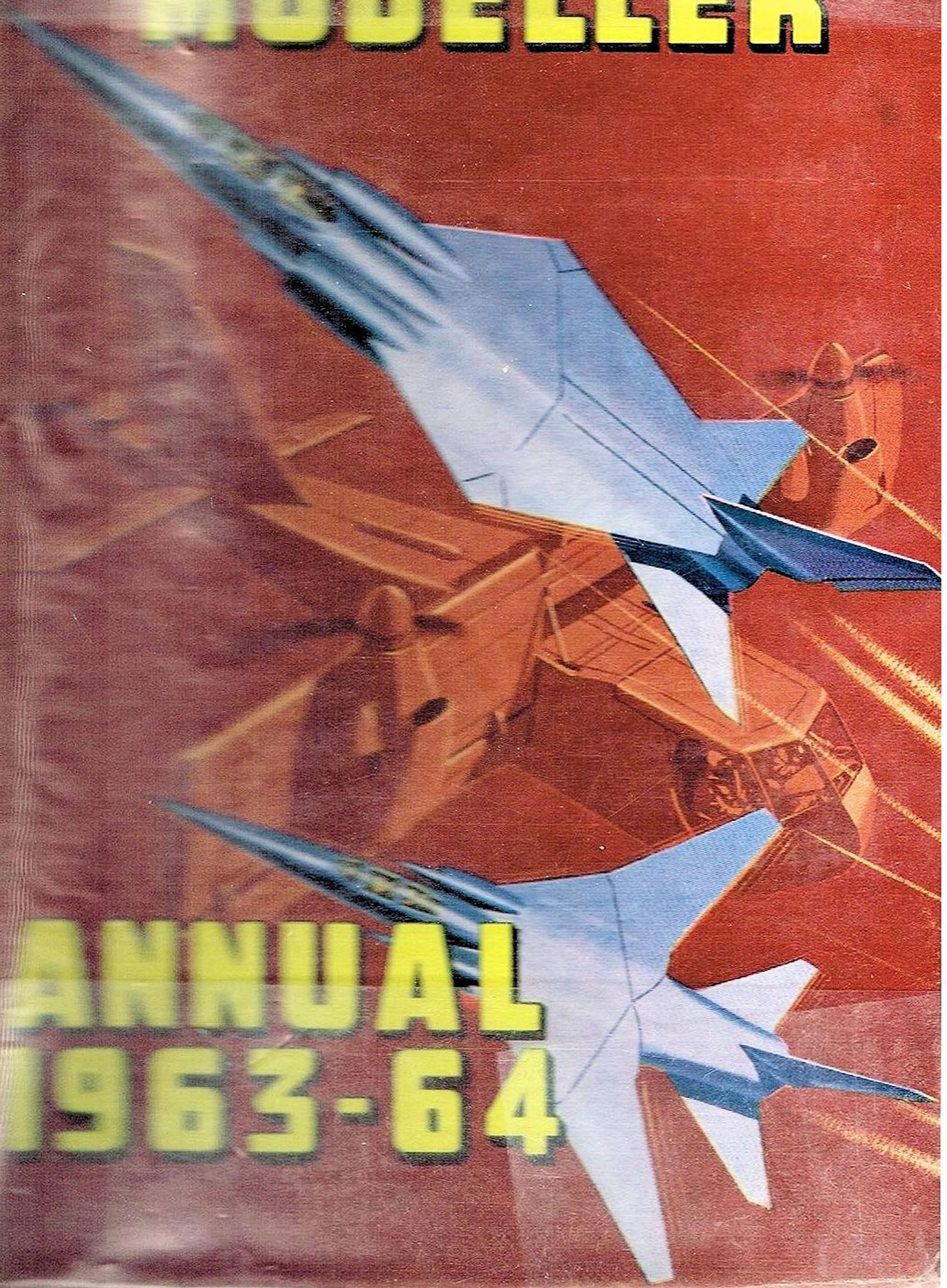
AERO MODELLER



ANNUAL 1963-64

AERO MODELLER ANNUAL 1963-64

AEROMODELLER ANNUAL 1963-64

THERE is nothing really quite like AEROMODELLER ANNUAL. We have a lot of fun preparing material for your perusal, which involves reading virtually every aeromodelling magazine and piece of literature that we know of, published anywhere in the world. We hope you will get equal pleasure from our selection which embraces models from most countries in Europe, France, Belgium, Germany, Finland, Italy, Czechoslovakia, Russia, many parts of the Commonwealth, New Zealand, Canada, and of course a good helping from the United States . . . these models are adequately dimensioned for anyone to build with a little skill and cover the whole gamut of aeromodelling, free flight power, scale, control line stunt, scale combat, team racing, gliders A/1 and A/2, radio control models, jetex, helicopter, Wakefields, in fact the lot . . .

Articles as ever try to strike a new note. Lead feature on use of Expanded Polystyrene will undoubtedly be popular, equalled only by our usual full-size article, this year on the latest trend towards movable wings—either "switch-blade" or incidence changing. Other articles cover airfoils, lightweight radio control, a terrific article on dry batteries, Glow Plugs, Melinex covering, Unnecessary weight, "Power Rudder", Engine Care, Contest Results international and British, Engine Analysis, F.A.I. Records, a really nice mixture for everyone to find something to his taste.

Cover painting is by Laurie Bagley, and depicts two of the moving wings type of aeroplane which we may soon be seeing aloft in both full-size and model form.

Since 1948 AEROMODELLER ANNUAL has come to brighten the aeromodellers' year . . . add this to your collection or make it number one on the shelf . . . we shall be back next year.

A MODEL AERONAUTICAL PRESS PRODUCTION

Publishers of
AEROMODELLER

10/6

AEROMODELLER ANNUAL 1963-64

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

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

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1963

AEROMODELLER ANNUAL 1963-64

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

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INTRODUCTION

NEITHER a vintage year on account of weather or surprising new developments in the model field, 1963 has, nevertheless provided its quota of incident. Our Nationals, held once more, after some eve of contest alarms, at Barkston Heath, enjoyed their usual increasing attendance—though alas a record supply of wind marred what could have been an outstanding long weekend. On the personal side, aeromodelling suffered a great and quite unexpected bereavement in the death of Stan Rushbrooke in January. As a personal friend, colleague, and aeromodelling stalwart of nearly a lifetime, his place will never quite be filled. World tributes testified to the high regard he enjoyed everywhere, and there is no doubt that his beneficial influence will leave a lasting mark on the aeromodelling scene.

Most notable aspect of full-size aeronautics of recent months has been the growing preoccupation with moving wing aircraft, as opposed to helicopters. Switchblade methods have been devised to enjoy changes of aspect ratio and wing area in flight, or the whole wing can adjust its incidence for varying needs. Our cover picture—by Laurie Bagley as usual—depicts two approaches to this latest notion. So far fullsize is ahead of model development in this field. We hope we have provided enough material to encourage a number of enthusiasts to try their hand at one or other of the methods outlined. On the face of it, a model solution to the problem, perhaps with r/c installed, appears simpler than that of the model helicopter, which cannot yet claim to be thoroughly mastered.

Model kit manufacturers after some hesitation have begun to embrace expanded polystyrene as a building material. Unfortunately, the lead has come from continental and American producers . . . our own British manufacturers are still uncertain. However, it will become more and more the used thing for those special parts it suits so well, and we must remember the long period of resistance to balsa (such a long time ago now!) Anyway our article on its use should enable many keen experimenters to evaluate the medium for themselves. Another new material, of course, is Melinex, also featured in this volume.

Radio control developments have simply galloped ahead this year. We are happy to welcome a number of new manufacturers, and to see the consolidation of one or two older established firms, who have now become an accepted part of the modelling pattern. Smaller, better, lighter equipment has vied with cleverer more elaborate outfits at the other end of the scale. For the first time in British radio control history we can truly say, in the words of the old song, "you pays yer money and yer takes yer choice."

Flying fields still represent a problem. The Model Trade Federation is endeavouring to advise clubs on the procedure for obtaining local authority assistance in this matter, but this is only scratching at the surface. More thought must be given by manufacturers to efficient and acceptable silencing systems which will take the nuisance angle out of powered flying, and make the aeromodeller an accepted member of the community everywhere. We have said this year after year—it is only sinking in very slowly—but the whole future of urban model flying is dependent upon it!

With this volume we are joined in compilation and editorship of AEROMODELLER ANNUAL by Ron Moulton, on the principle that two heads are better than one (and two pairs of shoulders to share the load). We hope you like the mixture as well as last year, but in any event please help us in the future by your comments, friendly or critical.

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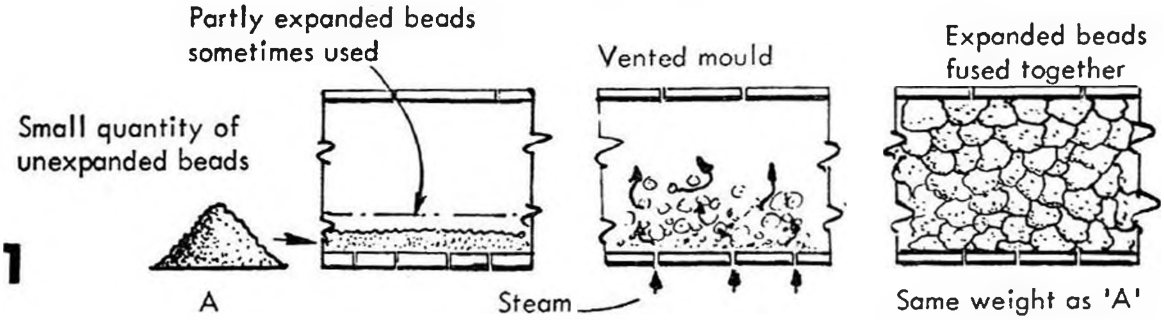


MODELLING IN EXPANDED POLYSTYRENE

UNTIL now there have been comparatively few new constructional systems used in model aeroplanes. Expanded polystyrene, however, is rapidly becoming an interesting additional modellers' material. We first heard of expanded polystyrene from the United States where a number of enterprising modellers had carved wing sections from it, using a hot wire. Today, a well known German manufacturer actually moulds complete models from the material using a much coarser density and consequently heavier version of similar mixture.

What is it?

Expanded polystyrene is produced by heating polystyrene beads which contain a volatile expanding agent. The small beads used in this system, will be treated in the following manner: when heat, 90—100°C. usually supplied by passing steam through the beads, reaches the mixture the beads tend to expand rather like pop corn. Now imagine making a heated mould and part filling it with "pop corn"; as the temperature rises so the corn "pops" filling the mould. A much lighter density material results, in fact no heavier than the small quantity of "pop corn" which was originally placed in the mould.

Expandable polystyrene beads behave in a very similar manner; however, it is necessary to what we call pre-expand the beads first. This means a more even filling of the mould results when the beads are finally expanded to their full-size. The structure of expanded polystyrene is therefore a collection of cellular bubbles, that is to say, each bubble is full of a number of smaller bubbles each, of course, surrounded by a minute skin of polystyrene. There is a certain "stickiness" during this expanding process which causes the individual bubbles to adhere to each other and the main bubbles in a like manner (see Fig. 1).

When the mould becomes completely filled as the material expands, the bubbles are squeezed flat against the sides of the mould and allow the polystyrene itself to follow the mould shape accurately. There are one or two difficulties which lie in wait for the modeller attempting to produce a model by this method; not the least being the difficulty of producing steam at the correct temperature and in the required volume, furthermore, the mould has to be carefully designed and vented in such a way that excess steam may escape without permitting the expanding beads to clog such outlets.

We will therefore deal with the more "orthodox modeller's" idea of making pieces of sheet or block polystyrene into components to be used in model aircraft.

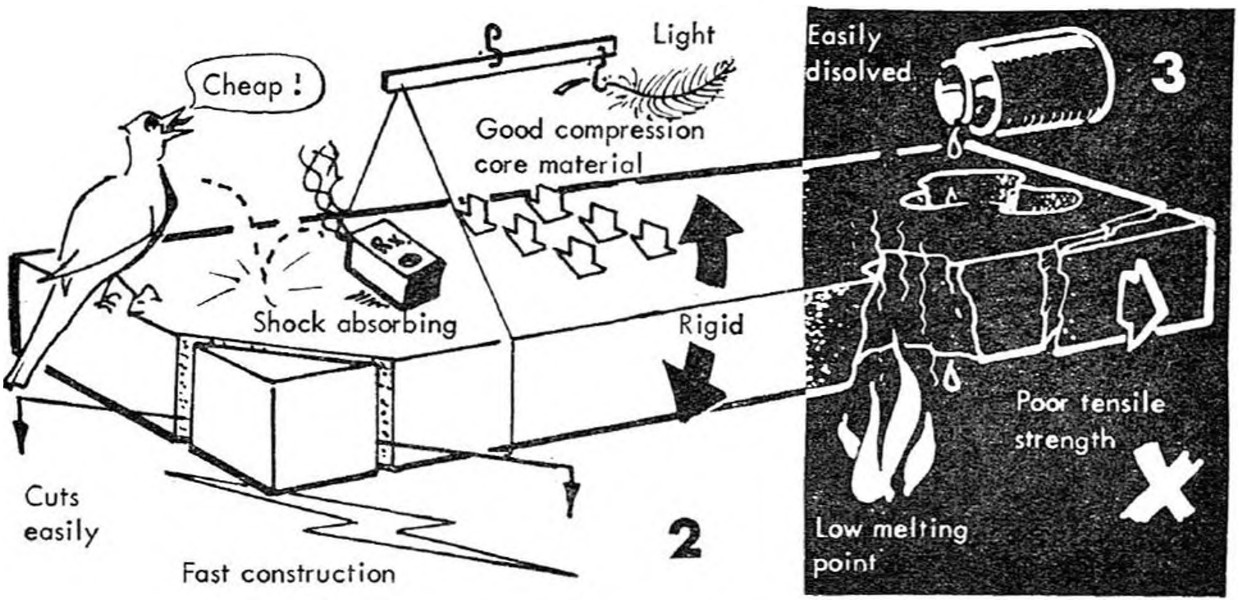
General Characteristics

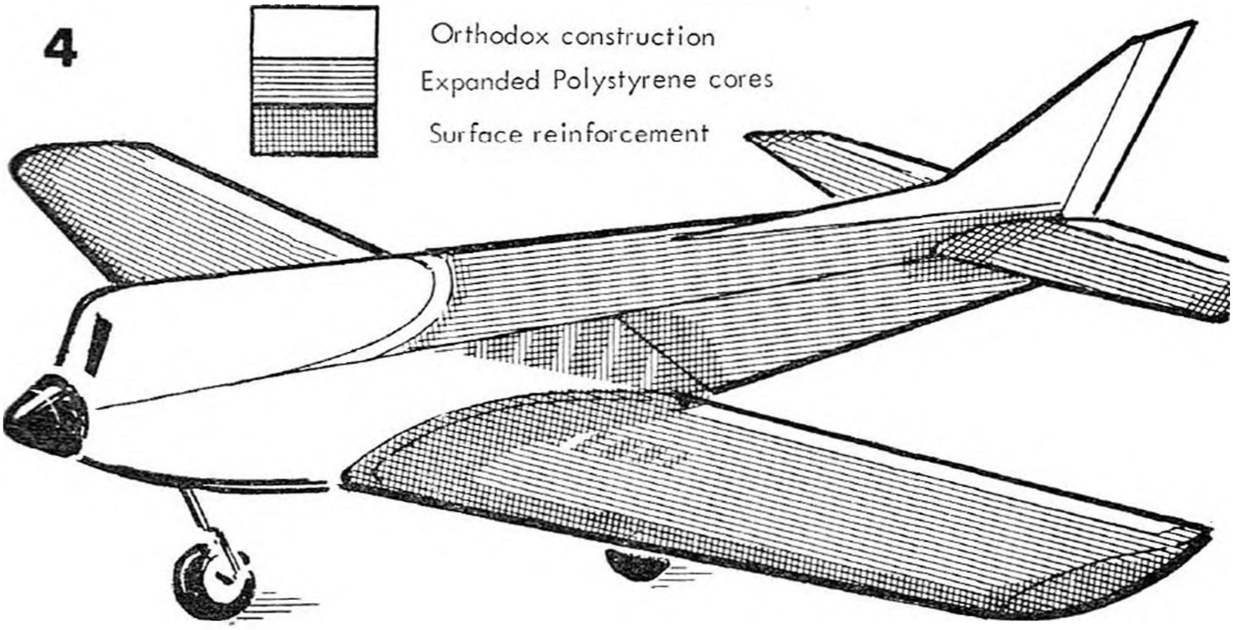
First and foremost, the most interesting thing about expanded polystyrene sheet is its extremely light weight. In fact it is considerably lighter than the softest balsa wood and, when suitably used in an orthodox piece of model construction tends to be slightly stronger for a given weight. We will not say that expanded polystyrene is actually stronger than balsa because it is likely to become damaged more readily than its wood counterpart. That is to say, being grainless, it needs to have a certain amount of reinforcement in order to give it directional stability. This directional stability is, of course, one of the natural features of wood and is employed in plywood for bi-directional strength. In plain balsa wood as a longitudinal rigidity, but low lateral rigidity. Slightly more rigidity is found in quarter grain sheet. Expanded polystyrene is not very strong in tensile loads but it will, however, when carefully cut and sensibly reinforced, stand considerable compressive loads. The solid type of construction is the most natural choice for this type of material and one treats it merely as a space filler, continuous web/continuous rib type of construction. Some time ago honeycomb structures were mentioned in *Aeromodeller*. These were skinned with balsa wood and provided an extremely rigid, warp-free, and crush-resistant piece of construction. The weight of such a component was, however, heavier than the normal balsa equivalent due to the fact that the honeycomb was made of brown paper and the density was slightly higher than the orthodox rib and spar arrangement.

Expanded polystyrene being a much lower density lends itself rather better to the construction of model aeroplanes.

What are the advantages? Fig. 2

1. Extremely light.
2. Very fast construction.
3. Reasonably cheap.
4. Smooth surfaces obtainable.
5. Adapts itself to use with other material.





Disadvantages

Fig. 3

1. Susceptible to attack by fuel, some adhesives, cellulose, and excess heat.

This may seem a rather alarming list of failures. However, the problem is not insurmountable and the chief difficulty, that of attack by fuel, can be overcome quite easily by using a suitable covering and designing the structure in such a way that it does not fatigue and allow the ingress of fuel beneath such a protective surface.

Where to use it

Basically a model aeroplane can make use of expanded polystyrene structures most advantageously on the flying surfaces, although some models have been seen with fuselages and even detail carried out in this material. For the purposes of radio controlled models, however, an all-polystyrene fuselage is not a particularly good idea in view of the fact that so much internal space is required at the point where most of the loads occur. Aft of the trailing edge of the wing, however, it is quite a feasible proposition to have an almost solid polystyrene tail boom. Push rods or even nylon cords on the lighter models have no difficulty in passing through the material providing a way has been cleared for them with a suitable tool. However, perhaps the best arrangement for a fuselage is that of a ply and balsa front end with a polystyrene tail boom. Polystyrene wings may be suitably reinforced with ply and balsa at the centre sections and any points where rubbing is likely to occur, i.e. leading edge and wing tips. Providing a thick tail section is chosen there is very little to prevent one using the material for this purpose as well (see Fig. 4).

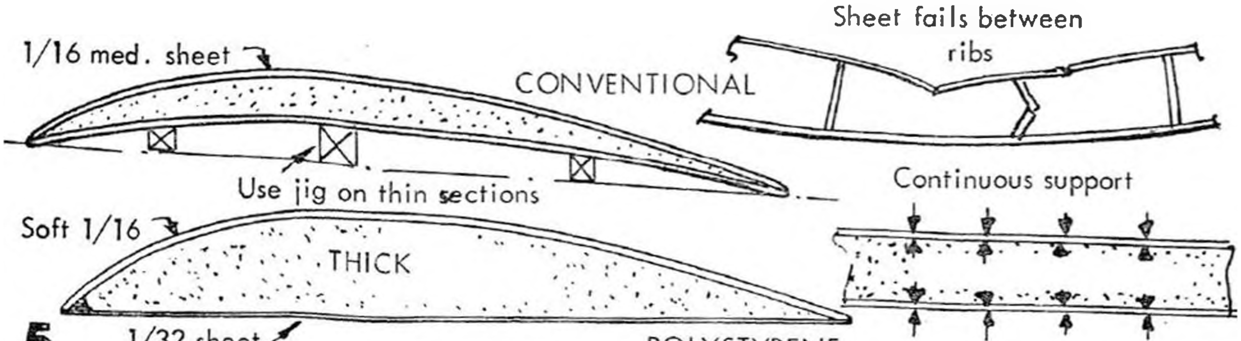
One should avoid going "polystyrene mad" and making the entire model so light and consequently structurally weak in certain areas by putting all one's faith in the material itself. It should be remembered that expanded polystyrene is really a filler and such structural strength as may be needed must be in the form of load bearing skins.

It is up to the designer of the model to decide whether these skins shall be thin high tensile membranes, allowing the polystyrene to take the compressive loads which it does admirably in certain circumstances, or whether he will employ fairly orthodox construction by having both compressive and tensile skins and relying on the expanded polystyrene to merely act as a core to resist crushing and support the skins against buckling locally. Such a structure is extremely strong and is easily made by covering the entire polystyrene core with sheet balsa of quite thin or light stock. Alternatively, spars may be used with covering in an even lighter material such as Melinex or one of the tracing films such as "Permatrace".

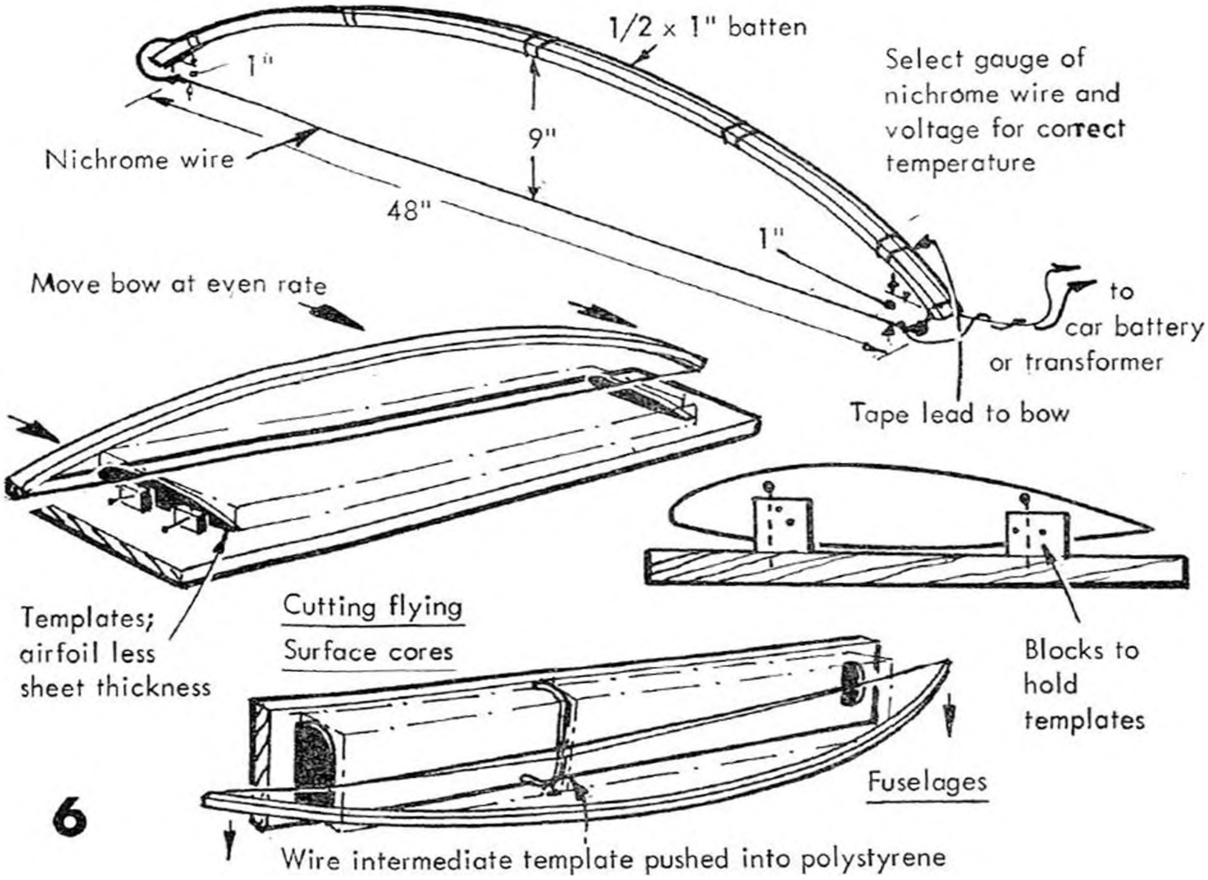
There are economy measures such as using perfectly ordinary brown paper, yes, just brown paper and glue. it looks rather like a home handyman's do-it-yourself article doesn't it? Simply form the polystyrene to the shape you need, slap on the glue, cover it with pre-glued brown paper, seal the edges with gum strip, if you like, add a coat of emulsion paint, this has no effect on the polystyrene as it has a water base, then dope and fuel-proof in the normal way. Fig. 5 shows some typical systems. Now for a little more detail.

How to form Polystyrene

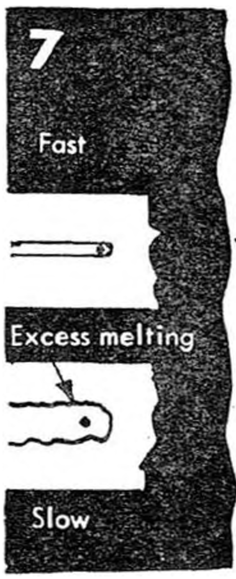
The basic tools are simple and inexpensive. The recognised way of cutting the material is by means of a heated wire. All one has to do to produce such a tool is to take a length of Nichrome wire and stretch it tightly on a suitable batten of wood say 1 in. by ½ in. The batten should be about 4 feet long and bent just like a bow. The ends of the wire are connected with flex to a suitable power source such as a model railway transformer (see Fig. 6). The author uses a 20 volt. Hornby railway transformer which once served a gauge 0 layout. This provides just the right amount of power to heat a piece of wire from an old electric fire element. The wire should not be red hot, in fact, one should be able to touch it without getting burnt. Do not hold your fingers on too long, however, as you may have a tender skin! The actual test of the correct temperature is carried out by resting the wire on the expanded polystyrene and increasing the voltage or putting a variable resistance in series with the wire so it may be gradually brought up to the right temperature to *just start* melting the material. Excess heat is most harmful; it melts the polystyrene far too quickly and causes uneven cutting, as shown in Fig. 7. In use, a jig is made up with balsa or plywood end ribs and a board. The polystyrene is roughly cut to shape, dropped between the ribs, and the hot wire drawn smartly from leading edge to trailing edge pressing it against the rib sections. Perfectly straight tapered wing or parallel chord, should result. For extremely sharply tapered wings it is advisable, although not essential, to make a special "winding jig" as shown in Fig. 8, which permits a smooth movement of both root and tip ends of the wire. Earlier tests in cutting sharply tapered wings showed that if the tip was cut at the same speed as the root the wire came out of the trailing edge too soon and a wavy trailing edge resulted. If, however, one tried to reduce the speed of cutting at the tip while concentrating on the root end the tip tended to move at an uneven rate; this caused, even with the correct temperature of wire, an uneven cutting due to the fact that the polystyrene was rather "over-cooked" at the tip and excess melting had the effect of producing ridges in the surface (Fig. 9). This is not so important if the wing is to be covered with balsa

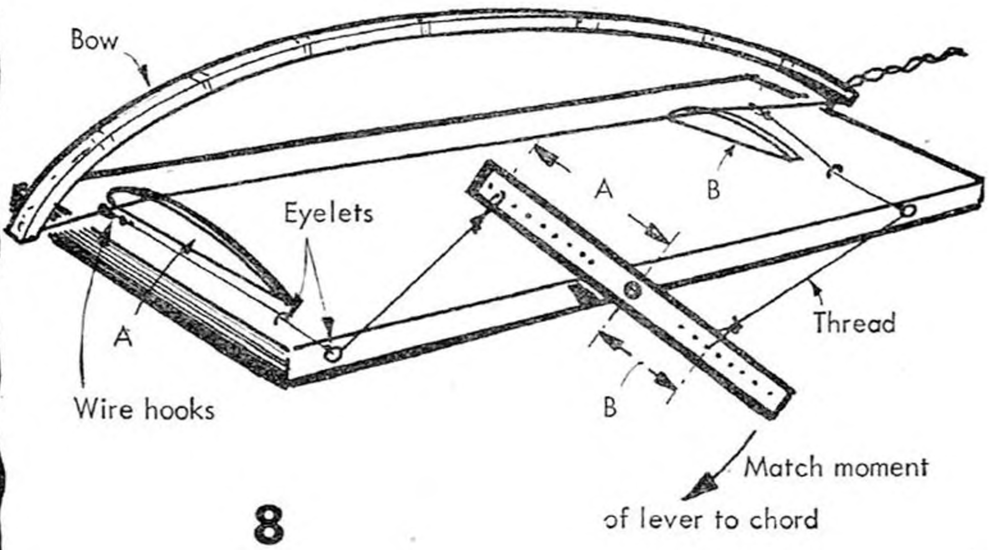

1/16 med. sheet
CONVENTIONAL
Use jig on thin sections
Soft 1/16
THICK
1/32 sheet
POLYSTYRENE
Sheet fails between ribs
Continuous support

5

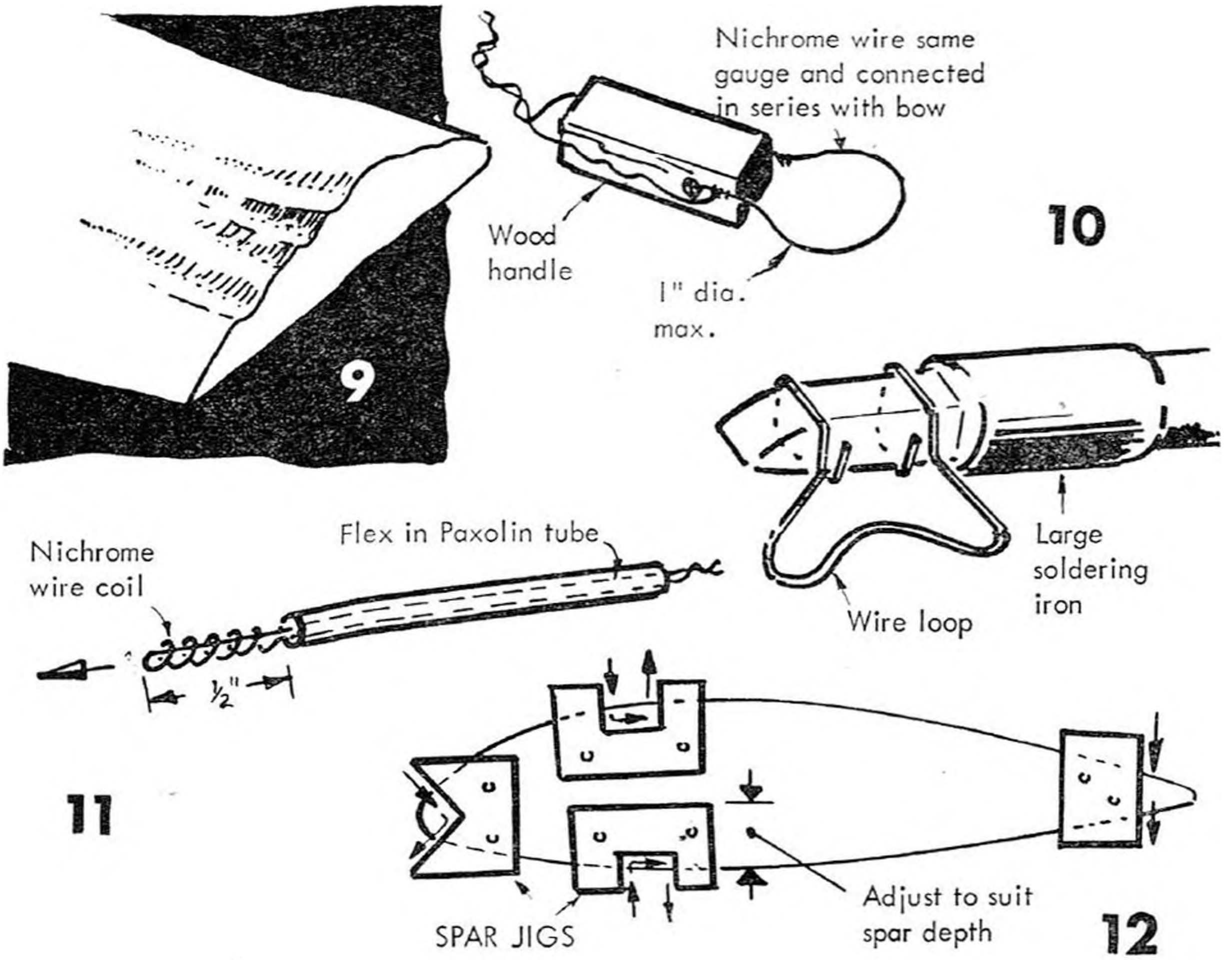

1/2 x 1" batten
1"
9"
Nichrome wire
48"
1"
Select gauge of nichrome wire and voltage for correct temperature
to car battery or transformer
Tape lead to bow
Move bow at even rate
Templates; airfoil less sheet thickness
Cutting flying Surface cores
Blocks to hold templates
Fuselages
Wire intermediate template pushed into polystyrene

6


7
Fast
Excess melting
Slow


Bow
Eyelets
A
B
A
Thread
Wire hooks
B
Match moment of lever to chord

8



but in this particular case it was a brown paper and glue job. Many other forms may be cut using this bow and wire technique. However, a soldering iron with a loop of piano wire clamped to the bit will do. It is better to use a large electric soldering iron rather than the instrument variety in order to obtain sufficient saturation of the wire (Fig. 10). One may then bend the wire (cool please!) and cut more intricate shapes in small areas by hand when using this method, in fact the author has experimented with this technique for sculpture. Holes may be drilled by passing a hot wire straight down into the material; if the hole is an exceptionally long one it is advisable to insulate most of the length of the wire with either a hard plastic sheath allowing the bare end only to be heated, this avoids excess burning of the polystyrene at the upper end of the hole (Fig. 11). Such an application is used to make control runs down a fuselage. Grooves for spars, leading or trailing edges, are easily made by pinning small sub jigs to the ends of the finished wing unit as shown in Fig. 12. Insert the wire on its bow in these jigs, give quick flick of the wrist and out comes a piece of expanded polystyrene the shape of the spar, leaving a perfectly tight-fitting groove for the balsa or hardwood.

Adhesives

Unfortunately the more popular cellulose adhesives are definitely out. Expanded polystyrene just gives up as soon as it gets a whiff of cellulose, dissolving into a pulpy mess. A water-base adhesive is the easier to use. Le-Page's white glue is a cheap and quickly applied example. Alternatively some of the "tacky" air drying glues such as Seccotine or ordinary household pearl glue may be used, although the latter tends to be a little brittle. Cascamite is another good adhesive for this purpose. It rather depends on what you want to glue to the polystyrene. The author favours P.V.A. white glue for sticking polystyrene to itself. Covering may be attached with Polycell paste or thinned down pearl glue. The advantage of this system is that it forms an impervious skin underneath the covering and protects the polystyrene from the action of subsequent proofing coats. It must be remembered that a paint or varnish which is proof against fuel, may dissolve the polystyrene which it is trying to protect. Therefore a coat of emulsion paint makes doubly sure that no such tragedy shall occur.

Let us take a simple example of a typical wing for a sport radio model as shown in Fig. 13. First cut the expanded polystyrene as previously described, a matter of a few minutes in fact. Slot the root end to take a plywood dihedral brace and groove the leading edge and top and bottom for spars. Insert tapered balsa spars and leading edge and cover with either very soft $\frac{1}{16}$ in. balsa or with a wider spar, brown paper. The brown paper should be free from wrinkles and provides a nice smooth surface on which to apply the finish. Lap-joints, in the paper can be accommodated underneath and on a small wing (about 48 in. span) it is possible to cover each half wing in one piece lapping it over the leading edge and joining it just inboard of the trailing edge on the under side. Avoid sharp edges on expanded polystyrene structures. It does not matter if a trailing edge is as much as $\frac{1}{8}$ in. thick providing it is rounded.

Occasional knocks and dents do very little harm to the structure as the brown paper is unlikely to be pierced by such damage. Where excessive wear is likely to occur such as the centre section and wing tips it is advisable to cover over the brown paper with bandage, silk or even glass fibre cloth and an application of glass fibre resin. Further covering of paper or silk may then be applied before finishing with emulsion paint and dope or fuel proofer.

A few models built with expanded Polystyrene

First something for beginners: An indoor flier

Real economy in this first model; just one sheet Kotina under-wallpaper expanded polystyrene sheet makes about half a dozen of these little models, the price; about 6*d*. each!

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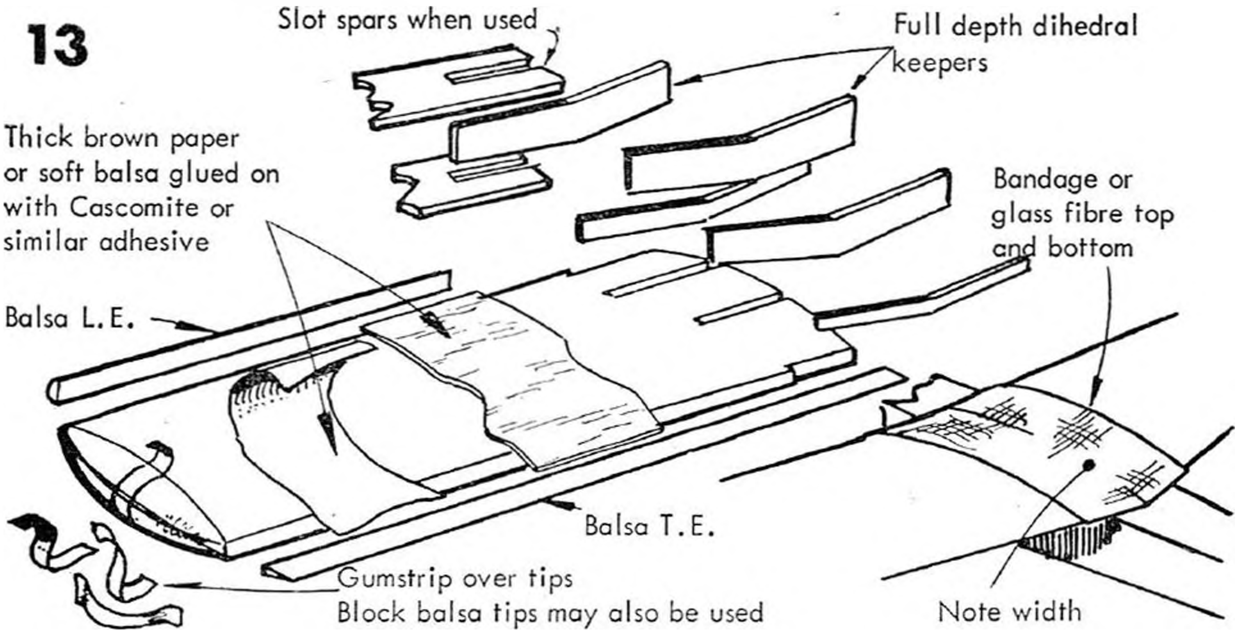


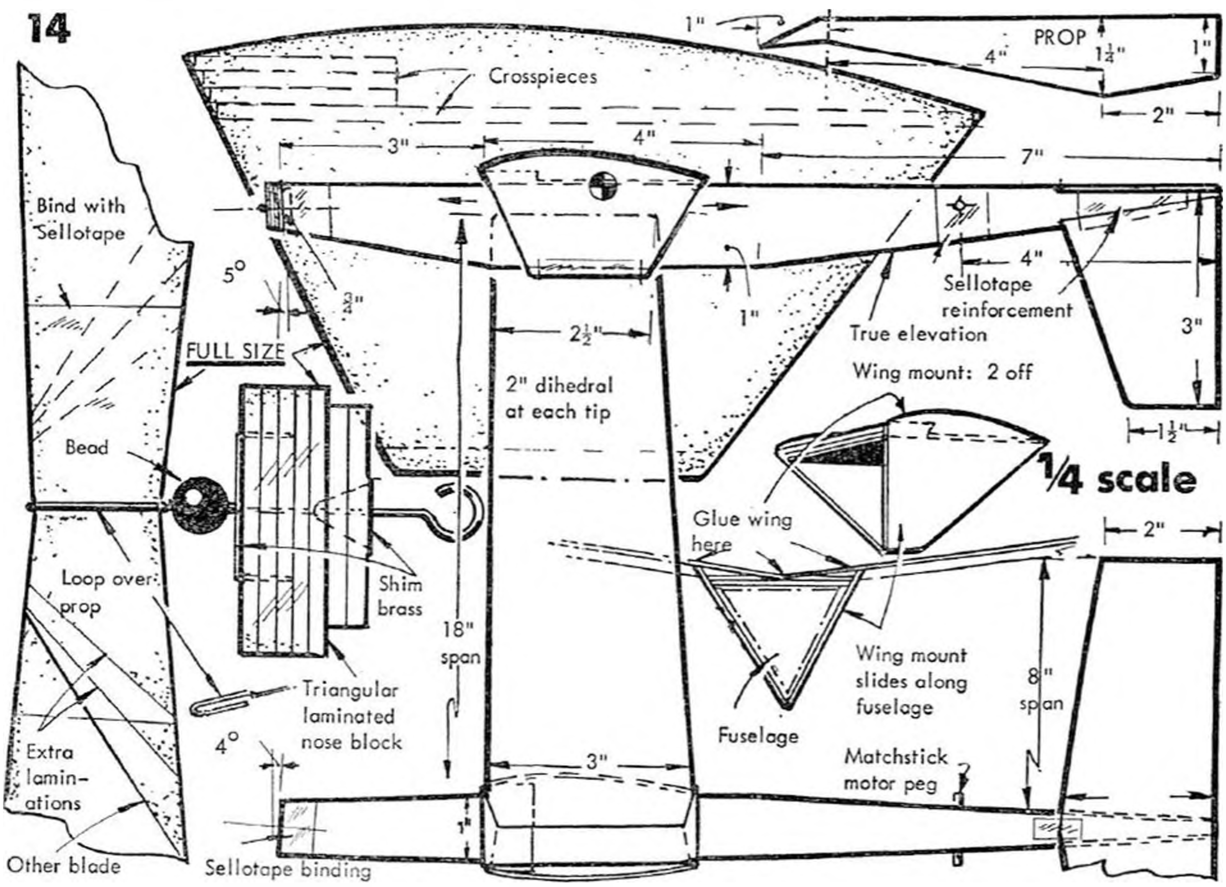
Orthodox sheet balsa type of construction is used here, the expanded polystyrene sheet is sufficiently thin to permit cutting with razor blade or even scissors. Cut out the wing and tail panels and join them with P.V.A. white glue. You will find this glue takes rather longer to set with expanded polystyrene than in an orthodox wood joint. Do not hurry, however, the whole model will fall apart if you are too hasty. Even Sellotape may be used to add reinforcement to some of the joints. The fuselage is made from three panels of the same material and the nose block from four or five layers covered in Sellotape to resist wear. A binding of Sellotape round the nose prevents the material from wearing as the rubber motor is wound. Study the full-size and reduced view in Fig. 14, even the prop. is made from expanded polystyrene warped by placing round a hot tube. Just rest it on the radiator and twist, ours was produced on a studio oil stove. Excess heat will cause the material to shrivel, so care is necessary here. The prop. shaft should be a piece of thinnest piano wire you can obtain, 28 gauge for instance, passed through a couple of scraps of brass shim or a piece of aluminium tube in the nose block. A bead forms a bearing to absorb some of the thrust of the mighty rubber band which provides the power! Three thin bands should provide sufficient urge when looped together in "series".

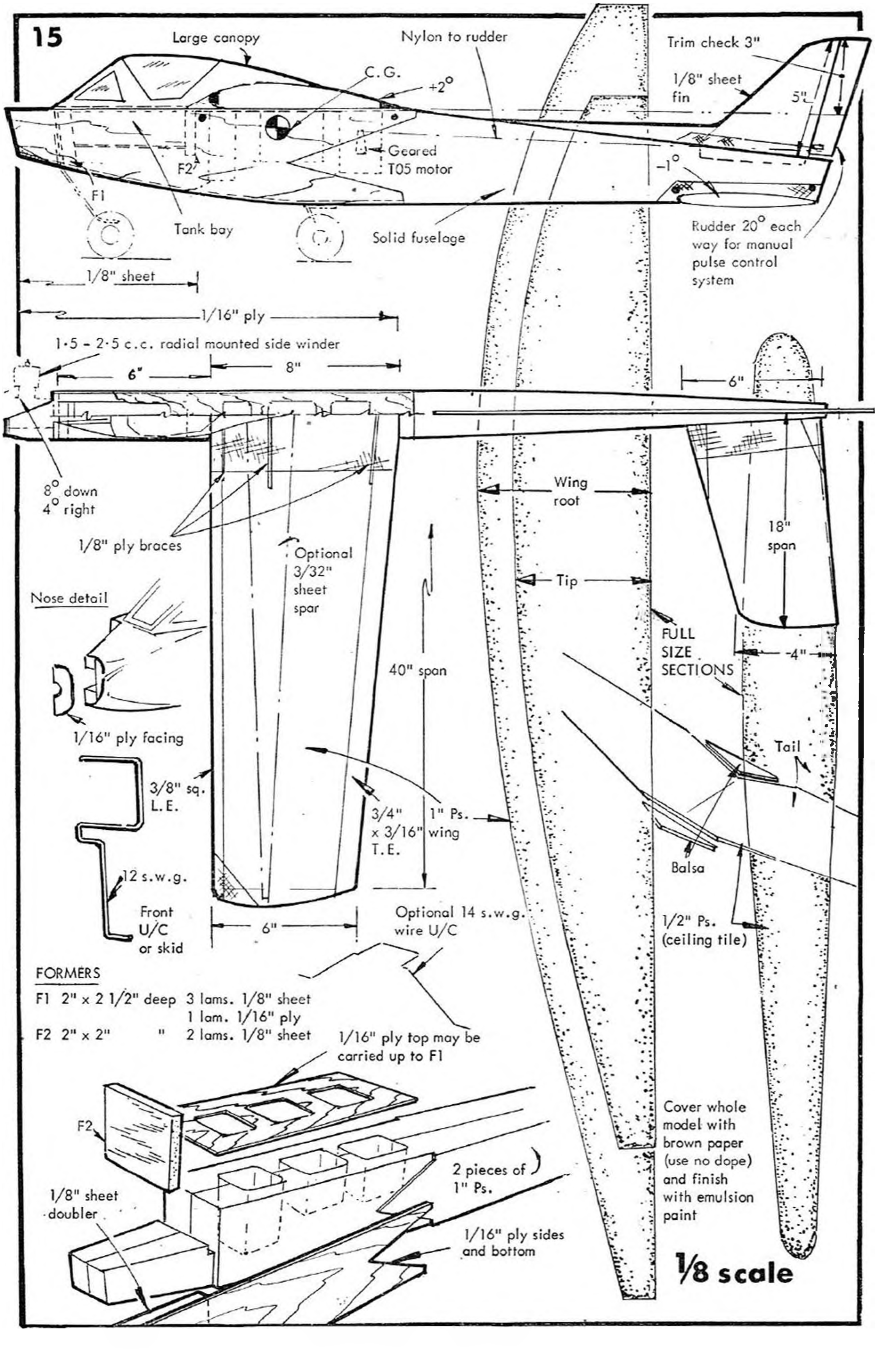
Trimming is hardly necessary, just warp the surfaces slightly, when necessary. The wing mount will slide along the fuselage till the G.C. comes in the correct position. The completed model should weigh about ⅛ oz. or even less.

Now a sport free flight or single channel radio model

All the constructional forms previously mentioned have been employed and it is only necessary to draw route and tip rib templates in order to produce the wing. Everything else should be self explanatory from Fig. 14.

14




15
Large canopy
Nylon to rudder
Trim check 3"
C. G.
+2°
1/8" sheet fin
5"
Geared T05 motor
-1°
F1
F2
Tank bay
Solid fuselage
Rudder 20° each way for manual pulse control system
1/8" sheet
1/16" ply
1·5 - 2·5 c.c. radial mounted side winder
6"
8"
6"
8° down
4° right
1/8" ply braces
Optional 3/32" sheet spar
Wing root
Tip
18" span
Nose detail
FULL SIZE SECTIONS
4"
40" span
1/16" ply facing
Tail
3/8" sq. L.E.
3/4" x 3/16" T.E.
1" Ps. wing
Balsa
12 s.w.g.
Front U/C or skid
6"
Optional 14 s.w.g. wire U/C
1/2" Ps. (ceiling tile)
FORMERS
F1 2" x 2 1/2" deep 3 lams. 1/8" sheet
1 lam. 1/16" ply
F2 2" x 2" " 2 lams. 1/8" sheet
1/16" ply top may be carried up to F1
F2
Cover whole model with brown paper (use no dope) and finish with emulsion paint
2 pieces of 1" Ps.
1/8" sheet doubler
1/16" ply sides and bottom
1/8 scale

Larger and more heavily laden models, including multi radio models, sometimes need a little extra structural reinforcement to enable them to withstand the extremely high flight loads which occur in some stunt manoeuvres. Furthermore such models tend to have a much higher number of airborne hours on their log than their free flight counterparts.

We shall therefore consider the best ways of preserving the model constructed in this manner, Fig. 14 shows the "danger areas".

1. Make sure that there are no sharp edges to become grounded or dented.

2. Reinforce all rubbing surfaces and doubly reinforce such rubbing surfaces where they are in the slip stream.

3. All undersurfaces should be treated with an extra strong covering and ply reinforcements where they are likely to make contact with the runway intentionally or otherwise.

4. Keep the expanded polystyrene well away from fuel tank areas or silencers (which get pretty hot).

5. Areas which receive excess handling such as might be encountered in hand-launching or just general carrying around and "fumbling" areas should be reinforced across the inside of the structure by means of extra webs of the harder material and the surfaces in those regions covered with a load spreading surface such as $\frac{1}{32}$ in. ply and well protected against fuel.

6. Even balsa fuselages tend to get a little tatty with much handling and squeezing. And it only needs a little fuel inside to make the model fold up in the middle of a flight.

7. Surprisingly enough the models we have seen with expanded polystyrene wings seem to last as long as their balsa and silk covered counterparts and unless they receive a very severe prang could be considered as their equal.

8. On the advantage side, however, it is possible to produce many wings and tail surfaces at one session for a lower price than the more orthodox system and the advent of strip ailerons makes construction a lot easier in this case.

9. Modifications are easily carried out simply by sawing out any sections which require changing and gluing in new pieces with the appropriate adhesive which takes readily to the large areas which are then exposed. That is one of the advantages of the material in that there is always plenty of surface on which to work.

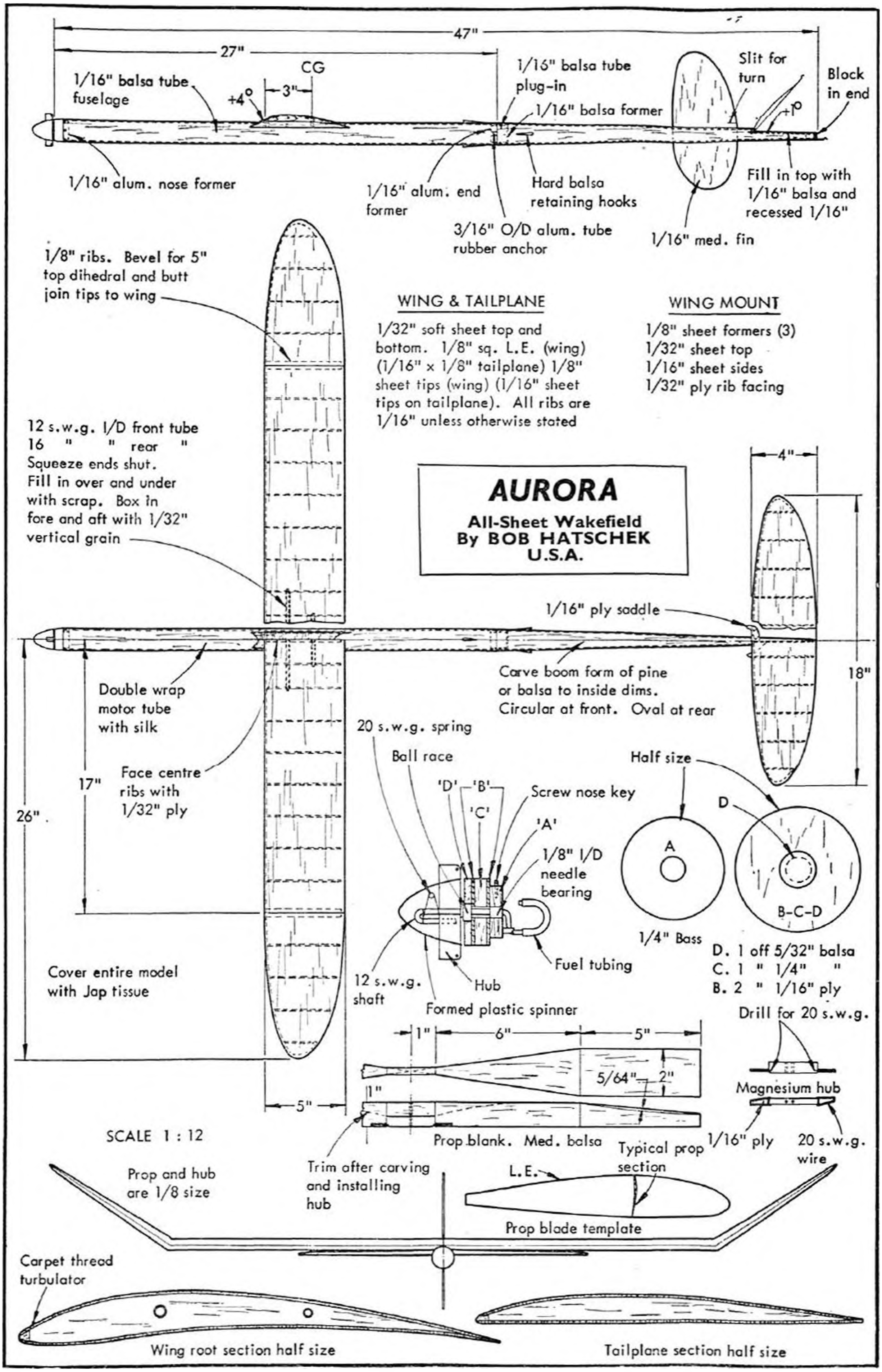
Sizes: Basic sheets of $\frac{1}{2}$ in., 1 in., $1\frac{1}{2}$ in. and 2 in. thickness, 8 ft. × 6 ft. and 4 ft. × 8 ft. Some manufacturers sell thicker but small offcuts.

Source of Supply: Some builder's merchants and a few "Do-it-yourself" suppliers. Messrs. Jablite also supply single sheets direct, within reasonable distance.

Price: Price varies with manufacturer and density of material; example, 1 in. thick 8 ft. × 4 ft. sheet cost £3 from a builder's merchant.

Conclusion: With careful cutting, an 8 ft. × 4 ft. sheet should provide sufficient material for about five R/C wing cores approximately "Orion" size, and offcuts may be glued together if you are thrifty.

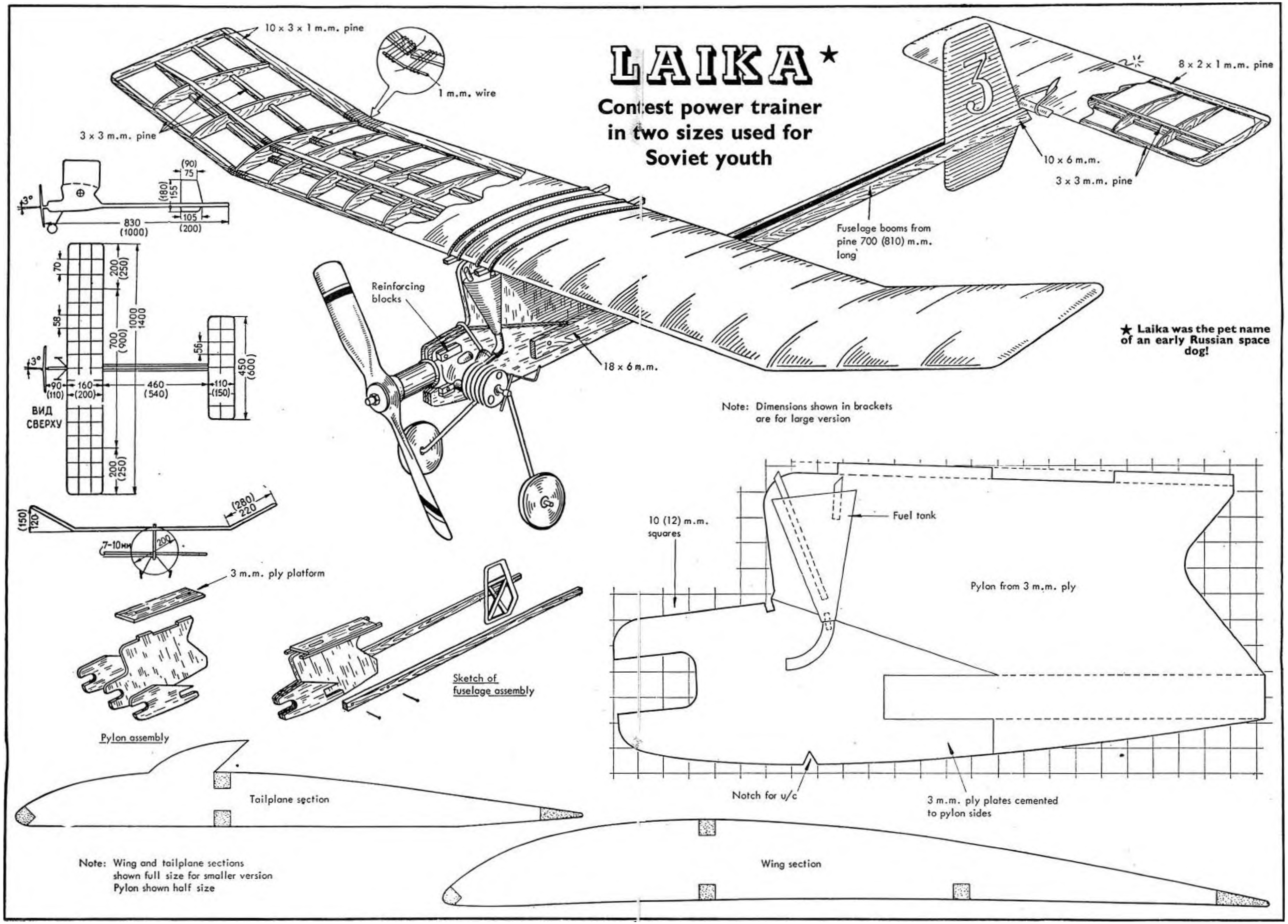
The construction is not difficult; price is quite low and a model is produced very quickly . . . . Give it a try.



MODEL AIRPLANE NEWS, U.S.A.

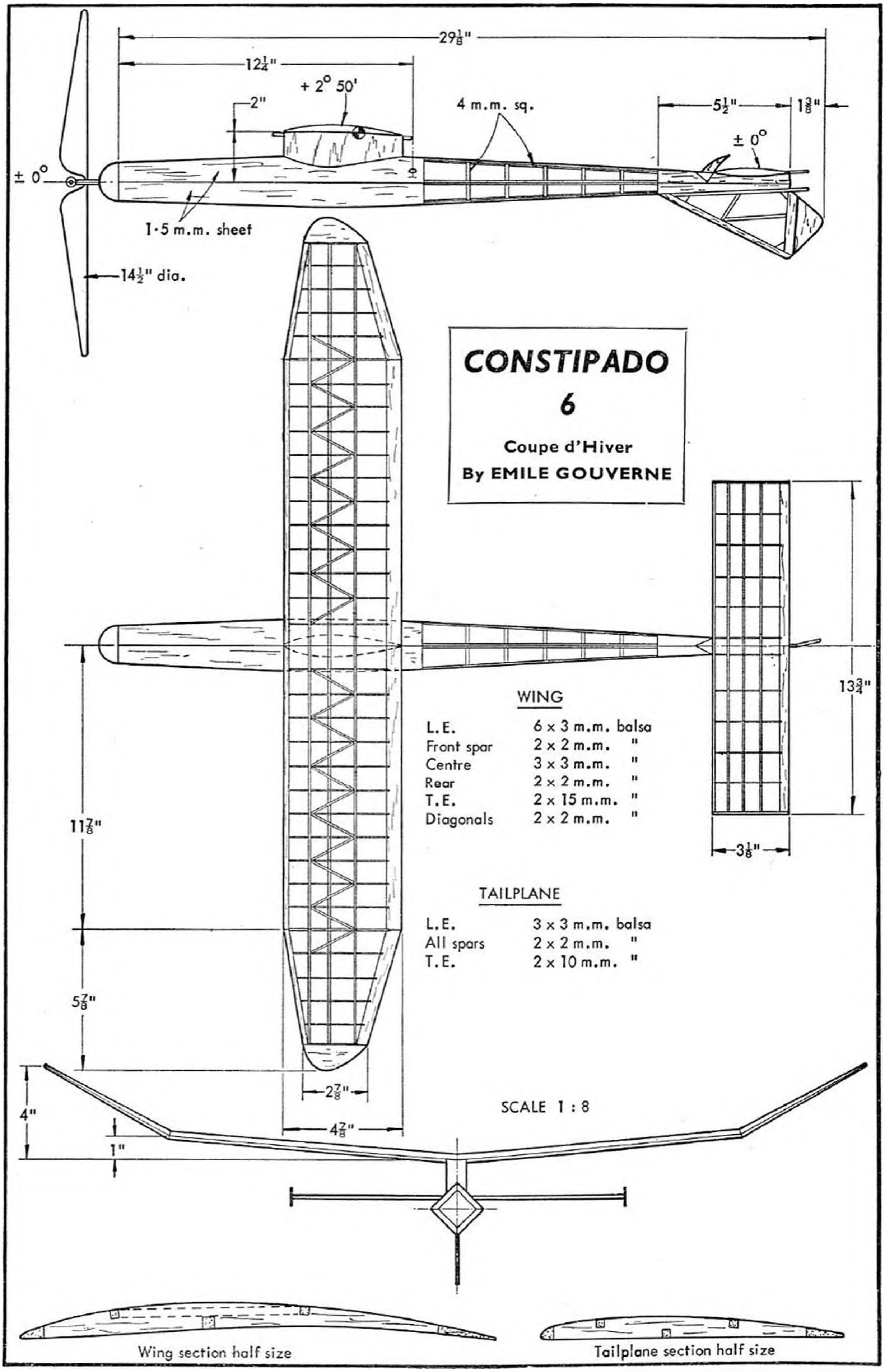
LAIKA*

Contest power trainer in two sizes used for Soviet youth

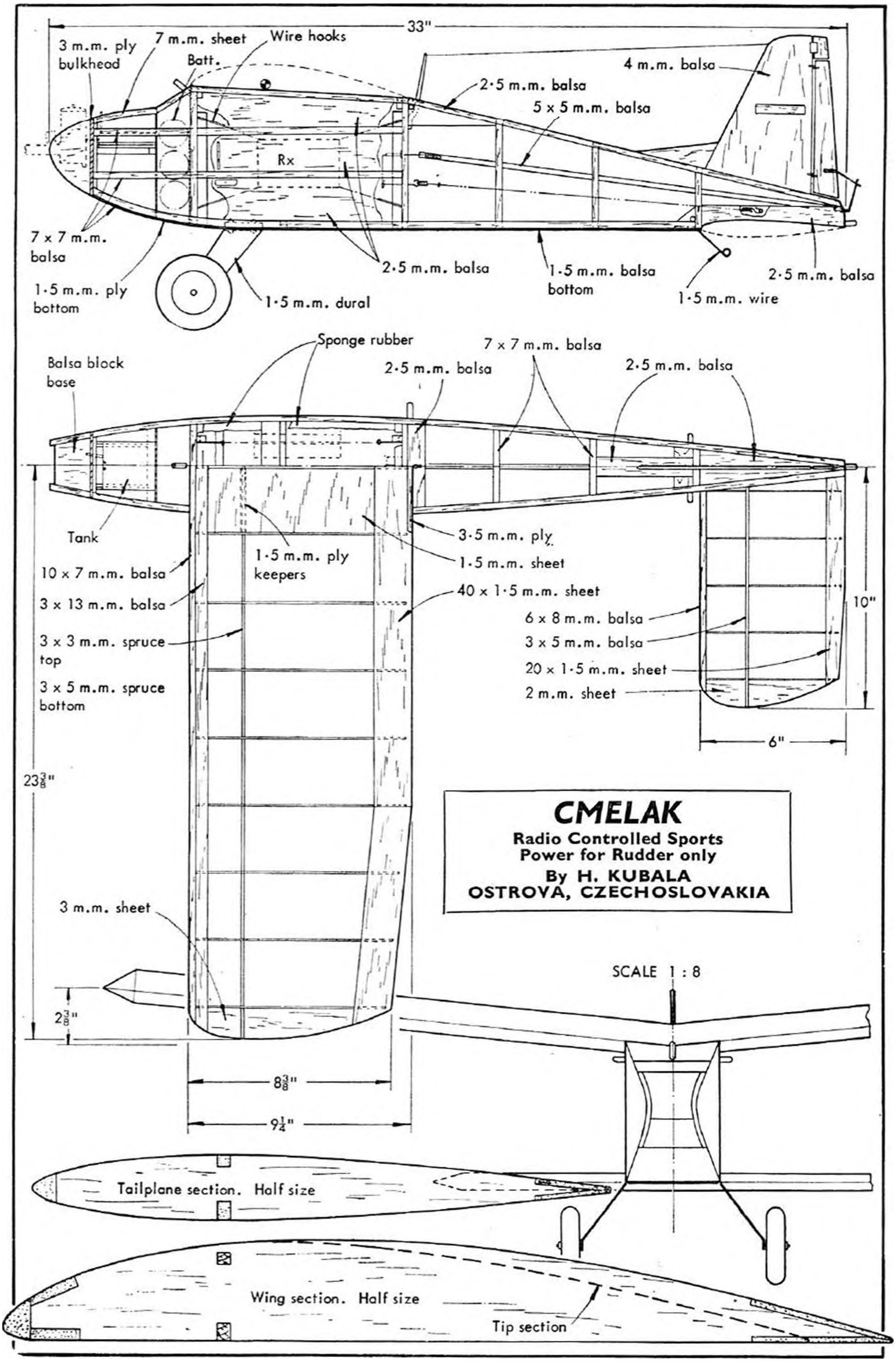


★ Laika was the pet name of an early Russian space dog!

RODINY KRILA, U.S.S.R.



MODELE MAGAZINE, FRANCE

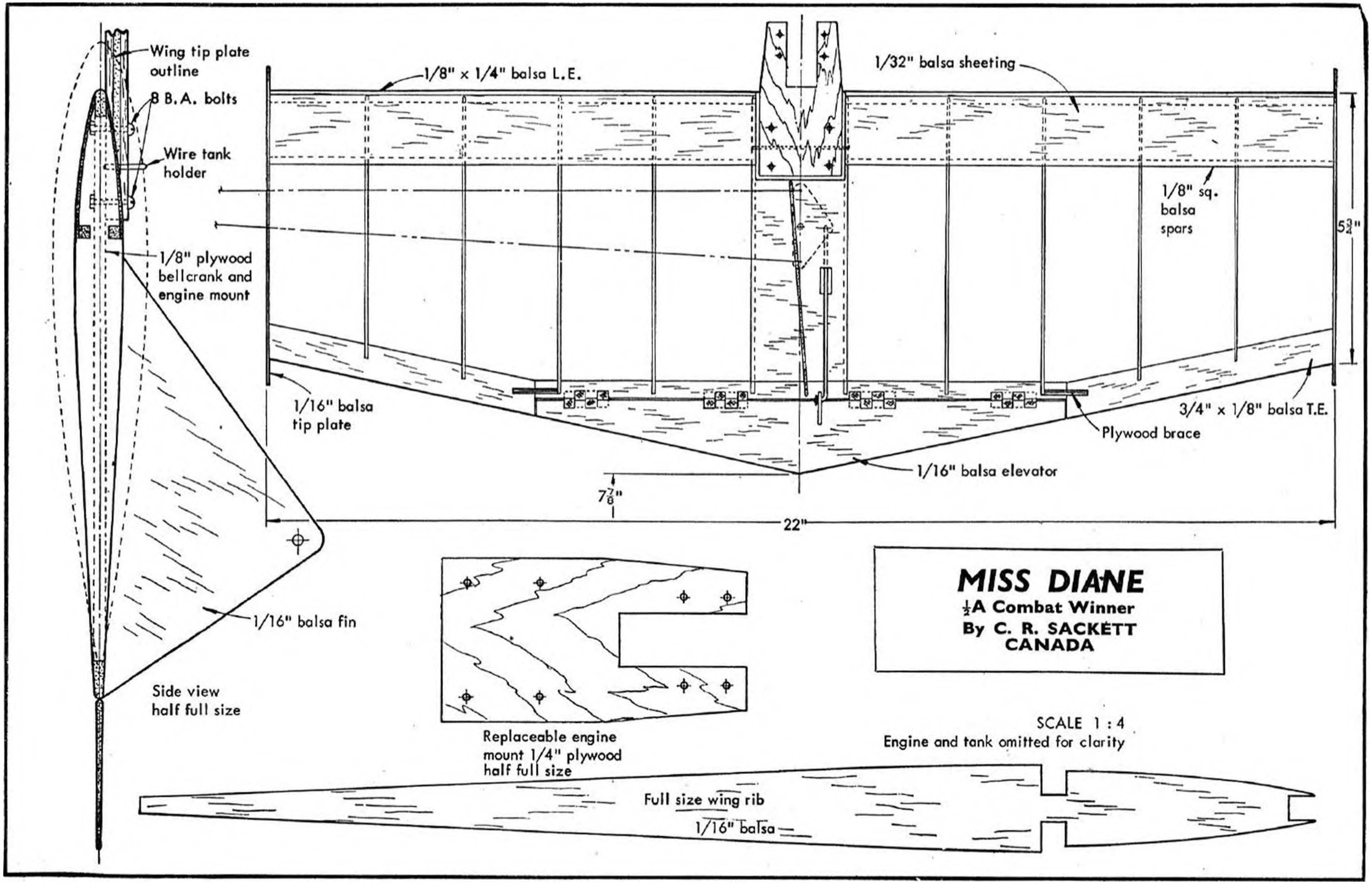


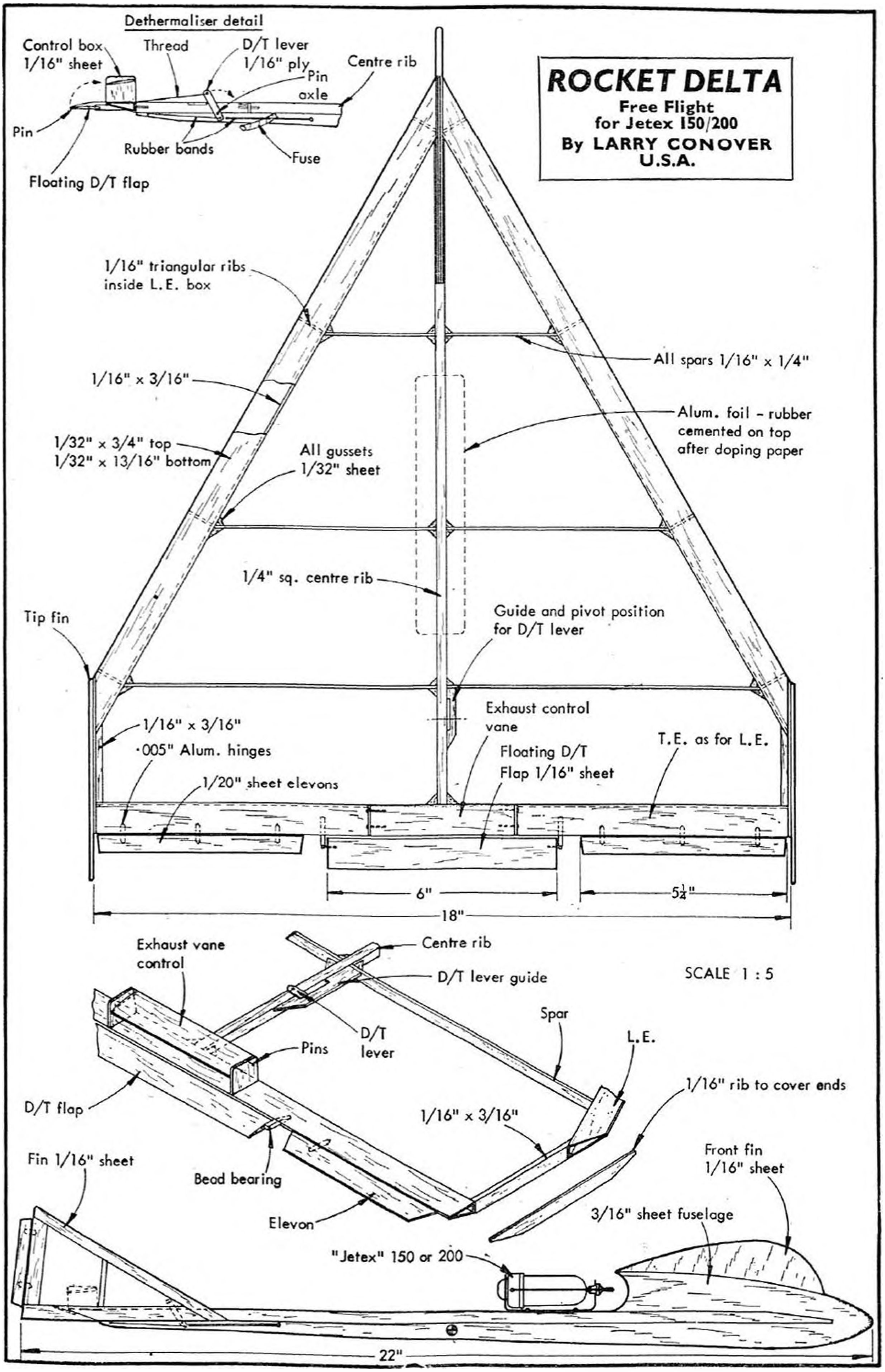
CMELAK

Radio Controlled Sports
Power for Rudder only

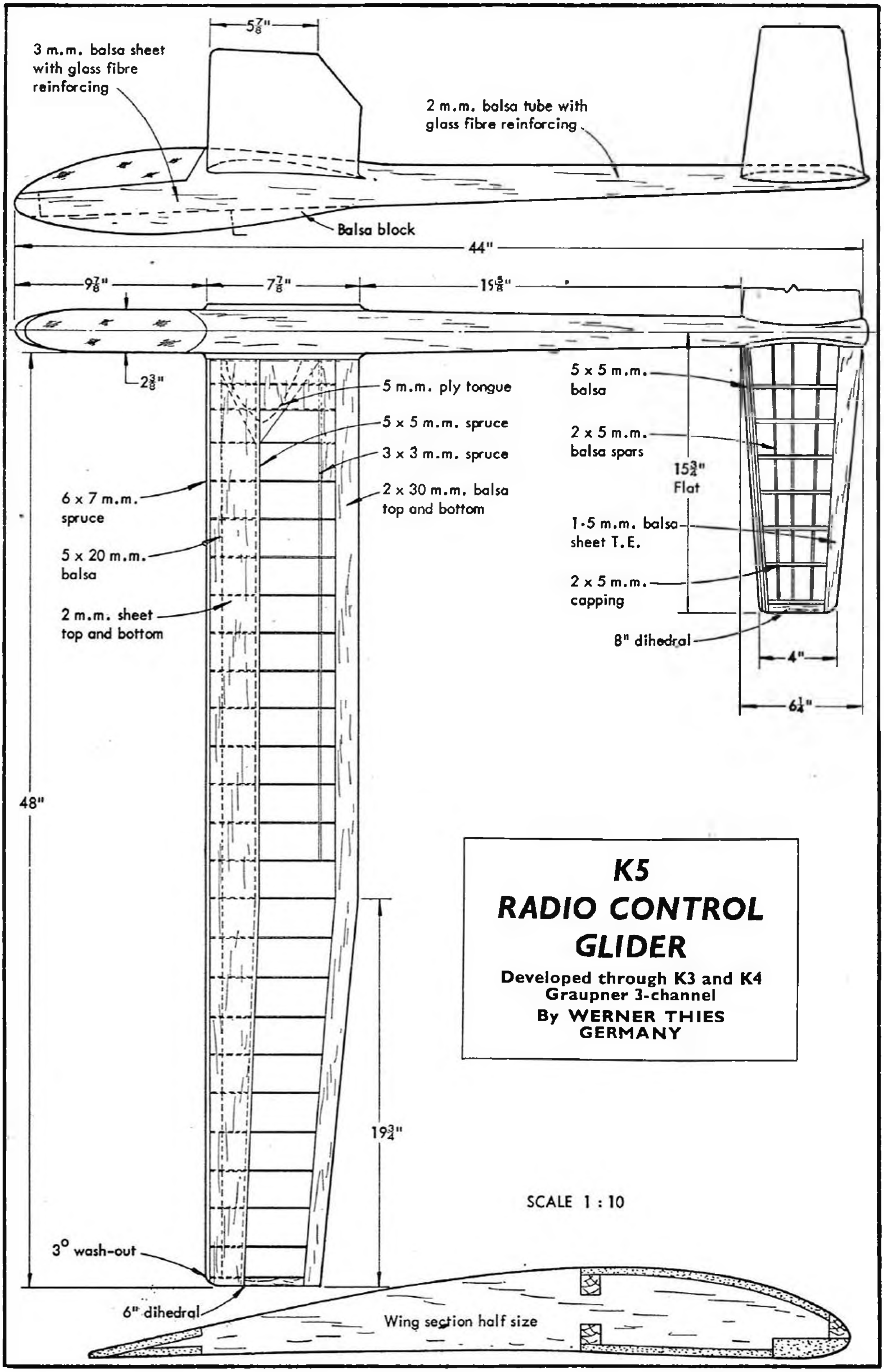
By H. KUBALA
OSTROVA, CZECHOSLOVAKIA

LETECKY MODELAR, CZECHOSLOVAKIA

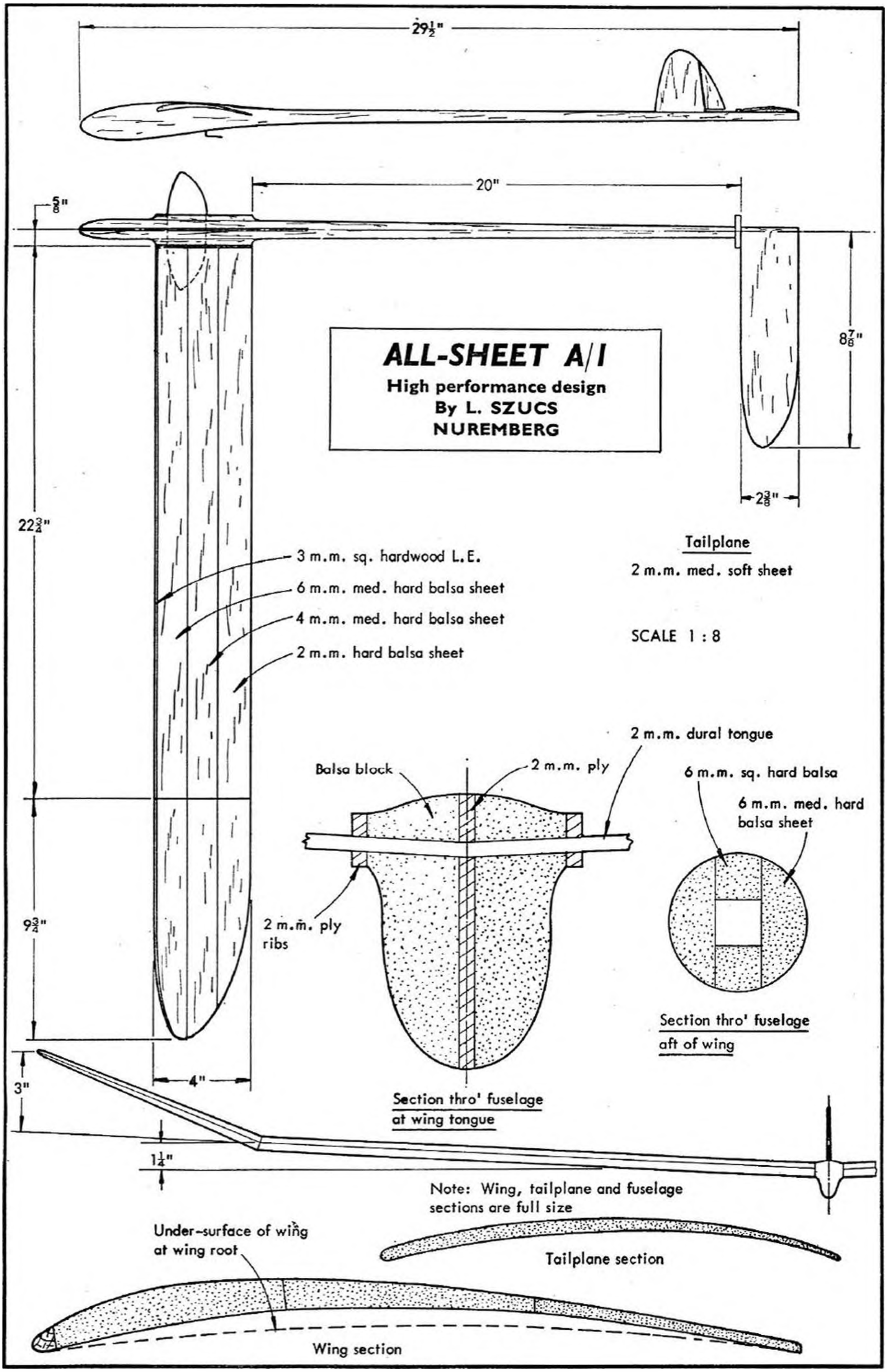

Wing tip plate outline
8 B.A. bolts
Wire tank holder
1/8" plywood bellcrank and engine mount
1/8" x 1/4" balsa L.E.
1/32" balsa sheeting
1/8" sq. balsa spars
5¾"
1/16" balsa tip plate
3/4" x 1/8" balsa T.E.
Plywood brace
1/16" balsa elevator
7⅞"
22"
1/16" balsa fin
Side view half full size
Replaceable engine mount 1/4" plywood half full size
MISS DIANE
½A Combat Winner
By C. R. SACKETT
CANADA
SCALE 1 : 4
Engine and tank omitted for clarity
Full size wing rib
1/16" balsa



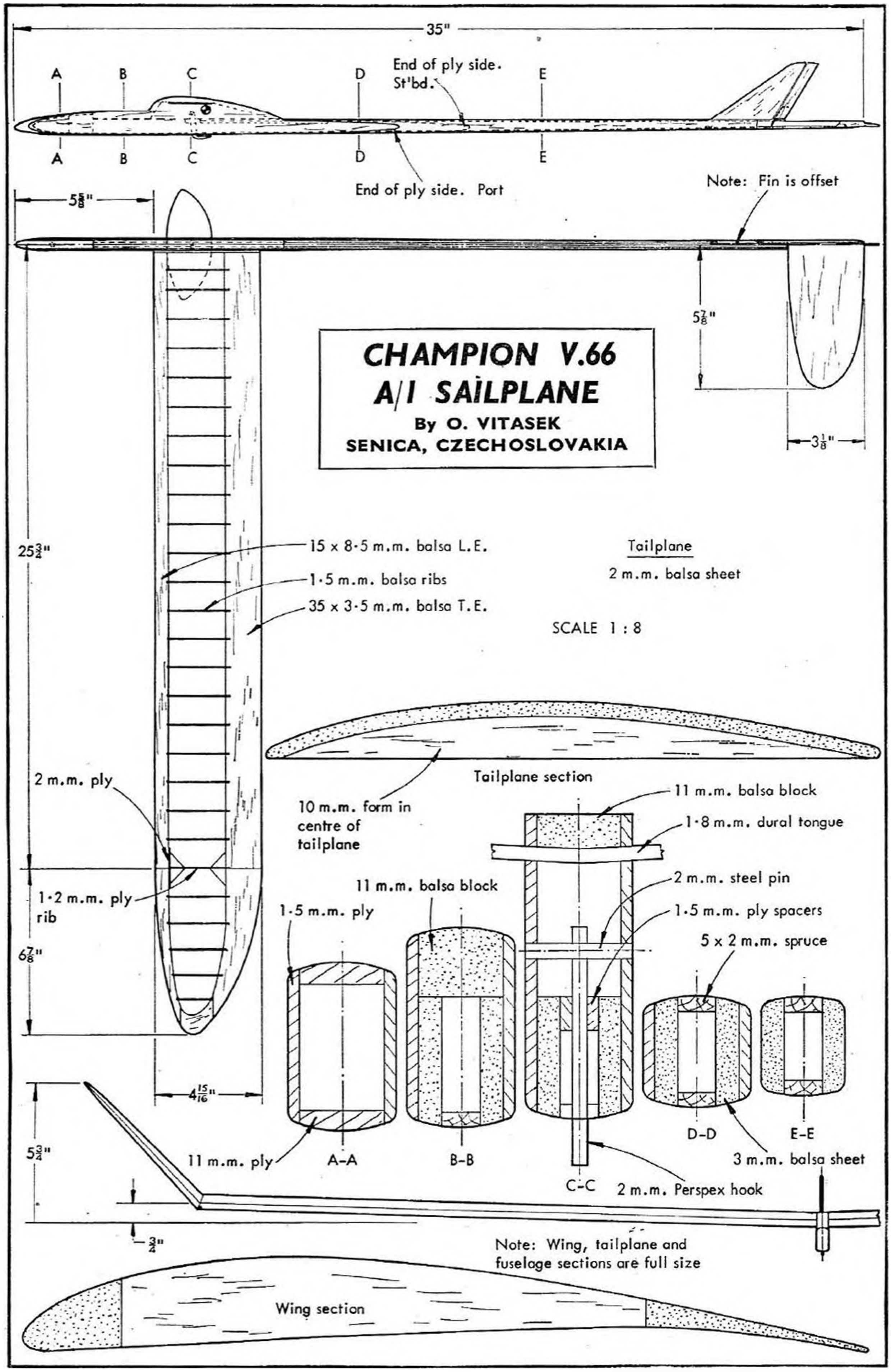
MODEL AIRPLANE NEWS, U.S.A.



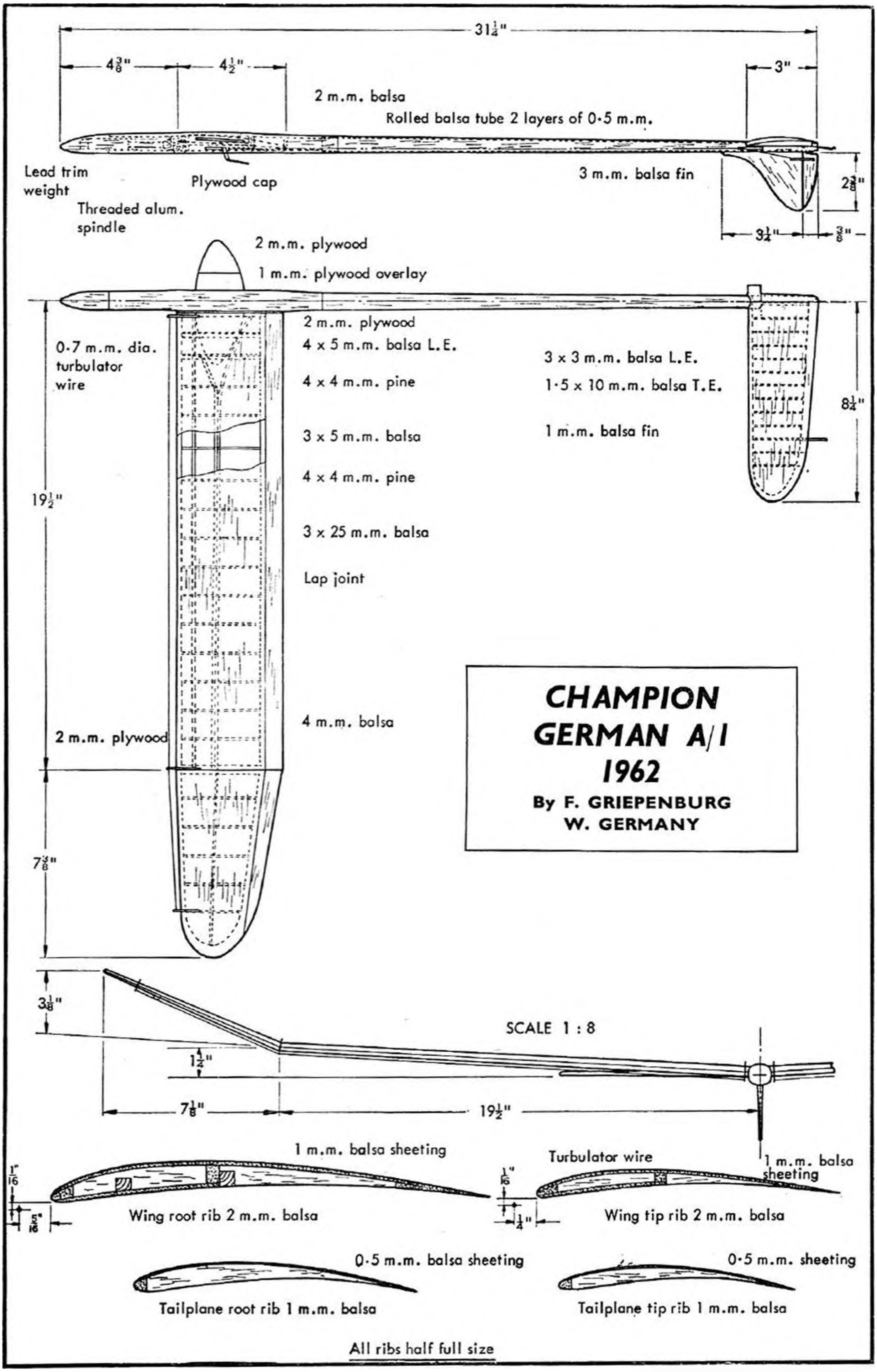
MECHANIKUS, GERMANY



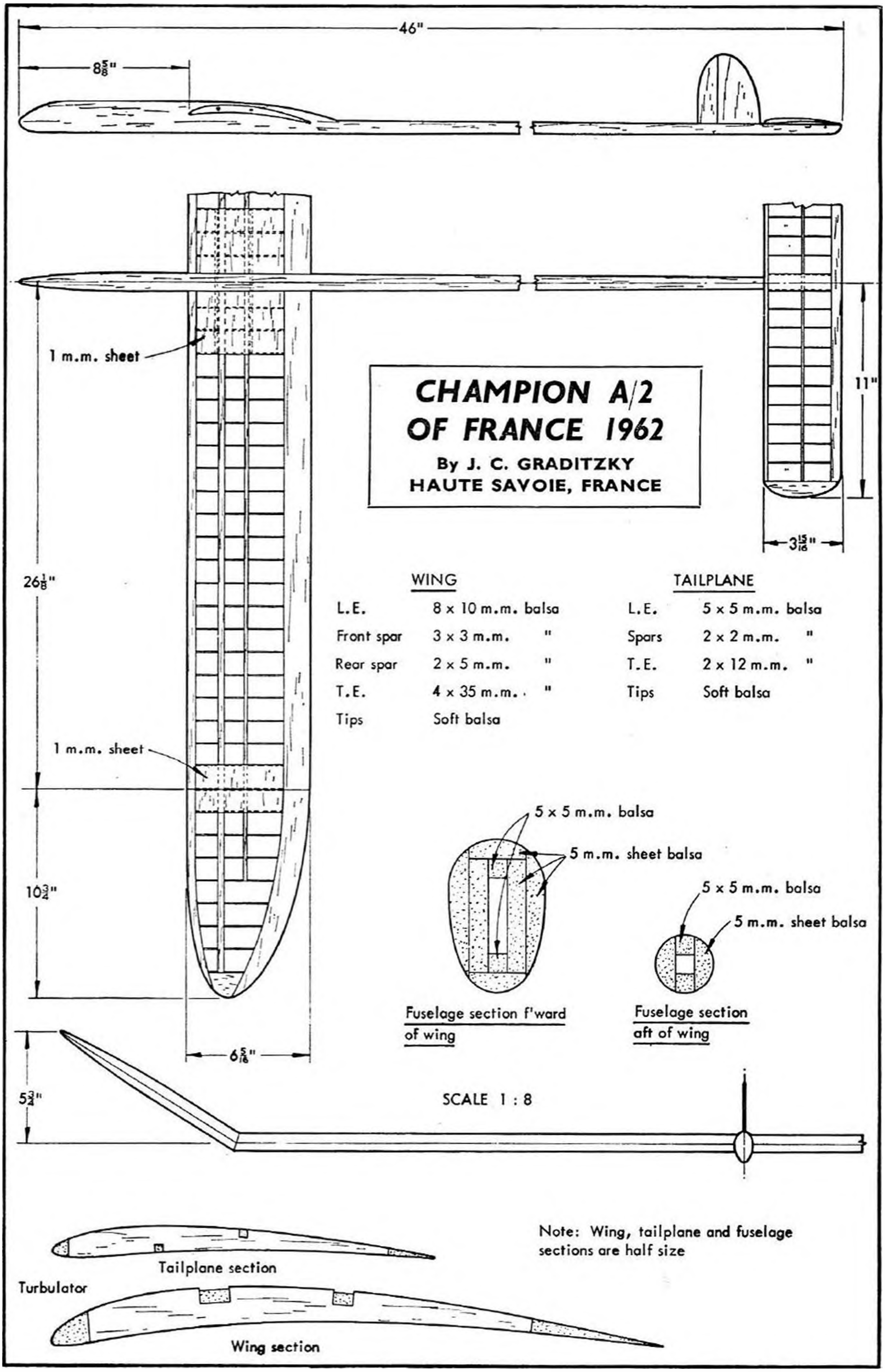
FLUGMODELLBAU, GERMANY



MODELAR, CZECHOSLOVAKIA



MECHANIKUS, GERMANY



MODELE REDUCT D'AVION, FRANCE

KITS versus CONTEST DESIGNS

THE fact that very few contests are ever won by models built from kits is quoted as being due to the fact that a kit, even of a successful contest design, is not quite the same as the original—implying that the original designer "holds something back", as it were (presumably on the basis that the main secret of success in contests is "design"). In actual fact this is seldom, if ever, true. Certainly there may be detail differences, but these are not likely to be significant. Some of the differences may be dictated purely for reasons of production. Others may be some detail the designer has actually improved on in drafting out the kit plans. The real answer to this question is that as far as contest winning is concerned, it is the man more than the model that counts. Given a dozen or more absolutely identical models to trim and prepare for a contest by different individuals, for instance, the results achieved would vary widely. Yet, of course, there *are* differences between "kit" and "one-off" or contest designs.

First consider how and why a kit is produced. By far the greater majority are produced to appeal to a popular market with the emphasis on "sports" or general flying rather than contest work. At the same time these designs must be made as foolproof as possible—easy both to build and fly. Most start life as a design developed *for* kitting, which implies the most economical allocation of materials, perhaps even tying model and spar lengths to a box size, and evolving the design around certain kit production methods.

The result is usually an attractive model capable of flying well, but one which lacks a number of requirements for a contest model. If a power model, for example, it will almost certainly be underpowered by contest standards—and will probably not have enough reserve stability to take higher power if an attempt is made to boost performance that way. The kit designer chooses lower power because he knows that the normal customer will find such a combination much easier to trim—and probably also means that a cheaper engine is suitable. As far as possible the good kit designer tries to make both construction and handling as straightforward as possible so that the builder and flyer does not have to call on experience in order to achieve satisfactory results.

The other type of kit model is where a kit is produced of an existing, successful design—usually one which has an impressive record of contest wins to its credit. This type has always been particularly popular in America (probably because they always had a greater number of contests and contest winners). but in proportion has dropped considerably both in the United States and this side of the Atlantic during the last decade. This is mainly because the contest-minded customer represents only a very small proportion of the total customers for kits—and probably prefers to build his own models from basic stock materials, anyway. Even the appeal of the contest-winning model is low for "popular" sales and the cost often higher than "straight" kit designs.

There is also an "in-between" type, directed towards the more specialised fields. Here the kit designer produces a model which has an excellent contest *potential* and actively pursues this angle; or an expert contest modeller is asked to produce a specific kit design incorporating performance potential.

To quote specific examples, the Frog "Jackdaw" was produced by a *kit* designer as a model both for "sport" radio control and with a contest potential —as amply demonstrated when it was flown by Stewart Uwins. In America, Top Flite kitted Ed Kazmirski's "Orion" and "Taurus" championship-winning R/C multi models. and also incorporated into their range a non-contest proven model by Kazmirski (the "Tauri") with "class" performance, although ostensibly a "multi" trainer.

Suppose the kit manufacturer starts with an individual bought-in design (i.e. a contest winner). To make it a commercial proposition for kitting and selling at a reasonable price he may have to rationalise the material list to reduce the number of individual material sizes. This may entail minor design changes, none of which is likely to be very significant. On the other hand, he may be able to adopt the original specification complete. Much depends on how "individual" the original design is. Some "one off" models, for example, are built from standard material sizes; others may have all spars taper-cut from sheet and other non-standard sections. Overall only the structure weight and strength is likely to be affected (both likely to be increased in the kit version). Performance should not be greatly affected, if at all.

The only significant difference is likely to be in the matter of wood *selection*. Although the original designer may specify wood densities, the kit manufacturer cannot exercise the same control over material selection as an individual. The meticulous individual builder, for example, may select two or three sheets for cutting wing ribs from perhaps several dozen sheets initially. The kit manufacturer must work on an average density figure for selection, and probably die cuts the ribs anyway, so that the customer has no selection at all left to do. Again this is only likely to result in a small weight penalty.

The only real limitation in a good kit, in fact, is in the weights and strengths of spars, and weights of shaped block components. Wing tip blocks can—and often do—differ considerably in weight in even the most carefully selected kits. The fussy builder is then left with the alternative of replacing the heavier block with a lighter one, or weighting the lighter tip to balance.

With spars there may be a certain amount of allocation possible so that sets of spars chosen for one wing match those in the other wing for weight and strength. Alternatively, the individual builder may be happier in replacing one or two spars for better "match" or strength. Again personal preference counts a lot here. Some individuals prefer to use very light grade Balsa and generous sections; others prefer hard grades of balsa and smaller sections.

Another feature on which kit designs can fall down is in the supply of sheet for wing covering, fuselage sides, etc. Wing sheeting is often too hard and rigid, which makes for difficult construction as well as adding unnecessary weight. Fuselage sheeting and tail stock is again often heavier than it need be, and "bendable" when it would be better rigid. Again it is a case of it being easy for the individual modeller to pick out just the right grade and cut for a particular job, but virtually impossible to exercise anything like the same degree of control on a production basis.

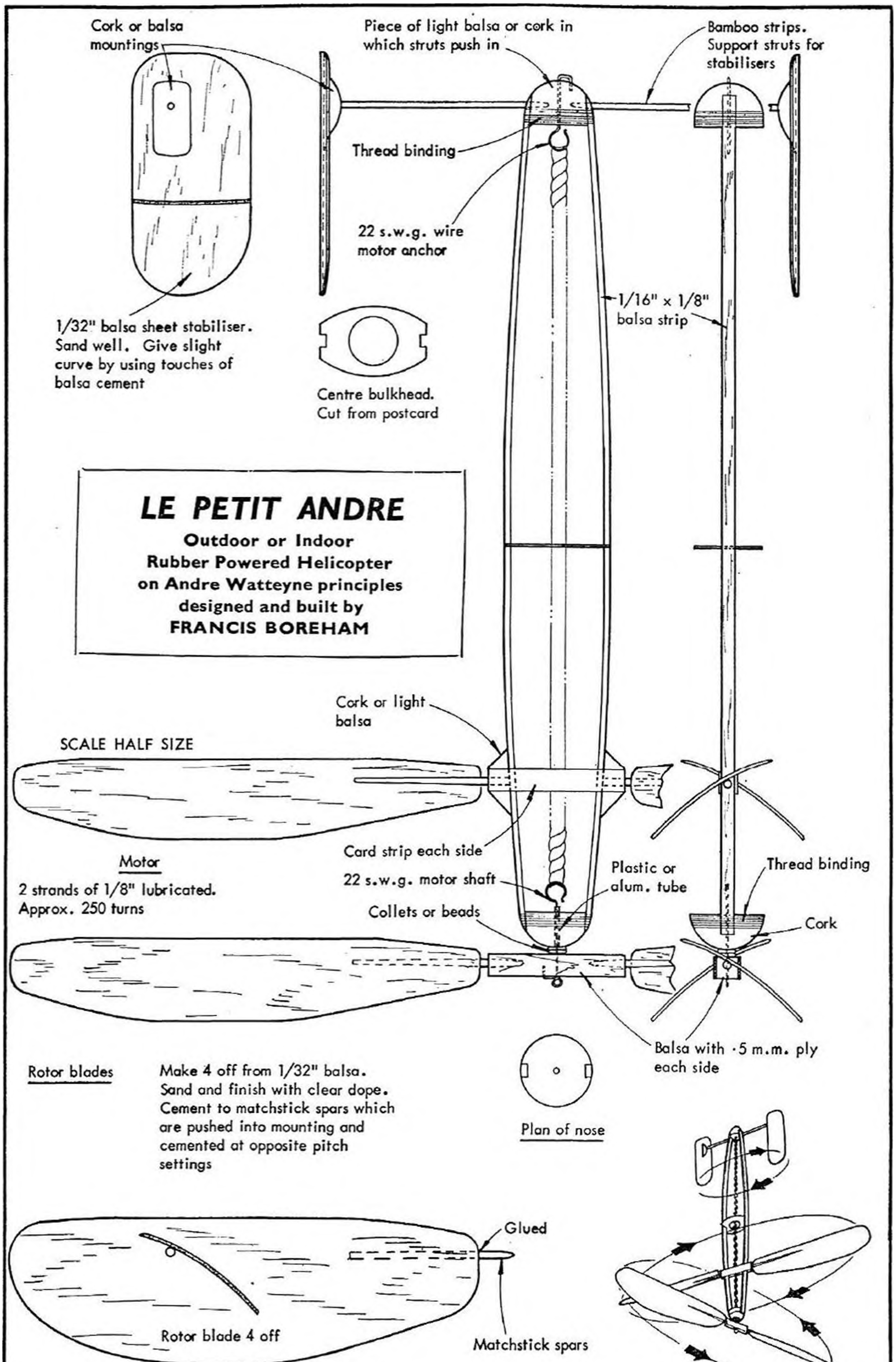
These, in fact, are not so much faults with kits as inherent limitations —considering the building of an individual model with the best possible performance potential for that design. For a general purpose or "sports" model these are not even limitations at all for such models have a far greater tolerance in respect of weights and strength. What it does mean is that if you are looking for the best possible model from a kit, replacement of certain kit materials can be advantageous. Most aeromodellers of some experience can get a lot of satisfaction building from kit models by adding individual touches, anyway.

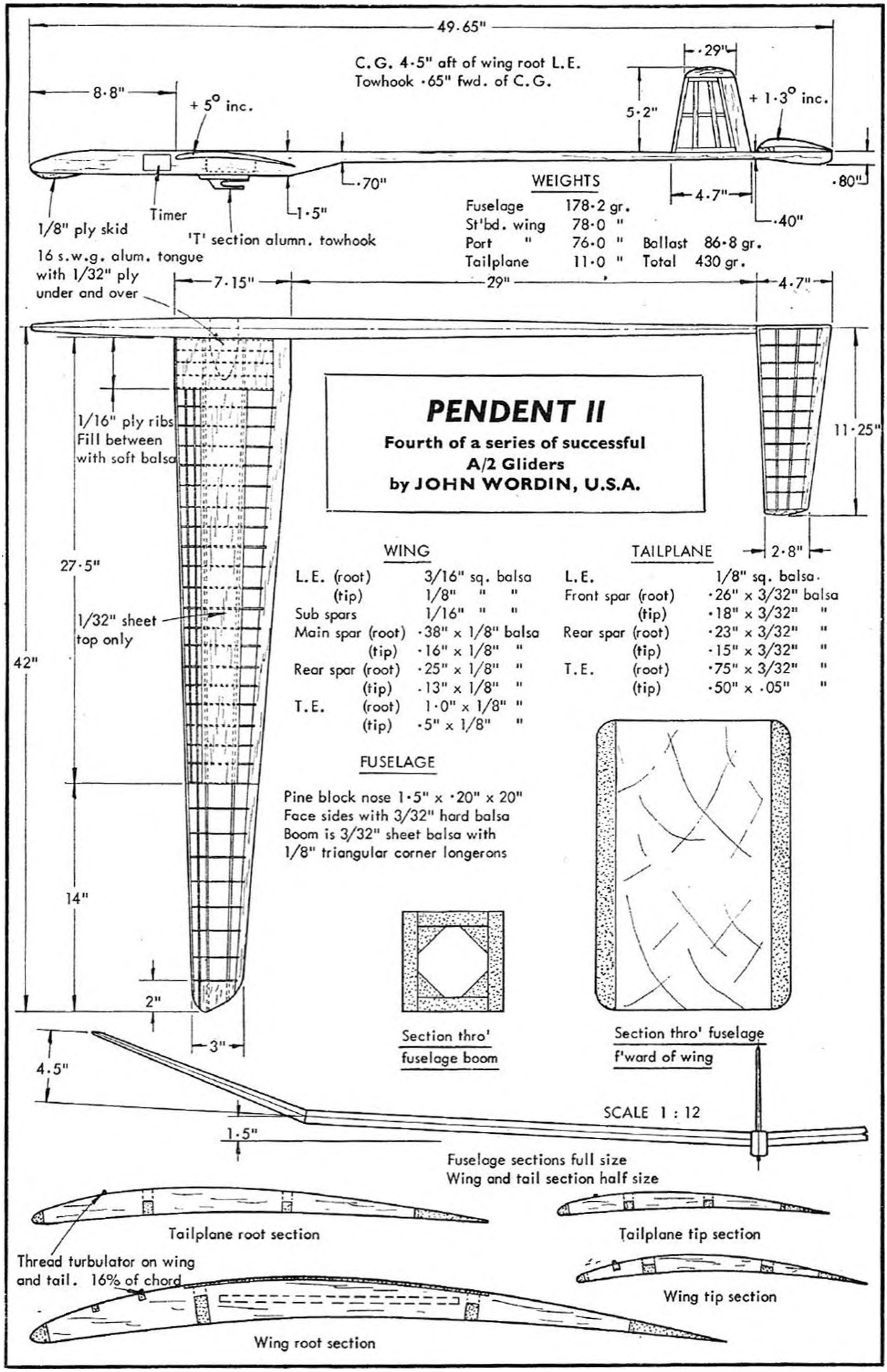
There are, of course, poor kits—but these are relatively few indeed these days on this side of the Atlantic (and some of the worst offenders from the United States seem to have disappeared from the market now, anyway). Such models are usually bought-out designs or designs by aeromodellers for kitting which have been produced without proper regard for material selection, and in some cases even material quality. Whilst a model may be completed successfully from such a kit, its performance is likely to be disappointing. It will most likely be weak where it needs to be strong, and vice versa. Certain parts may even have definite flaws—we have even seen knot holes in engine bearers, for example. The pity of it all is that in many cases the *design* is excellent, but to build it properly would demand wholesale replacement of kit parts—which is a high price to pay for the design!

Production facilities of individual manufacturers also affect material selection, and also the degree of prefabrication in the kit. So far, for example, American manufacturers are the only firms who can successfully and consistently die-cut $\frac{1}{4}$ in. thick balsa sheet and $\frac{3}{16}$ in. (or even $\frac{1}{4}$ in. ply). In this country $\frac{3}{16}$ in. balsa is the usual limit for die cutting, and $\frac{1}{8}$ in. thick more usual for anything approaching harder grades. Ply above $\frac{1}{16}$ in. thick is seldom die-cut, but either bandsawn or printed. In Germany, on the other hand, ply parts are usually printed and also balsa parts of $\frac{3}{16}$ in. thick or greater. Also most of the German die-cutting is done with the softer or lighter grades of balsa and very seldom quarter-grain (as is desirable in ribs).

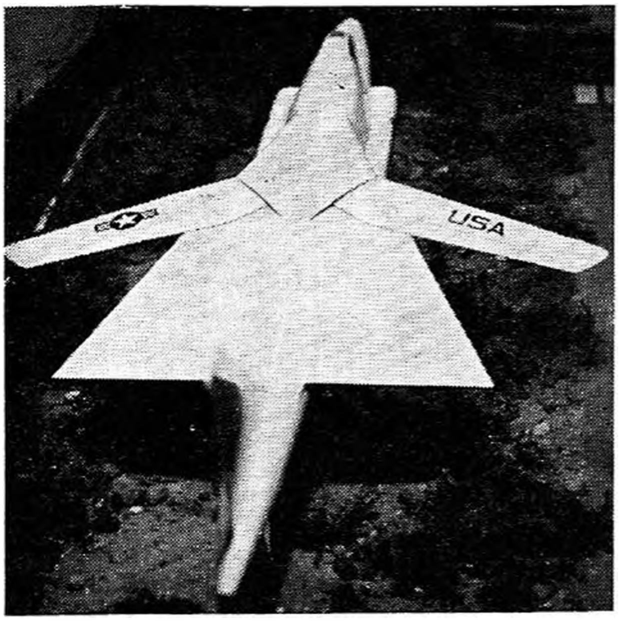
The quality of die-cutting is also variable. In this respect British die-cutting is as good as any for consistency and cleanness, and with absence of crushing (often very marked on light balsa sheet with less developed die-cutting techniques) or after a long production run. Provided it is not inaccurate, indifferent die-cutting is probably better than no die-cutting at all; but poor die-cutting often goes hand in hand with a poor choice of balsa grade (for the particular component concerned), in which case the more particular builder may prefer to replace the parts anyway and cut from selected sheet, using the kit original as a pattern.

Another query which often crops up is why only American kits for large models (usually radio controlled models) include die-cut fuselage sides in one piece measuring 36 in. long or more. For a similar production on this side of the Atlantic the usual solution for such a kit production would be to die-cut the sides in two or more parts to join together (or bandsaw to a one-piece outline). The answer is purely one of economics. Die-cutting machines as utilised for kit production in this country are limited to a maximum cut of about 18 to 24 inches. Longer parts could be die-cut, but would need new machines for the job—and there is just not the production requirement available to justify the cost of such machines. The very large kit model of this class, for example, would probably not have a production run of more than 500 to 1,000, and still smaller "repeats". It would take dozens of such productions to justify a machine for the job—or a firm order for something like 50,000 off a model like the "Taurus"!


Cork or balsa mountings
Piece of light balsa or cork in which struts push in
Bamboo strips. Support struts for stabilisers
Thread binding
22 s.w.g. wire motor anchor
1/16" x 1/8" balsa strip
1/32" balsa sheet stabiliser. Sand well. Give slight curve by using touches of balsa cement
Centre bulkhead. Cut from postcard
LE PETIT ANDRE
Outdoor or Indoor
Rubber Powered Helicopter
on Andre Watteyne principles
designed and built by
FRANCIS BOREHAM
Cork or light balsa
SCALE HALF SIZE
Card strip each side
Motor
2 strands of 1/8" lubricated. Approx. 250 turns
22 s.w.g. motor shaft
Plastic or alum. tube
Thread binding
Collets or beads
Cork
Balsa with ·5 m.m. ply each side
Rotor blades
Make 4 off from 1/32" balsa. Sand and finish with clear dope. Cement to matchstick spars which are pushed into mounting and cemented at opposite pitch settings
Plan of nose
Glued
Rotor blade 4 off
Matchstick spars



SCATTER NEWSLETTER, U.S.A.



WHICH WAY FOR "UP"?

A survey of just a few of the year's exciting aeronautical projects of modelling interest.
By R. G. Moulton.

Republic have combined the British vectored-thrust power unit with a variable sweep wing in their Delta VTOL project long range Mach II Fighter. Wings shown here in extended position.

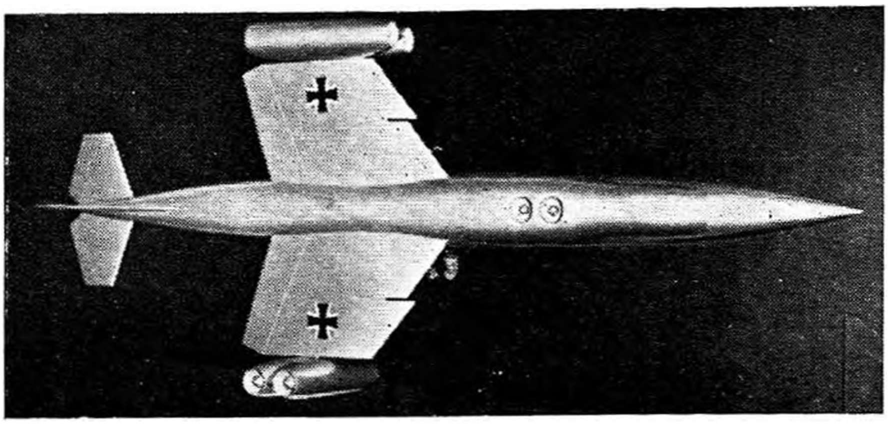
THE year 1963 will go down in Aeronautical History as the beginning of a VTO era. It marked the culmination of experiments during the past decade, by practically every one of the major manufacturers. No one could possibly have left the 25th International Aviation Salon in Paris during June without the firm impression of endeavour by all big aircraft names in this new sphere.

Though this development of the true vertical take-off and landing machine is universal, it has only become possible through British engines. The Rolls-Royce lightweight RB 108 for multiple vertically-mounted installations and the swivel nozzle vectored thrust Bristol Siddeley Pegasus, American General Electric Lycoming, Pratt and Whitney and Allison units are used in prop, jet and fan types for variable wing machines, tilt wings, fan lift machines, *etc.*

The incredible aspect of the VTO phase is the variety of application. Obviously no one plan is sufficiently clear cut to be claimed the best—although all makes have their own firm views. The disadvantages are all connected with fail-safe conditions—a factor which was forcibly brought home to Bill Bedford the Hawker Chief Test Pilot, when he lost vertical thrust at 15 feet, only a matter of yards from the writer at Le Bourget in June.

Accidents apart, the Hawker P1127 appears to the author to have the most useful approach and the forthcoming Republic machine (with Fokker connections) has a special fascination.

Republic has designed a vertical/short take-off and landing aircraft for strike-reconnaissance missions. It is a single-seat, single-engine design featuring a highly swept delta planform and a variable-geometry wing, which is mounted in forward position to make a canard configuration. Horizontal and vertical thrust is provided by a Bristol-Siddeley BS 100 lift-thrust engine with rotating nozzles. Low speed and static attitude control is provided by forward and aft-mounted pitch and yaw jets and wing-mounted roll jets, all actuated by the normal flight controls of the aircraft. Performance extends to Mach 2 at 60,000 feet, and maximum ferry range is 3,300 nautical miles with external fuel. The aircraft can accommodate a large variety of missions because of its extreme performance and payload versatility. It introduces the variable sweep wing to VTO and so brings in another aspect which came to fruition in 1963. The



Combination of German manufacturers produced the Messerschmitt VJ 101C with wing tip swivel jets and two fixed jets in fuselage using Rolls-Royce system. Aircraft is reminiscent of a discarded Bell project.

Barnes-Wallis "Swallow" which once was a pipe-dream for the talented Vickers engineer, has now become part of the everyday scene. Future manned fighters are more than likely to employ this clever idea.

This, and in fact, all the ways and means that designers are using to get aircraft off the ground in a vertical plane, have an attraction for aeromodelling. Unorthodox approaches in full-size are always first proved to a successful stage as a model, and that is why we are presenting this survey. If it can be done in the full-size—why not as a model?

The VTOL machine is a challenge to the model designer. Perhaps the following data will bring inspiration for production of some fascinating unorthodox model prototypes in 1964:

Messerschmitt's Approach

Why did EWR Sud select the Rolls-Royce principle of separate lift jets for the VJ 101C, Germany's first vertical take-off aircraft?

The reason was given by Director Karl Schwarzler, of EWR Sud, in an account of the development of the VJ 101C, at the first Press demonstration of the aircraft. Herr Schwarzler said: "It is four years since, at the suggestion of the West German Federal Minister of Defence, the firms of Bolkow, Heinkel and Messerschmitt combined their development teams to form the Entwicklungsring Sud (EWR) to develop a vertical take-off interceptor aircraft. This aircraft was to have a performance corresponding to that of a modern supersonic fighter but was also to be capable of vertical take-off and landing, making it independent of large runways which are vulnerable in war.

"The need for Mach 2 performance dictated from the start the use of jet engines with reheat. A series of project studies was made with deflected jets, swivelling engines, and with various combinations of lift engines and propulsion engines." Herr Schwarzler then referred to current VTOL aircraft, the Short SC1 and the Mirage III-V which have separate lift and propulsion engines; and to the P1127, which has engines with swivelling nozzles, the total thrust of which is used for normal flight.

"The ratio of lift engine thrust to propulsion engine thrust depends on the duty which the aircraft has to perform", he said. "In general, more thrust is required to lift the aircraft than for horizontal flight. In any case it is advantageous to use the thrust of the propulsion engines for lifting the aircraft and to supplement deficiency in lifting thrust by means of lift engines.

"The VJ 101C project emerged as the most favourable solution . . .".

Why swivelling engines? On this point Herr Schwarzler said:

"Perhaps the most interesting features of the aircraft are the swivelling engine pods at the wing-tips, which are used here for the first time. Some may hold the view that it would be simpler to deflect the jets instead of swivelling the engines. However, it was found that the cost in weight for jet deflection is at least as high as for engine swivelling. Moreover, the thrust losses which are always present with jet deflection are avoided.

"Another factor is that the problem of deflecting a reheat jet had not yet been solved. The swivelling engines, however, permit the reheat, which is there in any case for supersonic flight, to be utilised for vertical take-off also. After a series of design projects for pod swivelling, two solutions emerged which appeared favourable. The one was based on a large-diameter ball bearing which could be let into the side wall of the pod and about which the pod rotated; the other on a hollow shaft passing right through the pod between the two engines. The latter was incorporated in the experimental aircraft.

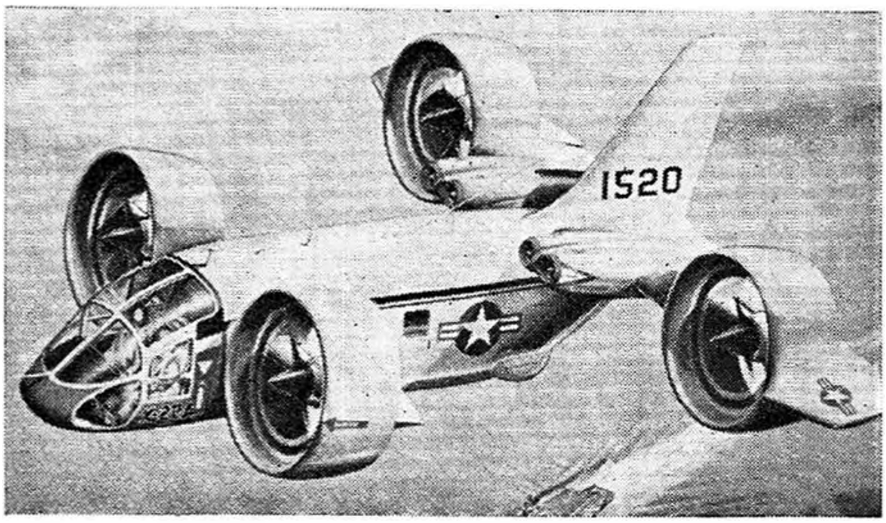
The control rods for engine operation could be passed through the hollow shaft, also the necessary pipe lines for fuel and hydraulic oil. The aim was to reduce as far as possible the number of services passing through, and for this reason the engines are started hydraulically, since this can be done with the same hydraulic lines as already exist for the hydraulic pumps. The pod is swivelled by a hydraulic jack which has two pistons arranged in tandem and is operated by both hydraulic systems.

The six RB145, 2,750 lb. thrust engines form a triangulated group giving a total lift thrust of 16,500 lb. Stabilisation during jet-borne flight is achieved by varying the thrust of the engines. Transition to wing-borne flight is achieved by tilting the wing-tip pods from the vertical to horizontal position. When the aircraft is wing-borne the two RB145s in the fuselage are shut down and the wing-tip engines are used for forward flight.

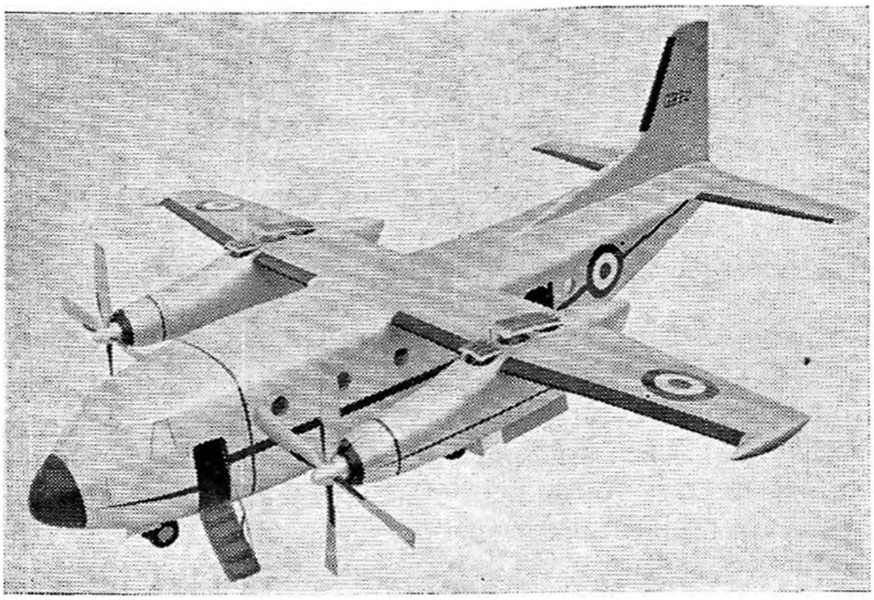
Fiat's VTOL G-91 Successor

The G95/4 is equipped with a compound propulsion system, which has been selected after deep research and study conducted by the Fiat project engineering branch in the field of V/STOL propulsion. Again, this is the Rolls-Royce principle using separate lift jets.

The system consists of two jet engines with afterburner for the propulsion, installed in the aircraft tail section, with air-intakes on the fuselage sides, and four lift jet engines, vertically installed close to the centre of gravity area of the fuselage. The thrust of the latter engines can be slightly deflected



Bell X-22A Research Transport, two of which are being made, uses four ducted fans which can be rotated for true VTOL, whilst normal jet thrust is employed for transition to horizontal flight.



This FIAT Transport project utilises normal prop jet horizontal propulsion but has a battery of vertical power jets within each nacelle. This project has aroused extensive technical interest. General opinion is that it is most likely to gain contracts.

through swinging nozzles. The adoption of four engines for lift and two engines for propulsion, besides giving a high safety factor even in case of failure of one of the engines, also allows a total weight, and the fuel consumption to remain within reasonably low limits.

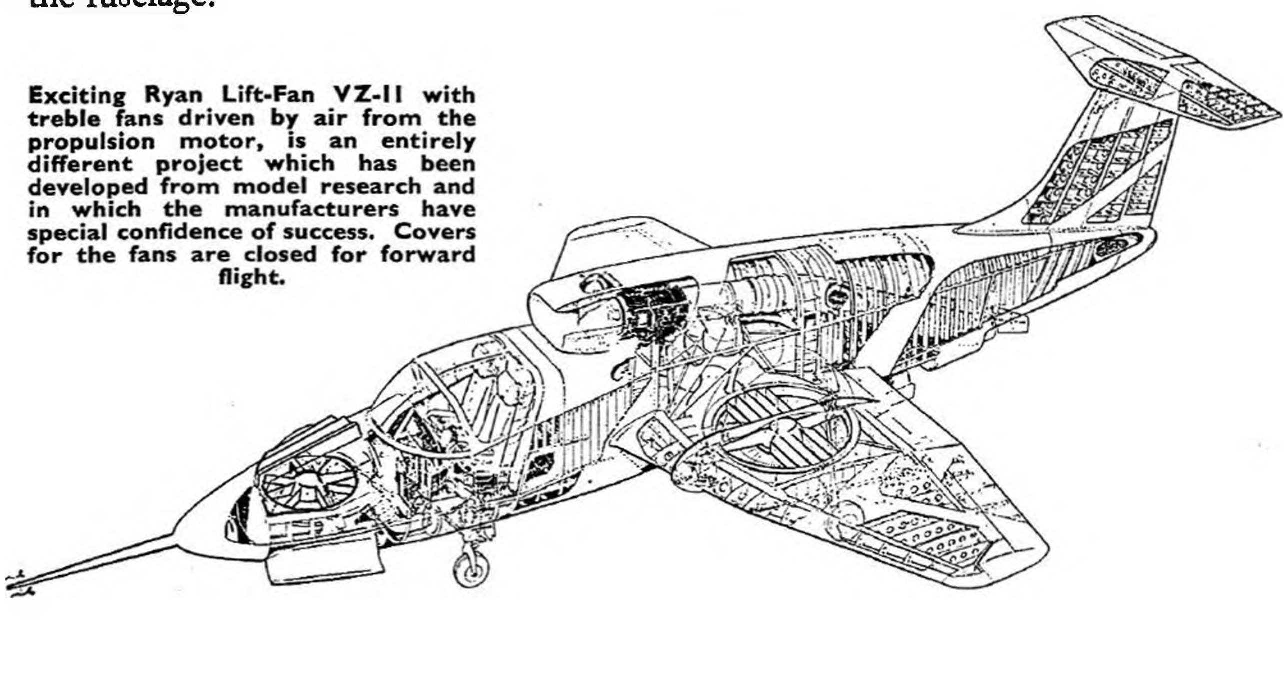
As on the other VTOL machines, in addition to the conventional flight controls, there is also a cold jet control system for hovering and transition. Cold jet controls are fed with air spilled from the lift engines.

The two control systems are in parallel and are controlled through the conventional control stick and rudder pedal in order to permit easy transition and a quick familiarisation of the pilot with the flying techniques of VTOL aircraft. Also, the controls for the two groups of engines have been conceived in such a way to make their use particularly easy.

Ryan's Lift Fan Machine

Basic components of the Ryan lift-fan VZ-11 propulsion system are two J85 turbojet engines, mounted high on the fuselage. Two five-foot diameter tip turbine driven fans are submerged in the wings and a smaller fan in the nose of the fuselage.

Exciting Ryan Lift-Fan VZ-11 with treble fans driven by air from the propulsion motor, is an entirely different project which has been developed from model research and in which the manufacturers have special confidence of success. Covers for the fans are closed for forward flight.



For vertical flight, diverter valves direct the jet exhaust to the tip turbines to drive the lift fans. Because the fans multiply the available thrust by 300 per cent, the basic engines can be sized for cruise conditions, and not oversized to meet vertical flight requirements. For forward flight, the diverter valves close the fans off and allow operation as a conventional jet aircraft. The nose fan is used to provide lift, pitch trim and control.

Crossover ducting between engines and fans insures that sixty per cent of the total lift will be available with only one engine operating. Under standard conditions and normal landing weights, adequate lift will be available for vertical landings with a single engine. Conventional landings can be made with a single engine under any loading condition.

The VZ-11 is designed to have outstanding control capabilities in hovering and slow flight. The fan crossover duct system will provide balanced forces for attitude control as well as sixty per cent of lift, should one engine become inoperative as with most VTOL types. An ejection seat is installed for the pilot's safety.

Major features of the VZ-11 concept are the flexibility of the system and the long history of development and testing of its components. Both factors increase the reliability of the aircraft.

For example, power transmission is accomplished by *pneumatic* coupling. All gearboxes and shafting are eliminated, which reduces maintenance and parts problems. The entire control for hovering and transitional flight is obtained from the primary propulsion system, which eliminates the need for auxiliary ducting and variable nozzles.

Another reliability advantage is the low speed of the main fans, which is only 2,600 r.p.m.—or about the same speed as a light plane propeller. The relatively low velocity and low temperature of the fan efflux, give the VZ-11 facility for flying from almost any small area.

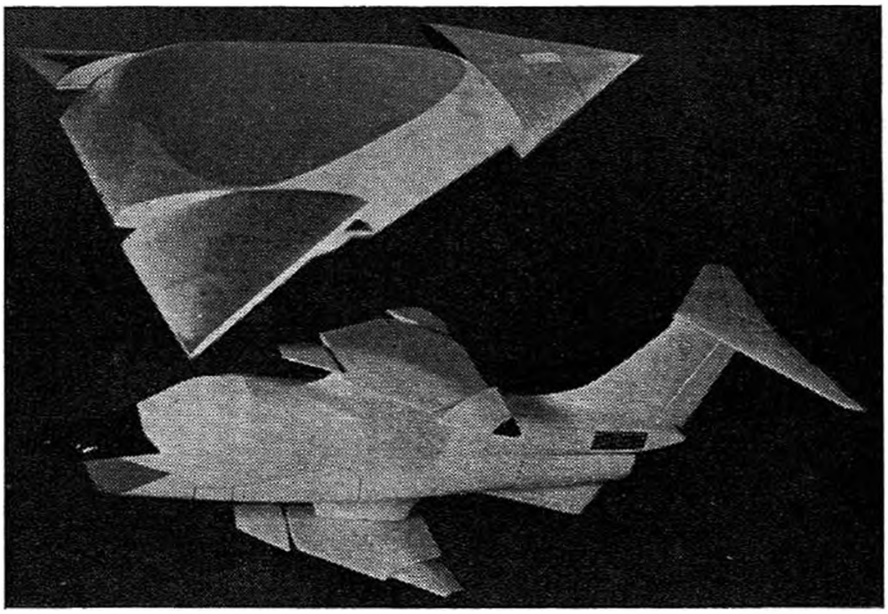
Since the VZ-11 programme started, scale model lift fan aircraft have been tested at various wind tunnel test locations including the David Taylor Model Basin in Maryland. These tests have provided information on the optimum design for the VZ-11 engine inlet and data on high and low speed flight performance. A similar NASA fan-in-wing full-scale wind tunnel model has been tested at the Ames 40 by 80 foot wind tunnel.

Since 1955, Ryan has been directly engaged in studies of V/STOL aircraft utilising the basic fan-in-wing concept and has completed a U.S. Air Force contract to develop the parameters for well-matched fan propulsion system and airframe configurations. This work led to the Ryan proposal which was selected as the winning design in the VZ-11 design competition. Over the years, Ryan has accumulated a unique backlog of three million manhours of V/STOL engineering experience in developing four major V/STOL aircraft and participating in the design of a fifth.

Peter Girard's "Heliplane"

An entirely different concept in VTOL (vertical take-off and landing)—the turbojet delta wing Heliplane—has been patented by Peter F. Girard, Ryan Project Engineer, Special Projects, after seven years of "off and on" study.

Internationally noted as the test pilot of the Ryan X-13 Vertijet, world's first pure jet VTOL and the propeller-driven VZ-3RY Vertiplane, Girard has created a design which theory shows to be more efficient than present turbojet



Rotating Delta wings which act as helicopter rotors are the creation of Peter Girard, a Project Engineer at Ryan. Close up of a "wing" illustrates how the tips are rotated to provide vertical thrust. Wings are locked in position for horizontal flight.

aircraft in the hovering condition, and which is capable of transition to supersonic speeds.

The Heliplane consists of a somewhat conventional body and tail group, to which are attached two rotary, delta-shaped wings, one above and the other below the fuselage.

Exhaust from the single jet engine is diverted to an auxiliary turbine which drives a shaft connected to a single gearbox for contrarotation of the "rotor-wings" in vertical take-off and landing, and in low horizontal speed and hovering.

Wing rotation is stopped in cruising flight, during which the Heliplane operates as a conventional delta wing turbojet aircraft. Stopping the wing rotation is feasible because of the delta planform of the wings, which produce much lower levels of vibration and transients during transition than the straight tapered conventional planform.

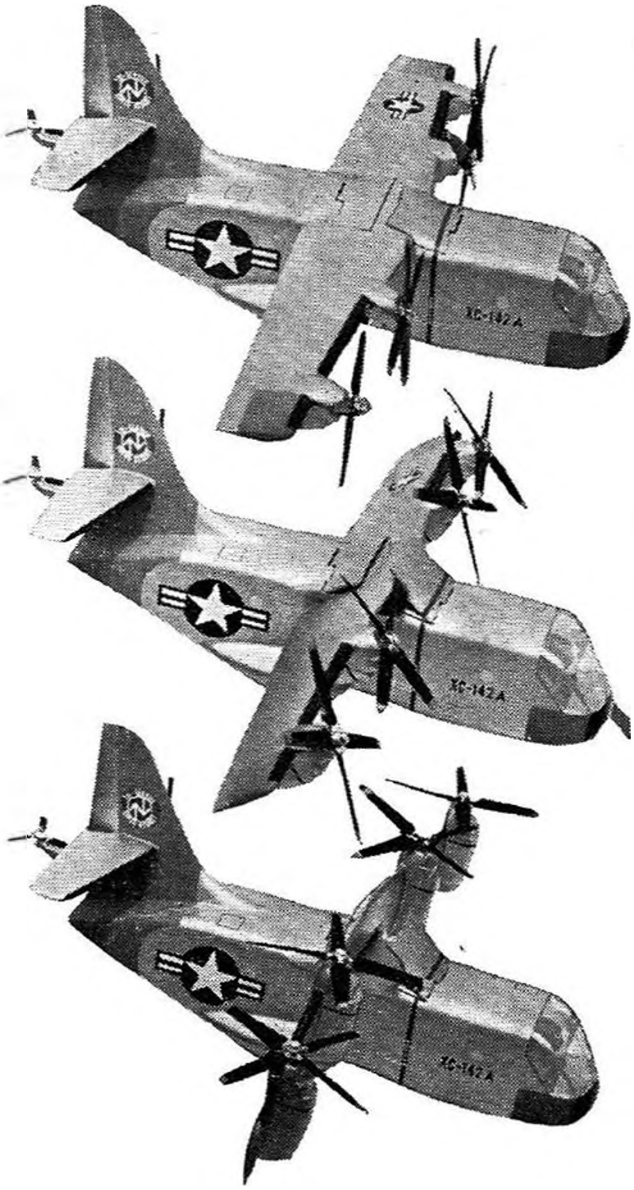
Directional control in the VTOL mode is provided by diversion of exhaust gases through ports in the aft end of the fuselage.

The delta wings are equilateral triangles which Girard believes will demonstrate remarkable aerodynamic characteristics. Theoretical analyses have shown hovering figures of merit as high as 74 per cent (the average helicopter has a figure of merit of approximately 70 per cent).

Having obtained the patent and built models of the Heliplane, Girard has constructed a model of the wing in his home workshop to perform hovering tests of a quantitative nature as a check on the results of theoretical analyses.

Tilt Wings

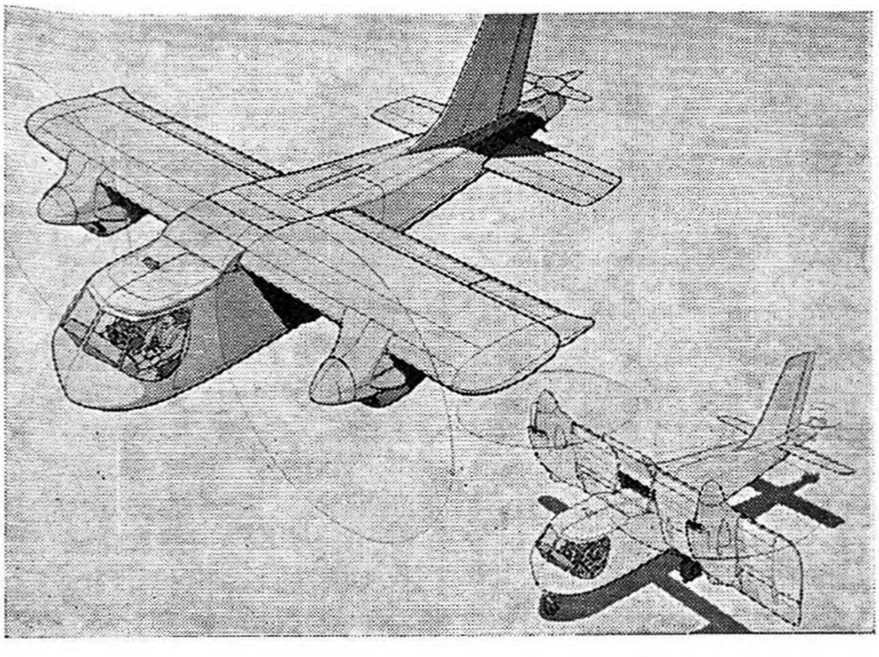
The Vought-Hiller-Ryan XC-142 Tri-Service Transport is a V/STOL aircraft that will swiftly transport troops, supplies, and equipment from assault ships or airfields into unprepared areas under all weather conditions. Employing a unique tilt-wing enabling it to take-off and land vertically or in short distance, depending on the terrain, the transport can fly 200-300 miles—fully loaded—at a cruising speed of 250-300 knots. The cargo compartment holds 8,000 pounds of equipment or supplies, or 32 combat-ready troops. Used as a "flying hospital", it can carry as many as 24 litter patients.



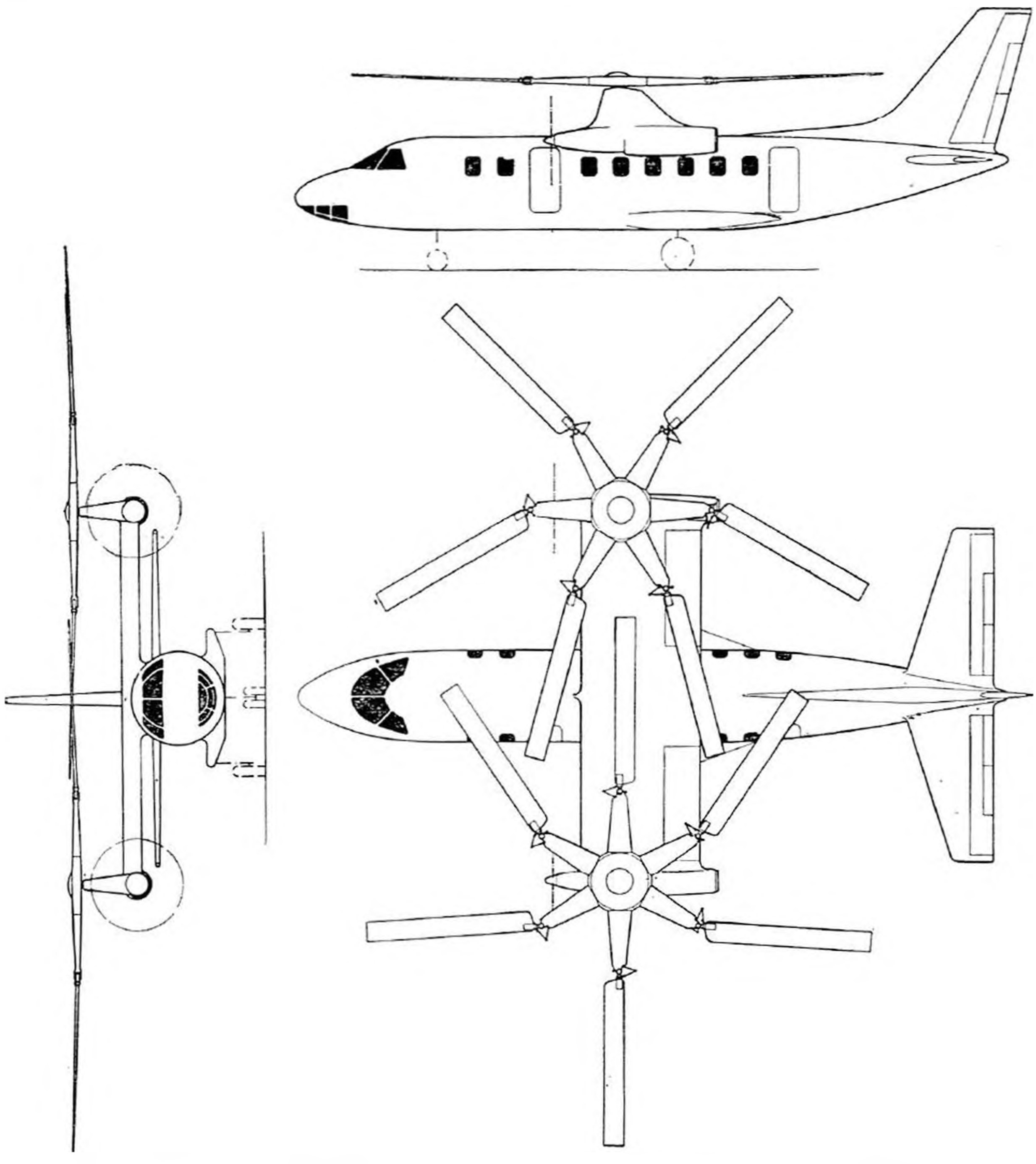
Three views showing the transition from vertical to horizontal flight of the Vought-Hiller- Ryan XC-142A Transport in advanced stage of construction. Full slipstream effect is obtained over the entire wingspan and special airscrews permit VTOL operation by means of tilting the wing, while a tail rotor gives horizontal stability.

The XC-142's four T-64-GE-6 engines drive four conventional fifteen and a half foot, four-blade propellers and a horizontally-mounted eight-foot diameter tail rotor. Safety features include a system of cross-shafting connecting all four engines and tail rotor. Over-riding clutches are provided so that the plane can remain aloft with a minimum of two engines in operation. Dual synchronised wing tilting actuators provide "fail-safe" reliability.

A mechanical integrator linkage that transmits cockpit control motions to the proper control surface as a function of wing incidence is a unique feature of the XC-142's flight control system. A dual four-function stabilisation system gives the transport stability during IFR flight, hovering, and



Twin-engined tilt-wing project by Canadair is the CL-84, beating a rather lonesome track as a twin-engined tilt-wing project in view of fail-safe requirements.



A blend of everything in the BOLKOW P110 Rotorcraft using the Derschmidt high-speed rotor system which enables it to fly at 310 m.p.h. This is a 23-seat short-range airline project using two 3,300 h.p. engines, driving normal air screws for forward thrust plus the inter-meshing rotors, each of 43 ft. 2 in. diameter. Other combinations of helicopter and conventional air frame designs are likely to appear in the coming year from well-known manufacturers.

transition. The hydraulic system is used for engine starting, power control, and stabilisation, as well as utility and emergency systems operation.

The wing is mounted on the fuselage at four points and tilts through an angle of 100 degrees, allowing the XC-142 transport to hover in a tail wind. The wing has full span, double-slotted flaps with the aft outboard sections operating independently as ailerons. The horizontal tail is a single movable unit, shaft-supported on two bearings by the vertical tail.

The Canadair **CL-84** aircraft also achieves its VTOL capability through the application of the tilt-wing/deflected slipstream principle. The wing and propulsive system are mounted on a common axis in the fuselage about which they may be rotated, either in flight or on the ground. To take-off vertically, the wing is tilted upwards and sufficient thrust is generated by the propellers to lift the aircraft. Once airborne, the wing angle may be decreased, reaching its full-down position when the aircraft has attained sufficient forward speed to fly on wing lift alone. This is the normal cruising configuration.

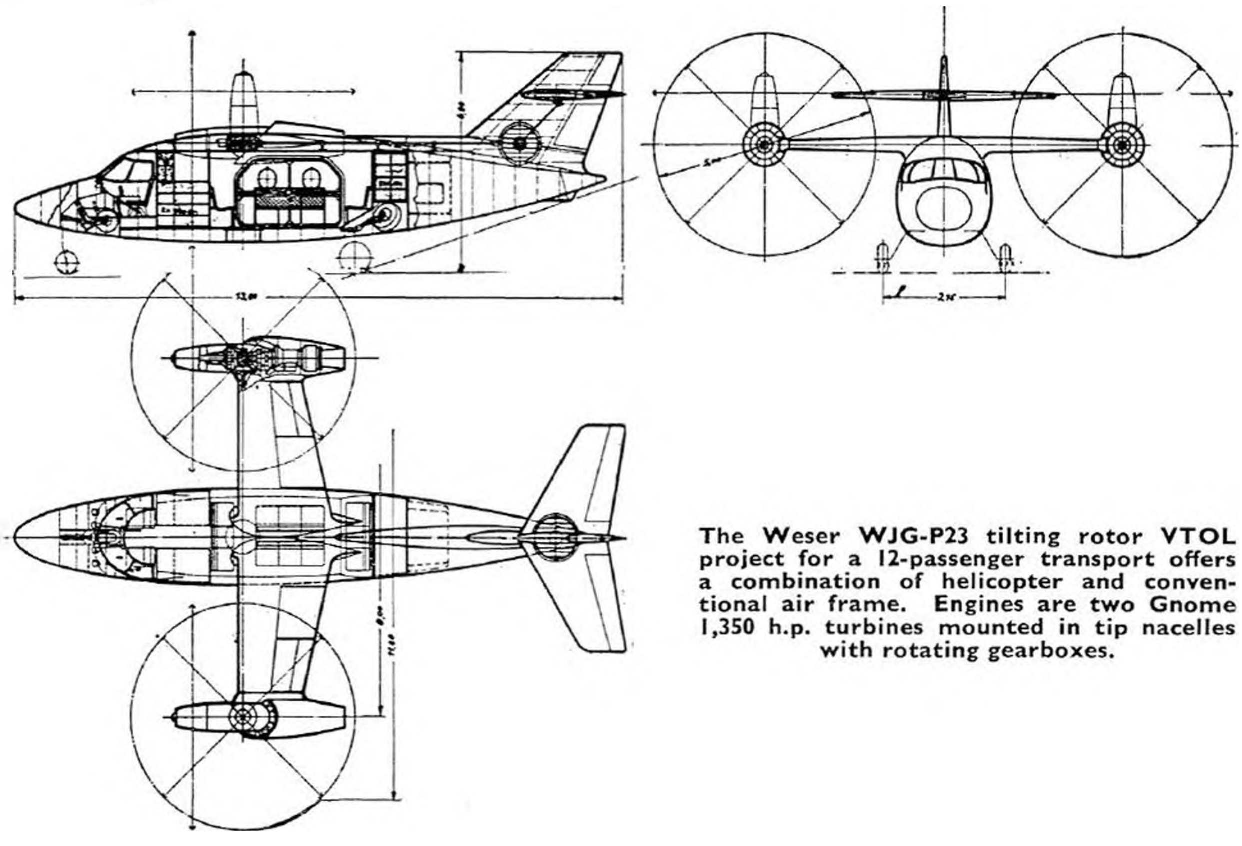
To land vertically from the cruise configuration, the sequence is reversed. As the wing rotates upwards, the forward speed decreases until it reaches zero, at which time the aircraft is hovering like a helicopter. A slight reduction in thrust then allows the aircraft to settle to the ground.

At low or zero forward speeds, the CL-84 is claimed to be much more efficient than the jet-lift types of aircraft and its cruise efficiency far surpasses that of the helicopter. The high efficiency of the CL-84 in cruise is due largely to the free-turbine power plants which allow the necessary low propeller r.p.m. in cruise without a sacrificing engine.

Lightweight propellers, with glass-fibre reinforced plastic blades and integral gearboxes have been selected for the CL-84 from considerations of weight, performance, reliability and VTOL experience. The interconnecting shafting between the engines ensures safe operation even with one engine inoperative.

During cruise, the tail rotor, which supplies pitch control during slow speed flight, is shut down and conventional aerodynamic controls are used. The handling qualities of the CL-84 over the full speed range compare to those of modern fixed wing aircraft. Its ability to accelerate and decelerate quickly provides for effective evasive action in battlefield areas.

Even a short take-off run yields an appreciable gain in payload. This is due to the increased effectivity of the wing from the use of leading and trailing edge flaps. For example, the CL-84 can take-off over a 50-foot obstacle in 500 feet carrying twice its normal VTOL payload.



The Weser WJG-P23 tilting rotor VTOL project for a 12-passenger transport offers a combination of helicopter and conventional air frame. Engines are two Gnome 1,350 h.p. turbines mounted in tip nacelles with rotating gearboxes.

When all the engineering aspects of the tilt-wing transport are developed, it will open entirely new vistas for air transport in hitherto inaccessible areas. To the modeller, especially scale control-line, it offers a tremendous challenge for ingenuity. Wings which are tilted in angle of attack are the approach for VTOL and now we revert to the variable sweep wing, which we first discussed in connection with the VTOL Republic strike-recce type.

The "Swing-Wing"

The original idea of varying angle of wing sweep according to aeroplane speed can be traced back to a version of the German-built Messerschmitt P-1101. The prototype flew in 1944 and fell into Allied hands in May, 1945.

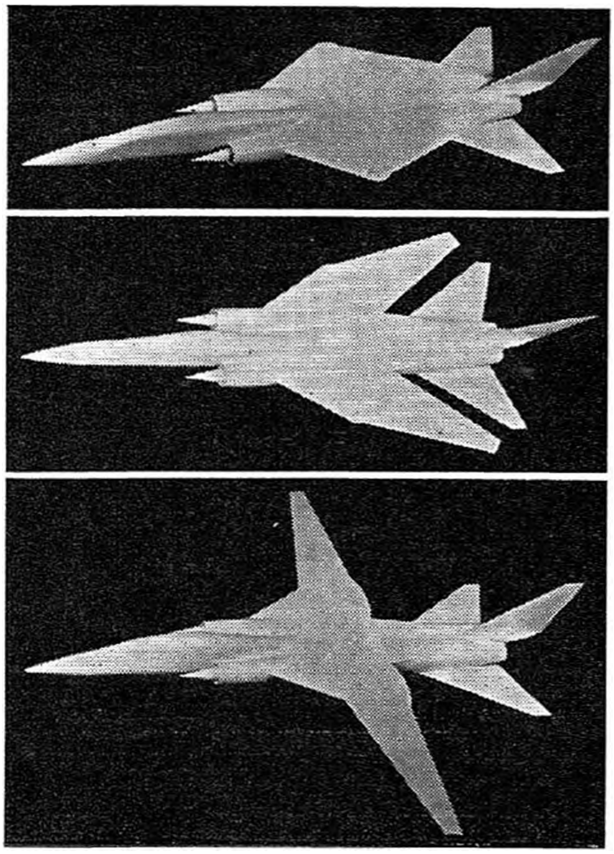
After the war, the National Advisory Committee for Aeronautics (now NASA) initiated a programme which resulted in the Bell X-5, with variable sweep from 20 to 59 degrees.

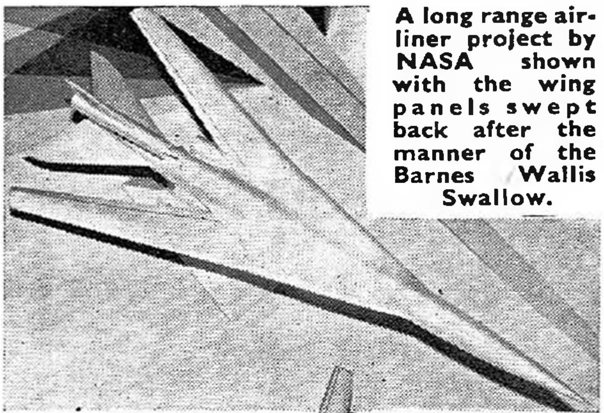
Then Grumman stepped in with the swept-wing Grumman F101-1.

About the same time, Dr. Barnes Wallis, of Vickers-Armstrongs, revealed his proposal for a supersonic airliner, using variable sweepback on the wings. This was called the "Swallow" project.

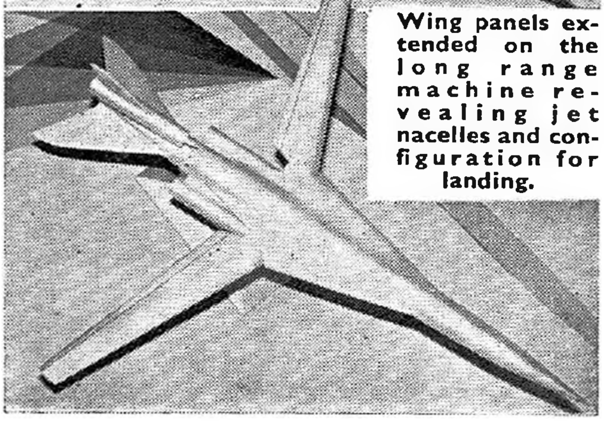
This sort of design called for a massive mechanism which proved impractical. Tests indicated longitudinal instability at relatively low angles of attack in the high-sweep attitude, and at moderate angles of attack in the low-sweep attitude. Lack of significant control and possibility of complete loss of control in the event of engine failure were largely unfavourable.

Although the F-111 project is secret, photographs below, left, of an NASA research model to 1/24th scale have been hinted as being most likely to convey the general shape of the TFX F-111 machine. Variable sweep wing stages are shown for high speed to low speed flight extending from normal sub-sonic landing speeds to Mach III. The wing panels are also extended for long range ferry flying.

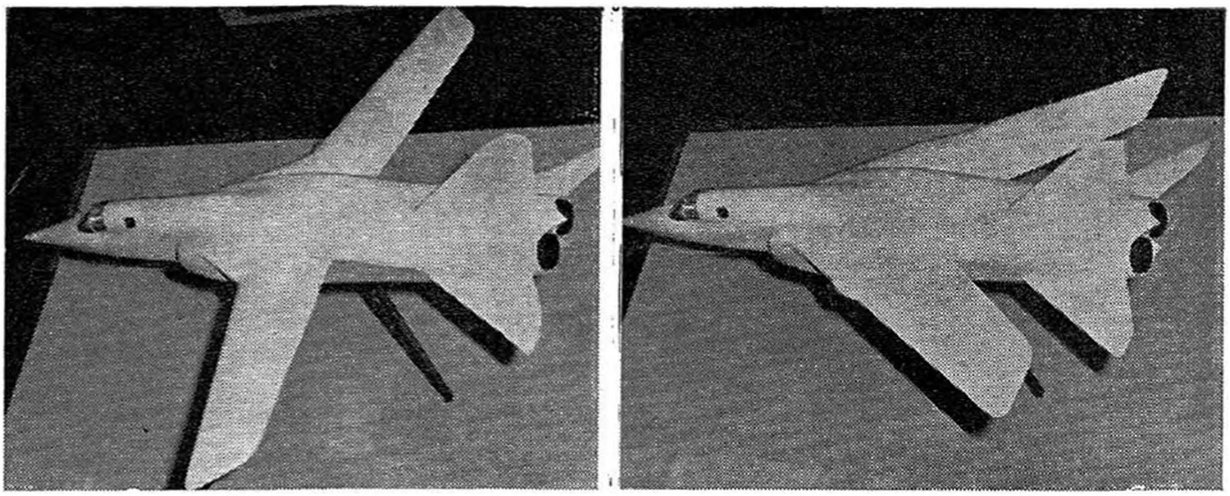




A long range airliner project by NASA shown with the wing panels swept back after the manner of the Barnes Wallis Swallow.



Wing panels extended on the long range machine revealing jet nacelles and configuration for landing.



Exhibited at Paris with a suggestion that it might be close to the TSR-2 project, this British variable sweep wing clearly indicates an English Electric family resemblance in high speed form, but utilises side-by-side twin jet mounting.

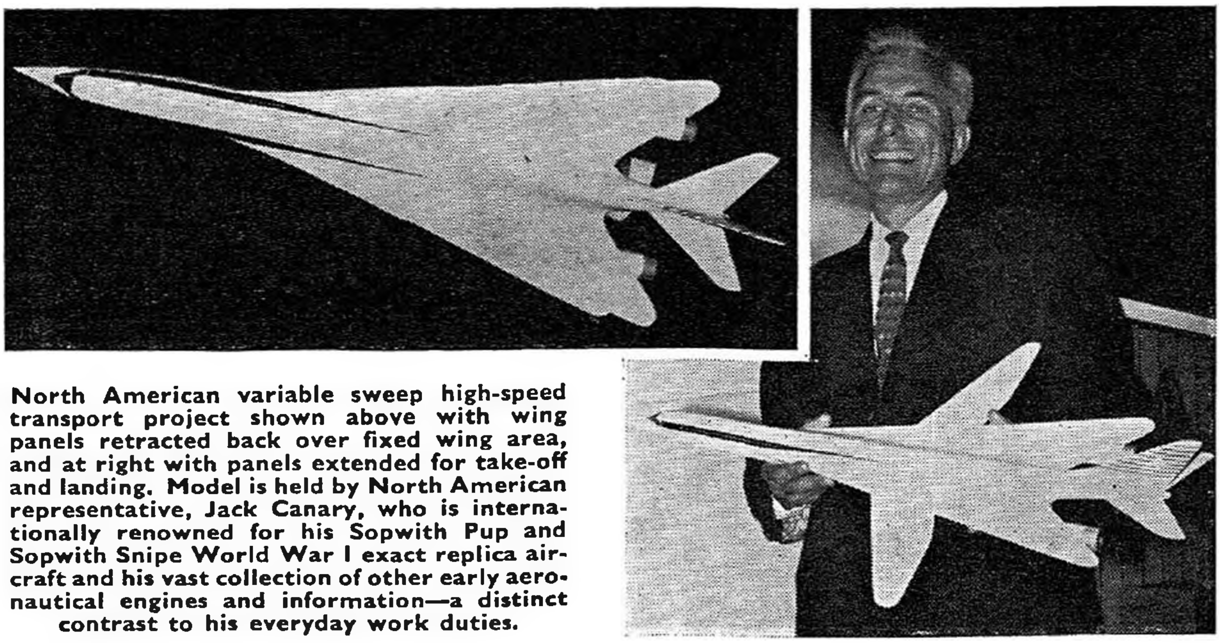
In 1959 Tactical Air Command (U.S.A.) stated its requirements for a multi-purpose fighter to NASA. By 1960, John Stack and a nucleus of men from the Swallow project had evolved a system—based on original work by Thomas A. Toll—in which the pivot point was placed out on the wing, away from the fuselage.

Two of the engineers who worked in the early Swallow project, William J. Alford and Edward C. Tolhamus, applied for a patent on the principle in July, 1960.

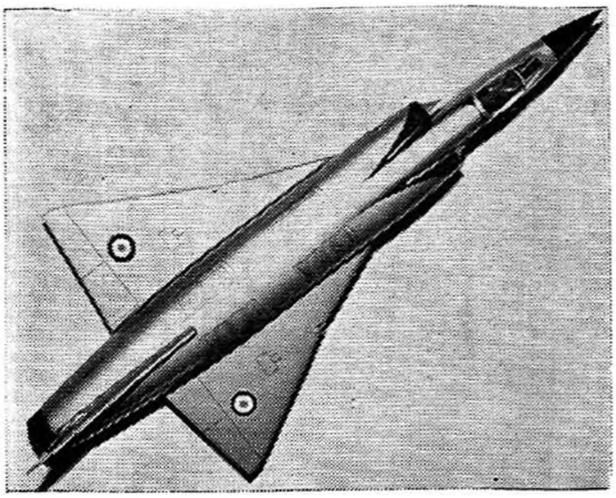
Then the U.S. Air Force took its requirements to industry, with the General Dynamics Grumman team winning one of the longest and most exacting competitions in U.S. history.

Long and acrimonious testimony before Senate, involving cases for Boeing and the General Dynamics proposals for this "TFX" contract brought to light the bitter competition which exists in the U.S. Aviation industry.

Artist's impressions of the TFX which will be known as the F-111A in the Air Force and F-111B in the Navy, show the movable wing as on this Aeromodeller Annual cover. It will have a Pratt & Whitney JFT-10A-20



North American variable sweep high-speed transport project shown above with wing panels retracted back over fixed wing area, and at right with panels extended for take-off and landing. Model is held by North American representative, Jack Canary, who is internationally renowned for his Sopwith Pup and Sopwith Snipe World War I exact replica aircraft and his vast collection of other early aeronautical engines and information—a distinct contrast to his everyday work duties.



Model above exhibited at Paris Aero Show of the VTOL Mirage III-V, showing four intakes for multiple Rolls-Royce Vertical jets in the fuselage and diminutive wings on large body.

The Balzac in hovering flight at Paris using vertical thrust through four apertures in the fuselage underside and stabilising jets at air frame extremities.

Turbofan and be capable of a wide speed range of operation. Navy version will have a strengthened landing gear for high landing loads and bolt-on wing tips for extra area.

Other Variable Sweep Wings

Many tactical fighter project models, and indeed transports were exhibited at the June Le Bourget Salon Aeronautique. North American, British Aircraft Corporation and N.A.S.A., each displayed actual tunnel models, all overpainted in the 1963 fashion tone of white. Some of them are pictured here, and again, they give the enterprising aeromodeller a source of design stimulus for the unorthodox approach.

STOL with 45° jet deflection and full flap over grass at Paris Aero Show of the Hawker P-1127 which uses swivelling jet nozzles for vertical and horizontal flight. Unfortunately this particular exhibition terminated in a crash due to the jet nozzles adopting an excessive aft angle at a critical hover stage.

VERTICAL TAKE-OFF AND LANDING AIRCRAFT

Aircraft	Mode	Power	Remarks
Aerodynamic deflection			
RYAN VZ-3 "Vertiplane"	Slipstream deflection with variable wing camber	900 h.p. Lycoming driving 2 three-blade airscrews.	Fixed leading edge with large area flaps. Large wing/end plates, high tailplane.
VERTOL VZ-2A	Tilting wing.	900 h.p. Lycoming driving 2 three-blade airscrews.	First tilt wing with rotating thrust, transition VTO 23-7-58.
HILLER X-18	Tilting wing.	Two Allison T40, 5,850 h.p. driving twin contra props and Westinghouse J-34 1,540 h.p. for control.	2nd U.S. Tilt wing, uses jet thrust stabilisers at nose, tail and tips for transition.
VOUGHT-HILLER-RYAN XC-142A	Tilting wing plus tail rotor.	Four General Electric T64 of 2,850 h.p. driving 4-blade airscrews.	3rd U.S. Tilt wing, to fly March '64, a tri-service trooper/transport 32 passengers.
BELL X-22A (derived from DOAK 16)	Part tilting wing plus rotating ducted fans.	Four General Electric T-58 of 1,250 h.p. driving airscrews on foreplane and mainplane within ducts.	Four jets for forward thrust, also drive rotors. Canard configuration with tilting foreplane and mainplane tips. 6 passengers.
CANADAIR CL-84	Tilting wing plus tail rotor.	Two, 1,100 h.p. turbo props.	First Canadian tilt wing trooper/transport. Full span slipstream deflection.
RYAN (Girard) "HELIPLANE"	Rotating Delta wings.	Prototype plans not released.	Contra-rotating delta wings give vertical lift, remain fixed for forward flight.
Thrust deflection			
CURTISS-WRIGHT X-19	Tilting airscrews.	Two Lycoming T-55 driving four airscrews on foreplane and mainplane.	Fixed Canard configuration with tilting nacelles at tips. To fly late 1963.
RYAN VZ-11 (XV-5A)	Lift fans in wings and nose.	Two General Electric J85 turbojets.	Jet exhaust driven fans give vertical lift. Louvres closed in nose and wings for forward flight.
VANGUARD 2 "OMNIPLANE"	Rotors in wings plus tail thrust airscrews.	One Lycoming YT-53 600 h.p.	6 ft. 6 in. Rotors in wings give vertical lift, tail airscrew has a ring duct, all mechanical transmission.
BELL X-14	Jet thrust deflection.	Two Armstrong-Siddeley Viper Turbojets.	Conventional airframe configuration for jet thrust deflection experiments.
LOCKHEED XV-4A "HUMMING BIRD"	Jet thrust deflection.	Two Pratt & Whitney JT12 turbojets.	Thrust bleed to vertical ducts in fuselage, virtually cold air thrust for VTO.
HAWKER P-1127	Vectored thrust through 4 effluxes.	One Bristol-Siddeley "Pegasus".	Rotating nozzles plus jet stabilisers at extremities. Development prototypes for P-1154. First transition 12.9.61.
MESSERSCHMITT VJ-101	Rotating tip nacelles.	Six Rolls-Royce RB-145 Turbojets two in each nacelle, two in fuselage.	Forward thrust from 4 of the 6 VTO units. Supersonic X2 version being developed.
REPUBLIC VTOL	Vectored thrust through 4 effluxes.	One Bristol-Siddeley 100	Rotating nozzles plus jet stabilisers at extremities and variable sweep wings in Canard configurations.
Vertical Thrust			
SHORT SC-1	Vertical thrust, multiple jet plus propulsion jet.	5 Rolls-Royce RB108, 4 mounted vertically for VTO thrust.	Delta experiment to prove vertical thrust theory. First of its type.
MARCEL-DASSAULT "BALZAC"	Vertical thrust, multiple jet plus propulsion jet.	8 Rolls-Royce RB108 mounted vertically, one Bristol Siddeley "Orpheus" for forward thrust.	Delta development of Mirage for subsequent Mirage III-V.
FIAT G95/4	Vertical thrust, multiple jet plus propulsion jets.	4 unspecified VTO jets with swinging nozzles plus 2 after-burning propulsion jets.	Swept wing tactical support aircraft to succeed Fiat G91 of less than 8 tons. Cold jet control systems for VTO at extremities.

Transport Projects

Mixed vertical/forward thrust aircraft using pure turbojet, turbine driven rotors and/or turboprops are under development by Armstrong-Whitworth (AW681), Focke-Wulf, Bolkow, Fiat (G222), Sikorsky and Messerschmitt.

H.T.O.L. (Heliport Take Off and Landing)

Another full-size development with model applications.

Wren 460 conversion of a Cessna Skylane opens up new vistas in low speed aerodynamics.

Take a standard Cessna 180 or 182, have it modified extensively by Wren Aircraft Corp. of Fort Worth, Texas, and it becomes the WREN 460, a machine with a 26-160 m.p.h. airspeed range. The manner in which this remarkable transformation takes place is an object lesson to aeromodellers—maybe the ULS system of control foreplane trimmers will have its uses for sport modelling.

Certainly a flying scale Wren 460 would make a most interesting subject.

Now for an explanation of the features:

The Wren 460 is equipped with full-span, double-slotted flaps that can be lowered to 40°. At the fully extended position, the lift of the Wren wing is increased nearly *three* times over the normal configuration, and drag is approximately quadrupled.

Large, effective Flaps

As this drag begins to take effect, additional power is required to offset it. As the flaps continue to be extended and drag increases, still more power is required to maintain level flight. This situation is known as "flying up the backside of the power curve". This *dual* use of power—for both high speed flight *and* low speed flight—is the source of Wren's model designation "460"—*dual* use of the power from the 230 h.p. Continental 0-470 engine.

Thus, it can now be seen that 200 h.p. is required for *both* at 160 m.p.h. speed and for a speed slightly below 25 m.p.h. In between these speeds, the power needed to maintain level flight drops to a low of about 75 h.p. to stay level at 75 m.p.h.

Flap design such as that used on the Wren is certainly not new, having been used many times before, but seldom to the extent utilised in the Wren. One development *is* of particular interest, however, and that is the unique Wren design which finds the turning vane (the smaller flap located between the wing itself and the larger, trailing edge flap) *always* at the most effective position in relation to both wing and trailing edge flap, regardless of extended position. This unique design results in complete elimination of the "buffeting" that is a common occurrence in most double-slotted flap installations.

There are many facets to the problem of providing adequate control under conditions of slow air speeds. Of primary concern is the lack of *energy* in the passing air, when the plane is flying at speeds below 60 m.p.h. As the *speed* decreases by one-half, the *energy* drops by three-fourths.

To provide normal control surfaces with enough area to be effective at speeds in the 20 to 40 m.p.h. range results in far too sensitive control at normal speeds because these control surfaces would then be almost as large as the wing itself.

Low Speed forward planes

Wren answers this problem by use of the patented Robertson ULS (Ultra Low Speed) control system.

Since the large flaps effectively "blanket out" the conventional horizontal

The photo of the Wren 460 clearly illustrates the "Wren's teeth" in neutral position above the wing, the low speed forward planes on the nose and the anemometer on the starboard wing strut which is necessary to record accurately the very slow flight speed down to 26 m.p.h.

tail surface, pitch control becomes the major problem during slow flight for an aircraft in the Wren's size/weight/power category. In addition to the other problems affecting control when flaps are extended is the great lift generated *behind* the centre-of-lift of the wing in normal flight. As the centre-of-lift thus moves *rearward*, a strong *nose-down* reaction develops. To correct this resulting unbalance, normal elevator action would use up the full available force that it could generate.

The ULS system, mounted on the nose of the Wren, directly in the propeller slipstream, deflects this strong air blast to produce powerful control forces at low airspeeds equal to that of the normal elevators at speeds of 70-80 m.p.h. At 30 m.p.h., however, the normal elevators are producing only about one-seventh as much control force as they do at 70 m.p.h.

Because power is required to offset the drag produced by extended flaps at slow speeds, the blast of air from the propeller increases in force as the speed of the airplane decreases. In turn, this results in the effectiveness of the ULS controls *increasing* as the speed of the plane *decreases.*

The ULS controls are integral with the elevator controls by a direct push-rod linkage to the control yoke. They operate in conjunction with the normal elevators at all times. Being of small area relative to the elevators, they provide a very minor effect during cruising conditions when the elevator itself provides adequate control with very slight deflections.

The ULS contributes to the overall lift by providing an *upload* in counterbalancing the tail's *download* resulting in a greater net lifting force on the aircraft.

Wren's Teeth

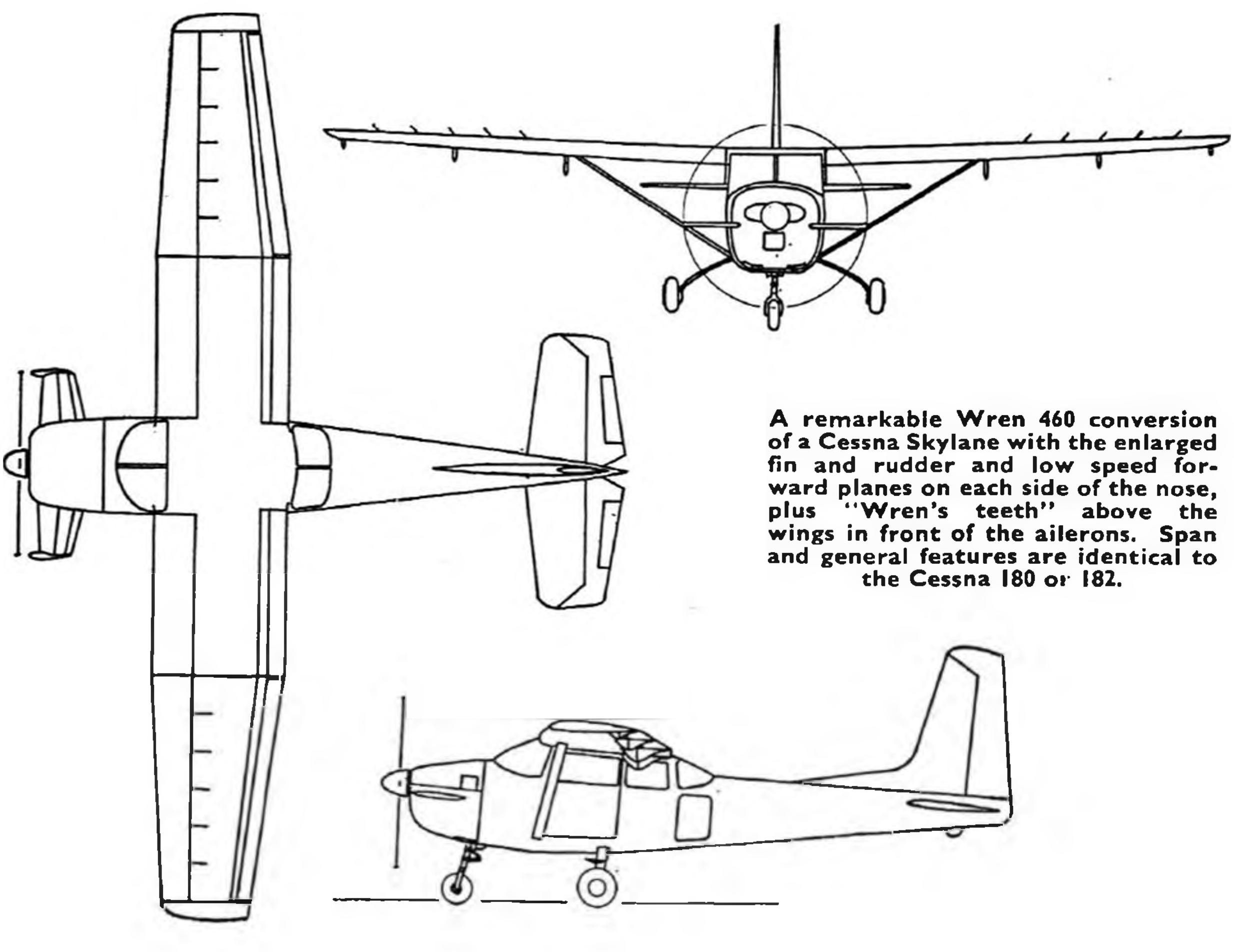
At slow speeds, such as those encountered by the Wren, another phenomenon occurs in that the use of great amounts of aileron deflection creates enough drag to bring an undesired "yaw" toward the "down" aileron ("up" wing). This action is opposite to that desired in a correctly banked turn.

This adverse yaw characteristic is eliminated in the Wren by use of another new design feature used for the first time. Termed "Wren's Teeth", these appear as five thin steel plates mounted above each wing directly ahead of the ailerons. In normal flight conditions, these "teeth" retain a "feathered" position edgewise into the slipstream and canted about 30° toward the wing tips. The Wren's Teeth are connected directly to the aileron control linkage. When an aileron is deflected *upward*, the Wren's Teeth on that wing *only* rotate about their mounting pivots turning about 50° broadside to the slip-stream, providing drag on the down-wing, thus offsetting the adverse yaw of the opposite wing. The "Teeth" on the opposite wing remain stationary. The advantage of the Wren's Teeth as a "spoiler" lies in the *instant* reaction they generate.

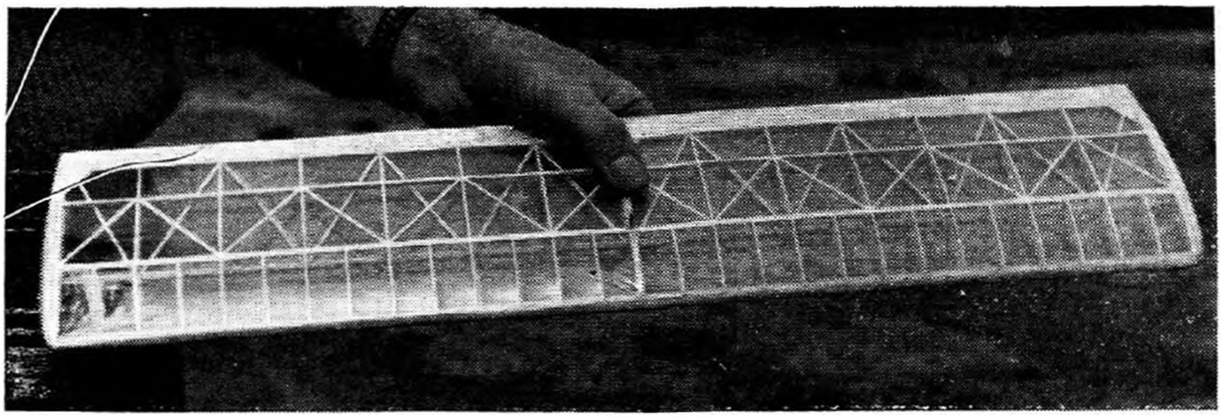
Augmented Leading Edge

To provide effective stall resistance at slow speeds, the full length of the leading edge of the Wren wing has been "augmented" by a wrap-around cuff of sheet metal that enlarges the radius of the leading edge and causes a slight "drooping" appearance in cross-section. This blunted leading edge produces exceptional stall resistance up to high angles of attack (28°). Stall is preceded first by gentle buffeting felt in the rudder pedals, then by increasing mild buffeting. Stalls are extremely gentle. The Wren will *not* stall power-off. Because of the strong control forces generated by the ULS control, it is im-practical to eliminate power stalls.

These, then, are the methods utilised by Wren to provide slow flight capability combined with safe and effective manoeuvring control even at speeds to or below 26 m.p.h. The only ill effect of these devices is a net decrease of approximately 4 per cent in the high speed capabilities.



A remarkable Wren 460 conversion of a Cessna Skylane with the enlarged fin and rudder and low speed forward planes on each side of the nose, plus "Wren's teeth" above the wings in front of the ailerons. Span and general features are identical to the Cessna 180 or 182.



Melinex clear covered tailplane by Jim McCann for a ½A power model shows the rigid structure he advises, later version of which is described in this feature.

READY-MADE COVERING—MELINEX

Our first introduction to Melinex came through the Hatfield Group Man-powered aircraft detailed in the last Aeromodeller Annual. The "*Puffin*" is entirely covered in Melinex. It was applied for two reasons. Firstly to maintain light weight by preventing water absorption in the bare balsa structure. Secondly to improve the aircraft surface aerodynamically.

It can do exactly the same for aeromodelling. A few modellers have used it successfully and we feel it has a great future. Not necessarily a complete replacement for doped tissue: but certainly to be used in particular cases, as we shall outline.

First, the official description:

"Melinex" is the registered trade mark of polyethylene terephthalate film manufactured in Great Britain by the Plastic Division of Imperial Chemical Industries Limited.

For a little over a decade the only form in which polyethylene terephthalate polymer has been fabricated in the United Kingdom is that of fibre, sold under the registered trade mark "Terylene". More recently, however, attention has been directed to the polymer's film-forming characteristics, and a considerable amount of work has now been carried out on the manufacture of "Melinex" polyester film.

"Melinex" film is tough, transparent and flexible, with a high surface gloss, and has outstanding mechanical strength over a wide range of temperatures. It is used in a multitude of commercial applications from camera film to sweet wrapping, book covers to typewriter ribbons, insulation, musical drum heads, yacht sails, Christmas tree decorations, food wrappings, all forms of packaging, adhesive tapes, gaskets, for tracing, loudspeaker diaphragms, electrical goods manufacture and magnetic recording tapes.

In other countries it has a different trade name, for example in France it is "Terphane"; Germany, "Hostaphan"; Italy, "Montivel"; Japan, "Tetoron" and "Diafoil" and in the U.S.A. it is "Mylar".

One of the first to realise the potentialities of Melinex for aeromodelling was Jim McCann, of Redcar, Yorks. His article in "*Northern Area News*" of August, 1962 gave a new technique for model covering:

"Adhesives presented a problem at first. I tried tissue paste, balsa cement, P.V.A., Lepage's Liquid Glue and Araldite—all were of no use, and eventually I tried Evostik—this adhered very well, but was a bit thick and messy. Finally I used two parts of Evostik and one part of chloroform, and this has proved satisfactory.

"The Melinex is cut a little oversize, and laid on a 'Formica' surfaced table, smoothing out all wrinkles and trapped air with a *fluff free* duster. The wing (or tail) is then coated thinly around the edges with the thinned-down Evostik and allowed to dry. Then the frame is placed onto the Melinex and gently pressed into contact with it. After removal from the table, complete the 'contact' process, and trim off. Cambered surfaces are done similarly, except that the L.E. is placed in contact first, and then the frame is rolled over the film, finally picking up the film at the T.E., then trimmed off, allowing a little overlap, the overlap coated with Evostik and after drying, pressed down. This method results in a moderately tight covering, but not tight enough. Since it cannot be doped again an alternative method had to be found, and it turned out to be very simple—simply hold in front of an electric fire, and it goes drum-tight, with less sag than with doped tissue. Melinex melts at about 250°, so care must be used to avoid local overheating, which results in holes suddenly appearing.

"I covered the wings and tailplane of a 34 in. power model (Tee Dee ·020) and the weight of the covering was:

Tailplane (60 sq. in.) (*i.e.*, 120 sq. in. of Melinex) 17 grains
Wing (140 sq. in.) (*i.e.*, 280 sq. in. of Melinex) 40 grains
(480 grains = 1 oz. approx.)

This works out at about 0·12 oz. to cover *both* wings and tail. On this basis a Wakefield size model could be covered with only about 0·25 oz. of Melinex.

"My power model flew quite well, but it showed up one disadvantage of Melinex—lack of torsional stiffness. My wings were simple parallel ribs and two spars and flexed slightly. On stripping and re-covering with tissue, this flexing disappeared.

"In spite of being completely transparent, it is highly reflective and visibility did not pose the problem it was thought it would".

We supplied Jim with samples of different types of Melinex, including some which had been processed by printers in colour and with metallised surface and he has produced the following summary of experiments up to present.

Clear transparent Melinex is available in a wider range of thicknesses than any other form—the best for model use are 25 and 50 gauge (¼ and ½ thou. respectively)—only snags are that the static electricity charge makes handling rather tricky, and its complete lack of colour, although this is affected by it being very reflective, for visibility it is no worse than a light-coloured tissue model. It shrinks readily by local heat, *e.g.*, an electric fire, but care must be taken to avoid overheating, which melts the Melinex into holes.

Metallised Melinex. Handling qualities much improved due to almost total absence of static. However, the very reflective surface (comparable to a mirror) makes shrinking by heat rather difficult, *as the heat is reflected*, the Melinex remaining comparatively cool. It is only too easy to overheat suddenly and produce holes—most annoying!

Coloured Melinex. Two types. (*a*) Transparent Melinex with colour on surface. This shrinks well with heat, but the colour is *not fuel proof.*

(*b*) Metallised Melinex with colour applied on surface. Again is not fuel proof, and in addition the aluminium coating reflects heat—probably the most unsuitable unfortunately.

Structures for Melinex Covering

We will consider wings, tail and fin only, for power fuselages are invariably sheet boxes, similarly Wakefields and A/2.

Melinex does not impart torsional rigidity as does tissue, so straight away conventional parallel ribs are out of the question. Even with diagonal bracing the structure is not rigid enough. The other anti-warp type of structure (which I sometimes use) is the D section torsion box, where the front one-third (approximately) is sheet-covered on top and bottom and webbed, is rigid; but the large area of sheet tends to conduct the heat away from the Melinex, resulting in uneven shrinkage unless heating is prolonged and this entails the risk of melting holes in those areas not sheet-covered.

By far the best type of construction is geodetic (and this applies to tissue covering also). It is sufficiently rigid on its own, and providing materials are carefully selected carries no weight penalty. Using the construction detailed later, I have built a 30 in. x 4 in. wing down to 0·4 oz., which is reasonably light. Geodetic construction may be considered a must for Melinex.

Adhesives for Melinex

1. *Evostik*. This on its own is too thick—when thinned down, two Evostik to one solvent (I used chloroform), is about right—it has good adhesion and when set does not allow the Melinex to slide during shrinking. I found that the finger tip is the best "tool" for spreading Evostik but tends to be messy unless one is continually cleaning the finger with solvent-soaked rag.

2. *Holdtite "Tite bond"*. Another satisfactory adhesive—clear and colourless and suitable straight from the tube. It is thin and spreads easily and adheres well. It must be allowed to dry out before applying Melinex and then allowed to set before shrinking to avoid "sliding".

3. *National* 31-341. A white milky adhesive—easy to spread but very slow drying—must be allowed to dry out before applying Melinex. Adhesion to Melinex is satisfactory, but does not appear to stick to balsa too well—Melinex can be peeled off the frame quite easily, which is not the case with Evostik.

My considered opinion is that Melinex is a very suitable material for aeromodelling use, *providing*:

1. Its use is confined to flying surfaces only.
2. The structure must be built with Melinex in mind, since it imparts little or no torsional rigidity. Geodetic or similar is essential for light structures, *e.g.*, open rubber wings, while heavier wings, *e.g.*, F.F. power a box-section L.E. of approximately 35 per cent chord would be adequate, preferably with warren girder type ribs from rear of box L.E. to the T.E.
3. Rather difficult to use on elliptical surfaces or other surfaces where there is a double curvature—tends to wrinkle along the edges. Therefore, better on constant chord or straight taper wings.
4. A different handling technique is necessary and practice will produce a neat job.

When used, Melinex provides advantages which outweigh these minor snags, as detailed on the following page.

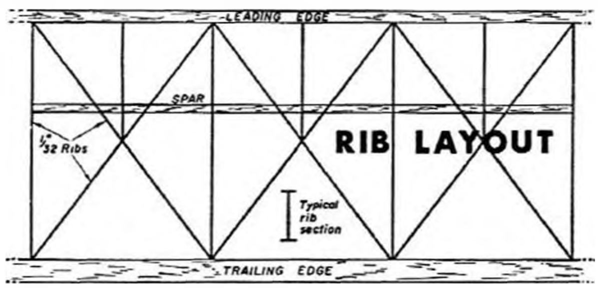
5. *Advantages.*
(*a*) Very light weight.
(*b*) Almost indestructible—will not puncture or rip like tissue—can be jabbed with a finger and will not tear.
(*c*) Clear Melinex is *completely* fuel proof (unlike some so-called fuel proofers).
(*d*) Does not require doping (a boon to those with chest conditions).
(*e*) Super smooth finish, as smooth as glass, giving lower drag.
(*f*) Less sag between ribs.

In conclusion I would say that "Melinex" has a lot to offer, and while it may not be the ideal covering material, it does go part of the way to overcoming some of the drawback of tissue covering.

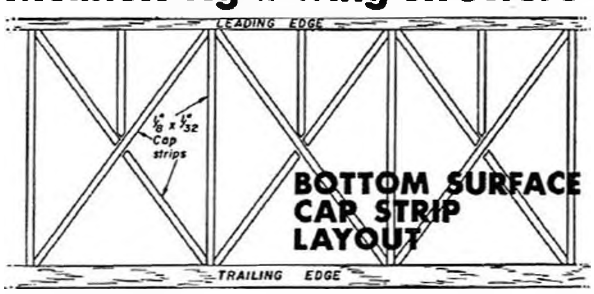
For a warp free, rigid structure, the diagonal rib system is advised.

This method of construction concentrates strength on the outer surfaces, where it is most needed for rigidity.

1. Pin down L.E. and T.E. add lower cap strips (for flat bottom sections) thus:
   Note that lower cap strips are composed of one full length, and one in two halves, between bays.
2. Add lower spar.
3. Add chord-wise ribs, notching each for spar.
4. Add diagonal ribs, putting full-length ribs over the cap strip which is in two halves.
5. Add riblets.
6. Add upper spar.
7. Add upper cap strips—diagonal ribs which are in two halves have continuous cap strips.



'Melinex' rigid wing structure

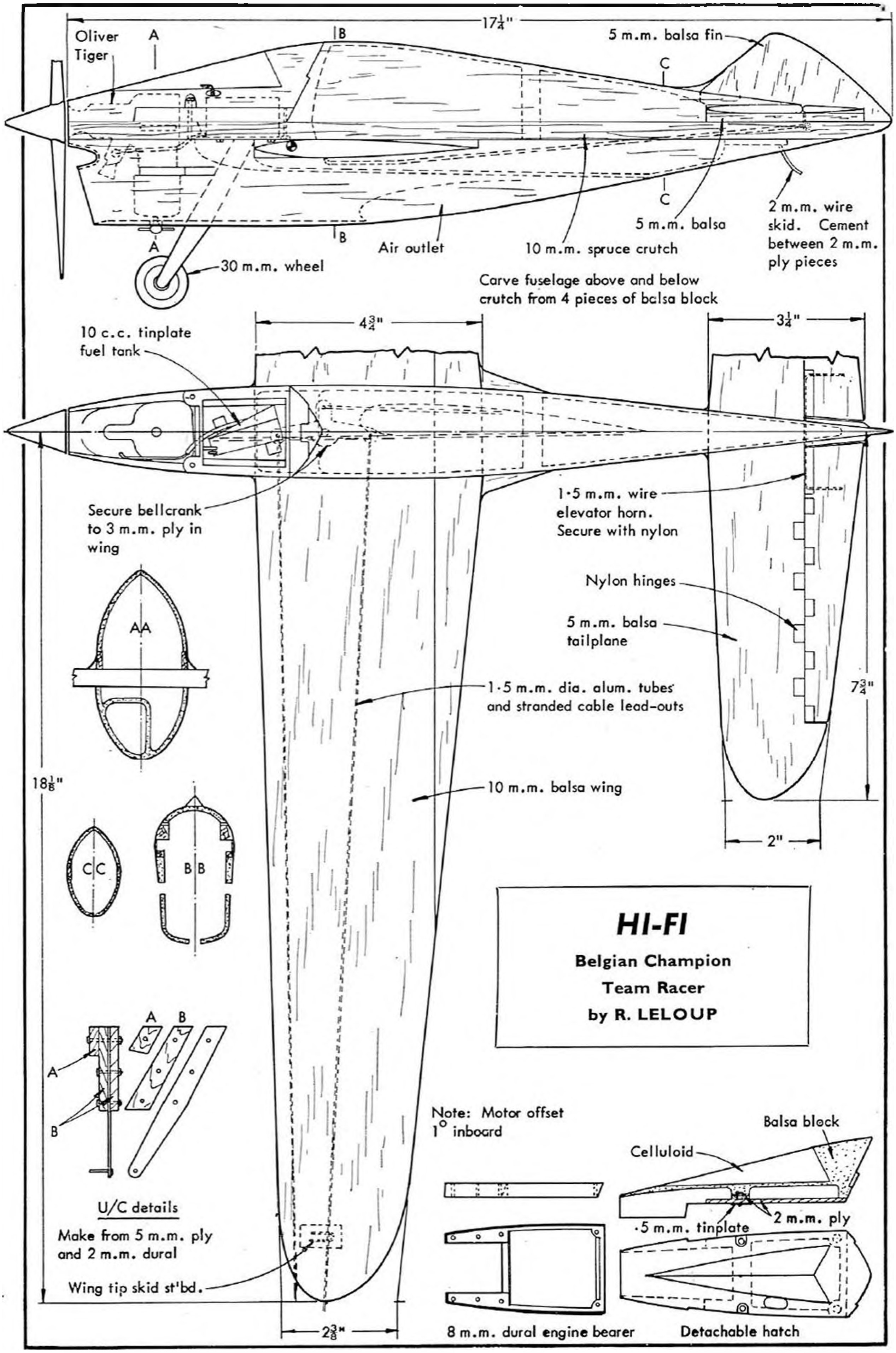


This method adds to rigidity by means of cap strips, strength is added by having continuous cap strips over those diagonal ribs which are in two halves. For larger wings, spars can be webbed.

Up to 6 in. chord, $\frac{1}{32}$ ribs and $\frac{1}{8} \times \frac{1}{32}$ cap strips, from light (*i.e.*, 6 lb/cu. ft.) quarter grain quite sufficient—this produces light, rigid structure and riblets preserve a reasonable entry for wing section.

Those experimenters who would like to try Melinex are offered a sample sheet free of charge, by courtesy of the printers who have produced the coloured 50-gauge material ($\frac{1}{2}$ thou.) and Model Aeronautical Press Ltd. Send foolscap or larger, self-addressed and 3d. stamped envelope to:

Melinex Sample,
Aeromodeller Annual,
38 Clarendon Road,
Watford, Herts.



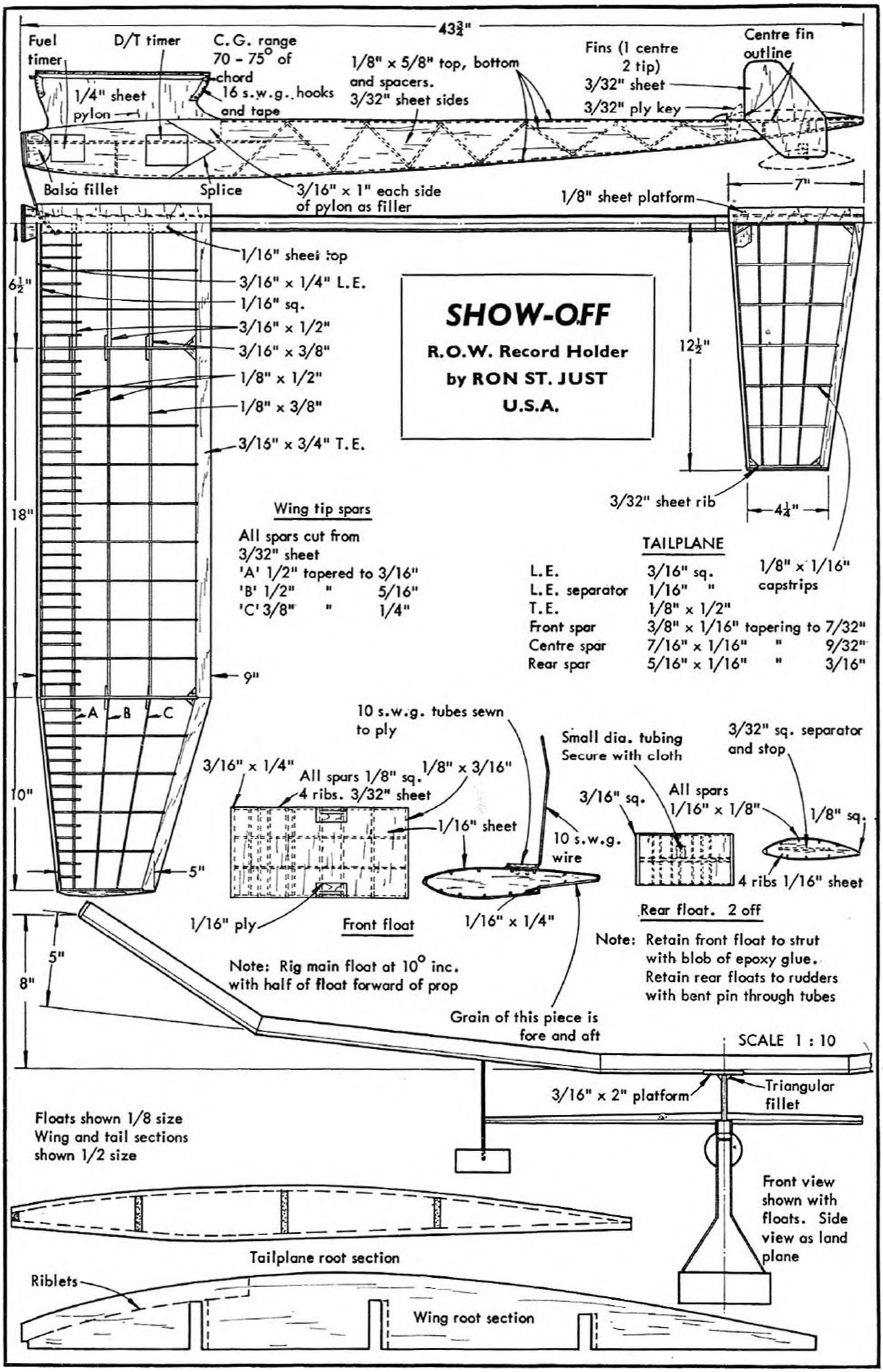
HI-FI

Belgian Champion

Team Racer

by R. LELOUP

MODEL AVIA, BELGIUM


43¾"
Fuel timer
D/T timer
C.G. range 70 - 75° of chord
16 s.w.g. hooks and tape
1/4" sheet pylon
1/8" x 5/8" top, bottom and spacers.
3/32" sheet sides
Fins (1 centre 2 tip)
Centre fin outline
3/32" sheet
3/32" ply key
Balsa fillet
Splice
3/16" x 1" each side of pylon as filler
1/8" sheet platform
7"
1/16" sheet top
3/16" x 1/4" L.E.
1/16" sq.
3/16" x 1/2"
3/16" x 3/8"
1/8" x 1/2"
1/8" x 3/8"
3/16" x 3/4" T.E.
6½"
18"
9"
10"
5"
A
B
C
SHOW-OFF
R.O.W. Record Holder
by RON ST. JUST
U.S.A.
12½"
3/32" sheet rib
4¼"
1/8" x 1/16" capstrips
Wing tip spars
All spars cut from 3/32" sheet
'A' 1/2" tapered to 3/16"
'B' 1/2" " 5/16"
'C' 3/8" " 1/4"
TAILPLANE
L.E. 3/16" sq.
L.E. separator 1/16" "
T.E. 1/8" x 1/2"
Front spar 3/8" x 1/16" tapering to 7/32"
Centre spar 7/16" x 1/16" " 9/32"
Rear spar 5/16" x 1/16" " 3/16"
10 s.w.g. tubes sewn to ply
Small dia. tubing Secure with cloth
3/32" sq. separator and stop
3/16" x 1/4"
All spars 1/8" sq.
1/8" x 3/16"
4 ribs. 3/32" sheet
1/16" sheet
10 s.w.g. wire
3/16" sq.
All spars 1/16" x 1/8"
1/8" sq.
4 ribs 1/16" sheet
1/16" ply
Front float
1/16" x 1/4"
Rear float. 2 off
Note: Retain front float to strut with blob of epoxy glue. Retain rear floats to rudders with bent pin through tubes
Note: Rig main float at 10° inc. with half of float forward of prop
5"
8"
Grain of this piece is fore and aft
SCALE 1 : 10
3/16" x 2" platform
Triangular fillet
Floats shown 1/8 size
Wing and tail sections shown 1/2 size
Front view shown with floats. Side view as land plane
Tailplane root section
Riblets
Wing root section

Know your 'Dry' Battery

A survey by R. G. MOULTON

With acknowledgements to Burgess Battery Co., The Ever Ready Co. (G.B.) Ltd., Chloride Batteries Ltd., Mallory Batteries Ltd., "Electrical Review", "Wireless and Electrical Trader", "Electrical Manufacture" and T. G. Scott & Son, Ltd.

THERE are two kinds of power source, as employed in general modelling use for electrical purposes. They are technically referred to as PRIMARY and SECONDARY cells.

Primary cells are "once-only" units with a chemical composition that produce E.M.F. (Electro Motive Force) or voltage as the constituent chemicals are consumed to ultimate exhaustion.

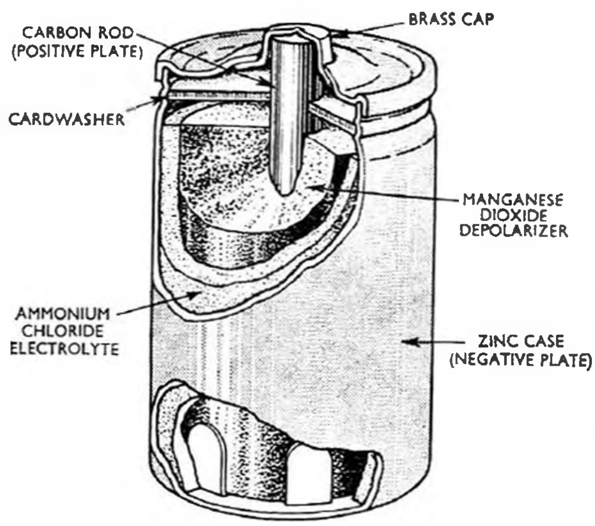
Secondary cells are storage units. The chemical reaction is "reversible" *i.e.* the cell can be returned to its charged state by passing current through in the opposite direction.

Typical Primary cells are the so called "dry" batteries and Secondary cells the lead-acid accumulators or nickel-cadmium button shape cells.

For simplicity, we shall confine our discussion to the often maligned and rarely understood example of Primary cell as most commonly employed for aeromodelling particularly for Radio Control. This is the "*Pen Cell*". In the U.S.A. it is referred to as an AA size cell, an International reference is "Pen-light Mignon". Sizes are unfortunately not standard and vary from $1\frac{15}{16}$ in. to 2 in. length, and $\frac{17}{32}$ in. to $\frac{9}{16}$ in. diameter according to maker. Weight also varies according to the chemical constituents and construction from ·6 to ·85 ounce.

Besides these physical differences, the cells have different performance characteristics and vary in price.

Thus it can be seen that even dealing with the simple pen cell, the variety of distinctions between makes is somewhat confusing. Because of this it is advisable to first learn something of how the "dry" cell works.

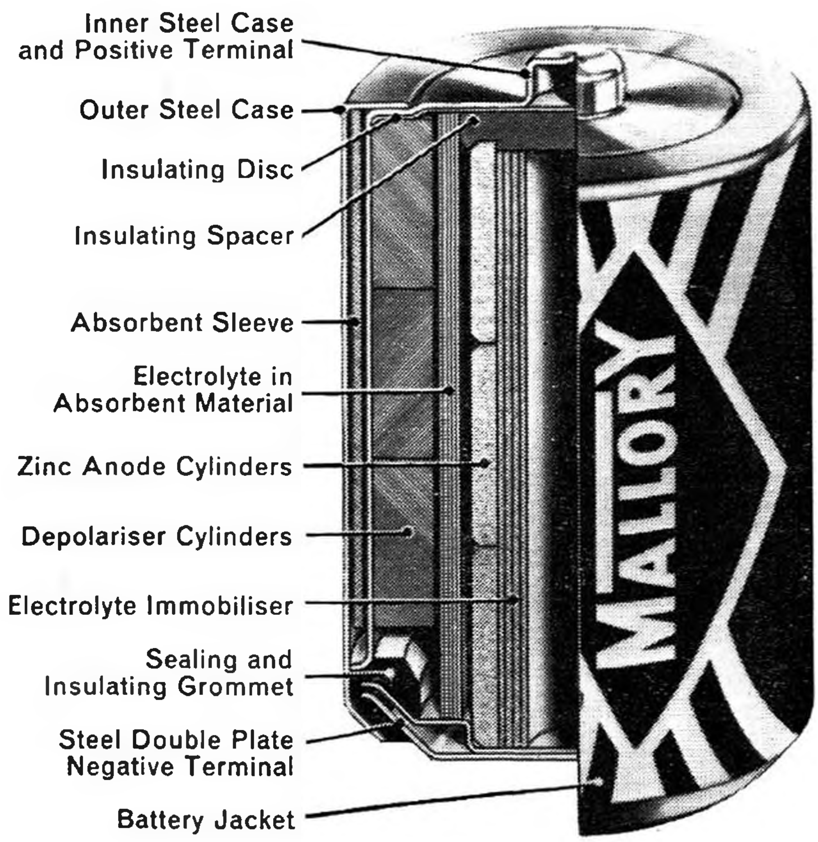


SINGLE CELL

Leclanché Type Cells

Most of the dry cells currently available are variations of the Leclanché type cell, with the electrolyte in paste or jelly form. One advantage this confers is the ability of the cell to work in any position. A typical construction uses a rod type carbon electrode with the depolariser in the form of manganese dioxide and powdered graphite, as a stiff paste moulded round, the whole being wrapped in canvas and placed inside a zinc cylinder. Space between the cylinder and the element is filled with jelly in which sal ammoniac (Ammonium Chloride) and glycerine electrolyte have been mixed. The shelf life of a dry cell depends on the drying-up of the sal ammoniac jelly and the depolariser paste. The discharge characteristic of the cell is determined by the amount of active material used and the size of the container. Dry cells have a low internal resistance when new, owing to the large surface of the zinc container, but resistance increases with age as the jelly and paste dry.

In use, the zinc and ammonium chloride react to produce zinc chloride, ammonia and hydrogen, the hydrogen being absorbed on passing through the manganese dioxide which is reduced to a lower order oxide. When the current from the cell and the hydrogen flow through the manganese dioxide ceases, the unstable lower oxide absorbs oxygen and reverts to manganese dioxide. One improvement which has been made to reduce the internal cell resistance is the



Section of a typical Leclanché zinc-carbon type cell reveals internal structure of the most commonly used "dry battery". At right is a cross sectional view offering interesting comparison showing the Mallory Manganese structure which is very complicated but offers many advantages as described in the text. We are indebted to Mallory Batteries Limited for provision of the majority of illustrations in this feature.

replacement of the porous pot by canvas, a form of construction known as the "sack" element.

Effectiveness of the manganese dioxide depolariser depends on the chemical quality. Natural manganese dioxide is satisfactory for some purposes but some battery manufacturers make their own.

Alkaline Cells

A modified version of the Leclanché, utilising an alkaline electrolyte instead of the acidic ammonium chloride, gives a better high rate performance, and can be more readily manufactured in smaller sizes. The smaller sizes are generally for low current drain applications only, although an "inside out" construction (*i.e.* with the positive plate connected to the outer case) has been designed, with potassium hydroxide as the electrolyte, for higher current drains.

The energy/volume ratio of alkaline-manganese cells is higher than the acidic Leclanché cell, and they have a longer shelf life. They may well eventually replace the Leclanché for general commercial use, but at present are slightly more costly to produce. Cost of a pen cell is 2/9 in G.B. (Mallory Mn 1500) and 50 cents in U.S.A. (Burgess AL-9). These appear to be identical cells each made in the U.S.A.

In these cells, the anode consists of a central zinc cylinder which forms the negative pole, so that it is constructed in the opposite way to the zinc-carbon type of cell, where the positive carbon rod is the central feature and the zinc outer case is the negative pole. (*See sketches on page opposite.*)

The positive electrode in the manganese alkaline cell is integrated with the depolariser compound identified in the sectional view shown, as the depolariser cylinders. These are three rings which form the outside wall of the cylindrical cell structure, and they are in intimate contact with the inner steel casing. They are composed of compound containing carbon, and this compound acts in very much the same way as does the central carbon rod in a zinc-carbon cell.

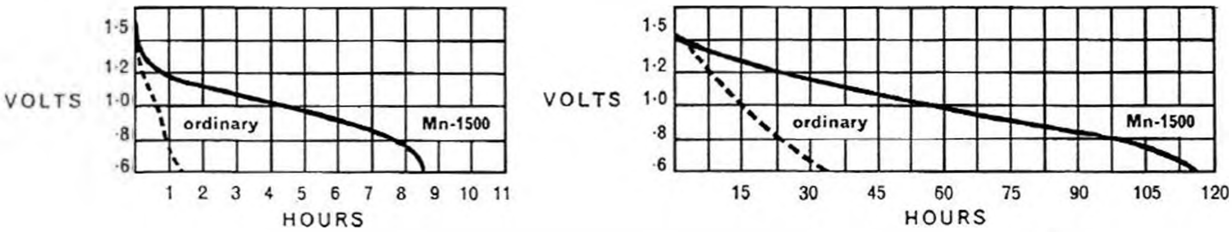
The cell is made uniform in polarity with other makes of dry cell by forming a positive pip in what would otherwise be the "bottom" of the case and then "inverting" the case. Plus and minus signs are marked on the label.

As can be seen, there is an inner and an outer steel case, and it is the inner case that is positive. By pressing the pip into it at its closed end a positive cap is obtained, but it is in contact with the outer steel case, so the case has the same polarity as the top cap.

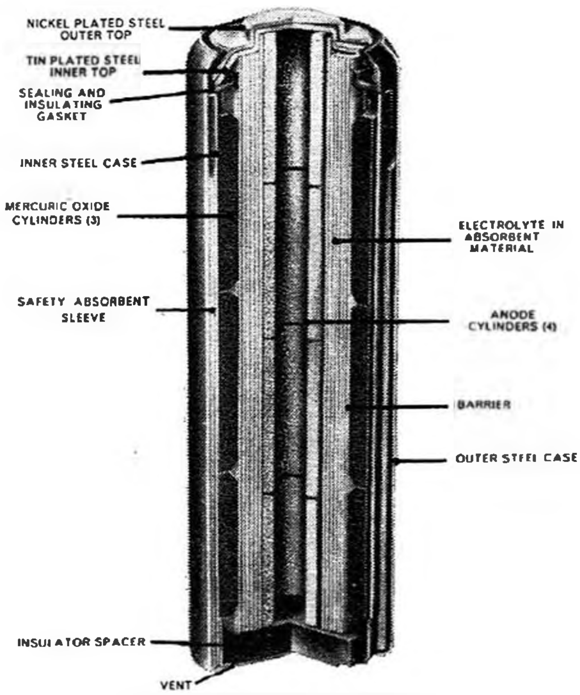
A large contact at the opposite end to the pip provides the negative connection and if the cell is inserted into the battery compartment pip first, its polarity will be the same as that of a zinc-carbon cell. As the case is of the opposite polarity to that of the "bottom" contact, however, its insertion into a metal battery box may possibly result in a short-circuit either to the case or to the spring.

The manganese alkaline cell is of quite elaborate construction. It has the "breathing" space between the inner and outer steel cases to permit release of gas generated in the cell, and it is claimed to be absolutely *leak-proof* and corrosion-proof under normal circumstances. Other advantages are that it can be stored for two years without deterioration and can supply heavy currents on demand.

The normal voltage is 1·5 V per cell, but like the zinc-carbon cell this



Top graphs clearly illustrate the distinction between standard zinc-carbon cells and a pen cell equivalent Manganese battery. Graph at left is for continuous 200mA drain and that at right is for continuous 20mA drain. Immediately below is cross sectional view of a Mercury battery, similar in structure to the Manganese.



CYLINDRICAL STRUCTURE

suffers a rapid initial drop before settling down to its normal steadier condition at about 1.25 V. Beyond that point its voltage drops in a long gradual slope, something like the slope of a zinc-carbon cell but much less steep. Its life is claimed to be from three to ten times as long as that of an equivalent zinc-carbon cell, up to the end-point voltage, depending on the application.

It is in the heavy current applications that the advantages of the manganese alkaline batteries are to be found. Although they do benefit a little from rest periods, they do not *depend* on them as do zinc-carbon cells, and they are not intended for light duty work or for short intermittent operation with long periods of rest. Such conditions are ideal for the zinc-carbon battery.

Advantageous application of the manganese alkaline battery will be in 3 V receiver use, there the same battery is subjected to extra loading for escapement drive. The long shelf-life is an added safety factor. They are, in fact, to be thoroughly recommended for all lightweight R/C equipment.

Dry Cell Service

The service obtained from a given cell will depend on several factors including current drain, discharge temperature, discharge time cycle, end point voltage, and storage prior to use.

Temperature plays an important part in dry cell service. Most dry batteries are designed to operate near 70° F. Prolonged exposure to temperatures much above 130° F. may cause the battery to fail suddenly. With this qualification it may be said that the higher the discharge temperature, the greater the energy output.

A reduction in discharge temperature reduces the energy output. If ordinary dry batteries have been stored at room temperature of about 70° F. and are then removed to a cold location of 0° F. or below, it will require several hours for battery temperature to drop significantly. During this period the battery will continue to operate, though at slightly lower voltage caused by the lower temperature. In many instances it may be possible to insulate or protect the battery to prevent rapid cooling. When this is done, near normal service may be obtained, depending only on how rapidly the battery is allowed to cool.

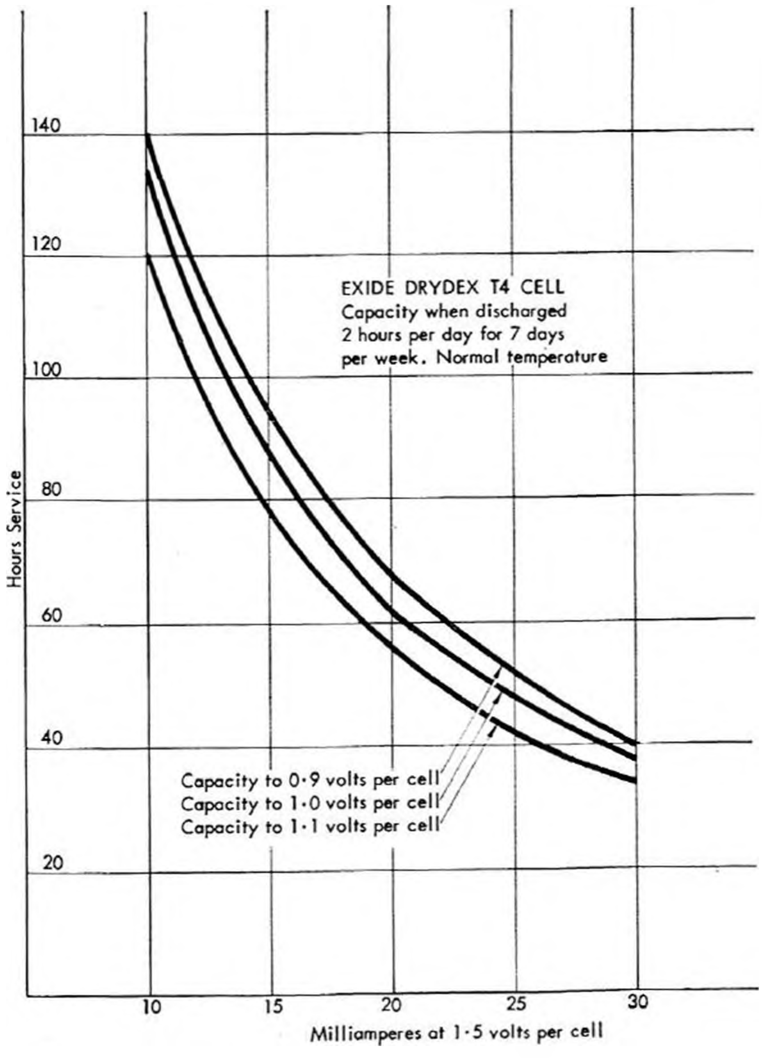
After prolonged exposure to 0° F. or slightly below, ordinary batteries will give very little service except on relatively light drains. After prolonged exposure to about —10° F. they will become useless even on light drains. This will answer the many queries which arose in our last, very hard winter, when glow plug ignition batteries refused to work on the field and radio models gave trouble. Special types, using electrolyte designed for low temperature operation, must be used where batteries are to be stored and operated in this temperature range.

Service life at low temperatures is reduced because of retarded chemical action within the cell. Exposure to low temperatures will not damage dry cells. In fact, low temperature storage is extremely beneficial to shelf life. Batteries can be stored for years with little or no deterioration at temperatures near 0° F. When removed from low temperature storage the cells may be warmed to return them to their original condition.

On the other hand, high temperature storage is harmful to dry cells and serves to reduce their shelf life. This is due to accelerated chemical action and to loss of moisture from within the cell at higher temperatures. For this reason dry batteries should be stored in a cool place. Refrigerated storage is beneficial.

The standard round cell has a sufficiently stout gauge of zinc for its case to ensure that at no time during its useful life will the outer surface of the zinc be punctured. This is just as well in any case, because otherwise the messy jelly electrolyte would begin to escape in many instances while the cell was still in use.

We have seen cases that have been eaten through, and we are well aware of the consequences, but we know that this state of affairs arises only when a cells has been left in position long after its useful life is finished. Electrolytic action goes on when the voltage at the terminals has fallen very low indeed, and it is important to remove a dry battery from its container as soon as it is exhausted.



Manufacturer's performance graph for a typical "transistor application" dry battery of pen cell size showing expectation of life from a good zinc-carbon battery.

Leak-proof Cells

One company, however, makes a speciality of a zinc-carbon cell that is claimed to be completely leak-proof.

Alpha Accessories Ltd. make this claim for the Ray-O-Vac cells that they manufacture under licence from the Ray-O-Vac company in Wisconsin, U.S.A. These cells are of the Leclanché type, but they are encased in a steel container that is sealed.

The leak-proof cell 2LP is of the same voltage and physical dimensions as the popular U2 cell, but it is only one of the range of Ray-O-Vac leak-proof batteries which comprise half a dozen equivalents to other popular dry battery sizes. Ray-O-Vac also make what they call a standard range in addition to the leak-proof range, and from a comparison of prices the leak-proof types cost about one and a half times the price of the standard ones.

Layer-type Cells

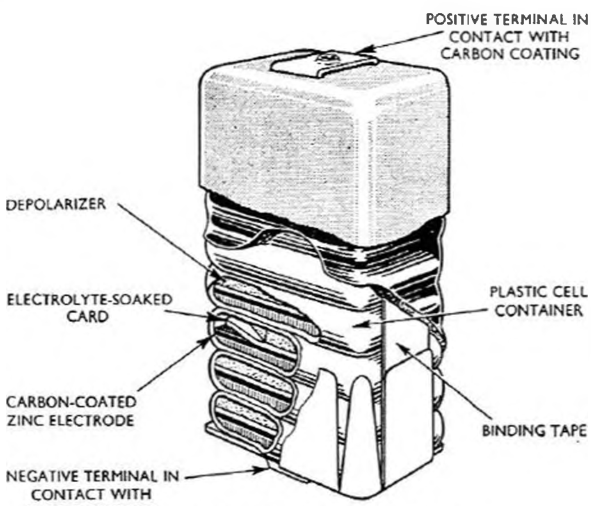
It was the search for new means of meeting the constantly increasing demands for new standards of performance that led the battery manufacturers to devise a new type of cell construction, called the layer type. This is virtually a dry Leclanché cell of thin, square shape, something like a biscuit, but it is basically the same type of electric cell as the round type.

Several advantages derive from its special construction, however. Because it is square, it makes up with other cells into a more compact battery, because the space wasted between round cells is occupied by the corners of square cells. Because the cells are flat, and the two electrodes are on opposite sides of the "biscuit", they can be arranged in series simply by stacking one on top of the other.

The component parts of a layer type cell are shown. The top one is a "cake" of depolariser, comprising manganese dioxide and carbon, and the bottom one is a zinc plate, whose underside is coated with carbon.

The upper side of the zinc plate is coated with a paper lining that is saturated in electrolyte, and in order to prevent the zinc from coming into direct contact with the cake of depolariser a paper separator is inserted between them.

When two such cells are stacked one on top of the other, the carbon base of one comes into contact with the depolariser cake of the other, and completes one cell. A carbon disc would complete the second cell. This explains why the positive carbon electrode of the cell is coated directly on to the negative zinc electrode of the same layer unit. Actually it belongs to the next cell down.

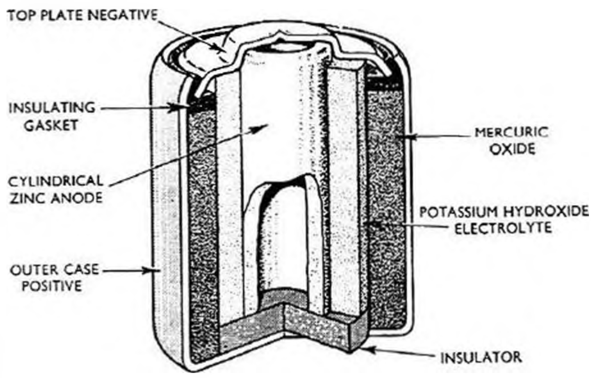


LAYER TYPE HIGH-VOLTAGE BATTERY

MODERN LECLANCHÉ CELLS

Here is one of the greatest advantages of the layer type cell. In a stack of the kind just described there is no physical dividing line between one electrical cell and the next. There is the physical division between two physical units of the type just described, but each requires the proximity with the next cell to complete an electrical cell. The positive electrode in one physical cell unit is actually the positive electrode of the next electrical cell down.

Thus when two or more such cells are made up into a battery, the stack is a continuous succession of 1·5 V units without any deliberate connections. Each cell is part of the next, and poor contact between them is impossible so long as they are firmly held together physically. The cells are tightly strapped together with cord or tape.



BASIC RUBEN - MALLORY MERCURY CYLINDRICAL CELL

Applications in which advantage is claimed for this single feature include receivers, where the alternative is usually a number of separate round cells. For aeromodelling, the layer battery brought untold advantages in weight saving for radio control, in the days of 90 V. Rx. requirements.

Mercury Cells

During the last war, considerable research work was undertaken to obtain a cell which had a higher capacity than the Leclanché and which could be stored and used over a wider range of temperatures.

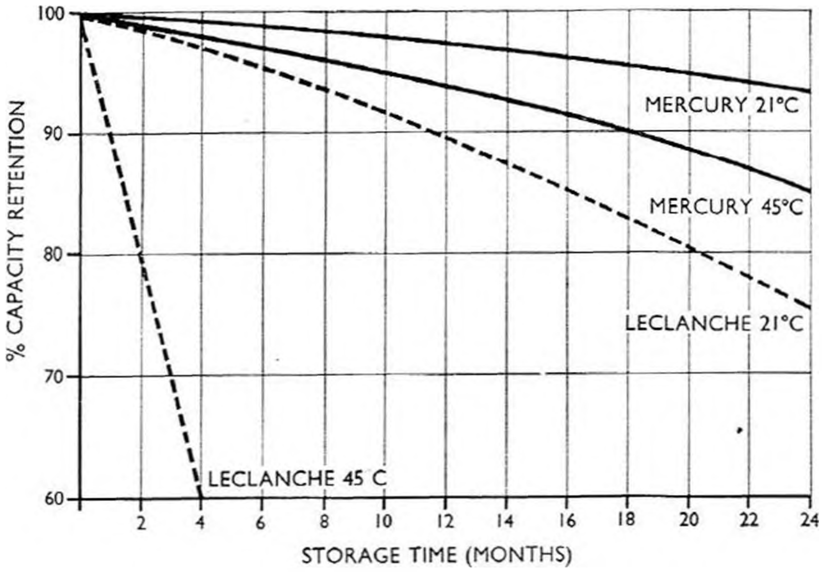
An electrochemical system using zinc and mercury plates was devised by Dr. Samuel Ruben, and it is this cell which, developed over later years, has proved to be a major contribution to miniaturisation—in fact the smallest cell ever manufactured for commercial use is of the mercury type.

Mercury cells have a very high energy/volume ratio; two Faradays are liberated for each gram-mole of electrode material activated. One gramme of mercuric oxide and 0·302 grammes of zinc produce a capacity of approximately 250 mA-H—something like six to seven times the capacity of the materials used in Leclanché cells!

The cell uses a form of "self-depolarisation". In this type, what would be the "hydrogen barrier" is arranged to be of the same basic metal as the positive plate. In this manner the film or deposit does not affect the current "flow" of positive ions, nor does it raise the internal resistance during operation: it merely builds up the positive plate.

Perhaps the first notable design change is the "inside out" construction. The negative electrode is formed by zinc, either as a foil or as a pressed powder, while the positive electrode is formed by mercury, liberated during operation from the mercuric oxide which also acts as the "depolariser". In practice a small percentage of micronised graphite is added to the mercuric oxide, to improve its physical characteristics and to reduce the internal resistance of the cell. The electrolyte is a concentrated aqueous solution of potassium hydroxide and zinc oxide. Mercury cells have a high stability which is attributable to the saturation of the electrolyte with potassium zincate, formed by the reaction between the zinc oxide and potassium hydroxide. This inhibits attack of the caustic solution on the zinc electrode, i.e., the possibility of hydrogen evolution during storage or normal discharge is limited.

When the cell is connected to an external circuit, zinc ions enter the electrolyte to displace positive ions of hydrogen, which in turn move to the



TYPICAL STORAGE TIMES FOR PRIMARY CELLS

Graph at left illustrates the longer shelf life of the Mercury battery over zinc-carbon. Graph below indicates the longer active period of the Mercury pen cell equivalent, according to load, over standard zinc-carbon.

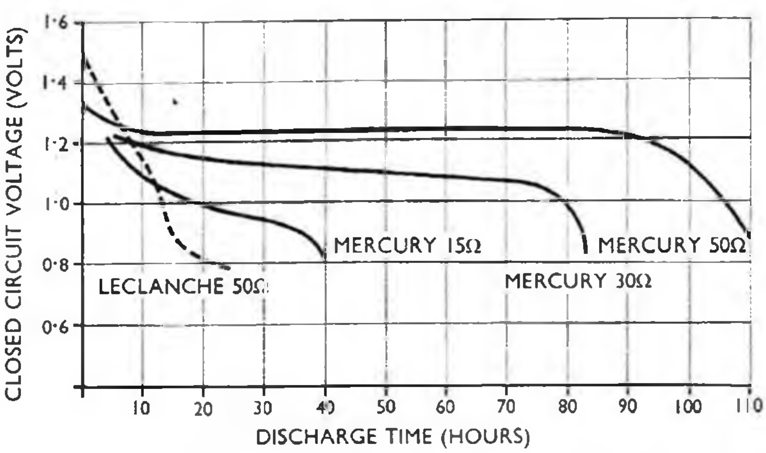
mercuric oxide. Here positive ions of mercury are displaced, the hydrogen combining with the oxygen to form water. The displaced positive mercury ions take up the incoming electrons and are neutralised: polarisation does not occur since mercury is itself the electrode material.

The discharge characteristic of the mercury cell is remarkable in two respects: its longevity and its e.m.f. stability. The longevity is the result of the exceptional energy volume ratio of the materials used. A cell of 2·4 in. by 1·2 in. diameter has been commercially constructed to have a capacity of 14,000 mA-H and a rated current drain of 250 mA. It can be reasonably concluded that the miniaturisation of a mercury cell would give favourable and useful results. The smallest cell ever produced, the Mallory ZM-312 measuring only 0·135 in. by 0·305 in. diameter and weighing 0·02 oz., has a capacity of 36 mA-H and a rated current drain of 2 mA. Such cells have opened new possibilities in many of the research sciences, where miniaturisation is a prerequisite for experimentation and ultimate use. The long life of mercury cells makes them ideal for use in equipment which once set into operation must continue to function for as long as possible. Duration record attempts for example?

The Mallory ZM-9 equivalent of a Pen Cell has a nominal voltage of 1·4 V. and costs 3/6 per cell. Its 2,400 milliamp hour capacity at drain tolerance of 200 mA makes it attractive for special purposes.

An advantage offered by Mercury batteries over those of the Leclanché type in the particular case of transistor receivers is the maintenance of practically constant output voltage irrespective of the current flowing or the age of the battery.

The only disadvantage is, that no warning is given that the battery is nearing the end of its useful life, and a



'PENLIGHT' SIZE CELLS DISCHARGED CONTINUOUSLY AT 21 C (DISCHARGE RESISTOR VALUE INDICATED) voltage measurement would not show it. On the other hand, a spare battery can be held in stock for a matter of years if necessary without serious deterioration.

Though prices are fairly high, the claim is made that watt for watt they are cheaper than the Leclanché type of cell.

Kalium Cells

Although not generally available there is one other type of primary cell which merits a place in this discussion, and like the Mercury cell is one of the most efficient types with 2,000 milliamp hour capacity in a Pen Cell size KJ 41 Burndept cell. The flat discharge characteristics are such that Kalium cells have many engineering applications, including missile power services. Little is known of the construction of these Zinc/Potassium hydroxide/Mercury oxide cells, but we may well be hearing more of them in future.

Battery Selection

If dry cells of the Leclanché type are discharged at heavier rates than those for which they are designed, the recovery period of the depolariser is too small, and the cell is overloaded.

The life of a dry battery is determined by six factors:

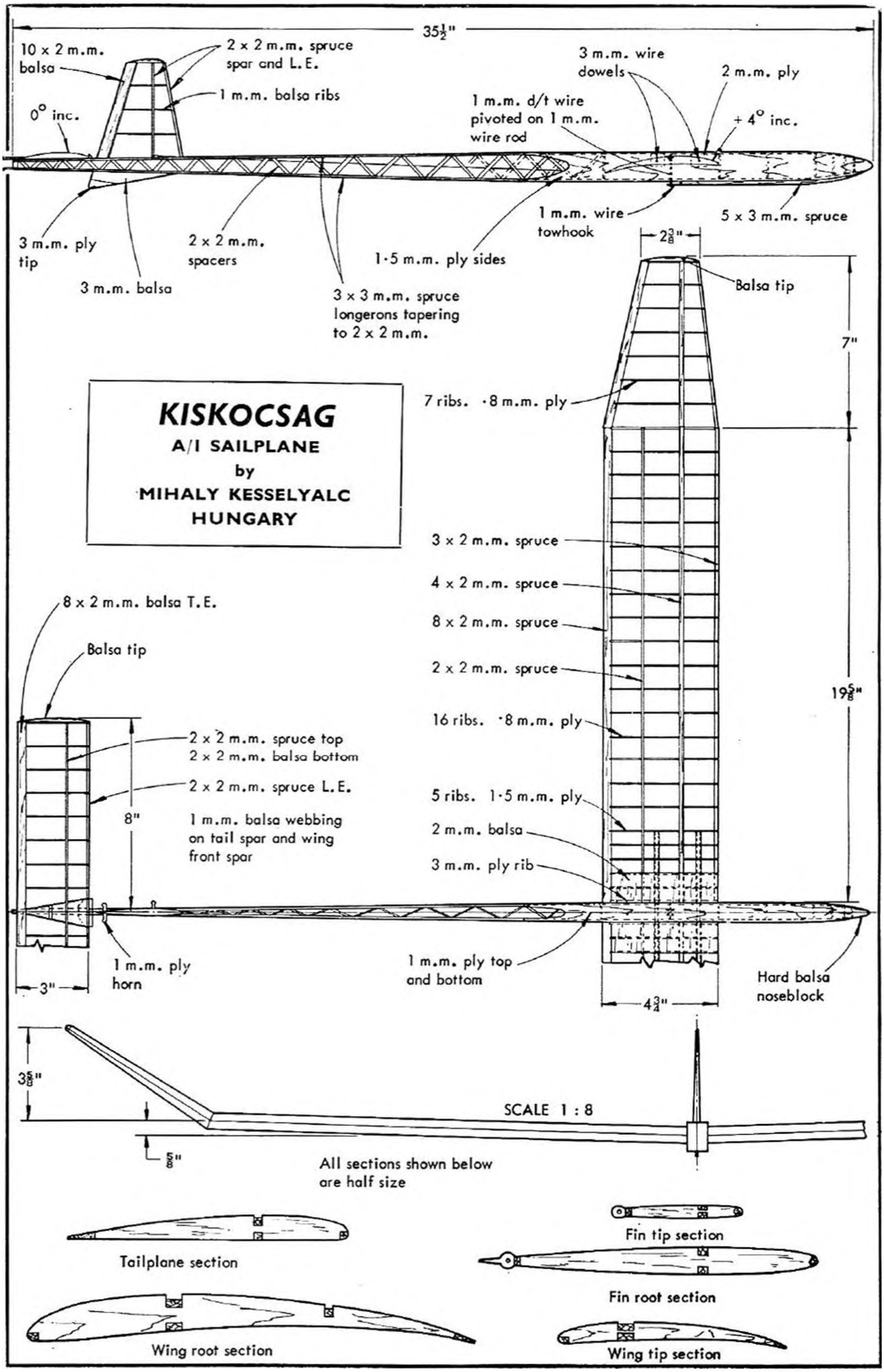
1. *Size.* 2. *Initial current drain.* 3. *End point voltage.* 4. *Hours of use per day.* 5. *Temperature.* 6. *Storage period before use.*

Since any one of these factors will affect the actual number of hours, days or months that a battery will last in a user's hands, it is impossible to predict zinc-carbon battery life exactly.

Most manufacturers have a sufficiently wide range of products to enable the modeller to obtain the cell nearest his requirements. Additionally developments such as the Manganese Alkaline cell and "Activator" cells, "Energisers" and the like, all indicate that high drain from low voltage, small cells is to be matched by new products.

BRITISH PEN-CELL SIZE "DRY" BATTERIES

Make	Type	Nominal Voltage	Capacity	Suggested Current Range	Weight	Diam.	Length	Construction
Ever Ready	D-14 & U12	1·5	Cannot be quoted for Zinc-Carbon cells. Higher drain than quoted is possible with longer rest periods.	1-30 mA	·6 oz.	35/64 in.	1 31/32 in.	Zinc-Carbon Leclanché
Ever Ready	U7	1·5		1-50 mA	·8 oz.	35/64 in.	1 31/32 in.	Improved Zinc-Carbon Leclanché
Exide Drydex	T4	1·5		1-50 mA	·8 oz.	9/16 in.	2 in.	mproved Zinc-Carbon Leclanché
Exide Drydex	T5	1·5		1-30 mA	·6 oz.	9/16 in.	2 in.	Zinc-Carbon Leclanché
Vidor	V12	1·5		1-30 mA	·6 oz.	35/64 in.	1 31/32 in.	Zinc-Carbon Leclanché
Vidor	V7	1·5		1-50 mA	·8 oz.	35/64 in.	1 31/32 in.	Zinc-Carbon Leclanché
Burgess / Mallory	AL-9 / Mn-1500	1·5	1,800 mA-H	1-150 mA	·84 oz.	35/64 in.	1 15/16 in.	Manganese-Alkaline
Mallory	ZM-9	1·4	2,400 mA-H	1-200 mA	1·05 oz.	33/64 in.	1 31/32 in.	Mercury
Burndept	KJ. 41	1·34	2,000 mA-H	1-150 mA	·78 oz.	9/16 in.	1 31/32 in.	Kalium



MODELLEZES, HUNGARY

LIGHTWEIGHT R/C

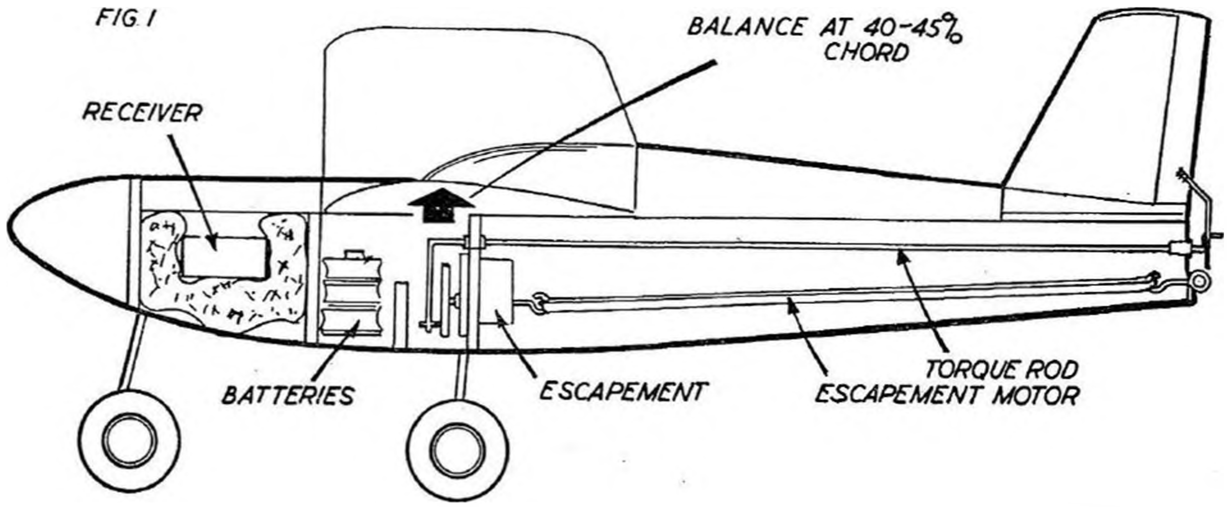
TWO major factors have contributed to the reduction in bulk and weight of radio control receivers—the adoption of all-transistor circuitry assembled on a printed circuit panel and the elimination of the relay in favour of direct current output to the actuator (transistors again providing the means of current amplification). The all-transistor relayless receiver means a further reduction in weight in that both it and the actuator can be powered by a single lightweight battery (2·4 to 6 volts as a typical range, with 3 volts a good average figure). Total weight and bulk of the complete radio gear (receiver, battery and actuator) are thus well within the load-carrying capacity of the smallest practical size of power model.

The result is a radio controlled model which can span 20 in. or less and is capable of being flown in a space little larger than a tennis court. Such a model has distinct limitations, of course. Control is virtually limited to "rudder only" and the model is suited only for calm weather flying since it will inevitably lack penetration on an upwind course. There is very little that can be done about this other than to make it fly faster—by increasing its wing loading or adopting an underelevated trim—which partly defeats its own object in making the model much trickier to control. On the other hand small models are remarkably crash-resistant and an accidental pile up will seldom produce more damage than torn covering or a bent undercarriage.

Miniature R/C models with lightweight radio equipment are, therefore, truly models for flying for fun. Their cost can be kept quite low—the cost of the model itself is virtually negligible—and they can be built and fitted out in a very short time.

Typical size of a modern all-transistor relayless receiver is about $1\frac{3}{4}$ in. × $1\frac{1}{2}$ in. (printed circuit panel dimensions, with a weight of about $1\text{-}1\frac{1}{4}$ ounces. A relay receiver of the same type will require a little more panel area and add about $\frac{1}{2}$ ounce in weight. It is readily possible to accommodate the same circuitry on

FIG. 1



a much smaller panel, particularly if sub-miniature instead of miniature components are also used. If the size figure quoted is considered "standard" there are virtually two smaller size categories possible—*miniature*, reducing overall panel dimensions to approximately $1\frac{3}{4}$ in. × $1\frac{1}{4}$ in. and weight to $\frac{3}{4}$-$\frac{7}{8}$ ounce; and *sub-miniature* with a panel size of about $1\frac{1}{2}$ in. × 1 in. and weight about $\frac{5}{8}$ ounce.

Although the size reduction is considerable—the "sub-miniature" receiver has only a little more than half the panel area of the "standard"—the weight saving is not always so dramatic, and it may also suffer from certain circuit limitations due to over-simplification. There is no reason, however, why it should not have the same range and reliability as its larger counterpart, although it will probably tend to be more susceptible to interference from local "noise". The main appeal of the sub-miniature receiver is, in fact, its extremely small size. As a practical unit for a small model it offers no real advantages over a "miniature". A 24 in. span model, for example, will not show any marked difference in performance whether the receiver weighs $\frac{5}{8}$ ounce or $\frac{3}{4}$ ounce—and even swapping the two over will hardly change the trim.

There is no need to go overboard for "sub-miniature" receivers for small models, therefore, when a "miniature" will probably be just as suitable. Nor is there much point in trying to reduce receiver size still further, only as a selling point for manufacturers to produce the "world's smallest". It is not like an engine where engine size and model size to match are directly related. On the other hand the fact that "miniature" and "sub-miniature" receivers have appeared has encouraged all radio designers to think in terms of more compact layouts, which is a good feature as long as crowding of components does not lead to circuit troubles.

There is also another important point to be considered. However much one miniaturises the receiver its basic function remains that of an "on-off" switch. To utilise its response it still has to be coupled to an actuator to translate this into mechanical movement, i.e. of the rudder. Relayless single-channel receivers invariably couple to escapements and escapements are the one type of component which does not readily lend itself to miniaturisation. Thus we could end up with the anomalous situation of a relayless super-sub-miniature receiver (or micro-miniature receiver) controlling an escapement considerably larger and heavier than itself—simply because there is no practical method of scaling down the escapement in similar proportions.

The main troubles in attempting to scale down a standard escapement design are (i) loss of electrical efficiency because of the reduced size and (ii) far more critical mechanical action, calling for greater precision in manufacture and assembly. The latter is a feature on which many larger escapements fall short anyway and to aggravate this trouble is hardly going to improve reliability.

TYPICAL RADIO INSTALLATION WEIGHTS

COMPONENT	TYPE & WEIGHT (OUNCES)					
	ULTRA-LIGHT		LIGHT		NORMAL	
Receiver	Sub-Miniature	$\frac{5}{8}$	Miniature	$\frac{3}{4}$—$\frac{7}{8}$	Standard	1—$1\frac{1}{4}$
Receiver Battery (3·6 volts)	DEAC 225	$1\frac{1}{2}$	DEAC 225	$1\frac{1}{2}$	DEAC 225	$1\frac{1}{2}$
Actuator Battery	—		—		DEAC 225	$1\frac{1}{2}$
Actuator	Escapement	$\frac{5}{8}$—$\frac{3}{4}$	Escapement	$\frac{5}{8}$—$\frac{3}{4}$	Escapement	$\frac{3}{4}$—1
Switch & Wiring		$\frac{1}{4}$		$\frac{1}{4}$		$\frac{1}{2}$
TOTALS		3—$3\frac{1}{8}$		$3\frac{1}{8}$—$3\frac{3}{8}$		$5\frac{1}{4}$—$5\frac{3}{4}$

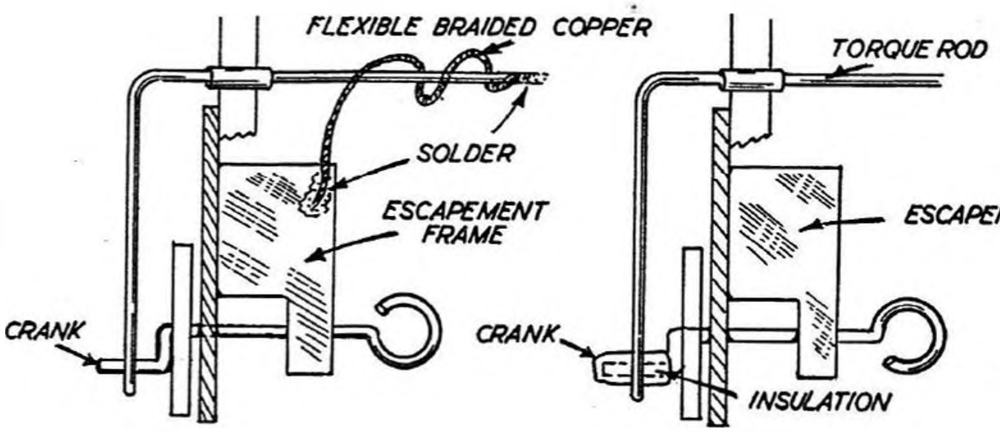


FIG. 2

Nevertheless serious attempts are being made to produce smaller escapements to match the "miniatures" and "sub-miniatures", but they will not necessarily be all that much smaller than present day units and will probably weigh as much, if not more, than the sub-miniature receiver. Meantime we are forced by circumstance to match standard escapements to the miniature and sub-miniature receivers. Very similar remarks apply to that other necessary circuit component—the on-off switch.

The typical American miniature or sub-miniature receiver is designed to operate on a nominal 3 volts (normal usable supply range is 2·4 to 3·6 volts) with the output matching a 5 to 8 ohm escapement coil. Taking as a typical figure a half volt drop through the receiver, this will represent about 3·1 volts switched across the escapement coil with a 3·6 volt receiver battery (equivalent to an output current of just over 300 milliamps with an 8 ohm escapement); or about 2 volts across the escapement coil on minimum supply voltage.

These figures are consistent with the working requirements of most top standard American escapements, many of which will work quite happily on 1·5 volts. They are marginal for most British escapements which normally have a slightly higher coil resistance and are usually specified for 4·5 volt operation, although some of the best will operate satisfactorily on 3 volts. It is virtually imperative in such cases, though, to use the maximum receiver voltage permitted. The safest choice—in our experience at least—is to use an American escapement with an American miniature relayless receiver as this does provide a better match with considerably more tolerance on battery voltage.

In the model the escapement will be the largest single item of control equipment and the only one which needs to be rigidly mounted. The logical position is more or less amidships under the wing trailing edge position, or slightly farther forward, if possible, to get a reasonable length of rubber motor. The battery will weigh more than the receiver and is best located under the wing centre near the balance point, with the receiver forward of it—Fig. 1. Both battery and receiver can be accommodated in oversize compartments and located by wrapping in foam plastic or lightweight insulation packing.

Some designers prefer to reverse the battery and receiver positions from that shown. This is more conventional practice anyway and also utilises the battery weight to offset the escapement weight as far as balance is concerned, as well as minimising the length of wiring between receiver and escapement. However, it is an advantage *not* to have a miniature receiver and escapement too close together since "noise" generated by metallic parts of the escapement motion or linkage in rubbing contact may cause interference with the receiver.

The usual cause of "noise" is the escapement drive pin rubbing in the wire yoke connected to the rudder torque rod. It is a simple matter to subdue this "noise" by bonding, which is good practice anyway. This consists simply of soldering a length of plaited or highly flexible conductor between the escapement body and the driven wire member, as in Fig. 2. Both metallic components are then electrically connected and cannot generate electrical "noise" by rubbing together. Another method is to *prevent* rubbing metal-to-metal contact by slipping a length of insulated sleeving (e.g. thin fuel tubing) over the escapement drive pin or binding this pin with adhesive PTFE tape. The latter is to be preferred since the PTFE surface has very low friction whereas plastic tube rubbing in a wire yoke can tend to bind at times.

The Macgregor "Minimac" miniature receiver introduced in 1963 overcomes interference problems in a different way. It can be used as a conventional relayless receiver with a single 3 or 4·5 volt battery operating an escapement direct (when it is as susceptible as any other "miniature" to interference); or a separate actuator battery can be connected to the circuit, switched through the output stage. Although this means an additional battery it does virtually eliminate any chance of interference between the actuator and receiver. In this case, however, it is essential that *both* batteries are switched off when not in use.

To a large extent this question of "interference" is exaggerated. With miniature and sub-miniature receivers it is something which can be rather prevalent even with escapements—but the cure is simple. Just bond the escapement. Interference is far more likely with motor servos close to a miniature receiver, even with conventional "suppression"—but motor servos are just not used with ultra-small, lightweight R/C models (and seldom in any case with single-channel relayless receivers).

Installation requirements on the small, lightweight R/C model of up to about 30 in. span are covered by a single standard escapement giving sequence rudder operation, with self-neutralising action on release of signal. You can use a compound escapement if you prefer to have "selective" rudder signalling (press-and hold for "right", press-release-press and hold for "left"), but this is hardly necessary on a small, simple model unless you are specifically used to this system. It will be bulkier and heavier than necessary, and cost more for a very similar duty.

The 30 in. span model is, however, large enough to carry a second simple escapement which can be triggered by the compound escapement, if you want an extra control. There will probably be room to mount the two escapements side by side (vertically), or, if not, one above the other and staggered as necessary

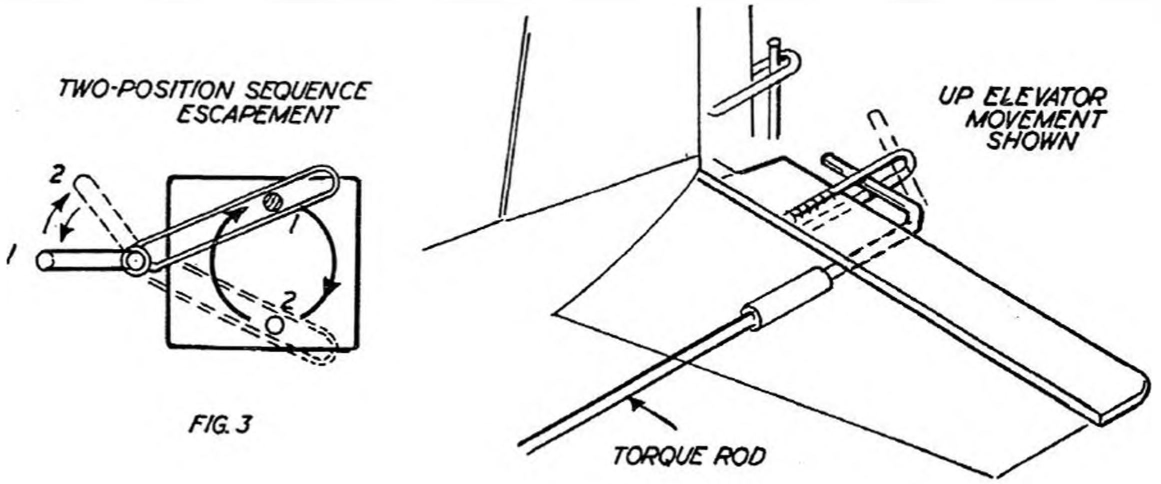


FIG. 3

LIGHTWEIGHT R/C MODELS

WINGSPAN	ENGINE GLOW cu. in.	ENGINE DIESEL c.c.	CONTROL(S)	ACTUATOR	APPROX. MODEL WEIGHT	COVERING
Under 18″	·010	—	Rudder	Simple Escapement	4—5	Tissue
18—22″	·020	—	Rudder	Simple Escapement	5—6	,,
22—26″	·049	·5	Rudder	Simple Escapement	6—7	,,
26—30″	·049	·8	Rudder + Elevator Trim	Compound Escapement	6—10	,,
30—36″	·049 —·09	·8—1·0	Rudder + Elevator Trim	Compound Escapement	10—16	,,
36—42″	·09	1·0—1·5	Rudder * + Elevator Trim or Engine Speed	Compound Escapement or Multi Servo*	14—20	Tissue or Nylon

*TWO-CHANNEL OPERATION RECOMMENDED

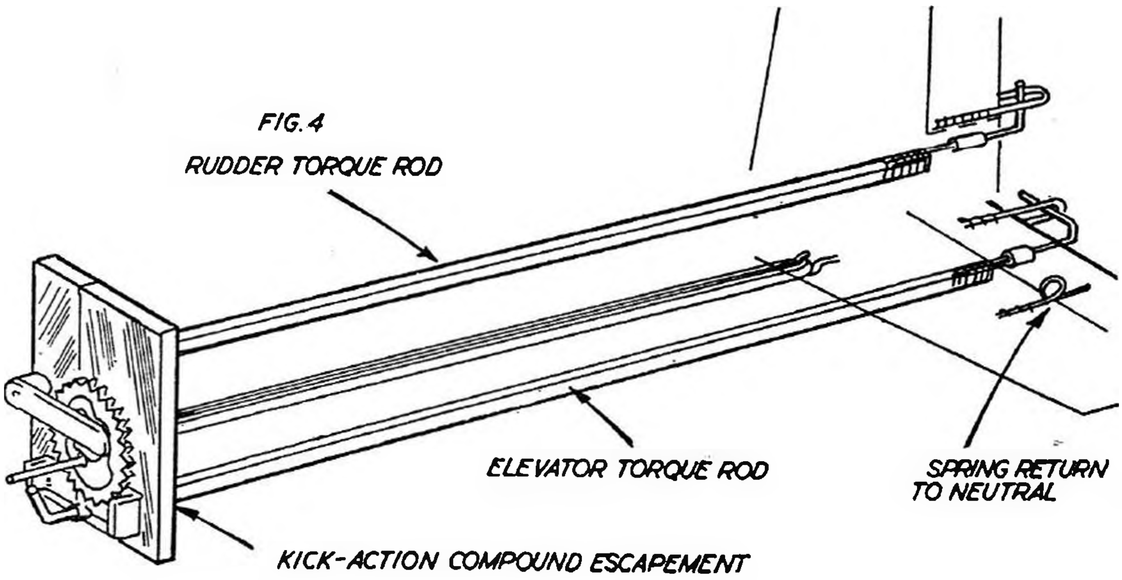
for clearance. To utilise "quick blip" switching for the second escapement, however, the original compound escapement must have provision for this on its own switching circuit. Normal "quick blip" switching relies on using the back contact of the relay in the receiver. With a relayless receiver the necessary "extra contact" must be incorporated on a switching panel on the compound escapement itself.

The logical second control with a small, light model is "down" elevator trim using a sequence (non-centrallising) secondary actuator—Fig. 3. This enables the model to be trimmed out "free flight" style for a climb under power, which should then give enough elevation for a loop following straightening out of a spiral dive and provide for reasonable turns with blipped rudder without the nose immediately dropping. "Down" elevator trim will then enable the model to be put into a shallow dive under power at any time to lose height or produce penetration upwind. If the model, itself has good directional stability and is free from warps all you have to do is to line up the flight direction with rudder control, blip on the "down" trim and wait for it to make headway and lose height. "Down" trim blipped on immediately after the pull-out from a spiral dive, followed immediately by "right rudder" (just a touch) and "left" (held on a little longer) can also produce a reasonable barrel roll. You have to be quick about this one, though, and get the trim off at the end of the manoeuvre.

Note that although a *four-position* sequencing escapement would provide *both* "up" and "down" trim positions (in sequence up-neutral-down-neutral, etc.), this is not recommended as a practical proposition. Trim is usually wanted in a hurry—and needs to be taken off in a hurry—which calls for *positive* signalling "on" or "off". With a *two-position* sequencing escapement the trim *is* either "on" or "off" (neutral), so the pilot *always* knows what the next "trim" signal will give.

Just how much trim is required will depend very much on the model design and line-up. About $\frac{1}{16}$ in. should be enough, but this is something you can only arrive at by trial and error. Too little is probably better than too much. This is a "trim" rather than a positive control.

There is, of course, also a case for using the secondary actuator to provide full "up" elevator control; or alternatively "up elevator" trim. Taking "full up" first, this would call for the model to be slightly underelevated in normal trim, but climbing slightly. Full "up" when signalled would then give loops, on demand, but very little else. There would be no method of correcting

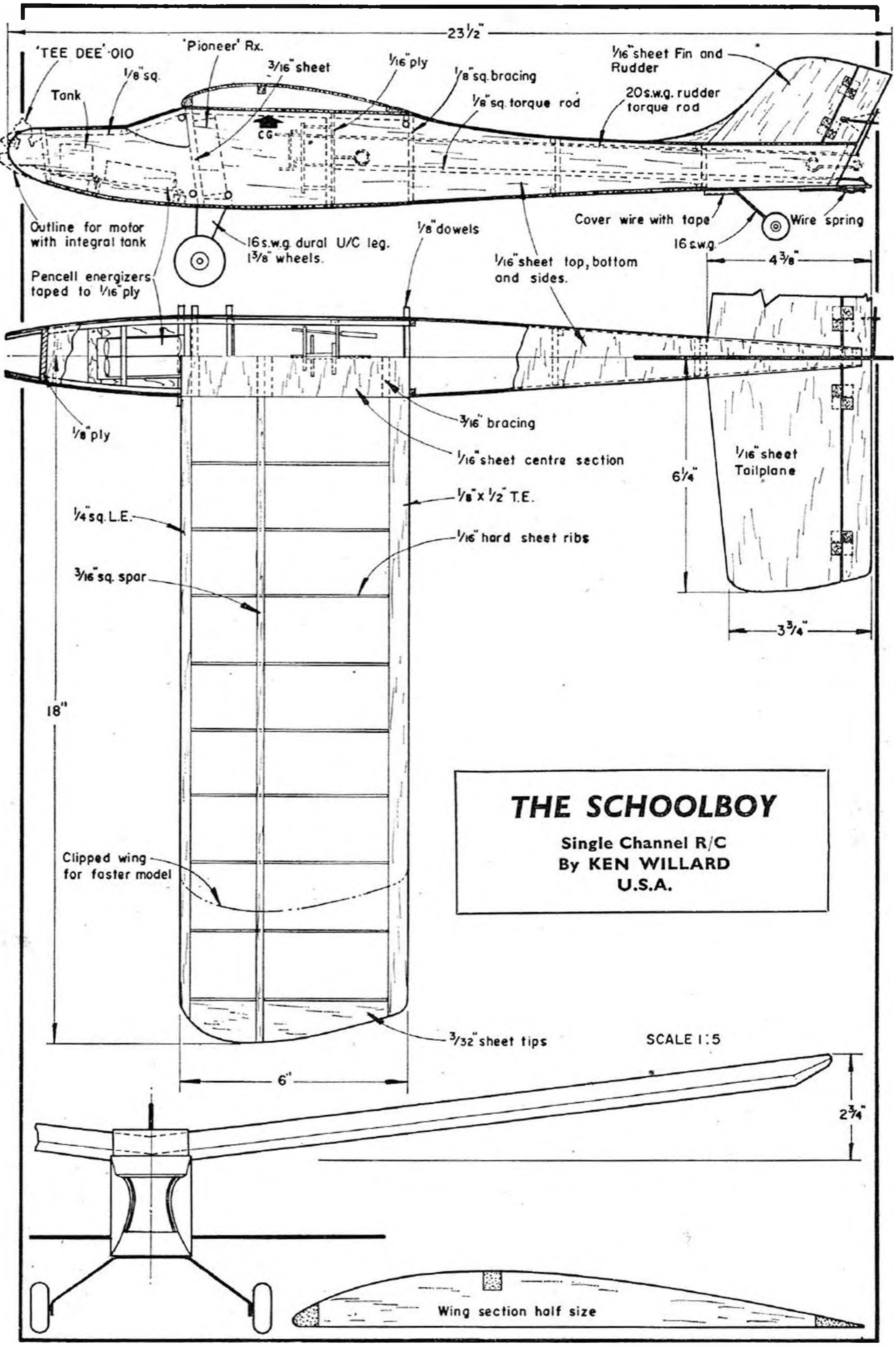


"ballooning". Up "trim" offers rather more scope. The model would then be trimmed for a fairly steep climb with "up trim" on; and reversion to "neutral" elevator would produce a shallow dive. "Neutral" is then available to correct "ballooning" or for going into a roll following a spiral dive; and "up trim" for going into a loop following a spiral dive.

A simpler "trim" installation is provided by a single compound actuator with "kick" action—Fig. 4. This can be used to provide "up" or "down" elevator movement in the appropriate signalled position of the actuator, the control surface being centered by spring action on release of signal. In this case, of course, elevator trim has to be held on and thus rudder cannot be signalled at the same time. The "kick action" compound escapement, however, weighs very little more than a simple escapement and so can readily be accommodated in smaller models. With small models, too, the fact that the (single) actuator rubber motor has to work against the elevator spring for elevator movement is not significant. This is a limitation of the "kick action" compound escapement with larger models where the rubber power available is often not sufficient for positive elevator movement.

Small, light models are far more responsive than their larger "rudder-only" counterparts—and also more bumped about by gusts, etc. They are much more lively to fly and there is a distinct advantage at times in having a reasonably stable model where one can neutralise everything and let the model sort itself out. If it were possible to fit a 30 in. span model with "full house" multi, for example, it would be quite a job to keep on top of controlling it all the time. Things happen very quickly with a small model and so if you can build in a bit of "kindness" to pilot error in the design it can help a lot.

The one thing to avoid in small models is excess weight. That "the heavier they are the harder they hit" is very true. The only serious damage we have done to small R/C models was with a ·8 c.c. (McCoy) diesel powered 30 in. span job which was rather loaded up (before the days of miniature receivers and all-transistor circuits demanding quite a battery weight). It had a habit of breaking wings in semi-crash landings and eventually wrote itself off completely. We have had lightweight R/C models of similar size hit in an inverted spinning attitude (yes, barrel rolls should be started higher up!) and had them flying again in a quarter of an hour after "cement" repairs. Such models would



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be judged light by "free flight" standards and the radio gear does not add much extra weight. Yet they fly better and last longer as a consequence.

Silk or nylon covering is definitely out for small R/C models, for example. It can double a wing frame weight, as well as probably pulling it out of shape when doped in any case. Tissue covering may split, but it lends itself to cement repairs on the field—and the little jobs seem to perform just as well with a few holes in the covering.

We use rubber model quality balsa for all airframe parts with sheet fuselage sides and panels almost "punk" grade, but it is amazing how tough this becomes with tissue covering over it. If a 30 in. wing weighs more than an ounce and a half covered and doped we reckon to have made a mistake in balsa selection somewhere and the complete model with engine, radio and battery should work out at about 7 ounces, or not more than 8 ounces with a secondary escapement for elevator trim. Then, incidentally, you can fly the model on a Cox ·010, although it does look and sound rather like an underpowered bumble-bee. A Cox ·02 is just about right—or an 049 if you want a "hot" job on your hands. The tables summarise some of the more important data.

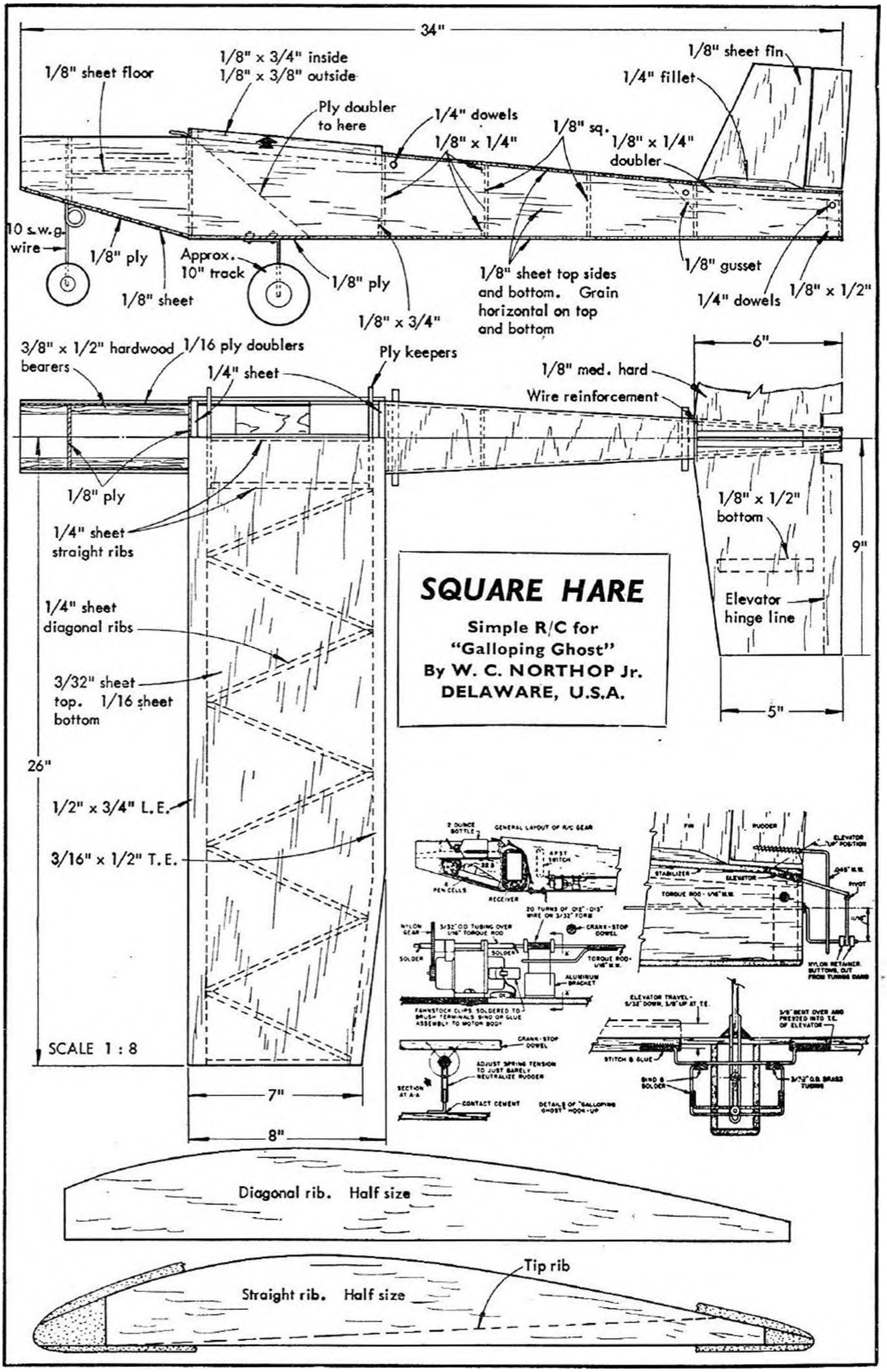
Much of the above comment is, of course, personal preference. Another such preference is for glow motors throughout the R/C models. They may not all develop the same power size for size as diesels and they do require a battery for starting and fuel proofer on the model. But they run smoother, and are less susceptible to changes in flight speed and seldom give vibration troubles provided you check (and correct as necessary) the balance of the prop. This latter point is very important in the case of the modern high-revving small glow motor. A correctly balanced prop. can add a couple of thousand revs to the speed and virtually eliminate vibration. With relayless receivers, though, small diesels are probably just as good on lightweight R/C models and as far as the average British modeller is concerned diesels still seem easier to start.

TYPICAL R/C LIGHTWEIGHTS

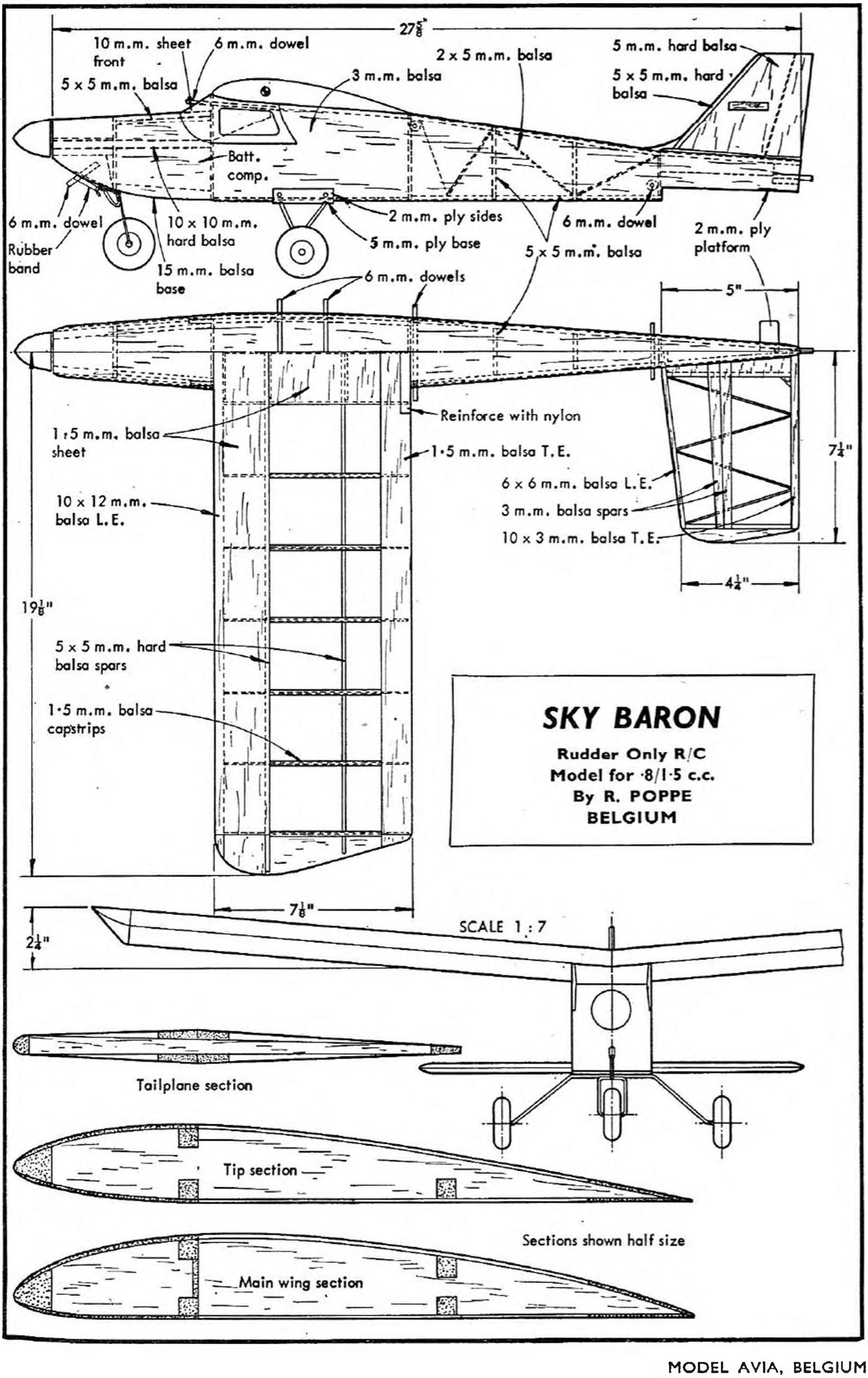
MODEL	SPAN	ENGINE	REMARKS
Top Flite Roaring 20 (U.S.A.)	21"	·010-·020 cu. ins.	All sheet covered structure, including wing
Top Flite School Boy (U.S.A.)	29"	·010-·020 cu. ins.	All sheet construction, including wing
Top Flite Cessna 175 (U.S.A.)	30"	·020 cu. ins.	All sheet construction
Goldberg Junior Falcon	37"	·049 cu. ins. (·8 c.c.)	Tricycle undercarriage
A.P.S. Jumping Gemini	28"	·049 cu. ins. (·8 c.c.)	Plan RC/839, price 3/6, including post.
A.P.S. Minnie	24"	·020 cu. ins.	Plan RC/766, price 4/6, including post.

SUITABLE RECEIVER CIRCUITS FROM RADIO CONTROL MODELS AND ELECTRONICS

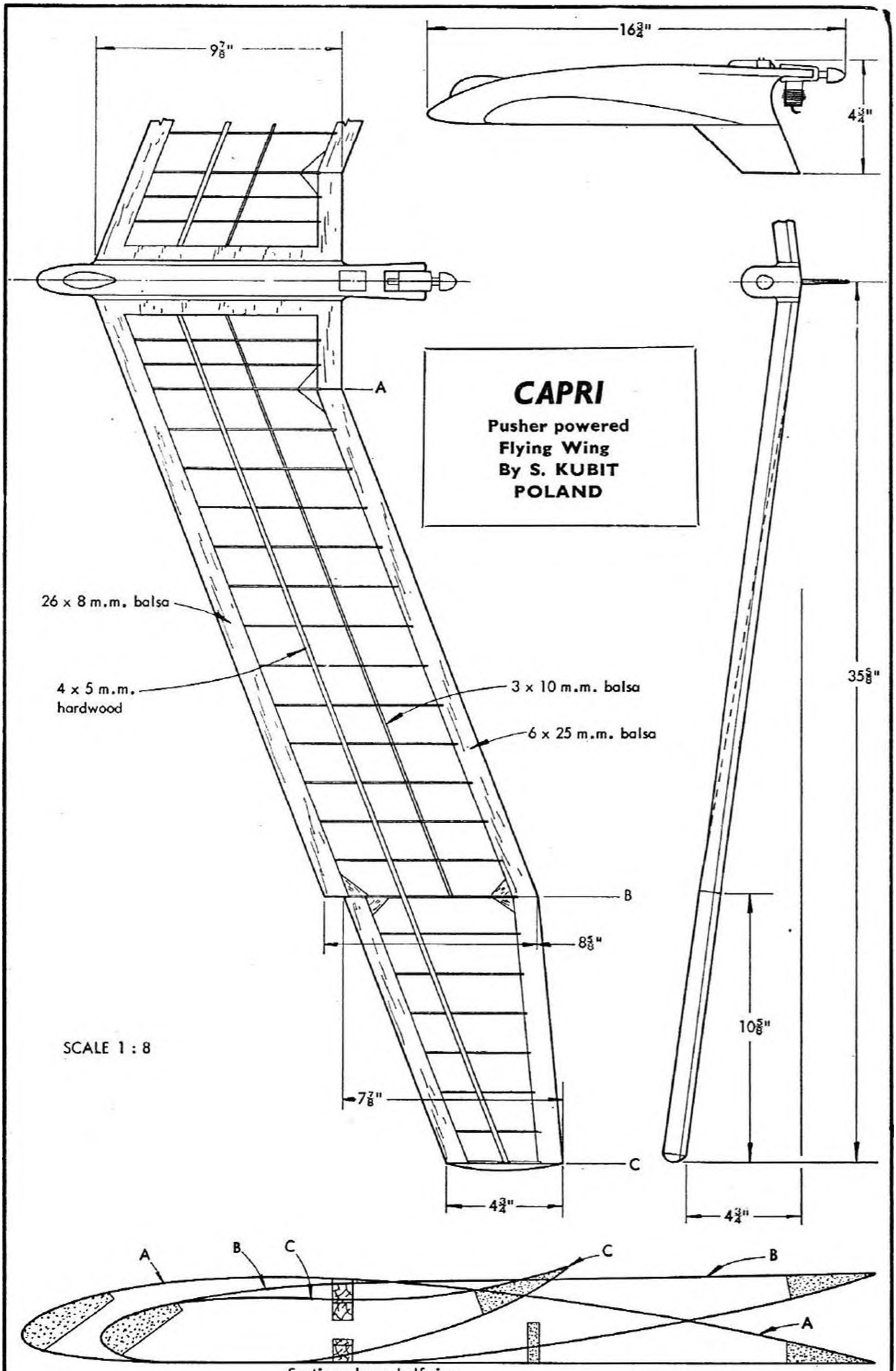
RECEIVER	SIZE	No. of TRANSISTORS	TYPE	REMARKS
Mini 4	2"×1¼"	4	3-4·5v. relayless tone	Published October 1962, modifications March 1963
The New 305	2¾"×1$\frac{1}{16}$"	4	4·5v. relayless tone	Published November 1962
Terrytone	3⅛"×2"	4	4·5v. relayless tone	Published December 1961



AMERICAN MODELER, U.S.A.

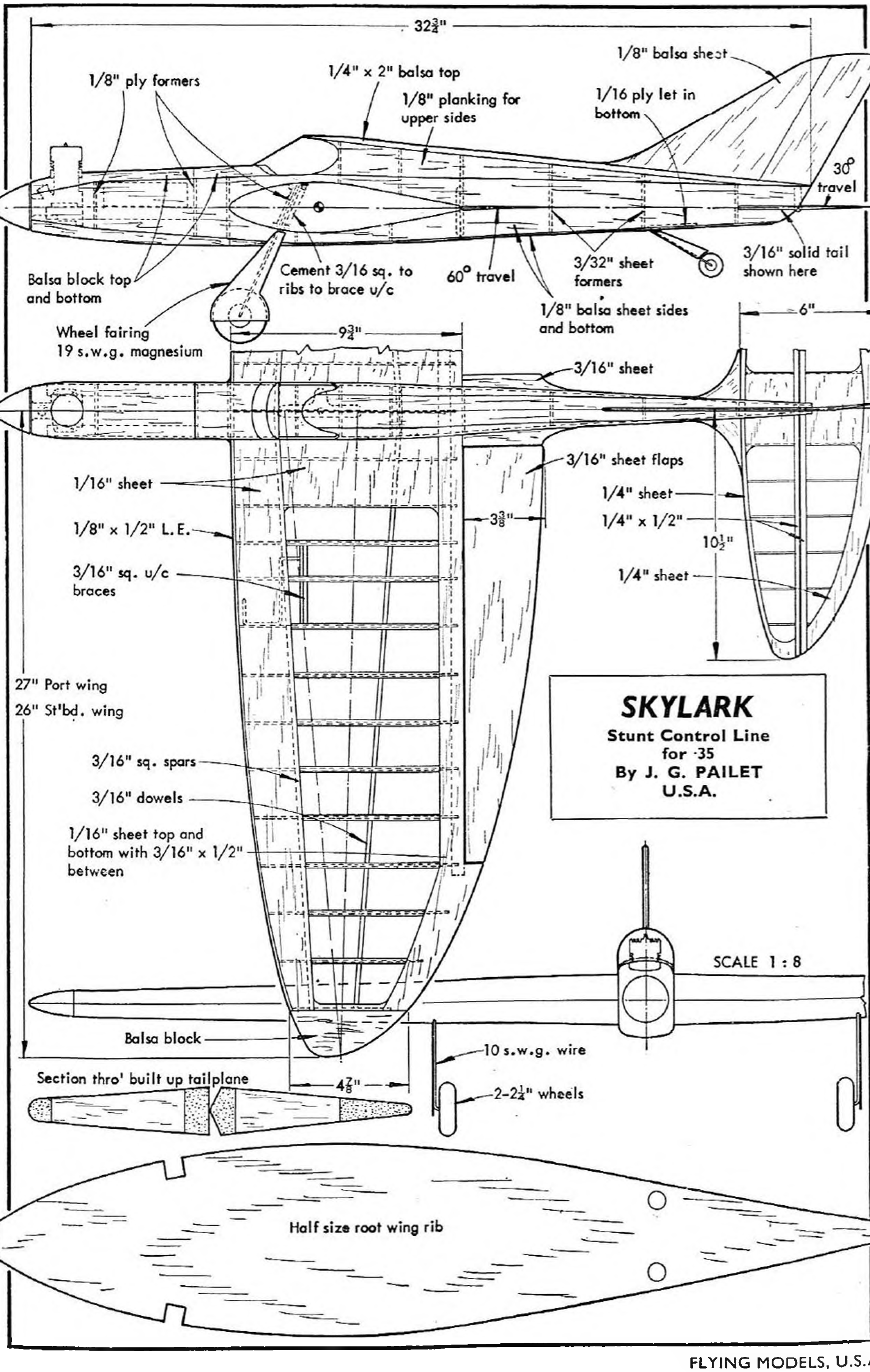


MODEL AVIA, BELGIUM

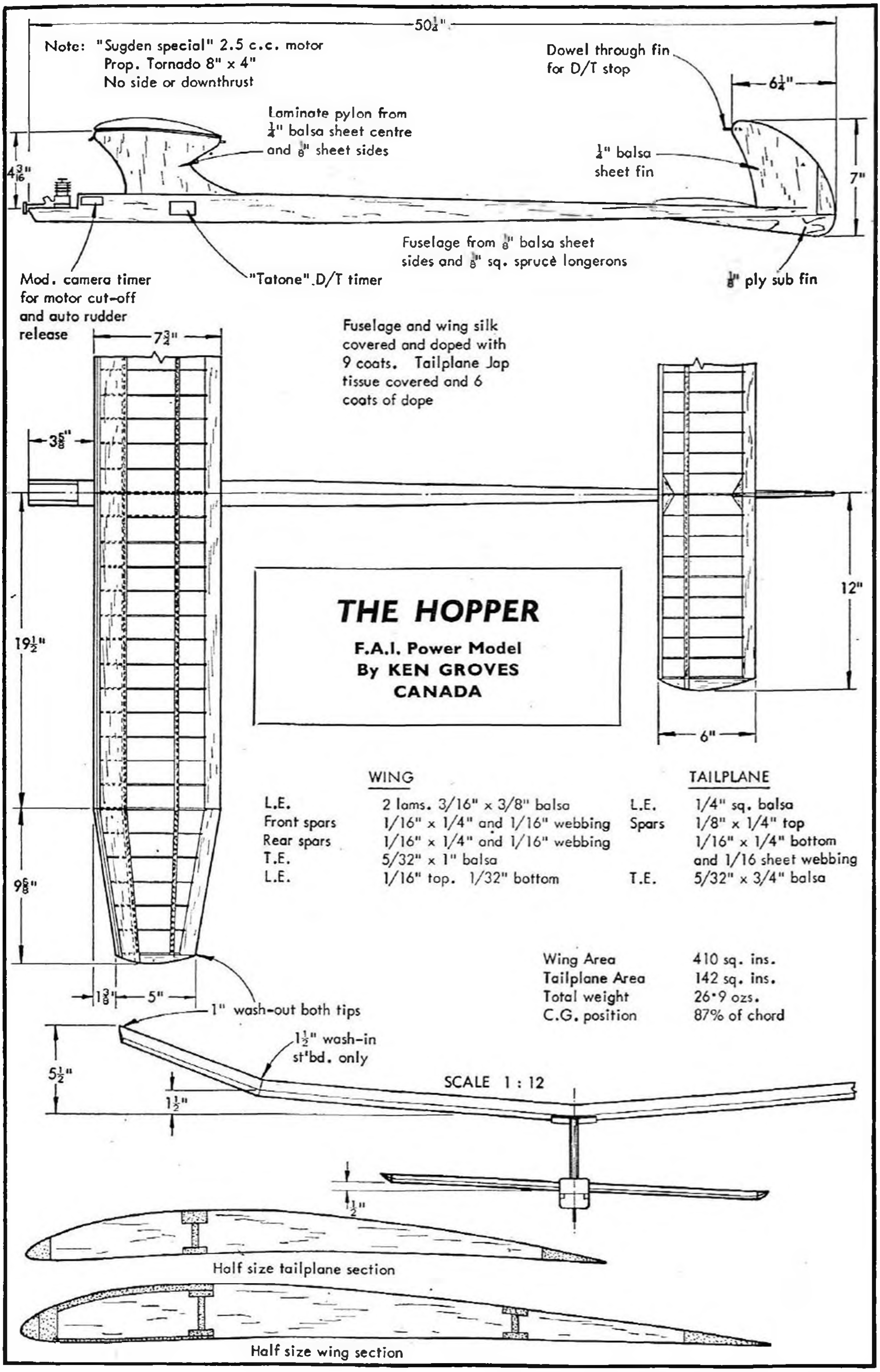


Sections shown half size

MODELARZ, POLAND



FLYING MODELS, U.S.A.



CANADIAN MODEL AIRCRAFT, CANADA

UNNECESSARY WEIGHT

THE volume of balsa in a complete "Taurus" wing (70 in. span 720 sq. in. wing area) is equivalent to two 36 in. lengths of 10 in. square block. Two such blocks of balsa could weigh anything between 10 and 40 ounces depending on the grade selected. Thus by using all of the lightest grade or all of the heaviest grade, one could build two geometrically identical wings of this size differing in weight by nearly two pounds!

This comparison is, of course, over-simplified. Obviously one could not use the lightest grade of balsa throughout such a wing. Equally one would not be expected to pick out all the hardest possible balsa for every part. Yet the fact remains that on the question of balsa selection two typical wings could vary by as much as one hundred per cent in weight—the one builder favouring light stock wherever possible and the other heavier, stronger stock throughout. Whether the latter wing *would* be all that much stronger in practice is debatable. Strength in the right place is essential, but excessive strength in other parts (which invariably means excessive weight) does not necessarily add to *overall* strength. The whole model being heavier will have greater normal landing shocks and a greater impact force in crash landings. A light model can be less vulnerable than a heavy model in this respect, provided it has no built-in weaknesses, and its performance can be better.

Common sources of excessive or unnecessary weight on wing structures are shown in Fig. 1. Sheet leading and trailing edges contribute quite a high proportion of the total wood volume. Leading edge stock (1) can be quite light, bendable grade, provided it is not too brittle. There is a difference between brittle and stiff stock. The latter is stiff by virtue of the "cut" whereas brittle stock is just too light for large unsupported areas and easily punctured or fractured by pressure. The same sort of local weakness comes from using sheet leading edge stock which is too thin. The overall strength of $\frac{1}{16}$ in. sheet 6 lb. stock, for example, is better than $\frac{3}{32}$ in. sheet of twice the density. Another fault with sheet covering which is too thin is a tendency to sag between supporting ribs and spars, leading to the so-called "starved horse" appearance. While this spoils the looks and aerodynamic form of the wing, it is also weak since the covering lacks stiffness under bending loads.

The leading edge member itself (2) is often made heavier than necessary. The "Taurus" wing dispenses with this spar entirely, relying simply on a formed or moulded sheet leading edge. This has been found no more prone to damage than a conventional structure although, of course, much more difficult to produce (the formed leading edge is supplied in the "Taurus" kit). The main purpose of a leading edge spar with sheet covering is to supply support and a jointing surface for upper and lower sheeting. It can therefore be made from light density wood, with a reasonably generous section. If the model is to be flown under particularly trying conditions—e.g. subject to landing in scrub—a stronger leading edge spar might be advisable, with even possibly external

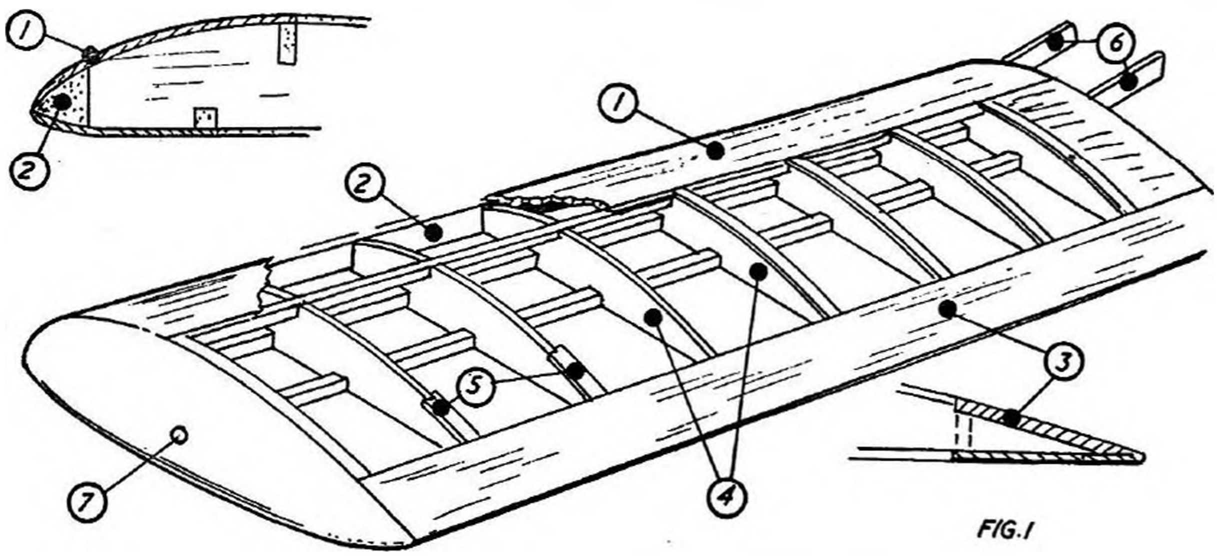


FIG. 1

reinforcement. Control line model wings also benefit from a beefed up leading edge, but here weight is not so important anyway.

Trailing edges need to be stiff and rigid. This characteristic is given more by balsa "cut" than density and light to medium quarter-grain stock can be far more satisfactory as a structural member than much heavier grade wood which bends readily. With built-up sheet trailing edges (3) quite light quarter-grain sheet can be used satisfactorily and represent a considerable saving in weight. The limiting factor is that the sheet must be stiff enough and strong enough to resist distortion on unsupported areas and edges. If there is a risk of the front edges of the sheet sagging between ribs, a false spar consisting of fill-in pieces of very light sheet between the individual ribs is good practice.

Ribs (4) should again be cut from quarter grain stock and it is far better to use thicker sheet of the lightest grade than thinner sheet of heavier grade. For the same overall weight (both in quarter grain balsa) the thicker sheet ribs will be stiffer. Saving weight by punching or cutting holes in ribs is seldom worthwhile. The actual saving in weight is usually virtually negligible, and the risk of reducing the stiffness or local strength of the rib considerable.

Rib capping strips (5), normally used with sheeted leading and trailing edges, are often cut from unnecessarily heavy stock. The actual amount of stock used is quite small, so weight difference is not all that significant in this case, but cap strips cut from very light stock are perfectly adequate and easier to bend to conform to the rib shape. Soft capping strips also require a minimum of sanding to finish flush with the sheeting—an operation which can lead to accidental damage to the ribs if carried out too enthusiastically.

Another common source of unnecessary weight is in wing joiners and dihedral braces (6), usually cut from ply. Excessively strong braces can actually reduce the wing strength by creating a weak spot or "stress concentration" where the joiner stops. Joiners or braces should be designed to *distribute* stress, not purely as sources of local strength. Bonner popularised the unbraced centre section joint on the "Smog Hog" where the mainspars are merely scarfed together at the centre without any normal bracing and claimed far *less* wing breakages as a consequence. Not many people are prepared to go to this extent, and properly designed centre section bracing is more or less essential on most free flight models. The main thing is to *design* a form of bracing which gives the right amount of reinforcement without adding *unnecessary* strength and weight.

WEIGHTS OF BALSA SHEET
(Weight in ounces)

GRADE & DENSITY (lb./cu. ft.)	LIGHT OR SOFT 6	LIGHT-MEDIUM 8	MEDIUM 10	MEDIUM-HARD 12	HARD 14	EXTRA HARD 16
36″×3″×1/32″	·1875 (3/16)	·25 (1/4)	·3125 (5/16)	·375 (3/8)	·4375 (7/16)	·5 (1/2)
1/16″	·375 (3/8)	·5 (1/2)	·625 (5/8)	·75 (3/4)	·875 (7/8)	1·0 (1)
3/32″	·5625 (9/16)	·75 (3/4)	·9375 (15/16)	1·125 (1 1/8)	1·3125 (1 5/16)	1·5 (1 1/2)
1/8″	·75 (3/4)	1·0 (1)	1·25 (1 1/4)	1·5 (1 1/2)	1·75 (1 3/4)	2·0 (2)
3/16″	1·125 (1 1/8)	1·5 (1 1/2)	1·875 (1 7/8)	2·25 (2 1/4)	2·625 (2 5/8)	3·0 (3)
1/4″	1·5 (1 1/2)	2·0 (2)	2·5 (2 1/2)	3·0 (3)	3·5 (3 1/2)	4·0 (4)
3/8″	2·25 (2 1/4)	3·0 (3)	3·75 (3 3/4)	4·5 (4 1/2)	5·25 (5 1/4)	6·0 (6)
1/2″	3	4	5	6	7	8

Just automatically cementing on substantial ply braces is poor practice. The job needs thinking out, not only to save weight but to give greater overall strength by distributed stress.

Finally the wing tips (7). Modern practice is to cut tips from solid block balsa which in the case of a large chord, thick section radio control model wing can amount to a considerable volume, and weight. Obviously the lightest grade of balsa is the logical choice, but even so an individual shaped tip may weigh up to two ounces or more. In the case of kits where tips are supplied as pre-shaped blocks, density may be higher, and both tips are seldom exactly matched for weight. Thus in addition to adding unnecessary weight, the balance of the wing is thrown out by one tip being appreciably heavier than the other.

The only load the wing tip is likely to be called upon to carry is rubbing contact with the ground in a ground loop or crash landing. Accepting the fact that a weak tip *might* get damaged in this way, there is every reason for reducing tip weight to the minimum possible. Besides the obvious one of reducing wing weight, and making the wing easier to balance, weights at wing tips can produce instability in turns or aggravate straight flight trim problems.

Where solid block tips are used, therefore, they should be reduced to minimum volume; and if the block size is still substantial, hollowed right out for lightness. They will receive extra strength from the covering in any case, so hollowing out to 1/8 in. walls does not necessarily make them fragile. Hollowing out must, of course, be done after the tip is fully shaped. This means tack-

APPROX. WEIGHT BIRCH PLYWOOD

THICKNESS	WEIGHT ounces /sq. in.	lb./sq. ft.
1/32	·016	·148
3/64	·024	·210
1/16	·032	·288
5/64	·037	·331
3/32	·045	·404
1/8	·058	·518
5/32	·070	·638
3/16	·083	·745
1/4	·109	·979
5/16	·141	1·270
3/8	·173	1·555
1/2	·222	2·000
0·8 millimetre	·016	·138
1 ,,	·019	·170
1·5 ,,	·029	·254
2 ,,	·039	·330
2·5 ,,	·047	·341
3 ,,	·058	·516
4 ,,	·077	·696
5 ,,	·093	·828

STEEL WIRE DATA

S.W.G. SIZE	NOMINAL DIA. ins.	CROSS SECTIONAL APPROX. sq. in	APPROX. WEIGHT ounces per 10″ length
8	·160	·0201	·91
9	·144	·0163	·74
10	·128	·0129	·585
11	·116	·0106	·48
12	·104	·0085	·385
13	·092	·00665	·30
14	·080	·005027	·225
15	·072	·004072	·182
16	·064	·003217	·145
17	·056	·002463	·112
18	·048	·001810	·082
19	·040	·001257	·057
20	·036	·001018	·046
21	·032	·000804	·036
22	·028	·000616	·028

cementing the tip block in place, carving and finishing to blend with the wing, then cutting off and hollowing out before finally cementing back in place. Then finally check that the complete wing balances about its centre line (or both wings have the same weight *and* balance about the same point on their semi-span in the case of two-piece or plug-in wings).

If the balance is badly out, it will almost certainly have to be corrected by adding weight to the lighter tip. It is improbable that enough excess weight can be sanded off the heavier wing to compensate. This leads to another important point—check that material selected for each wing half is "paired". That is to say wing sheeting for the port wing should weigh the same as that for the starboard wing, and the same with the spars. Again this close selection is not always possible with kit materials and it may even be necessary to replace some of the spar or sheet stock to ensure a good balance. And if the wing tip blocks are heavy, replace them with the lightest grade block you can find. Not only will this eliminate unnecessary weight but the soft blocks will be much easier to carve to shape!

Expanded polystyrene has been used in place of balsa for solid tips. It is obtainable in "block" sections, with a density as low as 2-3 pounds per cubic foot (or less than half the weight of the lightest grade of balsa). The material is, however, much more difficult to carve and finish smooth. The best tool for carving is a hot wire rather than a knife, finally finishing by sanding and then tissue covering. The result is a relatively rough surface although the application of covering will both fill and smooth it. In general, soft balsa is a better material even if it is that little bit heavier.

Fuselage weight is probably not so easy to control. Common sources of excess weight are, however, the undercarriage (1) and wheels (2)—Fig. 2. A slightly thicker gauge for the undercarriage wire (or thicker sheet dural for a leaf-type undercarriage) and a surprising amount of extra weight can creep in unexpectedly. A *good* quality spring steel wire of 12 gauge, for example, can be just as strong as a heavier undercarriage in 10 gauge wire of softer grade. Or perhaps the addition of a simple light gauge spreader wire can be effective in bracing a thinner gauge wire undercarriage against "spreading" and save an ounce or more. Similarly with sheet dural undercarriage legs. By selecting a high tensile grade of light alloy sheet, 16 gauge material can be stiffer and less subject to bending than softer $\frac{3}{32}$ in. thick sheet at two thirds the weight—or perhaps the spreader wire again can make all the difference.

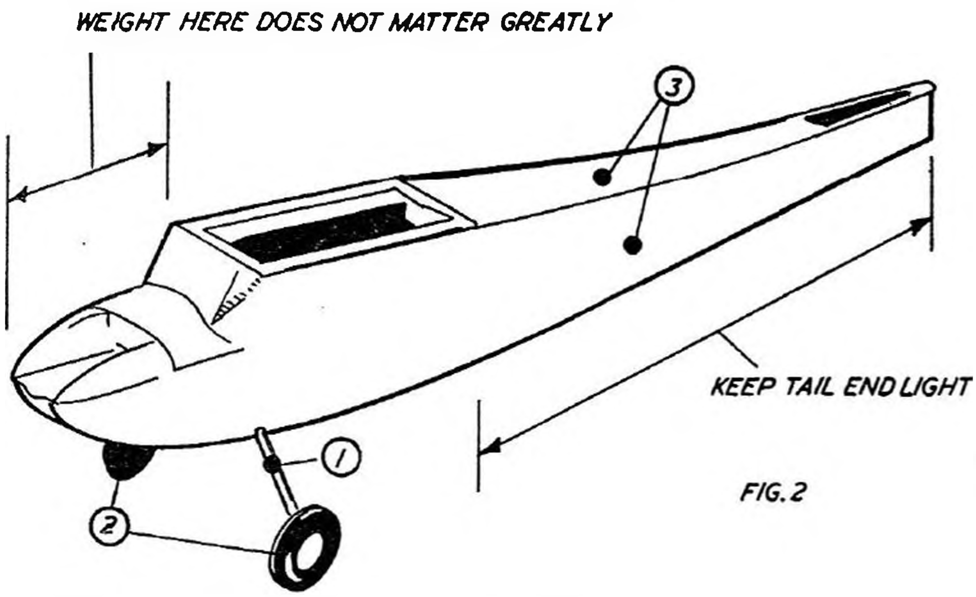


FIG. 2

Wheels are a case in point where weight can vary enormously. Commercial "balloon" wheels of $2\frac{1}{2}$ in. diameter, for example, can vary in weight from as little as $1\frac{3}{4}$ ounces to 8 ounces the pair. The heavier wheels are not necessarily more durable; nor (equally) the lightest wheels necessarily the best. But just accepting any wheels of the right size without checking weights may impose an unnecessary weight penalty. Added weight low down is not necessarily beneficial in improving "pendulum stability". This is very much a fallacy.

Unnecessary weight can be added by choosing too heavy a grade of balsa for fuselage sheeting. Similar rules as for ribs apply. Light, quarter grain sheeting of reasonably generous thickness is better than heavier, lighter stock. The whole of the fuselage surface will be reinforced by covering, anyway and, with nylon covering especially, one can use the very lightest grade of balsa for the job. Where fuselage strength needs boosting up, such as at the nose or points of local stress concentration, this can easily be done with sheet balsa doublers inside. Ply sheeting should be kept to a minimum since ply is usually at least three times as heavy as balsa for similar thicknesses. One of the main things is to keep the tail end of the fuselage light. Weight here is just as bad as excess wing tip weight, and can even call for additional weight to be added to the nose in the form of ballast to trim.

The same considerations apply to the tail unit, only even more so. On the majority of free flight models the tailplane is made much stronger and heavier than it need be. The tailplane, after all, is a straight aerofoil which carries relatively little load. Nor is it in a position where it is prone to suffer crash damage, especially if it is held on with rubber bands. Ideally it should be as light as you can make it, provided it has the necessary stiffness to resist warping. If sheeting is used for leading edge covering this should be the lightest obtainable, with spar stock light or light-medium (nothing heavier) and light quarter-grain stock for the trailing edges. Ribs can be ultra-light quarter-grain sheet. Basically, in fact, if one built a tailplane from random stock balsa an "ideal" weight figure for this unit would be between one half and two thirds of the figure obtained from the "mock-up"—achieved by meticulous selection of balsa grades.

Where solid sheet is involved on the tail unit, such as elevators for tailplanes of all-sheet fins, the best choice is a fairly substantial sheet thickness, selecting the lightest possible weight in quarter-grain stock. Thickness will ensure reasonable freedom from warping and quarter-grain stock rigidity. Weight can then only be cut down by using about 6 lb. density stock, or even lighter. Again in the case of fins, at least, the sheet surface will be covered to finish, which will add further strength. It is usually much simpler, quicker and equally effective to use tissue covering for solid surfaces rather than nylon which would be the logical choice for wings and fuselage. It will also save weight.

Covering plus doping adds appreciably to the weight of any model. In the case of nylon there is a considerable difference in the weight of nylon material which can be used for the job. The lightest material (weight per square yard) will be more than strong enough for the largest model and can represent a saving of many ounces on the total weight of the model, provided it has a close weave which is filled by one or two coats of dope.

Nylon (or even lightweight silk) covering tends to become prohibitively heavy on smaller models. There is also the fact that full strength dopes have to be used to tauten these materials, which may warp light structures badly. Tissue covering is a far better proposition in such cases and, if extra strength is needed, double-tissue covering. This will still work out considerably lighter than nylon or silk covering, although it will not have the same tear strength.

Finally a word about doping and finishing. It is generally known that colour dopes are heavy and to colour dope a model can add so much weight as to detract from performance. On the other hand "full" coloured models are much more attractive. Much depends on whether you place appearance before performance, or vice versa. You can, however, still get good "solid" colour effects by using well thinned coloured dopes over the corresponding colour of covering (tissue or nylon). Such a mixture would consist of about a 1:4 mixture of colour dope and clear dope, with an equal amount of thinners added for spraying.

Of the "solid" colours, the lighter the colour, in general, the heavier it is likely to be. White dope, for example, is much heavier than red, blue or black. Yellow is a light colour which has only moderate weight—about the same as red, but heavier than black. Aluminium is about the lightest of the "colour" dopes and quite attractive light "solid" colours can be produced by mixing with blue or red.

Basically all colour dopes are "unnecessary" weight and so their use is strickly limited on free flight models where performance is the main aim. This, however, is a field where personal choice or preference is very much in evidence. Good workmanship is further enhanced by a first-class finish, and coloured dopes used wisely and not to excess have a definite attraction.

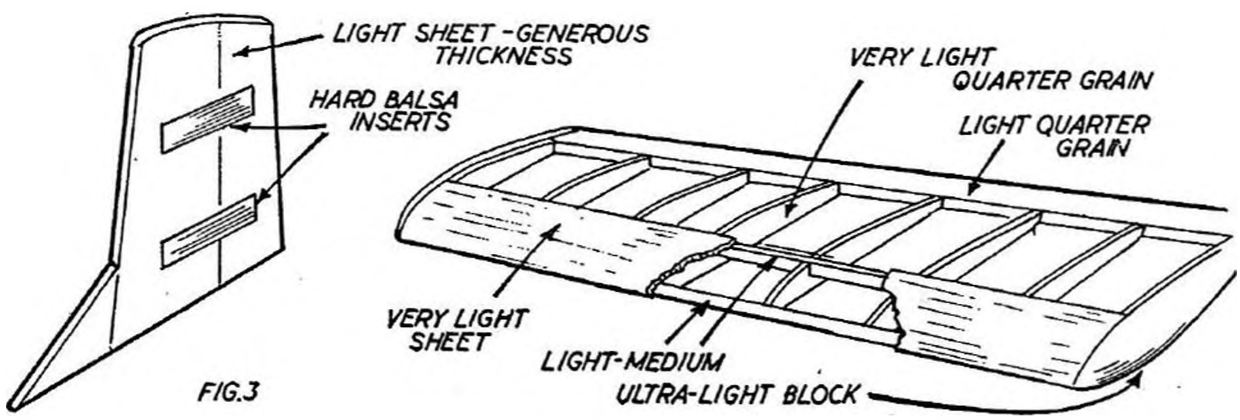
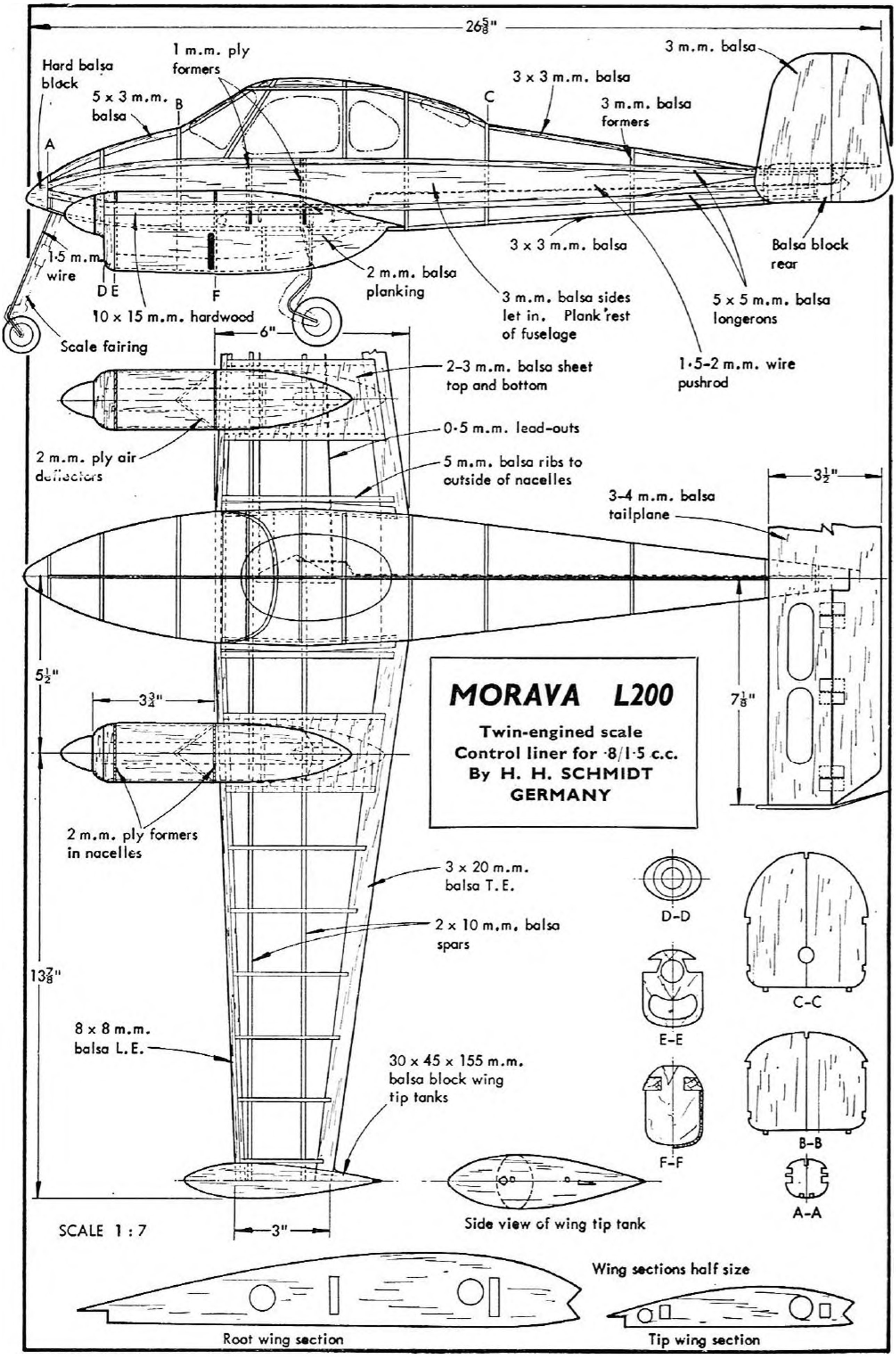
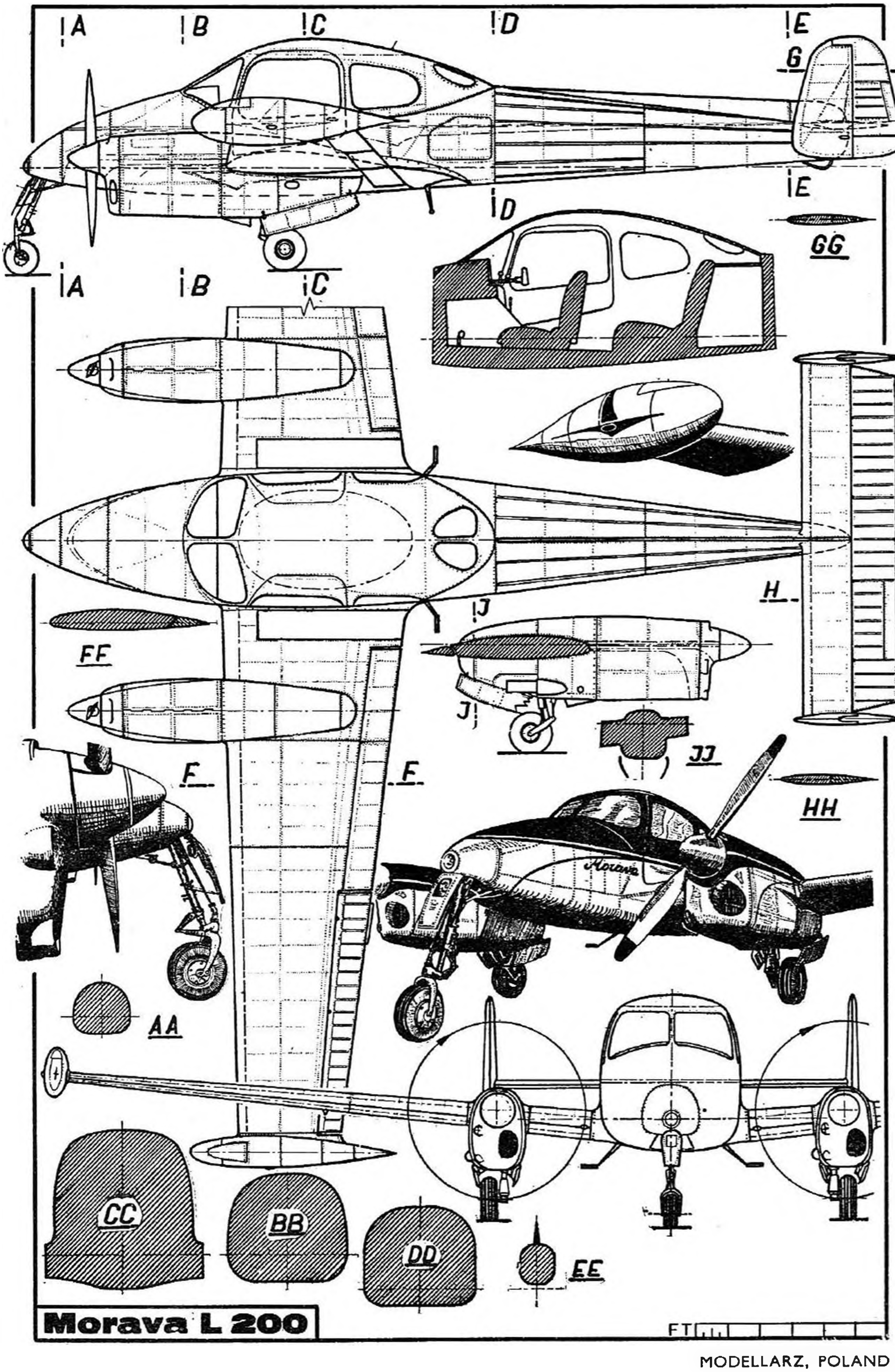


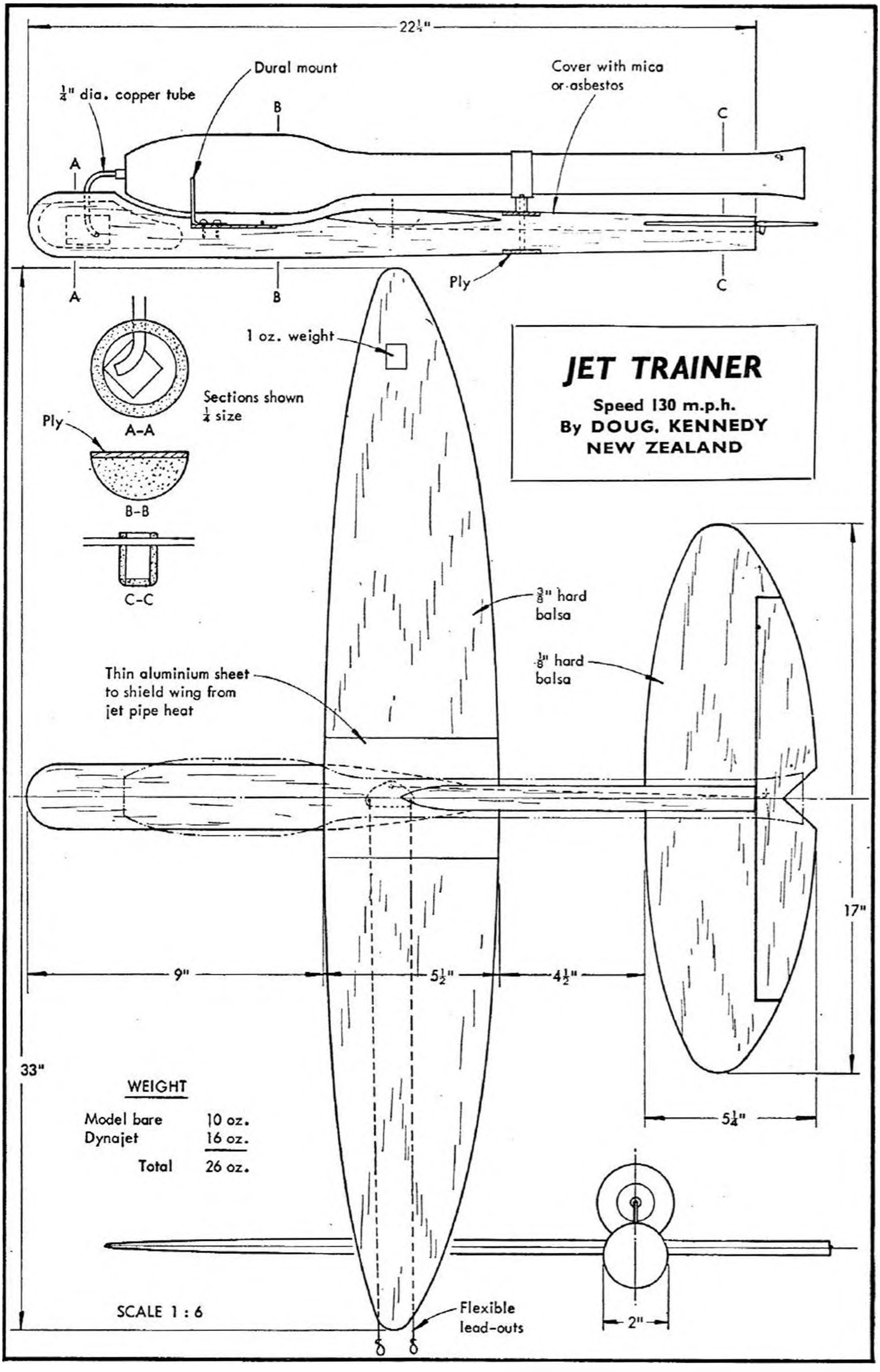
FIG.3



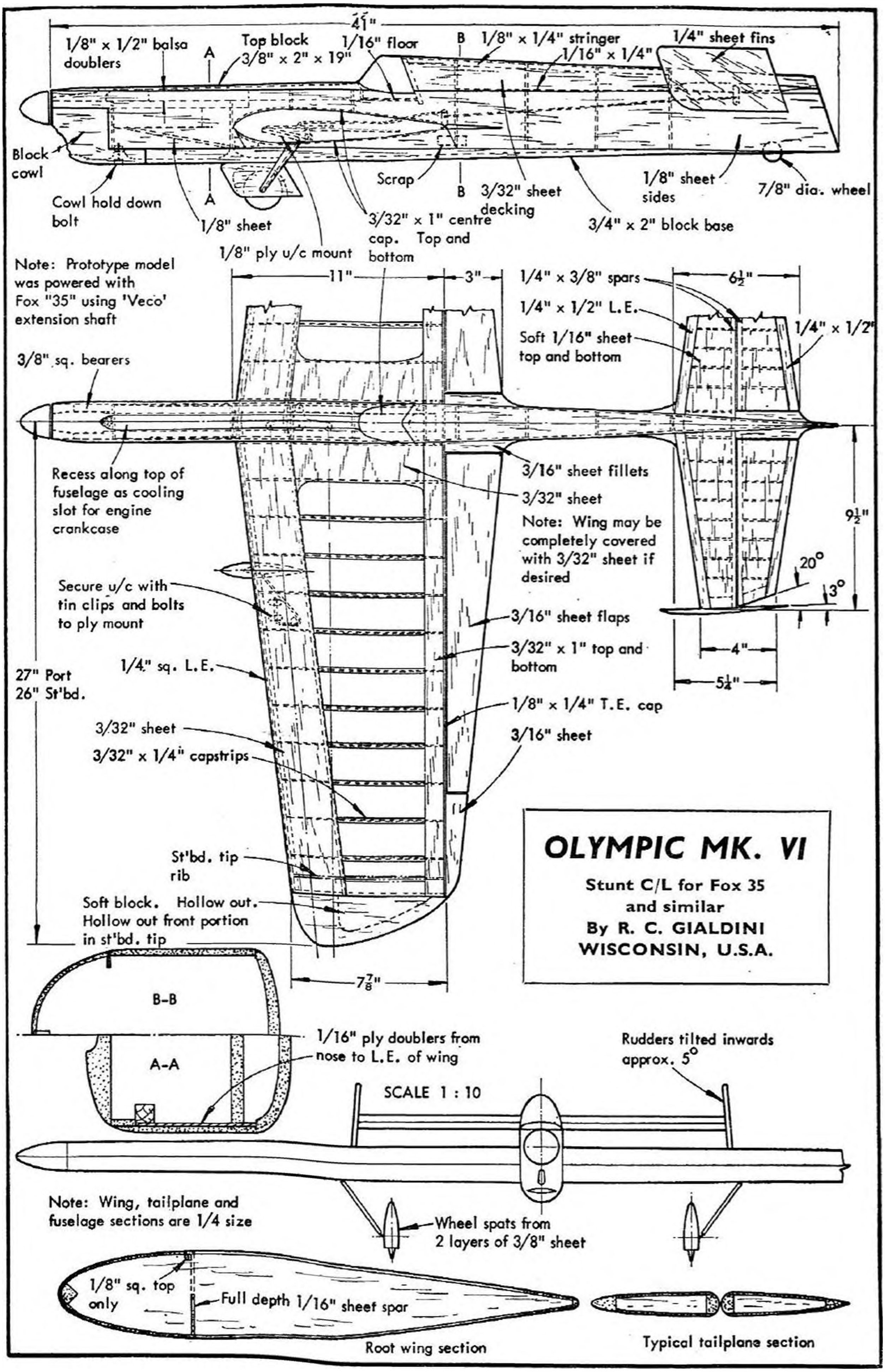
FLUG MODELLTECHNIK, GERMANY



MODELLARZ, POLAND



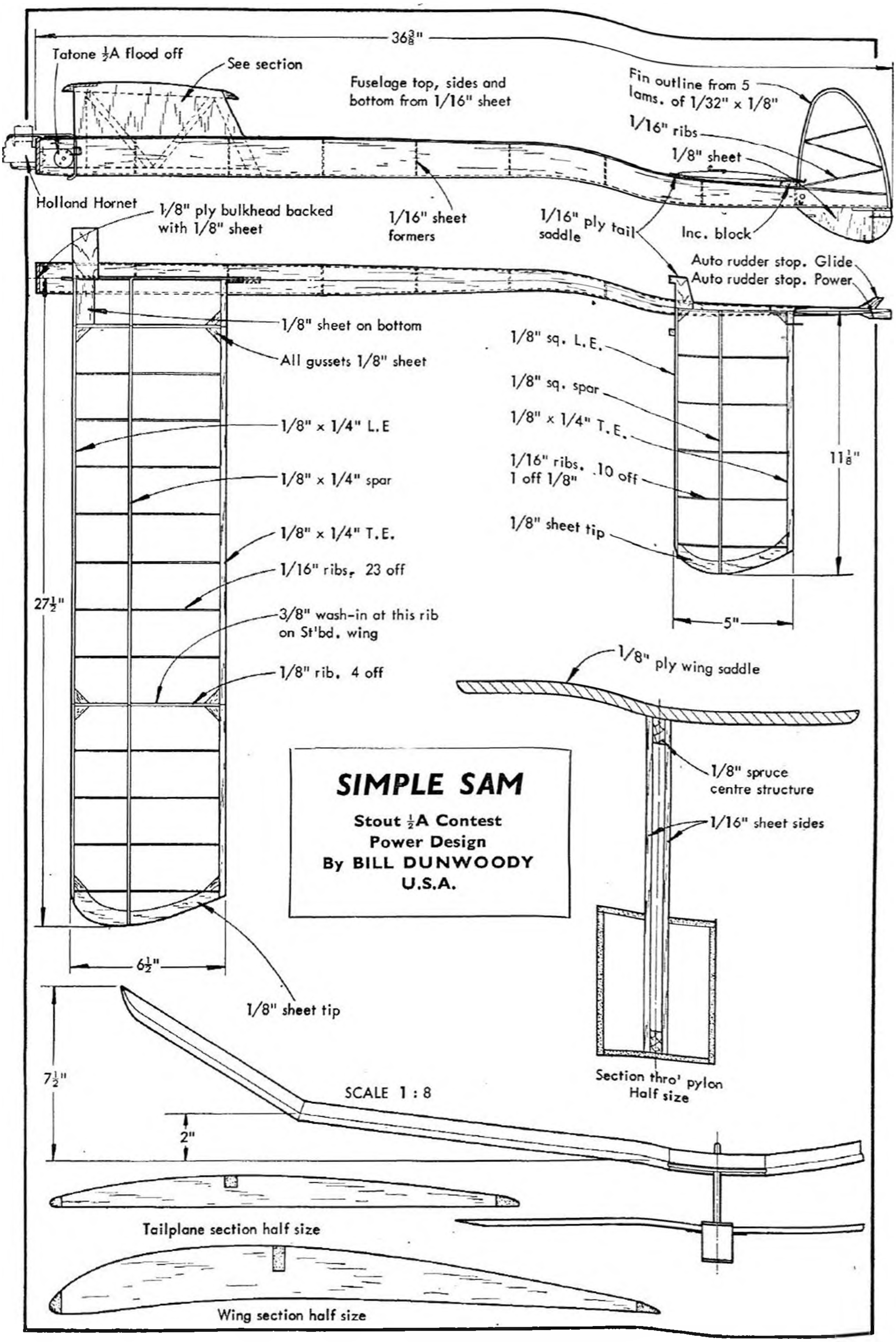
UPPER HUTT BULLETIN, NEW ZEALAND



OLYMPIC MK. VI

Stunt C/L for Fox 35 and similar

By R. C. GIALDINI
WISCONSIN, U.S.A.



SIMPLE SAM

Stout ½A Contest Power Design
By BILL DUNWOODY U.S.A.

GLOW, PLUG, GLOW!

THE glow engine, basically, is designed around a particular fuel, to provide both the required amount of through-flow of fuel (induction and exhaust) and a compression ratio to match the requirements for igniting the fuel with the proper "timing". These are largely fixed factors, inherent in the construction of the particular engine, but two variables remain—the fuel and glow plug. The engine can be "tuned" by these two variables, which practice may even be necessary in order to achieve consistent running. This is because the behaviour of glow fuels is very much influenced by atmospheric conditions. Thus an engine designed and developed in, say, California to match a particular fuel with a particular glow plug may well not perform consistently on that same fuel and plug in Europe, or even on the east coast of America. Equally a particular glow engine which normally runs well may suffer a drastic loss of power on a very cold day or, in more critical cases, over the course of a single day due to temperature and humidity changes. Solutions to such cases can normally be found in a change of fuel, a change of glow plug, or both.

The theoretical ideal two-stroke cycle (Otto cycle) is shown in Fig. 1 as a plot of volume against pressure inside the cylinder. At point A the piston is at bottom dead centre. As the piston moves up the cylinder, volume decreases and pressure increases until point B or top dead centre is reached. The degree of compression, which is normally defined as the compression ratio, can be expressed as V_A/V_B, or

$$\frac{\text{swept volume}+\text{head volume}}{\text{head volume}}$$

At top dead centre the ideal Otto cycle assumes that the compressed mixture is ignited and burns at constant volume, the result being an immediate rise in pressure to point C. This pressure drives the piston down, with decreasing gas pressure and increasing volume until bottom dead centre is again reached at point A.

In practice, of course, the actual two-stroke cycle is appreciably modified, both by mechanical and thermal considerations. On the mechanical side, compression does not start at bottom dead centre since the exhaust ports are open in this position of the piston and only closed when the piston has moved up the cylinder a certain amount. Similarly the exhaust will open again before bottom dead centre. It is also impossible in practice to achieve instantaneous ignition at top dead centre. On the "gas" side, compression will not be fully adiabatic since there will be some heat loss through the cylinder walls, the build-up of pressure over BC cannot be accomplished at constant volume, and gas expansion from C to A will not be adiabatic. The practical two-stroke cycle will, therefore, assume more of the form shown in Fig. 2. It is significant that the greatest differences between the two occur at points B and C, which are those parts most affected by engine design geometry. These refer to the compression and ignition characteristics.

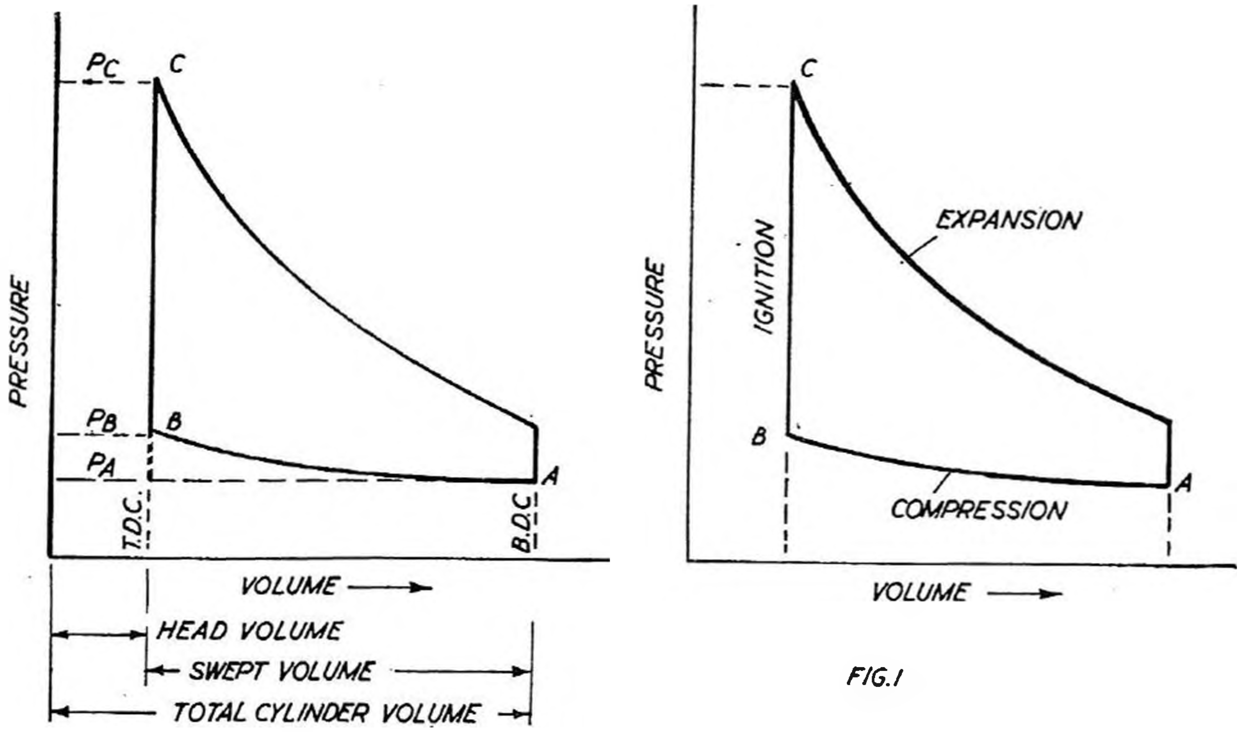


FIG. 1

Any practical ignition system inevitably implies a time lag which means, basically, that ignition must take place before top dead centre to allow time for the propagation of the flame. The actual "timing" point is also dependent on engine speed. If too delayed there will be a power loss because the potential peak pressure is never realised after top dead centre. If too early, peak pressure will be built up in the cylinder head before the piston has reached top dead centre and oppose the final upward travel, again resulting in a marked power loss—Fig. 3.

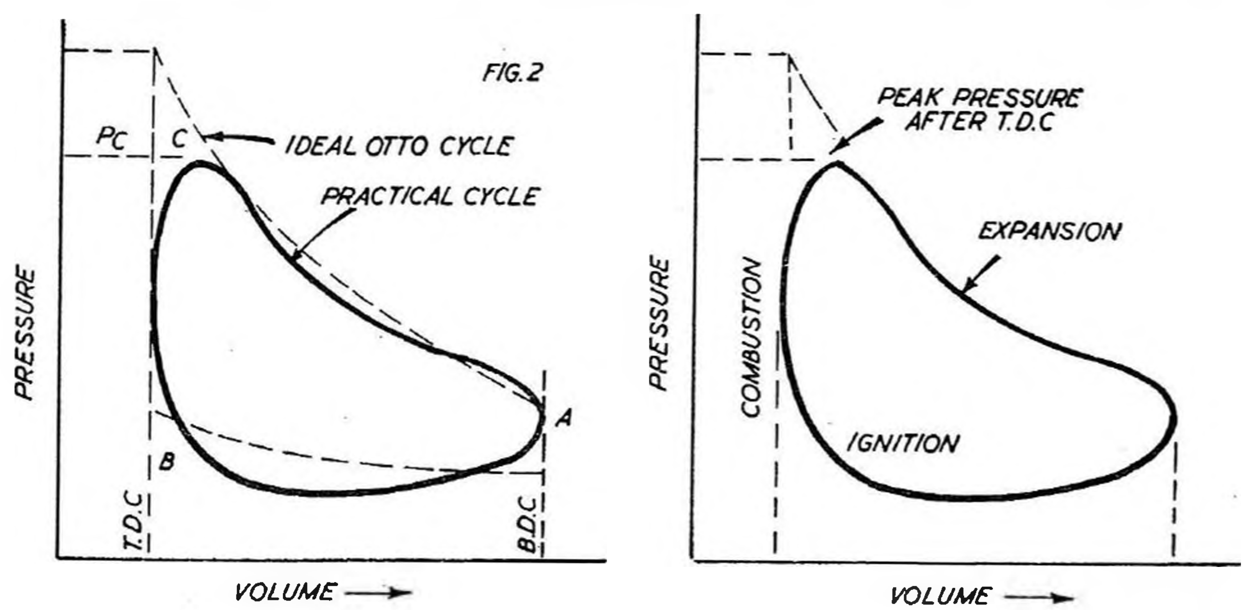
With spark ignition, timing is purely mechanical and so it is a relatively simple matter to arrive at an optimum setting. With compression ignition, although thermal energy is added to the gas at constant pressure rather than constant volume, the working cycle approaches far more closely to the ideal Otto cycle and timing is fairly easily accomplished by adjusting the compression ratio. This also explains why diesels are less critical as regards fuel, and at the same time why diesels are basically "one speed" engines for a given compression setting.

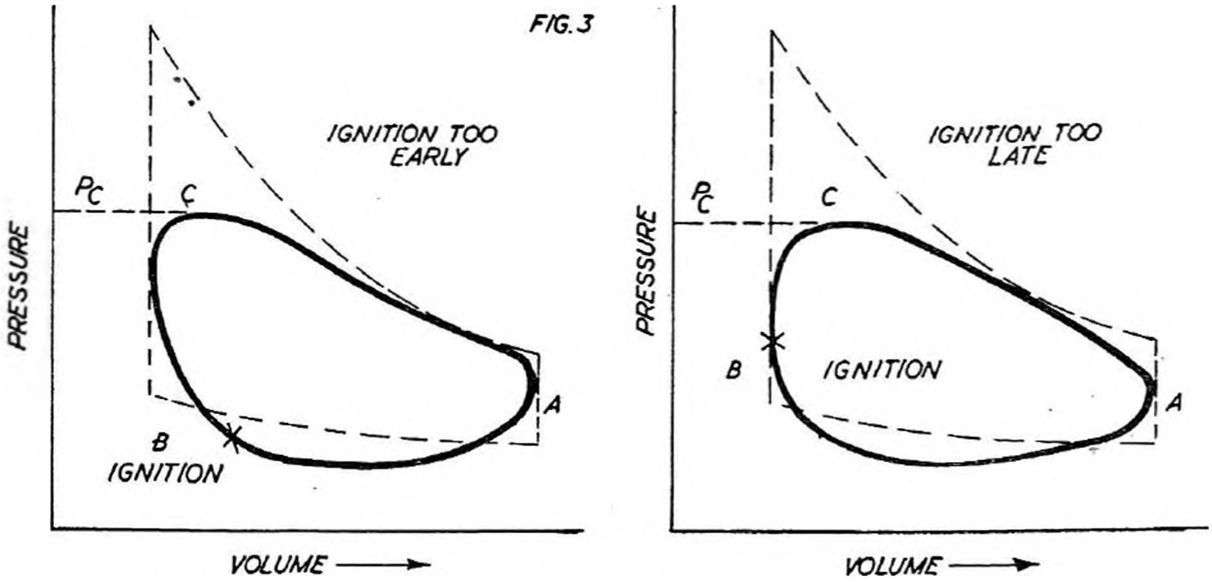
In the case of glow engines ignition is initiated by a localised hot spot produced by the catalytic action of an alcohol fuel on a platinum wire element heated directly by battery for starting. The actual process of ignition is very simple, but widely affected by a considerable number of variables. The primary requirement is that the hot spot temperature be high enough to ignite the fuel mixture at all. An important secondary requirement is that the point at which ignition takes place should have the correct "timing" in order to develop maximum pressure on the cycle.

For a given fuel-air mixture, ignition characteristics can be expressed in the form of a curve like that of Fig. 4. At any point (i.e. combination of temperature and pressure) above the line ignition will occur. Corresponding temperature and pressure points which fall below the line will not fire the mixture. But even in the ignition range the only control over the ignition point or timing is the correct match of temperature and pressure. Certain factors are fixed by the engine geometry, such as the compression ratio, but the others are dependent on the fuel and plug characteristics. Thus the performance of a glow engine is inevitably linked very closely to the fuel and plug characteristics, and affected by any changes which may occur in these characteristics (such as a change of fuel characteristics with a change in temperature or humidity). One can vary both as adjustments although it is obviously more convenient to employ a suitable standard fuel wherever possible and match the plug to it, if necessary. For more specialised applications where optimum performance is essential, on the spot fuel adjustments may be called for as being a more flexible method of control. Thus the former method would normally be employed with sports or radio control models; and the latter for contest models.

With glow engines the localised hot spot is invariably produced by a coil of thin platinum, platinum-iridium or similar platinum alloy wire. The temperature achieved is dependent on the thickness of the wire, the catalytic heating of the particular fuel mixture and the *position* of the element. The actual firing or ignition point is further influenced by the compression ratio (i.e. as affecting both the "temperature" and "pressure" side of the ignition/no-ignition curve for the fuel. In general terms, glow plugs are described as "cold", "normal" or "hot", referring broadly to the actual temperature achieved at the element during normal running conditions. Thus starting with a "normal" plug, replacement by a "cold" plug will require a higher pressure to fire the same mixture (retarding the timing, in effect); and a "hot" plug will have the effect of advancing the timing. The range of "cold" and "hot" plugs available in this country is very limited. However, standard or normal plugs of different makes will usually have "hot" or "cold" characteristics relative to each other and show such timing effects.

Element hot spot temperature itself is only part of the story. On ignition of the gases element temperature will tend to rise still further, being heated by the flame. The extent of this temperature rise, and also how much heat is retained, will depend on the mass of the element and the degree to which it may be shielded from the circulating gases and flame. On the subsequent compression stroke element temperature will still further be modified by the cooling effect of the transfer gases (and in particular the extent to which the element is shielded from them) and catalytic heating. During a single cycle, therefore, the plug element undergoes a variety of heating and cooling effects. To eliminate,





or at least reduce, corresponding wide variations in temperature the plug element needs to have a high thermal inertia, although for most practical purposes reasonable temperature stability can be given by adequate shielding. That is why the element is normally enclosed within the body of the plug, or a hole in the head, rather than directly exposed.

The normal coiled element has a comparatively low thermal inertia and thus is likely to be subject to excessive loss of temperature running under conditions promoting considerable cooling—e.g. a very rich mixture for slow speed running on a multi-speed engine. This can be offset by increasing the degree of shielding, although if shielded to an excessive amount starting characteristics of the engine may deteriorate. The more usual solution in such cases is to fit an "idle bar" across the bottom of the plug which acts as a high inertia section to conserve heat under slow running conditions (very rich, "wet" mixtures) and maintains a suitable temperature for consistent ignition on the coiled element. At the same time, too, the idle bar provides some additional shielding for the coiled element. The idle bar itself does not have to be platinum for it is the coiled element which is still responsible for the localised hot spot which produces ignition.

A plug with idle bar (or specially shielded element) is more or less the standard choice for multi-speed glow engines, although not necessarily an automatic solution to running problems. Again an individual plug may be a little too "hot" or "cold" to suit a particular engine and fuel, when another make may be found to give more consistent results. It has also been found in some cases that the actual position of the idle bar when the plug is fitted can make quite a difference—e.g. a change in plug washer thickness to enable the plug to be turned through a further 90 degrees to change the attitude of the idle bar relative to the transfer gas flow. Failing satisfactory performance with a variety of different multi-speed plugs, a change of fuel mixture is about the only other solution.

Quite a number of troubles with multi-speed glow motors are not the effect of badly matched plug and fuel at all, but are due simply to the fact that the engine is new and stiff and needs more running-in before it will perform satisfactorily. Some engines, in fact, need several hours of running time before they can be capable of giving fully flexible throttle response and consistent low speed running characteristics. The fact that a multi-speed engine will consistently hold *high speed* settings does not necessarily mean that it is "run in" as far as low speed performance is concerned. To attempt to cure lack of running-in with changes in plug is futile, simply a waste of time.

The reason why a battery is needed for starting a glow engine, incidentally, is that starting is characterised by a "wet" cylinder and over-rich mixture—the former giving direct cooling of the plug element and the latter calling for a higher temperature to fire the richer mixture anyway—see Fig. 4. Thus extra heat needed is supplied by an external battery. Here, too, we see the need for maintaining glow element temperature for slow running with rich mixture since, regardless of cooling effects, the actual hot spot temperature needs to be higher to get the mixture to ignite. In particularly bad cases, e.g. where no multi-speed glow plug gives the right operating characteristics, it is a perfectly practical proposition to apply extra heat for slow running via an external battery and this can produce most consistent results. It does, however, complicate the issue, and it is far better to sort out this particular problem with glow plug selection and fuel adjustment, if necessary.

To discuss fuels briefly, these, too, can be "hot" or "cold" although these terms are normally used in a different sense. The description "hot" fuel is normally employed for a fuel of "racing" type, containing a high proportion of nitromethane. The "nitro" content is largely balanced against engine design. It is an obvious advantage to use simple non-doped mixtures for sports work and general flying (particularly as the saving in cost is very substantial), and the engine designed to utilise such fuels has a higher compression ratio than the "racing" engine designed for "racing" fuels. In such cases the addition of nitromethane to a basic or straight fuel may give some improvement in power or smoothness of running at high speeds, but the benefits are limited. Above a certain proportion of nitromethane, further addition makes little or no difference—except to fuel cost! The "racing" glow engine, on the other hand, may have most unpleasant running characteristics on straight fuels, difficult to start, inconsistent in running and lacking in power. Handling qualities and power output then progressively, and almost proportionately improve with increasing nitromethane content. The limiting factor may ultimately be the plug, or the strength of the engine to stand up to ultra high speed running. It is quite common with high-power, high-speed glow engines running on high-nitro fuels to burn out glow plugs with astonishing regularity—even once per flight. The breakdown is often due to mechanical causes (i.e. the rapidly fluctuating high pressures generated in the head) rather than thermal shock alone. Thus a

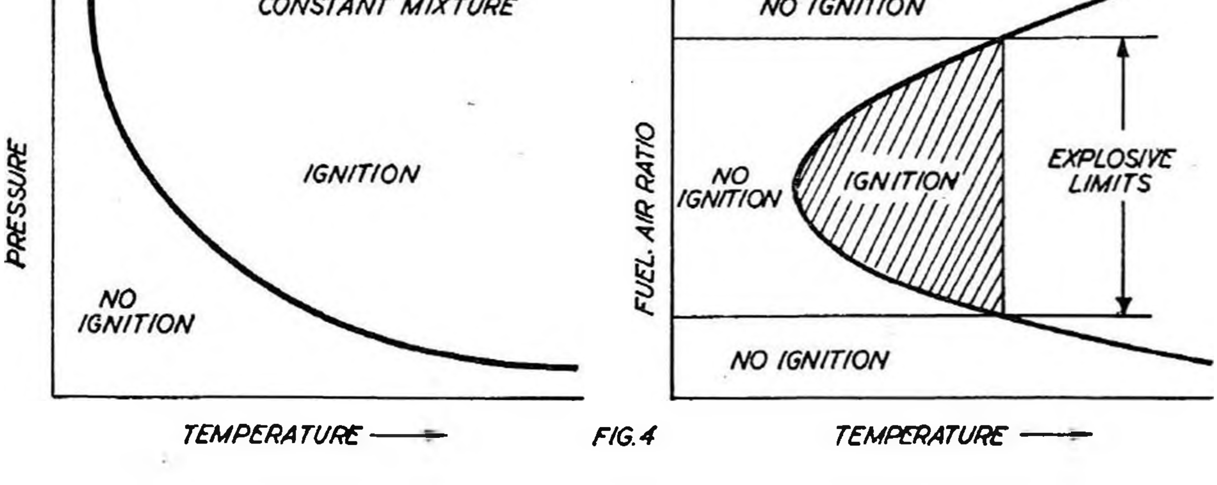


FIG. 4

satisfactory plug may have to be chosen more for the robustness of its element rather than (thermal) type.

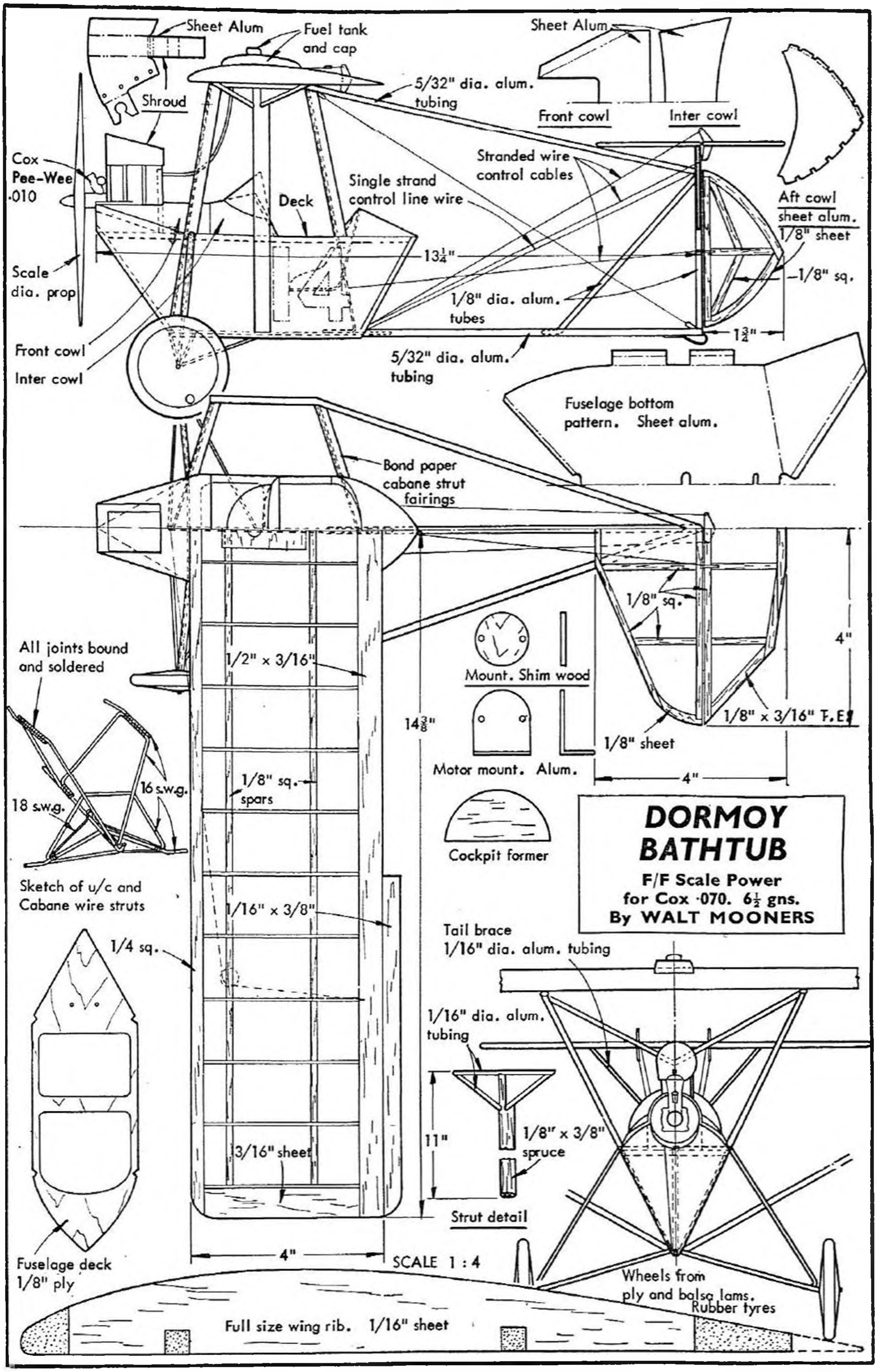
Contrary to the popular usage of the term, nitromethane fuels are basically "cool" in the physical sense, although they also have the effect of advancing the effective timing. The fact that a racing glow engine may run at a hotter cylinder temperature is due mainly to the greater frequency of firing cycles. In such cases one of the more effective means of controlling plug performance is through cylinder head temperature, and thus indirectly controlling the temperature of the plug in intimate contact with the head. Solid heads have high thermal inertia and thus retain heat better. A finned head may dissipate heat too rapidly, leading to a lowering of the hot point temperature and the effect of retarding the ignition. Again this is a characteristic normally sorted out by the engine manufacturer, but not necessarily under the same operating conditions as the customer may ultimately be using the engine.

When a glow engine suffers unexpected loss of power it is often difficult to decide whether this is due to a "retarded" timing effect or "detonation" (premature firing). The former is more likely to occur in very cold weather and the latter in hot, wet weather—assuming that the original fuel and glow plug combination have been determined under "average" conditions.

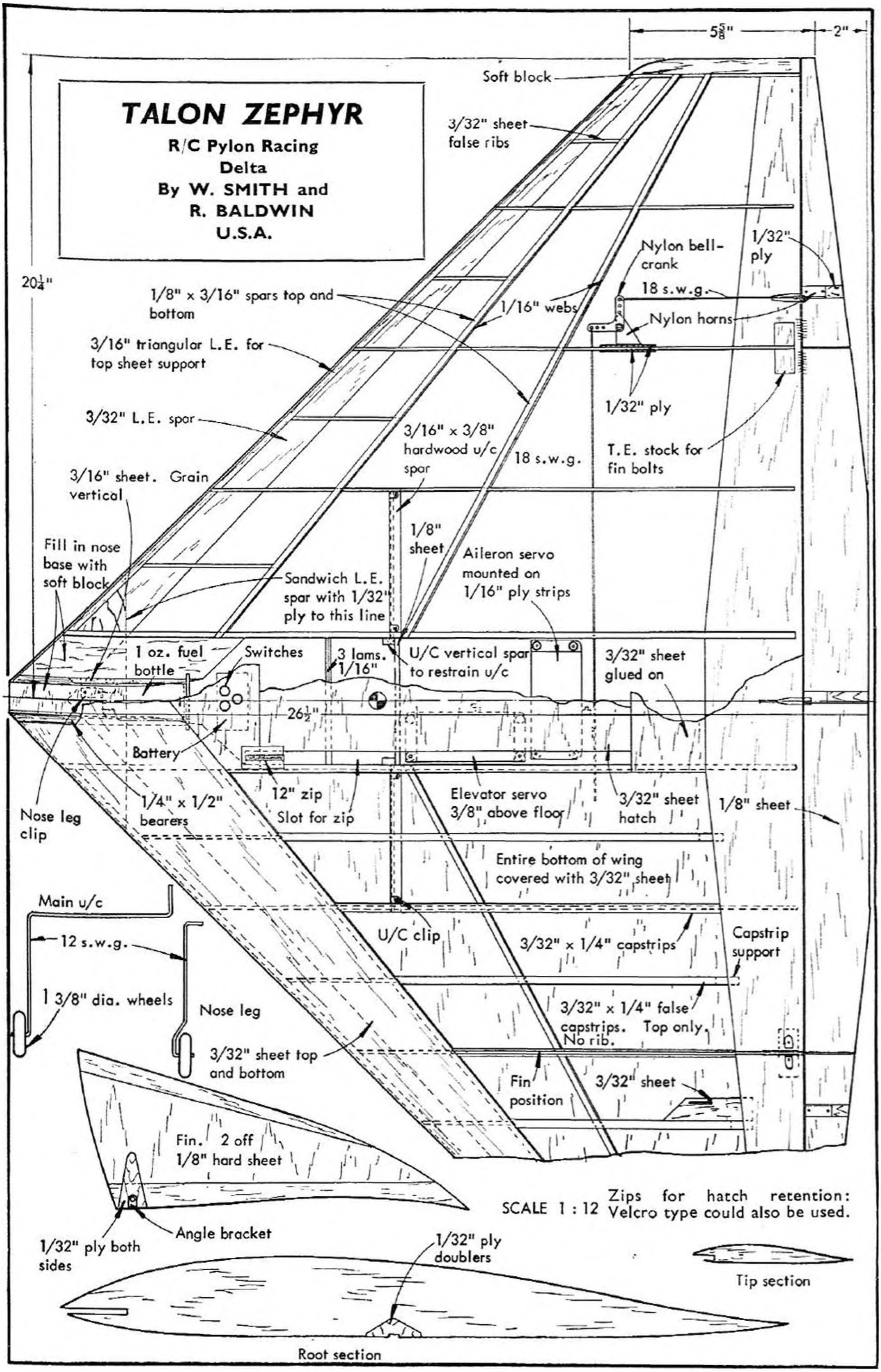
Cold conditions have probably resulted in a richer-than-average needle valve setting, with the engine still running poorly and starting characteristics sadly deteriorated. A "hotter" plug should affect at least a partial remedy, provided one is available. The addition of a little ether to the fuel can also improve starting characteristics under such conditions; and the addition of nitromethane recover much of the lost power and make for smoother and more consistent running. A simpler solution is to reduce the proportion of oil in the fuel mixture (e.g. add methanol), although this can be damaging if the oil proportion is reduced to too low a level and lubrication impaired.

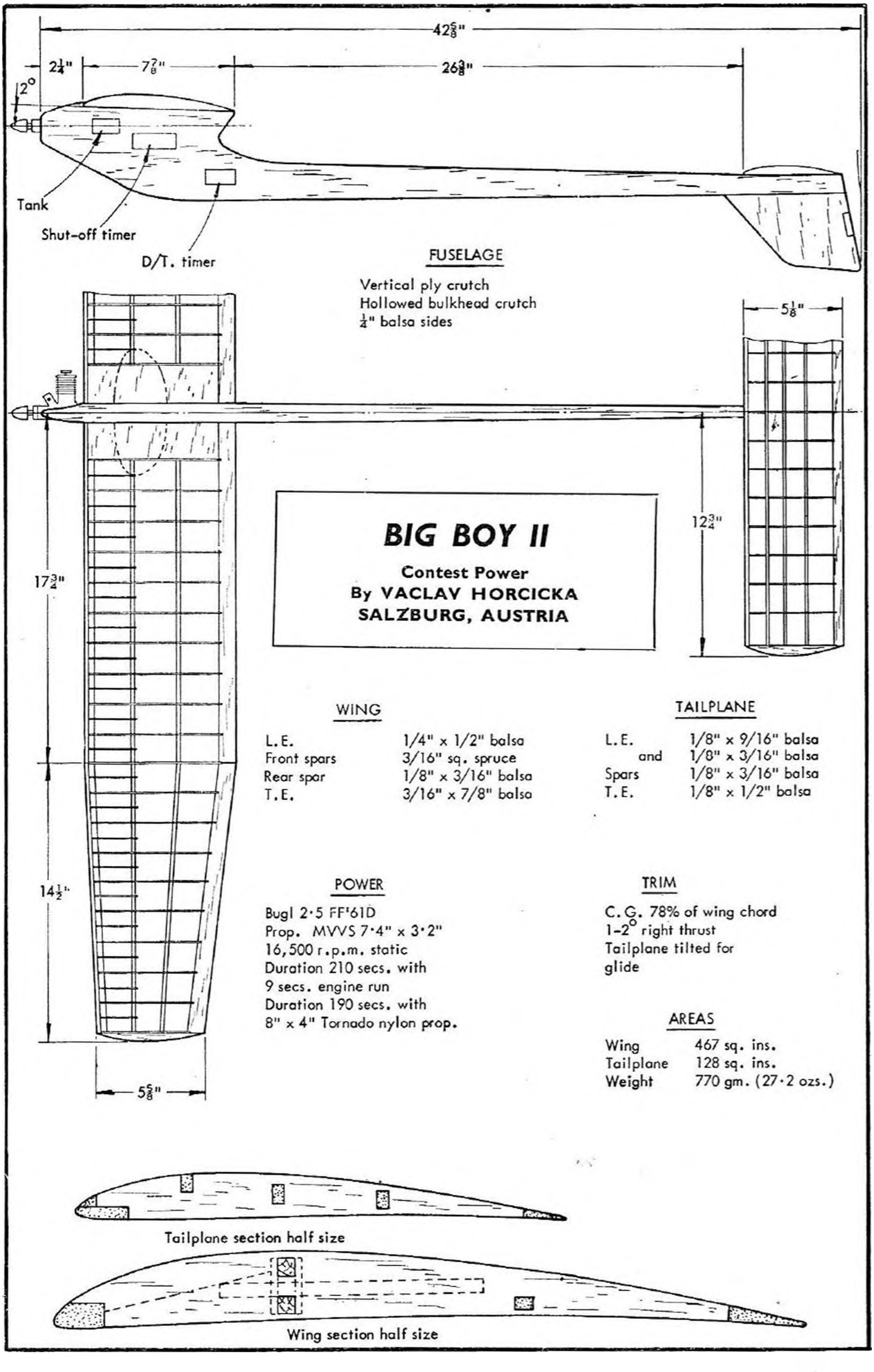
Warm conditions tend to raise the cylinder operating temperature through calling for leaner needle valve settings which, in turn, generate more internal heat. As a consequence the mixture also fires earlier or pre-detonates and part of the "kick" from each exploding gas charge is acting *against* rotation. The obvious move is to richen the mixture up, but then the engine will not two-stroke consistently. However much you fiddle with needle valve adjustment the engine just lacks power. The only real answer is to try a cooler plug but, although this may restore consistent running, it is still unlikely that the engine will develop its normal full power. The same with altering the fuel mixture. You may get the engine to run better, but it will still almost certainly remain "off form". An additive which often works for "cooling" purposes to combat detonation is benzene or nitrobenzene, or, more simply, increase the proportion of oil in the mixture. In the case of a nitromethane fuel, a decrease in the nitro content will have the same effect in reducing detonation—and a corresponding loss of power from the engine which depends on the "nitro" proportion for its normal performance.

Most of these "adjustments" are purely "cut and try". There are no hard and fast rules which hold under all circumstances, and no such thing as a "multigrade" glow fuel. Glow engines, in fact, can be just plain temperamental at times, which is not all that surprising considering the many factors which can affect ignition "timing". Because of the inter-relationship of these variables it is a bit surprising that glow plug engines are normally as consistent as they are!



AMERICAN MODELER, U.S.A


TALON ZEPHYR
R/C Pylon Racing
Delta
By W. SMITH and
R. BALDWIN
U.S.A.
5⅝"
2"
20¼"
Soft block
3/32" sheet false ribs
1/8" x 3/16" spars top and bottom
1/16" webs
3/16" triangular L.E. for top sheet support
3/32" L.E. spar
3/16" x 3/8" hardwood u/c spar
18 s.w.g.
Nylon bell-crank
18 s.w.g.
Nylon horns
1/32" ply
1/32" ply
T.E. stock for fin bolts
3/16" sheet. Grain vertical
1/8" sheet
Aileron servo mounted on 1/16" ply strips
Fill in nose base with soft block
Sandwich L.E. spar with 1/32" ply to this line
1 oz. fuel bottle
Switches
3 lams. 1/16"
U/C vertical spar to restrain u/c
3/32" sheet glued on
26½"
Battery
1/4" x 1/2" bearers
12" zip
Slot for zip
Elevator servo 3/8" above floor
3/32" sheet hatch
1/8" sheet
Nose leg clip
Entire bottom of wing covered with 3/32" sheet
Main u/c
12 s.w.g.
U/C clip
3/32" x 1/4" capstrips
Capstrip support
1 3/8" dia. wheels
Nose leg
3/32" x 1/4" false capstrips. Top only. No rib.
3/32" sheet top and bottom
Fin position
3/32" sheet
Fin. 2 off 1/8" hard sheet
SCALE 1 : 12
Zips for hatch retention: Velcro type could also be used.
Angle bracket
1/32" ply both sides
1/32" ply doublers
Tip section
Root section


42⅝"
2¼"
7⅞"
26⅜"
2°
Tank
Shut-off timer
D/T. timer
FUSELAGE
Vertical ply crutch
Hollowed bulkhead crutch
¼" balsa sides
5⅛"
12¾"
17¾"
14½"
5⅝"
BIG BOY II
Contest Power
By VACLAV HORCICKA
SALZBURG, AUSTRIA
WING
L.E. 1/4" x 1/2" balsa
Front spars 3/16" sq. spruce
Rear spar 1/8" x 3/16" balsa
T.E. 3/16" x 7/8" balsa
TAILPLANE
L.E. 1/8" x 9/16" balsa
and 1/8" x 3/16" balsa
Spars 1/8" x 3/16" balsa
T.E. 1/8" x 1/2" balsa
POWER
Bugl 2·5 FF'61D
Prop. MVVS 7·4" x 3·2"
16,500 r.p.m. static
Duration 210 secs. with
9 secs. engine run
Duration 190 secs. with
8" x 4" Tornado nylon prop.
TRIM
C.G. 78% of wing chord
1-2° right thrust
Tailplane tilted for
glide
AREAS
Wing 467 sq. ins.
Tailplane 128 sq. ins.
Weight 770 gm. (27·2 ozs.)
Tailplane section half size
Wing section half size

WIRE BENDING AND FORMING

ALTHOUGH steel wire used for aeromodelling components is generally referred to as piano wire, actual grades sold under this name may range from relatively soft steel wire to true hard-drawn "piano wire"; and materials from mild steel through plain steels of various temper, plated steel wire, to stainless steel. Thus the strength and degree of hardness may vary enormously between different specimens of the same nominal specification (diameter size). At one extreme there is the soft wire which is quite readily bent to shape, but just as readily bent out of shape (e.g., on an undercarriage) or prone to straightening out (e.g., on a propeller shaft). At the other there is the wire which is so hard and brittle that any attempt to work it through sharp bends results in it cracking or fracturing.

Wire is produced by drawing, a process which results in work-hardening of the material. The degree of work-hardening depends both on the properties of the basic material and the ultimate reduction in section. Finer wires, in general, tend to be more work-hardened and stronger than thicker wires, because of the greater number of drawing operations to reduce to final diameter and may, in fact, be several times stronger than the basic material in its original rod shape. This is all to the good since bending and forming thin wires is usually straightforward, unless the material has been work-hardened to the extent of becoming brittle.

It is in the larger sizes—e.g. from 20 s.w.g. size and larger—that there is usually the greatest difference in "drawn strength". The slightly softer materials are to be preferred for ease of bending and forming, but are less satisfactory if they lack the necessary "spring" qualities. This is particularly important in the case of power model undercarriage legs where, to get adequate spring stiffness, wire diameter may have to be increased. A really springy 12 s.w.g. wire, for example, may be every bit as strong as softer 10 s.w.g. wire, and the latter will be half as heavy again because of its greater cross section. On the other hand, really hard 10 s.w.g. wire is virtually impossible to bend into close coils (as might be called for to produce a coiled spring in a nosewheel leg) without a machine tool for the job. Even then, if too hard it could fracture. It would, therefore, normally be annealed before bending and then re-tempered.

The subject of wire bending and forming really starts with wire selection. Some people prefer to accept a slightly softer wire for propeller shafts or undercarriages in order to be sure of getting clean, accurate bends without having strained the wire. This is usually all right unless the wire is *too* soft. A soft propeller shaft on a rubber model, for example, is not likely to stay true for very long and may require repeated straightening during use—until eventually it has developed a more or less "unstraightenable" kink, or even breaks. A soft undercarriage is relatively useless since it offers little protection in hard landings. As a consequence it needs more or thicker wire to stiffen it, such as double legs (for fore-and-aft stiffness) or a cross spreader (to resist splaying out).

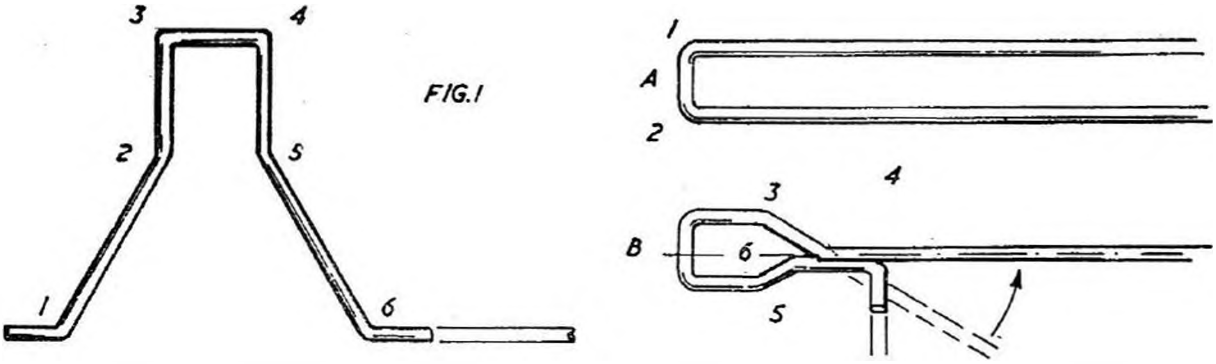


FIG. 1

Basically, hard "springy" wire is the best choice in each case, limited only in application by its workability. One can assess the "temper" of a wire fairly readily by bending a length grasped in each hand, thumbs facing each other and with the wire running over them. The thumbs should be about three inches apart for testing 18-16 s.w.g. wire, and a progressively greater distance with thicker diameters. Then bend the wire through about 20-30 degrees. Hard wire will flex when bent, but spring back straight when released. If the wire shows any permanent bend when released it is relatively soft and unlikely to be of much use. It may be a very good specimen on which to *practice* wire bending, however, just to get the hang of the techniques involved.

It is often recommended that to bend "hard" wire (the logical choice for undercarriages) the wire should first be softened by heating to red heat and then allowing to cool. Certainly this will make the wire easier to bend, but it will also destroy its spring temper. Nor will it recover this temper without further heat treatment—something which cannot be done by guesswork or simple methods. More likely the wire will be ruined by this treatment. As a general recommendation, therefore, wire should always be bent in its original state and never "softened" for working. This may limit the scope of bending in thicker wire sections, but it will at least ensure that the wire retains its consistent properties.

Simple straight bends up to a right angle can be done with stout pliers in the case of thinner wires (up to about 18 to 16 s.w.g.), or in a vice. The latter technique is usually necessary for thicker wires, and often preferred for 16 s.w.g. size. With this method the end of the wire is gripped in the jaws of the vice (with the rest of the wire protruding from the top or one end, as most convenient) and the bend formed by tugging the free length of wire round to shape. With a little practice clean, accurate bends can be formed by this method, although it is limited to the type of bend geometry which can be tackled. It is usually possible to "vice bend" a comple undercarriage, for example, since there is sufficient straight length between each bend to allow fitting into the jaws of the vice, but a typical rubber model prop. shaft is another matter—Fig. 1. In the latter case bends "A" and "B" should be done in the vice, if possible, and the

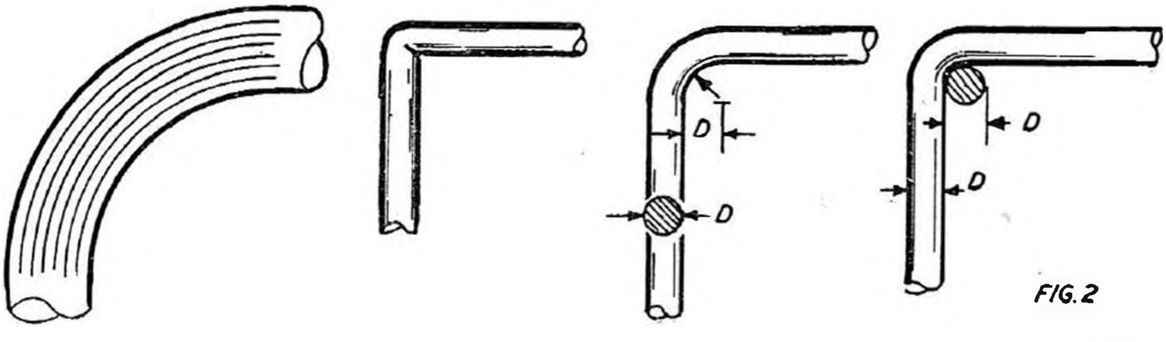


FIG. 2

WIRE DIMENSIONS

S.W.G. No.	NOMINAL DIAMETER* inches	NOMINAL DIAMETER* millimetres	POSSIBLE MAXIMUM* Dia. (ins.)
8	·160	4·06	·168
9	·144	3·66	·150
10	·128	3·25	·135
11	·116	2·95	·122
12	·104	2·64	·110
13	·092	2·34	·096
14	·080	2·03	·0838
15	·072	1·83	·0756
16	·064	1·63	·0673
17	·056	1·42	·0591
18	·048	1·22	·0509

* THIS VARIATION POSSIBLE WITHIN NORMAL MANUFACTURING TOLERANCES

remainder by pliers. Note particularly the order of making the bends in the case of the undercarriage which leaves the longest "free length" or wire available for manipulation.

All bends will have a certain practical radius. A completely right-angled bend, for example, could not be produced without kinking the wire—Fig. 2. Ideally the bend (inner) radius should be not less than the wire diameter as this will ensure that material on the outer layers of the bend are not stressed beyond their limit. As the enlarged section shows, the degree to which the outer fibres of the wire are stretched around a bend can be considerable. If the material is already hard drawn—which implies a considerable stretching of the fibres—this additional stretching can easily cause it to fracture. Softer wires can, therefore, be formed to smaller actual bend radii. Too small a bend radius on a hard wire may result in considerable weakening at the bend, if not actual fracture. If a wire does show signs of fracture at a bend, reject that piece and start again. The component will never be reliable. If a sharp bend still proves impossible, the radius of bend must be increased.

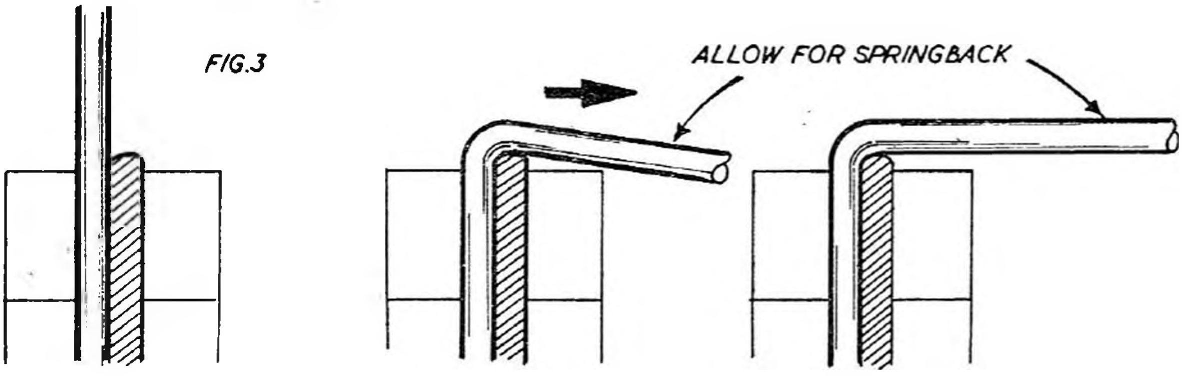


FIG.3

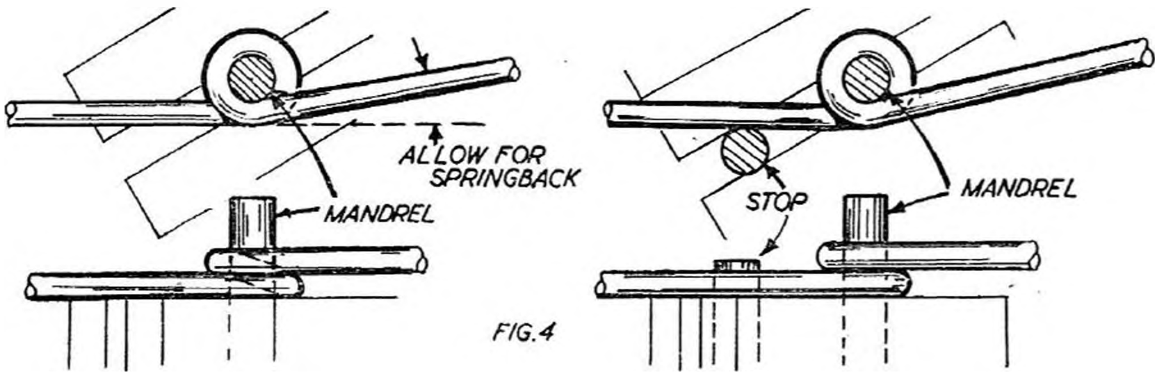


FIG.4

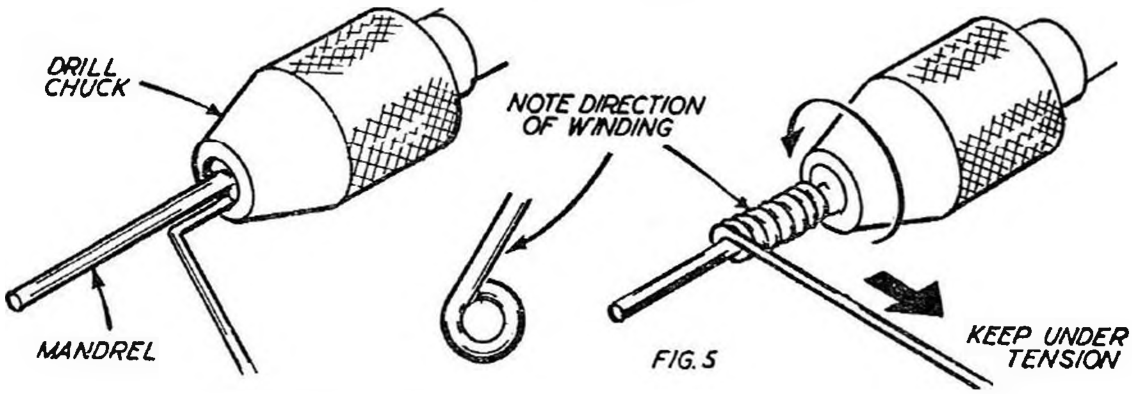


FIG. 5

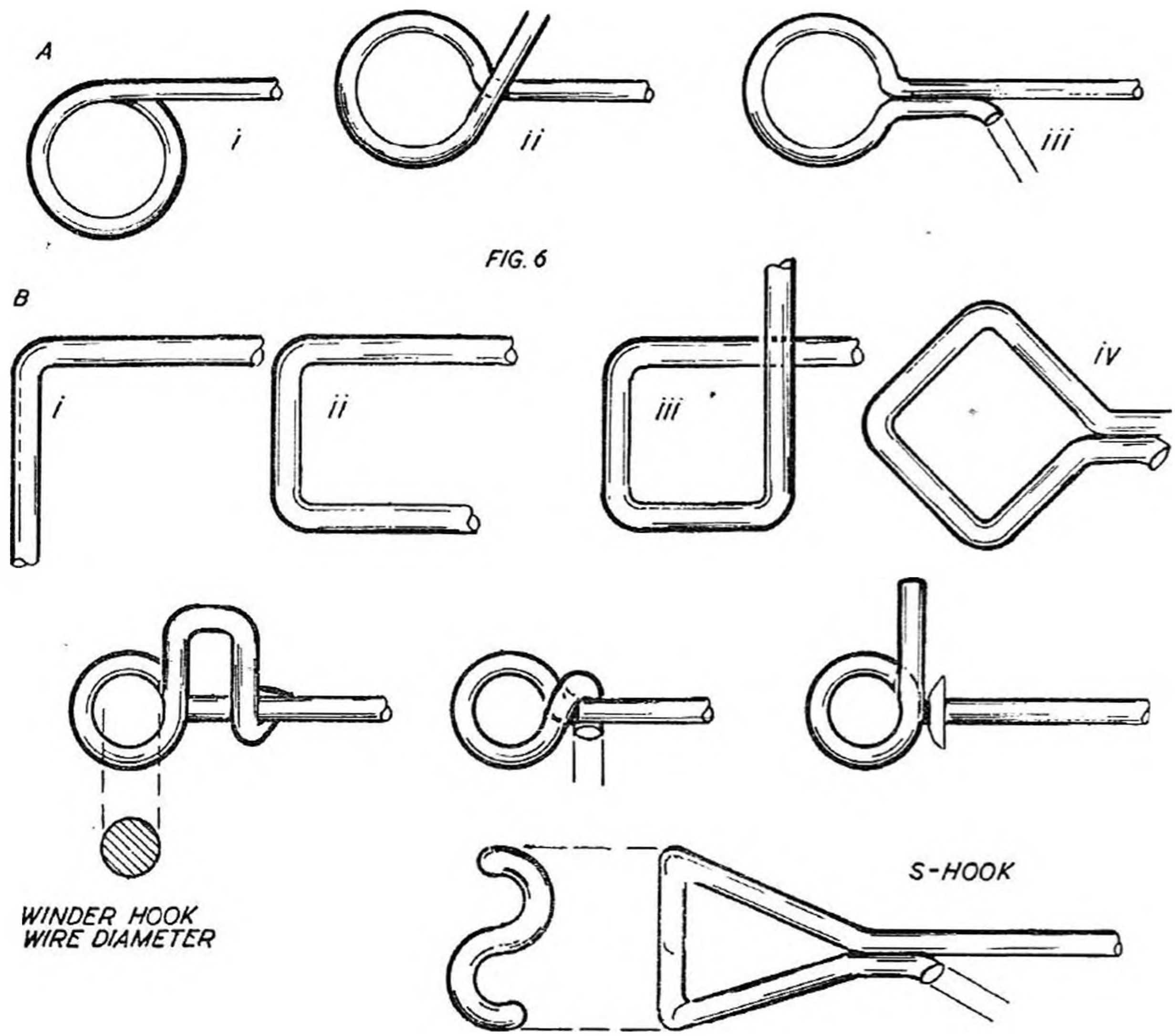
Right angled bends need to be pulled or bent through slightly more than 90 degrees, to allow for springback. This can be done using a couple of steel plates protruding slightly above the vice jaws, as in Fig. 3. The inner edges of these plates should be rounded off to help the wire assume a good practical bend radius. The plates need to be rigid since the bend is formed by a good strong tug on the wire as it is pulled down into the bend shape. One of the secrets of clean vice-bending, in fact, is to keep as much tension on the wire as possible in the direction shown by the arrow, as the bend is made. If the bend proves impossible to "pull" to the required shape it can be assisted by pressing down on the bend with a piece of hard material, but *never hammer* to shape.

Coils are invariably best bent around a mandrel as this gives neater and more accurate results than bending with round-nose pliers (thicker wire could not be bent with pliers anyway). The mandrel should be a length of *metal* rod gripped in a vice. The diameter of the mandrel should be slightly less than the inside diameter required for the coil, to allow for springback. The difference required will depend on the wire diameter, stiffness and to a certain extent the bending technique (mainly how well you can keep tension on the wire during bending).

With thin wire, bending can be done with a single mandrel, keeping tension on *both* ends of the wire and simply winding it in place—Fig. 4. With thicker wire it will be necessary to use a second mandrel of similar diameter to act as a stop. This second mandrel should protrude only enough to lock the wire so that the bend can be completed by bringing the free length of the wire over the top of the stop in completing a close bend. Again remember that springback will affect the final bend angle and adjust accordingly in completing the coil. Also take care to get the coil bedding down snugly.

For long coils, invariably wound in thinner wire, the (wire) mandrel should be held in the chuck of a hand drill and the drill held in a vice. The end of the wire to be formed is bent up at right angles and pushed between the jaws of the chuck. Rotating the drill will then wind coil upon coil of wire on to the mandrel Fig. 5. Keep plenty of tension on the wire to ensure close coils, and feed the wire correctly to ensure that adjacent coils are formed snugly against each other.

Such coils can be wound in either direction. In the case of a propeller clutch, winding in the direction shown in the smaller sketch will ensure that the coils tighten on the shaft when the freewheel pin is engaged. Thus although the clutch would be soldered to the shaft in any case this provides an extra measure of safety. To get a tight initial fit on the shaft, too, the wire used for the mandrel should be slightly smaller in diameter than the propeller shaft



wire—e.g. a $\frac{1}{16}$ in. drill shank is usually slightly smaller in diameter than 16 s.w.g. wire (nominal diameter ·064 in.). Remember, however, that s.w.g. wire sizes are nominal and actual diameter may differ by several thou. from the specification diameter.

Rubber model prop. shafts are normally bent in 16 s.w.g. wire, some typical forms being shown in Fig. 6. The simple loop type (A) should be bent in three stages—(i) the loop bend around a mandrel, followed by an angled bend to align the shaft (ii), and finally finishing the short end of the loop (iii). Bends (ii) and (iii) are made with pliers. Diamond hooks and other shapes are best bent with pliers. Normally all such bends are completed *after* the propeller shaft is inserted through the propeller and noseblock since it is more important to get the *winding loop* at the front end correctly bent. This should always be a *close circular loop* which fits the hook in the winder snugly, and should always be mandrel bent. The bend is then completed by locking the free end around the shaft, or bending an integral clutch loop—(C). The latter is quite practical in 16 s.w.g. wire. The reason why the winding loop should be of small diameter is that a large loop allows it to climb around the winder hook. A snug fitting loop will not "climb".

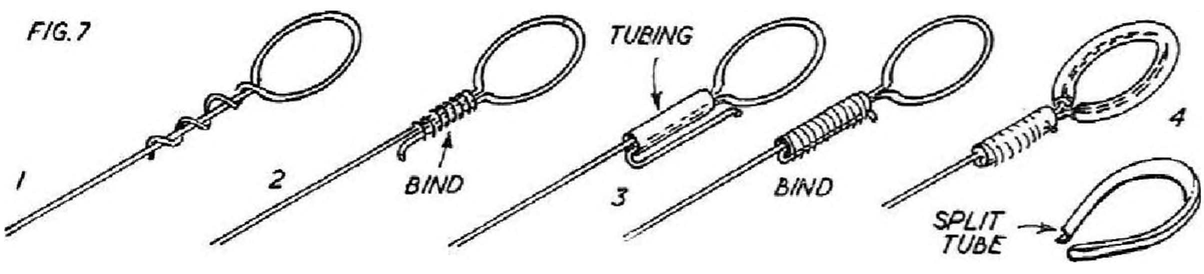
A particular form of loop shape on the rubber end of the prop. shaft which is a bit tricky to bend is the "S" hook—(D). The advantage of this shape is that rubber cannot climb round the hook but will always tend to centre itself—provided the "S" is the right way round. If the "S" is bent the wrong way the rubber will start to climb *off* the hook as soon as you start winding. The bends have to be made entirely with pliers and need careful manipulation to get accurate, with the centre of the "S" (which is the point where the rubber will tend to locate itself) accurately in line with the propeller shaft. The diagram shows a suitable sequence for forming.

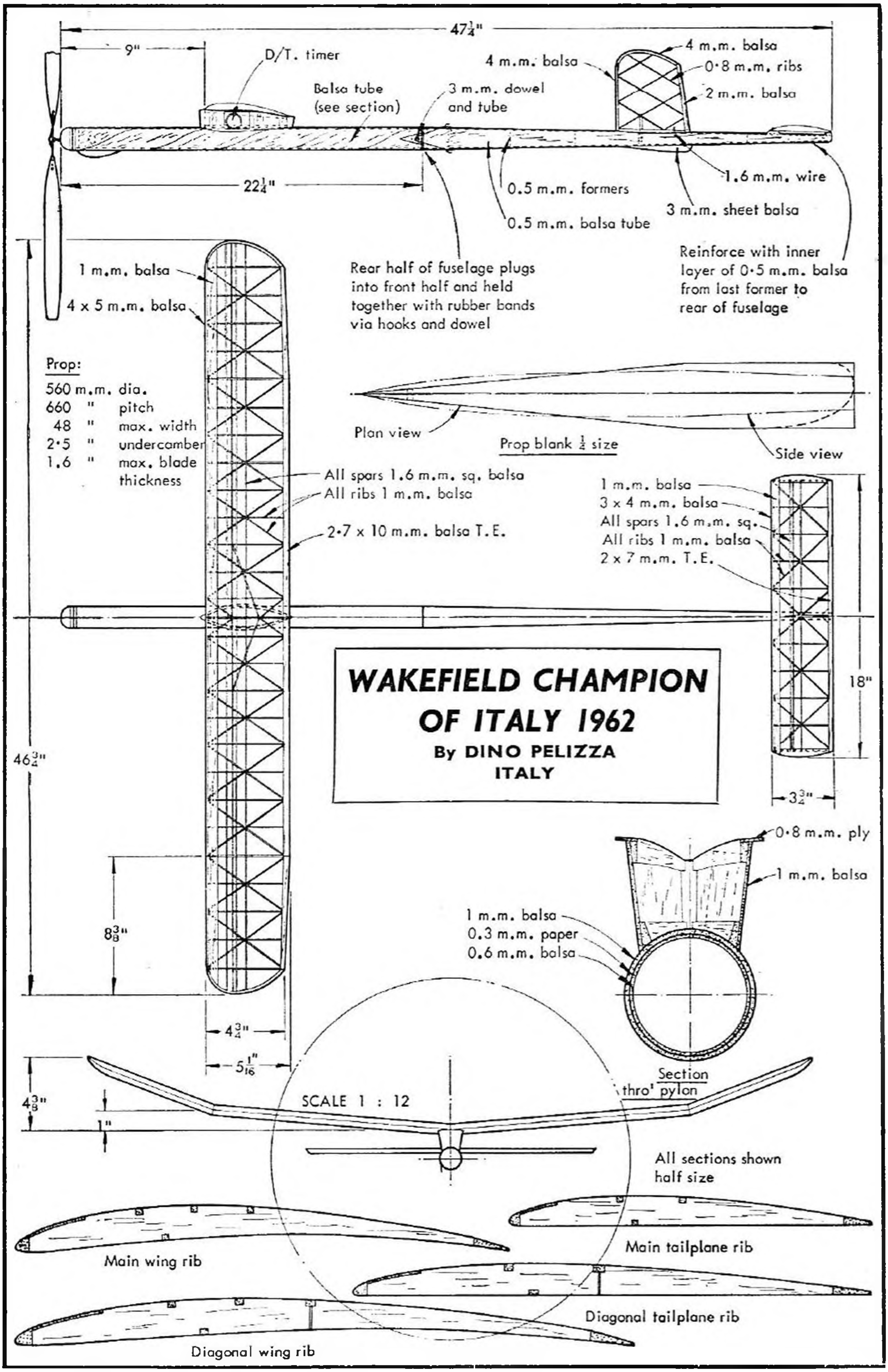
Soldering is to be avoided as far as possible with steel wire components. However, in certain cases, soldered joints are unavoidable. In such cases absolute cleanliness of the wire parts is essential, rubbing bright clean with emery paper, and an acid type flux *must* be used. Ordinary cored solder is no good at all and, usually, an "old fashioned" soldering iron heated in a gas flame is to be preferred to an electric iron. Where practical—e.g. in soldering together two undercarriage legs—parts to be soldered should be bound with thin fuse wire or thin (thoroughly cleaned) copper wire. The iron should be very hot and the solder should flow readily over the whole of the join area.

Soldered joints should always be avoided on control line wire ends since these may well weaken rather than strengthen the wire immediately outboard of the joint. Many people prefer simply to wind the wire back over itself after forming the end loop, as in (1), Fig. 7, although a bound end is much better. This can be done as shown in (2) or (3), using thread of thin copper wire or fuse wire for the binding. With metallic wire the binding is *not* soldered but can be further secured by coating with ordinary cement (although some people prefer Araldite. Note that in both cases the wire is first brought back on to itself from the end loop; then either bound (2) or passed through a short length of 20 or 22 s.w.g. aluminium or copper tube on the wire (3); then doubled back again and bound.

The actual loop itself will benefit from being fitted with a thimble (4). This can either be a short length of 22 or 20 s.w.g. aluminium or very soft copper tubing slipped on the wire initially and bent with the wire; or a true wire end thimble formed by splitting a length of aluminium tube bent to conform to the shape of the required loop and the wire end bent around the thimble before being made off.

FIG. 7

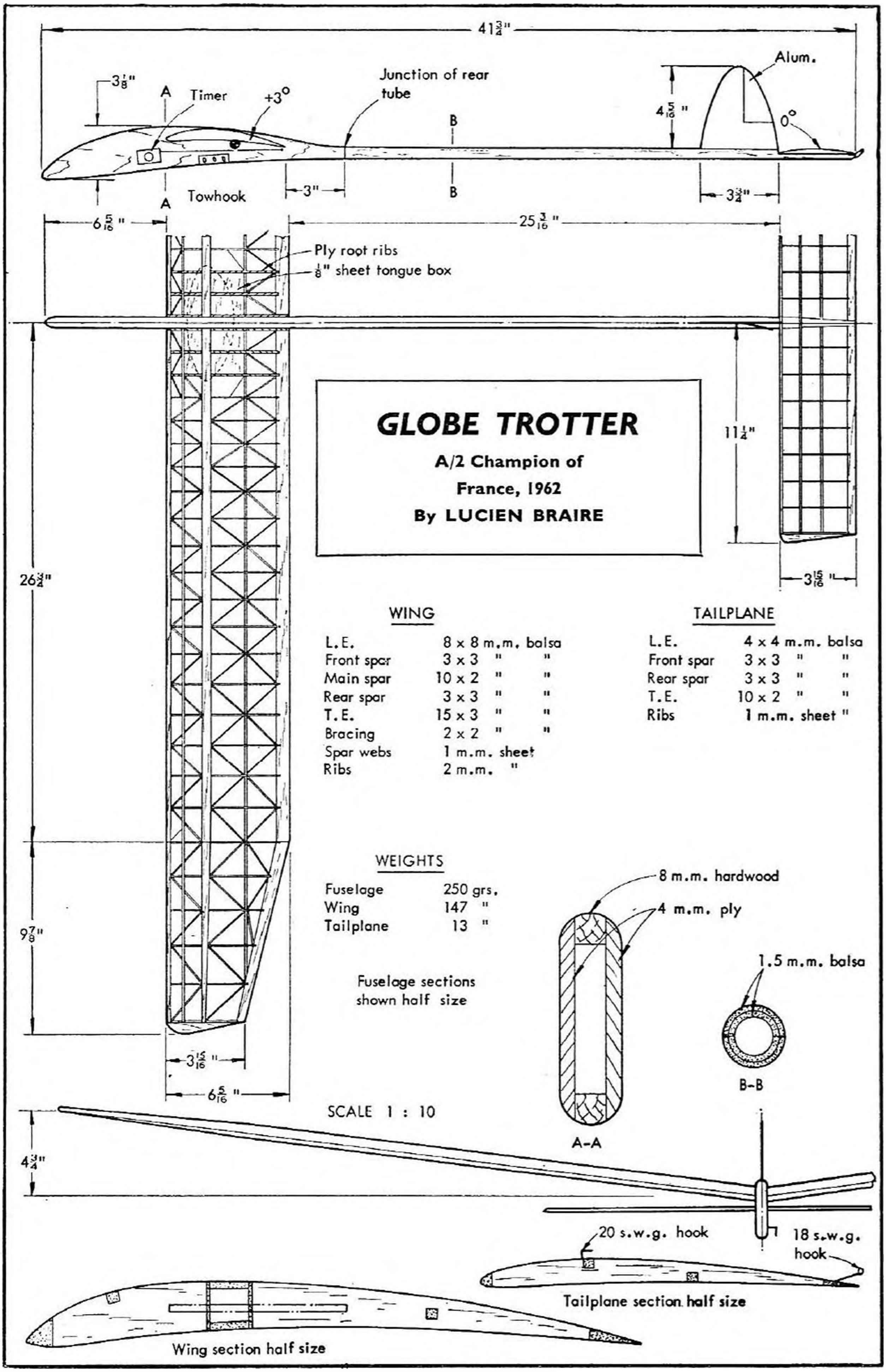




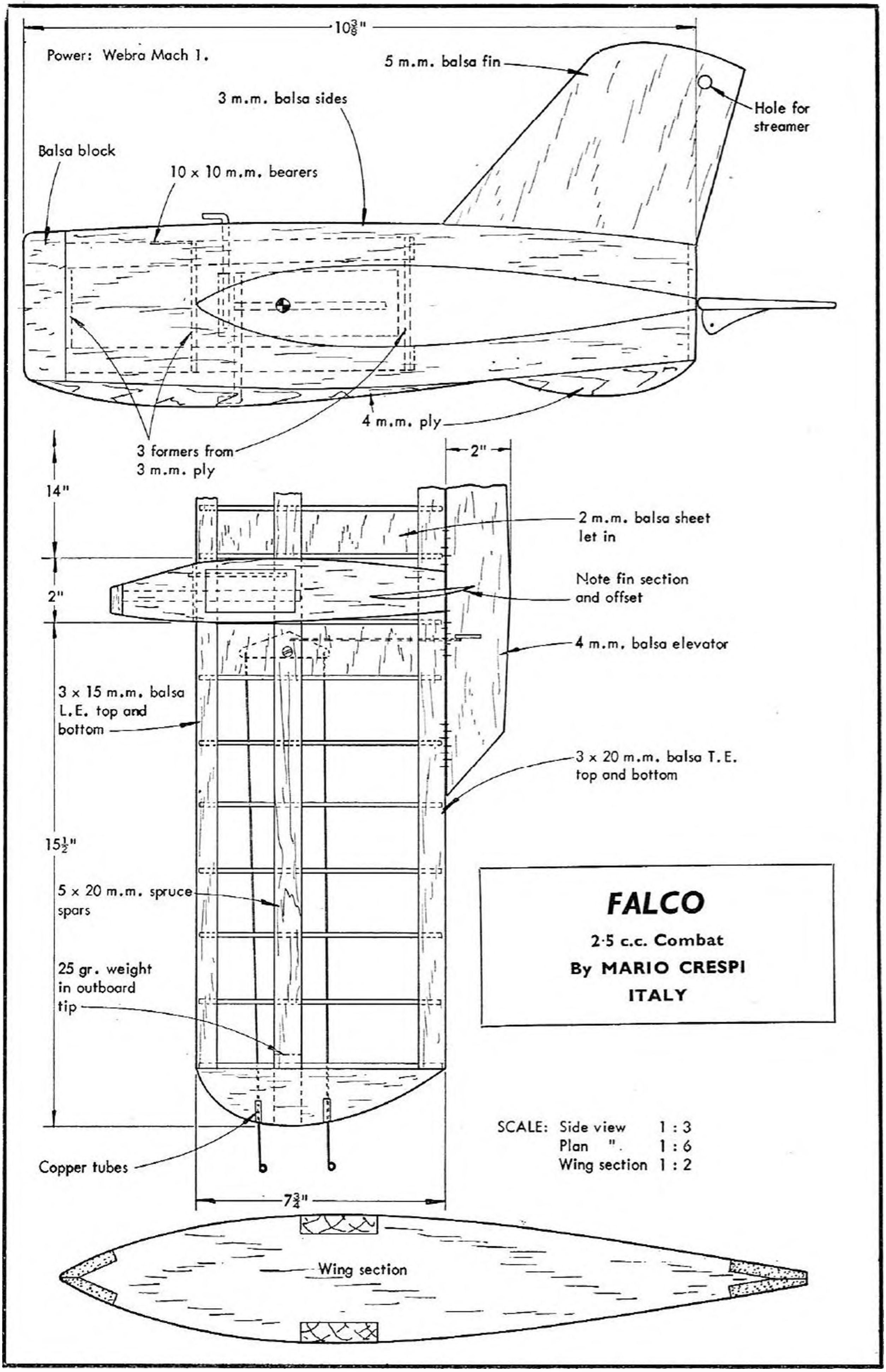
WAKEFIELD CHAMPION OF ITALY 1962

By DINO PELIZZA
ITALY

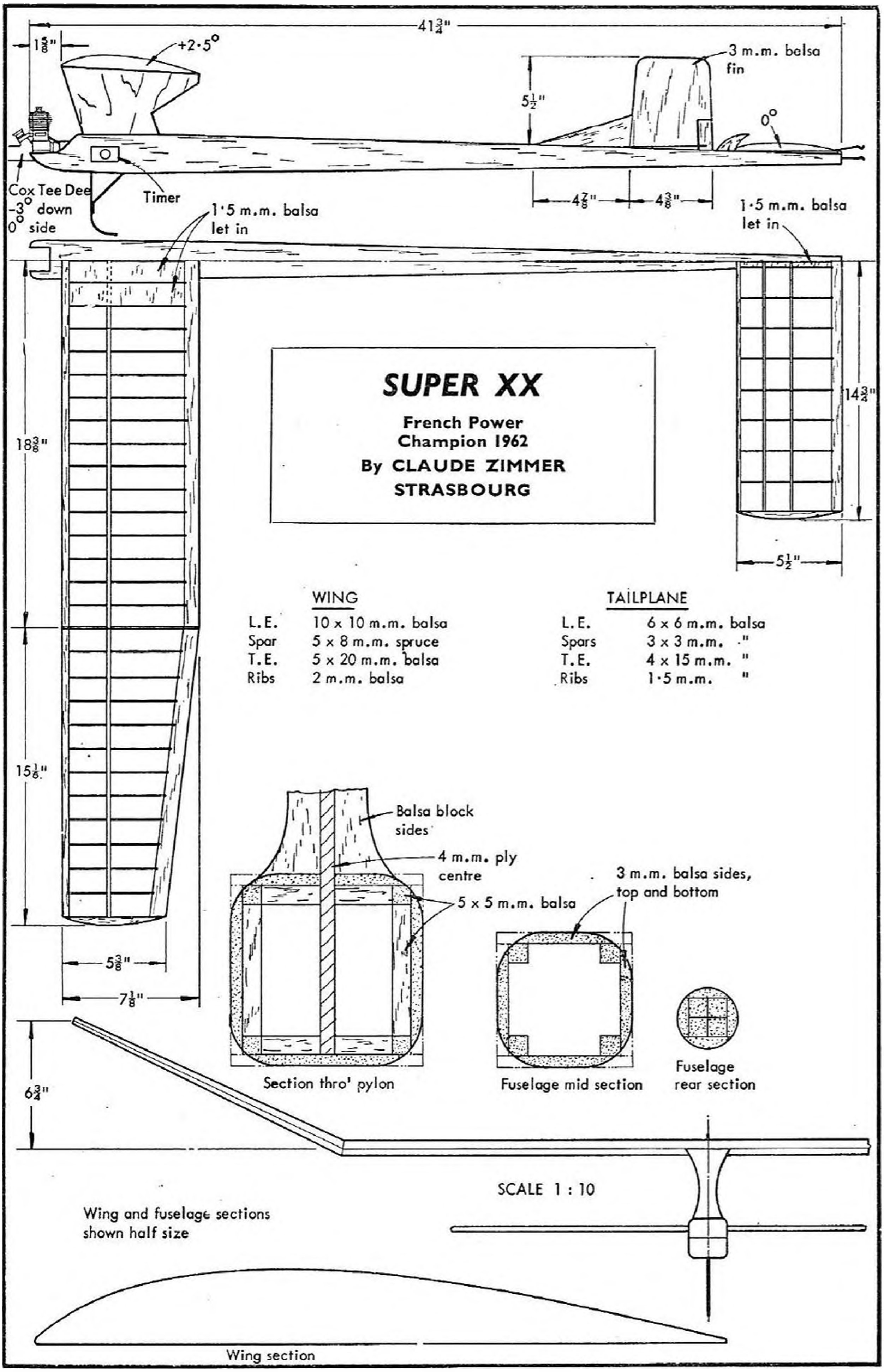
RASSEGNA DI MODELLISMO, ITALY



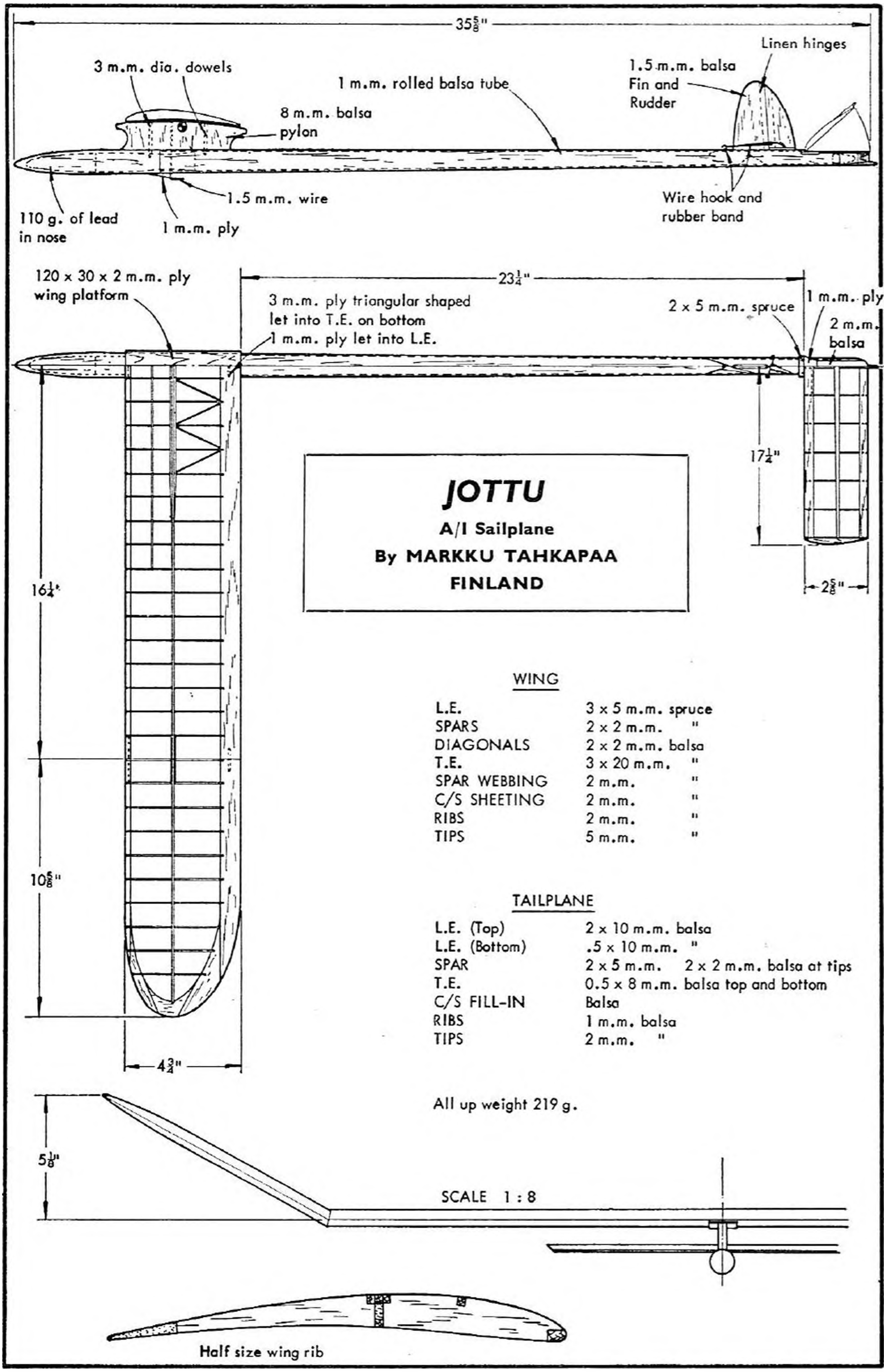
MODELE REDUIT D'AVION, FRANCE



RASSEGNA DI MODELLISMO, ITALY



MODELE REDUIT D'AVION, FRANCE



JOTTU

A/1 Sailplane

By MARKKU TAHKAPAA

FINLAND

WING

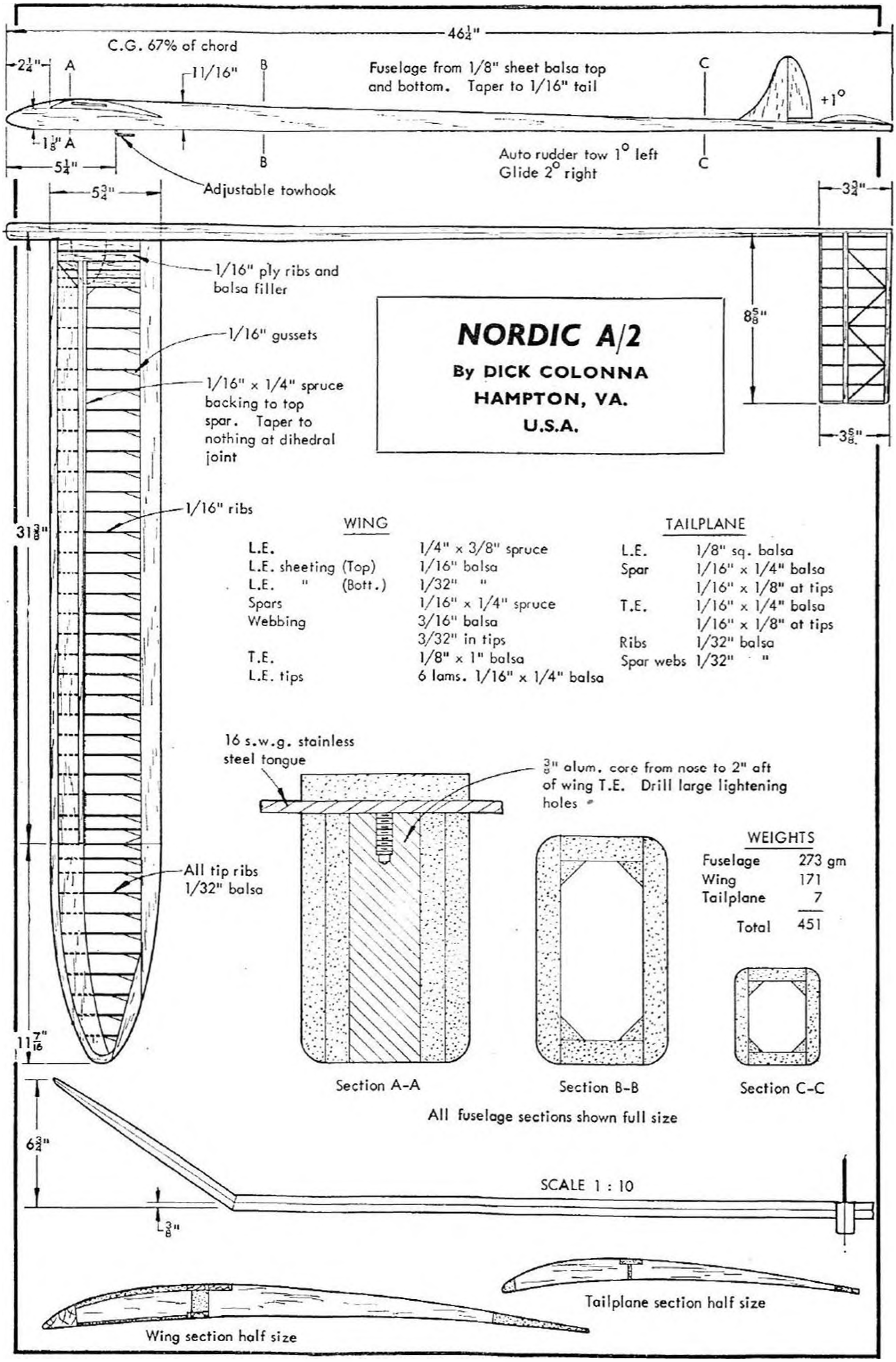
L.E.	3 x 5 m.m. spruce
SPARS	2 x 2 m.m. "
DIAGONALS	2 x 2 m.m. balsa
T.E.	3 x 20 m.m. "
SPAR WEBBING	2 m.m. "
C/S SHEETING	2 m.m. "
RIBS	2 m.m. "
TIPS	5 m.m. "

TAILPLANE

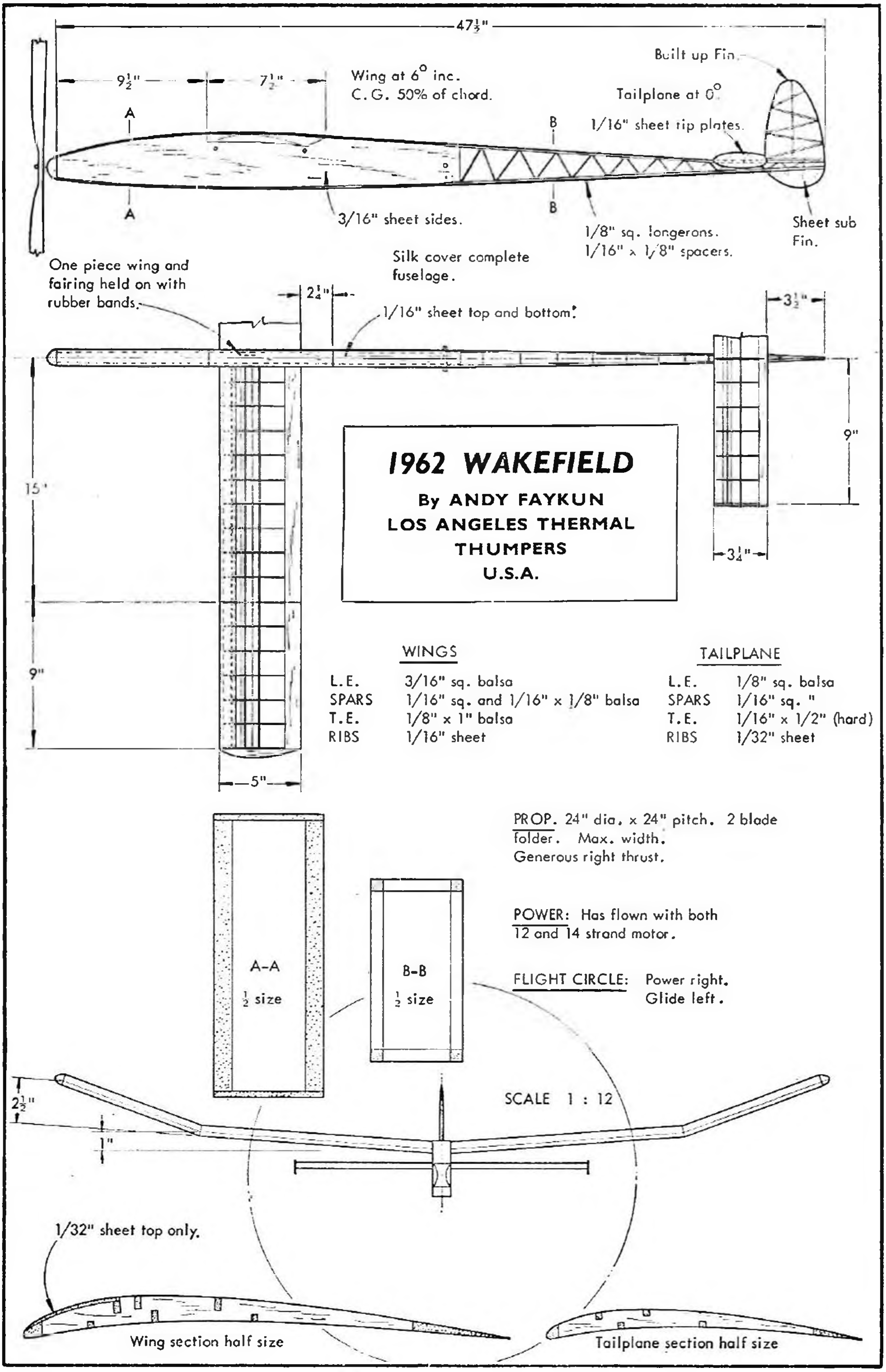
L.E. (Top)	2 x 10 m.m. balsa
L.E. (Bottom)	.5 x 10 m.m. "
SPAR	2 x 5 m.m. 2 x 2 m.m. balsa at tips
T.E.	0.5 x 8 m.m. balsa top and bottom
C/S FILL-IN	Balsa
RIBS	1 m.m. balsa
TIPS	2 m.m. "

All up weight 219 g.

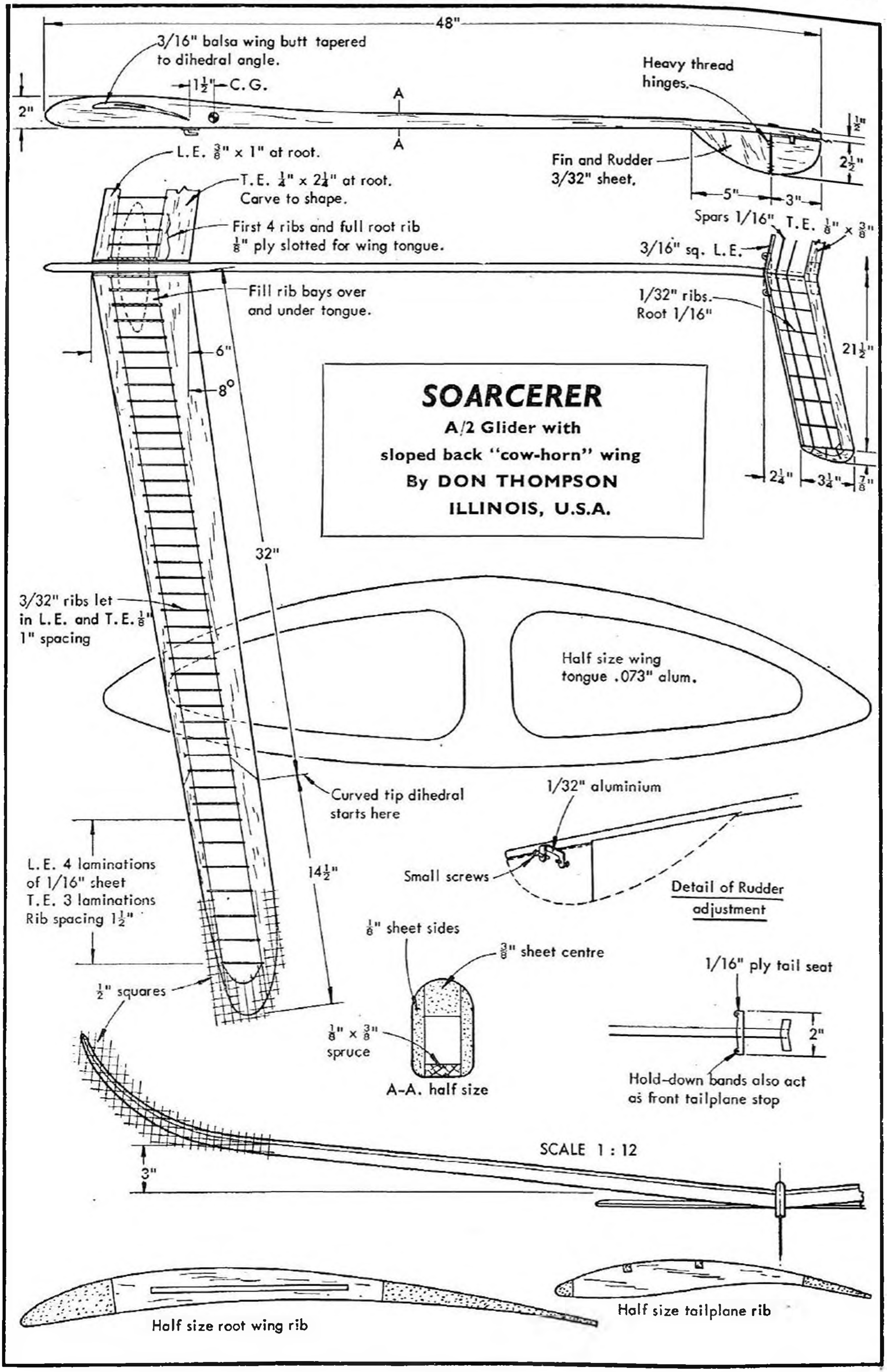
ILMAILU, FINLAND


46½"
C.G. 67% of chord
2¼"
A
11/16"
B
Fuselage from 1/8" sheet balsa top and bottom. Taper to 1/16" tail
C
+1°
1⅛" A
5¼"
B
Auto rudder tow 1° left
Glide 2° right
C
5¾"
Adjustable towhook
3¾"
1/16" ply ribs and balsa filler
8⅝"
1/16" gussets
NORDIC A/2
By DICK COLONNA
HAMPTON, VA.
U.S.A.
1/16" x 1/4" spruce backing to top spar. Taper to nothing at dihedral joint
3⅝"
1/16" ribs
31⅜"
WING
L.E. 1/4" x 3/8" spruce
L.E. sheeting (Top) 1/16" balsa
L.E. " (Bott.) 1/32" "
Spars 1/16" x 1/4" spruce
Webbing 3/16" balsa
3/32" in tips
T.E. 1/8" x 1" balsa
L.E. tips 6 lams. 1/16" x 1/4" balsa
TAILPLANE
L.E. 1/8" sq. balsa
Spar 1/16" x 1/4" balsa
1/16" x 1/8" at tips
T.E. 1/16" x 1/4" balsa
1/16" x 1/8" at tips
Ribs 1/32" balsa
Spar webs 1/32" "
16 s.w.g. stainless steel tongue
⅜" alum. core from nose to 2" aft of wing T.E. Drill large lightening holes
WEIGHTS
Fuselage 273 gm
Wing 171
Tailplane 7
Total 451
All tip ribs 1/32" balsa
11 7/16"
Section A-A
Section B-B
Section C-C
All fuselage sections shown full size
6¾"
SCALE 1 : 10
⅜"
Tailplane section half size
Wing section half size

SCATTER, U.S.A.


47½"
9½"
7½"
Wing at 6° inc.
C.G. 50% of chord.
Built up Fin.
Tailplane at 0°
1/16" sheet tip plates.
A
B
3/16" sheet sides.
1/8" sq. longerons.
1/16" x 1/8" spacers.
Sheet sub Fin.
One piece wing and fairing held on with rubber bands.
Silk cover complete fuselage.
2¼"
1/16" sheet top and bottom.
3½"
9"
15"
3¼"
1962 WAKEFIELD
By ANDY FAYKUN
LOS ANGELES THERMAL THUMPERS
U.S.A.
WINGS
L.E. 3/16" sq. balsa
SPARS 1/16" sq. and 1/16" x 1/8" balsa
T.E. 1/8" x 1" balsa
RIBS 1/16" sheet
TAILPLANE
L.E. 1/8" sq. balsa
SPARS 1/16" sq. "
T.E. 1/16" x 1/2" (hard)
RIBS 1/32" sheet
5"
PROP. 24" dia. x 24" pitch. 2 blade folder. Max. width.
Generous right thrust.
POWER: Has flown with both 12 and 14 strand motor.
FLIGHT CIRCLE: Power right. Glide left.
A-A ½ size
B-B ½ size
SCALE 1 : 12
2½"
1"
1/32" sheet top only.
Wing section half size
Tailplane section half size

SCATTER, U.S.A.



48"
3/16" balsa wing butt tapered to dihedral angle.
1½" C.G.
A
A
2"
Heavy thread hinges.
½"
2½"
Fin and Rudder 3/32" sheet.
5"
3"
L.E. ⅜" x 1" at root.
T.E. ¼" x 2¼" at root. Carve to shape.
First 4 ribs and full root rib ⅛" ply slotted for wing tongue.
Spars 1/16"
T.E. ⅛" x ⅜"
3/16" sq. L.E.
Fill rib bays over and under tongue.
1/32" ribs. Root 1/16"
6"
8°
21½"
SOARCERER
A/2 Glider with
sloped back "cow-horn" wing
By DON THOMPSON
ILLINOIS, U.S.A.
2¼"
3¼"
⅞"
32"
3/32" ribs let in L.E. and T.E. ⅛"
1" spacing
Half size wing tongue .073" alum.
Curved tip dihedral starts here
1/32" aluminium
L.E. 4 laminations of 1/16" sheet
T.E. 3 laminations
Rib spacing 1½"
14½"
Small screws
Detail of Rudder adjustment
⅛" sheet sides
⅜" sheet centre
1/16" ply tail seat
½" squares
⅛" x ⅜" spruce
A-A. half size
2"
Hold-down bands also act as front tailplane stop
SCALE 1 : 12
3"
Half size root wing rib
Half size tailplane rib

BASIC FACTS ABOUT AEROFOIL SECTIONS

THE question of choice of aerofoil section for a particular model is as important, or as unimportant, as you care to make it. On the one hand you can go "all mathematical" and design a section which, in theory at least, offers a superior performance. On the other you can just draw out a section which looks right (or use the edge of your shoe as a pattern, as one well-known American designer claims to do!) If the two sections are about the same thickness performance will probably be very similar when actually applied to a model.

This does not necessarily decry the merits of careful evolution of "theoretical" sections for model application as some extremely useful and enlightening results have been obtained in this field. Many highly favoured "practical" sections are, in fact, based on "theoretical" shapes. At the same time, however, the "theoretical" section is not necessarily superior, and in many cases may prove inferior, to cut-and-try sections. This proved particularly true in the case of the earlier so-called laminar flow sections.

The theories are there to study and learn from, or disregard as you prefer. Actual wind tunnel data obtained at model speeds and under realistic airflow conditions are all too sparse, but again there have been useful contributions in this field. The majority of earlier wind tunnel tests on "full size" sections are relatively useless quantitatively for model work, and not even all that valid comparatively since test conditions tended to differ considerably. The final answer, in fact, is simply how a given section performs on a given model and the best way of choosing a wing section remains that of basing the section on one which has already proved its worth in practice.

This still leaves plenty of scope for experiment, but experiment without some background knowledge as to cause and effect can be relatively useless—normally producing "negative" rather than "positive" results. It may also duplicate investigation of data which are already established facts, with the ultimate "new discovery" something which other modellers have known and appreciated for years. The purpose of this article is, therefore, to deal with basic aerofoil facts, treating the subject in a non-mathematical manner.

The most elementary of all aerofoils is simply a flat plate, like a wing or tailplane cut from sheet balsa. It is well known that a flat plate is a very *inefficient* aerofoil and its performance can be much improved, first by giving it *camber* and then by adding a streamlined fairing around the camber line to give the aerofoil more *thickness*—Fig. 1. The first stage of modification produces the *curved plate* aerofoil, and the second the conventional aerofoil section. Both are capable of further modification.

With the curved plate, performance (and efficiency) will be affected both by the amount of camber and the position of the point of maximum camber, and to a rather lesser extent the shape of the camber line curve. An increase in camber will tend to increase the lift generated by the aerofoil, but at the same time will also increase the drag. Another characteristic of increasing camber is

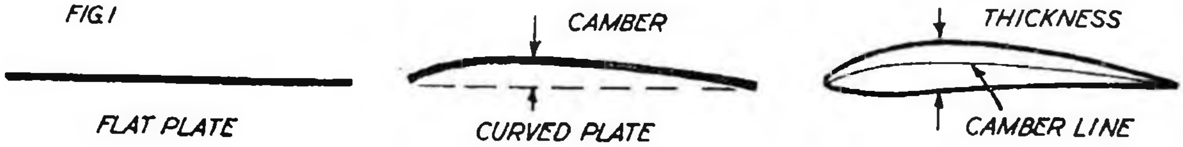


FIG. 1

that the centre of pressure movement will become more marked with change of angle of attack. The best compromise is usually a moderate amount of camber (not more than 10 per cent of the chord) with the point of maximum camber located somewhere around the one-third chord point—Fig. 2. Such sections can be surprisingly efficient at low speeds, although their application is virtually restricted to indoor free flight models. The McBride B7 section used to be a favourite here although modern indoor sections tend to have rather less camber and the point of maximum camber located more aft—Fig. 3.

Extending camber line modification further, the undesirable large centre of pressure travel of a relatively large camber can be offset by sweeping up or reflexing the trailing edge. While this produces a more stable section, and will also usually reduce drag, lift is considerably reduced. The only justification for

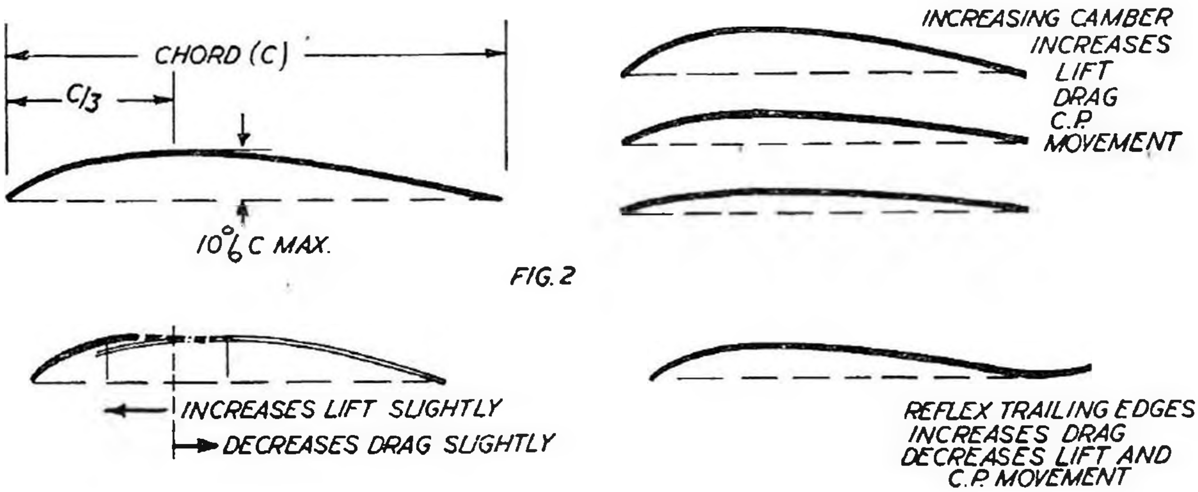
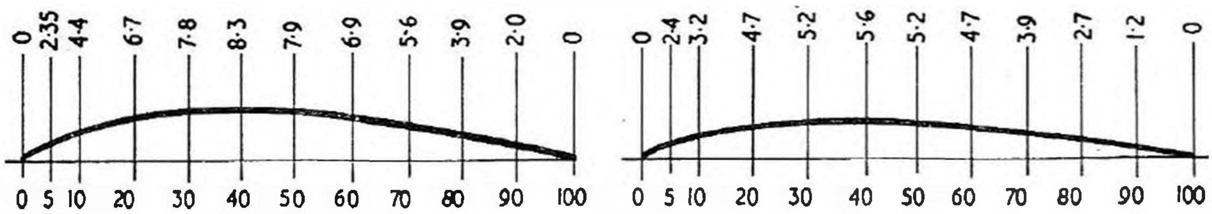


FIG. 2

such sections, therefore, is where stability is more important than performance, such as in a tailless design. With all orthodox design layouts wing instability (due to centre of pressure movement) can readily be controlled by a suitable size of tailplane.

The apparent basic object of putting a streamlined fairing around a curved plate is to provide enough depth of section to accommodate wing spars. Many model designers have worked on the basis that the curved plate is inherently a low drag section because of its thinness and approaches the ideal for all types of "duration" models. When it becomes necessary to thicken the section to accommodate spars the fairing thickness is kept to a minimum. This, in fact, is typical of the aerofoil sections favoured for modern towline gliders, which are basically curved plate sections with a minimum thickness fairing—



MCBRIDE B-7 FIG. 3 MODERN

FIG. 4

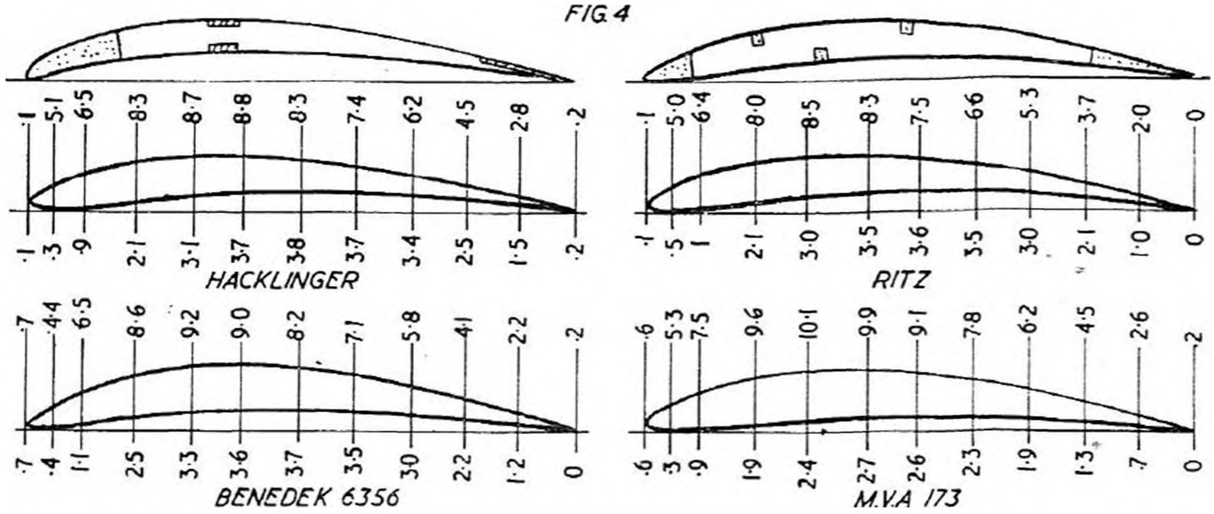


Fig. 4. The actual camber line and final thickness is largely dictated by structures developed to suit such very thin aerofoils and still give a wing with adequate strength under bending loads, with camber line sometimes further modified by "flap effect".

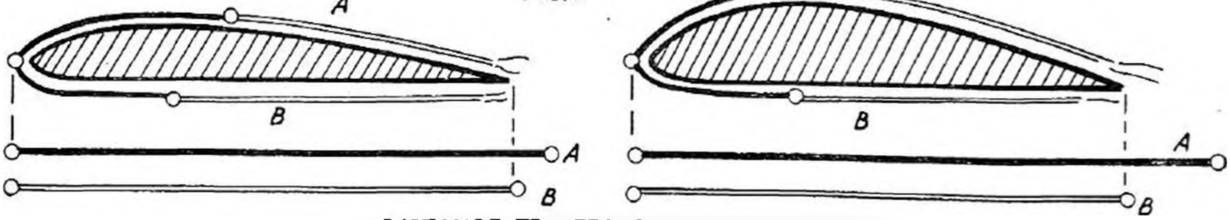
"Flap effect" is the reverse of reflexing. By drooping the aft portion of a normal camber line a marked increase in lift can be obtained, at the expense of increasing the drag and centre of pressure movement. If only a moderate droop is employed (e.g. about 5 per cent maximum), the result can be a definite increase in performance. If overdone, the excess drag will more than offset any benefits to lift. The drag become prohibitive for the section to be employed for normal flying.

"Flap effect" can work extremely well at low speeds, e.g. on gliders and duration-type rubber models. It is virtually useless on duration-type power models since at the higher speeds of power-on flight it makes trimming extremely critical, as well as the fact that the added drag detracts from climb performance. In other words, "flap effect" can show useful benefits at fairly high angles of attack (i.e. the trim corresponding to optimum glide or low-powered climb performance), but merely produces an exaggerated centre of pressure travel at low angles of attack (corresponding to high speed climb trim).

The idea that camber rather than thickness is responsible for good lifting properties, and thus the thinner the section the better with a given camber to minimise drag, is not completely true. Admittedly increasing the thickness does increase drag, but at the same time it also increases lift. This can be explained by reference to Fig. 5.

The majority of wing lift is produced by the reduction in pressure of air over the upper surface of an aerofoil, this reduction in pressure being directly

FIG. 5



DISTANCE TRAVERSED BY AIR MOLECULES

related to the *velocity* of the air over the upper surface. Simplifying the airflow pattern, compare the case of a group of air molecules meeting the leading edge of both a thin and thick aerofoil of the same camber. The airflow splits at the leading edge, part flowing over the upper surface and part over the lower surface, the two displaced streams rejoining at the region of the trailing edge. In the case of the thick aerofoil section the length of patch that the upper surface flow has to traverse is greater than that of the flow past the thin aerofoil. For the upper and lower surface flows to rejoin, the upper surface has thus to travel *faster*, so that effectively it exerts less pressure per unit area of surface. In other words, the thick aerofoil develops more lift than its thin counterpart by virtue of its greater upper surface area.

Increasing camber and increasing section thickness, therefore both increase lift. At the same time, both increase the drag of the section. For "duration" type models minimum drag is desirable, provided this is not achieved at the expense of good lifting properties. For other types of models fairly high section drag may be desirable. Each type of model, therefore, has more or less evolved its own "typical" forms of aerofoil section.

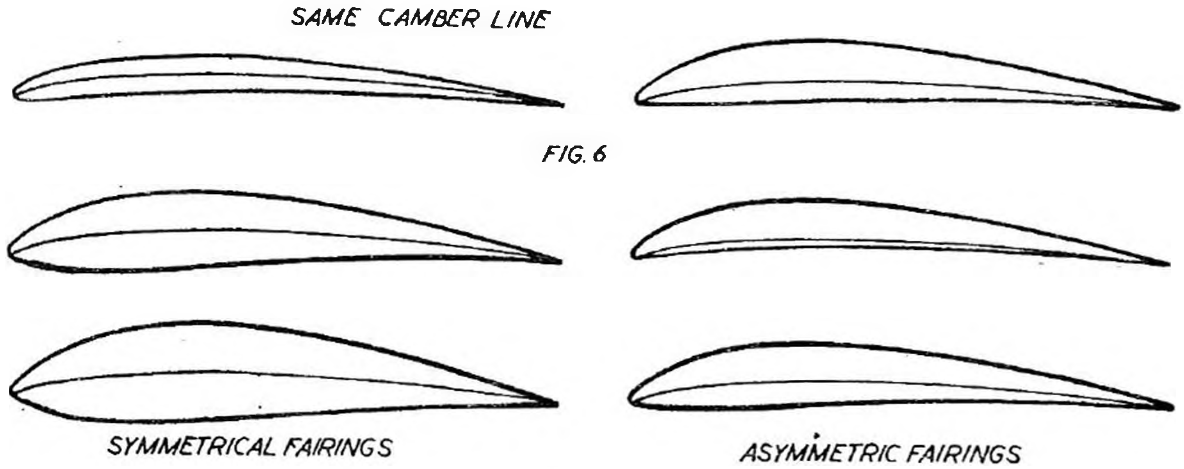
Typical glider sections have already been mentioned, although these are used mainly in the A2 and smaller contest sizes. Larger gliders will normally benefit from the use of thicker, but still strongly cambered sections. The main reason for this—which applies to all model aerofoils—is that the smaller the wing (or more specifically the smaller the chord) the less efficient sections tend to become and the more all sections of similar thickness tend to have more or less identical characteristics.

If the aerofoil chord is quite small—typically less than about three inches at model speeds—practically any section will tend to have the same "lift" characteristics as a flat plate. The effect of adding camber will be mainly to move the centre of pressure aft and increase the centre of pressure travel with changing angle of attack. The effect of adding thickness will be merely to increase the amount of drag.

With increasing chord size the section becomes progressively more efficient aerodynamically so that with a chord of about six to eight inches, at typical model speeds, the same amount of lift can be produced by a thicker section with less camber, compared with a thin, more heavily cambered section, and with comparable or less resulting drag. At the same time the reduction in camber means that the section is more stable, calling for less tailplane area to control the centre of pressure movement; while the increase in section thickness makes it easier to accommodate deep spars for improved strength in bending.

Although rubber-duration model wing chords are usually of the same order of size as A2 gliders, somewhat thicker sections are usually preferred since this enables the camber to be reduced and the model consequently easier to trim under power. Relatively thick sections like the Clark Y, R.A.F. 32 and Joukowski used to be favoured, although these have given way to thinner counterparts where the maximum thickness of section seldom exceeds 10 per cent of the chord, and with undercamber definitely best.

Undercamber refers to the bottom surface being concave. This is given naturally by adding a symmetrical fairing around a cambered centre line, although with a particular form and thickness of fairing the actual undersurface may become substantially straight—Fig. 6. A simple practical modification of the section is to draw in a straight undersurface. Many model aerofoils, in fact,

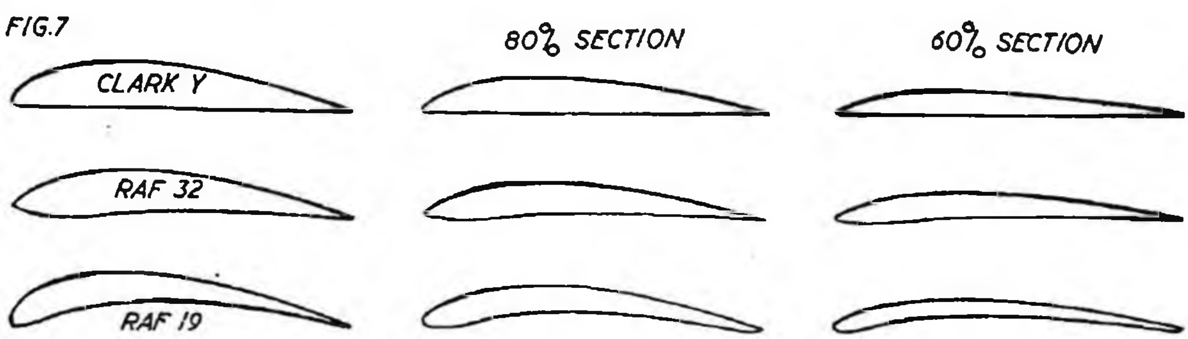


are designed on this basis by simply adding a "typical" upper surface curve to a flat bottom. Such sections have practical advantages when it comes to building the wing and are thus a logical choice for small models, or for sports models (where maximum section efficiency is not important). A flat bottom section, too, generally has a smaller centre of pressure travel than an undercambered section, making "power on" trimming easier.

Flat bottom sections, however, are not particularly good for duration work and bi-convex sections definitely poor. This is especially true if they are also reduced in thickness, since this implies a reduction in camber—Fig. 7. The undercambered section of similar thickness will usually show markedly superior results on rubber models at least without aggravating power on trimming difficulties to the point where the model is critical on trim; and a further improvement may be realised by the addition of a little "flap effect".

In the case of power duration models, undercamber is desirable to get the best out of the glide performance, but can make power-on trim tricky. Sections still need to be kept reasonably thin (not more than 10 per cent) to reduce drag, but with only very moderate undercamber, if any. This automatically implies a limit to the amount of camber, the danger here being that by reducing camber and thickness one can produce a thin, substantially flat bottom section which is excellent for power-on performance but has a relatively poor glide performance. It may make the model a lot easier to trim and fly, but the overall performance potential is relatively poor without thermal assistance. Some designs may compensate for this by the terrific height gained on the power run, but as far as glide is concerned their performance in this respect may well be inferior to that of a sports type rubber model.

There are various ways of affecting a better compromise between power-on and glide requirements. One is deliberately to slow the power-on



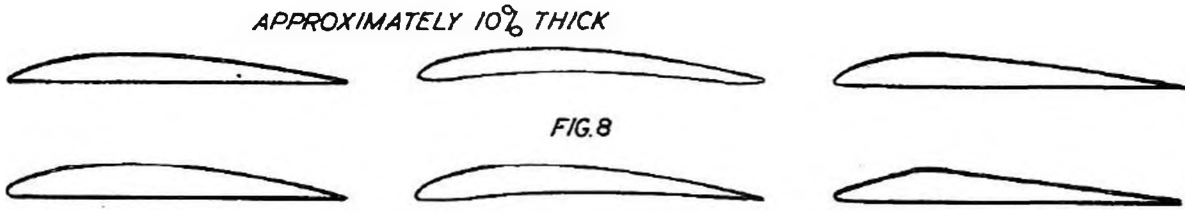


FIG. 8

speed by using a much larger wing area to increase drag under power and use a good gliding section. However, this "kills" climb performance , so that considerably less height is reached on a restricted power run. The natural tendency is then to add more power to improve the climb, getting back to the tricky-to-trim set-up.

With contest power runs restricted to ten to fifteen seconds, height under power is, in fact, more important than minimum sinking speed on the glide, calling for the use of the most powerful engine available in its class. The individual designer, therefore, has evolved or selected an aerofoil section which experience has shown can be tolerated under high-climb conditions and still give a reasonable glider performance. It may be flat-bottomed or slightly undercambered, but in the latter case undercamber will usually be quite small. Other power-duration sections adopt a rather more generous undercamber with an attempt to offset the undesirable effects by the stabilising influence of a reflexed trailing edge—Fig. 8.

The use of bi-convex sections or symmetrical sections is more or less restricted to control line stunt models and radio controlled models, both of which are called upon to operate over a wide speed range when flying through manoeuvres. "Duration" performance has no significance in such designs. The bi-convex section, basically, is formed by adding a thick fairing around a cambered centre line; and the symmetrical section a fairing of any thickness around a flat plate centre line. Being symmetrical, the latter is the more obvious choice for a model which is to be manoeuvrable in both the normal and inverted attitudes. The single channel radio model which cannot be flown inverted can best use a bi-convex section (with or without the undersurface being modified to a straight line to give a flat bottom). Control line stunt models and fully aerobatic multi-channel radio models will normally benefit from using purely symmetrical sections, unless only restricted operation under inverted flight conditions is contemplated.

Contrary to popular belief, the symmetrical section is capable of generating good lift without excessive drag and is, in fact, a very efficient aerofoil as well as one with a smaller centre of pressure movement than a cambered aerofoil.

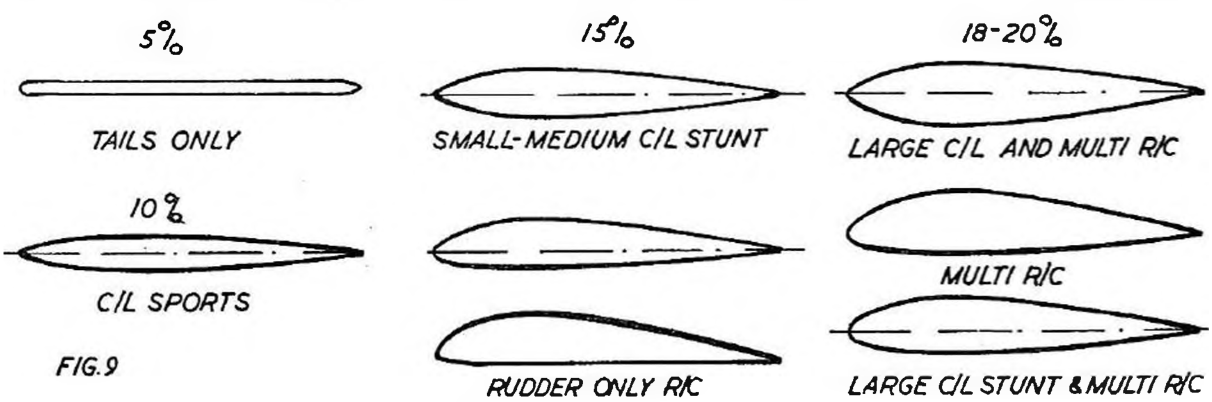


FIG. 9

It does not, however, become a good lifting section until it is made reasonably thick. Under 10 per cent thickness, for example, it has more or less flat plate characteristics. Thus a 10 per cent (or less) symmetrical wing on a control line or R/C model will produce a fast flying model without really achieving any of the more favourable characteristics of the symmetrical section. Increasing section thickness to 15 per cent (or even greater) can result in a very efficient section and the increase in drag can be of marked benefit in certain manoeuvres (e.g. by preventing the model building up excess speed in dives). Symmetrical sections of up to 18 per cent thickness are, in fact, becoming the vogue for R/C multi designs, after having established their superiority for control line stunt many years ago. For best results, however, symmetrical section thickness should be matched against model size. With smaller models a thickness of 15 per cent appears to be about the optimum, with 18 per cent thickness on larger models. For this particular application, too, symmetrical sections with quite blunt leading edges are usually best.

The use of section thickness as a means of speed control can be most effective. It can also be used as a means of stall control, particularly on tapered wings. An increase in section thickness towards the tips will normally delay tip stalling and eliminate wing-dropping in turns, etc. On free flight models tip stalling can be eliminated by other means, e.g. incorporating wash-out towards the tip, but on aerobatic models where similar wing characteristics may be required for both normal and inverted flight, wing warping cannot be employed.

THE "POWER RUDDER'

PROBABLY more nonsense has been talked—and written—about spiral stability than any other aspect of model aircraft design. The most successful answer nearly always turns out to be one of "cut and try"—and having arrived at a suitable size of rudder for a particular layout, stick to it for future design of similar type! Meantime, of course, there is always somebody ready to try something different—such as all the rudder under the fuselage, forward fins, fins under the middle of the fuselage in the form of a "belly"—and quote theories as to why they are the "complete answer.. (but not when the model does eventually pile in).

Basically, so many things affect spiral stability that it is impossible to deal with them briefly—and to begin to analyse them theoretically demands an exceptional knowledge of aerodynamics and mathematics. Broadly, however, the initial requirement is a model which is directionally stable—e.g. has *enough* fin area—with the following other design features all helping:

(a) Large fuselage side areas
(b) Long fuselage
(c) Generous wing dihedral
(d) Low aspect ratio wing
(e) Small wing incidence and C.G. well aft
(f) Wing on pylon

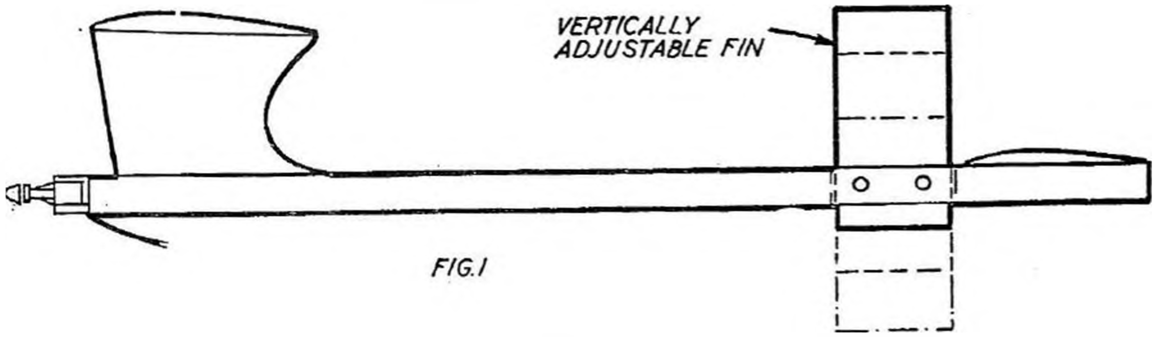


FIG. 1

(g) Low slung rudder (fin) area
(h) Tailplane and fin out of slipstream
(j) Anhedral on tailplane (negative dihedral)

Not all features can be incorporated in a single design, of course, nor are all necessary. Some have a more marked effect than others and, if present in suitable proportions, eliminate the need for further "corrective" features. One of the most significant factors is, however, the disposition of side areas—a forward fin above the fuselage (such as provided by a pylon) and low mounted fin areas aft of the centre of gravity tending to be beneficial. This helpful effect is more marked the farther the areas from the centre of gravity—hence the pylon model is, or should be, better as regards spiral stability with the c.g. well aft, even behind the trailing edge.

Possibly the neatest practical solution to all this possible confusion is the so-called "power rudder' or fixed fin which is mounted in a slot in the fuselage—Fig. 1. The main requirement is that this fin should be of sufficient area for the necessary degree of directional stability. Its position can then be adjusted up or down, vertically, by trial and error to arrive at the most suitable position for stability in turns.

Actually vertical adjustment of the fin will have a turning effect itself, without using any rudder or tab offset. Lowering the fin will tend to promote a turn to the right; and raising it a turn to the left when the model is under power in each case. This provides a much safer turn adjustment on a high power model than any rudder tab.

The reason why the straight fin acts as a "rudder" is due to slipstream effect, or propwash. The propeller generates a blast or circular column of air spiralling back in an anticlockwise direction, viewed from the front—Fig. 2. The net effect of this is to produce a sideflow on "straight" fin areas with equivalent reactions:

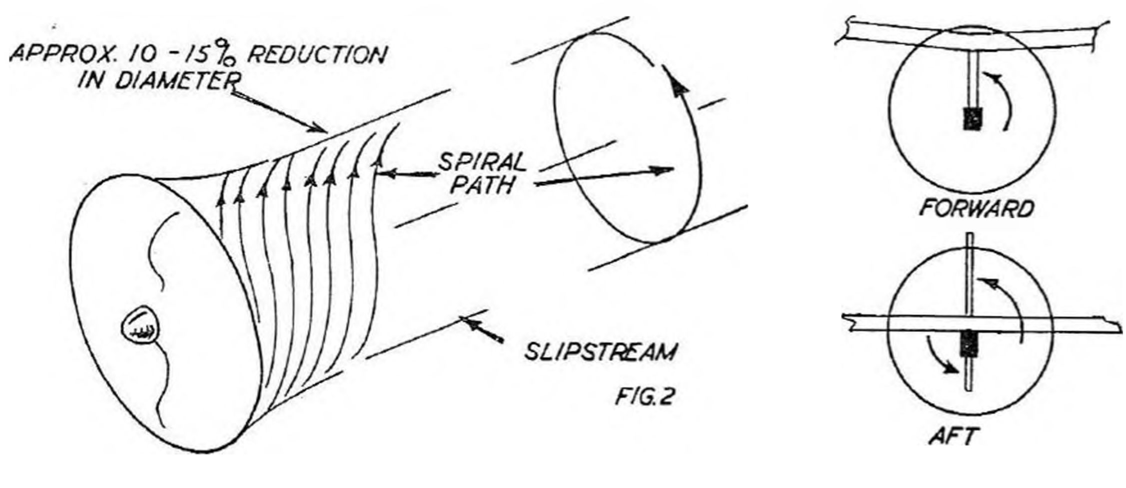


FIG. 2

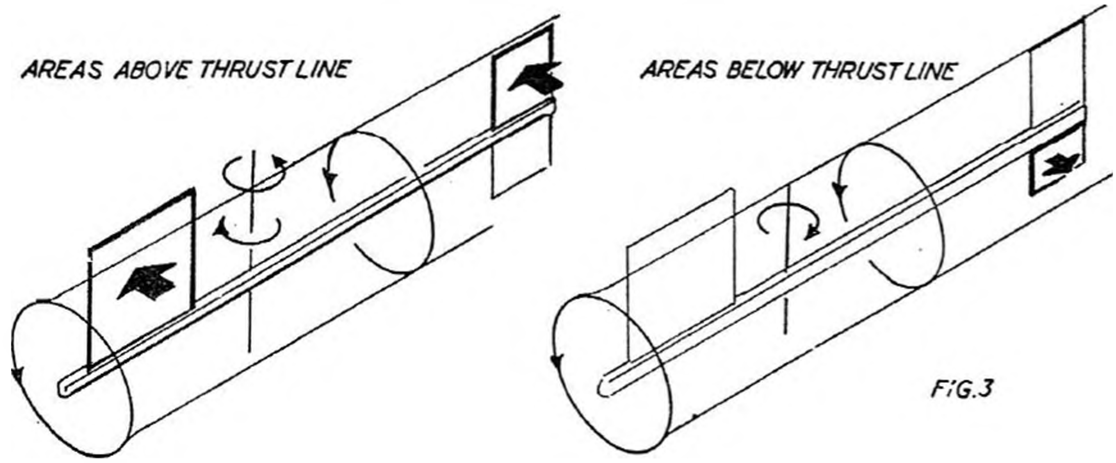


FIG.3

(i) Side areas above the thrustline (centreline of the slipstream)
  (a) aft, tend to roll the model to the right and yaw to left
  (b) forward tend to roll and yaw the model to the right

(ii) Side areas below the centreline
  (a) aft, tend to roll the model to the right and yaw to right

Since the aft (fin) area is usually relatively small the yawing effect is usually more noticeable than roll, hence raising the fin area tends to promote a left turn and lowering it a right turn.

The actual effect is, of course, modified by the position of the propwash relative to the surfaces involved (varying also with downthrust), and by side-thrust. In extreme layouts, such a very high thrust line designs—Fig. 4—the fin area may be entirely outside slipstream effect. With more conventional layouts there is ample scope to utilise fin effect in and out of the slipstream to produce a desired degree of turn—e.g. enough turn effect to counteract torque.

Instead of arguing out spiral stability problems with theory, therefore —and ending up for better or worse with a fixed configuration to evaluate by flight testing—the "power rudder" offers a practical solution for turn trim and spiral stability adjustment, provided the other major factors affecting spiral stability are not so far out as to render the model spirally unstable anyway. At least the various effects can be observed in flight—and not on paper!

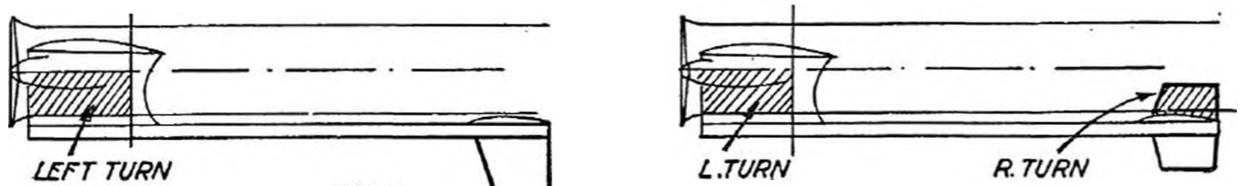


FIG.4

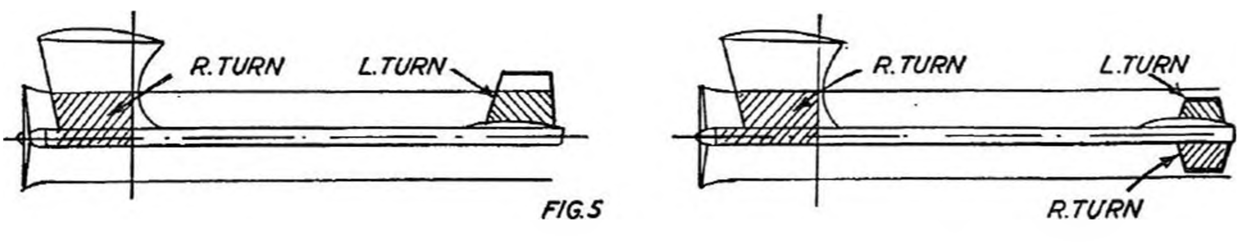
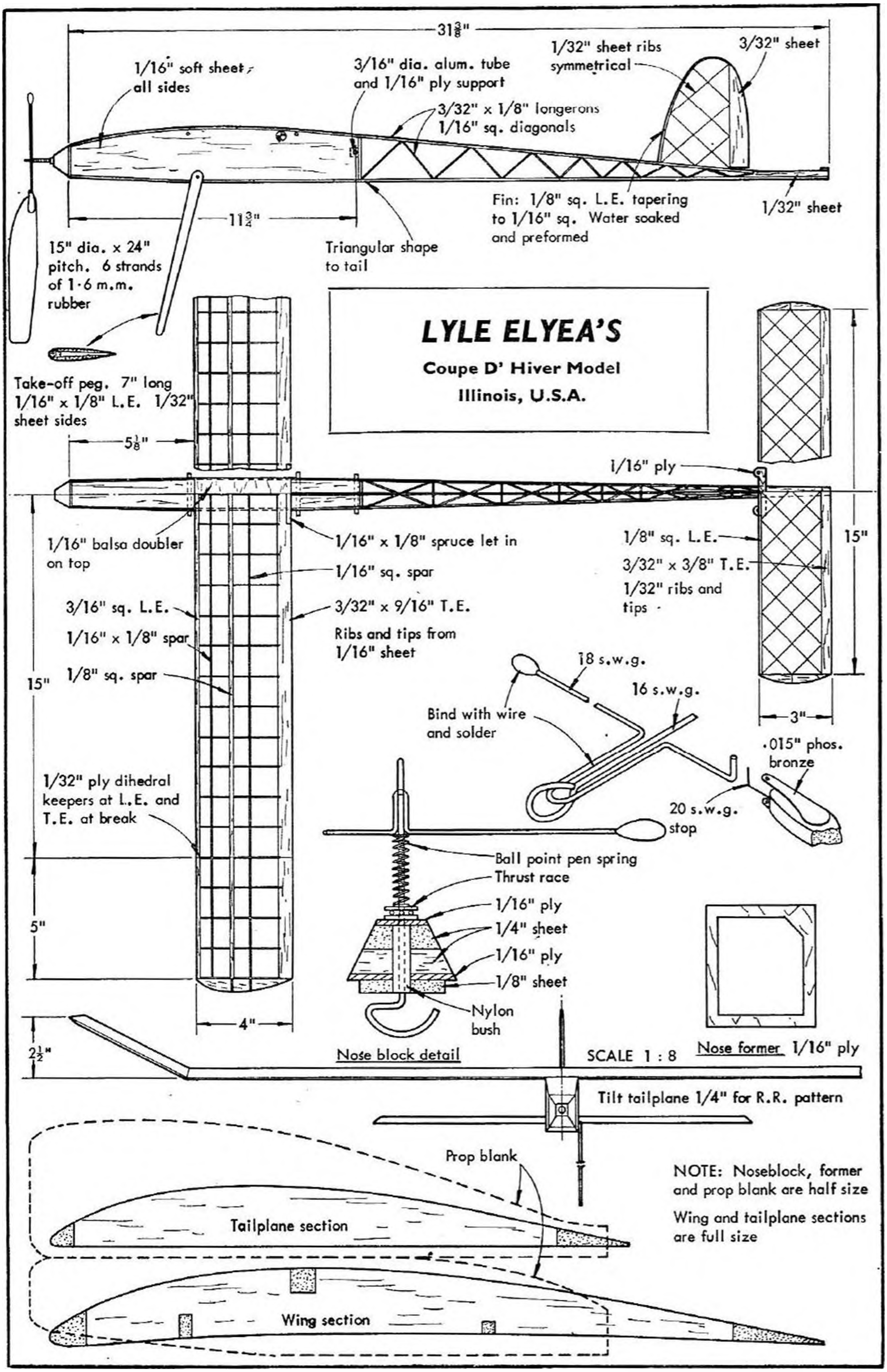


FIG.5



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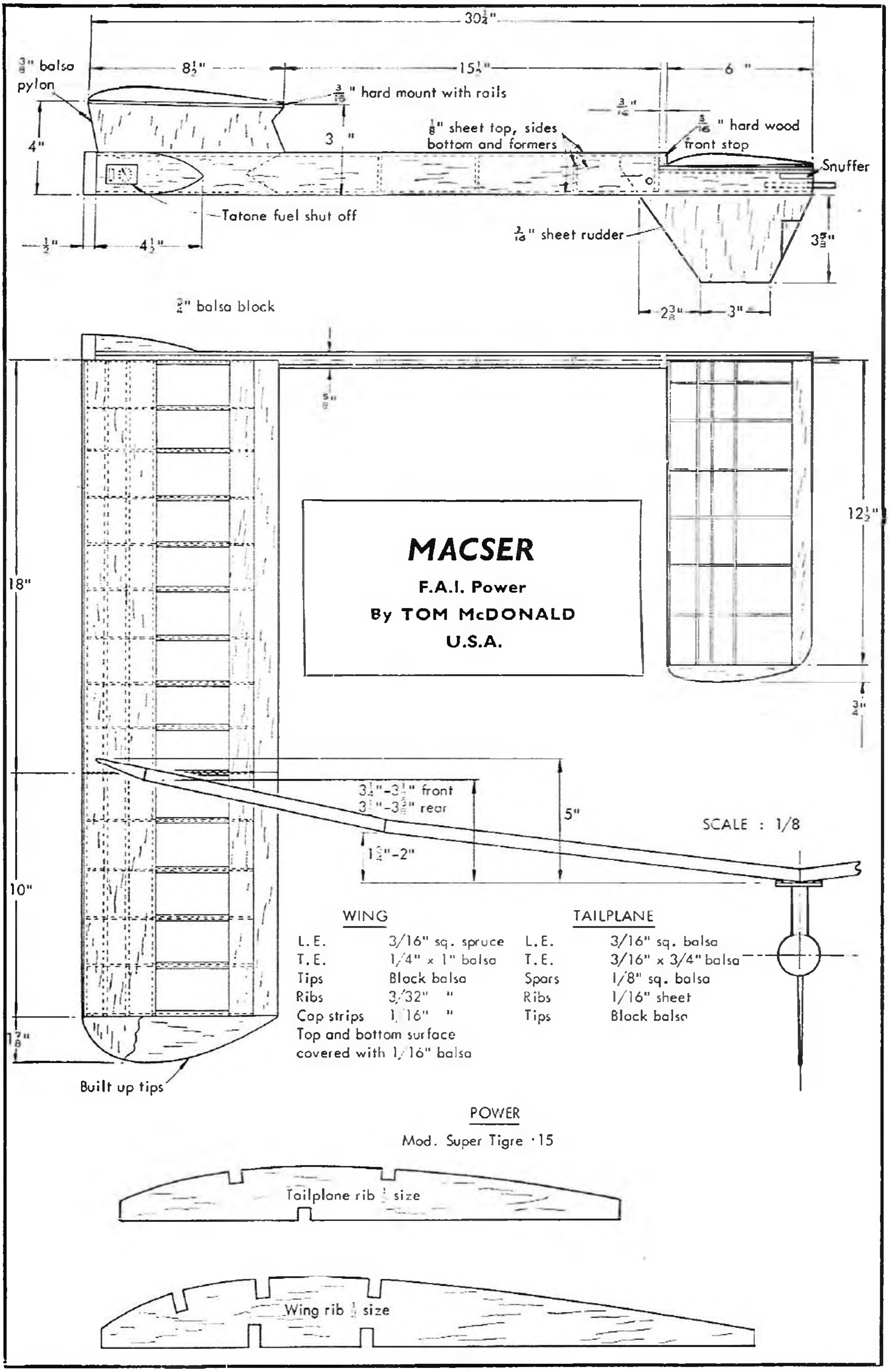
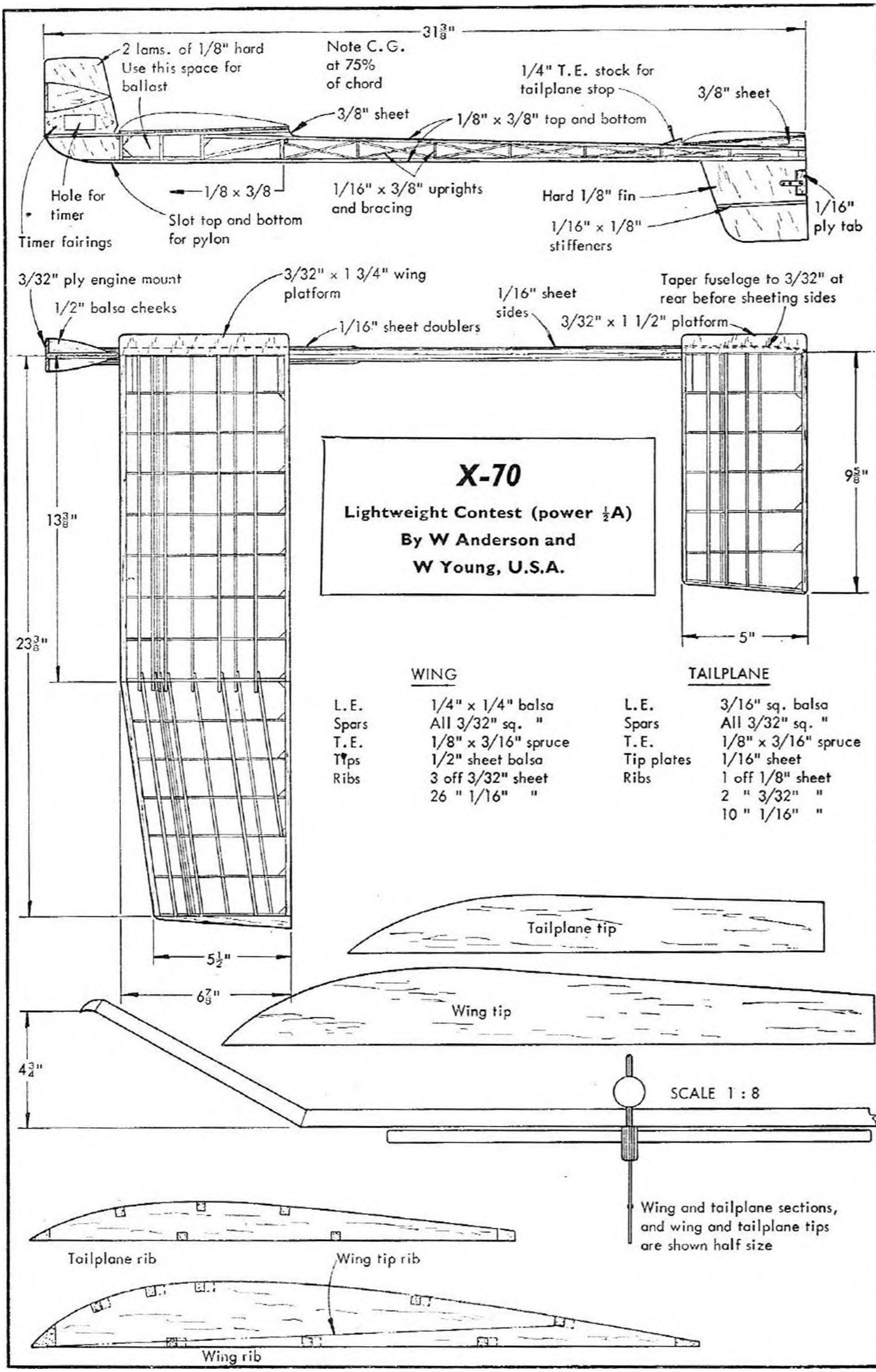


THE AIRFOIL U.S.A.



MODEL AIRPLANE NEWS, U.S.A.

TAKING CARE OF YOUR ENGINE

Not only beginners but expert aeromodellers often abuse engines sadly. Probably this is because not all aeromodellers are engineers and it needs an engineering mind to appreciate the comparative delicacy of a miniature two-stroke engine. It may seem tough and rugged enough, but it is not crashes which cause all the damage. Even just taking it apart and putting it together again can result in marked loss of performance, unless certain basic rules are observed, to say nothing of the chance of producing actual physical damage in the process.

As the service department of any British engine manufacturer will tell you, the most common damage suffered by engines is a bent connecting rod or damage to the piston assembly. This even exceeds crash damage, but is peculiar to diesels. The cause is forcing the piston to turn over top dead centre in a completely flooded cylinder. The leverage which can be applied on the propeller acting against a hydraulic lock produced by raw fuel trapped in the head is quite considerable—and the resulting force large enough to bend a connecting rod. When one manufacturer turned over to glow motor production he reported that his "damaged engine returns" were down nearly a hundred times—simply because you cannot "lock" a glow motor in the same way.

Glow motors have their own inherent weaknesses, however. Typically the smaller mass-produced glow motor features a soft steel cylinder screwing into the crankcase with a glow head screwing into the top of the cylinder. Unscrewing the head to replace a burnt out element (with a new head) often results in the cylinder unscrewing, not the head. Attempting to lock the cylinder against unscrewing by gripping it with pliers or sticking a screwdriver through one of the exhaust ports will almost certainly result in a ruined cylinder. It is not hard enough to withstand this treatment, so it will distort. This is not a "beginners" fault. Expert aeromodellers maltreat glow engines in this way—and suffer the same consequences. If you do not mind having to buy a new cylinder and piston assembly each time you want to change the glow head, use this "agricultural" method. If not, use two *properly sized spanners*—one to fit the glow head and the other to lock the cylinder as you unscrew the head.

The other thing which prompts the "screwdriver through the exhaust" technique is to lock the motor against rotation to remove a stubborn propeller nut or screw—with the chance of damaging the cylinder and piston, and bending the connecting rod. Again the remedy is perfectly obvious—*never do it.* There is always some other, safer way.

Only the absolute beginner would think of gripping a motor in a vice for bench running, but exactly the same prohibition applies to gripping any part of the motor in a vice for disassembly. Pressure die castings are readily distorted or even cracked by such treatment, and soft steel parts marked or squashed out of shape. A point about hold-down bolts for engines, too. Small American engines supplied with hold-down bolts for mounting all too readily work loose when running. This may not cause actual damage—although it will result in an appreciable loss of power—but it is not doing the engine any good.

The fact that it can vibrate badly will probably loosen bolts holding it together, so that suddenly it gives up running or proves absolutely impossible to start. Part of the fault in such cases is often in the hold-down bolts themselves. Popular American sizes have a relatively coarse thread and often very loose-fitting nuts—a combination just made to vibrate loose. B.A. screws are usually much better—6 B.A. or 8 B.A. according to engine size and the size of the holes in the mounting lugs—and can really be made vibration proof with a second nut to lock (or even a spring washer under a single nut). For 6 B.A. size (and larger) you can also buy proper lock nuts with nylon or fibre inserts. Certainly this will be easier than trying to find further American size nuts to fit as lock nuts to the original bolts—or to replace those that have vibrated off and disappeared!

What sort of attention does an engine need to keep it in good condition when installed in a model and used normally? Very little. Provided it is properly and firmly mounted, and fitted with a balanced propeller, it will not suffer undue wear and loss of power through vibration. The through flow of oil when running—fuel mixtures always have excess oil—will ensure both adequate lubrication and internal "washing". About the only proviso here is that the proportion of oil in the fuel should be sufficient.

Most commercial fuels have a more than adequate proportion of lubricant. Lubricant itself is a poor fuel and that amount which does get burnt contributes little or nothing to the power. You can increase the "power" of a fuel by decreasing the oil content in favour of more actual fuel (i.e. more paraffin in the case of diesel fuels, or more methanol in the case of glow fuels). Provided the engine is well run-in the proportion of lubricant can usually be reduced quite safely to 20 per cent of the total mixture. This is only worthwhile when you *do* want to get a bit more performance out of the engine. For most applications the chosen type and size of engine will have more than enough power, when a standard fuel (with excess lubricant) is the logical choice.

Although fuels consist, basically, of mixtures of oils, they can be corrosive—largely due to the inclusion of small proportions of "dope". Thus in time a heavily nitrated diesel fuel may show marked corrosion of the piston and cylinder bore. This is most likely to occur if the engine stands idle for long periods between use. Run regularly the corrosive residues are washed out. Certain proprietary fuels are more corrosive than others in this respect. This does not make them any worse as fuels—they may, in fact, give the best results—but merely means that engines run on such fuels and then left idle should be cleaned out before storing—e.g. by flooding with a light machine oil or detergent oil, or even being given a preliminary run on an undoped fuel prior to "flushing" and storage. In any case any engine put aside for storage should have a few drops of oil squirted into the cylinder and the engine turned over by hand a few times to cover all the rubbing surfaces with a film of lubricant. Also storage should be in a reasonably dry (and preferably slightly warm) place. It is surprising how easily pistons and cylinders can rust—and corrosion of this nature does permanent damage to smooth ground and polished surfaces.

Glow fuels are not normally corrosive at all. However, many suffer from a tendency to deposit out gummy solids on the inside of the cylinder, almost literally covering the bore with a coating of "varnish". This increases friction and has a dragging action on the piston, materially reducing performance. The best solution if "varnishing" is suspected is to dismantle the engine and mechanically clean the cylinder bore, using fine steel wool. Although the cylinder is usually soft you are not likely to damage the bore at all with steel wool—but do not use emery or similar types of abrasive or otherwise you certainly will.

Practically every engine will go "stiff" after being idle for some time, simply because residual oil has tended to solidify and become gummy. A generous squirt of oil or fuel through the exhaust port will usually free the engine up completely. This sort of gum does not stick as "varnish" and is washed right out as soon as the engine starts running again.

The "washing" action of the fuel can also be illustrated by the fact that you *can* use an abrasive (such as domestic metal polish) to speed up the running-in process without damaging the engine. If a drop or two of abrasive is introduced into the intake when the engine is running it will assist in wearing down high spots rapidly and in the course of a few minutes running all traces of the abrasive are washed out. This is not recommended as general practice, but is a very useful dodge when an engine is persistently stiff and virtually refuses to free up with further running. On no account, however, should this treatment be used with ball race engines. In this case there is the risk of abrasive being trapped in the races and causing high wear on the rings.

Running-in is a much misunderstood process. With very few exceptions, all new engines benefit from running-in for anything up to two or three hours. Depending on the tightness of the initial fits; materials of construction; the accuracy of the piston and cylinder as regards concentricity; and the bearing fit; running-in will produce a progressive increase in performance, up to a limit where all rubbing surfaces are nicely bedded down. Some engines will run freely after a few minutes actual running time and show no further increase in performance thereafter. Others will take a much longer time before they show no further increase in r.p.m. on a given prop. size; or in the case of a throttled engine, will show consistent slow running characteristics with flexible response to the throttle. Once run-in diesels will usually go on giving a consistent performance for hundreds of hours, if necessary. Glow motors, on the other hand, tend to run-in to a peak performance, hold this peak for a period and then start wearing out with further running, with a progressive less of performance. In other words, one can literally run-in a glow motor too much—to the point where it is starting to wear out!

The two combinations concerned in running-in are the piston-cylinder fit and the main bearing. In the former case actual clearance is not so important as accuracy of fit—i.e. piston and cylinder truly circular. The more accurate these components are the less the time required for running in, regardless of clearance. Materials of different hardness for piston and cylinder run-in best, and also generate less friction when running—hence the almost universal choice of either a "hard" cylinder and "soft" piston combination, or vice versa.

As regards the main bearing, ball races need no running-in—hence running-in a ball race engine should take less time than a plain bearing engine with a similar piston-cylinder fit. However, the main "time" requirement is usually in the piston-cylinder fit, so this does not necessarily apply in practice. With a plain bearing engine, however, it is possible that the bearing will take longer to bed down than the piston-cylinder combination, particularly if the bearing shape is poor or the shaft badly finished (it is readily possible for a centreless grinder to form a series of "flats" on a shaft, for example, rather than a true circular surface). A bad bearing, in fact, will never run-in or bed down properly and further running may even aggravate the trouble.

A clue here is to feel the bearing immediately after the engine has stopped. If cool, all is well. If definitely hot it may be a case of a bad bearing or simply a bearing which requires more running-in time to free up. The performance of standard plain bearing engines is very much dependent on the quality of the bearing and a bearing slightly on the slack side initially, is often usually better than one which is apparently better in that the shaft cannot "rock".

Running-in should be conducted at reasonably *high* speeds. Low speed running literally lets the engine get nowhere, as well as putting *more load on the bearings*. For initial running a propeller one inch larger in diameter than the "matching" size can be used. After that there is no harm in using the standard prop., unless the engine shows definite signs of distress—i.e. inconsistent running or overheating.

The more running-in an engine needs—or receives—the greater its susceptibility to *alignment*. Since there is a side load on the piston when reciprocating in the cylinder, piston and cylinder will have been worn in with respect to this side load. If subsequently the cylinder is removed and re-assembled in a different manner (e.g. turned through 90 or 180 degrees), almost certainly the performance will suffer.

Many engines have a cylinder which is held down by bolts and can be fitted in any one of three or four angular positions, differing by 120 or 90 degrees, respectively. When such engines are disassembled for any reason after running, therefore, the cylinder position relative to the crankcase should always be marked, so that the cylinder can be reassembled in the original position. The same applies to the piston and the connecting rod, which can also be assembled 180 degrees out from its original position, although this is not usually so important.

A basic rule is that engines should *not* be disassembled, unless this becomes strictly necessary, although this should not result in any harm if the proper precautions are taken. There is, however, always the risk of damage, particularly when knocking the crankshaft back to free the propeller driver. If this has to be done, always put a nut on the end of the shaft (or a screw, as appropriate) and drive on the nut rather than the end of the shaft with a soft drift, not a hammer. Removing the shaft of a ball race engine, too, may upset the alignment of the ball races, unless the shaft is a free fit. Sometimes, also, a burr of metal can be picked up when driving out a shaft which scores the bearing length. All the time and trouble taken in proper running-in can be ruined by mis-handling in taking an engine apart—as well as spoiling the engine for further use. The great temptation, too, is to get rough with certain screwed assemblies that are tight, gripping one of the components in a vice. At the very least you will probably mark the component badly. At the worst you may ruin it.

About the only call to take an engine apart—unless it has obviously suffered internal damage and you want to examine it—is if it has suffered a crash and it is suspected that dirt or abrasive grit has got inside the cylinder. Even then such action may not be necessary. Let's start from the moment of recovering the engine from a crash which has buried it in the ground.

The one thing *not* to do is to try to turn the engine over—a logical temptation, just to see if the shaft will still go round! This will only push any dirt or grit which has entered the exhaust ports up and down the cylinder and possibly score the piston or bore. If the shaft is bent—soft crankshafts are employed on many glow motors—this could also damage the bearing.

If the engine shows no signs of damage it can probably be got running again just by cleaning off. If the model is still flyable, this can usually be done on the field simply by squirting generously with fuel and wiping clean with a rag. If the piston has stopped blocking the exhaust ports, dirt is unlikely to have got inside, but squirt fuel generously around the ports to wash clean. If the piston has stopped with the ports open, flood the cylinder with fuel repeatedly through the ports to wash out, holding the engine inverted so that no dirt can wash down into the crankcase through the transfer. All being well, you can then set about flying again.

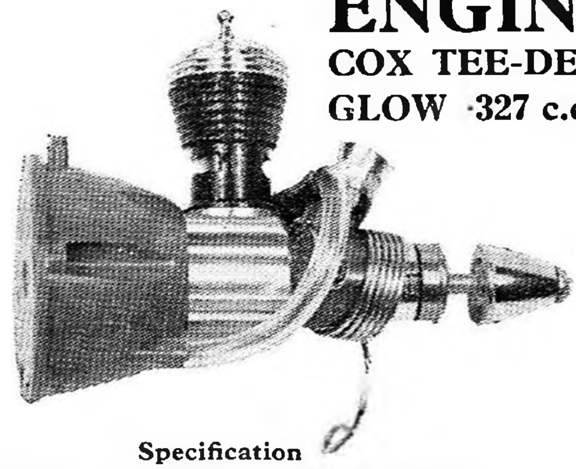
If the model is not flyable—or actual damage to the engine is apparent, cleaning is best left until back in the workshop. After cleaning you can then squirt oil through the exhaust port *and* intake and turn the engine over gently. If it feels "gritty", stop at once. The engine will have to be taken apart for further cleaning—and there may be something bent. It may be, for example, that some grit has got into a ball race and you will not be able to wash this out without taking the engine apart.

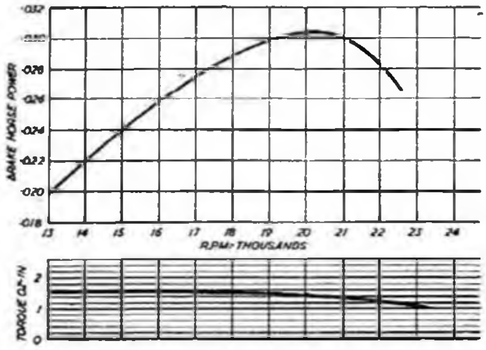
Petrol or paraffin is the best fluid for cleaning—*not* degreasing fluids like carbon tetrachloride. Carbon tet. can cause rusting of cast iron components (e.g. deisel engine pistons). And always lightly oil all the rubbing surfaces before assembly. If the engine does not run properly after reassembly, check cylinder assembly as mentioned previously (different assembly will not stop it running, unless the porting is asymmetric when the engine will *only* run with the cylinder the right way round.) If in doubt, make a note of the correct way round of cylinder and piston when taking apart. The most likely cause of poor running, however, will be actual damage—such as a bent crankshaft (check by turning the prop. over and checking the travel of a blade tip); distorted cylinder (piston is stiff when turned over); displaced bearings (on a ball race engine, indicated by roughness when turned over). Before looking for such major faults, however, check that the cleaning is complete and it is not just the spray bar jet hole which is blocked up.

As with practically all machinery, the guiding rule is "when running well, leave well alone". If inconsistencies show up, look for *minor* troubles, such as a loose screw giving an air leak, cylinder partly unscrewed, etc. No engine is likely to go wrong on its own, if reasonably well looked after. Nor do they normally need any more "regular maintenance" than a wipe off with a clean rag after use. Decarbonising is seldom, if ever necessary, as although a deposit will build up on the top of the piston it takes tens of hours for this to reach any appreciable thickness, and even then it is not doing any harm. Unlike larger two-strokes with more restricted port sizes, carbonning does not result in loss of performance since the ports themselves never coke up. Remember, however, that glow motors can "varnish" up.

ENGINE ANALYSIS

COX TEE-DEE ·020 GLOW ·327 c.c.





Specification

Displacement: ·3266 c.c. (·0199 cu. in.)
Bore: ·300 in.
Stroke: ·282 in.
Bore/stroke ratio: 1·16
Bare weight: ·85 ounce
Max. power: ·0304 B.H.P. at 20,500 r.p.m.
Max. torque: 1·6 ounce-inches at 15-16,000 r.p.m.
Power rating: ·093 B.H.P. per c.c.
Power/weight ratio: ·036 B.H.P. per ounce

Material Specification

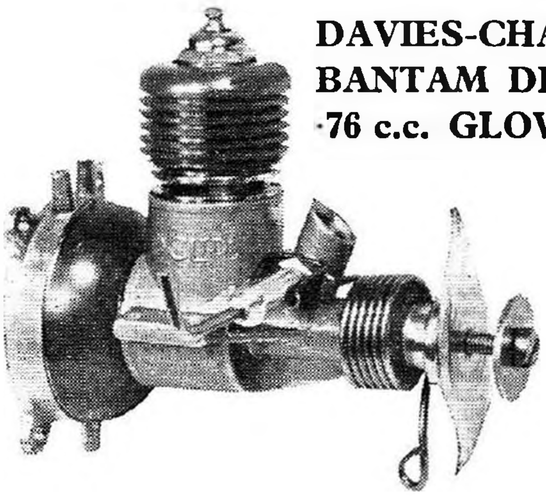
Crankcase: machined from light alloy bar, "gold" finish overall
Crankshaft: hardened steel, 1/16 in. diameter steel screw propeller shaft
Piston: hardened steel
Cylinder: soft steel
Connecting rod: machined from dural (ball-and-socket little end)
Intake body: moulded plastic, located by screwed dural collar
Venturi: turned aluminium
Spraybar housing: steel
Cylinder head: turned dural, integral 1·5 volt glow element
Crankcase back cover: moulded plastic
Rear-cover tank: moulded plastic, with plastic end
Main bearing: plain

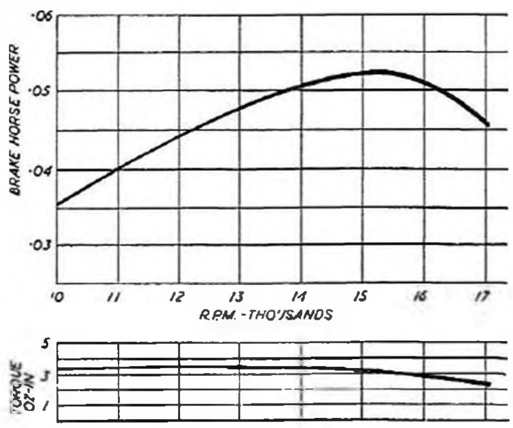
Manufacturers:
L. M. Cox Mfg. Co. Inc., Santa Ana, California, U.S.A.
British Importers:
A. A. Hales Ltd., 26 Station Close, Potters Bar, Middlesex

Propeller—R.P.M. Figures	
Propeller	*r.p.m.*
3⅛ × 2½ (Cox three-blade plastic)	21,000 plus
5¼ × 3 (Top Flite)	11,200
5¼ × 4 (Top Flite)	9,500
5 × 4 (Keilkraft nylon)	10,200

Fuel used: nominal 20 per cent nitromethane, 25 per cent castor, 55 per cent Methanol.
NOTE: These propeller-r.p.m. figures are largely of academic interest. No standard commercial propellers available in this country are a "match" for the ·020 other than the Cox 3⅛ in. dia. three-blade and Cox 4 × 2½ plastic (two-blade).

DAVIES-CHARLTON BANTAM DE LUXE ·76 c.c. GLOW





Specification

Displacement: ·762 c.c. (·0465 cu. in.)
Bore: ·410 in.
Stroke: ·352 in.
Bore/stroke ratio: 1·17
Bare weight: 2 ounces (with tank)
Max. B.H.P. ·053 at 14,500 r.p.m.
Max torque: 3·3 ounce-inches at 12,000 r.p.m.
Power rating: ·07 B.H.P. per c.c.
Power/weight ratio: ·026 B.H.P. per ounce

Propeller—R.P.M. Figures			
Dia. × Pitch		*Stand. Bantam*	*Bantam De Luxe*
6 × 3	Top Flite nylon	11,500	12,500
6 × 4	Top Flite nylon	9,700	10,800
5¼ × 3	Top Flite nylon	12,000	14,600
5¼ × 4	Top Flite nylon	12,000	13,400
5¼ × 4	Top Flite nylon	12,000	13,400
6 × 4	D-C nylon	11,500	12,700
5¼ × 3½	D-C nylon		15,600
5 × 3	K-K nylon	11,500	12,800
52 × 4	K-K nylon	11,500	12,700

Fuel used: D-C Quickstart glowfuel

Material Specification

Crankcase: light alloy pressure die-casting
Cylinder: leaded steel
Cylinder jacket and head: turned dural
Piston: hardened steel
Crankshaft: hardened steel, 6BA propeller shaft (bolt)
Connecting rod: light alloy forging
Bearings: all plain
Plug: KLG Quick Start, short reach, 1·5 volt
Spraybar assembly: light alloy
Propeller driver: dural
Manufacturers:
Davies-Charlton, Ltd., Hills Meadows, Douglas, Isle of Man

Propeller—R.P.M. Figures	
Propeller	*r.p.m.*
6 × 4 Top Flite nylon	14,500
5¼ × 3 Top Flite nylon	21,000
6 × 3 Top Flite nylon	18,400
5¼ × 4 Top Flite nylon	18,200
6 × 4 Davies-Charlton nylon	17,000
5¼ × 3½ Davies-Charlton nylon	24,000
6 × 4 Frog nylon	15,400
6 × 4 Stant	12,200
6 × 3 Stant	14,400
5 × 3 Keilkraft nylon	21,000
5 × 4 Keilkraft nylon	19,800

Fuel used: 25 per cent nitromethane, 20 per cent castor, 55 per cent methanol

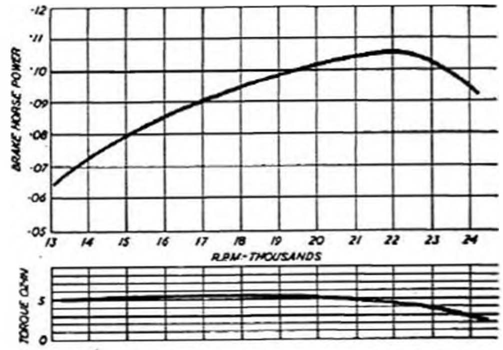
COX TEE-DEE ·049 GLOW ·819 c.c.

Specification

Displacement: ·819 c.c. (·0499 cu. in.)
Bore: ·406 in.
Stroke: ·386 in.
Bore/stroke ratio: 1·05
Bare weight: 1½ ounces
Max. power: ·105 B.H.P. at 22,000 r.p.m.
Max. torque: 5·5 ounce-inches at 18,000 r.p.m.
Power rating: ·128 B.H.P. per c.c.
Power/weight ratio: ·07 B.H.P. per ounce

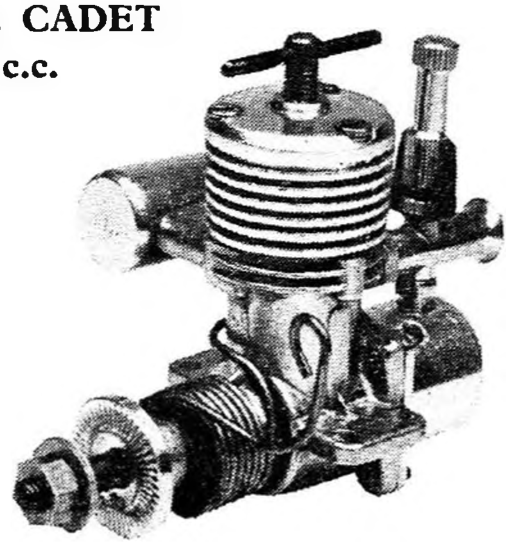
Material Specification

Crankcase: machined from light alloy bar stock
Intake housing: injection moulded plastic
Cylinder: mild steel (integral fins)
Cylinder head: turned from light alloy (integral glow element)
Back cover: machined from solid



Crankshaft: hardened steel
Connecting rods: hardened steel (machined), ball and socket little end
Piston: hardened steel (hardened on walls only), flat top
Propeller shaft: steel screw and spinner (turned from light alloy)
Venturi intake: machined from light alloy
Carburettor collar: light alloy (anodised gold)
Needle: steel (spring ratchet)
Propeller driver: machined from light alloy (anodised gold)
Manufacturers:
L. M. Cox Manufacturing Co., Box 476 Santa Ana, California, U.S.A.
U.S. Retail price: $7.98
Price in G.B.: £3/17/6
British Importers:
A. A. Hales Ltd., Potters Bar, Middlesex

E.D. CADET ·984 c.c.



Specification

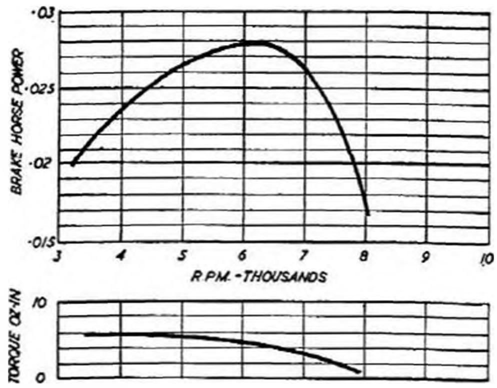
Displacement: ·984 c.c. (·061 cu. in.)
Bore: ·437 in.
Stroke: ·400 in.
Bare weight (including tank and silencer): 3⅝ oz.
Max. power: ·028 B.H.P. at 6,400 r.p.m.
Max. torque: 6 ounce-inches at 4,000 r.p.m.
Power rating: ·028 B.H.P. per c.c.
Power/weight ratio: ·0047 B.H.P. per ounce

Material Specification

Crankcase unit: light alloy pressure die-casting, bright finish
Cylinder liner: hardened steel
Piston: cast iron
Contra piston: mild steel
Crankshaft: hardened steel
Main bearing: bronze bush
Cylinder jacket: turned dural
Tank: turned dural
Intake tube: light alloy pressure die-casting, bright finish
Spraybar assembly: brass

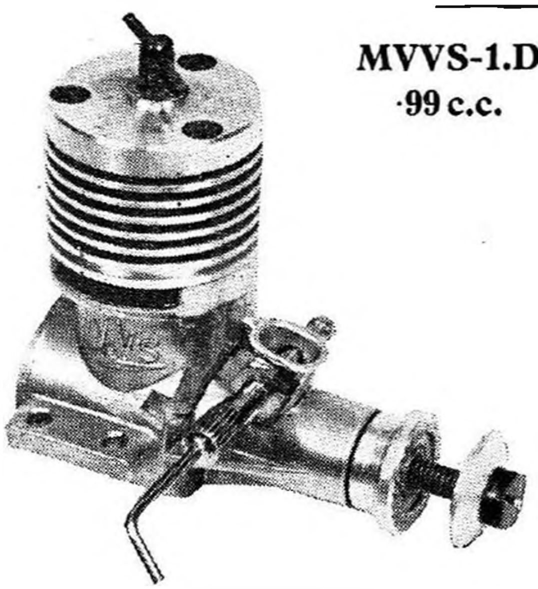
Propeller—R.P.M. Figures	
Propeller	*r.p.m.*
9 × 6 (Frog nylon)	5,200
9 × 4 (K-K nylon)	5,800
8 × 4 (K-K nylon)	6,400
8 × 6 (K-K nylon)	5,500
9 × 4 (Top Flite nylon)	5,400
8 × 4 (Top Flite nylon)	6,400
7 × 4 (Top Flite nylon)	7,000

Con. rod: light alloy forging
Silencer: 1 in. × ½ in. diameter with stub exhaust pipe
Price: £3/3/-



Manufacturers:
E. D. Engineering & Electronics Ltd., Island Farm Road, West Molesey, Surrey.

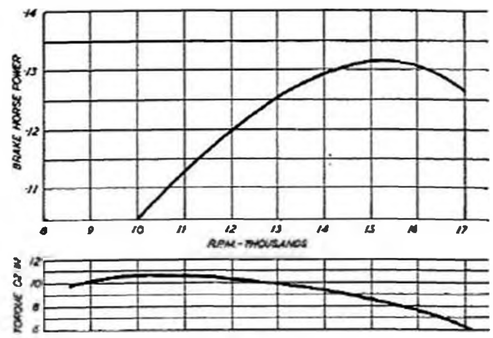
MVVS-1.D
·99 c.c.



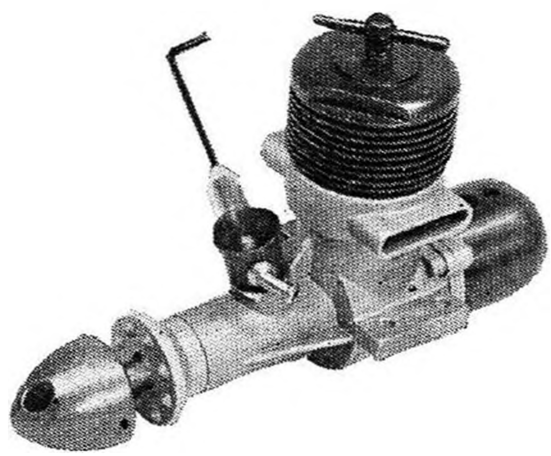
Specification
Displacement: ·99 c.c. (·01622 cu. in.)
Bore: ·420 in. (10·7 mm.)
Stroke: ·430 in. (11 mm.)
Bare weight: 2¾ ounces
Max. power: ·132 B.H.P. at 15,400 r.p.m.
Max. torque: 10·8 ounce-inches at 10,500 r.p.m.
Power rating: ·13 B.H.P. per c.c.
Power/weight ratio: ·048 B.H.P. per ounce

Material Specification
Crankcase unit: light alloy gravity die-casting
Cylinder liner: hardened steel
Piston: cast iron
Contra-piston: cast iron
Connecting rod: light alloy
Crankshaft: hardened steel
Cylinder jacket: turned dural
Cylinder head: dural (solid)
Crankcase back cover: turned dural
Prop. driver: turned dural
Spraybar assembly: brass

Propeller—R.P.M. Figures	
Propeller	*r.p.m.*
7 × 6 (Frog nylon)	10,800
7 × 4 (Frog nylon)	13,200
8 × 4 (K-K nylon)	10,800
7 × 4 (K-K nylon)	12,600
6 × 4 (K-K nylon)	16,000
8 × 4 (Top Flite nylon)	10,500
7 × 4 (Top Flite nylon)	12,500
6 × 4 (Top Flite nylon)	17,000



MAROWN SNIPE 1·5



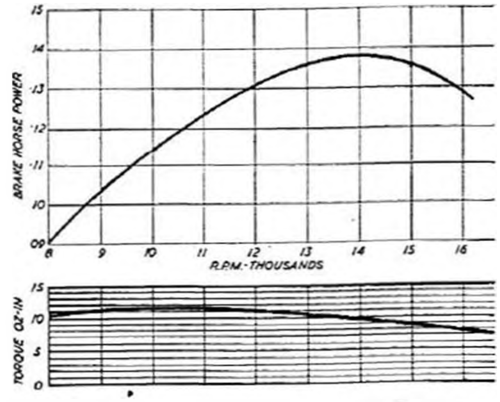
Specification
Displacement: 1·50 c.c. (·0915 cu. in.)
Bore: ·5065 in.
Stroke: ·454 in.
Bore/stroke ratio: 1·12
Weight: 3⅞ ounces
Max. power: ·138 B.H.P. at 14,000 r.p.m.
Max. torque: 11·5 ounce-inches at 10,500 r.p.m.
Power rating: ·092 B.H.P. per c.c.
Power/weight ratio: ·0356 B.H.P. per ounce

Material Specification
Cylinder: case-hardened steel BSS EN 351, internally ground to finish
Crankshaft: case-hardened steel BSS EN 33, ground to finish
Piston: Meehanite
Contra piston: cast iron
Crankcase unit: pressure die-cast light alloy
Cylinder jacket: dural (anodised red)
Main bearing: Meehanite bush

PROPELLER—R.P.M. FIGURES

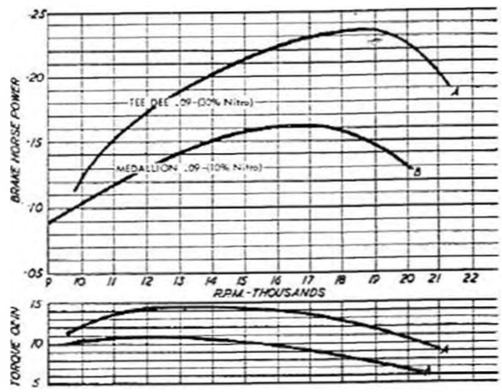
Propeller	*r.p.m.*
7 × 4 (K-K nylon)	13,100
6 × 4 (K-K nylon)	16,000
5½ × 4 (K-K nylon)	18,500
7 × 6 (K-K nylon)	9,800
8 × 4 (K-K nylon)	10,000
7 × 4 (Frog nylon)	12,200
7 × 6 (Frog nylon)	10,800
7 × 6 (Top Flite nylon)	10,800
6 × 4 (Top Flite nylon)	17,000
8 × 4 (Top Flite nylon)	10,600
8 × 4 (Trucut)	10,800
7 × 4 (Trucut)	12,800
9 × 4 (Trucut)	7,800
8 × 4 (Stant)	9,600

Connecting rod: high tensile light alloy L 64
Intake: dural
Spraybar: brass



Crankcase back cover, propeller driver: light alloy die-castings
Spinner: turned dural, anodised red
Manufacturers:
Marown Engineering Ltd., Glen Vine, Isle of Man
Price: £3/2/- including Purchase Tax

COX TEE-DEE ·09 GLOW and MEDALLION ·09



Specification

Displacement: 1·497 c.c. (·0914 cu. in.)
Bore: ·497 in.
Stroke: ·471 in.
Weight: Medallion 09—2¾ ounces
Tee Dee 09—2¾ ounces
Max. power: Medallion 09—·162 B.H.P. at 16,500 r.p.m.
Tee Dee 09—·235 B.H.P. at 19,000 r.p.m.
Max. torque: Medallion 09—11 ounce-inches at 12,000 r.p.m.
Tee-Dee 09—14·7 ounce-inches at 14,000 r.p.m.
Power rating: Medallion 09—·108 B.H.P. per c.c.
Tee Dee 09—·1575 B.H.P. per c.c.
Power/weight ratio: Medallion 09—·059 B.H.P. per ounce
Tee Dee 09—·086 B.H.P. per ounce

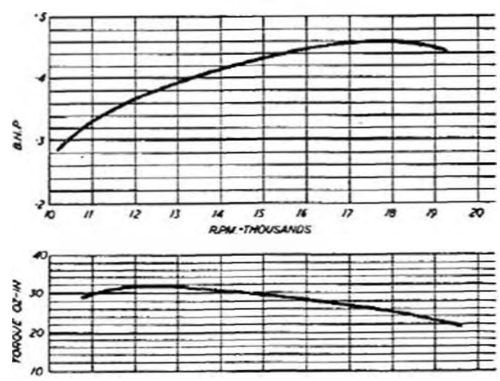
Material Specification

Crankcase: light alloy, machined from bar stock
Cylinder: mild steel
Piston: steel with hardened walls
Crankshaft: hardened steel
Connecting rod: hardened steel (ball and socket little end)
Cylinder head: light alloy
Crankcase back cover: light alloy
Carburettor: plastic housing with pressure tap (blind as supplied)
Medallion 09—brass spraybar and steel needle valve carburettion
Tee Dee 09—light alloy intake tube (venturi) with peripheral jets; needle valve in separate housing feeding into annular passage connecting jets
Prop. driver: light alloy (anodised gold on Tee Dee 09)
Prop. shaft: diameter mild steel screw cadmium plated
Aluminium spinner with Tee Dee 09

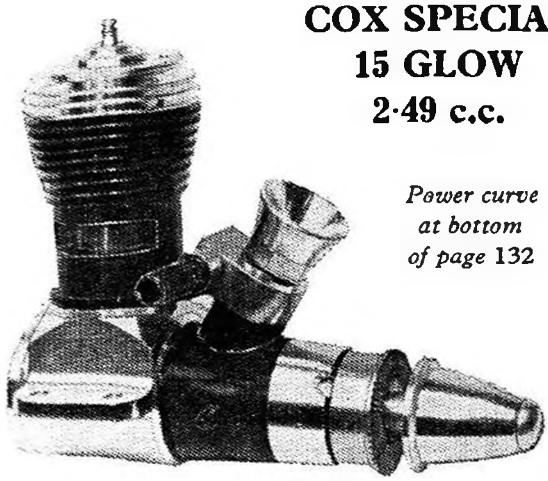
PROPELLER—R.P.M. FIGURES

	Tee Dee 09	*Medallion* 09
6 × 4 Top Flite	19,500	17,200
7 × 4 (Top Flite)	15,500	12,900
8 × 4 (Top Flite)	13,200	11,300
9 × 4 (Top Flite)	8,700	7,700
6 × 4 (K-K nylon)	19,000	17,100
6 × 3 (K-K nylon)	20,800	19,000
7 × 4 (K-K nylon)	15,400	13,300
8 × 4 (K-K nylon)	12,200	10,300
6 × 4 (D-C nylon)	20,000 ×	—
7 × 4 (D-C hylon)	15,900	14,200

Fuel used: Tee Dee 09—Cox Nitro 30 Racing fuel; Medallion 09—Cox Thimbledrome glow fuel



COX SPECIAL 15 GLOW 2·49 c.c.



Power curve at bottom of page 132

Specification

Displacement: 2·449 c.c. (·1494 cu. in.)
Bore: ·591 in.
Stroke: ·556 in.
Weight: 4½ ounces.
Max. power: ·46 B.H.P. at 18,000 r.p.m.
Max. torque: 32 ounce-inches at 12,000 r.p.m.
Power rating: ·185 B.H.P. per c.c.
Power/weight ratio: ·102 B.H.P. per ounce

Material Specification

Crankcase: machined from light alloy bar stock
Intake housing: injection moulded plastic
Cylinder: mild steel (integral fins)
Cylinder head: turned from light alloy (integral glow element)
Back cover: machined from solid
Crankshaft: hardened steel $\frac{7}{16}$ in. diameter
Connecting rod: machined from light alloy (plain big- and little-ends)
Piston: cast iron special alloy
Propeller shaft: ·161 in. N.S.F. steel screw and spinner (turned from light alloy)
Venturi intake: machined from light alloy
Carburettor collar: light alloy (anodised gold)
Needle: steel (spring ratchet)
Propeller driver: machined from light alloy (anodised gold)

Manufaturers:
L. M. Cox Manufacturing Co., Box 476, Santa Ana, California, U.S.A.
U.S. retail price: $14.98
Price in G.B.: £7/6/-

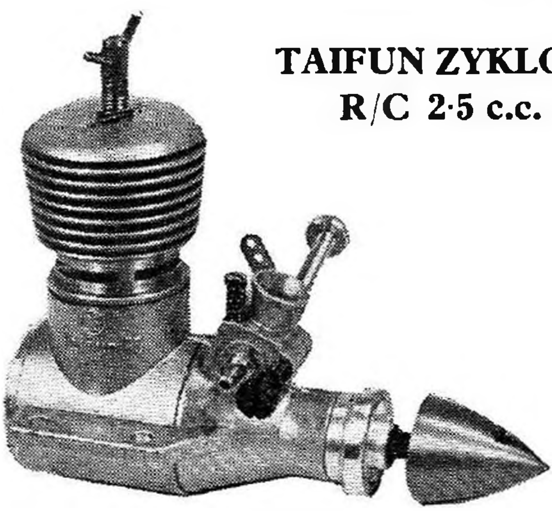
British Importers:
A. A. Hales Ltd., Potters Bar, Middlesex

PROPELLER—R.P.M. FIGURES

Propeller	*r.p.m.*
8 × 4 (Trucut)	17,500
9 × 4 (Trucut)	13,800
9 × 6 (K-K nylon)	11,800
9 × 4 (K-K nylon)	14,200
8 × 4 (K-K nylon)	16,300
7 × 4 (K-K nylon)	19,200
9 × 4 (Top Flite nylon)	13,600
9 × 3 (Top Flite nylon)	15,800
8 × 4 (Top Flite nylon)	16,700
7 × 6 (Top Flite nylon)	16,600
7 × 4 (Top Flite nylon)	20,000

Fuel used: Cox Racing glow fuel (30 per cent nitromethane)

TAIFUN ZYKLON R/C 2·5 c.c.



Specification

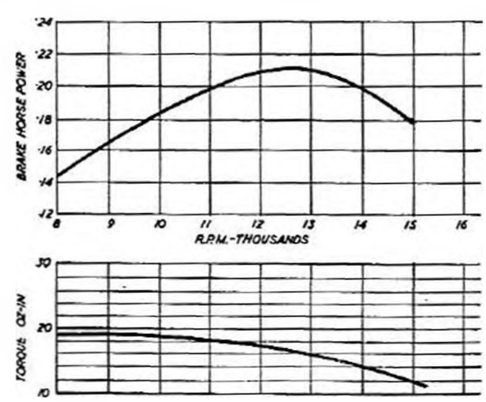
Displacement: 2·540 c.c. (·1548 cu. in.)
Bore: ·597 in. Stroke: ·553 in.
Bore/stroke ratio: 1·08 Bare weight: 5¾ ounces
Max. power: ·21 B.H.P. at 12,500 r.p.m.
Max. torque: 19 ounce-inches at 9,000 r.p.m.
Power rating: ·083 B.H.P. per c.c.
Power/weight ratio: ·0365 B.H.P. per ounce

Material Specification

Crankcase: light alloy pressure die-casting
Cylinder: hardened steel
Cylinder jacket: turned dural (anodised mauve)
Piston: cast iron
Contra piston: hardened steel
Connecting rod: turned dural
Crankshaft: hardened steel (stress relieved after heat treatment)
Bearings: plain with single ball race at rear
Propeller driver: turned dural
Spinner nut: dural, anodised mauve
Crankcase back cover: turned dural

Manufacturers:
Johannes Graupner, Kirchheim-Teck, W. Germany

British Agents:
Ripmax Ltd., 80 Highgate Road, London, N.W.5.
British price: £5/7/6



PROPELLER—R.P.M. FIGURES

Propeller	*r.p.m.*
9 × 4 (Trucut)	10,400
8 × 4 (Trucut)	12,300
7 × 4 (Trucut)	14,600
9 × 4 (K-K nylon)	11,000
8 × 4 (K-K nylon)	12,500
7 × 4 (K-K nylon)	14,400
7 × 6 (Top Flite nylon)	12,800
8 × 4 (Top Flite nylon)	13,000
9 × 4 (Top Flite nylon)	10,400
9 × 6 (Top Flite nylon)	8,000
8 × 4 (Stant)	11,400

MOKI M-3 GLOW 5·96 c.c.

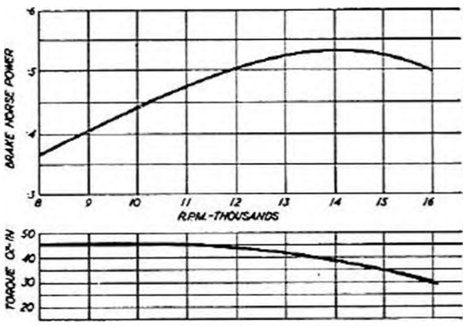
Hungarian engine not available in U.K.

Specification

Displacement: 5·94 c.c. (·36 cu. in.)
Bore: ·7874 in. (20 mm.)
Stroke: ·748 in. (19 mm.)
Weight: $7\frac{5}{8}$ ounces
Max. Power: ·53 B.H.P. at 13,800 r.p.m.
Max. torque: 45 ounce-inches at 10,000 r.p.m.
Power rating: ·089 B.H.P. per c.c.
Power/weight ratio: ·067 B.H.P. per ounce

Material Specification

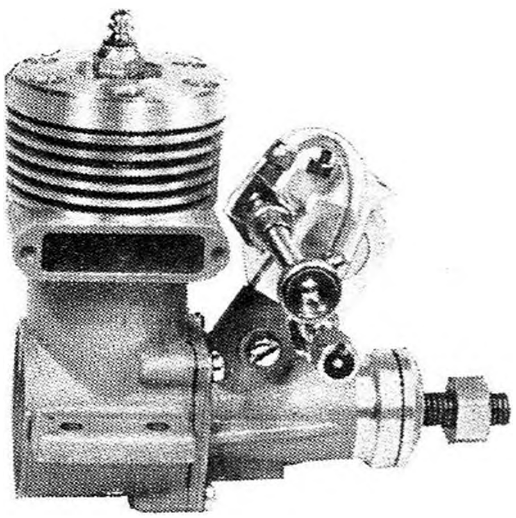
Crankcase: light alloy die-casting
Cylinder: mild steel (integral fins)
Head: light alloy die-casting
Piston: cast iron
Connecting rod: dural
Crankcase back cover: dural
Prop. driver: dural
Spraybar: brass



PROPELLER—R.P.M. FIGURES

Propeller	*r.p.m.*
9 × 6 (K-K nylon)	11,600
9 × 4 (K-K nylon)	15,000
9 × 7 (K-K nylon)	11,000
10 × 6 (Frog nylon)	11,200
9 × 6 (Frog nylon)	13,100
8 × 6 (Frog nylon)	13,500
10 × 6 (Top Flite nylon)	10,600
9 × 6 (Top Flite nylon)	12,100
11 × 4 (Top Flite nylon)	10,500

ENYA 45 R/C GLOW 7·36 c.c.

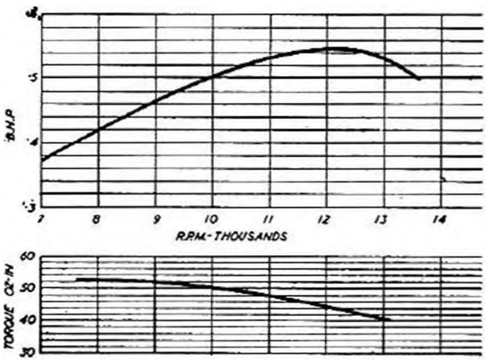


Specification

Displacement: 7·36 c.c. (·449 cu. in.)
Bore: ·874 in.
Stroke: ·748 in.
Weight: 10 ounces
Max. power: ·55 B.H.P. at 12,400 r.p.m.
Max. torque: 52·5 ounce-inches at 7,800 r.p.m.
Power rating: ·075 B.H.P. per c.c.
Power/weight ratio: ·056 B.H.P. per ounce

Material Specification

Cylinder/crankcase unit: pressure die-casting in light alloy, sand-blast finish
Cylinder liner: mild steel
Piston: cast iron
Con. rod: light alloy forging
Crankshaft: hardened steel
Main bearing: plain (bronze bush)
Front bearing unit: pressure die-casting in light alloy
Cylinder head: plain type, machined from dural
Throttle body: machined from dural
Barrel valve: brass

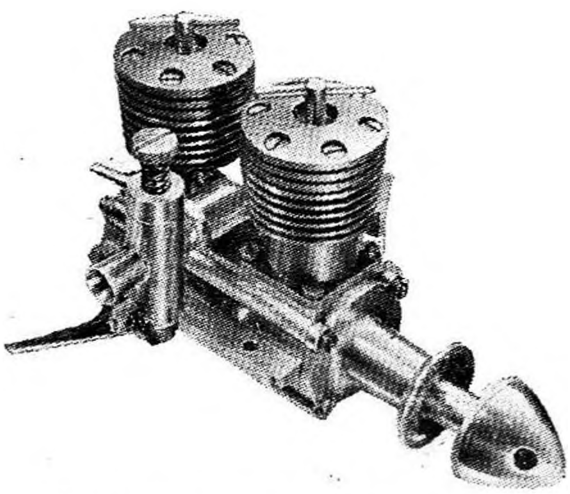


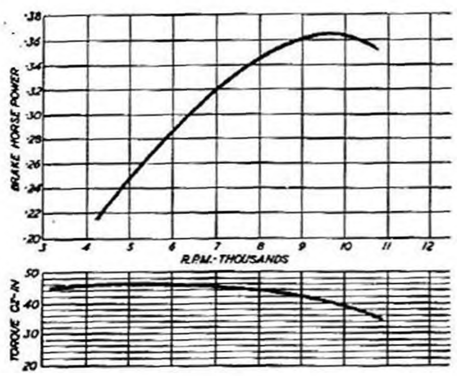
PROPELLER—R.P.M. FIGURES

Propeller	*r.p.m.*
10 × 6 (Top Flite nylon)	10,700
11 × 4 (Top Flite nylon)	11,000
12 × 6 (Tornado nylon)	9,000
12 × 5 (Tornado nylon)	9,900
12 × 4 (Tornado nylon)	10,500
12 × 4 (K-K nylon)	11,000

Fuel: non-nitrated R/C glow fuel (25 per cent castor 75 per cent methanol, plus additives)

TAPLIN TWIN Mk II 8 c.c.





Specification

Displacement: 8 c.c. (·488 cu. in.)
Bore: ·705 in.
Stroke: ·625 in.
Weight: 17½ ounces
Max. power: ·363 B.H.P. at 9,450 r.p.m.
Max torque: 46 ounce-inches at 5,000 r.p.m.
Power rating: ·045 B.H.P. per c.c.
Power/weight ratio: ·021 B.H.P. per ounce

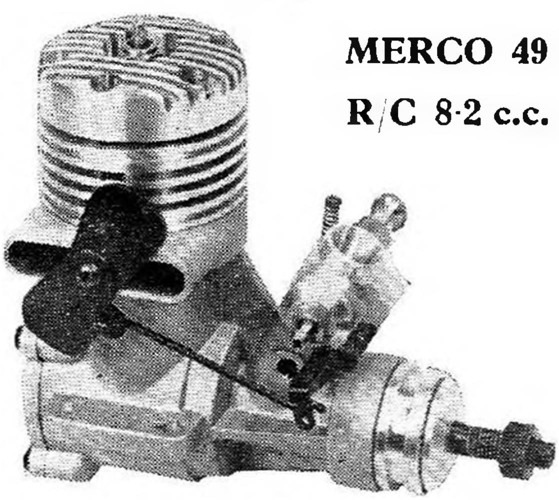
Material Specification

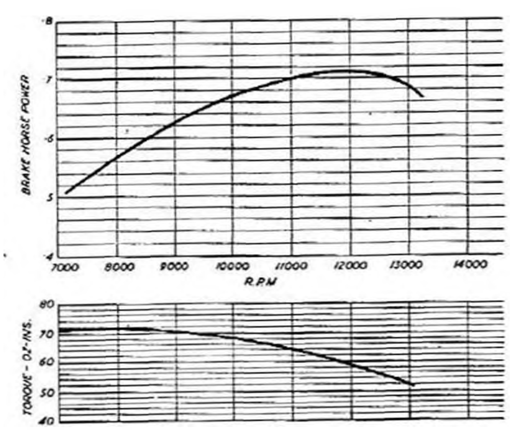
Crankcase: light alloy gravity die-casting
Cylinder: high tensile steel, hard chrome plated bore
Pistons: Meehanite
Contra pistons: Meehanite
Connecting rods: light alloy forgings
Crankshaft: main—nickel plated steel; intermediate—nickel plated steel
Main bearings: front (main shaft) roller race rear (main shaft) ball race
Intermediate shaft bearings: two ball races
Front bearing housing: light alloy die-casting
Crankcase back cover: light alloy die-casting
Cylinder jackets: dural, anodised red
Heads: dural, anodised red
Carburettor: gravity die-casting with turned light alloy components
Spraybar: brass
Propeller driver: dural, anodised red
Spinner: dural, anodised red

PROPELLER—R.P.M. FIGURES

Propeller	*r.p.m.*
14 × 6 (Trucut)	5,800
13 × 8 (Trucut)	6,100
13 × 6 (Trucut)	6,800
12 × 6 (Trucut)	7,400
12 × 4 (Trucut)	9,000

MERCO 49 R/C 8·2 c.c.





PROPELLER—R.P.M. FIGURES

Propeller	*r.p.m.*
12 × 6 (Tornado nylon)	10,200
12 × 5 (Tornado nylon)	11,000
12 × 4 (Tornado nylon)	11,750
11 × 6 (Tornado nylon)	11,500
11 × 4 (Top Flite nylon)	12,300
10 × 6 (Top Flite nylon)	12,500
10 × 6 (Frog nylon)	12,700

Fuel: Mercury No. 5
Recommended propellers: R/C 12 × 6 or 11 × 6; Free flight 12 × 4 or 13 × 4; Control line 12 × 5 or 11 × 6

Specification

Displacement: 8·2 c.c. (·49 cu. in.)
Bore: ·880 in.
Stroke: ·805 in.
Bore/stroke ratio: 1·09
Bare weight: 13 ounces
Max. power: ·72 B.H.P. at 12,000 r.p.m.
Max. torque: 72 ounce-inches at 8,000 r.p.m.
Power rating: ·088 B.H.P. per c.c.
Power/weight ratio: ·0555 B.H.P. per ounce

Material Specification

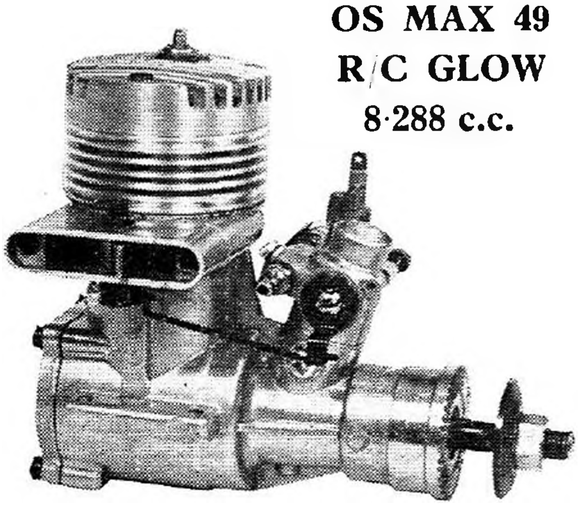
Crankcase: pressure die-casting in L.33 light alloy sand blast finish
Crankshaft: EN. 1A steel, case hardened

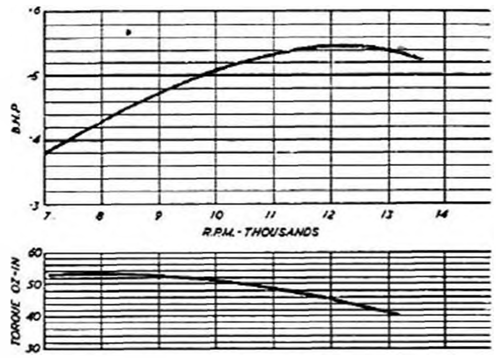
Liner: EN.1A steel, case-hardened, ground and honed to finish
Piston: low expansion light alloy; two cast iron rings
Connecting rod: RR.56 light alloy forging
Cylinder jacket: turned dural
Head: turned dural
Crankcase back cover: pressure die-casting in L.33 light alloy, sand blast finish
Gudgeon pin: EN.1A steel, hardened and ground; fitted aluminium end pads
Main bearings: ½ in. ball race (rear) and 8 mm. ball race (front)
Cylinder head: dural turning, central plug position, contoured combustion chamber
Carburettor unit: turned dural body and barrel valve; brass spraybar and thimble
Prop. driver: turned dural, split steel collet fitting
Exhaust baffle, throttle arm, linkage: black-finished steel

Manufacturers:

D. J. Allen Engineering Ltd., 30 Angel Factory Colony, Edmonton, N.18
Price: £11/19/8 including Purchase Tax

OS MAX 49 R/C GLOW 8·288 c.c.





Specification

Displacement: 8·288 c.c. (·5055 cu. in.)
Bore: ·897 in.
Stroke: ·800 in.
Bare weight: 10½ ounces
Max. power: ·55 B.H.P. at 12,200 r.p.m.
Max. torque: 53·5 ounce-inches at 8,000 r.p.m.
Power rating: ·0665 B.H.P. per c.c.
Power/weight ratio: ·0485 B.H.P. per ounce

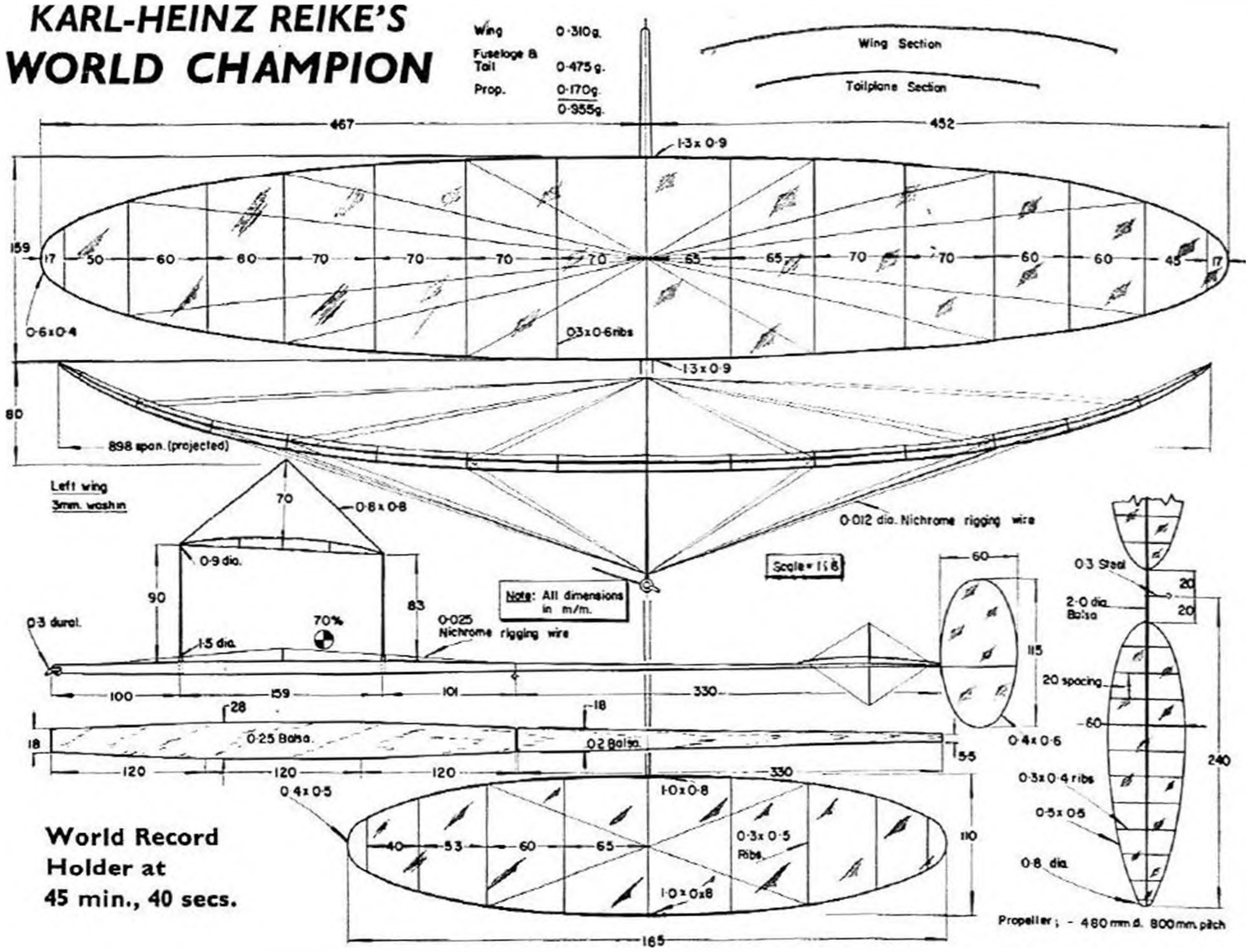
Material Specification

Crankcase/cylinder unit: light alloy pressure die-casting
Cylinder liner: hardened steel
Cylinder jacket: turned dural
Head: light alloy die casting
Piston: cast iron
Connecting rod: machined from light alloy
Crankshaft: hardened steel
Crankcase back cover: light alloy die-casting
Bearings: ball race (rear) and bronze bush (front)
Prop. driver: light alloy die-casting: patented counterbalanced type
Throttle body: pressure die-casting in light alloy
Barrel throttle: brass

PROPELLER—R.P.M. FIGURES

Propeller	*r.p.m.*
10 × 6 (Top Flite nylon)	10,900
11 × 4 (Top Flite nylon)	11,000
12 × 6 (Tornado nylon)	9,200
12 × 5 (Tornado nylon)	10,000
12 × 4 (Tornado nylon)	10,700
12 × 4 (K-K nylon)	11,000

Fuel used: 75:25 methanol:castor plus additives equivalent performance to 5 per cent nitro-methane fuel



WORLD INDOOR CHAMPIONSHIPS
Held at R.A.F. Cardington, Bedfordshire, England
September 22nd—23rd, 1962

RESULTS

No.	Name	Nation	1	2	3	4	5	6	Total
1	Karl-Heinz Rieke	Germany ...	41:39	**43:08**	**45:40**	38:50	39:19	—	88:48
2	Max Hacklinger ...	Germany ...	34:13	37:42	**42:40**	36:34	**43:37**	39:38	86:17
3	Carl Redlin ...	U.S.A. ...	**38:43**	34:23	**45:17**	34:33	27:05	37:40	84:00
4	**Ron Draper** ...	**Gt. Britain**	**40:44**	0:07	24:50	33:55	**35:48**	25:33	**76:32**
5	Klaus Hewel ...	Germany ...	30:03	**35:07**	**33:54**	0:18	25:09	32:03	69:01
6	**Ray Monks** ...	**Gt. Britain**	28:31	**33:03**	21:26	26:51	**34:36**	32:50	**67:39**
7	Esko Hamalainen...	Finland ...	**32:57**	**34:05**	12:28	0:19	—	—	67:02
8	Antal Egri... ...	Hungary ...	**32:25**	**34:01**	30:57	17:58	22:16	25:35	66:26
9	Geza Varszegi ...	Hungary ...	16:36	27:12	**30:49**	23:33	23:30	**28:20**	59:09
10	William Bigge ...	U.S.A. ...	8:17	**30:21**	21:19	25:11	9:21	**28:08**	58:29
11	John Malkin ... (proxy E. Thorpe)	New Zealand	19:25	22:01	**28:03**	24:53	**25:04**	24:09	53:07
12	**Reg Parham** ...	**Gt. Britain**	**26:44**	23:54	**25:46**	11:26	19:37	25:20	**52:30**
13	Dick Kowalski ...	U.S.A. ...	**32:46**	11:39	18:25	**19:33**	11:31	—	52:19
14	Harri Raulio ...	Finland ...	**22:56**	17:53	27:23	1:03	1:03	14:55	50:19
15	Arto Tauria ...	Finland ...	0:06	10:31	**27:04**	0:07	**23:13**	7:29	50:17
16	Zoltan Ocsodi ...	Hungary ...	15:04	0:25	**23:01**	**17:10**	0:10	0:34	40:11

(World Record—subject to confirmation—K-H. Rieke (Germany) **45:40**)

Total of two best flights counts

TEAM RESULTS

1	Germany	244:06	2	**Great Britain**	**196:41**
3	United States	194:48	4	Finland	167:38
5	Hungary	165:46	6	New Zealand	53:07

Tom Brett, U.S.A. (left) and Harry Brooks, G.B., who achieved unprecedented "equal first" at 1962 Championships at Kenley, under the rule that counts "nearly equal" as equal. In the fly-off Tom Brett became the trophy holder and specific champion.

WORLD RADIO CONTROL CHAMPIONSHIPS

Held at R.A.F. Kenley, Surrey, England

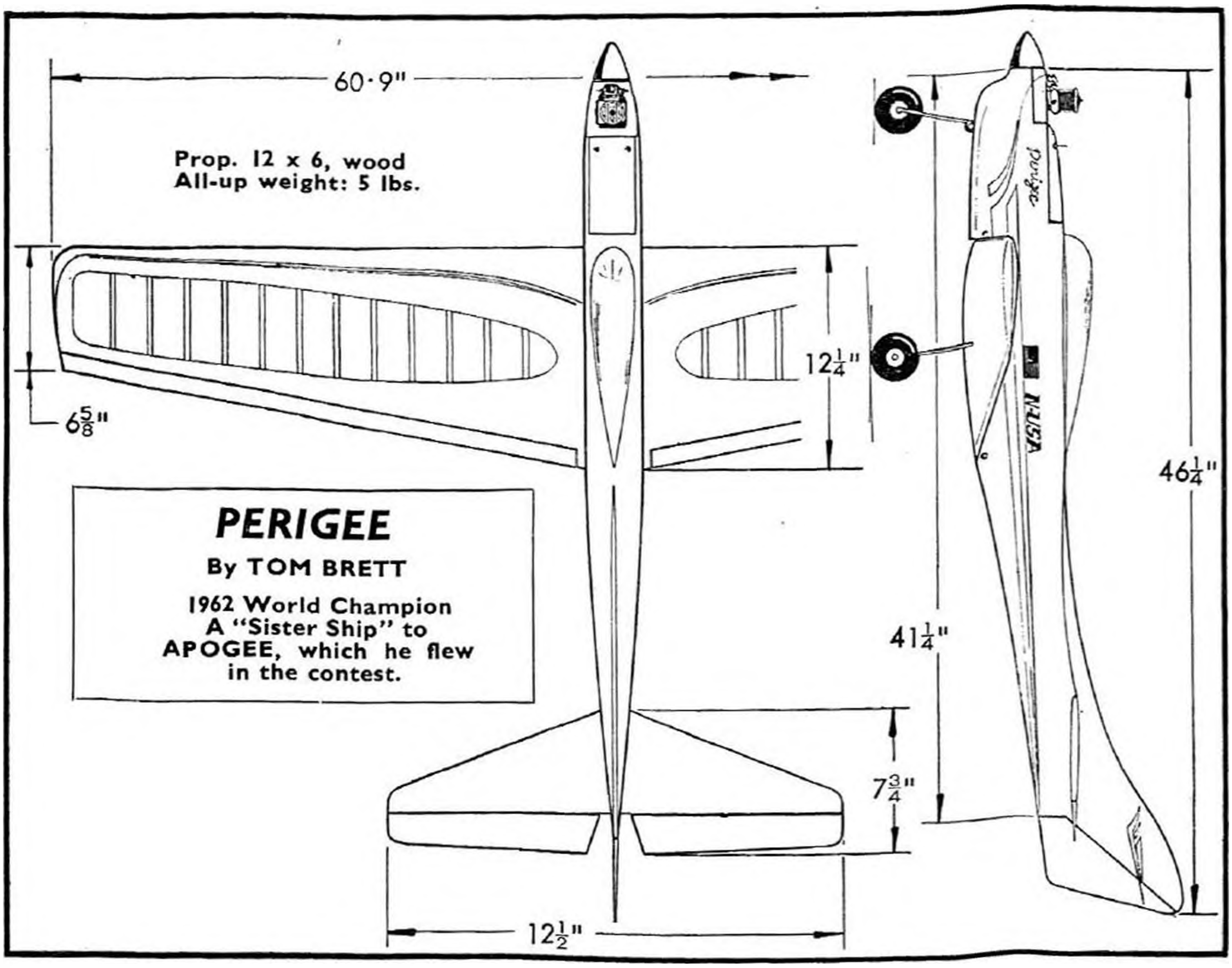
August 17th—19th, 1962

INDIVIDUAL PLACINGS

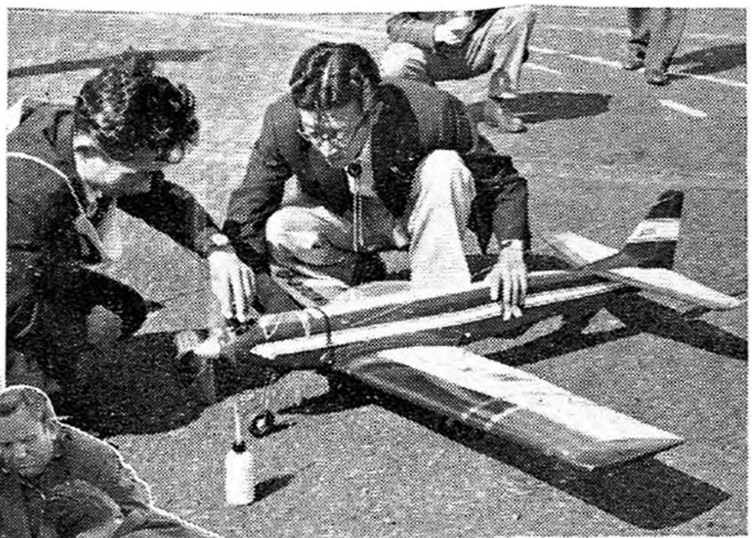
				Score	*Engine*	*Radio*
1	T. Brett	U.S.A.	1396 + 1537	2933	K & B 45	Orbit 10 (Superhet)
2	**H. Brooks**	**G.B.**	1423·6 + 1507·6	2931·3	Rogers-McCoy 60	F & M Hercules/Midas
3	**C. Olsen**	**G.B.**	1280·6 + 1469	2749·6	Merco 49	R.E.P. Dekatone
4	**F. Van den Bergh**	**G.B.**	1177·6 + 1451	2628·6	Merco 49	Orbit 10 (Superhet)
5	D. Brown	U.S.A.	1304·3 + 1281·6	2585·9	Merco 49	O/D Quadruplex
6	F. Bosch	Germany	1264·3 + 1292	2556·3	Super Tigre 51	OMU 10
7	J. M. Malherbe	S. Africa	1108 + 1185	2293	Veco 45	Orbit 10 (Superhet)
8	G. Samaan	Germany	1126 + 1027	2198	Merco 49	Bellaphon/Polyton
9	W. Robinson	U.S.A.	892·6 + 1243	2135·6	K & B 45	Orbit 10 (Superhet)
10	C. Teuwen	Belgium	1010·3 + 1024·3	2034·6	K & B 45	Orbit 10 (Superhet)
11	H. Gast	Germany	967·6 + 1027	1994·6	K & B 45	Bellaphon/Polyton
12	A. Bellocchio	Italy	1028 + 955	1983	K & B 45	Orbit 10 (Superhet)
13	E. Corghi	Italy	984·3 + 935	1919·3	Super Tigre 56	Controlaire 10 (Superhet)
14	M. Kato	Japan	1006 + 904·6	1910·6	K & B 45	Orbit 10 (Superhet)
15	P. Eliasson	Sweden	889 + 1016·3	1905·3	Merco 49	Kraft 10 (Superhet)
16	A. Sauthier	Switzerland	840·6 + 1047	1887·6	K & B 45	F & M Hercules/Midas
17	P. Louis	Belgium	847 + 935	1782	K & B 45	Orbit 10 (Superhet)
18	R. Dilot	Sweden	765·6 + 811·6	1577·2	K & B 45	Bramco 10
19	A. Matthey	Switzerland	678·3 + 767	1445·3	OS 49	F & M Hercules/Midas
20	J. DeDobbeleer	Belgium	778·3 + 634·6	1412·9	K & B 45	Orbit 10 (Superhet)
21	A. Bickel	Switzerland	615·3 + 745·6	1360·9	K & B 45	Nievergelt
22	H. Oki	Japan	405·6 + 876·3	1281·9	Enya 45	Kraft 10/Chimitron
23	F. Plessier	France	652·3 + 601·3	1253·6	K & B 45	Bellaphon/Polyton
24	J. Levenstam	Sweden	627 + 600	1227	Merco 49	R.E.P. Octone
25	V. Miliani	Italy	585 + 575·3	1160·3	Super Tigre 56	Alletti 10 relayless
26	F. Martens	Holland	592 + 536·6	1128·6	K & B 45	Self-made Orbit/R.E.P.
27	P. Marrot	France	563·6 + 508·3	1071·9	Super Tigre 56	Self-made O/D
28	A. A. Arler	U.S.S.R.	402·3 + 189·6	591·9	Webra 7·6 twin	Rum-1 (7)
29	P. Velichkovsky	U.S.S.R.	264·3 + 274	538·3	Super Tigre 29	Self-made 10
30	W. van de Hoek	Holland	20 + 195·3	215·3	Veco 29	Self-made/Orbit
31	W. de Mulder	Holland	58·3 + 91·6	149·9	K & B 45	Self-made/Orbit
32	P. Stephansen	Norway	46·6 + —	46·6	Enya 29	Self-made O/D

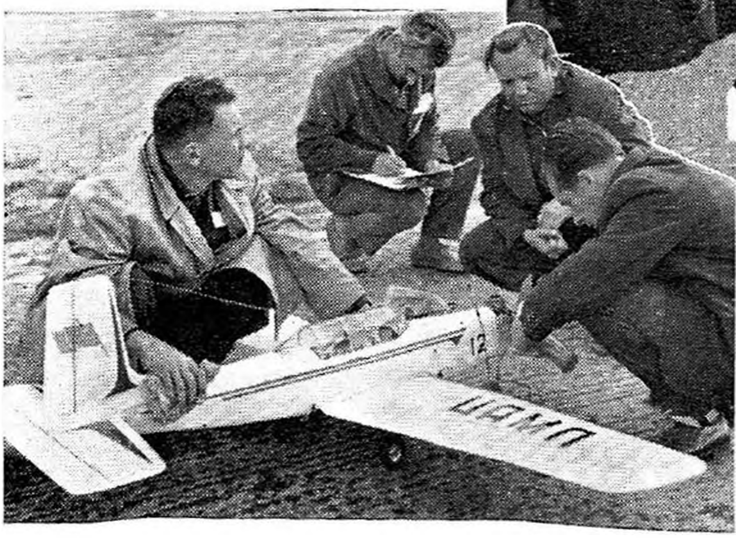
TEAM PLACINGS

1	**Great Britain**	8309·4
2	U.S.A.	7654·5
3	Germany	6748·9
4	Belgium	5229·5
5	Italy	5062·6
6	Sweden	4709·5
7	Switzerland	4693·8
8	Japan	3192·5
9	France	2325·5
10	South Africa	2293
11	Holland	1493·8
12	U.S.S.R.	1130·2
13	Norway	46·6

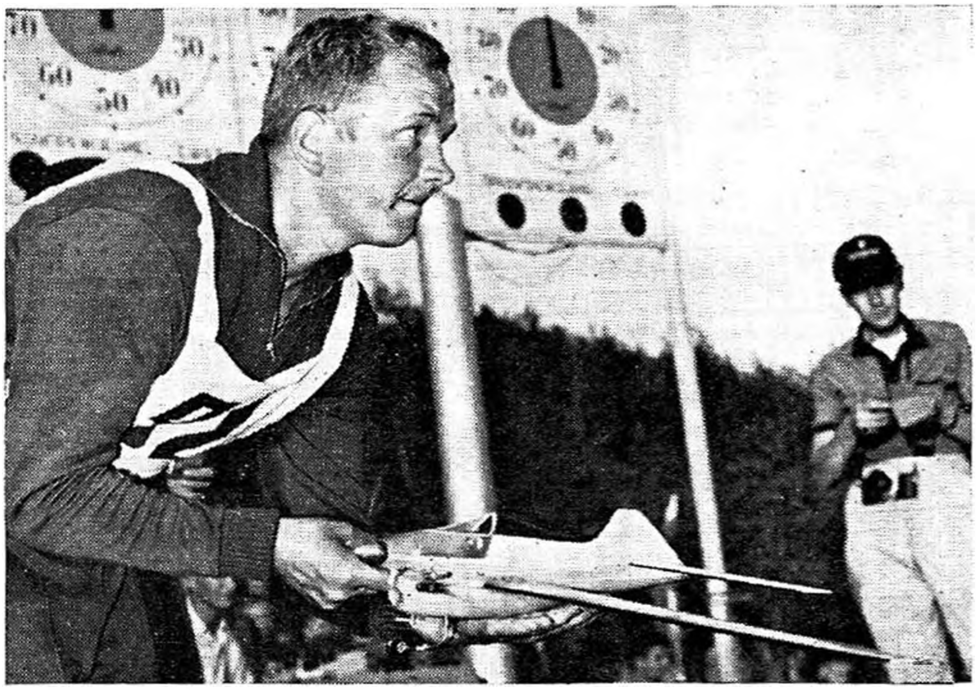


M. Kato and H. Oki (right), entrants from Japan, who showed how to take part in a world championship and really enjoy it! Whilst not amongst the top ten were by no means in the tail and were probably amongst the most popular competing visitors.





A. A. Arler and P. Velichkovsky from U.S.S.R. struggled hard and painstakingly to make the grade—an impossible task where individual skill was not enough with the obsolete—though beautifully prepared—equipment in use. We do hope 1963 will see them at their best with this year's circuits!



Chkourski, U.S.S.R., keeps a sharp eye on his pilot Sirotkin, as he holds the controversial winning team racer.

WORLD CONTROL LINE CHAMPIONSHIPS

Held at Kiev, U.S.S.R., September 1st—7th, 1962

TEAM RACING

1	Sirotkin—Chkourski	U.S.S.R.	—	**4:38**	4:48	S/Tigre G20D (Mod.)
2	Gelman—Radtchenko	U.S.S.R.	4:57	**4:41**	4:52	S/Tigre G20D (Mod.)
3	Purgai—Katona	Hungary	**4:40**	—	—	Moki TR6
4	Bjork—Rosenlund	Sweden	**4:44**	4:57	—	Oliver Tiger
5	Uhl—Ilg	W. Germany	5:22	**4:48**	—	Oliver Tiger
6	Rosler—Malik	W. Germany	5:16	**4:51**	—	Oliver Tiger
7	Sundell—Sundell	Finland	5:02	**4:55**	—	Oliver Tiger
8	**Davy—Long**	**Great Britain**	**5:06**	—	—	ETA 15D
9	Lerf—Frigyes	Hungary	**5:08**	6:00	—	Moki TR6
10	Grondal—Lecuyer	Belgium	—	**5:08**	—	Oliver Tiger
11	Trnka—Drazek	Czechoslovakia	5:15	**5:09**	—	MVVS TR
12	Richter—Turk	Austria	—	**5:14**	—	Bugl
13	Gurtler—Klemm	Czechoslovakia	**5:15**	6:05	—	MVVS TR
14	Schluchter—Fromm	W. Germany	**6:30**	**5:15**	—	Oliver Tiger
15	Berglund—Kjellberg	Sweden	**5:16**	—	—	Oliver Tiger
16	Babitchev—Krasnoroutski	U.S.S.R.	—	**5:17**	—	Rythm
17	**Smith—Edmonds**	**Great Britain**	**5:20**	5:28	—	Oliver Tiger
18	Vassilev—Vlaitchev	Bulgaria	**5:21**	6:01	—	—
19	Bugl—Kirchert	Austria	**5:30**	5:50	—	Bugl
20	Alseby—Buornwall	Sweden	6:48	**5:35**	—	ETA 15 D
21	Stockton—Jehlik	U.S.A.	**5:38**	—	—	ETA 15 D
22	Czifra—Viszmeg	Hungary	5:54	**5:47**	—	Moki TR-6
23	**Adams—Lucas**	**Great Britain**	—	**5:49**	—	CCS
24	Edwards, C.—Edwards, P.	U.S.A.	**5:54**	6:35	—	Oliver Tiger
25	Rosinski—Sulis	Poland	8:10	**5:55**	—	MVVS TR
26	Zube—Willberg	E. Germany	—	**6:04**	—	MVVS TR
27	Votypka—Komurka	Czechoslovakia	—	**6:24**	—	MVVS TR
28	Tomaszewski—Koslowski	Poland	—	6:25	—	MVVS TR
30	Wilke—Wolff	E. Germany	**6:54**	8:14	—	ETA 15D
31	Saukkonen—Saukkonen	Finland	**7:06**	—	—	Oliver Tiger
32	Silex—Georgescu	Rumania	—	**7:44**	—	Rivers 2.5
33	Topalov—Petrov	Bulgaria	—	**7:59**	—	—
34	Csomo—Purice	Rumania	8:21	**8:10**	—	Rivers 2.5
35	Nikolov—Rachkov	Bulgaria	—	**8:45**	—	—

AEROBATICS

(3rd flight qualifiers) 42 *entries*

			FAI	*FAI*	*AMA*	*Total*	
1	Grondal...	Belgium ...	930	**983**	944	1927	Fox 35
2	Kari ...	Finland ...	846	**923**	965	1888	Veco 35
3	Kondratenko	U.S.S.R.	**895**	887	992	1887	Kometa 35
4	Bartos ...	Czechoslovakia ...	883	**945**	930	1875	MVVS 5.6
5	Sirotkin...	U.S.S.R....	949	**1009**	862	1871	MVVS 5.6
6	Egervary	Hungary ...	926	**947**	911	1858	Veco 35
7	Simonov	U.S.S.R....	869	**899**	951	1850	Own design
8	Silhavy ...	U.S.A. ...	892	**945**	904	1849	Fox 35
9	Seeger ...	W. Germany	853	**922**	925	1847	Enya 35
10	Gabris ...	Czechoslovakia ...	896	**922**	889	1811	MVVS 5.6
11	**Warburton**	**Great Britain** ...	853	**870**	**937**	1807	Merco 35
12	Southwick	U.S.A. ...	857	**913**	875	1788	McCoy 35
13	**Brown** ...	**Great Britain** ...	878	**906**	873	1779	Merco 35
14	Masznyik	Hungary ...	**901**	865	878	1779	Moki M-2
15	Williams	U.S.A. ...	846	**868**	896	1764	Fox 35
16	**Higgs** ...	**Great Britain** ...	724	**885**	875	1760	Merco 35
17	Herber ...	Czechoslovakia ...	806	**874**	850	1724	MVVS 5.6
18	Bjornwall	Sweden ...	800	**880**	831	1711	Fox 35
19	Kaminski	W. Germany	813	**861**	844	1705	Fox 35
20	Sundell ...	Finland ...	803	**865**	839	1704	Merco 35
21	Kroh ...	W. Germany	807	**888**	800	1688	Fox 35
22	Macon ...	Belgium ...	812	**842**	844	1686	Fox 35

TEAM PLACINGS

(Team Race)

1	U.S.S.R. ...	14:36
2	W. Germany	14:55
3	Hungary ...	15:35
3	Sweden ...	15:35
5	**Great Britain**	16:15
6	Czechoslovakia	16:48
7	Poland ...	18:18
8	Bulgaria ...	23:05

(Aerobatics)

1	U.S.S.R. ...	5608
2	Czechoslovakia	5410
3	U.S.A. ...	5401
4	**Great Britain**	5346
5	W. Germany	5240
6	Hungary ...	4451
7	Finland ...	4434
8	Belgium ...	4340
9	Sweden ...	3066
10	Austria ...	2279
11	E. Germany...	2241
12	Rumania ...	1812
13	Poland ...	1442
14	Bulgaria ...	503

Louis Grondal, Belgium, with his winning Fox-powered aerobatic model—which has now achieved a double-first, and for the pilot his third visit to the winner's rostrum, all well-deserved successes.

Gyula Krizsma, Hungary, designer and maker of the Moki S-3 which powers his winning speed model. Practice makes perfect, and the Hungarian success on this and other occasions bears witness to the dedicated manner in which they work at their hobby.

TEAM PLACINGS

(**Speed**)

1	Hungary ...	637
2	Italy	630
3	U.S.A. ...	607
4	Czechoslovakia	605
5	U.S.S.R. ...	604
6	**Great Britain**	564
6	W. Germany	564
8	Bulgaria ...	537
9	Poland ...	496
10	Rumania ...	493
11	E. Germany...	463
12	Finland ...	374
13	Sweden ...	368
14	Austria ...	173

SPEED

(*Speed in Kilometres*)

1	Krizsma ...	Hungary ...	211	204	**218**	Moki S-3
2	Ricci	Italy	**214**	213	209	Super Tigre G20
3	Toth	Hungary ...	200	**211**	210	Moki S-3
3	Prati	Italy	—	**211**	209	Super Tigre G20
5	Lauderdale	U.S.A. ...	—	194	**209**	Supre Tigre G20
6	Bathge	Hungary ...	200	205	**208**	Moki S-3
6	Pech	Czechoslovakia	197	—	**208**	MVVS 2.5/58
8	Grandesso	Italy	—	204	**205**	Super Tigre G20
8	Schuette ...	U.S.A. ...	—	**205**	—	K & B 15R
10	Natalenko	U.S.S.R.	200	—	**204**	Own design
10	Tourkine...	U.S.S.R.	**204**	—	195	Own design
12	Gorziza ...	W. Germany	184	194	**203**	S/Tigre Rossi
13	Burda	Czechoslovakia	196	**200**	—	MVVS 2.5/58
14	**Drewell** ...	**Great Britain**	184	192	**198**	CCS
15	Jaaskelainen	Finland ...	**197**	189	195	Super Tigre G20
16	Sladky	Czechoslovakia	194	184	**197**	MVVS 2.5/58
17	Kouznetsov	U.S.S.R.	178	**196**	183	Own design
18	Frohlich ...	W. Germany	175	—	**195**	S/Tigre Rossi
19	Carpenter	U.S.A. ...	**193**	—	—	K & B 15R
20	**Butcher** ...	**Great Britain**	186	188	**192**	CCS
21	Vassilev ...	Bulgaria ...	176	—	**191**	Super Tigre G20
22	Hagberg ...	Sweden ...	—	**187**	176	Super Tigre G20
23	Bjork	Sweden ...	—	**181**	—	MVVS
24	Jaaskelainen	Finland ...	**177**	153	176	Super Tigre G20
25	**Copeman**	**Great Britain**	146	**174**	171	Super Tigre G20
26	Rachkov ...	Bulgaria ...	163	**173**	**169**	Supre Tigre G20
26	Nikolov-Tinex	Bulgaria ...	**173**	168	171	Super Tigre G20
26	Freundt ...	Austria ...	**173**	169	171	Bugl
29	Skotniczny	Poland ...	163	**171**	—	MVVS
29	Purice	Rumania ...	—	156	**171**	Super Tigre G20
31	Polster	E. Germany	—	165	**169**	Own design
32	Folek	Poland ...	—	162	**167**	MVVS
33	Ziegler ...	W. Germany	163	—	**166**	MVVS
34	Purice	Rumania ...	—	**162**	—	Super Tigre G20
35	Racosi	Rumania ...	—	**160**	160	Super Tigre G20
36	Cimoszko	Poland ...	124	143	**158**	MVVS
37	Wolff	E. Germany	—	**150**	150	MVVS
38	Meinhardt	E. Germany	140	**144**	136	Vltavan

WORLD AND INTERNATIONAL RECORDS

As at 1st January, 1963

ABSOLUTE WORLD RECORDS

Duration	Barber, Ian B.	New Zealand	9/10/1960	9 hr. 4 min.
Distance	Boricevitch, E.	U.S.S.R.	14/8/1952	378.756 km.
Height	Lioubouchkine, G.	U.S.S.R.	13/8/1947	4,152 m.
Speed	Kouznetsov, A.	U.S.S.R.	30/9/1962	316 km./hr.

CLASS F-1-A RUBBER DRIVEN

No.					
1	*Duration*	Kiraly, M.	Hungary	30/8/1951	1 hr. 27 min. 17 sc.
2	*Distance*	Tchiglintsev, G.	U.S.S.R.	1/7/1962	437,189 km.
3	*Height*	Poich, R.	Hungary	31/8/1948	1,442 m.
4	*Speed*	Davidov, V.	U.S.S.R.	11/7/1940	107.08 km./hr.

CLASS F-1-B POWER DRIVEN

5	*Duration*	Koulakovsky, I.	U.S.S.R.	6/8/1952	6 hr. 1 min.
6	*Distance*	Boricevitch, E.	U.S.S.R.	14/8/1952	378.756 km.
7	*Height*	Lioubouchkine, G.	U.S.S.R.	13/8/1947	4,152 m.
8	*Speed*	Stiles, E.	U.S.A.	20/7/1949	129.768 km./hr.

CLASS F-2-A HELICOPTERS—RUBBER DRIVEN

9	*Duration*	Evergary, G.	Hungary	13/6/1950	7 min. 43 sec.
10	*Distance*	Pelegi, G.	Italy	27/7/1958	605.10 m.
11	*Height*	Pelegi, G.	Italy	21/7/1958	205.12 m.
12	*Speed*	*No record established*			

CLASS F-2-B HELICOPTERS—POWER DRIVEN

13	*Duration*	Naidovski, V.	U.S.S.R.	2/8/1962	1 hr. 30 min. 49 sc.
14	*Distance*	Slepkov, V.	U.S.S.R.	27/9/1962	40.364 km.
15	*Height*	Borissov, B.	U.S.S.R.	18/8/1959	2,128 m.
16	*Speed*	*No record established*			

CLASS F-3 GLIDERS

17	*Duration*	Milutinovic, M.	Jugoslavia	15/5/1960	4 hr. 58 min. 10 sc.
18	*Distance*	Szomolanyi, F.	Hungary	23/7/1951	139.8 km.
19	*Height*	Benedek, G.	Hungary	23/5/1948	2,364 m.

CLASS F-1-B RADIO CONTROLLED—POWER

20	*Duration*	Malikov, N.	U.S.S.R.	3/8/1962	6 hr. 13 min. 52 sc.
21	*Distance*	Malikov, N.	U.S.S.R.	8/6/1962	182.123 km.
22	*Height*	Malikov, N.	U.S.S.R.	26/7/1961	2,250 m.
23	*Speed*	Dunham, R. & Bentley, J. Sr.	U.S.A.	19/11/1960	198.904 km./hr.
31	*Distance (Closed circuit)*	Malikov, N.	U.S.S.R.	31/5/1962	100 km.

CLASS F-3 RADIO CONTROLLED GLIDERS

24	*Duration*	Barber, Ian B.	New Zealand	9/10/1960	9 hr. 4 min.
25	*Distance*	Malikov, N.	U.S.S.R.	3/8/1962	11.503 km.
26	*Height*	Drojjine, N.	U.S.S.R.	6/6/1959	603 m.

CONTROL LINE SPEED

27	*Category I* 0-2.5 c.c.	Zbynek-Pech	Czechoslovakia	11/9/1960	246.07 km./hr.
28	*Category II* 2.5-5 c.c.	Shelton, Boyd & Harris, B. C.	U.S.A.	23/7/1958	253 km./hr.
29	*Category III* 5-10 c.c.	Kouznetsov, A.	U.S.S.R.	30/9/1962	316 km./hr.
30	*Category Jet*	Ivannikov, I.	U.S.S.R.	5/9/1958	301 km./hr.

MODEL SPECIFICATION FOR WORLD CHAMPIONSHIP FORMULA

Models with Rubber Motors

Class F.1

Models must conform to the "Wakefield" formula:

Total Area: 17-19 sq. decimetres.

Total Weight: 230 grammes minimum.

Total weight of the rubber motor (lubricated): 50 grammes maximum.

Gliders

Class F.3

Models must conform to the "Nordic" formula:

Total Area: 32-34 sq. decimetres.

Total Weight: 410 grammes minimum.

Length of Launching Cable: 50 metres maximum.

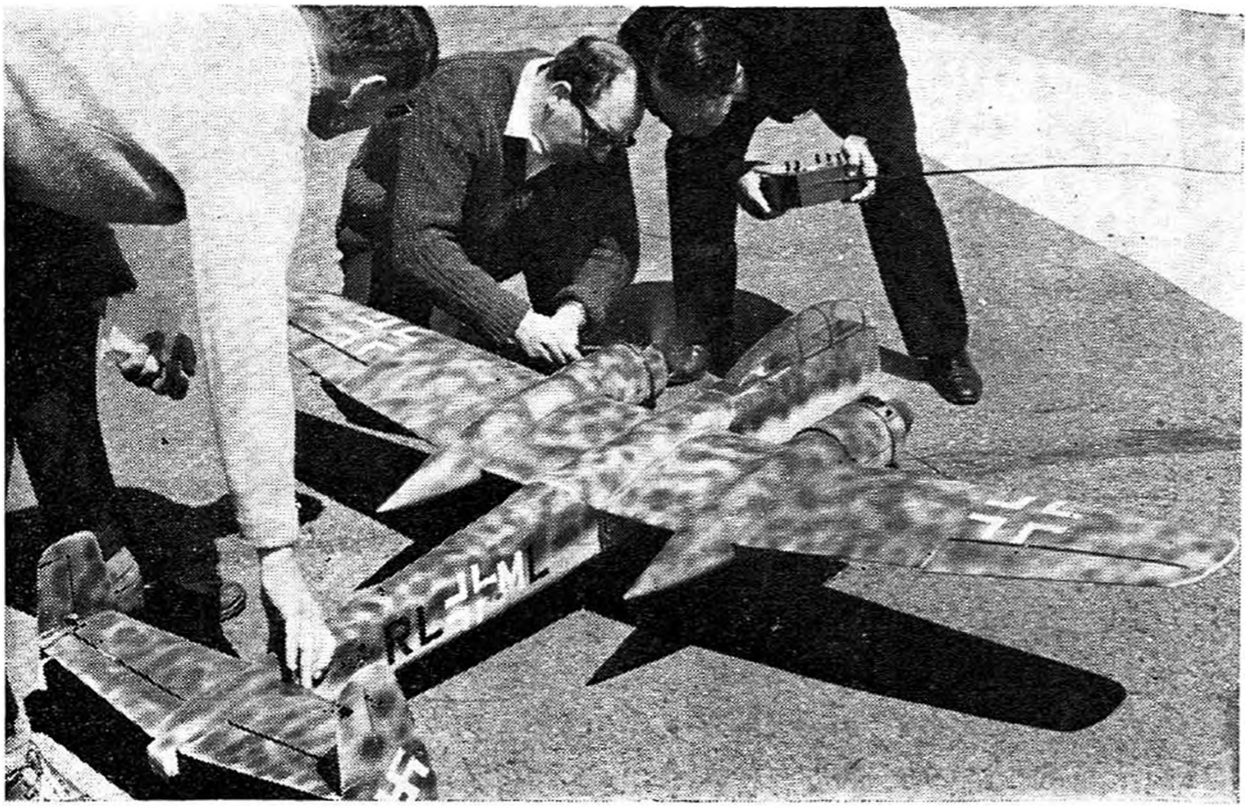
Models with Mechanical Motors

Class F.1

Motor: 2.5 c.c. maximum capacity.

Load per c.c.: 300 grammes.

Minimum Area Loading: 20 gr/dm².



Combination of experience. Frank van den Bergh, Harry Brooks and David Walker check the latter's Heinkel He.219 prior to flying at the 1963 Nationals. David built several multi engined scale radio control models during 1963. Heinkel powered by two K & B 45 engines and used F & M 10 radio

CONTEST RESULTS

Results of S.M.A.E. Contests for balance of 1962 season are included in this report to complete records. Those 1963 events which have been decided before going to press are also included and will be completed in next year's Aeromodeller Annual.

NORTHERN HEIGHTS GALA—July 1st, 1962—R.A.F. Halton, Bucks

"Flight" Cup—Open Glider

1 B. Lavender	Brentwood	6:00+3:01
2 A. Wisher	Croydon	6:00+2:36
3 W. Pateman	Northampton	6:00+1:13

"Fairey" Cup—Open Rubber

1 J. O'Donnell	Whitefield	6:00+7:44
2 G. L. Roberts	Lincoln	6:00+5:48
3 R. Monks	Birmingham	6:00+4:46

The Queen Elizabeth Cup—Wakefields

1 N. Elliott	Croydon	9:00
2 G. L. Roberts	Lincoln	8:57
3 A. R. Wells	Hornchurch	8:17

The "Thurston" Helicopter Trophy

1 R. Monks	Birmingham	440 pts.
2 R. Lowe	St. Albans	196 pts.
3 R. Dudley	Weston	184 pts.

"½A" Competition

1 J. O'Donnell	Whitefield	6:00+4:22
2 D. Harper	Glevum	6:00+1:22
3 G. French	Essex	5:51

The "De Havilland" Trophy—Open Power

1 J. West	Brighton	6:00+4:50
2 B. Eggleton	Baildon	6:00+3:53
3 M. Brown	Reading	6:00+3:25

"R.A.F. Flying Review" Cup—R/C Spot Landing of Nominated Time

1 E. Faulkner	W. Middx.	12:0 Pen. Pts.
2 T. M. Airey	W. Middx.	32:8 Pen. Pts.
3 D. W. McQue	Buccaneers	34:5 Pen. Pts.

Kell Combat Cup

1 P. Heeley Weston 2 B. Bumstead Kombo

RUSH TROPHY GALA—August 12th, 1962—Thornaby Aerodrome, Thornaby-on-Tees

Power

1 M. Proctor	Baildon	9:00
2 J. Bailey	Whitefield	8:23
3 J. Parrott	Whitefield	7:55

Glider

1 Spencer	Ashton	7:30
2 P. Wyatt	Ashton	7:25
3 P. Liddell	English Electric	7:03

Rubber

1 T. Stoker	Baildon	9:00+4:09
2 C. Rennie	Tynemouth	9:00+3:55
3 H. Tubbs	Baildon	9:00+3:45
4 D. Morley	Lincoln	9:00
5 P. Montgomery	Kirkcaldy	9:00
6 R. Pollard	Tynemouth	9:00

½A Team Race—(13 *entries*)

1 Hughes	Wharfedale	10:38.4
2 Bellamy	Wharfedale	11:07.3
3 Whitewood	Stanley	11:13

F.A.I. Team Race—(16 *entries*)

1 Davy/Long	Wharfedale	5:22.3
2 Drury	Rotherham	5:36
3 Kirton	R.A.F.M.A.A.	5:59

Class B—(10 *entries*)

1 Horton	Wharfedale	7:21.2
2 Northage	Wharfedale	9:04
3 Yates	Leigh	10:40

Combat—(16 *entries*)

1 Lee	Wharfedale
2 Bell	Ashington

Rush Trophy Winner: Tom Stoker—Baildon.

Topping the 1963 Wakefield Team Trials at R.A.F. Barkston Heath was Bruce Rowe from St. Albans, in action at moment of release for winning flight.

CLWD SLOPE SOARING—July 15th, 1962—Clwd Hills

Gosling Trophy

	J. O'Donnell	(Whitefield)	6:13
A/2	J. O'Donnell	(Whitefield)	6:13
Open	J. Conroy	(Wallasey)	6:11
Junior	R. Howard	(Chester)	5:15
R/C	J. Fellows	(Kidderminster)	37 pts.

SCOTTISH GALA — August 5th, 1962 — R.N.A.S. Abbotsinch, Paisley, Glasgow.

Clyde Model Dockyard Trophy

Open Rubber (18 *entries—6 flew*)

1 J. O'Donnell	Whitefield	9:00
2 H. Tubbs	Baildon	7:54
3 J. Pool	Halifax	7:08
4 J. Hannay	Wallasey	3:00

K.L.M. Trophy

Open Power

(23 *entrie.—7 flew*)

1 U. Wannop	C.M.	7:43
2 W. Douglas	Glasgow M.A.C.	6:21
3 M. Doyle	Belfast	5:53
4 J. O'Donnell	Whitefield	4:22

Open Glider

(24 *entrie—11 flew*)

1 B. Picken	Wigan	5:22
2 E. Black	Glasgow S.A.	4:41
3 P. Kazer	York	4:36
4 J. O'Donnell	Whitefield	4:32

Taplin Trophy

Radio Control (8 *entries—3 flew*)

1 Clark	Glasgow Barnstormers	230 pts.
2 Taylor	Glasgow S.A.	180 pts.
3 Halley	Kirkcaldy	150 pts.

F.A.I. Team Race

1 Cunningham	Prestwick
2 A. Wallace	Novocastria

Class B Team Race

1 D. Dugmore	Novocastria
2 D. Gordon	Dumbarton

KEIL TROPHY—Team Power—August 19th, 1962 (*Area Centralised*) 38 *Teams*

1 Surbiton	34:32
2 Brighton (A)	32:05
3 Baildon (A)	31:32
4 Rotherham (A)	30:03
5 Stevanage (A)	29:56
6 St. Albans	29:53

S.M.A.E. CUP—A/2 Glider—August 19th, 1962 92 *entries*

1 J. Abbs (Jr.)	Norwich	14:04
2 R. Monks	Birmingham	13:45
3 T. Toolan	Whitefield	13:37
4 S. R. Bowles	Norwich	13:27
5 L. Moore	Leamington	13:22
6 A. F. Wisher	Croydon	13:19

FARROW SHIELD—Team Rubber—September 19th, 1962 (*Area Centralised*). 8 *Teams flew*

1 Stevenage	25:52
2 St. Albans	14:20
3 Brighton	11:15

Top Junior C. Sherwood. Hornchurch

HALIFAX TROPHY—F.A.I. Power—September 19th, 1962. 16 *entries.*

1 S. Savani	Liverpool	8:29
2 V. Jays	Surbiton	6:50
3 M. Proctor	Baildon	6:12

U/R GLIDER—September 19th, 1962. 34 *entries*

1 J. O'Donnell	Whitefield	7:16
2 A. Wisher	Croydon	7:04
3 D. B. Spencer	Ashton	6:04

OPEN POWER—September 30th, 1962. 18 *entries*

1 S. Marshall	Boston	8:23
2 D. Furbank	Lincoln	6:13
3 M. Proctor	Baildon	4:32

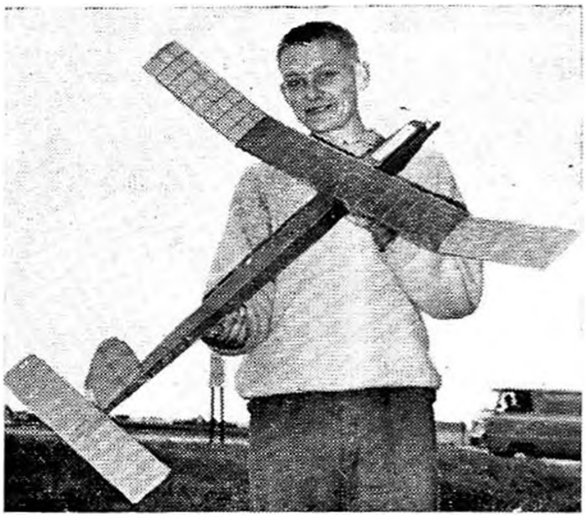
PLUGGE CUP—September 30th, 1962

1 Stevenage	1401.849 Pts.
2 St. Albans	1197.536 „
3 Brighton	1180.572 „

LEINSTER C/L CHAMPIONSHIPS—September 30th, 1962—Santry Stadium.

½A T/R	1st P. Brennan	North Dublin A.M.C.
Combat	1st G. Dickson	Belfast M.F.C.
F.A.I. T/R	1st G. Hand	Dun Laoghaire M.F.C.
(B) T/R	1st V. Corwell	North Dublin A.M.C.

Strange shape of J. McCann's twin engined Canard open ower contest model, did not detract from its effectiveness as a flier at the 1963 Rush Trophy Gala.



Winner of the 1963 Coupe d'Hiver, Franco-British challenge competition was D. Furbank of Lincoln who flew the popular A.P.S. Garter Knight design.

MODEL ENGINEER CUP—Team Glider—September 30th, 1962 (*Area Centralised*). 27 *Teams flew*

1 Norwich	M. Woodhouse	7:36
	B. Halford	7:55
26:16	S. Bowles	6:07
	A. Abbs (Jr.)	4:38
2 Brighton	F. H. Boxall	6:53
	D. Latter	6:44
25:20	K. Winstanley	6:09
	J. West	5:34
3 Stevenage	P. Giggle	7:28
	J. N. Brooks	7:19
25:02	G. W. Dallimer	5:41
	Mrs. M. Giggle	4:34

4 St. Albans 24:40; 5 Anglia 23:24; 6 Canterbury 19:14.

WESTON TROPHY—F.A.I. Rubber—September 30th, 1962. 14 *entries.*

1 N. Elliott	Croydon	13:25
2 H Tubbs	Baildon	12:04
3 J. O. D.	Whitefield	11:35
4 M. Woodhouse	Norwich	11:30
5 T. Stoker	Baildon	10:35
6 M. Bayram	Lincoln	10:02

QUICKSTART TROPHY — ½A Power — September 30th, 1962. 20 *entries*

1 A. G. Young	St Albans	9:00
2 P. Giggle	Stevenage	8:58
3 D. Pepperall	Stevenage	8:10
4 J. Boxall	Portsmouth	7:50
5 M. Wurrows	St. Albans	7:47
6 A. Wisher	Croydon	7:45

WHITE CUP—U/R Power—October 14th, 1962 (*Decentralised*).

1 D. Furbank	Lincoln	9.00 + 6.02
2 G. French	Anglia	9.00 + 5.33
3 W. Daniel	Walsall	9.00 + 5.30

FROG JUNIOR TROPHY—U/R Rubber Glider October 14th, 1962.

1 M. B. Bayram*	Lincoln	9.00 + 5.05
2 I. Penn	Littleover	9.00 + 2.53
3 P. Ball	Littleover	8.25

*Junior Champion, 1962, with gross total of 58 mins. 29 secs.

CROYDON M.A.C. GALA—November 11th, 1962—Chobham.

Rubber (15 *entries*)		
1 J. O'Donnell	Whitefield	6:00
Glider (15 *entries*)		
1 D. Butler	Surbiton	3:37
Power (13 *entries*)		
1 J. West / M. Dilly	Brighton / Croydon	6:00 + 2:34
Coupe D'Hiver (3 *entries*)		
1 J. O'Donnell	Whitefield	2:32
½A Power (9 *entries*)		
1 Hipperson	Croydon	4:10
A/1 Glider (8 *entries*)		
1 Wells	Hornchurch	2:50

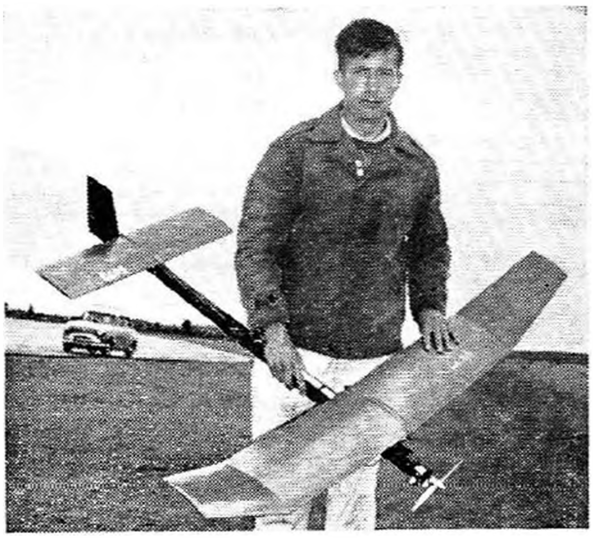
BRISTOL & WEST WINTER RALLY—February 3rd, 1963—Blakehill Farm Airfield

Open Glider		
1 C. Aitkenhead	Glevum	8:00
2 B. F. Bow	Bristol & West	7:53
3 R. Cummins	Bristol & West	5:37
Open Power		
1. A Young	St. Albans	9:00 + 4:11
2 A. Wisher	Croydon	9:00 + over-run
3 D. Harper	Glevum	8:12
Open Rubber		
1 J. O'Donnell	Whitefield	9:00 + 4:11
2 J.Cartwright	Bristol & West	9:00 + 3:33
3 J. Johnson	C.M.	8:00
½A Power		
1 D. Hipperson	Croydon	9:00
2 K. Smith	Croydon	7:53
3. H. W. G. Bunney	Bristol & West	7:25
F.A.I.—All Classes		
1 B. Eggleston (Power)	Bristol & West	8:18
2 J. O'Donnell (Wake)	Whitfield	7:59
3 Stevens (Power)	Swindon	5:42

Rally Champion
J. O'Donnell

One of the most challenging teams in F.A.I. and Class B Team Race circles are A. Wallace and A. Laurie of Novocastria, seen here with their Oliver Tiger powered F.A.I. racer.

Rare selection of scale subject is free flight Japanese "Kyushu—Shiragiku"—by Doctor M. F. Hawkins, who flew this $\frac{1}{16}$th scale D.C. Merlin powered example at the 1963 Nationals.



Top in power at the 1963 Team Trials was M. Green Lincoln who used this Cox.15 Special powered original. Model has thick sectioned fin and sheet covered wing.

COUPE d' HIVER—February 17th-24th, 1963 (Rubber)
1963 Provisional Results

1 D. Furbank	Lincoln	106	120	120	346
2 B. T. Faulkner	Cheadle	120	116	76	312
3 G. F. Kent	Wayfarers	120	120	71	311
4 J. O'Donnell	Whitefield	110	120	51	281
5 R. T. Faulkner	Luton	100	80	85	265
6 R. Flain	Crawley	58	107	60	225

K.M.A.A. CUP—A/2 Glider—April 7th, 1963 (*Area Centralised*)—113 *flew*

1 Manville, P.	Bournemouth	13 : 35
2 Doyle, M.	Belfast	11 : 49
3 Turner, J.	Sheffield S.A.	11 : 15
4 Baguley, J.	Hayes	11 : 12
5 Davies, E.	Wallasey	11 : 02
6 Dallimer, G. W.	Stevenage	10 : 40

HALIFAX TROPHY—F.A.I. Power—April 7th, 1963 (*Area Centralised*) 12 *flew*

1 Green, M.	Foresters	12 : 39
2 Percival, A. H.	Grantham	11 : 45
3 O'Donnell, J.	Whitefield	10 : 49
4 Fuller, G.	St. Albans	10 : 36
5 Head, G.	Portsmouth	9 : 09
6 Savini, S.	Wallasey	7 : 15

U/R RUBBER—April 7th, 1963 (*Area Centralised*), 14 *flew*

1 Elliott, R.	Portsmouth	9 : 00 +2 : 18
2 Brown, K.	Portsmouth	8 : 39
3 O'Donnell, J.	Whitefield	8 : 21
4 Chambers, T. B.	Tees-side	7 : 03
5 Stoker, T.	Baildon	6 : 48
6 White, D.	York	6 : 03

GUTTERIDGE TROPHY—F.A.I. Rubber—April 28th, 1963 (*Area Centralised*). 63 *flew*

1 Thomas, M.	Whitefield	14 : 30
2 Wells, A. R.	Hornchurch	14 : 21
3 McGarvey, W.	Stevenage	14 : 19
4 Roberts, G. L.	Lincoln	14 : 11
5 Tubbs, H.	Baildon	14 : 07
6 Hugh, B.	Springpark	14 : 01

ASTRAL TROPHY—F.A.I. Power—April 28th, 1963 (*Area Centralised*), 43 *flew*

1 French, G.	Essex	15 : 00 + 16 : 40
2 Green, M.	C.M.	15 : 00 + 10 : 29
3 Fuller, G.	St. Albans	14 : 46
4 Monks, R.	Birmingham	14 : 36
5 Cornell, G.	Croydon	14 : 31
6 Manville, P.	Bournemouth	14 : 12

U/R GLIDER—April 28th, 1963—(*Area Centralised*), 141 *flew*

1 Wisher, A. L.	Croydon	9 : 00 + 6 : 35
2 Abbs, A. (Junior)	Norwich	9 : 00 + 6 : 30
3 West, J.	Brighton	9 : 00 + 2 : 21
4 Manners, B. A.	C.M.	9 : 00 + 1 : 49
5 Salmon, R.	Halifax	9 : 00 + 1 : 47
6 Sherwood, S.	Hornchurch	9 : 00 + 1 : 14

BRITISH NATIONAL CHAMPIONSHIPS—June 2nd-3rd, 1963—R.A.F. BARKSTON HEATH

Super Scale Trophy (17 *entries*) *Free Flight Scale*

1 Simmance, J. L.	Wharfedale *Sopwith Snipe*	673
2 Hawkins, Dr. M. F.	C.M. *Kyushu Shiragiku*	630
3 Archbold, S.	Leicester *Nieuport* 28	337
4 Neal, D.	Leicester *Luscombe Skypal*	296

R/C Scale—25 *entries*

1 Bryant, D. F.	Bromley *Macchi MC*202	896
2 Morton, J.	Bristol *"Little Toot"*	801
3 Denny, F/O G. R.	R.A.F.M.A.A. *Bell P*63	469

Knokke No. 2 Trophy—19 *entries—Control Line Scale*

1 Randle, B.	(84 Sqdn. A.T.C. *Blackburn YB*-1	533
2 Day, A. C.	West Bromwich *Fokker DVII*	506
3 Lucas, R.	Sidcup *Vickers Viscount* 701	420

Sir John Shelley Cup—213 *entries*—*Unrestricted Power*

1 Green, M. H.	Foresters	8·03
2 Toolan, T.	Whitefield	7·13
3 Fuller, G.	St. Albans	6·57
4 Edwards, D.	St. Albans	6·06
5 Savini, S.	Wallasey	5·43
6 Moseley, J.	Baildon	4·17

Speed—101 *entries*

Class 1 (1·5 c.c.)

No flights

Class 2 (2·5 c.c.)

1 Drewell, P.	Sidcup	127·8

Class 3 (F.A.I.)

1 Butcher, N.	C.M.	115·9

Class 4 (5 c.c.)

1 Hall, J.	Chingford	126·3

Class 5 (10 c.c.)

1 Billington, M.	Brixton	157·5

Davies "A" Trophy—20 Km. final—90 *entries*—**Team Race Class A**

1 Smith/Edmonds	High Wycombe	10 : 14·6
2 Davy/Long	Wharfedale	11 : 05·2
3 Place/Burley	R.A.F. Helmswell	11 : 48·8

Davies "B" Trophy—24 *entries*—**Team Race Class B**

1 Dugmore/Bell	Novocastria	3 : 31
2 Lorimer, C.	S.A.A.	10 : 00
3 Taylor, C.	West Essex	—

R.A.F.M.A.A. Cup—84 *entries*—**Team Race ½A**

1 Sully, D.	Enfield M.A.C.	11 : 00
2 Dell, A.	Hayes D.M.A.C.	39 laps
3 John, Jr./Tech.	R.A.F.M.A.A.	1 lap

Lady Shelley Cup—15 *entries*—**Tailless**

1 Bow, B. F.	Bristol & W	3·11
2 Culpin, D.	Rolls Royce	0·46

Gold Trophy—32 *entries*—**C/L Aerobatics**

1 Warburton, F.	Wharfedale	1121
2 Jolley, T.	Whitefield	1094
3 Brown, R.	High Wycombe	994
4 Day, D. J.	Wolves	935·5
5 Hawkins, Dr.	C.M.	903
6 Perry, J.	Richmond	898

Women's Cup—17 *entries*—**All Classes Combined**

1 Jepson, Mrs. R. E.	Rotherham	4·53
2 Presnell, Mrs. Y.	Essex	3·30
3 Allsop, Miss S.	Chambridge	1·04

P.A.A. Load—17 *entries*—**1 c.c. Payload**

1 Hopley, N. S.	Richmond	2·46
2 Posner, D. S.	Surbiton	2·42

Model Aircraft Trophy—122 *entries*—**Unrestricted Rubber**

1 O'Donnell, J.	Whitefield	8·52
2 Roberts, G. L.	Lincoln	8·42
3 Latter, D.	C.M.	6·36
4 McGarvey, W. H.	Stevenage	5·16
5 Lowe, P.	Sharston	4·36
6 Faulkner, T.	Luton	3·52

Thurston Cup—255 *entries*—**Unrestricted Glider**

1 Burrows, M.	St. Albans	7·43
2 Spencer, B.	Ashton	7·32
3 Morris, C. H.	St. Albans	7·11
4 Wiseman, D. J.	York	7·05
5 Baguley, J.	Hayes	6·59
6 Anderton, A.	Norwich	6·32

Combat Final—128 *entries*

1 Perry, P.	Northwood
2 Burgess, A. R.	Weston, C.L.

S.M.A.E. Cup—34 *entries*—**Multi R/C**

1 Van den Bergh, F.	Bromley	2643
2 Brooks, H.	Southern M.F.C.	2534
3 Foster, S. L.	Lincoln	2291
4 Waters, P. T.	Port Talbot	1848
5 Rogers, P.	High Wycombe	1735
6 Allen, D. J.	West Essex	1726

GAMAGE CUP—U/R Rubber—June 30th, 1963—47 *flew* (*Area Centralised*)

1 Pavely, R.	Hornchurch	9·00	9·22
2 Wells, A.	Hornchurch	9·00	8·50
3 Furbank, D.	Lincoln	9·00	7·12
4 Monks, R.	Birmingham	9·00	7·05
5 Hydon, I.	Coventry	9·00	6·49
6 Roberts, G. L.	Lincoln	9·00	5·35

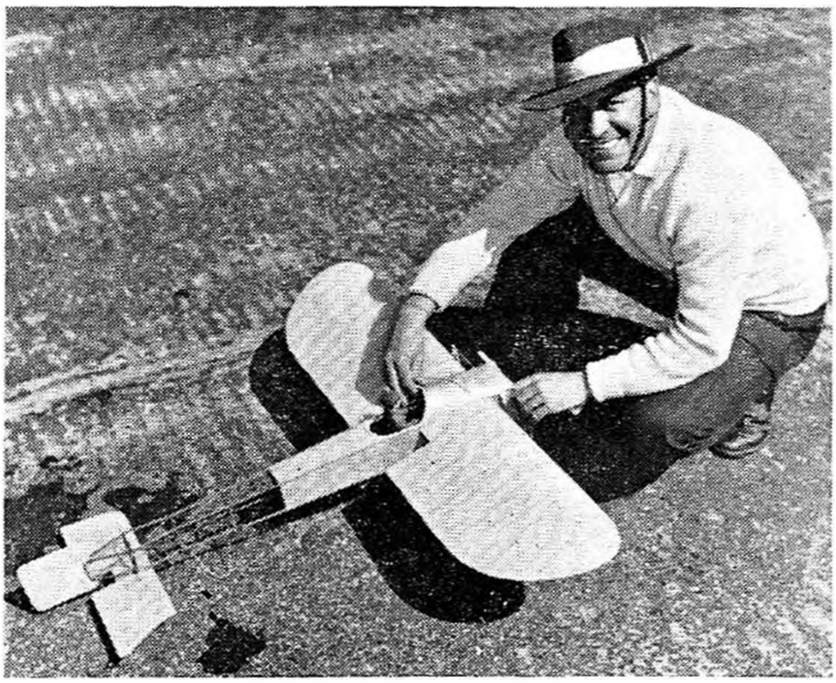
(21 maxs.)

PILCHER CUP—U/R Glider—June 30th, 1963 93 *flew* (*Area Centralised*)

1 Wright, J.	Hornchurch	9·00	5·20
2 Rose, D.	Grantham	9·00	4·40
3 Picken, B.	Wigan	9·00	2·48
4 Oldfield, D.	Norwich	8·54	
5 Burrows, M.	St. Albans	8·50	
6 Baguley, J.	Hayes	8·49	

QUICKSTART TROPHY—½A Power—June 30th, 1963—35 *flew* (*Area Centralised*)

1 Bayram, P.	Lincoln	9·00	2·21
2 Fuller, G.	St. Albans	8·35	
3 Lawson, P.	Baildon	8·11	
4 Hydon, I.	Coventry	8·09	
5 Cornell, G.	Croydon	7·58	
6 Monks, R.	Birmingham	7·56	



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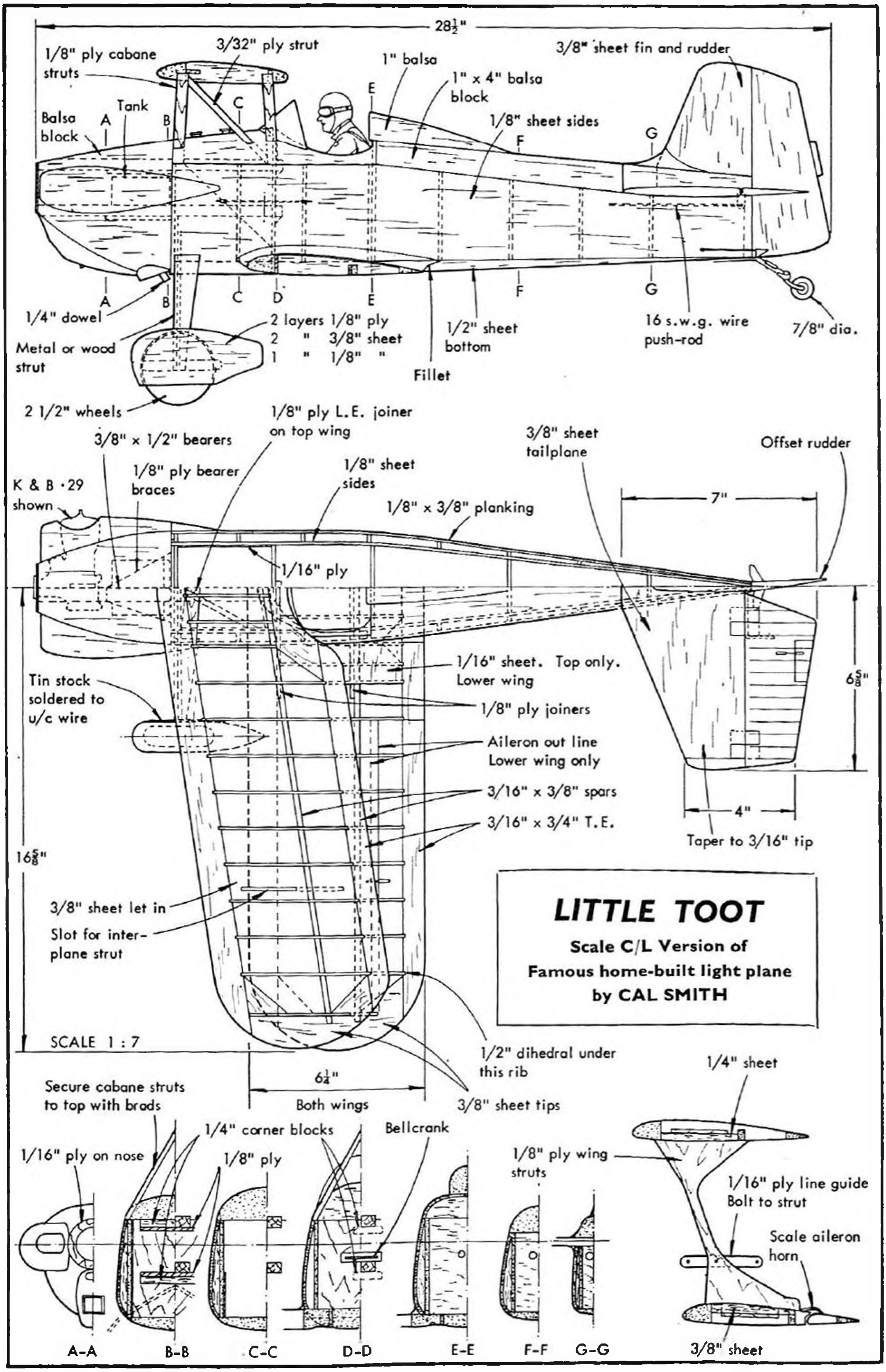

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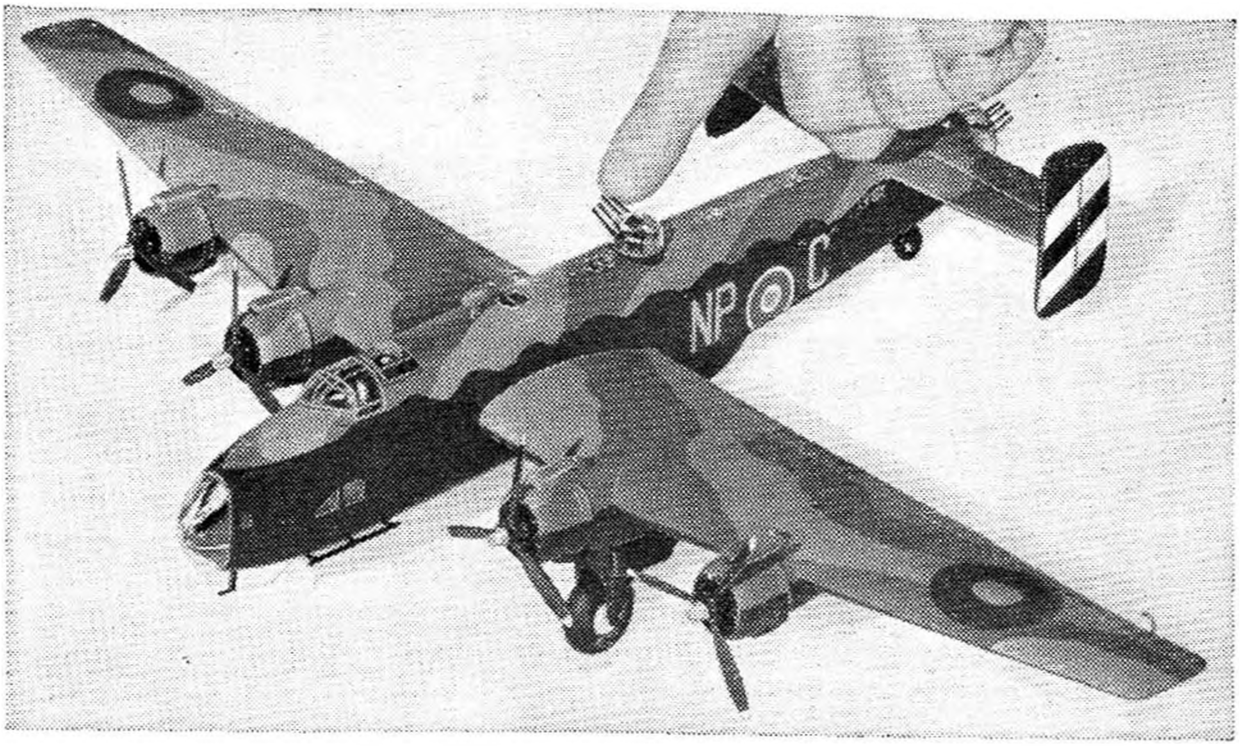


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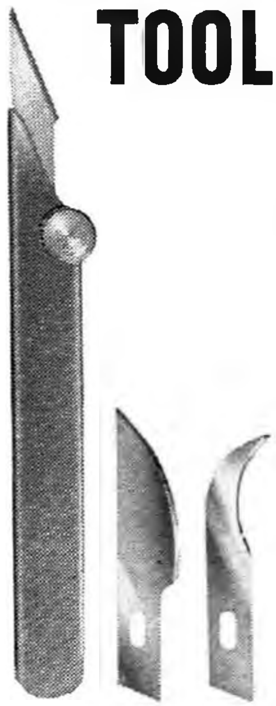

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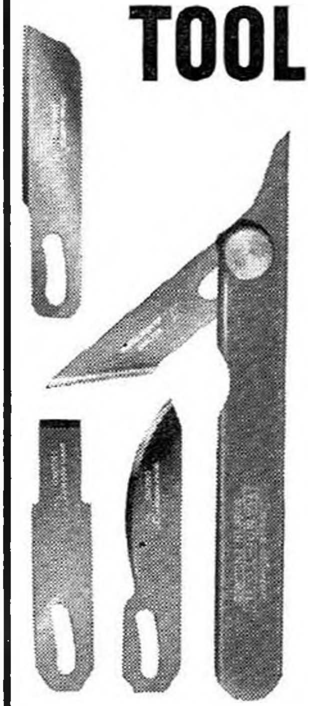

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