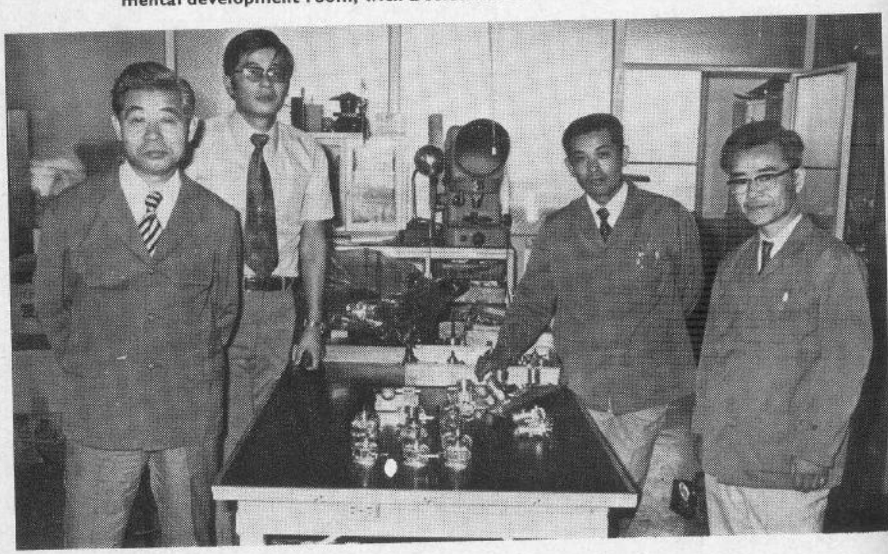
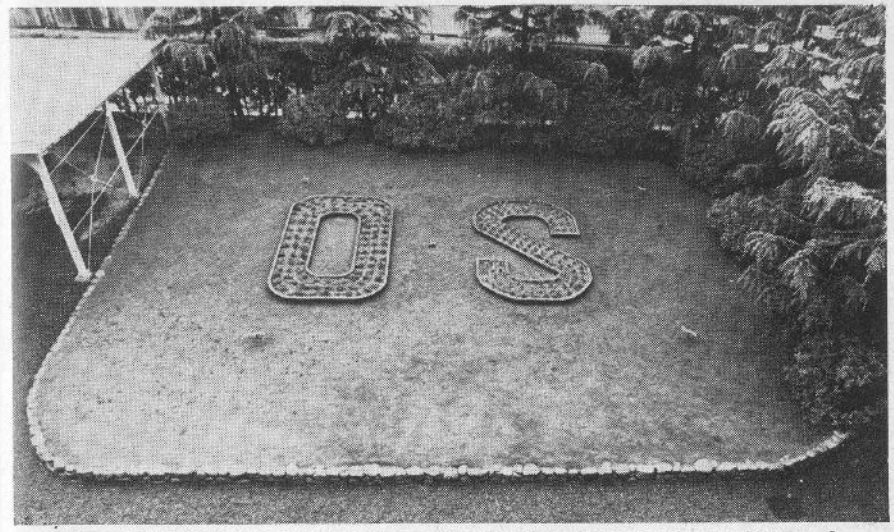
INSIDE THE O.S. ENGINE FACTORY by Ron Moulton

With a production average of 14,000 engines a month and a world wide reputation for value and quality the Ogawa Manufacturing Company of Osaka, Japan is one of the longest established firms in the world's model business. Shigeo Ogawa can still point with pride at the simple lathe which led him to make his first series production model engine surrounded as it is by the very latest in automatically controlled machinery turning out parts for his world famous Wankel engine.

Essentially a family business, with his daughter and son-in-law, "Joe" taking prominent parts in the management, O.S. are also well-known for the long service of their top executives. It is a company where tradition and dedication are respected ideals. Our photo-visit will convey a little of the intense

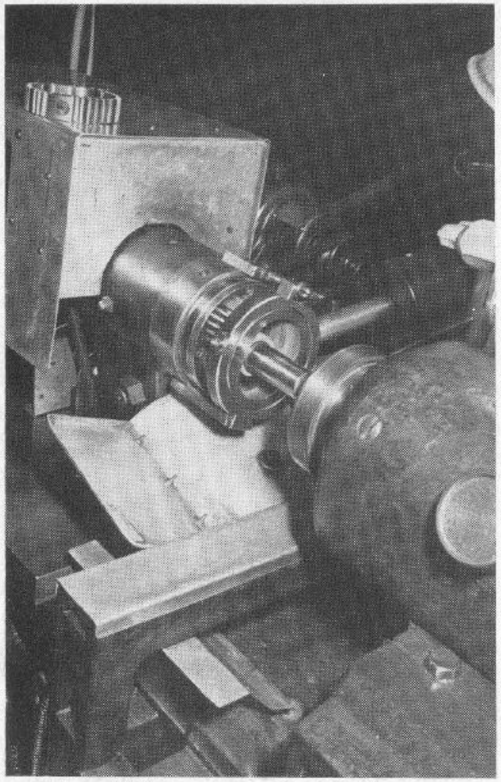
Executive quartet and design leaders in popular model engines, left to right Shigeo Ogawa, Minoru "Joe" Ogawa, Kazuhiro Mihara and Hiroshi Sawada who determine the type of product that OS will produce to meet their world wide demand. They are in the experimental development room, with a selection of Wankel units on the table.





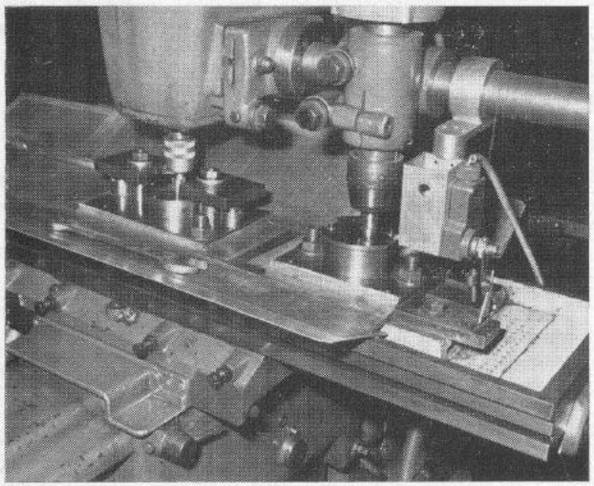
Opposite, the factory courtyard, and above, the view from the second floor roof garden. A hostel for employees is beyond the ornamental garden. Buildings contain recreation facilities and large canteen.

Shigeo Ogawa's treasured engine museum (there is also an R/C equipment section) includes all the classics and many rare Japanese originals, plus of course at least one each of all the O.S. engines ever made, starting with the very first ignition type made by Shigeo's father, the founder of the company.

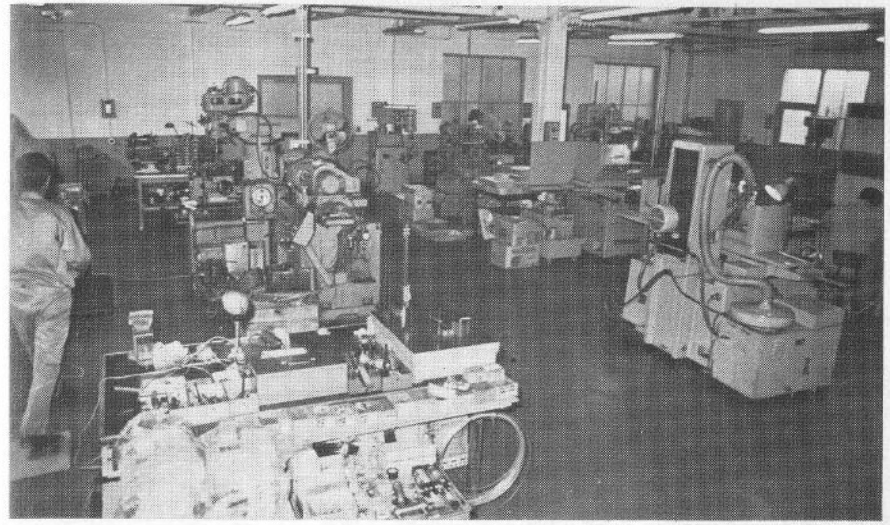


Of all the machining operations undertaken in the O.S. establishment at Osaka, that of shaping the inner face of the Trochoid on the Wankel engine is the most demanding. Special machines had to be devised before O.S. could start manufacture. They were the only company in the world—and still remain the only one, to meet the request to make the engine for Johannes Graupner of Germany.

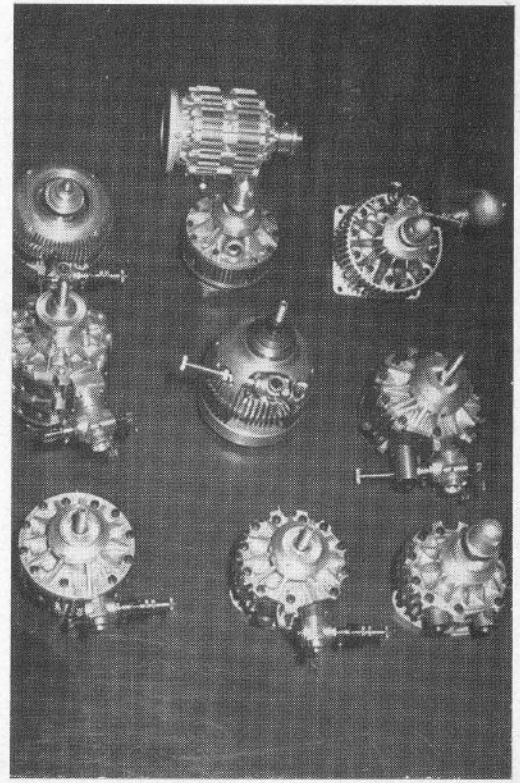
activity which goes to make this famous concern a leader in its field. We hope it will also show how the mass production high performance model engine is a product of the highest standards of engineering, with many complex operations in the process of manufacture—all contrived to make the miniature power units we tend to take for granted.



Another operation in the manufacture of a Wankel engine, where the vertical milling tool is guided by a complicated jig to follow the precise profile. Tolerances for the Wankel are much closer than for the average model engine.



Spacious workshops, with a planned work-flow pattern and highest standards of cleanliness are typified in this view of the machine shop which turns out the Wankel units. Ironically this collection of sophisticated machines has the very first O.S. lathe for company—and it still works well after almost 50 years' service!

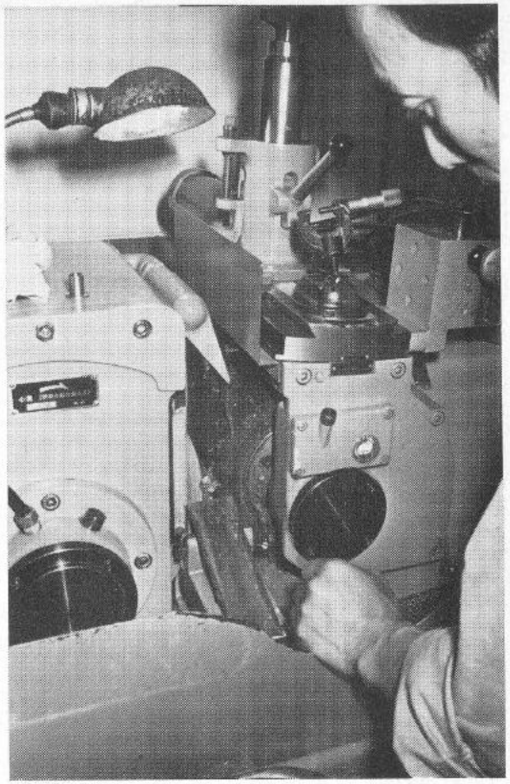


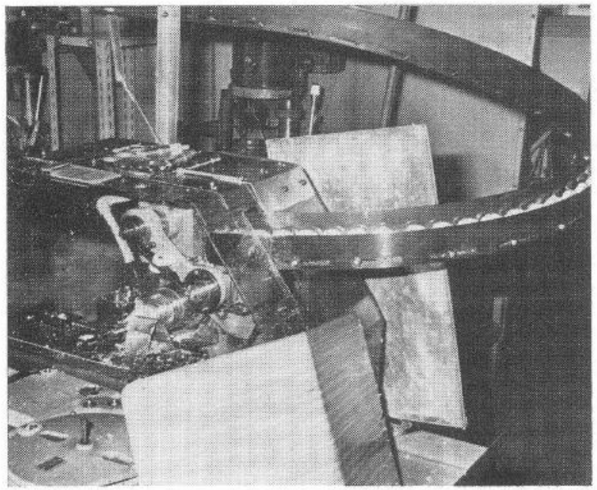
A random selection of ten different working Wankels! They include a few twin rotor units and various forms of cooling fin and induction positions. Few modellers appreciate the vast amount of research behind the present mass-produced and very successful Wankel.

Machine shop engaged in mass production of components such as cylinders, pistons, wristpins and crankshafts, where a high standard of automation is used, and regular inspection of quality is maintained by personnel. A lot of the machinery has been specially designed and made by O.S.

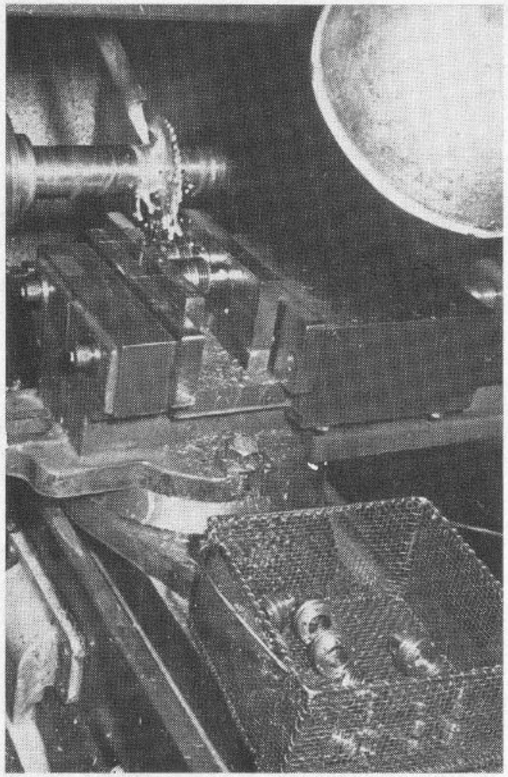
Typical of the automatic operations is the constant feed of "little end" pins (Gudgeon or Wristpins) through a centreless grinder which establishes a perfect diameter, ready for immediate assembly to the connecting rod and piston. Note box load containing thousands of these hollow pins.

A centreless grinder producing a piston with perfect size and finish. This machine is one of many which are continuously occupied to maintain the standards of interchangeability and quality of the O.S. products. With a daily production rate of 400–500 units of all sizes, only a few engines are actually tested at random before despatch yet each comes fresh from its box, ready to start at the hands of the modeller.



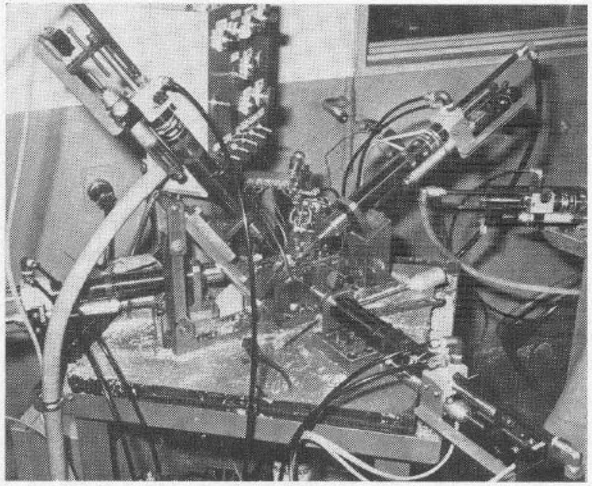


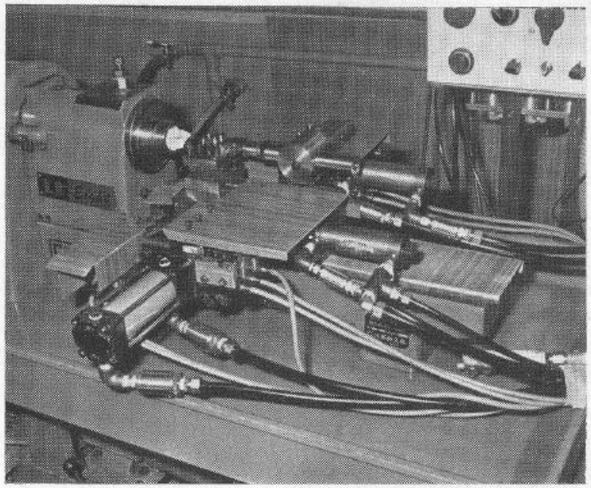
The "rail track" feed contains a long line of shunting cylinder heads, lined up ready for precision facing in the machine which has an enclosed transport cover. Micrometers and gauges are handy by all O.S. machines to check the precision.



A simple jig carries two cylinders and a rotating cutter slices out the ports as it is doused with emulsified coolant and lubricant. This operation is one of the least complex, yet is critical for eventual model engine performance. It is one instance where the parts are hand loaded and taken from the machine.

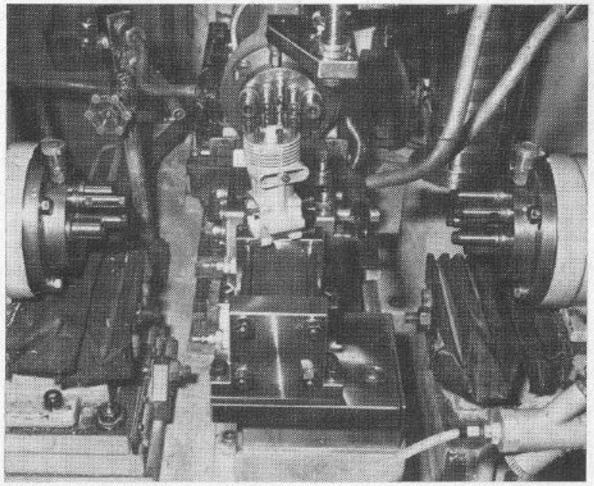
Five separate drilling ops on a carburettor are controlled by these spider like units which act in sequence under a programmed operation. With the arrival of radio control, the carburettor has become as involved as the rest of the engine itself!

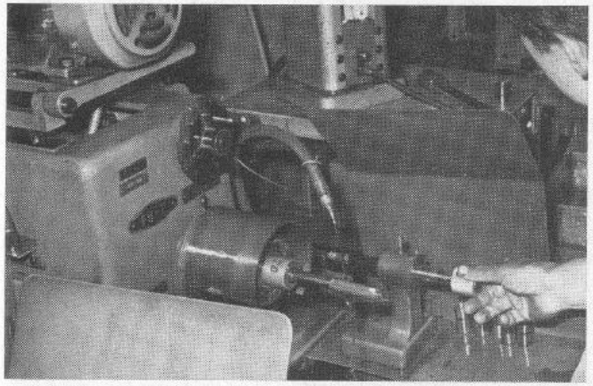




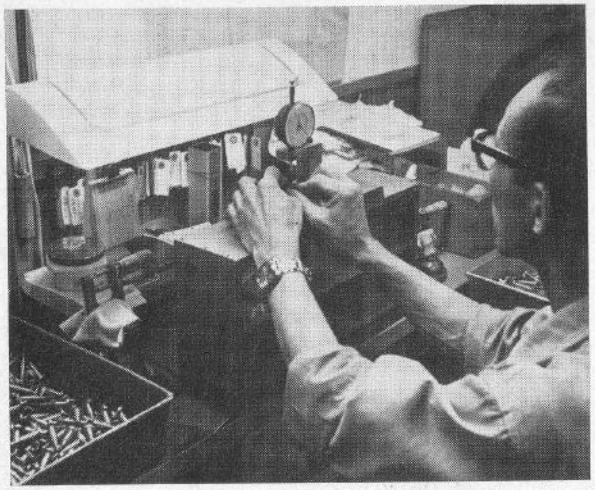
This elaborate programmed machine faces the cylinder head, a critical operation which has to be completed to finest tolerances. It is typical of the pneumatic controlled machinery being installed at the O.S. works.

A machine which drills and taps the cylinder block on its three machined faces for the retaining bolts at the head, front and rear. In this case, fourteen screw threaded holes are completed in one quick operation.





Since the earliest days of model engine manufacture, the cylinder hone has been a man and machine op. which ultimately determines the performance of the product. A cylinder is being checked on the air gauge to establish that it meets required standards.



Impressive feature of the O.S. works is the degree of inspection made between machine operating to maintain quality and accuracy. This dial test indicator is being used to check crankshafts which are then batched according to their slightest variations.

An air gauge indicates the precision of pistons as they are inspected and batched. All reciprocating parts come under this close scrutiny before final assembly. This ensures that pistons and cylinders are well matched.

After all the machining operations that are involved in model engine manufacture, the parts are assembled in a clinically clean area by girls using pneumatic screwdrivers. Supervisors inspect the completed engine before passing to packing dept., and eventual sales under Yasuo Tominaga's dept.—another long serving O.S. employee.

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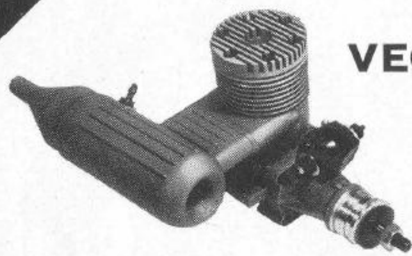

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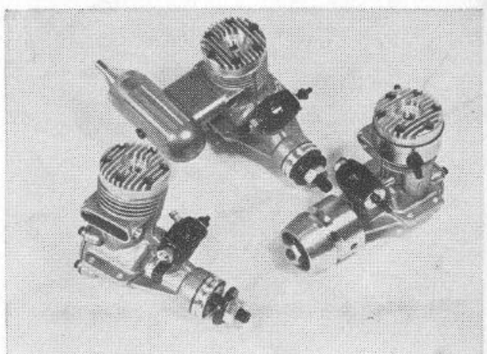

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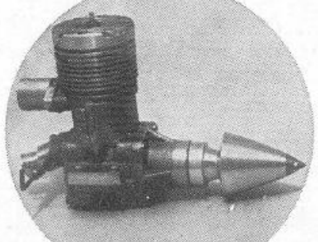

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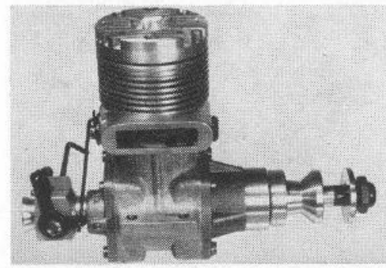

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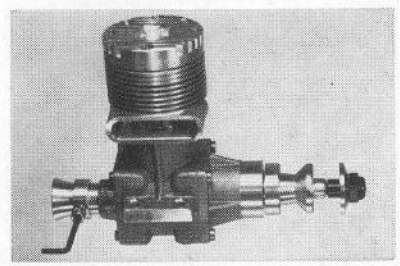

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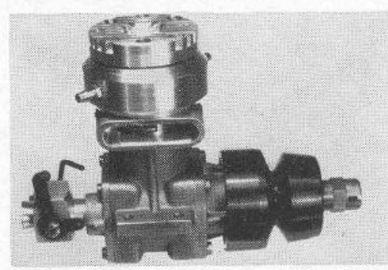

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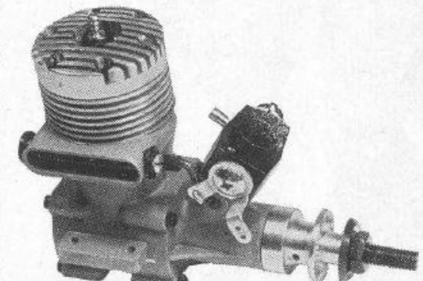

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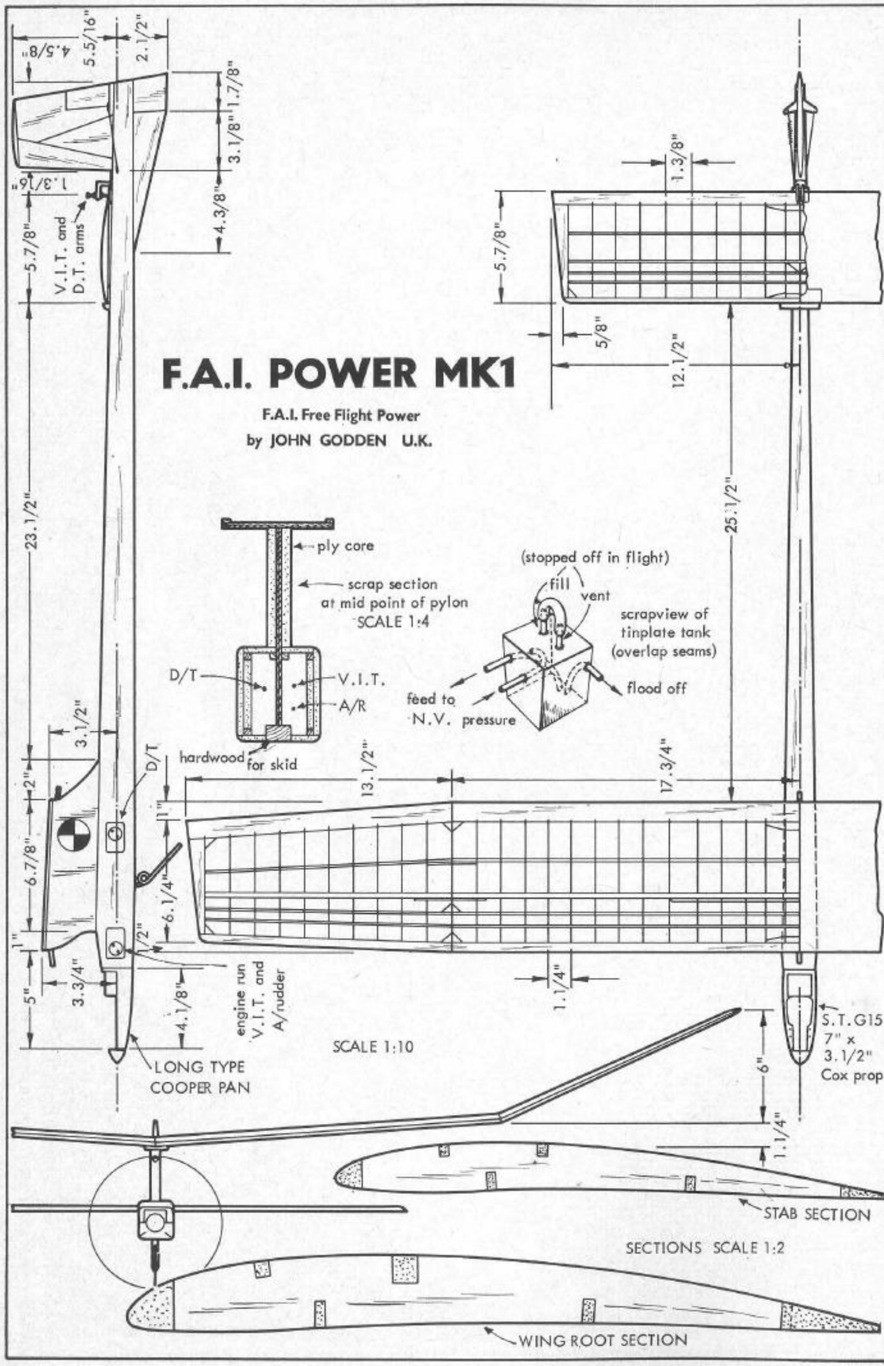

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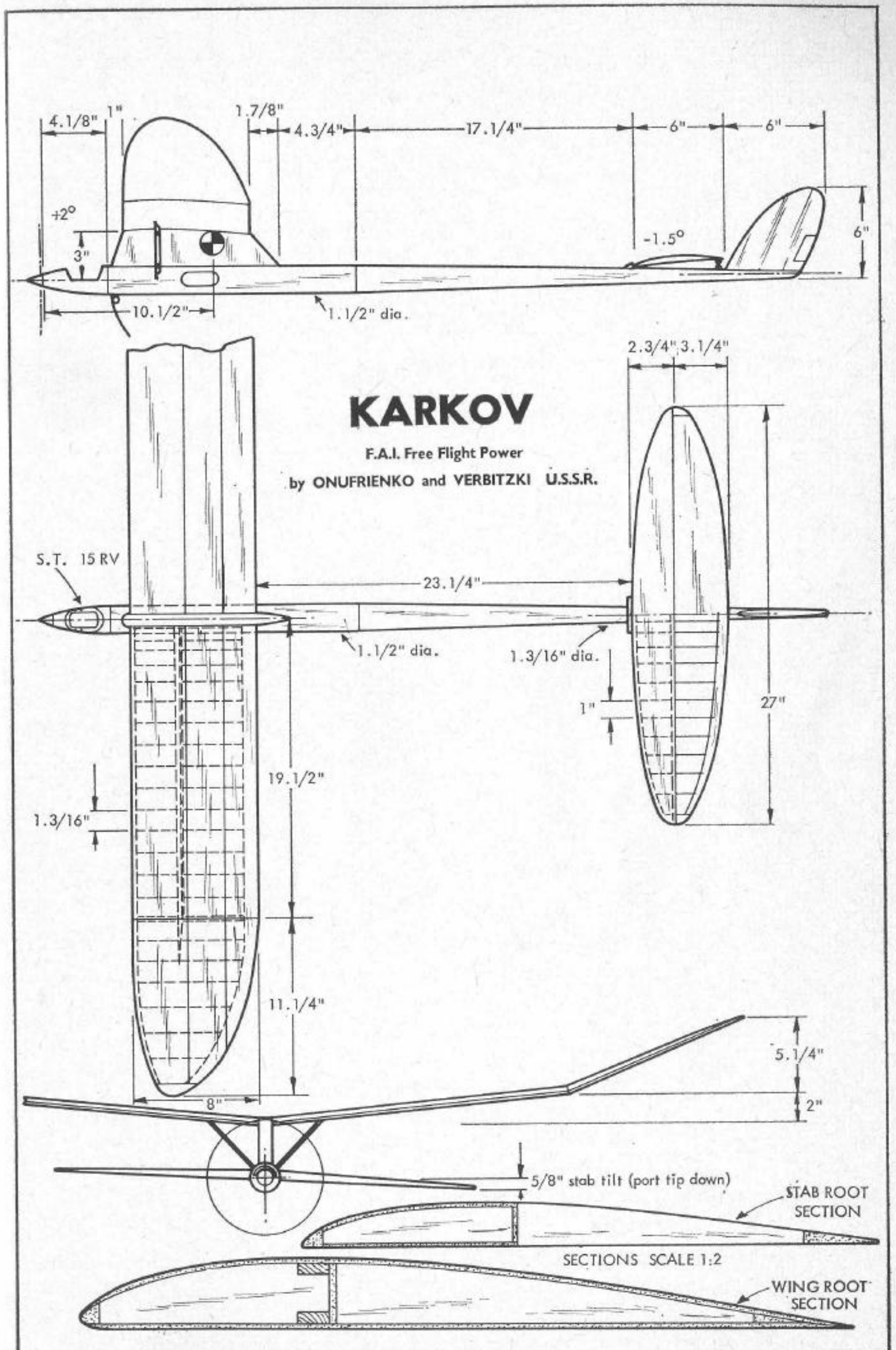

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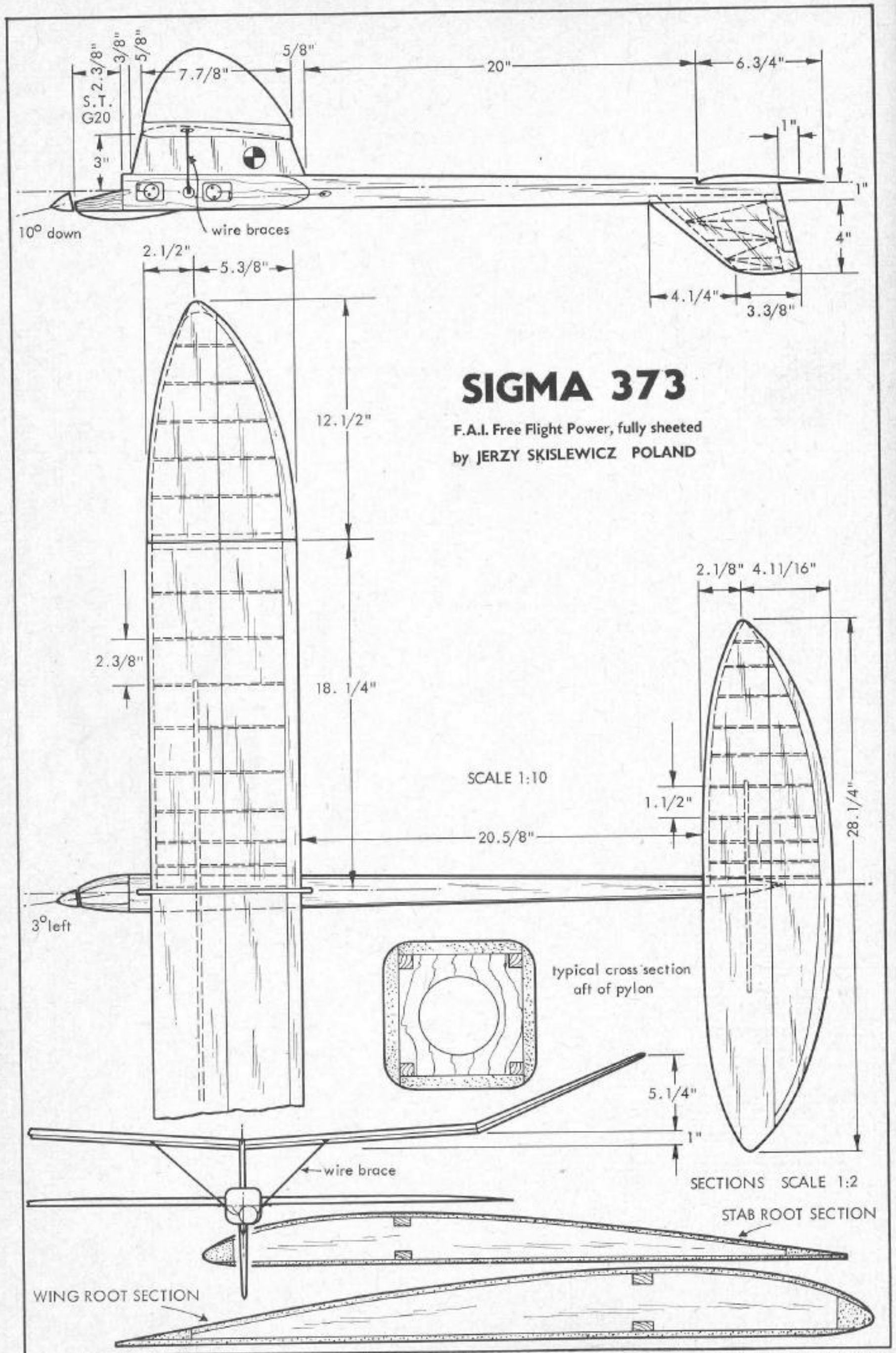

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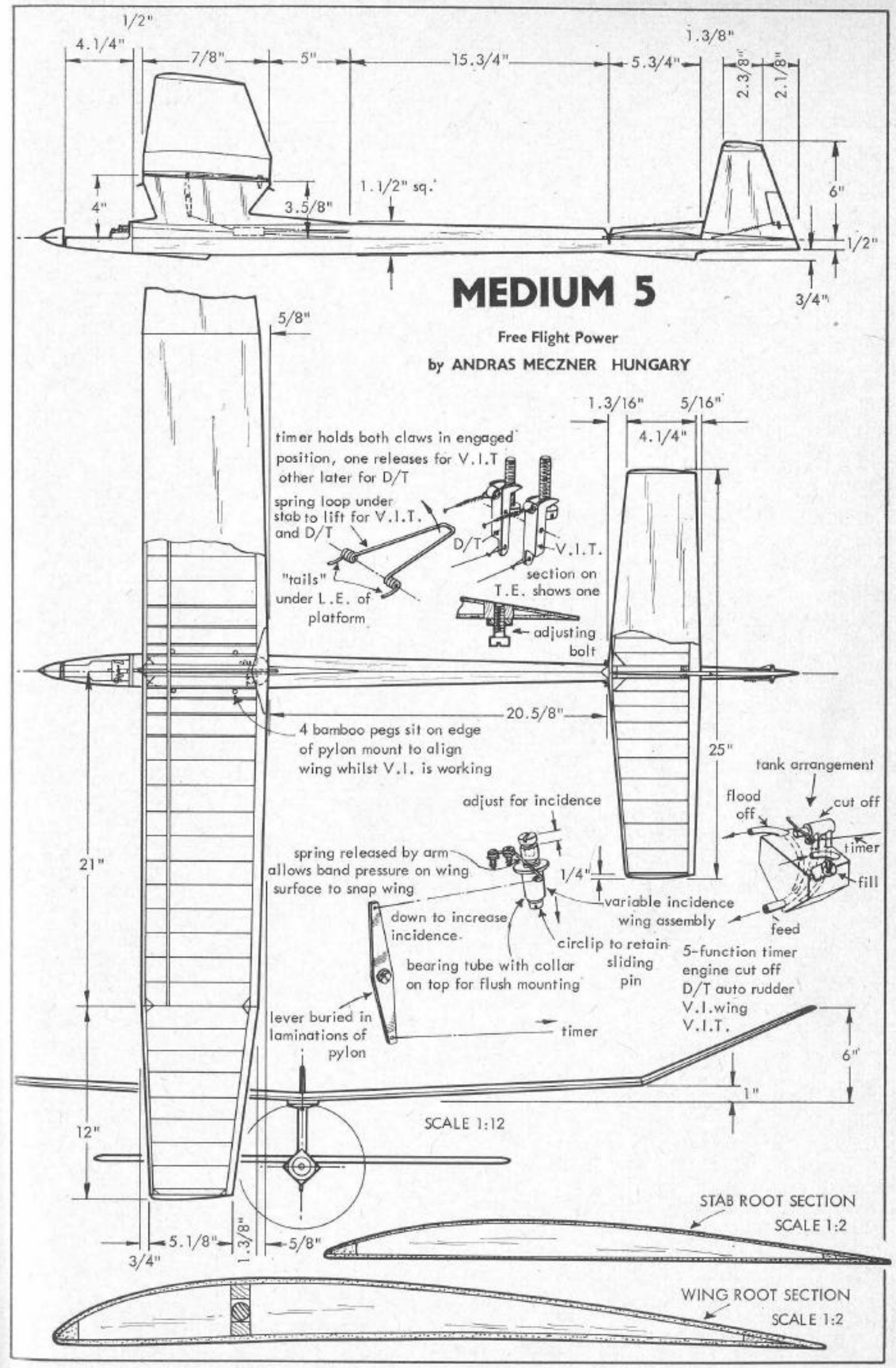

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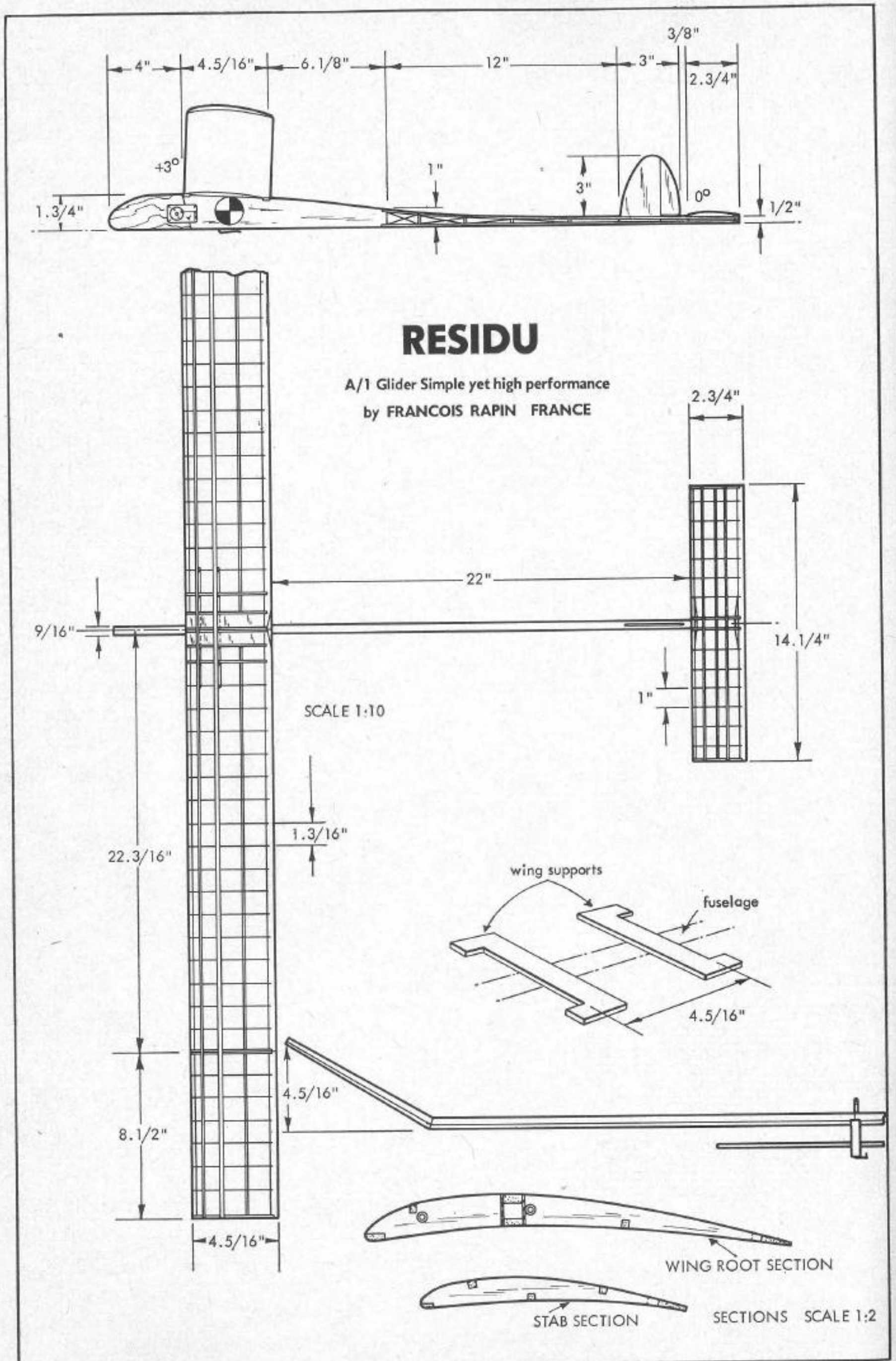

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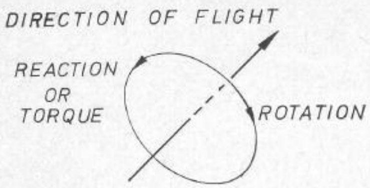


Diagram illustrates the reaction of torque in opposition to propeller rotation about the line of flight on an aircraft.

FIG.1

PROPELLER TORQUE AND GYROSCOPIC MOMENT

by J. van Hattum

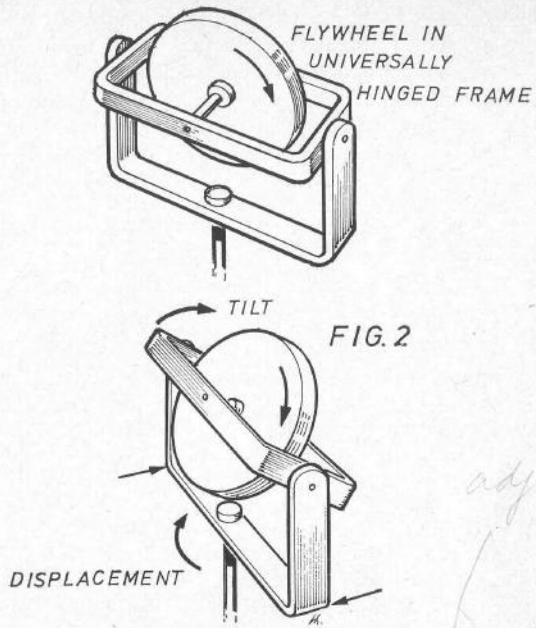
ANYONE who has flown a powered model, whether rubber- or piston-engined, free flight or radio controlled will be familiar with the phenomenon we call propeller torque, and the influence it has on the behaviour of the model. We may regard the fast revolving propeller as a twisted wing whose halves rotate about a common axis. As with a wing the propeller will supply both lift and drag. As a result of accelerating the column of air which is drawn through the propeller disc, thrust is developed. We may compare this to the mass of air which the wing moves downwards to create lift. However, everything has to be paid for: the wing will also have drag and the same applies to the revolving propeller. This produces a torque opposing the direction of rotation and if we have a right-handed propeller according to *Fig*. 1, then the torque reaction will tend to rotate the model in the opposite direction. It will tend to roll to the left which unless trimmed out will result in a slight skid towards the lower wing; the "weathercock" effect of the model would then put the model in a left turn while the dihedral of the wing will produce a compensating torque. It will later be seen that something should be done to counteract this turn, if only to some extent.

Propeller torque—that is the rolling moment acting on the model—goes up with the fourth power of the diameter and the square of the r.p.m. If one uses engines of equal power, then a large, slowly revolving propeller will have a greater torque than a small fast one.

Why should we not just let the torque have its way and accept the (left) turn? Nothing forces us to make the model fly straight, on the contrary: a circling model will have a better chance to contact a thermal. We should, however, realize that it will not just remain a simple turn. We may regard the propeller as a fast revolving flywheel. Quite apart from the fact that the torque-induced turn may prove to be too pronounced, we should also take into account another mechanical phenomenon: the gyroscopic moment.

Gyroscopic Moment

The daring young pilots of World War I who indulged in low-level turns close to the ground often had to pay for their boldness with their lives. When they made a sharp turn against the torque there was a chance that they would dive into the ground, whereas a turn in the opposite direction raised the nose of the plane and that could easily be followed by a stall and a spin. To many it remained a mystery.



What were the forces that acted so strangely upon the otherwise obedient aircraft? The phenomenon was well known, but not, apparently, to the poor pilots. Aircraft with rotary engines were much more prone to these capers than those with stationary engines, because the former had a considerably greater mass revolving at the nose.

The gyroscope consists of a fast revolving flywheel running in a universally jointed frame allowing it freedom to rotate in all planes as shown in *Fig*. 2. When we apply a couple to the vertical axis to make the flywheel change its attitude in the horizontal plane, we will find that it also tilts in the vertical plane which is normal to the flywheel itself. The frame in which the wheel is running will rotate and tilt. A freely suspended gyroscope will maintain its original attitude and will not be influenced by the attitude of the aircraft in which it is fitted. This characteristic is the basis of directional gyro's, turn indicators and automatic pilots. They have long been used to stabilize and direct torpedo's. *Fig*. 3 shows what happens to the aircraft in a turn, with the propeller rotating clock-

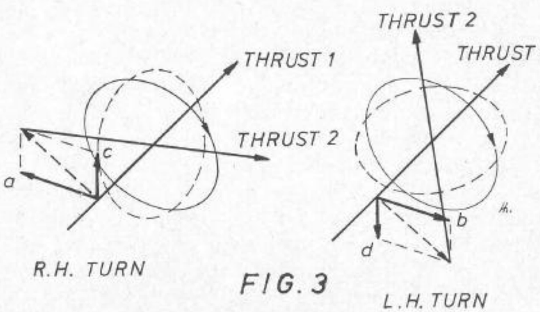


FIG. 3

wise as shown in *Fig.* 2, which would correspond to a turn to the right, it will refuse to move to **a** directly but move towards **c** as well. Similarly, if we try to move the axis towards **b** it will go towards **d** as well. To put it in practical terms: when we make a model turn to the left—with the torque—it will put the nose up, while if we make it turn to the right it will tend to put its nose down. We cannot afford to let the torque have its way, or the model will tend to stall, but we should not trim it to fly a sharp turn in the opposite direction, for that would mean a tendency to fly into the ground. However, let us first see what the gyroscopic moment would be in a particular case. We can calculate it from the equation:

$$M = \frac{0{\cdot}0196\ W_p.n.v.D^2}{R}\ \text{kg.m.}$$

W_p represents the weight of the propeller in kg., n the speed of revolution in revs. per second, v the flying speed in m/sec, D the diameter of the propeller and R the radius of turn both in metres.

Some Examples

It will be evident that the gyroscopic moment will be great when the weight, the diameter and the r.p.m. of the propeller are great and the same applies to the angular velocity of the turn v/R. Similarly the gyroscope effects will be greater in a right turn at high speed. In days long gone by, when Wakefield models, weighing half a pound, had a rubber motor of some 3 to 3½ oz., driving an 18-in. propeller (225 grammes, 100 grammes, 45 cm.), a rise-off-ground take-off with that amount of torque became a dicey affair. If the turn due to torque was not corrected properly, the model took up such an angle of bank that the left wingtip practically dragged over the take-off board, the model either continuing in a climbing roll or looped over on to its back. It might be worthwhile to investigate whether the gyroscopic moment still has an important influence on the behaviour of our models. Let us first take a modern Wakefield (*Fig.* 4b), assuming the following average values: $W_p = 20$ grammes; n = 20 revs. per second (initial burst of power); v = 8 m./sec.; D = 500 mm.; R = 5 metres. Remembering that the weight should be expressed in kg and the propeller diameter in metres, the gyroscopic moment will be:

$$M = \frac{0{\cdot}0196 \times 0{\cdot}02 \times 20 \times 8 \times 0{\cdot}5^2}{5}$$

$$= 0{\cdot}00314\ \text{kg.m. OR } 314\ \text{g.cm.}$$

We can represent the effect of this, by pretending there is an additional force F in the plane of the propeller, acting downwards or upwards, and an equal but opposite force at the centre of gravity of the model. This is shown in *Fig.* 4b with a model in a right-hand turn, so there will be a diving moment. When we assume that the propeller lies a distance d = 30 cm. in front of the c.g. the force F will be about 10 grammes. This is no negligible force: if we take the chord of the Wakefield at 12·5 cm. the effect may be likened to a forward shift of the c.g. of about 1 cm. which represents 8% of the chord and such a change in the trim of the model is bound to have a significant effect. With the model turning to the left with torque, there will be a climbing moment with an effect similar to a backward shift of the c.g. over roughly the same distance.

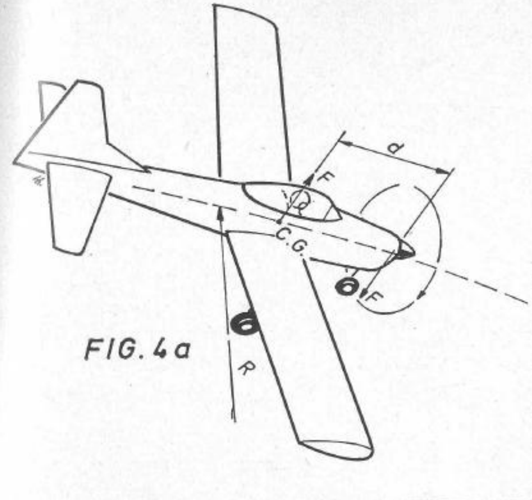


FIG. 4a

The handlaunch has greatly reduced our problem during the take-off as we can point our model in such a way that much of the danger can be eliminated, moreover we launch it at a fair height and at its correct flying speed. Most important of all, we use large diameter propellers which do not have the large initial increase of RPM associated with small ones. All the same, we cannot allow the torque to have all the say. However, before we discuss ways to compensate some of the torque-induced turn, let us see how it will affect a power model (*Fig.* 4a). For the purpose of a rough calculation we assume: $W_p = 20$ g; n = 300 revs. per second; v = 10 m./sec. (that is the speed at the start; it will build up considerably during the climb); D = 200 mm; R = 5 metres. We may now write:

$$M = \frac{0{\cdot}0196 \times 0{\cdot}02 \times 300 \times 10 \times 0{\cdot}2^2}{5}$$

$$= 0{\cdot}00932\ \text{kg.m. OR } 932\ \text{g.cm.}$$

We may take the average distance between the c.g. and the plane of the propeller as d = 25 cm. and the weight of the model at 750 grammes. Dependent

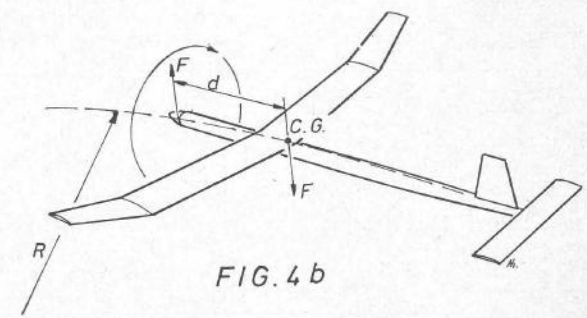


FIG. 4b

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$$= 0{\cdot}00314\ \text{kg.m. OR } 314\ \text{g.cm.}$$

We can represent the effect of this, by pretending there is an additional force F in the plane of the propeller, acting downwards or upwards, and an equal but opposite force at the centre of gravity of the model. This is shown in *Fig.* 4b with a model in a right-hand turn, so there will be a diving moment. When we assume that the propeller lies a distance d = 30 cm. in front of the c.g. the force F will be about 10 grammes. This is no negligible force: if we take the chord of the Wakefield at 12·5 cm. the effect may be likened to a forward shift of the c.g. of about 1 cm. which represents 8% of the chord and such a change in the trim of the model is bound to have a significant effect. With the model turning to the left with torque, there will be a climbing moment with an effect similar to a backward shift of the c.g. over roughly the same distance.

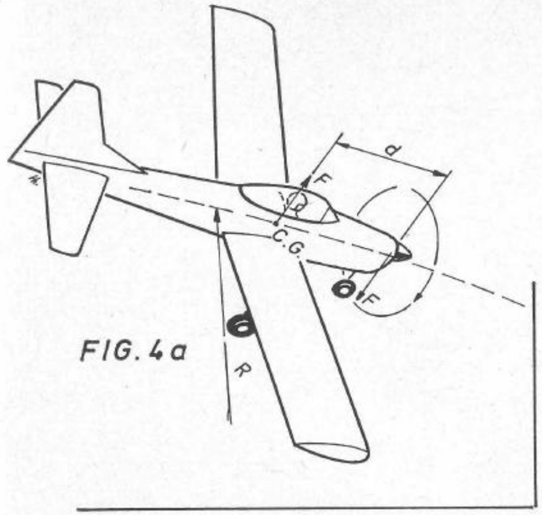


FIG. 4a

The handlaunch has greatly reduced our problem during the take-off as we can point our model in such a way that much of the danger can be eliminated, moreover we launch it at a fair height and at its correct flying speed. Most important of all, we use large diameter propellers which do not have the large initial increase of RPM associated with small ones. All the same, we cannot allow the torque to have all the say. However, before we discuss ways to compensate some of the torque-induced turn, let us see how it will affect a power model (*Fig.* 4a). For the purpose of a rough calculation we assume: $W_p = 20$ g; n = 300 revs. per second; v = 10 m./sec. (that is the speed at the start; it will build up considerably during the climb); D = 200 mm; R = 5 metres. We may now write:

$$M = \frac{0{\cdot}0196 \times 0{\cdot}02 \times 300 \times 10 \times 0{\cdot}2^2}{5}$$

$$= 0{\cdot}00932\ \text{kg.m. OR } 932\ \text{g.cm.}$$

We may take the average distance between the c.g. and the plane of the propeller as d = 25 cm. and the weight of the model at 750 grammes. Dependent

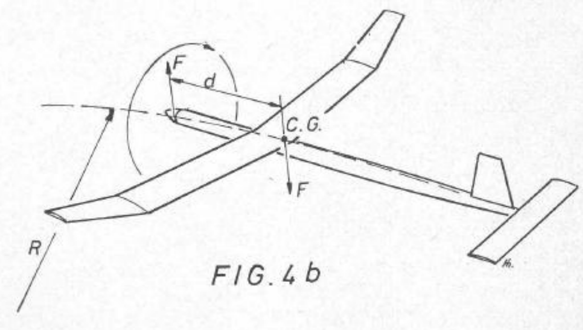


FIG. 4b

on the direction of the 5 m. radius turn, the vertical force at the nose will be 37 grammes either up or down. This is equivalent to a c.g. shift of just over 1 cm. and this will be forward in a righthand turn and aft in a lefthand turn.

With an average wing chord of 20 cm. the shift will be a little over 5 percent and, although this is less than we saw in the case of the Wakefield, it is by no means a negligible factor.

The above does not only apply to the types mentioned, but it holds true for all models and includes R/C, scale and sports models. R/C propeller-driven models in particular may have to fly tight turns at high revolutions and the resulting gyroscopic moment should be allowed for by the pilot. That by itself will be a warning not to stunt close to the ground, over the heads of spectators nor indulge in beat-ups, but none of us do that anyway . . . The foregoing should have made it clear that we should do something to harness the turn induced by the torque, but not to such an extent that the model turns in the opposite direction. A "tame" turn with the torque will still cause a slight climb and that may be just what we want.

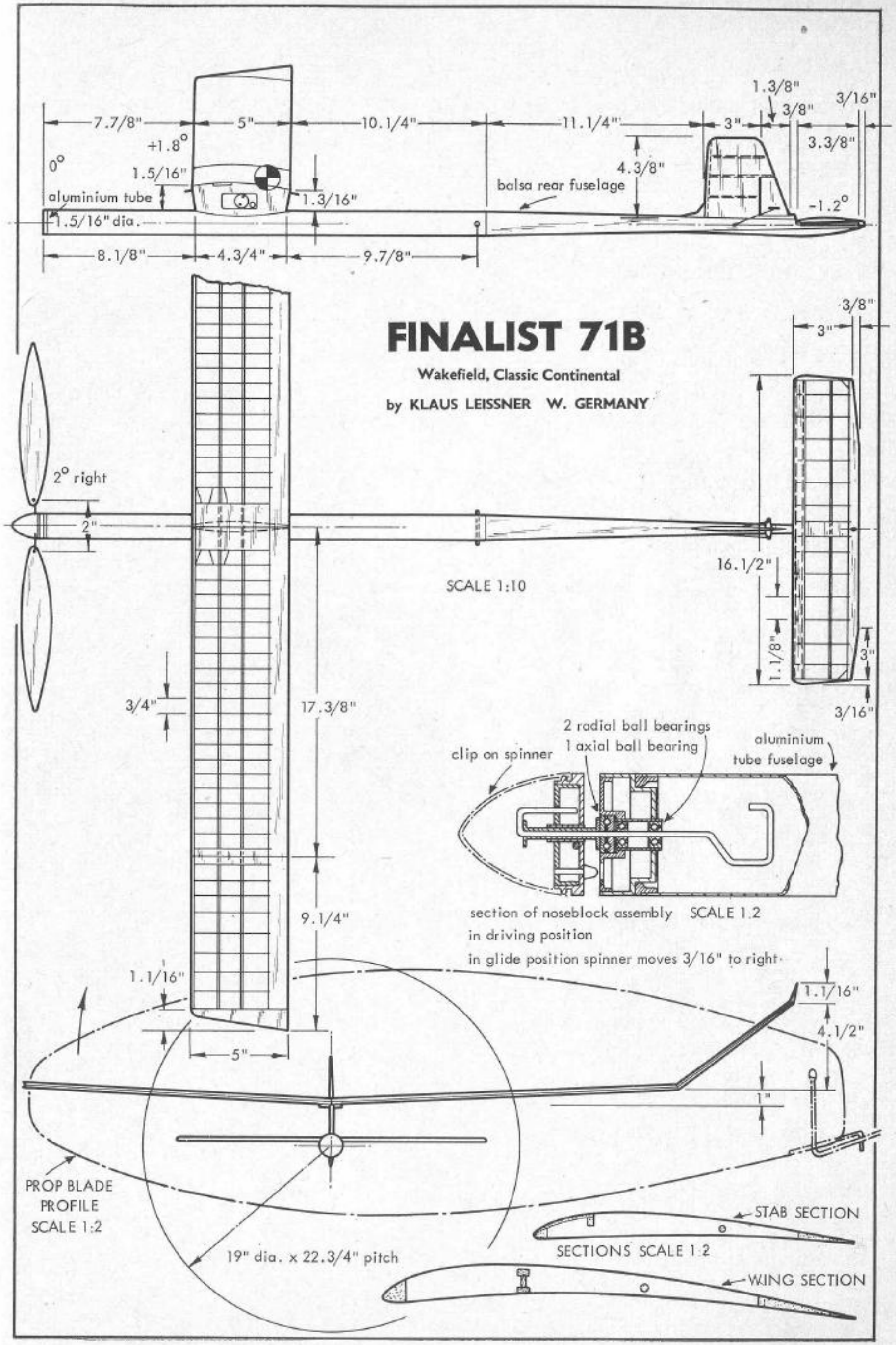
It is common practice to offset the thrustline some 1 or 2 degrees to the right. The thrust will then create a yawning moment to the right and the slipstream may also strike the fin in such a way that it will cause an additional yawing moment, but this effect may be small in contest models in view of the considerable distance between the propeller and the empennage, the chances being that the slipstream has been more or less straightened out by the time it has reached the tail. As has been mentioned in the beginning, the dihedral does its share in counteracting the torque, but one should note that this is not just a momentary upset but an influence lasting all the time the engine is running.

Off-setting the line of thrust is the only trimming method which does not have an influence on the behaviour of the model in the glide. The following tricks may also be used: Trim tab on fin (dangerous when it may lead to a spiral dive); washout on the righthand wing; tilted tailplane (if it can be combined with V.I.T.). In an emergency one has sometimes resorted to placing the wing askew on the fuselage, but this only works when the wing is a separate unit and it may not be easy to gauge the exact angle after a landing.

The gyroscopic moment is inversely proportional to the radius of turn and in our examples we have taken a fairly small radius to illustrate the point. If the model flies a 10-metre radius, the moment will be halved.

The weight of the propeller is important; the lighter we can make it, the less will be the gyroscopic moment.

When trimming a model it will be wise to reckon with these factors. It is hoped that this explanation will help to solve a problem here and there.



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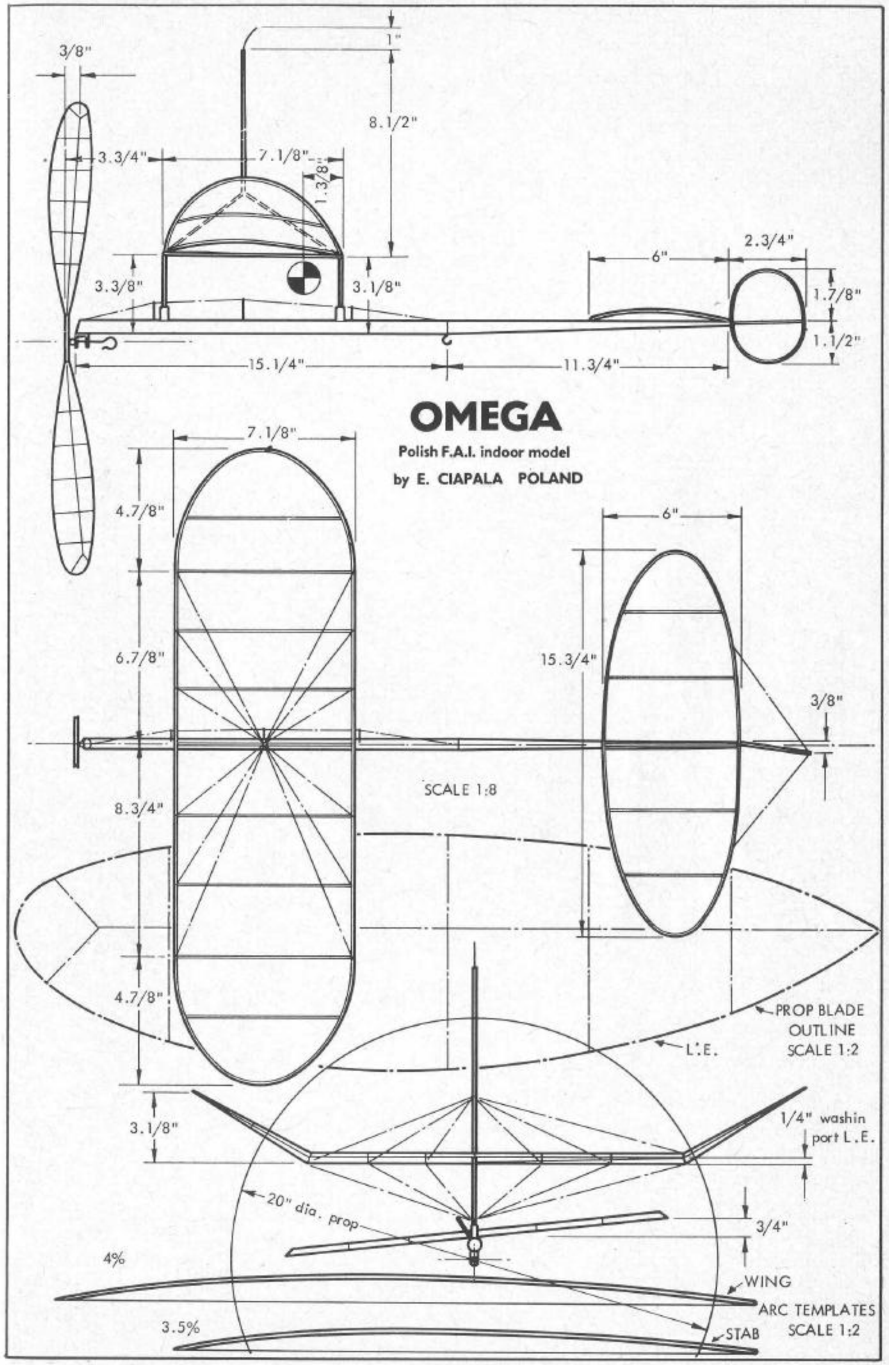
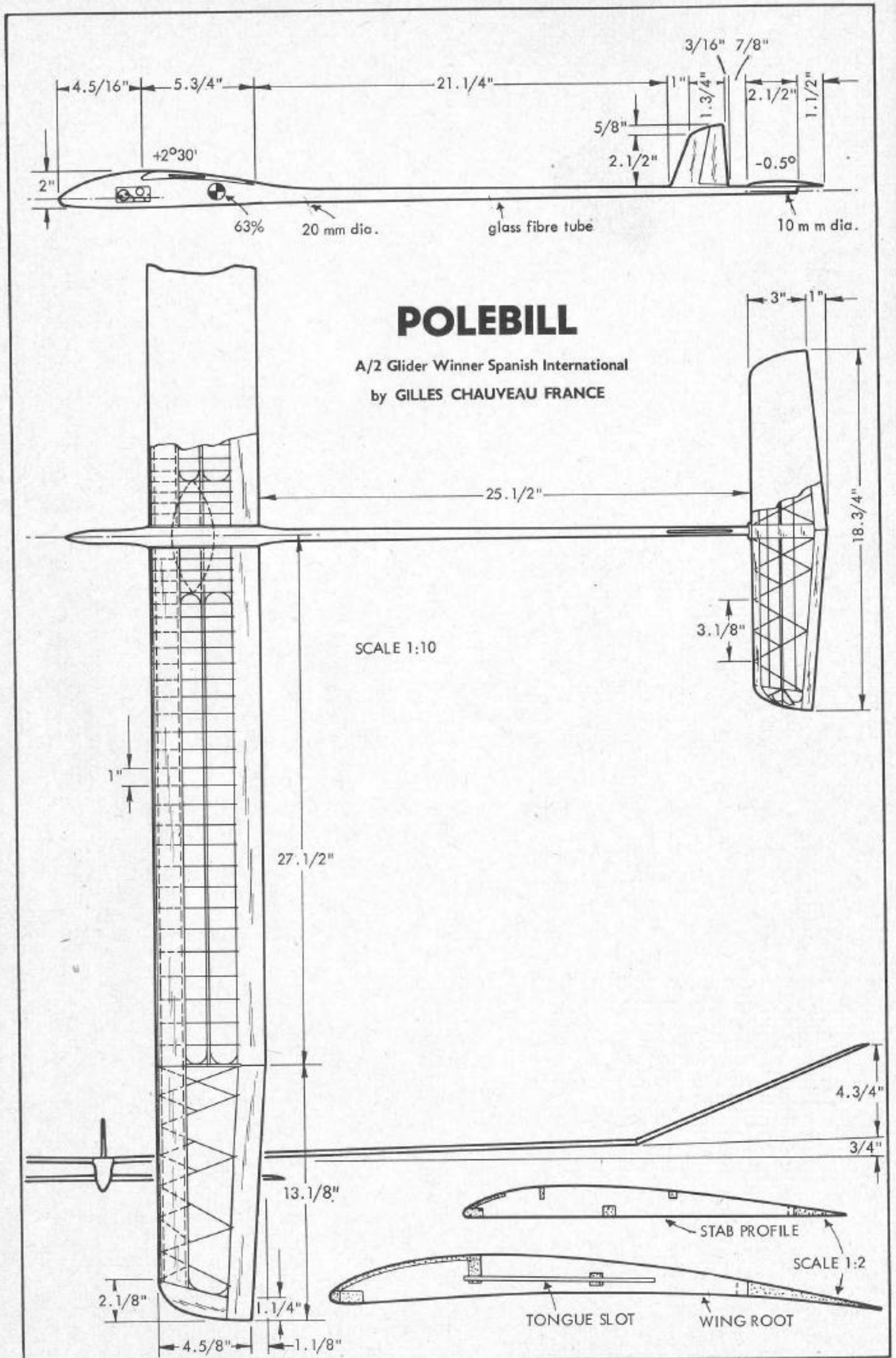


MODELARZ POLAND

POLEBILL

A/2 Glider Winner Spanish International

by GILLES CHAUVEAU FRANCE

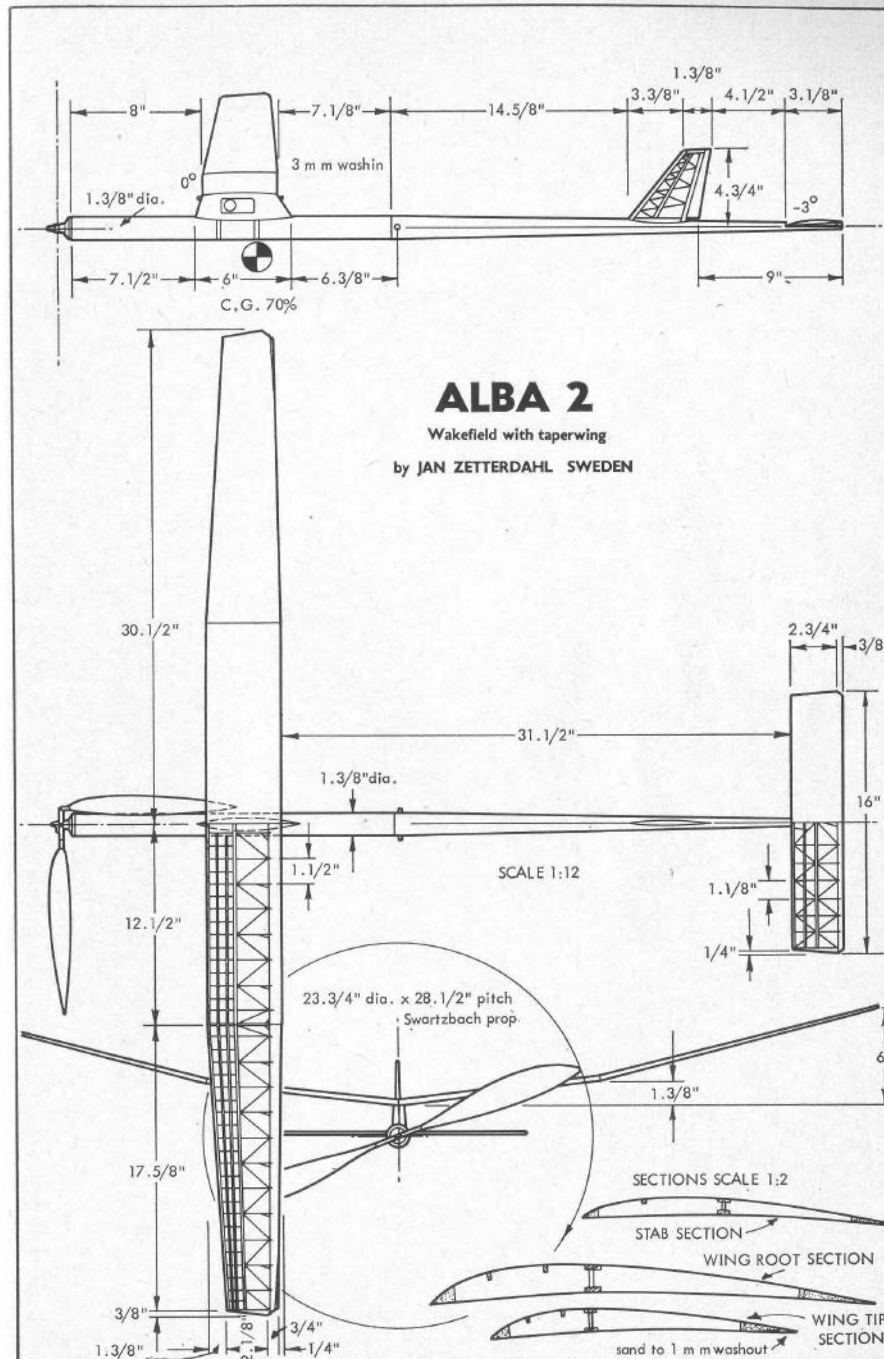


LE MODELE REDUIT D'AVION FRANCE

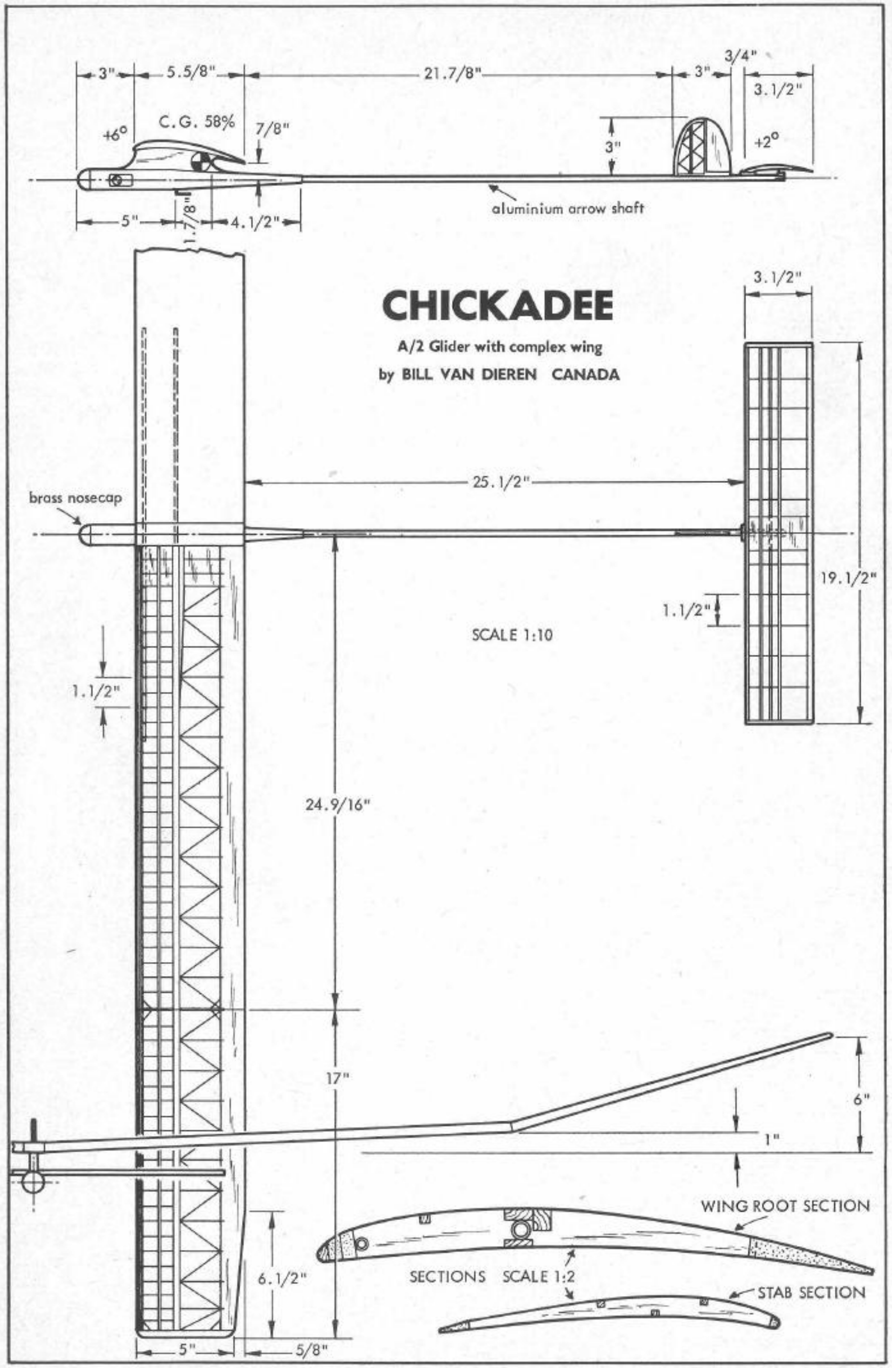
ALBA 2

Wakefield with taperwing

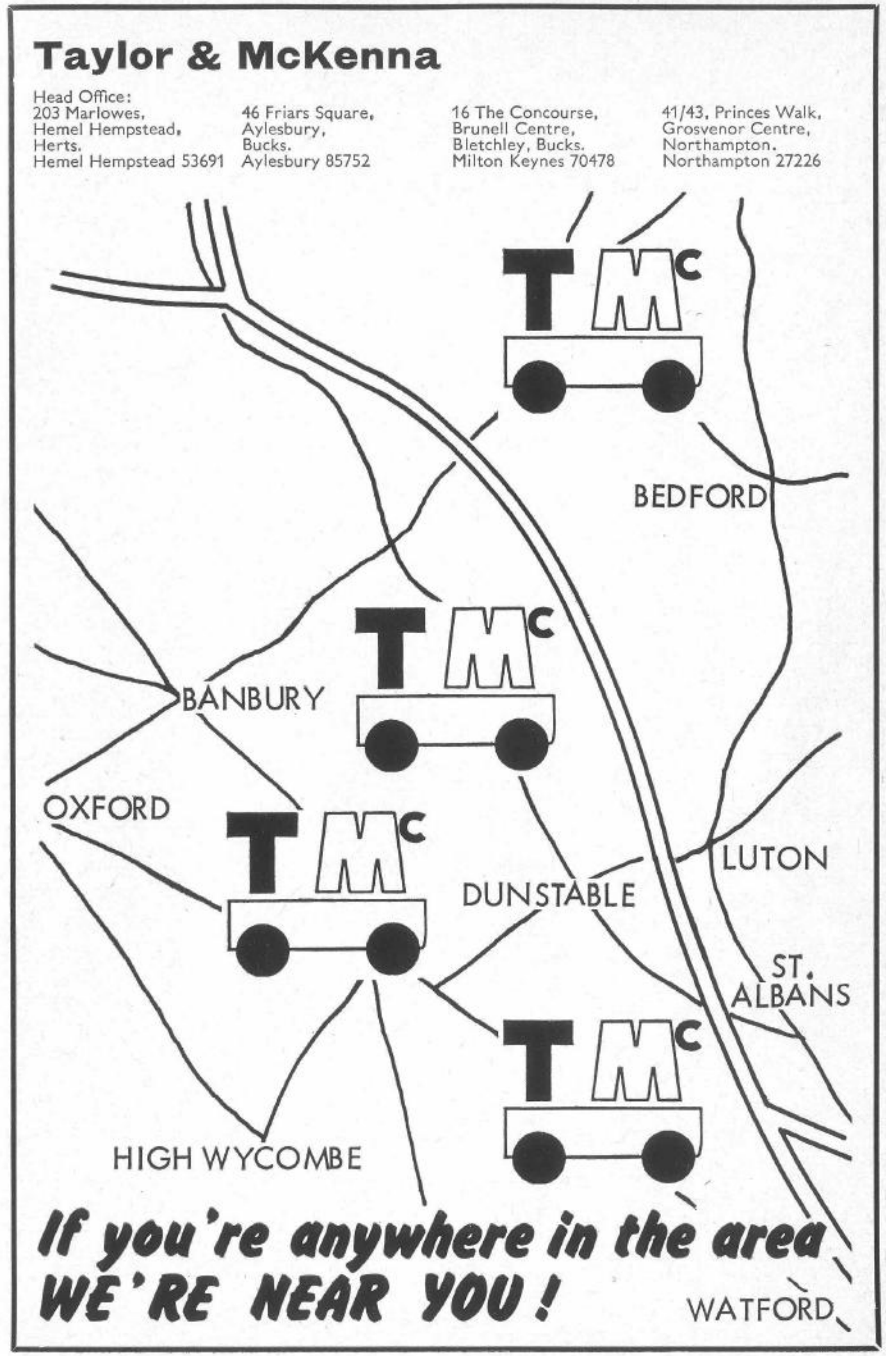
by JAN ZETTERDAHL SWEDEN

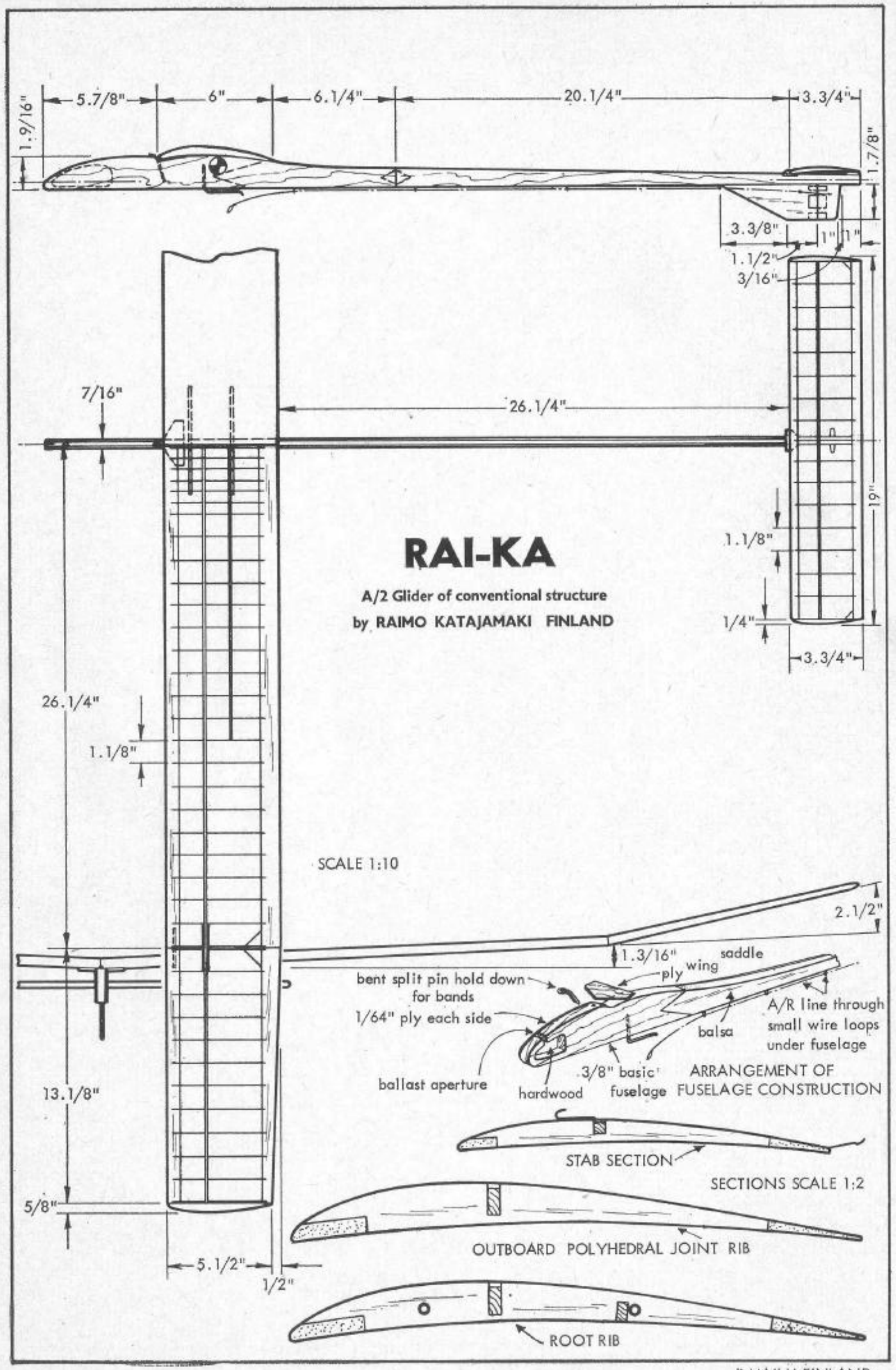


MODELLFLYGGNYT SWEDEN



VANCOUVER G.M.C. CANADA.





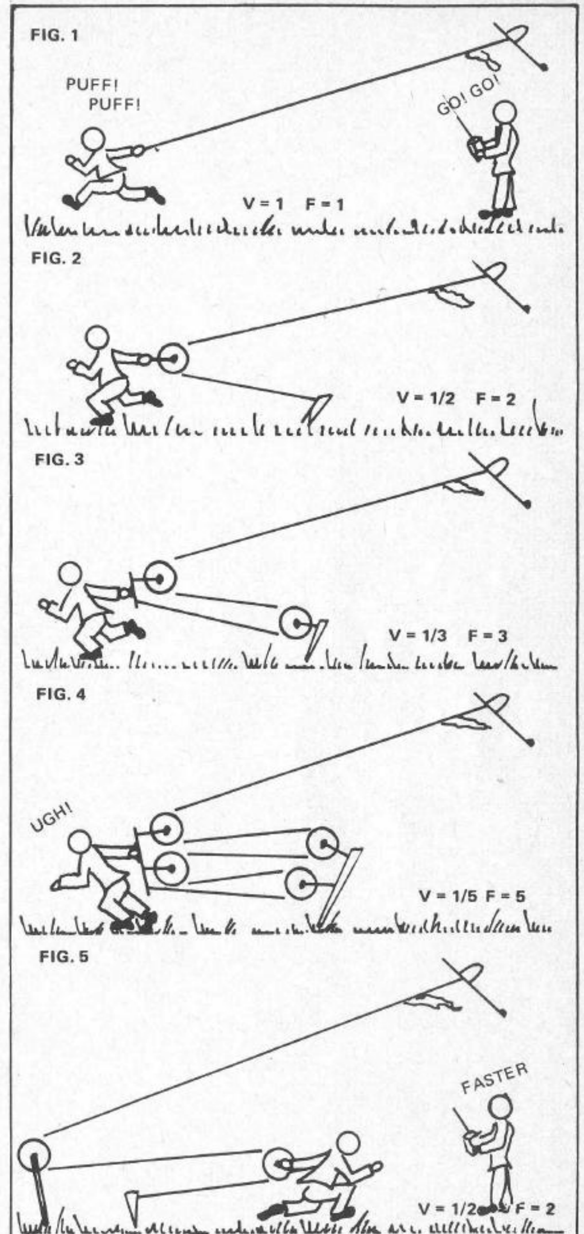
ILMAILU FINLAND

PULLEY LAUNCHING

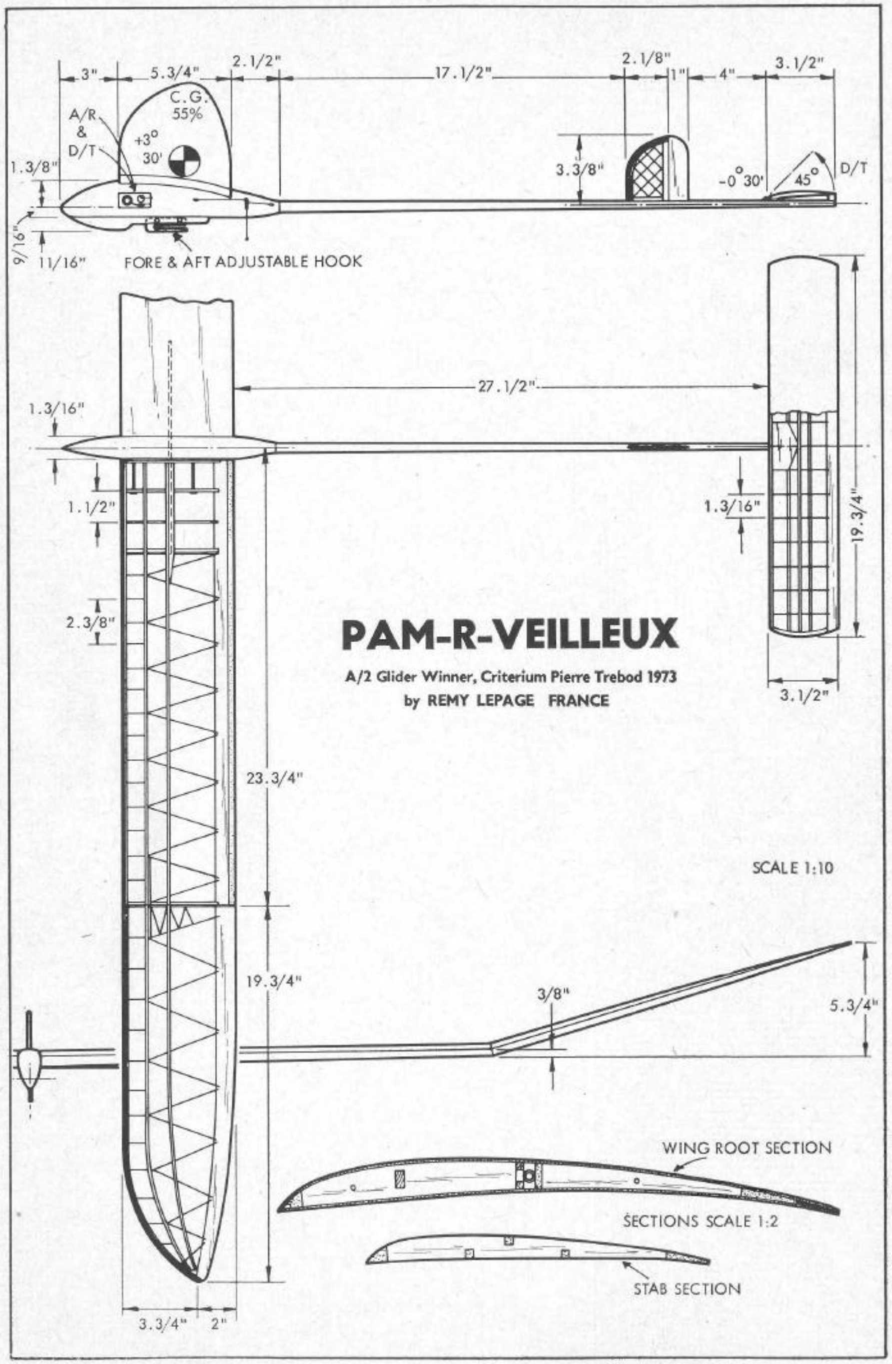
by Dr. Walter Good, U.S.A.

There is nothing more frustrating in model glider flying than being unable to tow to height, a glider that is too heavy for the prevailing wind speed. Radio gliders on long launch lines are frequently handicapped, hence the development of the powered (electric or internal combustion) winch. The ECCS Soaring Society in the U.S.A. opened a design contest in 1973 for winch and pulley tow ideas which produced many good and practical suggestions, the simplest of which was the sequence of 5 sketches by the R/C pioneer, Walt Good.

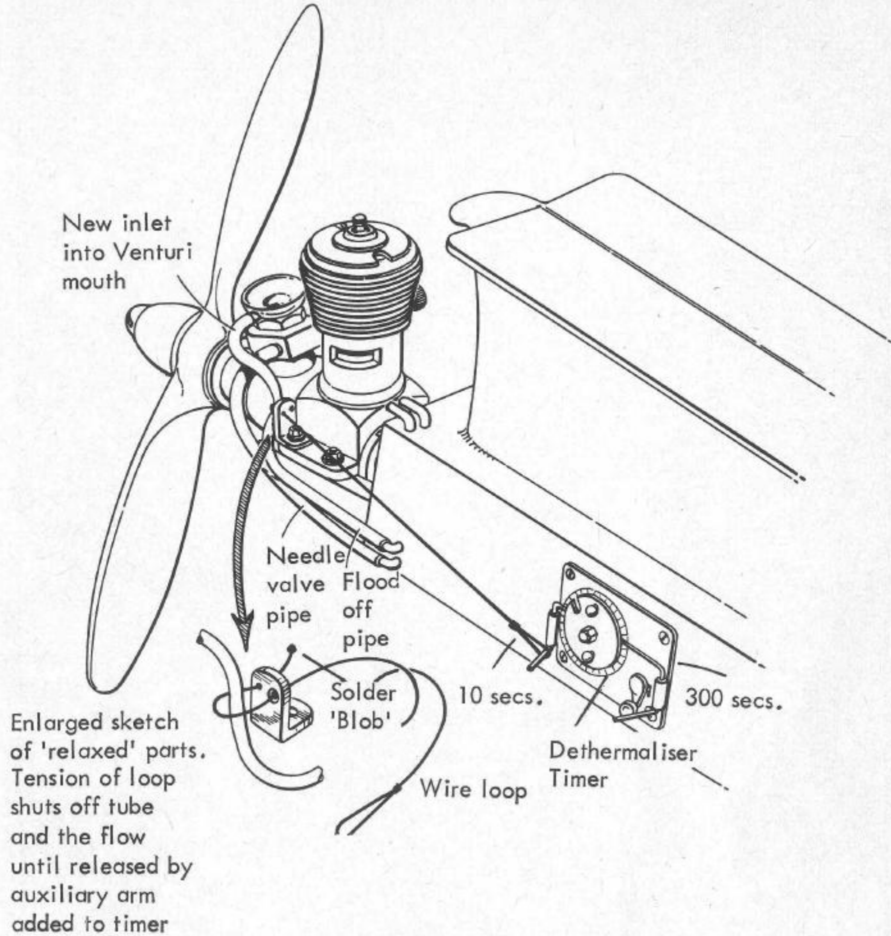
Spanish competitor in 1975 Eole Thermal Soaring International with a Scheme 5 pulley block.



GLIDER TOW METHODS WITH PULLEYS
V = Velocity of Towman vs Sailplane
F = Pull of Towman vs Sailplane
WALT GOOD 11-73



MODELE REDUIT D'AVION FRANCE



JIM CROCKET FLOOD OFF SWITCH

JIM CROCKET, of the Fresno Model Club, U.S.A., has derived a neat way to solve the long fuel line for competition flood off systems. It's a small clip that bolts to the engine mounting lug, and has 2 holes in one ear of the clip. The nylon cord that actually does the job of pinching the fuel flood-off line is routed through these 2 holes and then to the wire tab of the timer. When the timer is in the engine running position, the nylon cord pinches the fuel flood-off line closed. Then, when the timer unwinds to the engine off position, or in other words gets to the slot in the disc, the nylon cord is released, and the tension is taken off the pinched fuel tubing, and the engine is flooded off. Neat and simple, from Jim Crocket Replicas, 1442 N. Fruit St. Fresno, CA. 93728.

With Jim's "Switch", the flood-off line is less likely to let the engine stutter off since the shut off point is close to the venturi, and not back at the timer. *From San Valeers Newsletter, California, U.S.A.*

COMPUTERISED AIRFRAME WEIGHT CHECK —THE EASY WAY!

by Ron Warring

MOST every aeromodeller *must* have a pocket-size electronic calculator by now. So why not put it to good use by weight-check calculations when designing —or before building—your next model. The exercise can be very interesting— and the results most useful. And if you tackle it in a *simplified* manner, it's really very easy.

The trick is to work out 'section' sizes of units of $\frac{1}{32}$″ square. Balsa sizes are still standardised in inch fractions, and using this little trick will save any necessity of converting inch fractions into decimals to enter on your calculator.

The *key* is this little table which follows. It gives the weight in ounces per inch length of $\frac{1}{32}$″ square section for various balsa densities. These are called *density factors* and you will use the appropriate one in each calculation.

balsa density	*density factor*
lb./cu. ft.	
6	0·0000543
7	0·0000633
8	0·0000723
9	0·0000814
10	0·0000904
12	0·0001089
14	0·000127
16	0·000145

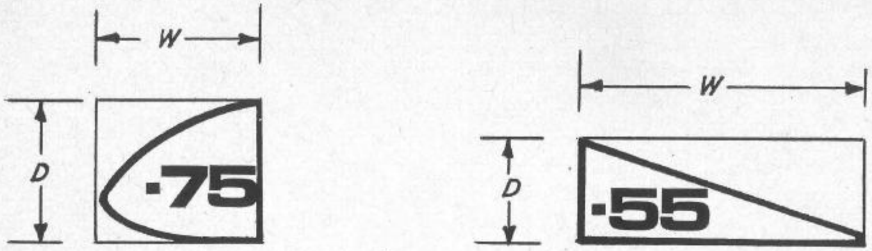


Fig 1

Every weight calculation is then based on *length* of the part concerned, its *section* expressed as so many $\frac{1}{32}''$ square units, and the *density factor* corresponding to the balsa density involved. As a simple example, let's work out the weight of a $36'' \times 3'' \times \frac{1}{4}''$ balsa sheet having a balsa density of 10 lb./cu. ft.

Length $= 36''$

Section $= 3'' \times \frac{1}{4}''$

$= 96 \times 8$ (expressed as $\frac{1}{32}''$ units)

Density factor for 10 lb. balsa = 0·0000904. Weight now follows by multiplying length, section and density factor, viz.

$36 \times 96 \times 8 \times 0{\cdot}0000904 = 2{\cdot}4993792$ oz.

or for all practical purposes, $2\frac{1}{2}$ oz.

There is another little trick we can use, too, to deal with sections or shapes which are not rectangular. Thus in the case of solid leading and trailing edges we can use the nominal *rectangular* ('W' and 'D'—see *Fig 1*) size of the section (in $\frac{1}{32}''$ units again) and correct for the typical section shape by multiplying by a *form factor*. For a typical leading edge the *form factor* is 0·75; and for a solid trailing edge 0·55—*Fig*. 1.

In the case of *ribs*, the chord is taken as the *length* dimension. The section is then taken as the maximum depth (D) of the section (in $\frac{1}{32}''$ units) multiplied by the thickness of the rib (again in $\frac{1}{32}''$ units). Typical *form factors* for ribs are 0·63 in the case of a solid trailing edge section, and 0·66 where a two-piece sheet trailing edge is used—*Fig*. 2.

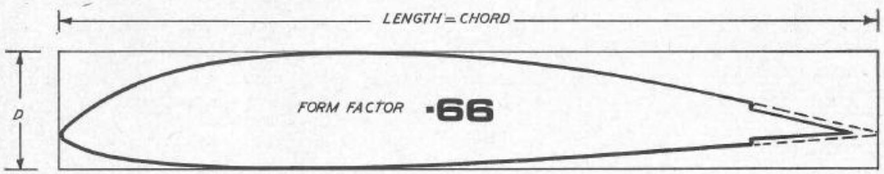
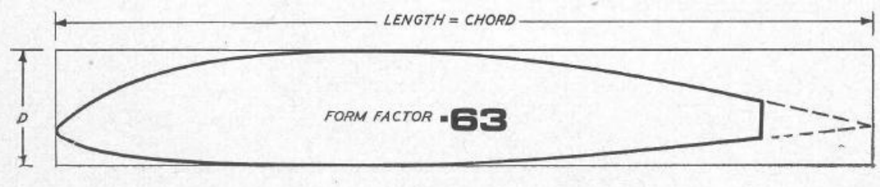


Fig 2



Now weight calculation becomes very simple, as the following worked out example will show. It is based on the wing design shown in *Fig*. 3. Weights are calculated for each of the component members in turn, based on multiplying together the following quantities:

number off
length
section (in $\frac{1}{32}''$ units)
form factor (where applicable, otherwise form factor = I.O.)
density factor

Leading edge—two off $29\frac{1}{2}'' \times \frac{1}{2}'' \times \frac{1}{2}''$—say 9 lb. density number (i.e. one for each wing half) 2
length 29·5
section (in $\frac{1}{32}''$ units) 16×16
form factor (i.e. as *Fig*. 1) 0·75
density factor (for 9 lb. density) 0·0000814
tap out the weight on your calculator *weight = 0·9221 ounces*
Top spar—two off $29\frac{1}{2}'' \times \frac{1}{2}'' \times \frac{1}{4}''$—say 12 lb. density
number 2
length 29·5
section 16×8
form factor I.O (i.e. with rectangular sections the form factor is unity and can be disregarded)
density factor 0·0001085 *weight 0·8194 oz.*
Bottom spar—two off $29\frac{1}{2}'' \times \frac{1}{4}'' \times \frac{1}{4}''$—say 14 lb. density
number 2
length 29·5
section 8×8
form factor 1·0
density factor 0·000127 *weight 0·4800 oz.*
Trailing edge—four off $29\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{16}''$—say 8 lb. density
number 4
length 29·5
section 48×2
form factor 1·0
density factor 0·0000723 *weight 0·8190 oz.*
*Ribs**—22 off $9\frac{1}{2}''$ chord (length), $1\frac{1}{2}''$ deep, $\frac{1}{8}''$ sheet—say 8 lb. density
number 22
length 9·5
section 48×4
form factor 0·66 (i.e. from *Fig*. 2)
density factor 0·0000723 *weight 1·9148 oz.*
Capping strips—22 off $4'' \times \frac{1}{4}'' \times \frac{1}{16}''$—say 6 lb. density
number 22
length 4
section 8×2
form factor 1·0
density factor 0·0000543 *weight 0·0765 oz.*

* Note: For a straight tapered wing base length (chord) and depth (D) of rib on *average* size of rib, or mean size between root rib and tip rib

Tips—two off $9\frac{1}{2}'' \times 2'' \times 1\frac{1}{2}''$—say 6 lb. density
number 2
length 9·5
section 64×48
form factor—difficult to estimate but say 0·75
density factor 0·0000543 *weight 2·3770 oz.*

Write all the individual weights down separately and add them up with the calculator:

leading edges	0·9221
top spars	0·8194
bottom spars	0·4800
trailing edge	0·8190
ribs	1·9148
cap strips	0·0765
tips	2·3770
total	*7·4088 oz*

That is the *design weight*, based on selecting sheet and strip balsa to the specified densities. The final (uncovered) wing weight will inevitably be higher because no account has been taken of the weight of adhesive, or dihedral braces. The latter can be calculated separately if you wish, using a density factor of 0·000435. For adhesive weight an additional allowance of 5% of the total should be adequate, but the 'old-fashioned' or pre-computer days aircraft designer would normally add 10 per cent to his estimated weight figure to be on the safe side. Just as CG positions tend to come out a little aft of the original design position, finished weights tend to work out heavier than estimated weights!

Weight control

The breakdown of weights is also useful to study when you want to save weight. In the worked out example, for instance, the tips are disproportionately heavy. They are decorative rather than functional—yet they weigh more than the ribs. This would point to saving weight by hollowing the tips right out—or using a lighter type of tip construction than carved from solid (particularly as 6 lb. density block might be hard to find for the tips).

It's easy, too, to use this weight breakdown to work out the weight of balsa sheet and strip to select from your stock. For example, 8 lb. density is specified for the trailing edges. A simple calculation will show how much a $36'' \times 3'' \times \frac{1}{8}''$ sheet of this density will weigh:
length 36
section 96×4
density factor 0·0000723
weight 1·0000 oz.
So in addition to your calculator you need an accurate letter balance or weighing machine! And don't forget, it's just as easy to work out estimated weights for fuselages and tail units of virtually any type of construction—provided you can 'guesstimate' or work out realistic form factors, where applicable. The following additional *density factors* will also be useful when using woods other than balsa:
obechi 0.0002198 spruce 0·0002940 birch 0·0003636

Incidentally, now that you are finding your pocket calculator fun to use, an amusing exercise is to calculate the equivalent volume of wood in terms of a 36″ length. A volume figure (not the true volume) is given by multiplying together the following:

number off
length
section
form factor (where applicable).

Using the same wing again as an example, the 'volume calculations' are:

$2 \times 29{\cdot}5 \times 16 \times 16 \times 0{\cdot}75 = 11\,328$
$2 \times 29{\cdot}5 \times 16 \times 8 = 7\,552$
$2 \times 29{\cdot}5 \times 8 \times 8 = 3\,776$
$4 \times 29{\cdot}5 \times 48 \times 2 = 11\,328$
$22 \times 9{\cdot}5 \times 48 \times 4 \times 0{\cdot}66 = 26\,484$
$22 \times 4 \times 8 \times 2 = 1\,408$
$2 \times 9{\cdot}5 \times 64 \times 48 \times 0{\cdot}75 = 43\,776$

Now add together all these individual volumes—
total = 105 652
Divide by 36 = 2934·7.
(This figure gives the cross section, in $\frac{1}{32}''$ squares, of a single equivalent block of wood 36″ long.)
Find the square root of this volume figure = 54·174
Divide by 32 = *1·6929*
This gives the dimensions of a square section, 36″ long, equivalent in volume to all the wood in the frame. In other words, all the wood in the wing amounts to the same as a 36″ length of 1·6929—or say $1\frac{11}{16}''$ square balsa block.

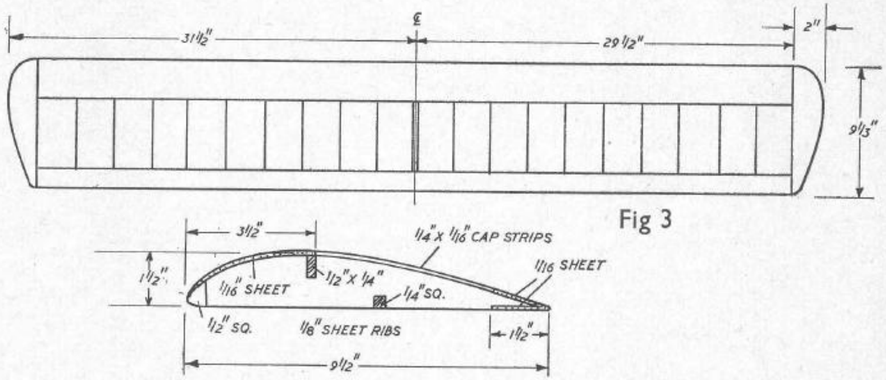
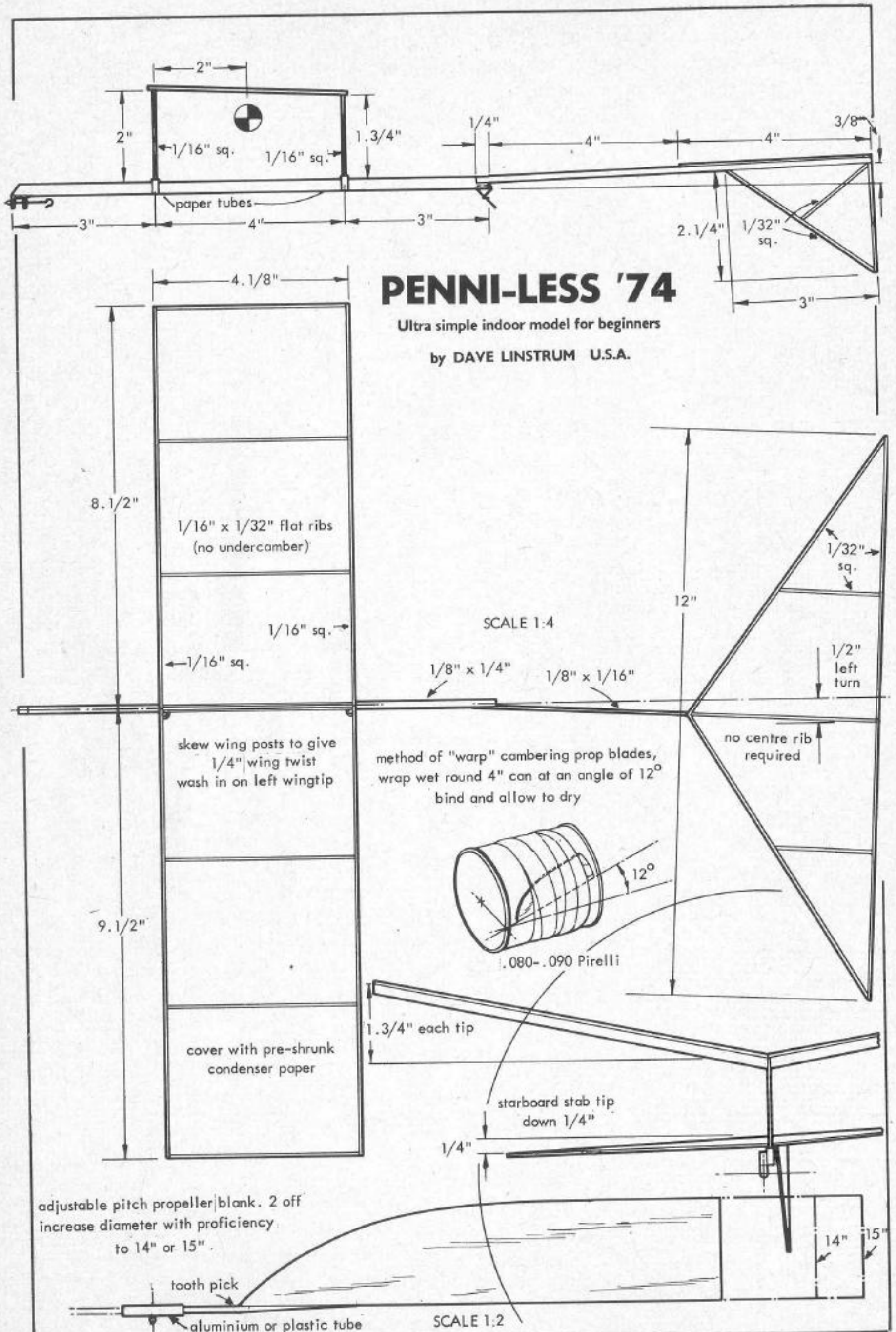
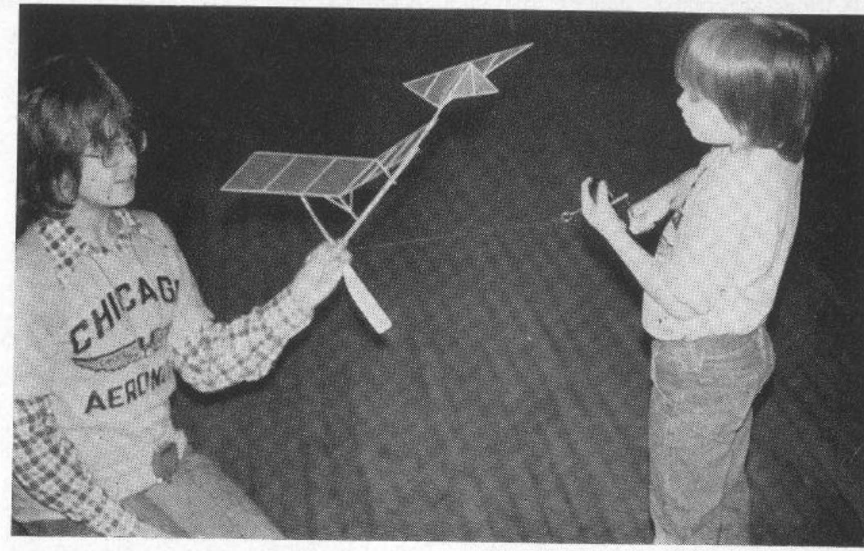


Fig 3



FLYING MODELS U.S.A.



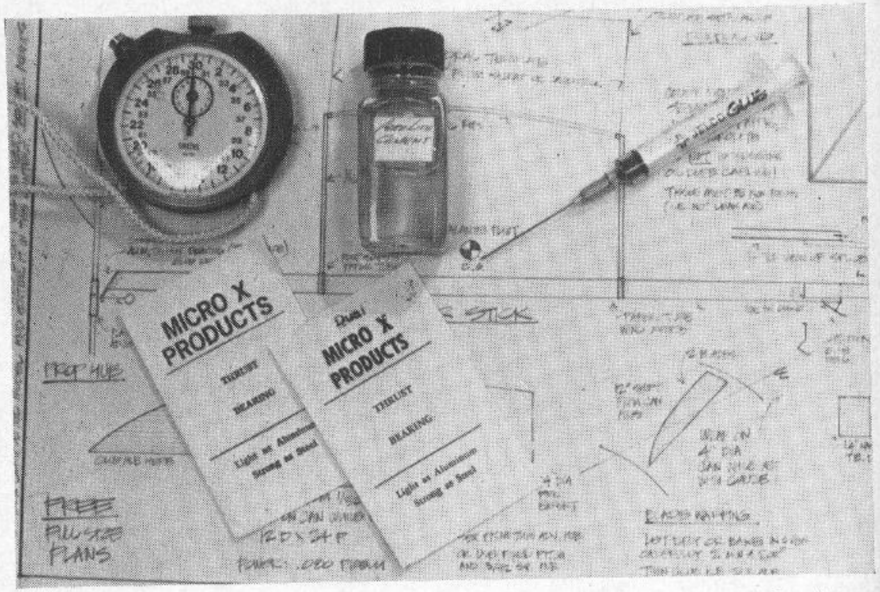
Author's son, Carl, winds his simple 'PENNI-LESS' as sister Mindi holds. Note Club T-shirt. This winding form is typical.

PENNYPLANE POTPOURRI
by Dave Linstrum VTO

THE AUTHOR has been flying Pennyplanes for over half a decade now, and the class is his favourite beyond a doubt. There is no other indoor type rubber model that is so *much* fun to fly with so *little* effort involved. Peanut scale comes a close second, but there the effort involved in building even a "standoff scale" replica is considerably greater than that of making a Pennyplane. Even the slowest of builders can fabricate a simple Pennyplane in a few hours.

The most recent Pennyplane built by the writer was assembled at the dining room table of good friend Pete Cameron of Crawley, Sussex. Pete sat opposite us and built his own version, taking a little longer since it was his first, and we had built over a dozen of the craft. The new models got their baptism at the Crawley Club meeting that evening, and the next day were flown in the Aeromodeller offices. There were sufficient hazards in the latter site to prevent any sort of record being set, except perhaps number of hang-ups on a R/C helicopter body hanging in the office!

Why does Pennyplane provide such fun and fascination, for both neophyte flyer and indoor expert? First you have to understand what a Pennyplane is—simply a very rudimentary paper covered indoor endurance model, with a minimum weight of a bit over 3 grams *sans* motor (the name derives from the weight limit, governed by the U.S. copper penny) and maximum span and length of 18 in. (45·7 cm.). Specifications have purposely been kept simple to allow a certain amount of design latitude that will stimulate experts to try new



Surprisingly, it is easy to go overweight if glue is over-applied (use syringe to apply drops). Light alumn. bearings are best.

concepts for greater endurance. The models are fun to fly because anyone with even a small amount of building skill (the author's son built one when he was six) can put one together with ordinary wood and tools, then get reasonable flights of several minutes without difficult trimming.

Pennyplane may be flown in almost any sort of hall, from a school gymnasium to a hangar, or even Cardington Airship Shed. Models are sturdy, thus easily handled by beginners and easily retrieved from hangups without danger of total destruction. A very real aspect of the fun is watching people who have never built an indoor model get good flights on their first go—there is no satisfaction like seeing beginner success. Meanwhile, the experts still have a challenge in wringing the last bit of time out.

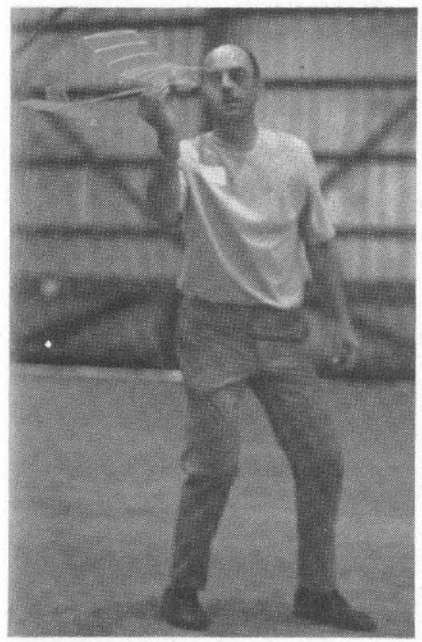
The concept for the event was originated in 1969 by Chicago Aeronut Erwin Rodemsky, who was basically dissatisfied with the results of "EZB" as a beginner event. EZB, or Easy B if you like, has no weight limit but a lot of other restrictions. Models must be built with hard-to-obtain indoor wood to be competitive. "*Captain Pennyplane*" Rodemsky (he is a Captain with American Airlines) thought the answer might be in a minimum weight limit that would allow outdoor balsa, or indoor wood and a bit of ballast for experts. The span and length needed limits to provide some uniformity in competition. Also the motor length, as a function of the distance between hooks, needed a limit to prevent a strong competitive edge gained by extra turns. Yet everything else was left wide open, to help stimulate design innovation. That this simplicity with open-ended rationale has worked is evident in the great variety of designs created in the class. Some of these are illustrated in the drawings, and photos which accompany this article. This is by no means an exhaustive compilation of designs, but merely a representative cross section of the breed.

The official Pennyplane rules, as formulated by the Chicago Aeronuts and used at the First Annual Pennyplane Event at the 1970 Chicago AMA Nationals (where the authors' models were flown by proxy) are as follows:

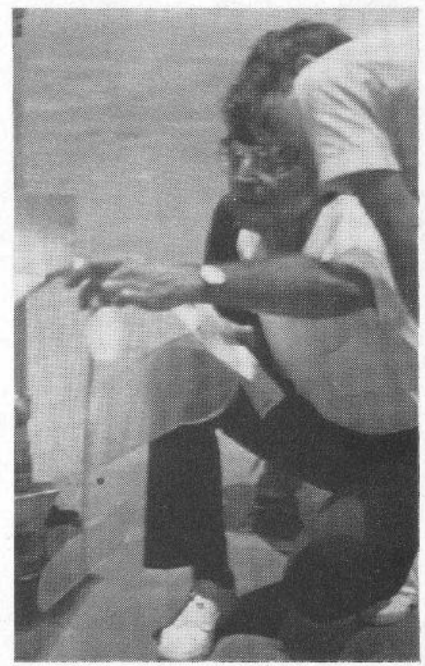
1. Model must weigh at least as much as a new copper penny.
2. Must not exceed 18 in. in length (including propeller) or wingspan.
3. Motor stick must not exceed 10 in. (from front of thrust bearing to rear hook).
4. Single rubber motor and propeller (no gears).
5. Motor must not be enclosed in body or motor stick.
6. Model must be weighed prior to each official flight.
7. Scale can be $\frac{1}{8}$ in. × 1 in. × 18 in. balsa, with a razor blade pivot in the center. The penny should be glued to one end, the other end projects over the edge of the table and the model is hung on the scale. The timer must make sure that no weight is removed prior to flying; and if model is retrieved, must be weighed after the flight.
8. Five official flights are allowed.
9. Highest single flight time wins.

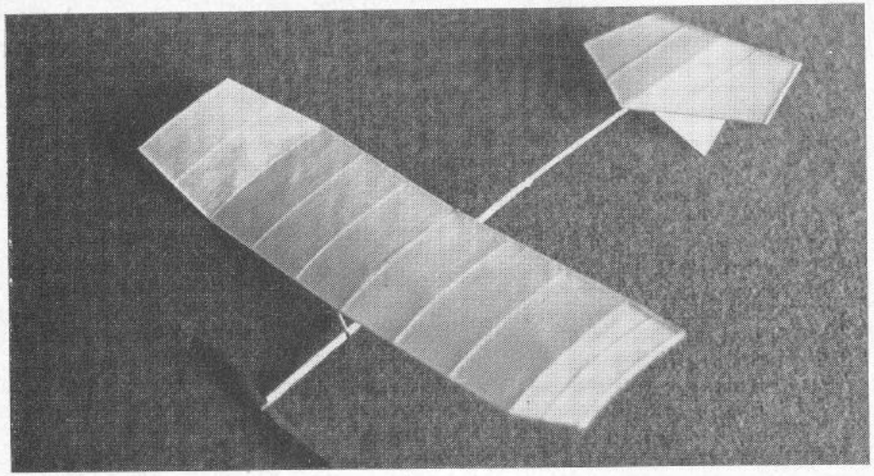
While these rules were very good indeed and stimulated a lot of interest in flying the class, the experience of running the event at the past five Nationals plus uncounted smaller meets (including some in the UK and in Sweden, where the class is known as 25 Ore Plane in deference to the Swedish 3 gram coin) has mellowed opinion to the extent that rule modifications are being considered. The class has been proposed to the Academy of Model Aeronautics for official status by Robert Meuser of Oakland, California. He suggests the following rules, which

Bob Hayes of sponsoring club, Chicago Aeronuts, about to launch his Sotich design "DUFFER DIP".



Stan Chilton weighs in Dan Brown's model (Jaecks' design) on typical scale, deflecting piece of piano wire. Model hung by Shaft/bearing.



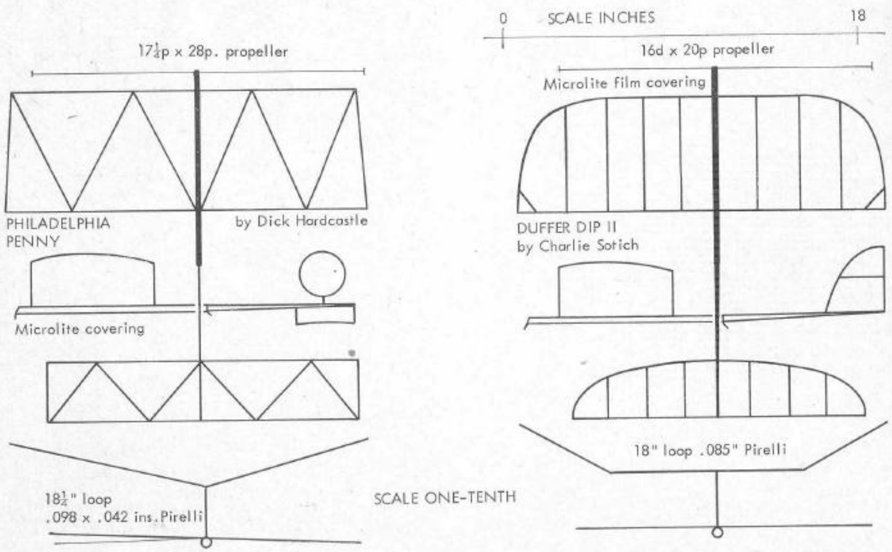


Author's crude Mather design "CALIFORNIA PENNY" built in Beirut weighed 3 cents with plastic prop, but still flew (just). No proper materials were available.

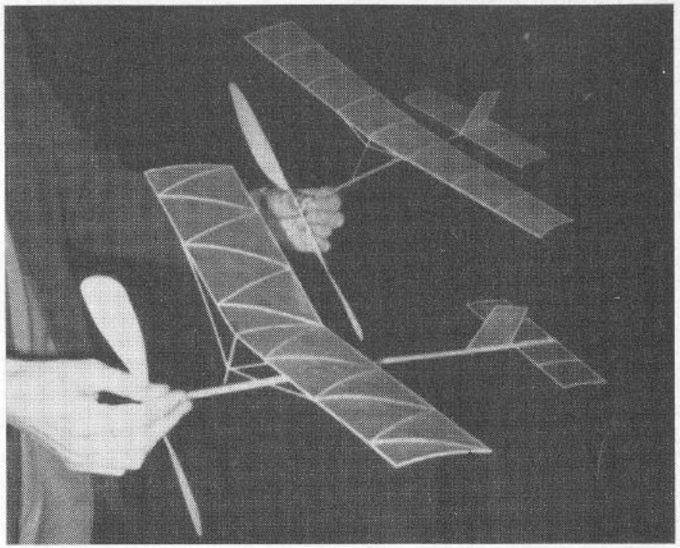
take into account the variation in performance between expert and beginner creations. The rules as currently debated by the AMA Free Flight Contest Board are:

PENNYPLANE
Except as noted below, the rules for FF INDOOR RUBBER, HAND-LAUNCHED STICK MODEL shall apply.

1. The model shall weigh at least 0·109 oz. (3·10 grams), (approximately the weight of a new U.S. copper penny) without the rubber motor.
2. The overall length, excluding the propeller, shall not exceed 18 in. (45·72 cm.).
3. The projected wing span, measured perpendicular to the motor stick, shall not exceed 18 in. (45·72 cm.)
4. The distance from the front of the thrust bearing to the rear of motor hook shall not exceed 10 in. (25·4 cm.). For pushers, interchange the words "front" and "rear".
5. A single direct-drive (ungeared) rubber motor and propeller shall be used.
6. The rubber motor shall not be enclosed.



Two British Pennyplanes seen at one of the Cardington Airship Shed meetings organised by the S.M.A.E. at rear, by Brian Kenny, and in foreground by Dave Goodwin.

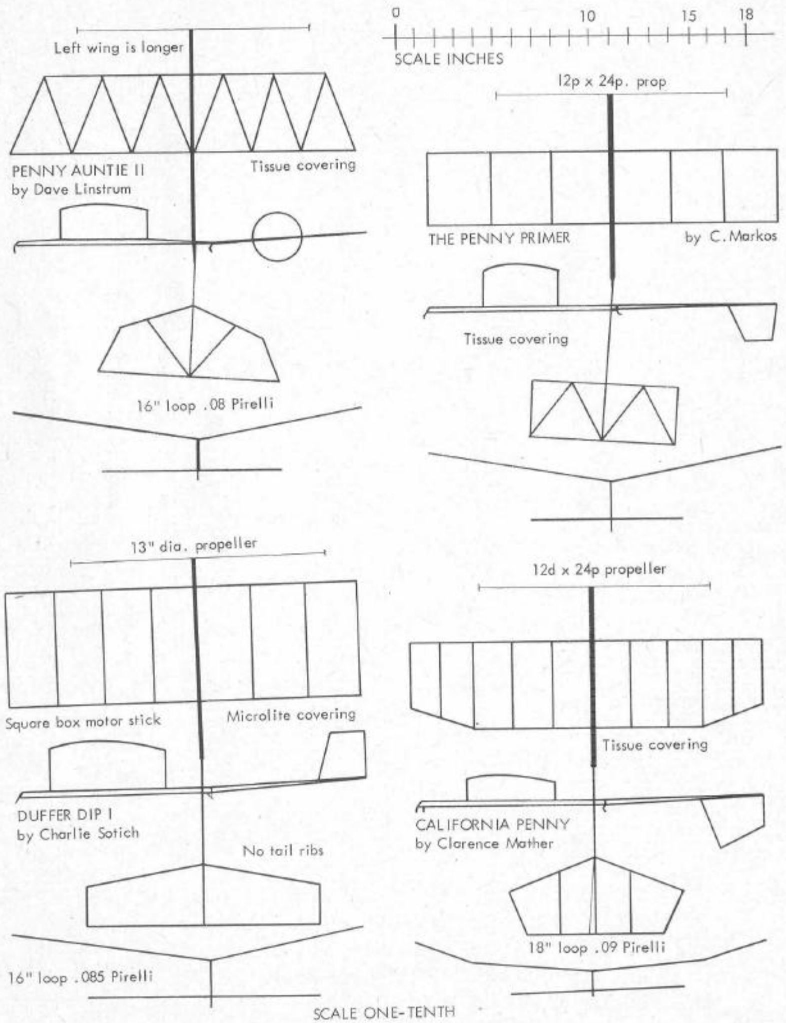


NOVICE PENNYPLANE
EXCEPT AS NOTED BELOW, THE RULES FOR **PENNYPLANE** APPLY

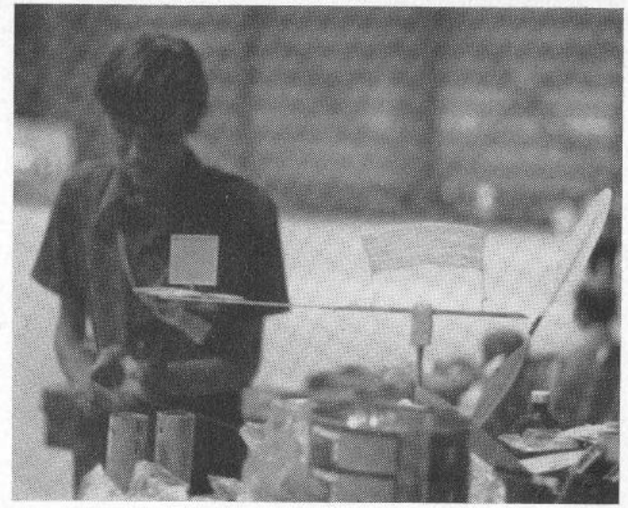
1. The wing chord shall not exceed 5 in. (12·70 cm.).
2. The dimensions of the horizontal stabilizer shall not exceed 4 in. chord by 12 in. span (10·16 × 30·48 cm.).
3. The motor stick shall be solid, and made from a single piece of wood. (The tailboom may be another piece.)
4. The propeller diameter shall not exceed 12 in. (10·16 cm.).
5. No "gadgets" of any kind are permitted on the model. (i.e., variable pitch props, automatic incidence changing mechanisms, etc.)

One other fun aspect of the event is the natural opportunity for amusing names used in christening new designs. There has been a strong tendency for designers to make puns on the event title, with such unlikely names as "*Penny Auntie*", "*Penny Wise*" (MAP Plan D 1110) and "*Penny from Heaven*" created by the author, the "*Penny Primer*" by Aeronut Chuck Markos, "*Plain Penny*" by Clarence Mather of the San Diego Orbiteers, and the "*Philadelphia Penny*" by St. Louis flyer Dick Hardcastle. The latter is a numismatist's name—the coin is the one minted in Philadelphia. Probably the most outlandish name—and design—is the one created by wag W. C. Hannan (another Orbiteer) in his "*Square Deal*" Pennyplane. This is 18 inch span, 18 inch length and all wing—simply a big square wing! It has a small vent in the midriff and a reflex trailing edge for stability. Other freak types include the tandems flown by John Kukon and the canards tried by Walt Mooney, Bill Gough, Dick Lyons and others. Colonel Bob Randolph came up with a "*BiPenny*" biplane to round out the unorthodox group.

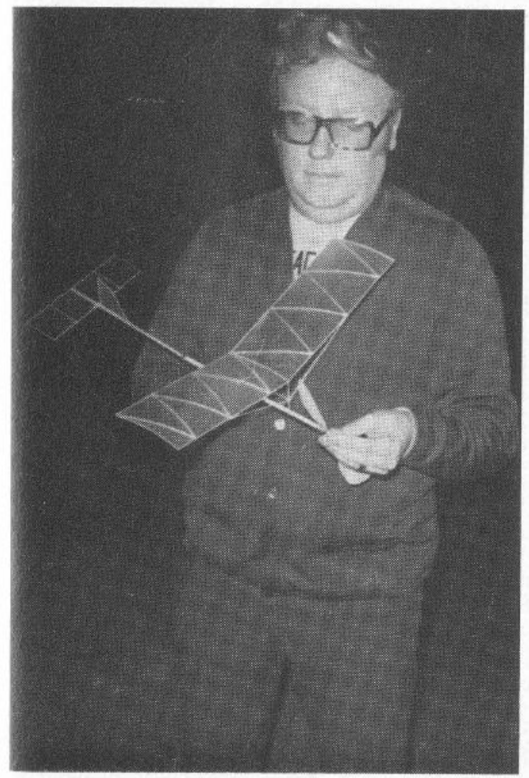
The above notwithstanding, the normal monoplane tractor configuration has been the most successful for the most flyers. However, evolution here has been considerable. Early designs of the season saw rather narrow wing chords, efforts to achieve rigidity with geodetic structures, and relatively small stabilisers. Props were generally small and high rpm, since a slow moving prop cannot climb a heavy model. As modellers gained more experience with the class, the designs became more attuned to performance. Wing chords increased (even to 18 in. as Hannan showed) to double the original width, prop diameter increased several inches, hollow tube motor sticks became popular, and stabs got bigger, with radically greater spans. These items shot flight times up from about 9 minutes to 12 and 13 minutes in a site with about a 100-ft. ceiling. Personalities involved in this design for ultimate performance crusade included Charles Sotich of the Aeronuts, Tom Sova, and Dennis Jaecks, current Pennyplane record holder. Not to be outdone, Rodemsky came up with an ultimate design with a wing chord equal to the motorstick! One wonders if he could get the thing to fly without the prop nicking the wing LE. While these expert models set the high times, beginners were still learning, and having a ball, with simple, small models with props of about a foot diameter. Adjustable pitch props (pre-set before flying) as developed by Chuck Markos helped beginners to adjust models according to motor and air type.



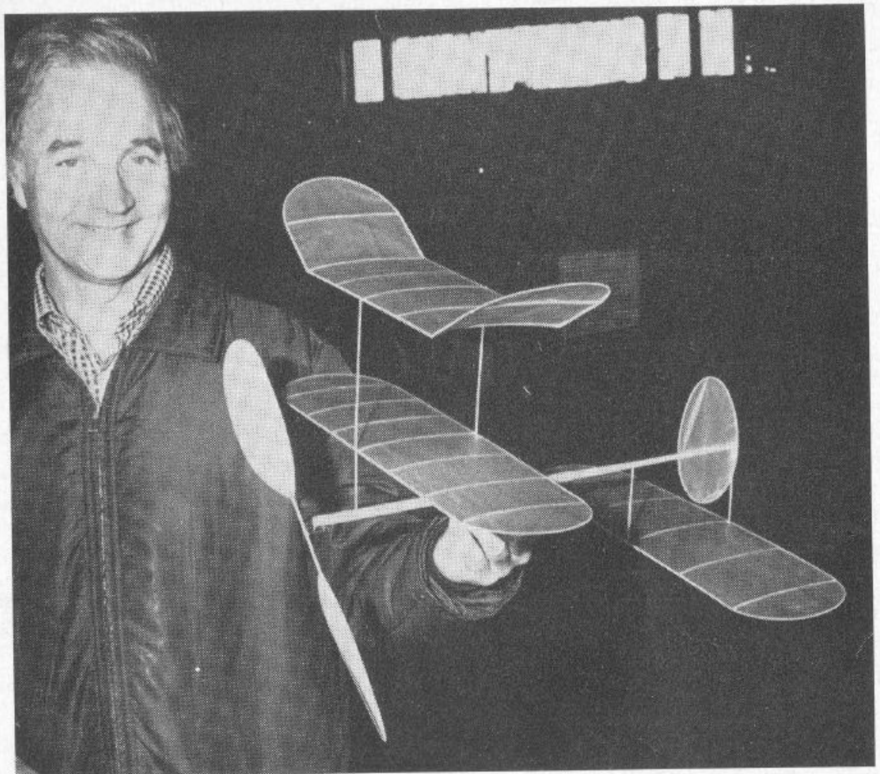
"PENNYPLANE" rests on typical split-sponge-on-a-stick run down stand at 1974 U.S.A. Nats—4th Annual Pennyplane in Blimp Hangar at Houston, Texas. Note strange fin-on-a-stick, adjustable pitch hub prop.



Below, Dave Goodwin of Sheffield with one of his Pennyplanes.



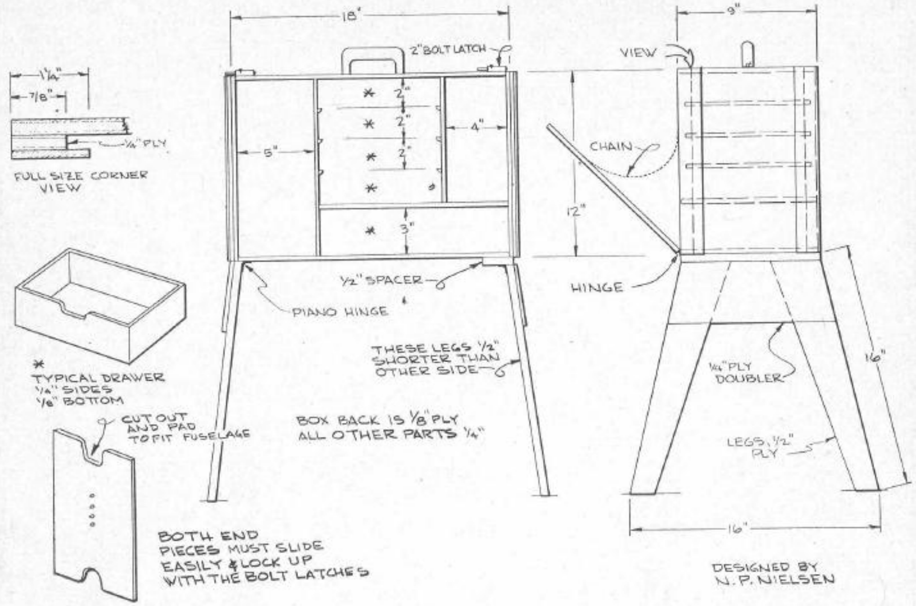
Now that Pennyplane has come of age and is being considered as an Official AMA Event, where do we go from here? The author believes that evolution of the expert class will go toward increasing areas and prop diameter, while keeping component weight to an absolute minimum through use of light wood and light covering such as microfilm or the polycarbonate film Micro-Lite. Ballast added on a very short nose will get the weight up to a penny's worth. Beginner models will tend to become more alike, almost like a one design class, with more simplification of structure and thought given to foolproof construction and trimming technique. The design with the minimum number of pieces, squared off, quick to build from common wood, with a prop adjustable to the motor for good climb and cruise, will give the beginner the most satisfaction.



Inspired by an American interpretation of the rules by Doug McClean, Reg Parham made this Biplane (Triplane?) condensor paper covered large area model, which suggests further permutations.

We hope that we have whetted your appetite to try Pennyplane. While Easy B has been a common enough event at UK indoor contests, Pennyplane is only now taking hold. Expert outdoor flyer Dave Goodwin of Sheffield has tried it—and come back for more. Full size plans are available for the beginner design "Penny Wise" (MAP Plans Service) which appeared in the June 1971 issue of Aeromodeller (Plan price 35p from APS, 13 Bridge Street, Hemel Hempstead, Herts.) A more sophisticated type is the "*Penny from Heaven*" (also by the author) which appeared in the June 1975 Model Airplane News. Full size plans are available by sending $2 to MAN, One North Broadway, White Plains, N.Y. 10601, U.S.A. Indoor supplies such as motors, wire, bearings, etc. may be purchased from Laurie Barr, 4 Hastings Close, Bray, Berks.

One of the nicest things about Pennyplane is the way it develops confidence to try more sophisticated indoor models, particularly the fragile FAI microfilm types such as will be flown at the Indoor World Championships at Cardington in 1976. If you are able to get good time from a simple Pennyplane, you are well on your way to learning how to get 30 minutes from a microfilm model with only one third the all-up weight. Then you will need the info in "Indoor News and Views" edited by Bud Tenny, Box 545, Richardson, Texas 75080, U.S.A. Write to him for subscription rates. You might as well know that he created the last word in Pennyplane names—the "*Tenny Penny*".



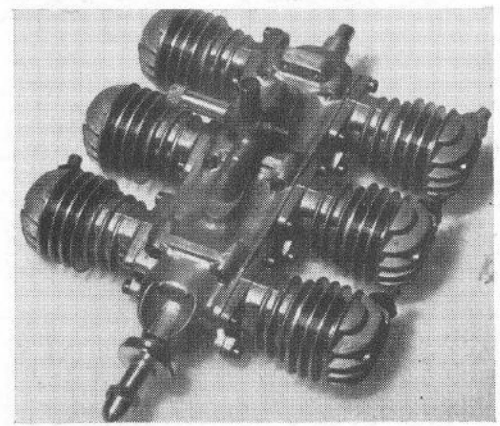
PORTABLE FIELD WORKSHOP *from Northrop RCMAC—USA*

MODEL ENGINE MISCELLANY

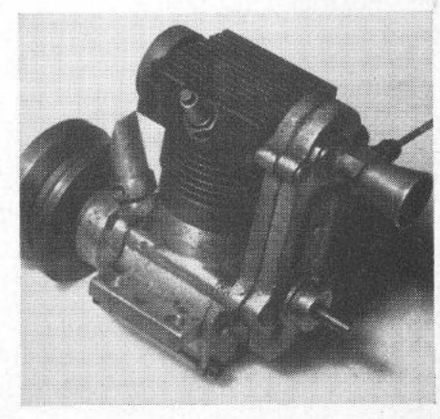
Many moons ago, R. E. Nichol, otherwise known as "Doc the Mad Modeller", set out on the task of preparing a "*Pictorial Model Engine Atlas*". Doc's labours took him throughout the U.S.A. to Japan and Europe. He collected a fantastic variety of photographs and logged thousands of different model aero engines for his task. They included steam, compressed air, diesel, glow plug, carbide, petrol ignition, in fact, every known means of reciprocating action to drive a propeller.

In the end, Doc himself disappeared from view (*where* are you now Doc?), leaving us with a large selection of his collected photos in the hope that one day we might break the price barrier to produce what would be a directory of engines in picture form.

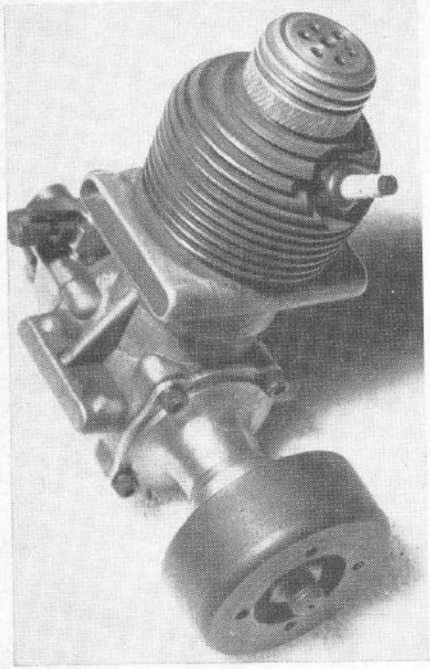
Rather than wait forever, this small group of the unusual among his subjects, is chosen to show that there really is nothing "new" in the world of miniature engine design. Some are of prototypes; others actually went into production but in the main, each effort to seek more efficiency or power output by less than conventional means, ended when it came to trying to sell the product; for despite all his curiosity and clamour for something "different" there's no-one more conservative than a modeller when buying a new engine!



FLAT-SIX Dan Calkins started making Elf engines in Portland, Oregon during 1932. By 1935 he was selling the Elf Corncob and in 1940 had a line of single, twin and four cylinder units that became famous for their extreme power to weight ratio. The "6" was the ultimate. It had a compression ratio of 20:1, used glow plug ignition, sold at 75 dollars and was ·594 cu. in. Induction was by reed valve. But the crankshaft was tough to make so the production was short-lived.

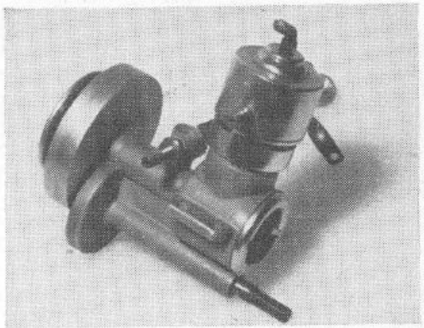


ROTARY VALVE 4-STROKE Tom Dooling, Jr. made model engines from 1936, became involved with race cars for Reginald Denny and after many experiments, made the world beating '29 and '61 racing engines for which his name is best known. Meantime this 4-stroke which has the distinction of an intake in front and exhaust at the rear of the cylinder head, was one of the experiments. It ran up to 28,000 rpm, had a bore of .94 and stroke of ·875 ins. but the rotary valve bearing lubrication was its weakness.

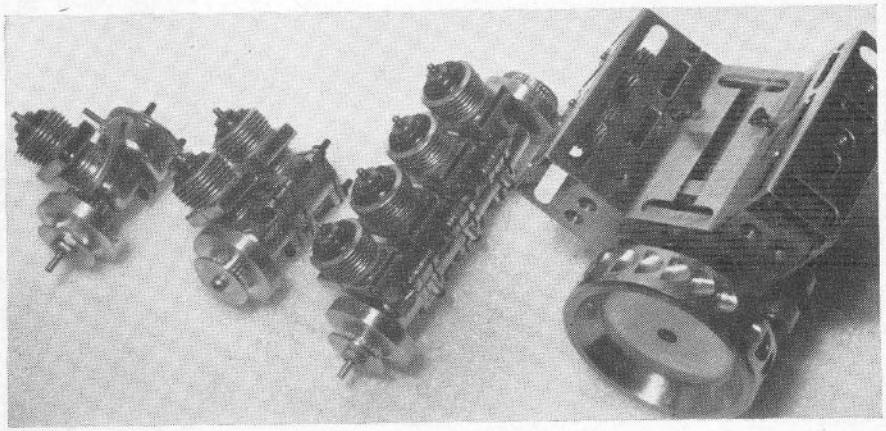


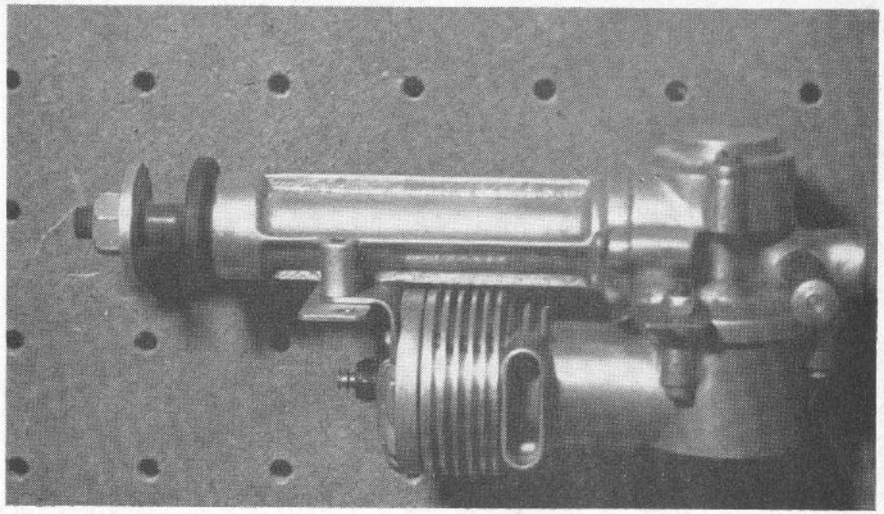
Left: **PEPPERPOT HEAD** Dooling stepped piston engine which did not work out but was a brave attempt to miniaturise what has been moderately successful in full scale practice.

Below: **GEARED MARINE UNIT** In 1959, the Hungarian State model engine factory saw the answer to the problems of small marine engines in their 1cc "Seal" diesel. The Crankcase incorporated a second shaft housing for geared drive to the propshaft, leaving the flywheel free of any coupling complications.



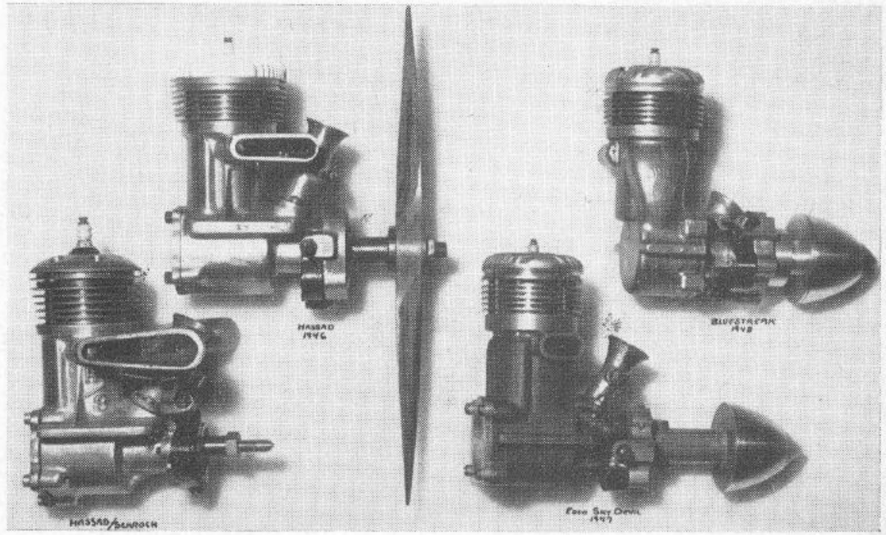
Below: **VARIATIONS ON A CYLINDER** From 1955 to 1960 the K & B Allyn "Marfury" ·060 unit appeared in many guises. Single and twin cylinder glow plug marine versions were made in quantity and modellers saw the possibilities as in the four-in-line and the vee-four marine examples here.

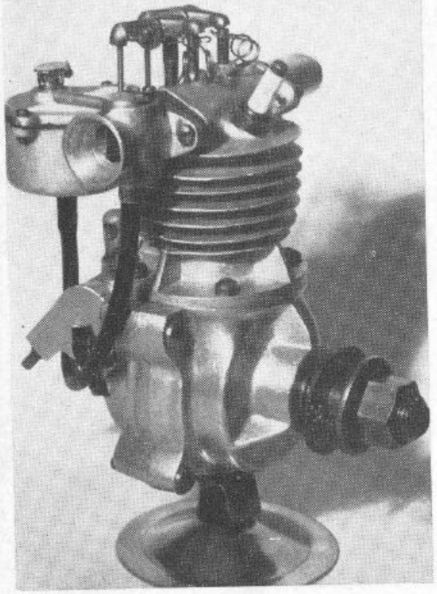




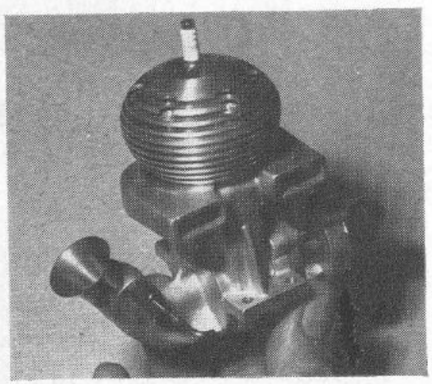
SIDEWINDER Clarence Lee produced custom made engines leading up to the famous Veco 45 and others. In 1952 he made the '29 Sidewinder and in 1954, eight more were made with K & B engines. The means of turning the shaft around a corner is an intriguing solution to streamlining.

HASSADS Ira Hassad designed many engines for production starting here with the Hassad/Schroch c1 1941, a ·605 racer with spark ignition, forward exhaust and rear transfer passage through the EDCO Skydevil series to the Bluestreak (top right) of which 2,000 were made· The contrast in carburettor intake lengths and the change to conventional side exhaust after a significantly prophetic beginning with large manifolds shows how Hassad was obliged to be "ordinary" to sell his products.



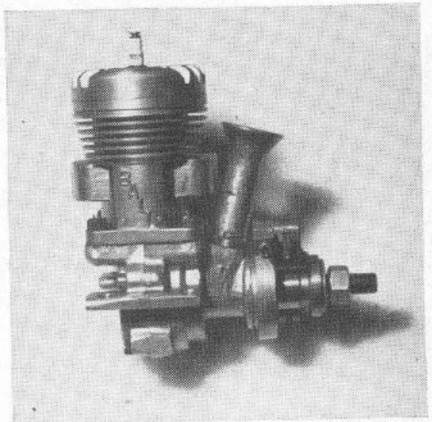


Above: **OHV 4-STROKE** with a split case, the Feeney was a wartime classic in three sizes, 10cc, 15cc and 20cc, by Jack Feeney and Casimier Leta of Chicago. Sold complete or in kit form the Feeney was the American equivalent of Edgar Westbury's British designs but the market for four-strokes was — and always has been — very limited.

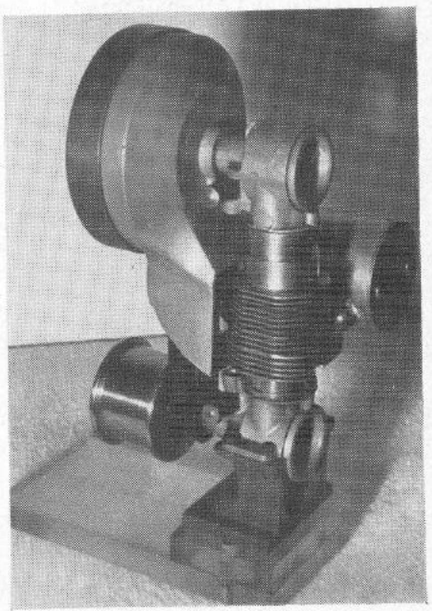


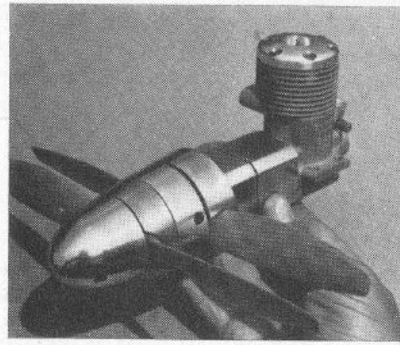
Above: **CAVE COBRA 60** One of the first with a form of ducted or directed intake flow from the rear carburettor, the 1947 Cobra was for racing cars but had an attraction for speed control line. Exhaust manifolds collected from ports at front and rear with transfer passages at sides of cylinder.

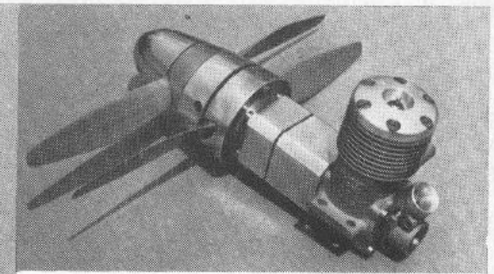
Below: **BALL 604.** By B & D Racing Engine Labs of Michigan, the massive Ball 60 was all intake and exhaust. It could rev to over 20,000 r.p.m. once started with a small propeller, or flywheel but like most of its 1948 contemporaries was limited by the ignition system.



Below: **HEAD TO HEAD** Opposed pistons in the Bruce Underwood Yellow Jacket 75 cu. in. prototype with a common combustion cranker. Made with Vivell crankcases it has an impeller cooling fan and a silencer.

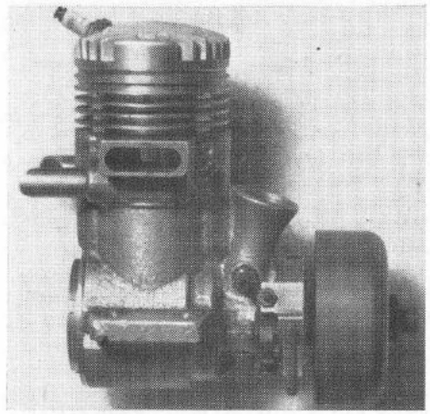


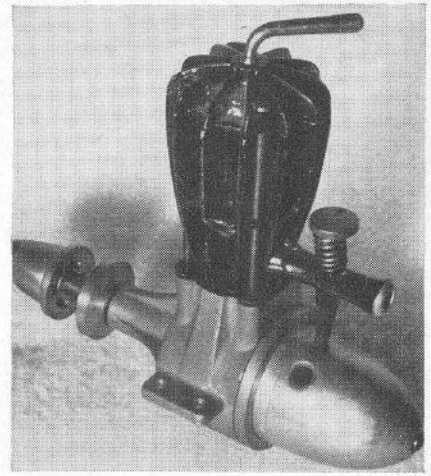




Above: **CONTRAPROP** Experimental Super Tigre ST24 has a co-axial shaft and gearbox unit on the crankshaft housing, to drive the contra-rotating propellers. Drive losses rarely justify the advantages.

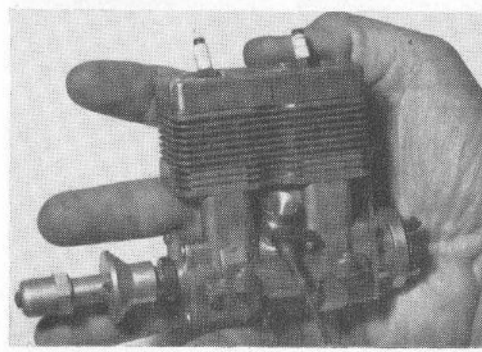
Below: **DOOLING DUAL** Tom Dooling's two stroke with 2 of everything. Doc Nichol's information reads:— dual pybass porting both intake and exhaust plus dual case relief. Both shaft and rotor induction, a supercharger was to be fitted to the rear, attached to case relief ports, but performance was the same without the supercharger.

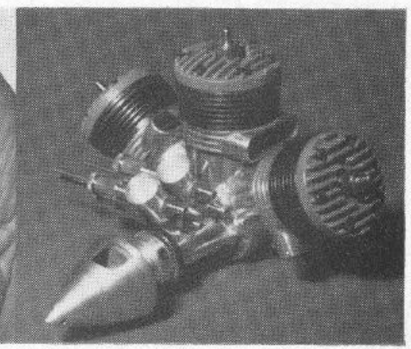


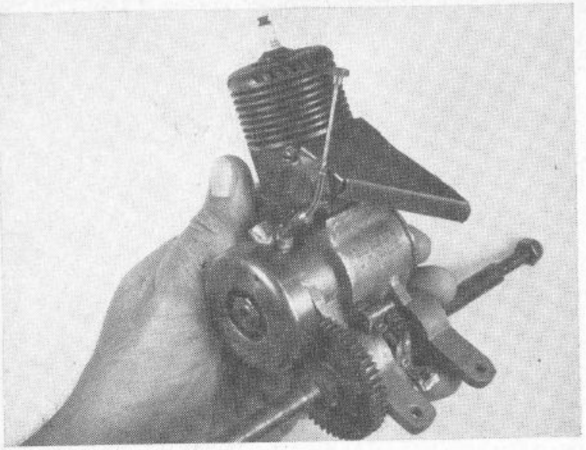


Above: **PEARDROP** Italian Helium C-6 diesel of 1946 Vintage used an all cast cylinder jacket with vertical fins. Like most large (6 cc.) diesels of this period, the crankshaft was a weak point.

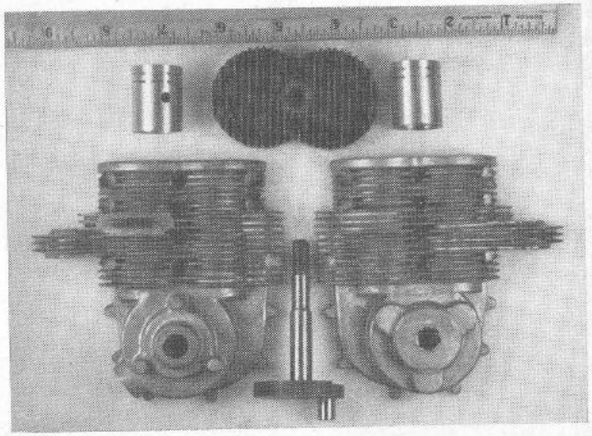
Below: **MULTIS** Left is the superb Dooling ·604 twin, bore ·719 ins. stroke ·750 ins and right, a K & B "Fake" radial "three" which would not be beyond the bounds of possibility though presenting a distinct challenge of balancing!



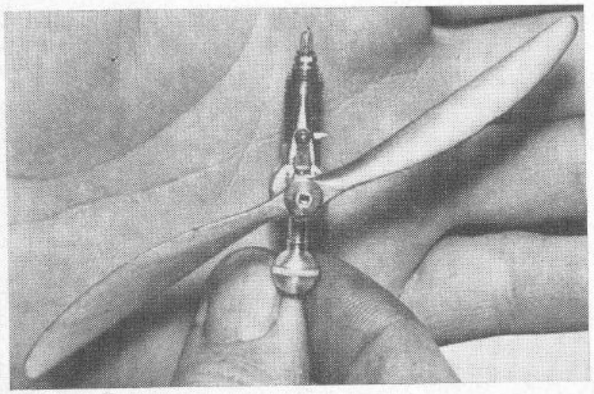




HILLER AXLE DRIVE Made for racing cars, with an incorporated axle/gear/mounting unit, the Hiller Hornet ·647 cu. in. was a petrol ignition engine produced for the Comet car.



SPLIT TWIN Two cylinders with a common combustion chamber as used by the Puch motors for motorcycles. Bores and stroke timing vary in the two cylinders.



MINIATURE One of Ray Arden's little jewels, this has a bore and stroke of ·220 ins. weighs 87 grams and runs at 1,200 r.p.m.! It has spark ignition and over 200 hours of running time, flying a 12 inch wingspan model. The glow plug can be attributed to Ray Arden for model use, so can many model engine design features.

F.A.I. WORLD RECORDS (as at 1-7-75)

Free Flight
Class F-1-B
RUBBER DRIVEN

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

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

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

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

POWER MODELS
Class F-1-C

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

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

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

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

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

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

RUBBER-DRIVEN HELICOPTER
Class F-1-F

No. 9 **Duration**
A. Nazarov (*U.S.S.R.*), June 3rd, 1968 .. .. .. 33m. 26·7s.

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

No. 11 **Altitude**
Giulio Pelegi (*Italy*), August 3rd, 1974 .... 598 m.

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

POWER-DRIVEN HELICOPTER
Class F-1-A

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

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

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

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

GLIDERS
Class F-1-A

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

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

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

INDOOR MODELS
Class F-1-D

No. 32 **Duration**
K. H. Rieke (*W. Germany*), September 22nd, 1962 .. 45m. 40s.

No. 32a **Less than 8 m. ceiling**
Duration
Robert J. Platt (*U.S.A.*), December 30th, 1972 .. .. 22m. 10s.

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

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

RADIO CONTROL POWER DRIVEN
Class F-3-A

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

No. 21 **Distance in a straight line**
A. Bellochio (*Italy*), July 25th, 1969 .. .. 377·350 km.

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

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

No. 31 **Distance in a closed circuit**
B. Kunce (*U.S.A.*), February 17th, 1968 .. .. 338·04 km.

R/C SEAPLANE

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

No. 49 **Distance in a straight line**
R. D. Reed (*U.S.A.*), February 26th, 1972 .. .. 133·875 km.

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

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

No. 52 **Distance in a closed circuit**
W. Kaiser (*W. Germany*) May 1st, 1972 .. .. .. 238·85 km.

R/C GLIDERS
Class F-3-B

No. 24 **Duration**
E. Miakinine (*U.S.S.R.*), Sept 30–Oct. 1, 1973 .. 25h. 44m. 8s.

No. 25 **Distance in a straight line**
Jerry D. Krainock (*U.S.A.*), September 7th, 1974 .. 43.77 km.

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

No. 33 **Speed in a straight line**
L. Aldoshin (*U.S.S.R.*), October 9th, 1971 .. .. 182 km/h.

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

R/C HELICOPTER
Class F-3-C

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

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

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

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

CONTROL LINE
Class F-2-A

No. 27 **Speed (2·5 c.c.)**
Lauderdale McDonald (*U.S.A.*), May 4th, 1963 .. 273·66 km/h.

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

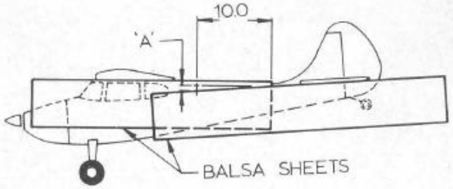
No. 29 **Speed (5–10 c.c.)**
V. Kouznetsov (*U.S.S.R.*), September 30th, 1962 .. 316 km/h.

JET MODELS

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

TRIO OF TIPS FROM THE FLIGHTMASTERS

famous Californian club for scale modellers yields useful features in its regular newsletter



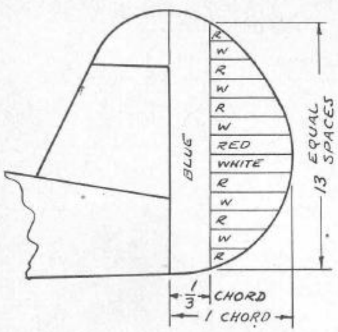
ANGLE DEGREES	'A' INCHES	ANGLE DEGREES	'A' INCHES
1/4°	1/32	2 1/2°	7/16
1/2°	3/32	2 3/4°	15/32
3/4°	1/8	3°	17/32
1°	3/16	3 1/4°	9/16
1 1/4°	7/32	3 1/2°	5/8
1 1/2°	1/4	3 3/4°	21/32
1 3/4°	5/16	4°	11/16
2°	11/32	4 1/4°	3/4
2 1/4°	3/8	4 1/2°	13/16

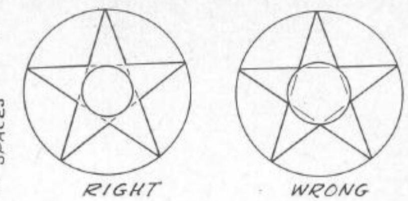
WHAT'S THE ANGLE?
by John Laycock

Checking the angle of wing and tailplane on a model can be a problem. Often the wing and tailplane angle is sighted, with final adjustments being made during test flying. Here is a method of solving the problem. Using two sheets of balsa, hold one under the wing and the other under the horizontal stabilizer as shown in the sketch. Overlap the sheets and pin or tape together. Find dimension 'A' over the 10″ length and using the table, the angle can be found.

The same principle can be used for low wing models and also for checking down the side thrust. Select balsa sheets having *straight* edges!

From: N. American Rockwell Flightmasters Flying Scale News and Views





LAYING OUT U.S. ARMY WING AND RUDDER MARKINGS
by Ken Hamilton

The layout of prewar U.S. Army wing and rudder markings are frequently done incorrectly on models, and full size restorations. The red circle inside the five pointed white star should *not* touch the inner corners of the star. Instead, it should *float within* the white star, of such diameter that it would just come tangent to the lines which would be formed if the straight side of the star were extended on across to make a pentagon.

As to the rudder, the vertical blue stripe is always *one third* the maximum rudder chord in width. (Many are made too narrow). Then the rear edge of the blue stripe is divided into 13 equal spaces for 7 red, and 6 white horizontal bars. This formula works regardless of rudder shape, square or rounded.

From: N. American Rockwell Flightmasters Flying Scale News and Views

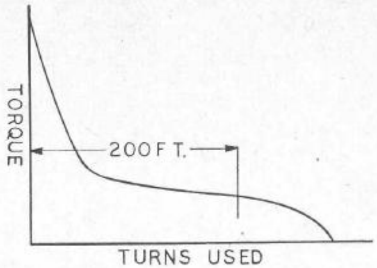
QUICK COWLS
by Harold Osborne

For aircraft of the 1929 through 1938 era, simple lazy mans solution for a Townsend ring for a radial engine is to use the bottoms of the plastic bottles now available on the shelves of your local supermarts. They are unbreakable and look well. Some are pre-coloured and do not even need painting! Painting is difficult but can be accomplished if you lightly scuff with sandpaper or even steelwool, then spray some auto primer. When dry, lightly sand again and paint the colour of your choice.

Some bleach bottles come a deep blue in three sizes. The small size is $3\frac{1}{4}''$ diameter × $\frac{15}{16}''$ chord, the middle size $4\frac{5}{9}''$ diameter × $1\frac{3}{16}''$ chord, and the large size $6''$ diameter × $1\frac{3}{4}''$ chord. The small size matches a scale of $\frac{3}{4}'' = 1$ ft. for aircraft such as the Vickers Jockey, Grumman FF-1, Boeing F4B4, and the Curtiss Helldiver, etc. The medium size matches $1'' = 1$ ft. for these aircraft. The large size is an odd size matching approximately $1\frac{1}{3}'' = 1$ foot scale.

Other plastic bottles such as Dishwasher soap are ideal for various later aircraft of the 1938–40 period, which used long chord cowls. For inline engines try the oblong section bottles with rounded tops—you'll be surprised at what can be found in the local store!

From: N. American Rockwell Flightmasters Flying Scale News and Views



DESIGN PARAMETERS FOR RUBBER SPEED MODELS

by Charlie Sotich

Once a popular British class, then "relegated" to being only of interest for record purposes, Rubber-driven speed has become a relatively new craze in the U.S.A. This feature helps solve the major design problems.

How do you decide what your new rubber speed model should be like? It's a good idea to first look at other models that have been successful in this event, then go over the rules to see what restrictions are placed on the models. In the case of the NFFS rubber speed rules, one of the big requirements is to have the model fly 200 feet. It must also take off unassisted and not rotate more than 360°.

It is not enough that a model fly just 200 feet. It must be capable of flying farther because as the turns are used up by the propeller the torque decreases and so does the thrust. The model accelerates rapidly to its maximum speed and then slows down as the torque decreases.

It has been reported by a number of people who served as judges at the finish line of speed events that the models were slowing down very noticeably when they crossed the finish line (in addition, to climbing, in most cases).

Instead of designing a model to fly 200 feet it would be better to have it capable of going 300 feet. The length of the rubber motor required to fly a model this distance depends on the number of turns you can put in the rubber and the actual propeller advance per revolution as the model flys.

$$\textbf{Length of Rubber} = \frac{\text{Distance Travelled}}{(\text{Propeller Advance}) \times (\text{Turns/inch in Rubber})}$$

Using this formula and assuming a 300-foot travel distance, about 25 turns per inch (from *Table* 1 for 10 or 12 strands of 6 mm. Pirelli) and a 5-inch advance per revolution (10-in. pitch and 50% slip efficiency) we get:

$$\textbf{Length of Rubber} = \frac{300\text{ ft.} \times 12\text{ in./ft.}}{5\text{ in./rev.} \times 25\text{ turns/in.}} = 28{\cdot}8\text{ inches}$$

With 12 strands or less of $\frac{1}{4}$-inch rubber this length, there should be no trouble going well past the finish line at 200 feet. If your model flies with 12 strands and it is possible to handle more power, even with less turns per inch, you should still get the model past the finish line.

If the weight of the model structure is $\frac{1}{2}$ to $\frac{1}{3}$ of the total weight we can get some weight estimates assuming 175 inches of $\frac{1}{4}''$ Pirelli per ounce.

TABLE I

Strands	6 mm		4 mm	
	Turns	*Torque*	*Turns*	*Torque*
2	59·3	5·4	72·6	2·9
4	41·9	15·3	51·3	8·3
6	34·2	28·1	41·9	15·3
8	29·6	43·2	36·3	23·5
10	26·5	60·4	32·5	32·9
12	24·2	79·4	29·6	43·2
14	22·4	100·1	27·4	54·5
16	21·0	122·2	25·7	66·5
18	19·8	145·9	24·2	79·4
20	19·8	170·8	23·0	93·0

To get the model to take off unassisted within a very short distance, it is necessary to have a wing loading that is fairly light, say 4 ounces per 100 square inches or less. The lighter the wing loading, the easier the take-off. When there is less model weight (mass) to accelerate, a given amount of thrust gives a higher acceleration. The lower total weight also means the model is able to get airborne at a lower speed so will require a shorter take-off run.

Looking over the values in *Table* 2 we see a very wide range of values for weights and wing areas. By keeping the model weight between 2 and 2·6 ounces, the model should be light enough to take-off on 8 strands and, if built properly, be able to handle a 12 strand motor. With 12 strands, a 2·6 ounce model would weigh about 4·6 ounces complete. A wing area of 115 square inches would be adequate to give an acceptable wing loading. If we use an aspect ratio of 5 for the wing, this would mean a span of 24 inches and an average chord of 4·8 inches.

$$\textbf{Span} = \sqrt{\text{Area} \times \text{AR}} = \sqrt{115 \times 5}$$
$$= 23{\cdot}98\text{, say 24 inches}$$

$$\textbf{Average Chord} = \frac{\text{Area}}{\text{Span}} = \frac{115}{24}$$
$$= 4{\cdot}79\text{, say 4·8 inches}$$

SPEED FT/SEC FOR MPH WITH TIME/SECS FOR 200 Ft

Velocity mph	*Time Seconds*	*Speed ft/sec.*
100·00	1·36	146·67
90·00	1·52	132·00
80·00	1·70	117·33
70·00	1·95	102·67
60·00	2·27	88·00
50·00	2·73	73·33
40·00	3·41	58·67
30·00	4·55	44·00
20·00	6·82	29·33
10·00	13·64	14·67

SPEED FOR 200 FEET SECS/SPEED

Time seconds	Speed mph	Time seconds	Speed mph
1·00	136·364	3·00	45·455
1·05	129·370	3·05	44·709
1·10	123·967	3·10	43·988
1·15	118·577	3·15	43·290
1·20	113·636	3·20	42·614
1·25	109·091	3·25	41·958
1·30	104·895	3·30	41·322
1·35	101·010	3·35	40·706
1·40	97·403	3·40	40·107
1·45	94·044	3·45	39·526
1·50	90·909	3·50	38·961
1·55	87·977	3·55	38·412
1·60	85·227	3·60	37·879
1·65	82·645	3·65	37·360
1·70	80·214	3·70	36·855
1·75	77·922	3·75	36·364
1·80	75·758	3·80	35·885
1·85	73·710	3·85	35·419
1·90	71·770	3·90	34·965
1·95	69·930	3·95	34·522
2·00	68·182	4·00	34·901
2·05	66·519	4·05	33·660
2·10	64·935	4·10	33·259
2·15	63·425	4·15	32·859
2·20	61·983	4·20	32·468
2·25	60·606	4·25	32·086
2·30	59·289	4·30	31·712
2·35	58·027	4·35	31·348
2·40	56·818	4·40	30·992
2·45	55·659	4·45	30·644
2·50	54·545	4·50	30·303
2·55	53·476	4·55	29·970
2·60	52·448	4·60	29·644
2·65	51·458	4·65	29·326
2·70	50·505	4·70	29·014
2·75	49·587	4·75	28·708
2·80	48·701	4·80	28·409
2·85	47·847	4·85	28·116
2·90	47·022	4·90	27·829
2·95	46·225	4·95	27·548

This procedure gives one approach for determining some of the parameters in the design of a rubber speed model. If different assumptions are made you will get different results. The important thing is to get a model designed and built so you can fly it and find out what might be changed to give you better results.

From: The National Free Flight Society Digest

TABLE 2

RUBBER			MODEL WEIGHT OUNCES		TOTAL WEIGHT OUNCES		WING AREA SQUARE INCHES	
No. of Strands	Total Length Inches	Weight Ounces	50% Total	33% Total	Min.	Max.	4 oz./100 Min. Wt.	3 oz./100 Max. Wt.
8	230	1·31	1·31	2·62	2·62	3·93	65	131
10	288	1·65	1·65	3·30	3·30	4·95	83	165
12	346	1·98	1·98	3·96	3·96	5·94	99	198

FREE FLIGHT SCALE POWERED FLIGHT AND DOWNTHRUST

by Bill McCombs

ONE of the more frustrating things about free flight scale models is that so often when they have been trimmed for a good, slow, glide they will stall in powered flight—or loop if there is enough power. Most real aeroplanes (or R/C models) will do the same thing. That is, if their elevators are set for a good slow glide, or a very slow powered descent with engine idling, and then power is "poured on" they, too, will mush or stall, or loop if there is enough power. The purpose of this article is to summarize for the lesser-experienced modeller the main reasons which cause this troublesome stalling or looping and various means of eliminating it.

Gliding Flight

As modellers know from experience, the gliding speed of a model is controlled, or set, by the horizontal tail incidence. Tilting the trailing edge more downward is like "down-elevator". It makes the model assume a more nose-down attitude and glide faster (and steeper). Tilting the trailing edge *up* is like "up-elevator". and makes the aeroplane assume a more nose-up attitude and glide more slowly. Too much up-elevator will, of course, cause a stall. Anything else which has a nose-up trim effect is like up-elevator and, hence, can cause a stall if large enough.

A model is usually (and preferably) trimmed to glide reasonably slowly, just slightly faster than its stalling speed, particularly rubber models where good gliding duration is important. Therefore, anything which causes a little more nose-up trim change, like up-elevator, will then cause it to stall. It is helpful to remember this since, as discussed later, for typical real aeroplanes and free flight scale models the so-called "propeller effects" usually produce such a nose-up trim change—and a stall for models, unless downthrust or other things are used to prevent this.

Causes of Powered Flight Stalling

There are two main reasons which can cause a model which has been trimmed for a good slow glide to stall in powered flight (or to loop if there is enough power). These are (**1**) *Speed* (a speed faster than the gliding speed) and (**2**) *Propeller Effects*, which can cause a nose-up trim change just as more up-elevator would. The main thing to keep in mind is that to eliminate stalling in powered flight one most needs to provide a nose-down trim change, but *only* during the powered flight, *not* for the glide.

Stalling Due to Speed

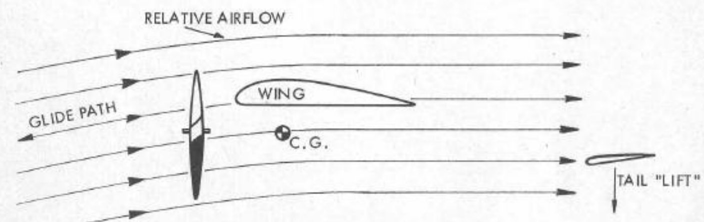
This is easily seen, of course, with a simple hand launched glider which has been trimmed for a good slow glide. When launched forward and slightly downward at its trimmed gliding speed it will glide smoothly and steadily to the ground. If it is thrown harder, faster than its trimmed gliding speed, it will nose up, and stall. If thrown hard enough it will loop. That is, a speed faster than the gliding speed will produce a more nose-up attitude and a climb. When the climb is steep enough and the speed has fallen off, a stall will occur, or there will be a looping if enough speed remains for this. The same thing can happen to an aeroplane in powered flight when its speed is faster than its trimmed gliding speed. Two things are of interest about this stalling or looping due to speed:

(**1**) The slower the glider (or powered model) is trimmed to glide, the greater, or quicker, will be its tendency to nose-up at a given faster speed. Of course, a "good" glide must be quite slow when duration is important. (**2**) The more forward the c.g. is located (the model tail being adjusted as needed for a slow glide) the more severe will be the nose-up tendency due to speed—and vice versa.

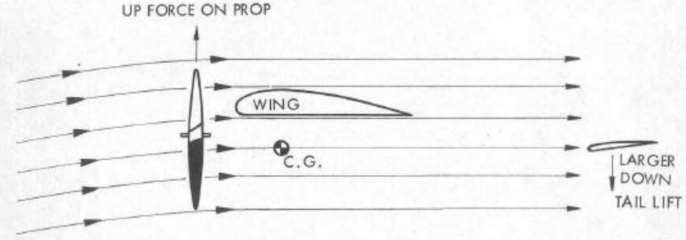
For example. If two identical gliders are trimmed for the same slow gliding speed but one has a much forward c.g., it will do a much "tighter" (smaller) loop when thrown hard than will the one with the more aft c.g. looping due to speed, for gliders or for powered models. However, one cannot have the c.g. too far aft or there will be troubles due to insufficient stability.

Of course, with a glider any stalling or looping can be prevented by throwing it in a banked attitude (banked opposite to its natural or trimmed gliding turn). This converts the loop into an upward spiral which, when thrown properly, goes smoothly into the glide. Stalling or looping due to speed can also be prevented by a turn for powered models, but this alone may not give best duration—or a good scale flight, and can cause other troubles sometimes.

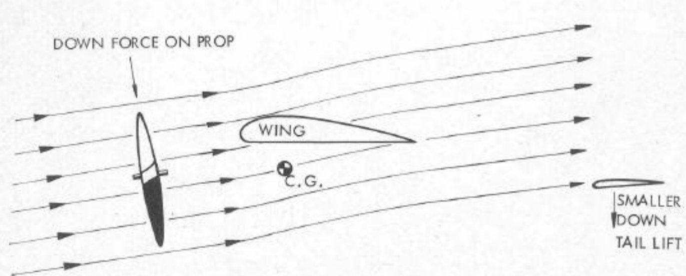
FIG. 1 EFFECTS OF POWER, WITHOUT / WITH DOWNTHRUST



(a) GLIDING FLIGHT (PROP STOPPED)



(b) POWER ON, PROP SPINNING, NO DOWNTHRUST



(c) POWER ON, PROP SPINNING, DOWNTHRUST

Stalling Due to Propeller Effects:

When a typical real aeroplane or free flight scale model has been trimmed for a good slow glide and there is no downthrust, there are three kinds of things due to propeller operation which can produce a more nose-up trim change (like more up-elevator would) and, hence, a stall in powered flight. These three effects are: (**1**) An upward force being generated at the spinning propeller, (**2**) The propeller slipstream causing a larger downward airload on the tail than is present for gliding flight. (**3**) The prop thrust force (which is in-line with the prop shaft) passing below the c.g.—as it must on many models.

The reasons for the first two effects are explained using *Fig.* 1*a* and lb., and the third effect using *Fig.* 2*a.*

Fig. 1*a* shows the model *gliding* down and also the "relative" flow of air which is indicated as flowing upward towards the model. The various angles are exaggerated for better illustration. Note that as the air flows past the wing it is deflected more downward (this produces the wing's upward list force, not shown). The tail is shown "nose-down" slightly, relative to the air flowing towards it, so a downward "lift" is generated by the tail. This downward tail lift is typical of free flight scale models (and real aeroplanes) since they have rather small tails and short aft fuselages.

Fig. 1*b* shows what happens if the propeller is put into operation. First, the oncoming air which passes in the prop region is deflected *downward* as it passes through the propeller "disc" and is forced aft at a much faster speed. This generates an *upward* force at the propeller as indicated. This is a nose-up trim effect on the model. Secondly, because of this downward deflection by the prop the air is seen to be flowing *more downward* (or less upward) at the tail than it was during flight. Hence, this causes a *larger* downward lift on the tail, and this is also increased much more because the air (within the slip-stream) is moving *much faster* than for gliding flight. This larger downward force is indicated and also tends to rotate, or "pitch" the model more nose-up, another nose-up trim effect. (Always consider the aeroplane to be supported only by a single "pin" through its c.g. to see how any force tends to rotate it.)

A third effect is shown in *Fig.* 2*a.* It is due to the propeller thrust force (which is in-line with the prop shaft). If this thrust force is *below* the aeroplane c.g. it tends to rotate the aeroplane *nose-up*, worsening the stalling trouble, and the farther it is below the c.g. the more its effect. However, if the thrust force passes *above* the c.g. it tends to rotate the aeroplane *nose-down* which is "good" as it lessens the stalling tendency. The higher it is above the c.g. the more its effect. This latter effect occurs mainly on low-wing models, particularly those with rather high thrustlines, but is not usually enough to overcome the two bad effects described previously. However, it is why low wings need *less* downthrust than do high wing models.

It can now be seen how downthrust "works" in eliminating the stalling or looping trouble (if enough is used). Using downthrust does three particularly helpful things and if enough is used, the *total* effects of power can be changed from the bad nose-up effect to a "good" nose-down effect, as needed to trim the powered flight as desired. As the prop shaft is tilted downward, the oncoming airflow will be deflected *less* downward as it passes through the prop "disc", and with enough downthrust the airflow will even be tilted *more upward*, as indicated in *Fig.* 1*c.* This produces a *downward* force at the prop, a nose-down effect. The airflow is now seen to be inclined more upward as it passes toward the tail (than with no downthrust) so it results in a smaller down load at the tail, which is most

helpful, a *lesser* nose-up trim effect like a bit of down-elevator. The downthrust also raises the thrust force with respect to the c.g., a good effect. Enough downthrust could even raise it above the c.g. giving a good nose-down trim effect—*Fig.* 2*b.* Hence, downthrust in a sufficient amount will produce the needed nose-down trim effect for powered flight. The modeller need only adjust the downthrust as needed to control the powered flight as desired. And, as mentioned previously its, "effectiveness" (how much is needed) can be partly controlled by the c.g. fore-and-aft location (not too far forward).

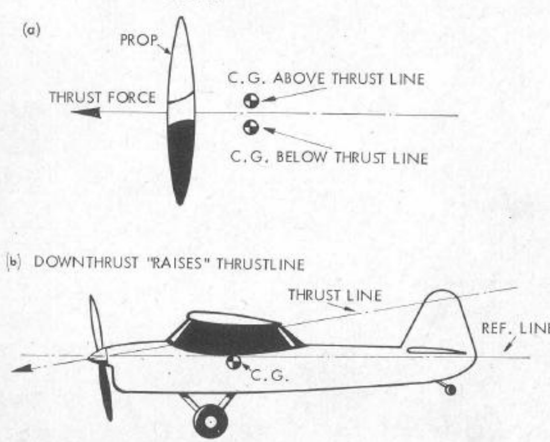
It can be shown that increasing the wing incidence (and *also* the tail incidence to retrim the glide) will have two similar types of effect as does downthrust. This is because the model still glides along the same path, but the fuselage (not the wing and tail), has now a more "nose-down" attitude and so does the propshaft, the same as downthrust with respect to the oncoming air. However, this does *not* raise (tilt) the thrustline upwards relative to the c.g. as downthrust does, so it does not produce the third good effect of raising the thrustline. For this reason, increasing the wing incidence is not as effective as is increasing the downthrust, for a given angular change, but it is a helpful means of trimming the powered flight.

As to *indoor* free flight scale models, these have no "glide" since the model descends with the prop still turning, a few winds always remaining in the motor (or should do this). For these models the slow powered descent would be considered to be the "glide" as far as the discussion of this article is concerned.

Finally, in comparing different aeroplanes it is also of interest to know that the following geometry items result in *less* downthrust being needed—and their opposites require more:—the larger the horizontal tail; the higher the propshaft (thrustline); the lower the c.g. (low wings), the more the wing incidence angle (and also the more L.E. up or T.E. down the tail incidence angle to trim the glide); and a moderate to long nose length (wing to prop distance).

From N. American Rockwell Flightmasters Flying Scale News and Views

FIG.2.



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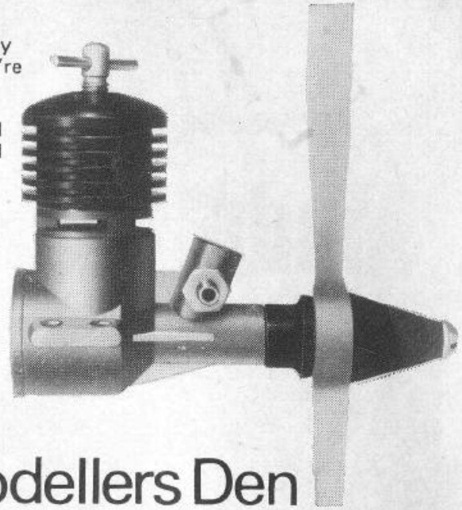

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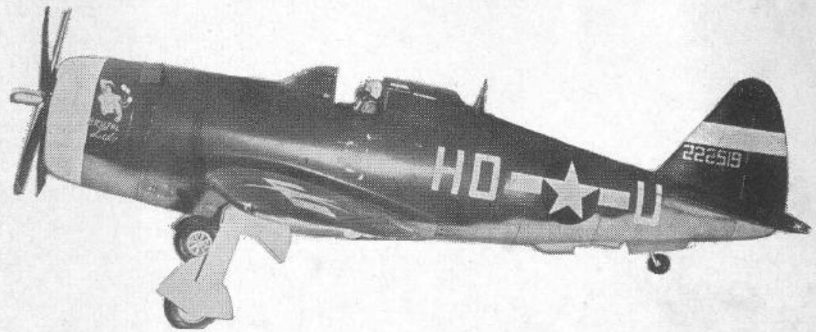

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