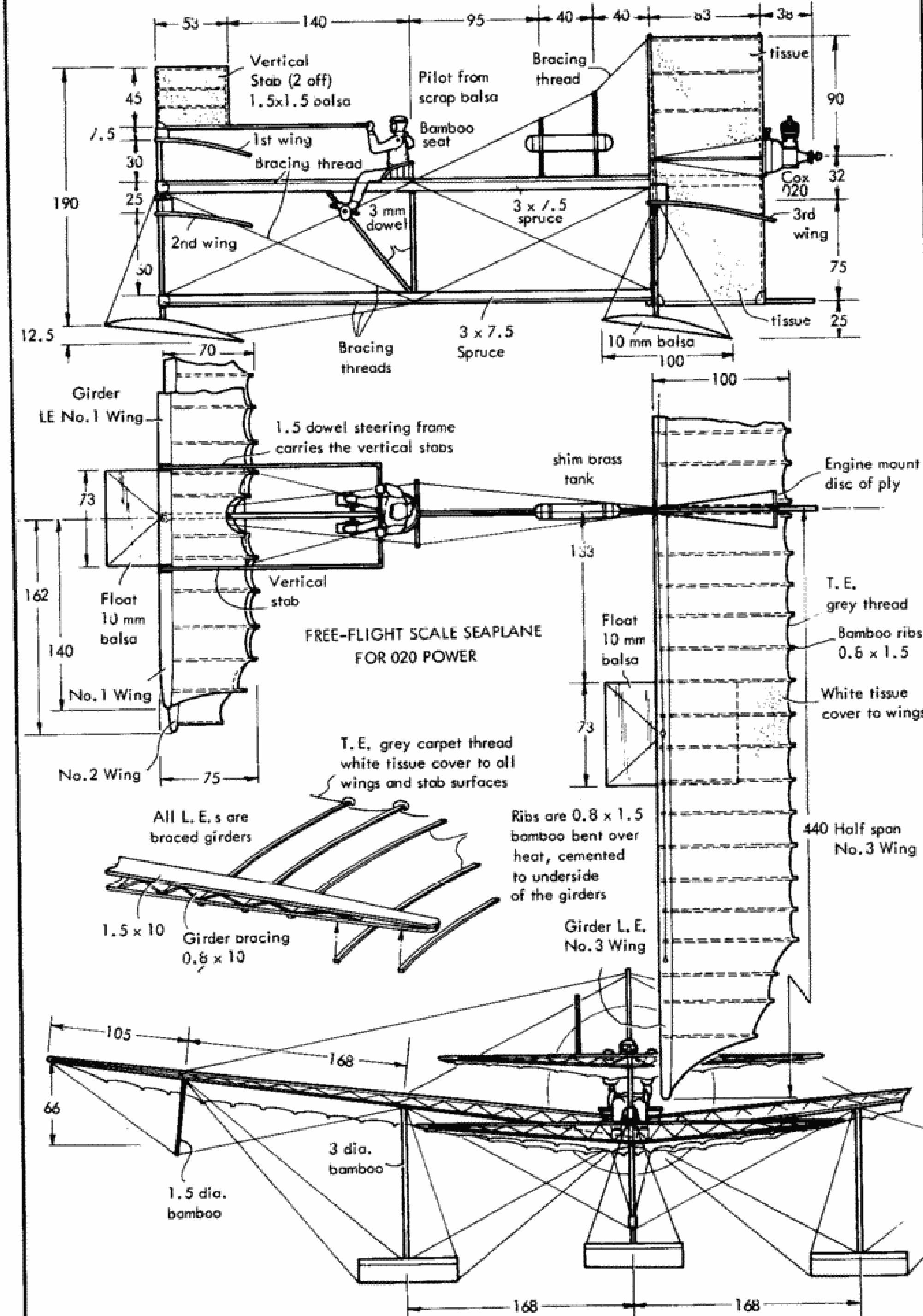
Empty weight of 70 lb., with son Tyler MacCready adding another 110 lb. gave a wing loading of only 0·18 lb./sq. ft.—in other words much less than normal for a free flight glider model! Only snag for this ultra-lightweight canard configuration M.P.A. was that it could not be handled in a wind greater than 2 m.p.h.! Although drag features were high calling for 0·35 b.h.p. to fly level, the Gossamer Condor shattered all pessimism by flying remarkably well over a Californian dry lake, Made in 3 months, it logged a hundred flights within a further month (December 1976) before the problems of turbulence, crosswinds and handling emerged. Propeller stall and acute drag will be familiar to all indoor model flyers and the Gossamer Condor ran these risks in its 40 × model size concept. Nevertheless it was the one machine which rivalled Stork for activity in the M.P.A. field and surprised the world with its unique approach.

A new double surface, tapered wing enabled the Condor to fly for over 6 minutes and through figure eights during over 400 flights in the first 6 months of 1977. After a few mishaps, the Condor was developed into a 96 ft., 12·8 aspect ratio sweptwing, with a foreplane which tilted or changed pitch for control. On August 23rd, 1977, Bryan Allen flew the course at Shafter Airport for an officially observed 6 minutes 22·5 seconds duration figure of eight and so the eighteen-year-old prize of £50,000 was claimed. Happily this does not terminate the story as Henry Kremer immediately and generously gave more prizes for the next achievements.

Readers seeking further information on the Kremer Prizes for achievement in Man-Powered Flight may obtain details on application to the Secretary, MPA Committee, Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ. See also *Man Powered Flight* by Keith Sherwin, published as an MAP Technical Publication by Argus Books, 192 pages, fully illustrated with design notes and historical data on most MPA projects, £2.95 in paperback binding.

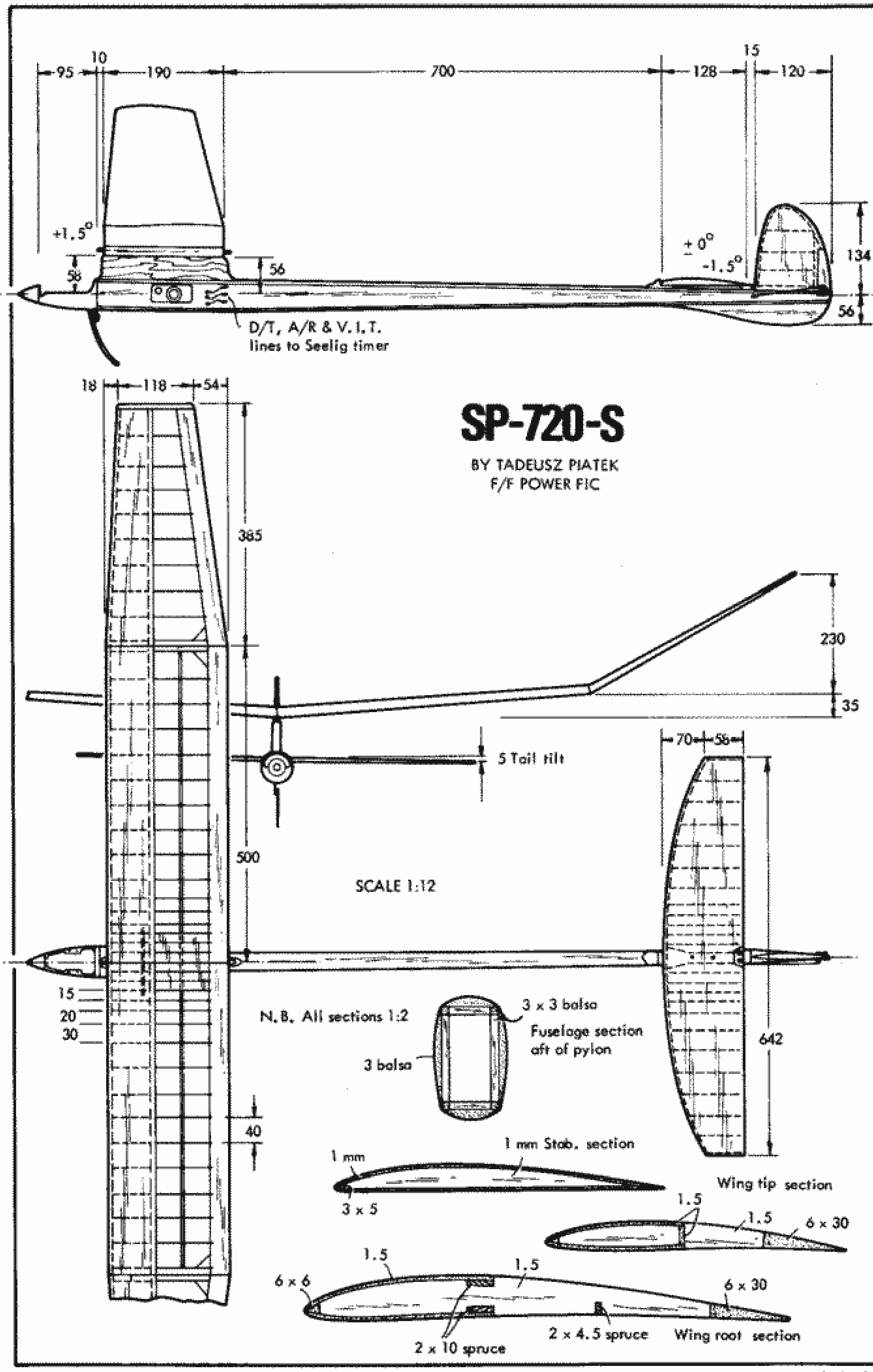
1910 FABRE HYDRAVION

BY W. R. STROMAN

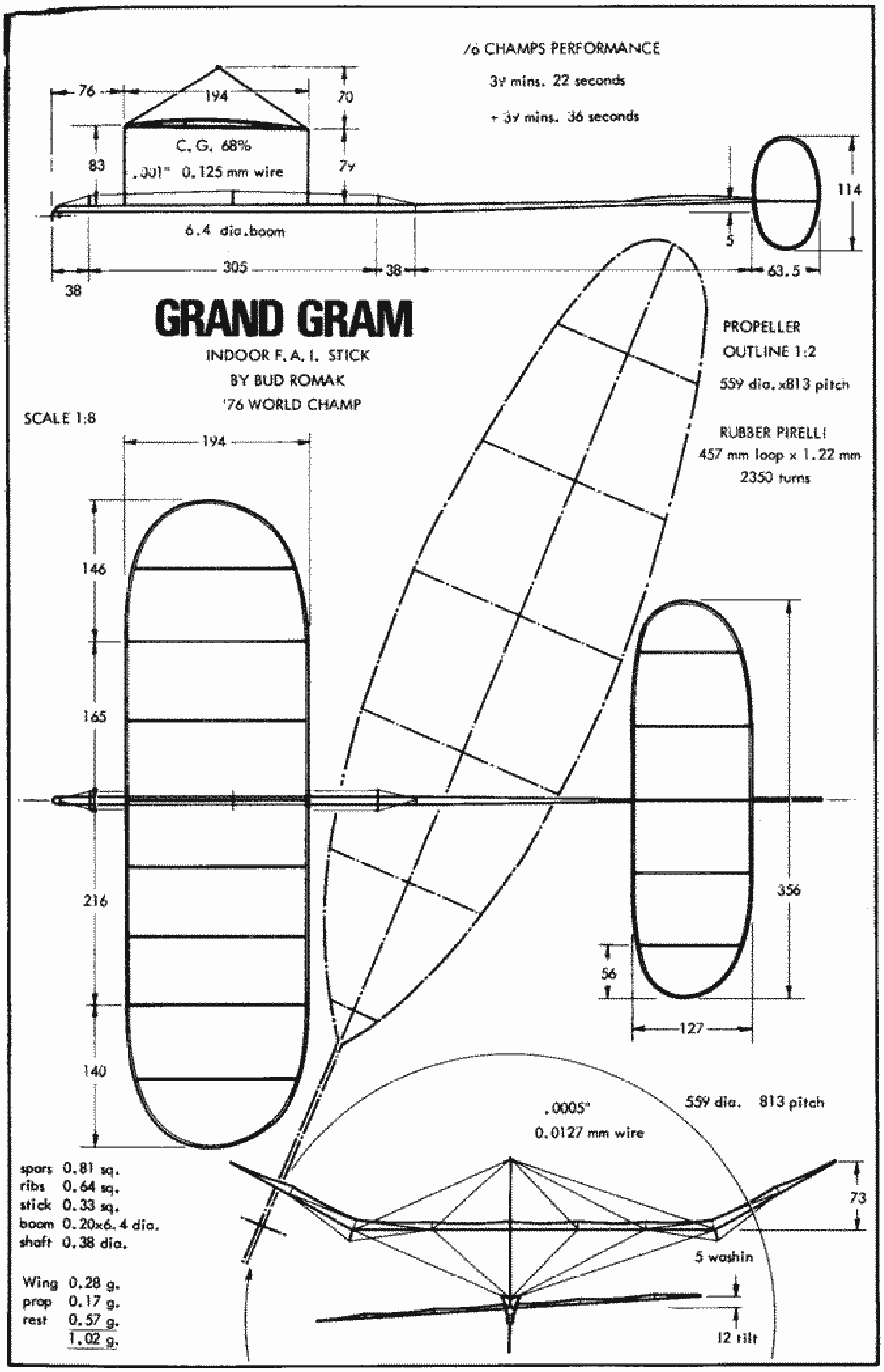


SCALE 1:6

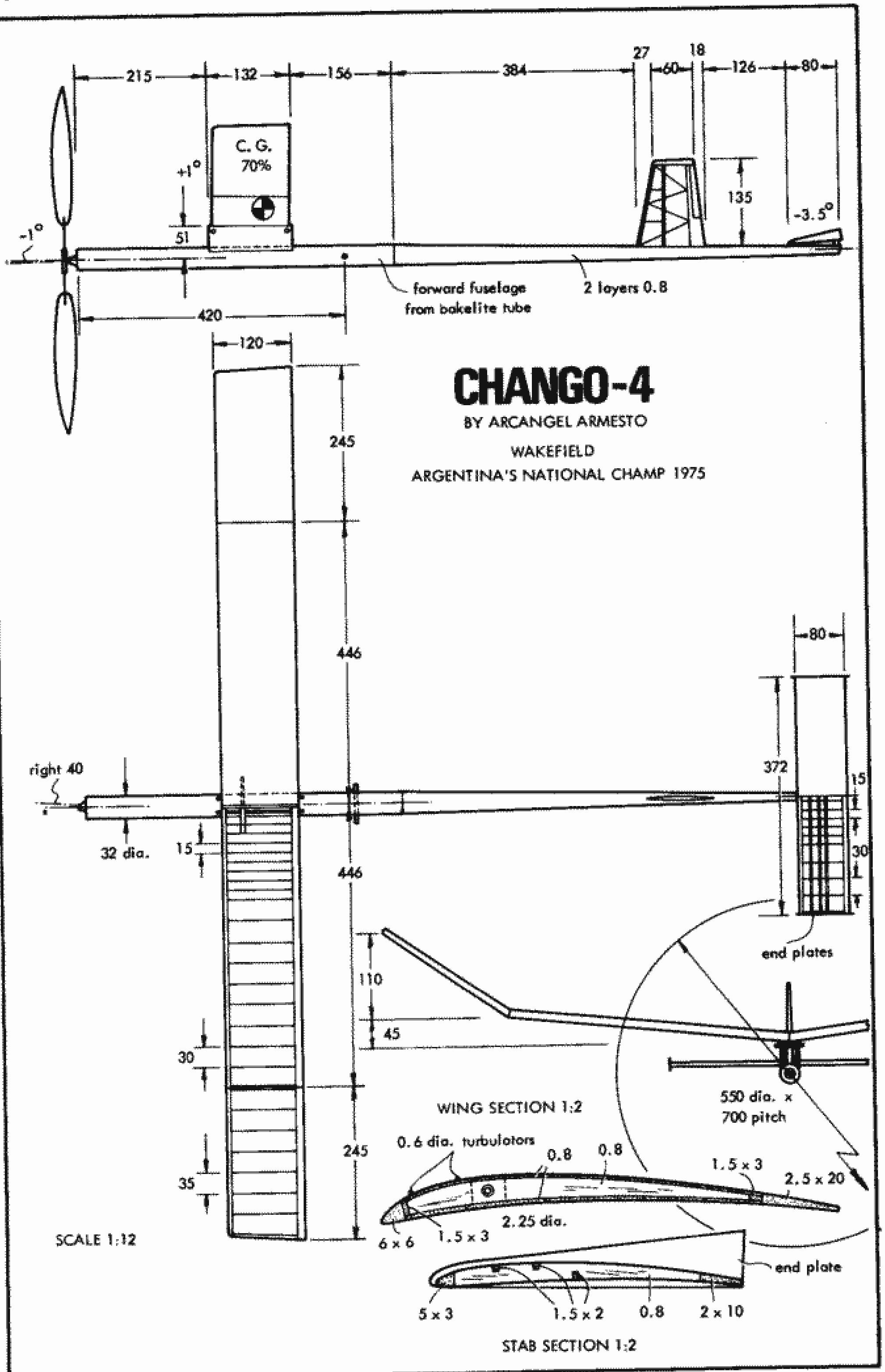
FLYING MODELS U.S.A.



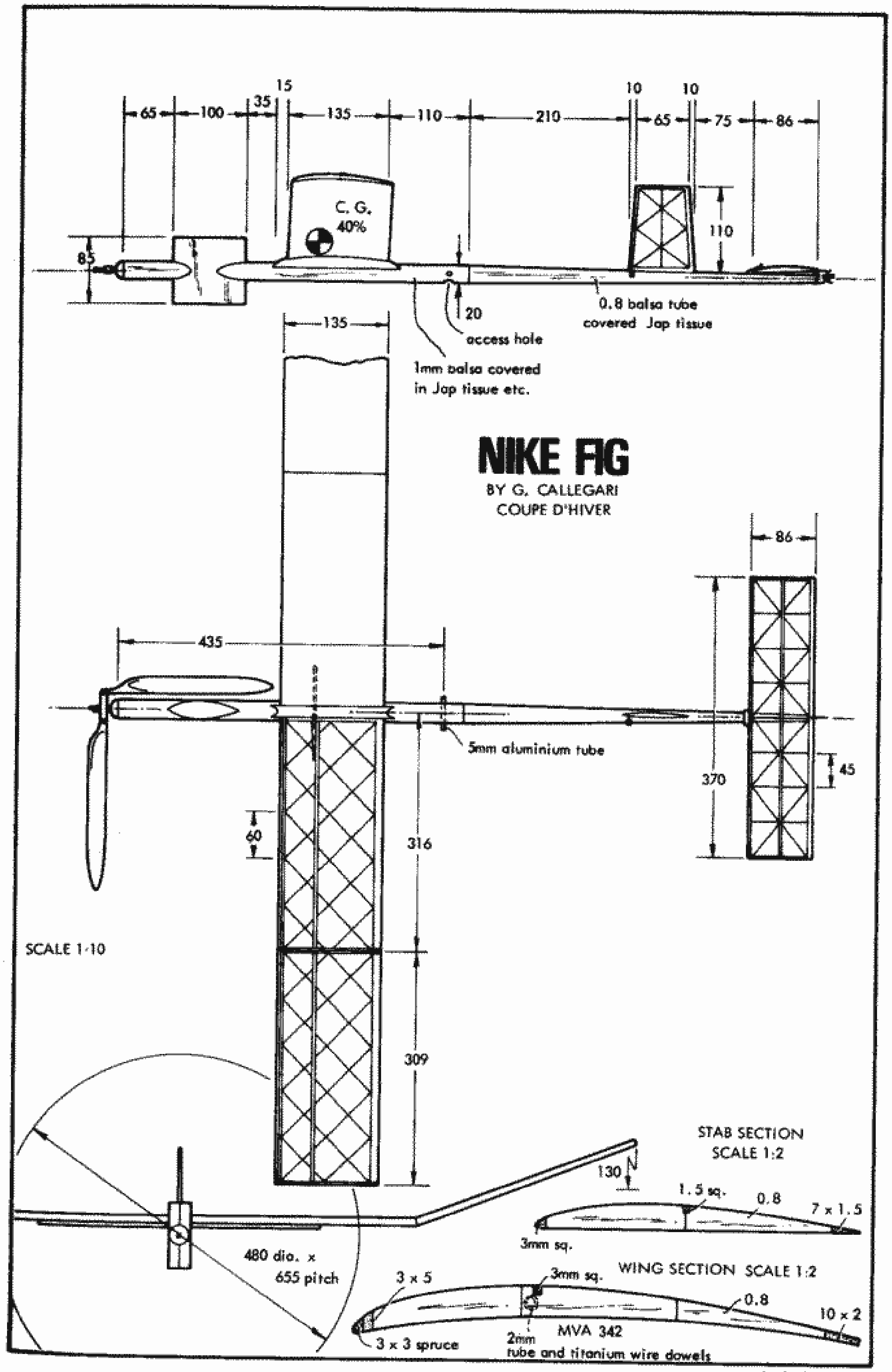
MODELARZ POLAND



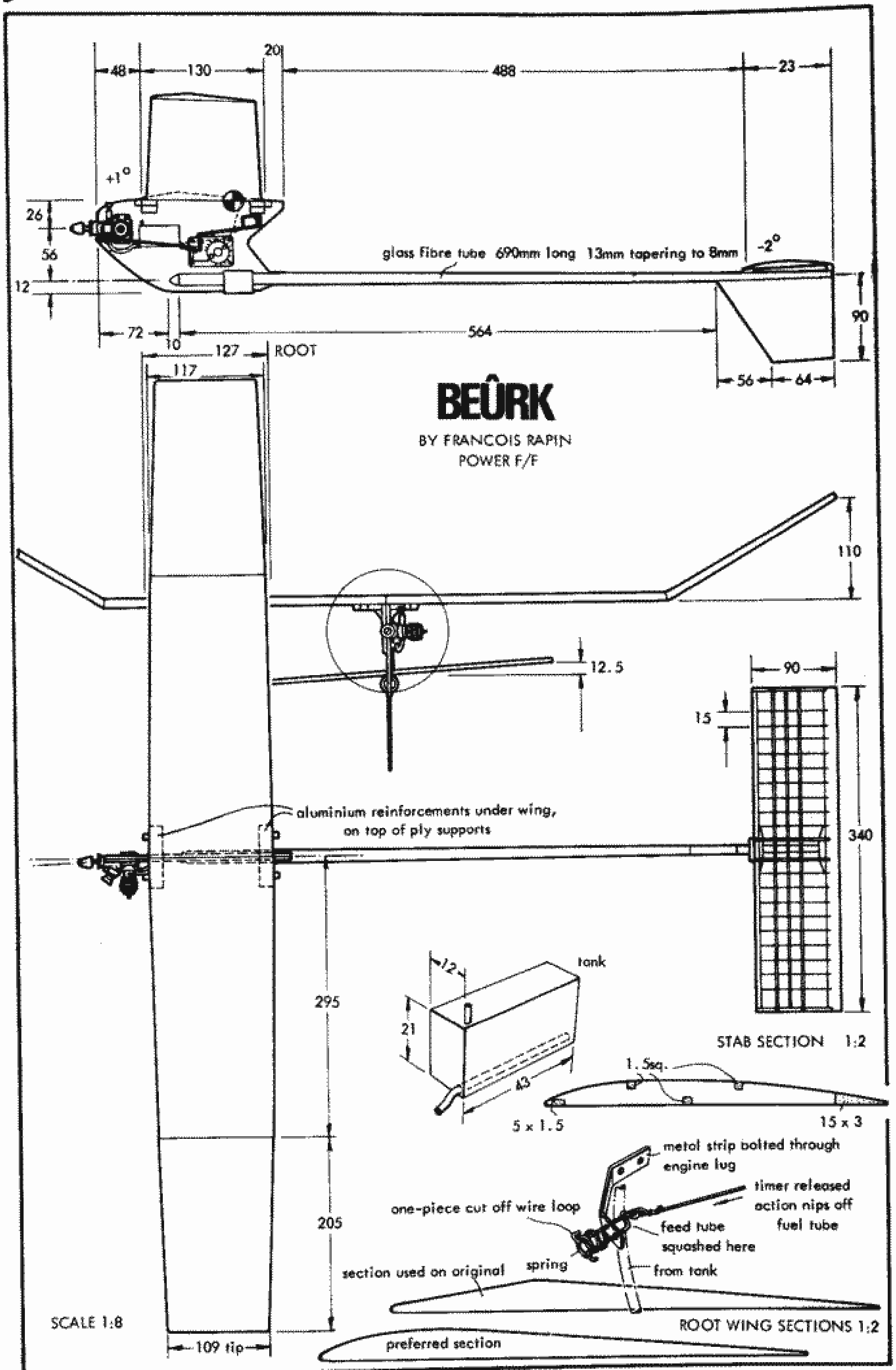
FROM MANY SOURCES INCLUDING MODELLFLYGNYTT SWEDEN



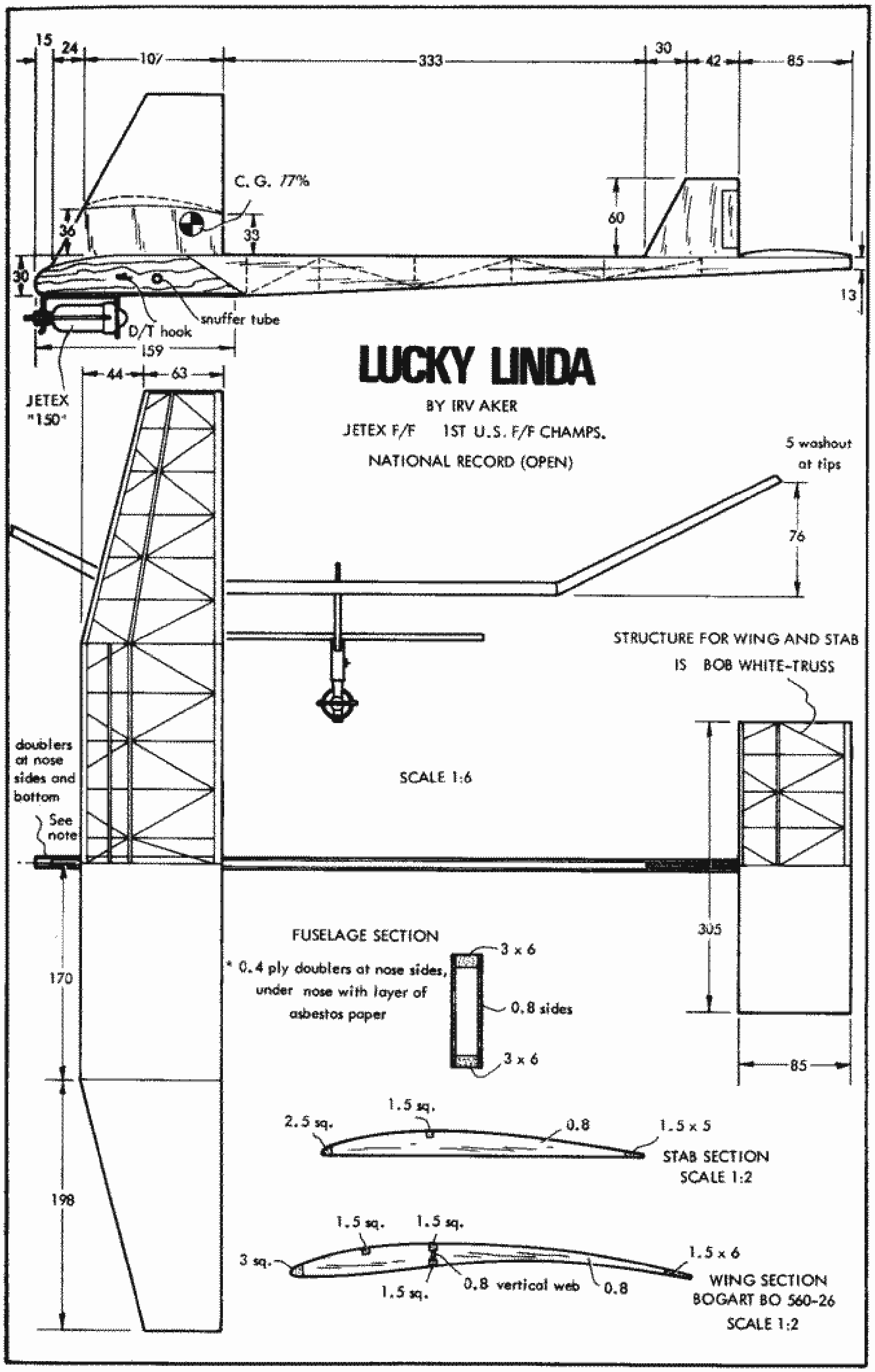
ALAS ARGENTINA


NIKE FIG
BY G. CALLEGARI
COUPE D'HIVER
65
100
35
15
135
110
210
10
10
65
75
86
C. G.
40%
110
85
20
access hole
0.8 balsa tube
covered Jap tissue
1mm balsa covered
in Jap tissue etc.
135
86
435
5mm aluminium tube
370
45
60
316
309
SCALE 1:10
STAB SECTION
SCALE 1:2
130
1.5 sq.
0.8
7 x 1.5
3mm sq.
WING SECTION SCALE 1:2
480 dia. x
655 pitch
3 x 5
3mm sq.
0.8
10 x 2
MVA 342
3 x 3 spruce
2mm
tube and titanium wire dowels

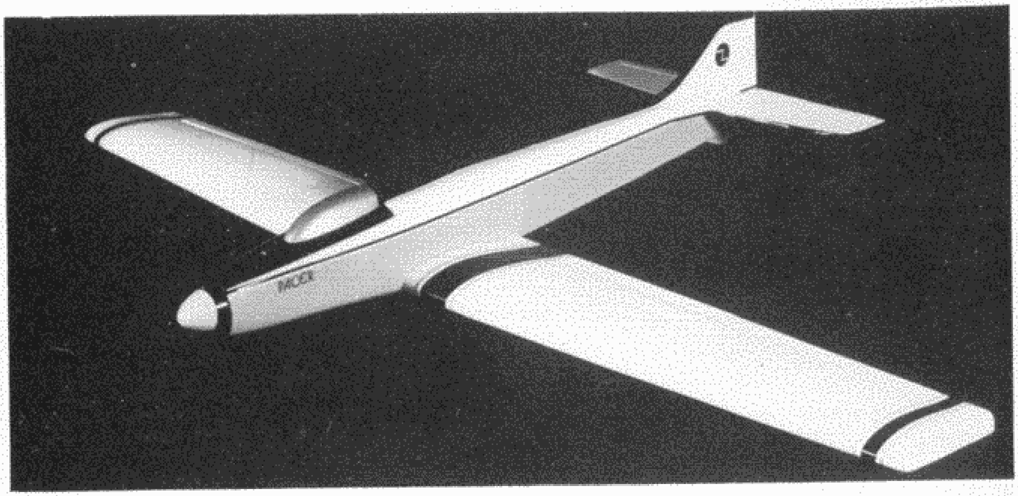
AVA ITALY



LE MODELE REDUIT D'AVION FRANCE



FREE FLIGHT NFFS USA



Famous Pacer, first published 1974, set standard for 1/2A performance, designed by Owen Kampen, kitted by Ace.

THE 1/2A REVOLUTION

by Alan A. Scidmore (*From R/C Sportsman, U.S.A.*)

By way of introduction . . .

ON OUR WAY to the E.A.A. annual wall-to-wall aeroplane event at Oshkosh in August 1976 we (Editor, his brother and son) stopped over with Carl Mohs at Madison, the university city of Wisconsin. We were overwhelmed by the idyllic situation of this beautiful spot. The huge lakes, beautiful dairyland, and strong aeronautical associations made Madison a prime hit with the wandering trio of modellers. More so when we were to discover how well organised is the Madison Area R/C Society (M.A.R.C.S.) with their aeromodelling centres laid on by the municipality. Even more so when it became apparent that we were in the company of a most inspiring group of inventive designers. In one hectic evening we flew a floatplane off the lake, watched a whole range of models being flown for fun off the close mown model park and came to realise we were with the very origins of the half-A craze that has swept across the U.S.A.

Among M.A.R.C.S.' 87 members is Owen Kampen, U.S. protagonist for rudder only, pulse designs and creator of 1/2A Pylon as well as 1/2A Aerobatics. His Pacer design initiated the concept which thousands have since followed for foam wing 22 oz. aileron/elevator controlled miniatures of the big-brother stunt models which will fly through the pattern, survive crashes, give full flight satisfaction and yet cost so little to build and operate. Owen showed how the Pacer performs, while fellow clubster Frank Baker put a semi-scale B26 with ·049s through its paces. Clearly we were missing something in Europe. Cannon lightweight R/C is best; but not essential. Any two function outfit of recent vintage can be accommodated and is light enough. Yet now, even a whole year later, the craze has yet to cross the Atlantic. Alan A. Scidmore, also in M.A.R.C.S., contributed a most useful description of this enthusiasm for 1/2A in *R/C Sportsman* which we feel sums up the spirit behind the class admirably.

Over to Alan . . .

In the not-too-distant past, the description "1/2A" or "Half A" meant small, rudder-only models which were all too frequently seen progressing rapidly down-wind in partially controlled swooping manoeuvres with the pilot hoping for the motor to stop. With the development of the light, reliable, relatively inexpensive semi-conductor/integrated circuit radio gear, however there has been quite a revolution in 1/2A R/C, particularly in the U.S.A. and surprisingly it has been slow to come to Europe.

Availability of this superb radio equipment has made many things possible which were previously unthinkable. Competition in 1/2A racing and aerobatics has been growing rapidly as well as sport flying. If you haven't considered 1/2A you are missing something. In this day of £50 kits, £75 engines, and £300 radios, the availability of small kits and two function radios is welcome indeed.

Half A flying is economical any way you slice it. A gallon of 25% Nitro will last forever—well, almost. The 1/2A model will fit into your Honda, Toyota, Fiesta, Mini etc., with lots of extra room for the small flight box needed. You won't hear a 1/2A pilot speak of 75p landings when the prop hits the terra-firma. A roll of Solarfilm or MonoKote will cover more than one model. Replacement engine parts are less costly. Need I say more about cost? Or should I drop a word comparing building time for the wee ones with that for the big ones? To some of us time is as valuable as money (*at times more valuable*—Ed).

Cox Tee Dee 051 with the Canadian Tarno Carb is an impressive combination. Rules for 1/2A aerobatics require neither silencer nor throttle but ecological demands in some areas make them advisable.

Perhaps you have steered away from 1/2A because of the association of 1/2A with the mass toy market. Don't underestimate the capabilities of a good 1/2A aerobatic type like the Pacer, or the thrill of racing snarling little 1/2A speedsters around a course in competition with fellow modellers. Or even the stability, reliability and just sheer pleasure of a 1/2A sport plane like the Wizard. A well balanced and trimmed Pacer with a good TD·049 can give you more thrills than you realise if you haven't tried it. These little craft are capable of most of the manoeuvres usually associated with the ·40 and ·60 size bombs. Inside loops, outside loops, inverted flights, axial rolls, and the eights can be beautifully done. With experience even four point rolls, vertical rolls, vertical 8s, a sort of a stall turn can be accomplished.

On the other hand don't be misled into thinking that it's all easy. Most 1/2A racers and sport planes are built with stability in mind and are relatively easy to fly. The aerobatic machines, however, are a different breed. They are not only designed to be neutrally stable, but they are extremely quick. This means that you have to keep alert and fly them all the way. Like its larger cousins the 1/2A aerobatic craft goes where you point it. If you put it in a nose up attitude or wing down attitude, it just stays that way until you correct its attitude. After your your first few flights with one of these gems you may say "wow—that's fun," but your hands will be shaking.

Landing these things is different as well. The wing loading is not high (if you are reasonably careful) and these aerobatic types are exceptionally clean—especially if no landing gear is used. The first landings usually overshoot your intended spot since they seem to glide forever. Some of

Designer Owen Kampen fires up one of his "bigger" sportsters at the M.A.R.C.S. field.

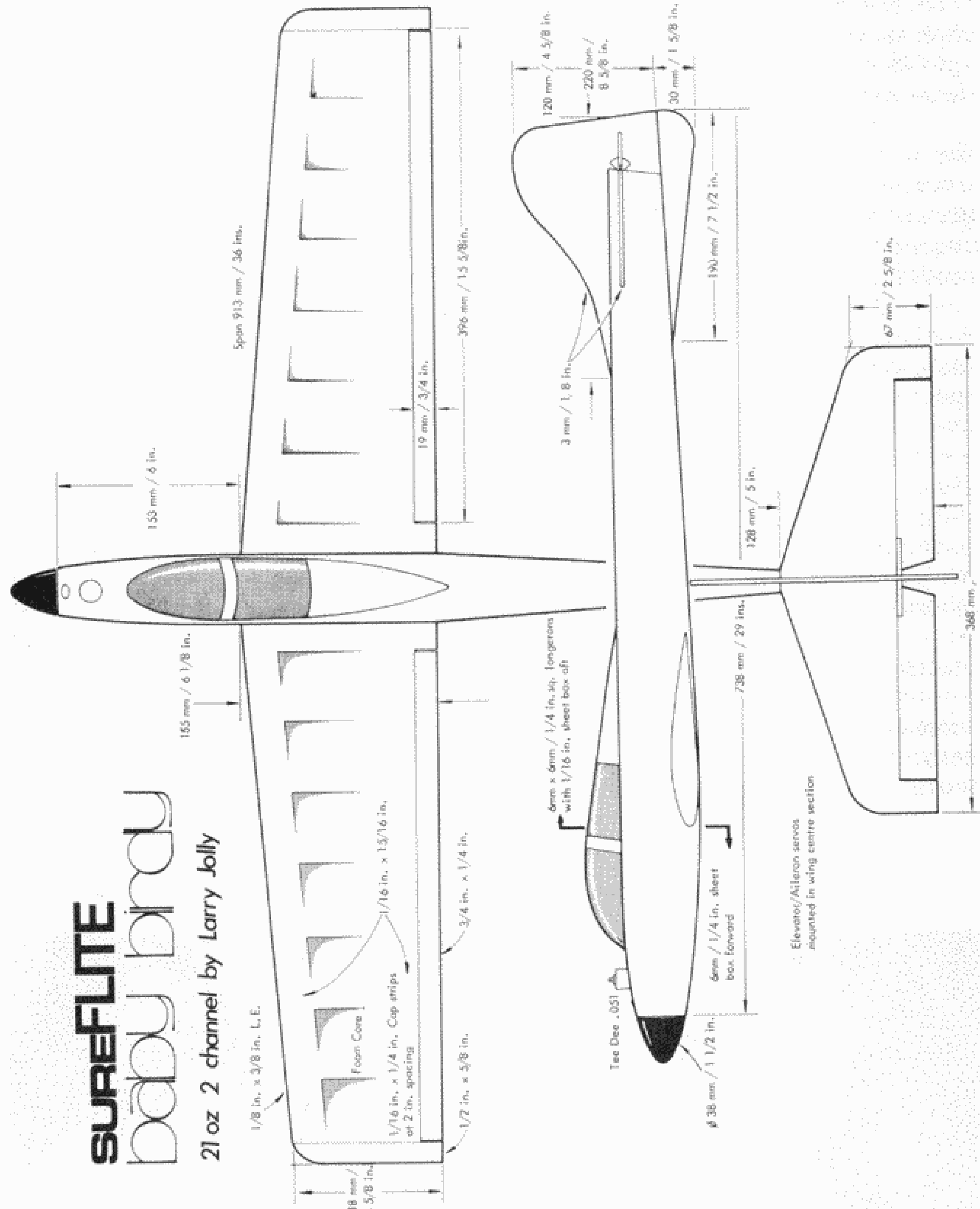
1/2A hot rocks in the Madison, Wisconsin M.A.R.C.S., do several dead-stick manoeuvres to kill speed or altitude. A dive, a loop, a roll, then a split-S into the wind before lining up to touch down. Fantastic fun with these little machines!

If you already have the 1/2A bug or want to enlarge your vistas for next year's modelling activities, why not promote some local 1/2A events? For example, 1/2A racing has been well publicised. Rules, suggested procedures, equipment for carrying out races, designs, and even engine tune-up and modification have all been dealt with in articles in the modelling magazines.

Madison club had its first formal scheduled 1/2A racing event in August, 1975. The interest started by that race was phenomenal. A second race, quickly scheduled for Memorial Day, was a success too with both spectators and pilots thoroughly enjoying it. However, club philosophy was somewhat different than that promoted by the R/C modeller rules. Perhaps you might consider some of these thoughts in promoting 1/2A events in your area. First, there aren't a large number of really competitive modellers in the M.A.R.C.S.—at least not in the way usually promoted in the modelling press. There are many creative, original, and wonderful people; but a majority are not interested in participation in the usual pattern or pylon competitions. Club 1/2A pylon rules reflect our attempt to keep from developing a limited interest event for the ultra-specialist who can modify engines.

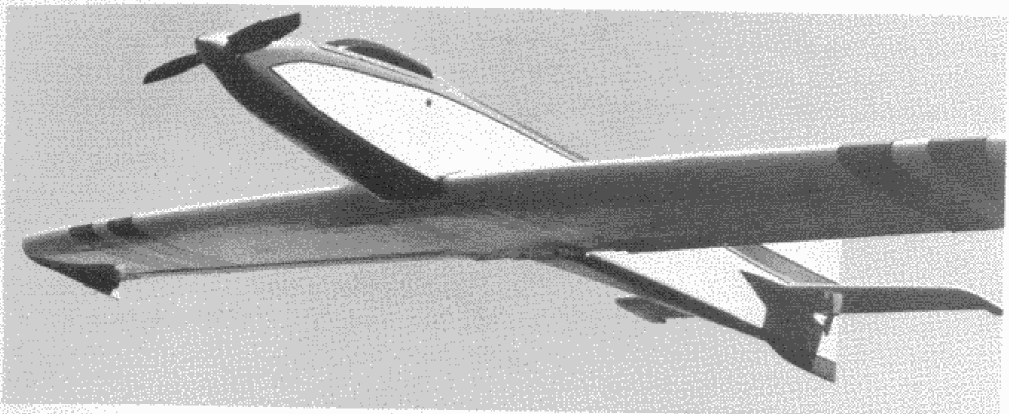
There were wing area (200 in.^{2}), wing thickness ($\frac{7}{8}$ in.) fuselage cross-sectional area (8·5 in.^{2}), and weight (20 oz.) minimum requirements. However, the engine had to be unmodified (Kirn-Kraft specials not allowed) without pressure, and with a maximum of 25% nitro in the fuel. These

Frank Baker starts his ·049 in the Pacer at Madison. Model has foam wings, 40 in. span.



restrictions accomplished two goals: first, it kept the equipment price down making the equipment equally available to each flyer. Second, it reduced both the speed, which was still plenty fast, and the difference in speed between airplanes. The latter factor places more of a premium on pilot skill and ability to fine tune the plane, engine and propeller for maximum results. These rules were felt to be very satisfactory and current feeling is to continue these rules for the 1977/8 season with the fuel for the heats provided by the club.

How about a 1/2A aerobatic event for your club for the next year? There should be only two main limitations: maximum total engine dis-



Downturned tips, full span ailerons and narrow elevators are Pacer characteristics on the mini-stunter.

placement of ·051 c.i. and maximum total fuel tank capacity of $1\frac{1}{2}$ oz. The fuel limitation expedites the running of the contest by limiting the air time of each contestant. The manoeuvre sequence we have settled on requires a continuous flow of manoeuvres. Each upwind manoeuvre (u) is followed by a downwind (d) one—there are no fly-bys until the last powered manoeuvre is complete. Our 1976 manoeuvre sequence was: 1. Launch—u; 2. Position—d; 3. Two inside loops—u; 4. Two axial rolls—d; 5. Inverted flight—u; 6. Cuban 8—d; 7. Vertical 8—u; 8. Four point roll—d; 9. One vertical roll—u or double Immelman; 10. Two outside loops—d; 11. Spot landing.

All manoeuvres were scored 10 points maximum each, except the launch and position for the first manoeuvre.

Of all the manoeuvres listed, the three most difficult are the vertical 8, four point roll, and double Immelman. Most flyers enter the vertical 8 at the middle, which is permissible, and complete the top of the 8 first. The four point roll—without rudder—requires the use of elevator to pitch the nose up just prior to entering the portions where the wings are vertical. The vertical roll was replaced by the double Immelman for 1977 events.

This manoeuvre sequence is challenging. The available models and engines can be made to perform these manoeuvres in a beautiful fashion. The sequence including turn-arounds and positioning for the next manoeuvre can be made extremely smooth and graceful. But—it's not easy. As in any other activity it takes good equipment and lots of practice to do well.

What equipment choices are there for 1/2A aerobatic competitions? Commercial kits like the Ace Pacer and Mach-None or Concept Model's Vixen are all satisfactory. Many home-brew designs are very capable of doing the manoeuvres sequence as well: Frank Baker's Thunderbolt, Bob Huisinga's 1/2A scale Miss Norway, my Firefly design.

To obtain high performance requires attention to a number of additional factors. Pay particular care to keep weight down while building and instal the radio gear to obtain proper c.g. It can be forward of the indicated balance point, but never to the rear. Add wing weight to balance axially. Reduce control to the bare minimum that will do the job—it makes flying smoother as well as easier on the nerves. The *only* engine is the Cox

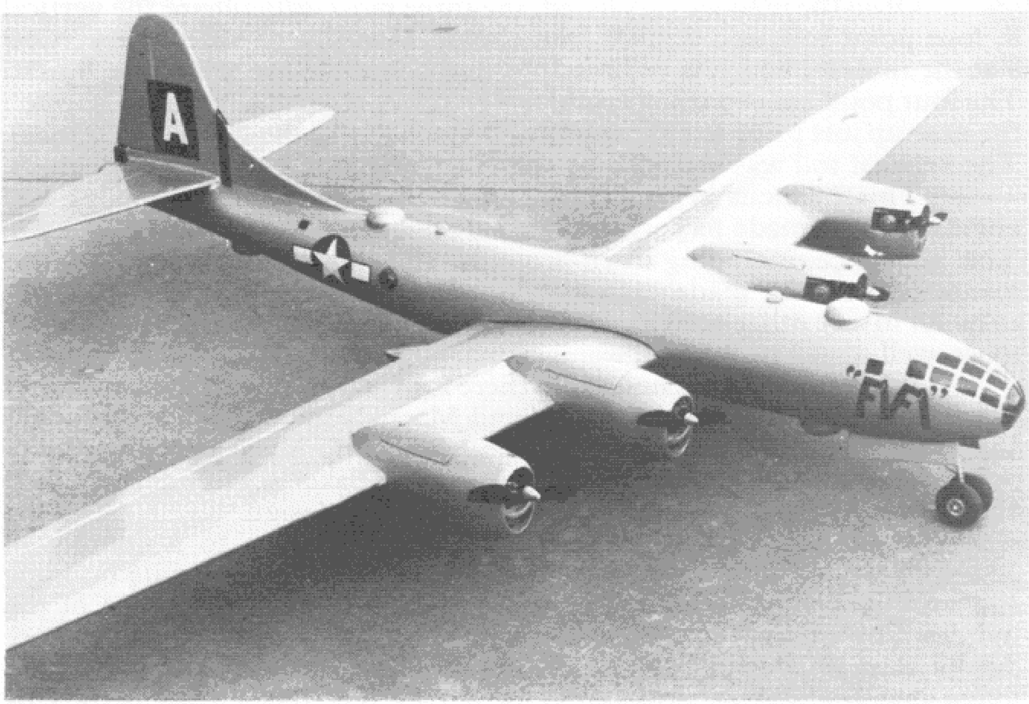
T.D. ·049 to ·051. However, not all T.D.s are equal. Changes have been made during the years and engines produced after 1973 seem to have an edge. Engines get distinctly better as they get older with the piston and cylinder fit one of the major factors. Modified T.D. engines, if available from your model dealer, offer a substantial increase in r.p.m.

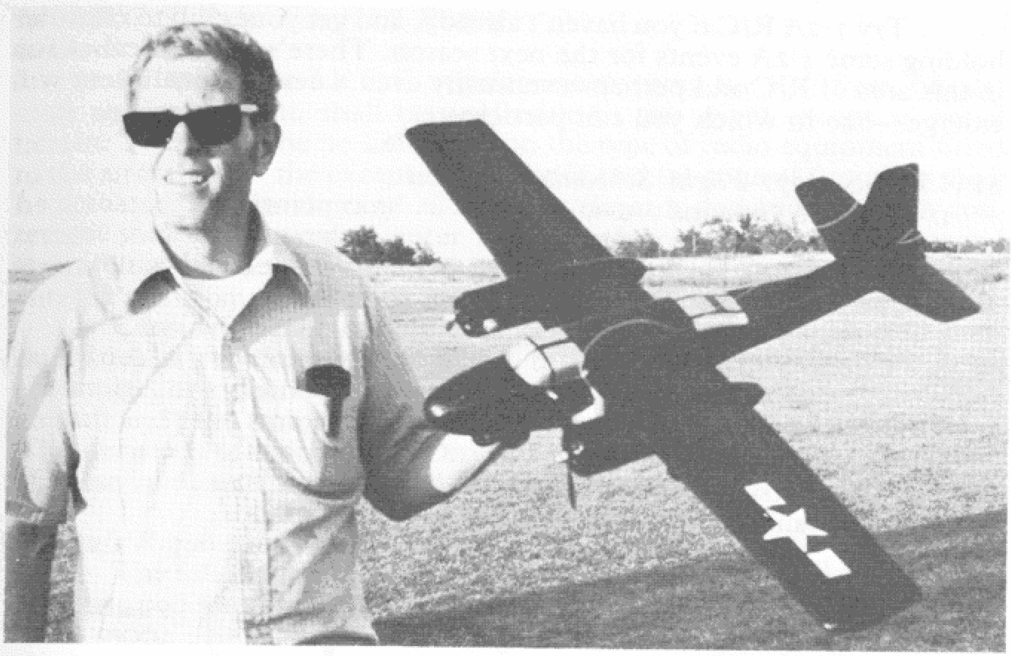
For consistent performance in 1/2A aerobatics a fuel pressure system is a must. There are commercial tapped rear crankcase covers or you can make one yourself by pressing a slightly tapped $\frac{3}{32}$ brass tubing into a drilled hole in the back cover plate. The tubing should be closed off on the crankcase end with solder and drilled with a small drill. A small hole smooths out the crankcase pressure fluctuations and keeps to a minimum the reverse flow of fuel into the crankcase during filling and starting. A properly installed pressure system is a beautiful thing to operate. You can adjust the engine on the ground and once in the air it just keeps on putting out the power regardless of the manoeuvre or attitude. With either a pressure system or suction system it pays to instal a fuel filter in your filling system since the little engines have very small orifices and needle valve openings.

Assuming that you are interested in 1/2A aerobatics just how do you get to be good at it? As in all other fields of endeavour the answer is PRACTICE.

Go out and try the manoeuvre again and again. Many of us look upon ourselves as weekend or Sunday fliers and say that we don't want to be a hot-shot competitor. Secretly we'd like to be a hot-shot, but can't spend the time or money it seems to take. Still, I recommend whether you fly ·60, ·40, or ·049 aircraft, that you practice some particular

Boeing Superfortress with four ·049s has 79 in. span, by Frank Baker.

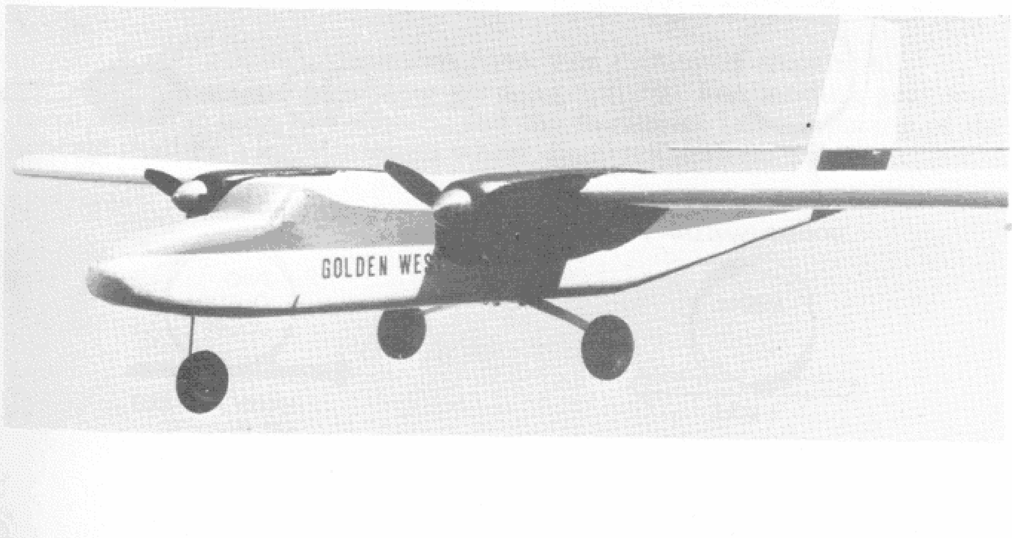




All foam B-26 by Frank Baker who flew as navigator in them. Two Cox ·049s give snappy performance.

manoeuvre sequence. Frequently a flyer gets to the point where he is capable of getting safely into the air, flying a loop, maybe a roll, and then a landing. Then he stops learning or quits the hobby for lack of challenge. The challenge is still here, however, and that challenge is to really learn how to fly. Make the plane do what you want, rather than reacting to the aircraft. Can you do a pure axial roll, a good stall turn, four-point roll, circle the field inverted, sideslip for a short-field landing? The challenge is to make the plane do what we want—recognisable bonafide manoeuvres. Horsing around is fun—but limited. Mix some practice at manoeuvres which tax your present abilities as well as the ones you feel that you can do well. You'll find that your horsing around will improve as well.

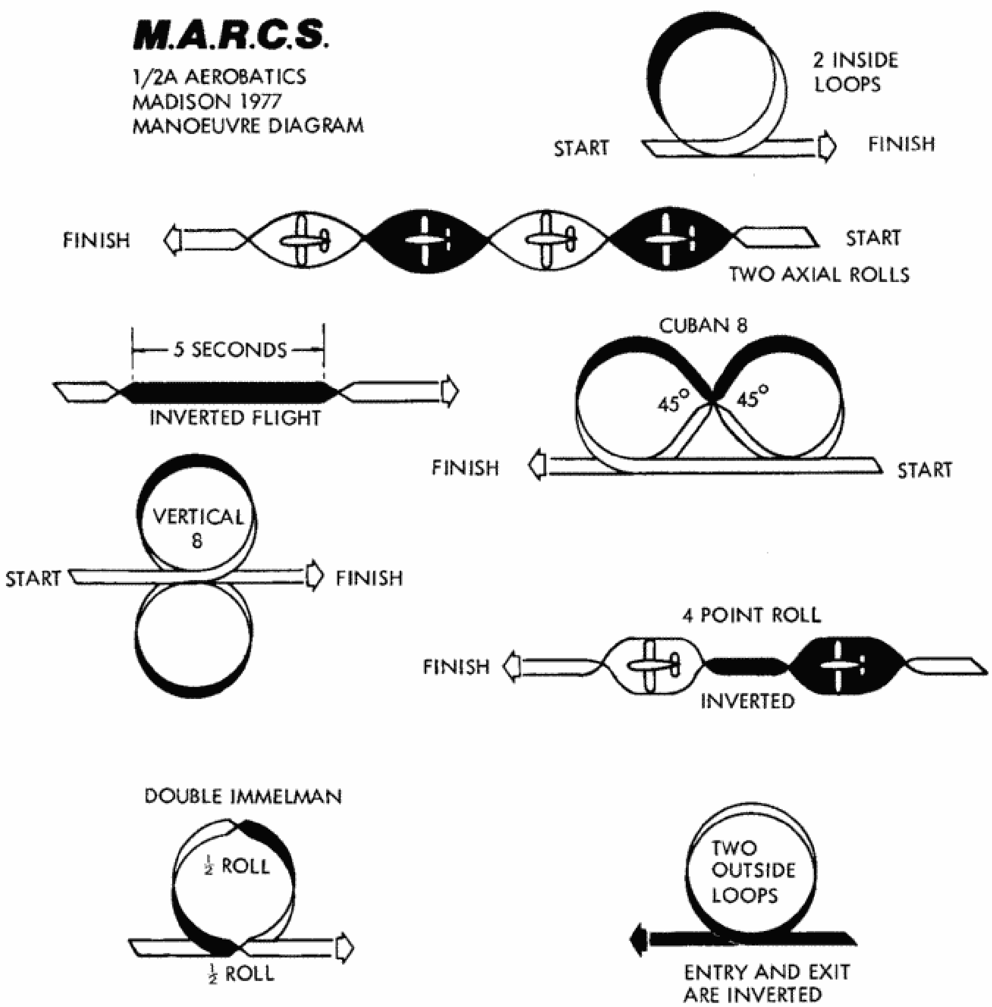
Semi-twin Otter follows the ·049 trend at M.A.R.C.S. club.



Try 1/2A R/C if you haven't already, and get your club to consider holding some 1/2A events for the next season. There's a great deal of fun in this area of R/C and perhaps eventually even a new national event will emerge—one in which you can participate.

M.A.R.C.S. 1977 Flight Schedule for Stunt

1.	Launch (upwind = u-w)	0 points
2.	Position for first manoeuvre	0 points
3.	Two inside loops (u-w)	10 points
4.	Two axial rolls (downwind + d-w)	10 points
5.	Inverted flight (u-w)	10 points
6.	Cuban 8 (d-w)	10 points
7.	Vertical 8 (u-w entry & exit)	10 points
8.	Four point roll (d-w)	10 points
9	Double Immelman (u-w)	10 points
10.	Two outside loops (d-w)	10 points
11.	Spot landing	10 points



M.A.R.C.S. Rules For 1/2A Racing

General:

All A.M.A. and F.C.C. regulations covering the R/C flyer, his aircraft and equipment, shall be applicable to this event except as noted herein. There shall be no limitation on the type of radio equipment fitted to the aircraft with the exception that only two (2) control functions shall be actuated, i.e. elevator and ailerons, or elevator and rudder. Each contestant shall be allowed to enter two aircraft in this event. The second aircraft may be used only as an alternate and does not constitute a separate entry. Parts from one aircraft may be used as parts for the other aircraft.

Consideration of safety of spectators, contest officials and conduct such as repetitive unsafe flying, intentional attempts to gain unfair advantage, or rules violations shall be cause for disqualification of both aircraft and pilot from this event at the discretion of the Contest Director. The decisions of the Contest Director or his designees to interpretation of these rules shall be final and binding on all contestants.

Aircraft Requirements

The following aircraft configurations are *not* allowed: Flying wing designs; pod and boom designs.

Aircraft Specifications:

Engine: Maximum total nominal engine displacement shall be ·0519 cubic inches. Engines must be production units assembled from factory available parts. Engine and all parts, whether original or replacement, must have been produced in quantities greater than 1000 units and must be available through normal retail outlets in the U.S.A. or from the engine manufacturer.

No pressurisation of the fuel system is allowed, except from atmospheric pressure.

No throttle shall be required for this event.

No muffler shall be required for this event.

Propeller: Either wooden or plastic type fixed pitch propellers are permitted. Propeller reworking is allowed.

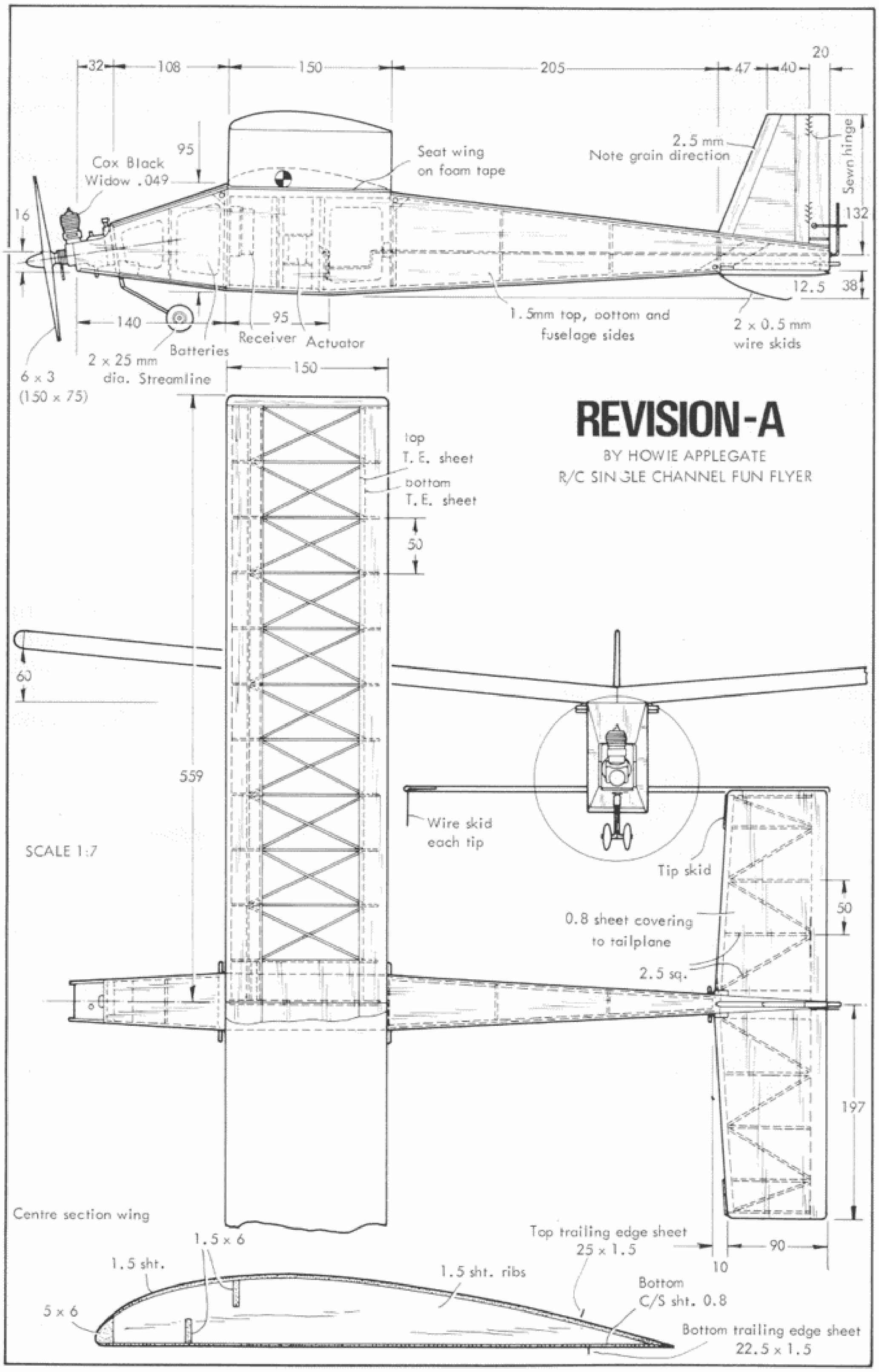
Weight: Weight less fuel but including all equipment necessary for flight shall be not less than 20 oz. There is no maximum weight limit.

Fuselage: The fuselage have a minimum cross-sectional area of 8·5 in.

Wing: 200 in.^{2} Minimum Area. $\frac{7}{8}$ in. minimum thickness.

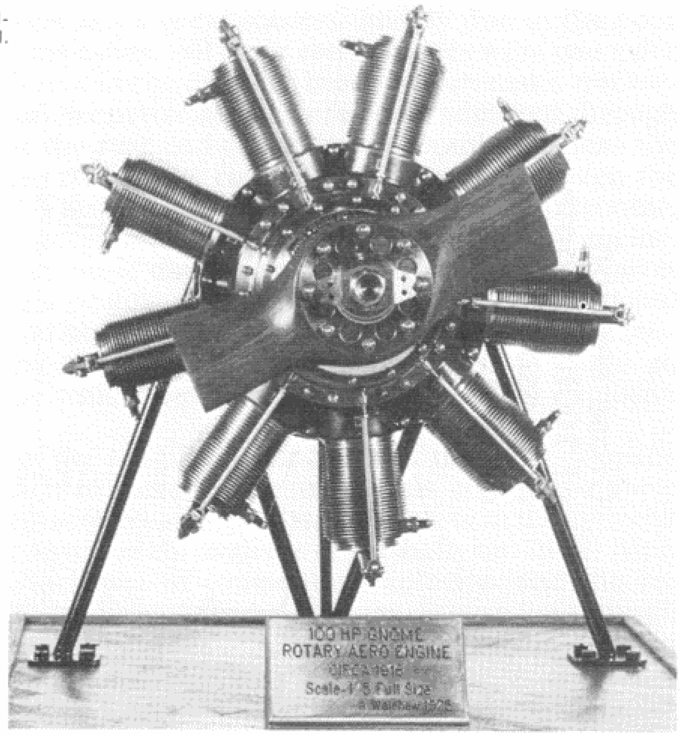
Landing Gear: Landing gear is required. The landing gear shall incorporate at least two wheels, and the minimum lateral spacing of the wheels shall be 3 in. Minimum wheel diameter shall be 1 in.

Now try it—you'll like it!



FLYING MODELS U.S.A.

1/5th scale Rotary Engine by A. Walshaw, a remarkable working model.



A MONOSOUPAPE ENGINE

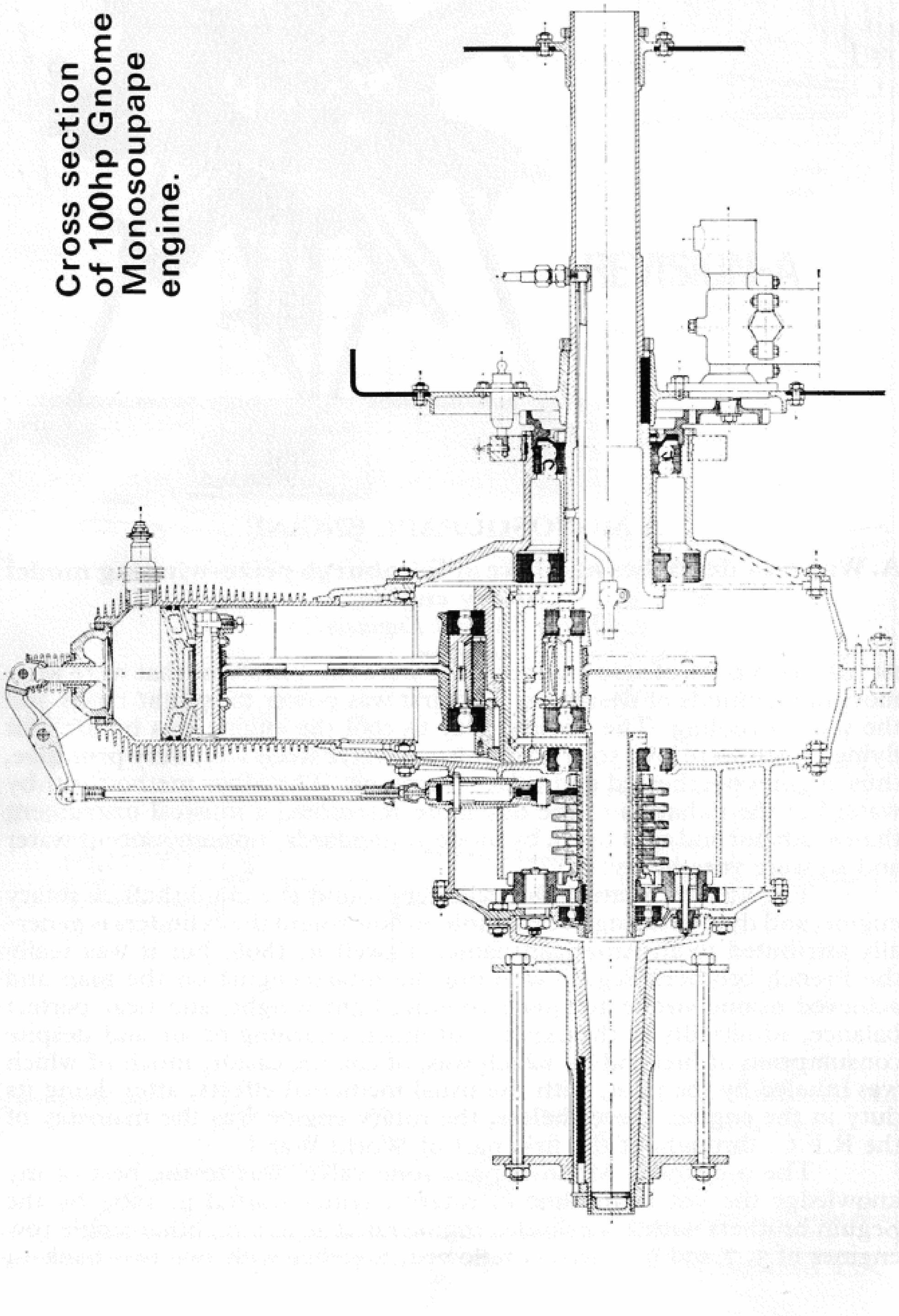
A. Walshaw describes his Duke of Edinburgh prize-winning model rotary engine

(*From "Model Engineer".*)

IN THE EARLY DAYS of aero engines there were two problems that were foremost in the minds of designers. The first was power to weight ratios and the second cooling. The obvious way to cool the engine was by air, but flying speeds were low, 50 or 60 m.p.h. and valve steels were very primitive, thus engines overheated and valves burnt out. The other method was by water but the radiators of the day more resembled a musical instrument than a radiator and contained, by modern standards, vast amounts of water and so were very heavy.

The idea of rotating the cylinders round the crankshaft, a rotary engine, and thus ensuring a reasonable airflow round the cylinders is generally attributed to an American named Fawell in 1896, but it was really the French brothers Seguin who put the rotary engine on the map and achieved in one stroke adequate cooling, light weight, and near perfect balance, admittedly at the expense of much churning of air and despite consumption of fuel and oil which was, of course, castor, much of which was inhaled by the pilot, with the usual medicinal effects, after doing its duty in the engine. Nevertheless, the rotary engine was the mainstay of the R.F.C. throughout the first part of World War I.

The 9-cylinder Monosoupape (one valve) was to the best of my knowledge the last in the line of rotary engines started in 1907 by the Seguin brothers with a 7-cylinder engine rated at 50 h.p., other single row engines of 5, 7 and 9 cylinders followed, together with two two-bank 14

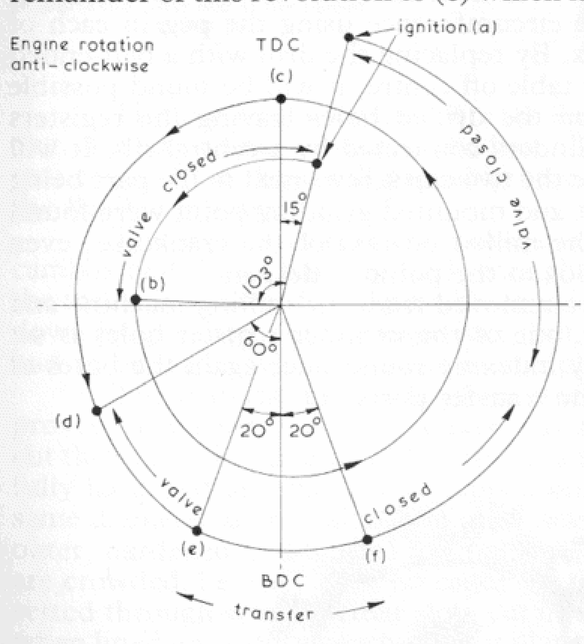


Cross section of 100hp Gnome Monosoupape engine.

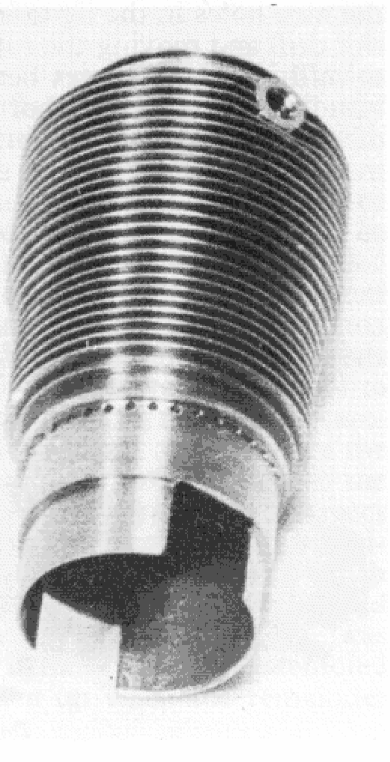
and 18 cylinders which were not a great success, mainly due to the poor cooling of the back row of cylinders. All these early engines were two valve having in addition to the valve in the cylinder head, an automatic transfer valve in the piston crown all the petrol/air mixture being admitted through a primitive carburettor at the rear end of the hollow crankshaft into the crankcase and being transferred to the combustion chamber through the valve in the piston crown. These valves were a constant source of trouble, being situated in a very inaccessible and inhospitable part of the engine. It must be remembered, in these days of nimonic alloys, that the valves of early aero engines were a prolific source of trouble even when exposed to the cooling air stream and not buried in the heart of an internal combustion engine cylinder. Any failure of the valve was liable to cause an explosion in the crankcase which was of course filled with an explosive petrol/air mixture.

The introduction of the 1913 Paris Air Show of the Monosoupape engine brought the solution to these problems. In this engine the valve in the piston crown was replaced by a series of transfer ports in the cylinder wall, the mixture was still admitted through the crankshaft, but in the form of a very rich mixture which was of course non-explosive, and the remainder of the air was admitted and the exhaust gases disposed of through the valve in the cylinder head. A study of the timing diagram will perhaps make things a bit clearer.

Starting at the point of ignition (a) the mixture in the combustion chamber explodes and expands through 103° to (b) when the valve opens, this is the power stroke; the gases then escape through the valve for the remainder of this revolution to (c) which is also T.D.C., the valve remains



TIMING DIAGRAM



The one-piece cylinder barrel and head, note plug socket, transfer ports and cylinder retaining ring just above, which is clamped by crankcase.

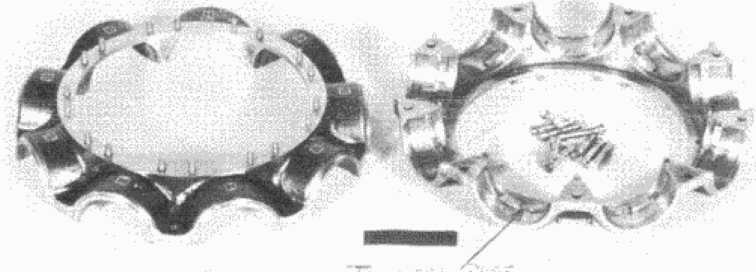
open and as the piston descends air is sucked in until the valve closes at (d), the piston continues to descend causing a partial vacuum until the piston crown uncovers the transfer ports in the cylinder wall at (e) when the rich petrol/air mixture in the crankcase is sucked in, the transfer ports are covered by the ascending piston at (f) and the mixture is compressed ready for ignition at (a) when the cycle starts again. The firing order is 1, 3, 5, 7, 9, 2, 4, 6, 8 and it will be seen that the engine operates on a four-stroke cycle.

After taking as many external dimensions as were practical from the full-size engine at the Royal Scottish Museum, a scale of one fifth full size was decided on; this gave a reasonably small model without making the smaller details too much like watchmaking. It also made the maths easy; to reduce full-size dimensions to one fifth divide by 10 and multiply by 2.

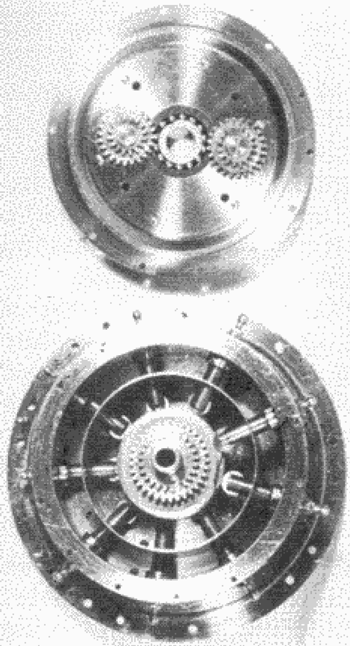
Work was started on the crankcase as it was felt that this would be the hardest part to make. Two slices of E.N.8 were faced up and bored through the centre to within $\frac{1}{4}$ in. of the finished size, the register which locates the two halves of the crankcase together was turned and the two halves fastened together with nine 8 BA cap screws. The inside of the crankcase was now bored out to finished size and a peg fastened in the flange.

The following operations were carried out on a milling machine, but I think that with a little ingenuity they could be carried out on a lathe with milling and indexing attachments. The jig is mounted on a rotary table centralised under the vertical head of the milling machine and the two halves of the crankcase are mounted on the jig with the peg in hole no. 1. Nine holes say $\frac{1}{32}$ in. less than the final size of the cylinder registers were drilled round the circumference using the peg in each of the nine holes in the jig to index. By replacing the drill with a ball-ended slot drill and moving the rotary table off centre, it will be found possible to mill away the spaces between the drilled holes leaving the registers standing as a series of short cylinders connected by a central rib. It will of course be necessary to remove the two cap screws next to the part being machined. A flexible drive shaft and mounted grinding point were found to be essential in cleaning up the milled portion of the crankcase; even so the operation proved laborious to the point of despair!

The crankcase and jig are removed from the milling machine and mounted on the lathe faceplate, one of the cylinder register holes is set concentric with a D.T.I. and by indexing round once again the bores of the registers are finished and the transfer ports cut.



Transfer ports are cut into halves of the split crankcase. Black mark is one inch (25 mm.) long.

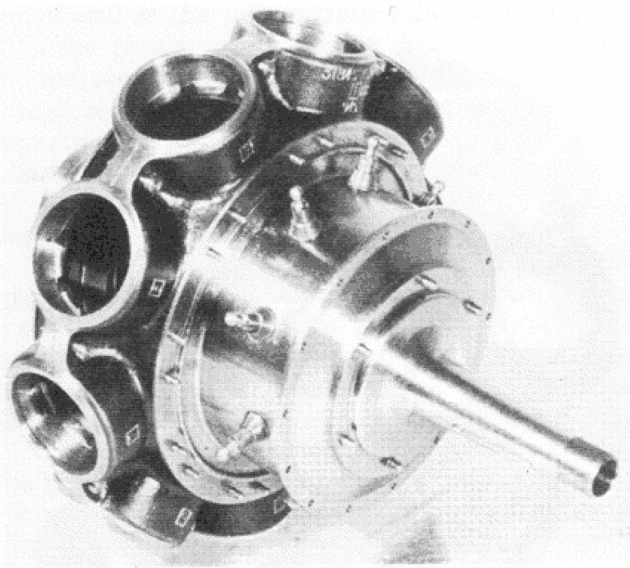


Finished crankcase at right, and the cambox above, the cylindrical ring supports the lower end of the tappet guides.

The final operation is to bore the flanges to size, removing the index peg, and take a final cut across the face of the flanges where the front and rear covers fit as these will probably bear witness of the hours spent with the flexible grinder.

The front and rear crankcase covers, known respectively as the cambox and thrust box, are fairly straightforward turning operations. In the thrust box it was found possible to use a commercial ball race, thinned down by grinding, for the large race, but the smaller race at the rear end had to be made, which was not as complicated as was anticipated.

The material used was silver steel, which, though not ideal, has proved satisfactory. The outer race was made first using a form tool to cut the semi-circular groove for the balls to run in; it was then very carefully hardened and the groove lapped out with a piece of brass wire the same diameter as the balls. The inner was then made to a tight fit on the outer, hardened and lapped to final size. It will be noted that the races are crowded, i.e. they have no cages. In this type of race the balls are inserted through semi-circular slots cut in the inner and outer races which when lined up opposite each other will just admit one of the balls. I found that the best method of achieving the correct clearance in the race was to lap the inner race until it was a fairly slack fit in the outer when assembled with three balls only, the clearance being taken up when the remainder were inserted.



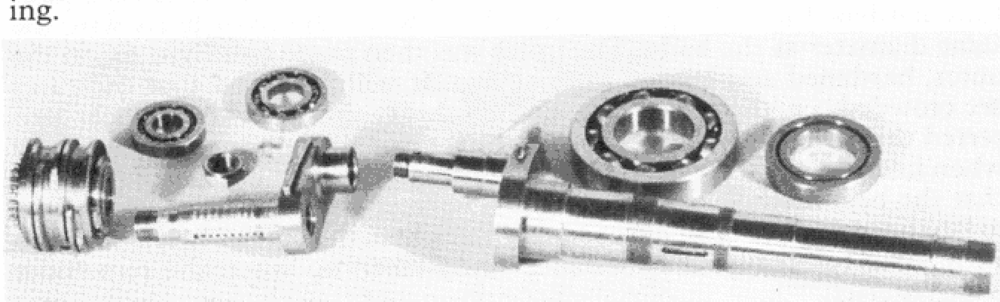
Left: Cambox cover in place, alignment is critical. Bottom: the crankshaft, bearings and cam assembly. Opposite are the eight slave rods pivoted on wristpins in the master rod.

To return to the thrust box, this is a forging with stiffening webs internally in the full-sized engine. In the model, however, it was turned up from E.N.1a, the thickness of the rear face being increased to compensate for the lack of webs.

The cambox is also turned up from E.N.1a. Great care was needed in boring out the inside to leave a cylindrical ring to support the lower end of the tappet guides, which are arranged radially at 40° intervals round the outside of the cambox. The ballrace at the rear of the box is again a thinned down commercial race. Apart from accurate positioning of the holes for the tappets it was a straightforward turning job.

The cambox cover is also from E.N.1a and is fastened to the cambox by fourteen 12 BA bolts; this cover carries the planetary gears for the valve gear. In all the parts mentioned so far great care was taken to ensure that front and rear registers were concentric as the whole alignment of the engine depends of them.

The crankshaft is in two parts, the front half serving to drive and support the camshaft; the rear half, with which the crankpin is integral, acts as the shaft on which the engine revolves and also attaches the engine to the aircraft. In the full-size engine the two halves of the crankshaft are fastened together with a male and female taper; in the model the taper was replaced by a close-fitting parallel spigot, the key in the full-size engine being replaced by a round dowel fitted half and half in the spigot and housing.



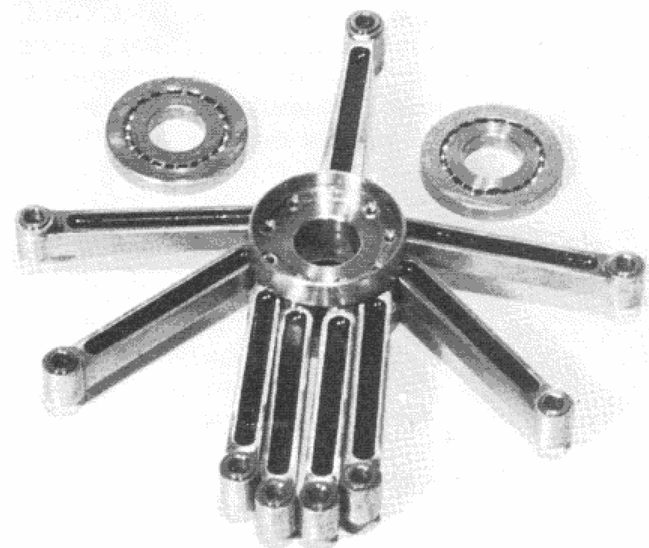
The two halves of the crankshaft were turned up separately, though looking back it would probably have been easier to have turned the crank-pin first, fitted the two halves and then finish turned the shafts. The material, by the way, is broken lorry half shaft, a fruitful source of very cheap high tensile steel. Both halves of the crankshaft are hollow, as is the crankpin. Petrol is carried in a tube through the rear half of the crank-shaft to the crankcase, where it just pours in, no complications of a carburettor here. The two oil supplies are also carried in tubes through the crank-shaft and then in drillings through the crank webs to the big end and cams.

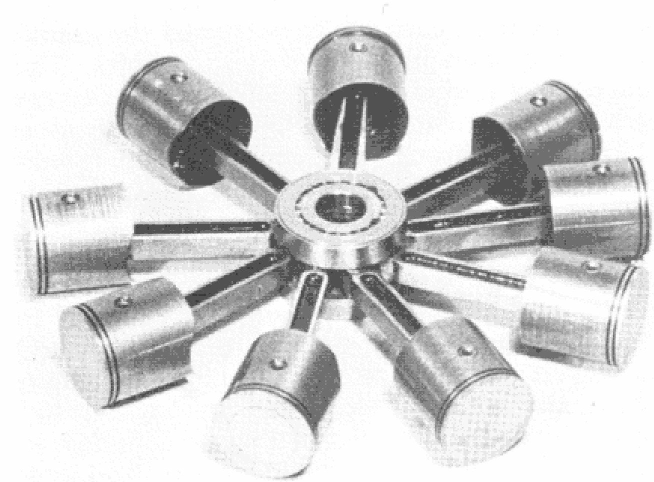
As previously mentioned, the cams are supported and driven by the front half of the crankshaft. The nine separate cams were milled to profile using an end mill, the form being very simple, just a tangential lift and a sharp fall, they are keyed to a bronze sleeve which rotates on the front half of the crankshaft, the inside of the sleeve having a series of annular grooves which serve to distribute oil from the crankshaft to the individual cams. The front end of the crankshaft carries a fixed gear of 24 teeth; in mesh with this gear are the large planetary gears (24T) which rotate on spindles fixed to the cambox cover and so rotate with the engine. Fastened to the large planetary gears and rotating with them are the two small planetary gears (16T); these mesh with a gear of 32 teeth fixed on the front of the cam sleeve, thus the cam sleeve rotates at half engine speed in the same direction as the engine.

The roller-footed cam followers therefore overtake and roll up the tangential lift on the cams, roll along the top and drop on the radiused fall. The cam followers are made from silver steel.

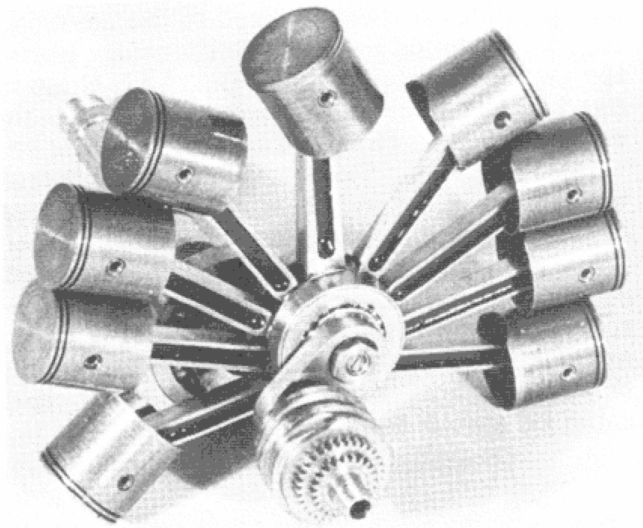
The hardened rollers run on hardened steel spindles; the follower assembly is prevented from swivelling in the bronze guides by the roller running in a slot in the guide, which is held in the cambox by a splined nut, the lower end projecting through the holes in the cylindrical ring inside the cambox, thus securing the guide rigidly. The followers are lubricated by splash from the cams.

The eight slave rods are pivoted on wrist pins in the master rod,

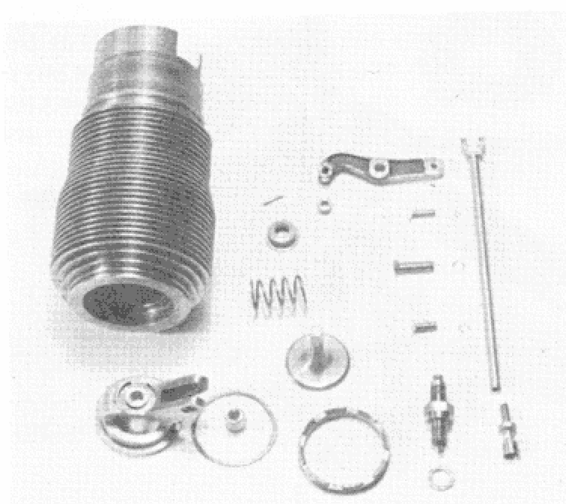




Pistons have two rings, and a cutaway in the skirt to give clearance for the piston in the next cylinder.



Assembled on the crankshaft, the rod and piston unit is in the first stage of building up the engine.



The valve gear. Spring is wound from piano wire, pushrods are actually Hypodermic needles! Pins are silver steel and machined from the solid.

which rotates on two home-made ball races. All the rods are made from E.N.8 and are bronze bushed for the gudgeon and wristpins which are silver steel. The wrist pins are drilled for oil supply from the big end; how effective this is I don't know, but there is no sign of wear as yet.

The pistons are made from cast iron with a steel crown and gudgeon pin housing. The pistons are provided with two rings $\frac{1}{32}$ in. square and proved very successful. The cutaway in the skirt is to clear the piston in the adjacent cylinder.

The cylinder barrel and heads are in one piece, in fact there is very little head, most of this area being taken up by the very large valve and its cage which is secured in the cylinder with screwed ring. The cylinders were first rough turned to within $\frac{1}{32}$ in. of finished size, the bores were then finished first with a D bit to shape the top of the combustion chamber and finally ground using a toolpost grinder based on the Quorn. The next operation was to finish the recess in the head for the screwed ring that holds the valve bonnet in place. As this is only ·1 in. × 60 t.p.i. and finishes up against a shoulder a tap was made from silver steel which did its job in a very satisfactory manner.

The cylinders, now finished internally, were mounted on a mandrel set between centres and the outside diameters and the groove which locates the cylinder in the crankcase finished; the hole for the sparking plug boss was also drilled and counterbored at this stage.

The last major operation on the cylinders is to form the fins; these were cut with a parting tool, plenty of suds and a slow speed. It was found to be necessary to pack the fins that had been cut with spacers to prevent them bending away from the tool; apart from tedium no real problems were encountered.

The valve cage assembly is one of the more complex parts of the engine resulting in a number of parts ending up in the box under the bench. The material again is E.N.1a. I use a lot of this free-cutting steel in parts that are not too highly stressed, it speeds operations up a lot and makes poor finish a thing of the past; its main disadvantage seems to be that it is rather liable to rusting. The rockers were machined from the solid on a very light pantograph engraving machine; it was not really up to its task and a lot of trouble was encountered with cutters deflecting. However, it is planned to build a much more rigid machine for future jobs. Incidentally all parts on the engine which are forgings on the full-sized job were first sand blasted and then coloured with a gun blueing solution, which gives a very passable representation of a forged finish.

The valves are made from free-cutting stainless steel (E.N.58B.M.), another excellent material. The stems are cross-drilled for the cotter pin which holds the valve cap in place; the springs were wound up from piano wire. I was fortunate enough to have a number of frighteningly large hypodermic needles which were ideal for the push rods; the bore of these needles was exactly 10 BA tapping which was fortunate as they were definitely not free-cutting! All pins in the valve gear are silver steel, and the circlips were rolled up from piano wire.

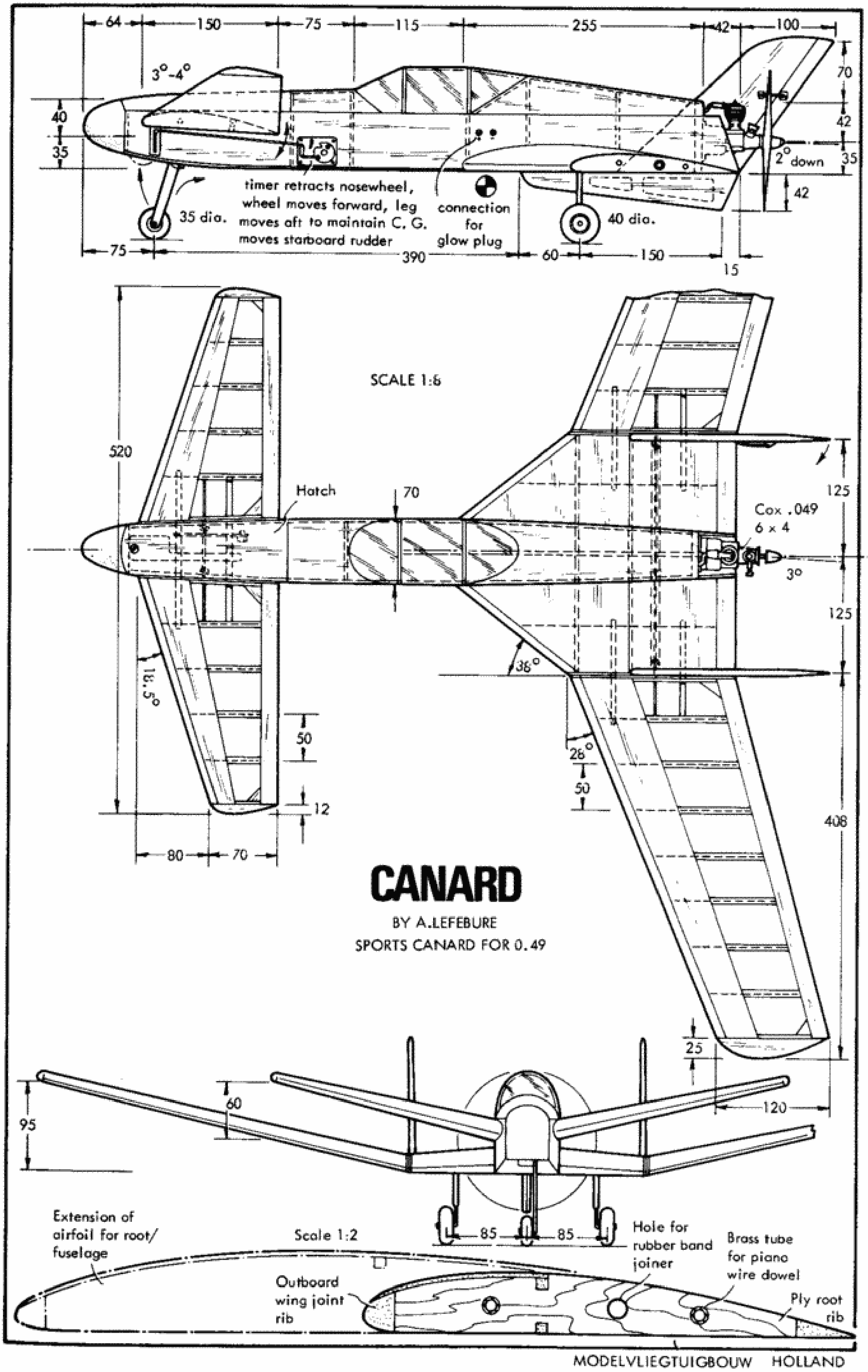
The oil pump and magneto are driven from a large gear wheel fastened to the back of the thrust box. The magneto is a dummy containing a contact breaker which gives two sparks per revolution; the magneto shaft turns nine times for every four revolutions of the engine, and it follows that the plugs receive nine sparks every two revolutions of the engine. Both the magneto and oil pumps are bolted to the front engine mount and so do not rotate with the engine. The casings of the magneto and oil pumps were cast from aluminium by the lost wax process. The oil pump delivers two separate feeds, one feeding the big ends and main bearings, the other the cams and front half of the engine. The pump itself is a twin plunger reciprocating pump with ball valves. I had a lot of trouble with these valves, which seat upwards, until I did away with the springs which were supposed to make them seat but in fact were holding them off!

The plungers are driven down by a cam which is integral with the worm wheel which is the last part of the drive from the engine, and are returned by a spring. The worm wheel was cut with a 20 t.p.i. tap as a hob; the tap was held in a fixture and the wheel blank mounted in a spindle so that it was free to rotate; the wheel blank was then fed into the rotating tap which cut a thread round its circumference, eventually forming the worm wheel. The worm is simply a screw the same diameter and pitch as the tap; the pair seem to perform well though a Whitworth form worm and wheel is to say the least unusual. The oil pipes are copper; if anyone knows of a source of *thin* wall $\frac{1}{16}$ in. dia. copper tube I would be pleased to know of it, I had to make mine by drawing down $\frac{3}{32}$ in. with a mandrel inside it, very tedious.

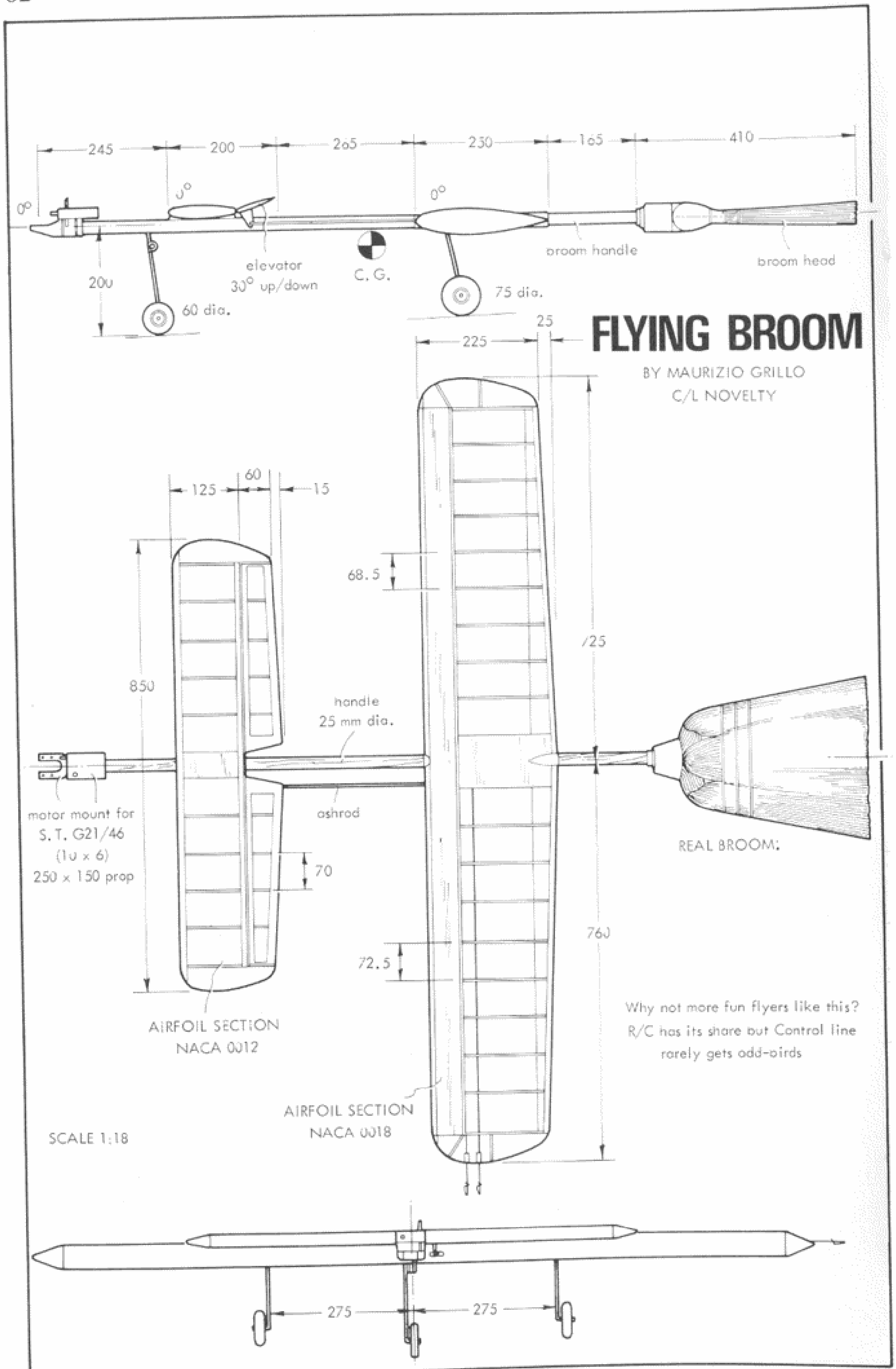
The name plates were made by photo engraving. The booklet produced by Kodak on the subject is a mine of information. The main obstacle is the large quantities the chemicals are packed in.

At this stage it would be nice to say that the engine started first turn of the prop: it didn't! I first tried the annular gap plugs but these did not like the amount of oil that the model and prototype burns; I then made plugs with conventional gaps and insulators from ceramic tube swaged into the steel bodies. The next problem was carburation, or rather lack of it. It will be remembered that there is no carburettor, the fuel just flows in. The engine proved to be very sensitive to both the height of the fuel tank and the amount the needle valve was open (which are of course interrelated); however, the engine was at last persuaded to run for more than a few seconds. A fuel pump has been developed which simplifies starting. The engine starts better than most glowplug engines and now runs on all 9 cylinders "most of the time" at about 2000 r.p.m. I run it on a 50/50 petrol benzol mixture with a dash of castor oil. I also use castor lubricating oil, it gives a very period smell to things. The propeller is 18 in. diameter laminated from mahogany and is caled from one used on an Avro 504.

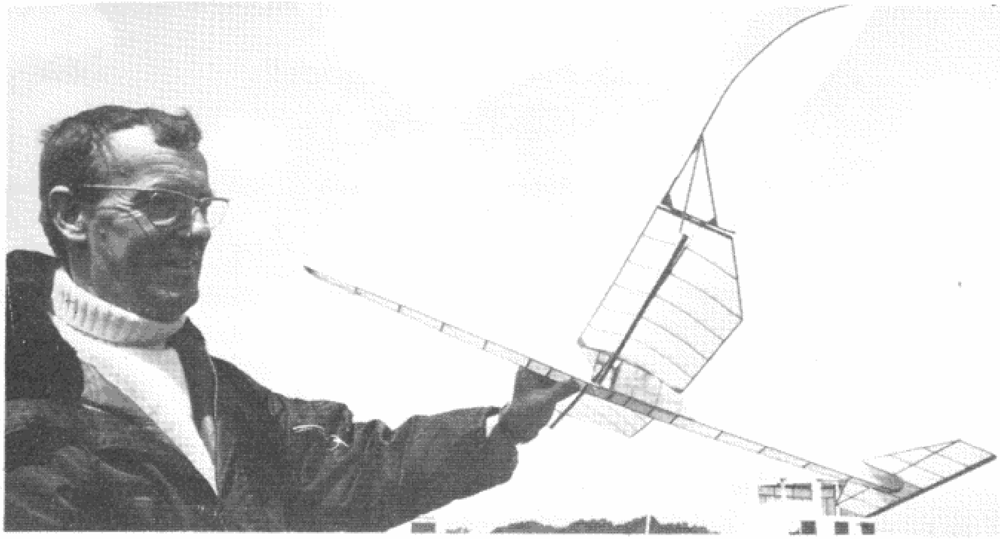
In conclusion I would recommend a scale aero engine as a good subject for anyone interested in I.C. engines. The scope is enormous, air or water cooling, radial, rotary, "V"s, "Y"s, even "H"s in any number of cylinders from one to forty-two. My own next prototype is a 14-cylinder Bristol Hercules; who will make its 18-cylinder sister the Centaurus?



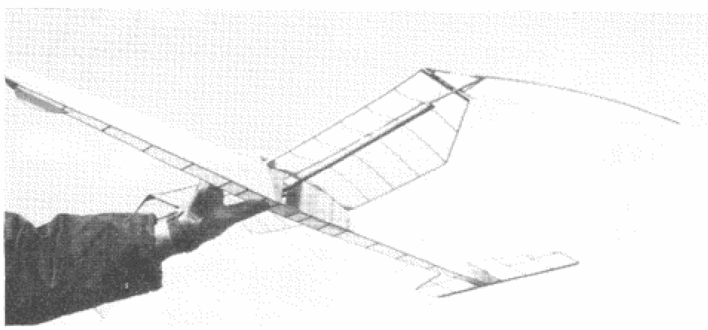
CANARD
BY A.LEFEBURE
SPORTS CANARD FOR 0.49
SCALE 1:6
timer retracts nosewheel, wheel moves forward, leg moves aft to maintain C. G. moves starboard rudder
connection for glow plug
35 dia.
40 dia.
2° down
3°-4°
Hatch
Cox .049 6 x 4
Scale 1:2
Extension of airfoil for root/ fuselage
Outboard wing joint rib
Hole for rubber band joiner
Brass tube for piano wire dowel
Ply root rib
MODELVLIEGTUIGBOUW HOLLAND



MODELLISTICA ITALY



Top: Alex Imrie with the "Schwingenflugmodell" flapping tips raised, and at right, on the full downbeat. Close-up of the very simple connecting rod and crank mechanism, below, also emphasises the birdlike air-foil on the fixed wing.

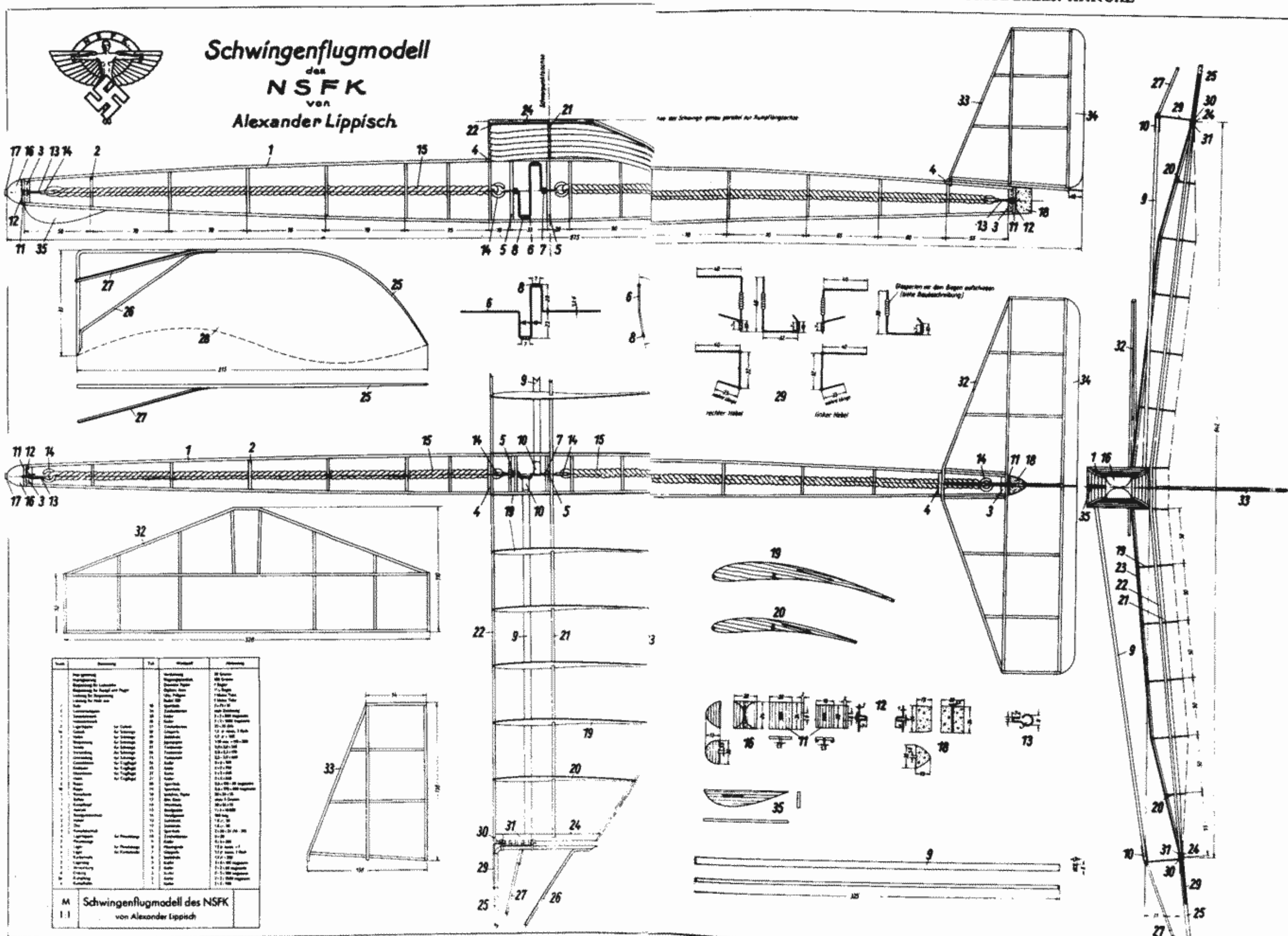


LIPPISCH ORNITHOPTER

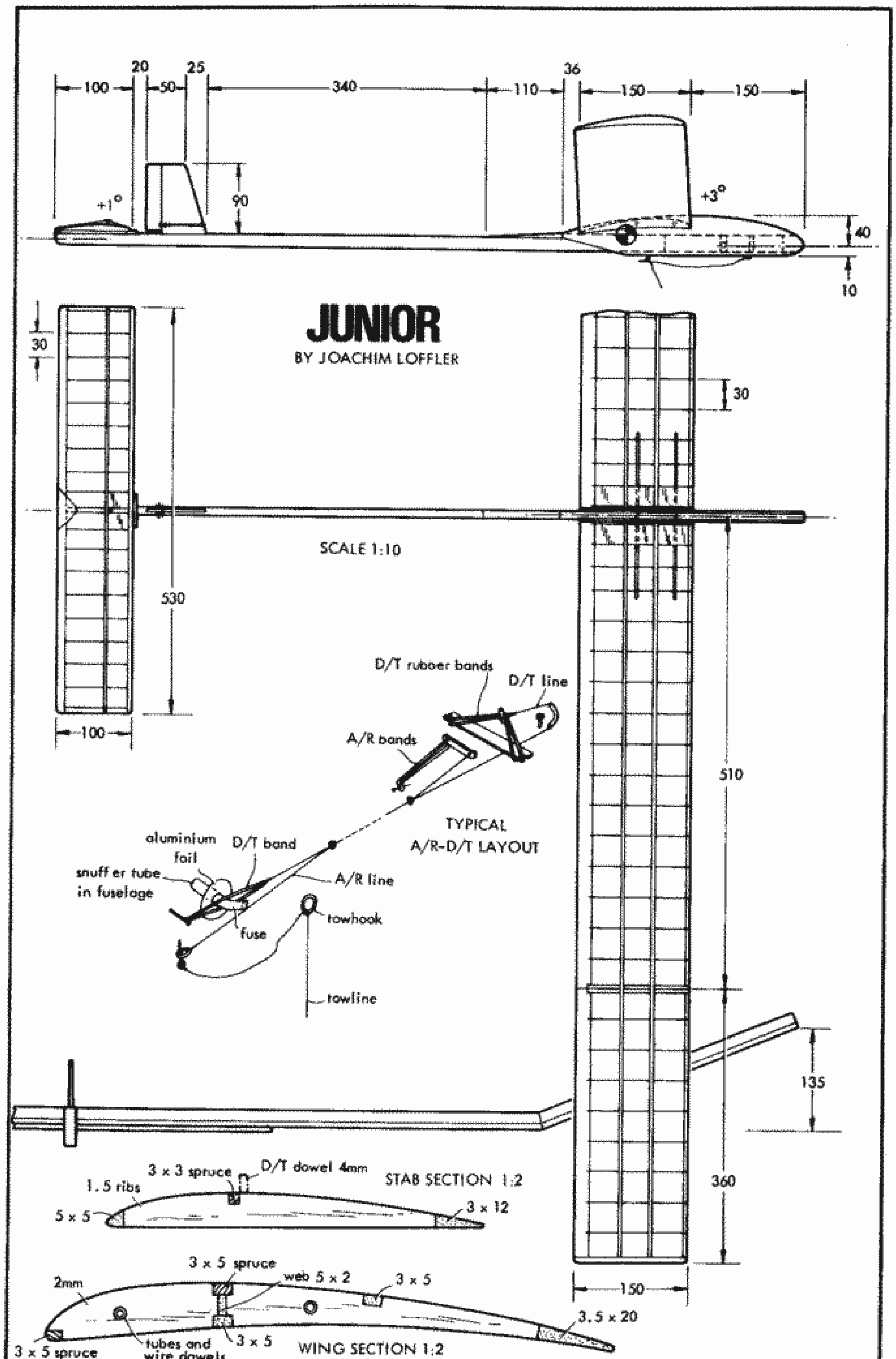
The original design as built by the N.S.F.K.

In his lifetime, Alexander Lippisch, created many great designs. Notably the famous German sailplanes and the Me 163 rocket fighter, and also many models of unorthodox configuration. They ranged from indoor lightweights to ground-effect machines, and among them was the ornithopter which became a standard design for the N.S.F.K.

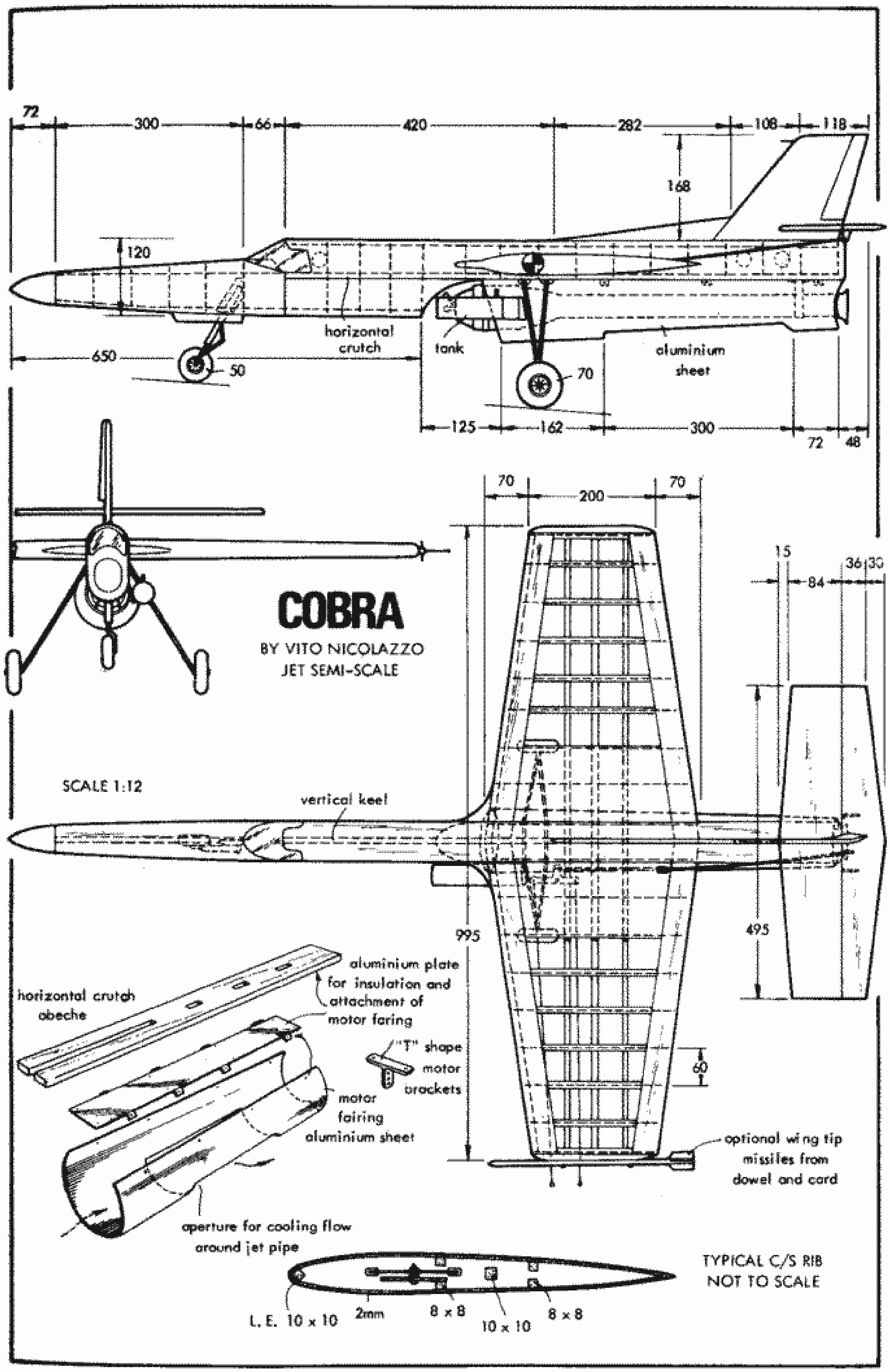
Alex Imrie made a replica from the plans as originally published in Germany (we can supply copies at £1 including postage) and as the photographs show, the result is no less impressive than it was 40 years ago.



1, 2×2 longerons. **2**, spacers. **3**, 2×5 spacers. **4**, spacer. **5**, 3×6 bearer. **6, 7, 8**, centrecrank 1·2 mm. and bearings. **9**, 3×6 push rod. **10**, 6×30 card strap. **11**, tailplug. **12, 13**, 1 mm. wire. **14**, valve rubber. **15**, 10 m. 1×4 rubber. **16**, noseplug. **17**, ballast. **18**, tailblock. **19, 20**, 0·6 ribs. **21**, 2×5 spar. **22**, 2×2 LE. **23**, 2×2 TE. **24**, 3×6 tip. **25, 26, 27**, Bamboo. **28**, 'Japan' paper. **29, 30**, 1·2 mm. wire and bearing. **31**, card strap. **23, 33**, 2×2 tailparts. **34**, card trim tabs. **35**, 2 mm. noseskid (All wood is spruce).



MODELBAU HEUTE E. GERMANY



MODELLISTICA ITALY

John Bottomley and Dennis Grocott pose with their test rig (left). Opposite, test rig used by A.M.A. officials at 1977 World Championships for R/C Aerobatics, Springfield, Ohio. Model being set in near tripod with engine operating and noise level recorded at second tripod position. All models were tested.

SILENCER DEVELOPMENT AND EVALUATION TRIAL

By John Bottomley and Dennis Grocott

Boscombe Down M.A.C.

The Noise Pollution Act requires that certain noise criteria be met in order to avoid annoyance to the general public. No hard and fast levels have been established for model aero engines, however a limit of 80 dBA at 7 m. is commonly taken. Initially the object of this trial was to establish current performance and noise levels of popular model aero engines operated by members of Boscombe Down M.A.C.; and to develop a reasonably effective and efficient type of silencer. During initial work and as a result of general study on the subject it quickly became clear that we were unlikely to make any startling discoveries. So, a further objective was added, namely to evaluate for members of a predominantly sport flying club, which of the many commercial silencer designs fulfilled the following criteria:

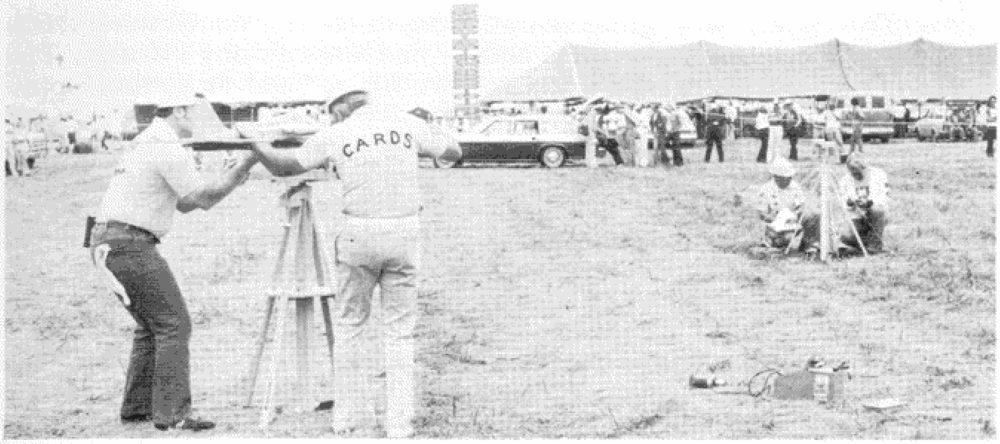
a. Reduced the exhaust noise to an acceptable level.
b. Produced a fairly small power loss.
c. Was interchangeable between various types and sizes of engine.
d. Was robust, easy to fit, and of long operating life.
e. Represented good value for money.

Equipment and Instrumentation

Engines

All engines used so far in the trial are of the glow plug ignition type, and were equipped with throttle type carburettors.

a: OS Max-H 40 R/C. (OS Type 4A carburettor). *b*: Merco 29 R/C. (Merco twin needle carburettor.). *c*: Enya 35 BB R/C. *d*: Fox 45 R/C ("Schnuerle"). *e*: K&B 40F R/C Series 71 (Perry carburettor). *f*: Enya 35 R/C. *g*: OS Max 25R/C. *h*: Veco 19 R/C BB (German-made type) (Perry carburettor).



Silencers

The following types of silencer were assessed:

i: OS 703. *ii*: 702. *iii*: HB 20/Veco 19 standard type. *iv*: Merco 29/35 universal type. *v*: Somoso II, IV, V and VI. *vi*: Weston Small and Large clip-on type. *vii*: Weston in line add-on type. *viii*: Powermax "dustbin" type. *ix*: Piper Frequency Modulated type. *x*: DAC Components Spina-flo for 29/35 size engines. *xi*: Enya expansion chamber type. *xii*: Nopol pneumatic silencers (various sizes). *xiii*: Schrader pneumatic silencers (various sizes). *xiv*: ED No. 2 manifold. *xv*: Own design expansion chamber and baffle JB Mk. 1).

In an attempt to eliminate as many variables as possible and extraneous effects, and also to facilitate the easy mounting of the various engines a test bench was constructed. The engines were mounted in a Davies-Charlton engine test stand. In order to prevent the engines from pulling out when running, a bolt was placed in each of the rearmost engine mounting lug holes.

The engine r.p.m. was monitored by a Southern Instruments portable tachometer equipped with a photo-electric probe. The noise levels were monitored and recorded by:

a. Bruel & Kjaer sound level meter—Type 2203.
b. B. & K. 1″ omnidirectional microphone.
c. Nagra III tape recorder.

The tapes using the above equipment were read on a B. &. K. analyser. The fuel used was "straight" 80% Methanol and 20% Castrol M castor oil.

The propellors used were of a pitch and diameter commonly used for sport R/C flying with any given engine, and ranged from a Top Flite 10″ × 6″ nylon for the ·40 to ·29 cu. in. engines to either a Tornado 9″ × 6″ nylon or a Strato 9″ × 6″ wood for the ·25 cu. in. to ·19 cu. in. engines.

Touch type temperature probes were used to record:

i Exhaust gas temperature at open exhaust/silencer outlet (°C).
ii Component temperature; e.g. silencer body (°C).
iii Ambient air temperature (°C).
iv Fuel temperature (°C).

Method of Test

The engines were given an initial run in the test bench to establish the optimum starting procedures and to find the running settings. The ability of each engine to hold a steady "two stroke" and maximum r.p.m. was assessed.

For each test the selected engine/silencer combination was attached to the test bench, and the engine was started with a Kavan 12 v. electric starter. As soon as a stabilised "two stroke" and the maximum r.p.m. were achieved, a 30-second tape recording was made of the noise levels being emitted by the engine/silencer/propeller combination. At the same time the visual readings of dBA and dBLin were noted from the B. & K. noise level meter.

Initially, recordings were made in four positions relative to the engine. These were: in front of the propeller disc, exhaust side of the engine, behind the propeller disc, and the induction side of the engine. The recordings were made at a distance of 7 metres from the noise source, and at a height of 1 metre.

Datum recordings were made of each engine in the open exhaust condition, and with a standard manufacturer's silencer fitted. Then every possible silencer was tried on a given engine—in each case a 30-second recording was made, plus dBA and dBLin readings noted, and the stabilised r.p.m. noted.

During a test on any engine/silencer combination anomalies (if any) in starting/restarting, running qualities, throttling qualities, and needle valve sensitivity were noted.

The precautions taken in order to ensure as much repeatability as possible included retention of same combinations for each trial, this applying to props, fuel, plugs, and positioning.

Results

The tables contain a tabular summary of results for every engine/silencer combination assessed. Many more tests were in fact conducted and many engine/silencer combinations were repeated during different test sessions to establish a common result between various batches of data.

The noise readings (in dBA and dBLin) are obviously affected by the hangar used for the tests, because of relections from the walls, resonance of items inside the hangar etc. The considered opinion is that the noise reading could be up to 6 dB higher because of this. Measurements on the flying field and subsequent flight tests would quantify this figure.

Each silencer will now be considered in turn from the points of view of silencing effect, interchangeability, ease of fitting and robustness.

OS 703 SILENCER This silencer is standard equipment on the OS Max 40R/C, and as can be seen in the Table it reduced the observed dBA value from 101–104 in the open exhaust condition to 95–5 with the silencer fitted. There was also a reduction in r.p.m. on a Top Flite 10″ × 6″ nylon from 12,300 to 11,500. Interchangeability was not assessed since the OS 703 was designed to fit OS engines only. The method of fitting was good, with the flange locating the silencer on the exhaust stack and the strap holding the silencer firmly—possibly too firmly for the inevitable "hard landing". Both pressure and priming nipples, and a pressure outlet blank are supplied.

OS 702 SILENCER This silencer is standard equipment on the OS Max 25 R/C, and as can be seen in the Table, it reduced the observed dBA value from 95–6 in the open exhaust condition to 84–8 when fitted. The reduction in r.p.m. was more marked than the OS Max 40 R/C/OS combination; namely 10,700 to 9,800 on a Tornado 9″ × 6″ nylon propeller. The remarks made above on the interchangeability, etc also apply.

STANDARD HB 20/VECO 19 SILENCER This silencer is an optional extra with either the HB 20 or Veco 19 engines—in this case it was assessed on a Veco 19 BB R/C (made in Germany). The method of attachment is fairly unusual, being necessary since the engine crankcase casting still contains the holes in the exhaust stack for the throttle linked exhaust flap. A tightly fitting bar is pushed through these holes at either side of the stack. In the centre of this bar is a threaded hole, and a bolt passing through the silencer and exhaust extension, screws into this, thus attaching the silencer to the engine. In use this method of attachment was found to be simple and positive, providing the exhaust bar was aligned correctly. No provision is made for priming or exhaust pressure tapping. Since it was felt that the exhaust bar could have some effect on noise/r.p.m. levels, the exhaust bar only configuration was assessed. The Table shows the observed dBA values of 96 for open exhaust, 95·5 with exhaust bar and 88 with silencer fitted. Corresponding r.p.m.s were 10,250; 10,500; and 10,300/400. The slight variation in r.p.m.s is thought to be due to the relative newness of the engine, although it did appear to run more evenly with the silencer fitted—perhaps a back pressure effect.

MERCO 29/35 STANDARD SILENCER This silencer is an optional extra for Merco 29/35 engines, and is believed to fit the early Merco 49/61s. Unless assembled with a silicone sealing compound it was found to leak unburned oil from all joints. The method of attachment was neat, but quite tedious, especially after some hours use, when the attachment studding threads became covered in burnt castor oil. A priming hole is drilled in the outer half of the silencer, but no pressure nipple for pressurising the fuel system. Also the tapered shape makes fitting of commercial "add on" silencers difficult. The Table shows the observed dBA values of 95–8 for open exhaust, and 89–91 with silencer fitted. The corresponding r.p.m.s were 9,750–500 and 9,700/400 respectively. Some variations were noticed however during other tests on the same configuration; in a different test session e.g. 92 dBA and 10,000 with silencer fitted. No reason could be found for these differences.

SOMOSO ADD ON SILENCERS These were received towards the end of the rig tests and therefore only limited tests have been undertaken. Somoso Types II, IV, V and VI have been assessed.

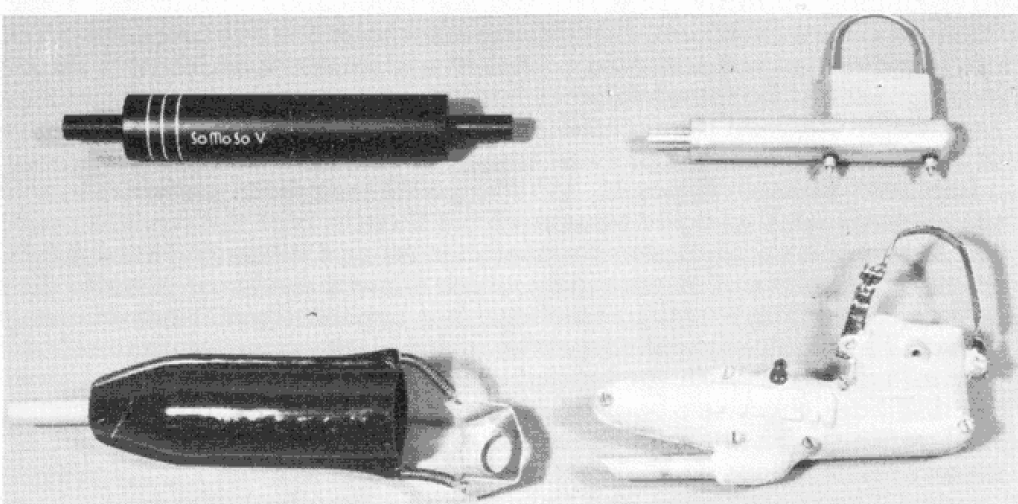
a SOMOSO II: (·09–·25 cu. in.) This silencer is of the straight principle as opposed to expansion chamber type. The central tube has a number of holes or cut-outs in it, which allow the exhaust gases to dissipate their energy in the absorbent, but apparently non-oil-retaining cover. The whole of the silencer is anodised black in an attempt to reduce the oil retention. With the limited use so far this appears to work very well. The silencer can be used either way round with no appreciable difference. From the interchangeability point of view it can be fitted to any small expansion chamber type silencer, which has a tailpipe type outlet. The construction and finish are to a very high standard—even to the extent of complementing a model's appearance. No internal cleaning is apparently necessary since any residual oil from a previous run is blown out at the start of the next one. The only comparative rig tests were conducted on a Veco 19 BB R/C equipped with a Strato 9″ × 6″ wooden propeller. Tests were conducted with a 12″ length of small bore silicone tubing connecting the standard silencer to the Somoso II, and also the shortest possible length (as recommended). The observed dBA values were 88 with standard silencer, 78/9 with the addition of 12″ silicone tube and Somoso II, and 82/3 for shortest silicone tube and Somoso II. The corresponding r.p.m.s were 10,300–400; 9,100; and 9.800. Thus showing that the shortest connecting tube causes the least power loss in terms of r.p.m. reduction. The apparent increase in noise level with the shortest tube is in fact due to the r.p.m. increase (i.e. propeller noise) compared with the 12″ of tube.

b SOMOSO IV (0·29–0·40 cu. in.) This silencer is essentially the same design as the Somoso II, but scaled up for larger engines, and therefore the comments made earlier on construction, appearance etc, apply equally to the Somoso IV. The silencer was assessed on an OS Max 40 R/C, and a Merco 29 R/C with and without the standard Merco silencer.

Considering first the OS Max 40 R/C; this was installed in a Piper Club airframe, and was fitted with an OS 703 silencer and 7″ of small bore silicone tube, and a Top Flite 11″ × 4″ nylon propeller. This configuration gave 85–7 dBA and 10,000 r.p.m. The addition of the Somoso IV produced 85–7 dBA again, but the r.p.m. had increased to 10,750.

Considering secondly the Merco 29 R/C; this was installed in the test rig as normal, and was fitted with an ED No. 2 manifold and a 10″ × 6″ Top Flite nylon propeller. This configuration produced 94/5 dBA and 10,100 with a very critical needle valve setting. The addition of the Somoso IV produced 87 dBA and 9,750 r.p.m. Both dBA readings are down on the Merco in open exhaust mode, and the r.p.m. values are increased. Finally the Merco 29 plus standard Merco silencer, Top Flite

Tested silencers and add-ons, the Somoso V for ·40 to ·60 cu. in., Spinaflow for Merco ·29–·35 engines, bottom left, the large Weston clip-on silencer for ·40–·60 cu. in. and the Piper No. 2 Frequency Modulated Silencer for 05·40 or Enza ·35.



10″ × 6″ nylon propeller, and a short length of small bore silicone tube pushed in the silencer outlet. This configuration produced 87/8 dBA and 10,000–9,700 r.p.m. Addition of the Somoso IV produced 88 dBA and 9,800 r.p.m. Although apparently similar figures, the exhaust noise was reduced leaving induction roar and propeller noise dominant.

c SOMOSO V (0·40–0·61 cu. in.) This silencer is of apparently different construction. It was especially noticeable that the r.p.m. increased after the silencer had warmed up. The same three configurations were assessed as the Somoso IV.

i OS Max 40 R/C + OS 703 silencer + 7″ small bore silicone tube
85–7 dBA and 10,000 r.p.m.
ii As for i but addition of Somoso V
84–6 dBA and 10,850 r.p.m.
iii Merco 29 R/C + ED No. 2 manifold
94/5 dBA and 10,100 r.p.m.
iv As for iii but addition of Somoso V
80 dBA and 600–7000 r.p.m.
(N.B. The engine ran very roughly and then cut abruptly.)
v Merco 29 R/C + standard Merco silencer + 2″ silicone tube
87/8 dBA and 10,000–9700 r.p.m.
vi As for v but addition Somos V
Initially 82 dBA and 8000 r.p.m.
then 86 dBA and 9500 r.p.m. as silencer warmed up.

d SOMOSO VI (0·45–0·61 cu. in). The same remarks on construction and appearance etc apply to the Somoso VI as they did to the Somoso IV and II. The following figures were obtained:

i OS Max 40 R/C + OS 703 silencer + 7″ small bore silicone tube.
85–7 dBA and 10,000 r.p.m.
ii As for i but addition of Somoso VI
85–7 dBA and 11,150 r.p.m.
iii Merco 29 R/C + ED No. 2 manifold
94/5 dBA and 10,100 r.p.m.
iv As for iii but addition of Somoso VI
87 dBA and 9500 r.p.m.
v Merco R/C + Standard Merco silencer + 2″ silicone tube
87/8 dBA and 10,000–9700 r.p.m.
vi As for v but addition Somoso VI
84/5 dBA and 9500–9300 r.p.m.

WESTON SMALL AND LARGE CLIP ON TYPE These silencers are in the form of open fronted, glass-fibre expansion chambers. They are designed to be attached to the end of expansion chamber silencers such as the Merco or Enya type. A spring clip holds the silencer in position. The outlet tube also forms a baffle in that the inside end is crimped and small holes are drilled in the tube to allow the exhaust gases into it and thus out to atmosphere. Constructionwise the glass-fibre mouldings were good and reasonably well finished, but there were some loose fibres on the inside walls of the expansion chamber. Also the holes in the outlet tubes were not de-burred. The small size clip-on was a good fit on the Merco silencer, as was the large size clip-on on the Enya. However the addition of a moulded-in silicone rubber seal would have improved the fit and very probably have reduced the noise also. "Knock-off-ability" was good, whilst remaining in position for normal use. Also it was possible to vary the direction of the exhaust plume by angling the clip-on. The small clip-on was assessed on the Merco 29 R/C, and the Enya 35 R/C. (N.B. The Enya 35 R/C was found to be very sensitive to additions to the standard expansion chamber, e.g. a short length of silicone tube, the same internal diameter as the silencer outlet, cut the r.p.m. on a given propeller by 33%).

i Merco 29 R/C + Merco Silencer
89–92 dBA and 9700–9400 r.p.m.
ii As for i but addition of small Weston clip-on
83–5 dBA and 9600 r.p.m.
iii Enya 35 R/C plus standard Enya silencer
89/90 dBA and 9600 r.p.m.
iv As for iii but addition of Weston clip-on (small)
81–3 dBA and 8600 r.p.m.
v As for iii but addition of large Weston clip-on
86–9 dBA and 9500–9750 r.p.m.

WESTON ADD-ON SILENCER This silencer was also a glass-fibre moulding, with the addition of a tubular inlet and outlet. Comparative trials were conducted using each end as an inlet, and it was found that when connected with the end nearest the "W" of Weston as inlet, a reduction of 1–5 dBA was achieved with no r.p.m. difference. The Weston Add-on was assessed on the following engines, Merco 29, OS Max 40, OS Max 25, K. & B. 40F, and Veco 19 BB.

i Merco 29 R/C + Standard Merco silencer
89–92 dBA and –9400.
ii As for i plus Weston Add-on, clamped between silencer halves ("W" fwd.)
82–4 dBA and 9500 r.p.m.
iii As for ii but ("W" aft)
85–7 dBA and 9500 r.p.m.
iv OS Max 4p R/C + OS 703 + 7″ of small bore silicone tube and 11″ × 4″ Top Flite Nylon prop
85–7 dBA and 10,000 r.p.m.
v As for iv but addition of Weston Add-on
86 dBA and 11,000 r.p.m.
vi OS Max 25 R/C + OS 702 + 4½″ of small bore silicone tubing
85–7 dBA and 9880 r.p.m.
vii As for vi but addition of Weston Add-on
82–5 dBA and 9500 r.p.m.
viii K. & B. 40 R/C + Powermax silencer
88/9 dBA and 11,000 r.p.m.
ix As for viii but addition of Weston Add-on
86–8 dBA and 10,000 r.p.m.
x Veco 19 R/C BB + Standard Veco silencer
88 dBA and 10,300–10,400 r.p.m.
xi As for x but with the addition of Weston Add-on
89 dBA and 9300 r.p.m.

POWERMAX DUSTBIN TYPE SILENCER The example tested would only fit its intended K. & B. 40F R/C. Construction was simple; the expansion chamber consisting of two co-axial, close-fitting, thin wall tubes. A positionable end cap was a plug in fit and contained an outlet pipe, which allowed exhaust gas to exit at right angles to the airflow. The outlet pipe contained several sets of various size holes and thus also acted as a baffle. Location on the engine exhaust stack was provided for by the different size cutouts in the tubes forming the expansion chamber; and the silencer was held on to the engine by a metal strap. The following figures were taken:

i K. & B. 40F R/C—Perry Carb—open exhaust
103/4 dBA and 11,000/250 r.p.m.

ii As for i plus Powermax dustbin type silencer
88/9 dBA and 11,000 r.p.m.

PIPER FREQUENCY MODULATED SILENCER A single sample was tested on an Enya 35 R/C and a K. & B. 40F R/C. Construction is very robust and heavy (over 5 oz.) and consists of a sand cast expansion chamber which is bolted together. The expansion chamber is cigar-shaped and the rear half contains a piece of aluminium swarf in the form of a spiral. A 6 mm. or 8 mm. outlet pipe can be fitted in the side. Also the length of the outlet pipe can be varied for best results. A priming hole is provided in the exhaust extension, and a pressure nipple in the side.

i Enya 35 R/C—open exhaust
99/100 dBA and 10,000 r.p.m.

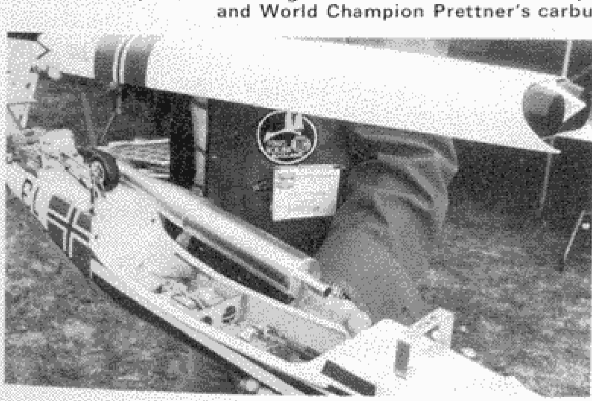
ii As for i but with the addition of the Piper FM silencer and 6 mm. outlet
87–9 dBA and 9750 r.p.m.

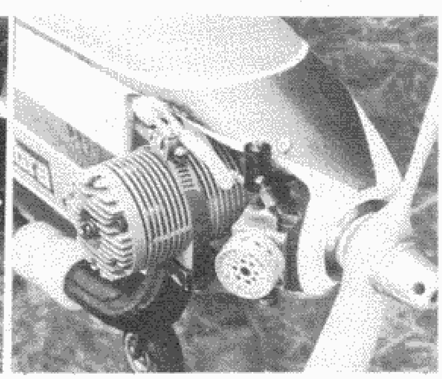
iii K. & B. 40F R/C—open exhaust
103/4 dBA and 11,000–11,250 r.p.m.

iv As for iii but with the addition of Piper FM Silencer and 6 m. outlet tube.
87–9 dBA and 10,000 r.p.m.

DAC COMPONENTS SPINAFLO SILENCER Two examples were used for assessment, a small size to fit the Merco 29 and a large size originally designed for an early Fox 40. The Spinaflo is a conventional expansion chamber silencer, fitted with spiral-flow inducing

Latest developments, Norwegian Ernst Totland's enclosed pipe, hidden by detachable jet pipe cowl (left) and World Champion Prettner's carburettor silencer at right.





bafles near the outlet pipe. Interchangeability is effected by a series of exhaust stack extension pieces. The expansion chamber is also made in several sizes to suit popular engine capacities. The silencer is attached to the engine by a piece of studding which passes around the cylinder, through the exhaust extension and the expansion chamber. No provision is made for tapping exhaust pressure for the fuel system although a priming hole is provided in the exhaust extenstion. The method of attachment, whilst very similar to the Merco system, is an improvement over that system since the threaded ends and the nuts are external to the expansion chamber and hence do not become covered in burnt-on carbon. The following figures were taken:

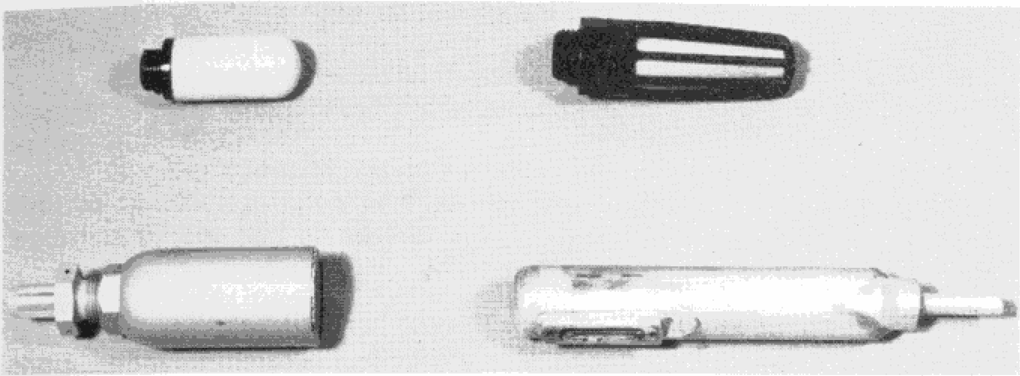
- i Merco 29 R/C—open exhaust
  95–98 dBA and 9500–9700 r.p.m.
- ii As for i but plus Spinaflo silencer (small)
  86–89 dBA and 8500 r.p.m.
- iii As for ii but plus $4\frac{1}{2}''$ of small bore silicone tube
  87/8 dBA and 8375 r.p.m.
- iv As for iii but plus Weston Add-on
  85/6 dBA and 8570 r.p.m.
- v K. & B. 40F R/C—open exhaust
  103/4 dBA and 11,000–11,250.
- vi As for v but plus large Spinaflo
  88–90 and 10,300–10,400 r.p.m.

ENYA 35 SIZE EXPANSION CHAMBER The Enya 35 seemed to be over sensitive to additions to the standard silencer. However, the engine *is* well matched to the expansion chamber supplied with it. Nevertheless encouraging results were obtained with the large Weston clip-on and the Piper FM silencer; so further tests will be conducted and reported on in Part 2 of this report. The following results were obtained:

- i Enya 35 R/C—open exhaust
  99/100 dBA and 10,000 r.p.m.
- ii As for i but plus Enya silencer
  89/90 dBA and 9600 r.p.m.

NOPOL PNEUMATIC SILENCERS Three sizes were obtained from Bestobell Acoustics for evaluation, namely $\frac{1}{2}''$ BSP and $\frac{1}{8}''$ BSP—the size referring to the inlet. The PVC diffuser core had a stated temperature limit of +80°C, however both of the $\frac{1}{8}''$ BSP samples had holes blown in them despite being located well downstream of the main silencer and connected via a long (12″) length of silicone tubing. The full results can be obtained from the tables but typical values were 1 or 2 dBA decrease in noise level, with no effect on r.p.m. However, there were several distinct disadvantages. Firstly, the diffuser type PVC core tended to spread the exhaust plume over a wide area—thus leading to a very messy model. Secondly the PVC core quickly became saturated in unburned castor oil, leading to an increase in exhaust system back pressure and a reduction in power. A by product of the increased back pressure was improved throttle characteristics, especially on the Merco.

SCHRADER PNEUMATIC SILENCERS Two types were tested, namely $\frac{1}{2}''$ and $\frac{3}{8}''$ PVC types and a Type 476, brass-swarf-filled



Schrader PVC Pneumatic Silencer, Nopol PVC, Schrader-type 476 Pneumatic silencer with PVC type inside and the JB Mk. 1 welded silencer as tested.

metal type. A third type was made by fitting a ⅜″BSP PVC type inside the empty metal case of a Type 476. The performance of these pneumatic silencers was considerably better than the Nopol, in that the observed dBA values decreased by 6 dBA, whilst the r.p.m. increased by 200–300. However on the debit side the Schrader PVC core seemed less able to withstand the exhaust gas temperatures, and also appeared to become oil soaked after a very short time. Similarly the remarks on exhaust plume diffusion and improved throttling apply here.

ED No 2 MANIFOLD. Whilst not a silencer in its own right, it was used as a universal manifold on the Merco 29; thus allowing a direct comparision of the various types of add-on silencer. The Merco 29 is by no means ported for such a free flow manifold, but r.p.m. increases of between 350 and 600 were noted for the engine when fitted with only the manifold, compared to the open exhaust configuration. However engine handling characteristics became critical and throttle control non-existent!

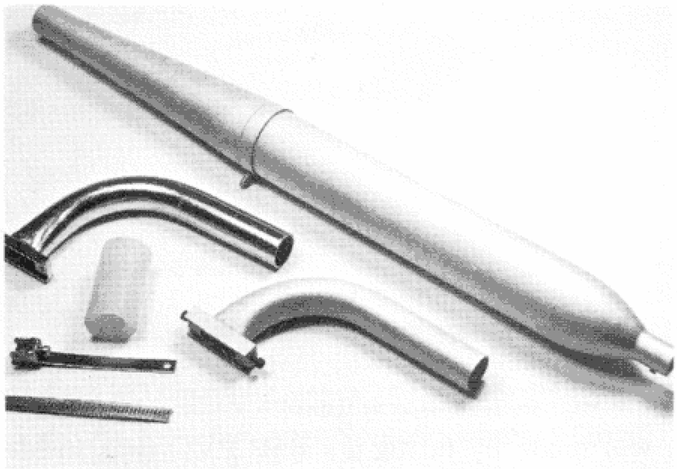
OWN DESIGN SILENCER (JB Mk 1) An attempt to produce a cheap, fairly efficient silencer from low cost/scrap items. The expansion chamber is a thick walled aluminium cylinder, with a central tubular baffle, running the whole length of the silencer. The baffle is welded in place at the rear end, and located at the front by passing the mounting strap bolts through it. Initial designs with no baffles, and then steel wool filling were largely unsuccessful. The current baffle contains a number of small holes in the rear end of the tube, thus allowing the exhaust to pass out into the tail pipe. The design is fairly restrictive as can be seen from the results in Table D2, but further work on the baffle would probably improve the balance between silencing and power loss.

i Merco 29 R/C open exhaust
95–8 dBA and 9750–9500 r.p.m.

ii As for i but plus JB Mk 1
82 dBA and 8250 r.p.m.

Summary

A partially expected result was that the manufacturer's silencers did not meet the 80 dBA at 7 metres limit. The tests in the hangar proved this, even allowing for a 6 dBA increase because of hangar effects However, neither did the replacement silencers such as the DAC Spinaflo or the Piper FM.



HP tuned pipe silencer with alternative steel and alloy elbows, PVC connection and clamps.

It was already known that propeller noise was a significant contributor to the overall noise level; but when the r.p.m. fell below 9000 the reduction in noise was really noticeable. Thus an "efficient" silencer could be one which reduced the engine r.p.m. so much that it became quiet! This also explains the apparent incongruity of the Somso and Weston Add-on silencers, which appeared to increase the noise levels. In fact, some lost engine power was being restored and hence the propeller r.p.m. increased—thus increasing the overall noise level as measured by the meter. Subjectively, the exhaust noise levels decreased, and the propeller noise was clearly audible by the Mk. 1 human ear.

Initially, tests and recordings were made in four positons relative to the engine, but as experience was gained the recording position was standardised as the exhaust side. Thus enabling silencers to be assessed as noise reflectors or shields.

It was also found that engines tended to run much hotter in the test rig, and therefore each test and recording was made during an engine run of approximately 60 seconds duration. This certainly accounts for some of the inconsistencies in the Veco 19 R/C BB results, which showed a marked power loss on warming up. There was no evidence to suggest an efficient silencer caused the engine to run hotter than in the open exhaust configuration. But, an inefficient silencer, causing a large power-loss, such as the JB Mk. 1, causes an increase in cylinder head temperature.

Comparative tests were carried out with wooden and nylon propellers during the trials. It was difficult to detect any difference, since different propellers of nominally the same diameter and pitch, gave widely differing r.p.m. readings.

It was not possible to separate propeller noise from induction roar, but it is thought that a significant proportion of the noise level remaining after an efficient exhaust silencer has been fitted, is induction roar.

Conclusions

Current commercial silencers are able to reduce exhaust noise to near acceptable levels.

Propeller noise is a significant contributor, particularly as exhaust noise decreases. Propeller noise is drastically reduced below 9000 r.p.m.

Throttle characteristics tend to improve with the addition of an efficient silencer.

Add-on silencers, used in addition to manufacturer's own designs appear to offer the greatest reduction in noise, often coupled with an increase in power.

Smaller capacity engines tend to lose more power through the fitting of an efficient silencer than the larger ones. The power loss is not restored by the add on silencers.

Recommendations

On the basis of the ground rig tests the following tentative recommendations are made.

Club members purchase an add-on or clip-on type silencer to supplement existing expansion chamber type silencers supplied with the engines.

Models are operated with as large a propeller i.e. large diameter, low pitch) as possible to keep propeller r.p.m. at or below 9000.

MERCO 29 R/C

Test No.	*Sample No.*	*Observed values*		*R.P.M.*	*Sampling location*	*Silencer details*	*Remarks*
		dBA	*dBLin*				
3	1	98	99–101	9500	Exhaust	Open exhaust	All tests: Top Flite 10"×6" nylon propeller. Partial throttle reading
3	2	95	97–98	9600	Behind	Open exhaust	
3	3	87	87	4600	Behind	Open exhaust	
3	4	96	97–100	9750	Inlet	Open exhaust	
3	5	96	97–99	9750	Front	Open exhaust	
4	1	90/1	91–93	9400	Front	Standard Merco Silencer	
4	2	91	93–98	9500	Exhaust	Standard Merco Silencer	
4	4	90–92	92–95	9500	Behind	Standard Merco Silencer	
4	5	84	84/5	4500	Behind	Standard Merco Silencer	
4	6	89/90	90–94	9700	nlet	Standard Merco Silencer	Partial throttle reading
5	3	94/5	96–98	10100	Exhaust	ED No. 2 manifold only	
6	5	93/4	95–97	9400	Exhaust	As for Test No. 3 +12" of ⅜" silicone tube	
8	3	85	88	8500	Exhaust	JB Mk. 1	Leaking. Engine difficult to start. Needle value setting very sensitive
9	4	78	82	7850	Exhaust	JB Mk. 1+12" of ⅜" silicone tube	
13	5	91	91/2	9500	Exhaust	As for Test 6 No. 5+½" BSP Nopol	
13	8	92/3		9250–9500	Exhaust	As for Test 6 No. 5+⅜" BSP Nopol	
14	1	82	85–87	8250	Exhaust	JB Mk. 1	Now welded construction
13	2	84/5	86/7	9000	Exhaust	As for Test 6 No. 5+Ford Escort expansion box	
13	4	88/9	88–90	9500	Exhaust	As for Test 6 No. 5+½" BSP Schrader PVC	
13	5	87/8	88–90	9600	Exhaust	As for Test 6 No. 5+Schrader Type 476	
13	6	87/8	88–90	9750	Exhaust	As for Test 6 No. 5+⅜" BSP Schrader PVC	
13	8	87	87–89	8800	Exhaust	As for Test 6 No. 5+⅛" Nopol reversed in tube	

MERCO 29 R/C

Test No.	Sample No.	Observed Values dBA	dBLin	R.P.M.	Sampling location	Silencer details	Remarks
16	2	91/2	92/3	9500	Exhaust	As for Test 6 No. 5+Weston Add-on ('W' Fwd)	
17	2	83–85	87–90+	9250	Exhaust	Merco Silencer+ small Weston clip-on type	
17	3	82–84	88–90+	9500	Exhaust	Merco Silencer+ Weston Add-on ('W' Fwd)	
17	4	85–87	89/90	9500	Exhaust	Merco Silencer+ Weston Add-on ('W' Aft)	
28	1	86–89	90+	8500	Exhaust	Small Spinaflo	
28	2	87/8	89–91	8375	Exhaust	Small Spinaflo+ $4\frac{1}{2}$" small bore silicon tube	
28	3	85/6	87–89	8750	Exhaust	As for Test 28 No. 2+Weston Add-on ('W' Fwd)	
33	1	75–77	77–79	7550	Exhaust	ED No. 2 Manifold + Weston Add-on connected, by shortest silicon tube—engine unhappy	
36	1	87	90	9750	Exhaust	ED No. 2 Manifold +Somoso IV	
36	2	80		6000–7000	Exhaust	ED No. 2 Manifold +Somoso V	
36	3	87	88/9	9500	Exhaust	ED No. 2 Manifold +Somoso VI	
36	4	92	94	10100	Exhaust	Merco Silencer	
36	5	87/8	93	9700–10000	Exhaust	Merco Silencer+ 2" small silicon tube	
36	6	88	91/2	9800	Exhaust	Test 5+Somoso IV	
36	7	82	84/5	8000	Exhaust	Test 5+Somoso V	Same test, 1500 r.p.m. increase when silencer hot
36	8	86	88	9500	Exhaust	Test 5+Somoso V	
36	9	84/5	87	9300–9500	Exhaust	Test 5+Somoso VI	
36	10	83	86	9100	Exhaust	Test 5+Weston ('W' Fwd)	

ENYA 35 R/C & ENYA 35 BB R/C

Test No.	Sample No.	Observed Values dBA	dBLin	R.P.M.	Sampling location	Silencer details	Remarks
22	1	99/100	101/3	10000	Exhaust	Open exhaust	
23	1	89/90	90–93	9600	Exhaust	Standard Enya silencer	
24	1	81–83	88–90+	8600	Exhaust	As for Test 23 No. 1+small Weston Clip-on	
25	1	86–89	90–92	9500–9750	Exhaust	As for Test 23 No. 1+large Weston Clip-on	
26	1	79–81		8500	Exhaust	As for Test 23 No. 1+$\frac{1}{2}$" RSP Nopol	Engine not running cleanly
27	1	87–89	88–90+	9750	Exhaust	Piper FM+small outlet	Top Flite 10"×6" nylon propeller

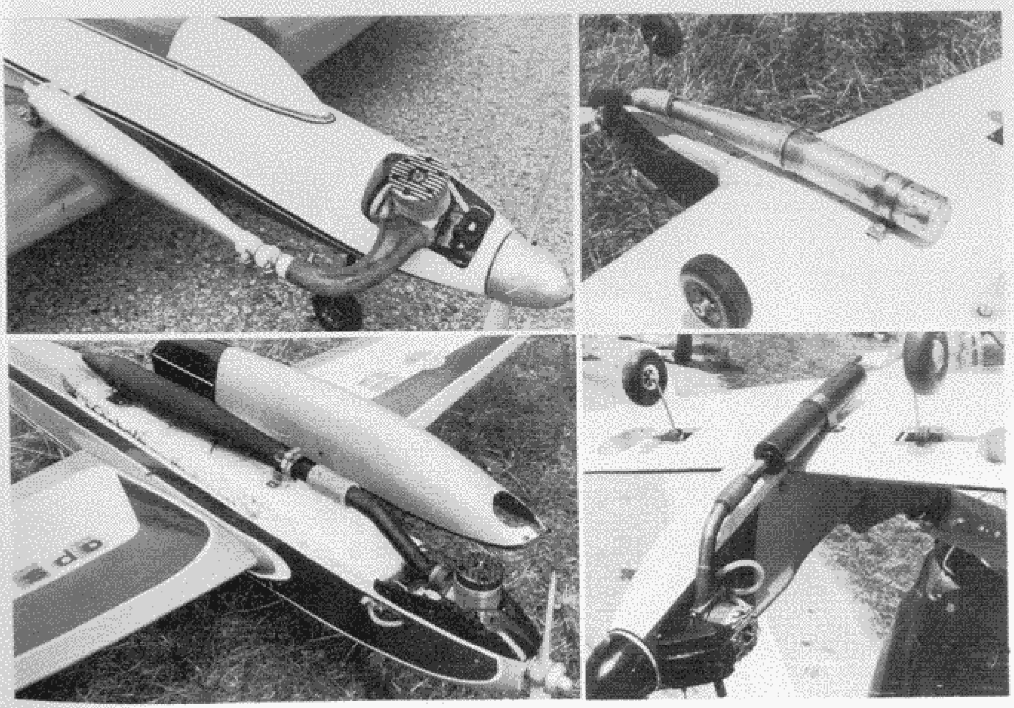
ENYA 35 BB R/C

Test No.	Sample No.	Observed Values dBA	dBLin	R.P.M.	Sampling location	Silencer details	Remarks
12	2	90/1			Exhaust	Standard Enya silencer as for 12 No. 2+$7\frac{1}{2}$" of $\frac{1}{16}$" I/D silicone tube	Top Flite 10"×6" nylon propeller
12	4	82/3					

OS MAX 40 R/C

Test No.	Sample No.	Observed Values dBA	dBLin	R.P.M.	Sampling location	Silencer details	Remarks
1	1	103/4	101–104	12100–12300	Exhaust	Open exhaust	Top Flite 10"×6" nylon propeller
1	2	101	100–102	12250	Behind	Open exhaust	
1	3	101	101/2	12300	Inlet	Open exhaust	
1	4	102/3	100–102	12300	Front	Open exhaust	
2	1	92/3	93/4	11500	Front	OS 703	
2	2	93	94–96	11500	Inlet	OS 703	
2	3	94/5	94–98	11500	Behind	OS 703	
2	4	92/3	93/4	11500	Exhaust	OS 703	
11	1	91/2	93/4	11000	Exhaust	OS 703	Different Engine. Top Flite 10"×6" wooden propeller
11	2	90/1	92–94	11300	Exhaust	As for 1+12" of 3/8" I/D Silicone	
11	3	89–91		11000	Exhaust	As for 2+1/2" BSP Nopol	
11	4	89–91		11200	Exhaust	As for 2+3/8" BSP Nopol	
29	1	85–87	88–90+	10000	Front	OS 703+7" of 3/8" I/D Silicone	Same engine as in tests 1 & 2, 11"×4" Top Flite nylon. Installed in cub airframe less wingss
29	2	83–85	85/6	10000	Behind	OS 703+7" of 3/8" I/D Silicone	
29	3	86–89	87–90	10875	Front	As for 1 & 2, + Weston Add-on	
34	1	86		11000	Front	Weston Add-on	Same airframe, prop as Test 29
34	2	85–87	87–90	10750	Front	As for Test 29 No. 1+Somoso 4	
34	3	84–86	88–90	10850	Front	As for Test 29, No. 1+Somoso 5	
34	4	85–87	88?	11150	Front	As for Test 29 No. 1+Somoso 6	

Silencers at the 1977 World Championships, at bottom left is Bengt Lundstrom's clever internal tuned pipe and right, the carb: silencer box on a Norwegian Spitfire by Tore Paulsen.



FOX 45 R/C (Schnuerle)

Test No.	Sample No.	Observed Values dBA	dBLin	R.P.M.	Sampling location	Silencer details	Remarks
15	1	103/4	103/4	13500	Exhaust	Open exhaust	Annular adaptor fitted. Tube split soon after test started. Tornado 10"×6" nylon propeller
15	2	97/8	100	12000	Exhaust	As for Test 15 No. 1+12" of $\frac{11}{16}$ I/D silicone tube	

K. & B. 40F R/C

Test No.	Sample No.	Observed Values dBA	dBLin	R.P.M	Sampling Location	Silencer details	Remarks
18	1	103/4	102–104	11000–11250	Exhaust	Open exhaust	(Perry Carb)
19	1	88/9	91–93	11000	Exhaust	Powermax dustbin type	
19	2	86–88		10000	Exhaust	Powermax dustbin type + Weston Add-on	
20	1	87–89	89–90+	10000	Exhaust	Piper FM (small outlet)	
21	1	88–90	91–95	10300–10400	Exhaust	Spinaflo for Fox 40	Top Flite 10"×6" nylon propeller

OS MAX 25 R/C

Test No.	Sample No.	Observed Values dBA	dBLin	R.P.M.	Sampling location	Silencer details	Remarks
30	1	95/6	96/7	10700	Exhaust	Open exhaust	Nos 1–4 9"×6" Tronado nylon
30	2	84–88	87–90	9800	Exhaust	OS 702	
30	3	85–87	87–90	9875	Exhaust	OS 702+4½ small bore silicone tube	
30	4	82–85	88–90	9500	Exhaust	As for No. 3+ Weston Add-on	
30	5	85–87	86–90	10750	Exhaust	As for No. 2	9"×6" Strato wood

VECO 19 BB R/C

Test No.	Sample No.	Observed values dBA	dBLin	R.P.M.	Sampling location	Silencer details	Remarks
35	1	96	95	20250	Exhaust	Open exhaust	
35	2	95·5	95/4	10500	Exhaust	+Silencer Bar	
35	3	88	88/9	10300/400	Exhaust	+Standard Silencer	
35	4	82	85	9000	Exhaust	+12" small bore silicone tube	
35	5	78/9	83	9100	Exhaust	+Somoso II	Handling characteristics difficult
35	6	82/3	84/5	9800–9600	Exhaust	Test 3+Somoso II+shortest silicone tube	
35	7	86	88	10600	Exhaust	Test 6+Somoso IV	
35	8	86	88	10500	Exhaust	Test 6+Somoso V	
35	9	86	88	10500–10200	Exhaust	Test 6+Somoso VI	
35	10	80	83	9200	Exhaust	Test 6+Weston Add-on+shortest tube	
35	11	78	80	9100	Exhaust	Test 6+Weston Add-on+12" tube	

Gearing

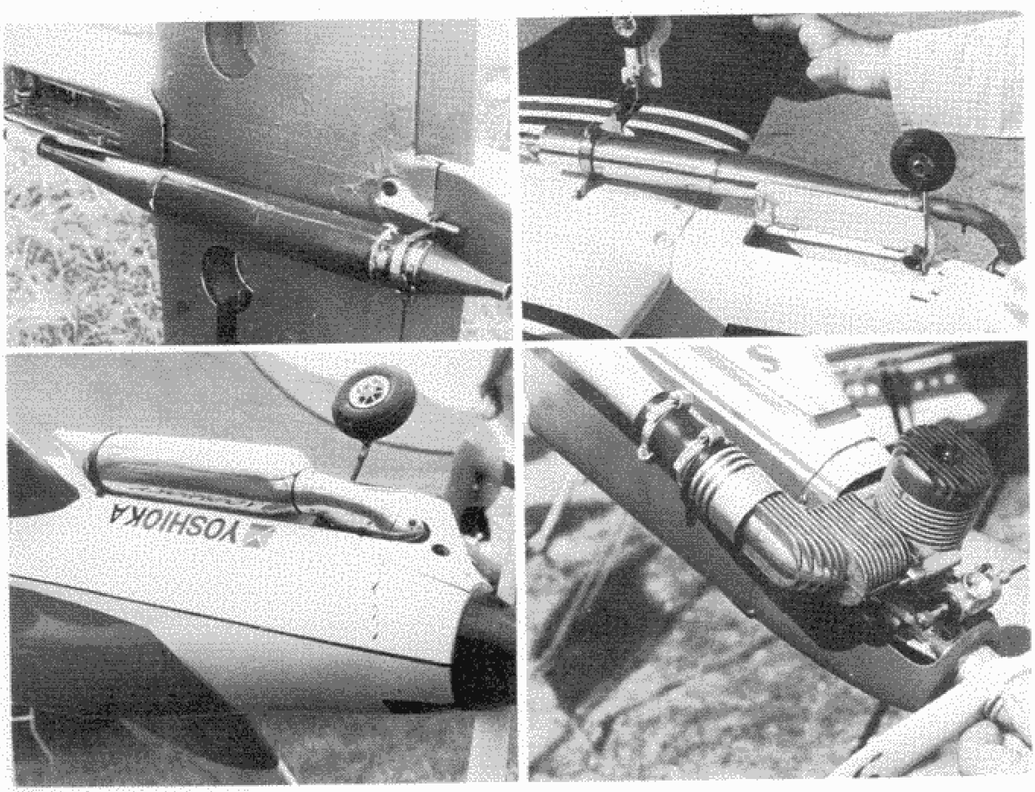
As a direct result of the conclusions reached, further work has been carried out on two methods of reducing propeller r.p.m. whilst allowing the engine to operate somewhere near its peak power realisation r.p.m. The two methods were:

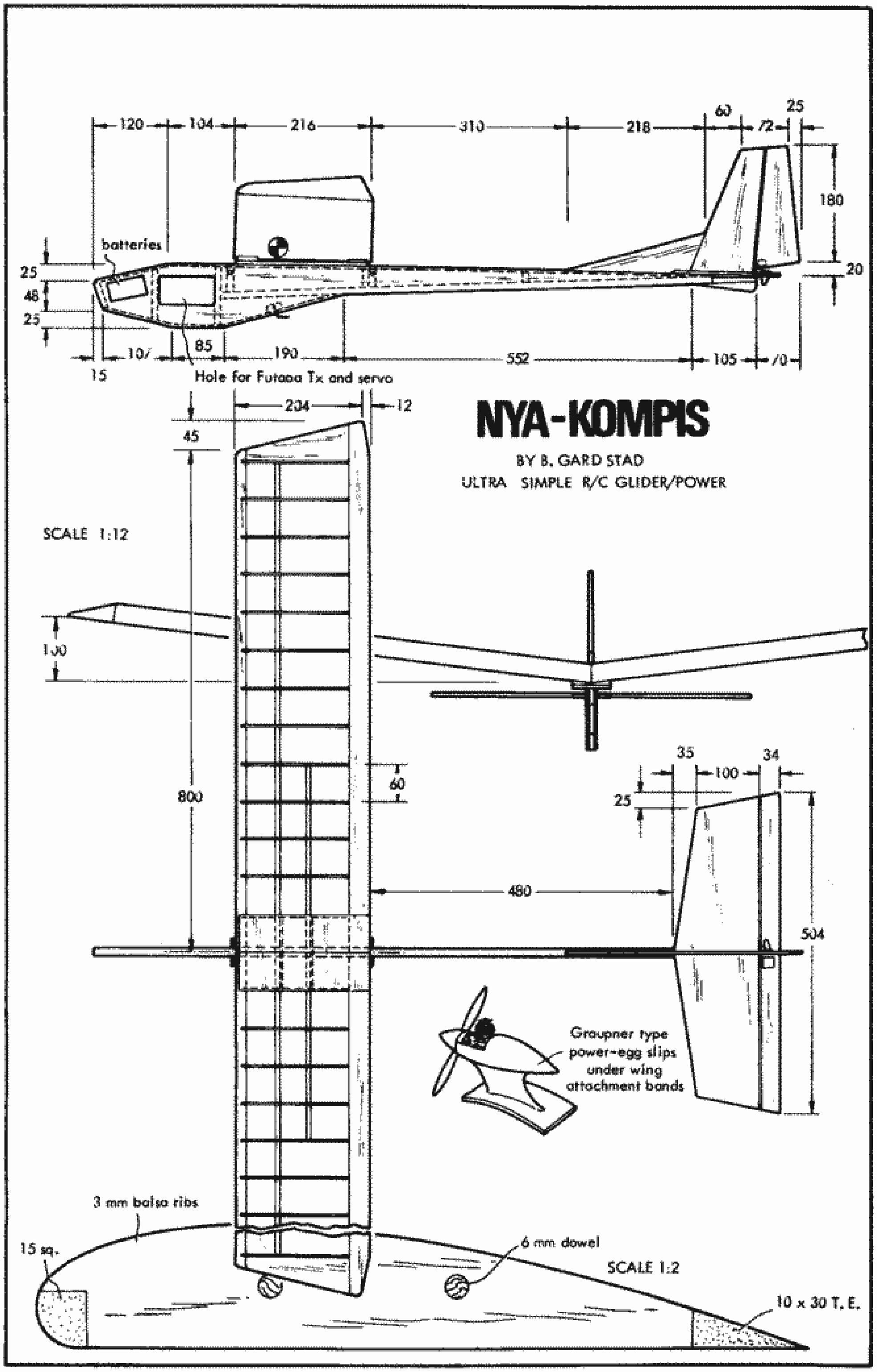
a Reduction gearing using spur gears (4:3)
b Tooth belt drive reduction system (2:1)

An immediate result of (*a*) was the emergence of gear noise as a significant factor. Steps are being taken to investigate the possibility of enclosing the reduction gearing in the hope of reducing this to acceptable levels. Tests on the prototype toothed belt reduction system are to follow.

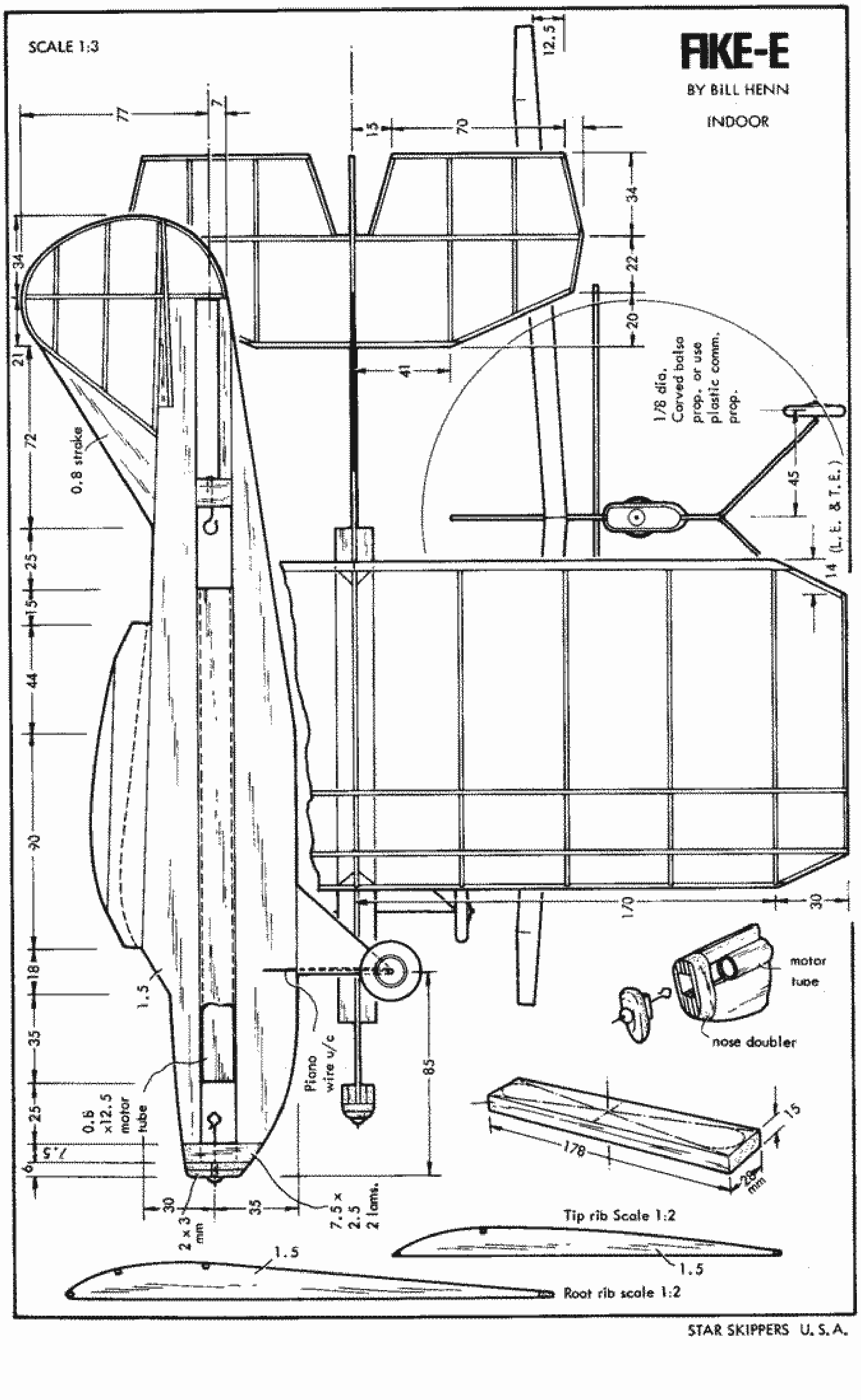
Subjective flight trials have been carried out on several engine/silencer combinations—some seeming to be quieter than others. The ease of operation of the engines when fitted with various silencing systems remained much the same as with the normal single silencer. However, certain combinations proved to be critical from the point of view of maintaining a constant and adequate power output, i.e. sudden reductions in power in flight leading to forced landings. Ground checks were not able to reproduce these symptoms. An added hazard was the inability to hear one's own engine when the "noisy" conventional silenced engines were started and flown!

Below, top, two external pipes, one with adjustable frequency cone at rear, and bottom, the Japanese Champion's silencer, with the SuperTigre noise absorbing finned elbow at right.

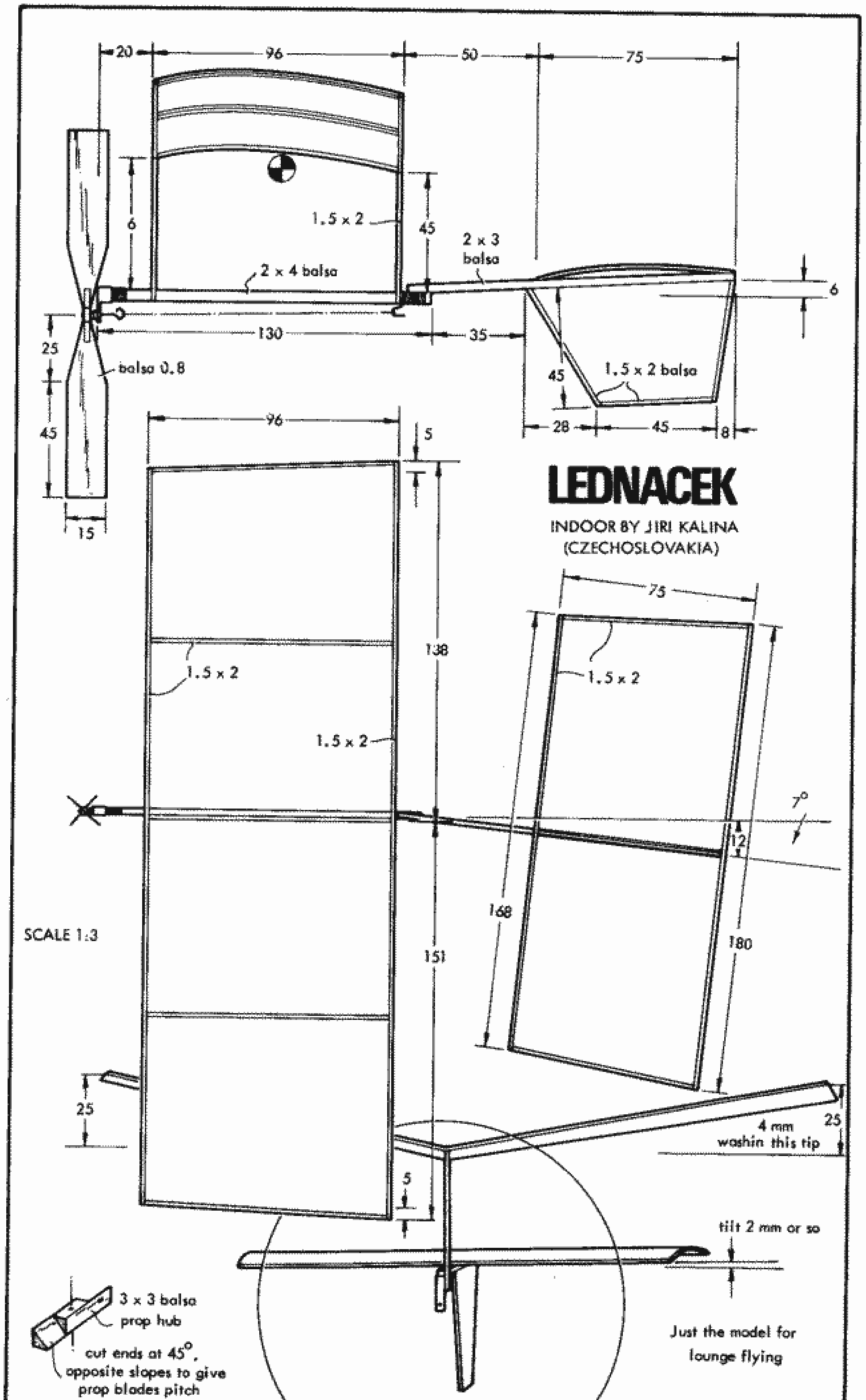




ALLT OM HOBBY SWEDEN



STAR SKIPPERS U.S.A.

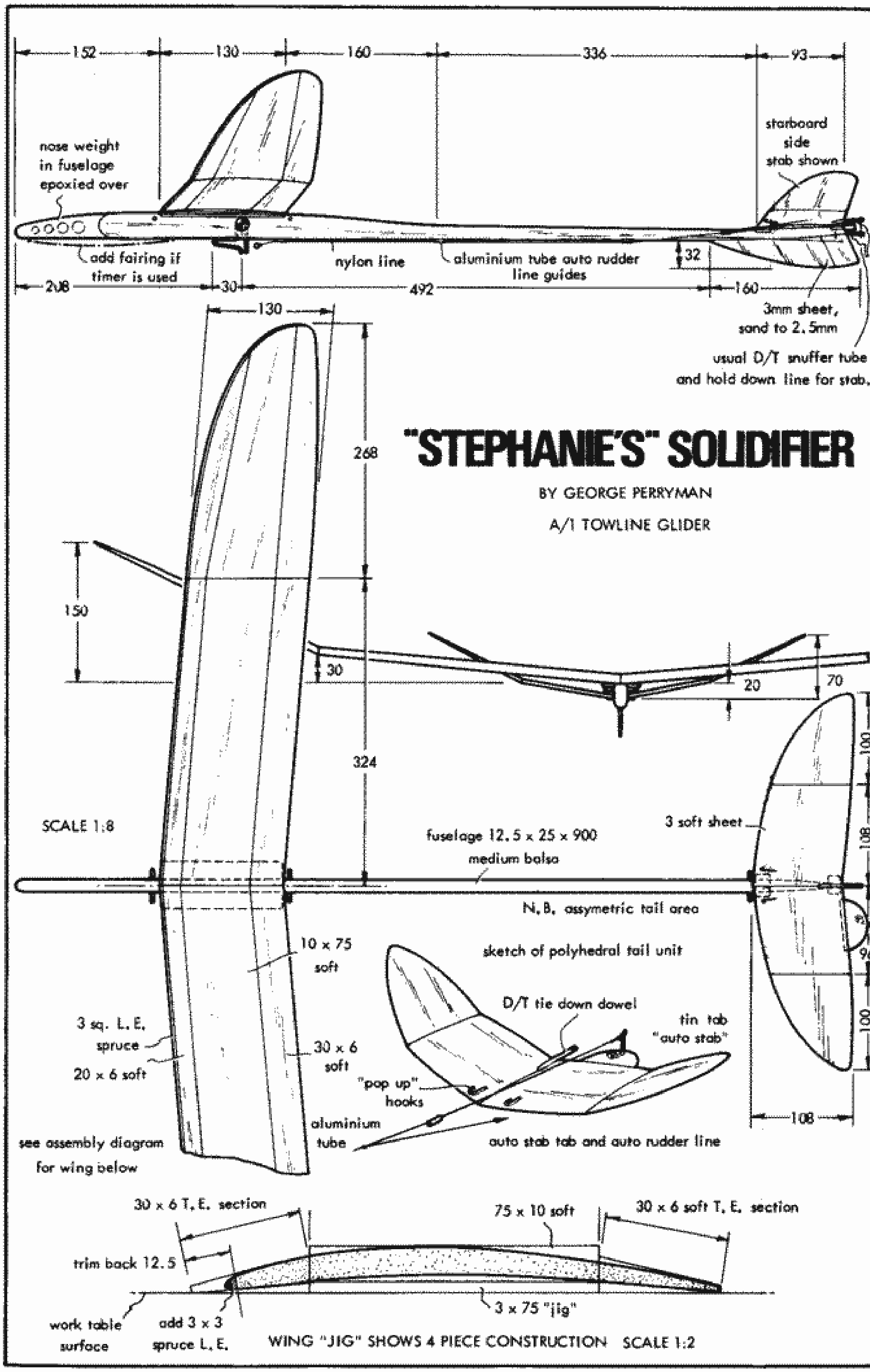


SKRYDZLATA POLAND

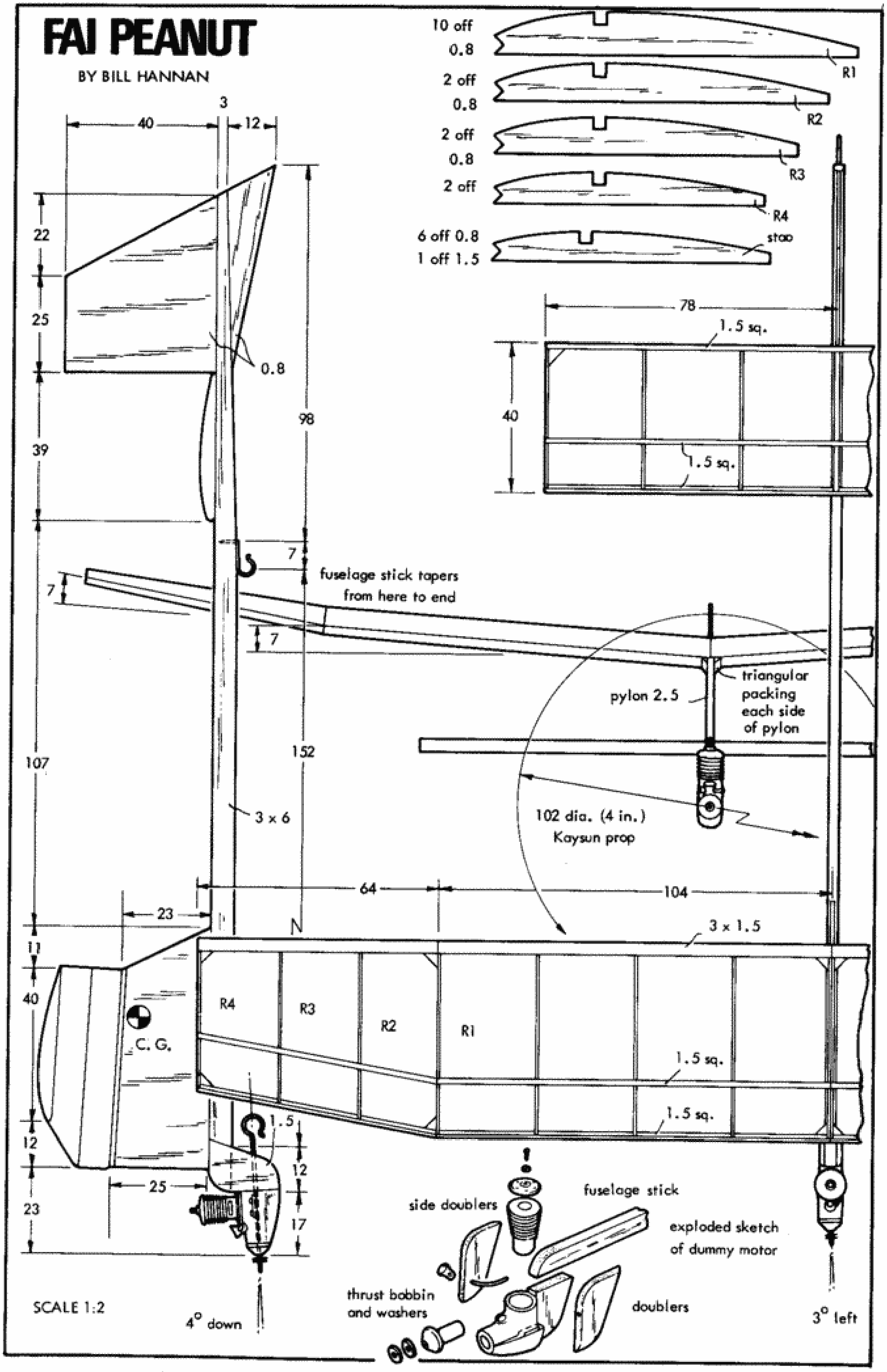
"STEPHANIE'S" SOLIDIFIER

BY GEORGE PERRYMAN

A/1 TOWLINE GLIDER



MODEL BUILDER U.S.A.



MODEL AIRPLANE NEWS U. S. A.

F.A.I. WORLD RECORDS

(as at 1–7–77)

Free Flight
Class F-1-B
RUBBER DRIVEN

No. 1 **Duration**
V. Fiodorov (*U.S.S.R.*), June 19th, 1964 .. .. .. 1h. 41m. 32s.

No. 2 **Distance in a straight line**
G. Tchiglitsev (*U.S.S.R.*), July 1st, 1962 .. .. .. 371·189 km.

No. 3 **Altitude**
V. Fiodorov (*U.S.S.R.*), June 19th, 1964 .. .. .. 1,732 m.

No. 4 **Speed in a straight line**
P. Motekaytis (*U.S.S.R.*), June 20th, 1971 .. .. .. 144·9 km/h.

POWER MODELS
Class F-1-C

No. 5 **Duration**
I. Koulakovsky (*U.S.S.R*), August 6th, 1952 .. .. .. 6h. 1m.

No. 6 **Distance in a straight line**
E. Boricevitch (*U.S.S.R.*), August 15th, 1952 .. .. .. 378·756 km.

No. 7 **Altitude**
G. Lioubouchkine (*U.S.S.R.*), August 13th, 1947 .. .. .. 4,152 m.

No. 8 **Speed in a straight line**
Doubenitsky (*U.S.S.R.*), June 25th, 1973 .. .. .. 173·45 km/h

No. 45 **Seaplane Distance in a Straight Line**
M. Sulc (*Czechoslovakia*), October 3rd, 1973 .. .. .. 15,700 m.

No. 46 **Seaplane Altitude**
M. Sulc (*Czechoslovakia*), October 3rd, 1973 .. .. .. 1,960 m.

RUBBER-DRIVEN HELICOPTER
Class F-1-F

No. 9 **Duration**
A. Nazarov (*U.S.S.R.*), June 3rd, 1968 .. .. .. 33m. 26.7s.

No. 10 **Distance in a straight line**
Giulio Pelegi (*Italy*), August 3rd 1974 .. .. .. 5,237 m.

No. 11 **Altitude**
P. Motekaitis (*U.S.S.R.*), August 30th, 1975 .. .. .. 812 m.

No. 12 **Speed in a straight line**
P. Motekaitis (*U.S.S.R.*), June 12th, 1970 .. .. .. 144·23 km/h.

POWER-DRIVEN HELICOPTER
Class F-1-A

No. 13 **Duration**
S. Purice (*Rumania*), October 1st, 1965 .. .. .. 3h. 12m.

No. 14 **Distance in a straight line**
V. I. Titlov (*Hungary*), October 1st, 1963 .. .. .. 91·491 km.

No. 15 *Altitude*
S. Purice (*Rumania*), September 24th, 1963 .. .. .. 3,750 m.

No. 16 **Speed in a straight line**
A. Pavlov (*U.S.S.R.*), September 20th, 1970 .. .. .. 116·12 km/h.

GLIDERS
Class F-1-A

No. 17 **Duration**
M. Milutinovic (*Yugoslavia*), May 15th, 1960 .. .. .. 4h. 58m. 10s.

No. 18 **Distance in a straight line**
Z. Taus (*Czechoslovakia*), March 31st, 1962 .. .. .. 310·33 km.

No. 19 **Altitude**
G. Benedek (*Hungary*), May 23rd, 1948 .. .. .. 2,364 m.

INDOOR MODELS
Class F-1-D

No. 32 **Duration**
Cat.4. D. Kowalski (*U.S.A.*) August 4th, 1976 .. .. 50m. 41s.

No. 32a **Cat 1 Less than 8 m. ceiling Duration**
T. F. Vallee (*U.S.A.*), August 22nd, 1975 .. .. .. 22m. 45s.

No. 32b Cat 2 **8–15 m. ceiling Duration**
Jiri Kalina (*Czechoslovakia*), August 26th, 1970 .. .. .. 30m. 7s.

No. 32c Cat 3 **15–30 m. Ceiling Duration**
Edward Ciapala (*Poland*), August 19th, 1973 .. .. .. 33m. 34s.

RADIO CONTROL POWER DRIVEN
Class F-3-A

No. 20 **Duration**
Lars Giertz (*U.S.A.*), July 5–7, 1974 .. .. .. 14h. 29m. 51s.

No. 21 **Distance in a straight line**
R. Weber (*U.S.A.*), August 16th, 1975 .. .. .. 428 km.

No. 22 **Altitude**
M. Hill (*U.S.A.*), September 6th, 1970 .. .. .. 8,208 m.

No. 23 **Speed in a straight line**
Goukoune and Myakinine (*U.S.S.R.*), September 21st, 1971 .. .. 343·92 km/h.

No. 31 **Distance in a closed circuit**
Richard Weber (*U.S.A.*) May 31st 1976 .. .. 683 km.

R/C SEAPLANE

No. 48 **Duration**
W. Kaiser (*W. Germany*), April 15th, 1972 .. .. .. 6h. 18m. 17s.

No. 49 **Distance in a straight line**
Norman Bowles (*U.S.A.*) March 6th, 1976 .. .. 217.6 km.

No. 50 **Altitude**
M. Hill (*U.S.A.*), September 3rd, 1967 .. .. .. 5,651 m.

No. 51 **Speed in a straight line**
Goukoune and Myakinine (*U.S.S.R.*), October 25th, 1971 .. .. 294 km/h.

No. 52 **Distance in a closed circuit**
B. Peterson (*U.S.A.*), September 14th, 1975 .. .. .. 246 km.

R/C GLIDERS
Class F-3-B

No. 24 **Duration**
E. Miakinine (*U.S.S.R.*), September 30th–October 1st, 1973 .. .. 25h. 44m. 8s.

No. 25 **Distance in a straight line**
J. R. Hiner (*U.S.A.*), May 24th, 1975 .. .. .. 51·28 km.

No. 26 **Altitude**
Raymond Smith (*U.S.A.*), September 2nd, 1968 .. .. .. 1,521 m.

No. 33 **Speed in a straight line**
W. Sitar (*Austria*) May 29th, 1976 .. 303 km/h.

No. 34 **Distance in a closed circuit**
C. Aldoshin (*U.S.S.R.*), October 24th, 1974 .. .. .. 522 km.

R/C HELICOPTER
Class F-3-C

No. 35 **Duration**
H. Pallmann (*Germany*), July 13th, 1974 .. .. .. 1h. 45m.

No. 36 **Distance in a straight line**
N. Rambo (*U.S.A.*), January 26th, 1974 .. .. .. 2,509 m.

No. 37 **Altitude**
H. Pallmann (*Germany*), July 31st, 1974 .. .. .. 1058 m.

No. 38 **Speed in a straight line**
Hubert E. Bitner, Jr. (*U.S.A.*) October 17th 1976 .. 56·484 km/h.

No. 39 **Distance in a closed circuit**
D. Schluter (*W. Germany*), June 20th, 1970 .. .. .. 11·5 km.

CONTROL LINE
Class F-2-A

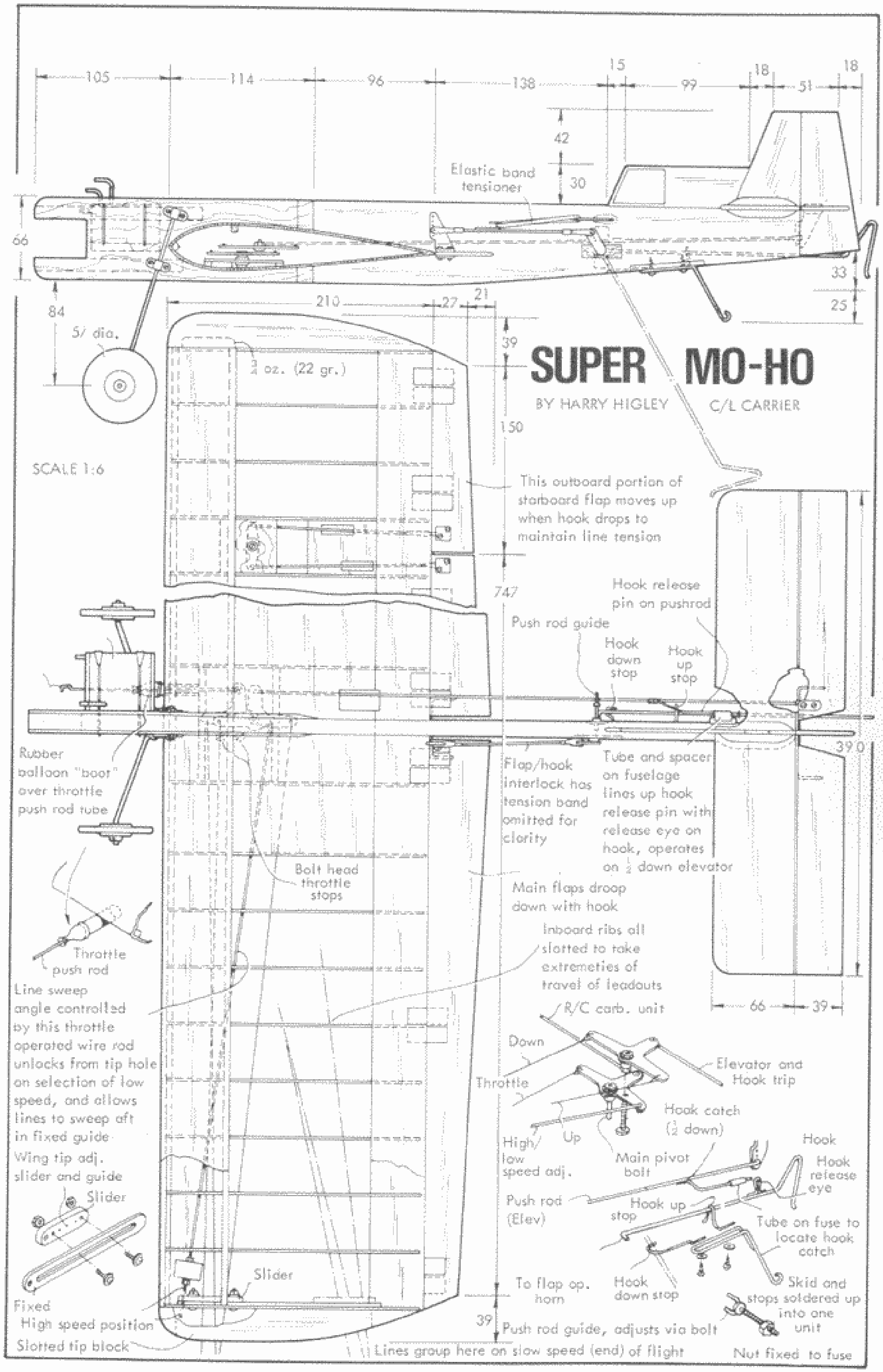
No. 27 **Speed (2·5 c.c.)**
S. Jidkov (*U.S.S.R.*), September 22nd, 1975 .. .. .. 290·30 km/h.

No. 28 **Speed (2·5–5 c.c.)**
McDonald (*U.S.A.*), November 15th, 1964 .. .. .. 288·95 km/h.

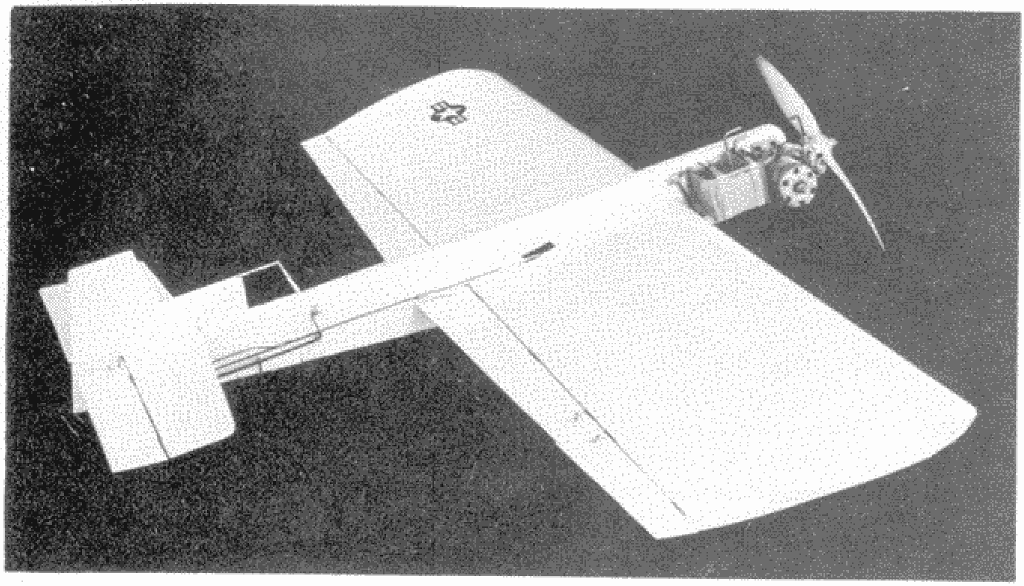
No. 29 **Speed (5–10 c.c.)**
V. Kouznetsov (*U.S.S.R.*), September 30th, 1962 .. .. .. 316 km/h.

JET MODELS

No. 30 **Speed**
L. Lipihsky (*U.S.S.R.*), December 6th, 1971 .. .. .. 395·64 km/h.



MODEL AIRPLANE NEWS U.S.A.



Author's Mo-Ho with outboard aileron, flaps and throttle control, drawing opposite.

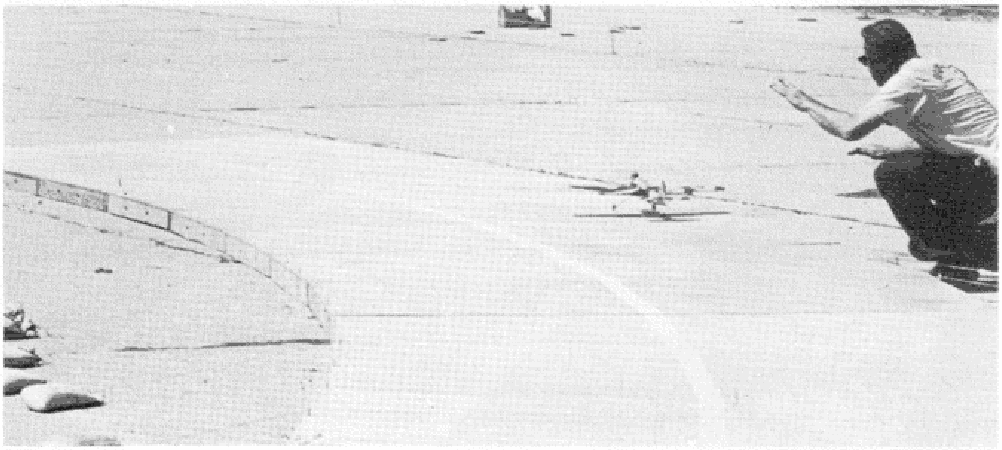
AN INTRODUCTION TO NAVY CARRIER

By Harry Higley

Columnist "Model Airplane News", U.S.A.

CONTROL Line Navy Carrier, is a competition event that is popular in the United States; but enjoys only a limited success elsewhere in the world. This uneven distribution of popularity is relatively easy to understand if we look back a few years. In the early part of World War II things went bady for the Allied Forces in the Pacific Theatre with good news being almost exclusively reports of successful battles waged by carrier-based aircraft. Names of naval aviators were in the press and on the tongue of everyone in our very tense country. The raid on Pearl Harbor had dealt the U.S. a critical blow that may have made the Pacific campaign seem more important to us than to our allies with a concomitant emphasis in the most spectacular type of operations, Naval Aviation. With so much importance attached to this type of tactic and the associated military hardware it was only natural that model builders pattern an event around the big flat-top carriers and their planes. In the 1940's, and until recently, the U.S. Navy would serve as hosts for our Nationals so it is not surprising that this very unusual event found itself the centre of attraction for many years at the largest contest in the U.S.A. Control Line Navy Carrier was offered as an official event for the first time at the 1950 National Model Airplane Championships. First place went to the late S. Cal Smith and his O. & R.60 powered Douglas Skyraider.

The object of the event is to simulate the performance of an actual Navy carrier plane. A model carrier about 44 feet long is placed in the flight path around the circumference of the circle. The carrier deck is made from plywood and common construction using "two by four" studs. At today's prices 100 studs and ten sheets of plywood costs a lot of money, even if spread over many people. It will be realised that a deck will last



Lew Dembrowski releases his son's model from typical U.S. deck, note sandbag loaded arrestor cables.

a long time if properly treated. Some have been in service since the event started, but if new flyers want to try out the event for fun, they could use a more economical approach. This means doing without the ply deck and using the ground. Ten pieces of 200 pound test nylon line about 16 feet long have sand bags tied to each end. These are laid across the flight path and comprise the landing area. The lines need no eyelets, though raising the cables off the ground with blocks of wood is necessary. The grass deck, as this arrangement is called, is entirely satisfactory.

The contestant must take off successfully and fly for half a mile at maximum speed. Since the distance is so short, (only seven laps), it is very important that the model accelerates as fast as possible. The engine is then throttled down and at the flyer's signal, the officials time him for seven laps while the plane is being flown as slowly as possible. At the completion of the low speed portion of the flight the score is

$$180 + 10^{\star} \frac{\text{(time for low speed)}}{\text{(time for high speed)}}$$

Each plane is equipped with an arresting hook and, as for the "grass" deck, the ply deck has a number of cables stretched over the stern with a 5 lb. sand bag at the end of each line. The flyer must bring the plane over the deck and have his hook engage one of the cables so as to bring the model to rest. If he is lucky enough to do this on the first pass he receives 100 points. Each time he misses his landing, he has 5 points deducted from the 100 points. The rules are, of course, more complicated than this but going into more detail would not enhance the discussion at all.

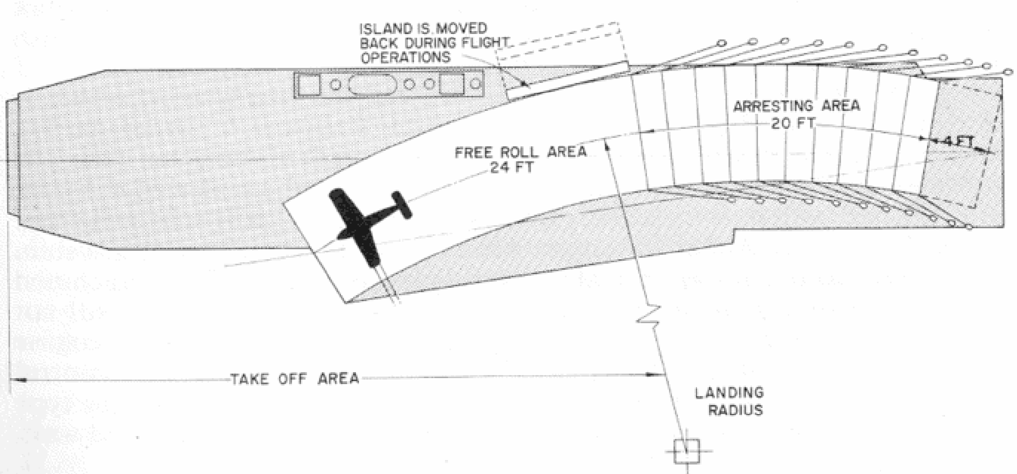
We have three classes of Navy Carrier in the U.S. Any modeller with a reasonable level of ability will find at least one of them to his liking. Class II is the oldest of the three, the original 1950 version having evolved into this. An engine as large as a ·65 is permitted and an additional 100 points is awarded if the plane is a scale model of a carrier type aircraft.

The flight of such a model is breathtaking. Take-off is practically instantaneous and half a lap later the model is doing 120 mph! The pull on the lines is tremendous; the flyer digs his heels in and hangs on. Rules require he tie the handle to his wrist with a heavy thong. There have been no accidents, a fact we are quite proud of. At the completion of high speed, the competitor slows his model down, will normally take a few minutes to collect his wits, then drop the flaps and hook. Some planes are equipped with ailerons which are deflected in an effort to make the model roll away from the flyer. Some participants also deflect the rudder for the same reason. Now a signal is given to the officials to start the flow speed timing. The model that a moment ago was screaming around at 120 m.p.h. is now floating along at 20 to 25 m.p.h. and any miscalculation will cause it to fall out of the air.

The landing is most interesting to the spectators but is very straight-forward. The only problem occurs when there is a strong wind, then everyone has problems. After all this the flyer is usually more than a little shaky as it is quite thrilling. Class I is much like Class II, the chief difference being the maximum engine size, which is ·40.

Ten or twelve years ago it became apparent that Class I and Class II were very specialised events requiring hard to build planes, expensive racing engines, hard to find custom throttle systems and too many aborted flights for the number of attempts. Even so, they have maintained a level of popularity; however, a trend was developing in control line to provide events that were easier. Profile Navy Carrier, the third class, required a plain bearing ·36 front induction engine and a suction fuel tank. So far this requirement has permitted everyone to use R/C type engines. Undoubtedly someone will eventually provide a successful hand made super engine but to date they have not worked well. The plane must have at least a 300 sq. in. wing and a profile fuselage. It is much easier and less expensive to fly this event than either of the two older ones. An additional advantage is that a Profile Carrier Plane can be flown from grass. The scale ships land very fast and unless they are flown on a hard surface they are likely to cartwheel on an unsuccessful arrested landing.

It would seem that if the non U.S. readers of this Annual were to select one of these three events it should be the Profile category. However, experience shows that the European modeller tends to be more



AMA CL NAVY CARRIER CLASSES								
			Required minimum diameter of each line					
			Single strand			*Multri-strand*		
Class/ engine size (cu. in.	*Max model weight*	*Required line Length*	*1 Line*	*2 Lines*	*3 Lines*	*2 Lines*	*3 Lines*	*Pull test*
Class 1: ·0000–·4009	4 lb	60′0″–60′6″	·026″	·020″	·015″	·020″	·015″	25G
Class II: ·4010–·6500	4 lb	60′0″–60′6″	·033″	·024″	·018″	·024″	·018″	25G
Profile: ·0000–·3600	4 lb	60′0″–60′6″	—	—	·015″	—	·015″	20G

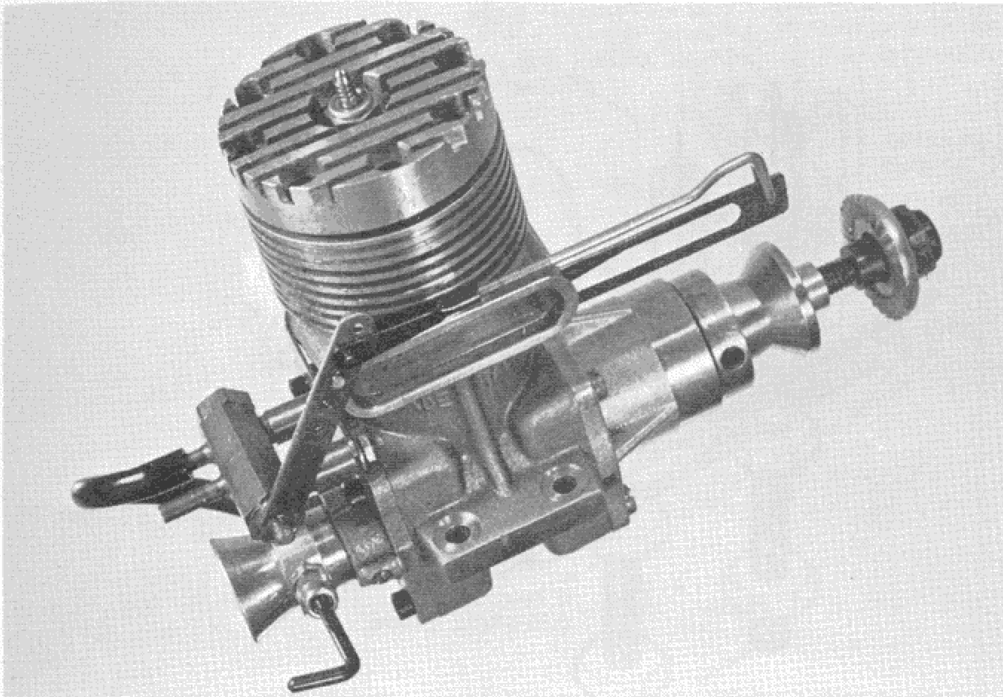
serious than his American counterpart. We have many thousands of flyers with no interest in competition, they just enjoy a flying and picnic session on Sunday afternoons. I am led to believe a much higher percentage of modellers in Europe are competition oriented; hence, maybe the scale classes are in order so we will discuss equipment for all three events.

Class I and II—the "scale events" as they are called, require racing engines. Since the introduction of the Rossi 60 (not the very latest R C model), no other engine has made much of a dent. A few Super Tigre G65's and O.P.S. engines have been used but the Rossi is by far the most popular. The newer engines are probably better but so much work is required to make an engine work well that many carrier flyers are reluctant to try a new engine when one they have is working well. These two classes are racing events in every sense of the word but with one advantage worth illustrating. A Class C speed model released with too lean a mixture can cook the engine in one flight. A Class II Navy Carrier ship released too lean can be throttled down and landed with no damage to the engine. This being true, our engines last a long time, which might also account for the Rossi's continued popularity; they last for years. I suspect that as the old Rossi's wear out they will be replaced by more modern designs.

Class I has many more flyers and no one engine dominates the event. The K. & B. 6·5, ST G 40, OS-MAX 40 are all common sights at a contest. Many preschneurle K. & B.'s are also seen but they don't quite have enough power. In both of these high performance events it is not uncommon for some "not too serious" flyer to use a sport engine and finish a winner because everyone else had problems. Reliability counts!

Most of these problems stem from the throttle system, which is our next topic of discussion.

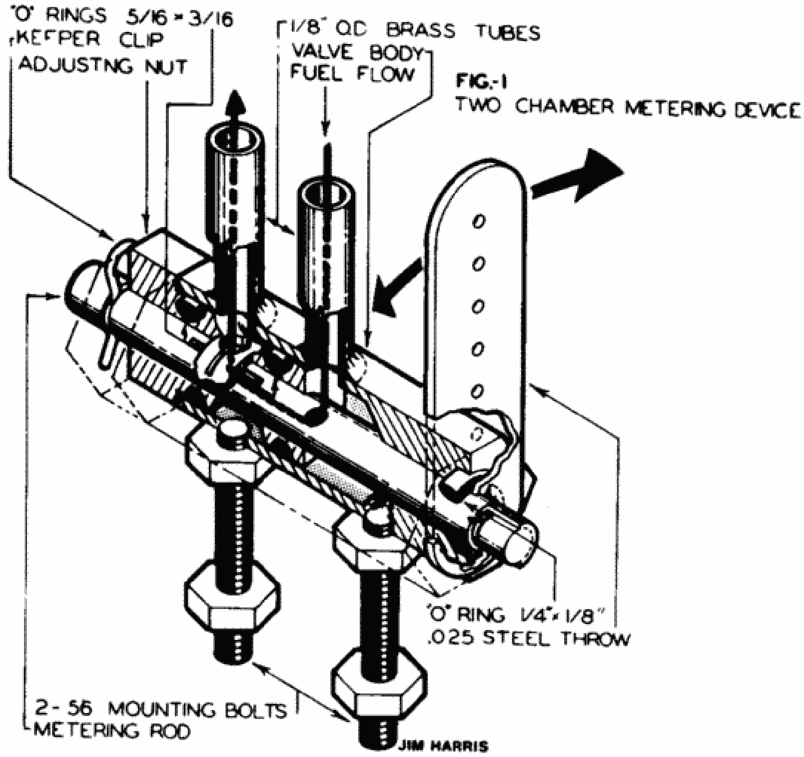
The scale events require all the power that can be mustered so pressure fuel systems and wide open venturi's are the order of the day. An R/C carb will not work as the bore is too small or if it is enlarged there are still problems. About fifteen years ago Bill M. Johnson devised a system that is still in use today. A slide valve is placed in a carefully machined slot in the exhaust. As the slide closes, the exhaust backpressure will not permit a full charge of fuel to enter the combustion chamber and the engine slows down. The shape of the opening in the slit permits careful control of the amount of exhaust that is allowed to escape. A drum or rotary type exhaust valve will also work but this must be a carefully machined unit, not the loose-fitting variety encountered on an R/C engine.



Rossi 60 with metering device and custom-made exhaust slide throttle.

There are basically two approaches one can use to install a slide valve. On engines such as the K & B ·40 and Rossi ·60, the slide can be placed directly in the stack. This is the method that is used the great majority of the time, and a detailed explanation of how this is done will be given. The other method, used on such engines as the H–P and Super Tigre, is to make a block to house the slide, and screw the assembly to the engine using the holes that are provided for a tuned pipe or muffler. The block can be made with a drill press and a grooving saw which will be described later. The block makes it difficult to cowl directly under the exhaust stack. A simple solution is to screw a piece of aluminium sheet to the bottom of the block to fill in the gap.

If the slide is to be put in the exhaust port, five simple tools must be made: a slide holding fixture, a "C" clamp with notches filed in the stationary clamp pad, a slotting fixture, a slotting saw and a grooving saw (see sketches.) The slide holding fixture and "C" clamp are used to hold the slide valve while the hole is being smoothed and the "V" at the back of the hole is being filed. The slotting fixture is used to guide the slotting saw when the slots at the ends of the exhaust stack are being cut. The slide saw is used to cut these. These parts are made from a piece of $\frac{1}{8}$ in. × 1 in. × 18 in. oil hardening tool steel and a piece of band saw blade ·025 in. × $\frac{1}{2}$ in. × 36 in. Both of these items can be obtained from an industrial supply house. If these tools are to be used only a few times, no heat treating is necessary. If high usage is anticipated, the tools should be heat-treated to cutting tool hardness. This is a little beyond the capability of the average modeller and the job is best given to a tool maker or machinist. If he charges anything at all, it shouldn't be much.



The slotting and grooving saws are made from the band saw blade. Lay the lengths of blade on a flat piece of steel, gently hammer the set out of the teeth and then stone the sides of the teeth until the whole blade is uniformly ·025 in. thick. The slotting saw is $\frac{1}{2}$ in. wide; the grooving saw must be narrow enough to fit in the exhaust port, and the blade should have 24 teeth per inch. Now that all these tools are made, let's put a slide valve in the exhaust port.

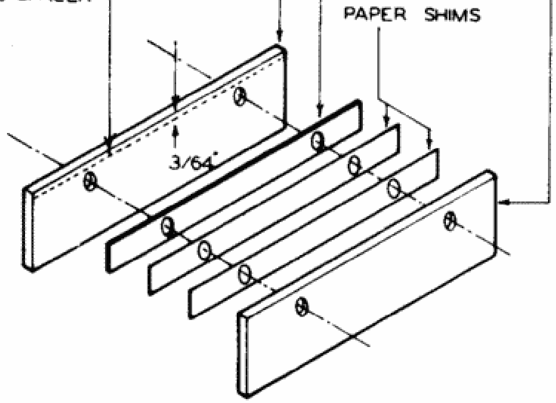


FIG. 3
SLIDE HOLDING FIXTURE
ALL PIECES 3 3/4" LONG
ALL HOLES 1/4" D
BOLT TOGETHER WITH 1/4"-20 SCREWS

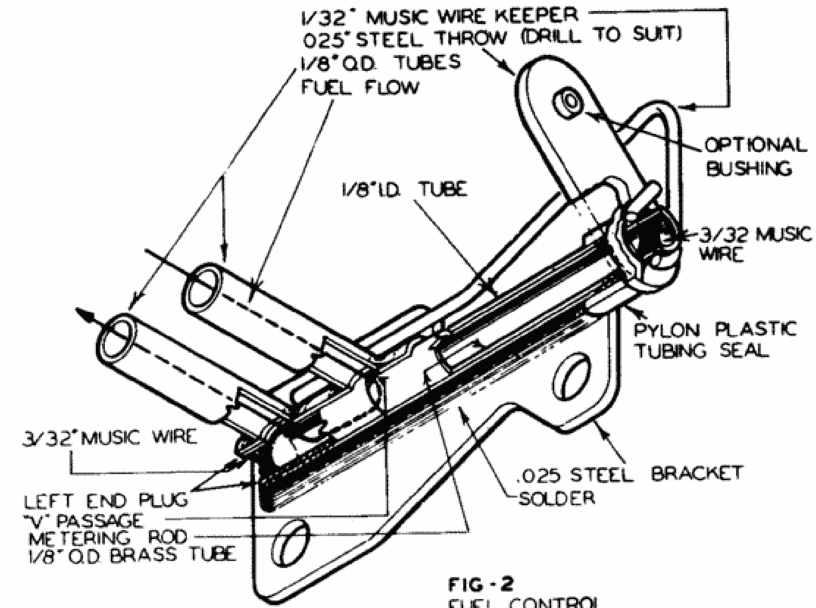


FIG - 2
FUEL CONTROL
METERING DEVICE

The grooves in the top and bottom of the exhaust port should be cut in several steps. First drill two holes the diameter of the final opening on the blade so that the height of the slide will be the thickness of the exhaust opening plus $\frac{1}{16}$ in. The slide should move freely through the port but with almost no play. Stone or sand the top and bottom of the slide so that it will not wear the grooves any deeper. The hole in the slide is cut in several steps. First drill two holes the diameter of the final opening in the slide. Next, remove the material between the holes with a cut off wheel mounted in a handy grinder. Last of all mount the slide in the slide-holding fixture and clamp this assembly in a vice. File the "V" in the back

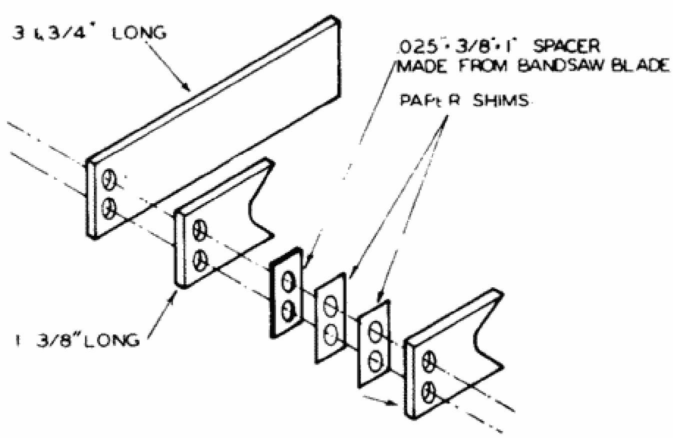


FIG 4
SLOTTING FIXTURE
1/8"·1" OIL HARDENING TOOL
STEEL UNLESS OTHERWISE
NOTED

BOLT TOGETHER WITH
1/4 - 20 SCREWS

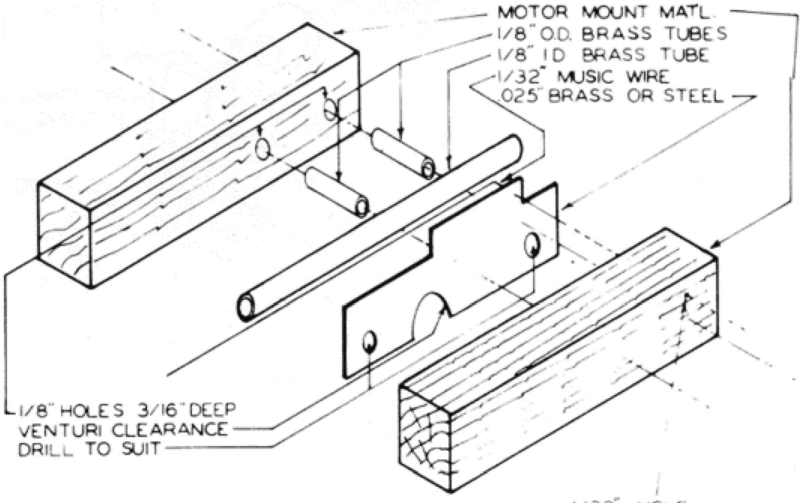


FIG-5
METHOD OF HOLDING
VALVE BODY ASSEMBLY
FOR SOLDERING
CLAMP IN VICE.

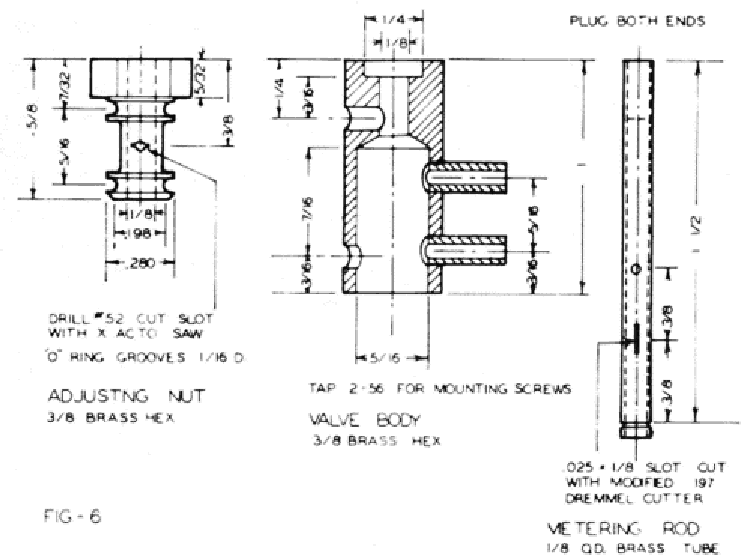


FIG-6

of the hole with Swiss pattern files and then stone the sides of the slide until no burrs remain. This completes the first part of the custom carb; there remains the metering device.

As the engine is slowed down, it will flood and stop unless the fuel flow is restricted during idle. The metering device performs this function. Of the two types of metering devices, the first is comparatively new and requires a lathe to make but offers the advantage of easy idle mixture adjustment. The second, Bill Johnson's fuel control, can be made in an average modeller's workshop and over the years has more than proven itself.

The adjusting nut on the first type works on exactly the same principle as the aluminium wheel on a Perry carb. On early prototypes we used such a wheel instead of the adjusting nut.

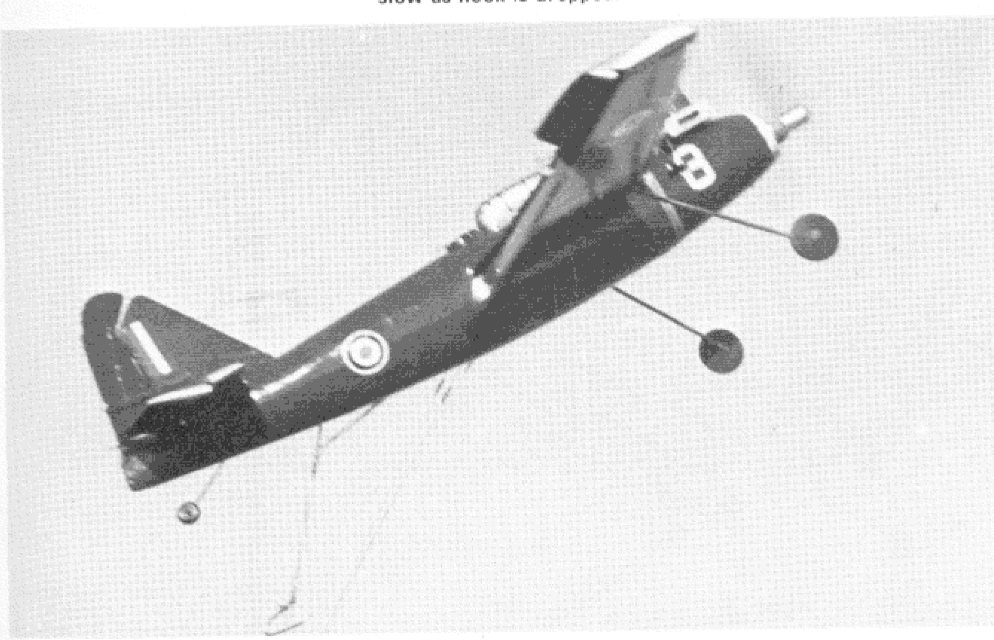
The nut consists of two chambers separated by an "O" ring with "O" rings sealing the valve body at either end. To get from one chamber into the other, the fuel must pass through the metering rod. In the first chamber, fuel has unobstructed passage into the rod. To get from the rod to the second chamber, fuel must pass through a hole in the adjusting nut as well as through the slit in the metering rod. As the metering rod is rotated, the slit in it and the hole in the adjusting nut come out of alignment and hence reduce the flow from one chamber into the other. The adjusting nut can also be rotated. This feature has two advantages. First, the unit can be mounted in any position and then the nut can be turned to align with the slit. This saves the work of resoldering the throw. Secondly, in idle the nut can be rotated slightly to adjust the idle. This normally does not affect the high speed adjustment.

The drawings are such that a qualified person should have no trouble making the unit, but it does require a lathe and some skill at grinding cutters. Efforts are being made to make the unit available commercially. In the past we have supplied it on a limited basis.

The second type of metering device works in the following way. Fuel flows through the inlet tube, past the "V" in the metering rod, then out the outlet tube. As the metering rod is rotated the "V" moves out of alignment with the hole in the valve body and thus flow is restricted.

The sketch shows how the valve body is assembled. A few additional tips will be given. To prevent solder from sticking to areas where you don't want it, rub these areas with greasy fingers and sand the other areas. Dutch Boy 60–40 solder works best. Use soap and water to clean off the flux after soldering. After the valve body is assembled, drill the

Lee Rytarsyk's Barracuda in slow speed with flaps drooped, aileron and elevators up, and throttle set slow as hook is dropped.

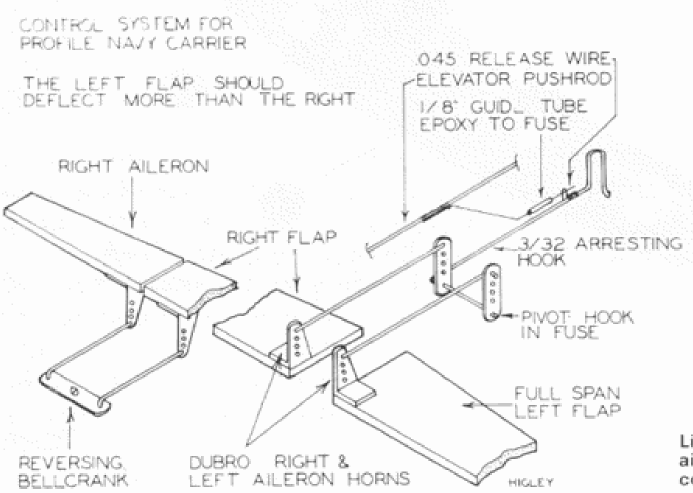


inlet and outlet holes by first spot drilling with a $\frac{3}{32}$ in. drill (don't do more than make a dent), then drill through with a $\frac{1}{16}$ in. drill. This will insure that these holes will line up with centres of the inlet and outlet tubes. The left plug covers exactly half of the $\frac{1}{16}$ in. hold. This plug is installed after the body is assembled. It is necessary to re-drill the outlet hole at this time. This part may be soldered in place but this is a little tricky as the heat may melt the solder that is holding the valve body together. A beginner might be well advised to clean both parts carefully and epoxy them together. The left plug and the metering rod are sealed with a short piece of $\frac{3}{32}$ in. music wire soldered in place.

The metering rod for this unit requires some explanation. The left plug and the metering rod must mate perfectly. This means the internal ends of these pieces must be perfectly square. This can be accomplished by drilling an $\frac{1}{8}$ in. hole in a piece of $\frac{1}{2}$ in. square steel. The ends of these tubes can be filed until each of them is level with the top of the steel. This same piece of steel can also be used as a guide to file the "V" in the metering rod. File a "V" in this steel block with a triangular file until it produces a "V" in the metering rod that is ·040 deep. The taper on the leg of the "V" that closes the hole may need some adjustment to provide the correct transition from high speed to low. There will not be much metal removed; often just a shine is all that is required. Don't make any adjustment until after several attempts are made to obtain idle and you have obtained some feel for this. At this point we have the exhaust slide installed and the metering device made. Now there remains the problem of linking the two together so the engine will run well enough to adjust.

To perform the bubble test attach pieces of surgical tubing to the inlet and outlet tubes. Let one rest in a cup of water and blow through the other without puffing the cheeks. This will cause bubbles in the cup. Now close the throttle. In the low speed position, the opening in the exhaust should be less than $\frac{3}{16}$ sq. in. and the bubble rate should be about one fifth what it was at full throttle. Use different holes in the throw and adjust the "Quick Link" to the slide until this combination is achieved. Now the engine can be run to make fine adjustments.

It is best to have the engine a little rich as the throttle is closed.



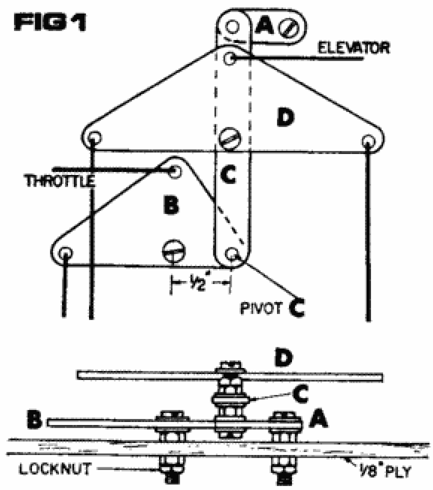
Linkage for a typical flap/hook/aileron system (in addition of course, to elevator and throttle!).

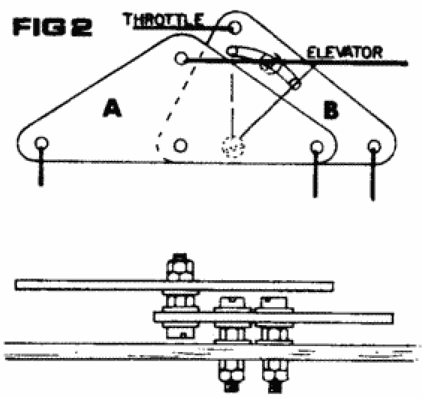
Marvin Martinez made this Skyraider for Class 1 using a K & B 40 with 9×7 in. propeller.

An engine can be damaged on a lean slow run. One last very important point: do not expect an engine to idle well unless it is broken in.

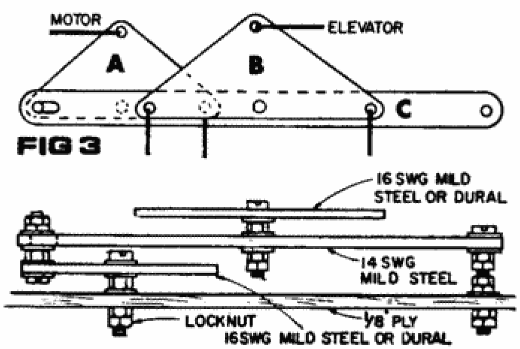
The most popular plane for the scale events is the German Guardian though the Martin Mauler is also common. Both of these are kitted in the U.S. though many are scratch built. The British Naval aircraft are numerous and diverse in design. In the U.S. some flyers from the Detroit area have used the Dumbo, Firefly and Barracuda with considerable success. Most Class I and Class II entrants are very experienced modellers who custom build most of their own equipment so not much is available commercially. A notable exception to this rule is the control system. G & S Products of LaGrange, Oregon markets a very nice one. The handle sells for $10.00 and the bellcrank assembly goes for $5.00. Fifteen dollars is a lot of money to a U.S. flyer and no doubt this is true of his United Kingdom counterpart, but the G & S system will last as long as you might care to use it and brings a high resale price. Home made versions are fine and the Reeves system features in the *Aeromodeller* back in November 1968 was a specially good example.

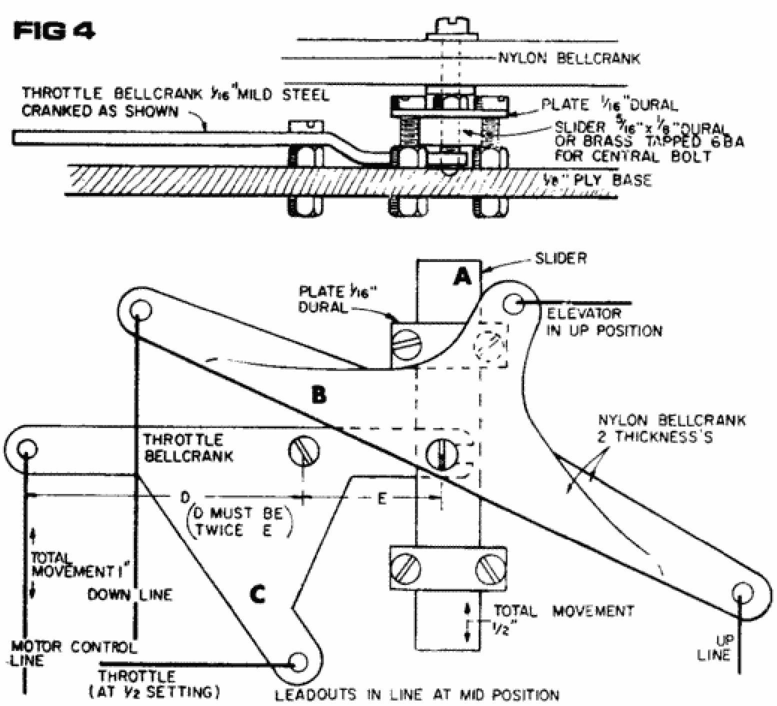
The Reeves simple unit is shown consisting of two bellcranks, B for throttle and auxiliary operation, and D in conventional form for elevator contro. Note that bellcrank B is so shaped that the dimension from the leadout wire to the pivot is double that from the main pivot to pivot C. Bellcrank D is mounted on member C just as any bellcrank is mounted to a normal ply mounting plate, allowing free but not sloppy movement. C is then attached to A and B in a similar manner and these are in turn mounted to the usual plywood plate. The operation is straightforward, when the third line operates B, member C complete with the elevator bellcrank is moved in an opposite direction, thus maintaining a compensating force on the lines at all times. Elevator movement is unaffected. The simplest possible unit dispenses with members A and C completely but does affect the elevators slightly, dictating fairly slow movement of the throttle. The elevator bellcrank A is simply mounted on B, and in turn B complete is attached to the mounting plate. To avoid distortion and stiff operation a guide slot is shown cut in B. A normal 6BA bolt in the mounting plate, with the bolt head holding B down should avoid any such problems. Accurate work is essential here to ensure a good sliding fit. Another simple





Bellcrank systems
by Mick Reeves.

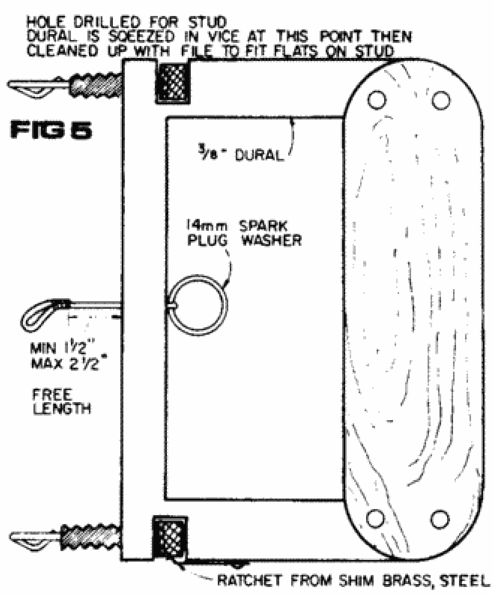




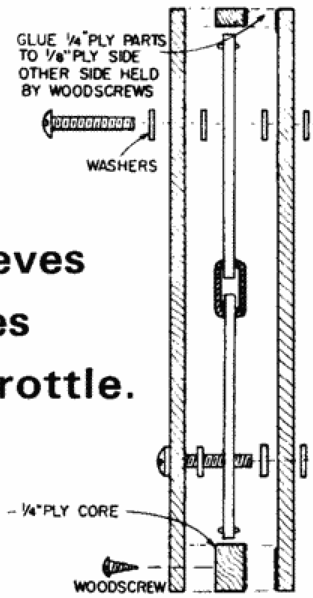
mechanism again using flat components is shown with two normally shaped bellcranks A and B (note size differential) are used in conjunction with a compensating bar C. Bellcrank (throttle) A is bolted to the plywood mount as usual as is the compensating bar (with bellcrank B previously fitted) at opposite end. Bellcrank A and bar C are now bolted together again allowing for free movement Operation in this case of the throttle bellcrank in turn actuates the compensating bar to move the elevator bellcrank in the opposite direction. Our last unit requires a little more work; but in turn should be very smooth in operation. The $\frac{5}{16}$ in. × $\frac{1}{8}$ in. duralumin, or brass slider A is taped centrally to take a 6 BA bolt. Four 6 BA holes are drilled in the top plates and correspondingly in the plywood mounting plate. Using 6 BA nuts and bolts the top plates are assembled to the mount finally adjusted to give free movement for the slider between the top of the nuts and the bottom of the plates. Fit the bellcrank B (double thickness nylon shown) to the slider using a 6 BA bolt, washer and very important, the nut locking this bolt to the slider. Bellcrank C is formed to the shape paying special attention to the fork in the end. Make sure that those prongs are long enough not to disengage on full movement! Like the previous units the operation is straightforward, slider A being a more sophisticated counterpart of member C in the first system.

In terms of expense the three line handle is the most costly item. The following designs should do much to alleviate this, but for ultimate simplicity the pull ring handle is a practical workable answer. The actual handle could either be of ply or hardwood, bolted to a frame of $\frac{3}{8}$ in. duralumin. Slots for the adjusting nuts are cut with a file and hacksaw and $\frac{1}{4}$ in. diameter holes drilled into the ends, extending from $\frac{1}{2}$ in.–$\frac{3}{4}$ in. beyond the slot to allow for a reasonable range of movement. Flats can be filed on two $\frac{1}{4}$ in. Whitworth studs and the main frame squeezed at the ends in a vice to avoid the studs rotating when they should not. The adjusting nuts are added through the slots with a simple ratchet, if desired. To complete the unit a curtain ring (sparking plug washer shown) is required to operate the third line. Finally, the Reeves handle unit. From $\frac{1}{4}$ in. ply and $\frac{1}{8}$ in. ply the core and sides are fretted, whilst the throttle control arm is of brass tubing squeezed to a $\frac{1}{4}$ in. × $\frac{1}{2}$ in. rectangular shape. Slots are cut in this to engage the pivoted duralumin arms (take care that these are long enough not to disengage on full movement) holding the elevator wires, and an adjuster is fitted to the other end. The middle is shaped for finger operation. Araldite the brass tube line guides in position, and the finger guide to the throttle arm and assemble the unit. Note that only one side is glued to the core, the other being held in place by woodscrews allowing access for maintenance.

The Profile Carrier Event is not at all like the other two classes. Requiring the use of a suction fuel system makes the standard inexpensive R/C carb competitive. The Super Tigre ST 35 Combat R/C has dominated the event since it was conceived but the McCoy, Fox, Enya and OS are also popular. Requiring a 300 sq. in. wing forces a lot of emphasis to be placed on the low speed; so much so, that some flyers even use 400 sq. in. The planes can be simple or complex with no apparent advantage. I like lots of gadgets, flaps, ailerons and wingtip line guide that is sprung back for low speed. Others use only a throttle and can hang the plane in a near vertical stall during low speed.



M. Reeves Handles for Throttle.



By far the most important selection is fuel. Winners use 70% nitromethane, 10% propylene oxide and 20% synthetic oil. A beginner is well advised to use less potent blends for practice and early competition. Any other fuel with 25% to 40% nitro is acceptable; though performance will be less than with the 70% formula.

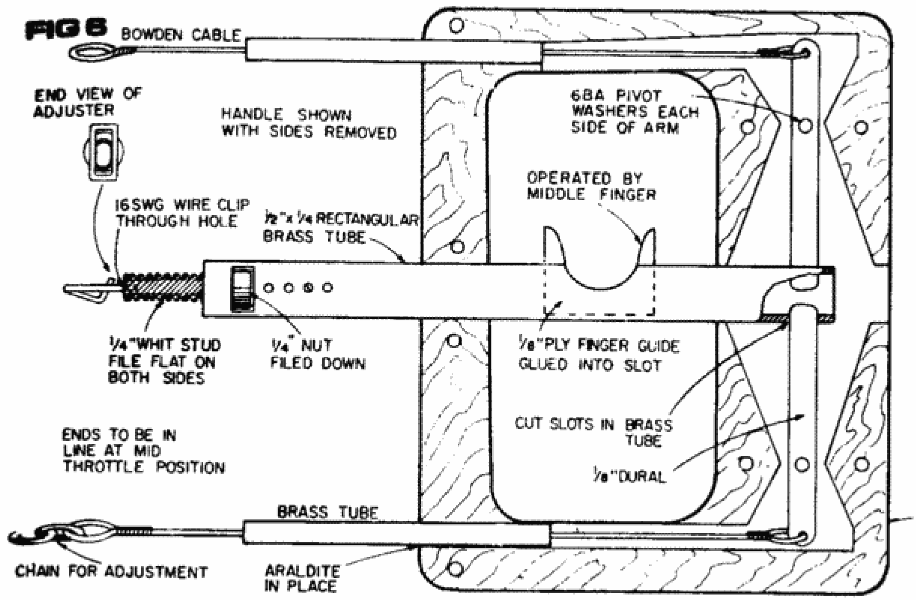
The problems with the 70% formula are that it runs hot, often blows a plug a flight and may reduce engine life. In some cases, the engines may not stand the stress, particularly if they are not well broken-in. These facts may seem to contradict our thesis concerning low cost but they don't, because practice and help of experienced flyers will make the limitations understood in very short order.

The Super Mo-Ho has working ailerons, flaps and a device to sweep the lines back at low speed that was suggested independently by Mark Dembrowski and Joe Koch. The control system was dreamed up by Don Gerber and modified by Dave Wallick. And so it is with competition—most ships are merely a hodgepodge of other people's ideas.

The original Mo-Ho, as it appeared in *Model Airplane News* (January '73), was quite competitive at the time of publication and still is not a bad choice; however as luck would have it, I crashed the ship two weeks before the 1973 Oshkosh Nats. The Super Mo-Ho was built in one week and incorporated improvements including a large thicker wing. I felt that this would not hurt the high speed and hoped the low could be improved. Apparently both wishes were realised. High speed is nearly always in the 80's. Low speed is often under 23 m.p.h. Again, the ship alone cannot guarantee this type of performance it also takes a lot of practice.

The plane's first official flight won the 1973 Nats. Its second official flight won the huge Cleveland Junior Air Races. Its winning ways were to continue until Roy Cordes won the 1974 Woodland Aeromodellers Contest. The Super Mo-Ho had to settle for 2nd. A long string of 1st places

FIG 6



continued until Mark Dembrowski won the 1975 Canadian Nats. Again we had to settle for 2nd place. As of this writing, the ship has not lost since.

Many of these wins were not easy; often less than three points separated 1st and 2nd places. In one case, a contest was won by only ·3 of a point. The need for practice is even more apparent when you consider the closeness of these scores.

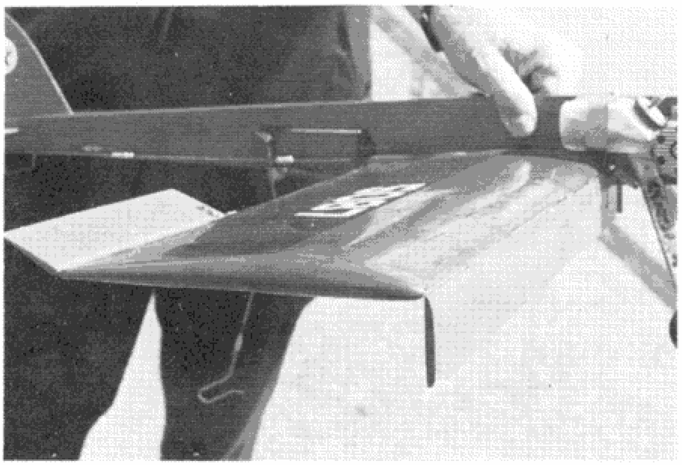
We will discuss certain troublesome aspects of construction, but the time-and-space-consuming "Glue part A to B" will be avoided. A rank beginner should not attempt a ship as complex as this one, yet even an advanced novice does not need a detailed procedure. Hence only the highlights will be discussed.

The wing is of the standard semi D-tube construction which is light, strong and relatively easy to build. The spacing of the ribs at the centre of the wing might scare some people because of the long span between the two centre ribs. If relatively hard planking is used, the fuselage may be thought of as an external rib. In practice, stress cracks have never been a problem nor has crushed planking caused any trouble.

A very problematic shortcoming was the hole for the throttle push rod. The engine exhaust would dump waste in the opening to the extent of causing the plane to gain 3 oz. of weight. The plan shows a boot made from a balloon that will eliminate the problem.

One last feature that could cause weakness is the long line cutouts in the ribs that accommodate the line sweep feature. The cutout does not leave the wing with much compressive strength. All this means is the pit crew cannot squeeze the inboard wing very hard.

If the G & S crank is used, the release for the line sweep can be connected to the down line. When installed, the control must be absolutely free throughout its entire range of travel. The most frequent cause of binding is a push rod that does not line up properly with the hole in the control



Glen Lee's less successful leading edge flap as used by Boeing, an interesting application which should not be dropped altogether.

horn or bellcrank. To achieve proper alignment may require a half dozen reinstallations, so don't glue the bellcrank mount in until the system is free.

The line sweep mechanism needs a few comments. As a rule of thumb the father forward the lines, the faster the plane will fly. However, the ability to maintain line tension at low speed is reduced as the lines are moved forward in the wing.

Until recently, a happy medium was found in the sense that the lines were positioned in the wing tip at a location that would cause only a moderate loss of speed, and line tension would be adequate at low speeds. Like most happy mediums, too much was lost in the name of compromise. The line sweep allows the fastest high and the slowest low because the lines are positioned as far forward as possible for the high speed; prior to starting the slow speed the line sweep mechanism is activated by throttling the engine down. Then the lines exit near the trailing edge of the wing.

As I explain the functioning of the fine sweep mechanism, it would be best to have the plans in front of you. Note the location of the line sweep release wire. At high speed, the wire extends through the first hole in the slide and into the plywood guide which is glued to the wing tip. As the throttle line is pulled, the release wire is pulled out of the slide which then moves to its rearmost position. No spring or rubber band is necessary; the plane's natural inclination to fly away from the circle will cause the slide to move back and stay back.

The release wire passes through a piece of tubing between the last two ribs. This tube is necessary to keep the release wire from flopping around in the wing after the slide is released.

Resetting the slide is very simple. Pull the throttle wire to get the release wire out of the way. Use the lines to pull the slide all the way forward. Pull the elevation control lines to position the release wire into the holes in slide and guide. This may sound a little complex, but even simple things can take a lot of words to explain.

Re-reading this material and looking at the plans will show that not much is involved. The use of this device increased the high speed about 4 m.p.h. and reduced the low speed about 2 m.p.h. When it is remembered that a contest can be won or lost by a fraction of a point, you can appreciate the importance of improvements that are this dramatic.

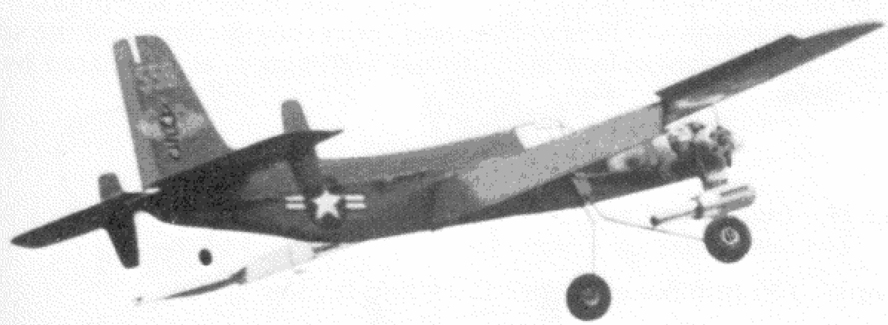
After the wing is assembled, the controls are working and all planking is in place, the fuselage can be constructed. This is very straightforward and should present no problems. It is best to wait until the finish is applied to the model before all the wire is added to the fuse. Painted wire looks bad and can cause problems of binding. The wing and all control surfaces are covered MonoKote. The fuselage is painted with Hobbypoxy. MonoKote increases the strength of the wing, and the epoxy is almost impervious to fuels.

This event is second in popularity in the U.S.A. only to Combat which means a lot of people have a lot of fun with it. It would be my hope that someday the Navy Carrier event will enjoy international popularity.

The Royal Navy has constructed a nice deck which has been used as *H.M.S. Flycatcher* in Britain. I don't wish to appear overly aggressive, but if you Britishers would build a *Ringmaster* or *Flite Streak*, install a hook and throttle system, I think you would find an event that is easy and a lot of fun. I would guess you would soon find it among your most popular events.

As I doubt many *Aeromodeller* readers have even heard of me it may be opportune to describe my interests. Our family is basically of the Sunday picnic and fly variety mentioned earlier with a tolerance, indeed an encouragement, of my passion for Carrier. We drive as far as 400 miles to attend a contest and enter perhaps as many as ten in a year. If I have a passion for Carrier, I also have an almost equally intense interest in all phases of control line and I try to follow all developments in this category. It is my priviledge to write the monthly feature "Round and Round" for *Model Airplane News*, which consumes most of my time and energy. Many of the photos and drawings that accompany this article were taken from *Model Airplane News* whose publisher was kind enough to let me use them here. (*Thanks from us too—Ed.*)

Stan Lopes' Grumman Guardian fitted with a silencer, in slow flight.



S.M.A.E. Carrier Deck Regulations

16.1 The specifications of the deck shall be identical with the existing deck constructed by the Royal Navy.

16.2 The model must take off and land on an undercarriage of fixed or retractable type, in the latter case, the wheels must be extended for landing. Models must be equipped with arrester hook which will have a maximum extendable length of less than one third of the model's overall length. Models must fly in an anti-clockwise direction, and to qualify for scale (bonus) points, engine(s) must be of the same thrust type as used in the prototype. No method may be used to assist take-off other than the thrust developed by the in-flight power unit.

16.3 Stranded cable of minimum diameter 0·0136 in. will be used for two-line systems for engines up to 0·40 cu. in. (6·55 c.c.) (Light Laystrate). Stranded cable of minimum diameter 0·018 in. will be used for two-line systems for engines from 0·40 to 0·60 cu. in. (10 c.c.) (Heavy Laystrate). Additional lines may be of any diameter. The lines shall be 60 ft. plus 6 in., minus 0 in., from the grip of the control handle to the centre line of the model. Model lines and handle shall withstand a pull test of twenty times the weight of the model.

16.4 Three minutes will be allowed from the competitor beginning to start his engine, for the model to become airborne. Exceeding this time allowance will cause an attempt to be recorded. A further two minutes is allowed for each additional engine of a multi-engined model. An attempt will also be recorded where the model has been released for a take-off. Three attempts will be allowed for the two official flights, the highest scoring flight to count for the purposes of determining the competitor's placing. A flight is considered official when the competitor signals for a timed, low-speed run. In the case of an uncompleted flight programme, points will be scored for the parts carried out, and also for the scale. All ground other than the deck shall be considered water, and touching ground will terminate the flight.

16.5 The model shall not exceed an altitude of 20 ft. for more than half a lap during a timed run. No whipping is allowed at any time. High speed flight will be the first seven laps of the flight, timed from a standing start. Low speed flight will be the next seven laps after the competitor signals the start of his low-speed run by a pre-arranged signal, and this will be timed from passing over the stern of the carrier. The flyer will not walk a circle of larger than 3 feet radius during this phase of the flight.

16.6 Speed points will be scored as four times the percentage of the speed made by the differential between low and high speed, as calculated by the following formula:

$$\frac{H - L}{H} \times 400$$

where H = high speed and
L = low speed

Example: 100 m.p.h., high speed; 25 m.p.h., low speed;

$$= \frac{100 - 25}{100} \times 400 = 300 \text{ points.}$$

16.7 The competitor shall signal to the judges when he is ready to land. The landing takes place at the end of the next complete lap after signalling, any subsequent laps being penalised by the deduction of 5 landing points for each extra lap. It is desirable that a centre marker be provided, approximately 18 in. square and not more than ½ in. thick, to assist the competitor in lining-up for the landing. Points will be scored as follows:

(1) 100 points for an arrested landing ending with the model at rest at the normal ground angle appropriate to the type of undercarriage used.

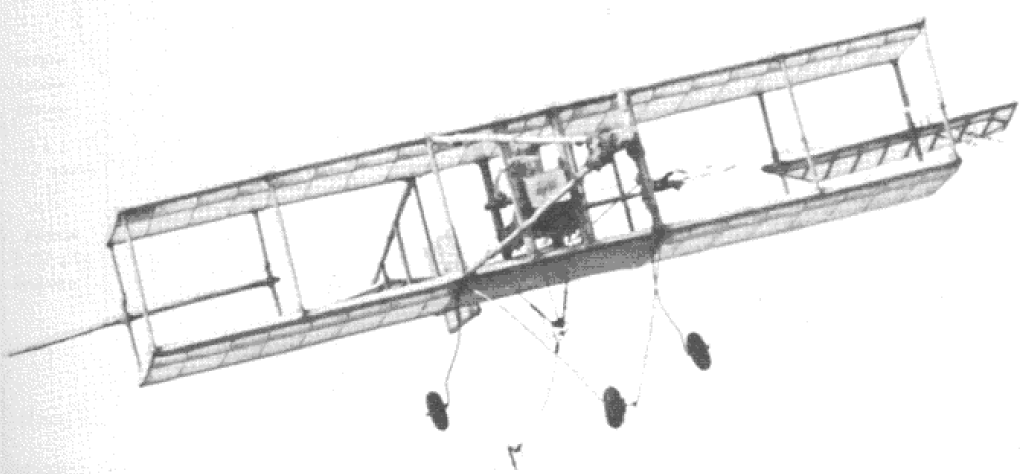
(2) 50 points for an arrested landing ending with the model at rest at any other angle, while still have both main wheels in contact with the deck.

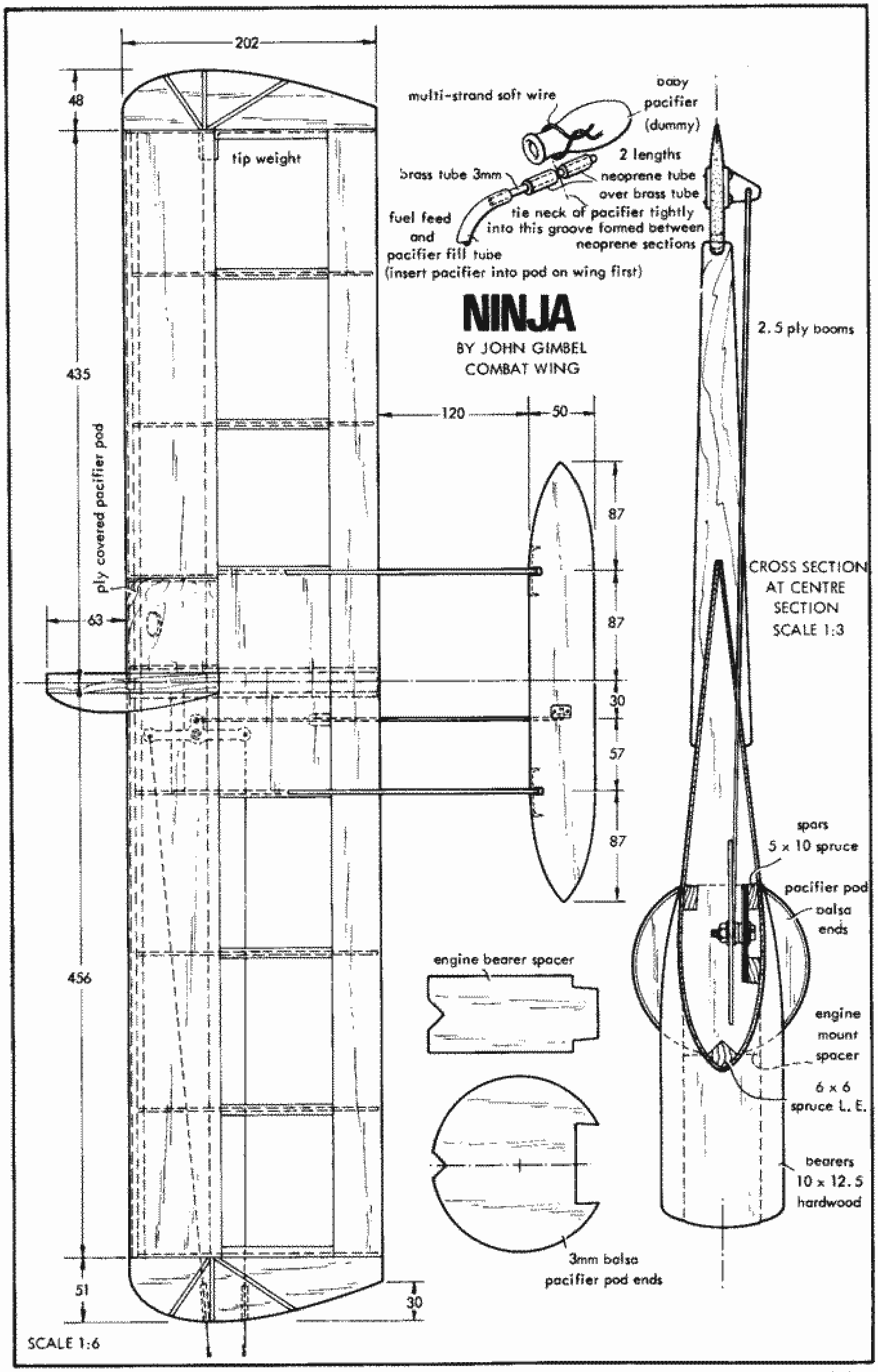
(3) 25 points for a landing on the deck, ending with the model at rest in any position not fulfilling the requirements of (1) or (2) above.

16.8 A carrier aircraft of any nation shall score 100 scale bonus points. A carrier aircraft is defined as any full-size aircraft which has at any time been fitted with arrester equipment designed for deck landing.

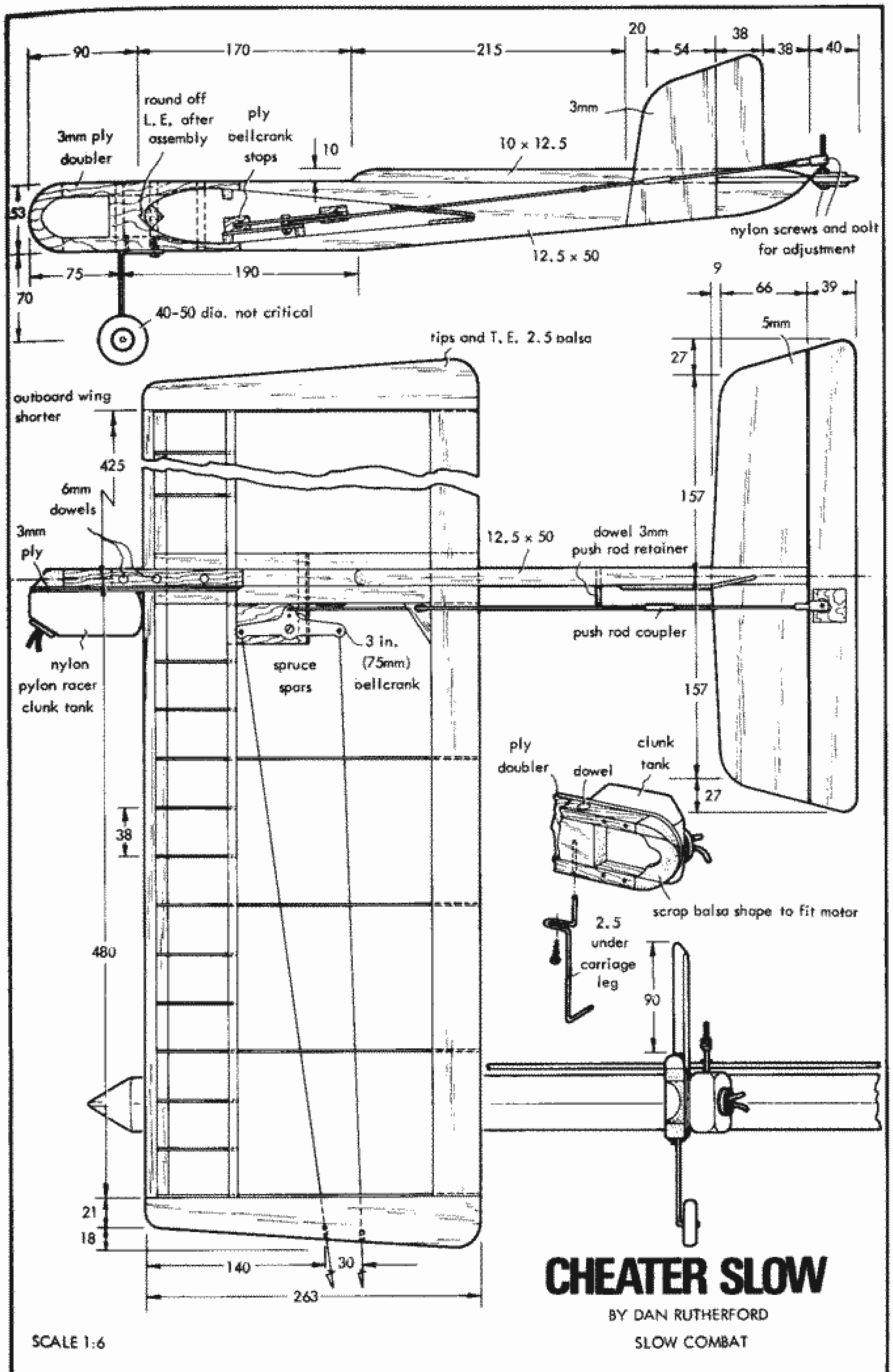
16.9 For the purpose of this contest, scale bonus points shall only be awarded to a model with fuselage, air brakes, and the outline of wings, tailplane, elevators, flaps, fin and rudder to the same scale within a tolerance of plus or minus 5% in line or dimension. undercarriages shall emerge from the model in the same location as the prototype, but need not be to scale. It is not necessary for flaps to operate in the same manner as the prototype. Engine and accessories may protrude from the contours of the model providing the clearance around the protruding part does not exceed ¼ in. Wing dihedral shall be plus or minus 1%. If a clear canopy is not used, the cockpit or canopy area shall be defined with a contrasting colour or colour outline. Colour schemes and markings shall approximate to a scheme used on the prototype. Scale three view drawings must be submitted to qualify for bonus points. The drawings shall be from a source acceptable to the contest director. Any deviation from these definitions and tolerance will result in *NO* scale points being awarded.

Ted Kraver's novel bamboo Curtiss Pusher Class 1 Carrier entry, note line and aileron angles.





MODEL AIRPLANE NEWS U. S. A.

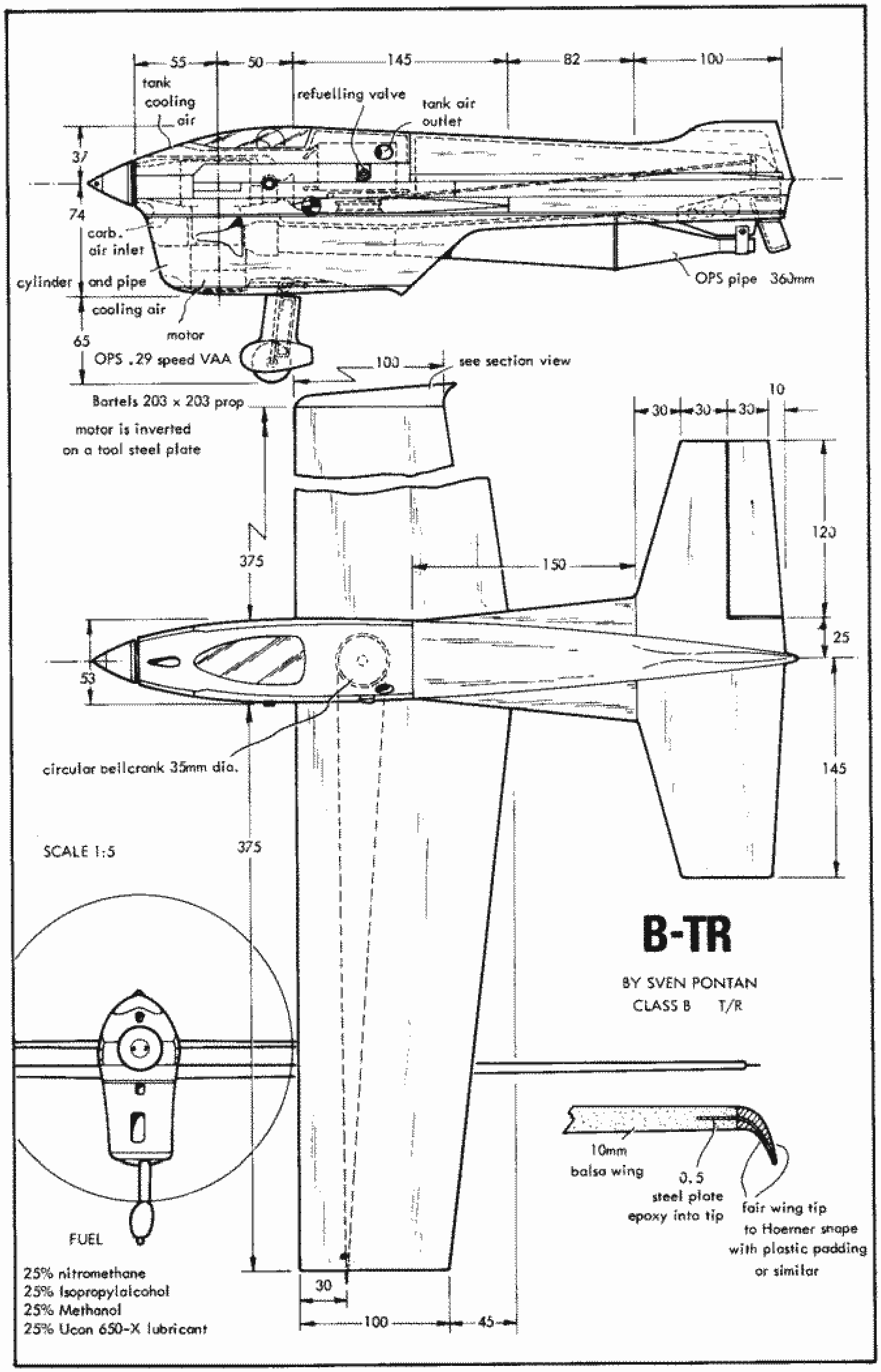


CHEATER SLOW

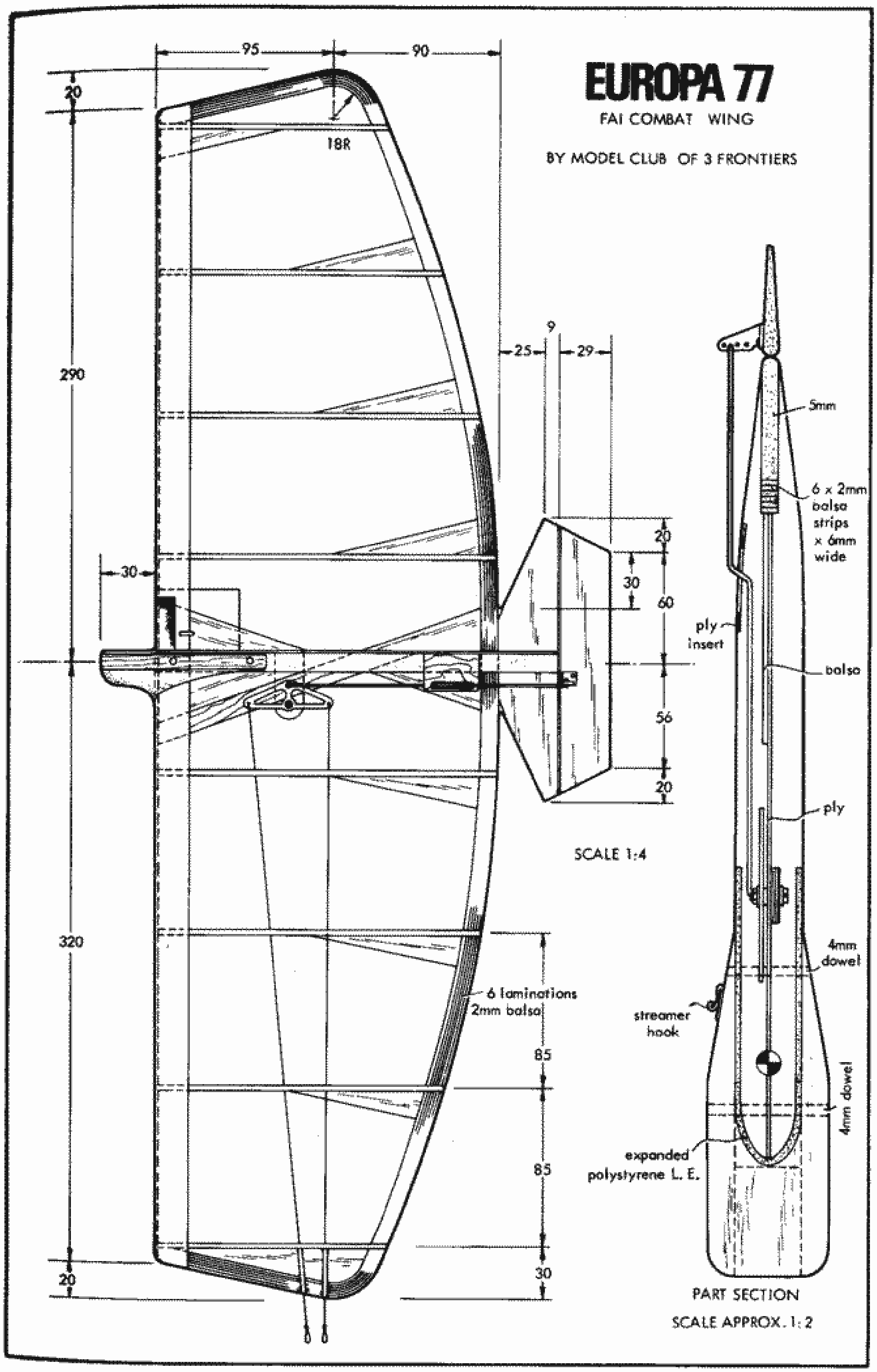
BY DAN RUTHERFORD

SLOW COMBAT

MODEL AVIATION U.S.A.



MODELLFLYGNYTT SWEDEN



MODELE REDUIT D'AVION FRANCE

ON SILENT WINGS—"BIRD" GLIDERS

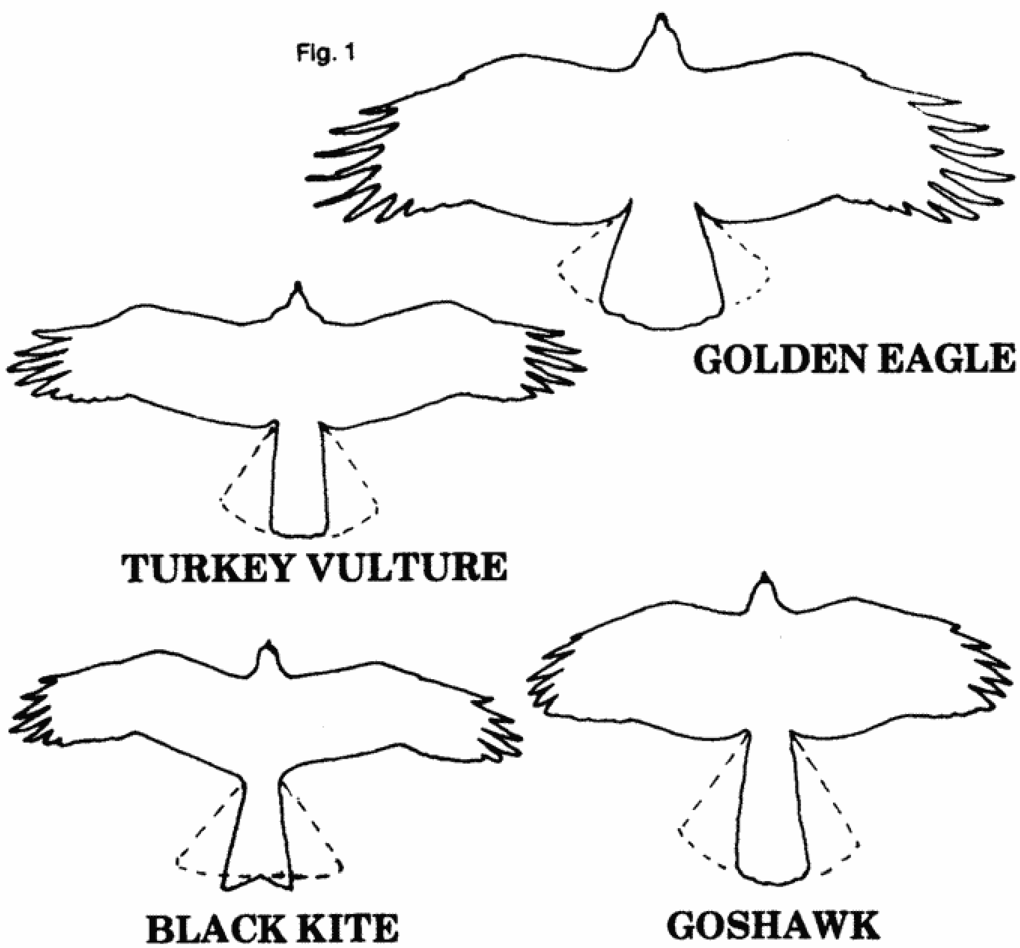
by Bill Tinker

(From "Airborne", Australia)

FROM time to time I've watched eagles, pelicans and hawks soaring in the company of models on slopes and in thermals. The contrast between nature and the man-made "bird" has long intrigued me. Nature's product, with their short broad wings, close coupled tail and no fin, have looked to be hopelessly unstable—and yet on many occasions when comparisons could be made, they have outperformed the model they have accompanied.

Some years ago I was exploring the swept forward wing configuration, and later whilst browsing through the library I found a book on birds of prey that included scale silhouettes of the major species throughout the world (see *Fig. 1*). Their generally forward swept, low aspect ratio wings were analysed, and I drew up a specification for a model. For a long time I played around with paper and balsa miniatures and was surprised to find that these were remarkably stable, and could be induced to fly in very small

Fig. 1



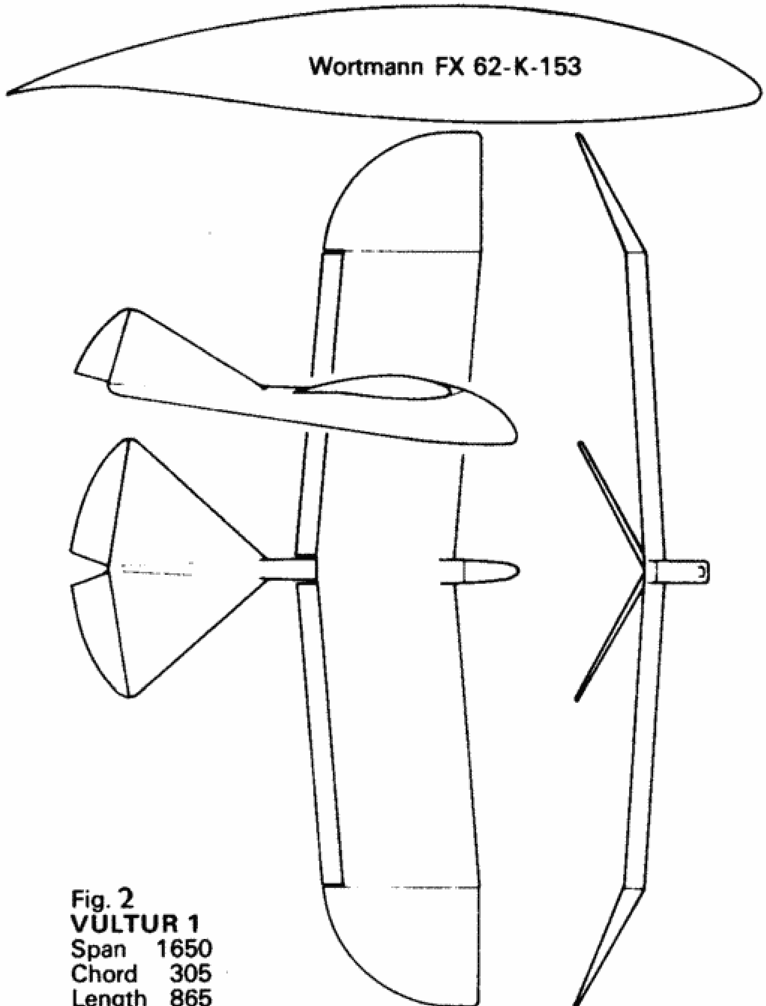


Fig. 2
VULTUR 1
Span 1650
Chord 305
Length 865
Weight 1.3 kg

diameter circles. Finally, convinced that my specification was practical, I made drawings and started work on a radio soarer.

Again from the library, I had acquired data on one of the Wortmann wing sections and decided to try this out at the same time. As birds manage without a vertical fin, I felt duty bound to manage without one, too, but my sense of conventional aerodynamics made me include some side area aft, by adopting a V-tail. Turns were to be initiated by aileron, and polyhedral was incorporated in imitation of the real thing (see *Fig. 2*).

The prototype was borne eventually to the nearest slope—a little apprehensively as my aerobatic soarer had been attacked viciously by an eagle a few weeks before, and I wondered what it might make of a rival that looked even more like the genuine article!

Anyway, as it turned out that was the least of my worries. Launched into the air 300 ft. (sorry,—100 metres) above the valley, the Vultur was indulging in joyful exuberance—while I sweated on the control stick trying to trim out its slightly alarming skittishness! Having more or less succeeded in that, a turn was overdue, so confidently I leaned sideways on

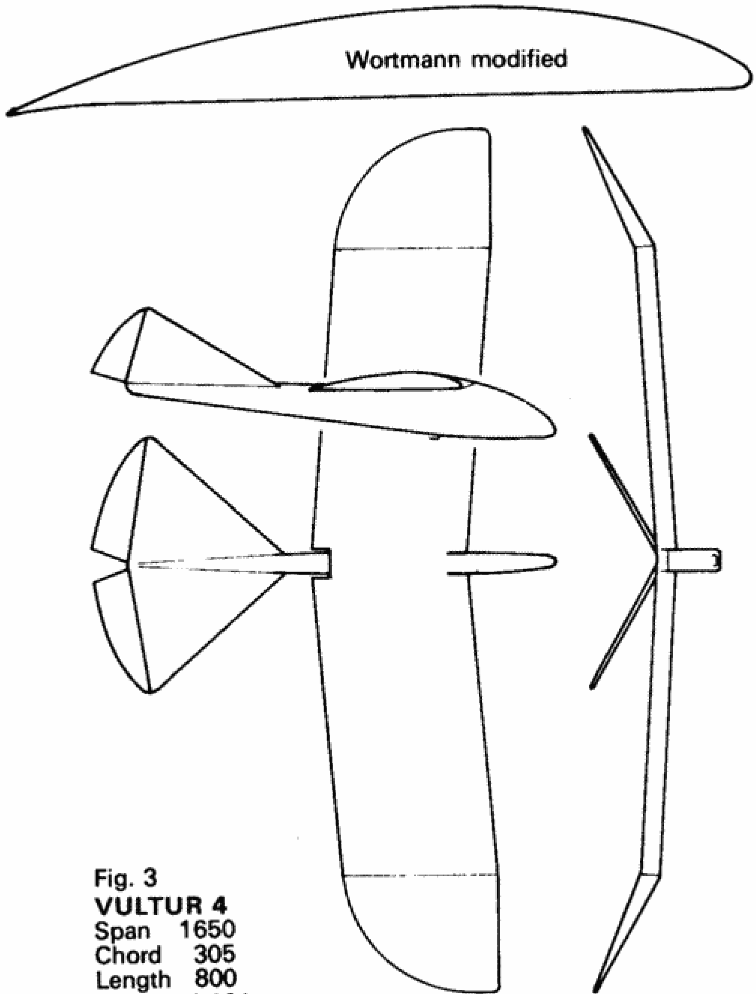
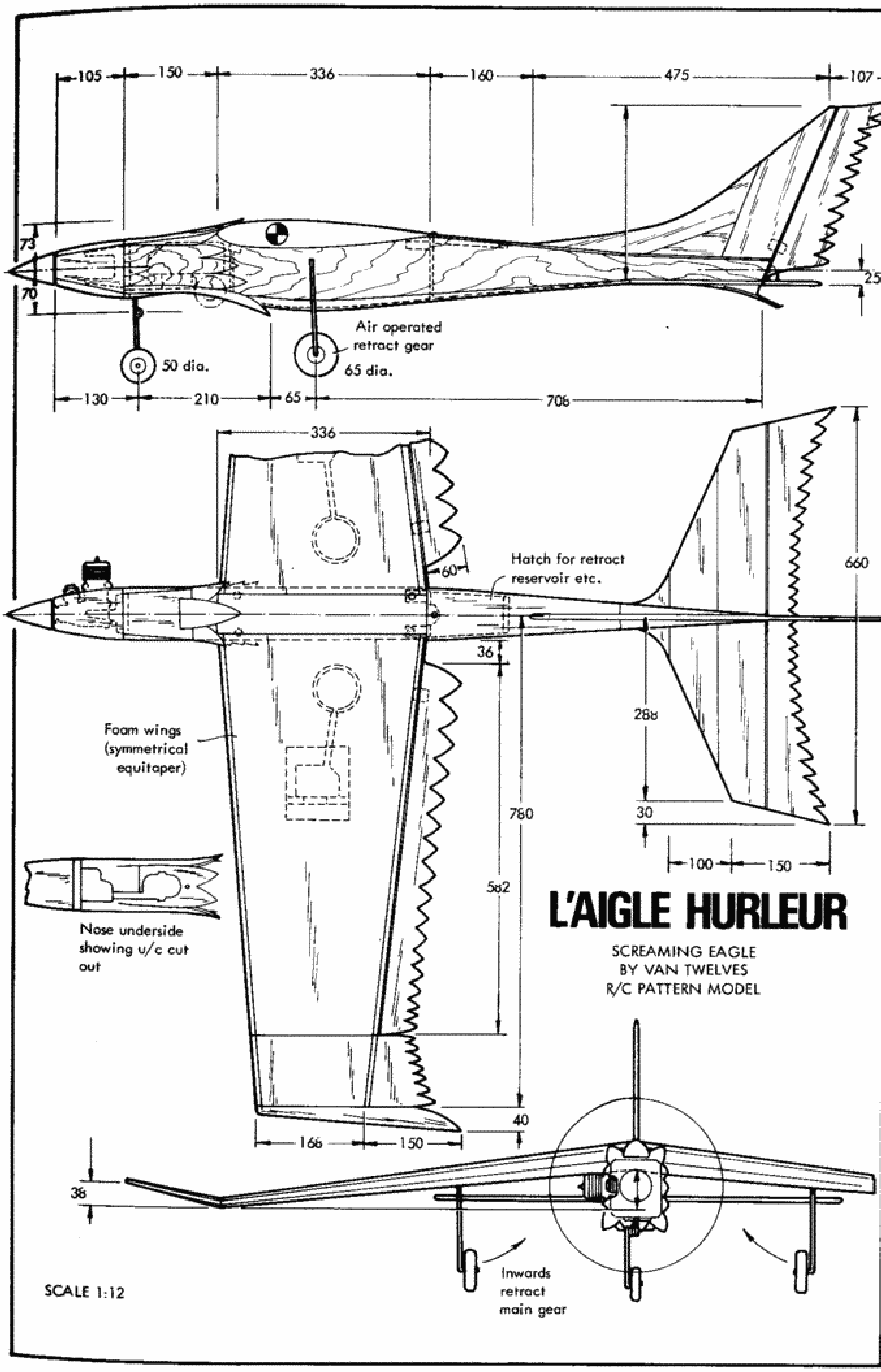


Fig. 3
VULTUR 4
Span 1650
Chord 305
Length 800
Weight 1.13 kg

the stick. Vultur ignored me! Horrified, I pointed the stick towards space, away from rising terra firma and stood there waiting for the crunch. It came, but not before the aircraft had wandered aimlessly along the slope making it absolutely clear that I might point it up or down, but most certainly not from side to side!

True to the form of mad scientists, I was back a few days later with Vultur 2—a patched Vultur with a monstrous fin sprouting between the V-tail and a rudder coupled to the ailerons. This time it submitted and dutifully reacted to my commands, but now another "characteristic" began to show. Its slow, almost majestic flight in a five knot breeze, slowly transformed into a liability as the wind strengthened. The trim button was progressively pushed forward without much to show for it in terms of penetration. As the button hit the far stop, Vultur 2 acted like a hawk invited to lunch. The transition from nose-down flight to a near vertical drop was so sudden that I over reacted and the model was wrenched up and down like a Yo-Yo until I pulled the trim off the stop. I began to



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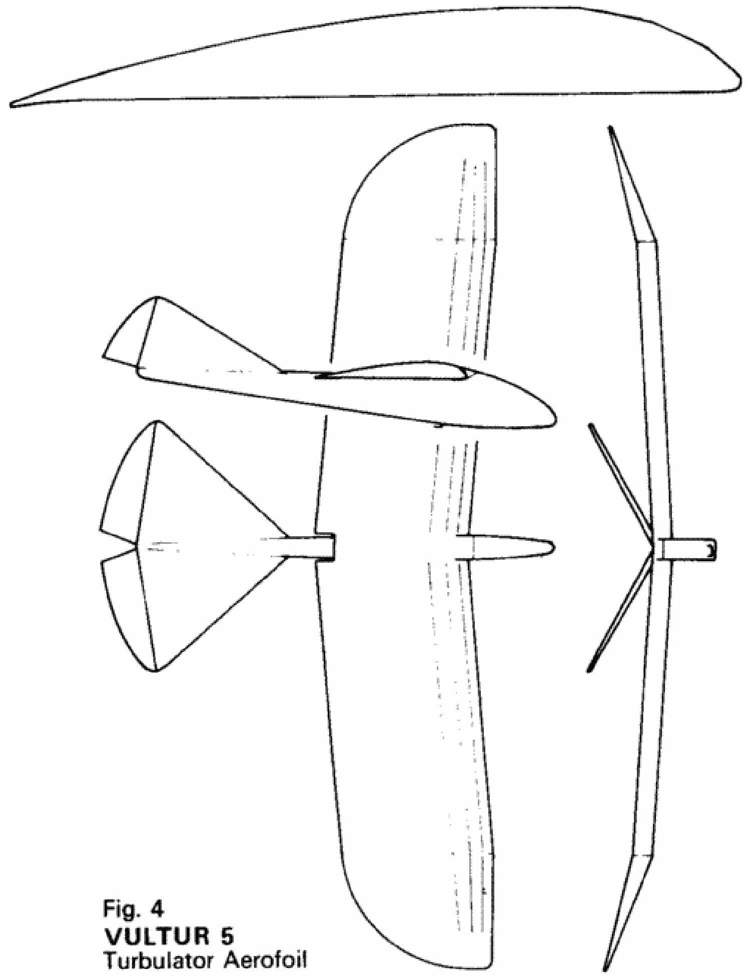


Fig. 4
VULTUR 5
Turbulator Aerofoil

look upon the aerofoil section with some suspicion—it seemed to have something more (or is it less?) than an angle of zero lift!

The fin spoiled the original concept and the machine was carrying too much nose ballast, so surgery was performed once again. A longer nose was grafted, the ailerons immobilised. The fin was amputated, the internals torn out and rearranged. Vultur 3 emerged with differential movement added to the elevators, more aquiline features, a towhook and 6 oz. (170 g) lighter.

Towing trials proved to be trouble free. Control response was satisfactory both on and off the tow. The ability to circle tightly was retained by this "full scale" model, but the sinking speed was too high, and penetration poor. By now the aerofoil was definitely suspect. I felt that a more orthodox, aerodynamically thinner section would improve performance. The 1976 State Gliding Championships were approaching, and I had intended to attend to observe before getting involved in serious competition again. But why not enter, for the hell of it? No time to build a new wing—

so out came the scalpel! The undercambered 15% thick Wortmann was converted by ripping out the bottom spar, cutting back the webs and ribs to give a flat bottomed section of about 12%. A quick trial indicated an improvement in both longitudinal stability and sinking speed.

Reaction to Vultur 4 on the contest field probably can be summed up by the most asked question—"What'n hell's that?" (see *Fig. 3*). The contest was flown in a very strong wind. Vultur was released in the first round and headed into wind. After a few seconds it was evident that its ground speed was negative, and as I gaped at it flying remorselessly backwards, I allowed the nose to swing too far to the left. From that moment the flight became hilarious. All my efforts to induce it nearer to the centre of the field failed. She slope soared along the Camperdown Grandstand roof, executed a tough-and-go off the ridge and an Immelmann into a tall tree behind. For all this versatility I was awarded nothing for that round—the tree was outside the landing limits! Vultur, patched and epoxied and trying to digest the best part of a pound of lead, was hurled into the elements for round two—and behaved impeccably. She zig-zagged into wind

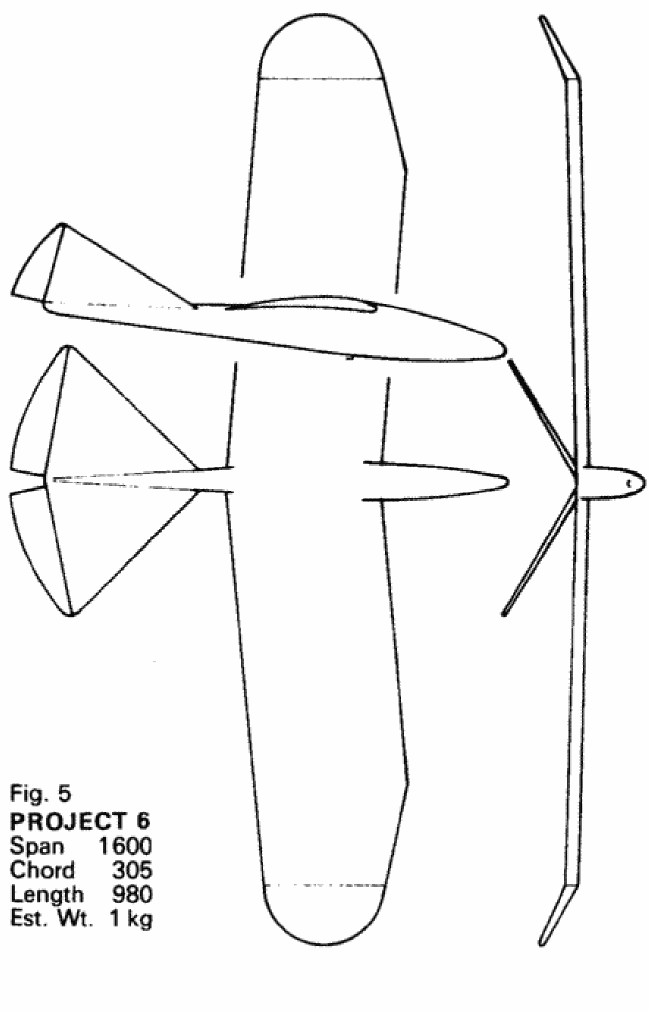


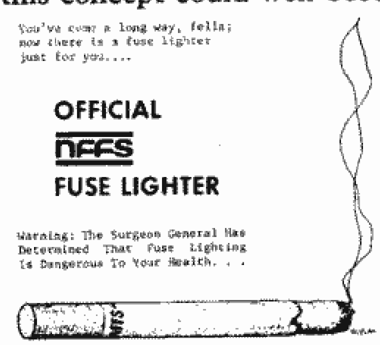
Fig. 5
PROJECT 6
Span 1600
Chord 305
Length 980
Est. Wt. 1 kg

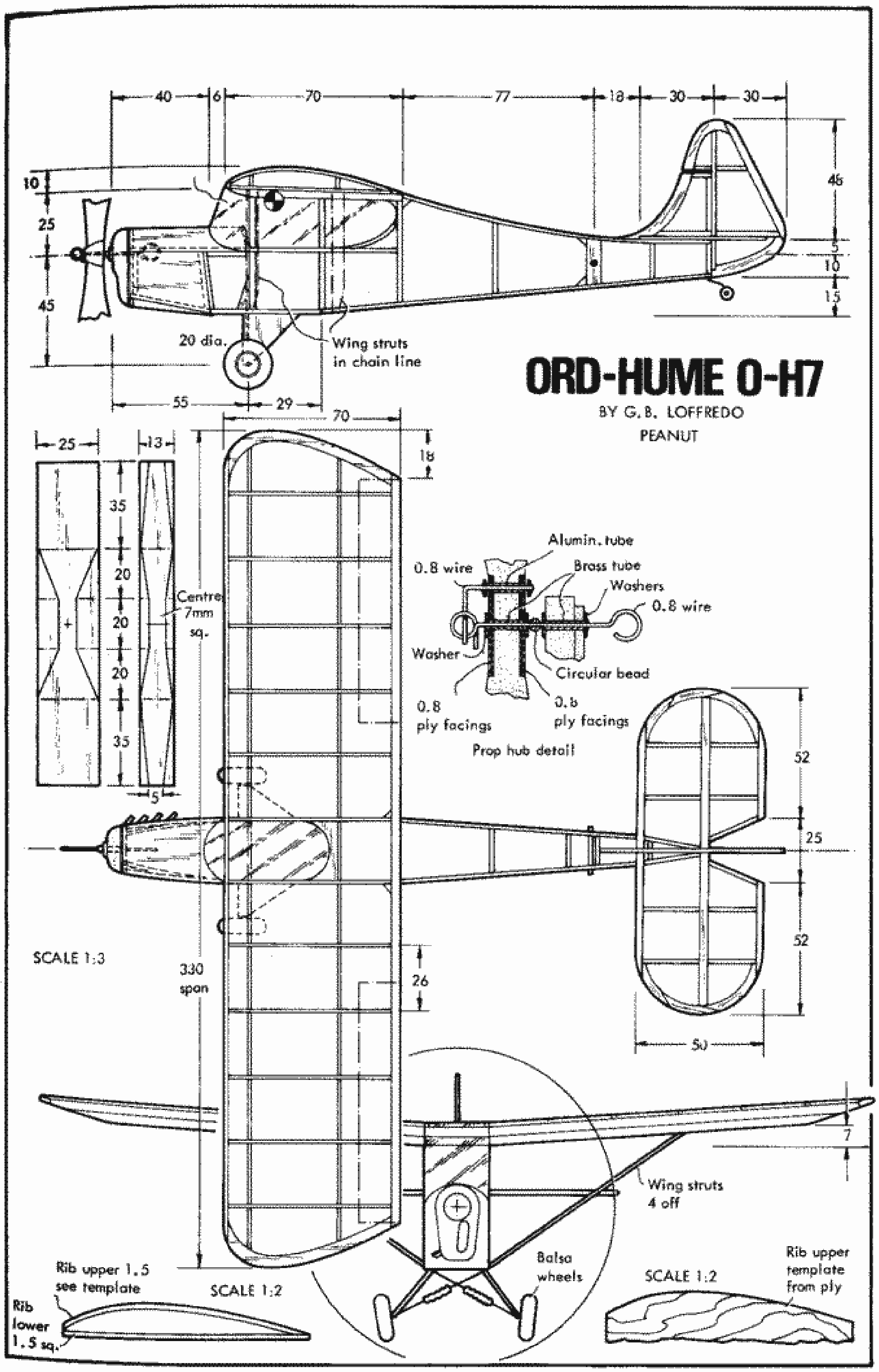
with better penetration and touched down one and a quarter metres from the spot in a time comparable with many of her competitors. Round three was another disaster due to pilot error, all the way. I ignored a wind change immediately prior to launch, towed up cross wind and released virtually downwind of the spot. Vultur again demonstrated her violent dislike of full down trim and the flight ended safely but rewardless outside the landing area once more.

More relaxed flying of Vultur 4 revealed that sinking speed and penetration both needed improvement. Some increase in still air duration was achieved by using a turbulator, so I am convinced that the choice of the Wortmann was wrong. On the bright side, lateral and directional stability was excellent, even with the tendency to wallow following coarse control movements. Longitudinal stability was satisfactory—inclined to be a little touchy, but not beyond gentle control. In fact, I have now developed the "feel" so that handling no longer needs to be conscious. Vultu has currently undergone further surgery—this time to modify the top surface of the wing to a max-depth-at-30% type aerofoil. Spanwise spars have been added to the forward section to modify the curve and to encourage turbulation. At the same time the tip dihedral was recuded by 8° (see *Fig. 4*). Directional response now is, naturally, somewhat slower but still sufficient for control under tow. It does suggest, though, that if the primary role is to be slope soaring, the faster response configuration may be preferable. Attempts at aerobatics on the slope produced a surprise! The aircraft would not spin! Full up and hard right produced only very tight circles with an increased rate of sink rather than a rapid loss of altitude. So how to get out of really strong thermal lift, I wonder? Full down elevator, I suppose!

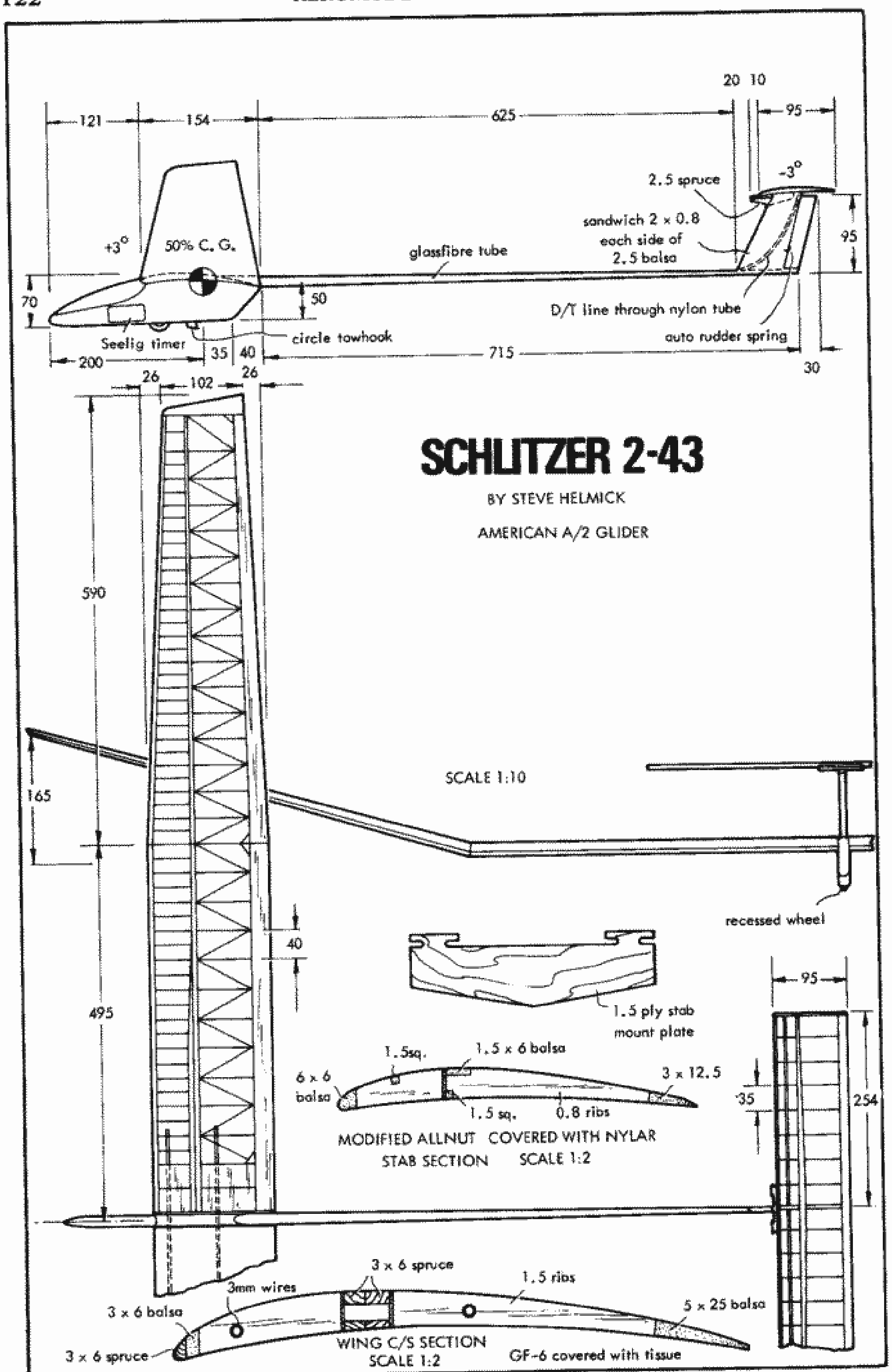
Meanwhile, unballasted, Vultur 5 makes an interesting light wind slope or thermal soarer. Ballasted she will cope with moderate breezes (18–24 k.p.h.) but beyond that we do as the birds do—walk! Facing facts, a bird has an airborne brain, inbuilt thermal sensors, variable camber wings, slotted wing tips, airbrakes etc. But, how well would they cope with only two channels?

Projected Vultur 6 will evolve on these lines: a lengthened nose to eliminate balance weight altogether: a thinner wing section—Eppler or Benedek (see *Fig. 5*). Remember, at —say 6%—the actual thickness of the wing will be no less than that of the Cirrus but with only a little more than half the span. A slight increase in span to allow a longer taper to the tip might also be beneficial. With attention to drag reduction and a little development this concept could well become potent.

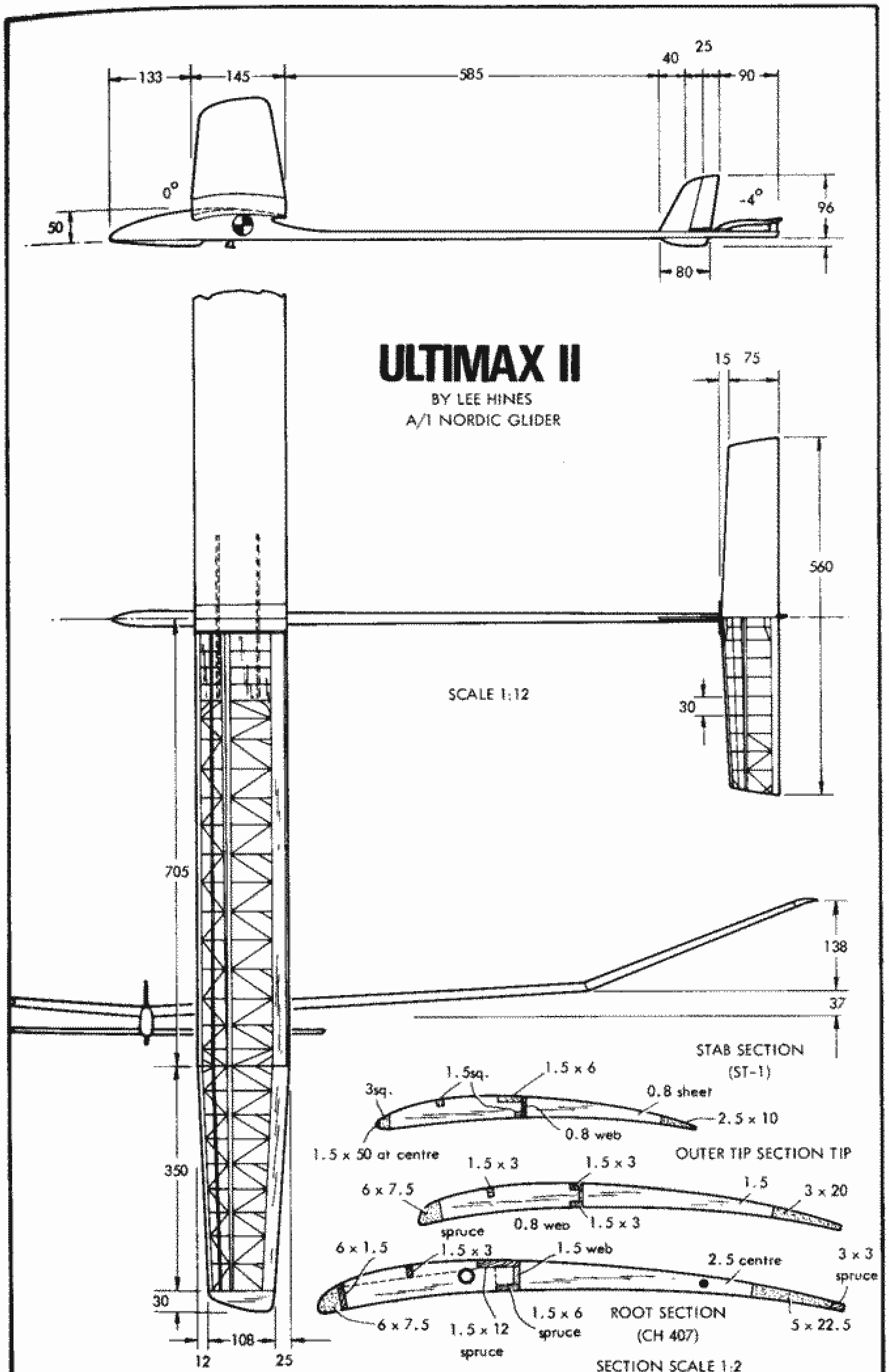




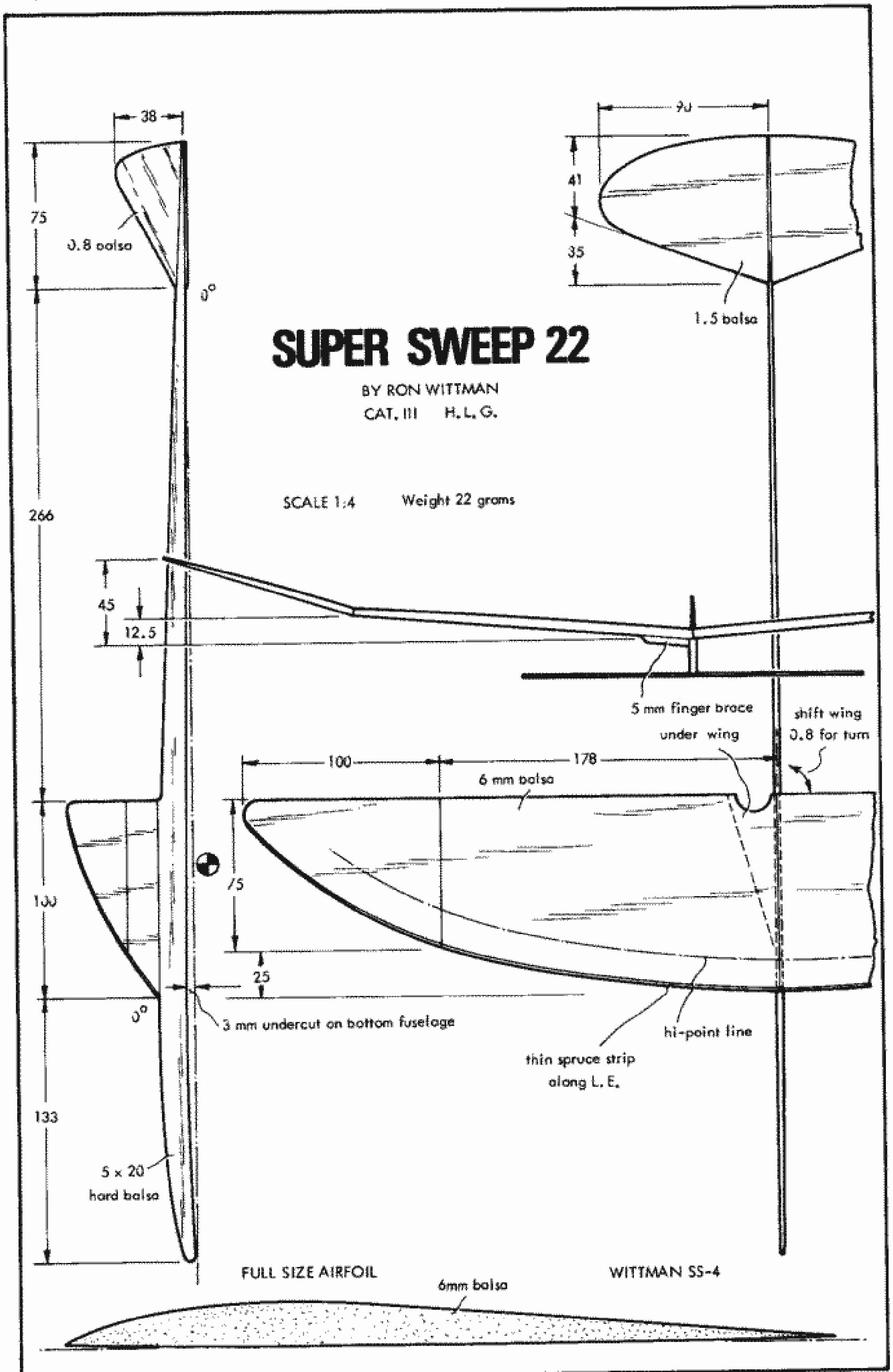
MODELLISTICA ITALY



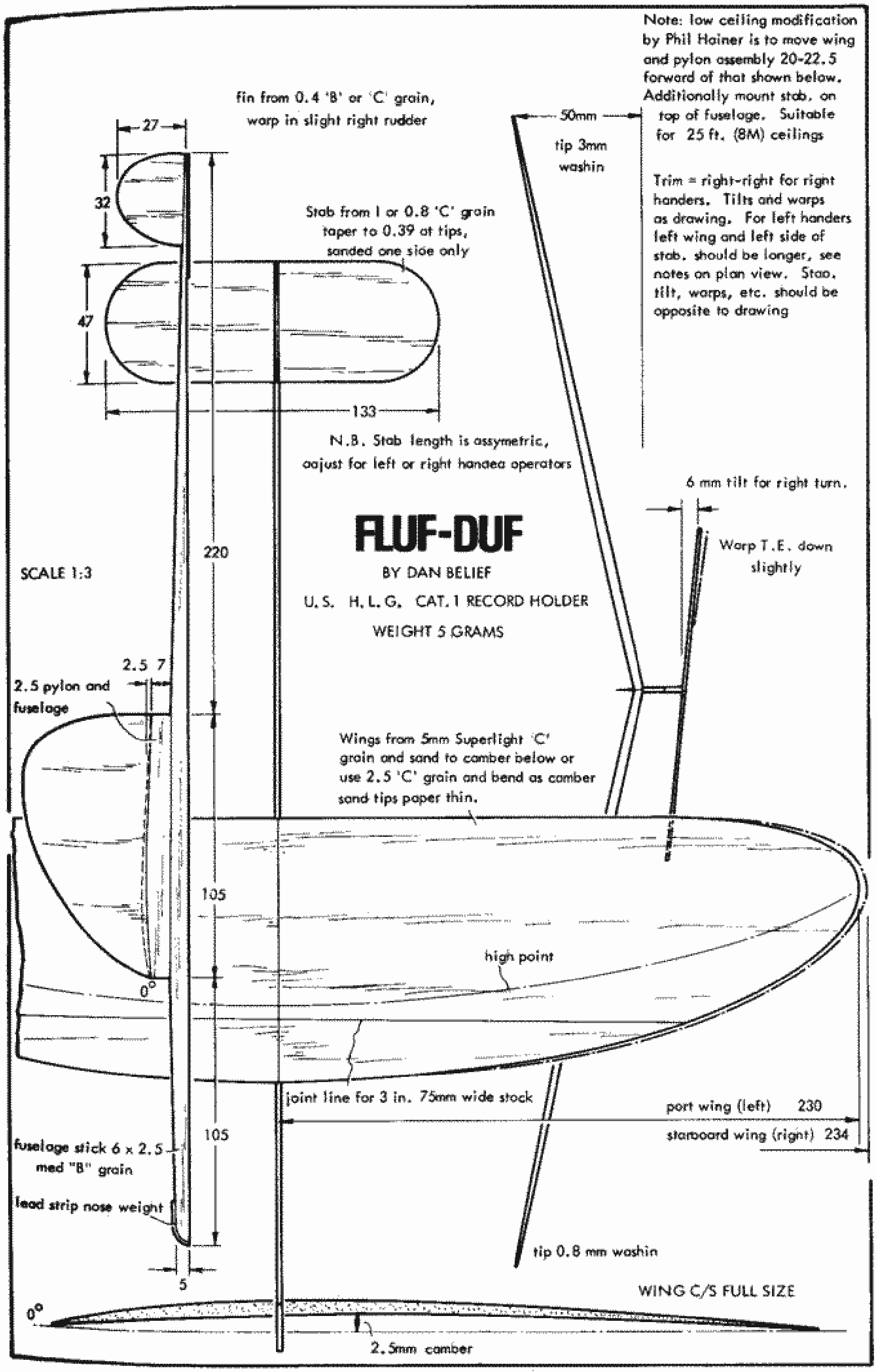
WILLAMETTE PATTER NEWSLETTER U.S.A.



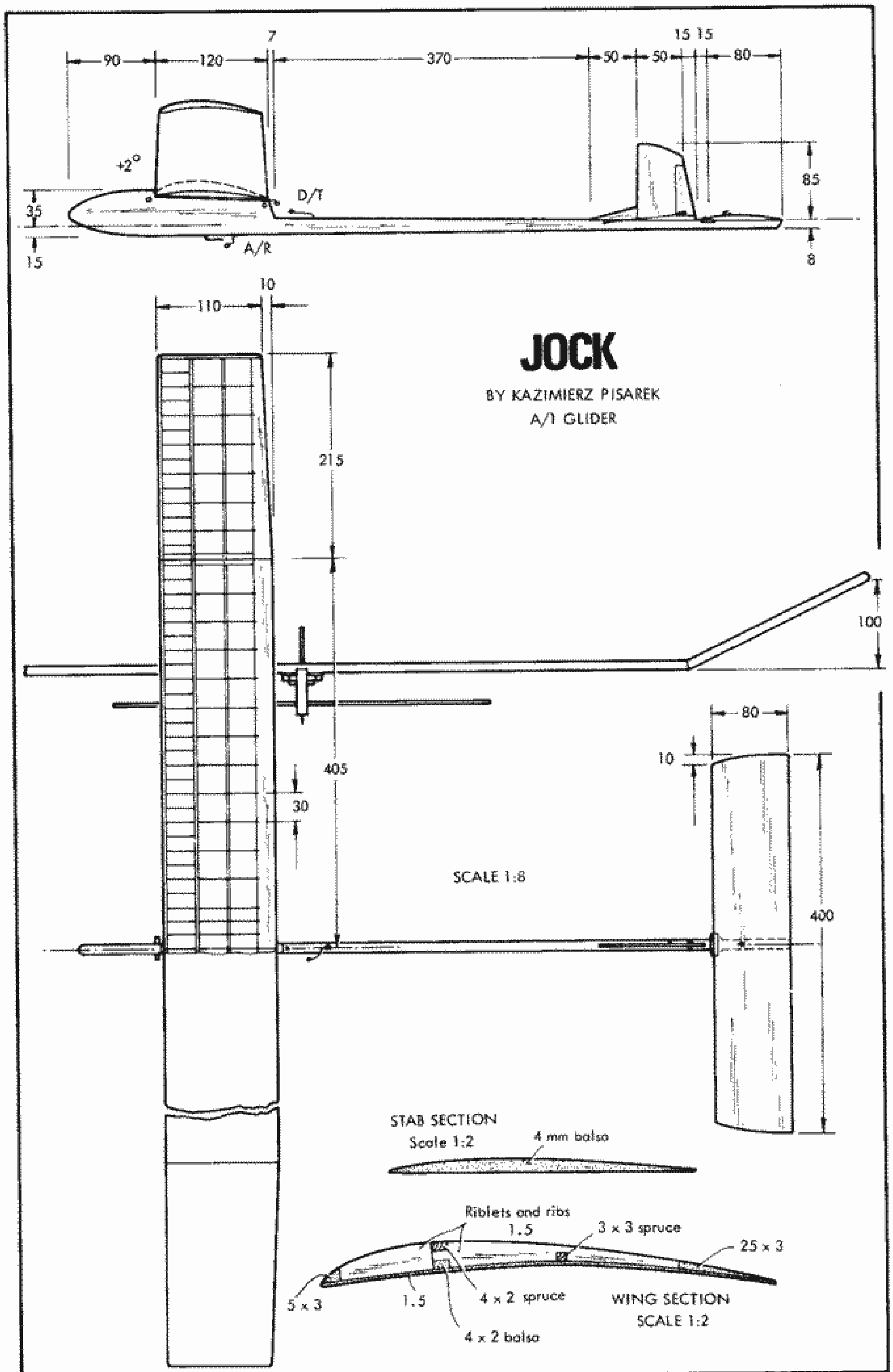
NFFS FREE FLIGHT U.S.A.



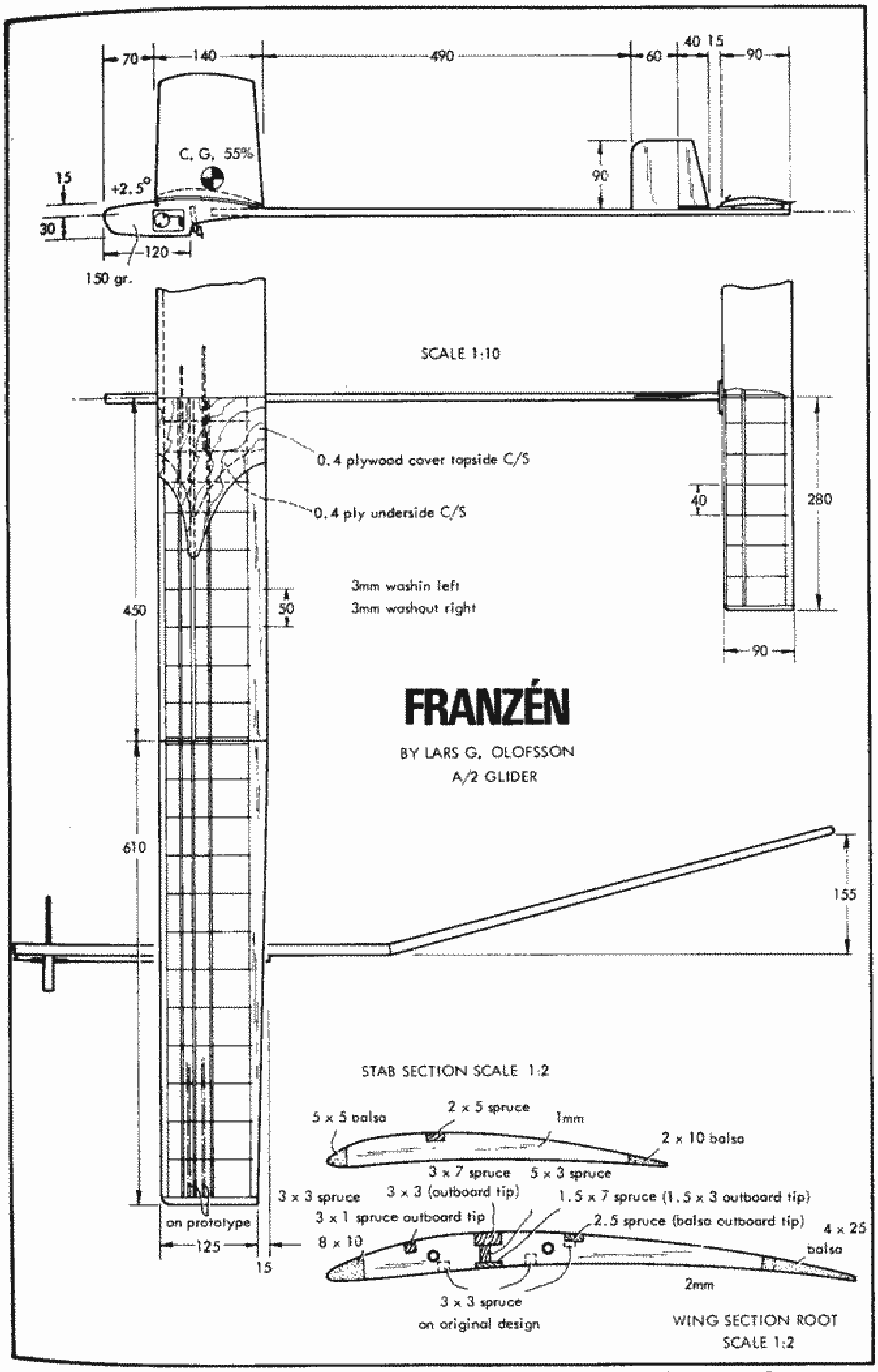
NFFS SYMPOSIUM 1976 USA



WILLAMETTE PATTER NEWSLETTER U.S.A.



MODELARZ POLAND


70
140
490
60
40 15
90
C. G. 55%
15
+2.5°
30
90
120
150 gr.
SCALE 1:10
0.4 plywood cover topside C/S
0.4 ply underside C/S
40
280
3mm washin left
3mm washout right
450
50
90
FRANZÉN
BY LARS G. OLOFSSON
A/2 GLIDER
610
155
STAB SECTION SCALE 1:2
5 x 5 balsa
2 x 5 spruce
1mm
2 x 10 balsa
3 x 7 spruce
5 x 3 spruce
3 x 3 spruce
3 x 3 (outboard tip)
1.5 x 7 spruce (1.5 x 3 outboard tip)
3 x 1 spruce outboard tip
2.5 spruce (balsa outboard tip)
4 x 25 balsa
8 x 10
on prototype
125
15
2mm
3 x 3 spruce
on original design
WING SECTION ROOT
SCALE 1:2

THE AGES OF MAN

by Paul Lagan (*New Zealand*)

THE AGES OF MAN ... it's amazing how one's attitude changes with age. At 15 we have the enthusiasm to take anything on that strikes our fancy and we have absolutely no patience ... it must happen *now*! The 15-year-old aeromodeller is still learning manipulative skills, has no knowledge of, nor interest in, the organization of his hobby and only wants to get that half-finished creation flying. At 25, this same boy has weathered the storms of his teenage distractions from modelling—he has been through the girl craze, the booze craze, the motor-bike craze and, in many cases, he is married and maturing fast. He is looking into a large cave which he probably fears a little but which he hopes will reveal a long, peaceful, prosperous life for him and his family. He has found the ready-money of his youth must stretch to take in his family commitments and is learning fast the meaning of a sensible budget. If he is still keen on aeromodelling then he is at a golden age—he has the skills virtually mastered, he is quick in mind and quick in eye and he is still not too bothered with administration and so has no binding commitments in this respect. His finance limitations force him to "select" the classes he flies and he flies these with fervent desire for success and recognition. A golden age.

At 35 our modeller has completed the most active decade of his life. In these past 10 years he has established himself in the community; become a family man and his path is usually well defined in his chosen profession or following. He has become interested in the politics of the country and in the politics of his sport and hobby—if he isn't a worker helping on committees or helping publish his club bulletins or fostering the juniors in his club then he is usually a fairly vocal "knocker" very ready to criticise and to sound-off to all and sundry. He has become a little conceited about his past conquests and a little over-confident of his ability. He has reached an age of great mental maturity where he can shrewdly assess the amount of effort required for a task before attempting it and due to this he is starting to tend toward procrastination. By 35 if he is going to do it he would have done it—but the 35-year-old mind is full of thoughts on his future triumphs and victories. He tends to have developed fixed ideas on most things and is starting to enjoy reminiscing on past happy times.

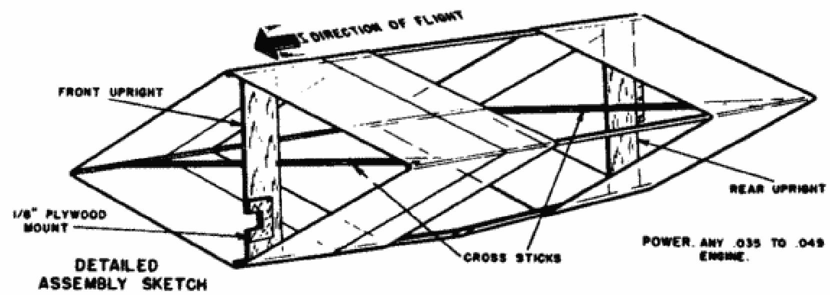
The 45-year-old has become less and less interested in outright competition in all things–he is less competitive at his work and is less competitive in his aeromodelling but he does like to be well thought of. To this end, he is very painstaking and has a tendency to overemphasise his *past* abilities—to himself if not to others. He has become much more interested in the finer things of life—he appreciates fine wines, good scenery, classical music and above all hates pollution of all types. His modelling also reflects these feelings and he will drift happily toward scale, vintage, radio gliders and the like and usually has little real appreciation for the faster, noisier, exciting aspects of life and his hobby.

At 55 our modeller is fast feeling like retiring—his attitudes move further from the rowdy things around him and he is starting to become a little intolerant of the "here today, gone tomorrow" attitude of youth.

He is intensely interested in permanent things and will treasure reminders of the past and collect rarities—vintage engines, etc. are priceless to him. He is still a very capable person and can, if he takes the trouble, regain most of the skills of his previous years and fly and live as well as the next man but things are fast becoming such a bind....

And so on to 65, 75 and? The 65+ modeller is a rarity. At this age, the average NZer likes to putter with his interests to his own satisfaction. He is generally not too sociable and is quite content to philosphise about the world and life. All those things he put off until he retired all of a sudden don't seem so important anymore—he sees little point in doing a lot of things and is very aware of the need for creature comforts.

Notwithstanding all of the above, every man is different—several have the attitude of a 25-year-old right into their 60's—some act like a 70-year-old in their 30's but let us hope that with his great hobby of aeromodelling, *all* treat it as a pastime that they can enjoy and that they can help others enjoy—at all ages, we should refrain from trying to get the most *out* of our hobbies unless we are prepared to put an equal amount back *in*. The most active aeromodellers should divide their activity equally between *using* the facilities created for their pleasure and actually fostering and assisting in the creation of those facilities. Do you do your bit, regardless of age?



FLITE KITE

by J. Lowrie McLarty

(from "American Aircraft Modeler", U.S.A.)

FLITE kite not only flies without wind but without string as well. Any box kite can be adapted to fly using the steps below. The kite described is based on the kind sold with about a 28 in. length. Some balsa, paper, cement and a Half-A engine complete the bill of material and an hour or less should see your Flite Kite ready to go.

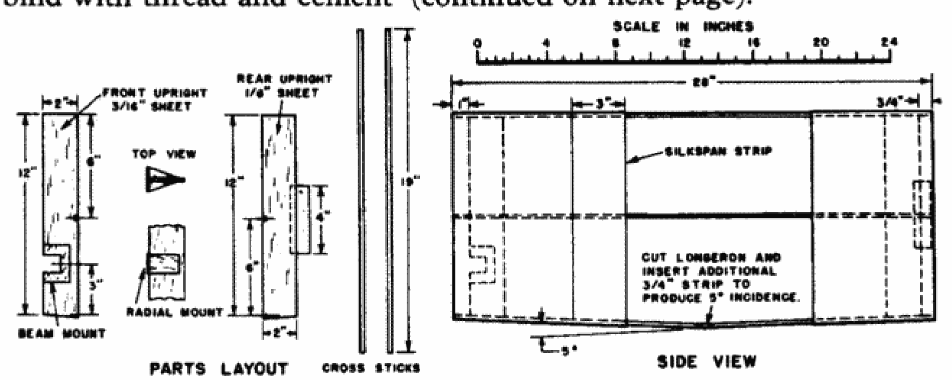
The construction and assembly steps are as follows:

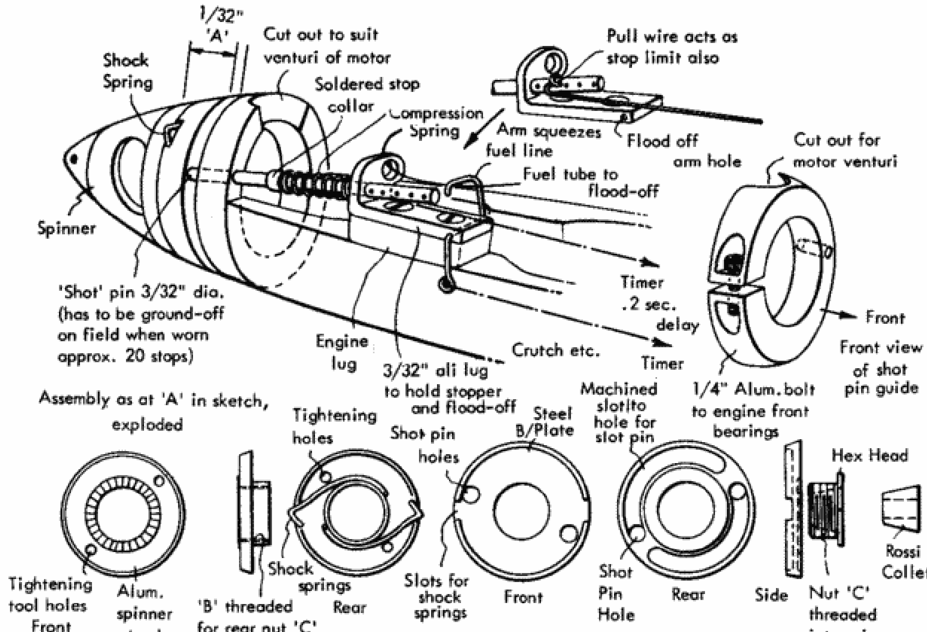
Step 1. From 5 × 50 mm. hard balsa sheet cut the front upright with a notch for the cross stick shown in step 3 and either make a cut out if your engine is beam mounted or cement on balsa angle blocks if the engine is firewall or radial mounted. In either case use 3 mm. ply between engine and balsa and cement all pieces well.

Step 2. From 3 × 50 mm. balsa sheet cut the rear upright and notch to fit the cross stick shown in step 3. Cement and pin a thin aluminium or fibre 25 × 100 mm. piece as a rudder.

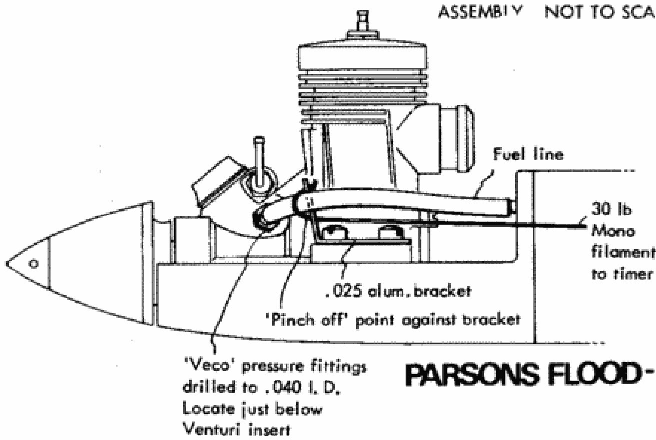
Step 3. From 5 × 10 mm. hard balsa cut two cross sticks to be trimmed to exact length on assembly step 4.

Step 4. Assemble kite as per box kite assembly instructions except use uprights and cross sticks made in steps 1, 2, and 3. Cross sticks step 3 are to be as long as possible to make the covering tight. Wind and cement thread 75 mm. behind front box kite panels and cover entirely around with silkspan folded over and cemented in a manner similar to the box kite panels. Cut the bottom longeron, insert a piece made from the discarded box kite cross sticks to make the longeron 20 mm. longer than it was and bind with thread and cement (continued on next page).





HATSCHEK PROP STOPPER
ASSEMBI Y NOT TO SCALE



PARSONS FLOOD-OFF

This operation provides incidence between front and rear panels to give longitudinal stability.

Step 5. Entire "model" should be given two or more coats of plain dope and another of fuel proofer if a glow engine is used instead of a diesel. Mount the engine and balance the model at the rear of the front panels as shown in step 4. Use bolts as weights cemented at the front or the rear to obtain this C.G. position. The final C.G. will be determined by the glide, which should be flat without a tendency to dive, climb or go through a series of stalls. The weight should be shifted for adjustment. Some down-thrust may be necessary with higher powered engines.

Tethered flights can be made overhead with the usual box kite bridle and line but with the string arrangements installed upside down as if the tail of the plane were the front of the kite.

USE THAT RUDDER

says Len Salter, *Chairman Cape Town Radio Flyers*

I WOULD hazard a guess that (apart from when performing aerobatics) 95% of flyers never use rudder when airborne. The majority of models today have steerable nosewheels and when the rudder—nosewheel stick on the TX is operated during take off and landing, it is primarily a question of steering the nosewheel.

Once airborne, the rudder is forgotten till touch down. As an aircraft will turn adequately by means of ailerons only, the question arises (with tricycle u/c) why bother to have a moveable rudder? It would certainly be easier to incorporate the fin and rudder as one solid unit when building.

We all know that full size single-engined aircraft with tricycle u/c have moveable rudders, so there must be justification for it.

One reason is for the comfort of the passengers during a turn. A slight downward pressure of the body into a seat is readily acceptable, but sideways movements are not. Imagine a weight suspended on a cord from the cabin roof. In straight and level flight it will hang perpendicular. For comfort in a turn it must remain thus—in relation to the aircraft, and rudder is used to achieve this. In practice a much more refined instrument in the cockpit gives the pilot the same information.

As model flyers we feel no discomfort in a turn, and it is difficult to detect if our model is turning correctly in this respect, so naturally we do not even consider it.

Perhaps I have almost convinced you by now that you don't need a rudder for non-aerobatic models with tricycle u/cs, but the rudder has an important function which few modellers seem aware of, and it is this. OPPOSITE RUDDER IS THE BEST MEANS OF PICKING UP A DROPPED WING, and this applies especially when nearing the ground on landing, and during the initial stages of lift off.

Let us investigate the reason for this. Imagine you are one metre above the ground on landing approach and turbulence causes your left wing to suddenly dip. Owing to your low airspeed, the sudden increase in the angle of attack, plus the increase in drag caused by operating the ailerons, may stall the down going wing. At best the airflow over that aileron (which has an even greater angle of attack than the wing) will be turbulent, rendering it almost ineffective.

The fact that the aircraft is banked to the left will cause it to turn to the left. If instead of applying right aileron, you apply right rudder (a) you will have no aileron drag; (b) the turning of the aircraft to the right will speed the airflow and increase the lift of the dropped wing and (c) you will line yourself up with the runway again.

This practice by the way is standard for full size aircraft.

(*Especially a Flying Flea!—Ed*)

The moral of the story then is, during the critical take off and landing periods on all types of aircraft, forget the ailerons and *use that rudder.*

There is also a further reason why you should use rudder if your model is not equipped with differential ailerons. You may be aware of "adverse yaw effect" caused by aileron drag, and it works thus on some aircraft.

If you are flying straight and level and give right aileron, the additional drag caused by the down (left) aileron can actually turn your aircraft in the opposite direction. In normal flight, the use of rudder as well, will overcome this tendency.

When you consider all the facts I have set out here, I hope it makes you realise the importance of that rudder, and don't forget that your aircraft's reaction to rudder control movement is related to its airspeed, so you will need a big movement at low airspeed.

If, as does happen, you lose an aileron in flight, don't panic and plonk your model down as soon as possible. Just keep calm, because as I hope you now realise, you will not need your ailerons to make what could be a perfect landing.

If you practice with that rudder during all take offs and landings, you will react spontaneously to a sudden dipped wing.

SUPER TANK

Rediscovery of the pressurised fuel system for both R/C and C/L

by David Gierke (*From "Model Aviation", U.S.A.*)

HOW OFTEN have competition flyers been frustrated by engines that are hopelessly flooded at just the wrong moment? As most are well aware, if the flyer is not careful, a backflow condition through the pressure line of the conventional tank will flood the engine crankcase. The R/C pattern enthusiast who points his model into a prolonged vertical dive, only to have his engine flame out towards the bottom of the manoeuvres knows this condition too well.

With the improvements in engine technology and its related systems (carburettors, glow-plugs, fuels, etc.) the fuel tank looms as the problem child of the power development family as it always has with C/L Stunt. But a solution is at hand which promises to end all the problems we have had to tolerate.

The "new" tank promises to have the following advantages:

1. Fuel will not foam in the system.
2. Fuel pick up is not critical with respect to location in the tank.
3. Tank is non-critical to vibration mounting.
4. Tank will empty the fuel without having the tendency of running lean towards the end.

Here's how it works: From the diagram note that a pliable rubber bladder has been sealed *into* a conventional plastic (or any other airtight container) tank. Pressure from the engine (muffler, timed, or untimed crankcase pressure) is admitted *between* the outer shell and the bladder. The solid fuel pickup, with its multiple hole arrangement (to ensure fuel flow during any condition of bladder collapse) is positioned along the length of the inner bat at random. The system needs only a pickup tube plus an air bleed vent bag through the air bleed vent. Filling is accomplished through the pickup or feed line. After filling, the air bleed vent is capped off.

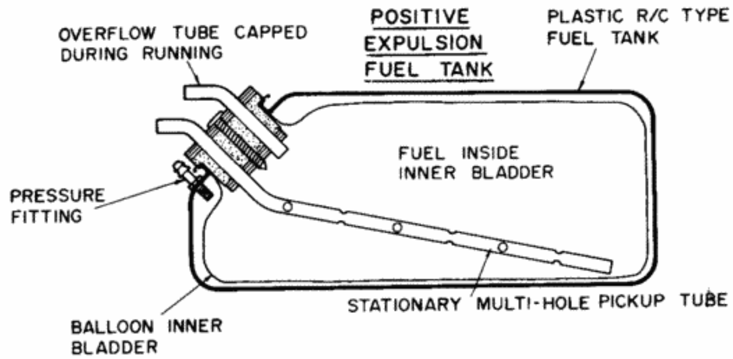
The bag is filled only to its unstretched capacity.

This system works differently from that of a pen bladder or baby pacifier (dummy).

The external pressure forces fuel from the airless bladder, through the fuel lines and into the metering device (needle vale) at the engine carburettor. The tank operates by the tried and proven concept of "pressure differential". The higher pressure on the outside of the bladder or bag forces the fuel towards the lower pressure created at the engine crankcase.

Since there is no air in the bladder, there can be no foaming. The bladder collapses uniformly, because of equal pressure around itself, therefore pickup tube positioning is of little importance. N.A.S.A. has used this concept for years in its "positive expulsion" fuel systems, designed for use in space (rocket-engine fuel system etc.).

As with spacecraft fuel systems our Super Tank is not affected by external forces such as gravity, inertia, etc. These external forces continually affect the fuel in a conventional tank, sloshing it about madly. Fixed pickups for these tanks tend not to remain submerged within the fuel.



Clunk-type tanks have mechanical and kinetic problems related to the external forces.

It should be obvious that there can be no crankcase flooding through the pressure lines (backflow) with this system. Beautiful throttle operation can be maintained by use of low pressure (muffler pressure—about ·15 p.s.i.) to the tank.

The one feature which is difficult to get used to, concerns the ability to empty itself almost to the last drop! Towards the end of a run the bladder looks like a flat prune, with all of its wrinkles. Never again will you finish a flight with a tank containing as much as 10% of its fuel remaining. The Super Tank operates at the proper needle setting to the last second, whereby it merely loses r.p.m. and stops. No longer will the engine be subjected to the wearing effects of leaning out towards the end of the flight, as with conventional tanks.

As with most super ideas, there usually are drawbacks. This concept is no exception. The tank is unbeatable from the aspect of its operation. The hangup lies with the material used for the bladder. Most materials, such as natural rubber, deteriorate under the influence of fuels and time. Low percentage of nitromethane are better than racing fuels on the bladder longevity scale. Nevertheless even surgical tubing fuel line deteriorates after a period of time.

Neoprene holds up well but lacks that soft pliability of natural rubber. Using heavy walled balloons is satisfactory provided they are replaced often. One method which seems to prolong the life of such bladders is to squirt some glycerine into the system after each use. Of course the bladder must be flushed before using with fuel or alcohol. Balloons are generall unacceptable because they do not contour to the inside of the outer tank shell. This limits the overal capacity.

It seems ironic that the late great Jim Walker had the solution to the fuel delivery problem more than 25 years ago. Jim pressurised a balloon-type tank with a squeezing technique using rubber bands. His pressure regulator compensated for the ever-present fluctuations from the system.

Walker was way ahead of his time. The engines were of relatively low output (by today's standards) and didn't need the Walker fuel delivery system quite so much.

It has taken a while, but Jim's solution is about to be "rediscovered" to the benefit of all.

WORLD R/C THERMAL SOARING CHAMPIONSHIPS
WORLD R/C AEROBATICS CHAMPIONSHIPS
WORLD FREE FLIGHT CHAMPIONSHIPS

WORLD R/C THERMAL SOARING CHAMPIONSHIPS

Pretoria April 1977

PLACE	NAME	COUNTRY	TOTAL
1	S. Miller	U.S.A.	13185
2	F. Roos	S.A.	12919
3	**S. Bannister**	U.K.	12844
4	J. Ten Holt	Netherlands	12508
5	M. O'Reilly	Australia	11960
6	S. Smith	Australia	11855
7	R. Decker	W. Germany	11829
8	D. Nutter	U.S.A.	11702
9	**N. Mattingley**	U.K.	11343
10	F. Schiborr	W. Germany	11106
11	L. Payne	U.S.A.	10692
12	G. Laderach	Switzer	10659
13	E. Meester	Australia	10544
14	R. Baumgartner	Switzer	10523
15	R. Spavins	S.A.	10510
16	B. van Leeuwen	Netherlands	10489
17	P. Keim	Netherlands	10465
18	**A. O'Shea**	U.K.	10302
19	W. van der Meulen	Belgium	10194
20	P. Gassman	Switzer	10185
21	W. van Nuffel	Belgium	10181
22	P. Casadei	Italy	9761
23	A. Saager	W. Germany	9683
24	R. Reuland	Canada	9679
25	J. Greis	Luxemburg	9623
26	J. Humphreys	Canada	9621
27	F. Givone	Italy	9504
28	N. Drew	S.A.	9092
29	E. Pagliano	Italy	9002
30	J. Topf	Canada	8629
31	M. Kemp	Luxemburg	8599
32	A. Gouverneur	Belgium	8540
33	R. Sfredda	Luxemburg	8129
34	F. Wasner	Austria	7007

TEAM POSITIONS

1	U.S.A.	35579
2	U.K.	34489
3	Australia	34359
4	Netherlands	33462
5	Germany	32618
6	South Africa	32521
7	Switzerland	31367
8	Belgium	28915
9	Italy	28267
10	Canada	27929
11	Luxemburg	26351
12	Austria	7007

THE 1977 WORLD CHAMPIONSHIPS

IN

SOUTH AFRICA ● U.S.A. ● DENMARK

Abbreviated results

WORLD R/C AEROBATICS CHAMPIONSHIPS

Springfield July 1977

PLACE	NAME	COUNTRY	TOTAL
1	H. Prettner	Austria	25020
2	D. Brown	U.S.A.	24090
3	W. Matt	Liechtenstein	24065
4	I. Kristensen	Canada	23830
5	M. Radcliff	U.S.A.	22970
6	R. Miller	U.S.A.	22955
7	T. Yoshioka	Japan	22645
8	T. Okumura	Japan	22460
9	G. Naruke	Japan	22440
10	G. Hoppe	W. Germany	22265
11	B. Kjellgren	Sweden	21930
12	H. Neckar	W. Germany	21505
13	B. Giezendanner	Switzerland	21115
14	D. Fritz	Austria	20820
15	B. Bertolani	Italy	20635
16	G. Metterhausen	W. Germany	20360
17	**D. Hardaker**	U.K.	20205
18	W. Hitchcox	Canada	20140
19	R. Pasqualini	Italy	20035
20	E. Giezendanner	Switzerland	19895

61 flew 24 nations

TEAM POSITIONS

1	U.S.A.	70015
2	Japan	67545
3	W. Germany	64130
4	Switzerland	60470
5	Canada	60010
6	Austria	59865
7	Italy	59840
8	Sweden	59035
9	Australia	57590
10	United Kingdom	56355
11	South Africa	54190
12	Netherlands	53890
13	France	50020
14	Mexico	47675
15	Luxemburg	42660
16	Leichtenstein (2)	42480
17	Norway	35330
18	New Zealand (2)	32515
19	Brazil (2)	23910
20	Peru (1)	16200
21	Denmark (1)	15165
22	San Marino (2)	14245
23	Ireland (2)	12885
24	Belgium (1)	11295

WORLD FREE FLIGHT CHAMPIONSHIPS

Roskilde 6–12 July 1977

Results—F1A (A/2 Glider)

PLACE	NAME	COUNTRY	TOTAL
1	K. Abadjiev	Bulgaria	1257
2	A. Lepp	U.S.S.R.	1244
3	W. Kraus	Austria	1234
4	R. Chan	Korea	1232
5	L. Braud	France	1227
6	I. Horejsi	C.S.S.R.	1216
7	K. Sik	Korea	1213
8	V. Chop	U.S.S.R.	1207
9	H. Schmidt	W. Germany	1199
10	R. Chol	Korea	1180
11	K. Thormann	E. Germany	1180
12	V. Isaenko	U.S.S.R.	1169
13	**J. Cooper**	U.K.	1158
14	J. Drapeau	France	1155
15	J. Walters	U.S.A.	1151
16	P. Dvorak	C.S.S.R.	1150
17	G. Zojceski	Yugoslavia	1140
18	R. Spann	Austria	1136
19	L. Reynders	Belgium	1133
20	C. Markos	U.S.A.	1126
21	J. Titoff	Finland	1125
22	B. Jansson	Sweden	1121
23	A. Vidensek	Yugoslavia	1119
24	A. Bucher	Switzerland	1111
25	H. Wolf	E. Germany	1109
26	R. Sifleet	U.S.A.	1103
27	M. Pokorny	C.S.S.R.	1100
28	G. Hertzberg	Israel	1095
29	G. Zach	Austria	1095
30	D. Henke	E. Germany	1093
31	S. Larsen	Norway	1081
32	S. Olstad	Norway	1063
33	L. Valdemaro	Italy	1062
34	M. Bernisson	France	1058

82 flew 29 nations

TEAM POSITIONS

1	Korea	3625
2	U.S.S.R.	3620
3	C.S.S.R.	3466
4	Austria	3465
5	France	3440
6	E. Germany	3382
7	U.S.A.	3380
8	Yugoslavia	3304
9	W. Germany	3209
10	U.K.	3158
11	Switzerland	3126
12	Israel	3063

Results – F1B (Wakefield)

PLACE	NAME	COUNTRY	TOTAL
1	K. Sik	Korea	1253
2	S. Samokish	U.S.S.R.	1245
3	B. Son	Korea	1240
4	S. Masabumi	Japan	1227
5	J. Neglais	France	1202
6	F. Rado	C.S.S.R.	1197
7	G. Cassi	Italy	1185
8	W. Nimptsch	W. Germany	1177
9	A. Oschatz	E. Germany	1167
10	E. Mauri	Italy	1139
11	E. Reitterer	Austria	1137
12	K. Liwenborg	Sweden	1112
13	J. Klima	C.S.S.R.	1101
14	M. Usao	Japan	1097
15	K. Sol	Korea	1082
16	H. Zachhalmel	Austria	1080
17	**R. Pollard**	U.K.	1078
18	M. Kapetanovic	Yugoslavia	1074
19	W. Smitz	U.S.A.	1072
20	I. Zilsberg	U.S.S.R.	1060
21	P. Wlodarozyk	Poland	1060
22	L. Petrov	Bulgaria	1044
23	A. Poczobut	Poland	1041
24	K. Koskinen	Finland	1029
25	A. Sanavio	Italy	1025
26	R. Piserchio	U.S.A.	1018
27	R. Mielitz	E. Germany	1018
28	D. Siebenmann	Switzerland	1012
29	P. Skjulstad	Norway	1007
30	K. Lapinski	Finland	1005
31	I. Hideo	Japan	991
32	A. Armestd	Argentine	987
33	R. Magill	New Zealand	972
34	P. van Leuven	Australia	968

80 flew 30 nations

TEAM POSITIONS

1	Korea	3575
2	Italy	3349
3	Japan	3315
4	U.S.S.R.	3225
5	C.S.S.R.	3196
6	E. Germany	3140
7	Finland	3106
8	U.S.A.	3056
9	Austria	3001
10	Sweden	2968
11	W. Germany	2917
12	Finland	2867

Results—F1C (FA1 Power)

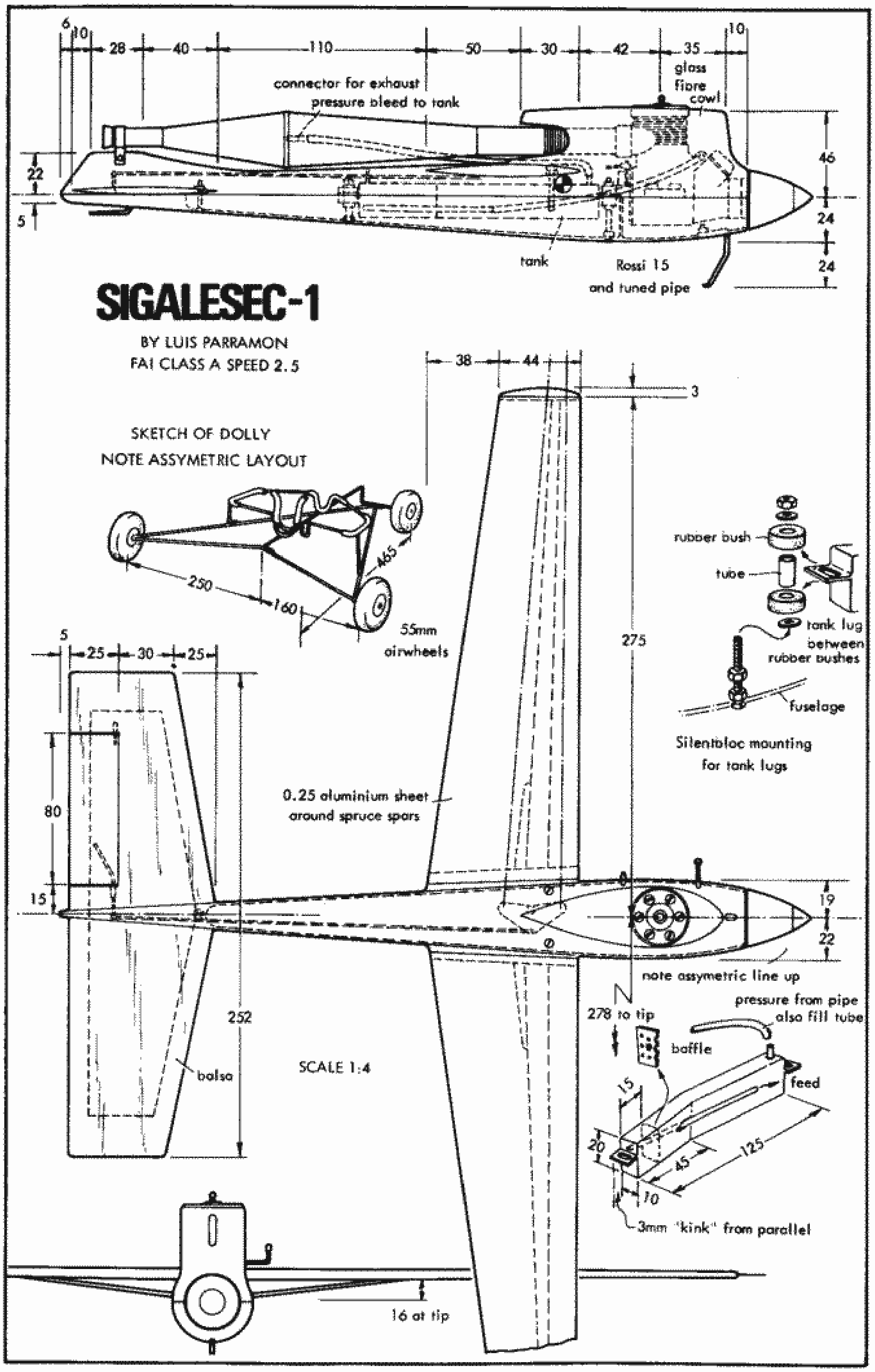
PLACE	NAME	COUNTRY	TOTAL
1	T. Koster	Denmark	2140
2	A. Meczner	Hungary	2101
3	E. Verbitsky	U.S.S.R.	2076
4	U. Schaller	Switzerland	2075
5	D. Sugden	Canada	2059
6	S. Reda	W. Germany	2053
7	O. Velunsek	Yugoslavia	2047
8	S. Lustrati	Italy	2035
9	K. Hui	Korea	1795
10	B. Fiegl	Italy	1766
11	M. Burns	Canada	1753
12	**S. Screen**	U.K.	1697
13	S. Agner	Denmark	1686
14	S. Sharin	U.S.S.R.	1497
15	G. Barbabella	Italy	1495
16	F. Hartwagner	Austria	1491
17	**M. Cowley**	U.K.	1481

All above qualified for the fly-off with perfect 1260 score

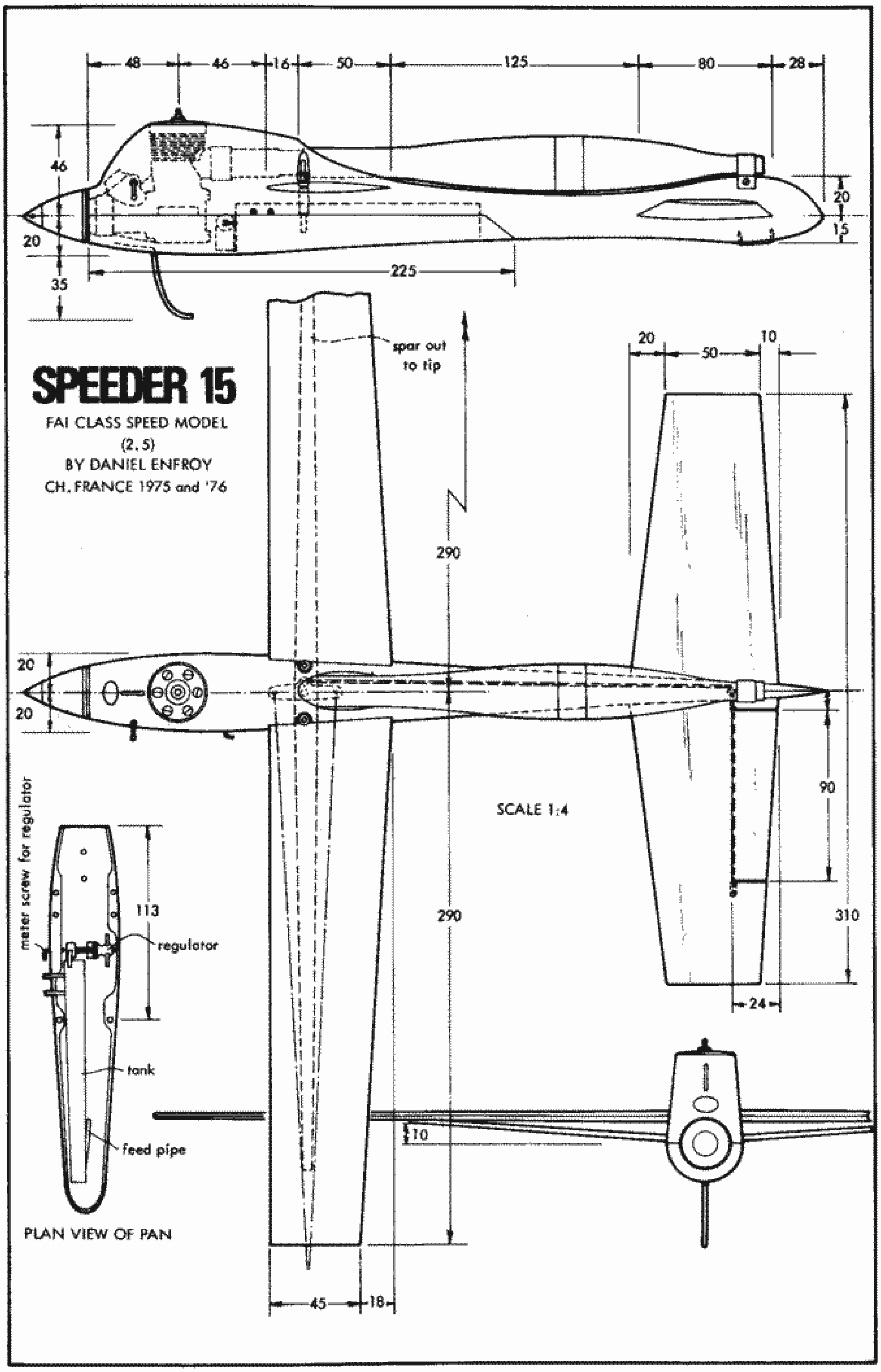
65 flew 24 nations

TEAM POSITIONS

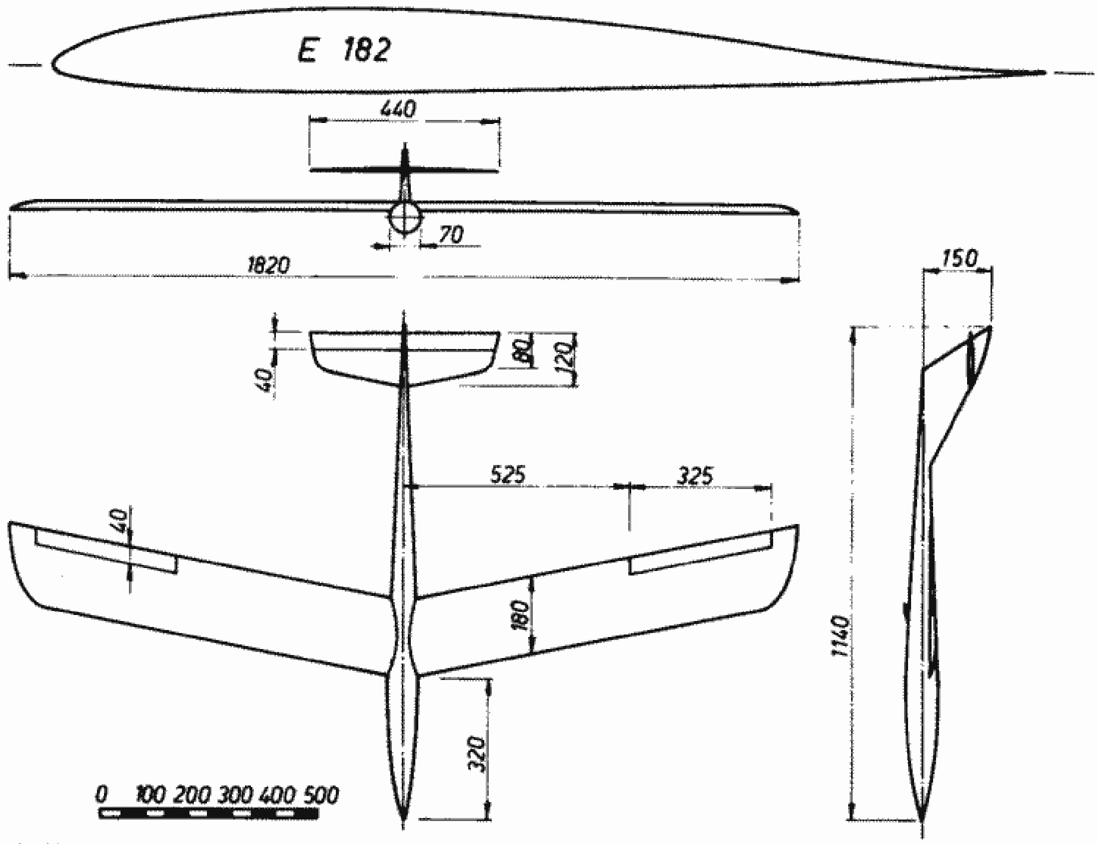
1	Italy	3780
2	Canada	3748
3	Korea	3722
4	U.S.S.R.	3716
5	Hungary	3700
6	U.S.A.	3682
7	C.S.S.R.	3662
8	U.K.	3661
9	Denmark	3660
10	Austria	3651
11	Yugoslavia	3646
12	W. Germany	3530


SIGALESEC-1
BY LUIS PARRAMON
FAI CLASS A SPEED 2.5
connector for exhaust
pressure bleed to tank
glass fibre cowl
tank
Rossi 15 and tuned pipe
SKETCH OF DOLLY
NOTE ASSYMETRIC LAYOUT
250
160
465
55mm airwheels
rubber bush
tube
tank lug between rubber bushes
fuselage
Silentbloc mounting for tank lugs
0.25 aluminium sheet around spruce spars
275
252
balsa
SCALE 1:4
note assymetric line up
278 to tip
pressure from pipe also fill tube
baffle
feed
125
45
20
15
10
3mm "kink" from parallel
16 at tip

AVION SPAIN

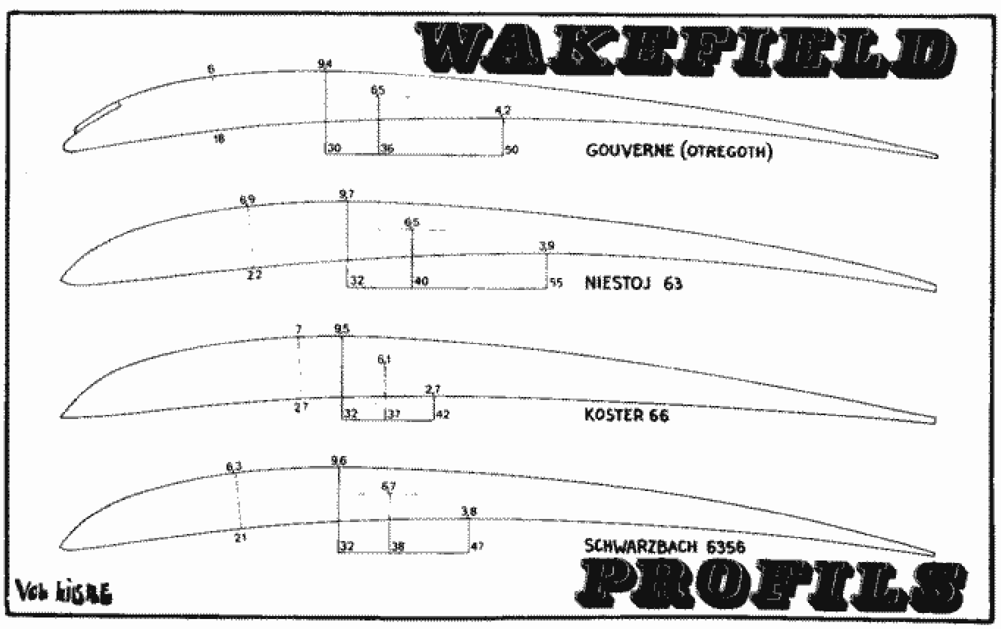


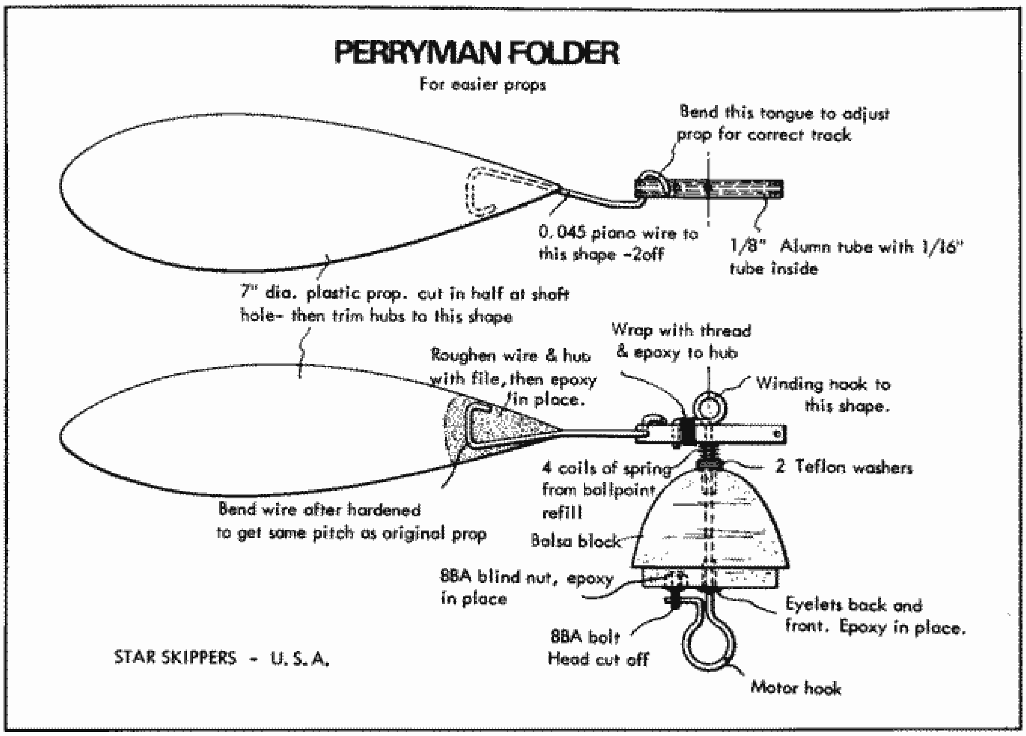
MODELE FRANCE



On May 29th, 1976 Werner Sitar (Austria) established a World Speed Record of 303 km./h. with the glider above. A later version with a 190×1802 wing achieved 390 km./h. The model is all glass fibre, formed in metal mould to highest standards. A straight wing version excelled in the 1977 European Soaring Championships at Oxford in August by winning the triple task event (Duration/Distance/Speed) against all "conventional" designs. It uses the Eppler 182 section.

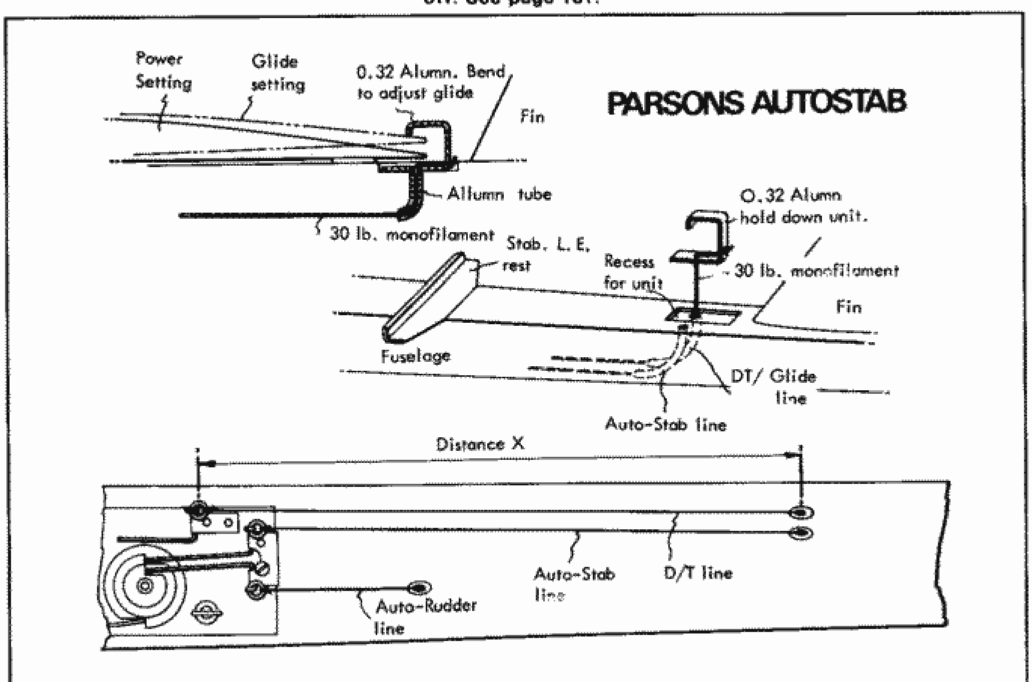
Below, a French analysis of Profiles for Wakefields from "Vol Libre".





George Perryman is one of those designers with a particular genius for producing top performance, even with small models for the novice. This use of a single blade from a plastic prop, to make a contest standard, folding unit is one we can really recommend.

Parson's Autostab (below) is a very simple means of obtaining v.i.t. (variable incidence tailplane) combined with dethermaliser release. The aluminium retaining U piece is held in place by tension of d/t line, released at 180 secs by the timer spiral. Auto-rudder and v.i.t. are simultaneous with engine shut-off. **See page 131.**



ENGINE RUN TIMING

Timing of engine runs becomes increasingly critical as the permitted duration decreases. The South Eastern Area Digest of Gen (*SEADOG*) published their views in conjunction with statistics from *Free Flight News*.

A brief summary of the problem involved in timing the engine leads to the analysis of the physical operation of engine run, as follows:

1. Decision to *start* watch.
   This can vary depending on the launch action and position of flyers hands on the model.
2. Reaction delay after taking decision to *start* watch. Human reaction delay is often quoted when stopping a watch; but rarely when starting it.
3. Decision to *stop* watch.
   As the only practical method available to determine the end of the run is the cessation of noise from the model. Considerable problems are involved, e.g.
   (a) delay due to human reaction
   (b) delay to wind speed
   (c) psychological factor dependent on rate of noise reduction at end of run
   (d) effectiveness of timekeeper's hearing
   (e) confusion due to more than one model being flown at once.

If the above points do not provide enough food for thought, then the results of a timekeeping experiment at the 1975 Spring two day F.A.I. meeting which was published in the June issue of FF news should stimulate.

A total of twenty-five timekeepers took part and three flyers.

At 8 secs. target:

	Under	*Correct*	*Over*
Flyer 1	35%	8%	57%
Flyer 2	38%	23%	39%
Flyer 3	24%	12%	64%
Average:	32.3%	14·3%	53·3%

At 6 secs. target: Flyers now reduced to 2.

	Under	*Correct*	*Over*
Flyer 1	15%	15%	70%
Flyer 2	26%	11%	63%
Average:	20·5%	13%	66·5%

At 4 secs. target: Flyers now reduced to 1.

	Under	*Correct*	*Over*
Flyer 2	39%	11%	50%
Average:	39%	11%	50%
Average overall times:	30·6%	12·8%	50·6%

The lesson is obvious: on these results the prospective flyer stands a 50:50 chance of being given an over-run.

Additionally it should be noted that at the 8 sec. run, the official timekeepers, who are included in the twenty-five in these results, gave the time as *under*; at the 6 sec. run, *over*; and the 4 sec. run, *under*.

Aeromodelling Magazines—June 1977

Adepte	16 Rue de l'Evangile, 75018 Paris, FRANCE.
Aeromodeller	13–35 Bridge Street, Hemel Hempstead, Herts., ENGLAND.
Aero Revue	Lidostrasse 5, 6006 Lucerne 15, SWITZERLAND.
Airborne	11 Cornwall Close, Gladstone Park 3043, AUSTRALIA.
Control Line Technique	Kinokuni Bldgs., 1–4–2 Ebesu-Minami, Shibuya-Ku, P.O.Code, 150, JAPAN
El Aeromodelo	San Antonio Maria Claret 47, Zaragoza, SPAIN.
Flaps	Zuniga 16, Valladolid, SPAIN.
Flug + Modell-Technik	D757 Iburgstrasse 38, Baden Baden, WEST GERMANY.
Flying Models	P.O. Box 700, Newton, New Jersey 07860, U.S.A.
Flyv	Romersgade, 19, Copenhagen 1362, DENMARK.
Hobby	Skolgrand 8A, P.O.Box 9185, 102 73 Stockholm 9, SWEDEN.
Hobby Bulletin	P.O.10, Bussum, NETHERLANDS.
Indoor News & Views	Box 545, Richardson, Texas 75081, U.S.A..
Indian Modeller	15 Shakespeare Sarassi, Calcutta 16, INDIA.
Ilmailu	Malmin Lentoasema 1, Helsinki, 70 FINLAND 00700.
La Conquette de L'Air	53 Avenue des Arts, Brussels 4, BELGIUM.
Le Modele Reduit D'Avion	12 Rue Mulet, 69001 Lyon, FRANCE.
Model Aeroplane Gazette	12 Slayleigh Avenue, Sheffield S10 3RB, ENGLAND.
Model Aviation	Academy Model Aeronautics, 815 Fifteenth Street N.W., Washington DC.20005, U.S.A..
Model Airplane News	1 North Broadway, White Plains, New York 10601, U.S.A..
Modelar	Jungmannova, 24, 11000 Praha 1, CZECHOSLOVAKIA.
Modelarz	ul Chocimska 14, Warsaw, POLAND.
Model Builder	621 West Nineteenth Street, Costa Mesa, Ca.92627, U.S.A..
Modele Magazine	15–17 Quai de l'Oise, 75019, Paris, FRANCE.
Modellflygnytte	Box 8044, 421-08 V Frolunde, SWEDEN.
Modelflynyt	Ålborggade 17, 4.th., 2100 København, DENMARK.
Modell	Postfach 1820, Klosterring 1, 733 Villingen, WEST GERMANY.
Modell Bau Heute	Storkower Str. 158, 1055 Berlin, EAST GERMANY.
Modellezes	H-1093 Budapest 1X, Szamuely, U.44, HUNGARY.
Modellistica	Borgo Pinti 99r., (Vincino via Giusti) 50121 Firenze, ITALY.
Modelli	Via Carnevali 68, 20158 Milan, ITALY.
Modelli and Sport	Via Cristoforo, Capone N 59–84100, Salerno, ITALY.
Modellismo	Corso Italia 8, Milan, ITALY.
National Free Flight Digest	1333 South Franklin Street, Denver, Colorado 80210, U.S.A..
Playmodel	Via Nemorense 90A, Rome, ITALY.
Radio Control Modeler	Box 487, Sierra Madre, California, U.S.A..
Radio Control Technique	Kinokuni Bldg., 1–4–2– Ebesu-Minami, Shibuya-Ku, P.O.Code 150, JAPAN.
Radio Modeller	High Street, Sunningdale, Berkshire, SL5 ONF, ENGLAND.
Radio Modelisme	21 Rue des Jeuneurs, Paris 2e, FRANCE.
RCM & E	13–35 Bridge Street, Hemel Hempstead, Herts., ENGLAND.
R/C Scale Modeler	Challenge Publications Inc., 7950 Deering Ave., Canoga Park, Ca. 91304, U.S.A.
R/C Sportsman	P.O. Box 11247, Reno, Nevada, 89520, U.S.A.
Scale Models	13–35 Bridge Street, Hemel Hempstead, Herts., ENGLAND.
Skrzydlata Polska	Ul Widok 8, Warsaw 10, POLAND.
Sport Modelismo	Rua Lidia Coelho 5, CX Postal 12235, Sao Paulo, BRAZIL.
Sea & Sky	Patrio Planning 1–22 Yothuya, Shin Jukuku, Tokyo, JAPAN.
Wings of Fatherland	Moscow B66, New Riadanskia 26, U.S.S.R.
Young Modeller	Moscow, A39, Suczewskaya Ul, 21. U.S.S.R.

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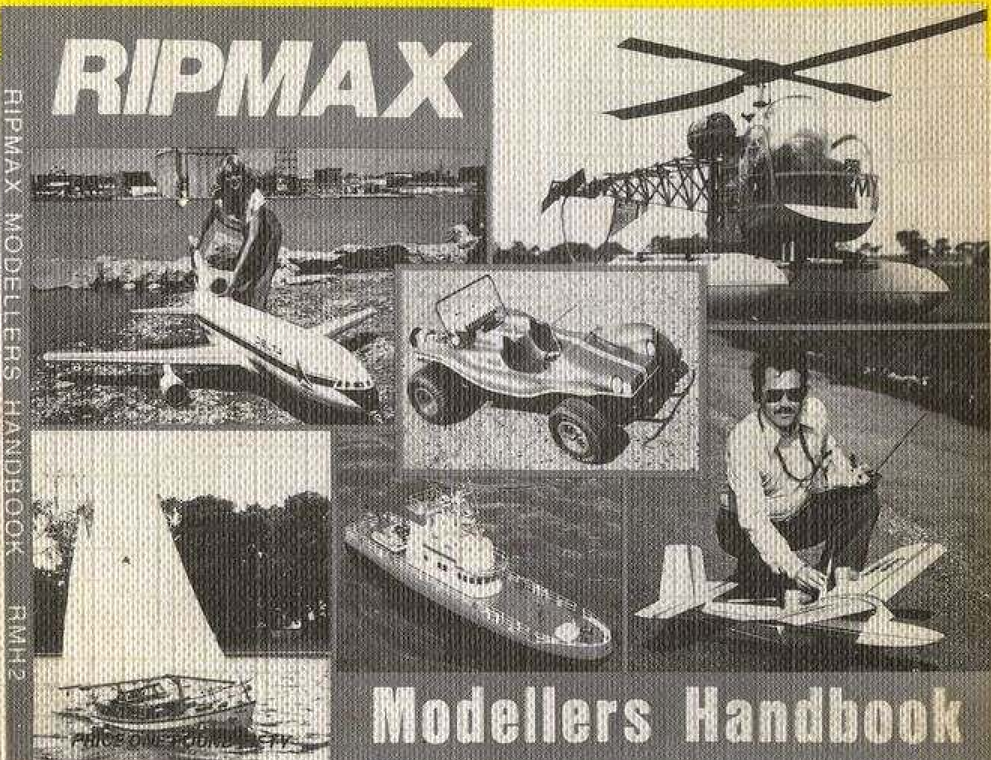

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