KEILKRAFT *Snipe*

KEILKRAFT *Conquest*

KEILKRAFT *Firebird*

KEILKRAFT *Gaucho*

AERO MODELLER

ANNUAL 1962-63

10/6

AEROMODELLER ANNUAL 1962-63

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*

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and
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AEROMODELLER ANNUAL 1962-63

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

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Cover picture: Painting by Laurie Bagley depicts the Hatfield man-powered *Puffin* light aeroplane in flight, with its Southampton rival in the middle distance framed against a starry sky where American space capsule *Friendship VII* is orbiting, a symbolic painting to record man's progress in A.D. 1962.

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INTRODUCTION

PROGRESS during the year on the man-powered machines under construction by groups seeking to win the £5,000 Kremer Prize has emphasised more than ever the close affinity between model-making and light aircraft. Needless to say material in demand has been balsa-wood; equally appreciated has been help in building from aeromodellers and the advice they have been able to give on flying of low-weight low wing-loading machines where anything above a light breeze has presented heavy weather.

Whilst aeromodelling has not been able to contribute to the other end of the speed scale, where rival spaceships are circling the globe in a celestial team-race event, we can at least congratulate ourselves that we are indeed using many of the same techniques in our modest radio control flying . . . though it may be a far cry from our best ten-channel equipment to orbit-controlling transmitters.

Once again we can claim with pleasure to have enjoyed the best-yet Nationals. R.A.F. Barkston Heath was again available, this year with camping facilities actually on the airfield. Never have we seen such a concourse of tents, caravans, trailers, lean-to and even hardy enthusiasts sleeping in ditches—at least until the inevitable rains came. Competition in free flight events was exceptionally keen, which, with the help of ideal flying conditions provided mass fly-offs in power and rubber events, the like of which we cannot remember. It is a pity that this vast enthusiastic gathering is only a once-yearly event, since opportunities for regular flying become harder and harder as airfields go under the plough or become sites of new town extensions. We can only say how much we owe to the devotion of local club officials who seem able time and again to find new flying fields at short notice, and to promote successful Area events in heavily populated areas.

This really all harks back to our pleas last year that something should be done to encourage the use of silencers before aeromodellers are driven yet further into the country. So far, one manufacturer only has announced an engine that will be available with integral silencer—and even this is not yet in full production. Please, please, manufacturers do, do something about it, and do it soon.

In general, the greatest strides of the year have been in the popularising of radio control flying. Nearly every club now has its R/C section, whilst a number of specialist splinter groups are thriving. British manufacturers are still too few in number, so that the door is wide open for the establishment of the better imported equipment. This is already having its effect, but happily it is not too late for our own people to recapture the home market in the more expensive ranges, as they have undoubtedly done in the simpler types of set. We hope too that more operators will pay their licence fees to the Post Office—5,000 paid-up r/c fans seems very few when over 40,000 copies of *Simple Radio Control* have been sold!

Climax of the Radio Control picture came with the 2nd World Championships, staged at R.A.F. Kenley during August. With support from 13 nations, this proved one of the finest exhibitions of flying yet witnessed, and the huge crowd that attended the three-day contest must have made history in the aeromodelling sphere, for they were engrossed for eight hours on each day, with many magnificent flights achieved.

In one of the closest finishes ever experienced, Harry Brooks of the British team got within 1.8 points of American Tom Brett, and was declared "equal first" in conformity with the rules. A fly-off, held to decide holder of the title of World Champion and the King of the Belgians Trophy, resulted in a clear win for the less nerve-stricken Brett, but Great Britain took team honours by a huge margin with equal first, second and third placings.

The 2nd World Indoor Model Championships take place again at R.A.F. Cardington, but unfortunately this book goes to press before the results of this meeting are available. In selection trials, held to elect the British team, all three members exceeded the 30 minute mark, with Ron Draper setting a new British record of 34 min. 34 sec.

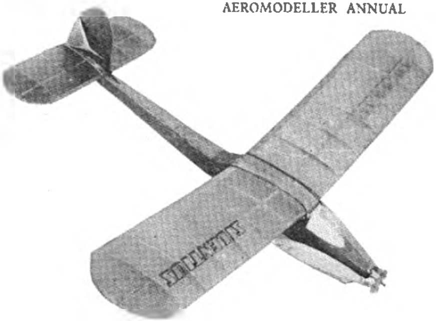
As we write this introduction, Ron Moulton makes ready to depart for Russia to report the first World Control Line Championships in Kiev. This is a happy augury of ever freer interchanges between our ideologies, and we are glad to feel that in the world of aeromodelling there are only differences of opinion as to the best model—which friendly competition can decide in the pleasant atmosphere of an all-nations rally.

We hope you like the mixture we have assembled this year. We do hope you will continue to let us have your views so that each edition can incorporate features that are in demand. As usual we have many people to thank for this year's ANNUAL in addition to those whose direct contributions have filled our pages.

WATER-POWERED FREE FLIGHT

By R. G. Moulton

Great possibilities of water-activated Sodium Chloride Accumulators for free flight



Graupner Silentius 40½ in. span, 140 sq. in. test model, which has been flown at up to a total weight of 5 oz. according to the types of battery employed during the tests. Folding propeller is another Graupner accessory with very neat plastic moulded hubs. The model has flown on a wide variety of battery power supply types.

SINCE we last discussed Electric Free Flight Power in the Annual of two years back, in the 1960-61 volume, there has been a lot of progress in this particular field. In that article we stated how the discovery of Dr. Ing Fritz Faulhaber's remarkably efficient electric motor, marketed for the model trade as the "Mikromax" proved the key to success. The power for weight ratio, and ability to operate on small lead-acid cells or pen cell dry batteries gave the opportunity for good flights with lightweight designs of special character. We detailed the *Silentius* and our personal experiences and wound up with the following summary:

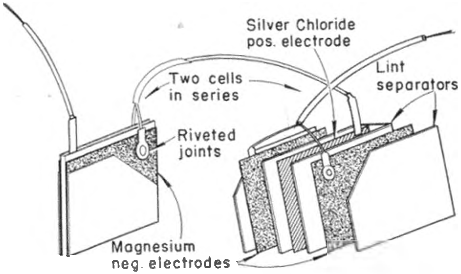
"Who knows, this type of flying may yet develop as new miniature electric motors appear, into a competition class? Time will tell. One thing is certain, that if a cheaper unit can be produced, then the ready-moulded all-plastic "toy" model for clip-in batteries, ready to fly straight out of the box, will be in great demand at Christmas time in 1963, 1964, 1965?"

We were not so very wide of true prophecy. In the intervening years, the need to obtain better power to weight ratio from cheaper electric motors has led to the "discovery" of the water-activated battery for model purposes. This has opened up a new prospect and special batteries have and are being made to suit cheaper motors. Moreover, the all-plastic model with clip-in batteries has arrived, and flies well.

What has brought this development about?

The answer is the introduction of Chloride Depolarised Water-Activated Batteries. They have trade names such as *Aquacel*, *Diamond Silver Cell* and *Mi-T-Cell* and are made in Britain, Japan and the United States for special purposes other than for models.

The most widespread application of the Silver Chloride cell is for rescue light and radio purposes. The battery has an excellent shelf life, and when applied to lights for life jackets, as is the case for many thousands of underseat jackets in airliners, it will be activated just when required, on immersion in the sea. Military aircraft, the Admiralty, Lifeboat institutions, all have special *Aqualite* and *Aquacels* made for them by the McMurdo Instrument Company of Ashtead, Surrey. These batteries can be designed to produce high or low voltage, for short or long periods. They can operate in extremes of temperature, as for example in the LM2 type which is suspended under meteorological balloons to illuminate a sighting bulb. The 3 volt unit weighs less than an ounce, has a



McMurdo Silver Chloride cell

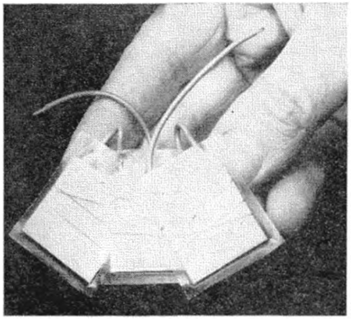
Left, construction diagram showing two cells in a McMurdo Aqualite. As the battery is consumed, the electrodes corrode and are thus not suitable for further use for charging. The silver chloride plate, which is the positive electrode, has a deposited surface to aid the flow of the ions.

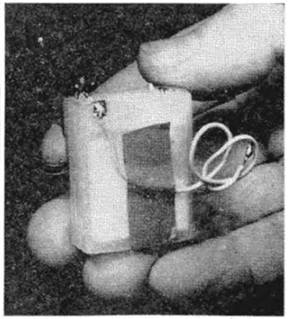
Below left, a 4·5 volt 3 cell pack produced for experiment by the McMurdo Co. and which give us fantastic flight performance. Not being contained in a polythene moulding, the cell components are bound together for close contact. To the right is the same battery contained in a polythene moulding.

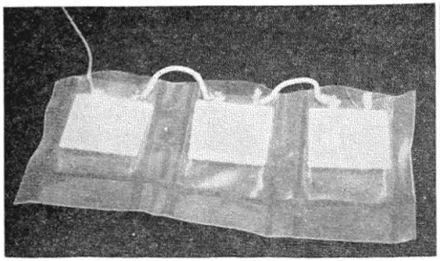
45-minute duration of discharge with an 0·75 watts lamp (2·5 v 0·3 amps) and has been tracked as high as 40,000 ft. altitude, where extremely low temperature can be expected.

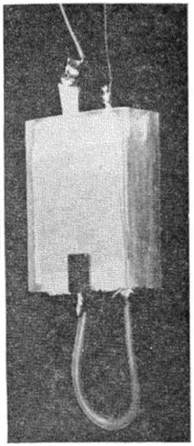
It was the specification of this Met. balloon battery which attracted us for modelling purposes. The output curve rises quickly after the cell is immersed in water and 2.8 volts is realised within 3 minutes. Output then remains practically constant for 45 minutes. A lighter version is known as LM4.

By arrangement with the McMurdo Co. we conducted a few experiments with the LM4. Whereas our previous experience with the Mikromax and the Silentius combination had resulted in best performance using 4 volts from a pair of Rulag or Magnalux lead-acid accumulators, we now found that the weight saving of the LM4 compensated for the lower voltage. Climb at a rate of about 5-7 feet per second was slightly less than before. However, repeated flights were made without sign of 'tiring' the power supply as becomes readily apparent with lead-acid cells. Eight flights were made before darkness intervened, the fuse being used to limit power runs to 30-40 seconds, and it would seem that a whole afternoon's sport flying with many times our session of eight flights could be obtained from one battery. It must be emphasised at this stage that the water activated battery is *not* rechargeable or re-usable for reasons we shall give later.





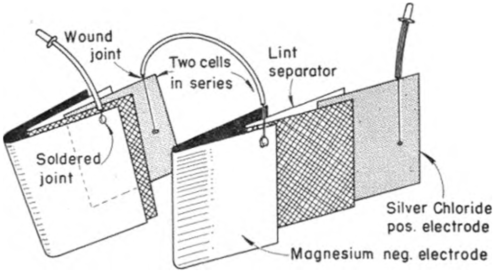




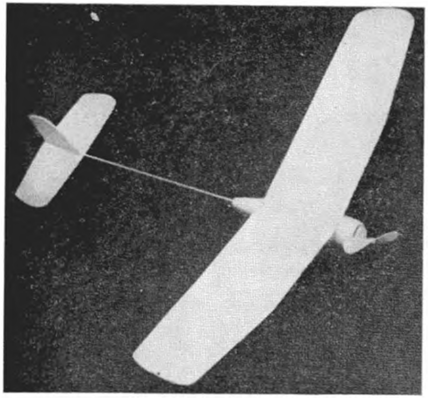
Triple cell 4·5 volt unit is another McMurdo experimental battery of smaller dimensions, similar in plate area to the Japanese Yuasa cells and contained neatly in one sealed jacket of thin polythene. Power output in this case is suitable for a "one shot" flight of fairly high power using the Mikromax electric motor.

At right is the modification of a McMurdo LM2 battery, normally used for meteorological purposes, but now made available by McMurdo Instrument Co. of Victoria Works, Ashtead, Surrey as the type LM4 without the balloon light and insulation muff at 10/6d. each. This battery has a 45-minute duration of discharge, which can be used intermittently in small increments over a one-day flying period and has given good results in the Silentius with Mikromax motor. Below is a diagram of the Japanese cell construction, different in several ways from that employed by the McMurdo Co. and which requires a salt water solution for activation. The individual cells are each contained in polythene bags.

Following the LM4, a series of tests were made using 4·5 volt triple cell packs with varying sizes of plate. These offered a considerable increase in the rate of climb, at the loss of having many repeated flights. Dependent upon the time taken to recover the model, the high power batteries gave two or three flights at most. Climax of these experiments was one of the most shattering experiences in many years of aeromodelling. We had been operating with smaller size cells in 3 volt and 4·5 volt combinations to make an assessment of performance according to battery power. The Mikromax was a standard 15:1 geared type, in a Graupner kit Silentius. Conditions were ideal, with wind



Japanese Yuasa Diamond Silver Cell for Sanwa Electra model



At left, the Sanwa Electra model made up from the kit now distributed by Ripmax Ltd. at 14 11d. including a set of batteries, propeller and motor. Made of expanded polystyrene, all parts are pre-moulded, span is 19 in., length 17 in. and weight ready to fly 10 oz.

Opposite, left, energising a set of Yuasa cells from Japan for test purposes. A salt water solution is required and some variation in performance can be obtained by the range of 10 to 20 per cent salt density. Yuasa cells have a duration of about 45 seconds useful period and this should be used within a few minutes of charging with salt water. The cells will deliver peak output within a few seconds of connecting to the motor.

Opposite right, the Sanwa Electra has a slot in the lower fuselage to take a two-cell pack giving 3 volts. These batteries should be fitted upside down before activating.

zero to 2 mph at most. A special 4·5 volt, 1·5 amp triple cell pack was fitted, checked for balance then activated. After a few seconds it was clearly evident that the battery was delivering far more power than previously experienced, and the model was released with about 20 seconds of fuse left to burn before switch-off.

Immediately, the Silentius entered a steeply climbing left-hand spiral, climbing at an estimated rate of 10 feet per second, possibly accelerating and certainly attaining at least 200 ft altitude within the 20 seconds of power run before the blades folded. At that height and in such conditions a thermal contact was inevitable and the flight duration was near to 6 minutes. Never was it more clear that the electric free flight model could be developed into a competition class. We must, however, repeat that this was an experimental battery, prepared by The McMurdo Instrument Co. to show what could be done.

Sport Flying

The obvious approach to electric power is in the provision of a silent, easy to operate propulsive source for the sport type of model or the novice "introduction" ready to fly.

Here we must turn to Japan, where the Yuasa Battery Co, Ltd has produced the V1A Diamond silver cell, which requires salt water as an activator and has a claimed standard output voltage per cell of 1·1 volt at 1·5 amps. Battery useful life is 50 seconds, and this can be utilised within about half an hour of activation. It is advisable to activate in the connected state with the motor, wait until the full power is realised, then to release. These batteries are light at about $\frac{1}{10}$th ounce per cell, they can be wired in series or parallel to make up combinations of voltage, and they are of course expendable per flight. Low labour costs in Japan permit a reasonably low cost per unit.

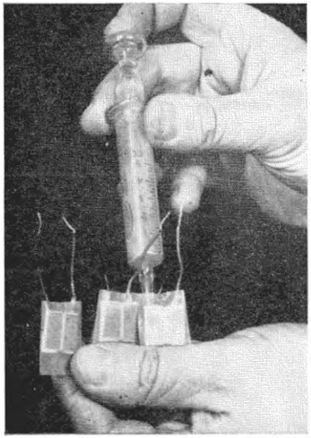
Additionally, the TKK Mabuchi Co produced a special "Air Plane 25" variant of their well-known type 25 motor, having a longer armature with two extra segments and corresponding extra power. This was for the Sanwa Model Co *Electra* ready to assemble model moulded in expanded polystyrene. The combination of the efforts of three Japanese companies produced what they justifiably claim to be the first electric-powered aircraft for popular appeal. It is distributed in Great Britain by Ripmax Marine Accessories and has already attracted a great deal of attention in the model and toy trade.

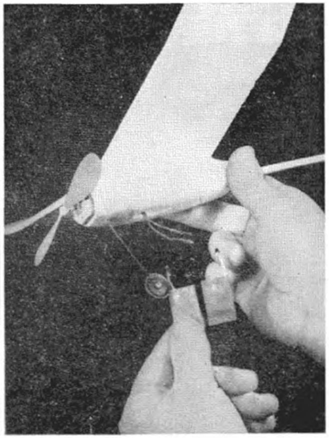
The contrast between the refined Silentius with super efficient Mikromax driving a large diameter (10-12¾ in.) prop at about 1,500 r.p.m., and the little white plastic Electra and the AP25 buzzing away at 3,400 r.p.m. direct driving a 4½ in. prop, is very much like comparison of the International Contest model with a sportster.

Each has an admirable purpose, and the Japanese approach, taking advantage of their low labour costs with three items that need high labour time to produce, is bound to achieve more attention. Larger models, and higher performance can only come as and when the purchasers are prepared to pay more for the batteries.

To understand a little more of how this is so, we must study how the water-activated battery works, and for this information we are indebted to The McMurdo Instrument Co.

Each cell consists of a strongly electro-positive metal in intimate contact with its own insoluble chloride; an aqueous, neutral, high conductivity electrolyte, and a strongly electro-negative metal to which the electrolyte is chemically inactive. When a load is connected across the cell, the insoluble chloride-decomposes and the metal deposited in a porous mass at the electrode while the chloride passes into the electrolyte in ionic form. The negative electrode is dissolved and the electrolyte is enriched by amounts of the chloride of the electro-negative metal. This is summed up as the change of an insoluble





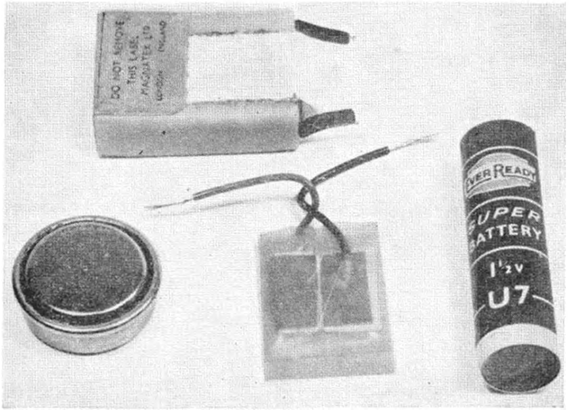
chloride and an insoluble metal, to an insoluble metal and a chloride in solution, which results in production of electrical energy.

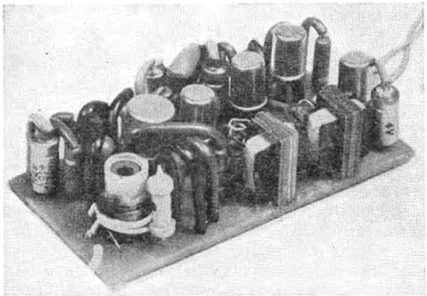
The negative electrode is Magnesium in our cases but Zinc can also be used for special applications in sealed batteries. The positive electrode is Silver Chloride, though cheaper Cuprous Chloride is an alternative. It is cast into a plate and has a chemical surface deposit according to manufacturer technique. The Electrolyte is water. Salt water is employed in many cases because it has necessary ions for rapid activation; but chemical impregnations in the lint separator wrappings make a salt solution unnecessary in the case of the McMurdo batteries. Because it is desirable to have a maximum of electrode plate area and a minimum of electrode spacing, the batteries are thin and flat. They are bagged in a polythene wrapper to hold the initial water content, excess of which is poured out after absorption. For high power, the plate area must be large. So one can appreciate that power is virtually proportionate to the amount of Silver Chloride (which has a standard cost of about 8/6d. per troy ounce) and magnesium.

The decomposition of the plates renders the cells un-rechargeable, and the limitation of use is often in our experience the decomposition of the actual wire connection to the plates, either riveted, or wound on, or soldered.

Manufacture of the cells is in fact a highly skilled process and we were very much impressed by the variety of types produced by McMurdo at their Ashtead Works. Many a life has been saved by their products, and we trust that our own encounter with them, though not resulting in something for all aeromodellers to enjoy, will have made interesting reading for experimenters.

Many electrical power sources have been tried in our efforts to obtain the most satisfactory power weight ratio for electric free flight. Some are illustrated here, at top the magnetex lead acid cell, sold in Germany as the Rulag and is used for a multitude of domestic purposes, including cigarette lighters. A pair of these cells will give excellent service in a 5 oz. model with Mikromax power and have the advantage of being rechargeable. Nickel cadmium button cells of the DEAC type are too heavy for their output for this particular purpose, so also is the dry battery as illustrated here by a Pencell, leaving all advantage to the water-activated silver chloride battery, the Yuasa type being shown here for size comparison.





J-QUE 3-VOLT TRANSISTOR RECEIVER

By Dave McQue
& Desmond Jones

Neatly constructed prototype J-QUE receiver displaying vertically mounted transformers.

This Rx. with minor alterations uses the circuit given in the author's "Introduction to Transistors" series. (Radio Control Models & Electronics.)

Several were built independently by local Club members in various forms and constructional styles. The one described here is a miniaturised version devised by D. Jones and incorporating ring circuit changes for 3V. operation and relayless output. The prototype is fitted in a Caprice A/1 glider, which now has a flat bottomed wing section (9 per cent).

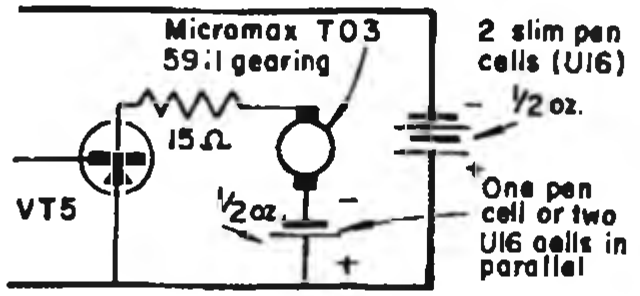
WITH shrinking flying fields and the ready availability of multi equipment, R/C modellers appear to divide into three classes. (1) The diehard single channel button pushers flying the same models they flew ten years ago, a dying race. (2) The multi at any price gang actually only moderate in numbers but high in performance. (3) The lazier types who like to fly small simple models, cheap and easy to build and repair, and unlikely to do a lot of damage to third parties or their motor cars—any more like me?

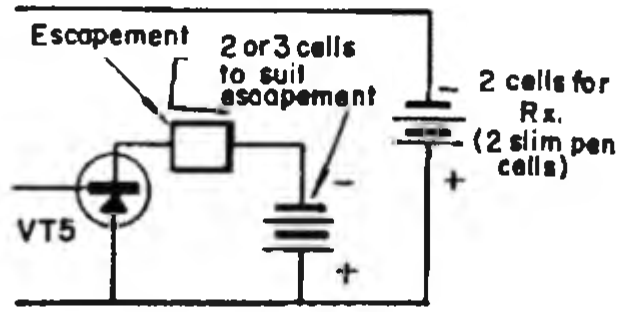
For a lightweight installation it is important to look at the equipment as a whole Rx., batteries and actuator. With any transistor Rx. the greatest factor will be the actuator and its power supply. Many circuits and units appear showing the use of a single supply for both Rx. and actuator. Strange as it may seem at first glance this is not satisfactory for the lightest installation if reliability is to be maintained at an acceptable level.

Put in the simplest terms, a battery should be chosen which will give adequate service with the actuator or escapement used. Deacs are preferable but pencells can be used provided they can be readily changed and rested after each flight, i.e. have two sets in service used alternately.

When pencells are used to supply the escapement it is unwise to use them to power the rest of the Rx. because the heavy drain of the escapement will reduce the battery voltage below an adequate level long before the cells are unfit for escapement use.

Two slim pencells are adequate to power the early stages of the Rx. and with this independent supply consistency of performance has been maintained for over three months including three 24-hour periods when I forgot to unplug the batteries.





For a really lightweight installation one has to look for something other than an escapement. I have used a Micromax T05 (59:1 gearing). This requires only a single cell for actuator supply and even then a limiting resistor of 15 ohm is a *must* to reduce the stall current to 100 mA, a safe limit for long motor life. Two U.16 (slim pencells) in parallel for the actuator and two more in series for the Rx. were used to produce a convenient shape of battery pack weighing 1 oz., details of this system are described later. Normal practice is to plug in at the commencement of an evening's flying session, and unplug before going home. Of course, if there are others flying in between your flights it is as well to switch off to avoid unnecessary wear and tear.

The Rx. is straightforward, uses no gimmicky circuitry and is temp. stabilised.

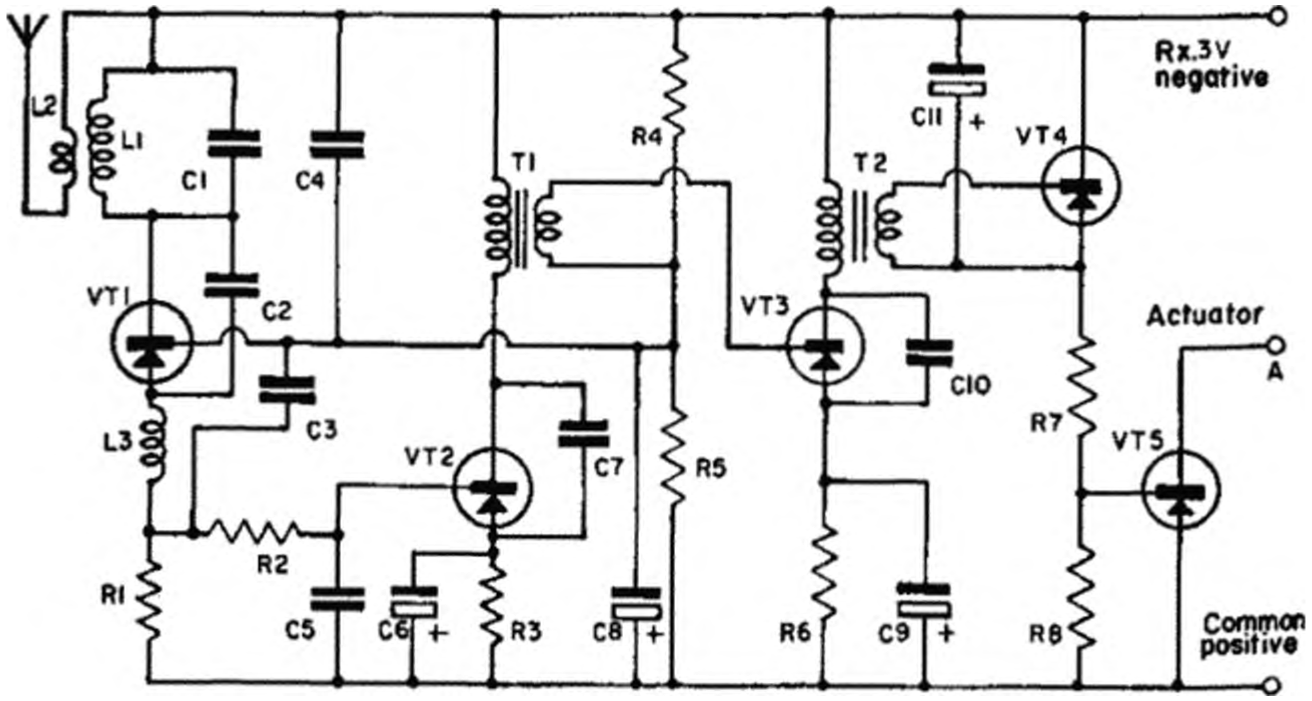
A Texas instrument 2G402 transistor (VT1) is used in the Supergen. detector stage, a Mullard OC.171 is also suitable.

A two stage audio (tone) amplifier follows using T.I. 2G302 transistors, VT2 and 3. Mullard OC 71's may also serve.

VT4 is a Class B stage and requires a switching transistor, we use the T.I. 2G302. Alternatives are OC.76, GET 114

VT5 is used as the actuator switch, possible transistors are 2G381, T.I.
OC.83
GET 114 } Mullard.

The printed circuit is shown both life-size and double. The latter for ease in assembly and identification. You can make your own or use a kit of parts. The P.C. board supplied in the kit is prefluxed and does *not* require cleaning.



Far left is the circuit modification to the Rx. last stage to drive a Mikromax T03 motor. Near left, wiring diagram and power supply details using an escapement. Right, full size etched circuit layout.

Start construction by checking components against the list and laying them out on a suitably marked piece of paper.

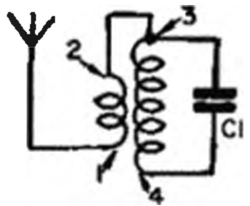
The transformers T1 and T2 as supplied require strengthening with Araldite. Carefully straighten out the leads. Do not pull or twist them. Apply Araldite to the wire side cheeks and wire and hang up to set (See Fig. A). The other cheeks will be attended to later, when the transformer is glued to the board.

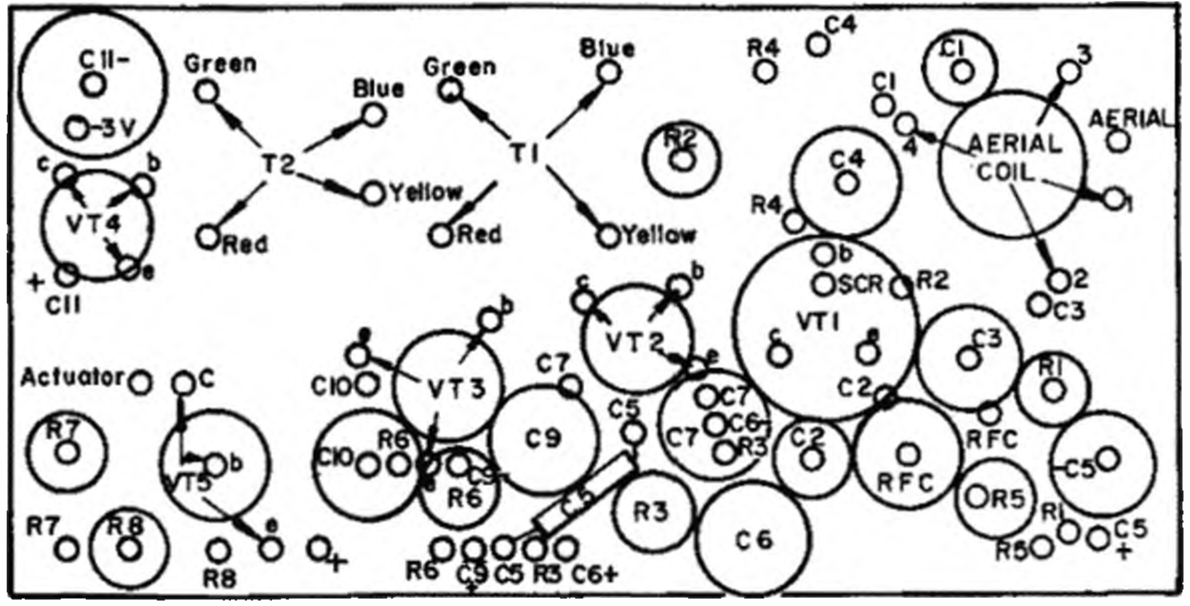
Mount L1 coil former in the board, apply polystyrene cement and secure the former with a ⅛ in. winding of thread (See Fig. B). Start the binding from the top and finish at the board, do not be too lavish with the cement.

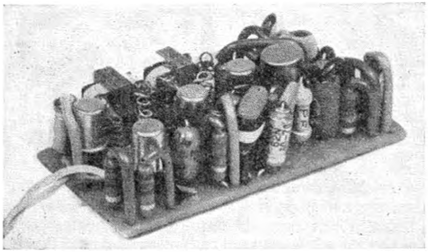
When the cement is set L1 can be wound on. Scrape the enamel off one end of the wire and tin it, push it through the L1 hole nearest the edge of the board and solder, wind on the coil and secure the top turn with thread which is then lightly cemented. Be patient and allow to set. While waiting wind L3. Some general notes on soldering will not go amiss at this point.

1. *A good, small, hot and above all clean well filed bit is essential. Keep a piece of clean rag handy.*
2. *Use* 60:40 (*red packet Multicore*) *resin cored solder preferably* 18G *or thinner. Acid fluxes are OUT.*
3. *Make sure the wires on the components are clean. Tin* **before** *assembly if required.*
4. *Use no more solder than necessary.*
5. *Apply the solder to the job and the iron to the solder. See Fig. C.*

Below, twice size component placement diagram. Hold page up to the light to see how the components coincide with the etched circuit layout. Right, numeral identification to transformer coil windings.







Another view of the prototype receiver, built for development purposes on a larger size baseboard panel.

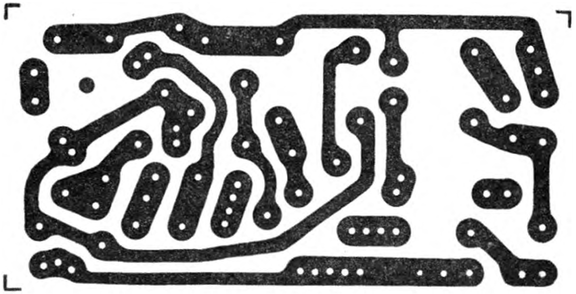
6. *Pass the leads through the holes before cutting and bend over $\frac{1}{8}$ in. Allow $\frac{1}{8}$ in. clearance from board at X, do not bend leads close to components. See Fig. C.*
7. *Remember molten solder flows under the influence of gravity—invert work to remove excess.*
8. *Most important of all. If you haven't done any before for goodness sake practice first with bits of wire, and scrap board, and even if you have maybe you are rusty and a bit of practice beforehand will help you to do a job that you will be proud of.*
9. *Finally, make sure you have the right wire in the right hole before you solder. Remember the craftsman checks twice and solders once.*

Now scrape the upper end of L1, tin and solder in.

L2 may now be wound over the lower end of L1.

The rest of the components can be assembled in sequence working from the coil end of the board. The transistors should stand $\frac{1}{4}$ in. clear of the board and will not require heat sinks so long as the iron application does not exceed 5 secs. (Re-read soldering note 8.)

The last things to be soldered in are the flexible aerial and battery connecting wires. There is not much point in using a switch with this light low consumption set, I fit a three-pin socket to the battery pack and a matching plug (with cut down pins) to the leads from Rx. and actuator. Rather than use another plug and socket in the actuator leads solder direct but leave adequate slack. If a switch is used it should be a double pole. One pole for each battery.



A pair of high resistance phones or a crystal earpiece, and a multirange meter are useful in checking the Rx. Tone signals can be followed through the Rx. up to VT3 collector, and the use of phones is recommended for accurate tuning.

Connect the phones or earpiece across T2 primary (VT3 collector and -3V.). With Tx. off a loud frying noise is normal. Switch on the Tx., but not the tone. Starting with the core in L1 right in, unscrew it (with a non-metallic screwdriver) until the noise disappears. Key tone which should then be heard. At close range the Rx. will respond over a turn or so of the tuning core but at range the tuning will be sharper. Make final adjustments with Tx. at least 200 yards away or, if the Tx. is Xtal controlled, with the Tx. aerial removed.

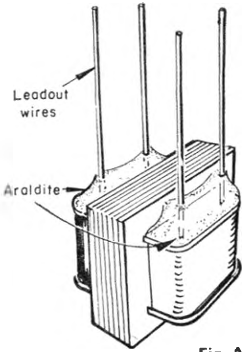


Fig. A

Alternatively, tuning may be accomplished by monitoring the actuator voltage or current, if a suitable meter is not available the actuator can be temporarily replaced by a torch bulb. A 6V 0.1A is best as it will light up on 3V. but not too brightly to be stared at whilst making adjustments.

On No Signal (Tx. off) the lamp will flash in a random fashion, if at all, with some Rx. more sensitive than most it will stay lit. But when tuned in to a carrier without tone it will go out and stay out. Then when tone is keyed on it will light up. The expected brilliance can be checked by shorting VT5 collector to its base.

With 4.5V. instead of 3V. for the Rx. the no signal noise with Tx. off may be sufficient to operate the actuator. One of my friends likes it that way as he knows he can't have a fly-away. However, if your flying field is well away from woods etc. this may not suit you and if on 3V. the Rx. sensitivity is too high you will have to shunt T1 primary (blue, yellow) with a 15K $\frac{1}{10}$W resistor. This has proved necessary in some cases due to the improved sensitivity (and reliable operation down to 2 volts) with the with the T.I. 2G402.

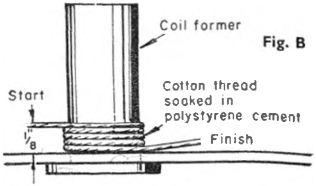


Fig. B

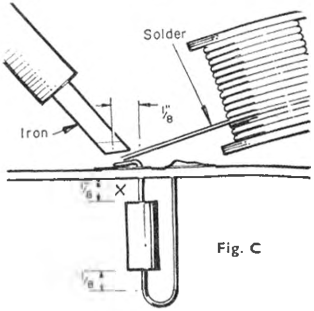
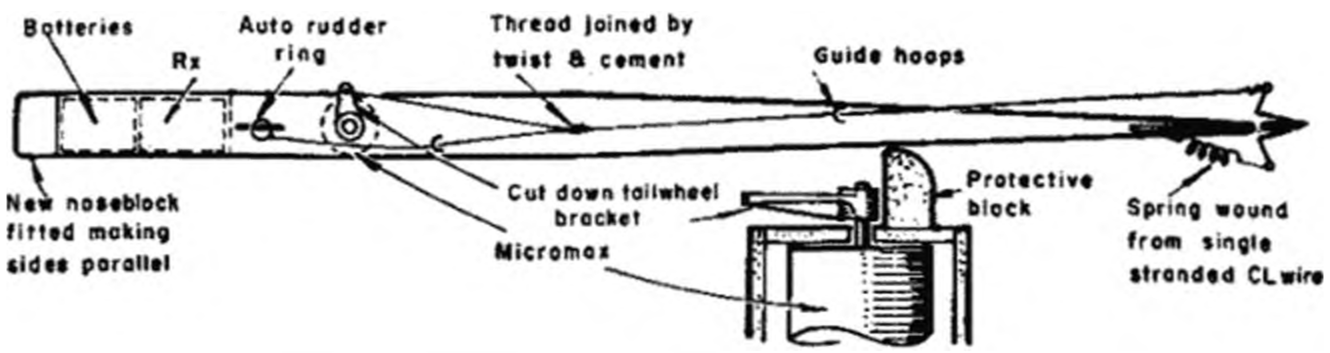


Fig. C



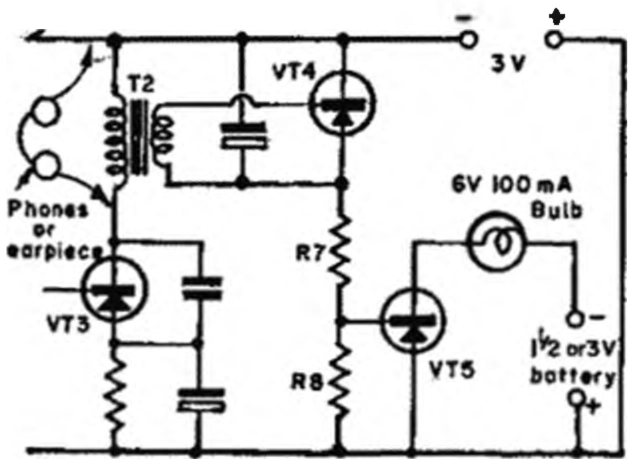
Installation in Caprice Glider (see sketch)

The Actuator system is added to the free flight auto rudder installation. A Fred Rising nylon tail wheel bracket is cut down and the hole opened up to a tight push fit on the Micromax shaft. Thread from this lever is secured to the common line to the rudder by cement. The Micromax motor is boxed in the fuselage by an additional $\frac{1}{2}$ bulkhead of $\frac{1}{8}$ in. sheet and $\frac{3}{16}$ in. sheet lid. With no signal the rudder is pulled to give a right turn by the spring, whilst towing up the ring on the towhook provides neutral rudder. When cast off the model will fly straight if the signal is "blipped" about once a second. To get a left turn release button count three then press and hold.

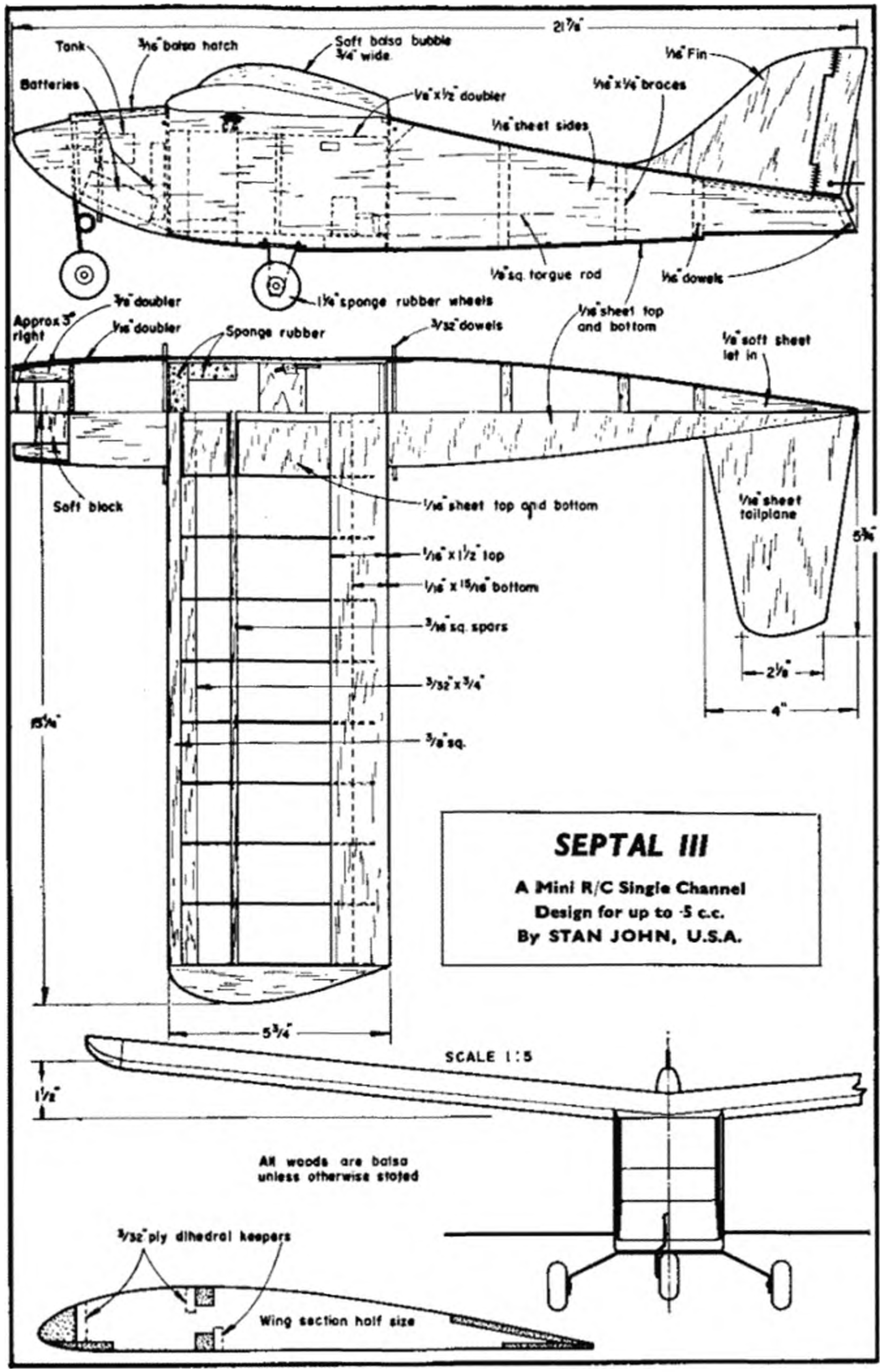
COMPONENTS LIST

R1 5.6k Ω 10%
R2 5.6k Ω 10%
R3 2.7k Ω 10%
R4 2.2k Ω 10%
R5 1k Ω 10%
R6 2.7k Ω 10%
R7 150 Ω 10%
R8 150 Ω 10%
(R1–R8) Lab. Type 5SWD 18 or Dubilier B.T.S.
C1 22pf Miniature Ceramic LEM
C2 10pf Miniature Capacitors LEM
C3 0.01mfd Type 400 Dubilier Capacitor
C4 0.005mfd Type 400 Dubilier Capacitor
C5 0.1mfd 3 Volts Erie Transcap.
C6 10mfd 16 Volts Mullard Sub Miniature Electrolytic
C7 0.005mfd Type 400 Dubilier Capacitor
C8 10mfd 16 Volts Mullard S/Min. Electrolytic
C9 10mfd 16 Volts Mullard S/Min. Electrolytic
C10 0.005mfd Type 400 Dubilier Capacitor
C11 25mfd 7 Volt Mullard Sub Miniature Electrolytic
L1 Radio Spares Miniature Dust Cored Former wound with 10 turns 28 S.W.G. Enamelled Copper.
L2 2 Turns of 7/.0048 in. Plastic Radio Spares Flex wound centrally on top of L1.
L3 Radio Spares 1 amp. T/V Choke rewound with 40 S.W.G. Enamelled Copper.
T1-T2 Ardente 5-1 Type D1001 Transformers
VT1 Texas 2G402, 2G415 or Mullard OC171
VT2-3 Texas 2G302 or Mullard OC44
VT4 Texas 2G382 or Mullard OC76/ACY20 etc.
VT5 Texas 26382 or Mullard OC83/4 or G.E.C. GET114

All lead out wire should be of Radio Spares 7/.0048 in. plastic covered flex.



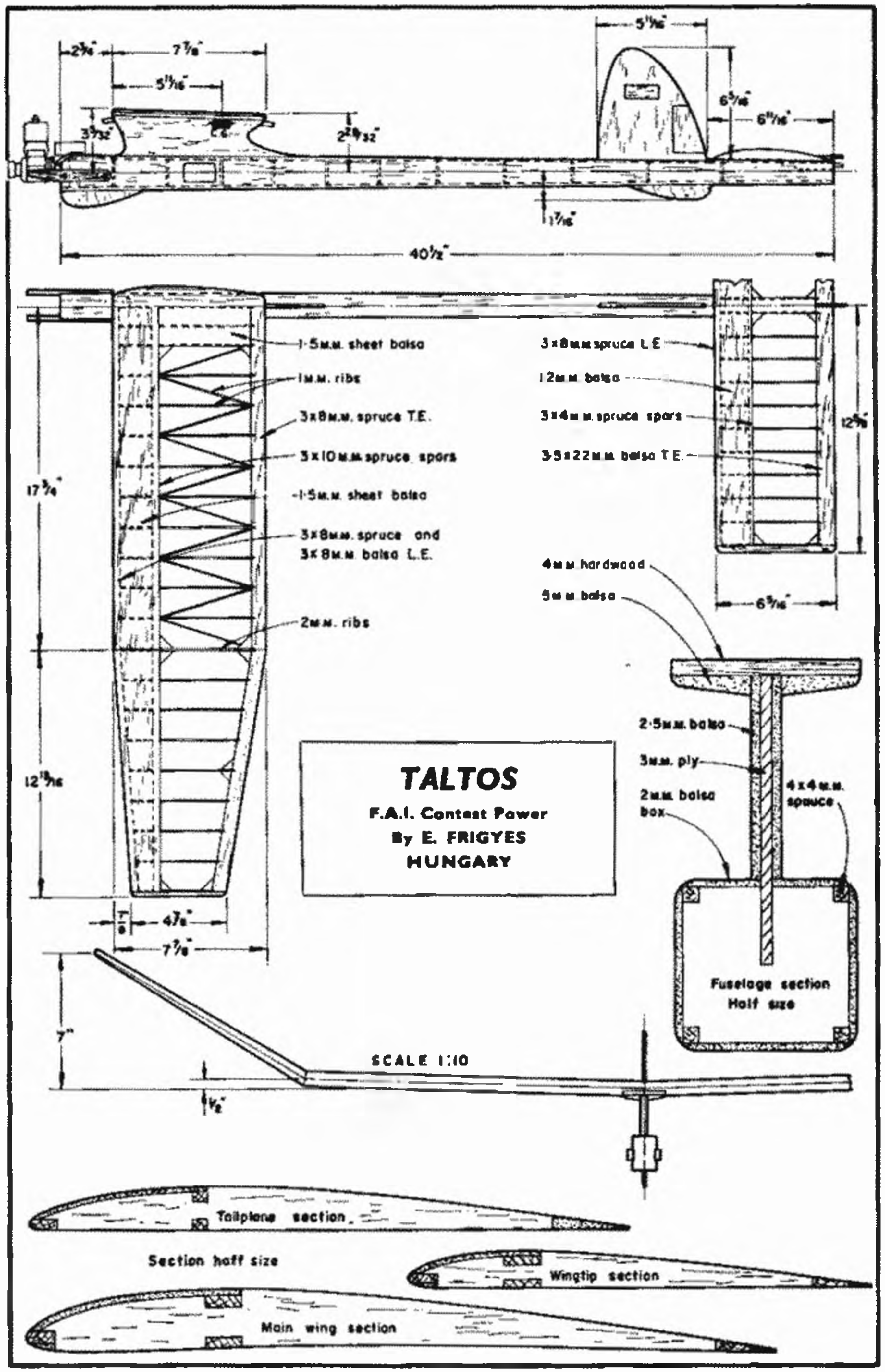
Insert 47K to 100K resistor in lead to phones.



SEPTAL III

A Mini R/C Single Channel Design for up to ·5 c.c. By STAN JOHN, U.S.A.

MODEL AIRPLANE NEWS, U.S.A.



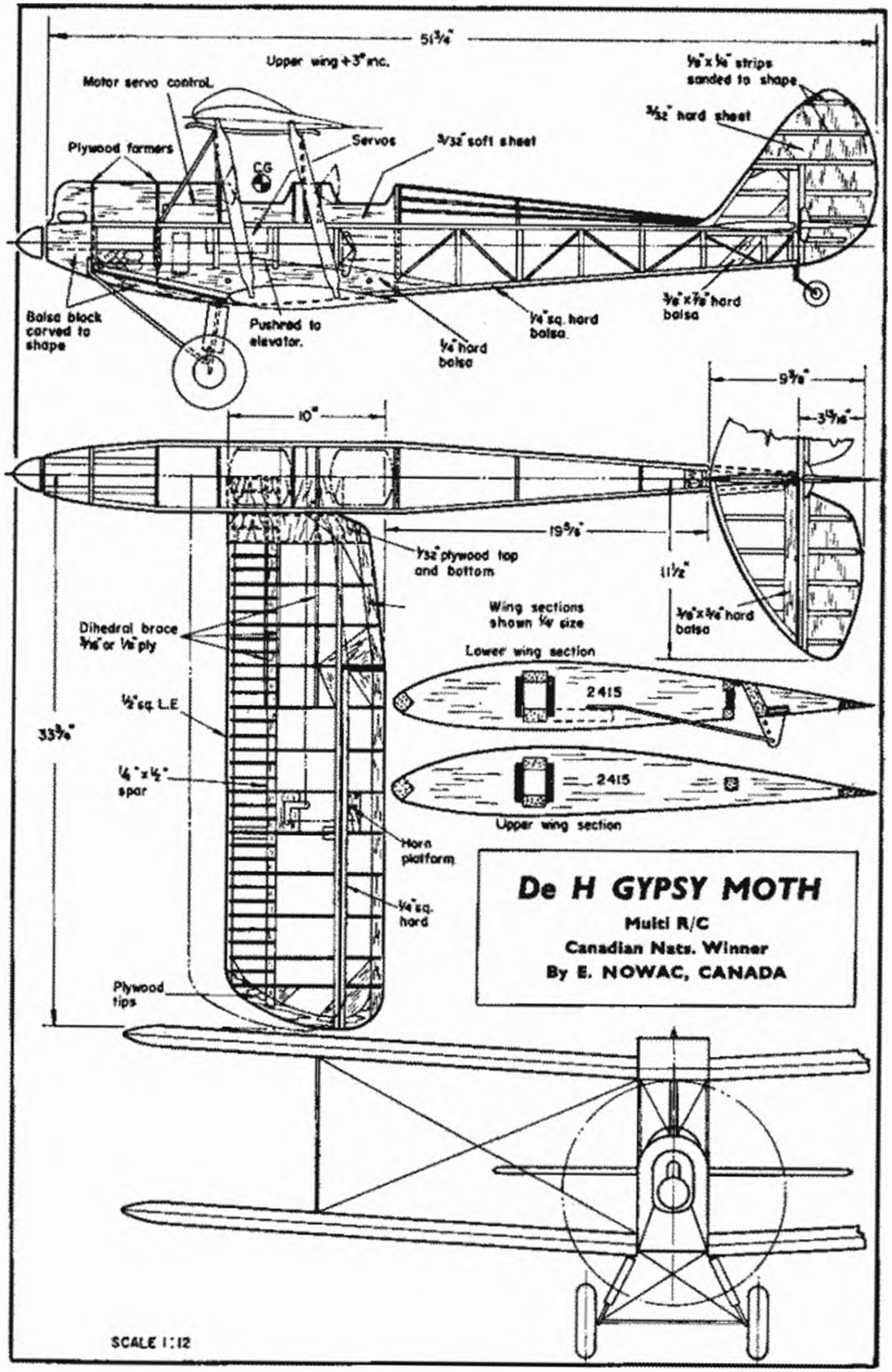
TALTOS

F.A.I. Contest Power

By E. FRIGYES

HUNGARY

MODELLEZES, HUNGARY



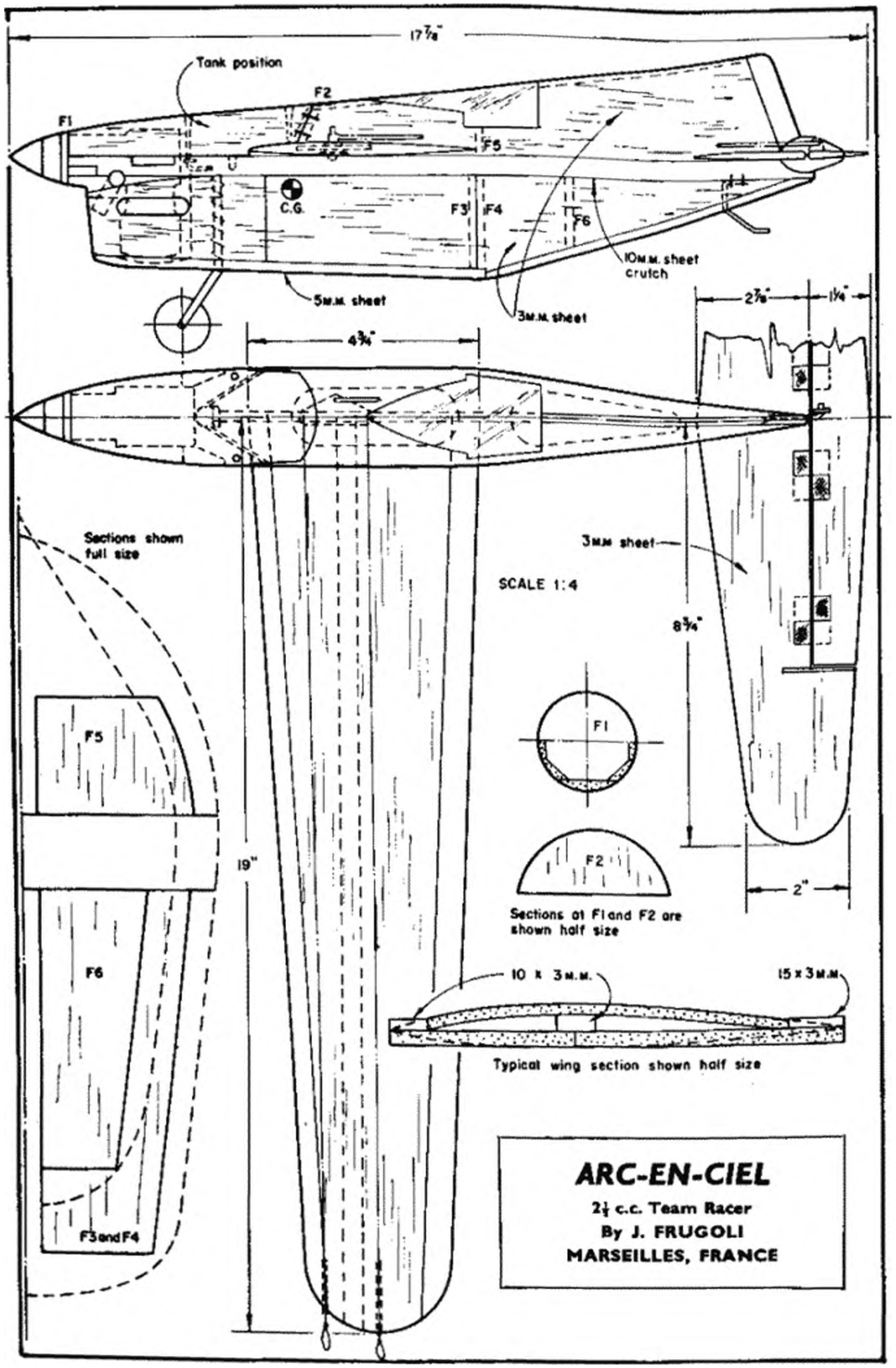
De H GYPSY MOTH

Multi R/C

Canadian Nats. Winner

By E. NOWAC, CANADA

FLYING MODELS, U.S.A.



ARC-EN-CIEL
2½ c.c. Team Racer
By J. FRUGOLI
MARSEILLES, FRANCE

MODELE MAGAZINE, FRANCE

WHAT ABOUT "STANDARD" MODELS FOR THE CLUB?

This account by Franz Czerny tells how the Austrian Model Society (OMV) developed a series of standard models aimed at producing polished contest flyers in the shortest possible time.

WHEN expert Austrian modeller Erich Jedelsky first began to use balsa, in common with so many others he tended to think in terms of the harder materials in which he had been working before. As a result of considerable re-thinking he changed his whole building technique (*no easy task for the continental modeller, who, even today, is often still wedded to hardwood construction.—Ed.*) to exploit the special features of balsa to the utmost advantage. Out of this new appraisal sprang the conception of a "Standard" series of models.

This is based on designs where both wings and tailplane are built completely of balsa, that is to say, without any tissue covering whatever. Such a method lends itself to easy and fast construction, so that even novices can produce successful models with little possibility of error. When the Austrian Model Society decided to create a series of models for beginners and introduce them into contest flying it was to Erich Jedelsky that they turned for inspiration. He was commissioned to produce suitable designs. This commission enabled him to perfect the "Standard" system and try it out on a wide selection of aeromodellers.

The organising body arranged for week-end courses in aeromodelling, where the novice would have expert help in trimming and flying his models. The difficulties of so instructing a host of beginners, all flying different models, and condensing such instruction into a weekend, are obvious. It was clear that courses could only be successful with a basic model that fulfilled certain conditions.

The basic design requirements were that models should be:

(1) Easy and quick to build. (2) Easy to trim.
(3) Very robust and dependable for training flights, and consistent in performance if used in competitions.
(4) With good flying qualities. (5) Of acceptable appearance.

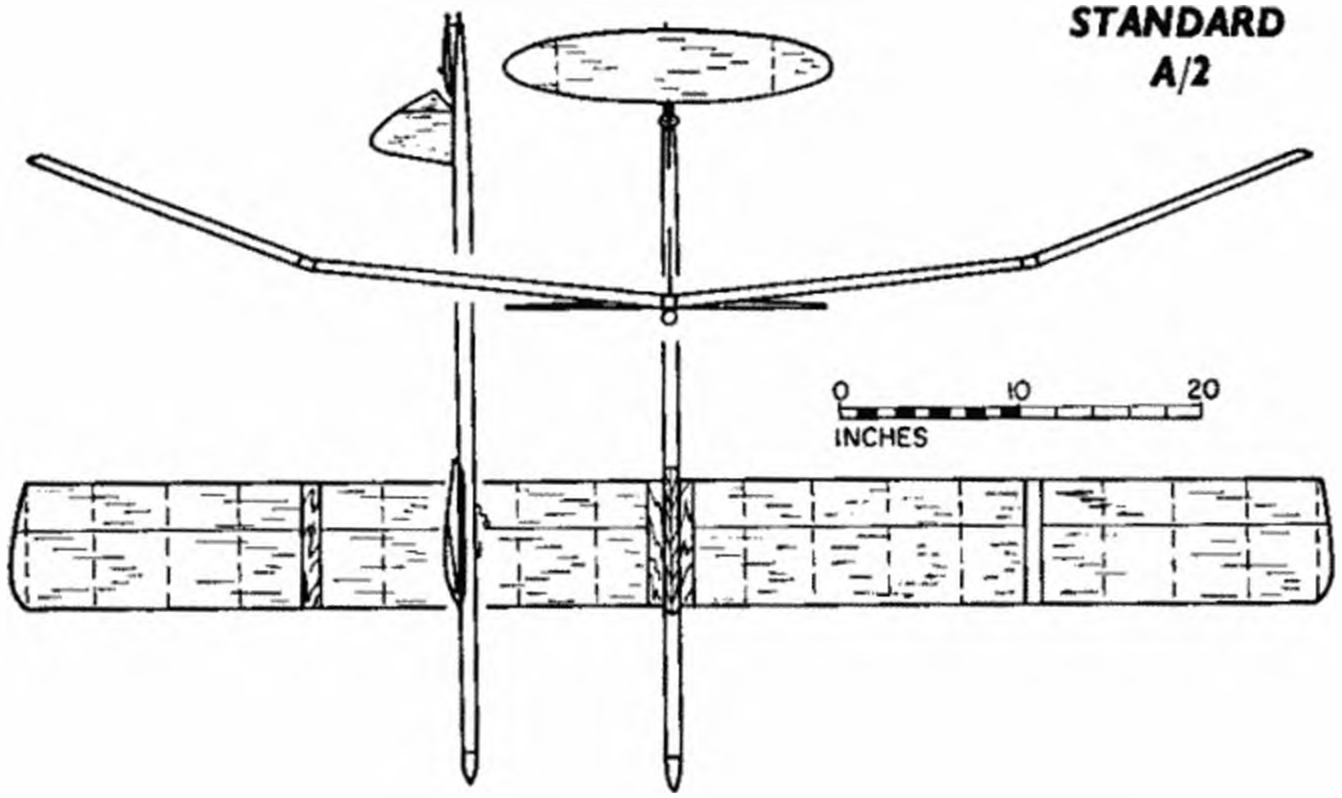
The Standard models are not high performance designs, but their flying qualities are quite good. They are intended as introductory training machines for contest flyers. They show the special features of particular F.A.I. classes, and serve to help the tyro become an expert contest flyer. After all, the only way to contest success is: Fly, fly, and then fly some more. This object, simple in itself, can be best achieved by having only as many models as are needed to keep flying (*cf. John O'Donnell's methods here—John seldom frivols with a lot of new designs, but keeps the old ones hard at work.—Ed.*). If the Standard models are not flown a lot, then they have failed in their purpose.

Let us see how they fulfil the specified conditions:

(1) It would be impossible to construct a simpler model more quickly by conventional means. Apart from the ribs there are no complicated parts. A little sanding and a wing is finished.

(2) The model is easy to trim because it is virtually warp-proof, and once trimmed stays that way for ever.

(3) Robust and nearly indestructible, for there is no covering to tear, which normally gives some strength, which upon tearing is lost.



(4) Flying qualities are good. Models flown in open contest have done well against stiff competition and always placed high.

(5) Looks! This is the hardest nut to crack. Not everyone likes them, but much can be done for "individual" appearance with a good paint job, and some waterslide transfers. (One drawback must be mentioned! It is quite difficult to get conservative modellers to try them—they are inclined to condemn them out of hand without even trying them!)

Material Specifications

Wings are of standard construction as created by Jedelsky. A good selection of firm and lightweight balsa is advised.

WINGS: **A/1** Leading edge $\frac{1}{8}$ in. square hardwood (spruce) then block $\frac{5}{16}$ in. soft balsa, rear part $\frac{1}{16}$ in. medium balsa (quarter-grain) Ribs $\frac{3}{32} \times \frac{5}{16}$ in. hardwood.

A/2 and 1·5 c.c. Free Flight Power: Leading edge $\frac{3}{16}$ in. square hardwood, block $\frac{3}{8}$ in. soft balsa, rear-part (flag) $\frac{1}{16}$ in. medium balsa (quarter-grain) Ribs $\frac{3}{32} \times \frac{3}{8}$ in. hardwood. TAILPLANES on all: $\frac{1}{16}$ in. balsa.

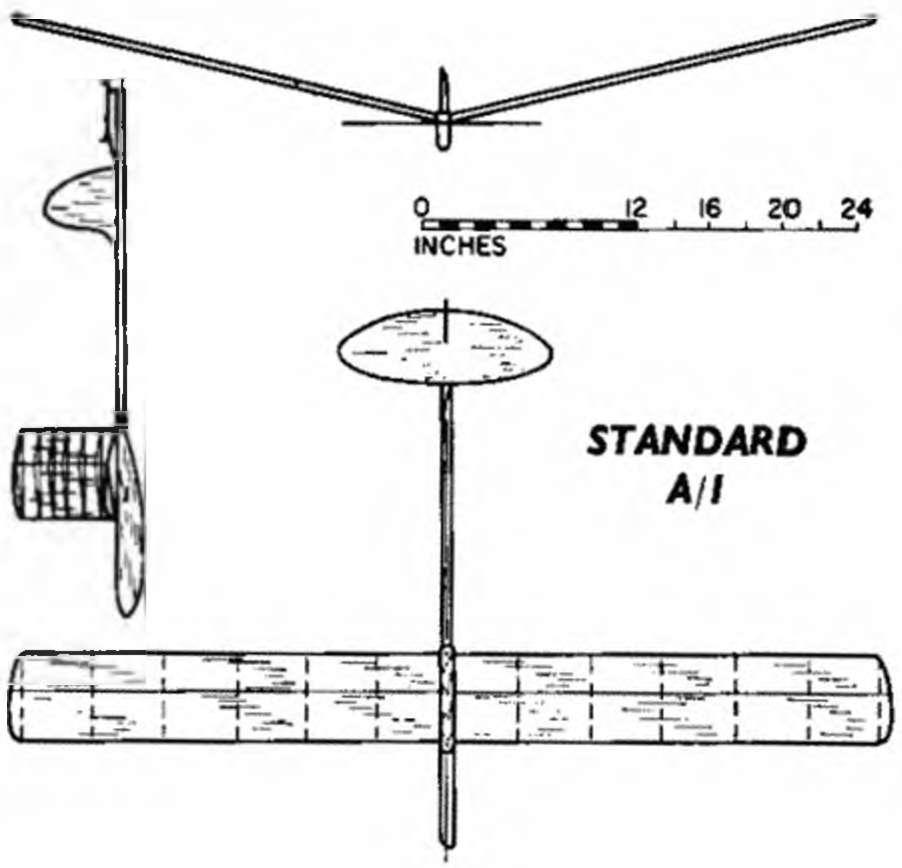
FUSELAGES: **A/2** and **Freeflight:** Paxolin tube of 1 mm. wall thickness, 18 mm. internal diameter, 20 mm. overall diameter. Pylon for motor from $\frac{3}{16}$ in. ply.

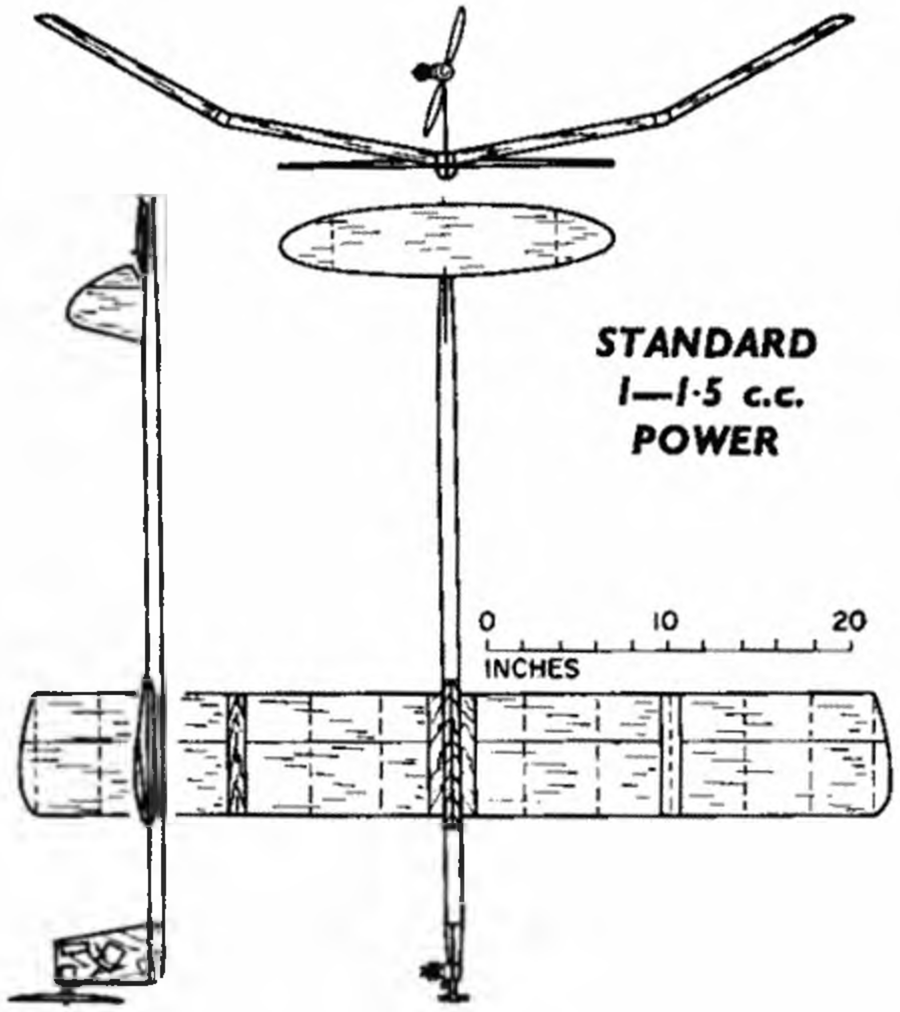
A/1 Rear $\frac{1}{8} \times \frac{3}{8}$ in. hardwood, two pieces glued together T-fashion. Front part of wing—block.

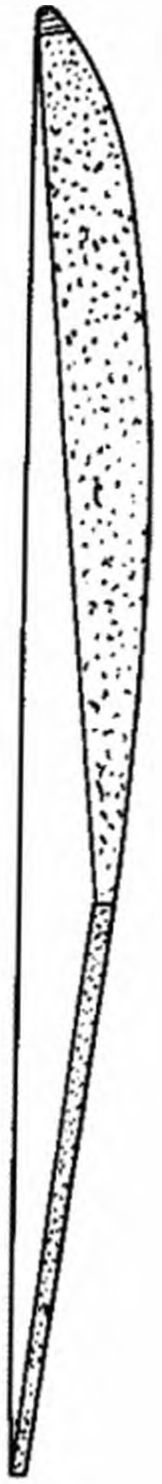
MODEL SPECIFICATIONS

	A/1	A/2	F/F Power
Wingspan in mm.	1240 (50 ins)	1820 (72 ins)	1200 (48 ins)
Length in mm.	750 (29¼ ins)	1050 (41½ ins)	1100 (43½ ins)
Tailplane span	300	450	450
Wing area dm2	15·49	30·26	18·7
Tail area in dm2	2·33	3·57	3·57
Total area dm2	17·82	33·83	22·27
Average weight (in gms.)	*180/250 6½/9 oz.	*410/460 14½/16½ oz.	*450/600 16/21 oz.
Dihedral in mm.	140	200	200

*Depending on balsa density, motor weight, paint job, etc.

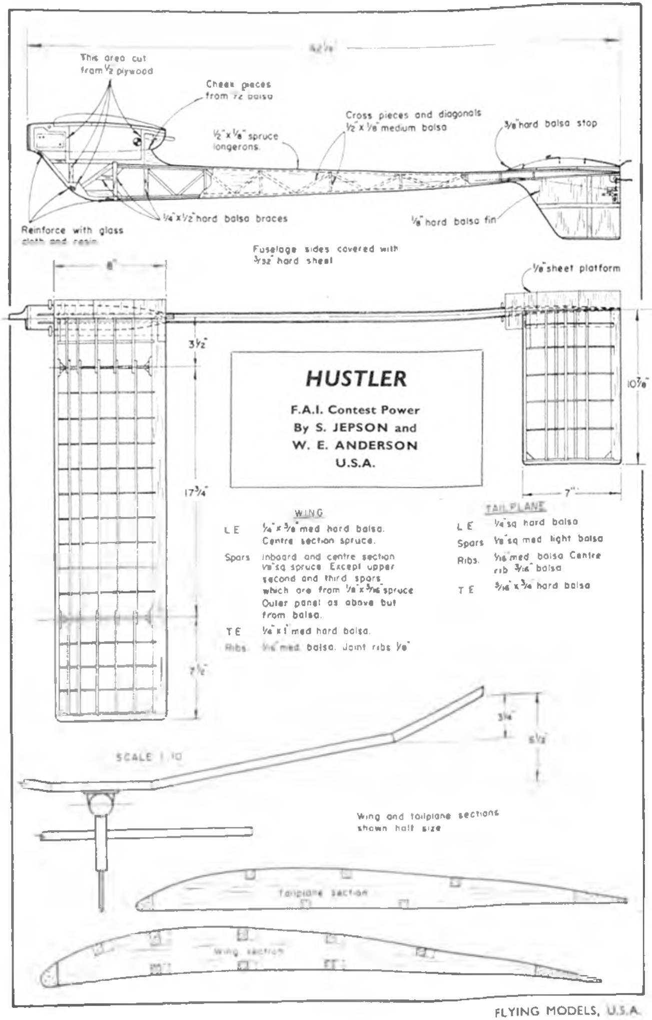






Above: Full-size A/1 Rib

Right: Full-size A/2 and Power Rib



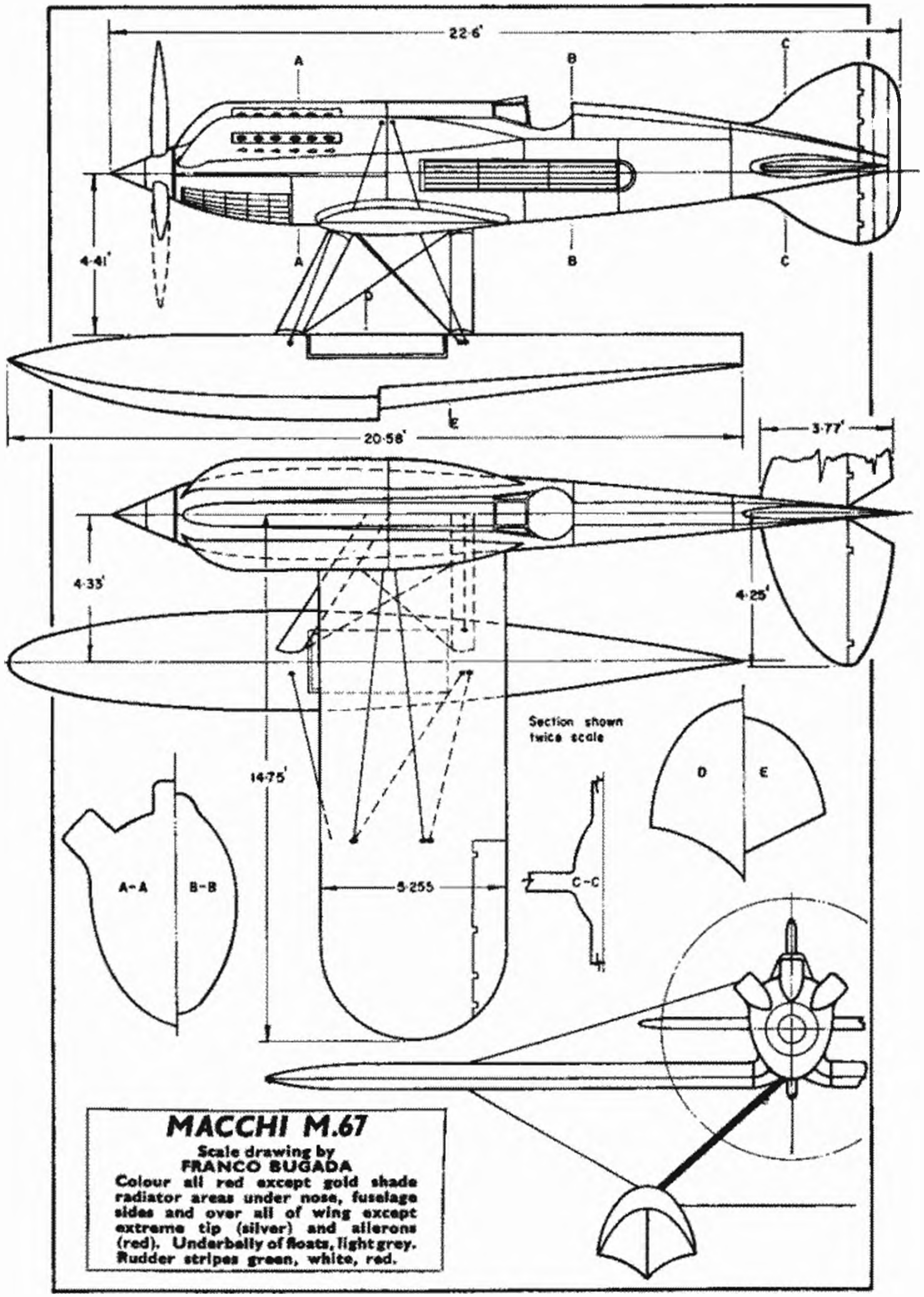
FLYING MODELS, U.S.A.

This is a model! Silvio Taberna's beautifully constructed winner of the first model Schneider Cup Race, at rest after a flight, note water droplets on under-surface of wing, also the opposite hand propeller to give torque assistance during the take-off stage, but still maintaining traditional anti-clockwise flight path.

SCHNEIDER TROPHY IN MINIATURE

ITALIANS have always had a fondness for speed and racing, either in the air, on water or on land. With the prospect of combining all the thrills of control line and over water operation, it is not surprising that a Schneider trophy in miniature, established at Varese (Italy) in July 1961, has aroused tremendous interest. In brief the specifications for the models are that they must be scale examples of full-size machines that have been constructed for the full-size Schneider trophy races. Any scale is permitted, but there is a limitation of a maximum engine of 2·5 c.c. (·15 cu. in.). Since points are awarded for scale then it is obviously to the advantage of the modeller to endeavour to enclose the engine and build as close a replica as possible. Line length is set at 13·27 metres and this gives a twelve lap course covering one kilometre. The model is timed for speed over these twelve laps which are signalled by the pilot to the two official timekeepers.

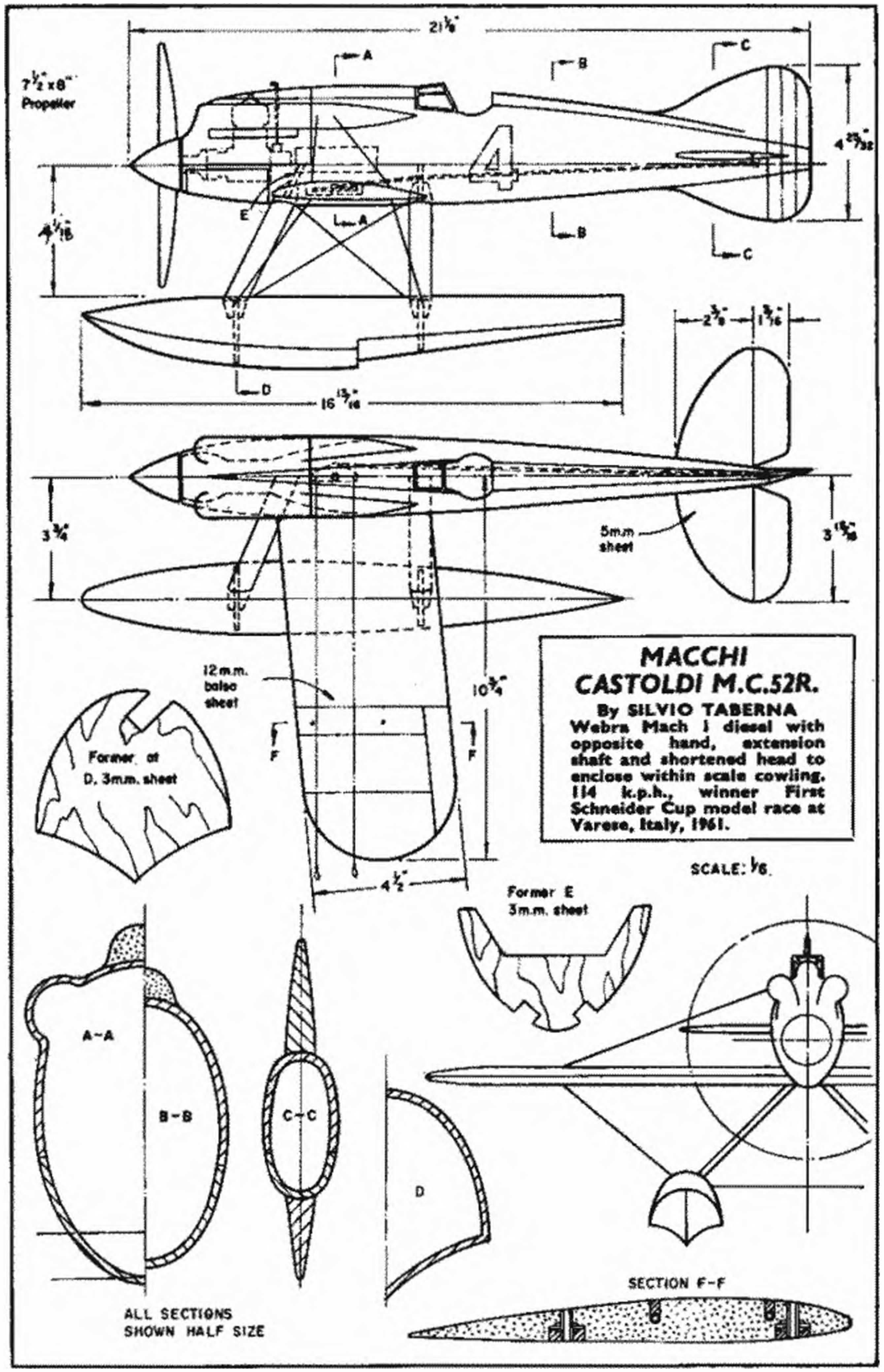
Additionally there are three judges and it is their duty to decide the points awarded for workmanship and the quality of take-off and landing, plus the actual scale accuracy. The results for 1961 were that the speed in kilometres per hour is taken as a set number of points. Then, points up to twenty were awarded for evidence of quality in take-off and another twenty for landing, making a total of forty points for these items. This maximum of forty was added to the speed figures and then judges decided among themselves what value of a K-factor should be awarded according to the scale. If the model was considered very accurate it would have a K-factor of 1, if moderately accurate 0·75, if it contained a number of concessions to scale the K-factor would only be 0·5. This K-factor then multiplies the total of points from speed and judging. Thus, for example, if the model flew at 100 k.p.h. and was given 30 points by the judges, making a total of 130 and it was an *accurate* model



MACCHI M.67

Scale drawing by
FRANCO BUGADA

Colour all red except gold shade radiator areas under nose, fuselage sides and over all of wing except extreme tip (silver) and ailerons (red). Underbelly of floats, light grey. Rudder stripes green, white, red.



MACCHI CASTOLDI M.C.52R.

By SILVIO TABERNA

Webra Mach I diesel with opposite hand, extension shaft and shortened head to enclose within scale cowling. 114 k.p.h., winner First Schneider Cup model race at Varese, Italy, 1961.

Franco Bugada and his remarkable Pegna P.C.7 model. Structural difficulty is that of balance with such a long nose using Super Tigre G20 15 glow engine.

Below: The Pegna P.C.7. at rest during flotation tests. Aircraft is then propelled by water screw until it planes upon the hydro-foils at the end of the undercarriage legs.

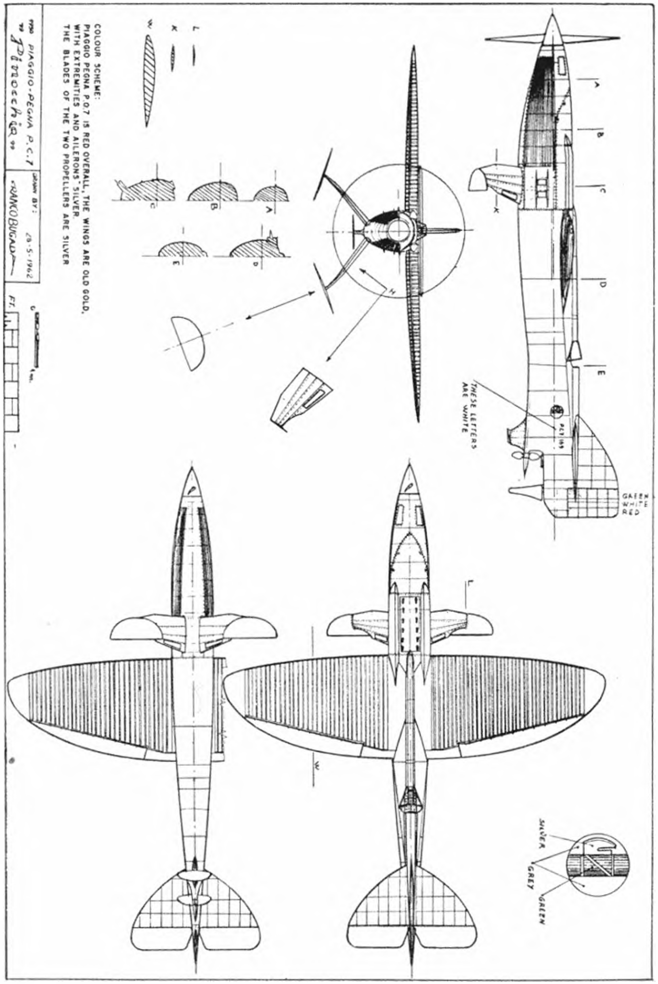
with a K-factor award of 1 then its final figure in points would be 1 × 130 which is 130. A much *less* accurate model would only have gained 97½ points.

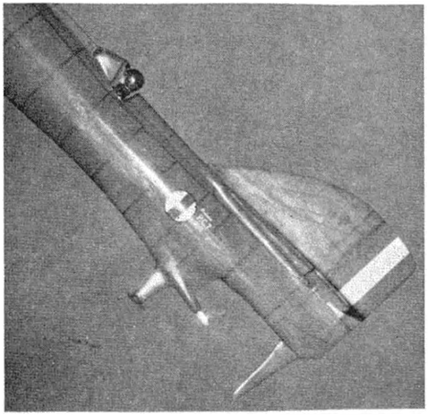
This system had disadvantages in that it was felt that too few points were awarded to the model itself and its actual flight appearance, and so for 1962 the rules have been changed.

There were five entries in the 1961 event, two Macchi 72, two M52R and one M39 and Silvio Taberna placed first and second respectively with his M52R and MC72 (which was published in May 1961 *Aeromodeller*). Fifteen or sixteen entries were anticipated for the 1962 meeting with many exciting prospects, including the SM65 twin engined type.

Naturally a twin must divide its allowed capacity over the two engines and so a 1 c.c. and a 1·5 c.c. are employed.

As for techniques, the lake at Varese is fortunately shallow at its edge and the water only knee high for the pilot. During the very critical take-off stage,





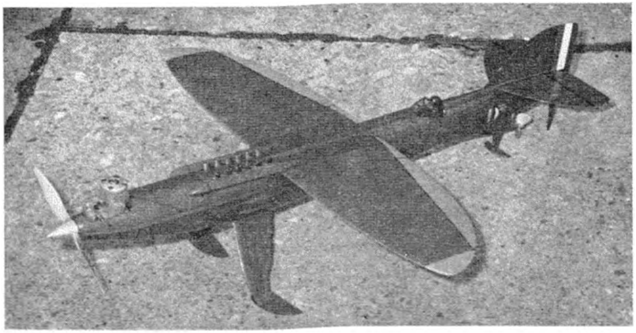
Rear fuselage details of the P.C.7 model by Bugada, made before he obtained final true scale details as shown in his drawing. Differences are small, involving the support for the rear fuselage hydrofoil. Model has proved to be very difficult for landing and take-off due to scale effect.

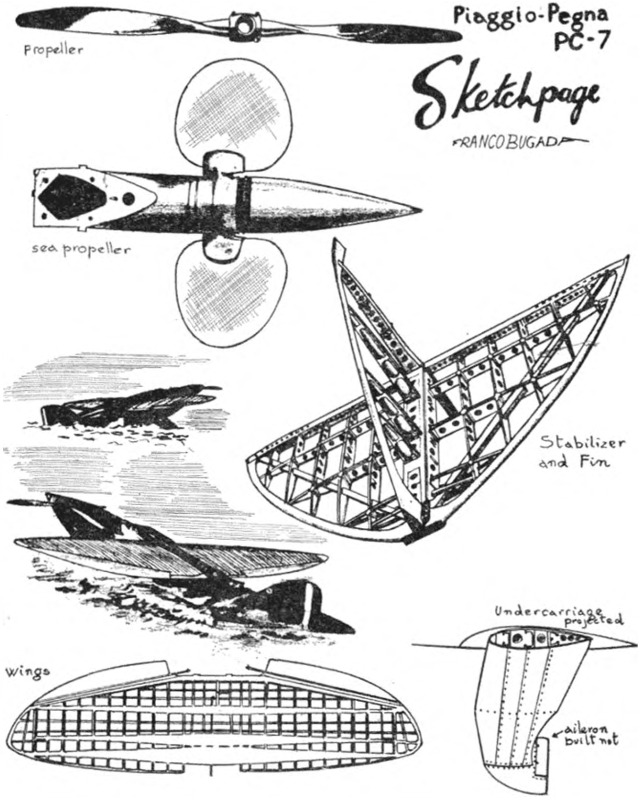
Below: Bugada's P.C.7 showing the scale engine exhausts and undercarriage with hydrofoils. Undercarriage is made of 4 millimetre ply, tail is 3 millimetre sheet balsa and same material is used for the general fuselage structure which is balsa planked. The wings are made from 12 millimetre sheet balsa.

when lines may trail in the water and there is a most difficult period when torque tends to send an anti-clockwise flying model in towards the pilot, it frequently becomes necessary for quick action to be taken. Taberna modifies his engines so that he can still fly anti-clockwise but the engines rotate clockwise and so torque gives him some assistance. Full " up " elevator is always essential for take-off and the landings are not stalled in, but instead the model is allowed to skim the water most effectively.

Possibilities

During a conversation with Franco Bugada, several fascinating aspects came to light and these are in the minds of the Italian modellers, to whom all credit must be given for their promotion of the ideas.





Firstly, there is the exciting prospect of team racing these Schneider seaplanes! With practice, handling is no more difficult than normal team racers but one can imagine the hazards and excitement of pit stop!—or *plop*!

Secondly, the Italians have a tentative scheme for definite team racing with scale models of well known undercarriage type racers as for example those that competed in the American *Bendix* and *Thompson* Trophy races, all to a fixed scale of $\frac{1}{7}$th and $\frac{1}{8}$th with the requirement for enclosed engines. Most encouraging for the scale enthusiasts, and we wish them all success. Bugada and his compatriots have produced a number of enterprising subjects, but none more interesting than his own scale model of the Pegna P.C.7. His model is fitted with a Super Tigre G20/15 2·5 c.c. glow motor, but the rear water screw is purely decoration. What follows is a general description, which Bugada has supplied, concerning this fascinating project.

Piaggio Pegna P.C.7 Racing Seaplane

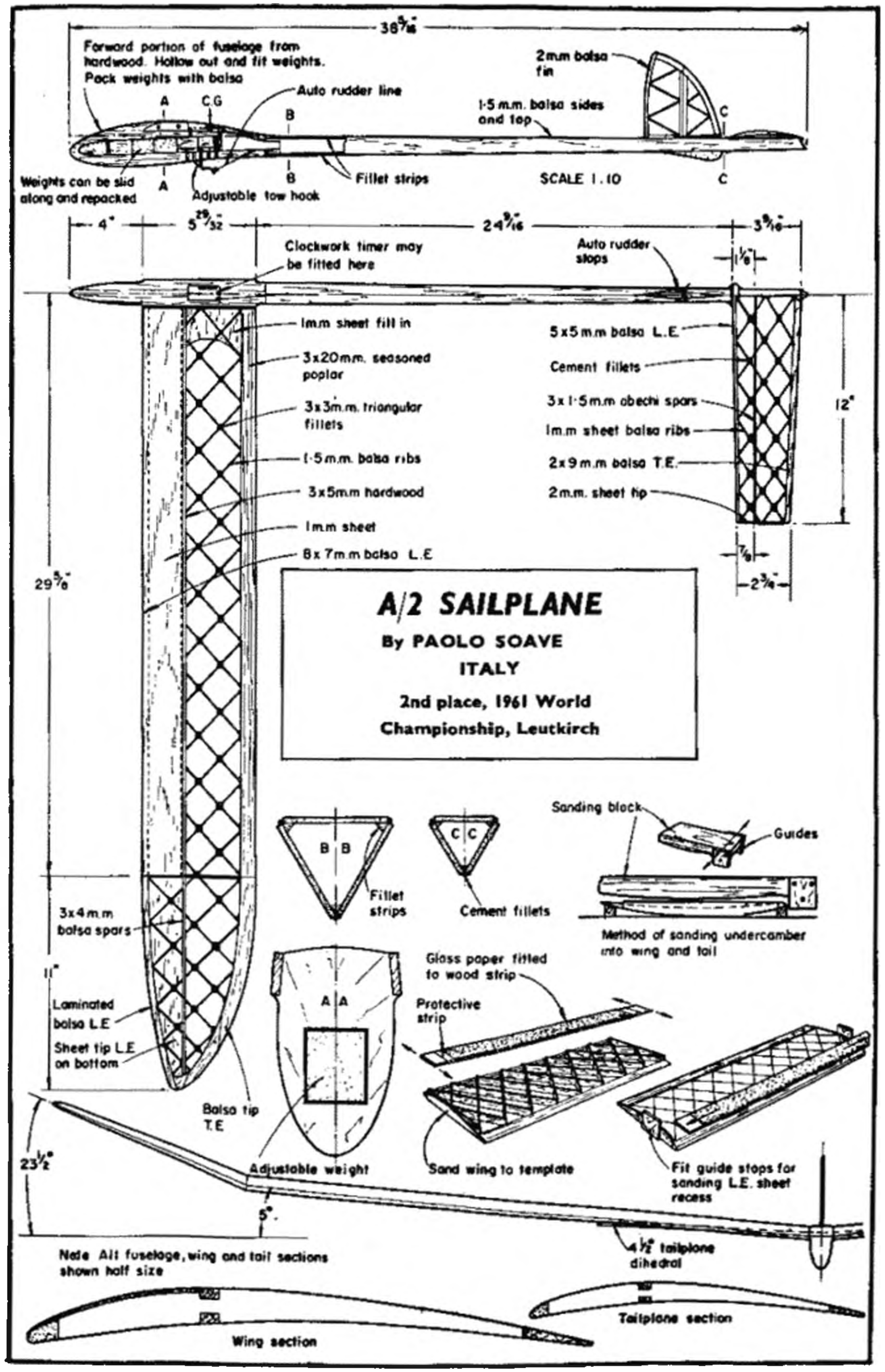
Giovanni Pegna was among the first engineers to execute studies on hydrodynamic foils as a substitute for floats in the racing seaplanes. He always maintained that high speeds were obtainable only with increased engine power, and a reduction of the aerodynamic drag. First realisation of Pegna's ideas was the monoplane projected in 1921 with a float-fuselage. The propeller axis was elevated from the usual position, thus the propeller went out the water, turned, and the aircraft floated. When the aircraft was in the air the propeller axis took up the usual position again. This interesting monoplane was projected and was baptised P.C.1. The *Societa Bastianelli di Roma* began building it, but for economic reasons the P.C.1 was never finished. The P.C.2 (Piaggio P.4) projected in 1923 was a classical racing seaplane for the Schneider Trophy Contest of 1924, which was not run. Next came the P.C.3. The fuselage section was modified and also the volume and the shape of the floats. This seaplane was built, but not finished for administrative causes. In 1927 the Regia Aeronautica put the engineer Pegna on to 1929 Schneider Cup projects. This was the P.C.4 racing seaplane; a low-wing monoplane with a float-fuselage; but the two engines mounted back-to-back (as in the Savoia Marchetti S.65) were in a nacelle standing above the float-fuselage. This project did not satisfy Pegna who then projected the P.C.5 and the P.C.6 with a first idea of hydrodynamic foils. The Piaggio Co. built a wind-tunnel at Finalmarina to make tests and made trials also in the hydro institutes like La Froude Basin of La Spezia with special motor-ships using foils. Then the engineer Pegna built a model; a monoplane baptised " X ", which was modified several times during the tests (for example the airfoil was modified from an original Curtiss to a Munk). With these trials he arrived at the definite project, the P.C.7. Hydrodynamic foils were adapted (the idea was that of stones hurled tangentially on the surface of water). Inverted Vee foils were used initially, added to the undercarriage and two small ones on the fin. The aircraft rose in the water with a sea propeller, skimming on the foils. When the air-propeller was completely out the water it began to turn. Naturally these propellers were also studied; a motorship with 300 h.p. was built to try the sea-propeller.

The construction of P.C.7 was begun in 1930. Initially the FIAT Co. promised to do the FIAT 1000 h.p. engine and the engineer Pegna studied a transmission system on this engine, but then the FIAT Co. renounced their interest. Engineer Giustino Cattaneo projected an Isotta Fraschini engine. The position of several items in the fuselage was particularly difficult and innumerable problems were resolved from day to day during construction by the engineer Pegna and his collaborators, engineer Gabrielli, Doctor Luotto, and Arrigoni.

Unfortunately only flotation trials were done. In fact the P.C.7 never flew because the sea propeller was starved of oil and seized during a take-off. The Piaggio Co. and the Regia Aeronautica then forsook this aircraft which was never able to compete in a Schneider Race nor to attempt a World Record.

Dimensions and Data

Span: 6,70m Length: 8,86m Height: 2,45m



A/2 SAILPLANE

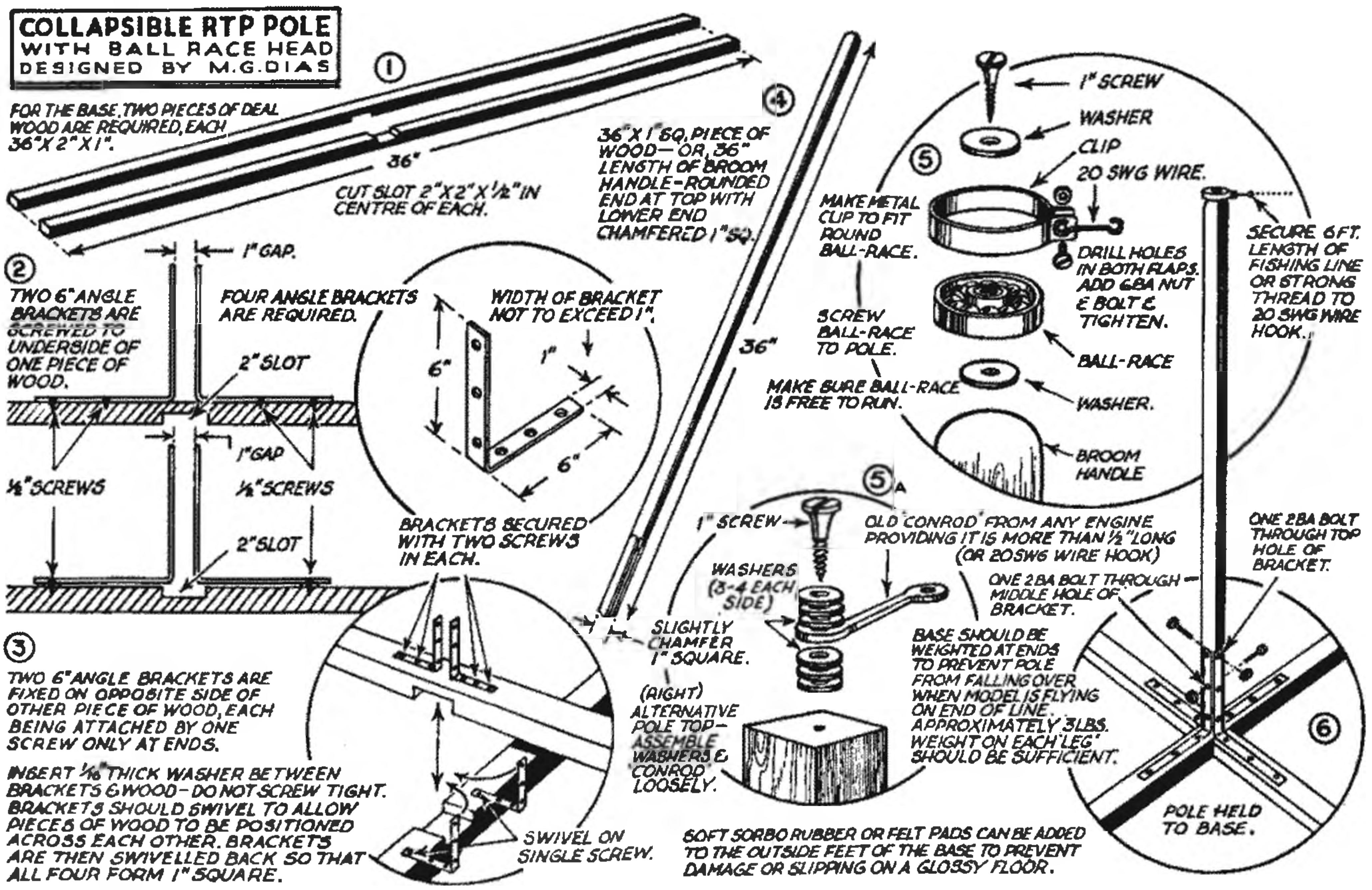
By PAOLO SOAVE

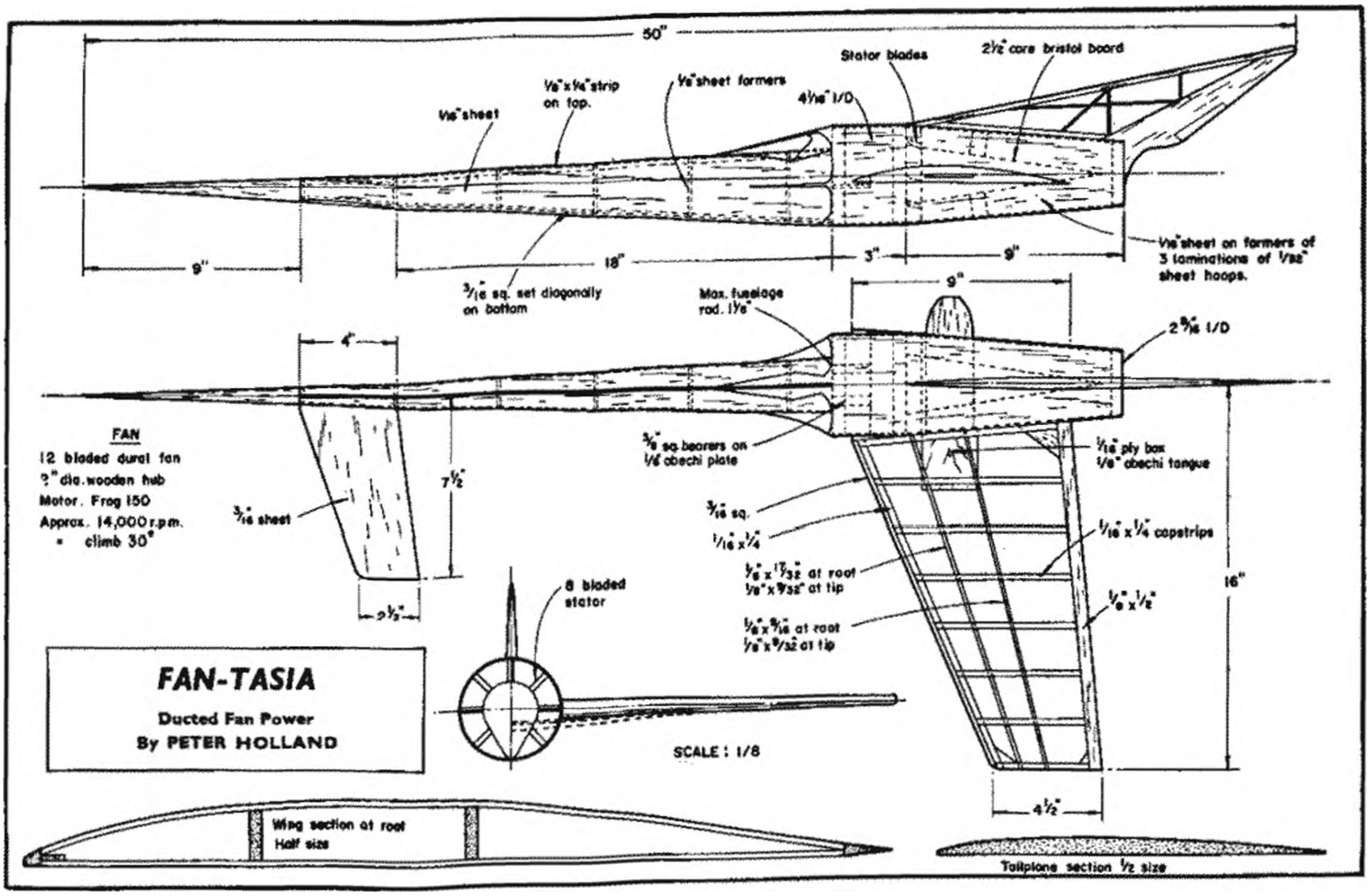
ITALY

2nd place, 1961 World Championship, Leutkirch

RASSEGNI MODELLISMO, ITALY

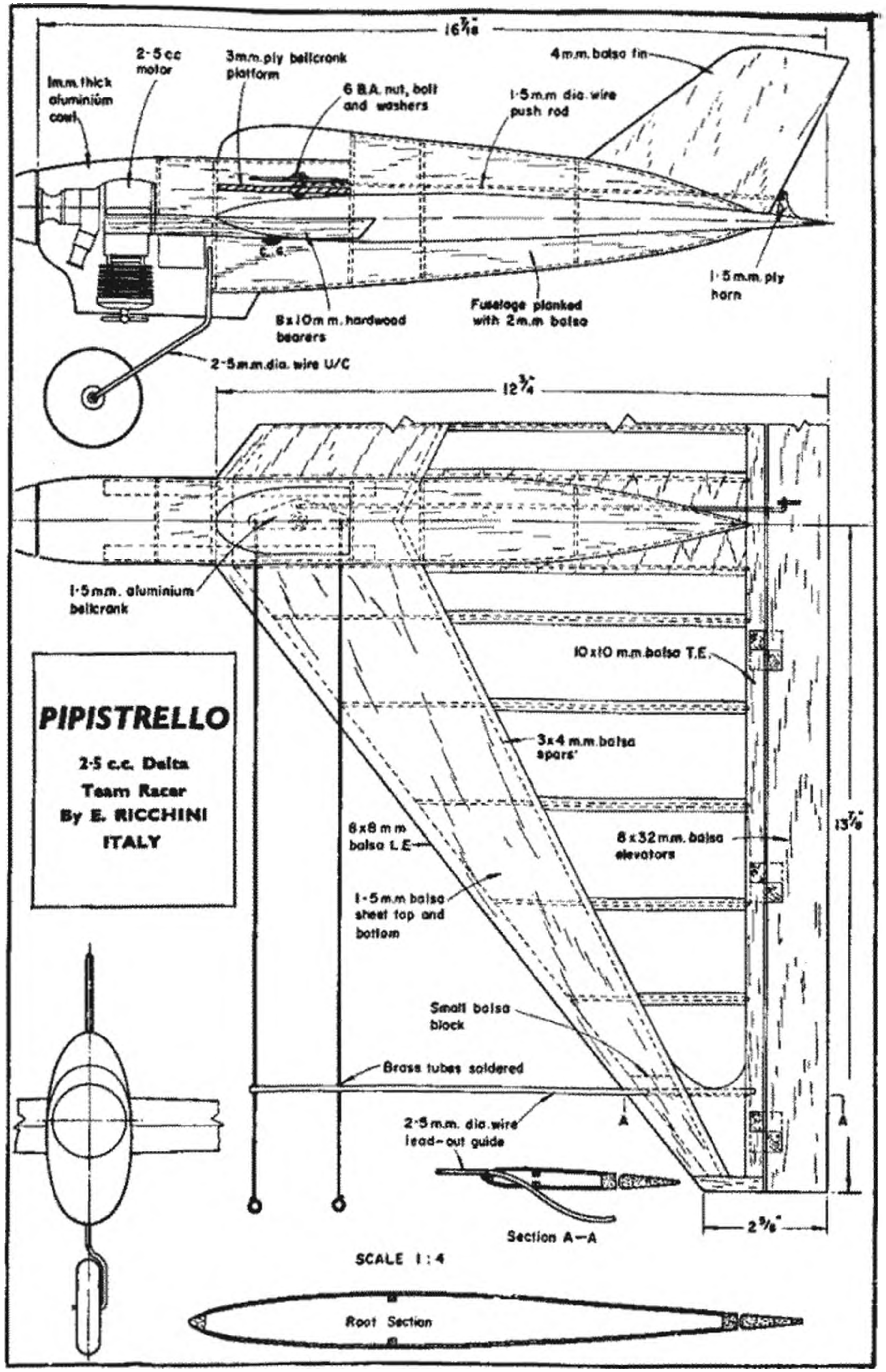
COLLAPSIBLE RTP POLE
WITH BALL RACE HEAD
DESIGNED BY M.G.DIAS





FAN-TASIA

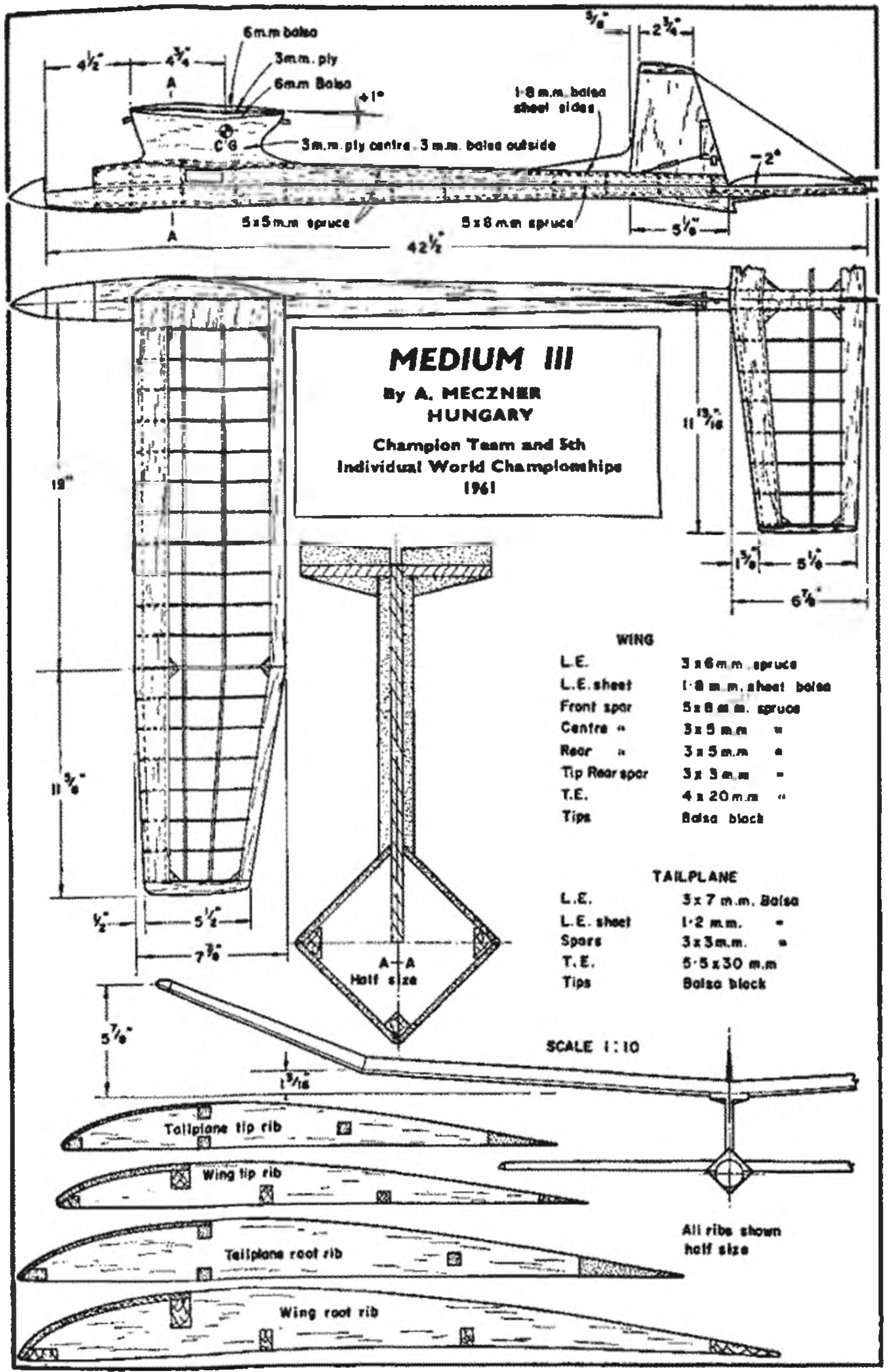
Ducted Fan Power
By PETER HOLLAND



PIPISTRELLO

2·5 c.c. Delta
Team Racer
By E. RICCHINI
ITALY

ALI, ITALY



MEDIUM III

By A. MECZNER
HUNGARY

Champion Team and 5th
Individual World Championships
1961

WING

L.E.	3x6m.m. spruce
L.E. sheet	1·8 m.m. sheet balsa
Front spar	5x8 m.m. spruce
Centre "	3x5 m.m "
Rear "	3x5 m.m "
Tip Rear spar	3x3 m.m "
T.E.	4x20 m.m "
Tips	Balsa block

TAILPLANE

L.E.	3x7 m.m. Balsa
L.E. sheet	1·2 m.m. "
Spars	3x3m.m. "
T.E.	5·5x30 m.m
Tips	Balsa block

SCALE 1:10

MODELLEZES, HUNGARY

LIGHTWEIGHT RUBBER MODELS

By Peter Gasson

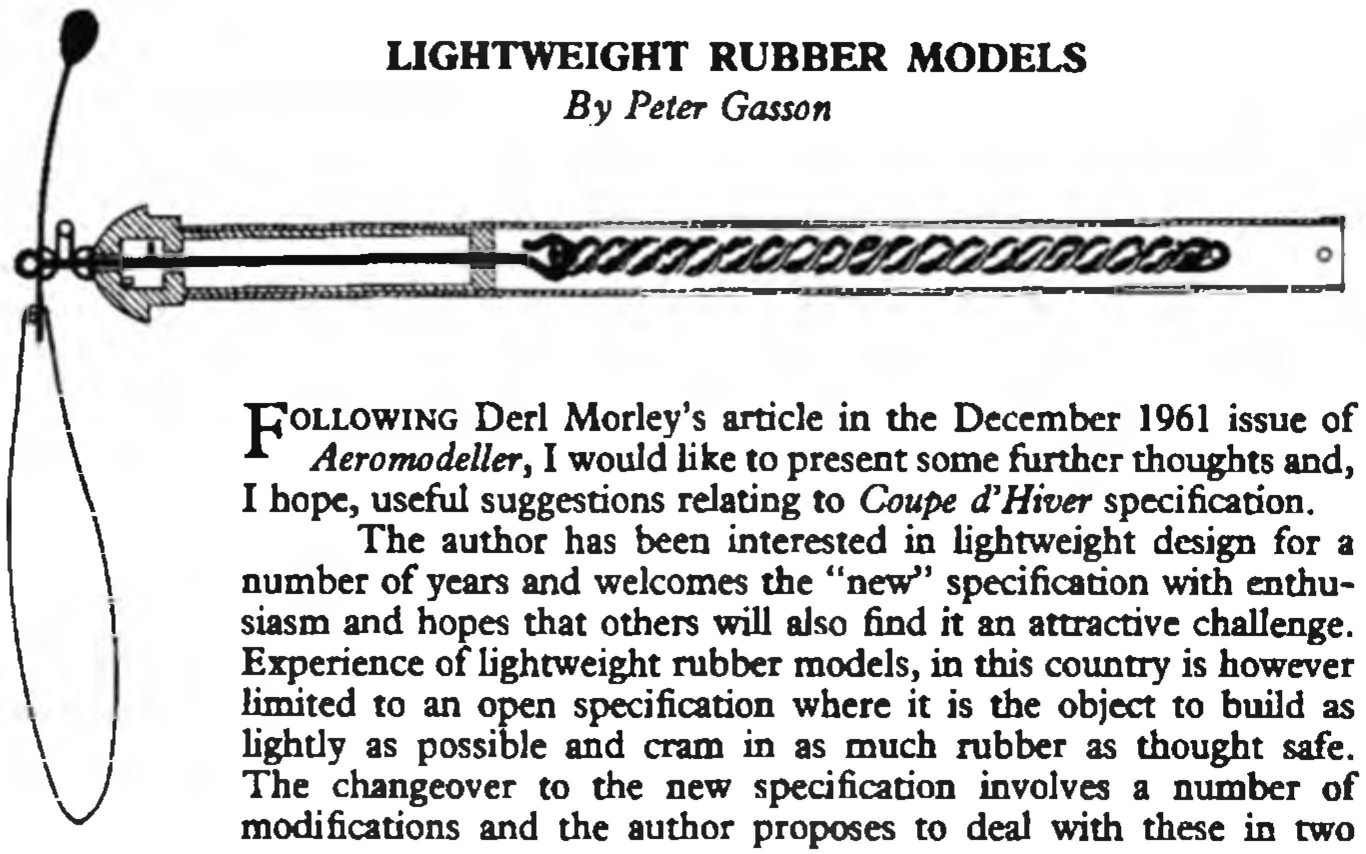


FIG. 3

FOLLOWING Derl Morley's article in the December 1961 issue of *Aeromodeller*, I would like to present some further thoughts and, I hope, useful suggestions relating to *Coupe d'Hiver* specification.

The author has been interested in lightweight design for a number of years and welcomes the "new" specification with enthusiasm and hopes that others will also find it an attractive challenge. Experience of lightweight rubber models, in this country is however limited to an open specification where it is the object to build as lightly as possible and cram in as much rubber as thought safe. The changeover to the new specification involves a number of modifications and the author proposes to deal with these in two stages.

Firstly, the continued development of the reader's own design is to be recommended and the first article is concerned with the modification of an existing design for those who already own an efficient lightweight. The method is illustrated by applying the modifications to one of the author's own lightweights and it is hoped that those who have not yet built a high performance lightweight will be attracted to the author's model.

Present Day Needs and a Review of the Proposed Formula

Today the need for long thermal flights has disappeared and the efficiency of the modern D.T. has removed the word OOS from our vocabulary. The problem today is rather one of flying space and of time-keepers' eyesight, it is logical therefore to design our models with this limitation in view. The problem of flying space has already been effectively dealt with by the current Wakefield specification, where it became necessary a few years ago to limit the rubber weight and therefore the performance to suit the available flying spaces.

As readers of the December 1961 *Aeromodeller* will know it is hoped to introduce into our contest calendar a new lightweight rubber class, the rules for which have been stated as follows:

1. A maximum of 10 gr. of rubber (0·352 ozs.)
2. A minimum of 70 gr. of airframe (2·46 ozs.)
3. A minimum of 20 cm.^{2} fuselage cross section (3·1 in.^{2})
4. Rise off ground (R.O.G.)

Most modellers I feel would, in view of our present requirements, accept rules 1, 2, and 3 without question. I am sure that rule 4 will make many modellers gnash their teeth as it has often done in the past. The difficulty of applying an R.O.G. rule is well known to all modellers who remember the contests of a few years back.

Why I say no R.O.G. Requirement

It all depends on what you mean by an R.O.G. flight.

Is the take-off to be realistic? If so, surely wheels and some length of run must be specified. Alternatively, if a prong of wire and a vertical take-off are accepted, how many points of the model are to be initially on the ground and what official action is to be taken should a strong gust lift one of these points away from terra firma while the unfortunate contestant is releasing his model. The last mentioned difficulty has been in the past a very common one. Bad weather conditions accompanying many of our contests make R.O.G. flights a hazardous occupation and spectators notorious for their unruliness are more likely to hem in a model rising from the ground causing it to crash before getting clear of the ground.

Why then must we be hampered by this useless and therefore unnecessary restriction which has caused so many good models to be smashed at the starting line? Fortunately this requirement was rejected in this country years ago and I trust that it will not live long in its present setting. At the most one could only recommend the R.O.G. rule as an optional requirement, beyond this it must surely be classed as a retrograde step.

The Conversion of an Open Ruler

The wing, tail and propeller will probably be suitable for a first experiment and it would in the normal way be necessary only to build a new fuselage and add any necessary ballast to bring the model up to 2·82 ozs.

However, the author suggests a different approach where use is made of the complete model with the addition of a light motor tube and modified propeller shaft. If the overall weight of the new model (2·82 ozs.) is about the same as that of the old model then the same cross section rubber motor will be required.

The weight of rubber used in the old style model was commonly more than 1 oz. (28·3 gr.) which is approximately three times the quantity to be used under *Coupe d'Hiver* rules. Since the cross sectional area of the motor will be unchanged it is clear that motors will be only one-third of the length previously used (and will stand only one-third of the turns). However, the major difficulty associated with this short motor is its correct location to suit the model's original C.G. position. One solution is to move the rear motor anchorage forward and add ballast to re-balance (*see* Fig. 1*b*), but if it is proposed to develop a new model then a more elegant approach is required. The new motor length is so short that no trouble in accommodating it will be experienced and it should therefore be mounted taut between anchors. The difficulty arises that the front anchor (the propeller) is almost certainly longitudinally fixed, shortening the nose of the old design will not usually be possible since the wing leading edge position

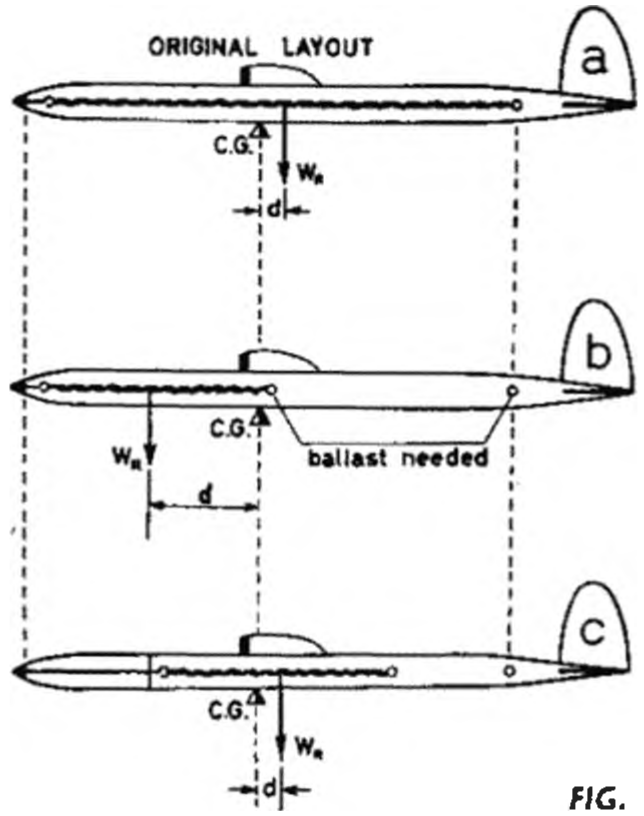


FIG. 1

FIG. 2

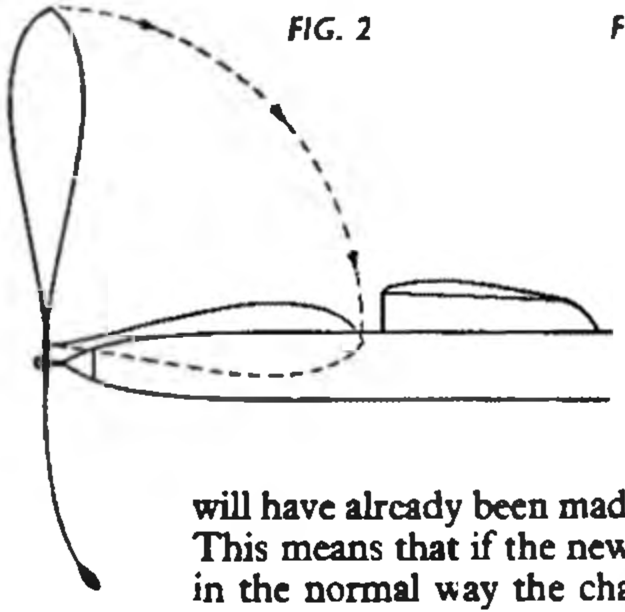
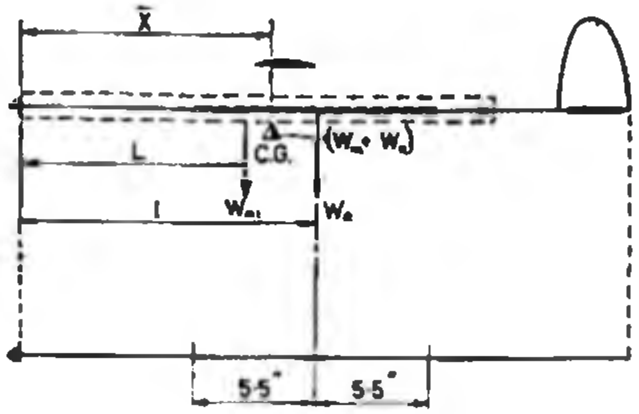


FIG. 4



will have already been made to facilitate propeller folding (*see* Fig. 2). This means that if the new short motor is connected to the propeller in the normal way the change in C.G. position would be considerable, leaving the new model very nose heavy unless ballast is used (*see* Fig. 1*b*). The most obvious remedy is to increase the tail moment arm to balance out this change in C.G. position. It must be remembered that if this solution is adopted then the aerodynamic longitudinal balance of the machine will be upset (since we propose to use the existing tail unit). An alternative would be to keep the same length fuselage making the rear of heavier construction to balance out the change in rubber position (this is effectively the same as adding ballast to this region which is generally undesirable).

Remembering some of the difficulties experienced with the freak long fuselage Wakefield models it is suggested that the new short motor is positioned about its original mid-point position (*see* Fig. 1*c*). (A French expert has recently stressed the need for a long tail moment arm but the author assumes that this does not refer to a preference for the ultra long freak designs.) This means that the front end of the motor will be some inches away from the old style propeller shaft and an extension will be needed. The rear anchor can be moved to a suitable position without difficulty if this should prove necessary. This system leaves the weight distribution and aerodynamic balance of the old model unchanged and therefore puts things on a sound footing for further development. If the old model weighed around 2·8 ozs. then it will be possible to use it complete with a modified propeller shaft and special motor tube.

The demand for maximum turns on the short length of rubber will become even more necessary making breakages more likely and the need for protecting the fuselage from such outbursts will have to be foolproof. As already mentioned the author proposes that the motor C.G. position is kept in its old position making it necessary to extend the propeller shaft length and move the rear anchor forward (*see* Fig. 1*c*). A convenient way of dealing with both problems at the same time whilst also satisfying the minimum weight requirement will be to introduce a light alloy tube (or balsa tube) into the existing fuselage. Motor anchorage positions can then be adjusted and a protection for the lightweight fuselage construction obtained (*see* Fig. 3).

Resolving a Subtlety

To ensure that the new C.G. position lies close to its old position one further point needs to be settled. It will be appreciated that in general the above device for replacing the old long motor by a shorter one, together with a tube, and arranging for the C.G. of the tube and short motor to lie on the old C.G. position only holds providing the combined weight of the tube and the short motor equals the original weight of rubber. It will probably occur, however, that the weight of the combination is different from that of the original motor. It is usually agreed that to take best advantage of a minimum weight specification the total weight of the model should be only just in excess of the specified minimum for which reason our tube weight should be adjusted to bring about this condition. (We have previously taken this to be 2·82 ozs.) Bearing this in mind it is necessary to calculate the geometry of the set-up to be used and for this purpose a typical layout is shown in Fig. 4 giving the forces involved. It will be remembered that it is proposed to keep the C.G. position in its original place, *i.e.*, a distance $\bar{X}$ from the nose former.

The weight W_{mt} of the motor tube will act at its mid-length a distance L from the nose former. The mid-point of the rubber motor must be positioned such that it balances the action of the two forces— W_{mt} and $(W_{mt}+W_R)$.

We note that all quantities are known except the distance l. (The motor tube weight is given by 2·82 ozs.—weight of wings, fuselage, propeller and rubber).

Taking moments about nose former we see that:

$$l = \bar{X} + \frac{W_{mt}}{W_R}(\bar{X} - L)$$

The mid-point of the rubber being at a distance l we arrange for our propeller shaft to terminate at $(l - 5{\cdot}5)$ inches behind the nose former and our rear anchorage at $(l + 5{\cdot}5)$ inches from the nose former.

For the convenience of those wishing to buy light alloy tube Table 1 gives the approximate weight oz./foot for tubes of different diameters and thicknesses.

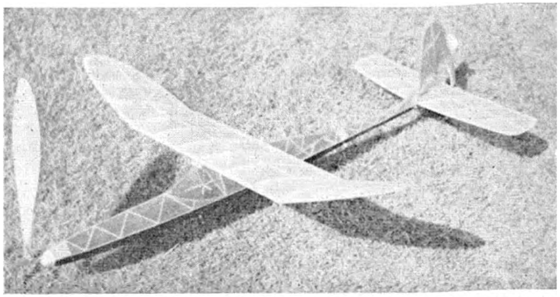
TABLE I
LIGHT ALLOY TUBE DATA

Nominal Diameter	THICKNESS S.W.G.					
	26	28	30	32	34	36
¾"	·77	·66	·55	·48	·42	·34
⅞"	·93	·77	·64	·56	·47	·39
1"	1·03	·87	·74	·63	·54	·45

Weights per foot have been given since in most cases this will, in fact, be almost exactly the length used for a *Coupe d'Hiver* motor.

The Author's Model

The model illustrated here is the outcome of a number of designs built by the author during the last fifteen years, it does not, however, represent a continued development over this period. Its aerodynamic shape and size is fairly conventional, the wing area being perhaps a little smaller than that commonly used in recent years. When designing the model the author set out to achieve extreme lightness with a view to experimenting further with the Marcus "Supa Dupa" formula. Construction is fairly straightforward and should not produce any difficulty to the modeller of one or two years' experience. It must, however, be pointed out that the structure of the model is rather complex and likely to



Winter Queen, a Coupe d'Hiver model by the author, available through the A.P.S. and shown on pages 48-49.

prove tedious to the newcomer to high performance models and on this account is not to be recommended to anyone who is not prepared to spend forty hours or so on its construction.

Lightweight Rubber Model History

We have dealt with the conversion of an existing design and it is now proposed to give an account of the author's more recent researches together with a brief history of lightweight rubber model development over the past twenty years.

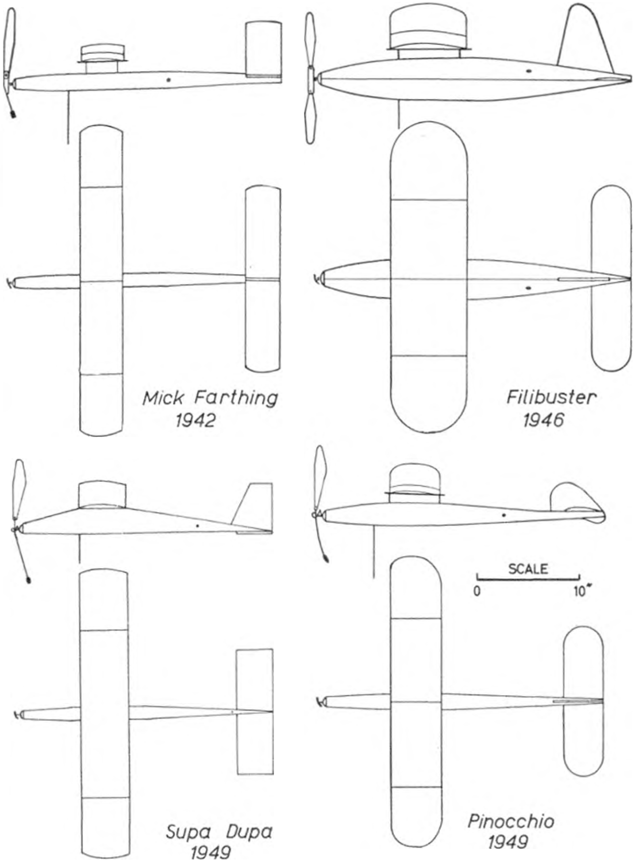
It is a little less than twenty years since the ultra lightweight rubber model was first introduced by Mick Farthing, and others, and during the following war years climbed to the height of popularity. Unfortunately, during the past ten years little further improvement has taken place in this country.

The correlation between lightness and high performance was in these early years thought obvious and this probably attracted many followers, but the main interest in this type was probably due to the wartime rubber shortage which, in these times, proved quite an embarrassment to the "Wakefield" flyer.

The models as pioneered by Mick Farthing were of about 30 in. wing span and 150 sq. in. wing area which were capable of regular flights of 2 to 2½ minutes' duration when handled by the experts. Structurally, the Mick Farthing lightweights were poor, the design being invariably of a straightforward, and by today's standards, of a crude nature. However, the excellent materials available today make it only too easy to criticise those early pioneers and the difficulties under which the wartime modeller laboured should not be underestimated. Nevertheless, lightweight structural design has improved one hundredfold since these times, but ironically enough it has taken the Wakefield modeller to develop it.

After the Mick Farthing and Ted Buxton models a smaller style model was evolved, an outstanding example of which is Laurie Barr's "Pinocchio" which appeared in print about 1949. The reason for the smaller model was presumably due to the low-energy rubber available in the early post-war years (six strands of ¼ rubber was only just sufficient). During the ten years 1951 to 1961 little interest has been shown in the small lightweight machine, that is until the arrival of Derl Morley's "Garter Knight"—*Aeromodeller*, December 1961.

FIG. 5



The models listed overleaf are those that the author considers to be the key models in the history of small rubber lightweights, and therefore are the ones which have influenced the author in his own designs. It is left to the reader to study the details and draw his own conclusions.

TABLE 2
TYPICAL MODELS

	DESIGN	MICK FARTHING	FILIBUSTER	SUPA DUPA	PINOCCHIO
Aerodynamic	Span	30	30	28	28
	Aspect Ratio	6·67	5·0	5·9	5·6
	Wing Area	133	180	133	140
	Wing Position	Parasol	Parasol	High	Parasol
	Wing Section	Marquardt	Marquardt	Curved Plate	Marquardt Style
	Weight	2·5	3·7	1·75	2·7
	Wing Loading	1·88	2·05	1·32	1·93
	Power	6—$\frac{1}{4}\times\frac{1}{24}\times30$	12—$\frac{1}{8}\times\frac{1}{24}\times30$	6—$\frac{1}{4}\times\frac{1}{30}\times28$	8—$\frac{1}{4}\times\frac{1}{30}\times30$
	$\frac{\text{Power Weight}}{\text{Frame Weight}}$ Ratio	0·667	0·68	0·75	0·65
	$\frac{\text{Power Weight}}{\text{Total Weight}}$ Ratio	0·40	0·41	0·43	0·40
	Fuselage Length	26	30	24·4	26·8
	Moment Arm	15·7	17·5	16·7	15·5
	Tail Vol. Coefficient	1·44	1·17	1·04	1·15
Structural	Wing L.E.	$\frac{3}{16}\times\frac{3}{16}$	$\frac{7}{16}\times\frac{1}{8}$	$\frac{1}{8}\times\frac{1}{8}$	$\frac{1}{4}\times\frac{1}{4}$
	Wing T.E.	$\frac{1}{4}\times\frac{1}{8}$	$1\times\frac{3}{16}$	$\frac{1}{4}\times\frac{1}{8}$	$\frac{1}{4}\times\frac{1}{32}$
	Fuselage Members	$\frac{1}{16}\times\frac{1}{16}$	$\frac{3}{32}\times\frac{3}{32}$	$\frac{3}{32}\times\frac{3}{32}$	$\frac{3}{32}\times\frac{1}{16}$
	Propeller Hub	Built up Balsa/Ply	Built up Balsa/Ply	Wire	Wire

ALL DIMENSIONS IN INCH UNITS

It will not take the reader long to notice the similarity of the four early designs and the author feels that it is possibly this very fact that caused interest in the ultra lightweight class to wane. However, a new challenge has now been introduced in the form of a restricted rubber weight and it is intended to design a model with this end in view.

The Design of a Coupe d'Hiver Model

The first question is clearly, what size should the model be? Past designs show that a model of about 150 sq. in. wing area is suitable and also that one of the sections listed in Table 3 can be relied upon.

Referring to Table 2 it will be noted that aspect ratios vary but slightly (between 5 and 6·67). Today, however, higher aspect ratios are popular mainly due to the high performance of the "Lincoln" type models where a value of 10 is the order of the day. Wing sections, however, have changed over the years and the once popular "Marquardt" section has been duly replaced, an up-to-date selection being given in Table 3. Prompted by the experiments of Werner Thies (*Aeromodeller*, February 1962) the author has himself become in favour of the flat-bottomed Go 795 section which is reported in Thies's article to give an excellent performance. For the author's model detailed here this is certainly verified, and further it makes construction easier and torsionally stiffer.

Further, six strands of $\frac{1}{4}$ in. × $\frac{1}{24}$ in. rubber will be required. Table 4 shows possible alternative power systems from which it will be noted that a number of alternatives are available. The $\frac{1}{4}$ in. × $\frac{1}{30}$ in. and the $\frac{1}{8}$ in. × $\frac{1}{30}$ in. strip have an unsuitable number of strands but offer a slight power boost if the number of strands is increased to 8 and 16 respectively. The length of all motors will be approximately 10·5 in.

TABLE 3
AIRFOIL SECTIONS DISCUSSED
CURVED PLATE

STATION	0	2·5	5	10	20	30	40	50	60	70	80	90	100
UPPER	1·45	3·65	4·7	6·3	7·75	8·5	8·8	8·45	7·85	6·9	5·7	4·25	1·45
LOWER	1·45	0·45	1·55	3·3	4·85	5·7	5·9	5·55	4·95	4·0	2·8	1·3	1·45

MARQUARDT

STATION	0	2·5	5	10	20	30	40	50	60	70	80	90	100
UPPER	3·75	6·5	8·0	9·9	11·9	12·6	12·4	11·4	10·0	7·9	5·5	2·7	0·0
LOWER	3·75	1·37	0·87	0·12	0·37	1·2	1·7	2·4	2·6	2·7	2·5	1·5	0·0

N.A.C.A. 6409

STATION	0	2·5	5	10	20	30	40	50	60	70	80	90	100
UPPER	0·0	2·96	4·30	6·31	8·88	10·13	10·35	9·81	8·78	7·28	5·34	2·95	0·0
LOWER	0·0	−1·11	−1·18	−0·88	0·17	1·12	1·65	1·86	1·92	1·76	1·36	0·74	0·0

GO 795

STATION	0	2·5	5	10	20	30	40	50	60	70	80	90	100
UPPER	2·4	4·4	5·3	6·45	7·65	8·0	7·9	7·4	6·5	5·25	3·85	2·2	0·4
LOWER	2·4	0·9	0·5	0·15	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·1

TABLE 4
RUBBER MOTORS

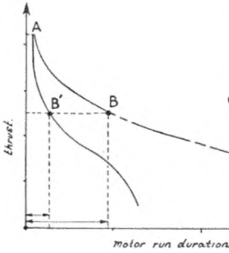
SIZE	$\frac{1}{4}\times\frac{1}{16}$	$\frac{1}{4}\times\frac{1}{24}$	$\frac{1}{4}\times\frac{1}{30}$	$\frac{3}{16}\times\frac{1}{24}$	$\frac{3}{16}\times\frac{1}{30}$	$\frac{1}{8}\times\frac{1}{24}$	$\frac{1}{8}\times\frac{1}{30}$	$\frac{1}{16}\times\frac{1}{16}$
No. STRANDS	4·0	6·0	7·5	8·0	10·0	12·0	15·0	16·0

ALL DIMENSIONS IN INCH UNITS

It will be clear to most modellers whether experienced or not that 10·5 in. is indeed a short length and as previously mentioned our fuselage will need to be of ample strength to resist any bad temper a breaking motor of this size may have. Some of the lost rubber weight can, therefore, be usefully employed to fulfil this function. It seems rather pointless under the present rules to build a delicate fuselage and protect it with a motor tube, a fuselage of sheet construction is therefore suggested.

The short motor length, however, imposes a more difficult problem as can be verified by flying an old design using the new power arrangement. Due to the shortness of the motor the power run is necessarily short but since the motor cross section will be the same as previously the maximum torque (and thrust) produced will be the same as for a conventional motor. The effect of this is best seen by reference to Fig. 6, which shows a torque time curve for the two types of motor in question.

FIG. 6



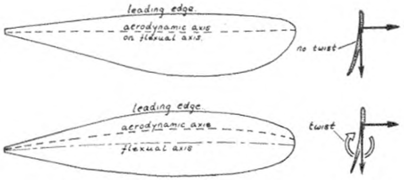


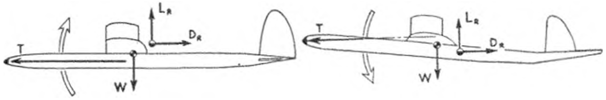
FIG. 7

In the past the initial surge of power A-B on the graph has been suppressed by using ample downthrust or even by delaying release of the model. Since the change in torque from A to B has taken place over a period of 10 seconds or so, the model has been able to adapt itself to its decreasing power supply without undue difficulty. The new power system, however, changes its face at a much faster rate (the initial burst from A-B lasting for less than 5 seconds) and further, the model will not have the benefit of the relatively long period at almost constant torque. As those who have flown rubber models will know the result of this latter feature is usually a stall and a tail slide, or alternatively most of the climb is spent in an under-elevated attitude with consequent low ceiling and poor performance. Derl Morley has since demonstrated that a model and propeller of conventional proportions can still cope and no one could argue this point in face of the excellent performance of "Garter Knight". The author, however, had already sought a less conventional solution before hearing of Derl Morley's successes.

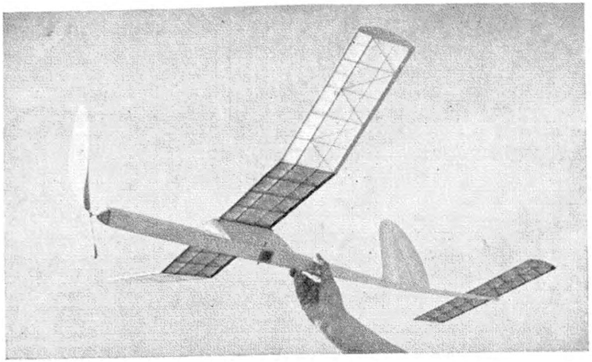
Now that the rubber weight premium is so high the problem of preventing a stall without undue wastage of power is obviously of prime importance. The author reached a solution to this problem in two steps. Firstly, a variable pitch airscrew of the Bilgri style was used, and secondly a negative thrust layout was employed.

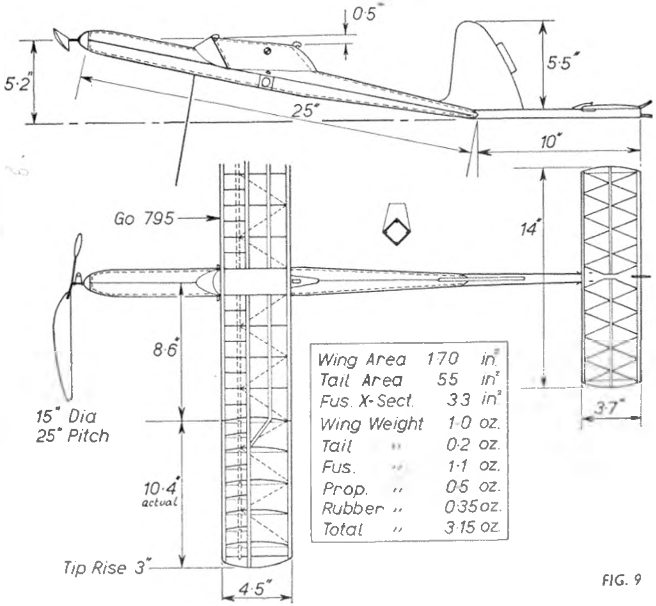
The Twisting Propeller

This is a propeller whose aerodynamic axis is in front of its flexual axis—*see* Fig. 7—and it therefore increases in pitch when the aerodynamic forces are large (*i.e.*, at the beginning of the power run). In this way the initial surge of power is killed and the delivery of thrust more uniform.



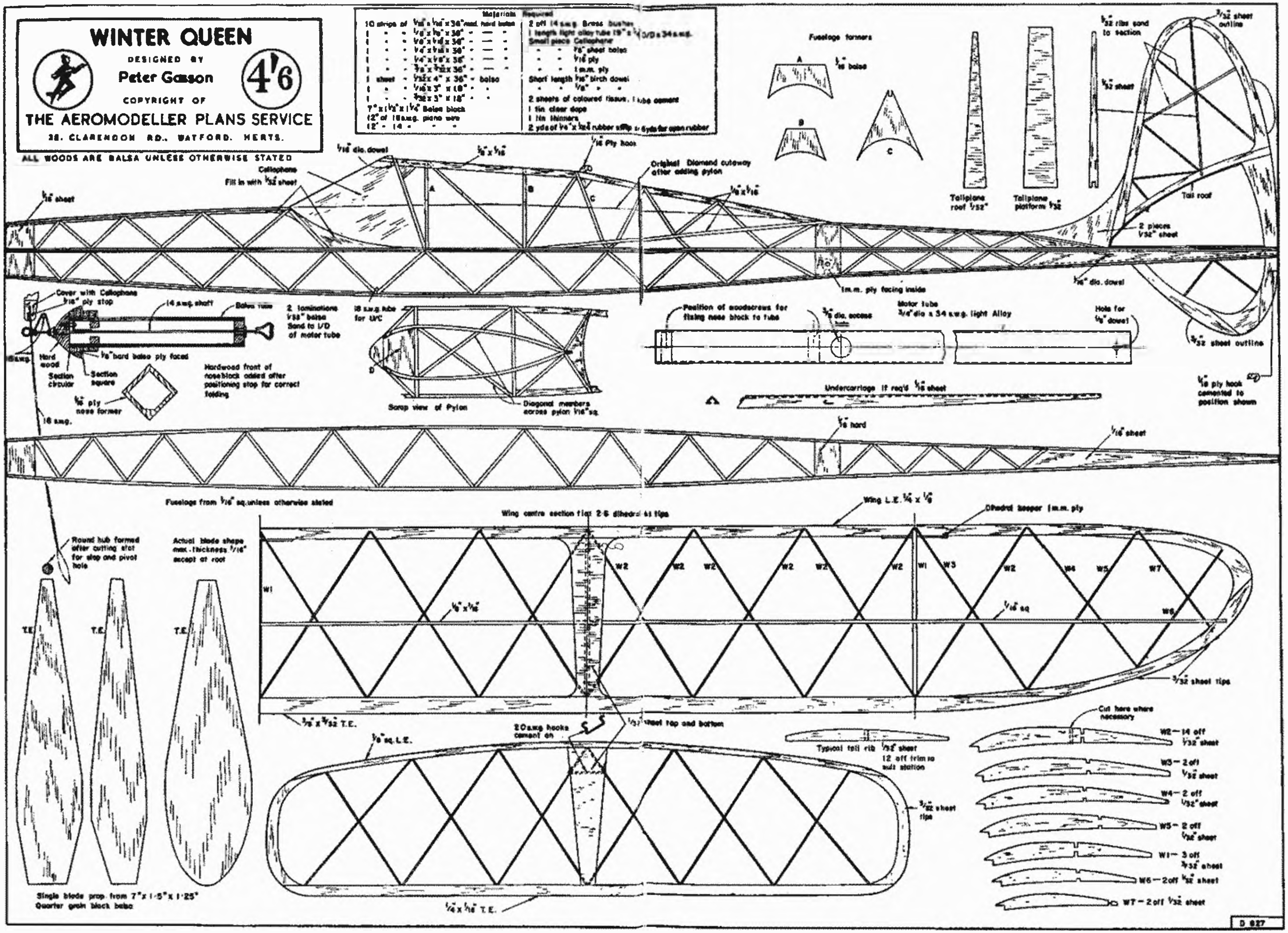
(a) (b) FIG. 8





Wing Area	170	in²
Tail Area	55	in²
Fus. X-Sect.	3·3	in²
Wing Weight	1·0	oz.
Tail "	0·2	oz.
Fus. "	1·1	oz.
Prop. "	0·5	oz.
Rubber "	0·35	oz.
Total "	3·15	oz.

FIG. 9


WINTER QUEEN
DESIGNED BY
Peter Gasson
4/6
COPYRIGHT OF
THE AEROMODELLER PLANS SERVICE
38, CLARENDON RD., WATFORD, HERTS.
ALL WOODS ARE BALSA UNLESS OTHERWISE STATED
Materials Required
10 strips of 1/16" x 1/16" x 36" med. hard balsa
1 " " 1/8" x 1/8" x 36" " — "
1 " " 1/8" x 1/16" x 36" " — "
1 " " 1/4" x 1/16" x 36" " — "
1 " " 1/4" x 1/8" x 36" " — "
1 " " 3/8" x 3/32" x 36" " — "
1 sheet " 1/32" x 4" x 36" " balsa
1 " " 1/16" x 3" x 18" " "
1 " " 3/32" x 3" x 18" " "
7" x 1 1/2" x 1 1/4" Balsa block
12" of 18 s.w.g. piano wire
12" " 14 " " "
2 off 14 s.w.g. Brass bushes
1 length light alloy tube 19" x 3/4" O/D x 34 s.w.g.
Small piece Cellophane
" " 1/8" sheet balsa
" " 1/16" ply
" " 1 m.m. ply
Short length 1/16" birch dowel
" " 1/8" " "
2 sheets of coloured tissue, Tube cement
1 tin clear dope
1 tin thinners
2 yds of 1/4" x 1/24" rubber strip or 6 yds for open rubber
1/16" dia. dowel
1/8" x 1/16"
1/16" Ply hook
Cellophane
Fill in with 1/32" sheet
1/16" sheet
A
B
C
Original Diamond cutaway after adding pylon
1/8" x 1/16"
Fuselage formers
A
1/16" balsa
B
C
Tailplane roof 1/32"
Tailplane platform 1/32"
1/32" ribs sand to section
1/32" sheet
3/32" sheet outline
Tail roof
2 pieces 1/32" sheet
1/16" dia. dowel
1 m.m. ply facing inside
Cover with Cellophane
1/16" ply stop
14 s.w.g. shaft
Balsa tube
2 laminations 1/32" balsa Sand to I/D of motor tube
18 s.w.g. tube for U/C
18 s.w.g.
Hard wood
Section circular
Section square
1/8" hard balsa ply faced
1/16" ply nose former
Hardwood front of noseblock added after positioning stop for correct folding
D
Scrap view of Pylon
Diagonal members across pylon 1/16" sq.
18 s.w.g.
Position of woodscrews for fixing nose block to tube
3/8" dia. access hole
Motor tube 3/4" dia x 34 s.w.g. light Alloy
Hole for 1/8" dowel
3/32" sheet outline
Undercarriage if req'd 1/16" sheet
1/16" ply hook cemented to position shown
1/16" hard
1/16" sheet
Fuselage from 1/16" sq. unless otherwise stated
Wing centre section flat 2·6 dihedral at tips
Wing L.E. 1/4" x 1/8"
Dihedral keeper 1 m.m. ply
Round hub formed after cutting slot for stop and pivot hole
Actual blade shape max. thickness 1/16" except at root
T.E.
T.E.
T.E.
W1
W2
W2
W2
W2
W2
W2
W1
W3
W2
W4
W5
W7
W6
1/8" x 1/16"
1/16" sq
3/32" sheet tips
3/8" x 3/32" T.E.
20 s.w.g. hooks cement on
1/32" sheet top and bottom
1/8" sq. L.E.
Typical tail rib 1/32" sheet 12 off trim to suit station
Cut here where necessary
W2 — 14 off 1/32" sheet
W3 — 2 off 1/32" sheet
W4 — 2 off 1/32" sheet
W5 — 2 off 1/32" sheet
W1 — 3 off 3/32" sheet
W6 — 2 off 1/32" sheet
W7 — 2 off 1/32" sheet
3/32" sheet tips
Single blade prop from 7" x 1·5" x 1·25" Quarter grain block balsa
1/4" x 1/16" T.E.
D 827

The Negative Thrust Layout

The second step was to revise the side elevation of an existing conventional model. The idea in this case came from American modeller R. J. Gallman, whose experiments with the Negative Thrust Layout verified that models of this type are practically stall proof. Fig. *8a* shows the conventional layout and Fig. *8b* the negative thrust model. The generalised forces acting in each case are as indicated.

It will be noted that for the conventional model an increase in thrust produces a nose-up turning moment, whereas for the Negative Thrust System an increase in thrust produces a nose down turning moment. The effect of these moments is to change the attitude of the model which in the case of the conventional model puts the nose up. This in itself is not a bad thing providing the thrust produced is sufficient to keep the model moving forward. Unfortunately, due to the rapid decrease in thrust during the initial period the conventional model can easily find itself pointing nose-upward with little power to keep it there and consequently a tail slide would invariably result (it appears that skilled trimming can prevent this). On the other hand the negative thrust system, if properly arranged, develops its own automatic correction to the rapidly varying thrust.

The sole difference between the two layouts is the vertical setting of the neutral point and centre of gravity positions relative to the thrust line. In the conventional layout the resultant drag force is above the vertical C.G. position and in the negative thrust system the resultant drag force is arranged below both the thrust line and the vertical C.G. position. This is conveniently accomplished by inclining the fuselage as indicated in Fig. 8. The wing position and angle of fuselage will govern the resultant drag position and it should be appreciated that inclining the fuselage is not in itself sufficient to ensure success. Since the wing drag contribution is by far the largest component its position is of paramount importance, if too high the resultant drag position will not be low enough whereas if too low the layout could easily develop a ground clinging tendency. The ideal position can only be determined by flight test trials, but the first attempt can safely be based on the author's own model which is detailed in Fig. 9.

Conclusion

The *Coupe d'Hiver* specification provides the incentive necessary to put the small lightweight rubber model (not so small by present trends) on a par with the ever-popular Wakefield model. The author feels that, in the past, interest in the lightweight model waned due to stagnation in design (this will be seen by looking at the designs shown earlier). During the past ten years, however, few people have seriously attempted to fly lightweight rubber models of the size contemplated here and the many developments which have arrived during these past few years and the influence of new blood will make the *Coupe d'Hiver* specification an attractive challenge. It is hoped that those who have troubled to read this article will have been encouraged into building a model and perhaps one or two will have learnt something to help them win a *Coupe d'Hiver* contest next year.

ANTI-WARP STRUCTURES

THROUGHOUT the whole history of aeromodelling warped structures have been the primary cause of trimming troubles or inconsistent performance. It is surprising, therefore, that the development and application of "anti-warp" structures is still somewhat limited and that "conventional" structural design is still commonplace. By "conventional" construction we mean, in particular, the orthodox single-spar design for wings and tailplanes which, because of its lack of rigidity, is particularly prone to warping when subjected to unbalanced torsional or tensional forces such as produced by covering materials when treated with shrinking dopes.

Basically there are three primary causes of warps, although all relate to an unbalanced or non-rigid structure in the first place. If the structure is perefctly rigid it will not warp when subsequently covered. Whilst it is easy enough to build a rigid structure it is not easy to do so without adding excess weight—and often a lot of excess weight—and so the desirable type of anti-warp structure is one which has sufficient rigidity in the right place and directly compares in weight with that of a conventional structure.

Models and full size aircraft differ with regard to this rigidity of structures, particularly wings. To produce a rigid full size aircraft wing is impractical, because it can only be achieved at a prohibitive cost in weight. This applies specifically to rigidity in a tip to tip direction. A wing which flexes is preferable to one which is rigid, and at the same time is stronger. It must still be sufficiently stiff to resist *twisting* under torsional loads, as this would affect trim.

In the case of models an *even* warp spanwise from root to tip is equally acceptable. It simply produces an increase or decrease in dihedral. The danger is that with simple, conventional structures the warp induced is not even and twist is applied to the wing (or tailplane). Again this may not be harmful if the twist is such that the tips have decreased incidence or "washout", provided it is similar on both wings. If excessive, however, it will reduce the efficiency of the wing. A twist in the opposite direction (e.g. wash-in at the tips) can upset stability, but the more usual form is a compound warp where the trailing edge

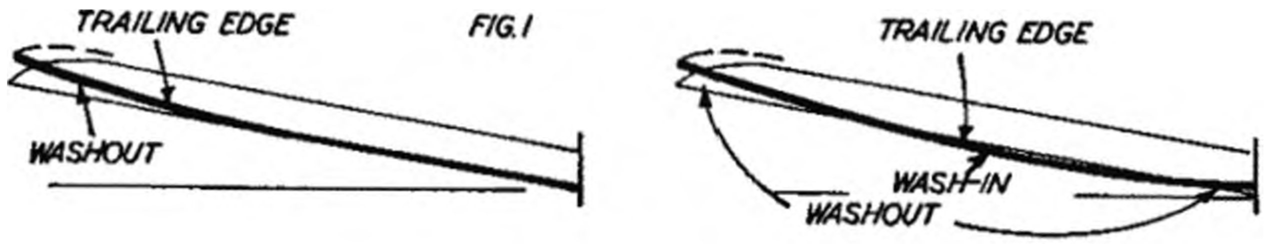


FIG. I

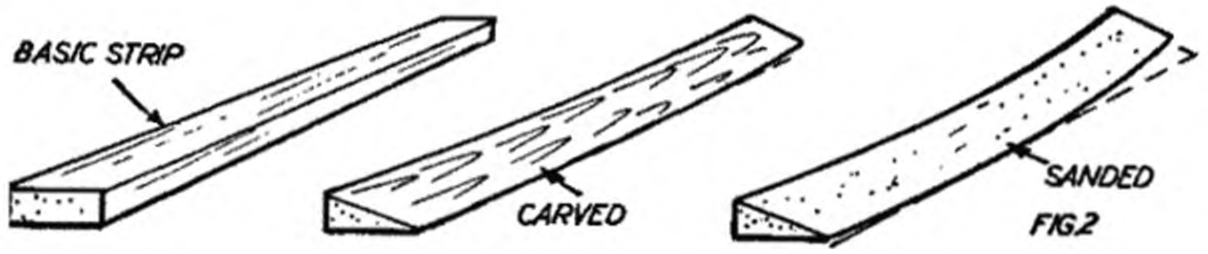


FIG.2

FIG.3

FIG. 4

UNDERSIZE SLOT

OVERSIZE SLOT

is bowed with the centre of the semi-span at a greater (usually) or lesser incidence than that of both the roots and tips—see Fig. 1. This is because the root structure is usually more rigidly supported than the remainder of the frame and so compound rather than simple twisting takes place under the tautening effect of the covering. It is best, therefore, to aim at a wing (or tailplane) structure which is both rigid in torsion so that it cannot twist, and rigid in a spanwise direction (so that compound warps cannot occur which could cause twisting).

Before considering what are suitable anti-warp structures we need to examine the three primary causes of warps. These are (i) built-in stresses in the frame; (ii) lack of rigidity in the finished frame; and (iii) insufficient strength in the frame to resist the tensional and torsional loads applied by the doped covering.

Dealing with built-in stresses first. It does not follow that a wing pinned out and built over a perfectly flat board will *be* true and flat when finally removed and cleaned up prior to covering. There are several ways in which stresses can be introduced which will cause the frame to "spring" out of shape when removed from the building board.

Take a typical solid trailing edge as a simple example. If this is rough shaped from a rectangular section with a knife or modelling plane it will tend to take on a slight bow, however rigid the original strip or sheet from which it is cut. Sanding to finish will then produce a further and more definite bow—Fig. 2. Whilst the section may be pinned down flat for building it is locked up stresses which will encourage it to revert to a bowed shape, or even produce a slight bow as the wing is removed from the building board. This can quite easily happen to a simple single-spar structure which is built flat and the trailing edge *then* sanded to finish. What was a perfectly flat panel when initially removed from the board now has a distinct bow on the trailing edge.

The cure for the "bowing" produced in finishing a solid trailing edge section is quite simple—merely sand the *bottom* face of the section until the bow is straightened out. It is best practice, therefore, to completely finish trailing edge sections *before* pinning down on the building board and leave only the lightest possible finish sanding to be done to clean up prior to covering.

The same applies to the leading edge, although not usually to the same extent. It is preferable to finish-sand to shape before assembly, but this is not always possible. If the section has to be worked down to final size after building of the frame watch for any "bowing" effects and sand on the opposite face (i.e. the underside) to correct. The leading edge being of more generous depth, and usually more rigidly backed up by proximity to spars, should not suffer from bowing as much as trailing edges.

The above considerations apply mainly to the simpler types of wing and tailplane structures. Where greater rigidity is given by the design this may be sufficient to resist built-in stresses and so the panel stays true and unwarped. Also the use of built-up leading and trailing edge members as in Fig. 3 is usually proof against "bowing" effects when finish-sanding. The glue line in such instances materially contributes to the rigidity of the composite section.

Other ways in which built-in stresses can be introduced are careless building and/or the use of a cement with strong contracting properties on light frame members. If a spar is forced into an under-sized rib slot, for example, it will be inducing a compression force in the rib tending to bow the whole section. Likewise an oversize rib slot with the spar glued in place with a cement which contracts strongly will introduce a tensional force and a tendency to bow the rib in the opposite direction—Fig. 4. Other examples are auxiliary spars being forced in place giving a spanwise deflection stress to the whole frame, or even added after the main frame is removed from the building board (when definite deflection may be produced).

Lack of rigidity in the frame is a question of design and introduces the main subject of what is an anti-warp structure. The conventional single-spar structure of Fig. 5 has only one real merit—simplicity and lightness. It relies for its rigidity on the tautness of the covering material, but as covering is never completely stable in this respect such a frame can never be relied upon to remain consistently true. Considering the frame itself, it is virtually anchored at three points at the wing root (X-X-X). It is relatively free to twist under torsional loads in either direction (which can lead to compound warps) and be subject to bowing in the spanwise direction. The "unbalanced" position of the mainspar normally means that spanwise warping will take the form of an upward bow or variable dihedral increasing towards the tip, although this may well be accompanied by twisting.

Such a structure can still be produced true, covered and doped, if it is pinned down to a flat surface throughout the drying-out period. This, in fact, is strictly *necessary* with light structures of this type. It does not follow, however, that it will *remain* true. Although dope dries out in a matter of less than an hour it will not set completely for some 24 hours and may well exhibit further tautening action for some one or two weeks. Thus for wing and tail structures of a type which *can* warp a conditioning period of some two weeks is required for the covered wing or tail to take up its final "set", before one can be sure of obtaining a consistent trim with the model.

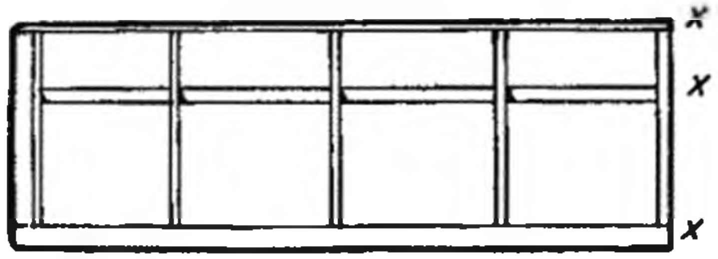
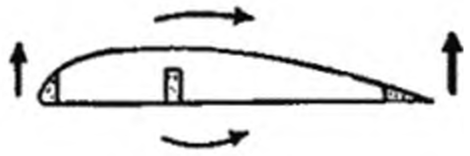


FIG.5



ARROWS SHOW SUSCEPTIBILITY TO WARPING

Even then, of course, extreme changes in conditions can cause changes in any inherent warps—and this is the primary cause of trim changes on high-performance models with conventional wing and tailplane designs. It needs only a small change on the tailplane to upset trim to a marked degree. This shows up most on a competition model where the trim is more critical. Sports models usually have far more latitude with regard to trim and may not be apparently affected.

If the performance of a contest-type model is inconsistent—and there is no obvious design or detail fault accounting for it—then changing warps on the tailplane (usually) or wing are nearly always the cause. The traditional method of removing or adjusting warps by heating the affected area (e.g. in front of an electric fire, or even in the exhaust of a car), twisting true and holding until set—is at best only a temporary cure and calls for re-trimming or a test flight to check the correction. Warps which are "corrected" in this manner, in fact, are never *completely* corrected. They are always likely to come back and so the model is always likely to suffer from variations in trim. Similarly the practice of strapping wings to flat boards or in jigs when not in use or similar devices to hold them true in storage is only an admission that the structure is prone to warping and thus the model inherently susceptible to inconsistency in performance. Such attentions are merely a compromise rather than a solution to producing wings and tailplanes which can be *trusted* to hold a fine trim.

Rigidity in a spanwise direction can be imparted by a more balanced arrangement of spars, although as we have already noted stiffening a wing or tailplane in this direction is not so important as providing rigidity in torsion. However, by stiffening the wing spanwise with a proper distribution of spars torsional rigidity will be automatically improved in most cases.

One of the first of the genuine "anti-warp" structures did, in fact, employ this principle, dispensing with a mainspar and replacing it with a number of very much smaller spar sections distributed top and bottom—Fig. 6. Multi-spar construction, as it is called, has the advantage of lightness as the total cross section of the individual spars is similar to that of a single solid spar for the same overall strength, but does rely on proper spar placement to be fully effective.

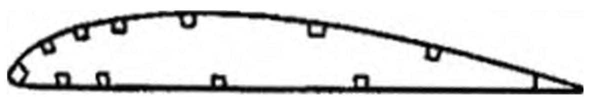


FIG.6 MULTISPAR

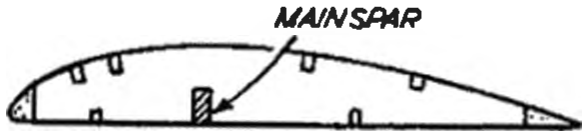


FIG.7 ANCILLARY SPARS

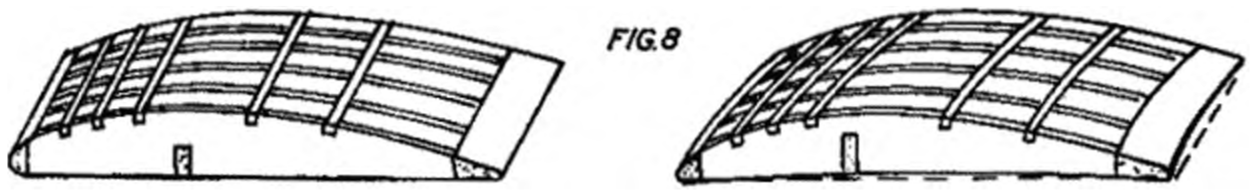


FIG.8

FIG.9

COMPLETE TORSION BOXES

INCOMPLETE TORSION BOXES

Besides taking all the bending loads (with the top spars in compression and the bottom spars in tension under normal flight loads), the positioning of the spars governs local stiffness. Thus spars grouped near the leading edge effectively stiffen the leading edge and the aftermost spars support the trailing edge against bowing. Torsional rigidity is improved by the shear resistance of the individual spars distributed over the bulk of the rib shape.

The chief disadvantage of the multispar wing is that to keep it light the individual spar sections must be quite small—$\frac{1}{16}$ in. square on a typical Wakefield wing of light-medium density, for example. Thus the local strength of each spar is small and such a wing, built really light, can be relatively vulnerable. It still seems an excellent type of straightforward design for tail units, however, which are less likely to heavy handling or knocks.

A variation on this theme is to use a number of small section spars as spanwise stiffeners around a reduced size mainspar (or mainspars), as in Fig. 7. The auxiliary spars also carry part of the bending load, enabling the mainspar section to be reduced, and can be made somewhat larger (usually deeper) than normal multispars to improve local strength. Such structure is usually heavier than properly designed multispar, but can give similar spanwise rigidity although somewhat reduced torsional rigidity.

The main danger in using auxiliary spars in this manner—apart from increasing weight unduly—is that an unbalanced structure may result. To quote an extreme example—if all the auxiliary spars are employed on top of the rib section to produce maximum resistance to normal "bowing"—Fig. 8—the result will be a wing or tail which, when covered, will warp with a downward bow. In this case the stiffness of the auxiliary spars resisting spanwise tension in the covering is far greater than the stiffness provided at the bottom of the section. Hence any multispar arrangement is only good if the spar locations are properly balanced. The optimum positions, and number of spars, can only be decided by experience, based on the particular type of structure concerned—e.g. wing or tailplane, light rudder or glider model or heavier power model, etc. Unbalanced spar arrangements are just as likely to produce twisting as well.

Where the model is large enough that the extensive use of sheet does not add an excessive weight penalty complete rigidity both spanwise and torsionally can be obtained by incorporating built-up box sections for the leading edge and trailing edge, as in Fig. 9. This is a favoured form for large wings which may be subjected to high flight loads (e.g. radio control and control line stunt). Any "break" in either torsion box—i.e. a side not filled in—will reduce torsional rigidity; also this system does not provide outstanding torsional rigidity with very thin aerofoil sections (as well as being difficult to accommodate within such sections).

With a conventional structure, torsional rigidity can be achieved by adding diagonal bracing, as in Fig. 10. It is usually adequate to brace only from the mainspar back to the trailing edge, although sometimes the leading edge is braced as well (dotted diagonal struts). To be effective the bracing must be rigid in compression, therefore a fairly generous section is required, resulting in a definite increase in structural weight.

Whilst this method is fairly widely used it is effective as a true anti-warp structure *only* if the wing is stiff enough spanwise to prevent "bowing". If the wing can warp in this direction the rigidity of the diagonal bracing will

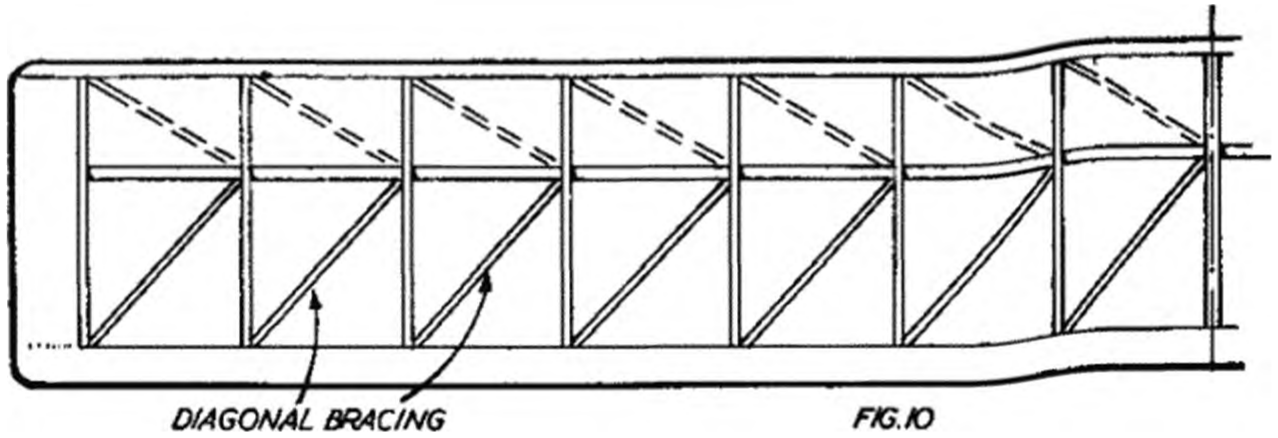


FIG.10

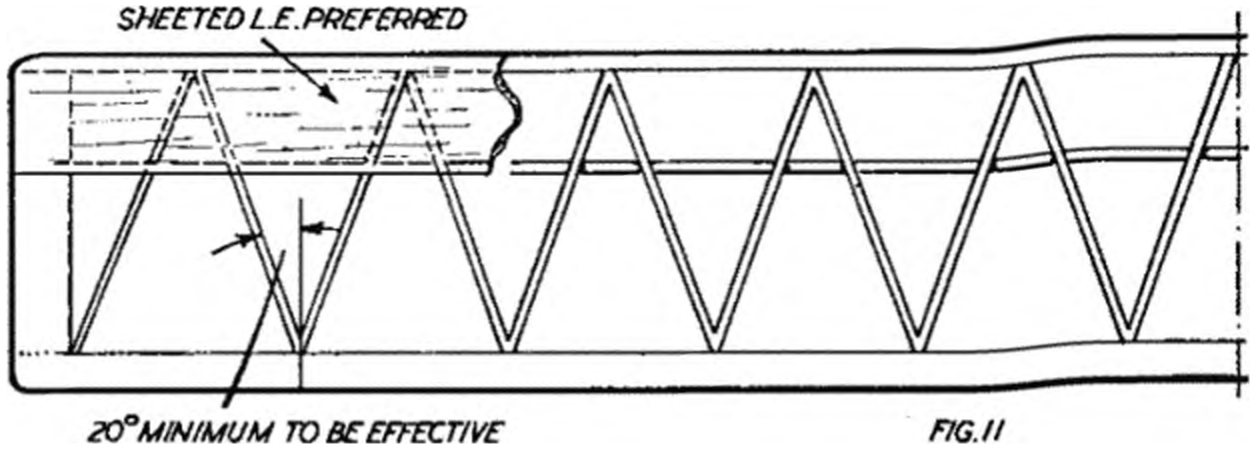


FIG.11

make it twist as well. On the whole, therefore, it is not a good solution. It adds weight and is not reliable unless the wing has good spanwise stiffness. It is more suited to tailplanes where suitable spanwise stiffness can be achieved with leading edge sheeting back to a (top) mainspar, although this still produces an unbalanced structure which can "bow" downwards and also twist. It is better to make the spar supporting the sheeting a light one and use a normal mainspar or auxiliary spars in the bottom to balance. The one thing about a diagonally braced frame, however, is that after a "conditioning" period any warp it has assumed by then is less likely to change again than an unbraced structure.

A far more logical solution is to use the ribs themselves as diagonal braces, which gives rise to two typical anti-warp structures—Warren girder (Fig. 11) and so-called geodetic (Fig. 12). In both cases the diagonal bracing effect, and thus the torsional rigidity of the whole, increases with increasing "angling" of the ribs, up to a maximum of 45 degrees. This presents a problem in both cases of distorting the true aerofoil section by leaving large unsupported areas of covering, particularly over the nose section. The Warren girder form suffers more than geodetic in this respect, so it is usual in this case to restrict the rib "angling" to a more modest figure, at some sacrifice in torsional rigidity.

In the basic form the weight increase, compared with a conventional wing or tailplane panel, is quite small. The ribs are longer but not necessarily any more numerous and, by proper selection of light, quarter-grain stock, rib weight should only be about 20-25 per cent of the total frame weight in any case. Thus these anti-warp structures impose little or no weight penalty, although they do result in poor aerodynamic form for the aerofoil section.

For all practical purposes this can be offset by using a form of construction with a sheet covered leading edge, the sheeting then forming a true aerofoil section over the most critical length. For a lightweight wing it is usually sufficient to use sheet covering on the top surface only and ignore the distortion of the lower surface where the covering sags between the splayed out ribs. If weight permits, nose ribs can be added to support the sheet and provide a better section, or in some cases nose ribs may be added and sheet covering omitted entirely.

Warren girder construction gives excellent results on power model wings and tailplanes, employing sheeted leading edges (top) and (possibly) false ribs for improving the under section at the nose. A suitable "pitch" for the ribs is 30 degrees, although often a smaller angle is employed, still retaining good torsional rigidity. The smaller the angle the less the overall "stiffness" of the wing, and also the more rib material required (and hence the heavier the wing).

For lightweight construction geodetic is to be preferred with an ideal pitch angle of 45 degrees so that individual ribs cross at right angles. Although this results in a distorted section when covered it is perfectly adequate for tailplanes of all sizes (sometimes with an auxiliary spar or two added at the nose to improve the section), and suitable as a *practical* wing design for those who do not set too great a store on pure aerodynamic refinements as regards wing sections. With a sheeted-in upper leading edge back to about 39 per cent of the chord there is little evidence to show that it is in any way inferior aerodynamically to a conventional wing with closely spaced ribs and it has been employed with considerable success on Wakefield and A2 glider wings and the like.

The geodetic type of wing allied to normal fore-and-aft ribs at the intersection results in a redundant frame which is extremely rigid and at the same

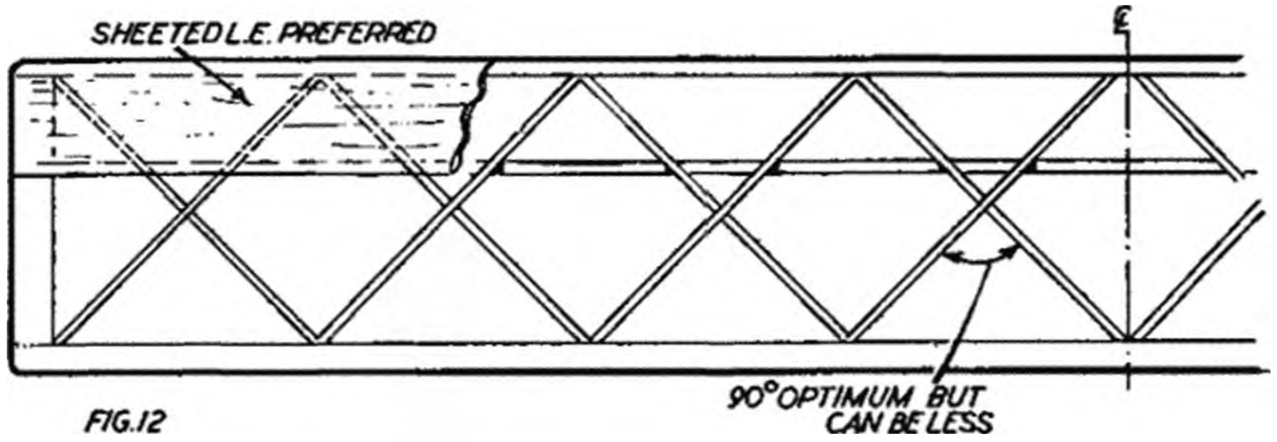


FIG.12

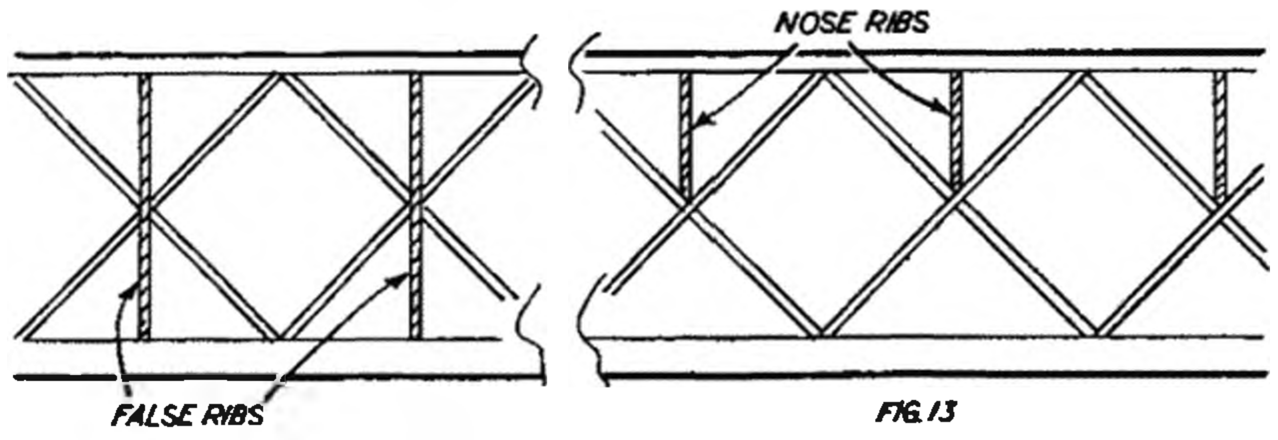


FIG.13

time restores some of the "true" aerofoil shape. It is not necessarily much heavier than basic geodetic and, in the case of a smaller wing (or tailplane), lighter than geodetic with a sheet covered leading edge. It is also extremely stiff spanwise, so that only relatively light spars are required to take the bending loads. It does not permit the same close rib spacing as normally selected for a lightweight tissue-covered "high performance" wing, but is comparable aerodynamically and can be built down to a similar weight.

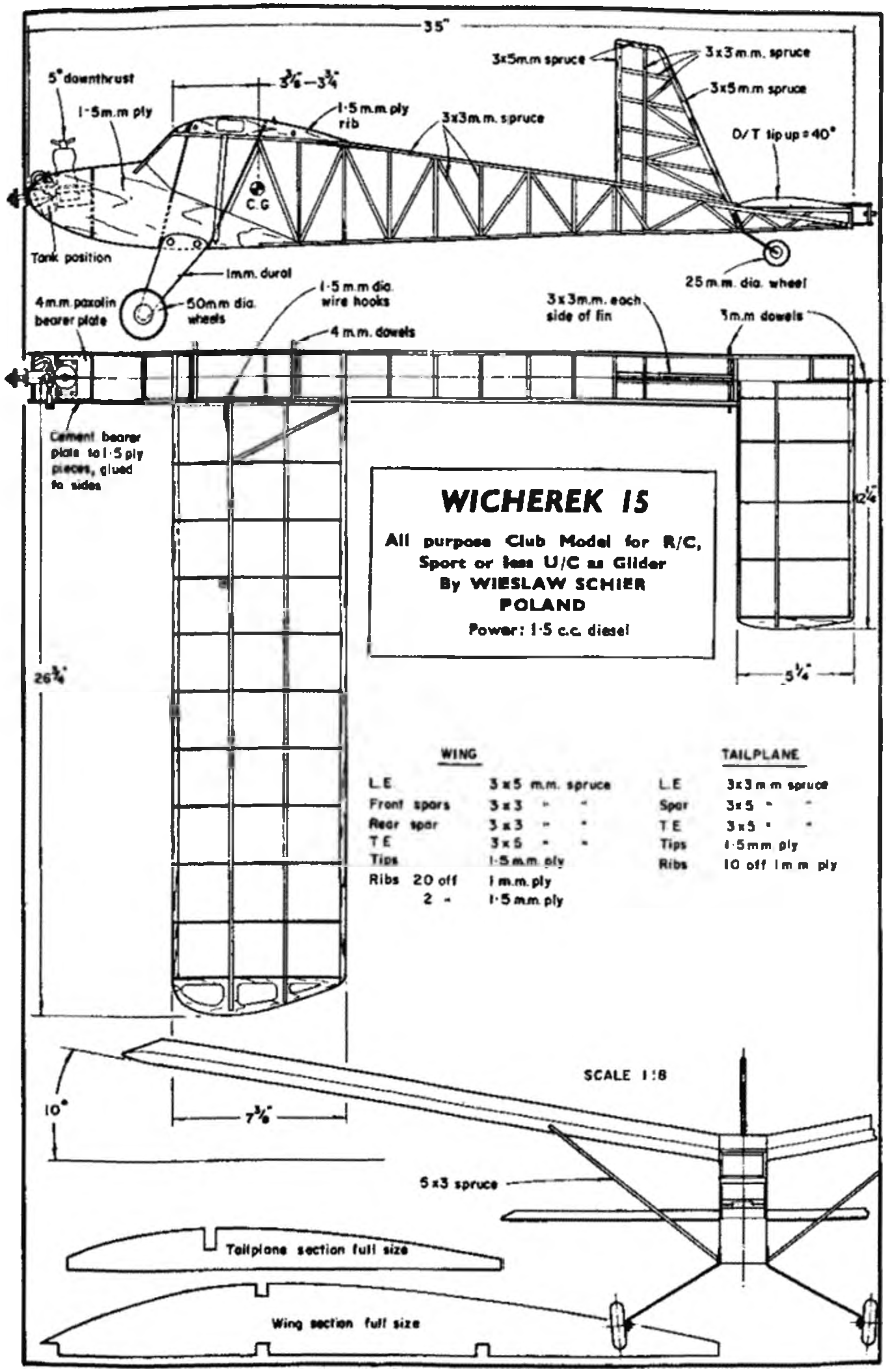
The geodetic structure scores over Warren girder in being more rigid for equal weight, or as rigid at less weight, depending on the material selection for similar forms of spar and sheeting arrangement. It may not look as attractive, but it is more efficient as an anti-warp structure, and less affected by "unbalancing" effects of badly chosen spar positions. On the other hand both types are relatively free from *twisting* effects if bowed through a spanwise warp and spanwise stiffness is not of critical importance. A geodetic frame consisting of leading and trailing edges only, root and tip and 45 degree pitch ribs (no mainspar) will tend to bow upwards when covered and doped, but it should not show any signs of twisting unless the ribs have been badly fitted originally with built-in stresses.

With careful material selection and employing a sheeted leading edge on the upper surface a geodetic wing (or tailplane) can be made as light as a conventional structure of similar overall strength. There will be no comparison as regards rigidity. The properly made geodetic wing or tail will stay flat after removing from the building board and remain flat and true through covering and doping and any subsequent exposure to changing conditions of heat and humidity. It relies on the covering only to provide an "aerodynamic" skin, not for rigidity, but its inherent rigidity is, of course, increased by that of the taut covering. To achieve a comparable performance, Warren girder construction usually has to be somewhat heavier.

One important point to be considered with true anti-warp structures is that any deliberate warps (such as wash-out at the wing tips) must be built into the frame; and also any warps accidentally built in due to bad construction will stay in. It is well-nigh impossible, for example, to add a little wash-in or wash-out on one wing to trim when the wing is covered and doped. Such a change can only be achieved at the expense of straining the structure and weakening it.

Of all the various forms of construction tried on lightweight wings and tailplanes, geodetic has proved far and away the most consistent, provided it is built right in the first place. It is equally suited for larger power model wings, although Warren girder is often preferred. Where weight is less important and the depth of section is sufficient to accommodate adequate torsion box sections, then the construction of Fig. 9 is generally preferred as cleaner in appearance and aerodynamic qualities, and usually equally satisfactory on an anti-warp basis.

Summarising, there is a strong case for recommending that *all* high performance contest models ranging from Wakefield and A2 size gliders and smaller up to the largest power models should have anti-warp *tailplane* structures—geodetic, Warren girder or multi-spar, in that order of preference; and almost as strong a case for wing structures. Also no covered and dope wing or tailplane which is *not* a true anti-warp structure can be considered to have assumed its "final" form as regards an inherent warping tendency until it has been "aged" for some two weeks after the finish dope coat has been applied.



WICHEREK 15

All purpose Club Model for R/C, Sport or less U/C as Glider
By WIESLAW SCHIER
POLAND
Power: 1·5 c.c. diesel

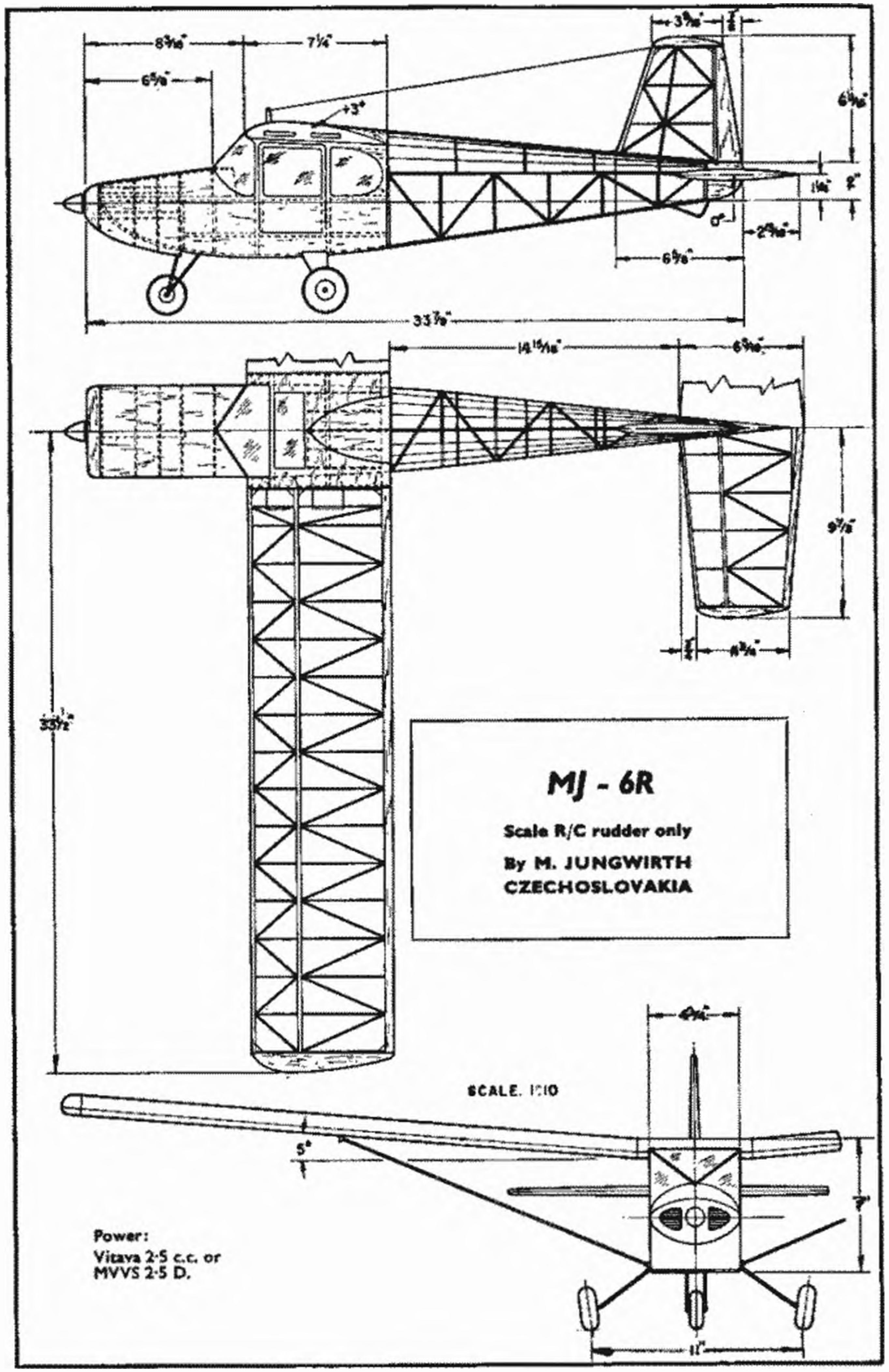
WING

L.E		3x5 m.m. spruce
Front spars		3x3 " "
Rear spar		3x3 " "
T E		3x5 " "
Tips		1·5 m.m. ply
Ribs	20 off	1 m.m. ply
	2 "	1·5 m.m. ply

TAILPLANE

L.E	3x3 m m spruce
Spar	3x5 " "
T E	3x5 " "
Tips	1·5mm ply
Ribs	10 off 1 m m ply

MODELARZ, POLAND



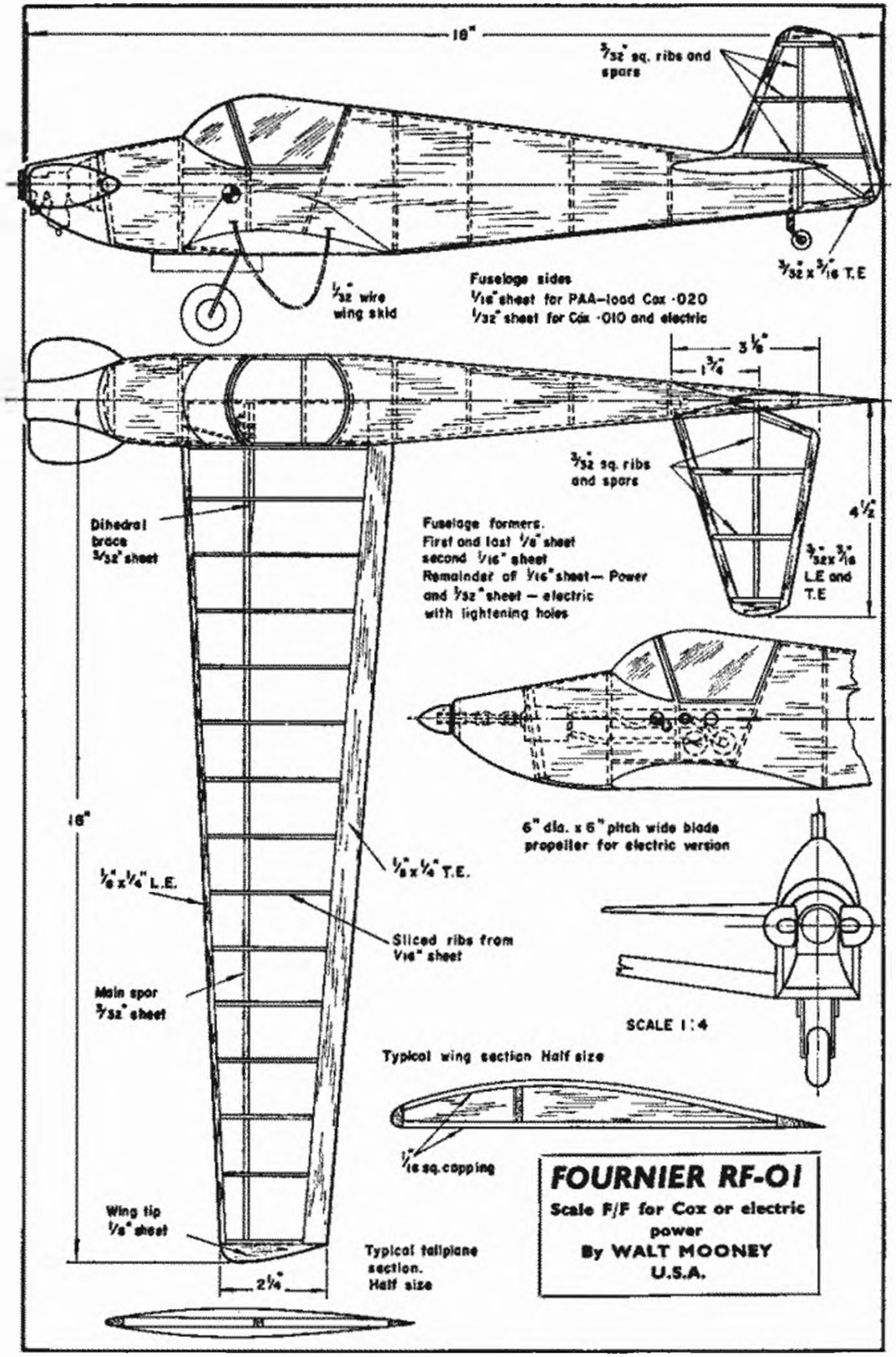
MJ - 6R

Scale R/C rudder only

By M. JUNGWIRTH
CZECHOSLOVAKIA

Power:
Vitava 2·5 c.c. or
MVVS 2·5 D.

LETECKY MODELAR, CZECHOSLOVAKIA

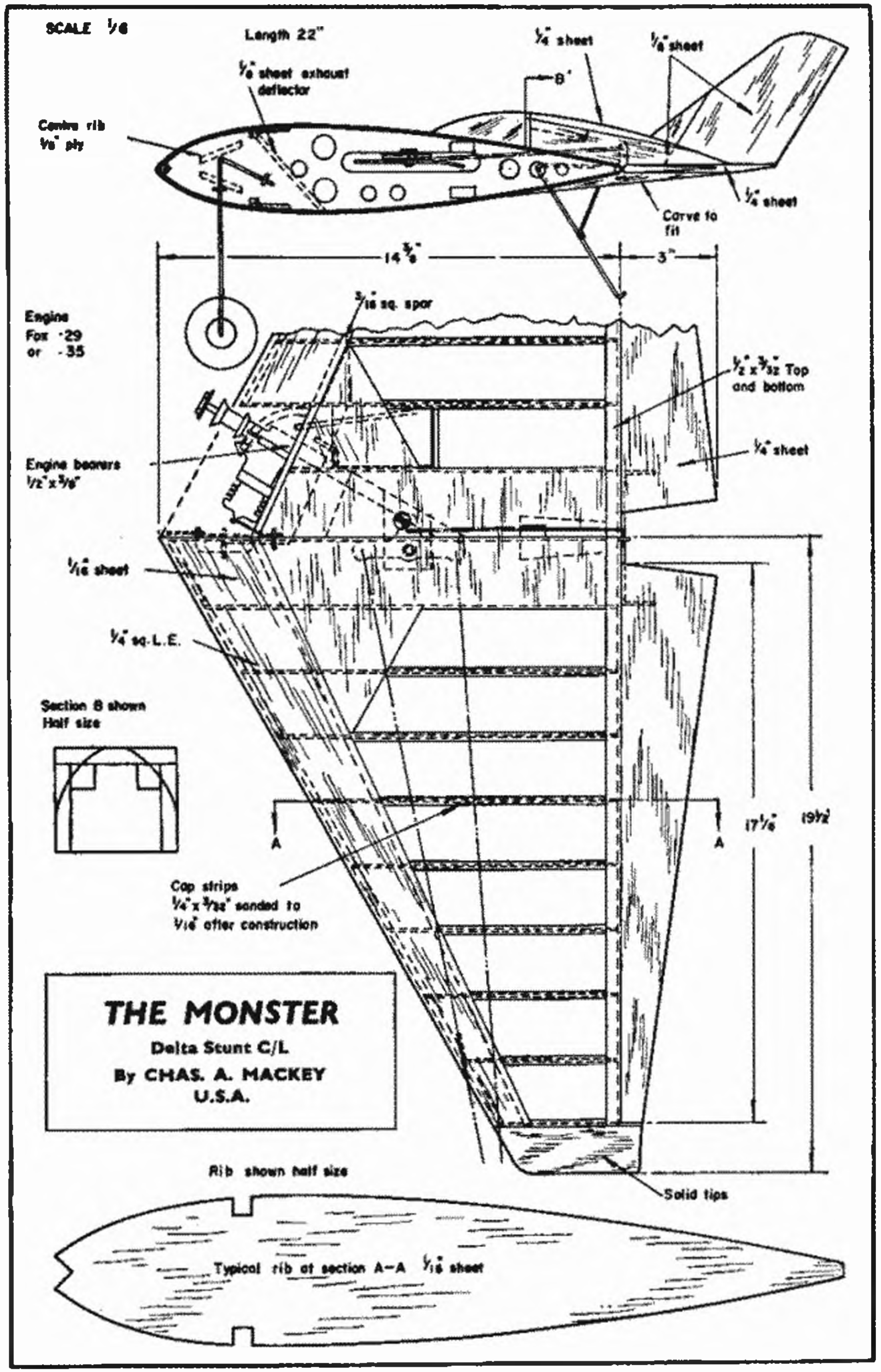


FOURNIER RF-01

Scale F/F for Cox or electric power

By WALT MOONEY
U.S.A.

MODEL AIRPLANE NEWS, U.S.A.

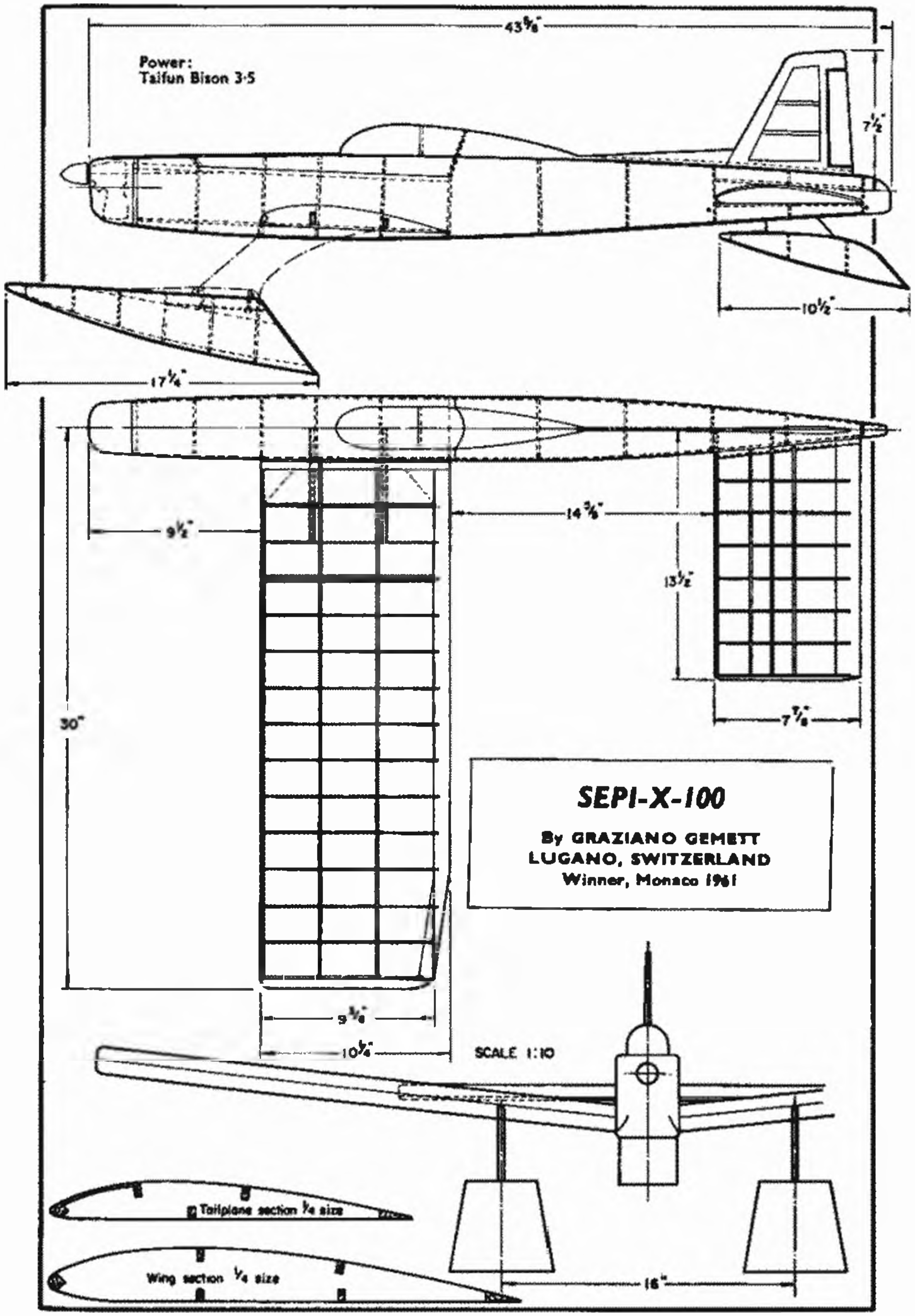


THE MONSTER

Delta Stunt C/L

By CHAS. A. MACKEY
U.S.A.

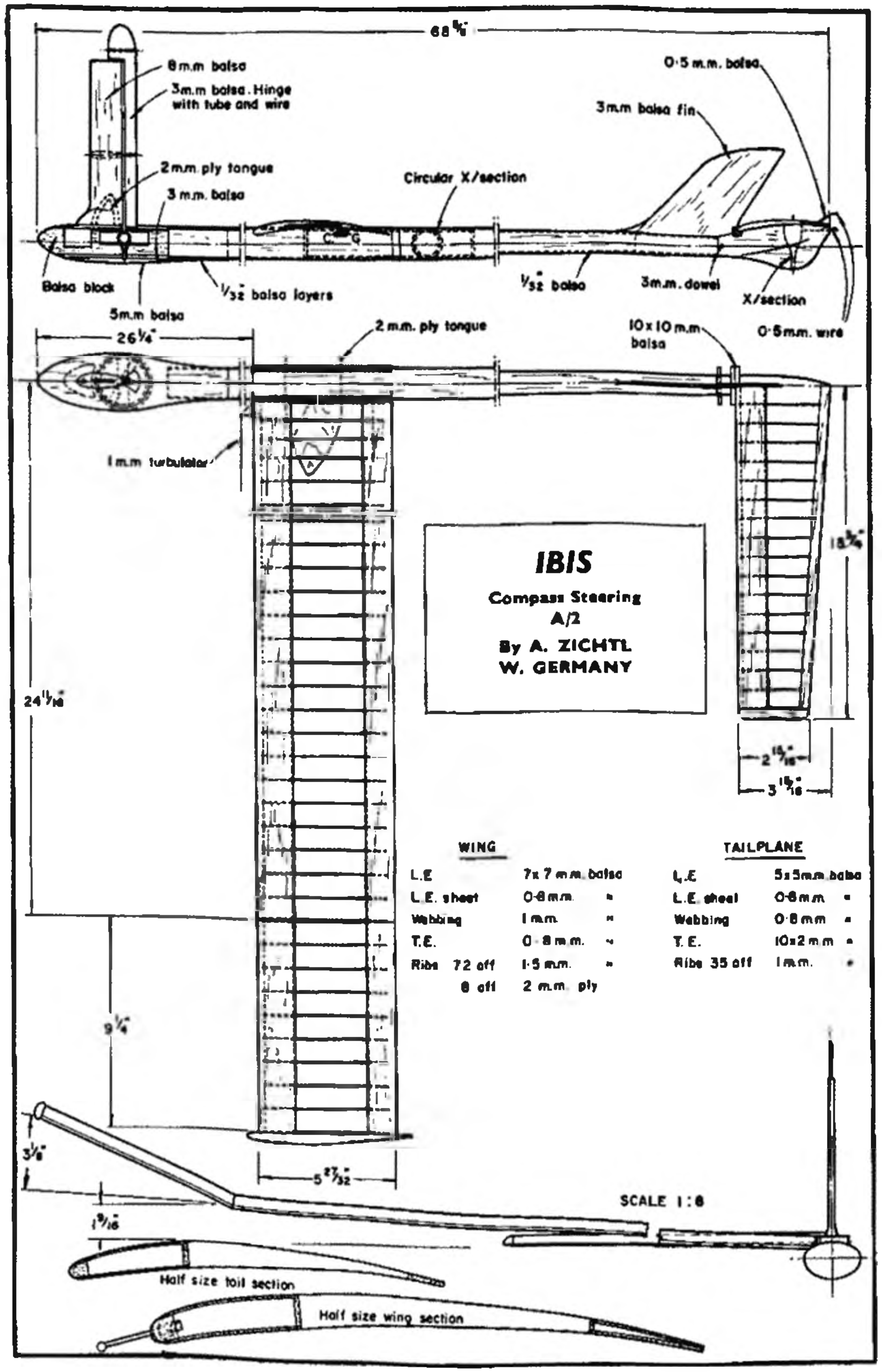
FLYING MODELS, U.S.A.



SEPI-X-100

By GRAZIANO GEMETT
LUGANO, SWITZERLAND
Winner, Monaco 1961

MODELL, W. GERMANY



MECHANIKUS, W. GERMANY

CONTROL SURFACE DESIGN FOR R/C MODELS

THERE is very little design data available on model control surface performance and control surface shape, size, movement, amount of balance (if any) are usually "guesstimated" or follow a design form which has proved successful on previous models. Shapes and proportions have become fairly standardised on this basis for radio control design, although still subject to improvement and development. Full size data does not help a lot in this respect for conditions are different, and even in full size practice such vital information as hinge moments are difficult to arrive at accurately without full scale wind tunnel tests, and applicable only at those speeds and sizes. Early wind tunnel test data on control surface behaviour is virtually useless to the model designer.

The main factors the designer has to decide in arriving at a suitable control surface are (i) area; (ii) proportion and shape of that area; (iii) amount of movement required; (iv) position (particularly in the case of ailerons); and (v) the force required to move the control surface to its maximum displacement.

Area requirements have been largely determined by experience, and to a certain extent are also bound up with movement (iii). They may also vary with the type of model—the more aerobatic models being associated with larger areas and/or larger displacements of control surfaces. The limiting factor is really the maximum amount of control surface movement which can be used without stalling the surface. This is usually about 20 to 25 degrees although in practice different maximum deflections may be employed. In the case of rudders, for example, sometimes as much as 30 or 40 degrees deflection is used. Elevators are usually limited to about 25 degrees maximum up and down (total movement 50 degrees), but sometimes as much as 30 degrees up and down. On control line models elevator movement may even be as much as 45 degrees up and down. Ailerons are usually limited to about 15 to 20 degrees up and down (30 to 40 degrees total movement), largely because stalling effects on ailerons make themselves much more noticeable. Greater deflections than about 20-25 degrees on any control surface do not normally produce a greater *force* and may, in fact, produce a reduction in effective control by stalling the surface, or an adverse effect on control through excess drag.

Basically, then, it pays to reduce control surface movement as far as possible—e.g. keeping within a 20 degrees maximum displacement. Up to about 20 degrees displacement control *force* increases in almost direct proportion to displacement. A 15 sq. in. control surface, for example, deflected through 10 degrees should have the same effect as a 7·5 sq. in. control surface deflected through 20 degrees. If, on the other hand, this control force is insufficient the angular movement of the larger area can easily be increased; but increasing the angular movement of the smaller area may not produce any appreciable improvement because the surface is stalled. Hence it is generally best to err on the generous side in proportioning control surfaces as there is considerably more latitude for adjustment. Control surface deflections required are, in any case, largely established by trial-and-error methods.

TABLE 1: TYPICAL CONTROL SURFACE AREAS

CONTROL SURFACE	AREA %	RELATIVE TO
Rudder	25—40	Fixed Fin Area
Elevators	25—40	Fixed Tailplane Area
Ailerons (area of both)	10—12½	Total Wing Area

Typical control surface areas employed are summarised in Table 1. These data are fairly representative of current practice. In the case of stabilising surfaces—e.g. the fin and tailplane—the incorporation of a movable surface within the outline of the (total) area represents a *loss* of effective (stabilising) area by that amount. In other words the *fixed* area (fin or tailplane) should be of the required size for stability, and the control surface an additional area which is *not* counted in as effective fin or tailplane area. This may only be theoretically true of a freely hinged surface which simply trails the main fixed surface as in Fig. 1, when it has no effective action at all; but applies as a general practical guide for all stabilising surfaces incorporating a movable control surface. If ignored it can lead to loss of stability under certain conditions through the effective fin (or tailplane) area being too small.

The *shape* of any control surface is not always so easy to decide. Theoretically, at least a long, narrow rudder (or elevator) will give the same control force as a short, wide one, for the same degree of movement—Fig. 2. The force required to move the two surfaces to their displaced postion will be different, however. This force is defined by the *hinge moment* or the product of the lift force (L) acting at the centre of pressure of the control surface and the distance of that centre of pressure from the leading edge (or hinge point, if this is not coincident with the leading edge). The centre of pressure will be at a definite percentage of the chord. The larger chord control surface will therefore have a greater hinge moment than a narrow chord surface for the same amount of lift generated—Fig. 3. Thus a narrow chord control surface would appear preferable on this score.

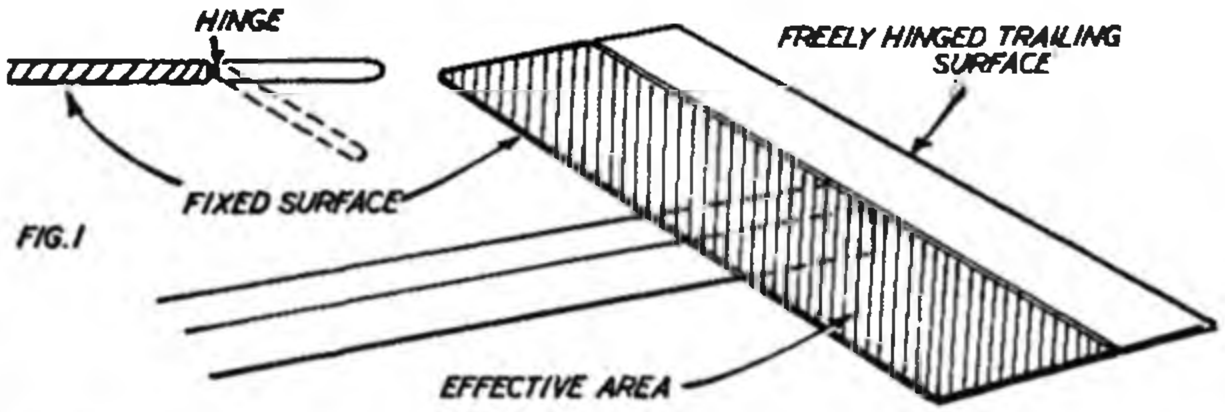


FIG. 1

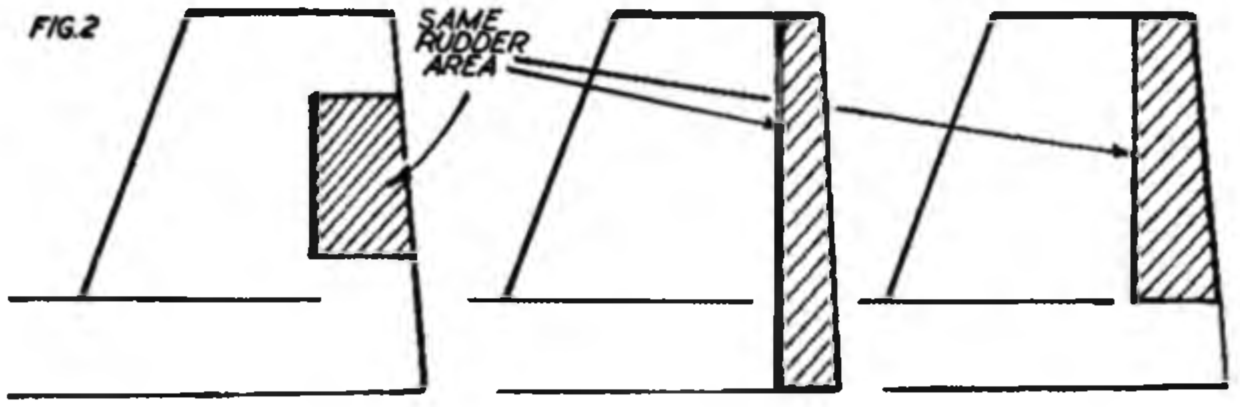


FIG. 2

FIG. 3

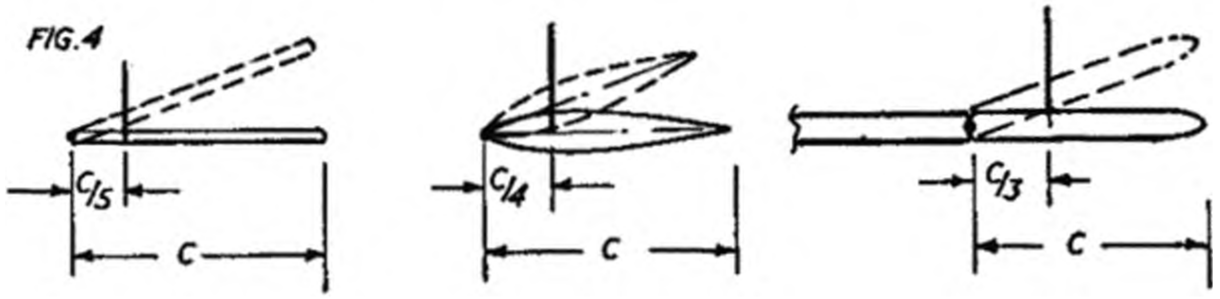


FIG. 4

There are several other factors to consider, however. If the chord is reduced too much the control surface may become less efficient and require greater displacement to produce the required lift. The amount of displacement required may bring it within the stalling range and so the required amount of lift may never be realised. Again, a fairly generous chord may be necessary in order to get enough area. In the case of elevators, for example, these generally run full span and unless the aspect ratio of the tailplane is increased, elevator chord is fixed by area requirements. Ailerons are not restricted in this respect and in conventional proportions account for only a proportion of the semi-span. A narrow chord full length aileron of similar area is perfectly feasible and can show a considerable reduction in hinge moment. This type of aileron is also shown to have some improvements in performance for highly aerobatic designs and has found considerable favour during the last year.

The hinge moment of any control surface can, of course, be reduced by "balancing" or setting the hinge line back—i.e. reducing the geometric distance "A". This is especially useful where the actuator is low powered (e.g. rubber driven escapements) and flight speeds may be high. Reducing the hinge moment also reduces the "bowing" effect on push rods and similar linkages between the actuator drive and the control surface horn. It is not normally necessary to balance the rudder on rudder-only models, escapement powered, although it is often advisable if the model is intended for aerobatics and can build up high flight speeds in dives. Elevators powered by escapements almost *always* need balancing to reduce the hinge moment as the lift forces generated are considerably higher than those of rudders, due largely to their considerably greater area. The use of elevators on a model, too, usually means that it will be dived and thus reach high speeds, and loads on control surfaces increase with the square of the speed. The load on a displaced control surface at 60 m.p.h., for example, is four times that on the same control surface at 30 m.p.h.

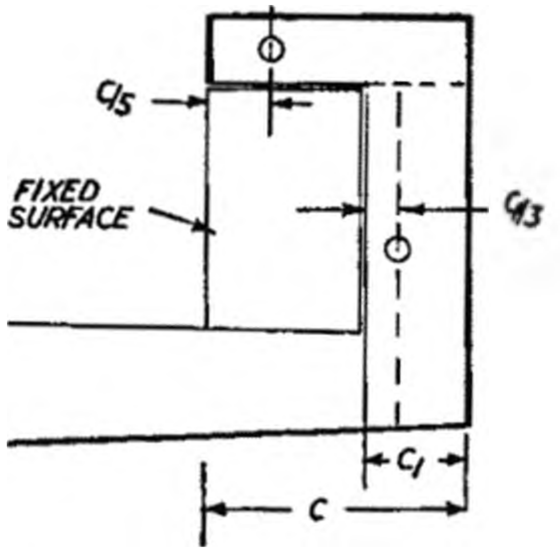
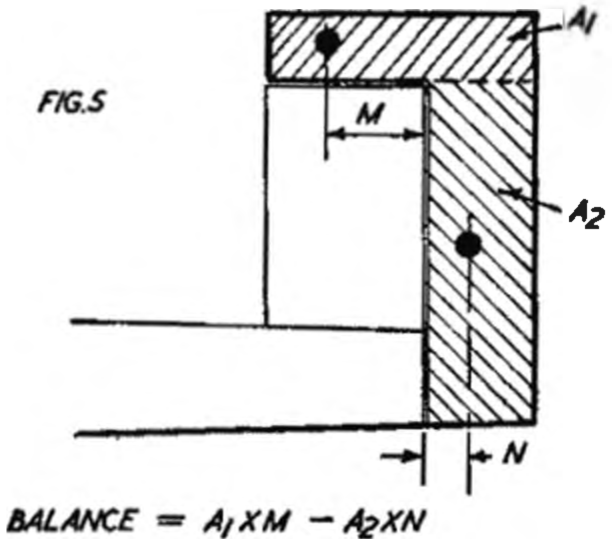


FIG.5



For the purpose of estimating simple balance of control surfaces the centre of pressure associated with maximum displacement (and thus maximum lift force) can be taken as 20 per cent of the chord in the case of flat plate sections; and 25 per cent of the chord with aerofoil sections—see Fig. 4. This refers to "free" or all-moving surfaces, which are seldom met with in practice (except for marine rudders). Where the control surface is hinged to a fixed surface the effective centre of pressure is moved back somewhat—approximately to 28-30 per cent of the chord in the case of a flat plate, and 33 per cent chord with a thicker symmetrical aerofoil section. Since no exact data are available it can be taken as a general rule that on all aircraft control surfaces trailing a fixed surface the centre of pressure is 33 per cent (one third) of the chord back from the leading edge. If part of the surface forms a "free" aerofoil, however, this section will have a more forward centre of pressure—20 per cent if the section is flat plate, and 25 per cent if a symmetrical aerofoil—see Fig. 5.

Such a shape, of course, automatically provides a "balancing" effect. The centre of pressure of the "free" aerofoil area is ahead of the hinge line and thus assisting the control surface to move after an initial displacement. The amount of balance can be calculated directly from the respective areas involved and their hinge moments. There are distinct disadvantages to this type of balance, however, although they have been used in the past on full size control surfaces. They tend to produce over-balance, which in turn can lead to flutter (although this latter phenomenon can be offset by applying mass balance in addition to aerodynamic balance). The most satisfactory method of providing aerodynamic balance is simply to set the hinge line back from the leading edge of the control surface—Fig. 6.

The amount of aerodynamic balance required is largely a matter of inspired guesswork, verified by practical results. Balance is effective in reducing the hinge moment, and if the hinge line and centre of pressure coincide, reduces the hinge moment to zero. At the same time, however, as the amount of aerodynamic balance is increased certain undesirable effects are introduced—notably a reduction in efficiency of the control surface and a tendency to promote flutter. An over-balanced control surface is worse than one with no balance at all. It has relatively low efficiency as a source of lift force, has to be positively held in *any* position and is always working against the normal actuator action. The optimum degree of balance is the minimum amount which gives enough balance to relieve the actuator of excessive loads, and without interfering with the efficiency of the control surface or leading to flutter tendencies.

Static balance is normally only important where the control surface has an appreciable weight. Flutter on a light control surface is usually due to aerodynamic over-balance, slack or distortion in the linkage system and hinges connecting the control surface, or lack of rigidity in the tailplane or fin structure itself. Static balance will not cure such faults, although it may tend to reduce their effects. Static balance, basically, implies adding weight forward of the hinge line (either as separate weights mounted on horns or incorporated in the control surface outline forward of the hinge line) so that the centre of gravity of the control surface lies on or slightly ahead of the hinge line. This is a precise form of balance which is difficult to arrive at on model control surfaces unless the hinges are particularly free, and is not normally necessary on model designs.

Ailerons require rather special consideration as control surfaces since they are capable of producing displacement in two planes—rolling and yawing. Ideally they should simply impart a rolling motion to the aircraft. With equal up and down movements, however, a strong yawing effect is also produced because of the increase in drag imparted on one side by the down-going aileron. This yaw is, in effect, opposing the turn induced by roll and can even be greater than the rolling effect—i.e. the yaw reaction can be so powerful that it reverses the normal aileron effect, slewing the model in the opposite direction to the turn which it is intended to take. At low speeds, too, there is a distinct possibility of stalling the lowered aileron, aggravating the adverse yawing effect and at the same time *decreasing* the roll reaction.

Undesirable yawing effects can largely be offset by giving the ailerons a differential movement so that the "up" movement is considerably greater than the "down" movement. Thus instead of, say, 20 degrees movement up and down the full aileron travel is adjusted to give 20 or 25 degrees "up" and only 10 or 5 degrees "down". This can readily be achieved by a suitable design of linkage, such as in Fig. 7 which restricts effective "push-pull" travel on the down-going motion. An alternative solution is to use a symmetrical linkage (i.e. one which gives equal up and down movement) but rig both ailerons at some *negative* angle (i.e. both 5 or 10 degrees "up" in the normal, neutral

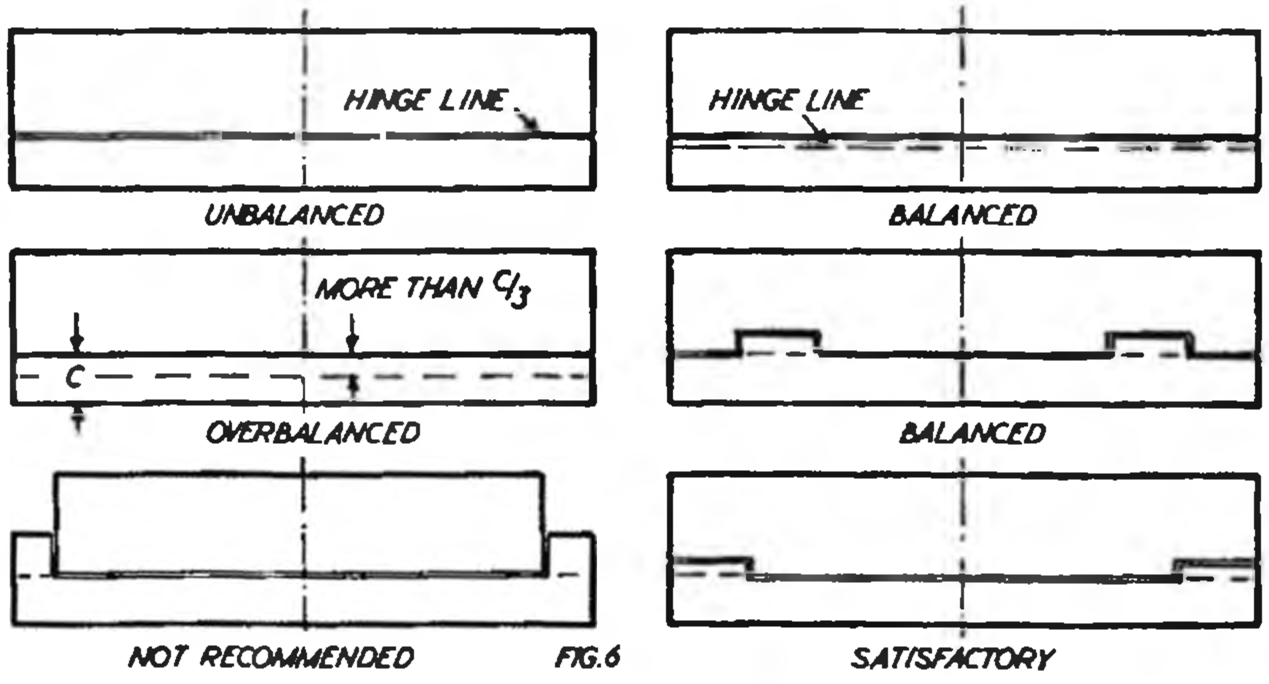


FIG.6

control position). The geometric "up" movement is now increased by this rigged angle; and the geometric "down" angle decreased by a similar amount. A further virtue of this type of rigging is that the wing is, effectively, given wash-out at the tips with neutral aileron position, which is a stabilising feature.

Further solutions for combating adverse yaw effects are found in special designs of ailerons. Numerous forms have been developed for full size aircraft, where they have proved particularly effective. In the light of practical experience, however, they do not appear to offer the same full benefits in model sizes over normal plain ailerons, although they do show some advantages on specific designs.

The Handley Page type (Fig. 8) is a balanced aileron of symmetrical section which is particularly suited to fairly thick section wings and where the control surface does not have to be moved through more than about 15 degrees. With differential movement the leading edge of the down-moving aileron then remains within the contour of the fixed aerofoil section: but the up-going aileron, at maximum movement, raises its leading edge above the wing surface. In this position it is generating increased drag and so introducing a yawing force opposite in direction to any adverse yawing produced by the down-going aileron. It is, in effect, creating an additional loss of performance (drag) to correct another loss—two "wrongs" making a "right", as it were.

The Frise aileron—shown in Fig. 9—is a neater and somewhat more efficient solution. The aileron section is a fairly normal type with a flat bottom and somewhat pointed nose. The hinge line is then mounted below the aileron centre line so that the up-going aileron always has its leading edge emerging into the airstream, generating drag on that side of the wing to promote a favourable yaw reaction (opposing the unfavourable reaction, just as with the Handley Page type). The down-going aileron always has its leading edge shielded by the main aerofoil section over its range of movement.

It is possible—in full scale practice, at least—to realise sufficient drag from the up-going Frise aileron to dispense with differential movement entirely, provided the leading edge of the down-going aileron always remains within the section. However, it is usually better to use the Frise aileron with differential movement so that the amount of "corrective" drag produced can be minimised.

There are several other features of interest with the Frise aileron. The hinge point is usually 20 per cent back from the leading edge (never farther back than 25 per cent), which gives a strong aerodynamic balance effect. The early emergency of the leading edge of the up-going aileron tends to produce an over-balance effect, so that operating loads are light. At the same time it is necessary to ensure that there is no slack in the control system linkage and that the push rod cannot bow.

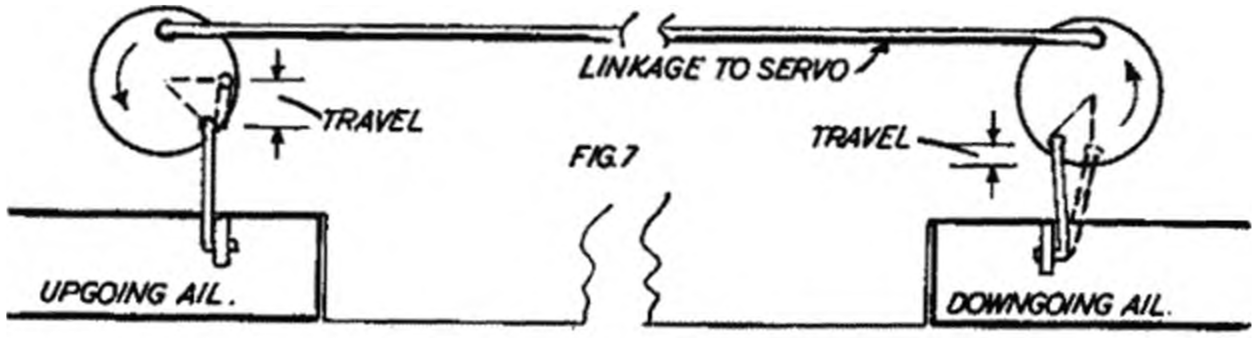


FIG.7

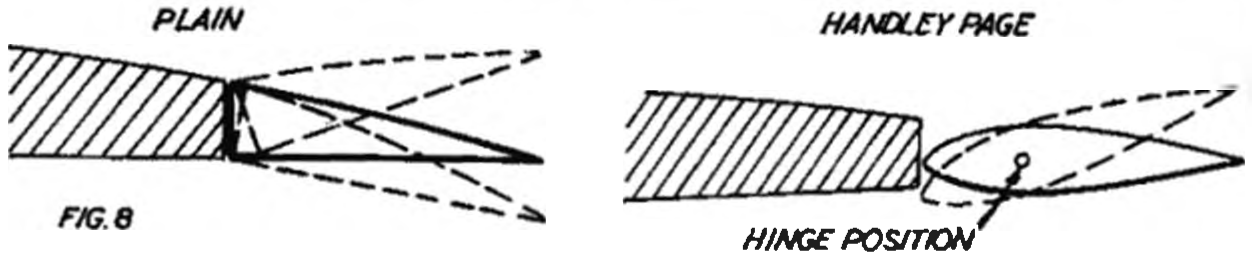
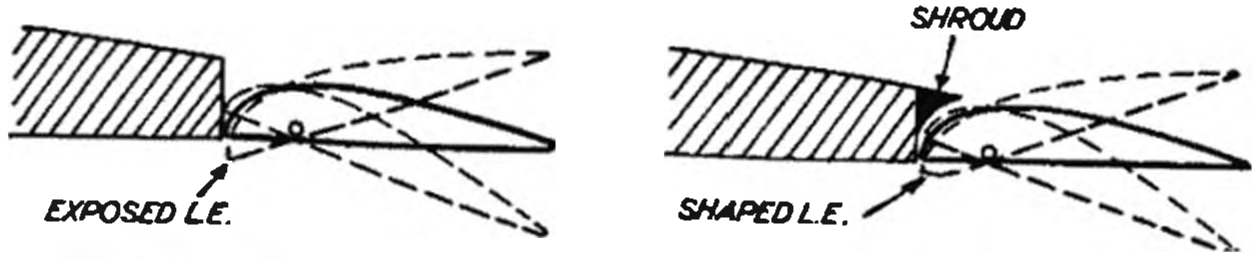


FIG.8

FIG.9



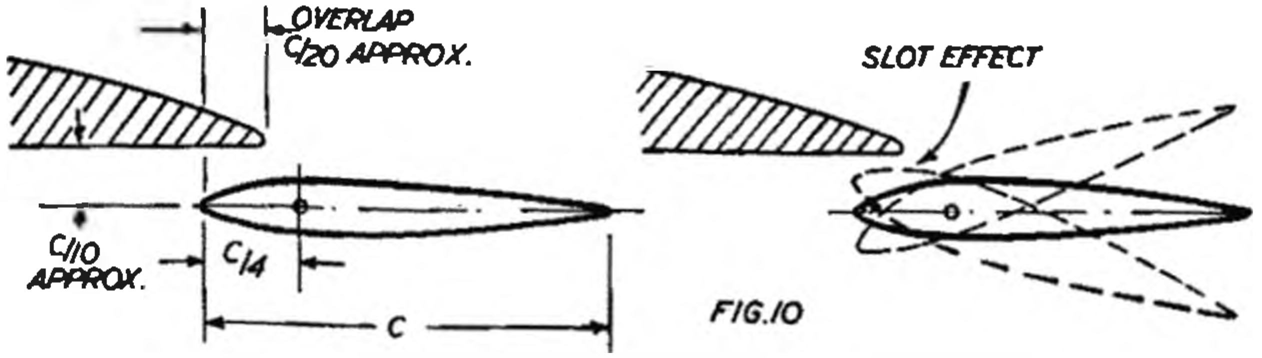


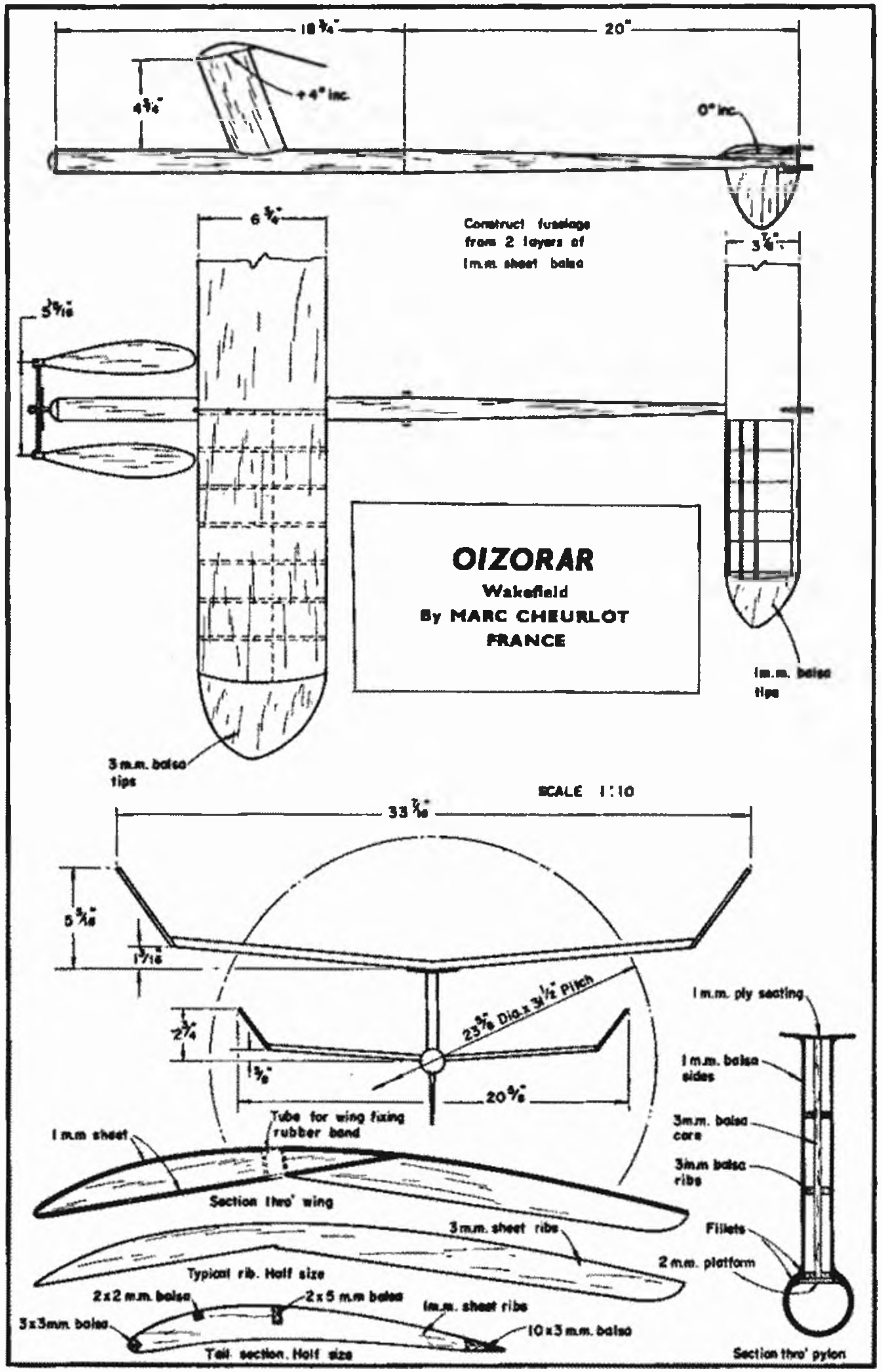
FIG.10

Both the drag and "balance" effect can also be adjusted in a practical manner. Rounding off the leading edge at the bottom reduces these forces and this section, being of balsa, is readily trimmed to shape even with the aileron in situ. The results of such trimming, however, are usually quite small on model ailerons, and often negligible.

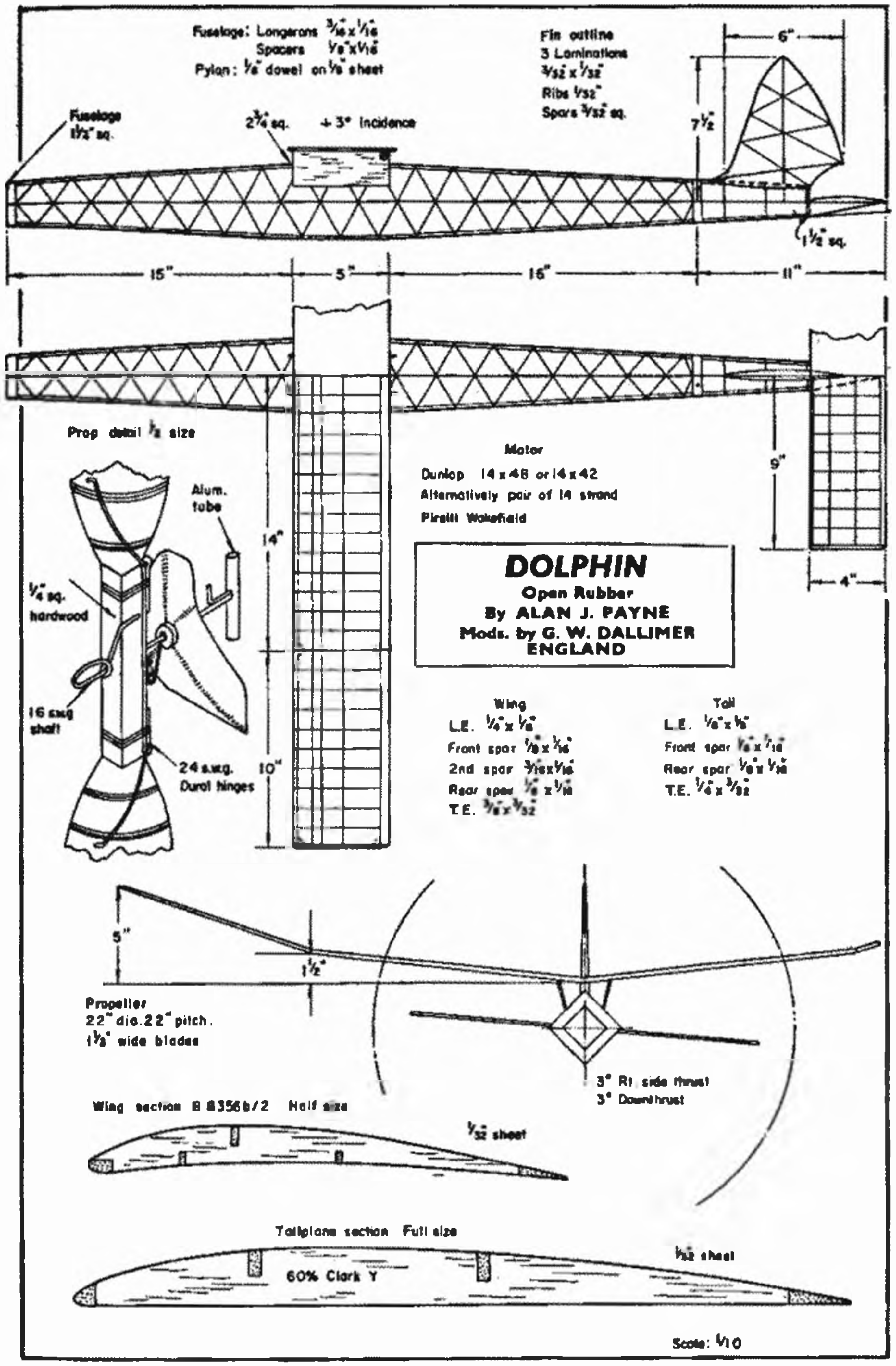
The other main feature of the Frise aileron is that its efficiency can be increased by fitting a shroud extending from the main aerofoil over the leading edge of the aileron. This should result in some drag reduction under normal flight conditions and a slot effect when the aileron is displaced to improve the airflow over the ailerons. Again this is something which shows positive results on full scale ailerons but less effect in model sizes.

There are a number of other ways of increasing the efficiency of an aileron—one basic solution being to separate it entirely from the main aerofoil as in the Junkers aileron of Fig. 10. The aileron is now a symmetrical aerofoil hinged at 25 per cent chord and mounted below and slightly overlapping the trailing edge of the wing itself. It is virtually a "free" aerofoil and at the specified hinge point virtually fully aerodynamically balanced, so that control loads are very light indeed.

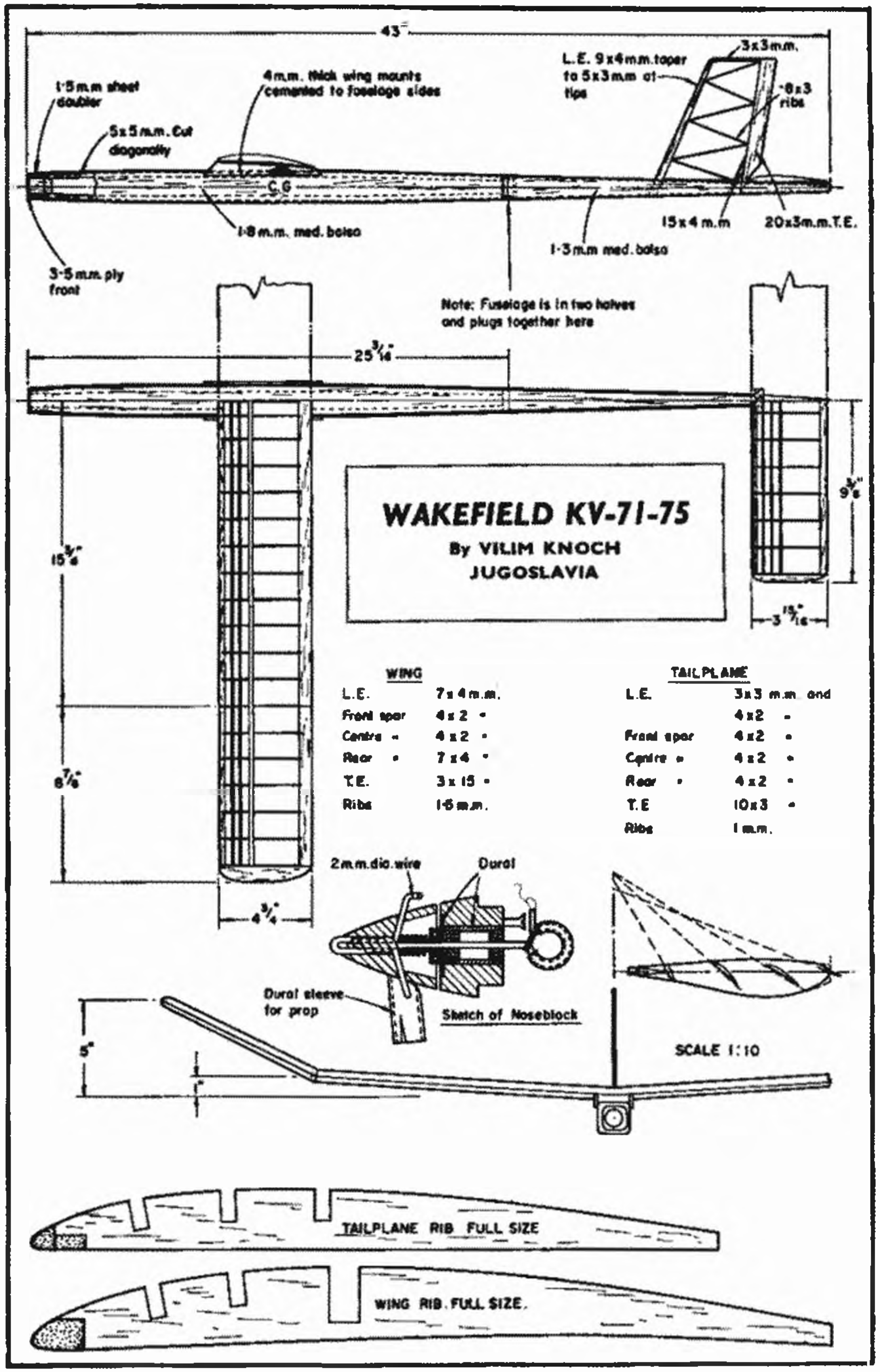
The particular advantage offered by this system is that the down-going aileron is subject to a slot effect by the leading edge approaching the main wing, increasing its efficiency and reducing its tendency to stall. It produces rather more adverse yawing effect than a Frise type aileron, however, and being separately mounted is somewhat more vulnerable (which could be an important consideration on a model). Another point is that in model sizes the narrow chord symmetrical section may well exhibit "flat plate" aerofoil characteristics, so that a hinge point at 25 per cent chord could result in over-balance and a tendency to develop flutter at high speeds. A hinge point no farther aft than 20 per cent of the chord would probably be much safer, regardless of the actual section of the aileron, which would normally be shaped from light sheet in any case.



MODELE AVIA, BELGIUM



NEWS & VIEWS, STEVENAGE M.F.C., G.B.



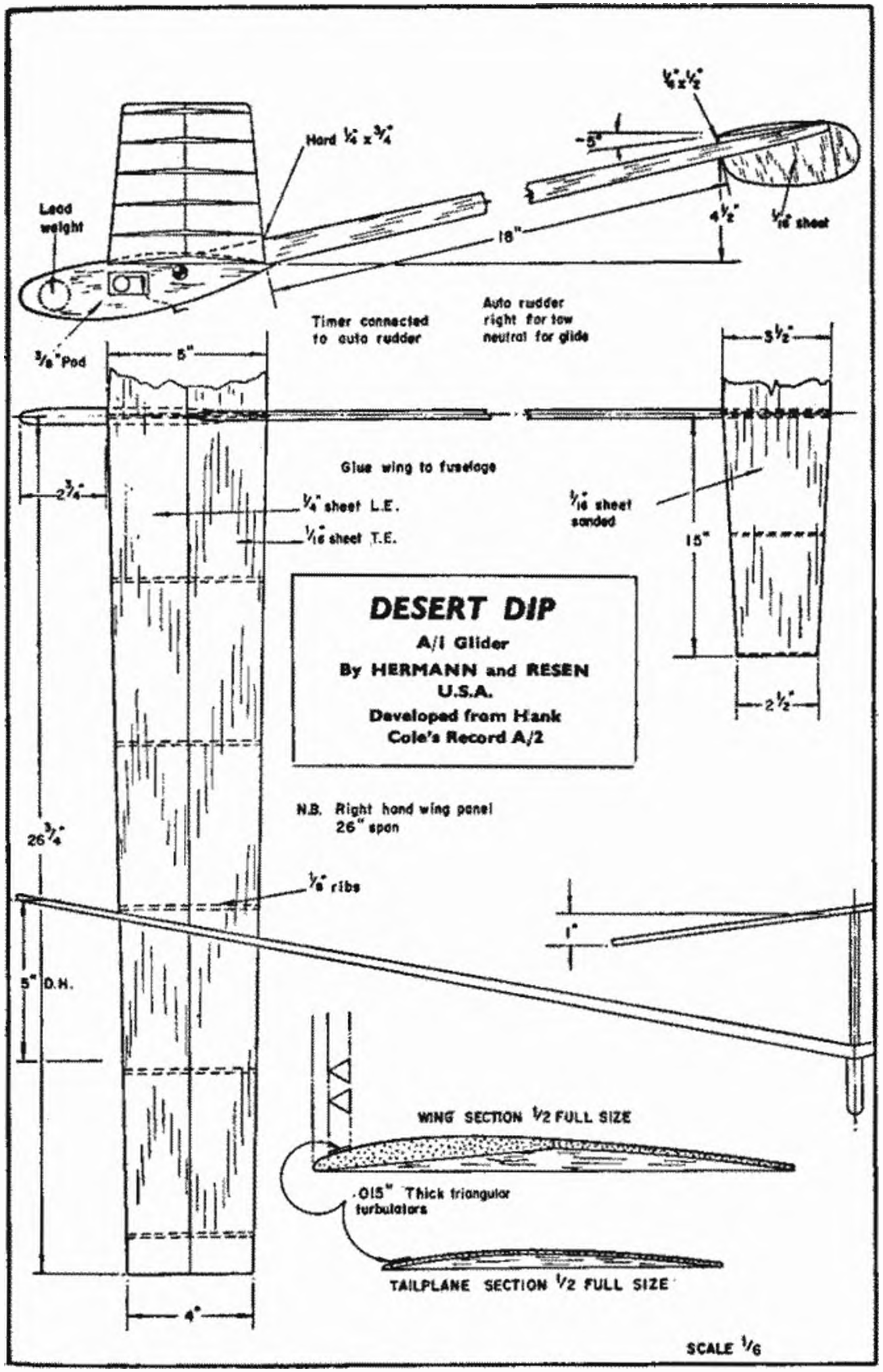
WAKEFIELD KV-71-75

By VILIM KNOCH
JUGOSLAVIA

WING	
L.E.	7 x 4 m.m.
Front spar	4 x 2 "
Centre "	4 x 2 "
Rear "	7 x 4 "
T.E.	3 x 15 "
Ribs	1·6 m.m.

TAILPLANE	
L.E.	3 x 3 m.m. and
	4 x 2 "
Front spar	4 x 2 "
Centre "	4 x 2 "
Rear "	4 x 2 "
T.E	10 x 3 "
Ribs	1 m.m.

AERO MODELAR, JUGOSLAVIA



DESERT DIP

A/1 Glider
By HERMANN and RESEN
U.S.A.
Developed from Hank
Cole's Record A/2

I.M.A.C., ILLINOIS M.A.C., CHICAGO, NEWSLETTER, U.S.A.

DESIGN THEORY — FACT AND FALLACY

THEORY *versus* practice has always been a controversial subject in aeromodelling, partly because the science of model design can never be an exact one. The best models are invariably produced on practical lines, backed by practical experience and test. The best and most consistent contest results are achieved by individuals with that extra flair for producing a model which is "right" and trimming it in the best possible manner. Success is as much a matter of long hours of work and application as anything else. Studying the theoretical side appears to pay very little in the way of dividends, yet it can be helpful and even necessary at times.

Attempts to sort out modern aerodynamic theory as applied particularly to model aircraft were made by the Low Speed Aerodynamic Research Association, founded in this country in 1944, but now defunct. Certainly they rationalised a lot of hitherto "wild" theory and introduced some very useful new approaches, some of which—particularly in the matter of low speed aerofoil design—has been carried on by other authorities. The practical aeromodeller, however, will still dispute whether a mathematically designed low speed aerofoil section is any better than his own particular choice— and if the practical man is also a good flyer he will beat the "theory" man with his theoretically superior design. It is still the individual who has the trimming and handling of the model which counts most in the end!

However, certain theories are useful as a *basis* of design, although not strictly necessary. It is readily possible to design a first-class contest model merely by following current practice in shapes, proportions, etc., and applying individual skill and preference in the matter of arriving at suitable structures. Calculation is restricted to working out areas—and that only to conform to a specification. Even such vital factors as rigging incidences and balance point are "guesstimated"—and in the case of an experienced modeller they usually work out pretty close to correct.

There are, in point of fact, very few *original* designs in any class of aeromodelling which can be considered outstandingly successful. Certain top-class designs have been developed through a series, and subsequently much copied by other designers. The "theoretical" designs normally enjoy only a brief period of publicity—and then usually only because of their novelty appeal or different look.

There are, of course, the notable exceptions—and these are models which have *started* trends. Their evolution has been dependent on design *thinking* (which means theorising) rather than straightforward development, although they may be related to previous experience. The pylon power model, for example, grew out of Carl Goldberg's bold idea that a microfilm indoor model layout had stability features attractive for handling high power engines—leading to the Valkyrie, Sailplane, Zipper and Interceptor. Apart from detail changes in proportions and developments in structures (some more influenced by prevailing rules than anything else), the top free flight power models twenty years later are not very much different from the "Interceptor" of twenty years ago.

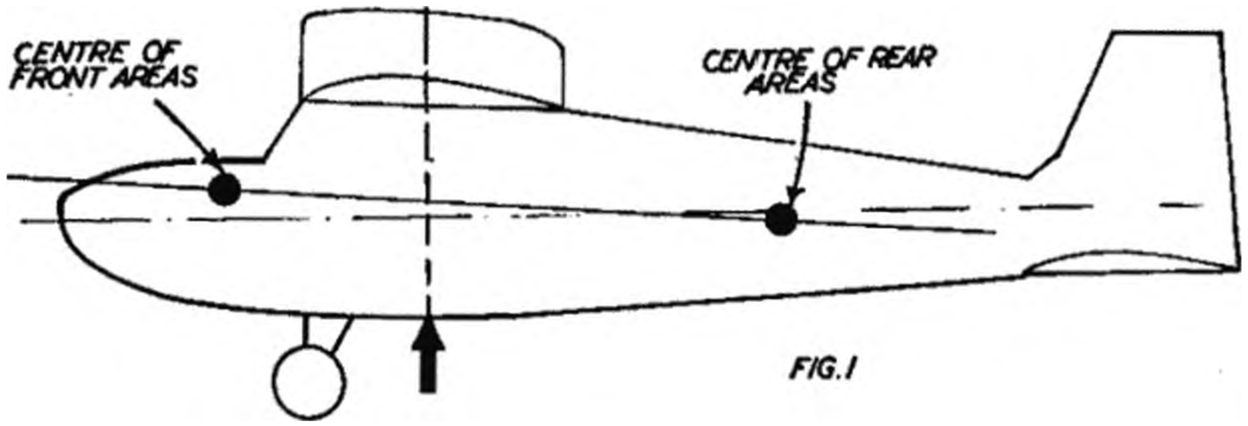


FIG. 1

The very long fuselage Wakefield evolved in a somewhat different manner. This was originated by Hank Cole of America after a lot of theoretical calculation on the potential performance of different possible design layouts. The final design put the c.g. 2 inches *behind* the trailing edge, and it worked. It was a very difficult model to beat with orthodox designs, except under rough conditions. It started a trend which was "killed" not by improvements in orthodox design but by a rule change which restricted the amount of rubber. Even with restricted rubber modern Wakefields still use what is basically an exaggerated fuselage length.

In the case of contest gliders, which have largely evolved around the A2 specification, design trends have been largely practical, following layouts and ideas which have proved outstanding the previous season (ignoring the fact that, often, it was the flyer which was outstanding rather than the particular design). The more revolutionary ideas, such as Ossi Czeppa's 1948 winner, has evolved into a more radical, orthodox layout—and even aerofoil sections are more or less standardised. So theory has not helped a lot here although design *thinking* has, provided it is investigated and proven by practical experience.

Rolling axis theory

Radio control model design, until quite recently, virtually resolved itself around a high wing layout with deep fuselage and underslung tailplane, conforming in side elevation to the "side area" or "rolling axis" theory, which was quite widely accepted at the time. This theory was that the rolling axis of the model was defined by a line joining the centres of the front and near side areas—Fig. 1. The dividing line for the front and rear areas was not always clearly defined, but was usually taken as a vertical through the c.g. The theory then stated that if this joining line sloped upwards then the model would have favourable stability characteristics when rolling into a turn. If the line sloped downwards, the nose would drop in a roll, leading to spiral instability.

The basic *idea* of such a definition of the rolling axis is sound, but the definition is not. The main factor governing whether the model tends to become spirally unstable when rolling into a turn will be dihedral effect and fin and rudder effect—the former providing a correcting force with sideslip and rudder effect tending to force the nose down. Too much directional stability (fixed fin area) makes for a weak rudder (calling for more offset to produce a quick response), and if allied to low dihedral makes for spiral instability. What is helpful, however, is to have the longitudinal *inertia* axis inclined upwards—i.e. for front and rear "areas" in the original theory (and Fig. 1) substitute front and rear centres of weights. Models which conform to the original "area" theory

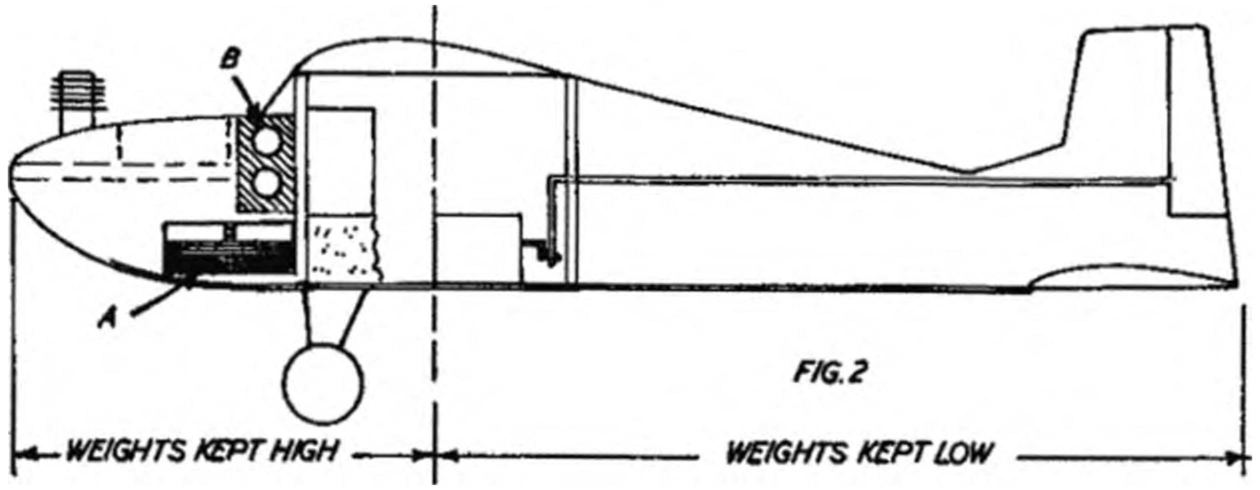


FIG. 2

for good rolling stability almost invariably have this positive incidence inertia axis because of the geometry involved. Both theories "work", but only the latter is correct, which can be proved, if necessary by ballasting an "area correct" model so that the inertia axis slopes downwards—with dire consequences on stability.

This theory also leads to the point that it is better to mount weights high in front of a radio control model rather than low. Common practice, for example, is to stow batteries under the engine mounts (position A, Fig. 2), when mounting at point B whould probably improve stability in turns (i.e. reduce the tendency for the nose to drop. An upright engine is also more helpful than inverted mounting for exactly the same reason—it helps to keep the nose weights high. A tricycle nosewheel is not helpful since it tends to lower the centre of forward weight.

C.L.A. Theory

The original side area theory or Centre of Lateral Area (C.L.A.) theory dates back to the 1930's and was a convenience for arriving at a suitable fin area for any type of free flight model. It consisted of cutting out a side view projection of the model and then trimming the fin shape until the pattern balanced with the centre of area behind—and also usually specified to be above—the design centre of gravity—see Fig. 3. Various alterations of projected area were made to compensate for the "effectiveness" of the different side areas as "fins", such as reducing the geometric depth of the fuselage in the case of a streamlined shape and increasing the effective height of the wing projection by 50 per cent to allow for the dihedral effect of both wings.

Certainly this was a simpler method than calculating fin areas required from quite complex formulas which were also current at one time (and, being based on out-dated full size theories, had little relationship to model requirements). It also, more by coincidence than anything else, gives a fin of reasonable size although, generally, a little on the small side for rubber models and a little on the large side for gliders and duration-type power models.

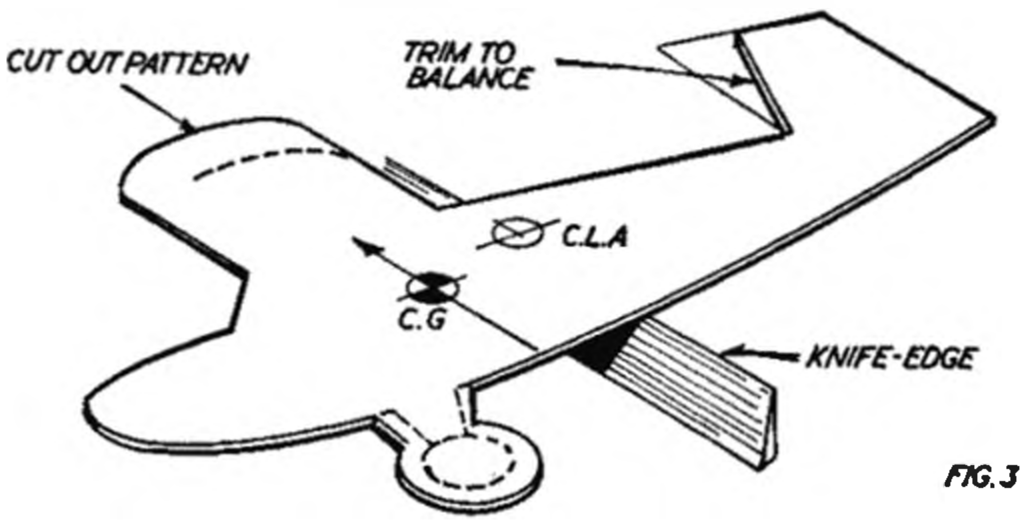


FIG. 3

Surprisingly, to many people who have always thought that the wrong fin area was the primary cause of spiral instability, fin area is not all that critical, but the degree of tolerance which can be accepted in fin area is dependent on the amount of dihedral used. The smaller the dihedral the smaller the range of fin area which will give satisfactory performance without running into spiral instability (through too much "weathercock" action) or "Dutch rolling" (caused by an excess of dihedral and needing an excess of fin area to counteract).—see Fig. 4.

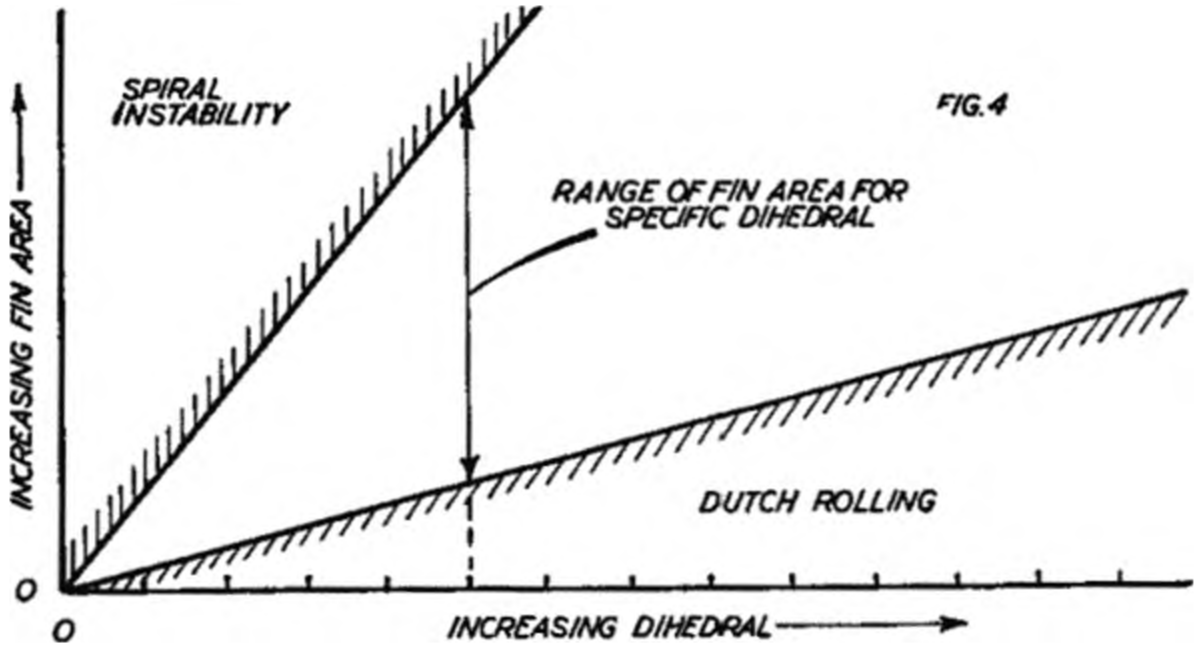
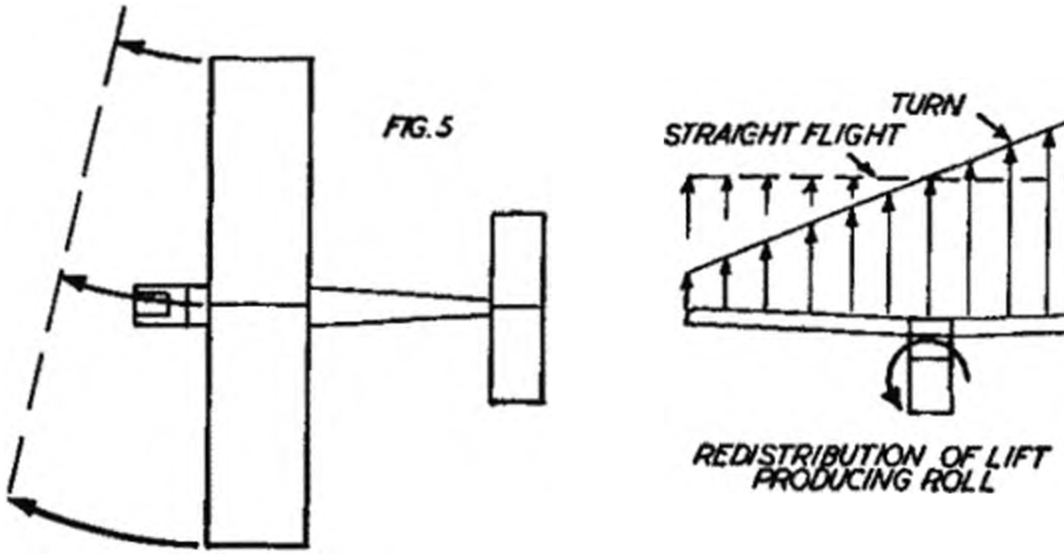


FIG. 4

Fin area

For satisfactory straight flight performance the fin area can be quite small and, according to another theory, the smaller the fin area the better for stability in turns (spiral stability). That is why power duration fins are generally small. They got trimmed down to minimum size at an early stage of design development and most designers have followed similar proportions ever since. The theory involved is simply that when making a turn which involved any appreciable angle of bank, fin action became that of an elevator, forcing the nose down and tending to promote a spiral dive. Thus the smaller the fin the less this unwanted effect.

In actual fact the "weathercock" action of the fin exerts a *stabilising* effect on turns since by the nature of the airflow over the model a yawing effect is produced tending to oppose or reduce the rate of turn. At the same time, however, it does tend to reduce the favourable effect of dihedral by reducing the amount of sideslip. Hence if there is too much "weathercock" action, the sideslip action is reduced to the point where the inner wing cannot assume a stable position balancing the roll induced by the turn, so it keeps on dropping and the model goes into a spiral dive. This again emphasises the relationship between fin area and dihedral and the fact that the smaller the dihedral the greater the necessity for getting the fin area correct.



REDISTRIBUTION OF LIFT PRODUCING ROLL

Often the real "nigger in the woodpile" is the *rolling* effect produced as soon as a model starts to turn. The outer wing travelling through the air faster than the inner wing, and thus generating more lift and producing a bank. The tighter the turn the greater this effect and this can be strong enough to overcome the corrective (stabilising) forces available. The gyroscopic effect of the propeller does not always help, either. In a right hand turn it tends to force the nose down, and in a left hand turn force the nose up. Thus a turn to the right induces a natural nose-down reaction which is reducing the spiral stability margin. A turn to the left may appear much safer, but the nose-up reaction could induce a stall. Trimming this out could actually lead to a degree of under-elevation and a reduction in the stability margin.

Spiral stability

The overall reaction in a turn—the "battle" between stabilising and destabilising forces is further modified by the effect of displacing the fuselage—or, more correctly, the fact that the true airflow is momentarily curved tending to strike the nose on the inside of the turn and the tail on the outside of the turn. Thus a forward-mounted pylon has an initial stabilising effect. This particular theory is incomplete, however, for as soon as the model banks into the turn sideslip starts and the airflow is further modified. Forward fin area is still stabilising in tending to resist and increase in rate of turn whilst tail side areas are tending to increase the rate of turn (and rate of roll at the same time). An excess of weathercock stability is thus an unstabilising factor with an appreciable amount of sideslip, although it may be effective initially in reducing the amount of sideslip. If the two actions seem contradictory it is still only a matter of fact. An excess of fin area may be perfectly satisfactory for normal flight and moderate turns, but if the model is made to turn more tightly spiral instability can result. It depends largely on how much the sideslip modifies the airflow on the fin. Hence also the reason why models trimmed for tight spiralling flight can, and often do, have fin areas cut down to a minimum, even to the extent of exhibiting "Dutch roll" characteristics. You can, almost literally, have it both ways, provided you have enough dihedral to provide stabilising action. The danger with an absolute minimum size of fin is that the weathercock stability margin changes with flight attitude and under certain circumstances it may be reduced to zero by other unstabilising factors (chiefly fuselage effects). The model then immediately becomes catastrophically unstable for the one thing all free flight models *must* have is a reserve of directional or "weathercock" stability.

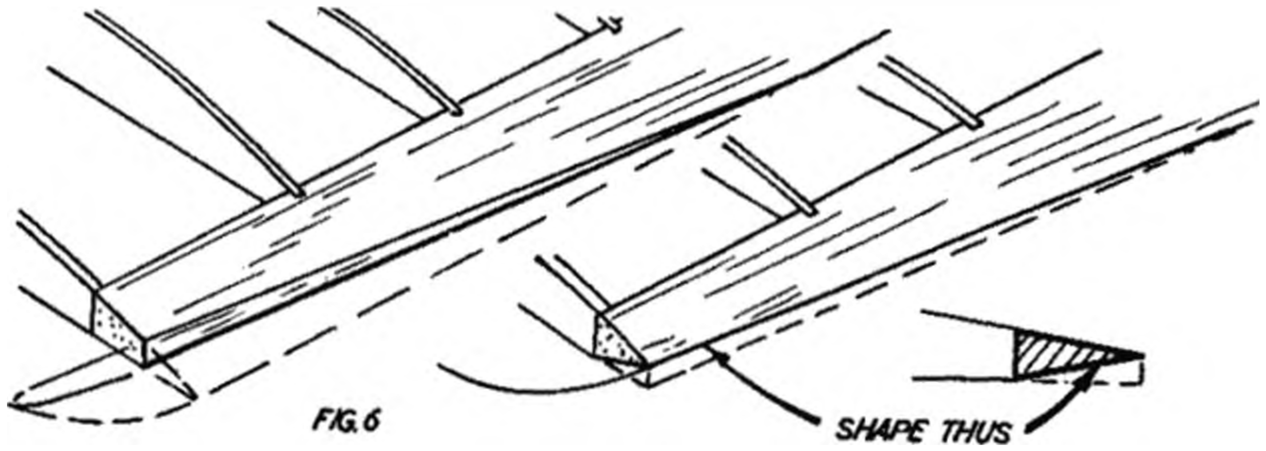


FIG. 6

The one stabilising feature which is seldom tackled—and could be to considerable advantage—is reducing the *rolling* effects—Fig. 5. A tapered wing reduces the unfavourable roll since there is minimum area where the airspeed is highest, but is not a very effective answer. To show any appreciable benefits the amount of taper would need to be greater than that which can be introduced without decreasing the efficiency of the wing or lead to other troubles such as tip stalling. If the inboard tip stalled, for example, it would aggravate the position. Nevertheless a wing with some taper on the outboard panel should be better than a parallel chord wing with a "square" tip, although the latter is a common standard for all types and sizes of model.

What can be of distinct benefit, however, is washout over the outboard portion of the wing. Whilst this may decrease the overall lift slightly it will also reduce the rolling moment in turns. Where maximum "duration" performance is not the main aim, then washout is a highly desirable design feature. It can, for example, be incorporated with advantage on most radio control model wings where again parallel chord planforms prevail. With substantial solid section trailing edges washout can easily be produced by shaping the tip section of the trailing edge as in Fig. 6.

Downthrust

Strangely enough very few theories have been advanced about "downthrust". It is either accepted as an essential feature of trimming or avoided as far as possible on the basis that "downthrust is simply a waste of power", the latter quote being a common fallacy. In terms of basic mathematics ten degrees of downthrust represents a power "loss" of only 1·5 per cent—see Fig. 7—relative to the datum line of the fuselage. The datum line, as such, is merely a geometric

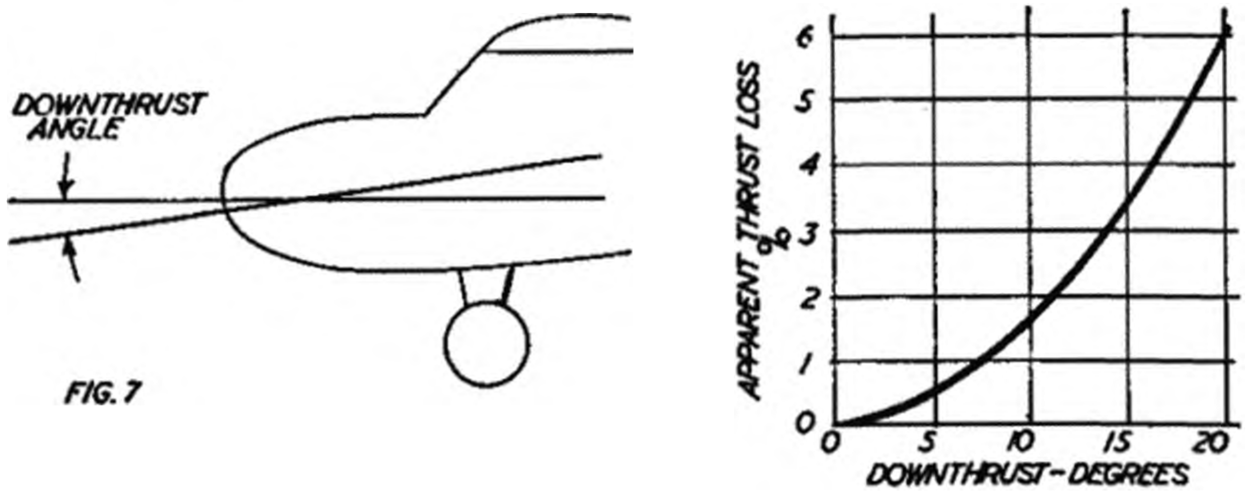


FIG. 7

convenience and in no way defines the actual *flight attitude* of the model. The latter is determined by *trim* which, in essence, results in a favourable angle of attack for the wing with all the forces acting on the model in equilibrium.

Trimmed flight attitude varies with the type of model. With a rubber model the wing angle of attack is usually high for maximum climb. With an operating angle of attack of, say, 8 degrees, and a rigging incidence of 3 degrees the datum line is inclined at 5 degrees positive to the flight path—Fig. 8. Any downthrust angle of less than 5 degrees, therefore, is effectively *upthrust* (relative to the flight path). It could be argued that the more effective upthrust the better, since this is providing a lifting force. But more important is the matter of controlling the variable torque output of the motor (and thus variable thrust from the propeller)—hence the convenience of adjustable downthrust as a method of trimming out the power run. The other way is by reducing (wing) lift efficiency by trimming the model for a tight spiral climb. This type of trim enables downthrust to be reduced to a minimum and is also a good way of trimming out a high powered rubber motor. Although the climb may appear more spectacular, however, careful trimming for a wider climbing turn with downthrust is capable of giving greater height from a rubber motor of normal proportions.

Downthrust is, in fact, simply a trimming convenience. Basically the need for downthrust is tied up with the rigging trim, and particularly the balance point. The farther aft the centre of gravity the less the need for downthrust in trimming because the longitudinal dihedral is reduced, consequently reducing the tendency for the model to nose up with increasing speed (high power). For stability reasons an aft c.g. position normally demands a pylon mounted wing to provide an adequate stability margin. With high-performance power-duration models, too, the wing angle of attack on the climb is deliberately kept low, with tailplane lift quite powerful as a controlling force. The need for downthrust in trimming is therefore less, and excessive downthrust is dangerous (rather than wasteful) in increasing the power of the tailplane.

The clue, basically, is the design c.g. position. If this is fairly well forward (common on shoulder wing designs, for example), there will be a need for downthrust in trimming. The farther forward the c.g. position, the more downthrust is likely to be required. Some shoulder-wing power models of the high-performance type require as much as 15 degrees downthrust or more. It is impossible to trim them out with less unless the c.g. position is moved aft, and the tailplane incidence increased to trim. Then the stability margin may be reduced to dangerously low levels. They will thus perform *better* with a lot of downthrust than re-rigged to trim on a smaller amount of downthrust.

Downthrust, however, is not a "cure all". A radio model trimmed with a forward c.g. position, for example, may continue to show excessive nose-up tendencies coming out of turns, or a tendency to "kite" rather than fly fast in straight flight with good penetration, with downthrust increased to 20 degrees or more. The model simply has too much longitudinal dihedral and the answer is to reduce the tailplane incidence and shift the c.g. back, as necessary, to trim. The points to watch in shifting trim are (i) trimming with the c.g. farther aft reduces the stability margin (and some designs are definitely limited with regard to the amount of rearward c.g. shift they can accommodate and still remain stable); (ii) trimming with the c.g. farther aft makes downthrust increasingly effective in action. These are not so much theories as established facts.

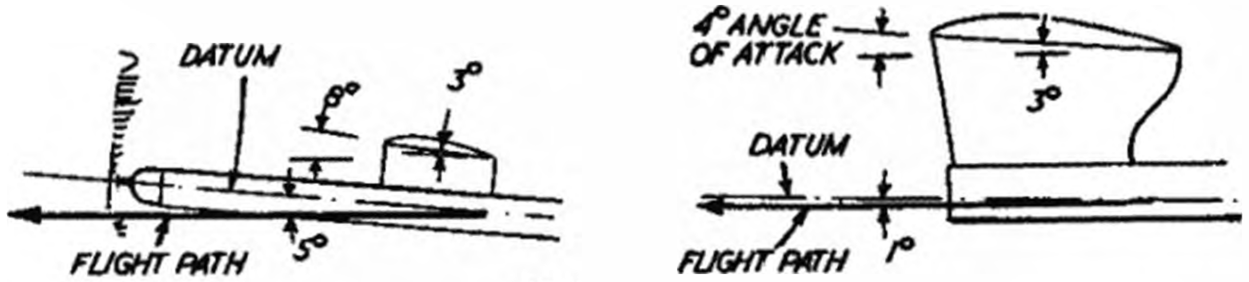


FIG.8

Stability margin and C.G. position

The stability margin for longitudinal trim is defined in modern theory as the distance between the c.g. and the neutral point (see *Aeromodeller Annual* 1961-62). As long as the neutral point lies behind the c.g. there will be a static stability margin but as the c.g. approaches the neutral point (e.g. the model is trimmed with the c.g. farther and farther aft) there will come a point where *dynamic* stability becomes marginal and instead of damping out pitching motions the flight path will take the form of a series of undulations or "phugoids" which may only be slowly damped out, or even increase in amplitude. This is quite distinct from an over-elevated trim where the model is actually stalling, although it is most common with high-performance models trimmed for optimum glide (where the wing is operating at a high angle of attack). It is also most likely to occur on the "cleanest" model designs (i.e. those with minimum drag), and those with minimum tail areas (e.g. high-performance gliders).

Theoretically, at least, dynamic instability of the phugoid type sets a limit on the minimum size of tailplane which can be used on a design and still hold "optimum" trim. In practical language, the smaller the tailplane area the more difficult it is to trim the model for minimum sinking speed on the glide since phugoid motion sets in before the limit of (wing angle of attack) trim has been reached. Working down to absolute minimum sizes for tailplane area on gliders for increased overall efficiency with a limit to total area can, therefore, be something of a canard. The limit of trim set by the onset of phugoid motion may not be the optimum for the wing, and so although more area is got into the wing the overall effect may not be as good as a similar layout and same total area but with a slightly larger tailplane.

Much depends on the flying conditions. Initial disturbances which are likely to lead to phugoid motion if the static stability margin is small are more likely to be set up in rough air than in calm conditions. A particular model, therefore, may not be able to hold "still air" trim in rougher weather and need retrimming (with a theoretical loss of performance). A model with an adequate stability margin, on the other hand, can still perform satisfactorily in rough air with its "still air" trim. It could, however, well be beaten under still air conditions by a model specifically designed to the limit for still air flying.

One source of phugoid motion which can generally be ignored is that which often occurs near the ground with a finely trimmed model. Although this is dynamic stability it is produced only by general turbulence near the ground. To adjust the trim to stop this will reduce the efficiency of the trim over the greater proportion of the flight and could cut a substantial figure off the total duration. A duration type model which has a tendency to show stalling characteristics or phugoid motion when gliding in close to the ground in windy weather, in fact, is usually an indication that the glide trim is about as good as you can get it—so leave well alone!

ASPECT RATIO

By Charles Sotich. An informative short to be read in conjunction with Nomographs on facing page. From IMAC, Illinois M.A.C. Newsletter.

ONE OF the many factors which make one model look different from another is the aspect ratio of the wing. Aspect ratio is the term given to the ratio of the wing span to the average wing chord. It is a precise way of telling how stubby or slender a wing is. The following formulas can be used for calculating it:

$$\text{Aspect Ratio} = \frac{\text{Wing Span}}{\text{Average Chord}} = \frac{\text{Wing Span} \times \text{Wing Span}}{\text{Wing Area}}$$

$$= \frac{\text{Wing Area}}{\text{Average Chord} \times \text{Average Chord}}$$

Example: A towline glider wing has a 72 in. span and 432 square inches of area. What is the aspect ratio?

$$\text{A.R.} = \frac{\text{Wing Span} \times \text{Wing Span}}{\text{Wing Area}} = \frac{72 \times 72}{432} \qquad \text{A.R.} = 12$$

Note that it was not necessary to know the wing shape in order to calculate the aspect ratio in this example.

The main importance of the aspect ratio of a wing in the overall design of a model is that it determines a portion of the drag due to the wing. The induced drag, which results from the wing generating lift, is reduced as the wing aspect ratio increases. In other words, a long narrow wing is more efficient than a short stubby one because it develops less drag. Therefore, by increasing the aspect ratio of a wing, it is possible to improve the flight time of a model.

There are also several other advantages to be gained from using higher aspect ratios. The tail volume coefficient (TVC), which is a measure of longitudinal stability, increases as the wing chord decreases. The TVC will increase by using a higher aspect ratio with the same tail moment arm length, or permit the use of a shorter tail moment arm with less inertia.

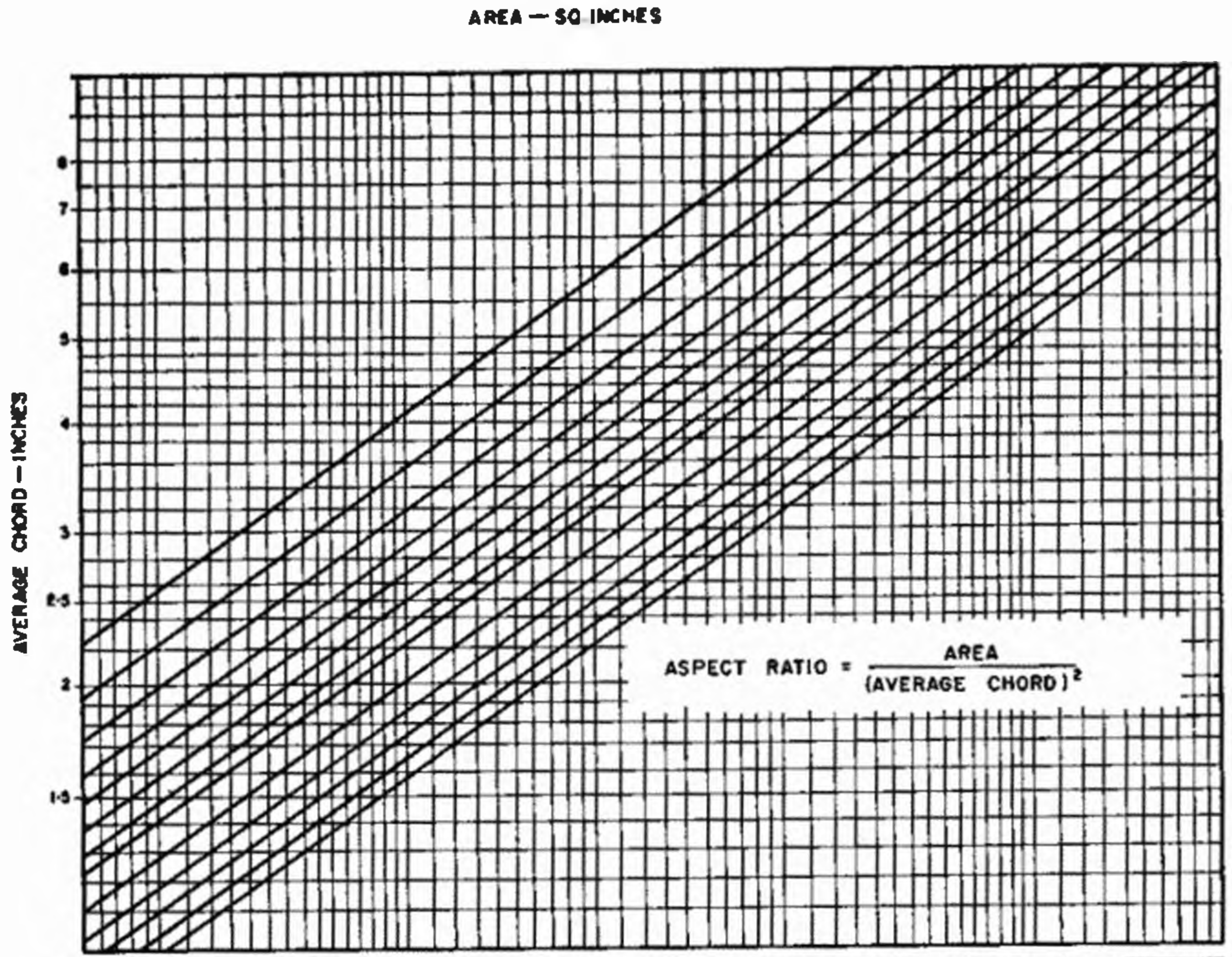
The high torque developed by rubber motors is more easily controlled when the wing area is further away from the propeller axis. By using higher aspect ratios, a smoother power pattern can be obtained from a rubber model or a larger diameter and consequently more efficient prop. can be used.

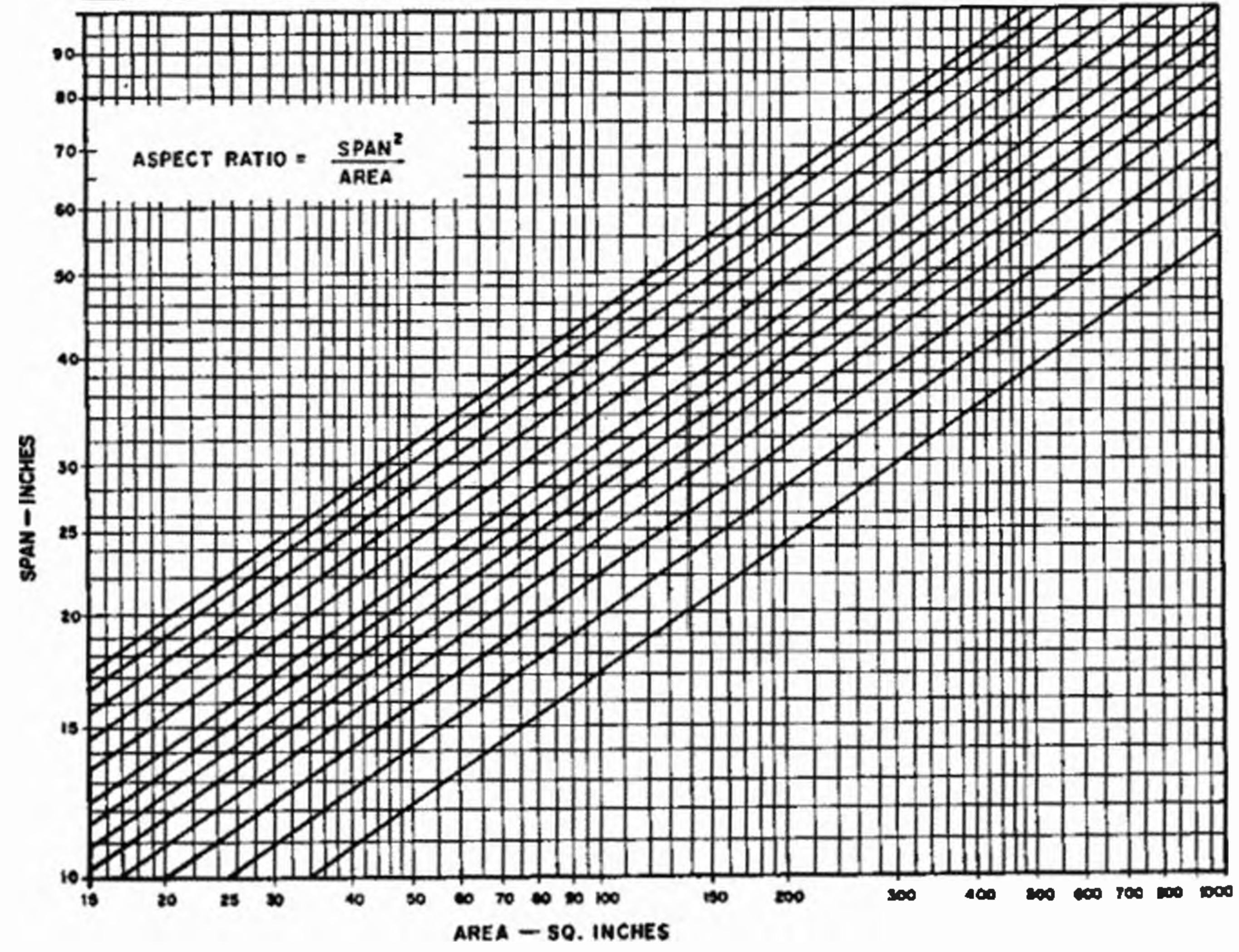
There are, however, several factors which make it necessary for the model designer to compromise and use a lower aspect ratio than he might desire. The main drawback to an excessivly high AR is that it results in a wing with a lower strength to weight ratio. This means that a high AR wing will be either heavier or weaker than a low AR wing of equivalent area.

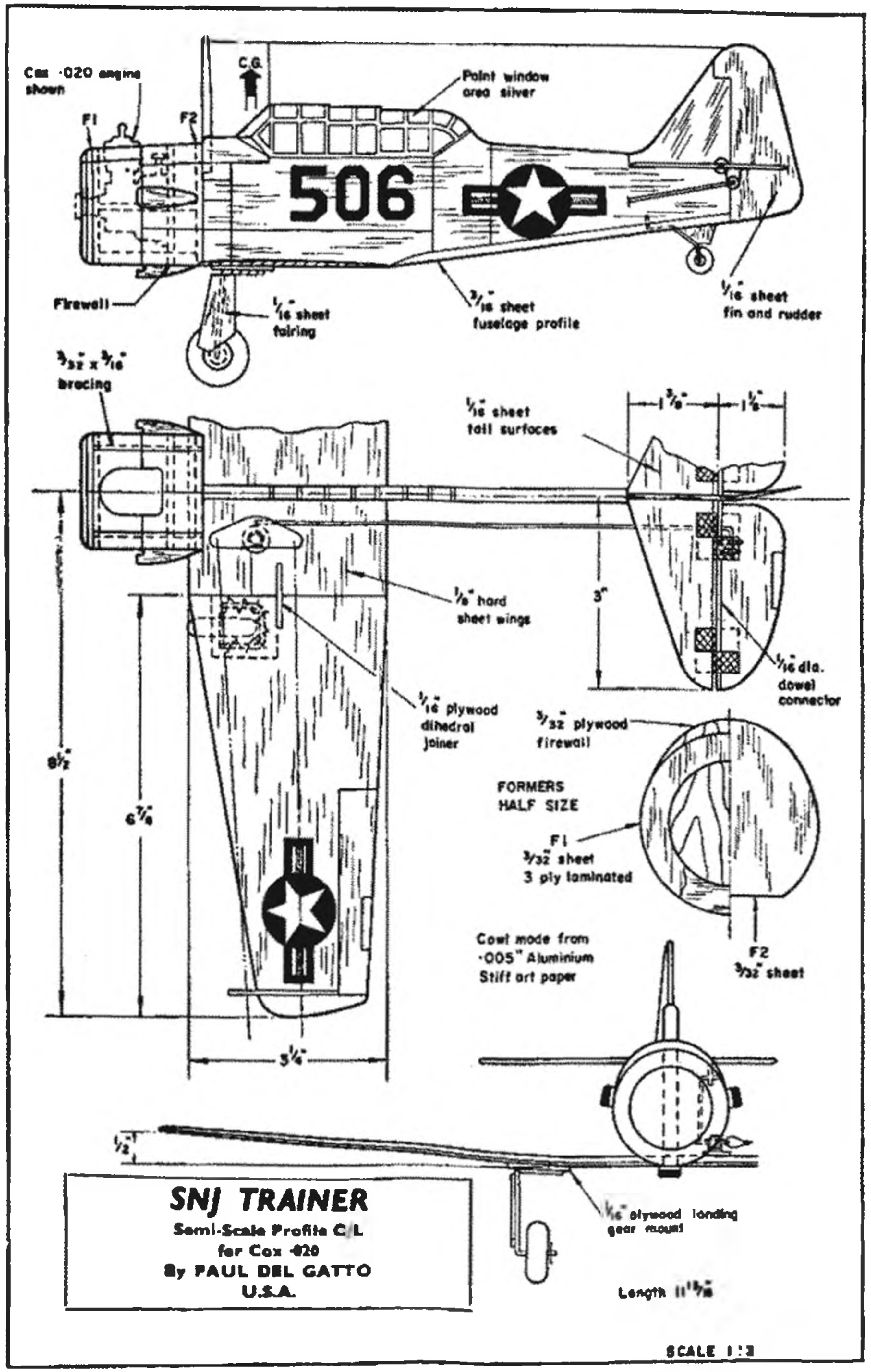
Long narrow wings are also more subject to twisting and fluttering than those that are stubbier. The lateral stability is reduced in two ways by a higher AR. First, the wing tip on the outside of the turn travels faster than the inside tip so that the outside wing develops more lift, tending to tighten the turn. Second, the high AR wing moves the weight of the wing farther from the CG, and increases the moment of inertia about the vertical axis.

The flight adjustments become more critical as the aspect ratio increases if optimum performance is to be obtained. Another minor effect is a reduction in the Reynolds Humber due to the narrower wing chord. This decreases the efficiency of the model. The following are typical aspect ratios used on contest models:

Hand Launched Glider, 4 to 10; Towline Glider, 8 to 15; Indoor Rubber, 6 to 9; Outdoor Rubber, 8 to 12; Free Flight Gas, 6 to 9.







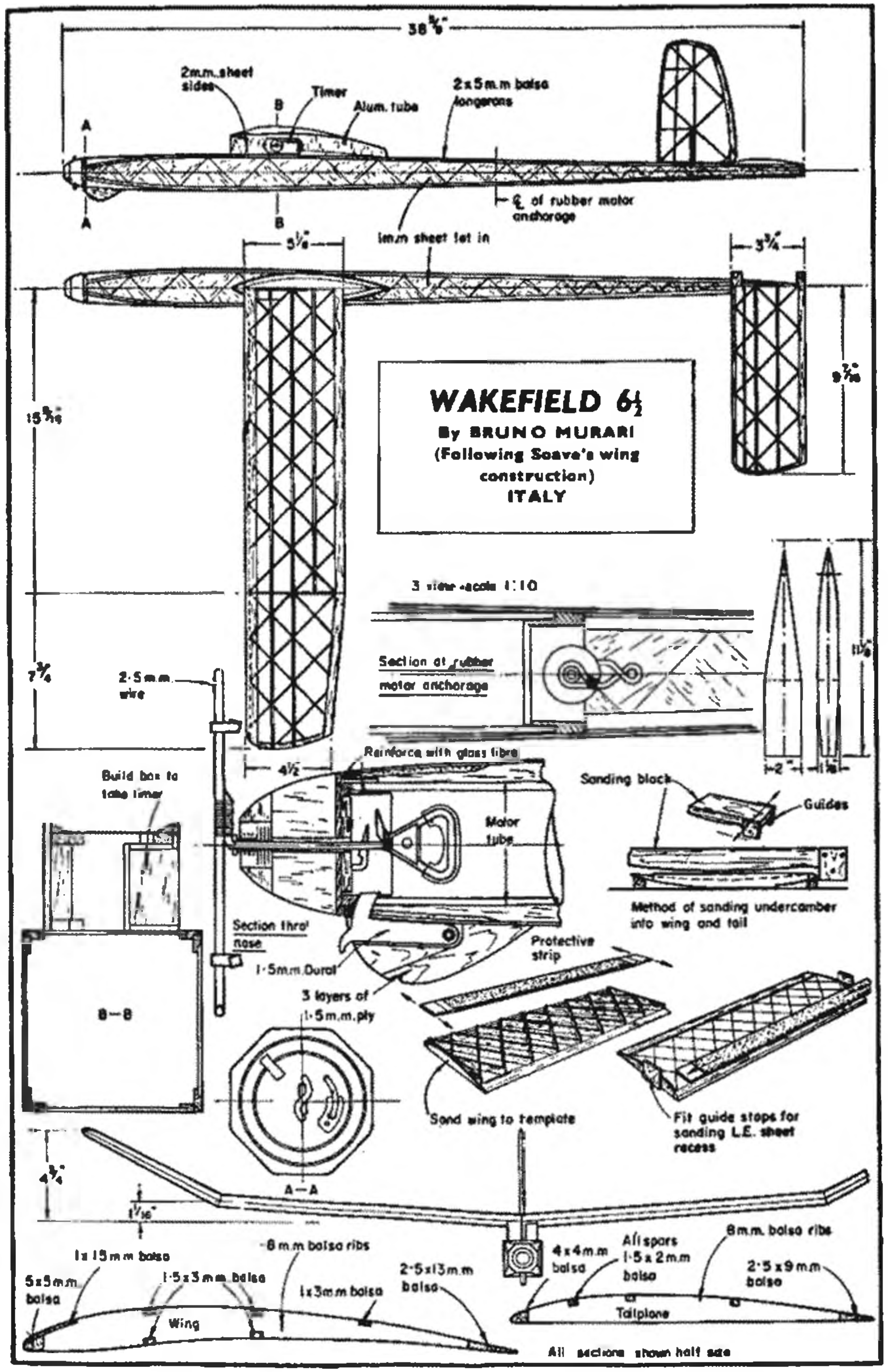
SNJ TRAINER

Semi-Scale Profile C/L for Cox ·020

By PAUL DEL GATTO

U.S.A.

MODEL AIRPLANE NEWS, U.S.A.



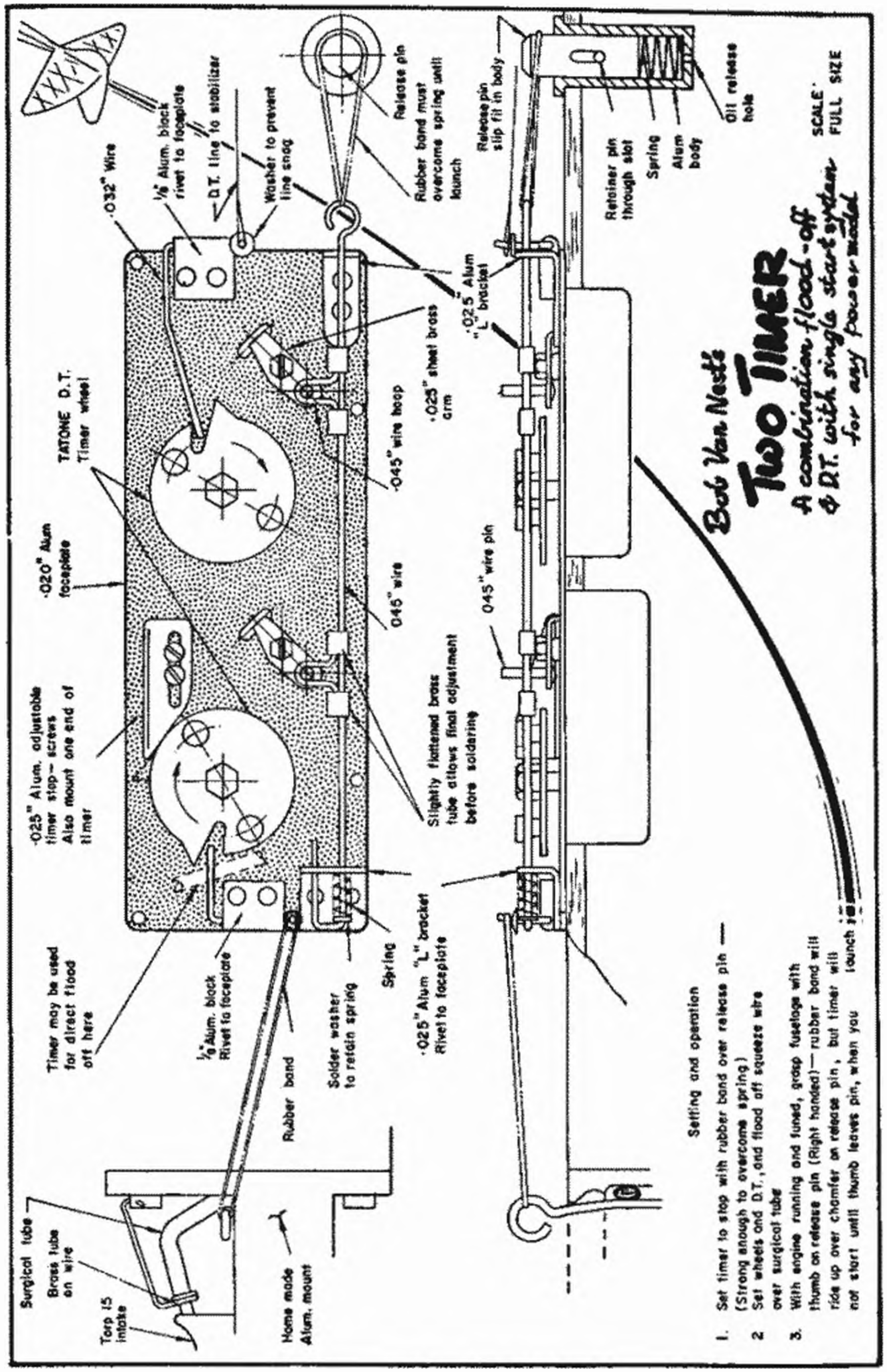
WAKEFIELD 6½

By BRUNO MURARI

(Following Soave's wing construction)

ITALY

RASSEGNA DI MODELLISMO, ITALY



Bob Van Nest's

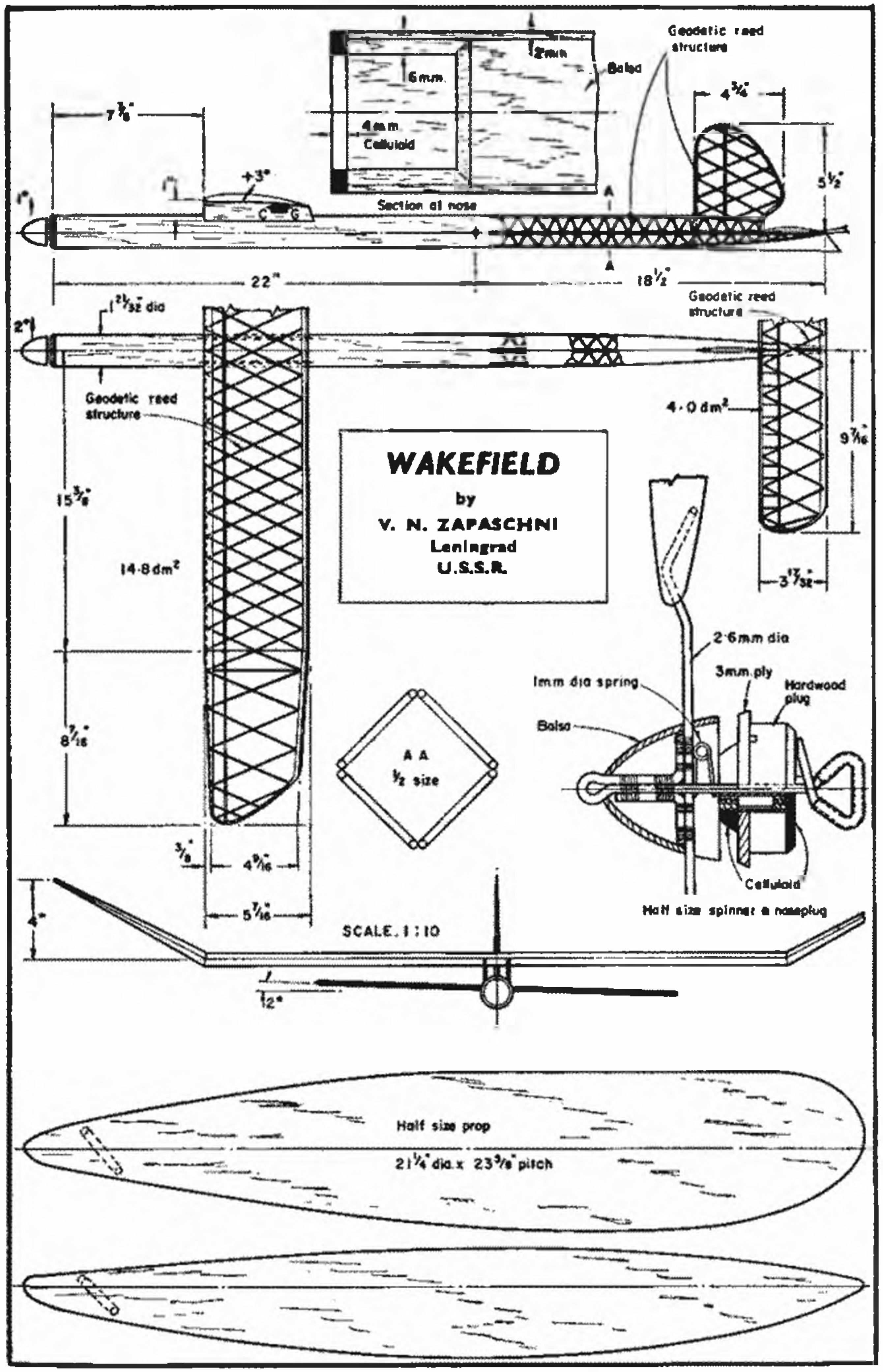
TWO TIMER

A combination flood-off & D.T. with single start system for any power model

Setting and operation

1. Set timer to stop with rubber band over release pin — (Strong enough to overcome spring)
2. Set wheels and D.T., and flood off squeeze wire over surgical tube
3. With engine running and tuned, grasp fuselage with thumb on release pin (Right handed)— rubber band will ride up over chamfer on release pin, but timer will not start until thumb leaves pin, when you launch

SCATTER NEWSLETTER (S. CALIFORNIA AERO TEAM) U.S.A.



WAKEFIELD

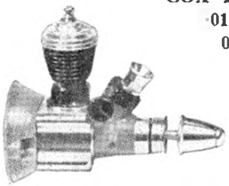
by

V. N. ZAPASCHNI
Leningrad
U.S.S.R.

LETECKY MODELAR, CZECHOSLOVAKIA

ENGINE ANALYSIS

COX TEE-DEE
·010 GLOW
0·163 c.c.



Specification

Displacement: ·163 (·00997 cu. in.)
Bore: ·237 in.
Stroke: ·226 in.
Bore/stroke ratio: 1·05
Weight: ½ ounce
Max. power (approximate): ·028 B.H.P. at 32,000 r.p.m.
Max. torque: 1.0 ounce-inches at 24,000 r.p.m.
Power rating: ·172 B.H.P. per c.c.
Power/weight ratio: ·056 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.

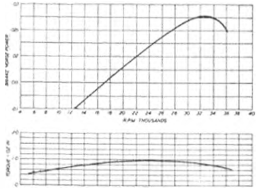
British Importers:

A. A. Hales Ltd., 26 Station Close, Potters Bar, Middlesex
Retail price: £3/18/10

Propeller—R.P.M. Figures

Propeller dia. × pitch	*r.p.m.*
3 × 1½ (Cox plastic)	27,000
5½ × 3½ (D-C Nylon)	7,800
6 × 3 (Top Flite nylon)	5,800
5½ × 3 (Top Flite nylon)	6,000
5½ × 4 (Top Flite nylon)	5,500
5 × 4 (K-K nylon)	6,000
5 × 3 (K-K nylon)	7,000

Fuel used: Keilcraft Record Super Nitrex



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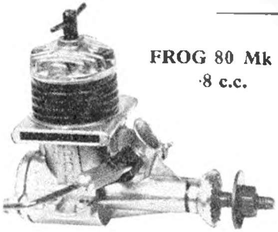
FROG 80 Mk II
·8 c.c.



Specification

Displacement: ·80 c.c. (·049 cu. in.)
Bore: ·400 in.
Stroke: ·392 in.
Bore/stroke ratio: 1·02
Bare weight: 1·9 ounces
Max. power: ·057 B.H.P. at 11,000 r.p.m.
Max. torque: 5·25 ounce-inches at 8,200 r.p.m.
Power rating: ·071 B.H.P. per c.c.
Power/weight ratio: ·03 B.H.P. per ounce

Propeller—R.P.M. Figures

Propeller dia. × pitch	*r.p.m.*
6 × 4 (Frog nylon)	13,400
7 × 4 (Frog nylon)	9,300
8 × 4 (Frog nylon)	6,500
6 × 4 (K-K nylon)	11,400
6 × 3 (K-K nylon)	13,800
5½ × 4 (K-K nylon)	14,000
7 × 4 (K-K nylon)	9,500
6 × 3 (Top Flite nylon)	14,200
6 × 4 (Top Flite nylon)	12,700
6 × 4 (D-C nylon)	14,500

Fuel used: new Frog "Powamix" diesel fuel

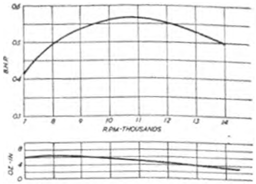
Material Specification

Crankcase: light alloy pressure die-casting incorporating stub exhausts
Cylinder: leaded steel
Piston: cast iron
Contra piston: mild steel

Connecting rod: light alloy forging
Crankshaft: hardened steel, 3 BA propeller shaft thread
Main bearing: plain
Cylinder head: light alloy die casting
Spraybar: brass (ratchet spring lock)

Manufacturers:

International Model Aircraft Ltd.
Retail price: £2/2/9 including Purchase Tax



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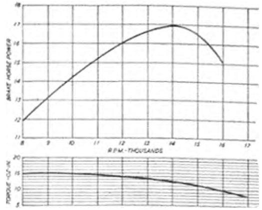
OLIVER
TIGER CUB
1·46 c.c.

Manufacturers:

J. Oliver, "Four Acres", Ringwood Road, Ferndown, Hants
Retail price: £6/10/0

Specification

Displacement: 1·46 c.c. (·089 cu. in.)
Bore: ·4659 in.
Stroke: ·523 in.
Bore/stroke: 0·89 in.
Bare weight: 4½ ounces
Max. Power: ·170 B.H.P. at 14,000 r.p.m.
Max. torque: 15 ounce-inches at 9,000 r.p.m.
Power rating: ·117 B.H.P. per c.c.
Power/weight ratio: ·041 B.H.P. per ounce



Propeller—R.P.M. Figures

Propeller dia. × pitch	*r.p.m.*
7 × 4 (Frog nylon)	14,400
7 × 6 (Frog nylon)	12,400
8 × 4 (Frog nylon)	11,000
7 × 4 (K-K nylon)	14,400
7 × 6 (K-K nylon)	11,400
8 × 4 (K-K nylon)	11,300
9 × 4 (Trucut)	8,500
8 × 4 (Trucut)	11,700
7 × 4 (Trucut)	19,000
7 × 6 (Trucut)	11,000
6 × 9 (Trucut)	11,400
9 × 4 (Top Flite nylon)	9,300
8 × 6 (Top Flite nylon)	9,500
8 × 4 (Top Flite nylon)	11,900
7 × 4 (Semo nylon)	13,800
7 × 6 (Semo nylon)	2,200
7 × 8 (Semo nylon)	9,800

Material Specification

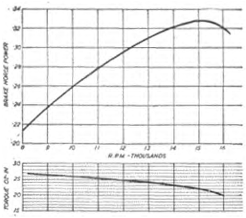
Crankcase: gravity die-casting in L.A.C. 113B light alloy, sand blast finish,
Cylinder: EN36 steel, fully hardened, ground inside and out
Piston: Meehanite
Contra piston: Meehanite
Crankshaft: EN202 hardened and ground between centres
Connecting rod: RR56 light alloy, fully machined
Main bearings: ⅜ in. diam. ball race (rear) ¼ in. diam. ball race (front)
Cylinder jacket: turned dural
Propeller driver: turned dural, steel split collet fixing
Propeller nut: 1 BA
Spraybar: brass
Crankcase back cover: turned dural, screw fixing

◆

OLIVER
TIGER III
2·424 c.c.

Specification

Displacement: 2·424 c.c. (·1479 cu. in.)
Bore: ·551 in.
Stroke: ·620 in.
Bore/Stroke: 0·89 in.
Bare weight: 5½ ounces
Max. Power: ·33 B.H.P. at 15,100 r.p.m.
Max. Torque: 26·5 ounce-inches at 8,600 r.p.m.
Power rating: ·136 B.H.P. per c.c.
Power/weight ratio: ·06 B.H.P. per ounce



Material Specification

Crankcase: gravity die-cast L.A.C. 113 B light alloy, sandblast finish
Cylinder: EN36 steel, fully hardened, ground all over
Piston: Mechanite
Contra piston: Mechanite
Connecting rod: RR56 light alloy, fully machined
Main bearings: ⅜ in. diameter ball race (rear); ¼ in. diameter ball race (front)
Crankshaft: EN 202 steel, hardened and ground between centres
Cylinder jacket: turned dural
Propeller driver: turned dural (steel split collet fixing)
Propeller nut: combined nut-stub shaft 5/16 in. o/d, tapped ¼ B.S.F.
Spraybar: brass
Crankcase cover: turned dural, screw fixing.

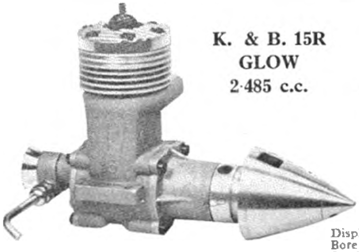
Manufacturers:

J. Oliver, "Four Acres", Ringwood Road, Ferndown, Hants
Retail price: £6/10/0

Propeller—R.P.M. Figures

Propeller dia. × pitch	r.p.m.
9 × 6 (Frog nylon)	10,900
8 × 4 (Frog nylon)	14,000
9 × 4 (Frog nylon)	10,300
8 × 5 (Frog nylon)	12,500
9 × 4 (K-K nylon)	12,200
8 × 4 (K-K nylon)	14,000
8 × 6 (K-K nylon)	11,450
7 × 6 (Trucut)	13,200
8 × 4 (Trucut)	15,400
8 × 6 (Trucut)	11,100
9 × 4 (Trucut)	11,750
9 × 6 (Trucut)	9,500
10 × 4 (Trucut)	8,500
7 × 9 (Trucut)	11,200
6 × 9 (Trucut)	14,900

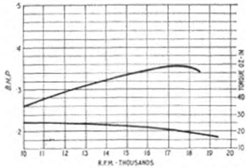
K. & B. 15R GLOW
2·485 c.c.



Propeller—R.P.M. Figures

Propeller dia. × pitch	r.p.m.
7 × 6 (Top Flite)	15,200
8 × 4 (Top Flite)	15,000
8 × 6 (Top Flite)	12,000
9 × 4 (Top Flite)	11,800
7 × 4 (K-K nylon)	17,000
7 × 6 (K-K nylon)	14,000
8 × 4 (K-K nylon)	15,000
7 × 4 (Frog nylon)	17,000
8 × 4 (Frog nylon)	14,500
7 × 4 (Trucut)	17,800
8 × 4 (Trucut)	15,500

Fuel used: Frog Redglow
Although Frog Redglow contains no Nitromethane, it is not a "straight" fuel, since it contains a small proportion of other ignition additives.
Manufacturerers' recommended propellers: C/L Speed 5⅜ in. to 5½ in. dia., 10 in. to 11 in. pitch. Free Flight 8 × 3 or 8 × 4



Specification

Displacement: 2·485 c.c. (·1516 cu. in.)
Bore: ·5995
Stroke: ·537
Bore/stroke ratio:
Bare weight: 4·9 ounces
Max. power: ·355 B.H.P. at 17,500 r.p.m. on. straight fuel
Max. torque: 26 ounce-inches at 11,000 r.p.m. on straight fuel
Power rating: 143 B.H.P. per c.c. on straight fuel
Power/weight ratio: ·0725 B.H.P. per ounce on straight fuel

Material Specification

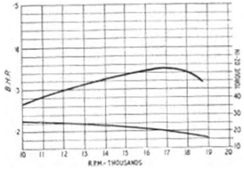
Crankcase unit: light alloy pressure die-casting
Cylinder liner: Meehanite
Piston: steel, hard chrome plated
Crankshaft: steel
Propeller driver: light alloy pressure die-casting (incorporating spinner backplate)
Propeller shaft: 3/16 in. N.S.F. studding, spinner and spinner nut as standard
Connecting rod: light alloy forging
Gudgeon pin: hollow, silver steel
Crankpin: steel, "electrolised" (press-fitted to crankweb)
Main bearings: two ¼ in. diameter lightweight ball races

Induction: rear rotor disc (plastic)
Front bearing housing: light alloy pressure die casting
Crankcase back cover: light alloy pressure die casting
Intake tube: light alloy, peripheral jets, transverse needle valve

Manufacturers:

K. & B. Mfg. Corp., Los Angeles 58, California, U.S.A.
Retail price in U.S.: $19.95

COX TEE-DEE 15 GLOW
2 449 c.c.



Specification

Displacement: 2·449 c.c. (·1494 cu. in.)
Bore: ·58465 in.
Stroke: ·556 in.
Bore/stroke ratio: 1·05
Bare weight: 4 ounces
Max. power: ·35 B.H.P. at 17,200 r.p.m. on straight fuel
Max. torque: 27 ounce-inches at 10,000 r.p.m. on straight fuel
Power rating: 143 B.H.P. per c.c. on straight fuel
Power/weight ratio: ·088 B.H.P. per ounce on straight fuel

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 5/16 in. diameter
Connecting rods: hardened steel (machined). Ball and socket little end
Piston: hardened steel (hardened on walls only), flat top
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)

Manufacturers:

L. M. Cox Manufacturing Co., Box 476, Santa Ana, California, U.S.A.

British Importers:

A. A. Hales Ltd., Potters Bar, Middlesex
Retail price: £6/4/0

Propeller—R.P.M. Figures

Propeller dia. × pitch	r.p.m.
7 × 6 (Top Flite)	15,100
8 × 4 (Top Flite)	15,000
8 × 6 (Top Flite)	12,000
9 × 4 (Top Flite)	12,000
10 × 3½ (Top Flite)	10,200
7 × 4 (K-K nylon)	17,000
7 × 6 (K-K nylon)	14,300
8 × 4 (K-K nylon)	15,000
7 × 4 (Frog nylon)	16,500
8 × 4 (Frog nylon)	14,500
7 × 4 (Trucut)	17,800
8 × 4 (Trucut)	15,500

Fuel used: Frog Redglow*
* Although it contains no nitro methane, it is not a true "straight" fuel since it contains a small proportion of other ignition additives

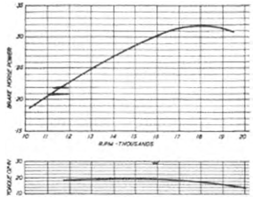
MOKI S-2 GLOW
2 465 c.c.

Specification

Displacement: 2.465 c.c. (·1503 cu. in.)
Bore: ·590 in.
Stroke: ·550 in.
Bore/stroke ratio:
Bare weight: 5 ounces
Max. power: 32 B.H.P. at 18,000 r.p.m.
Max. torque: 19·5 ounce-inches at 15,000 r.p.m.
Power rating: 1·3 B.H.P. per c.c.
Power/weight ratio: ·64 B.H.P. per ounce

Material Specification

Crankcase: light alloy pressure die casting
Cylinder liner: hardened steel
Piston: cast iron, ground and lapped
Cylinder head: turned dural
Crankshaft: hardened steel
Connecting rod: turned dural
Spraybar: brass (aluminium venturi insert)
Bearings: one 9 mm. ball race (rear); one 5 mm. ball race (front)
Propeller driver: turned dural
Crankcase backplate: turned dural



Developed by the Model Institute of Hungary, this motor has not yet been released for general production and sale overseas.

Propeller dia. × pitch	r.p.m.
8 × 4 (Frog nylon)	13,600
7 × 4 (Frog nylon)	16,200
7 × 4 (Keilkraft nylon)	16,600
7 × 6 (Keilkraft nylon)	13,500
8 × 4 (Keilkraft nylon)	13,200
6 × 4 (Keilkraft nylon)	20,800
7 × 6 (Top Flite nylon)	14,200
8 × 4 (Top Flite nylon)	14,100
6 × 4 (Top Flite nylon)	21,500
8 × 6 (Top Flite nylon)	10,000
7 × 4 (Trucut)	17,100
8 × 4 (Trucut)	14,600

Fuels: Frog Redglow and 75 per cent Methanol, 25 per cent Castor Oil

◆

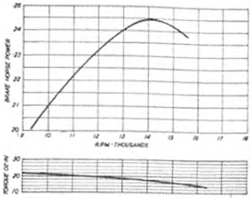
TAIPAN 2·5 BR
2·506 c.c.

Specification

Displacement: 2·506 c.c. (·1529 cu. in.)
Bore: ·576 in.
Stroke: ·5865 in.
Bore/stroke ratio:
Bare weight: 5½ ounces
Max. power: ·245 B.H.P. at 14,000 r.p.m.
Max. torque: 22 ounce-inches at 9,000 r.p.m.
Power rating: ·0975 B.H.P. per c.c.
Power/weight ratio: ·045 B.H.P. per ounce

Propeller dia. × pitch	r.p.m.
9 × 6 (Frog nylon)	10,300
8 × 4 (Frog nylon)	12,600
7 × 4 (Frog nylon)	15,200
9 × 4 (Keilkraft nylon)	11,400
8 × 6 (Keilkraft nylon)	10,900
7 × 6 (Keilkraft nylon)	12,600
8 × 4 (Keilkraft nylon)	12,800
7 × 4 (Keilkraft nylon)	15.500
9 × 4 (Top Flite nylon)	10,800
8 × 6 (Top Flite nylon)	10,900
8 × 4 (Top Flite nylon)	13,400
7 × 6 (Top Flite nylon)	13,400

Fuel: equal parts ether, castor and paraffin, 3 per cent amyl nitrate



Material Specification

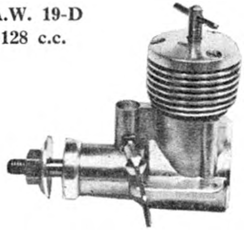
Crankcase: light alloy gravity die casting
Cylinder: hardened steel
Piston: Meehanite
Contra piston: Meehanite
Crankshaft: hardened nickel-chrome steel
Connecting rod: machined from dural
Cylinder jacket: machined from dural, anodised red
Main bearings: ⅜ in. twin/ball races—Hoffman races specified, Fischer races fitted

Manufacturers:
GORDON BURFORD, Australia

British Importer:
PERFORMANCE KITS

◆

P.A.W. 19-D
3·128 c.c.

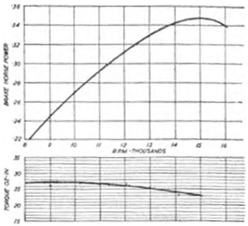


Specification

Displacement: 3·128 c.c. (·1912 cu. in.)
Bore: ·6425 in.
Stroke: ·590 in.
Bore/stroke ratio: 1·09 in.
Bare weight: 5½ ounces
Max. power: ·347 B.H.P. at 15,000 r.p.m.
Max. torque: 27·3 ounce-inches at 9,000 r.p.m.
Power rating: ·111 B.H.P. per c.c.
Power/weight ratio: ·063 B.H.P. per ounce

Propeller dia. × pitch	r.p.m.
9 × 6 (Frog nylon)	11,000
8 × 4 (Frog nylon)	14,200
8 × 5 (Frog nylon)	13,000
10 × 6 (Frog nylon)	8,800
10 × 3½ (Top Flite)	10,300
9 × 4 (Top Flite)	12,000
9 × 6 (Top Flite)	9,800
8 × 6 (Top Flite)	12,200
9 × 6 (Keilkraft nylon)	9,000
9 × 4 (Keilkraft nylon)	12,800
8 × 6 (Keilkraft nylon)	12,200
9 × 6 (Trucut)	10,200
9 × 4 (Trucut)	12,200
10 × 4 (Trucut)	9,800
8 × 6 (Trucut)	13,000

Fuel used: Equal parts ether, paraffin, castor plus 5 per cent two-stroke mineral oil plus 3 per cent nitrate



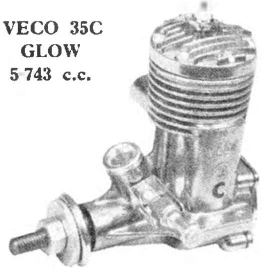
Material Specification

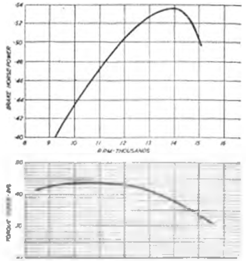
Crankcase: light alloy gravity die casting
Crankshaft: hardened steel
Cylinder: hardened steel
Piston: cast iron
Contra piston: cast iron
Bearings: ball race (rear); cast iron sleeve (front
Cylinder jacket: turned dural
Crankcase back cover: turned dural
Spraybar: brass
Connecting rod: turned from RR56 light alloy

Manufacturers:
PROGRESS AERO WORKS, Chester Road, Macclesfield, Cheshire
Retail price: £4/8/6, plus 16/- Purchase Tax

◆

VECO 35C
GLOW
5·743 c.c.





Propeller dia. × pitch	r.p.m.
10 × 6 (Top Flite)	11,500
10 × 3½ (Top Flite)	13,200
9 × 7 (Top Flite)	11,800
9 × 6 (Top Flite)	12,600
9 × 6 (Keilkraft nylon)	11,700
9 × 4 (Keilkraft nylon)	14,900
9 × 6 (Frog nylon)	13,600
10 × 6 (Frog nylon)	11,200
11 × 4 (Tornado)	11,200
11 × 6 (Tornado)	9,000
12 × 4 (Tornado)	9,700
12 × 5 (Tornado)	8,700

Fuel used: Keilkraft Record Nitrex 15

Specification

Displacement: 5·743 c.c. (·3502 cu. in.)
Bore: ·7845 in.
Stroke: ·725 in.
Bore/stroke ratio: 1·08
Bare weight: 7¼ ounces
Max. power: ·538 B.H.P. at 14,000 r.p.m.
Max. torque: 44 ounce-inches at 10,500 r.p.m.
Power rating: ·094 B.H.P. per c.c.
Power/weight ratio: ·0655 B.H.P. per ounce

Material Specification

Crankcase: light alloy pressure die casting
Cylinder (liner): mild steel (unhardened)
Piston: cast iron
Connecting rod: light alloy
Crankshaft: hardened steel, ¼ in. N.S.F. propeller shaft thread

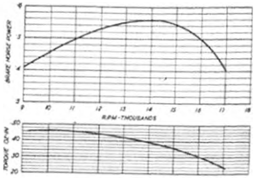
Cylinder head: light alloy pressure die casting
Glow plug: 1·5 volt element, ceramic insulator
Main bearing: plain, bronze bush
Crankcase back cover: light alloy pressure die casting

Manufacturers:
Veco Products Corporation, Burbank, California, U.S.A.
British Importer:
Bradshaw Model Products
Retail price: £8/5/0

◆

K & B 35 GLOW
5·78 c.c.

Manufacturers:
K. & B. Manufacturing Corp., Los Angeles, California, U.S.A.
Retail price in U.S.A.: $19.95



Specification

Displacement: 5·78 c.c. (3574 cu. in.) Bore: ·790 in.
Stroke: ·719 in. Bore/stroke ratio: 1 1
Bare weight: 8[illegible] ounces
Max. power: ·56 B.H.P. at 14,000 r.p.m.
Max. torque: 46 ounce-inches at 10,000 r.p.m.
Power rating: ·097 B.H.P. per c.c.
Power/weight ratio: ·063 B.H.P. per ounce

Material Specification

Crankcase unit: light alloy pressure die casting
Separate front bearing housing casting
Cylinder: Mechanite
Piston: chrome plated steel, ground finish
Crankshaft: hardened alloy steel, composite assembly, "electrolized" crankpin
Connecting rod: light alloy forging ("electrolized")
Cylinder head: light alloy pressure die casting ("electrolized")
Spraybar: brass
Bearings: [illegible] in. diameter ball race (rear) [illegible] in. diameter ball race (front)

Propeller—R.P.M. Figures

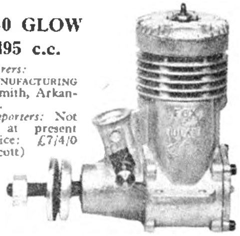
Propeller dia. × pitch	r.p.m.
9 × 6 (Frog nylon)	13,600
8 × 4 (Frog nylon)	15,700
9 × 4 (Frog nylon)	13,500
11 × 4 (Top Flite nylon)	10,500
10 × 6 (Top Flite nylon)	10,600
10 × 3½ (Top Flite nylon)	14,000
9 × 6 (Top Flite nylon)	12,600
12 × 4 (Keilkraft nylon)	10,500
11 × 4 (Keilkraft nylon)	11,700
10 × 4 (Trucut (wood))	11,700
11 × 4 (Trucut (wood))	9,400
10 × 6 (Trucut (wood))	11,000

Fuel: Frog Red Glow.

◆

FOX 40 GLOW
6·495 c.c.

Manufacturers:
Fox Manufacturing Co., Ft. Smith, Arkansas, U.S.A.
British Importers: Not imported at present
Retail price: £7/4/0 (Roland Scott)

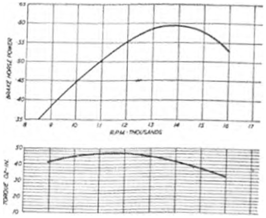


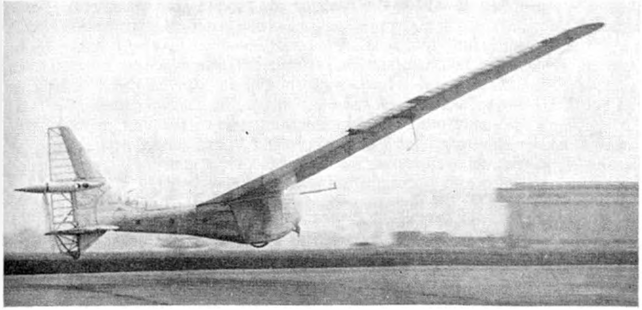
Specification

Displacement: 6·495 c.c. (·3961 cu. in.)
Bore: ·800 in.
Stroke: ·788 in. Bore/stroke ratio: 1·015
Bare weight: 7[illegible] ozs.
Max. power: ·595 B.H.P. at 14,000 r.p.m.
Max. torque: 47 ounce-inches at 11,500 r.p.m.
Power rating: 0915 B.H.P. per c.c.
Power/weight ratio: ·078 B.H.P. per ounce

Propeller—R.P.M. Figures

Propeller dia. × pitch	r.p.m.
11 × 4 (Top Flite)	10,500
10 × 6 (Top Flite)	11,900
10 × 3½ (Top Flite)	13,400
9 × 7 (Top Flite)	11,800
9 × 6 (Top Flite)	12,800
9 × 7 (Keilkraft nylon)	11,800
9 × 6 (Keilkraft nylon)	12,000
9 × 4 (Keilkraft nylon)	15,800
9 × 6 (Frog nylon)	14,000
10 × 6 (Frog nylon)	11,700
11 × 4 (Tornado nylon)	11,200
11 × 6 (Tornado nylon)	9,000





de Havilland photograph

Take-off! Designer J. C. Wimpenny pedals the " Puffin " at the de Havilland airfield, Hatfield, Hertfordshire. Still wind conditions are essential. A speed limitation of 3 knots windspeed is set before any attempt is made to bring the fragile frame out of hangar protection. Note dihedral flex, compare with drawing on page 99.

MAN-POWERED FLIGHT

by R. G. Moulton

THE age-old dream that every man would have a private aeroplane of his own, ready to take the air from a backyard take-off spot was stimulated yet again by the British National Press with reports of man-powered craft making flights of over a half mile. Those who accept harsh reality and respect the admirable achievement of any man-powered flight with the credit it deserves, will probably want to know more of the technical side of the story. Most successful efforts at the time of writing, have been the products of the Southampton University and the Hatfield Man-powered Aircraft Club. Each has taken a different line of approach, but many of the techniques are similar, and have an aeromodelling background. But first we should know a little of the reason for the stimulus of interest in Man-powered Aircraft.

Long ago, experiments in Italy, Germany and the U.S.S.R. met with varying degrees of success. The major problem is, of course, the power source, and the amount of power required to become airborne. Catapult launch had been used as an aid; but there remained many with purist thoughts who wanted to see man power his wings from standstill to touchdown.

At a January 1957 meeting at the College of Aeronautics, Cranfield, H. B. Irving, attending on behalf of the L.S.A.R.A. was elected Chairman of the then new Man-powered Committee. Interest increased to the extent that the Committee became a group within the Royal Aeronautical Society and many lectures, meetings and film shows were held to promote growth of understanding of the subject. A fund was opened since those with the enthusiasm were (as ever) the poorest among us, and in November 1959, Industrialist Henry Kremer offered a £5,000 prize for the first flight of a man-powered aircraft designed, built and flown within the British Commonwealth, under conditions to be laid down by the R.Ae.S.

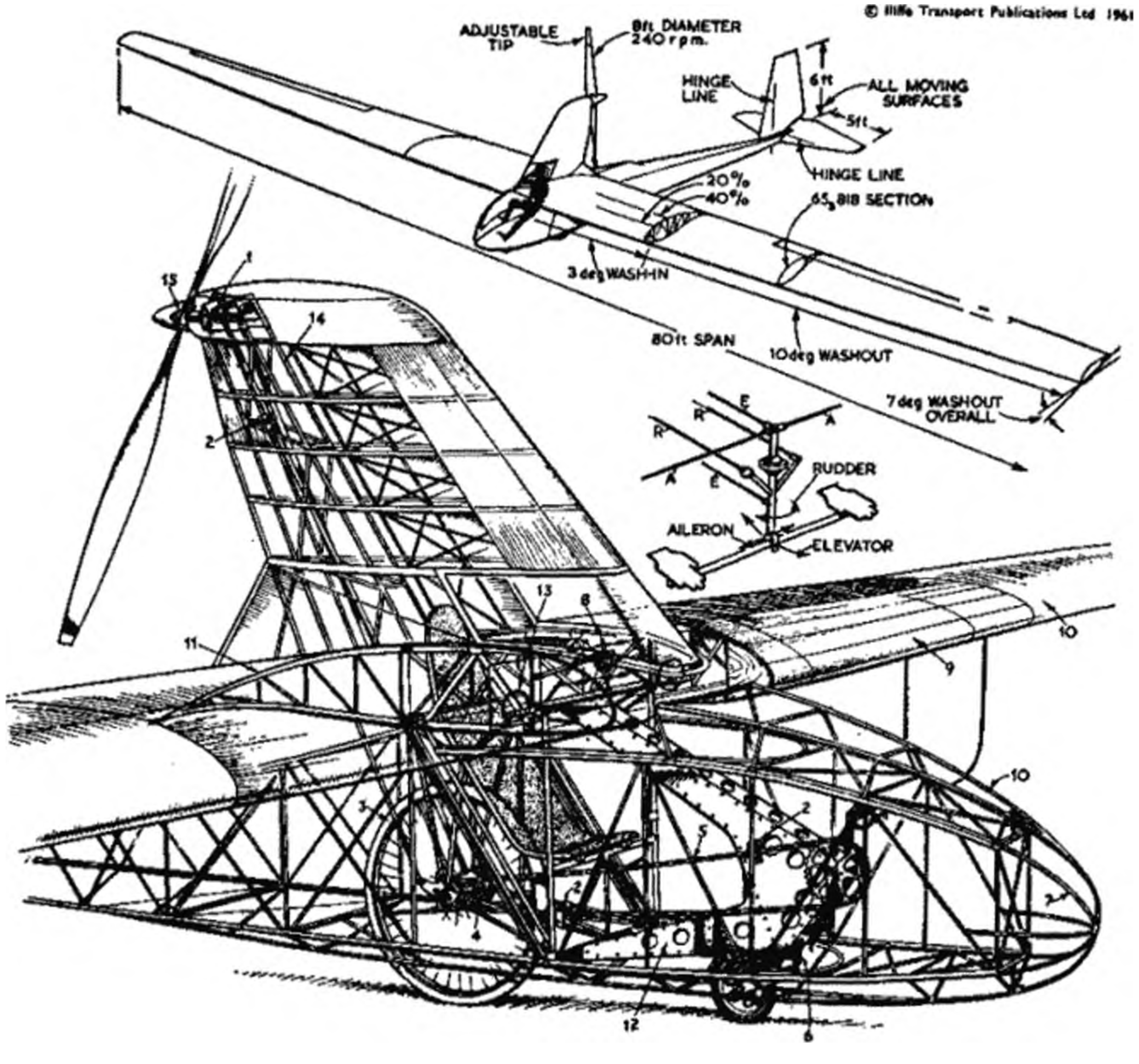
The problem of raising the costs of constructing the actual entries *still* remained, until Mr. Kremer stepped in again with a generous contribution which swelled the building fund to £5,000. Financial assistance up to £1,500 each has been offered to the Southampton and Hatfield Groups, whose entries were considered outstanding and a further substantial amount has been offered to the Southend Group, who are tackling the subject with a two seater.

There are many other entries, including one of the first to make any attempt, an ornithopter, several helicopters and "large model" types such as that by W. L. Manuel, well known for his slope-soaring gliders. These have not been considered promising enough to warrant financial assistance.

Conditions for the Kremer prize are quite simple. In brief they are:

1. Entrant, designer, pilot must be citizens of the U.K. or British Commonwealth and the aircraft to be designed, built and flown within the Commonwealth.
2. Aircraft must be heavier than air, powered and controlled by the crew throughout the flight. Use of lighter than air gases prohibited and no devices for storing energy permitted.

Important details of the Southampton University Man-Powered Aircraft showing the pilot attitude and means of control and power application



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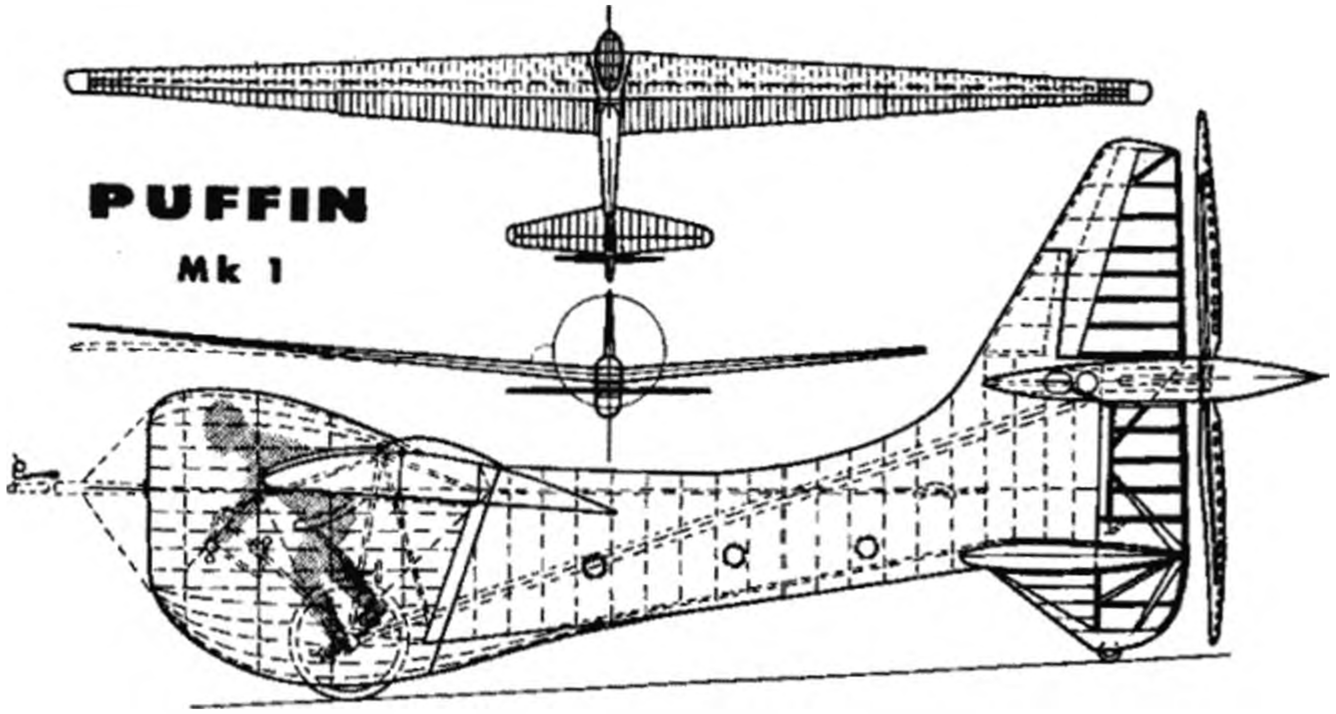


Three views of the Hatfield Club's Puffin show the short coupled fuselage, small tail area and large vertical surfaces. Note how the thrust line and shaft position have been dictated by the propeller diameter. Flat based aerofoil is a helicopter blade profile.

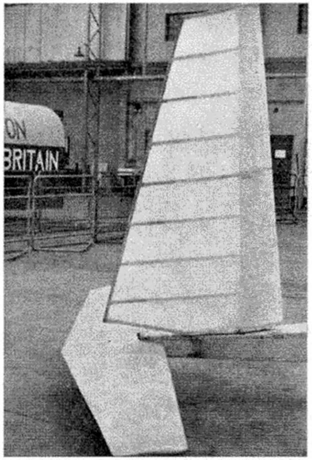
3. No limit to number of crew.
4. Flights to be made in still air, from level ground over a course observed by the Royal Aero Club.
5. Course to be a figure of eight with two turning points not less than a half mile apart. Start and finish line to be midway between turning points.
6. Start and finish altitude must be not less than 10 ft. above ground.
7. Aircraft to be in continuous flight over the length of the course.
8. Aircraft to be considered as gliders, no permit to fly or Certificate of Airworthiness required though entrants must have insurance cover against third party risks.

Closing date, originally set as February 1st, 1962, has been extended.

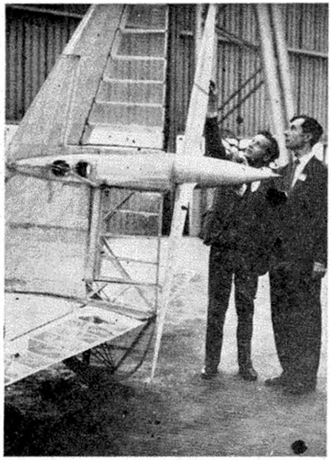
First flight by a British man-powered aircraft took place at 4.30 p.m. on November 9th,1961 at Lasham Gliding Centre with Chief Flying Instructor Derek Piggott (ex-aeromodeller and Wakefield team member for G.B.) pedalling and controlling the Southampton University entry. First to fly over a half-mile was the Hatfield Group's *Puffin* on May 2nd, 1962, when designer J. C. Wimpenny covered 993 yards.

These significant "firsts" were each the culmination of tremendous effort by keen enthusiasts. They had overcome all of the associated difficulties in reaching this stage of success, and yet were only part of the way along the path to the Kremer prize. Not that anyone should suggest that these groups were on a quest for bags of gold, we happen to know that the money side of the contest is rarely considered, and when it does arise, it is usually only thought of as a means of settling the accounts, for the construction of a man-powered aircraft is no cheap business.

The great reward is the sense of achievement. All those involved are endowed with the same appreciation of overcoming difficulties. They subscribe to the admirable view that nothing is worth doing unless it demands an exercise of all one's faculties, and it has been obvious that the many unexpected problems have served as a stimulant—though there have been times when all the balsa could quite have cheerfully been thrown out of the window in frustration!



All moving tail surfaces of the Southampton machine (badly warped alas!) are diminutive and extraordinarily lightweight



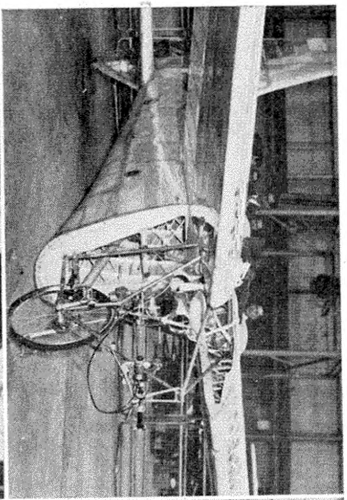
Designer J. C. Wimpenny at right and de Havilland test pilot J. H. Phillips, who made the first Puffin flights, examine the large propeller. Spinner is retained by a faithful rubber band.

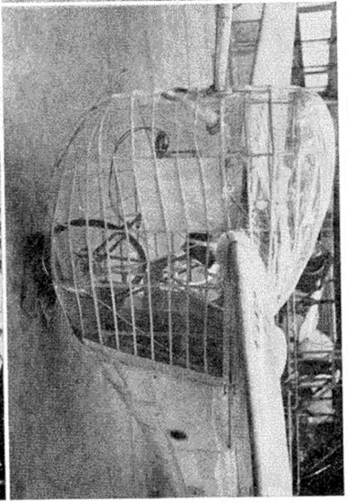
Basic Problems

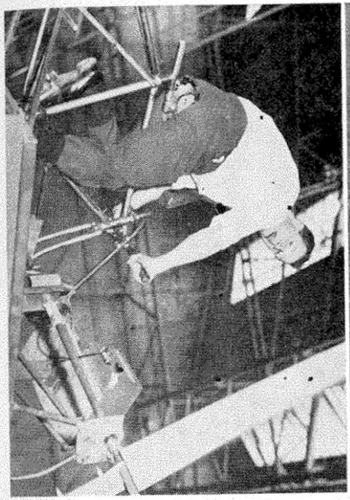
Whatever one's approach to the man-powered aircraft design, whether it be conventional or unorthodox, the first consideration is that of the *power available*. Since the course is something just greater than one mile, and the aircraft must rise under power, it is desirable to know how much a man (or two men) can produce through leg power for a sustained period. Figures have shown that an experienced racing cyclist can maintain about 0·5 horse power over the time needed to cover the distance.

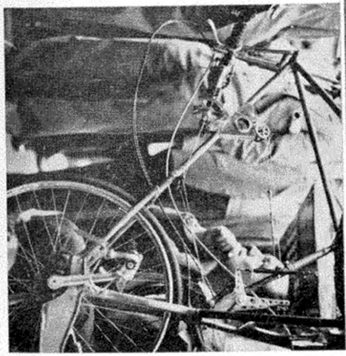
Next problem is that of *power application*. Pedalling appears to be the better primary power source; but the conversion of rotary action at the crew position to drive of a propulsive screw is a wide open choice. Direct gearing is used in the Hatfield machine, chain and flexible flat steel belt in the Southampton machine. Each has been subject to unexpected problems; but the Hatfield unit has been the least troublesome. Special gears, produced by Dunlop, and an extraordinarily light shaft, acid etched so thin that it can be depressed by finger pressure, yet no heavier than an original wound balsa shaft tube, has offered a very efficient drive system that experts did not deem possible.

Assuming a conventional airframe is to be used, one has next to consider the *optimum posture* for full power output. After much research, the University of Southampton elected for the reclined seated position, and the Hatfield Group for the normal cycling attitude. In either case, full consideration has to be given for the position of the controls, bearing in mind the fact that the pilot will have to co-ordinate control with power.





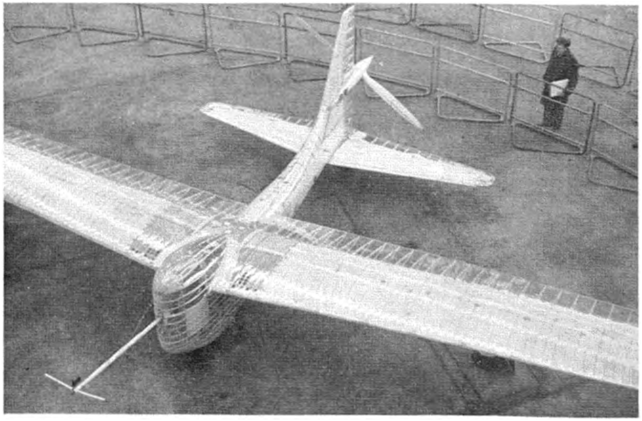


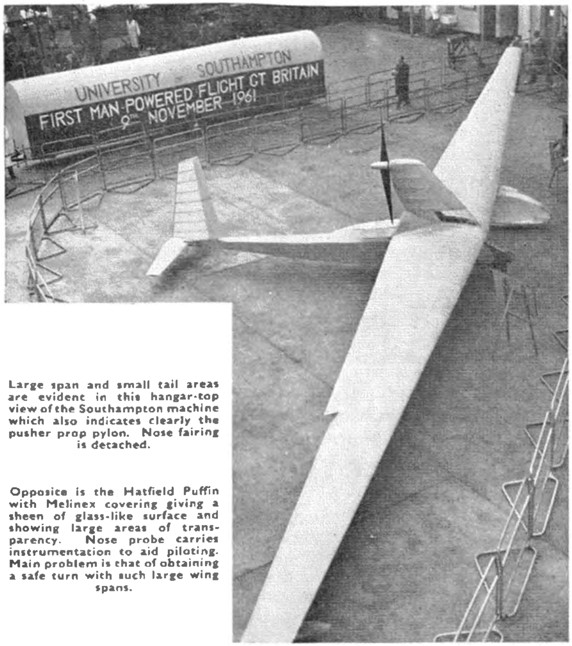


Puffin detail. Top left: the "works" showing special bicycle wheel and frame to take the pilot in cycling attitude with hands on twist grip controls. Note elegant fuselage cross section and fragile internal bracing. At right, the Melinex covered canopy in place. Pilot has one direct feed air tube (Supercharged?). At left, racing cyclist on the Hatfield team is reserve power man. Seen here on power test rig which indicates sustained horsepower. At right, control details.

Fourth problem is that of *optimum design*. With only half horsepower to play with at best, and the desirability to reduce loadings to the minimum, this is the greatest problem of all. Having considerable advantages with their aerodynamic research facilities, the Hatfield and Southampton groups each decided upon an all-up weight of about 265 lbs. including pilot, meaning an empty frame weight of about 120 lbs., and an area of 300 sq. ft. for the Southampton machine, 330 sq. ft. for Hatfield. The airfoils chosen were dictated by the amount of information available. A forward speed of 30 ft./sec. with 240/250 prop. r.p.m. using about 0·45 b.h.p. calls for efficient low speed airfoils which are laminar, Southampton selecting the undercambered NACA 65_3818 and applying 7 degrees washout overall to the tips, while Hatfield chose a flat based, almost "arc of circle" (Conover style) helicopter blade section with tips changing to NACA 6412. Aspect ratio is high, above 21 in each case so that spans are over 80 ft., and tip deflections over 18 in. Tailplane surfaces are very small, the Southampton aircraft tail area being just 5 per cent of the wing area! In this case it is an all moving surface, as also is their rudder, while the Hatfield machine uses thicker, and proportionately larger areas with conventional elevator and rudder arrangement. This has been dictated to some extent by the application of the pusher propeller, using the fin structure to carry the final bearings for the prop. shaft instead of having a special pylon. Large diameter props. are used, and for ground clearance a high shaft position is essential.

As all aeromodellers will appreciate, the propeller is an item of major importance. Frankly, we were surprised to learn that each group had been satisfied with one prop. on which to base all their tests and attempts. The Southampton prop. has a light alloy tube spar with metal ribs Araldited in place, then solid balsa fills the spaces. At the tips they drilled holes in the event that weights would offer some dynamic aid but these have not been found necessary. The Hatfield prop. is of two separate blades in adjustable pitch clamps at the boss, and weighs but a few ounces per blade, being all balsa with a spruce strengthener for part of the diameter. Personally we would have made a whole range of blade profiles, sections and varying areas but perhaps the facilities available to the two groups convince them that their figures are the best obtainable!

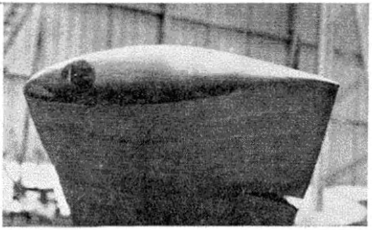




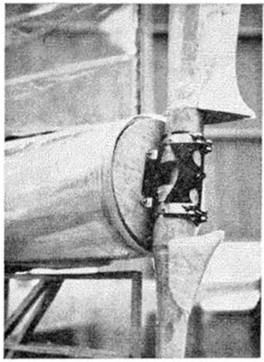
Large span and small tail areas are evident in this hangar-top view of the Southampton machine which also indicates clearly the pusher prop pylon. Nose fairing is detached.

Opposite is the Hatfield Puffin with Melinex covering giving a sheen of glass-like surface and showing large areas of transparency. Nose probe carries instrumentation to aid piloting. Main problem is that of obtaining a safe turn with such large wing spans.

The *drive* to the ground wheel for take-off and the prop. produces an interesting difficulty which has upset both parties. The ratio of the propeller and wheel drives must be near ideal so that the prop. takes over from the ground drive at the right airspeed. This is entirely dependent upon the windspeed, and as we all know, windspeed is rarely constant so the situation is reached where take-off speed is reached before the prop. has produced sufficient thrust for flight. The opposite happens in a calm. Here the prop. can be absorbing full power from a tired pilot before the wheel is driving up to take-off speed. The choice has to be made as to whether to gear the prop. and wheel ratios for calm or light wind conditions. Similarly, a free wheel had to be incorporated in the Hatfield machine to allow the wheel to accept overdrive on touch down. The balsa prop. shaft went "bang" before the free wheel was fitted. Only shock absorption is in the tyre of racing type on a 27-in. wheel, so it will be appreciated



Above is a wingtip on the Southampton machine, giving some idea of section and washout.



Left, the prop hub of the Puffin with spinner removed shows the adjustable roots. Screw clamps hold the blade halves at their setting. Note also the addition of streamlining cuffs at the root ends of each blade. A hook at the centre of the prop is for the rubber band that holds long balsa spinner in place.

that for the sake of the well-being of a lightweight and most carefully prepared airframe, the wheel and its spokes are carefully maintained!

Structures are most interesting, especially since they are in each case almost entirely of selected balsa, as it happens, Solarbo, which was of a grade we rarely see. When the Hatfield project was very much a secret we saw a small mountain of this sheet at the St. Albans M.A.C. headquarters, each sheet having its weight inscribed for selection. The club was responsible for a number of wing ribs and the fuselage frames, the latter from $\frac{1}{16}$ in. sheet! Their work has been much appreciated, not only for quality but also for the discretion they maintained in keeping the project under cover. On our next visit, all was hidden from view by the time we reached the top of their stairway!

This very light grade of Solarbo is in itself a major contribution to the success of both machines in question. When one considers the tip to tip 80 and 84 ft. span structures of the two wings and the fact that in scale, the airframe weights represent 7 ft. span models weighing less than one ounce, the measure of the achievement can be appreciated. But it is not only a question of material, for the adhesive used is also of great weight importance. Cellulose cement was used in limited quantities but to save weight, and following many test structures, Cascomite, Evo-Stick and Araldite (for metal part bonding) were used.

Balsa sheeting is applied extensively over the wing surfaces, but in the light of later discoveries, much of it would not have been used on the Puffin where it is non-structural. This arises from the use of "Melinex" sheeting, a plastic produced by Imperial Chemical Industries and which is used for ink drawing protection among other purposes. Clear, light, and capable of shrinking with application of heat from a local source, Melinex is non-porous, adheres with Evo-Stick contact cement, and eliminates doping. It was used on the Hatfield Puffin at a stage when the wing surface was buckling badly according to humidity and temperature. The undoped balsa was also gaining weight with damp atmosphere. Melinex was used over every part of the Puffin surface. On the wing, it is suspended off the still buckled sheeting by polyurethane foam. As the Melinex had been shrunk, so it adopted the airfoil camber and the

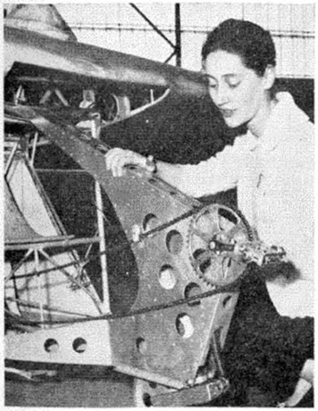
plastic foam had depressed irregularly to offer a smooth surface. It looks unusual but is most effective, giving the Puffin a glamorous "glass-case" appearance against the dull matt silver of the Southampton machine which is covered with lightweight parachute nylon, with four coats of dope applied.

This covering idea might yet have aeromodelling applications. Certainly a lot of ex-aeromodellers have been connected with both of these man-powered machines and the constructional techniques give ample evidence that earlier days have left their impression. But old aeromodellers may not be quite up to the times with flying tactics. For one thing, it was surprising to learn from one group member that artificial thermal breakaway had not been considered. With a hot runway and a water wagon from the fire brigade at their disposal they could possibly achieve wonders; but that is wishful thinking.

Each of the machines has its continual programme of trial and error to follow until the Kremer course is flown. As with models, accidents happen. Controls are unusual to say the least, and the turns (with 80 ft. and 84 ft. span to consider) are tricky. A bent wing means a lot of work and success is usually the result of a lot of perseverance through accidents.

It is significant that the two "firsts" were created by other than the specialist athletic pilots each group intend to use for the course flight. Derek Piggott test flew the Southampton machine because he could check the control system as an experienced gliding instructor and though no racing cyclist, he has made flights of 650 yards without difficulty. The Puffin was first test flown by J. H. Phillips, a de Havilland test pilot, then subsequently by another de Havilland test pilot, J. L. Barnes, and then by the designer himself, J. C. Wimpenny, who is neither a racing cyclist nor a qualified pilot. Familiarity with his project

Anne Marsden of the Southampton University team with the pedal gear on their project. Chain primary drive is transfered to steel belt drive to the propeller.



Another view of the Southampton "Office" indicating the sprung nose wheel and the main drive wheel behind the "seat".

and lack of experience with conventional controls may have been an advantage for that 993-yard flight on May 2nd, 1962. Anyway it displayed that a reasonable standard of physical fitness is sufficient to make a flight lasting almost two minutes.

It is to be hoped that in the intervening weeks between printing and issue of this AEROMODELLER ANNUAL, one or other of the entries in the Kremer prize contest will have achieved the goal. Whichever it is, deserves all the honours; but we are sure that the story will not end with a figure of eight, mile long flight. These enthusiasts have their teeth in a subject that provides refreshing exercise of thought and craftsmanship in an age where the missile and "tin-can" aeroplane have taken over the industry. Good luck to them, may their efforts prosper.

COMPARABLE DATA ON TWO M.P. AIRCRAFT

HATFIELD MAN-POWERED GROUP "PUFFIN":

Leading Dimensions

Wing span: 84 ft.
Wing area: 330 ft.^{2}
Overall length: 20 ft. (excluding nose boom)
Overall height: 9 ft. 4 in.
Propeller diameter: 9 ft.
Weight empty: 118 lb.
Typical all-up weight: 265 lb.
Examples of the weight of components:
  Fuselage (less pilot structure, wheels, etc.): 8¾ lb.
  Canopy (with boom and instruments): 2¼ lb.
  Tailplane (less elevators): 4¾ lb.
  Propulsion shaft: 2 lb.
  Propeller blades with final shaft and spinner: 2½ lb.

Wing detail

Aspect ratio: 21·4.
Wing root chord: 6 ft. 2 in.
Wing tip chord: 1 ft. 9 in.
Mean chord: 4 ft.
Wing section, root: 12 per cent t/c Wortmann type laminar.
Wing section, mid: 12 per cent t/c Wortmann type laminar.
Wing section, tip: 12 per cent NACA 6412 modified.
Dihedral: 5.25° (in flight).
¼ chord swee: 0.64°.
Aero, twist root/tip: 2°.
Taper ratio: 0,286.
Construction: Wood, Main spar and false rear spar, Torsion box 0-62 per cent c. Stabilised skin. Fabric covering on rear 38 per cent c. Balsa ribs spaced 7 in.

Ailerons

Type: Plain.
Span: 34 ft. 1½ in.
Area: 30 sq. ft.
Mean chord: 10½ in.
Max. deflection up: 70°.
Max. deflection down: 70°.
Mass balance degree: Nil.
Construction: Wood. Melinex covered. Ribs spaced 7 in.

Tail

Span: 16 ft. 9½ in.
Area of elevator and fixed tail: 42 sq. ft.
Area of elevator: 15 sq. ft.
Max. deflection up: 7°.
Max. deflection down: 22°.
Aerofoil section: NACA 0012.
Mass balance degree: Nil.
Tail arm (from ¼ chord m.a.c. wing to ¼ chord m.a.c. tail): 11 ft. 6 in.
Elevator aerodynamic balance method: Unshielded horn.
Elevator trimming method: Spring.
Horizontal tail volume coefficient: 0.374.
Construction: Wood. Plastic film covered. Ribs spaced 7 in.

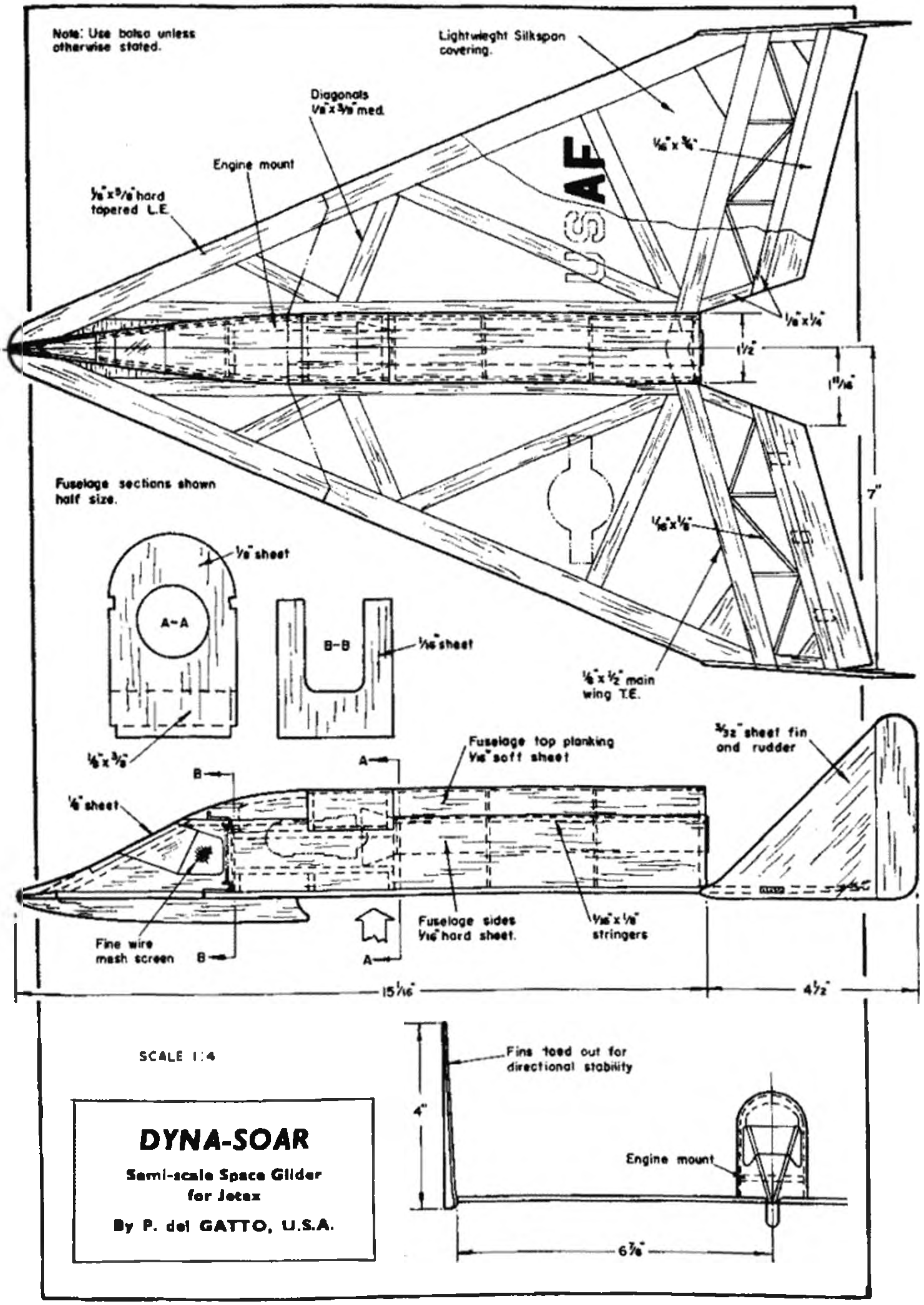
Vertical tail

Area of fin and rudder: 25 sq. ft.
Area of rudder: 11 sq. ft.
Aspect ratio: 2.92.
Tail arm: 11 ft.
Max. deflection: 28°.
Aerofoil section: NACA 0012.
Aerodynamic balance: Unshielded horn.
Construction: Wood. Balsa sheet covering.
Take-off speed: 29 km/h.
Cruising speed: 33 km/h.
Cruising power required (in ground effect): 0.30 Thrust horsepower.
  0.36 Pilot horsepower.
Min. sink condition (free air): 30.8 km/h 0.283 m/s.

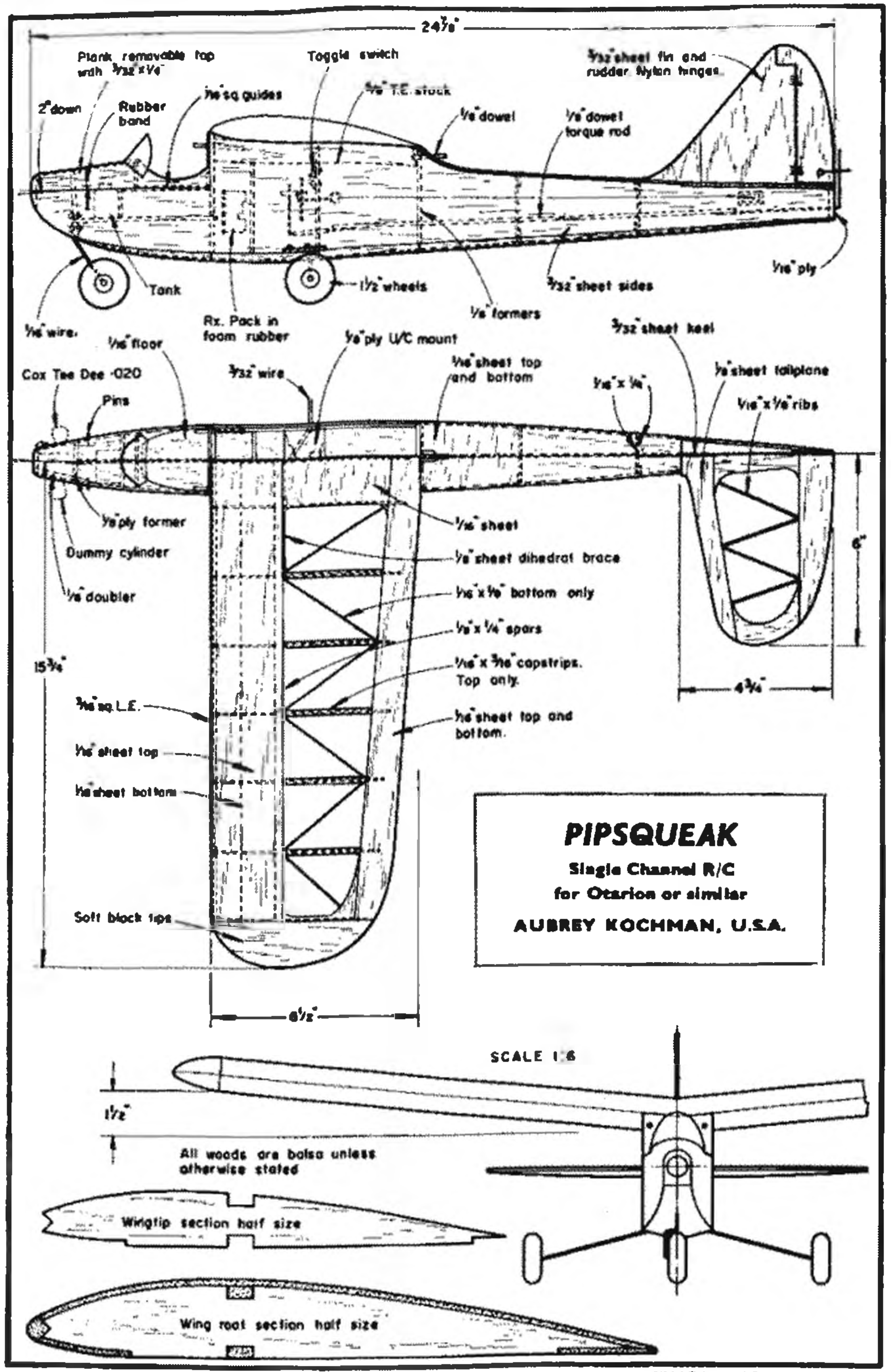
UNIVERSITY OF SOUTHAMPTON MAN-POWERED GROUP AIRCRAFT:

Leading Dimensions

Wing span: 80 ft.
Wing area: 300 sq. ft.
Aspect ratio: 21·3
Wing section: 53₃818.
(C_{D_0}): ·0085 (measured).
Optimum design: $C_L = \cdot 85$
The wing is elliptically loaded with 2½° built-in dihedral on the outboard wing tips.
The tip deflection under load is 1½ ft.
Fuselage length: 25 ft.
Tail moment arm: 17·5 ft.
A.U.W.: 264 lb.
Wt. empty: 124 lb.
Pilot wt.: 140 lb.
Wing loading: ·88 lb/sq. ft.
V_{min} H.P.: 30 ft./sec.
V stall: 24 ft./sec.
Design maximum power output: ·55 h.p.
Design cruise output at 15 ft.: ·45 h.p.
Design thrust h.p. required at 15 ft.: ·33 h.p.
(C_{D_0}) Aircraft (based on wing area): ·00433
Propeller diameter: 8 ft.
Speed: 240 r.p.m.
Section: Clark Y
Measured propeller efficiency: 90 per cent
Drive efficiency: 97 per cent
Ultimate load factor for wing: 6
Design load factor for wing: 4
V_{dive} 54 ft./sec.
All moving tailplane: Span 10 ft.
  Area, 15 sq. ft.
All moving fin: Height, 6 ft.
  Area, 16 sq. ft.
Ailerons span: 15 ft. (from 3 ft. inboard of tips)
Aileron chord/wing chord: 0·25
The aircraft is both longitudinally and directionally stable.



AMERICAN MODELER, U.S.A.



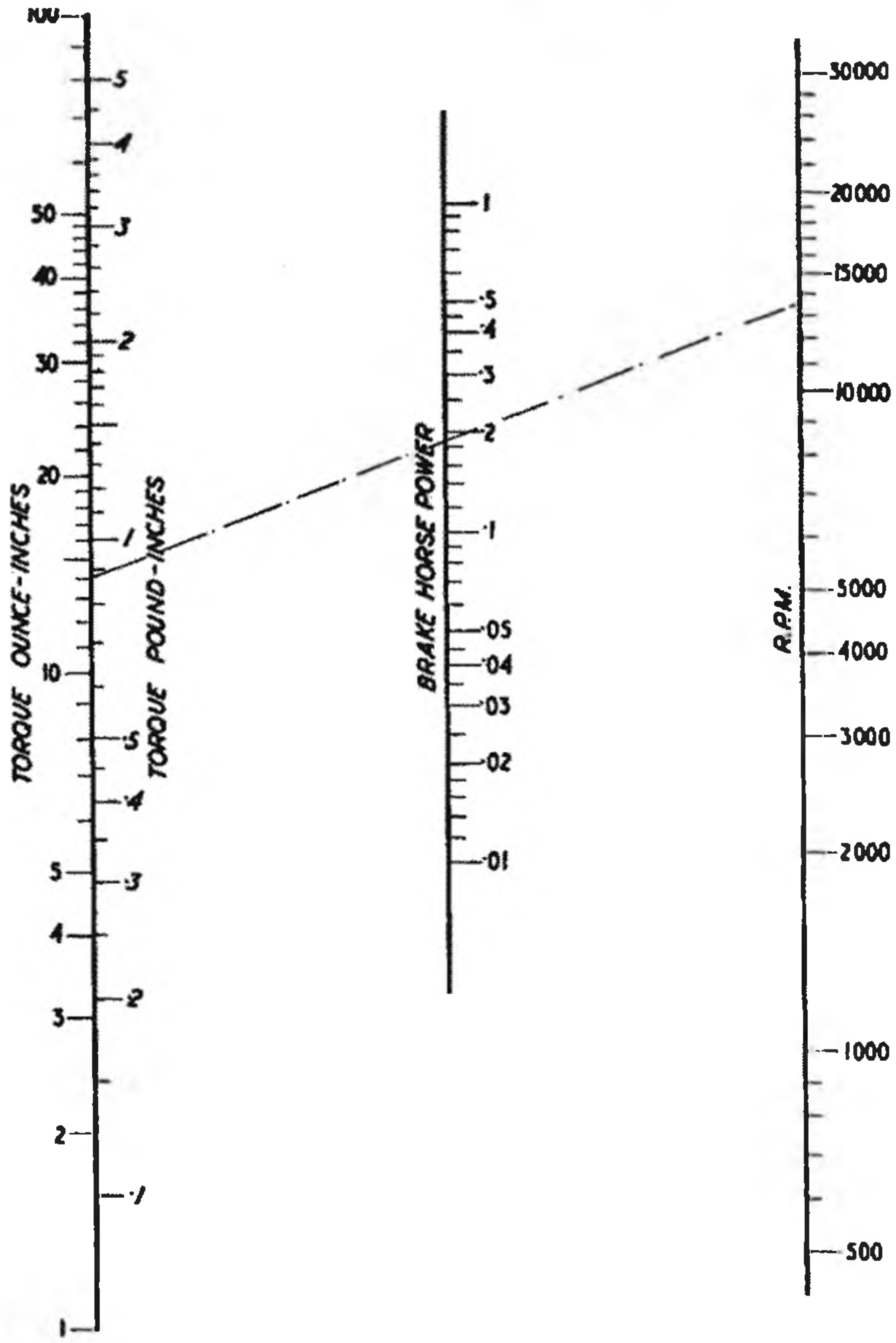
PIPSQUEAK

Single Channel R/C
for Otarion or similar

AUBREY KOCHMAN, U.S.A.

AMERICAN MODELER, U.S.A.

NOMOGRAPH: TORQUE: B.H.P.: R.P.M.



TORQUE—HORSEPOWER—R.P.M. NOMOGRAM

Connect the two known values by a straight line and read off the corresponding value of the third (unknown) at the intersection point on the remaining scale.
Example: to find the Horsepower corresponding to a torque of 14 ounce-inches at 13,500 r.p.m. The answer is ·19 b.h.p.

ATTACHE-CASE MODELS

Digested from an article in Flug Modell Technik
by Ing. W. H. Friese.

PERMISSION given in 1950 for the resumption of aeromodelling in Germany, on a limited scale, provided that aircraft did not "possess the properties of any experimental models" led to concentration on an ultra-small rubber driven type to a degree beyond any previous specialisation. Conditions of almost non-existent private transport, few and small flying fields, and practically no modelling materials all contributed to this cult of the miniature, particularly in the Berlin area.

There had of course been earlier attempts to build very small models. In the 1920s an 8 in. span model had been shown at an exhibition (presumably one of the first balsa models!) and one of the German publishing houses ran a competition in 1926 for such a model—but the author could not achieve success then with anything smaller than about 30 in. span. However, by 1930, using heavy materials such as pine, bamboo and ply, successful models of about 16 in. span were clocking durations of up to a minute.

The postwar group, however, owed little, if anything, to these earlier experiments. They were concerned to build and fly in the open air tiny models that could be packed away into an attache case or music case, that invited no adverse public transport comment, and could be made from straws, reed and, in later models, small quantities of balsa. Any football field was large enough for flying. Since outdoor flying was the ideal, robustness of construction and an ability to perform in adverse weather conditions was a most important part of all designs.

Study of some small birds and insects encouraged the group. If it was possible in nature, then man-made replicas might also manage it. A problem was offered in midget aerodynamics, and much time and thought devoted to its solution.

First discovery was that thick airfoils and symmetrical sections, with thickest point about 30 per cent back from the leading edge were of little use. Mini-wings must be thin and pointed at the leading edge. Thickest part of the profile lay further back than normal practice at about 40 per cent of wing depth. Wing planform should be as rectangular as possible with deep chord, undercambered if possible, or at least with a flat underside. Unlike German aerodynamicist F. W. Schmitz (*Aerodynamics of the Model Aeroplane*) the author had some success with elliptical wings, though angle of incidence had to be modified, with washout at the tips. Further experiments were devoted to high aspect ratio wings with catapult gliders, which would loop several times on launching and then go into an unexpectedly fast but level glide.

Propellers gave a lot of trouble. One type which proved particularly efficient was the so-called "Hamilton" which has blades with wide square cut ends (*cf. Cox propellers for their small engines today, Ed.*). Diameter of props was, on average, equal to half wingspan, and in some cases even more. At the end of the motor run blades would then provide some turbulence for the wings. Weight considerations made the idea of free-wheeling props impossible—but had the advantage that this lack of free wheeling enabled dethermalisers to be ignored without serious loss of models! Large propellers also made long gawky u/cs a must and prevented the development of true scale models.

Outdoor models such as these cannot be compared with indoor microfilm models, though some design features are common. However, the robust designs made by the author had the advantage of extremely long life. His *Mikrosparrow* built in 1949 will still take off from the seat of a chair today. It flew at countless exhibitions, outdoors and indoors, and would even tow a tiny glider. *Horsefly*, also built in 1949 is still flying today. Its wheels of little more than half-inch in diameter, bushed with straw joints, run as easily as the day they were made.

We offer the T-15, a low wing monoplane of about six inches span to those who would like to try their hand at a micromodel. This was originally built to see how near it was possible to get to semi-scale models and still achieve flight, and, of course, it incorporates the allegedly unsatisfactory elliptical wings. The prototype tipped the scales at just over 2 grms. (28.35 gms. equals 1 oz.!)

It r.o.g.'ed successfully (without a push) but had little or no glide. Then came aggravating trimming problems—if the power flight was good then the glide suffered and vice versa. However, these problems were eventually solved, and the model portrayed will give fascinating flights—though world breaking durations cannot be expected! Car roofs provide excellent take-off facilities by the way!

Because of their small size, these micromodels require a greater degree of care in construction than larger models. All errors are naturally relatively greater with them. Cement must be applied very sparingly, with a needle, in "microdroplets" as it were. Individual parts can be held only with tweezers (stamp collecting variety very useful here). Moreover, the model must stand being handled and wound up. Covering cannot be doped and torsion stresses must be built into the fuselage structure. Being undoped, wet weather is the one condition that so far defeats microflyers.

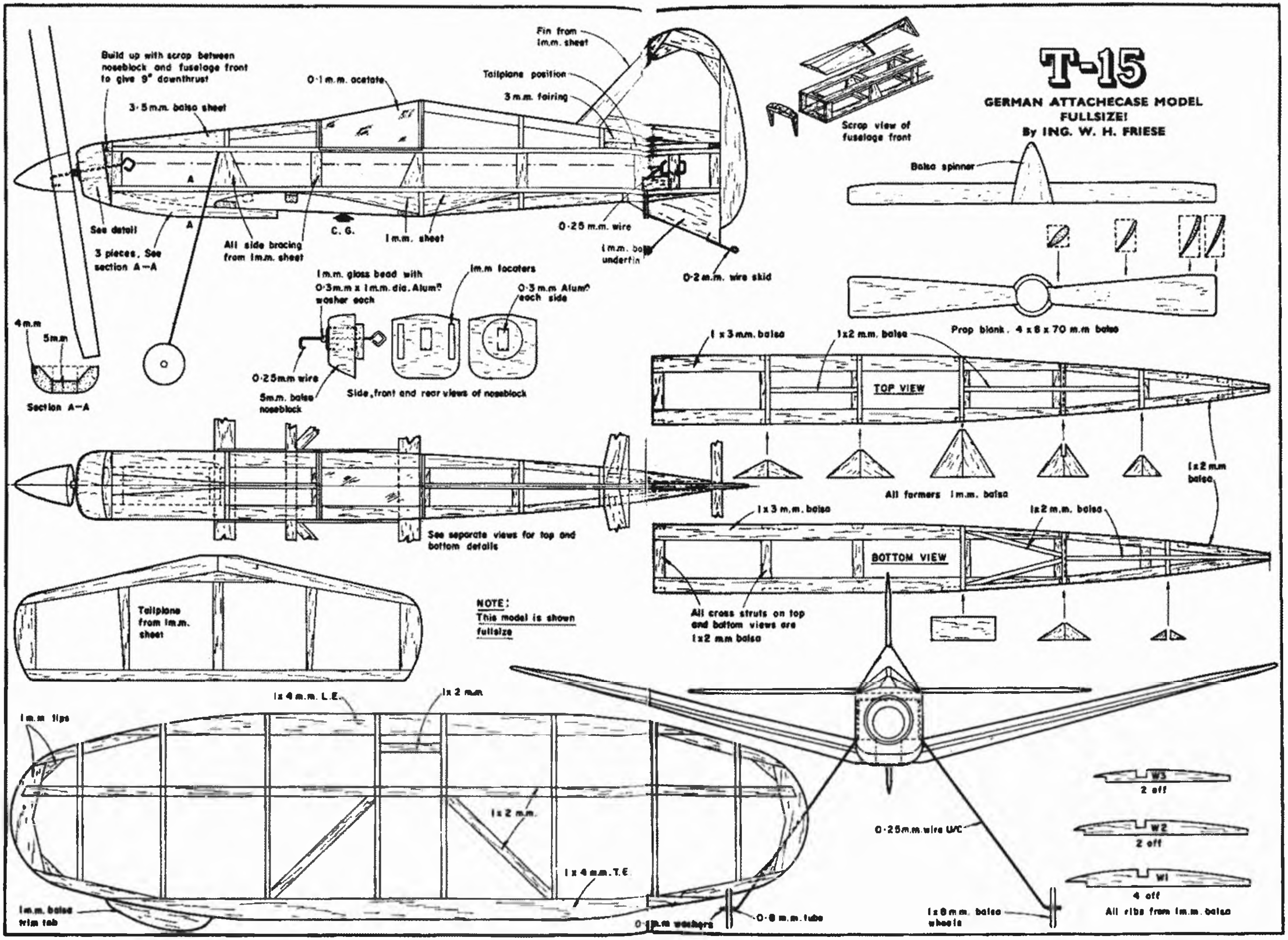
Some special tools have been developed for micro building, in particular, a small burner from a bicycle valve which provides the right heat for bending reed. In other respects no workshop is needed. A breakfast tray is adequate as a workbench and no one should complain of models built in the living room, the bedroom, digs, or an hotel room. Pins, razor blades, sand paper, wire cutters, pointed nose pliers, tweezers, scissors and magnifying glass (!) are virtually all that is required, plus a few scraps of balsa, some cement, lightweight tissue and paste. Add to this the patience of Job and success is assured.

A final warning when flying these babes. Keep your eye on the model when it lands, it can easily be lost in even shortish grass. Do not pile on the turns in strong thermal weather or it will be good-bye model!

T-15

GERMAN ATTACHECASE MODEL FULLSIZE!

By ING. W. H. FRIESE



FLUG-MODELL TECHNIK, W. GERMANY

GLIDE TRIM

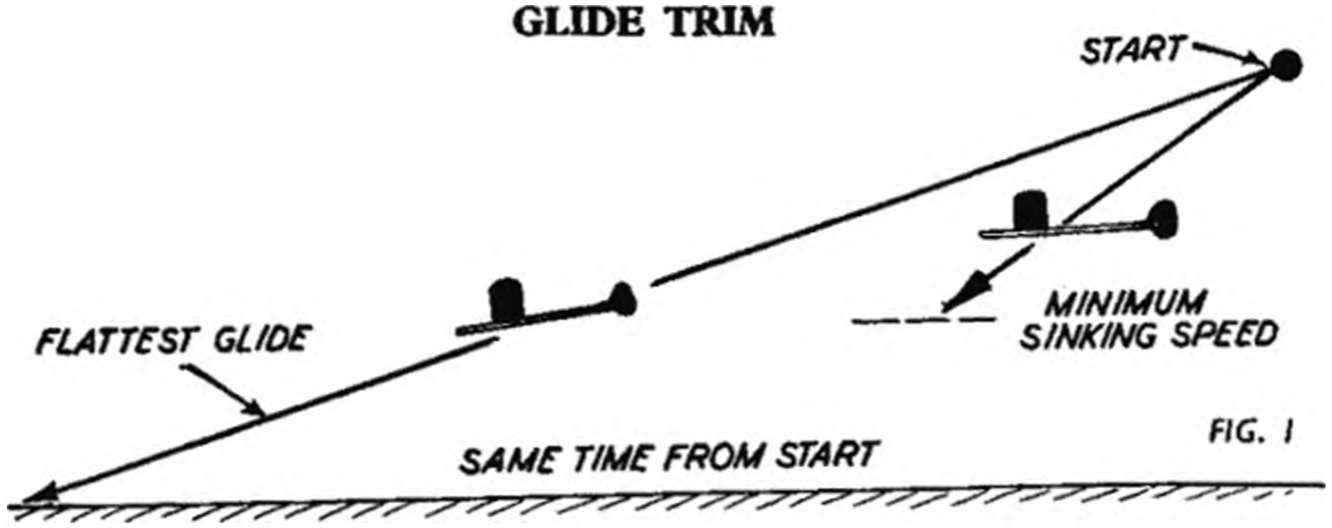


FIG. 1

The glide path of a model as viewed from the ground can be a deceptive thing. What *looks* a good glide may, in fact, represent an unduly high sinking speed; and what appears a poor glide *attitude* a good "duration" trim. Quite small differences in trim can make an astonishing difference to glide duration from a given height, although the ideal trim is often difficult to spot without actually timing the flight.

As a general rule, the majority of free flight models are trimmed out with an *under-elevated* glide. This is because the modeller goes on the *appearance* of the glide path rather than flying speed, and aims for what he estimates is the *flattest* glide. Although the flattest glide will give the longest distance covered gliding from a given height (which is not entirely desirable on a free flight model!), the trim corresponding to flattest glide usually results in a fairly high flying speed and consequently an actual *sinking* speed considerably greater than the minimum sinking speed which can be achieved with that particular design.

The comparison is shown in Fig. 1. With the flattest glide trim the model flies farther and faster, and also descends from a given height more rapidly. The vertical scale is not unduly exaggerated. Quite often careful trimming for minimum sinking speed can virtually double the glide duration, although the gliding *angle* may not be anything like as good. Glide *angle* is something to ignore with "duration" trim. On the other hand a flatter glide angle may be beneficial on a sports model as a safeguard against stalling on the glide; or to ensure better penetration on a radio control model. In the latter case the glide is usually deliberately under-elevated in any case to stop "floating" tendencies once the engine has cut and improve rudder effect by keeping the flying speed reasonably high.

One point which should be appreciated with a flat (under-elevated) glide, however, is that the shallower angle of approach to the ground does not make for a better "rolling" landing. Both the sinking speed and the flying speed are higher than need be, so the undercarriage has to absorb a higher vertical impact load and stands a greater chance of being "tripped" during the initial roll after touch-down.

Glide angle, flying speed (along the glide path) and sinking speed (relative to the ground) are all determined by the angle of attack at which the wing is operating—which in turn is determined by the trim. From the diagram of forces acting on the glide—Fig. 2—it will be appreciated that the resultant aerodynamic force (R) acts vertically in opposition to the weight. This can be split into component lift (L) and drag (D) forces, the former being resolved at right angles to the flight path and drag parallel to it. From simple geometry it then follows that the glide gradient is identical to the ratio of L/D.

If now we look at a graph showing how the ratio L/D varies with the angle of attack—Fig. 3—it will be seen that it reaches a maximum value at some quite low angle. In the case of an aerofoil alone this may be a matter of only a degree or so angle of attack. With the additional components of a complete aeroplane attached the drag is increased and maximum L/D occurs at some higher angle than that of the aerofoil alone. In both cases, however, the highest value of L/D— corresponding to the flattest glide—occurs when the trim is such as to give the wing a fairly low angle of attack. This means a fairly high flying speed to produce the required amount of lift.

Shown on the same graph is a curve of $L^{1\cdot5}/D$. Without going into the theory and mathematics involved, this represents a "minimum power" requirement to keep the aircraft flying. The angle of attack corresponding to the maximum value of this $L^{1\cdot5}/D$ curve thus represents the trim giving minimum sinking speed on the glide (and, equally, minimum power to sustain level flight, if a thrust force is available). It will also be noticed that the value of the L/D ratio at this higher angle of attack has fallen well below its maximum value—hence the glide corresponding to minimum sinking speed is much *steeper*.

Neither point—L/D maximum or $L^{1\cdot5}/D$ maximum)—can be worked out accurately for models, but the trim to realise either condition can readily be estimated by trial and error. The former trim, as already noted, corresponds to the flattest glide and greatest distance covered from a given height. The latter corresponds to the trim giving greatest duration from a given height. Flattest glide may be estimated by eye with reasonable accuracy. Any increase in elevation which slows the model up will then *decrease the sinking speed* until finally a limit is reached where the model stalls.

The trim for minimum sinking speed is nearly always that where the model is on the point of stalling, but does not actually stall. This, then, offers a useful method of arriving at the best glide trim—go on increasing elevation (e.g. by packing up the trailing edge of the tailplane a little at a time) until the model definitely starts to stall. Then either remove the final piece of packing which caused the stall, or slightly increase the *turn* on the glide to cure the stall.

The improvement over an original trim—e.g. usually somewhere around the flattest glide—can then be verified by timing the glide. It is useless carrying out final glide trimming (or timed glide tests) from a hand launch or low level launch. Accurate results can only be obtained from a "high start", such as

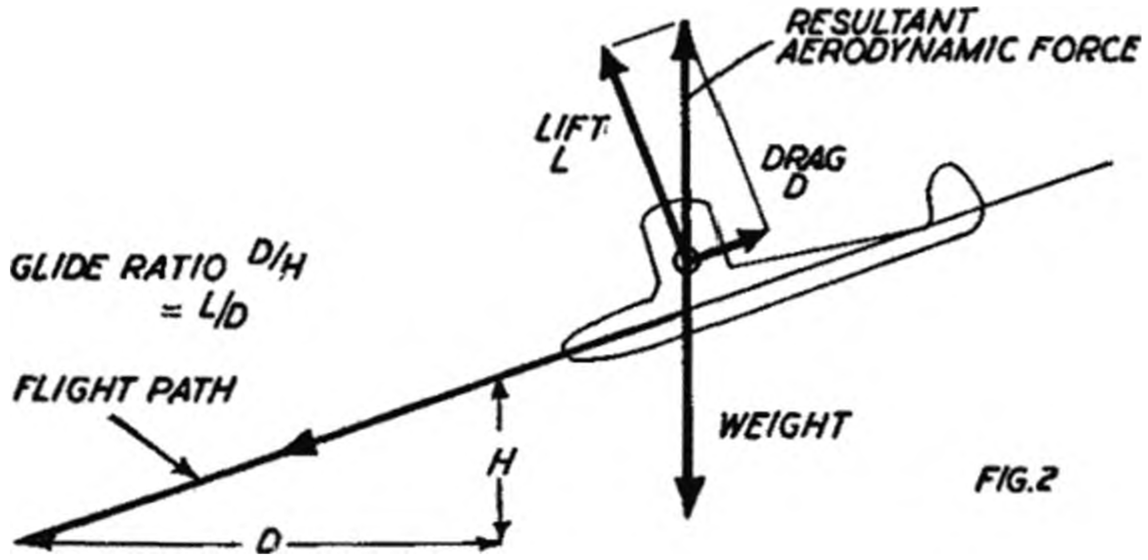
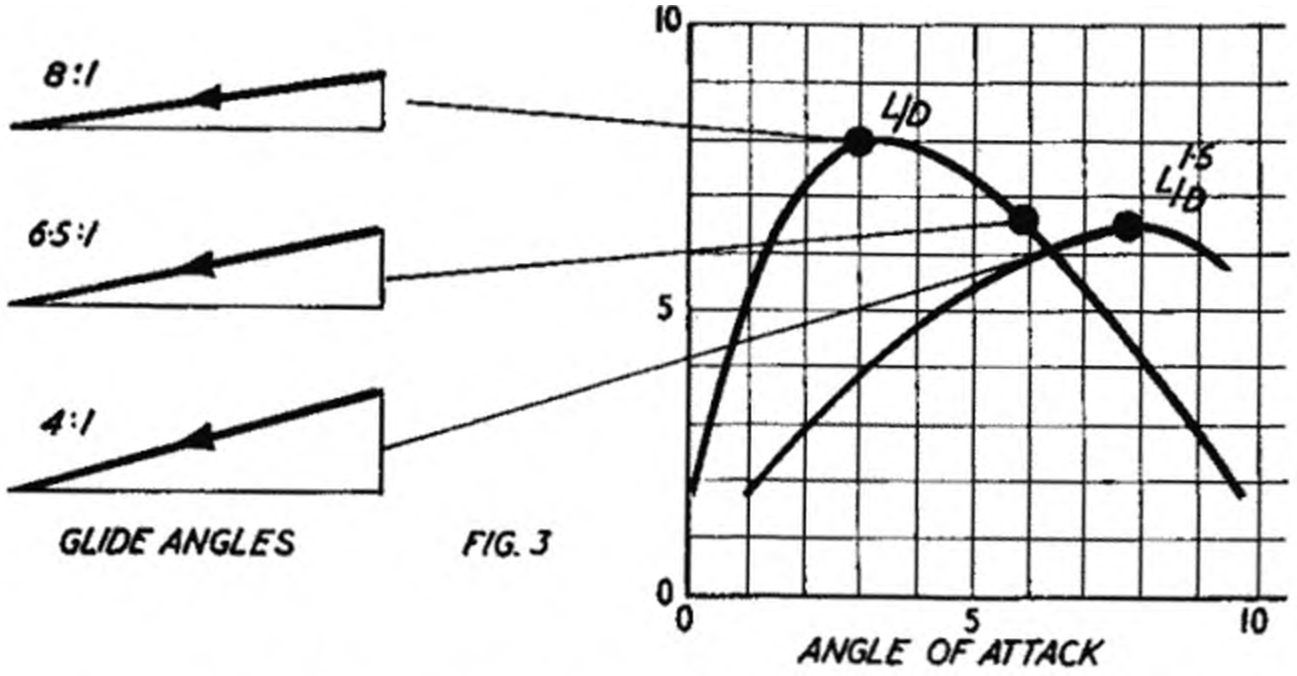


FIG.2



GLIDE ANGLES FIG. 3

launching a glider off a set length of towline (preferably at least 100 ft.) or flying a rubber model on a specified number of turns (preferably at least half turns). This establishes the glide trim in reasonably uniform air.

We have not mentioned power duration models in the above description for a very good reason. Although the optimum glide trim requirements are the same, adjusting glide by increasing tailplane negative incidence may have a drastic effect on the power trim. It is easy to add a bit of temporary downthrust to a rubber model to guard against stalling under power whilst trimming for best glide, then fix this tailplane trim and make final adjustments to the power trim with side- and down-thrust. The thrustline on power models is seldom adjustable in such a ready manner and since tailplane setting largely determines the thrustline setting, altering the tail may drastically affect the power-on trim, even for initial trimming.

Optimum trim is, therefore, more difficult to achieve, and a certain degree of glide performance may be sacrificed in the interest of power-on stability. More correctly, what usually happens is that the glide trim is never worked out to the best possible setting but rather a compromise trim accepted which gives an (apparently) satisfactory glide performance utilising the design layout of the model. With a powerful motor the model will get high enough in any case for the glide trim not to be so critical as with gliders and rubber models. Despite the apparent excellent glide of many large power duration models their sinking speed is often considerably greater than that of a typical rubber duration model with a large freewheeling propeller.

The aft centre of gravity trim on power duration models also makes it more difficult to establish a minimum sinking speed glide trim. With a small longitudinal dihedral the longitudinal stability margin is reduced and an involuntary stall can result in considerable loss of height before recovery. Exactly the same effect is observed in rubber models rigged with a c.g. position on or behind the trailing edge of the wing. Thus although the set-up is highly efficient from the duration point of view, with the tailplane contributing a good proportion of lift (thus utilising the total surface area more efficiently), it is often necessary to "play safe" on glide trim rather than trim for absolute minimum sinking speed. Somewhat similar considerations apply to gliders with "minimum area" tailplanes, particularly when trimmed to the limit and flown in gusty

weather. Logically one should *not* have to alter the trim of any duration model for different weather conditions, although this may prove necessary at times where longitudinal stability margins are low. This also explains why some "still air" designs will not perform satisfactorily in rough weather. They cannot be flown at "optimum trim" in the latter case.

Some facts about glide and glide trim:

(*i*) The gliding angle (for any particular trim) is independent of the wing loading. A heavily loaded model will glide just as *flat* as a lightly loaded model of the same size and type, but it will glide *faster*.

(*ii*) The "cleaner" the model the greater will be the difference between the trim for flattest glide and the trim for minimum sinking speed.

(*iii*) Models with a lot of "built-in drag" (large box fuselages, high-drag undercarriages, etc.) will tend to have a relatively poor glide duration even when trimmed for minimum sinking speed because the glide angle is poor (due to the high overall drag at any trim).

(*iv*) An undercambered wing section is usually beneficial on all models to achieve minimum sinking speed. Undercambered wings with a reflex trailing edge do not have such a good performance. The reverse trailing edge form—a mild flap effect—can materially improve the glide on most duration models. It cannot be used on power duration models, however, because of the drastic effect on power-on trim.

(*v*) When trimmed for minimum sinking speed a *straight* glide is not good, except in calm conditions. A reasonable turn associated with minimum sinking speed trim will help combat stalling in gusts.

(*vi*) Too tight a turn should always be avoided on the glide as this will usually result in an under-elevated trim. In continually banked flight, too, a certain amount of lift force is lost.

(*vii*) A freewheeling propeller on a rubber model is helpful in gusty weather. Its windmilling action acts as a brake if the model is stalled and put into a dive, preventing an excess of speed being built up and making for quicker recovery from the stall.

(*viii*) A model does *not* tend to "dive" downward and "zoom" on heading into the wind, unless the wind is definitely gusty. It may appear to do so as far as an observer on the ground is concerned, but this is largely an optical illusion. Below about 100 feet, however, wind flow is seldom uniform and gust effects may be apparent. At greater heights, apparent change of trim is usually due to vertical currents—thermals or down-draughts.

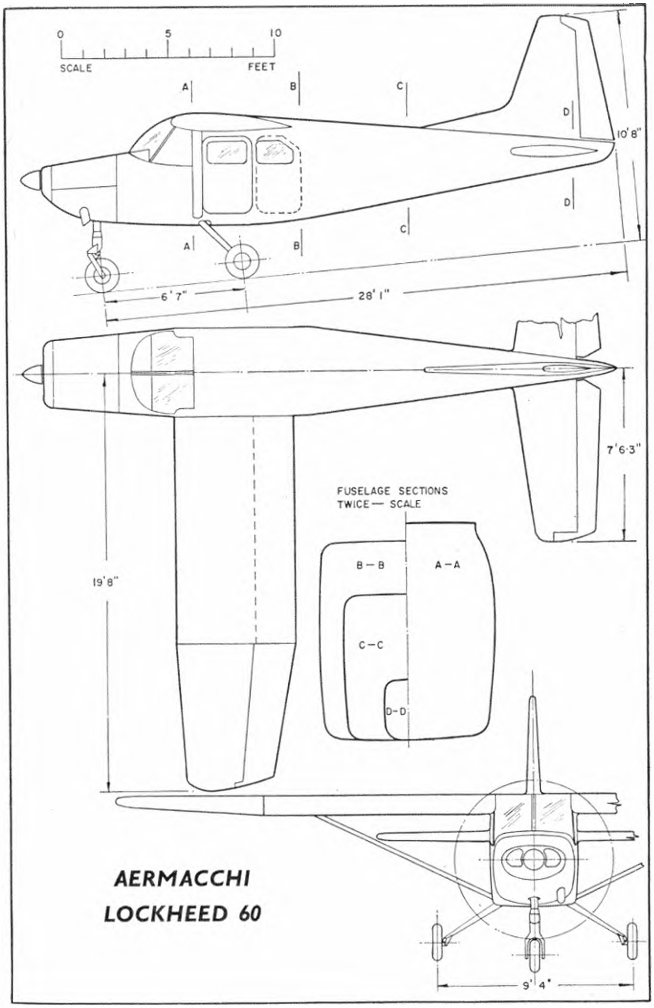
(*ix*) Basically, trimming a model for the *slowest* possible glide will approximate to minimum sinking speed. Altering the trim to slow the model up will also tend to straighten out any initial turn trim.

(*x*) Altering the turn trim after arriving at a trim for minimum sinking speed will *increase* the sinking speed. Adding more turn will under-elevate the model. Straightening out the turn will cause the model to stall.

(*xi*) In thermal weather very light models will often benefit from a slightly "stally" trim, provided the stall is rapidly damped and does not build up. They appear to pick up and take advantage of thermals better with this type of undulating glide path.

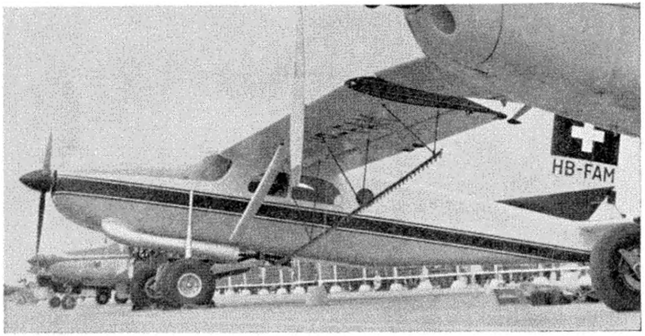
(*xii*) Models *can* glide right through a thermal. Usually on entering a thermal a model will automatically be induced to turn and stay inside the thermal. An initial turning trim helps.

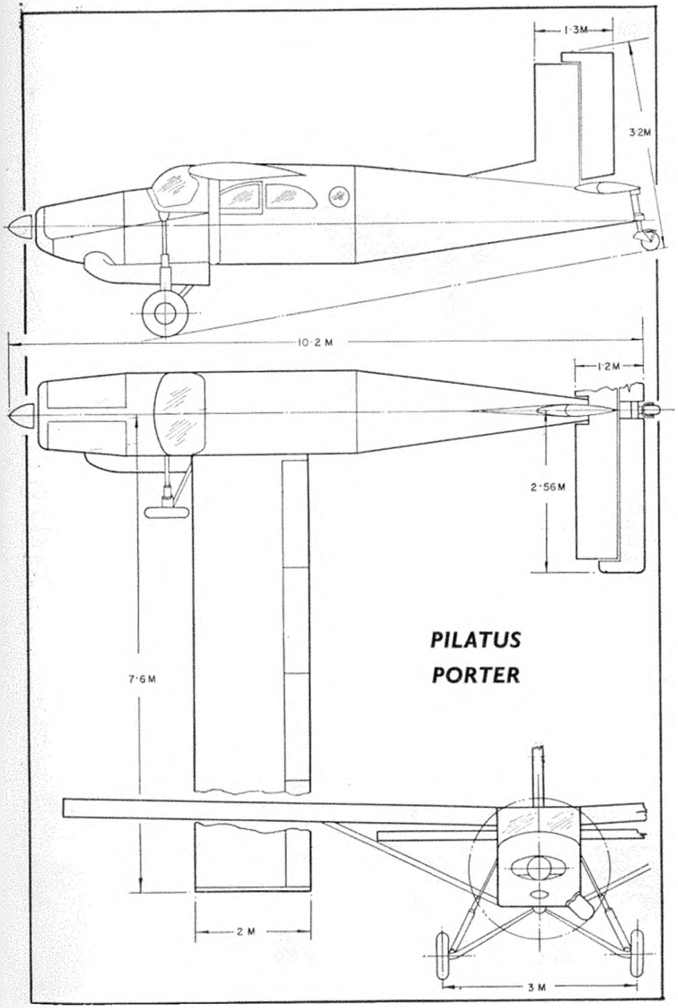
This " Utility ", being produced at Varese, Italy is ideal for free flight or as a scale subject for radio control. The backward inclined main landing gear, functional fuselage lines and generous tail surface areas are excellent features. Bright colour schemes add to the attraction. Ski variant is red, grey and natural metal. The European demonstrator below has bright orange where shown dark in this photograph, with light blue areas above, and for the underbelly, with all the remainder of the aircraft in glossy white. Registration I-MACH is in light blue. Spinner is light blue, prop blades are grey with yellow tips and the Lockheed Santa Maria sign is in dark red on the side of the nose, followed by the name Aermacchi—Lockheed 60 in capital white lettering. Interesting point on full-size that could work equally well for the model is a Centre of Gravity check. If, when the tail is depressed so that it touches ground, and when released, the nose-wheel returns to ground, then the C.G. is within required limits.



AERMACCHI LOCKHEED 60

Another " Utility ", perhaps less pretty than the Aermacchi; but at least one with dihedral is the Porter from Switzerland. This is an aeroplane that has been put to many uses and is shown in ambulance and sprayer types here. Fuselage cross section is rectangular with radiused corners, and the slab wing and tail surfaces make for very easy plan enlargement. The model would suit rubber as well as engine power, though the long nose will demand careful weight conservation in order to preserve the correct balance. Attractive colour scheme of the German registered " Aerodoctor " ambulance above is all white with red lettering, cheat line, tips of wings, elevators and rudder, undercarriage legs and wing leading edge. Stripes across the fin are grey as is also the underbelly. Registration D-ENLI is black on the fin, below black, red, yellow national marking.

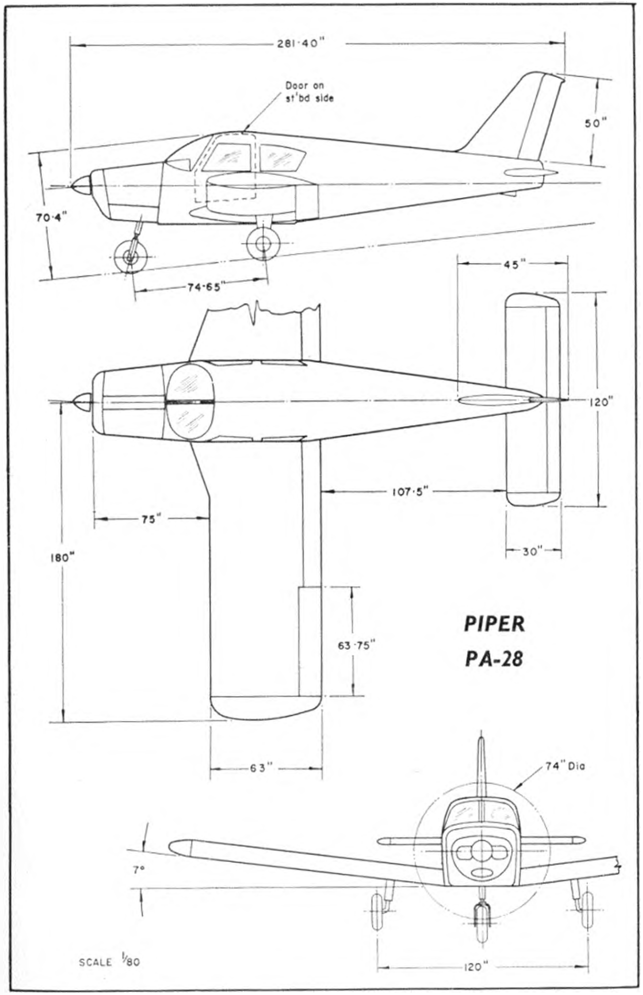




PILATUS PORTER

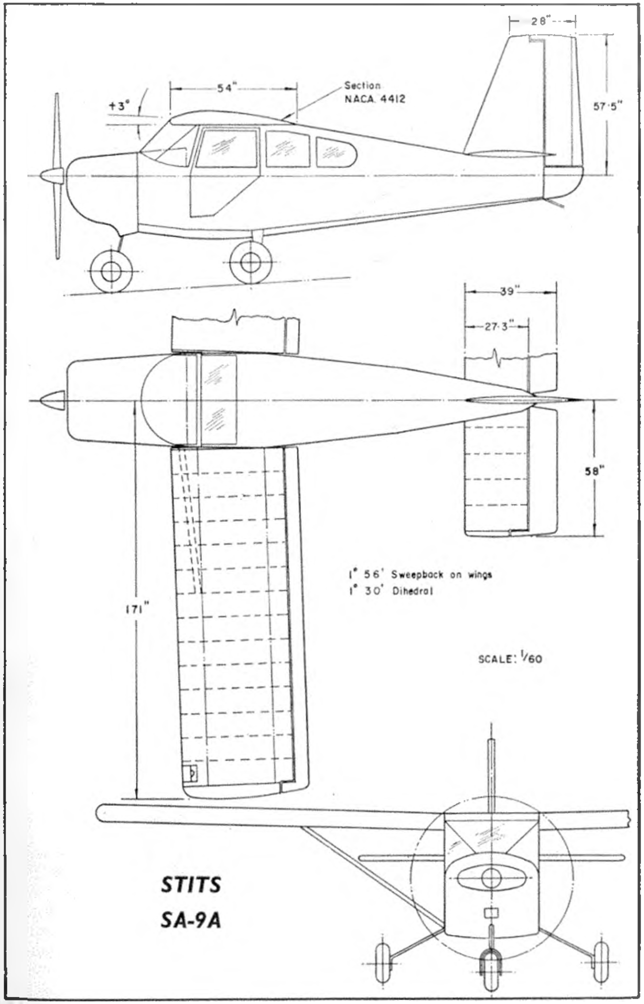
When Piper announced their Tri-Pacer replacement as a low wing one might have thought that scale modellers had lost the opportunity for making further models of the Lock Haven factory products. They would have been doubly wrong for the Cherokee, as it was christened, turned out to be another aeromodeller's dream from the Piper plant at Vero Beach, Florida. Seven degrees of dihedral for the thick, slab style wings will ensure lateral stability though the all-moving tailplane could well be enlarged a trifle for free flight without multi channel radio control. A number of Cherokees are now on the British register and the standard Piper colour schemes are varied in shades so that there is a wide choice for the modeller.

We fancy the Cherokee as a subject for six to ten channel radio control.



PIPER PA-28

Ray Stits of Riverside, California has produced some specially attractive subjects for scale modelling but none more suitable than the "Skycoupe" type 9A. Scheduled for assembly from plans or kits, the "Skycoupe" has now been certified by the U.S.A. authorities and may be taken up for full-scale production. Red and cream prototype shows its simple lines here. A 100 h.p. side by side two seater capable of 116 m.p.h. it has a metal fuselage with wooden wing and tail construction while the control surfaces are all metal. Note the strip ailerons, ideal for radio controllers, the large tail surface area, simple tricycle undercarriage and generally clean but easy to enlarge outlines. Moreover, the airfoil is our r/c and sports flying favourite—NACA 4412, what could be more ideal for scale?



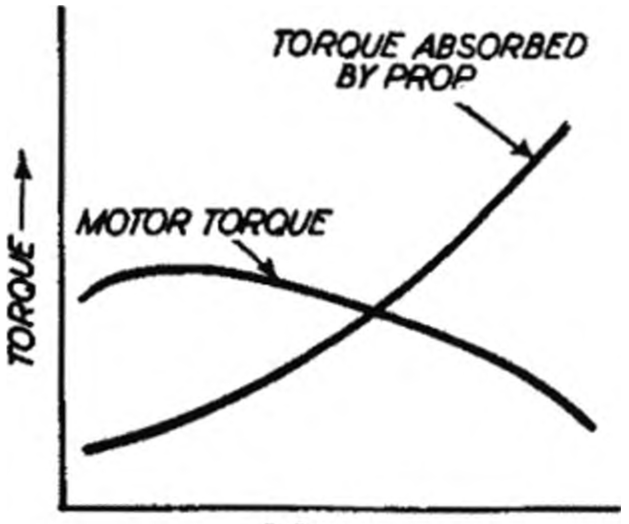


FIG. 1

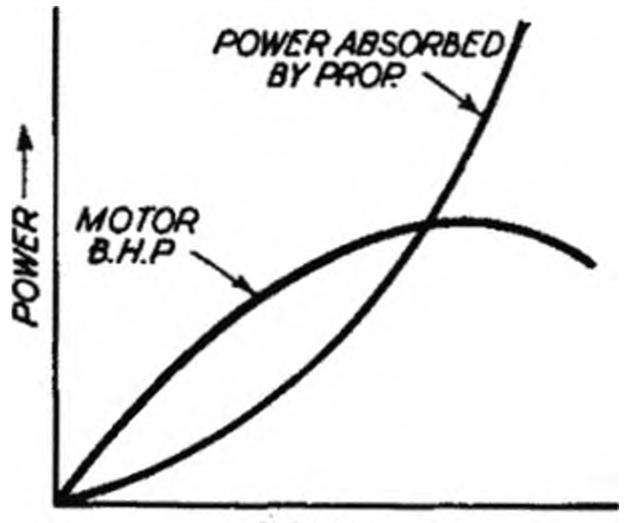


FIG. 2

POWER PROP. SELECTION

PROPELLER selection for a given type of model and specific engine or size of engine is usually best based on practical experience *on the flying field*. The best propeller for static running is not necessarily the best for performance in the air and whilst general recommendations are good enough for sports models something more specific in the way of selection is needed to get the best performance out of power duration models and, more particularly, control line T/R and speed models.

Basically a propeller has two main characteristics. It represents a load to be driven by the engine and, by virtue of its geometry and the speed at which it is driven, acts as a thrust producer. From the "load" point of view the right propeller is one which allows the engine to operate at the r.p.m. corresponding to peak power. Its efficiency as a thrust-producer is then determined by its diameter and pitch, related to the flight conditions under which it is intended to operate.

Dealing with the "load" aspect first. The useful output of the engine is the turning force or *torque* applied to the crankshaft, which is something that can be measured with suitable test equipment. The torque output of an engine varies with speed, being a maximum at some low speed and then *decreasing* with increasing speed—Fig. 1. Any given size of propeller requires an amount of torque to turn it in direct proportion to the square of the speed at which it is turned (r.p.m.), or in simple equation form:

$$\text{torque absorbed} = C_q \times (\text{r.p.m.})^2$$

where C_q is a constant (called the torque coefficient) for that particular propeller.

Plotted on the same graph as engine torque, the two curves will cross at some point corresponding to the speed at which that engine will drive that propeller. Equally, of course, knowing the torque output of the engine (e.g. from a test curve) and measuring the r.p.m. at which it drives a particular propeller, the torque at that r.p.m. can be found from the engine curve and the C_q of the propeller calculated. This can then be used to plot characteristic (torque absorption) curve for that particular propeller. Such a propeller is then "calibrated" for torque measurement for if used on any other engine the torque relative to the speed achieved with that engine can be determined from the propeller curve. This is not an *accurate* method, however, although it is quite widely used for torque measurement. Most engine manufacturers—and quite a few modellers—use a standard size of propeller to check engine output on a comparative basis. The higher the r.p.m. figure with a particular prop., obviously, the more power that engine is developing. As a method of power measurement, however, errors of the order of plus or minus 10 per cent are quite common, and even higher in certain circumstances.

Comparing a propeller characteristic (torque absorption) curve in this manner with an engine torque curve tells only the operating r.p.m. with that propeller. It is necessary to know the shape of the *power* output curve of the engine as well before the power level of the combination can be established. Power output or B.H.P. is proportional to torque *times* r.p.m., which invariably gives a curve rising to a peak and then falling—Fig. 2. The peak point corresponds to maximum power which that engine will develop, with a corresponding r.p.m. figure for maximum power output. Thus for maximum performance the "matching" propeller should have torque characteristics such that it operates at the r.p.m. corresponding to peak (engine) power. In other words the propeller characteristic curve should cross the engine torque curve at "peak" r.p.m.; or the propeller *power* absorption curve should cut the engine B.H.P. curve at its peak. The propeller *power* absorption curve can be calculated as C_q *times* $(\text{r.p.m.})^3$. However, it is more usual to work with *torque* curves for both propeller and engine and relate r.p.m. figures to the "peak" r.p.m. given by the engine B.H.P. curve.

Since each size, shape and type of propeller has its own specific torque coefficient, each will have its own curve for torque absorbed plotted against r.p.m. It is usual to draw such curves on logarithmic scale graphs, when each individual curve becomes a straight line—Fig. 3. If any engine torque curve is then plotted on this same graph, the point at which it cuts each propeller "curve" will then represent the r.p.m. achieved with that particular propeller.

In practice there may be considerable differences. The actual torque curve of a particular engine may be different from the published test curve achieved with an individual engine. Individual propellers may have slight geometric differences compared with the specimens used to determine the propeller curves, which appreciably modify their C_q values (moulded propellers,

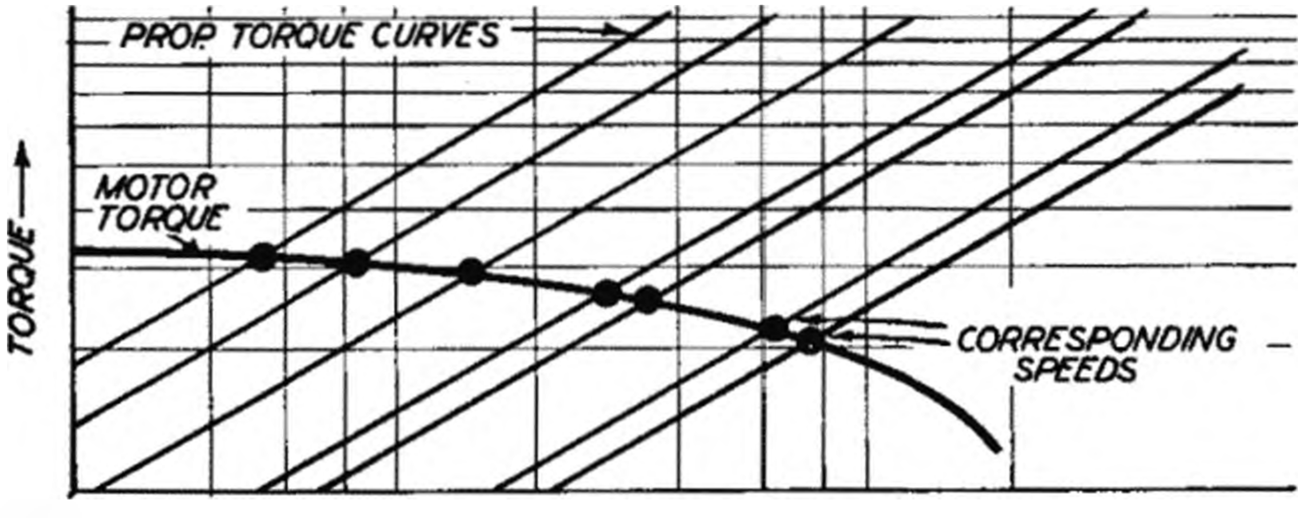


FIG. 3

for example, are prone to shrinkage in varying degrees depending on their temperature when removed from the mould, also small differences in form for the same nominal size produced in two-up or more moulds). Rather than being an exact method of selection, therefore, characteristic curves give approximate solutions as to what should be the best sizes of propellers to evaluate further by actual flight tests.

The problem is further complicated by the fact that all test data are related to static r.p.m. figures where the propeller is being operated in what is virtually a stalled condition. Since the propeller has no forward speed the blade angle of attack is the same as the pitch angle which, except at the tips of very fine pitch propellers, will invariably be higher than the stalling angle of the blade section. As with a wing when stalled, the corresponding drag (responsible for torque absorption) will be high. Under flight conditions when the propeller is moving forward as well as rotating the whole of the blade will be operating at a much lower angle of attack, and thus have lower drag. In other words its C_q value is reduced and so it will speed up—see Fig. 4.

It is impossible to estimate exactly how much a propeller will speed up due to "unloading" under flight conditions since this will depend on the original form of the propeller, the type of engine and the flight speed achieved. To date there have been no reliable data on "in flight" r.p.m. with different engine-propeller combinations, so a general solution is usually adopted. This normally assumes a 10 per cent increase in r.p.m. in flight, over static r.p.m. as measured with the same propeller and engine.

This is only a "guesstimate" and in some cases the actual light r.p.m. may be higher, or lower. Glow motors, for example, tend to give unflattering static r.p.m. figures, especially with high pitch propellers, yet are capable of speeding up very considerably in the air once the propeller is "unloaded". Diesels, on the other hand, are distinctly limited in the amount of speed up as a marked increase in r.p.m. affects the compression setting required to maintain consistent running. This is also demonstrated by the fact that a diesel will often begin to run badly, or even stop, when the propeller is drastically unloaded in a prolonged steep dive. A glow motor will go on speeding up (provided the mixture setting is not critical) as the propeller is unloaded and even continue to "shaft run" if the propeller load is removed entirely (e.g. the blades sheared off).

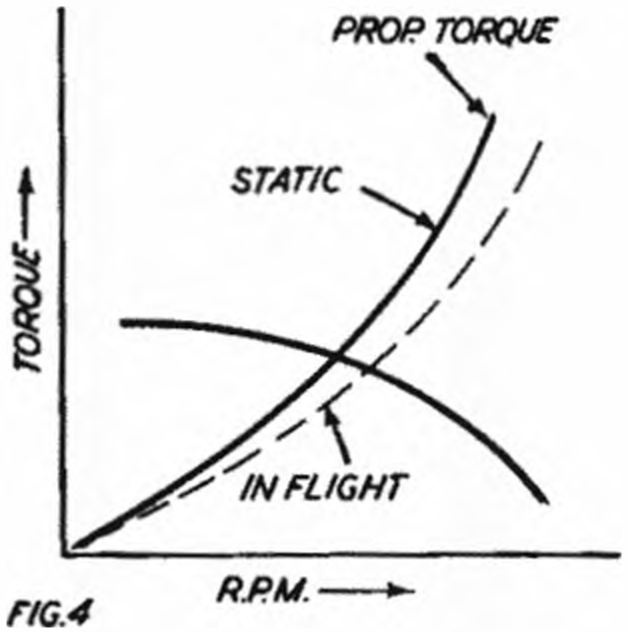


FIG. 4

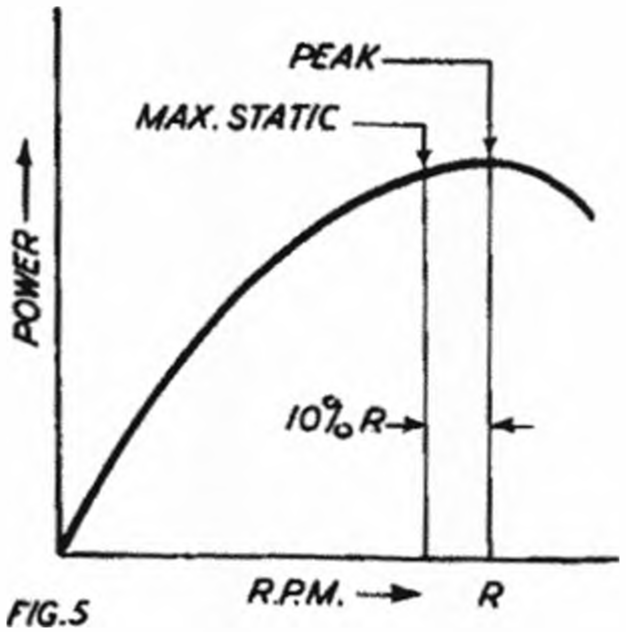


FIG. 5

For most practical purposes, however, a "speed up" of approximately 10 per cent over the static r.p.m. figure achieved with any propeller is a good basis for preliminary selection. A suitable minimum propeller size is then one which gives a static r.p.m. figure 10 per cent less than the peak r.p.m. for that particular engine—Fig. 5. Thus if the engine peaks at 15,000 r.p.m., a suitable minimum propeller size would be one giving 15,000 − 1,500 = 13,500 r.p.m. Note that "minimum" propeller size does not refer to diameter but the diameter-pitch combination. Basically, in fact, it refers to "minimum C_q".

To determine a suitable diameter-pitch combination it is necessary to take into account the flight speed. Again purely theoretical analysis can be misleading since there are many unknown factors involved. Actual flight speed, for example, is usually unknown except in the case of control line models where it can be measured accurately. And although the theoretical advance of the propeller can be determined from its pitch—speed in feet per second = geometric pitch in feet *times* revolutions per second—the *actual* advance per revolution of amount of slip is indeterminate.

Relating practical results to basic theory, a propeller slip figure of about 15 per cent seems to apply to control line speed work. On the basis it is possible to plot speed, propeller pitch and r.p.m. data on a common chart—Fig. 6. Note that both static and flight r.p.m. scales are given, the former being a figure for bench testing and the latter an estimate of in flight r.p.m. to compare with the peak r.p.m. of the engine concerned. In the case of glow motors, however, the peak r.p.m. figure may be higher in flight than shows on static test. With a diesel this is seldom the case.

Where speed performance is the aim (e.g. control line T/R or speed), performance is directly linked to propeller *pitch*. Thus to achieve, say, 100 m.p.h. with an engine which peaks at 15,000 r.p.m. a propeller pitch of 8½ inches is *essential*. Any lower pitch will not realise the design speed in flight. A higher pitch will (e.g. 10 inch pitch at 12,500 r.p.m. in flight) if the engine has the power available to turn it at the required speed, but will not reach *maximum* performance because the engine is now operating below peak r.p.m.

The static r.p.m. figure achieved with the required pitch of propeller will then determine a suitable *diameter*. Continuing with the same example—8½ in. pitch propeller for 100 m.p.h. design speed—the static r.p.m. figure required is about 13,500. If the engine will not achieve this with a certain diameter, then a smaller diameter (same pitch) will have to be selected until the necessary static r.p.m. figure is realised.

Whether the resulting diameter is a practical size depends almost entirely on the suitability of the engine as a "racing" power unit. If the diameter is too small the propeller will lack the necessary thrust, meaning that the engine just is not capable of the intended design speed. It pays, normally, to employ the maximum diameter that can possibly be utilised and reduce blade area and blade thickness (particularly the latter) to achieve the required r.p.m. figure. Larger diameter propellers are usually more efficient as thrust producers, even compared with a smaller propeller of the same blade area running at the same speed.

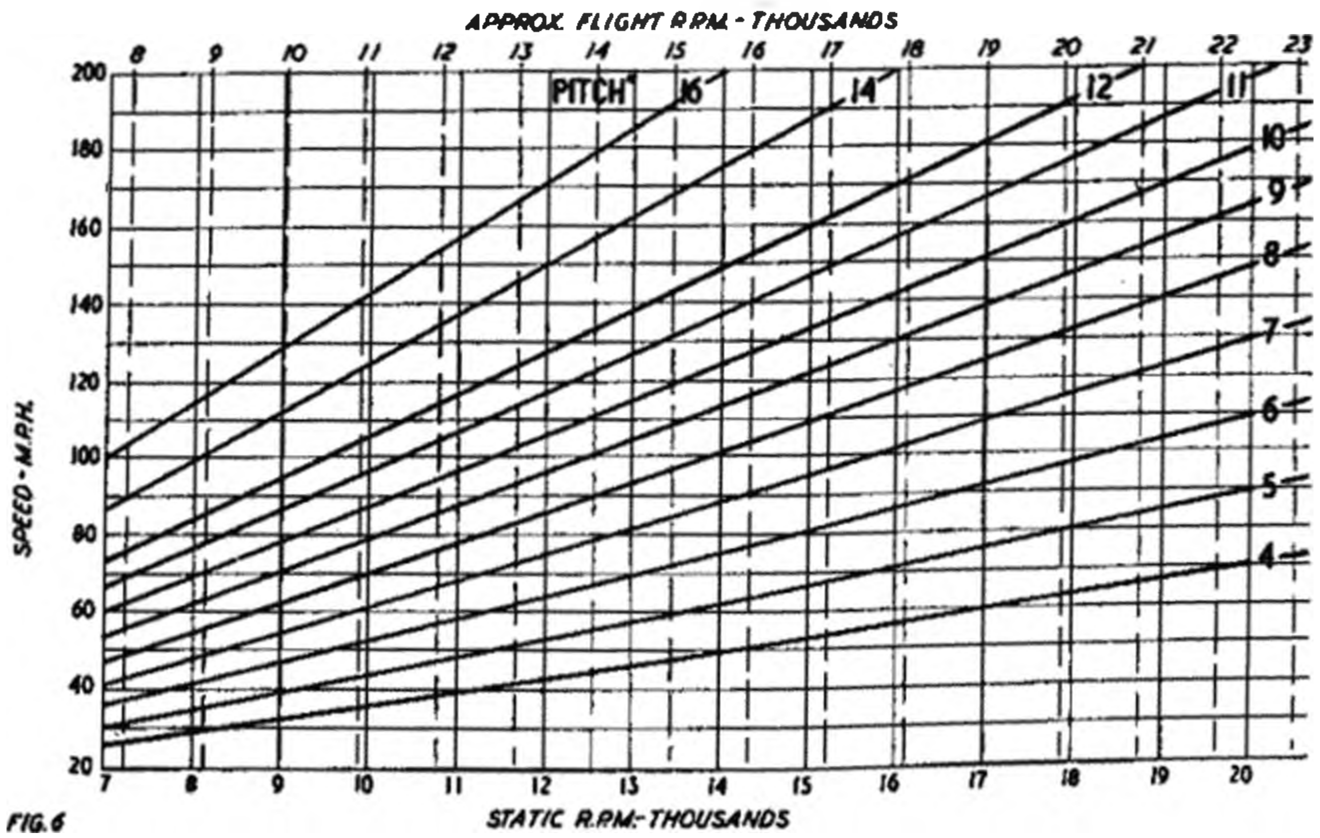


FIG. 6

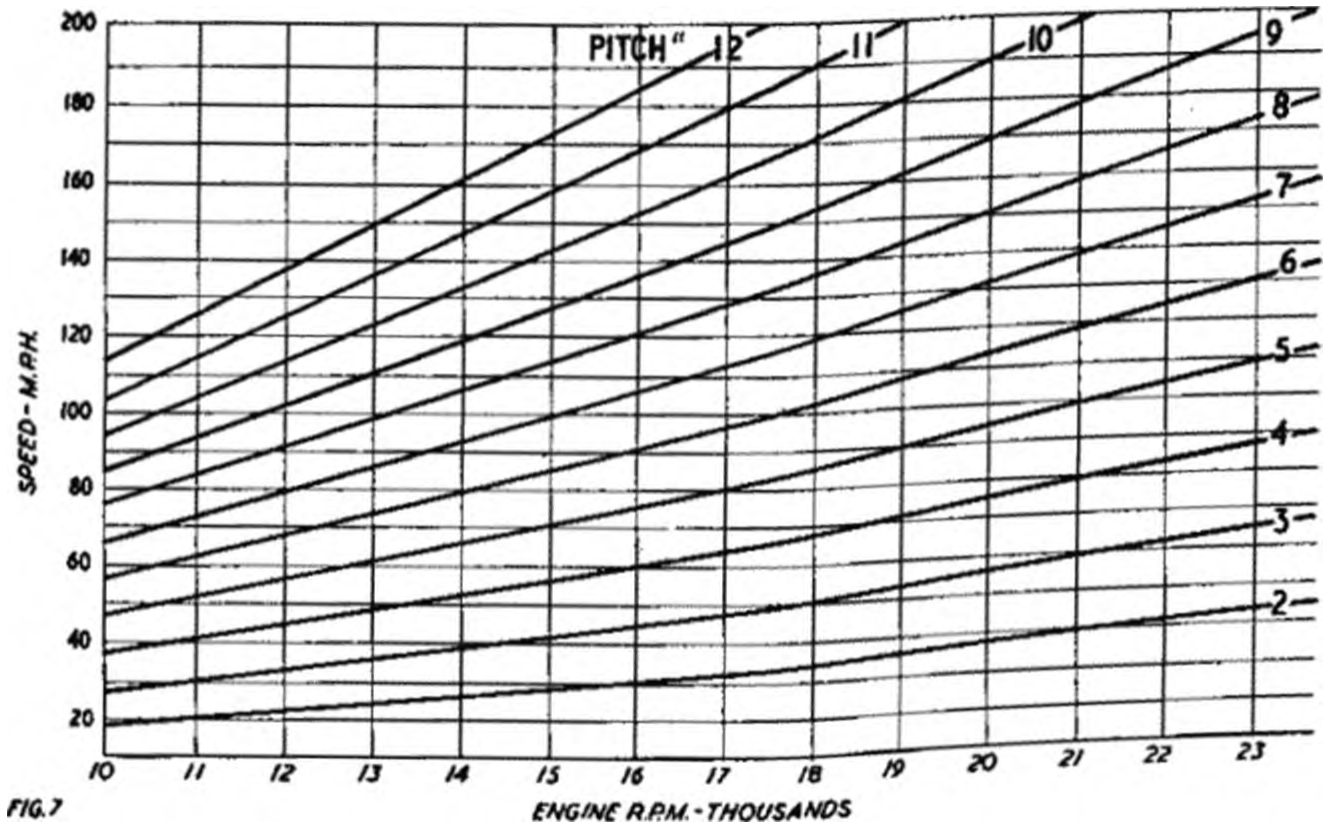


FIG. 7

For free flight work the same chart can be used as a general guide, although the actual flying speed is largely unknown, and not usually significant. On sports models, in particular, a relatively large amount of slip can be tolerated and relatively inefficient operation. For example, a propeller size is often selected which loads the engine to well below peak r.p.m. so that the engine is operating "partly throttled back", as it were. The larger diameter propeller makes for easier handling for starting and the lower running speed for smoother operation and less vibration. Utilising the full power of the engine—i.e. matching the propeller for peak power performance—may also make trimming more critical.

As a general rule in such cases moderate diameters and fairly high pitches are used with diesels; and larger diameters and finer pitches with glow motors. Fairly fine pitch propellers are virtually essential with the smaller sizes of glow motors which tend to peak at quite high r.p.m. figures and develop poor power at lower speeds. For sports flying it is generally quite satisfactory with a diesel to select a propeller size which gives anything between 60-75 per cent of the peak r.p.m. (static running). With glow motors the best choice is usually 70-80 per cent of the peak r.p.m. (static running).

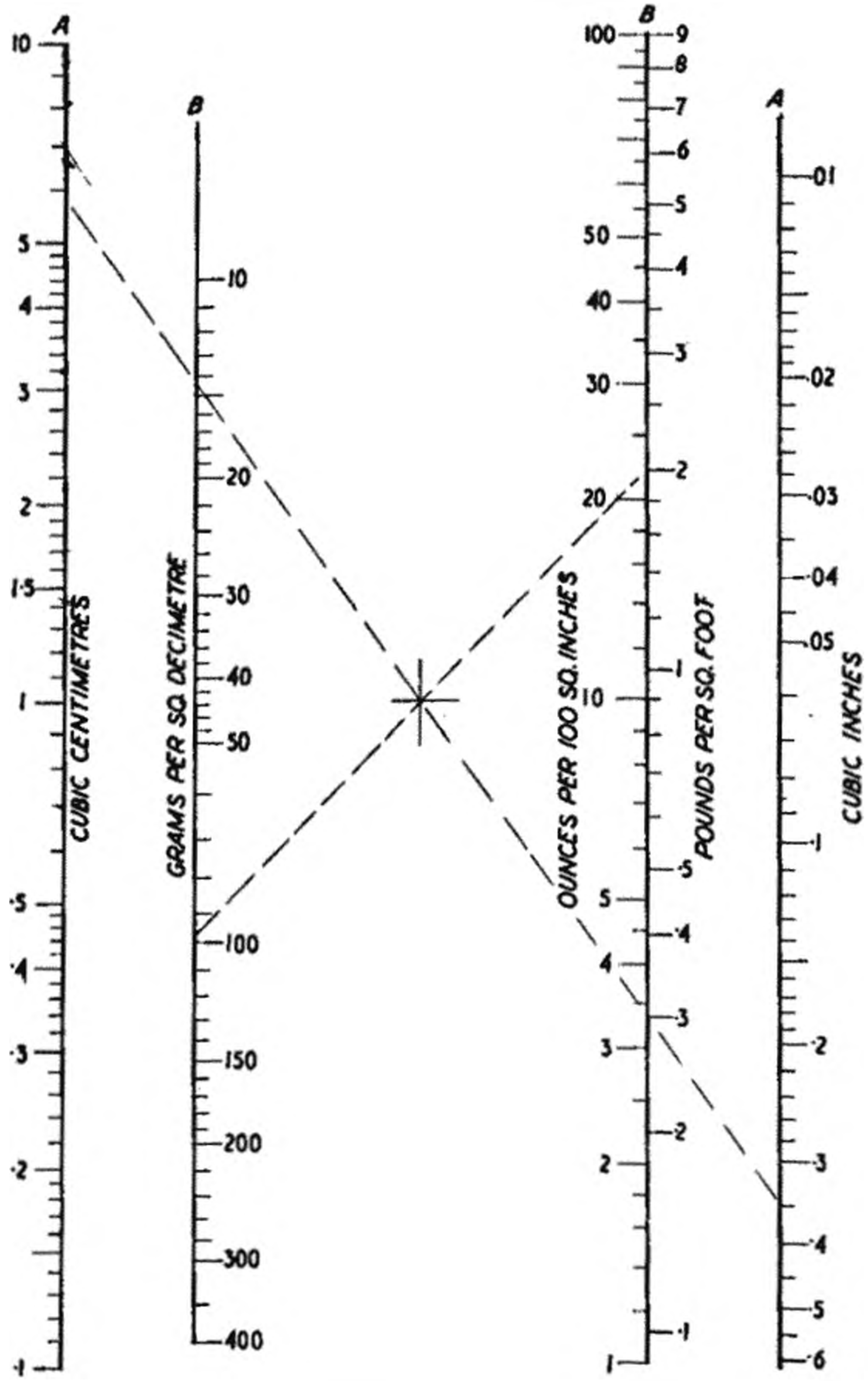
With aerobatic radio-controlled models a situation can arise where the varying speed from level flight to a dive can dictate a suitable propeller *pitch*. Fig. 7 plots theoretical maximum speed (no slip) for a range of pitches. At these speeds the propeller is operating at zero angle of attack and hence virtually completely "unloaded"—i.e. the engine will tend to "race" as with a flywheel load only.

Suppose, for example, a radio model uses a 12×4 propeller on a large glow motor, which normally peaks at about 13-14,000 r.p.m. Putting that model into a dive to build up speed to, say, 60 m.p.h. would necessitate engine r.p.m. increasing to about 16,000 r.p.m.; or at 80 m.p.h. to 21,000 r.p.m. If the engine cannot achieve this speed the propeller will begin to act as a brake with effective reverse thrust, thus limiting the flight speed. A higher pitch may therefore be essential to realise the full potential of the model's performance —e.g. an 11×6 instead of a 12×4.

High speed flight, in fact, is virtually synonymous with the use of higher pitches. At the same time high pitches may be used for moderate flight speeds to "tame" an engine and hold the r.p.m. figure down (on sports models), particularly with diesels. Models trimmed for a steep climb, on the other hand require moderate pitches with medium-revving engines (diesels) and fine pitches with high-revving engines ("racing" diesels and glow motors). It is usually best to err on the side of a relatively fine pitch in such cases, unless there is plenty of power in hand.

A point often overlooked is that a change in propeller can affect the *turn* trim on a free flight model. If the change produces an increase in operating r.p.m. then the torque reaction will be reduced; and conversely a prop. which lowers the operating r.p.m. will increase the torque reaction. In the former case this will tend to open up a left hand turn under power (or tighten a right hand turn); and in the latter case to tighten a left hand turn (or open up a right hand turn). This can often be used to advantage on sports models; and also on radio models as an assistance in final trimming out for straight power flight.

NOMOGRAPH: CONVERSION C.C./CU. IN. & GMS./SQ. DM. OZ./SQ. FT.



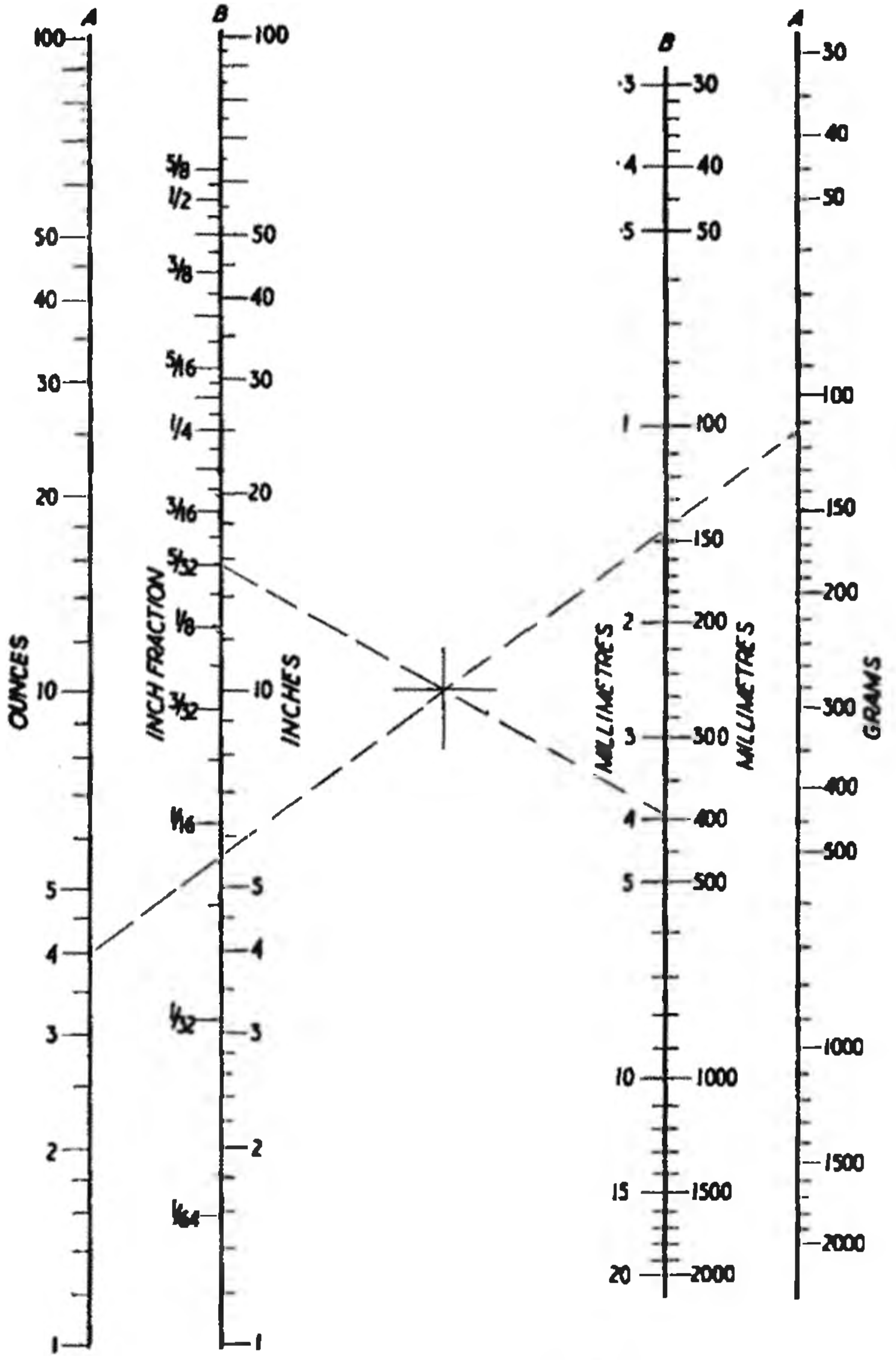
CONVERSION SCALES—ENGLISH/METRIC

To use this scale relate the two scales A or B via a straight line through the centre point. Note only A-A and B-B can be related in this manner—not A-B or B-A. The right hand scale B can also be used to convert loading figures from ounces/100 sq. in. to lb/sq. ft., and vice versa.

Example: to convert 2 lb/sq. ft. loading to grams per sq. dm., connect '2' on right hand 'B' scale through centre to grams per sq. dm. scale. Ans. 98 gm./sq. dm. approx.

Example: to convert ·35 cu. in. to c.c. Ans. 5·75 c.c. approx.

NOMOGRAPH: CONVERSION OZ./GMS. INS./MM.

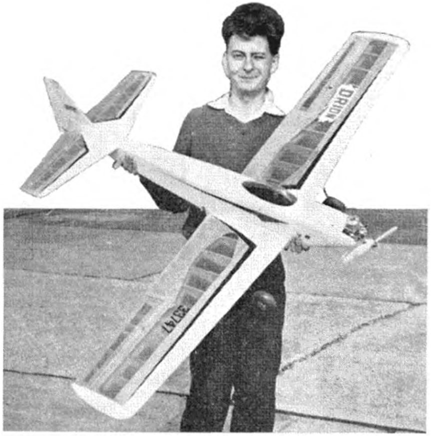


CONVERSION SCALES—ENGLISH/METRIC

Scales A and A or B and B are connected via a straight line through the centre point of the chart. Note that the inch fraction scale on the left hand B scale relates to the left hand side of the right hand B scale only.

Example: to find the metric equivalent of 5/32 in. Ans. 4 mm. approx.

Example: to find the metric equivalent of 4 ounces. Ans. 113 grams.



"MULTI" IS THE REAL ANSWER

This *Orion* kit model, built and flown by Tony Brown of Chesham, Bucks, has Orbit-8 radio, Bonner Duramite servos, Super Tigre 51 R C engine.

Only a few years ago, when radio control was quite well established in performance and reliability, it was still generally accepted that the scale-type low wing monoplane with little or no automatic stability was not a practical proposition. Today, the majority of the advanced R C aerobatic designs adopt a low wing layout, and the scale Spitfire, Hurricane or Mustang is a perfectly feasible—and successful—proposition. It just needs a certain amount of "piloting" experience to be able to fly such types. And the cause of this considerable change in practical standards? Simply 'full house' "multi" radio gear.

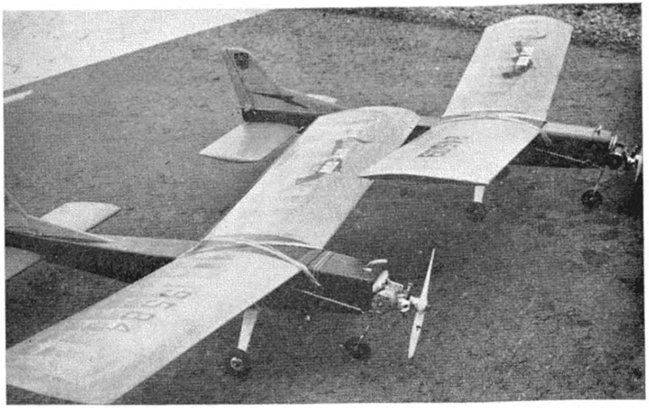
The basic difference between "multi" and "single channel" is that one permits *direct* signalling via the separate channels available, whilst single-channel operation is inevitably restricted to some form of sequential selection if more than one control movement is to be realised. Ignoring for the moment the proportional control systems which can be worked around single-channel signalling, let us compare "multi" and single-channel operation applied to *one* control only—the rudder. Rudder is the one primary control we *must* have on a model to be able to fly it successfully under remote control, right from the simplest single-channel system through to 'full house' "multi" (although in the latter case rudder control is not used a great deal it still cannot be dispensed with entirely on a conventional aeroplane layout. Equally, if we adapt single-channel radio to operating *ailerons* instead of rudder as providing "safer" turns, the answer is a model which is not fully controllable in the directional sense—and even difficult to keep under control at all. It becomes a "radio affected" model.

Two identical aeroplanes with just rudder control, the one operated by two-channel "multi" and the other by single-channel through a conventional actuator would appear to offer identical scope for flying, particularly if the single-channel actuator was of the selective type (press-and-hold for "right"; press-release-press and hold for "left"). In practice there will be a distinct difference between the handling and response of the two. The "multi" model with *direct* signalling of right or left will give considerably more scope. It will be much the easier to control in a "dive" by alternately blipping on "right" and "left" rudder, for example and still maintain the same heading. The single-channel model is all too easily "lost" in a turn to one side or the other with such a manoeuvre. In fact, everything about the "multi" model will be that much sharper in response, making it both easier to handle and increasing the scope of manoeuvrability.

Any rudder-only model, however, is distinctly limited in scope. It can be looped (with the proper technique and a suitable design and power); and it can perform something of a caricature of a roll. Commonly, however, it will require a change of trim to complete both manoeuvres—slightly over-elevated in the former case and under-elevated in the latter. In any appreciable wind, however, most of the flight-control time is taken up with keeping the model from losing too much ground downwind. The trim normally has to be changed to one which is distinctly under-elevated to achieve some reasonable degree of penetration—which practically eliminates the possibility of looping and makes the turn response to rudder even more drastic.

Rudder-only implies two distinct limitations—(*i*) a control which is really *too* drastic in effect and (*ii*) lack of any real control in the vertical plane, i.e. control over altitude. If rudder control is "desensitised" by reducing the movement it may be completely ineffective on the glide. The blipping technique mentioned can give a certain measure of "altitude" control and increase the flying speed and rate of penetration upwind, but many models will not respond to it at all satisfactorily. Putting the model into a spiral dive is a positive way of

Two examples of advanced rudder only design, the "Six Guns" of J. Dumble and P. Thornton. Thornton's has R.E.P. four-channel equipment for rudder and engine control with an Enya 29, while Dumble's has six channel radio, with four channels on rudder for coarse and fine angles of deflection using two servos. The other two channels control motor, in this case a Merco 35. Both models are only 48 in. wing span.



losing height—but also a lot of distance downwind and a complete loss of heading on the initial recovery.

Motor speed control is a very helpful addition and can make an excellent single-channel combination for calm weather flying. It is still nowhere near the answer for "all weather" flying and *complete* control. One can only *begin* to claim "complete" control when elevator control is also available.

This can still be done with single-channel equipment via cascaded escapements, or "trip" elevator position on a compound escapement. Again this makes a good combination for flying in calm weather, and under conditions where there is a reasonable amount of time to think and correct any false signals and the mechanical hook-up is dead reliable. But just as "multi" signalling of rudder only is more effective than "sequential" signalling, *direct* selection of positive rudder and elevator positions by four-channel "multi" is *very much* better.

The main limitation to four-channel "multi" (covering rudder and elevator) is that the model can become a little "hot" to handle. The ability of being able to lose speed by shutting the motor is a very valuable addition, calling for an additional one or two channels. The difference in installation cost of five- or six-channel equipment is virtually negligible, so the six-channel system is to be preferred as giving *direct* selection. With a six-channel system—rudder, elevators and motor speed—we then have a very controllable model with a wide range of aerobatic abilities. The severity of rudder response is partly offset by the fact that the direct selection enables it to be blipped rapidly, and there is also elevator there to blip on, if necessary, to keep the nose up.

The same coverage with single-channel equipment is impracticable. It *can* be done mechanically, but not as a practical solution for flying. Even cascaded escapements handling rudder and elevator are bad enough in response time when you do not make any mistakes in signalling—and a signalling mistake on top can lead to a lot of trouble. In all cases, however, right up to six-channel "multi" we still need a model with a reasonable reserve of automatic stability. Rudder elevator and motor speed does not give enough control for complete safety or the ability to pilot the model all the time.

Now let us see how a proportional single-channel system compares so far. Galloping Ghost appears to have immense possibilities, but more often than not seems to run into practical difficulties in handling, and particular difficulties on the "mechanics". When it *is* worked out properly, and is flown by a competent pilot in a suitable design, it can be most impressive and the equal of the six-channel "multi". The proportion of people who fail with it, however, is very high. When people fail with "multi" it is usually the fault of installation (poor servos, unreliable radio or poor model design) rather than the control *system* as such. Once "multi" is working properly it is relatively *easy* to fly.

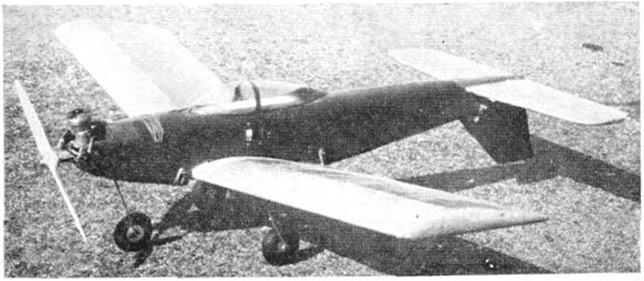
Proportional rudder is ideal in the theoretical sense that one can have full movement for violent response and "inch on" small amounts of rudder for gentle turns. Again, however, "multi" is a much simpler solution, if you are stuck with rudder-only control, as demonstrated by the 1962 R C Nationals winner. Two channels were used for full rudder movement and two more for intermediate rudder positions—two selective positions each side—"fine" or "coarse". To use a six-channel system in this way, however (the other two for motor speed), would not normally be a logical solution. Rudder-elevator-motor speed is a far more effective combination. Without elevators and motor speed a true spin is not possible; and without elevators any radio model is really only suited for calm weather flying.

Stepping the "multi" equipment up to eight channels enables ailerons to be added, when the model becomes *fully controllable*. The design need not have the same reserve of inherent stability, so it can be more aerobatic to start with. Provided you have the experience to cope—and the design is not downright unstable—rudder, elevators, motor speed and ailerons enable you to get out of almost any situation (if you have enough height!) and opens up scope for performing really smooth turns and true rolls. Smooth flying is also aided by the fact that a "zeroed out" trim can be adopted where the model stays on any attitude or course into which it is put. It is an advantage, in fact, to have a model which is destabilised in this manner. The model which is too stable will still have to be flown in "steps" on the climb and through certain other manoeuvres.

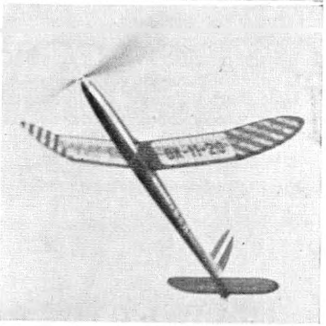
The majority of successful "multi-proportional" systems to date have concentrated on rudder and elevator (with additional motor speed available). They are thus still more limited than conventional eight-channel "multi" with bang-bang actuators, because aileron control is lacking. This has been overcome to some extent with coupled aileron-rudder, although this is essentially a compromise solution.

Nothing *less* than *separate* rudder, elevator and ailerons can compete with conventional "multi" for consistency of operation and the ease with which piloting skills can be acquired. The other particular advantage of conventional "multi" is that it is basically straightforward single-duty electronics, as far as the receiver and transmitter circuits are concerned, and the servo is a relatively straightforward electro-mechanical device which can be of rugged enough construction not to be critical in operating principle or rely on extremely fine adjustments or tolerances. Nevertheless the servo is still the heart—or rather the muscle power—of the system, of course, and must be of entirely reliable design and manufacture. Not all multi servos come in this category.

Basically, for the enthusiast who wants to achieve a satisfactory standard in radio control, "multi" is still the real answer and the cost something which has to be faced and met, somehow or other. It may mean considerable sacrifices in other directions, but by choosing reliable equipment the investment will give long-lasting service and satisfaction.



J. Singleton's small, rudder only, model using two channels of Orbit-10 Relayless and Bonner Transmite servo. Enya 15 engine.



Champions! Hungarian Imre Toth, leader at the Criterium of Aces 1961, Genk, Belgium, in F.A.I. speed with a fastest flight of 202.25 k.p.h. at left. Below him is Kjell Rosenlund of Sweden, deserving winner of the team race final in 4:40 with "Miss F.A.I.". Below is the 1961 World free flight power champion, Fritz Schneeberger of Switzerland, who made a perfect score of 900 seconds at Leutkirch. Below him is the previous winning Wakefield by Muzny of Czechoslovakia, which was placed 53rd in the 1961 event.

TEAM RESULTS

WAKEFIELD

1	Poland	2600
2	U.S.S.R.	2553
3	U.S.A.	2529
4	Yugoslavia	2510
5	Italy	2481
6	Sweden	2459
13	**Great Britain**	2333

A 2

1	Netherlands	2498
2	Czechoslovakia	2459
3	Italy	2420
4	Finland	2300
5	U.S.A.	2251
6	France	2235
8	**Great Britain**	2185

F.A.I. POWER

1	Hungary	2442
2	Czechoslovakia	2408
3	Switzerland	2354
4	Canada	2333
5	**Great Britain**	2326
6	Austria	2217

WORLD CHAMPIONSHIPS

Held at Leutkirch, Germany, August 31st—September 4th, 1961

F.A.I. Power

No.	Name	Nation	1	2	3	4	5	Total	Engine
1	F. Schneeberger	Switzerland	180	180	180	180	180	900	Cox T.D.
2	E. Frigyes	Hungary	180	162	180	157	180	859	Moki S-2
3	J. Cerny	Czechoslovakia	180	180	161	180	153	854	MVVS 2.5g
4	J. Sheppard	New Zealand							
	Proxy: P. Buskell	Great Britain	132	179	180	180	180	851	ETA 15D
5	A. Meczner	Hungary	158	180	137	180	180	835	Krizsma K.8
6	E. Verbitki	U.S.S.R.	160	176	149	175	171	831	Kharkov
7	G. Parry	Canada	153	180	134	180	180	827	Super Tigre G20g
8	H. Raulio	Finland	180	102	180	180	180	822	Super Tigre G20g
9	K. H. Rieke	Germany	180	102	161	180	180	803	K. & B. 15R
9	**G. R. French**	**Great Britain**	180	134	129	180	180	803	OS Max Spl.
10	S. Ranta	Canada	180	131	124	180	180	795	K & B 15R
11	V. Hajek	Czechoslovakia	180	180	103	180	151	794	MVVS.D.
12	**R. Monks**	**Great Britain**	179	160	180	101	166	786	K & B 15R
13	W. Horcicka	Austria	180	138	96	180	180	774	Bugl-D
14	M. Eriksson	Sweden	128	180	180	180	105	773	Super Tigre G20d
14	J. Fontaine	France	180	115	180	173	125	773	Super Tigre G20g
15	H. Wagner	Austria	180	86	180	180	138	764	Bugl
16	R. Cerny	Czechoslovakia	122	180	144	154	160	760	MVVS-D
17	G. Simon	Hungary	137	126	162	180	143	748	Krizsma K.8
18	E. Eng	Switzerland	85	180	168	180	133	746	Wbre Record
19	S. Pimenoff	Finland	180	166	86	180	126	738	ETA 15D
20	**A. Young**	**Great Britain**	116	159	102	180	180	737	ETA 15D
21	M. Bjelajac	Yugoslavia	180	115	180	152	98	725	Oliver Tiger
22	L. Larsson	Sweden	118	180	180	120	118	716	Super Tigre G20g
23	D. Surry	Canada	174	106	179	132	120	711	Super Tigre G20g
24	R. Schenker	Switzerland	90	180	78	180	180	708	Cox T.D.
25	J. Soares	Portugal	136	126	125	180	137	704	ETA 15D
26	R. Guilloteau	France	129	81	151	180	156	697	Super Tigre G20g
27	E. Padovano	Italy	136	143	97	140	180	696	Super Tigre G20d
28	K. H. Becker	Germany	131	180	180	89	114	694	ETA 15D
29	G. Guerra	Italy	79	180	112	141	180	692	Super Tigre G20g
30	W. McCormick	U.S.A.	127	121	180	180	79	687	K & B 15R
31	J. Thomson	Ireland	175	106	82	143	180	686	Super Tigre G20d
32	P. Billes	Austria	73	161	85	180	180	679	Bugl
33	M. Van Dijk	Netherlands	160	166	109	84	142	661	ETA 15
34	G. Poorman	U.S.A.	162	103	81	125	180	651	Super Tigre G20g
35	B. Filimonov	U.S.S.R.	92	180	78	180	117	647	Kharkov
36	A. Stepanovic	Yugoslavia	119	145	180	161	39	644	Acro 2.5
37	R. Hagel	Sweden	71	101	107	180	180	639	Super Tigre G20g
38	V. Pecorari	Italy	107	120	94	180	134	635	Super Tigre G20d
39	J. Benedik	Yugoslavia	132	82	102	129	180	625	OS Max 15
40	P. Laxmann	Finland	47	180	96	180	119	622	ETA 15D
41	Kusara-Ma	Japan							
	Proxy: R. Schwenn	Germany	122	89	114	180	109	614	Enya 15D
42	B. Bulukin	Norway	127	78	138	138	129	610	Super Tigre G20d
43	Jwaj	Japan							
	Proxy: W. Zwilling	Germany	89	163	118	142	91	603	Enya 15D
44	Z. Sulisz	Poland	130	98	161	167	18	574	ETA 15D
45	I. Henry	New Zealand							
	Proxy: P. Muller	Great Britain	180	86	—	168	130	564	Cox T.D.
46	A. Sereno	Portugal	161	139	74	94	86	554	ETA 15D
47	N. Christiensen	Denmark	66	168	52	180	80	546	Oliver Tiger
48	W. Czinczel	Germany	95	103	135	92	120	545	Webra Machl
49	T. Johannessen	Norway	85	111	124	87	129	536	Super Tigre G20d

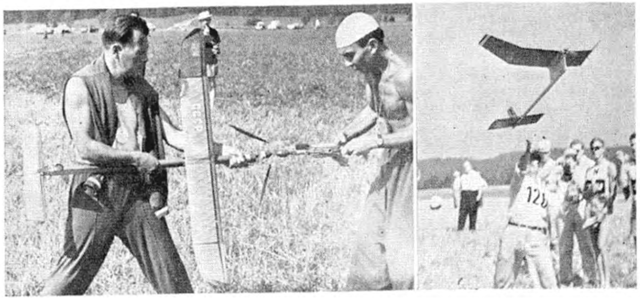
No.	Name	Nation	1	2	3	4	5	Total	Engine
50	John Winn	New Zealand							
	Proxy: V. Jays	Great Britain	—	176	113	92	151	532	Cox T.D.
50	A. Jermakow	U.S.S.R.	126	97	88	113	108	532	Zeiss
51	G. Giudici	France	136	82	100	92	105	515	Oliver Tiger
52	H. Pregaldien	Belgium	92	69	86	67	180	494	
53	Sugata	Japan							
	Proxy: A. Dreyer	Germany	117	85	164	66	52	484	Enya 15D
54	C. Sehldon	U.S.A.	113	180	96	89	—	478	Cox TD
55	F. Martino	Portugal	51	67	180	60	114	472	ETA 15D
56	M. Clement	South Africa							
	Proxy: L. Piesk	Germany	109	123	37	75	119	463	Cox Olympic
57	J. Oxager	Denmark	73	73	180	47	77	450	Webra Machl
58	E. Balasse	Belgium	83	81	55	72	151	442	Cox Olympic
59	J. Gorgorcena	Spain	83	75	85	95	100	438	Webra Machl
60	V. Matute	Spain	96	67	77	87	98	425	Webra Machl
61	F. Mortensen	Denmark	54	83	31	180	33	381	Super Tigre G20
62	G. Dalseg...	Norway	78	75	33	79	29	294	Oliver Tiger
63	P. Gonzalez	Spain	11	47	71	61	50	240	Oliver Tiger

WORLD GLIDER CHAMPIONSHIP FOR SWEDISH CUP (A/2)

No.	Name	Country	1	2	3	4	5	Total & Fly-off
1	A. Averijanov	U.S.S.R.	180	180	180	180	180	900 + 171
2	P. Soave	Italy...	180	180	180	180	180	900 + 159
3	G. Kalen	Sweden	180	180	180	180	180	900 + 147
4	T. Van't Rood	Netherlands	180	180	180	180	180	900 + 131
5	A. Rodrigues	Portugal	180	180	180	162	180	882
6	J. Michalek	Czechoslovakia	180	189	147	180	180	867
7	M. Hlubocky	Czechoslovakia	180	180	180	180	135	855
8	J. Daley (jun.)	U.S.A.	180	180	123	180	178	841
9	L. Lortz	U.S.A.	180	180	180	180	102	822
10	R. Guilloteau	France	98	180	180	180	180	818
11	T. Strang	Finland	180	89	180	180	180	809
11	P. Teunisse	Netherlands	180	110	180	180	159	809
11	O. Schnurer	Austria	180	180	180	180	89	809
12	**G. W. Dallimer**	**Great Britain**	180	180	87	180	180	807
12	**A. G. Freeston**	**Great Britain**	154	164	180	180	129	807
13	K. Gunther	Germany	124	180	180	180	142	806
14	A. Sulisz	Poland	81	180	180	180	180	801
15	H. Schnurer	Austria	180	180	136	119	180	795
16	J. Schulten	Netherlands	152	123	154	80	180	789
17	A. Boncompagni	Italy...	180	180	156	128	137	781
18	A. Skard	Norway	151	180	180	105	150	766
19	M. Pyykko	Finland	180	180	141	132	127	760
20	R. Borras	France	115	180	180	180	96	751
21	W. Cook	New Zealand						
	Proxy: M. Schmidt	Germany	106	180	180	180	103	749
22	C. Boscurol	Italy...	152	180	180	78	149	739
23	I. Spejzl	Czechoslovakia	180	64	180	180	132	736
24	S. Takko	Finland	68	180	170	171	142	731
25	G. Simon	Hungary	180	93	135	130	180	718
26	McGarvey...	New Zealand						
	Proxy: G. Roemer	Germany	82	180	180	177	96	715
27	J. Malkin	New Zealand						
	Proxy: G. Mailbaum	Germany	180	54	180	180	110	704
28	E. Berg	Denmark	80	90	164	180	180	694
29	A. Semskij	U.S.S.R.	76	180	180	124	130	690
30	A. Hermann	Germany	139	180	180	112	77	688

No.	Name	Country	1	2	3	4	5	Total & Fly-off
31	H. Michel...	Switzerland	97	180	180	180	49	686
31	J. McGillivray	Canada	101	180	180	91	134	686
32	I. Sares	Sweden	64	180	113	180	148	685
33	F. Fernandez	Spain	119	180	180	121	79	679
34	V. Miroslav	Yugoslavia	71	180	180	180	64	675
35	T. Borthne	Norway	180	91	55	180	168	674
36	—. Leduc...	Belgium	156	180	180	75	80	671
37	G. Giudici	France	180	95	180	76	135	666
38	A. Hansen...	Denmark	180	55	56	180	180	651
39	J. Glod	Luxembourg	180	149	35	180	103	647
40	A. Mederer	Germany	78	108	119	180	157	642
40	J. Nestratow	U.S.S.R.	131	74	118	180	139	642
41	—. Babic	Yugoslavia	106	65	76	180	171	598
41	P. W. Visser	South Africa	178	61	149	139	71	598
42	Mrs. E. Bell	U.S.A.	180	44	180	71	113	588
43	A. Hertig	Switzerland	97	65	63	180	180	585
44	B. Hansen...	Denmark	180	82	180	52	89	584
45	G. Fitzpatrick	Ireland	83	180	65	180	68	576
46	St. Rosycki	Poland	81	52	173	180	87	573
47	**B. L. Halford**	**Great Britain**	87	80	83	180	141	571
48	M. Sousa	Portugal	76	77	180	147	82	562
49	J. Benedikt	Poland	92	92	109	117	151	561
50	B. O. Modeer	Sweden	91	83	180	173	32	559
51	P. Stevo	Yugoslavia	67	77	113	180	119	556
52	R. De Graef	Belgium	82	83	80	180	90	515
53	H. Kargl	Austria	80	53	180	58	135	596
54	Ch. Bachmann	Switzerland	41	102	180	75	104	502
55	D. Mackenzie	Canada	115	49	49	180	97	490
56	R. Hassrod	Norway	180	59	69	44	135	487
57	B. Price	Canada	180	56	47	80	115	478
58	J. Guffens...	Belgium	57	99	103	99	112	470
59	L. Pando	Spain	180	61	29	75	107	452
60	J. M. Leick	Luxembourg	78	74	119	28	143	442
61	F. Kraemer	Luxembourg	133	32	43	92	111	411
62	A. Sereno...	Portugal	92	58	76	72	62	360
63	S. Gonzalez	Spain	70	27	94	63	82	334

Renowned exponent of Wakefield models, Zapaschni of the U.S.S.R., who utilises grass reeds extensively in the rear fuselage, tailplane and wing. Model is being held by Sokolov, famous A 2 flier. Together these two represent the very best in Soviet free flight modelling. To the right is the new trend of U.S.A. power model design, in this case as shown by Mike Poorman at the World Championships in Germany, 1961. A dud 3rd flight pulled him down to 34th place.



WAKEFIELD TROPHY (Individual)

No.	Name	Country	1	2	3	4	5	Total & Fly-off
1	G. Reich	U.S.A.	180	180	180	180	180	900+210
2	J. Kosinski	Poland	180	180	180	180	180	900+207
3	A. Alinari	Italy	180	180	180	180	180	900+169
4	L. Azor	Hungary	180	180	167	180	180	887
5	W. Niestoj	Poland	180	180	162	180	180	882
6	L. Riffaud	France	180	160	180	180	180	880
7	W. Zapaschni	U.S.S.R.	180	180	155	180	180	875
8	E. Fresl	Yugoslavia	180	180	180	180	154	874
9	S. Sjogren	Sweden	180	150	180	180	180	870
10	J. Petiot	France	180	145	180	180	180	865
11	J. Osborne	Netherlands	180	180	152	167	180	859
12	E. Hamalainen	Finland	180	180	136	180	180	856
13	K. Bousfield	Canada	174	180	180	149	172	855
14	I. Ivannikov	U.S.S.R.	171	154	169	180	180	854
15	G. Rupp	Germany	180	129	180	180	180	849
16	G. Krizsma	Hungary	159	180	145	180	180	844
17	W. Kmoch	Yugoslavia	180	180	180	136	164	840
18	U. Axelsson	Sweden	139	180	180	180	158	837
19	**G. Roberts**	**Great Britain**	142	180	180	180	147	829
20	J. Sokolov	U.S.S.R.	180	158	180	126	180	824
20.	F. Breith	Austria	173	180	180	111	180	824
21	J. Patterson	U.S.A.	180	180	101	180	180	821
22	St. Zurad	Poland	129	180	180	180	149	818
23.	K. Leissner	Germany	180	170	180	137	149	816
24	B. Storgards	Finland	168	136	148	180	180	812
25	C. Perkins	U.S.A.	152	180	116	180	180	808
26	J. Merori	Yugoslavia	180	180	180	127	129	796
26	R. Artioli	Italy	136	178	180	180	122	796
27	P. Aalto	Finland	180	180	180	66	180	786
28	B. Murari	Italy	131	159	135	180	180	785
29	R. Kieft	Netherlands	180	180	120	180	123	783
30	C. Meseburger	Spain	123	158	180	135	180	776
31	D. Mackenzie	Canada	127	180	180	122	166	775
32	**N. Elliott**	**Great Britain**	175	180	154	180	85	774
33	O. Ehmann	Germany	180	153	110	180	143	766
34	E. Tammel	Austria	138	180	180	180	82	760
35	M. Segrave	Canada	154	77	155	178	91	755
36	L. Flodstrom	Sweden	153	180	180	86	153	752
37	F. Fernandez	Spain	178	115	96	180	180	749
38	M. Rohlena	Czechoslovakia	178	116	180	145	129	748
39	R. Liechti	Switzerland	180	169	129	112	154	744
40	P. Lust	Netherlands	157	88	131	180	180	736
41	**J. O'Donnell**	**Great Britain**	126	121	138	180	165	730
42	E. Nienstedt	Denmark	172	180	133	180	60	725
43	P. W. Visser	South Africa	180	172	113	134	125	724
44	J. Malkin	New Zealand						
	Proxy: G. Maibaum	Germany	136	180	171	92	136	715
45	P. Rasmussen	Denmark	180	122	115	156	139	712
46	E. Frigyes	Hungary	77	180	128	180	138	703
47	A. Rodrigues	Portugal	180	180	117	68	154	699
48	E. Balasse	Belgium	180	148	95	177	91	691
48	A. Sereno	Portugal	107	129	153	174	128	691
49	E. Hegglin	Switzerland	113	81	180	172	144	690
50	J. Fontaine	France	180	129	85	108	180	682
51	P. Grunbaum	Austria	180	180	94	102	119	675
52	N. Hewitson	New Zealand						
	Proxy: Waldhauser	Germany	108	91	144	150	179	672
53	L. Muzny	Czechoslovakia	138	180	151	91	105	665
54	J. Cunderlik	Czechoslovakia	83	180	103	150	135	651
55	H. Dahl	Norway	180	161	63	136	99	639
56	W. Cook	New Zealand						
	Proxy: M. Schmidt	Germany	118	145	156	102	116	637
57	J. Meier	Switzerland	126	101	164	112	131	634
57	A. Simonsen	Norway	96	129	180	67	162	634
58	V. Matute	Spain	90	115	99	103	109	516
59	N. Stovland	Norway	126	117	147	—	92	482
60	M. Sousa	Portugal	145	58	85	23	166	477
61	H. Mikkelsen	Denmark	110	85	91	51	61	398

INTERNATIONAL FLYING WING COMPETITION

Held at Leutkirch, Germany, 1961

F.3 Class Flying Wing Glider

1	M. Hintermann	Switzerland	711
2	G. Zwilling	Germany	555
3	E. Mikulcic	Yugoslavia	553
4	W. Gerlach	Germany	533
5	S. Heinig	Germany	527
6	J. Cedomir	Yugoslavia	501

Team Results Flying Wing Glider

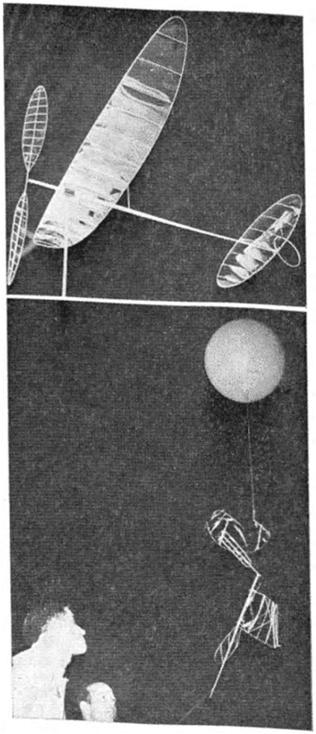
1	Germany	1615
2	Yugoslavia	1471
3	Switzerland	1398
4	Netherlands	886

F.1b Class Flying Wing Power

1	H. G. Neuhauser	Germany	376
2	W. Wassenaar	Netherlands	372
3	E. Mikulcic	Yugoslavia	268

F.1a Class Flying Wing Rubber

1	H. H. Laue	Germany	477
2	G. Fea	Italy	467
3	E. Mikulcic	Yugoslavia	250



Microfilm models are perhaps hardest of all to make and easiest to destroy. At top is a classic design capable of 45 minute flights by Max Hacklinger of Germany, featuring a most carefully designed propeller and rigidly braced wing. Below is what happens when the hydrogen-filled balloon and its tethering line are used to recover a model from girder work, this one being U.S.A. Carl Redlin's at the World Championships, Cardington.

CRITERIUM OF ACES 1961—Genk, Belgium

Flying Scale

			Scale	*Flight*	*Total*
1	Huybrechts	Belgium (Chipmunk)	67	81	148
2	Groos	Holland (Thunderb.)	56	88	144

C/L Aerobatics

			FA1(1)	*FA1(2)*	*AMA*	*Totals*
1	Grondal	Belgium	962	1086	1029	2115
2	Sirotkin	U.S.S.R.	986	976	1111	2097
3	Herber	Czechoslovakia	1024	1074	1008	2082
4	Seeger	Germany	922	990	1064	2054
5	Kroh	Germany	906	987	1021	2008
6	Bartos	Czechoslovakia	861	1010	971	1981

Speed

			Speed in k.p.h.		
1	Toth	Hungary	181.82	202.25	200
2	Peck	Czechoslovakia	179.10	195.65	201.12
3	Krizsma	Hungary	180	0	193.55
4	Proti	Italy	181.82	138.46	189.47
5	Hagberg	Sweden	183.67	177.34	0
6	**Wright**	**G.B.**	172.25	181.82	176.47

Team Racing

			1	2
1	Rosenlund/Bjork	Sweden	4:47	4:47
			Final	4:40
2	Leloup/Lecuyer	Belgium	4:55	
			Final	5:06
3	Azor/Kuhn	Hungary	5:15	4:50
			Final	5-15
4	Drazek/Trnka	Czechoslovakia	4:58	5:23
5	Malik/Robler	Germany	—	5:00
6	Pierree/Grondal	Belgium	5:13	5:25
7	Magne/Malfait	France	5:16	6:09
8	Egervary/Toth	Hungary	6:41	5:17
9	Schluchter/Fromm	Germany	5:18	5:31
10	Scherbakov/Gelman	U.S.S.R.	—	5:20
11	Saxer/Hedinger	Switzerland	5:23	6:00
12	Kononenko/Chkursi	U.S.S.R.	6:28	5:25
13	Gafner, N./Gafner, Ch.	Switzerland	5:27	6:10
14	Anderson/Bjornwall	Sweden	5:58	5:28

Team Racing

			1	2
15	**Nixon Ellis**	**G.B.**	5:28	—
16	**Edmonds, Taylor**	**G.B.**	5:36	5:32

COMBAT RESULTS

FINAL	SEMI-FINALISTS
1 Perry, P. (G.B.)	3 Schoppe, P. (Ger.)
2 Tribe, P. (G.B.)	4 Kellner, R. (Ger.)

QUARTER FINALISTS

Bjornwall, E. (Sweden) Haenebalke, G. (Belgium)
Benoy, J. (G.B.) Trnka, Y. (Czechoslovakia)

Six others eliminated

CRITERIUM POINTS

1	Czechoslovakia	8 points	6	France	18 points
			7	Italy	20 points
2	Hungary	9 points	8	Switzerland	21 points
3	Belgium	14 points		G.B.	21 points
4	Sweden	15 points	10	Spain	26 points
5	Germany	16 points	11	Austria	29 points

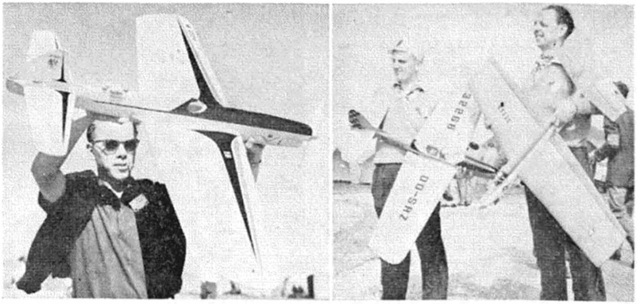
INDOOR MODEL WORLD CHAMPIONSHIPS—R.A.F. Cardington 1961

1	J. Bilgri	U.S.A.	32:24	6:15	37:49
2	K-H. Rieke	Germany	31:18	—	35:11
3	W. Bigge	U.S.A.	33:07	34:56	29:22
4	E. Hamalainen	Finland	21:34	33:03	27:40
5	**P. Read**	**G.B.**	27:09	32:48	17:46
6	K. Hewall	Germany	1:05	32:00	30:31
7	R. Hyvarinen	Finland	31:02	28:19	14:12
8	C. Redlin	U.S.A.	30:56	18:26	26:55
9	Z. Ocsody	Hungary	25:49	8:20	30:41
10	L. Englund	Finland	30:04	28:35	11:31
11	A. Egri	Hungary	22:51	25:27	27:15
12	**R. Parham**	**G.B.**	15:50	22:01	22:35
13	M. Hacklinger	Germany	4:27	22:21	19:43
14	**R. Draper**	**G.B.**	19:44	20:45	12:55

Team Results

1	U.S.A.	103:41
2	Finland	94:09
3	Germany	89:32
4	**G.B.**	76:08
5	Hungary	57:56

Stunt models at the Criterium of Aces. To the left Kroh of Germany chose a model obviously influenced by the lines of the latest American designs and to the right the well-known British father and son team of Frank Warburtons', holding semi scale Stampe Monitor and Lockheed U-2, each of which is included in Aeromodeller Plans Service.



Free flight model of the Longster Wimpy by D. Neal of Leicester M.A.C. entered in the 1962 British Championships, but which did not make the qualifying flight.

CONTEST RESULTS

Results of S.M.A.E Contests for balance of 1961 season are included in this report to complete records. Those 1962 events which have been decided before going to press are also included and will be completed in next year's AEROMODELLER ANNUAL.

HIGH WYCOMBE CONTROL LINE RALLY—April 30th, 1961—R.A.F. Booker.

F.A.I. Team Race

1	Wallace	Novocastria	5 : 06
2	Hall	Belfairs	5 : 23
3	Bassett	Ecurie Endeavour	*Retired*

Class "B" Team Race

1	Steward-Taylor	West Essex	7 : 01
2	McNess	West Essex	7 : 10
3	Wallace	Novocastria	9 : 56

Stunt

1	Brown, R.	Lee Bees	619 pts.
2	Christopher, D.	Western Clnrs.	588 pts.
3	Day, D.	Wolves	578 pts.

Combat

1	Perry, P.	Northwood
2	De Ville	Derby
3	Fountain Pinkert	Peterborough F.A.S.T.E.

SUTTON COLDFIELD RADIO CONTROL M.A.C. RALLY—May 7th, 1961—R.A.F. Wellesbourne

Rudder Only (Wilfred Jones Trophy)

1	Uwins, S. E.	238½ pts.
2	Roberts L.	155½ pts.
3	Fellows, B.	147 pts.

Multi Channel (Sanderson Masters Trophy)

1	Johnson, E.	1067 pts.
2	Rogers, P.	1015 pts.
3	Walker, D. G.	792 pts.

(*Best of two flights*)

R/C Scale (Dennis Thumpston Trophy)

1 J. R. Morton D.H. Gipsy Moth; 2 D. S. Skelcher (Small Heath M.A.C.) Luton Minor; 3 D. J. Bannister (Glevum M.A.C.) Fokker D VIII.

STOCKPORT ADVERTISER RALLY—May 7th, 1961—Woodford.

Open Glider (119 *entries*)

1	Illingworth, G.	Baildon	6 : 00
2	Copple, C.	Poulton	4 : 46
3	Ellison, T.	Avro	4 : 33
4	Hannay, J.	Wallasey	4 : 22
5	Rennie, C.	Chorlton	4 : 22
6	Beal, G.	Mexborough	4 : 11

Open Power (88 *entries*)

1	Stocker, T.	Baildon	5 : 22
2	O'Donnell, J.	Whitefield	5 : 07
3	Savini, S.	Liverpool	4 : 56
4	Boid, R.	Rotherham	4 : 31
5	Hadfield, W.	Ashton	4 : 20
6	Lea, R.	Congleton	4 : 09

Open Rubber (85 *entries*)

1	Tideswell, G.	Baildon	6 : 00 + 4 : 06
2	O'Donnell, J.	Whitefield	6 : 00 + 3 : 28
3	Barnes, J.	Liverpool	6 : 00 + 2 : 06
4	Dunkerley, P.	Timperley	6 : 00
5	Kimber, C.	Eng. Elec.	5 : 05
6	Tubbs, H.	Baildon	5 : 00

Chuck Glider (28 *entries*)

1	Stoker, T.	Baildon	2 : 32
2	Birks, J.	Chorlton	2 : 09
3	Ellison, T.	Avro	2 : 00

Junior Glider (22 *entries*)

1	Kazer, P.	York	4 : 41
2	Proctor, M.	Baildon	3 : 38
3	White, A.	Chester	2 : 28

Junior Rubber (4 *entries*)

1	Allen, J.	Ashton	3 : 40
2	Smith, B.	Eng. Elec.	1 : 57

Junior Power (10 *entries*)

Proctor, M.	Baildon	1 : 15

Flying Scale (16 *entries*)

1	Bridgewood, J.	Doncaster	Vultee Vig.	100
2	Jones, E.	Chorlton	Hawker Hind	94
3	Clifton, J.	Doncaster	Vultee Vig.	89
4	Coates, E.	Blackb'n A/C	Leopard Moth	81
5	Yates, H.	Wharfedale	Fokker DR1	79
6	Jones, G.	Cheadle	Tiger Moth	72

Radio (Rudder Only) (20 *entries*)

1	Purslow, B.	Chorlton	76
2	Munday, M.	Evesham	52
3	Lever, R.	Leigh	49½

Combat (60 *entries*)

1	Everitt, M.	Chester	22 pts.
2	Tribe, P.	Northwood	-1 pts.

Team Race F.A.I. Only

Davy/Long	Wharfedale	4 : 32
Horton/Baxter	Wharfedale	

Ladies' Trophy

Mrs. N. D. Stott	Eng. Elec.	3 : 00

Junior Rally Champion

Allen, J.	Ashton	6 : 03

Senior Rally Champion

O'Donnell, J.	Whitefield	14 : 46

R.A.F. M.A.A. CHAMPIONSHIPS—May 6th-7th—R.A.F. Debden.

Concours d'Elegance (Aeromodeller Trophy
J/T Johnson (Fighter Command)
Radio Control (Malta Cup
Cpl. Parton (Fighter) 2,062 points
F/F Power (Model Aircraft Trophy)
S.A.C. Standing (Flying Training) 315 secs.

Designer of several Keilkraft kits, notably the Caprice shown here, is Nevil Willis. Model happens to be that made by Mrs. Willis and flown in the Women's Cup at the British Nationals 1962.

F.A.I. Power
L.A.C. Lowman (Fighter) 111 secs.
Open Glider
1 F/O Hiscock 295 secs.
A/1 Glider
1 Cpl App. Winterhalter (Halton) 237 secs.
A/2 Glider
1 F/O Hiscock (Technical Training) 438 secs.
Thurston Trophy (Wakefield)
1 S/Tech. Anderton (Maintenance) 336 secs.
Open Rubber
1 S/Tech. Anderton 222 secs.
Scale Free Flight
1 Flt/Lt. Hough, S.E.5 (A.P.S.)
Stunt
1 Flt Lt. Falconer (Coastal) 493 points
Combat
1 Lt. Pinkert (U.S.A.F.)
Speed Class
1 Flt/Lt. Gould (Flying Training) 105 m.p.h.
Speed Class II
1 Maj. Johnson (U.S.A.F.) 112 m.p.h.
½A Power
1 Flt/Lt. Jones (Signals) 164 secs.
Team Racing (½A)
1 A/A White (Locking)
"A" (International)
1 S.A.C. Phinn
"B" (5 c.c.)
1 Major Johnson (U.S.A.F.)
Scramble
1 F/O Byrd 310 secs.

S.M.A.E. RADIO CONTROL TRIALS—April 22nd-23rd, 1961—R.A.F. Benson

Competitor	*1st Flight*	*2nd Flight*	*3rd Flight*
Van den Bergh, F.	1701·5	1735·5	1738
Johnson, E.	1553	1658·5	1648
Walker, D. G.	1445·5	1483	1671
Rogers, P.	1381	1399·5	1562·5
Brooks, H.	1458	1562	1037
Olsen, C.	558	1744·5	1541·5
Brown, P.	1206·5	1284·5	1131·5
Waters, P. T.	331	1181·5	868
Wingate, J. R.	346·5	422	1110·5

S.M.A.E. CONTROL LINE TRIALS—April 23rd, 1961—R.A.F. Debden.

F.A.I. Speed (14 *competitors*)

1	Wright, P.	West Essex	173 k.p.h. (108 m.p.h.)
2	Gibbs, R.	Hornchurch	163 k.p.h. (101·7 m.p.h.)
3	Butcher, N.	Croydon	162 k.p.h. (101·2 m.p.h.)

F.A.I. Team Race (27 *competitors*)

1	Edmonds, R.	High Wycombe	4 : 59 and 4 : 52
2	Long, K.	Wharfedale	5 : 10 and 4 : 54
3	Bassett, M.	C.M.	5 : 29 and 5 : 21

F.A.I. Aerobatics (5 *competitors*)

			F.A.I.	*A.M.A.*	*Total*
1	Brown, R.	Lee Bees	1026	1150	2176
2	Warburton, F.	Bolton	1072	1001	2073
3	Platt, D.	Wanstead	995	983	1978

NORTHERN HEIGHTS GALA—July 2nd, 1961—R.A.F. Halton.

Queen Elizabeth Cup (A/2 Glider)

1	Burrows, M.	St. Albans	9 : 23
2	Giggle, P.	Stevenage	9 : 02
3	Jays, V.	Surbiton	8 : 36

Flight Cup (Open Glider)

1	Young, F.	Birmingham	7 : 58
2	Cleghorn, W.	St. Albans	7 : 50
3	Jackson, C.	Surbiton	6 : 01

Fairey Cup (Open Rubber)

1	Barr, L. G.	Hayes	7 : 44
2	Latter, D. G.	Brighton	6 : 35
3	Fuller, D.	Bristol and West	5 : 49

De Havilland Trophy (Open Power)

1	Fuller, G.	St. Albans	12 : 02
2	Mussell, A.	Farnham	8 : 00
3	West, J.	Brighton	6 : 55

½A Power

1	Monks R.	Birmingham	5 : 41
2	Young, A.	St. Albans	5 : 10
3	Berryman, J.	St. Albans	4 : 43

R.A.F. Review Cup Radio (Spot Landing)

			error
1	Uwins, S. E.	A.R.C.C.	7 ft.
2	Olsen, C.	A.R.C.C.	13 ft. 6 in.

Keil Combat Cup
Tribe, P.
Thurston Trophy (Helicopter)
Borcham, F. G.
Aeromodeller Challenge Trophy
Berryman, J.

AREA CHAMPIONSHIPS—October 15th, 1961—R.A.F. Barkston Heath.

		Rubber	*Power*	*Glider*	*Total*
1	East Anglia	14 : 56	14 : 47	15 : 28	45 : 11
2	Midland	12 : 33	14 : 03	17 : 42	44 : 14
3	Northern	14 : 07	13 : 06	16 : 50	44 : 03
4	North Western	14 : 01	13 : 02	15 : 09	42 : 12
5	South Midland	12 : 02	13 : 09	14 : 36	39 : 47
6	London	13 : 49	11 : 09	12 : 43	37 : 41

INDOOR NATIONALS—Cardington—September 9th 10th.

Tissue Covered

1	O'Donnell, J.	Whitefield	9 : 01

Chuck Glider

1	Turner, M.	Charleton	54 : 5
2	Greaves, D.	Leamington	52 : 6
3	Lennox, R.	Birmingham	46 : 0

Indoor Micro

1	Read, P.	Birmingham	30 : 22
2	Parham, R.	C.M.	27 : 20
3	Barr, A.	Coventry	24 : 58

C.M.A. CUP—Glider U/R—October 22nd, 1961

1	Burrows, M.	St. Albans	8 : 24
2	Harper, D.	Glevum	8 : 20
3	Smith, T.	English Electric	7 : 40
4	Halford, B.	Norwich	7 : 20
5	Young, F.	Birmingham	7 : 03
6	Hughes, A. (J)	Hornchurch	6 : 50

MODEL ENGINEER CUP—Team Glider—June 18th, 1961

1	Simeons, C.	St. Albans	9 : 00 + 5 : 14
2	Roche, D.	Anglia	9 : 00
3	Knight, D.	St. Albans	8 : 36
4	Willsmore, M.	Anglia	8 : 01
5	Partridge, D.	Croydon	7 : 29
6	Burrows	St. Albans	7 : 18

FROG JUNIOR—Unrestricted Rubber and Glider—September 24th, 1961

1	Bayram, M.	Lincoln	8 : 55
2	Allen, J.	Ashton	7 : 58
3	Sherwood, G.	Hornchurch	7 : 58
4	Sulway	Croydon	7 : 00
5	Abbs, A.	Norwich	6 : 56
6	Kazer, P.	York	6 : 00

KEIL TROPHY—Team Power—September 24th, 1961

1	Simeons, J.	St. Albans	12 : 00 + 6 : 30
2	Fuller, G.	St. Albans	12 : 00 + 5 : 05
3	Young A.	St. Albans	12 : 00 + 4 : 39
4	Gaster, M.	Surbiton	12 : 00 + 4 : 31
5	Lucas, I.	Brighton	12 : 00 + 4 : 20
6	Green, M.	Foresters	12 : 00 + 4 : 10

FARROW SHIELD—Team Rubber—October 8th, 1961

1	Roberts, G. L.	Lincoln	12 : 00
2	Rowe, B.	St. Albans	11 : 47
3	Tubbs, H.	Baildon A.	11 : 37
4	O'Donnell, J.	Whitefield	11 : 33
5	Pool, J.	Halifax	11 : 25
6	Tideswell, J.	Baildon A.	10 : 57

TEAMS

Keil Trophy		**Farrow Shield**	
Baildon A.	47 : 43	St. Albans	35 : 58
St. Albans A	45 : 25	Lincoln	33 : 35
Stevenage A	44 : 33	Baildon A.	30 : 47
Surbiton	43 : 07	Baildon B.	28 : 19
Essex	42 : 24	Essex	25 : 21
Brighton A.	40 : 03	Chorlton	25 : 02

SCOTTISH GALA and U.K. CHALLENGE MATCH—August 20th, 1961—Abbotsinch.

Power

1	Eggleston, B.	Baildon	7 : 04
2	Hutton, C.	Wallasey	6 : 07
3	Bailey, T.	Novocastria	6 : 07
4	Firth, R.	Sheffield	5 : 56
5	O'Donnell, J.	Whitefield	5 : 55
6	Bathgate, D.	Edinburgh	5 : 35

Glider

1	O'Donnell, J.	Whitefield	7 : 14
2	Sleight, R.	Hayes	6 : 27
3	Allsopp, S.	Cambridge	5 : 22
4	Hannay, J.	Wallasey	5 : 06
5	Harris, J. B.	Prestwich	4 : 59
6	O'Donnell, H.	Whitefield	4 : 18

Rubber

1	O'Donnell, J.	Whitefield	9 : 00
2	Wannop, U.	C.M.	9 : 00
3	Tubbs, H.	Baildon	7 : 41
4	Shristie, C.	B.A.T.	7 : 17
5	Pool, J.	Halifax	6 : 57
6	Pollard, R.	Tynemouth	6 : 38
7	Montgomery, P.	Kirkcaldy	6 : 06

U.K. Challenge Match

	Power	*Rubber*	*Glider*
England	12 pts.	9 pts.	7 pts.
Scotland	3 pts.	6 pts.	8 pts.

K.M.A.A. CUP—March 25th, 1962.

Unrestricted Glider

1	Halford, B.	Norwich	9 : 00 + 0 : 49
2	Burrows, M.	St. Albans	8 : 33
3	Giggle, P.	Stevenage	7 : 59
4	Spencer, D. B.	Chester	7 : 57
5	Sladden, T.	Canterbury	7 : 54
6	Hughes, B.	Hornchurch	7 : 44

106 *entries*, 19 *returned no score.*
1960—169 *entries*—1961—206 *entries.*

FROG SENIOR CUP—March 25th, 1962.

Unrestricted Power

1	Price, J.	Norwich	9 : 00 + 1 : 45
2	Petrie, D. L.	Montrose	7 : 50
3	Fuller, G.	St. Albans	7 : 47
4	Payne, T.	Northampton	7 : 25
5	Harper, D.	Glevum	7 : 11
6	Dilly, M.	Croydon	6 : 51

58 *entries*, 21 *returned no score.*
1960—130 *entries*, 20 *in fly-off*—1961—44 *flew.*

F.A.I. RUBBER—March 25th, 1962.

Wakefield

1	Wells, A. R.	Hornchurch	2 : 34
2	Anderton, A.	R.A.F.	10 : 56
3	O'Donnell, J.	Whitefield	9 : 31
4	Nelson, W.	Sheffield	9 : 14
5	Godden, R. I.	Cambridge	9 : 08
6	Willmott, D.	Essex	8 : 57

21 *entries*, 2 *returned no score.*

ASTRAL TROPHY—April 8th, 1962.

Unrestricted Power

1	Castell, G.	Stevenage	9 : 00 + 3 : 42
2	Spencer, D. B.	Chester	8 : 52
3	Savini, S.	Liverpool	8 : 25
4	Green, M.	Foresters	8 : 23
5	England, D.	Grantham	7 : 23
6	Picken, B.	Wigan	7 : 08

50 *entries*, 14 *returned no score*
1960—40 *entries* (*F.A.I. Power*).

FLIGHT CUP—April 8th, 1962.

Unrestricted Rubber

1	O'Donnell, J.	Whitefield	11 : 37
2	Wolstenholme, D.	East Lancs.	9 : 14
3	Fletcher, D.	Timperley	7 : 10
4	Anderton, A.	R.A.F.	6 : 07
5	Thorpe, E.	Littleover	5 : 50
6	Whittaker, J.	Tun. Wells	4 : 25

21 *entries*, 9 *returned no score.*
1960—70 *entries*, 1961—39 *entries*

F.A.I. GLIDER—April 8th, 1962.

1	Hannay, J.	Wallasey	12 : 54
2	Williamson, D.	Timperley	12 : 12
3	Perry, P.	Birmingham	11 : 00
4	Wiggins, E.	Leamington	10 : 39
5	Worthington, H.	Wallasey	10 : 13
6	Moore, L.	Leamington	9 : 55

47 *entries*, 7 *returned no score.*

WOODFORD RALLY—May 20th, 1962.

Open Rubber (Northern Challenge Trophy)

1	Leppard, R.	Croydon	9 : 00 + 3 : 40
2	Pool, J.	Halifax	9 : 00 + 2 : 30
3	O'Donnell, J.	Whitefield	9 : 00

Open Power (Royal Aeronautical Society Cup)

1	Miller, D.	Cambridge	9 : 00
2	West, J.	Bristol	
3	Savini, G.	Liverpool	

Open Glider (Elite Trophy)

1	Fletcher, J. M.	Whitefield
2	O'Donnell, J.	Whitefield
3	Spencer, D. B.	Chester

Dennis Thumpston, normally well known for scale modelling, likes sport flying too and with the introduction of the lightweight Otarion receiver, fitted his five-year-old Frog Zephyr (D.C. Dart) with radio control. Result is a load of fun.

½A Power

1	Stoker, T.	Baildon	9 : 00
2	Ellison, T.	A. V. Roe	
3	Lee, W. A.	Chester	

Flying Scale (E. J. Riding Memorial Trophy)

1	Simmance, J.	Wharfedale	*Snipe*
2	Clifton, J.		

Radio Control (Rudder Class)

1	Whittaker, A. L.	L.A.R.C.A.S.
2	Askew, R.	L.A.R.C.A.S.

Radio Control (Multi Control)

1	Johnson, E.	A.R.C.C.
2	Rogers, P.	High Wycombe

Team Race (F.A.I.)

1	Long/Davy	Wharfedale
2	Wallace, R.	Chester
3	Crofts, A.	Derby

Team Race (–A)

1	Place, R.	Hemswell
2	Davy, L.	Wharfedale
3	Bellamy, L. M.	Wharfedale

Combat

1	Kendrick, M.	W. Bromwich
2	Lee A.	Wharfedale

TEAM TRIALS—May 27th, 1962—R.A.F. Barkston Heath.

Radio Control

		Best of two Flights 2nd Trial			*Best of 1st Trial*
1	Olsen, C.	1646	1683·5	+	1594·7
2	Van den Bergh, F.	1571·5	1521	+	1558
3	Brooks, H.	1548	1535·5	+	1510
4	Johnson, E. (reserve)	1414·5	1483·5	+	1689

Team Race

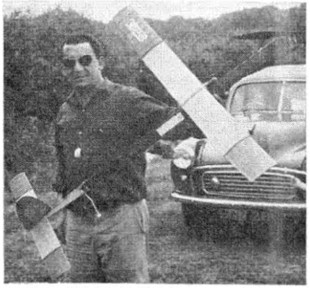
1	Long, K./Davy, L.	4 : 47·3
2	Edmonds, R./Smith, M.	4 : 52·7
3	Adams, C. J./Lucas, R.	5 : 29
4	French, T./Lambert, J.	5 : 51·6

(Average of 3 heats)

Control Line Aerobatics

		Trial 1	*Trial 2*	*Total*
1	Warburton, F. Bolton	2372	2041	4413
2	Higgs, G. Bolton	2058	2081	4139
3	Brown, R. High Wycombe	2074	1445	3419
4	Day, D. Wolverhampton	1932	846	2778

Derl Morley, designer of the Aeromodeller Plans Service "Garter Knight" model to the Coupe d'Hiver formula is also a great performer in open rubber events. This is the model he flew at the Northern Heights Gala and which also qualified him for a fly-off at the British National Championships 1962.



Control Line Speed

		Best four Flight Speeds		*Avge. m.p.h.*
1	Butcher, N.	114·2	117·1	
		120·4	122·4	118·5
2	Drewell, P.	120·4	113	
		115·4	118·3	116·75
3	Copeman, G.	114·7	117·1	
		115·3	117·5	116·75
4	Wright, P.	111·9	110·2	
		111·3	110·7	111

BRITISH NATIONAL CHAMPIONSHIPS—June 9th-10th, 1962—R.A.F. Barkston Heath

F/F Scale (Super Scale Trophy)

			pts.
1	Simmance, J.	Wharfedale	495
2	Hawkins, Dr. M.	C.M.	471
3	Bateman, D. W.	Luton	370
4	Archbold, J.	Leicester	254
5	Noble, A.	Leicester	198

R/C Scale

1	Thumpston, D. F.	S/Coldfield	656
2	Morton, J.	Bristol	510
3	Lowe, W. H.	Bromley	419
4	Anderson, P.	Wigsley	409
5	Franklin, G.	Leicester	387
6	Goldsmith, G.	Bromley	316

C/L Scale (Knokke No. 2 Trophy)

1	Randle, B.	Coventry	591
2	Day, A. C.	W. Bromwich	429
3	Hall, C. B.	Cambridge	424
4	Perry, S. B.	Glevum	404
5	Hawkins, Dr. M.	C.M.	358
6	Wheldon, C. P.	B'heath & H'owen	298

Sir John Shelley Cup (Unrestricted Power)

	Following made 9 minutes		*Fly-off times*
1	West, J.	Brighton	5 : 48
2	Posner, D.	Surbiton	4 : 44
3	Gaster, M.	Surbiton	4 : 14
4	Eggleston, B.	Baildon	3 : 42
5	Fuller, G.	St. Albans	3 : 34
6	Doyle, M.	Belfast	3 : 24
7	French, G.	Essex	3 : 06
8	Jays, V.	Surbiton	3 : 05
9	Parker, A.	Exmouth	3 : 03
10	Siggers, R.	Coventry	3 : 00
11	Riley, J.	Bristol Aces	2 : 54
12	Yates, D.	Wigan	2 : 48
13	Woolnough, J.	Tees-side	2 : 39
14	Johnson, W.	Norwich	2 : 28
15	Hanson, J.		2 : 15
16	Allsop, S.	Cambridge	2 : 11
17	Manville, P.	Bournemouth	2 : 09
18	Brown, M.	Reading	2 : 05
19	Harris, J.	B'heath	2 : 00
20	Lord, E.	E. Lancs.	1 : 46

Lady Shelley Cup (Tailless)

1	Pool, J. B.	Halifax	6 : 52
2	Hedgman, P.	Hayes	5 : 14
3	Bow, B. F.	Bristol Aces	5 : 07
4	Moore, L. E.		5 : 00
5	Strachan, C.	Exmouth	3 : 53
6	Jukes, B.	Birmingham	3 : 34

Ripmax Trophy (R/C Single Control)

1	Dumble, J.	Richmond	883·5
2	Donahue, R.	L.A.R.C.A.S.	672·5
3	Scott, R.	L.A.R.C.A.S.	539·5
4	Singleton, J.	Bristol R/C	485
5	Thomas, C.	U.S.A.F. Lakenheath	452·5
6	Dowsett, C.	Esher	407

Gold Trophy (C/L Aerobatics)

1	Warburton, F	Bolton	1220·5
2	Newman, J.	Northwood	1198
3	Jolley, T.	Whitefield	1095
4	Higgs, G.	Bolton	1056·5
5	Brown, R.	High Wycombe	1039·5
6	Christopher, D.	Weston	1016·5

Women's Cup (Rubber or Glider)

1	Mrs N. Scott	English Elec.	9 : 00
2	Miss Y. Mosedale	Essex	8 : 15
3	Mrs. B. Picken	Wigan	8 : 08

Interesting control line subject, a Chance Vought Corsair painted in Salvadorian colours. Note the single roundel on the left wing. Made by I. G. Birch of Leicester M.A.C. and entered in the British National Championships 1962

Payload (1 c.c. maximum)

1	Young, A.	St. Albans	7 : 56
2	Bunney, A. W.	Bristol Aces	7 : 35
3	Fuller, G.	St. Albans	6 : 47

Model Aircraft Trophy (Unrestricted Rubber)

	Following made 12 minutes		*Fly-off time*
1	Lennox, R.	Birmingham	10 : 16
2	Elliott, N.	Croydon	10 : 06
3	Paveley, D.	Hornchurch	10 : 01
4	Monks, R.	Birmingham	8 : 41
5	Leppard, R.	Croydon	8 : 18
6	Wannop, U.	C.M.	7 : 54
7	Garner, T.	Brighton	7 : 51
8	Greaves, D.	Leamington	7 : 30
9	Stokes, T.	Baildon	7 : 25
10	Turner, J.	Whitefield	7 : 16
11	Jackson, R.	Littleover	6 : 25
12	Wostenholme, D.	E. Lancs.	6 : 08
13	Strachem	Exmouth	4 : 46
14	Morley, D.	Lincoln	4 : 38

Thurston Cup (Unrestricted Glider)

	Following made 9 minutes		*Fly-off times*
1	Dallimer, G.	Stevenage	3 : 16
2	Wisher, A.	Croydon	2 : 47
3	Perry, P.	Birmingham	2 : 13
4	Rose, D.	Leicester	2 : 01
5	Liddell, P.	Novocastria	1 : 58
6	Wiseman, D.	York	1 : 47
7	Jones, B. D.	Northwood	1 : 41
8	Turner, M. A.	Chorlton	1 : 28
9	Giggle, P.	Stevenage	1 : 16
10	Jones, B.	Cardiff	1 : 13
11	Rider, C.	Wigan	1 : 10
12	Allen, J.	Ashton	1 : 02

Combat

Tie between

Mushett, G.	Leicester
Freebrey, P.	Northwood

Speed *m.p.h.*

Class 0 (1·5 c.c.) 12 *entries* 7 *attempts*

1	Sizmur, D.	Sidcup	77·65
2	Lawrence, B.	Tolworth	73·3

Class 1 (2·5 c.c. unrestricted) 20 *entries* 32 *attempts*

1	Drewell, P.	W.E.A.	126·3
2	Copeman, G.	Northwood	117·5
3	Lindsey, K.	Hayes	106·5

F.A.I. (2·5 c.c.) 23 *entries* 17 *attempts*

1	Drewell, P.	W.E.A.	123
2	Lindsey, K.	Hayes	103·5
3	Firbank, B.	Worksop	86·7

Class 2 (5 c.c.) 26 *entries* 41 *attempts*

1	Hall, J.	W.E.A.	144·3
2	Johnson, G.	F.A.S.T.E.	138
3	Nixon, H.	F.A.S.T.E.	137·2

Class 3 (10 c.c.) 16 *entries* 30 *attempts*

1	Johnson, G.	F.A.S.T.E.	166·9
2	Billinston, M.	Brixton	163·2
3	Gibbs, R.	Brixton	162·1
4	Pinkert, D.	F.A.S.T.E.	159·7

Total 97 *entries* 127 *attempts*

Davies "A" Trophy (F.A.I. class T/R 2·5 c.c.)

1	Wallace/Laurie	Novocastria	4 : 48·5
2	Yeldham/Hall	Belfairs	5 : 00·5
3	Long, K./Davy, L.	Wharfedale	5 : 03·4

Davies "B" Trophy (Class BT/R 5 c.c.)

1	Lucas, R.	W.E.A.	6 : 58·5
2	McGee, K.	Chorlton	8 : 24·6
3	Whitebread	W.E.A.	9 : 22

R.A.F.M.A.A. Trophy (Class ½A T/R 1·5 c.c.)

1	Ellis, M./Nixon	Hinkley	9 : 26·2
2	Bellamy, M.	Wharfedale	10 : 07·6
3	Place, R.	R.A.F.M.A.A.	11 : 03

INTERNATIONAL TEAM SELECTION TRIALS—August 12th, 1962. *7 entries*

1	R. Draper	Coventry	61.27*
2	R. Monks	Birmingham	61.08
3	R. Parham	C.M.	58.55
4	W. Spurr	Tees-side	53.49

Time given is aggregate of two best flights.

*Includes new British record of 34.34.

PILCHER CUP (U/R Glider)—66 *entries*—**June 24th, 1962**

1	M. Burrows	St. Albans	6:33
2	D. Latter	Brighton	6:13
3	K. Winstanley	Brighton	5:24
4	A. F. Wisher	Croydon	5:11
5	L. Larrimore	Portsmouth	4:27
6	M. Fripp	Brighton	3:49
6	J. O'Donnell	Whitefield	3:49

GAMAGE CUP (U/R Rubber)—48 *entries*—**June 24th, 1962**

1	J. West	Brighton	10:10
2	N. P. Elliott	Croydon	7:12
3	J. O'Donnell	Whitefield	5:17
4	D. Harper	Glevum	4:17
5	R. Paveley	Hornchurch	4:00
6	A. R. Wells	Hornchurch	1:46

S.M.A.E. C/L Stunt and Speed, R.A.F. Oakington, July 15th, 1962. *Weather, cold, showery, dull.*

Stunt

1	F. Warburton	Bolton	1049 points
2	J. Newman	Hayes	1028 points

Speed (*All speeds in m.p.h.*)

Class O.—5 *entries.*

1	R. L. Taylor	Brixton	87:73	Oliver Tiger Cub II

Class 1—6 *entries.*

1	P. Drewell	W.E.A.	126:3	C.C.S.

F.A.I.—6 *entries.*

1	N. Butcher	Croydon	121:7	C.C.S.
2	P. Drewell	W.E.A.	117:1	C.C.S.
3	G. Copeman	Northwood	111:9	Super Tigre

Class 2—6 *entries.*

1	R. L. Taylor	Brixton	139:8	Eta 29
2	H. Nixon	F.A.S.T.E.	134:7	Eta 29

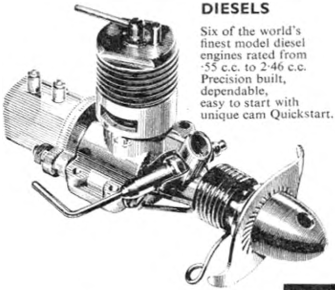
Class 3—7 *entries.*

1	M. A. Billinton	Brixton	146:2	McCoy 60
2	J. Taylor	Hayes	145:2	McCoy 60

Class 4—3 *entries.*

1	R. Gould	F.A.S.T.E.	149:1	Dyna Jet
2	B. Hopkins	Bristol	129:3	O.S. Jet

get out in front



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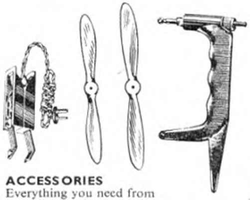

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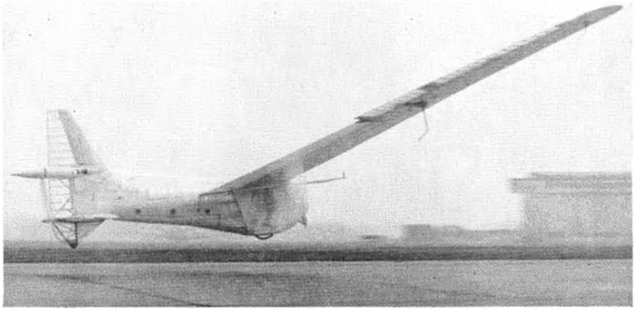

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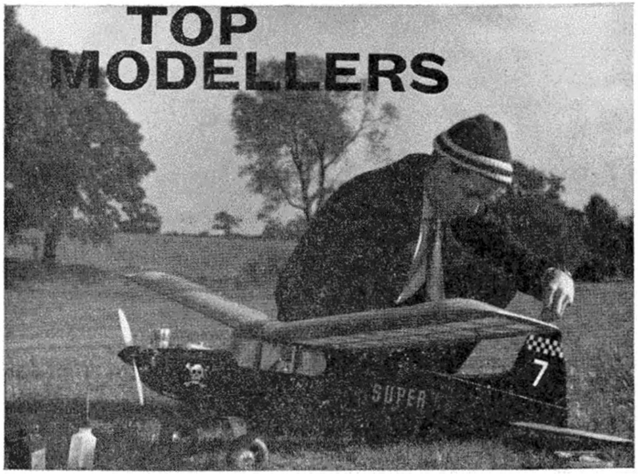

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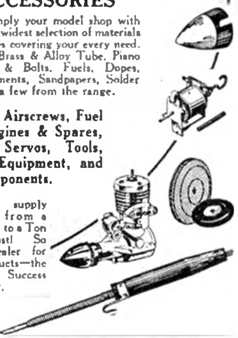

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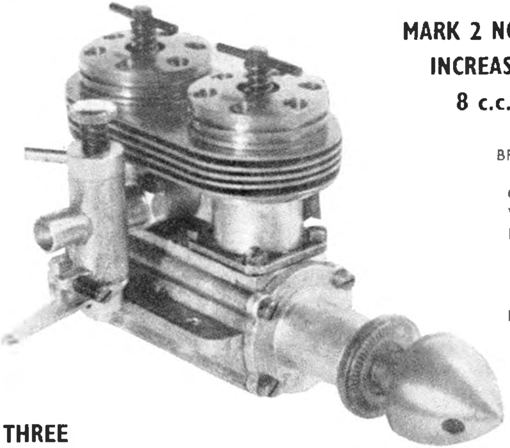

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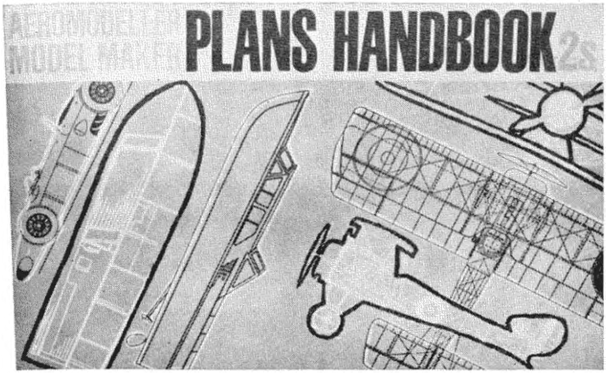

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G. W. Jones Bros & Co. Ltd.,
56 Turnham Green Terrace,
Chiswick, W.4.

Model Aircraft Supplies Ltd.,
29 Old Kent Road,
S.E.1.

Ripmax Ltd.,
39 Parkway,
N.W.1.

BERKSHIRE

Homecrafts & Models,
51 Cheap Street,
NEWBURY.

BUCKINGHAMSHIRE

The Model Shop,
5 Public Market,
SLOUGH.

CHESHIRE

Hewitts (Knutsford) Ltd.,
25 & 27 King Street,
KNUTSFORD.

ESSEX

Hills of Barking,
32-34 North Street,
BARKING.

E. Keil & Co. Ltd.,
Wick Lane,
WICKFORD.

GLOUCESTERSHIRE

I. Newman (Cheltenham) Ltd.,
127/9 Bath Road,
CHELTENHAM.

HAMPSHIRE

Grants Models Ltd.,
308 Charminster Road,
BOURNEMOUTH.

Precise Model Kraft,
80 Southampton Road,
EASTLEIGH.

HERTFORDSHIRE

H. A. Blunt & Sons Ltd.,
38 Fretherne Road,
WELWYN GARDEN CITY.

The Model Shop,
10 Church Hill Road,
EAST BARNET.

KENT

Birchington Engineering Co. Ltd.,
BIRCHINGTON.

Modern Models,
49-51 Lowfield Street,
DARTFORD.

MIDDLESEX

O.B.M. (Orders By Mail),
4 Lowden Road,
SOUTHALL.

Teddington Model Supplies,
86 Broad Street,
TEDDINGTON.

STAFFORDSHIRE

John W. Bagnall Ltd.,
South Walls Road,
STAFFORD.

Dunn's,
65 Lower High Street,
CRADLEY HEATH.

S. H. Grainger,
Caldmore Models,
108 Caldmore Road,
WALSALL.

The Handicraft Centre,
491 Dudley Road,
WOLVERHAMPTON.

SURREY

Heset Model Supplies,
61 Brighton Road,
SOUTH CROYDON.

Radio & Electronic Products Ltd.,
47 Queens Road,
WEYBRIDGE.

Whitewoods,
103 Brighton Road,
SURBITON.

SUSSEX

Planet Models & Handicrafts,
108 The Hornet,
CHICHESTER.

Solarbo Ltd.,
Commerce Way,
LANCING.

WILTSHIRE

Hobby's Corner (Swindon) Ltd.,
24 Fleet Street,
SWINDON.

WORCESTERSHIRE

A. N. Cutler,
7 Bridge Street,
WORCESTER.

YORKSHIRE

Humber Oil Co. Ltd.,
Marfleet,
HULL.

ISLE OF MAN

Davies Charlton Ltd.,
Hill Meadows,
DOUGLAS.

Marown Engineering Ltd.,
Glen Vine,
MAROWN.

SCOTLAND

Caledonia Model Co.,
478 Argyle Street,
GLASGOW, C.2.

Peter Montgomery,
273 High Street,
KIRKCALDY

WALES

Redana's Model Shop,
73-74 Kingsway,
SWANSEA.

AUSTRALIA

Gorrie's,
604 Stanley Street,
Wooloongabba,
BRISBANE.

CANADA

North York Hobbies & Crafts,
1910 Avenue Road,
TORONTO 12, Ontario.