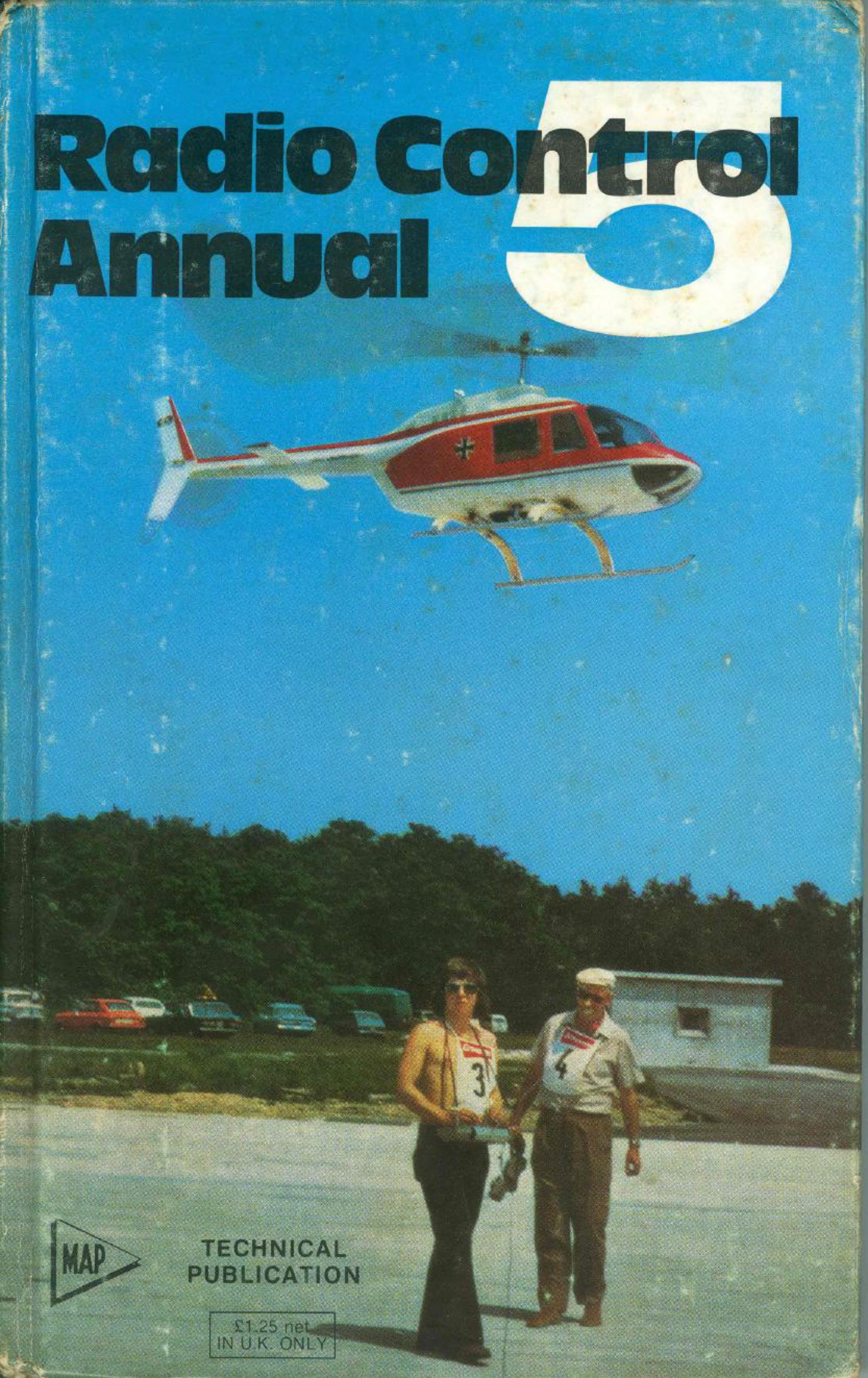
Radio Control Annual 5



MAP
TECHNICAL
PUBLICATION

£1.25 net
IN U.K. ONLY

RADIO CONTROL ANNUAL

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MODEL & ALLIED PUBLICATIONS LTD
13-35 BRIDGE STREET, HEMEL HEMPSTEAD, HERTS

Trade Distributors
MODEL AND ALLIED PUBLICATIONS LIMITED
STATION ROAD
KING'S LANGLEY
HERTS. UK

PRINTED IN GREAT BRITAIN BY BLACKFRIARS PRESS LIMITED, LEICESTER

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INTRODUCTION

RADIO CONTROL ANNUAL 5 continues the pattern set by our *Radio Control Manual* series which commenced back in 1965. Since then, the "Manuals" have chronicled the ever advancing state of the art in the radio controlled model hobby, following the emergence of new specialist interests—pylon racing, gliders, the achievement of R/C helicopters etc. R/C Manual also followed the vast improvements in radio control equipment during the past eight years, following the progress from the bulky, cumbersome non-proportional systems, through the first proportional equipments—the battle between analogue and digital concepts, to today's ultra light, highly reliable systems.

Radio Control equipment today owes everything to the rapidly advancing state-of-the-art in more commercial fields of electronics. During the past year, major difficulties have arisen due to shortages of electronic components. Three years ago when the U.S. space and military programmes began to slow, manufacturers of integrated circuits actively sought new outlets. The R/C equipment industry benefited, with some significant breakthroughs as a result, but more recently, business in integrated circuit manufacture has picked up due to the demand for pocket calculators, computers and electronic safety circuitry from the U.S.A. automotive industry, the latter prompted by new safety laws.

All this has left our radio control equipment industry in something of a short supply situation as regards components, but happily an improvement in the situation is now in hand.

Radio control equipment manufacturers really are to be congratulated on the extensive improvements achieved over the past two years, rarely at any direct cost increase to the customers. However, our 27 MHz waveband becomes continually more crowded. Although R/C systems in Britain operate on a "sport frequency" band spacing of 50 KHz, many stations used for industrial purposes operate at frequencies interspaced between our "spots". Consequently, we see that even more ingenuity may be called for as the need for greater selectivity in equipment operation becomes an ever more pressing necessity.

RADIO CONTROL ENGINE DEVELOPMENTS

By Peter Chinn

THE subject of radio-control engine development was previously dealt with in Radio Control Manual No. 2 some six years ago. Since that time, very considerable advances have taken place. In fact, more progress has been made in commercial model engine design during the past five years than over any similar period in the last two decades. Not only does the R/C enthusiast now enjoy higher performance, better handling, improved throttle systems and a much wider range of types from which to choose: he may also, if he so wishes, move away from the single cylinder two-stroke to more exotic designs, such as the O.S. Wankel rotary-combustion engine from Japan, or the Ross twin and multi-cylinder motors from America.

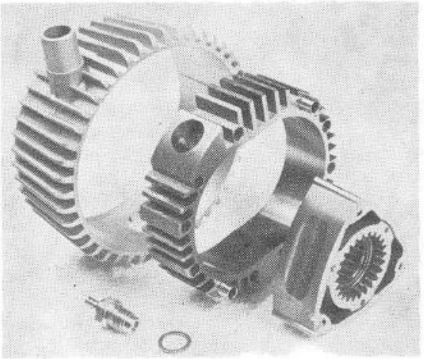
The expansion and diversification of the R/C engine market is, of course, all part of the rapid increase in the popularity of radio-control that has occurred in recent years in all the more advanced countries of the world.

Broadly, one can now divide R/C engines into four groups—at least so far as aircraft are concerned. These, we suggest, might be classified as follows:

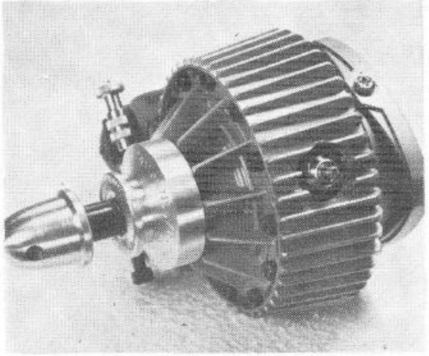
1. *Trainer and General Purpose.* Mostly comprising the less expensive engines ranging from ·09 cu. in. (1·5 c.c.) to ·36 cu. in. (6 c.c.) suitable for trainers, intermediate and other models requiring rather less than the highest levels of engine performance.

2. *40's and 60's.* These mainly comprise the powerful ·60—·61 cu. in. (10 c.c.) engines favoured for aerobatic contest models and for large single-engined scale models, plus certain high performance ·40 cu. in. (6·5 c.c.) engines which, for various reasons, are becoming popular for 'club' flying.

Heart of the Wankel motor, replacing the piston and cylinder, are its triangular rotor and epitrochoidal rotor-housing.



The O.S. 5 c.c. Wankel rotary combustion engine. Powerful, very smooth and a truly remarkable feat of design and production engineering.



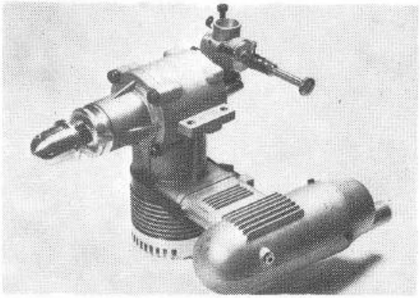
3. *Racing 40's.* A small specialised group of motors (only four or five makes at present) intended solely for pylon racing. Can be expensive.

4. *Specials.* Rotary, twin and multi-cylinder types, plus engines outside the FAI 10 c.c. capacity limit. Expensive.

It is not the purpose of this article to report in detail on every R/C engine that has been added to the market since our earlier review. Illustrated descriptions and test reports have, in any case, been published on most of these in *Radio Control Models & Electronics*. Instead, we will attempt to update our previous (1967) progress report by dealing with the more significant developments that have taken place.

The year 1967 closed with the promise of some very interesting developments for the future. During the summer of that year, the Japanese O.S. company had, at the request of the West German Johannes Graupner concern, undertaken to develop and manufacture a production version of the 5 c.c. Wankel engine that had been designed for Graupner by Ing. Schaegg and which, basically similar to the Wankel engines now proving so successful in the German NSU Ro.80 and Japanese Mazda cars, had taken several years to bring to fruition. The involvement of O.S. in the matter was, however, kept secret until October 1968 when O.S. pre-production models, including an experimental twin-rotor 10 c.c. version were publicly demonstrated.

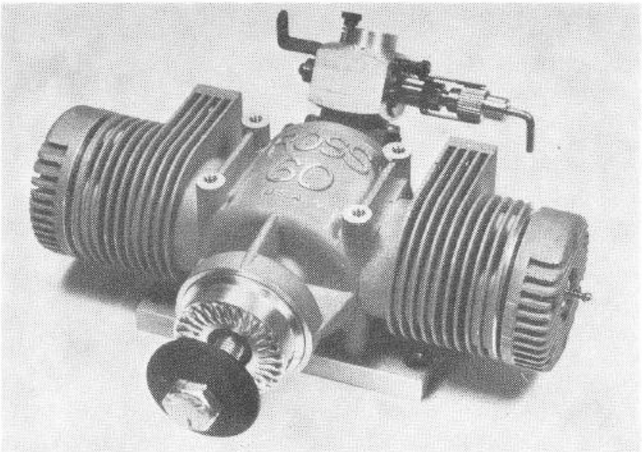
Actual manufacture of the O.S. Graupner 5 c.c. Wankel motor began in the following year, first with a pilot run of fifty engines, followed by an initial production batch of two hundred. The writer received one of the pre-production models for evaluation and this, after testing, was used in a model to make the first flights by a rotary-engined aircraft in the U.K. As more experience with this entirely new type of model engine was accumulated, O.S. steadily improved it by minor modifications here and there and, far from being a mere curiosity or a collector's item, the O.S. Graupner 5 c.c. Wankel motor has shown itself equal, if not superior, to reciprocating engines of equivalent displacement. It is powerful (around 0·70 b.h.p. at 16,000 r.p.m. on standard fuel), easy to start, has excellent throttle response and, as one would expect of a rotary motor, is outstandingly smooth running. Requiring only a small silencer to cope with its continuous exhaust gas discharge, it is also remarkably quiet. In this engine's manufacture, much closer tolerances are required than for reciprocating engines and O.S. have made an outstandingly fine job of producing it. The motor is currently priced in the U.K. at around the £60 mark.



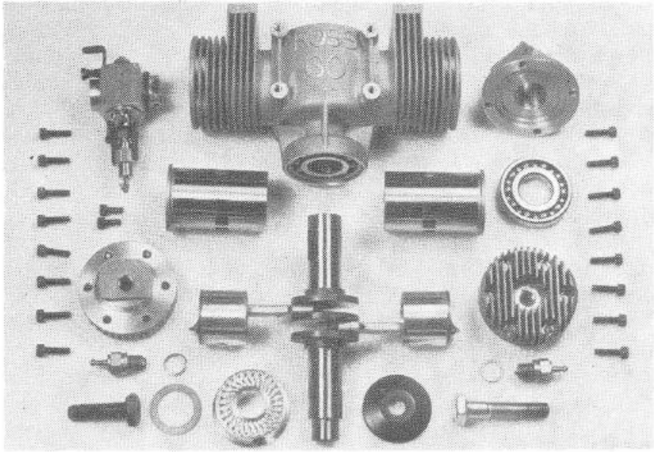
O.S. Max-H.80, largest single cylinder engine in production, has many useful extras. Ideal for big scale jobs or marine use.

The American Ross engines are another example of recent model engine design and manufacture where quality, rather than cost, has been the first consideration. First made in small numbers by their designer, Louis Ross, these engines were later built at the Northfield Precision Instrument Corporation's factory on Long Island, but Ross has now formed a new company, Rosspower Inc., for their manufacture.

Production began with the 10 c.c. Ross 60 horizontally-opposed, simul-



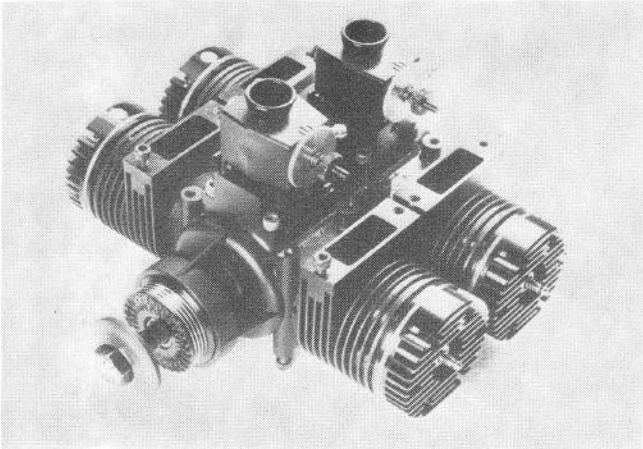
The excellent Ross 60 flat-twin engine. It weighs no more than a single cylinder 60.



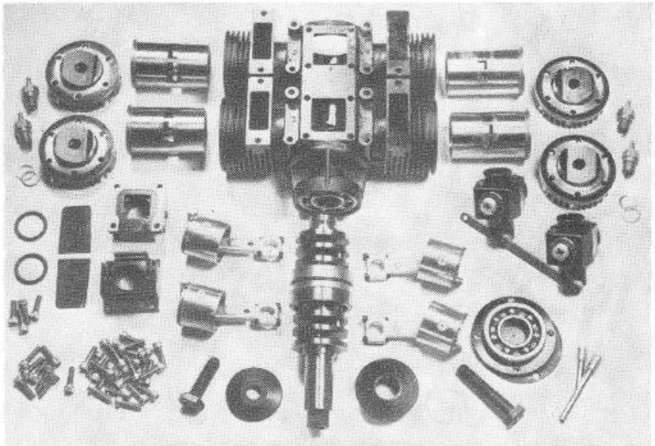
Parts of the Ross Twin. Crankshaft is supported in three ball-bearings. Engine has Kavan carburettor.

taneous-firing, twin-cylinder motor and now includes flat-four and flat-six cylinder models of 20 c.c. and 30 c.c. respectively. Remarkably compact, these engines feature directly opposed cylinders, the connecting-rods being staggered, rather than the cylinders themselves. Overall lengths of the multi-cylinder models are further reduced by using reed-valve induction to the individual crank chambers, each being fitted with its own carburettor—i.e. two carburettors for the Four and three for the Six. Perry carburettors are used, with coupled throttle linkages. We have had both the Twin and the Four on test and can confirm that they perform as well as they look. The Twin, priced at $125 in the U.S. and somewhat higher in the U.K. is, all things considered, not expensive by comparison with more conventional good quality engines. The quite splendid Four and Six, naturally, are a good deal more costly at $465 and $665 respectively.

The main advantage of an engine such as the 20 c.c. Ross flat-four, apart from its uncannily vibration-free running qualities and, of course, the



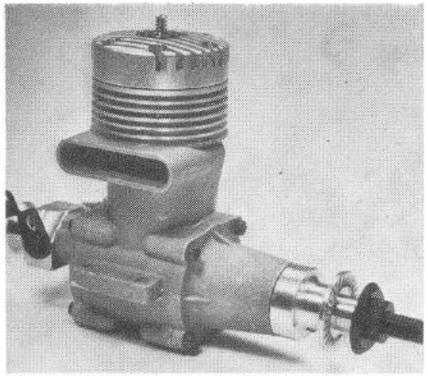
The magnificent Ross horizontally opposed 20 c.c. four-cylinder motor from the U.S.A. Very compact and only 26 oz. weight.



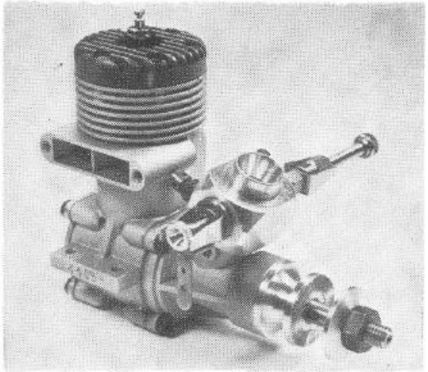
The parts of the Ross Four. A truly superb engine which is powerful and unbelievably smooth running.

sheer delight of owning such an impressive piece of machinery, is its ability to swing a really big prop—anything between 14 and 18 inch diameter in fact—which is just what one needs for lifting a heavy, bulky scale model. Unfortunately, engines of over 10 c.c. are outside the FAI limit for contest purposes but where such models can be safely flown (with valid insurance cover), a few c.c.'s over the limit can make all the difference.

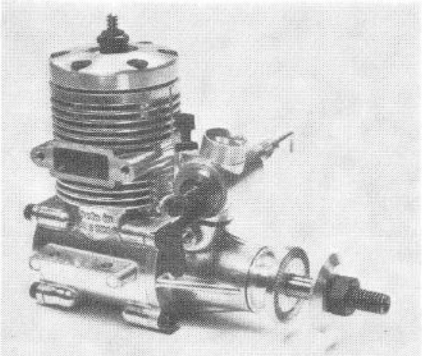
This has been convincingly demonstrated on many occasions by the 13·24 c.c. O.S. Max 80. Tested recently in its latest improved version (enlarged valve rotor, modified shaft and single ring piston) the O.S. 80 out-tuned most of the 60's by upwards of 600 r.p.m. on a 14×6 prop and went on to handle 15, 16 and 17 inch props with ease. Starting, running and throttling characteristics were excellent. The 80 is only 2 to 3 ounces heavier than the average 60 and is quite compact. It is also a most versatile engine: its valve rotor has an alternative drive slot enabling the engine to be instantly converted to opposite rotation; the complete carb



Above: 1971 K&B Torpedo 40 Series 71R, the final development of the very successful Torpedo 40 series originated in 1966.

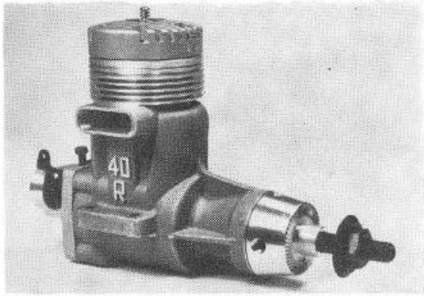


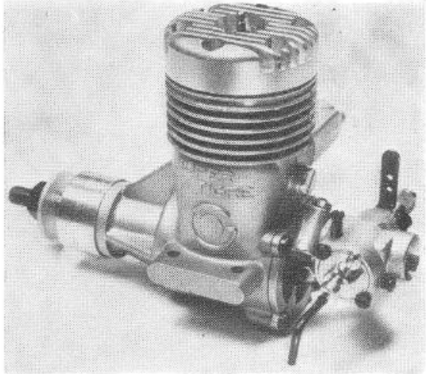
Above: Webra 40 R/C. Basically this is a scaled down Blackhead 61 and has performance to match.



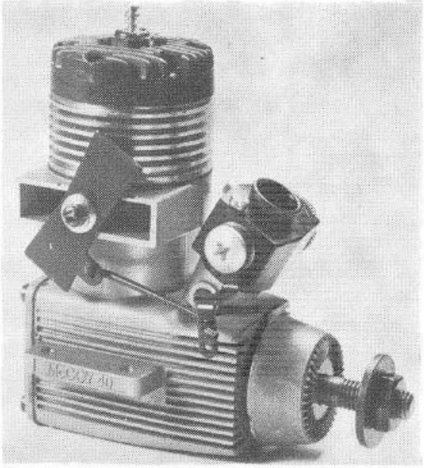
Above: The HP 40F-RC, one of the most powerful aerobatic type ·40 cu. in. engines offered to date.

Below: 1972 pre-production model K & B 40R. Only 100 made. These engines dominated U.S. pylon racing circuits during 1972-73.





Above: Super-Tigre G.40-ABC. Another pylon-racing contender, but likely to be superseded for PR by new STX-40 model.

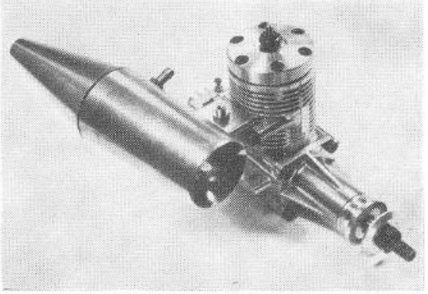


Above: American McCoy 40 R/C is also made in ·29 and ·35 versions. Bushed main bearing. Not yet available in U.K.

assembly can be rotated through 180 degrees for relocating the intake upright for inverted installations and the engine is quickly adapted to marine use by means of an optional watercooled head.

When our 1967 report was published, pylon racing engines, as a specific type, did not exist. They began to emerge with the throttle equipped version of the American K&B Torpedo 40 Series 67 rear disc valve control-line 'rat racing' motor and, over the ensuing four years, this design, through Series 69, 70 and 71 versions each developing more power, became firmly entrenched as 'the' pylon-racing unit. By 1971, however, it was apparent that the highly successful Torpedo crossflow scavenged design had just about reached the limit of its development and a new design with Schnuerle scavenging and a more rigid one-piece body casting, was laid down.

A pilot-run batch of one hundred of these engines was produced in 1972, forthwith set new standards of performance in the Formula I pylon racing class with times of well under 1 min. 30 sec. (and later under 1:25) for the regular pylon racing course, and also caused considerable agitation among those enthusiasts who had not been among the favoured few to be allocated one of the hundred. Our test unit produced a highly impressive 1·6 b.h.p. at 20,000 r.p.m. on 50 per cent pure nitromethane fuel but it is anticipated that future production models will better this by at least 10 per cent. At the moment, the engine is set up for Formula I class racing only, but a special FAI version for operation on straight methanol/castor-oil fuel is planned. The engine retains the ·840×·720 in. bore and stroke combination and Dykes piston ring of previous K&B 40's and, despite a hefty appearance, is only about 1 oz. heavier.

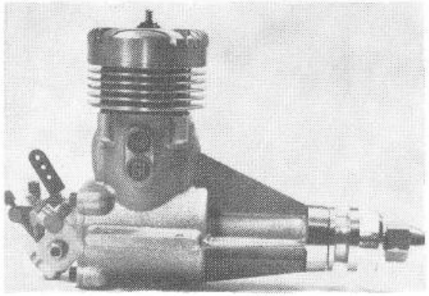


Rear disc valve HP 40R with HP air-scavenged silencer. PR version has been successful in FAI pylon racing.

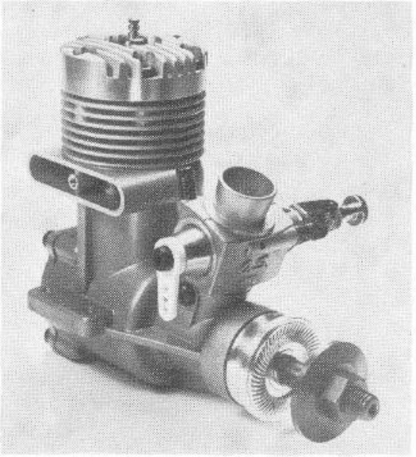
The only engines to have challenged K&B supremacy in pylon racing have been the Italian Super-Tigre G.40-ABC and the Austrian Hirtenberger HP 40R-PR. Super-Tigre successes have mostly been in the U.S. and generally as a result of the attentions of tuning specialists. The Austrian engine, on the other hand, has done particularly well in the U.K. in FAI racing where the stock HP 40R-PR has proved more than a match for the old Torpedo 40. (At the time of writing, the Schnuerle scavenged K&B 40R has yet to appear in competition outside the U.S.).

The HP was actually designed as far back as 1967 and was first seen in prototype form early in 1968, but underwent a protracted period of development including outside evaluation via a pre-production batch in 1970 before getting into regular production in 1971. Had the HP reached its 1972 level a couple of years earlier, it would undoubtedly have made a very considerable impact, anticipating, as it did, the new K&B and other pretenders to the pylon racing crown, by featuring Schneurle type porting from the beginning.

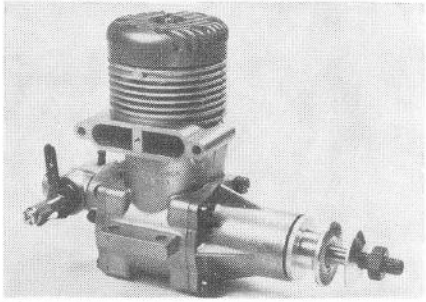
This scavenging system was, in fact, pioneered by Hirtenberger so far as commercial model engines are concerned and its value from the performance standpoint, already recognised



Above: pre-production HP 61 of 1967 set new standards of performance but its length and awkward carb were unpopular.

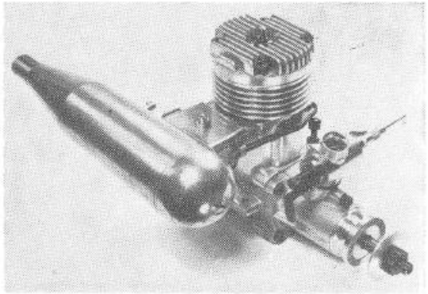


Above: good example of modern high-powered aerobatic '40', is 6·5 c.c. O.S. Max 40 R/C. Many '60' engine features.

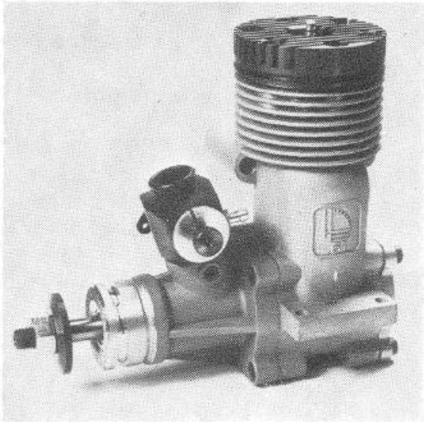


Above: Latest version of Italian Super-Tigre G.60RV R/C engine. Heavy but solidly constructed and finely finished.

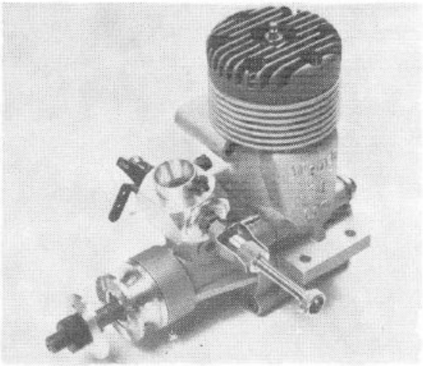
Below: 1973 production version of Austria HP 61F with optional HP silencer. Popular in U.K.



Below: The HB 61, a new make from West Germany, fitted with the American-designed Perry Carburettor.

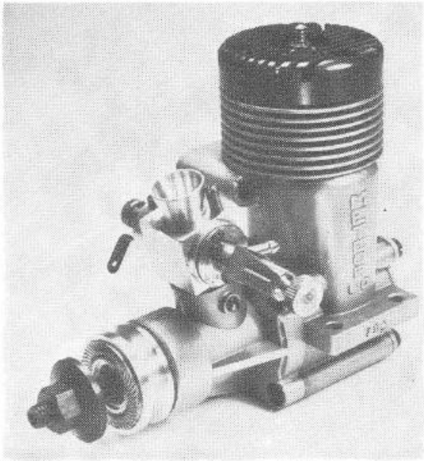


Below: West German Webra 61, not too well known in U.K., but very successful in U.S.A.



in the full-scale racing two-stroke engine field, was convincingly demonstrated by the prototype Paul Bugl designed rear-induction HP 61 in 1967 which, on test, outperformed all 10 c.c. R/C engines produced to that time. Unfortunately, certain other features of the engine, notably its considerable length and its awkwardly placed and difficult to adjust carburettor, did not go down too well with practical R/C modellers and it was not until 1970, when the Austrian factory introduced the HP 61F, a shaft-valve version of the 61 fitted with a simple automatic mixture control carburettor, that the HP really became established as a competitor in the 10 c.c. R/C aerobatic engine field.

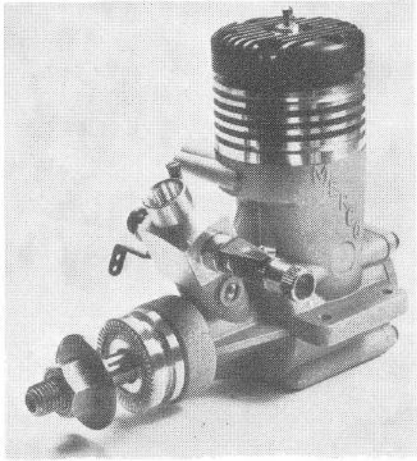
The HP 61F (helped initially by a low selling price) has become quite popular in the U.K., perhaps to the detriment of Britain's own Merco 61, but the Merco continues to sell in overseas markets and now in production is an improved version of the Merco which looks good and should offer a strong challenge to the imports. It has a new carburettor, larger ports, a higher compression ratio and a rebalanced crankshaft.



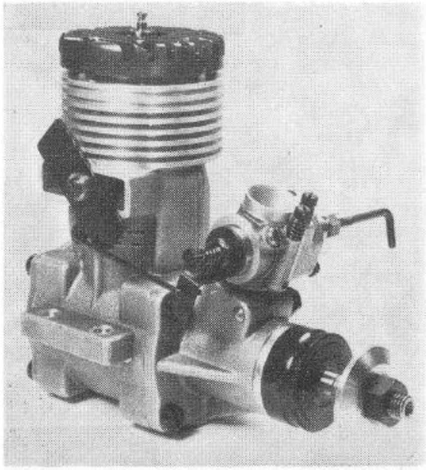
Regular production of this new British make, the Meteor 60, began in 1972. Has the usual 60 R/C features.

The range of '60' and '61' class engines on the market is larger than ever and substantial improvements in power output, throttling and durability have been made since our earlier report. In 1967, the favoured R/C engines were producing slightly less than 1·0 b.h.p., unsilenced, on standard test fuel (5 per cent nitromethane) but, within two years, this figure had been exceeded *with* silencers, while gross outputs had gone up by 25 to 30 per cent with such engines as the Webra 61 Blackhead, the O.S. 60 and 60F Gold-Head and the HP 61F. The Webra, designed by the late Gunther Bodemann and made in West Berlin, has enjoyed considerable contest success, particularly in the United States. It has now been joined by a new Schnuerle scavenged model developed by former HP designer Peter Billes and manufactured at a new Webra factory in Austria. The O.S. is available in two versions: one with orthodox shaft rotary-valve induction and the other with a drum rotary-valve at the rear like the O.S.80.

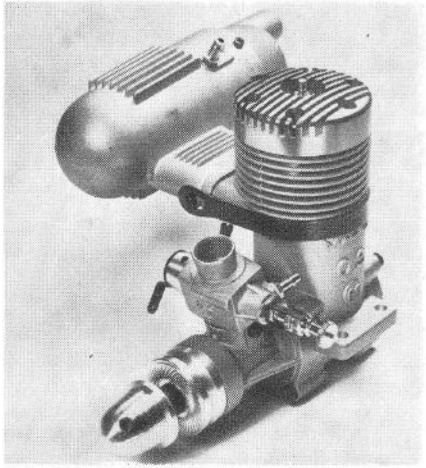
Some completely new makes in the 10 c.c. class have appeared since our



Improved 1973 model Merco 61. British Merco pioneered larger, ringed-piston, twin ball-bearing R/C engines in 1961.



OPS Ursus 60 engine from Italy has Schnuerle scavenging and ringless aluminium piston running in chromed liner.

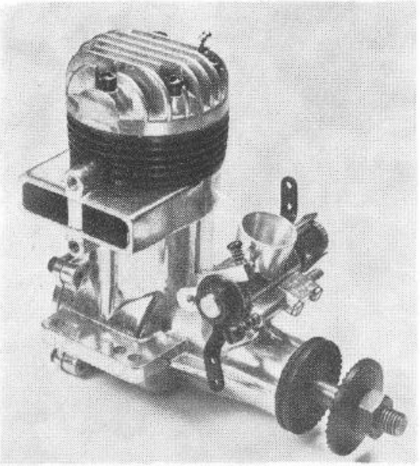


O.S. Max-H.60F 'Gold-Head' with latest O.S. automix carb. Silencers are included with all O.S. motors.

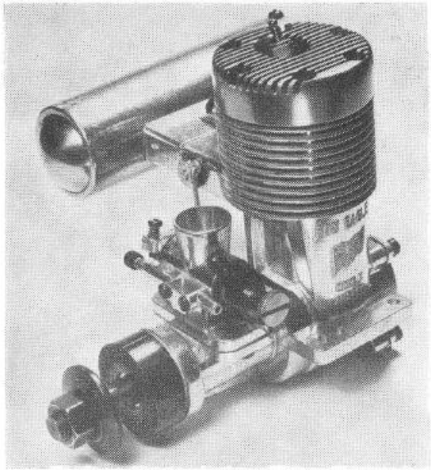
previous report. Significant among these are the German HB-61, the Italian OPS 60 and the Japanese YS-60. The initials HB stand for Helmut Bernhardt, a radio-control modeller from the earliest days of multi-channel R/C in Germany, who has now put part of his sizeable automobile instrument-making company to the task of producing model engines. These engines were first marketed under the name 'Veco Europe Series' by arrangement with the American K&B company (manufacturers of the 'real' Veco motors) presumably as an aid to getting them established, distribution being through the old-established Schuco firm. In fact, the 'Veco Europe Series 61' bears little resemblance to the American Veco 61 (it is much closer to the Webra 61) and the same engine is now also marketed through Johannes Graupner as the HB-61. Performance of our test sample was good and especially notable was the motor's above-average pulling power on the larger prop sizes. It is now available in a special version for helicopters.

The manufacture of OPS engines began with the small scale production of a Schnuerle scavenged racing engine with Zimmermann type disc-valve induction and tuned-pipe rear exhaust for control-line speed models and racing hydroplanes. The emphasis continues to be on engines of this type, although the company now also makes a robust shaft-valve, side-exhaust motor, the 'Ursus 60' for regular R/C use. OPS are also making a range of high performance ·40 cu. in. engines including a pylon racing unit. OPS 60 racing engines have achieved some notable successes in European contests and it will be interesting to see how their 40 shapes in pylon racing.

The YS 60, made by the Yamada Manufacturing Company Ltd., is, in many ways, one of the most interesting developments of recent years. Basically the engine is orthodox insofar as it is a shaft rotary-valve, twin ball bearing, crossflow-scavenged, ringed-piston engine of 24×22 mm. bore and stroke but, unlike any other production model motor at the present time, it uses a chromed *aluminium* cylinder-liner and incorporates a completely new concept in fuel systems.



Fox Falcon, rare among 60's in having a bronze main bearing instead of ball races, but very good value.



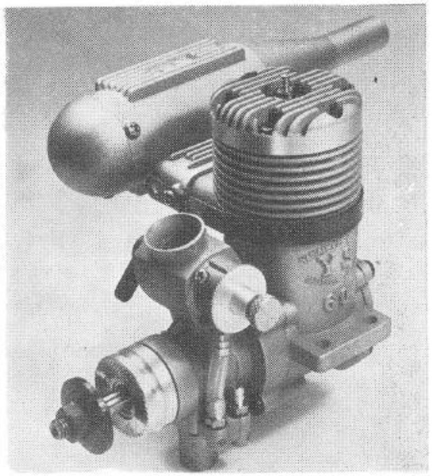
The American Fox Eagle 60 with the optional Fox silencer that is available as an extra.

In this, crankcase pressure is used both to pressurise the fuel tank and to actuate a device which controls the fuel supply to the engine. This eliminates the effects of variations in delivery pressure from the fuel tank and, at the same time, meters the fuel supply to the carburettor in accordance with throttle opening.

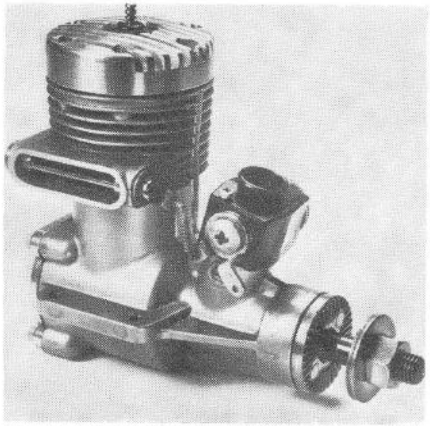
The Yamada company claims that, with this system, the fuel tank can be placed *anywhere* in the model—in the wing or tail if you like—without affecting performance and, having tested it, we can vouch for its effectiveness. With the tank on the end of a yard or so of fuel tubing, one can hold it above one's head or put it on the floor and the engine just keeps going.

The pressure regulating device is built in below the main bearing housing and meters fuel to an outsize carburettor above it. Because fuel pressure is so accurately controlled and does not depend on carburettor suction, a very large choke area is possible and this means less top-end restriction and a higher power output. Our test sample YS 60 in fact produced a peak output, without silencer, of 1·35 b.h.p. at 16,000 r.p.m. using standard 5 per cent nitro fuel.

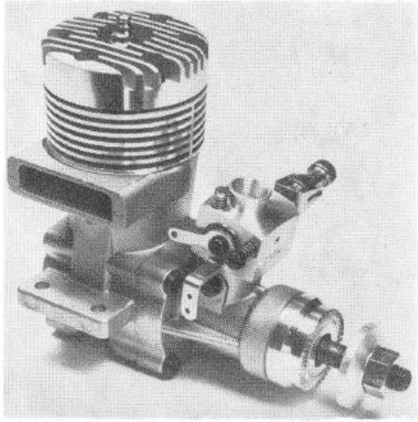
The YS system involves the use of a high pressure (rotary-valve timed) crankcase tapping and a non-return valve in the fuel tank. A much simpler and milder form of fuel tank pressurisation that has become popular during the past two or three years is to tap silencer pressure. Webra, O.S.,



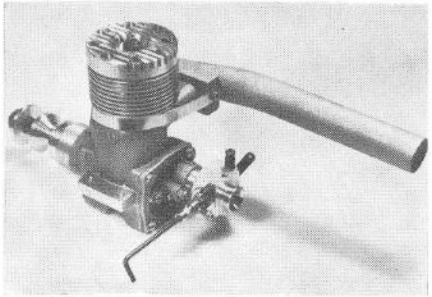
New Japanese YS-60 is unique in having built-in fuel regulator that makes it immune to variations in fuel pressure.



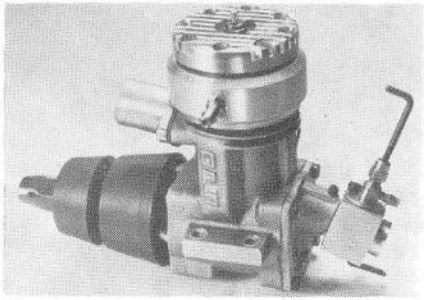
American Veco 61, made by K&B company. This is a 'customised' version assembled by designer Clarence Lee.



Latest version of the Japanese Enya 60 is this Mk. III-B with Enya G-8 large choke carburettor.



The very powerful Italian Rossi 60 R/C motor, here fitted with the special exhaust pipe available for it.



OPS Speed-60 R/C Racing Marine unit features Zimmermann type disc valve and tuned pipe rear exhaust.

HP, HB, Super-Tigre and Enya all now equip their silencers with outlet nipples for this purpose and there is no doubt that pressurising the tank in this way helps to even out minor variations in fuel delivery pressure and thereby reduce the risk of the engine cutting-out during certain manoeuvres. It is especially helpful where carburettor choke areas are slightly larger than normal and it is specifically recommended by Enya for the latest Enya 60-IIIB model when fitted with the optional Enya G-8 carburettor and by HP for use with the new Hirtenberger AFM carb.

On the subject of carburettors, the desirability of having some form of automatic fuel metering (again, especially with large choke carbs) is now widely accepted and practically all modern R/C 60's now incorporate this. Usually some form of adjustment is provided whereby the idle mixture can be set independently of the main needle-valve and the approximately correct mixture strength is then maintained automatically at intermediate throttle settings.

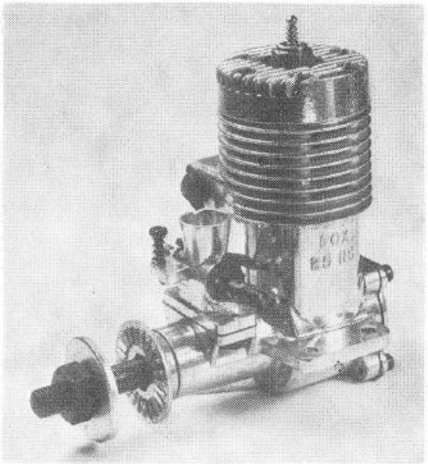
In addition to higher power outputs and better throttle control, current 60's are generally easier to handle and more durable than their predecessors. Improvements in piston rings, combustion chamber shapes and shaft balancing have resulted, in many cases, in quicker starting, more docile handling characteristics and smoother running qualities. The need for greater durability has led to the use of better piston materials and improved conrod bearings. The latter are usually phosphor-bronze bushed at both ends and, in one or two cases (e.g. Merco and O.S.), the piston bosses are also bronze bushed.

Some of the qualities of the better 60's are now beginning to spread to the leading front induction twin ball-bearing, ringed piston 40's such as the redesigned O.S. Max 40 R/C which was first marketed in the U.K. in the spring of 1973. Engines of this type, which also include the Webra 40, K&B 40F, HP 40F and Super-Tigre G.21/40FI, are now becoming widely used by club flyers for aerobatic models. While a 60 remains the favourite for competition flying, the top 40's are capable, in a slightly smaller and lighter model, of giving a performance that is comparable with that of a 60 powered machine at considerably reduced cost —i.e. smaller initial outlay for model and engine, accompanied by lower fuel consumption.

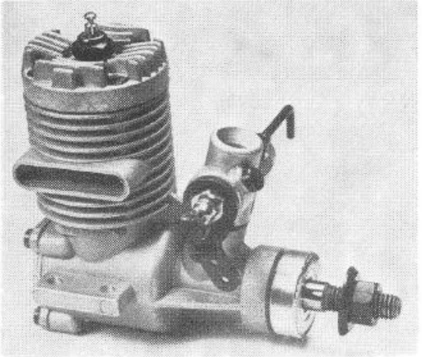
These engines are not, of course, to be confused with the pylon-racing 40's. By common consent, all the most widely favoured aerobatic 40's are of the shaft rotary-valve type at present, whereas the most successful pylon motors have rear-induction. Furthermore, pylon racing rules (or perhaps one should say the lack of them) have reduced the throttle control to nothing more than a cut-out device so that, with its vast unrestricted air intake, the modern pylon-racing engine is more akin to a control-line speed motor. It develops its peak output at 20,000 r.p.m. or more, which is well suited to tiny racing props but is unusable with the larger diameters and bigger blade areas necessary for pulling an aerobatic model up vertically. The necessary differences between the two types of engines are that the racing 40 is required only to develop as much power as possible under an almost constant load (i.e. flat out straight and level flying with only slight increases in load on take-off and through turns) whereas the aerobatic 40 must cope with wide variations in load and should also be capable of being safely throttled down and opened up again over, say, a 2,500-14,000 r.p.m. speed range irrespective of the model's attitude or the level of fuel within its tank.

Finally, we come to our 'Trainer and General Purpose' group. A few years ago this category would have included a fairly large proportion of small diesel and glowplug engines, with simple throttling devices, aimed at the 'bang-bang rudder-only' flyer. Beginners started with single-channel sequential-control equipment and, with a full-house reed outfit costing £150 or so, a lot of them stayed with single-channel and the low-powered models that went with it.

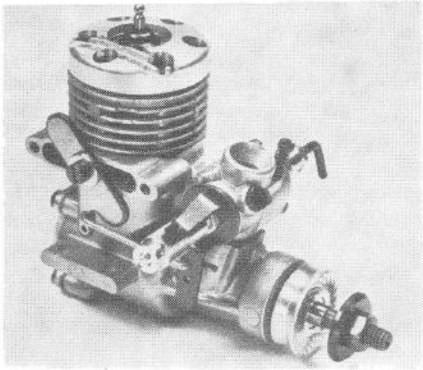
Nowadays, with proportional equipment so very much cheaper, the trend is away from the slow 'interrupted



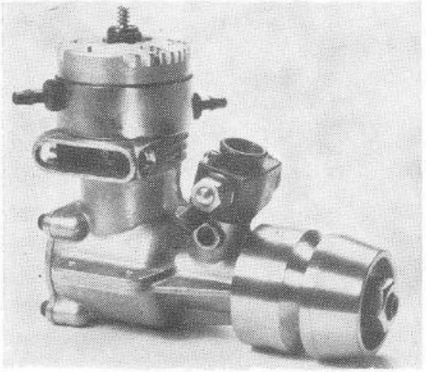
The low-priced Fox 25 R/C has a capacity of 4 c.c. and is simple, light and powerful.



Above: Italian Kosmic K-23 is produced by Komet Kart engine manufacturer. Well made with neat automix carb.

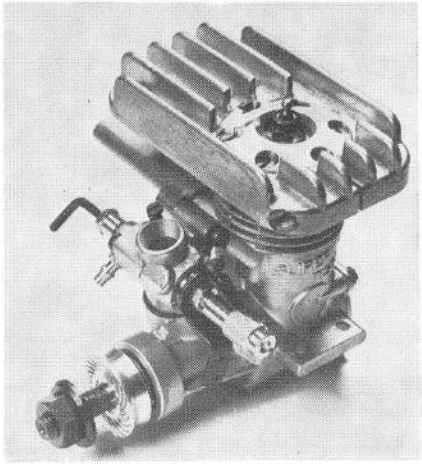


Above: one of a famous family, the R/C version of the popular Super-Tigre G.15 F/F and C/L engine.

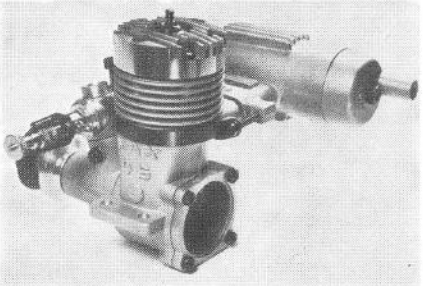


Above: German made version of Veco 19 is available in four types. This is the marine R/C model.

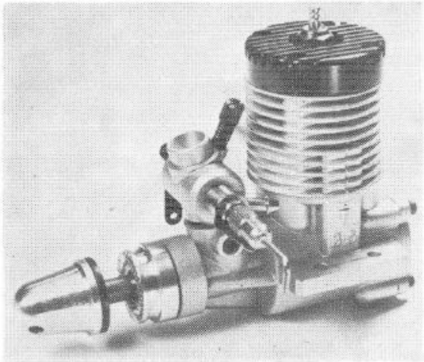
Below: Super-Tigre G.15/19-CAR motor, complete with 'heat sink' and exhaust extension for R/C racing cars.

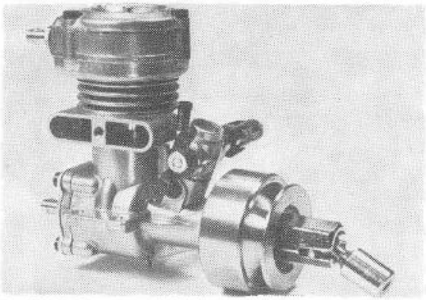


Below: Popular trainer engine is O.S. Max 20. Having same external dimensions is bored and stroked Max-25 shown here.

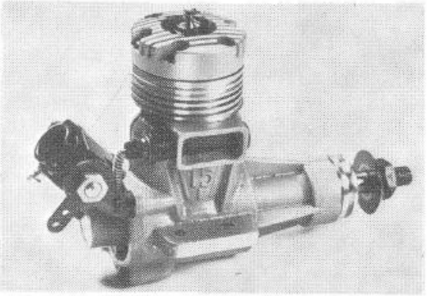


Below: The Taipan 3·5 BB made by well established Australian Burford company, has Schnuerle scavenging and an automix carb.





Available for several O.S. engines is conversion set for watercooling head and crankcase. Shown here is marinized O.S. Max-10.



New K&B 15R engine with Perry carb is No. 1 contender for 'Quarter-Midget' pylon-racing honours.

free-flight' type of model and towards heavier models requiring more powerful engines. R/C trainers are commonly powered with engines of between ·19 and ·35 cu. in.

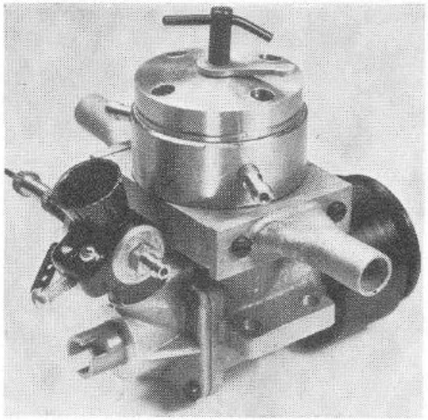
One of the most popular of these 19s, for many years, has been the 3·2 c.c. O.S. Max-19. In 1971 this was superseded by an entirely new model of similar size, the Max-20 and, based on the same main casting but having its bore and stroke slightly increased to raise its displacement to ·25 cu. in. or 4 c.c., is the Max-25. Like all current O.S. motors, the 20 and 25 are each sold complete with a silencer and are proving very popular. The 25 size was also taken up by the American Fox company at about the same time and, like the O.S., the Fox 25 offers the advantage of a lightweight compact power unit (overall sizes and weights are much the same as for the average 19) in which the extra swept volume amply compensates for the power lost when the engine is fitted with an effective silencer.

Other newcomers (1972-73) include the German HB 20, the Italian Kosmic K23 and the Australian Taipan 3·5. The HB is a development of the American Veco 19 (which HB also manufacture using U.S. castings) and like other HB engines, is fitted with a German made version of the American Perry carburettor. The Kosmic (·22 cu. in.) is made by the manufacturer of the Komet go-kart engines and is obviously intended to compete with its well-established compatriot, the Super-Tigre G.20/23 which, internally, it resembles quite closely. Incidentally, the Super-Tigre has been considerably improved and now includes a Super-Tigre Mag type carburettor with automatic mixture control.

The Taipan 3·5 (·21 cu. in.) is unusual among engines in this class in that it features Schnuerle scavenging and is available in a choice of two models, one with a bronze bushed main bearing and one with twin ball bearings. The Taipan is somewhat heavier than the others of this group but is very sturdily made and should be able to take more than average punishment.

Most of the engines in the ·29 to ·36 cu. in. group have been with us for some time but there are new Fox 29 and 36 R/C engines which are remarkably low-priced for motors of this size. They both have a bronze bushed main bearing and feature a special Fox carburettor with separate idling and high-speed jets. Incidentally, all the Fox engines are now very reasonably priced in the U.K. thanks to a special Fox marketing set-up and the Fox Falcon 60 is by far the cheapest large R/C engine now available.

Among the smaller sizes, the O.S.



E.D. Sea-Lion 5 c.c. diesel, intended solely for marine use, has rear drive take-off and, of course, water cooling.

'economy model', the popular 'Pet' 099 (1·6 cc.), has been completely redesigned and has reached its Mk. III version. The Max 10 (1·75 c.c.) is unchanged, as is the ever-popular 2·5 c.c. Max-III 15. The latter has been enjoying a new lease of life as a 'Quarter Midget' class pylon racing engine, although, with the popularity of this class on the increase, the trend will undoubtedly be towards more specialised engines and the writing is on the wall with the new K&B 15R Schnuerle port, rear drum valve, Perry carb equipped racing engine, costing more than twice as much as the O.S. Very powerful, our test K&B 15 had a somewhat ravenous appetite for K&B short-reach glowplugs, but reached (unsilenced) a highly impressive 0·50 b.h.p. at between 21 and 22 thousand r.p.m. on K&B Supersonic-1000 fuel.

Finally, a word about marine R/C motors, of which a much wider variety is now available. Most of these are watercooled versions of existing aircraft engines but there are a few that have been especially designed for boats, notably the compression-ignition units offered by E.D. Ltd. of Surbiton. E.D.'s recently introduced Viking 5 c.c. watercooled diesel has a special rear drive take-off for the propshaft, the flywheel being installed forward on the front of the ball-bearing mounted crankshaft for ease of starting. The engine includes a barrel throttle carburettor and, like its predecessor, the E.D. Viking, its internals are based on the well-tried Miles 5 c.c. diesel.

Marine versions continue to be made of the British Merco 29, 35, 49 and 61. The major American engine manufacturers do not offer water-cooled versions of their engines but Irvine Engines, the U.K. importers of K&B, offer their own excellent marine conversions of the K&B 15, 35 and 40 models.

Certain O.S. Max units, including the largest (Max-H.80) and smallest (Max-10) are available in water-cooled versions. These have special watercooled cylinder-heads (and, except for the 80, watercooled crankcase backplates) that are interchangeable with the aircooled components. Conversion sets are also obtainable enabling the owner to utilize one engine for both aircraft and boat use if he so wishes. Flywheels for O.S. engines, sold by the U.K. distributors (Keilkraft) are made in Britain.

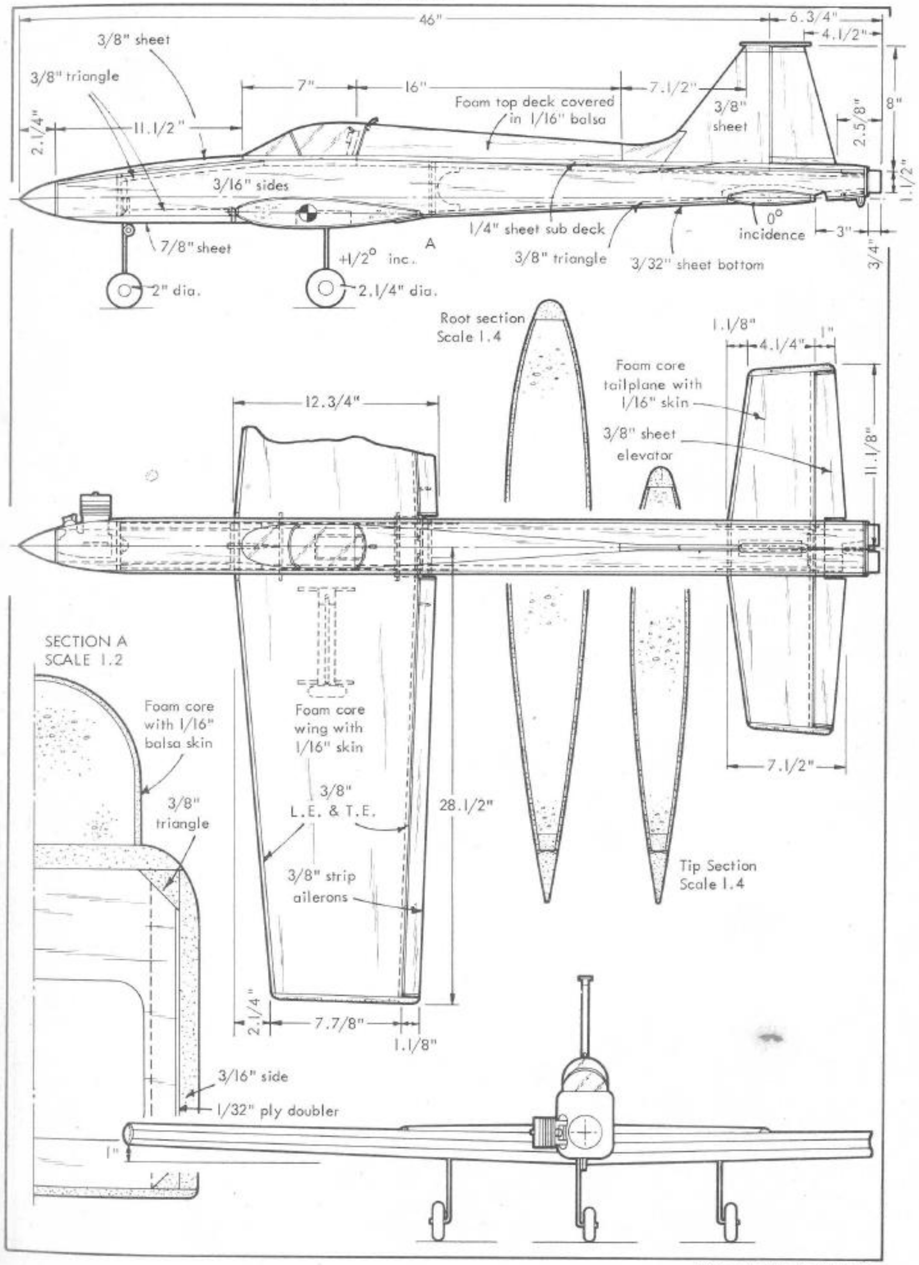
Most other makes have fixed water jackets. They include nearly all the engines in the Enya range, some Webras and Super-Tigres and all the HB and 'Europe Series' Veco models. The HP 40 and 60 engines, both front and rear induction are also produced in watercooled versions as are the Kosmic K-15 and K23, the Rossi 15 and 60 and all the OPS models.

All the engines we have mentioned in this article are either available now in the U.K. or are expected in the immediate future. The British R/C modeller has an immense range of engines from which to choose—a wider selection, perhaps, than anywhere else in the world.

Tiger Panzer

10 c.c. powered F.A.I. class aerobatic model
BY RICH BRAND

Scale 1:12

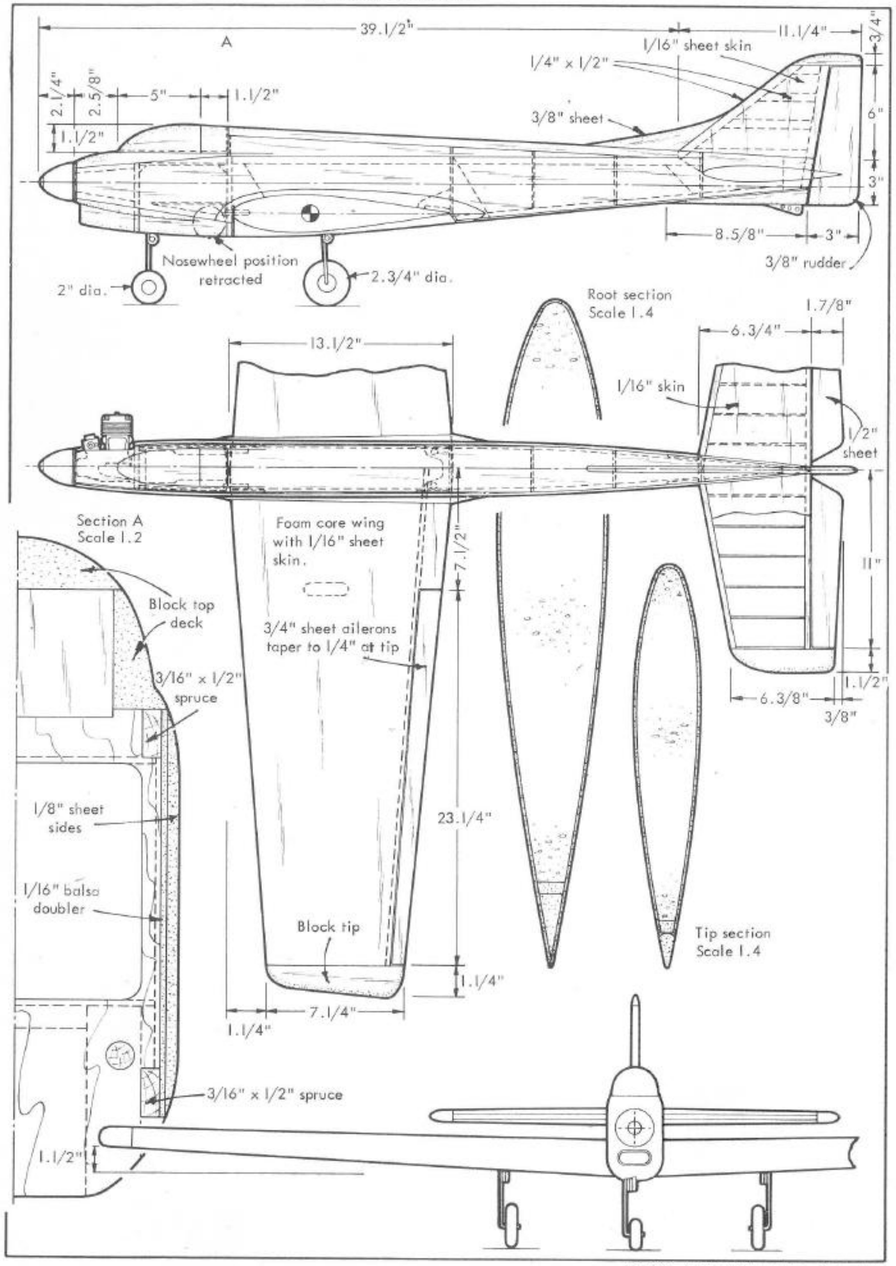


R.C. MODELER (U.S.A)

Swea'tater

10 c.c. aerobatic model for full house R/C
BY DON COLEMAN

Scale 1: 12

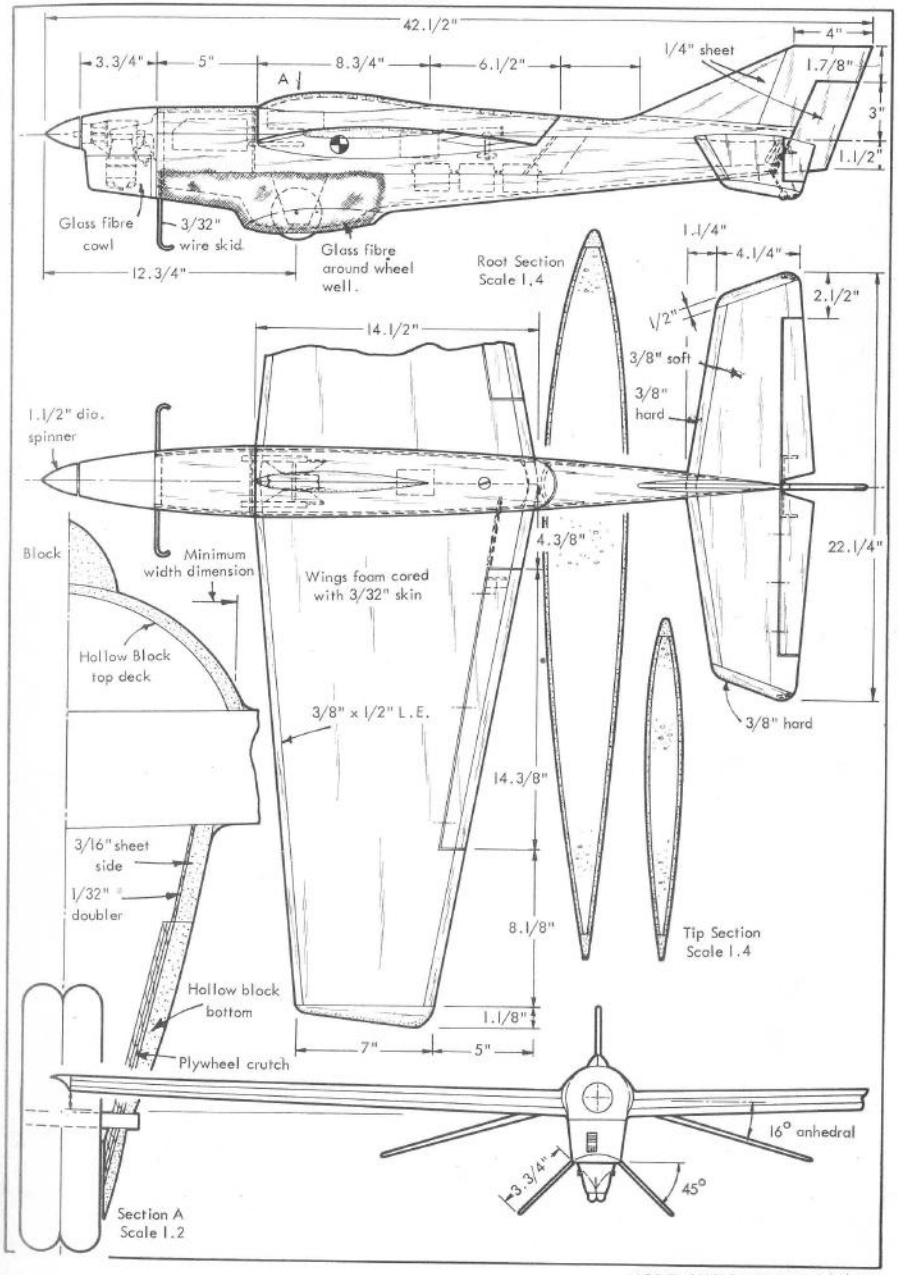


MODEL AIRPLANE NEWS (U.S.A.)

Bob Cat

F.A.I. Class Pylon Racer. Winner of 1972 Cranfield International and 1973 U.S. Nationals
BY BOB VIOLET

Scale 1: 10



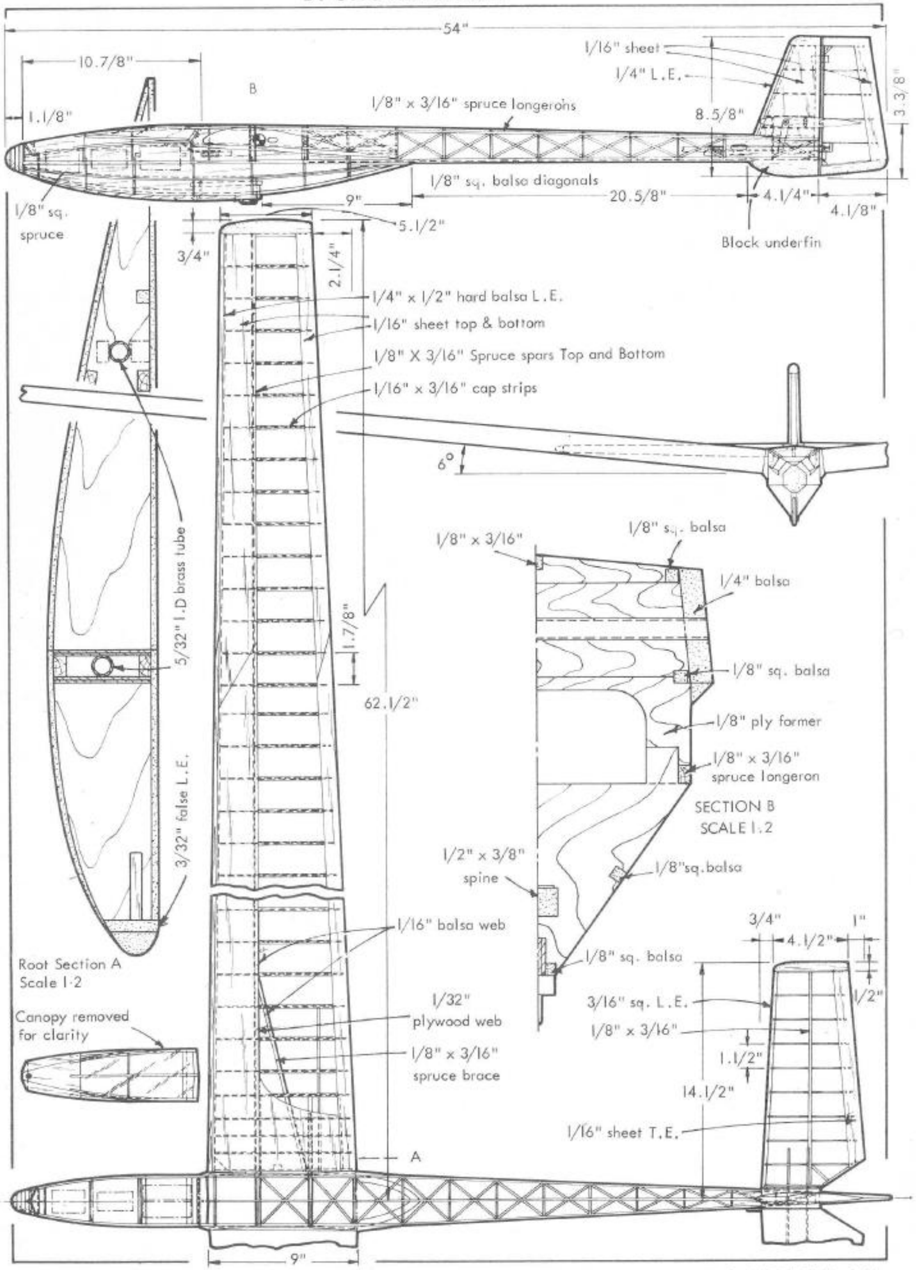
MODEL AIRPLANE NEWS (U.S.A)

Snoopy

**Contest winning R/C Thermal Soarer.
1973 U.S. Nationals Winner.**

BY OTTO HEITHECKER

Scale 1:12



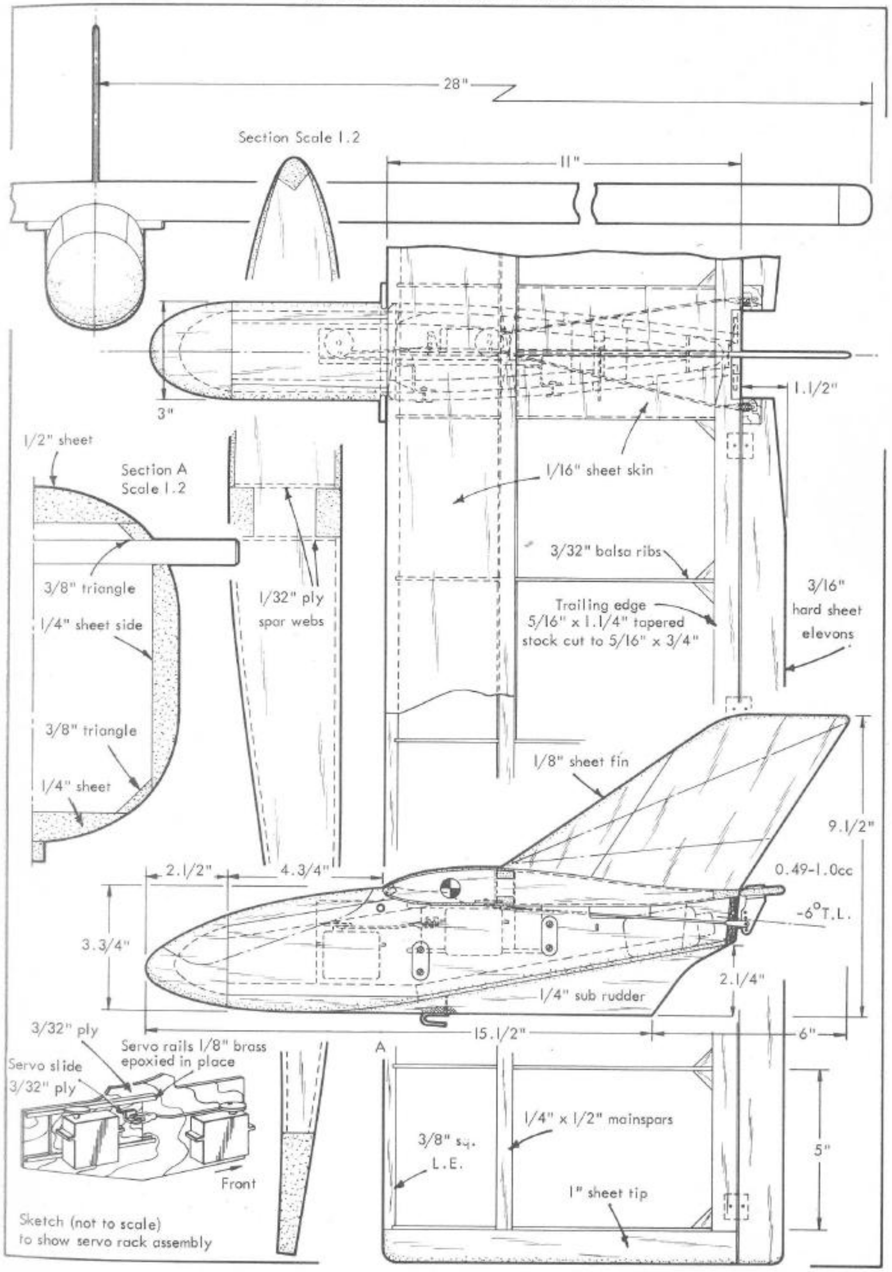
R.C. MODELER (U.S.A)

Little Plank

**Simple flying wing
slope soarer with power option.**

BY CHUCK CLEMANS & DAVE JONES

Scale 1:6



R.C. MODELER (U.S.A.)

THE ELECTROSTATIC AUTOPILOT

By Maynard Hill

FANTASTIC! Spooky! Unbelievable! Amazing! These are a few of the adjectives that have been used by some pilots who have flown radio-controlled airplanes fitted with a new type of stabilising autopilot that uses static electricity in the atmosphere as a reference signal.

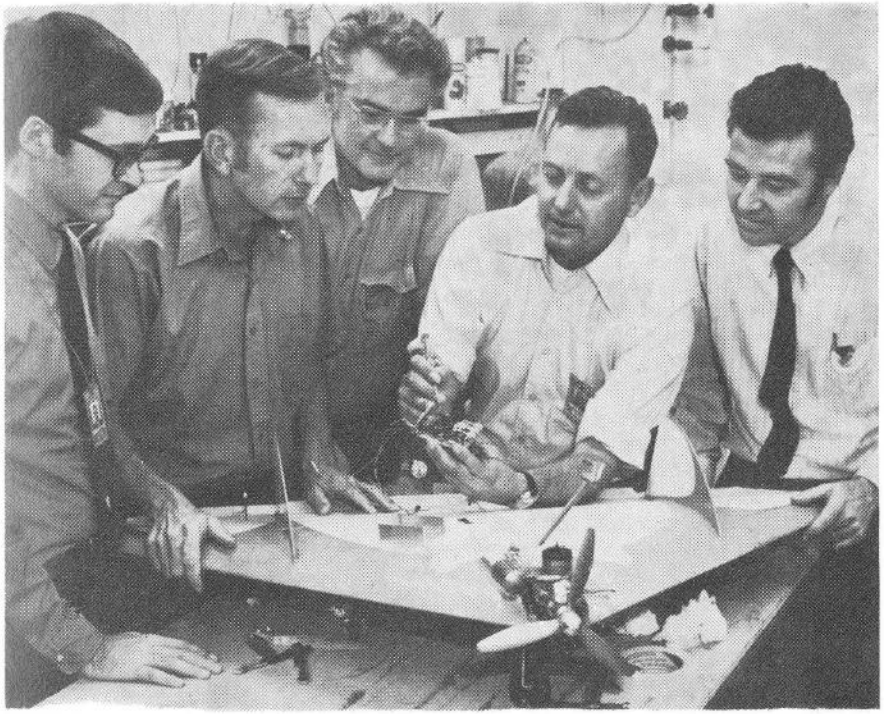
'How does it work? How did you ever think up a system like that? What does it cost? Will it work on a metal airplane or a light aircraft? How much does it weigh? Are there any moving parts? Will it work on a Helicopter? Is it good for pylon racers?' These are some of the questions that follow the adjectives.

The device is not a mysterious 'spooky' divining-rod type of thing. Neither is it a fantasy. It is real, it works, and it's based on scientific knowledge. The only unbelievable aspect of it is that there apparently has been no prior attempt using this particular combination of physical phenomena in a practical device for aircraft stabilisation. In fact, there has not been much exploitation of any of the voluminous research that has been performed in the field of atmospheric electricity during the past two centuries.

The electrostatic autopilot consists of a patch of harmless radioactive material mounted on each wing tip and on the nose and tail of an aircraft along with two highly sensitive differential voltmeters. As an end product, a stabilisation system has been developed which, under the conditions that we have flown, appears equal to the capabilities of conventional systems employing precision mechanical gyros.

The operating principles of the system are based on two key facets of atmospheric electricity that have been known for a very long time. One is Benjamin Franklin's demonstration in 1752 that lightning transfers large amounts of negative charge to the Earth. The other is Lord Kelvin's analogy, proposed in 1860, that the atmosphere is like a large capacitor where there is a highly conducting layer in the upper atmosphere that acts like a highly charged positive plate, while Earth acts as the negative plate of the capacitor. Through some unusual but very enjoyable experiments, new insight has been added to the 'capacitor idea'. We have shown that there are voltage levels within the atmosphere that are almost as smooth and horizontal as the equipotential planes seen in sketches in college text books describing the electric field between capacitor plates. The reference signals for stabilisation are derived from measurements related to these equipotential planes.

Let's answer some easy questions first. The two-axis stabilisers that we've flown weigh about 3 ounces. There are no moving parts in the sensor system. There are about fifty dollars worth of electronic components in our present autopilot design, but the real cost is yet undefined.



Some of the people who participated with Maynard Hill in development of system. Left to right: John Rowland, Robert Givens, Ray Cole, (Hill) and Chris Keller. Model is Talon Zephyr delta.

How did you 'think up' such a device? The answer here is that the device was not thought up. A unique set of circumstances involving seeing, hearing, doing and thinking led to recognising the possibilities of developing such a device. The combination that occurred was that a metallurgist with a good sense of musical pitch who had obtained a practical education in aerodynamics, control systems and metereology through an avocation of flying model airplanes was outdoors providing some 'flight service' to test an unusual instrument designed to study clear air turbulence. With such an unlikely list of prerequisites, maybe it does make sense that it took so long to discover static voltage stabilisation.

The experiment we were doing had been devised by John Rowland, a colleague at the Applied Physics Laboratory, who has a dedicated interest in learning about clear air turbulence created by thermals. During the past two years, we have worked together on a project in which we have used radio-controlled airplanes to make specialised soundings to measure air properties within thermals detected by large radar systems at Wallops Island. A photograph of the 'Catbird' one of the airplanes we have used a great deal is shown among these pages. This model is a beefed-up version of typical radio aircraft that have been used by the writer to set altitude and duration records.

A new kind of instrument for possible use in finding thermals was being developed. The idea was that thermals often pick up dust particles which could be charged with static electricity. A sensitive differential voltmeter was to be installed in the wing of an airplane. An audio tone being telemetered from the airplane was expected to play a high musical note if a thermal was on the left and a low tone if the thermal was on the right side of the aircraft.

In the March 1969 issue of *Flying Models* the author and Ben Givens reported a telemetering device for radio-controlled soaring gliders that tells a pilot on the ground when his model is in an updraft. This sensitive vertical velocity meter helped significantly in establishing a world altitude record of 3,680 feet for soaring gliders back in 1966. Many glider guiders use the ‘thermal sniffer’ today to improve their technique of soaring. Highly calibrated versions of the same type of vertical velocity meters have been of valuable use in the clear air turbulence studies being conducted at APL. But the device has a drawback. It can only tell you when the model is in a thermal. It cannot tell you which direction to fly in to find a thermal. Now John Rowland was proposing a device that might do this. It sounded like a great idea.

We installed the system in the wing of the battered but flyable 12-foot-span ‘Bong Boomer’ (*Flying Models*, February 1967) glider and fitted it with an engine to make the job easier. Several flying sessions were carried out during which we reached no conclusive results about thermal sensing. Tone variations were small and did not fit any consistent pattern when we flew near suspected thermal areas. A hard landing on a windy afternoon brought us, to a standstill. It appeared that horizontal voltage gradients due to thermals must be fairly small in magnitude. The attempt to develop a thermal direction finder was temporarily abandoned.

From my position in the ‘pilot’s seat’ I came away from these flights with a suspicion that the vertical voltage gradient was always much larger than thermal effects and that there was a systematic relationship between bank angle and the voltage being generated in the sensor system. Soon the rig was installed in another model designed to withstand more aerobatic violence than the one we had just damaged. A few hammerhead stalls and full rolls gave further strength to the suspicion. A quick trip to the shop was made to change some resistors and install a couple of capacitors to try to improve the sensitivity of the TM signal. By the end of the day it was clear that there was indeed a signal that very much resembled what one would expect from a vertical reference gyro. The pitch of the tone was remarkably steady during level flight. Slight banking turns of the right produced a mild upward shift in pitch and steep turns produced a beautiful high squeal. A low groaning tone accompanied a steep left turn.

A period of feverish flight activity followed during which the telemetering unit was flown in winds up to about 25 m.p.h., under low overcast skies, in a drizzle, in smog, near thunderstorms, and on two occasions into the base of heavy clouds at about 600 feet altitude. Ben Givens was especially helpful during this period. A tape recorder was always present taking down audio tones and comments by the pilot about the attitude of the aircraft. Flights were made with sensors mounted both for pitch and roll measurements. The audio tapes always fortified the conclusion that the voltage being produced was highly proportional to the attitude of the aircraft. The magnitude of the tone shift seemed very reproducible and noise-free regardless of the weather and time of day. Gusty winds did not seem to destroy the relationship between bank angle and tone frequency.

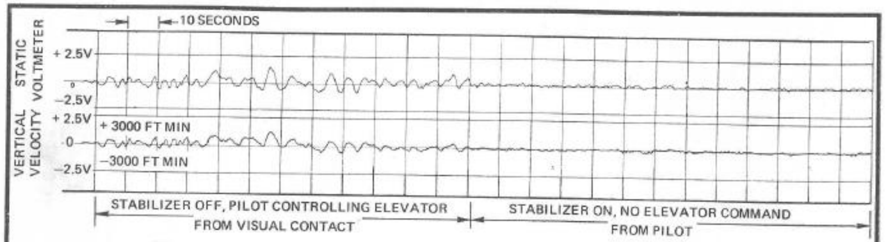
Ben and I spreadeagled the innards of the TM set and several Kraft servos out on a workbench. Measurements and adjustments were made, wires were strung and a switch was installed so as to be able to connect the generated signal to the aileron servo by command from the ground. We found a place in the servo where the feedback loop could be closed while still providing a capability for the pilot to override the ‘stabiliser’ with the control stick.

It is a thrilling experience to land a radio-controlled model aircraft directly in front of certifying officials after flying it to a world record altitude of 27,000 feet. A half hour earlier it had been but a small speck in high powered telescopes and the slightest malfunction would have meant total loss. Many other similar moments of satisfaction have occurred during my 38 years of aeromodelling. Some of the best ‘kicks’ have come from private little experiments that turned out wrong for practical use and right for learning something new. Other ‘kicks’ have come from such public spectacles as flying a radio-controlled model across the state of New York for a distance record. But none of the thrills has equalled the feeling that came when that stabilizer switch was first activated. The control transmitter had been trimmed to produce a condition of instability such that, in a ‘hands off’ condition, the airplane quickly rolled over into a steep descending spiral dive. Activation of the switch snapped the wings back up to a level position! ‘Wow! Look at that!’ was recorded on the tape recorder at over 100 decibels.

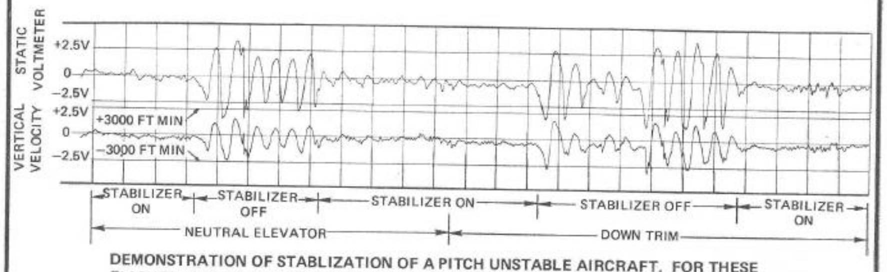
At first, it felt uncanny to be able to forget about giving roll commands. The airplane would fly hands off and return to level after every gust disturbance. We soon learned to trust the stabilizer. We could set the transmitter on the ground and watch the airplane fly across the sky. Full ‘hard over’ commands would result only in a very smooth graceful turn of constant and shallow bank angle as contrasted with vicious spiral dives or rolls that would occur without stabilisation. Even a *Tiger Tail* can be tamed to have *Rudderbug* flying qualities.

It wasn’t very long before we had the elevator servo of the Catbird responding to the nose probe and a second electrode mounted on top of the vertical fin as seen in some of the photos. The extended nose probe was used to prevent engine oil from getting on the front radioactive source. The sources are a polonium isotope that emits only alpha particles. These are stopped by thin plastic films or other organic films such as castor oil. There is no physical hazard from such polonium sources so long as the radioactive material is not ingested, and the units are normally supplied with a metallic grid to prevent this from happening accidentally. Incidentally, these radioactive sources can be bought in many record shops. They are attached to a paint brush type of deal that eliminates static electricity and lets you brush the dust off the record. If you buy one, read the instructions which advise you to keep them out of reach of children.

The demonstration of pitch stabilisation was even more dramatic than in the earlier case of roll. The centre of gravity of the aircraft was moved from its normal point of 25 per cent of the wing chord back to about 50 per cent by putting a crescent wrench in the tail section. This converted the airplane to a ‘real dog’. In the ‘hands off’ condition, the aircraft would enter a divergent phugoid that eventually built up into a sequence of violently steep dives followed by vertical climbs with vicious stalls and ‘flip over’ loops at the top. The telemetering signal sounded like a police siren! Activation of the switch resulted in almost immediate return to level flight and a pleasant steady tone from the TM.



COMPARISON OF BEST LEVEL FLIGHT BY A HUMAN PILOT AND BY THE SVS PITCH STABILIZATION SYSTEM. THIS FLIGHT WAS AT APPROXIMATELY 3000 FT ALTITUDE ON A DAY WITH MODERATE THERMAL TURBULENCE



DEMONSTRATION OF STABLIZATION OF A PITCH UNSTABLE AIRCRAFT. FOR THESE FLIGHTS, THE CENTER OF GRAVITY WAS SHIFTED AFT SO THAT THE AIRCRAFT WOULD ENTER A DIVERGENT STALL AND DIVE PATTERN WITH THE STABILIZER TURNED OFF. THE PEAKS AND VALLEYS REPRESENT NEARLY VERTICAL DIVE AND CLIMBS. DURING THIS PORTION OF FLIGHT THERE WERE NO ELEVATOR COMMANDS SENT TO THE AIRCRAFT BY THE PILOT

Fig. 1

Gusts were seen to lift the nose temporarily, but the feedback loop quickly returned it to level.

The pitch stabilising system was used operationally during two weeks of data flights at Wallops Island. Virginia and numerous quantitative telemetry records about its performance were obtained during about 10 hours of flying time. We found the stabiliser very useful in this CAT experiment in which one of the objectives was to measure vertical velocity of a thermal updraft. The procedure called for flying to about 4,000 feet altitude (in a restricted air space), shutting off the engine and gliding back down at minimum sinking speed of the aircraft. Under these conditions, the aircraft sinks at about 4 ft./sec. and vertical up-draft of this order or magnitude can be detected. But there has always been a tendency of the aircraft to swoop up and down mildly during this procedure. It is particularly difficult at altitudes above 2,000 feet for the pilot to see the small motions of the aircraft well enough to apply the necessary elevator commands to prevent all phugoid motions. The data on thermal velocity are complicated by these extraneous motions. Thus, smooth flight is very desirable. A typical TM trace, seen in Figure 1, shows that the autopilot obviously provides smoother flight than can a pilot on the ground. The bottom half of this same Figure shows how the stabiliser grabs hold of a tail-heavy airplane and makes it fly level.

A roll-axis stabiliser was next installed in the 44 in. span *Talon Zephyr* delta shown in some photos. It just seemed that things were going too well and we had to find some more severe tests to demonstrate that there

were some real problems with the new autopilot. The Delta seemed like an appropriate challenge as this kind of aircraft is unstable and hard to fly. We fully expected that if the stabiliser worked at all on this 'skittish' model we would probably see it oscillate badly in roll as the stabiliser tried to keep it level. But another momentous thrill came when the stabiliser switch was activated. Again, the aircraft snapped to level flight and took on characteristics of a boat skimming along the surface of the water. Normally this command would produce a continuous roll at a rate of about 360° per second, but now the pilot could remove his hands from the control stick and, providing the elevator was properly trimmed, the model would pop to straight and level flight and maintain a course that gave the impression it would like to go right out over the ocean and land at Paris!

This same Delta was soon fitted for simultaneous pitch and roll stabilisation. Again, the nose probe in front of the propeller was used, as seen on the cover. The fact that this probe is elevated about 8 inches above the wing tip probes has a special benefit in that it automatically couples some up-elevator with roll when the craft rolls to a banked turn. The result is that this airplane does coordinated turns and is almost as easy to drive as an automobile. My wife, Gay, has tried on several occasions to fly some tame models, but she has never had much success. To prove that this new system will permit a novice to fly, she took the control stick and was instructed only to (a) push the stick left to turn left, (b) push right to go right, and (c) let go of the stick if you get confused. She managed to run the airplane out of fuel. This performance was observed by members of the DCRC Club, and a controversy has arisen because, at the Club's annual family picnic, there is usually an event called 'Divorce R/C Style'. The object is for a husband to give his transmitter to his wife, and the time is measured until the husband grabs the transmitter to prevent a crash of his model. The DCRC picnic organisers are rumoured to be writing a rule against autopilots!

The Delta model is a good demonstration vehicle because without stabilisation, it will quickly roll and dive towards the ground if the pilot takes his hands off the stick. Subsequent turning of the stabiliser, however, results in very abrupt pitch and roll manoeuvres to bring the craft to level cruise attitude. If the model is rolled over inverted and then the pilot turns on the stabiliser and releases the stick, the aircraft quickly rolls or pulls a loop to get into the upright position. It is impossible for the pilot to hold the airplane inverted once the stabiliser is on. Automatic 'hands off' landings have been done with this delta using only the throttle to control the descent rate. Stabilised takeoffs from a paved runway have also been performed but we have encountered some unusual effects in taking off from grass fields. Evidently a blade of grass hitting one or the other sensor can impart a quick roll command as the craft is about to depart the ground. We have stabilised a Tiger Tail so that it flies inverted with 'hands off' the transmitter. We need a new record category—the longest sustained inverted flight. It would be easy with the device. You can set the transmitter on the ground and watch the model fly inverted.

It is not extremely time-consuming or difficult for skilled aeromodellers to reproduce this device and test it. For example, circuit diagrams and a description of the principles were given to Don Lowe and Dennis Ingebretson who run a project using radio-controlled model techniques for research at Wright-Patterson Air Force

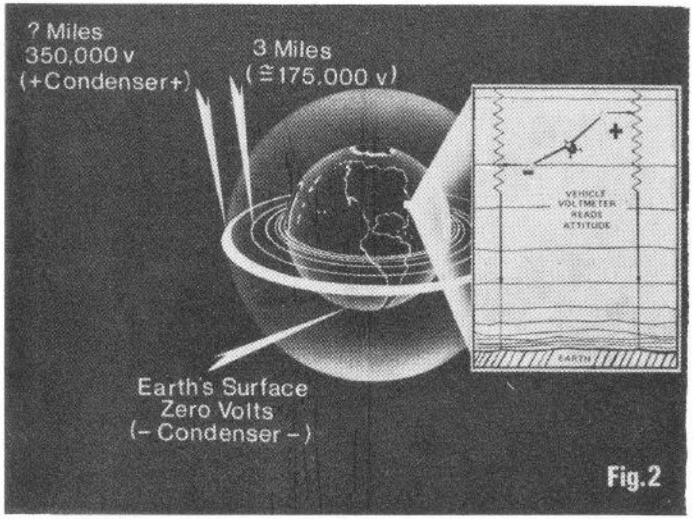


Fig.2

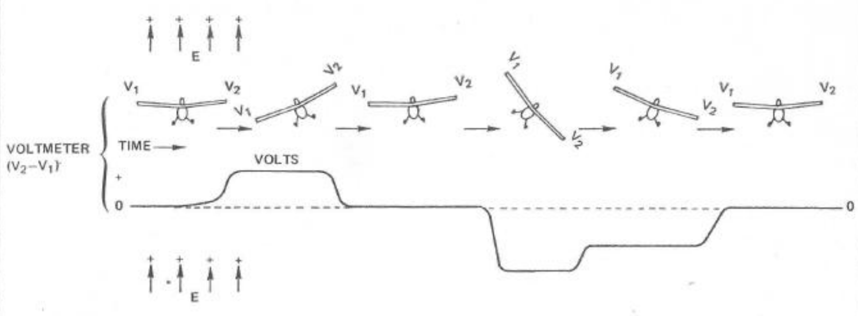
Base. Six days after receiving the information Don and Dennis called to say they had successfully flown the device 'two days ago on a day when there were thunderstorms nearby.' It worked the first time they tried it. This group has progressed rapidly and has done night flying and automatic landings with *Ugly Sticks, Big Daddies* and several other unusual airplanes.

Theory and Background

It isn't necessary or appropriate here to go into great detail to explain the physical phenomena of the atmosphere from which the signals are derived. If you are curious there is a brief description about atmospheric electricity in the November 1972 issue of *Astronautics and Aeronautics,* a magazine published by the American Institute of Aeronautics and Astronautics. This can be found in most all technical libraries. If you really want to study the details, there is an excellent book by J. A. Chalmers called '*Atmospheric Electricity*' published by Pergamon Press, 1967, and available in technical book stores.

A very simplified atmospheric model that helps explain the operation of the autopilot is shown in Figure 2. The air above Earth is like a huge twin-shelled spherical capacitor. The upper plate is some 20 or more miles high and consists of a highly conductive layer of air that is ionized by cosmic and solar radiation. The upper plate is charged to about 350,000 volts. The Earth's surface, which is also an excellent conductor, serves as the other plate of the capacitor.

The most widely accepted theory holds that thunderstorms maintain the charge on this capacitor. It was Ben Franklin who first pointed out that lightning typically puts negative charges onto the earth and it was Lord Kelvin who first suggested that the atmosphere can be likened to a spherical capacitor. Because both the upper air and the earth are highly conducting, lightning discharges that occur in Europe and Africa quickly spread to a uniform voltage over the whole globe. So when you are out flying an electrostatic autopilot on a clear Sunday morning you may actually be using power from lightning that is striking the Alps during a late afternoon thunderstorm. It is interesting to note that there are about 630 megawatts of DC power continuously flowing down through earth's atmosphere. That's enough power to light up a fair sized city!



PRINCIPLES OF VOLTMETERS FOR ATTITUDE SENSING

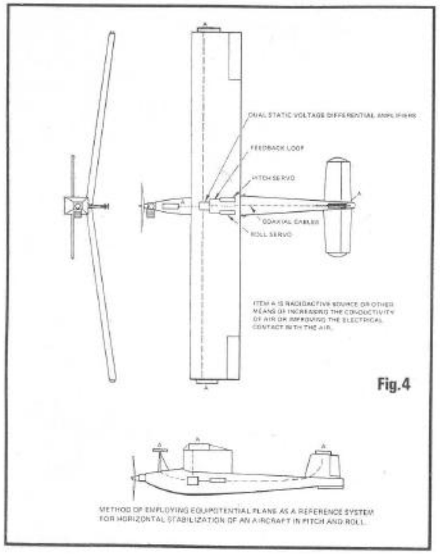
THE ELECTROSTATIC VOLTAGE GRADIENT (E FIELD) IS VERTICALLY ORIENTED, PROVIDING MORE POSITIVE VOLTAGE WITH INCREASED ALTITUDE. THUS WHEN THE AIRPLANE MODEL BANKS, (a) A VOLTMETER SENSES THE DIFFERENCE IN VOLTAGE BETWEEN THE WING TIPS (VOLTAGE IS PROPORTIONAL TO ANGLE OF BANK), (b) THIS INFORMATION IS FED TO A SERVO, AND (c) CORRECTIVE COMMANDS ARE FED TO THE AILERONS. THE MODEL THEN FLIES LEVEL AND STABLE IN SPITE OF GUSTS.

Fig.3

But do not get too concerned about such details. The voltage on the capacitor seems to be there on any day that it is reasonable to go flying radio-controlled airplanes. It's been measured for the past 150 years and hasn't disappeared, so we can probably count on it for the future. The gradient sometimes gets fouled up in snow storms and heavy rain, but it has been found pretty reliable in clear to mildly foul weather.

The voltage gradient is usually very strong near the ground where we fly R/C models. Typically it is about 180 volts per meter. That means that when you stand in an open field, your head is poked up at a point where the voltage is about 300 volts higher than your feet. If you stretch your arm vertically it reaches up to a point where the voltage is normally 400 volts positive. The antenna of your transmitter might see 600 or 700 volts. Except for the fact that the current that is available is extremely miniscule, you'd be dead long ago! But you have to believe this. When your R/C model banks to 45 degrees, the high wing tip would typically be 60 to 80 volts more positive than the low tip. This kind of signal is easy to pick up with the sensitive voltmeters shown here.

The principles of the sensor system can be visualized from Figures 2 and 3 where a radio-controlled airplane is shown to be flying at various bank angles to the earth's surface. The low wing picks up a negative signal while the high one gets a positive signal. We take the difference between these signals and connect the result to the servo system so as to provide the same servo motion that you as a pilot ordinarily would apply to the transmitter to bring the airplane back to level. The voltage gradient is everywhere in the sky, so it is as though the wing tips are attached to potentiometers that fly through the air with the airplane. If we also put a pair of sensors in the fore and aft direction as shown on Figure 4 we can also control the craft to keep it level in



ITEM A IS RADIOACTIVE SOURCE OR OTHER MEANS OF INCREASING THE CONDUCTIVITY OF AIR OR IMPROVING THE ELECTRICAL CONTACT WITH THE AIR.

METHOD OF EMPLOYING EQUIPOTENTIAL PLANE AS A REFERENCE SYSTEM FOR HORIZONTAL STABILIZATION OF AN AIRCRAFT IN PITCH AND ROLL.

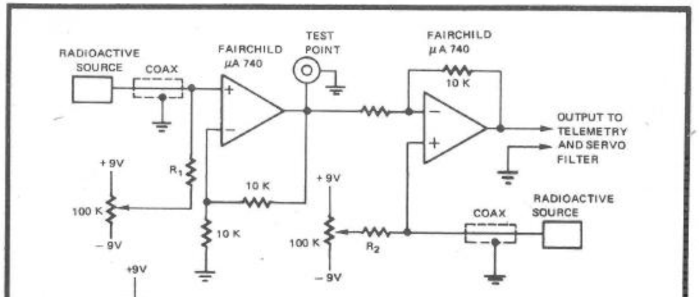
Fig.4

pitch. When both axes are stabilised, presto! you have a model that will 'zap' to level flight any time you let go of the stick. It will even recover from inverted spins automatically and come out flying upright and level with your hands off the control stick.

A circuit diagram for a single-axis attitude sensor (voltmeter) that is suitable for large slow airplanes such as the Catbird is shown in Figure 5. Figure 6 shows a special 'triangle circuit' that was developed by Ben Givens and which has been used on the Delta and conventional aircraft for providing pitch and roll stabilisation. This circuit includes an electronic switch for activating the feedback loop. This switch can be plugged into a spare channel and it is recommended that you don't turn it on for the first take-off. Only three radio-active electrodes are needed for this triangle circuit: one on the nose of the Delta (or vertical fin of a conventional aircraft) and one on each wingtip. The nose (or tail) probe is referenced to the electrical centre of the two wingtip electrodes.

The output of the differential voltmeters must be appropriately impedance matched and fed into the timing circuit of the 'one shot' generator in the servo. A diagram of how to do this on a Kraft 3-wire IC servo is shown in Figure 7. We haven't done this to any other type of servos, so we can't give instructions for other systems. You could ask the manufacturer how to do this on your set or ask some experienced electroniker for help. Needless to say, this is not a project for a neophyte experimenter. There are some pitfalls that need to be thought through. Like for instance, don't put this system onto a servo that will strip its gears if it goes out against the stops. You will need additionally circuitry to prevent this if you don't use something like Kraft KPS-9's which tolerate this brutality.

There is a simple but reliable test



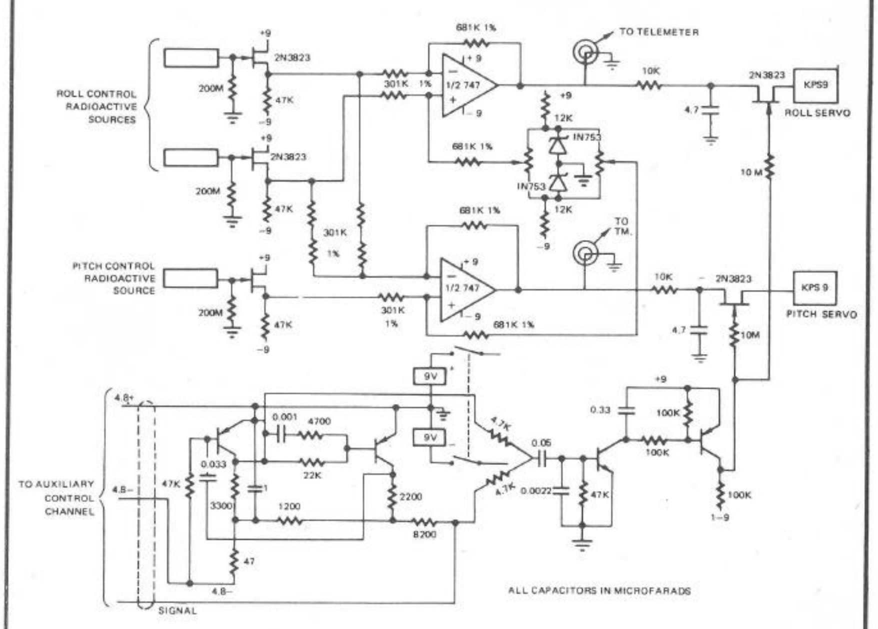
RADIOACTIVE SOURCES ARE STATICMASTER 2 μ500 – 500 MICROCURIE POLONIUM ALPHA SOURCE

R_1 AND R_2 ARE EQUAL. VALUES IN THE RANGE 100 TO 200 MEGOHMS WILL BE NEEDED, DEPENDING ON AERODYNAMIC CHARACTERISTIC OF THE AIRPLANE

SERVO INPUT MUST BE FILTERED AND AN APPROPRIATE IMPEDANCE MATCH MUST BE PROVIDED FOR THE PARTICULAR SERVO EMPLOYED.

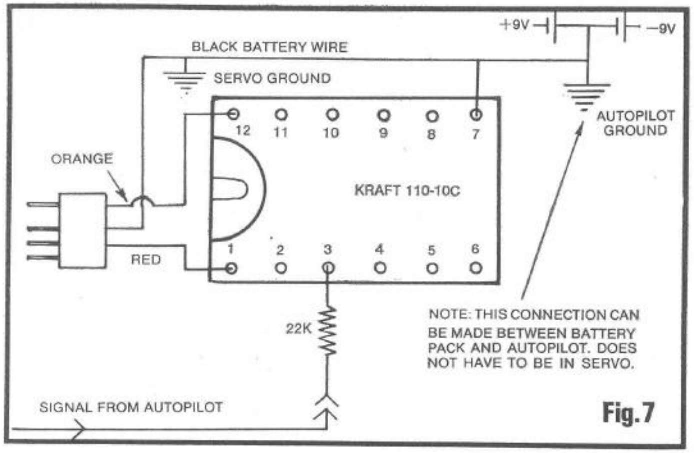
ELECTROSTATIC STABILIZER CIRCUIT

Fig.5



"TRIANGLE" STABILIZER CIRCUIT FOR PITCH AND ROLL

Fig.6



NOTE: THIS CONNECTION CAN BE MADE BETWEEN BATTERY PACK AND AUTOPILOT. DOES NOT HAVE TO BE IN SERVO.

Fig.7

to assure that the controls go in the proper direction to right the aircraft as opposed to turning it inverted. A hard rubber comb, brushed through the hair takes on a negative charge. When this negative charge is brought next to a wingtip, the aileron should deflect downward to produce extra lift, as this represents a wing that is inclined downward towards earth in flight. The elevator should go up when the comb is held at the nose of the aircraft. In an open field, the surfaces will respond to bank and pitch motions if the model is lifted off the ground and rotated. The amplitude of the response is not as large as when airborne, but the test is satisfactory for demonstrating that the system is operational. The comb can be used anywhere, but there will be no response to rotation indoors, under trees or near tall buildings because of electrostatic shielding by these objects.

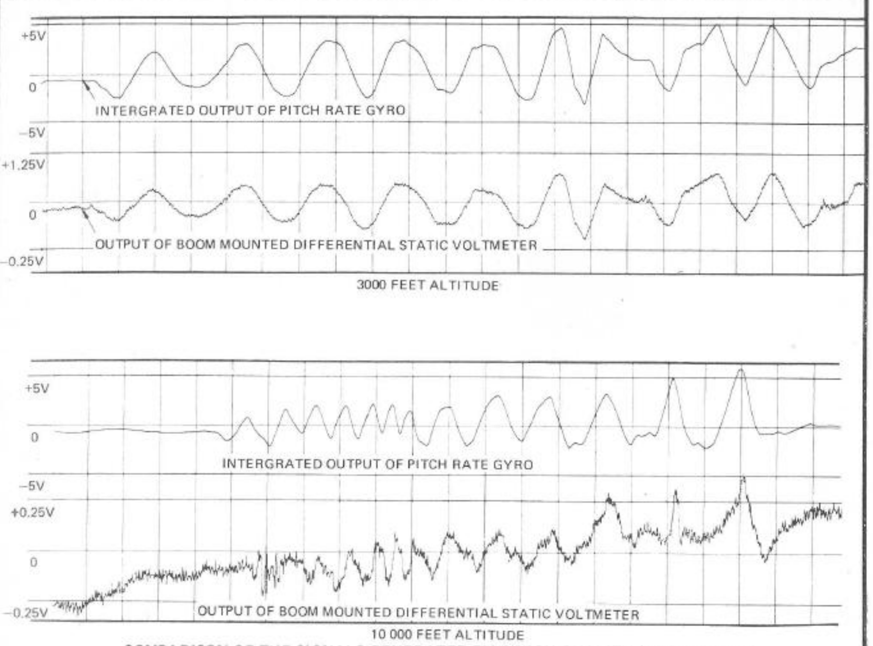
Measurement in R/C Airplanes

Sections of telemetering records taken during soundings and test flights of the Catbird airplane are shown in Figure 1. For these tests, the airplane carried a 5 lb. pay load consisting of a standard VCO-Multiplex FM Telemetering system plus sensors for altitude, vertical velocity, humidity temperature, airspeed and the static voltmeter output. The output of the SV pitch sensor and a vertical velocity meter are shown in this Figure as the top and bottom trace respectively in both of the records which were recorded at an altitude near 3,000 feet. The top half of the Figure shows a comparison between the best level flight, while under command of the human pilot standing on the ground using visual feedback, and that when the servo loop was closed and the pilot's hands were removed from the control stick. As seen here, the vertical velocity fluctuated through a range of about 600 ft./minute under human pilot control and this is decreased to about 100 ft./minute when the autopilot was turned on.

The lower half of Figure 1 shows how the stabilisation system operated when the aircraft was balanced so as to possess a divergent phugoid instability. When the stabiliser was turned off, the aircraft entered a series of severe stalls and vertical dives that would have continued indefinitely unless the pilot or autopilot provided some elevator command. Throughout this section of the TM trace, the pilot did not touch the elevator control stick and, as seen, recovery of level flight occurred almost immediately when the stabiliser was turned on. The effectiveness of the stabiliser in both neutral and 'down trimmed' elevator condition is shown.

Measurements with full scale aircraft

One of the photographs shows an installation that has been flown on a Cessna Skymaster in connection with thermal detection experiments using the static voltage sensor. The rig consists of a differential static voltmeter using electrodes mounted on a 10 foot long by 1 inch diameter fibre-glass tube that was attached to the bottom of an instrument pod located at about ⅔ of the span of the right wing. A conventional attitude gyro was mounted in the cabin near the centre of gravity of the Cessna. Figure 8 shows a recording of data of the two instruments during a small portion of a flight in which the aircraft was pitched up and down by pilot elevator commands while at 3,000 and 10,000 feet altitudes. The top line of each graph is the output (attitude) of the conventional gyro and the bottom trace is that obtained from the static voltmeter. A close similarity of the output on the two instruments at 3,000 feet is evident. This shows why this simple system works as an autopilot in radio-controlled airplanes. At that particular altitude, it probably would also have worked as an autopilot for the Cessna.



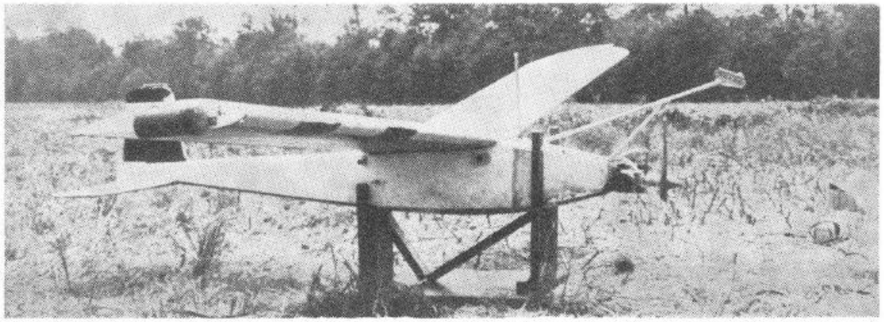
COMPARISON OF THE SIGNALS GENERATED BY A HIGH QUALITY (MECHANICAL) RATE GYRO WITH THOSE OBTAINED FROM A SIMPLE ELECTRONIC DEVICE FOR MEASURING DIFFERENTIAL VOLTAGE IN EARTH'S STATIC ELECTRIC FIELD

Fig. 8

The bottom half of Figure 8 shows a similar experiment at 10,000 feet on the same day. The signal strength from the static voltmeter we found to be greatly reduced as expected from some theories. A multiplication factor of five in voltage was used in producing the bottom line during data reproduction. The long-term upward drift of the SV is believed to be due to a temperature drift within the electronics. A correlation between the conventional gyro and the SV is apparent at 10,000 feet but it is definitely poorer than that obtained at 3,000 feet. So don't barge off and try to set a world altitude record with this device. Better you should try for endurance at low altitude because the device will let you catch 40 winks of sleep now and then. Watch out Winfred Kaiser! I'm out to take that 12 hour record of yours back again!

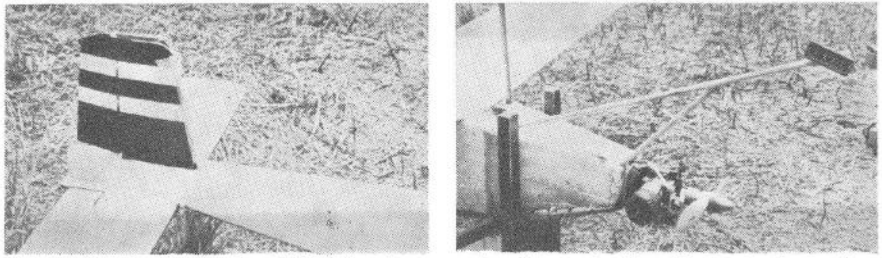
Summary of Observations and Conclusions

Approximately 200 flights of electrostatically stabilised radio-controlled airplanes have been made in the states of Maryland, Virginia, Pennsylvania and Ohio. None of these flights extended beyond about 3,500 feet altitude. No serious anomalies or erratic behaviour have been noted. Flights have generally been made in fair weather which included winds to 25 m.p.h. and strong thermal activity



Above: Hill's 'Catbird II' test aircraft once used for altitude record attempts. Note sensors on nose probe and in cylinder at wing tip.

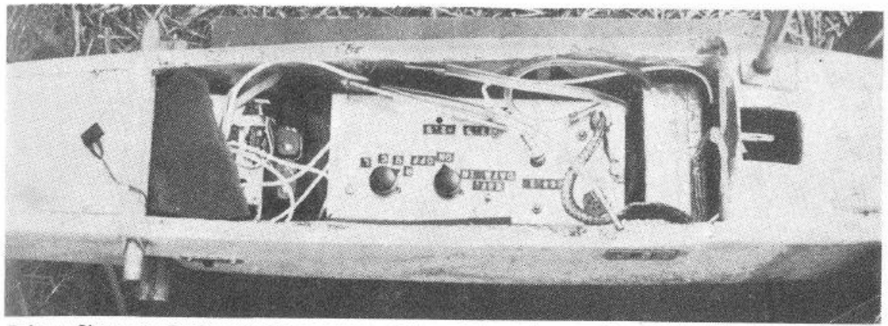
Below: Close-up of radio-active nose and tail sensors. Relation of one to the other establishes pitch angle of aircraft, while wing tip sensors do similar job in roll.



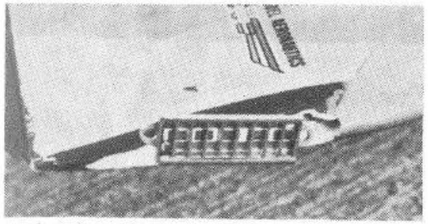
Successful horizontal stabilisation has been observed in light drizzles and on days with 100 per cent cloud cover at less than 1,000 ft. base. Also a few stabilised flights have been made within about a two-mile radius of visible lightning. We have observed the Delta aircraft to occasionally go into roll oscillation on hot smoggy days but this has never been seen on crisp, clear or cloudy, overcast days. Also on hot smoggy days a full hard-over command results in a slightly shallower turn than on cloudy days. Both of these effects are related to pollution and how it affects the voltage in the air. The voltage signals get stronger in polluted air. (Finally, we've found a place where pollution does some good!). 'Hands off' take-offs and landings have been done, as has night flying.

Some models have shown tendencies for a transient pitch up or pitch down originating in the static voltmeter system when engine power is increased or decreased. These pitch effects are related to velocity effects at electrodes, separation of charges in the structure and/or to generation of charged particles by the engine. These problems can be eliminated by (a) grounding the engine to the electronic ground of the stabiliser (b) placing metal tapes along the longitudinal and lateral axes on the bottom of the airplane and grounding this tape to the electronics (c) facing the radioactive source, into the wind so that the ions blow back onto the metal and (d), put a catching screen behind the sensor.

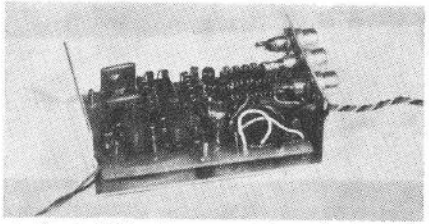
If the airplane continuously oscillates in roll or pitch, decrease the values of the gain resistors on the op-amps (i.e. the 68 1K's on the triangle circuit!), the Potentiometers in the vicinity of the Zener diode network are used to adjust the neutral trim. Before your first flight, disconnect the coax cables from the voltmeter circuitry and adjust these pots so that there is no deflection of the surfaces when you turn on the activating channel switch. (We use the retract gear channel of the Kraft for this). Take off with the switch turned off and get some altitude before you turn on the switch. If the model goes into a climb, dive or bank, you must trim the one or the other potentiometer for appropriate corrections.



Below: Close-up of wing sensor, a commercially available unit in U.S.A. Above: 6 channel telemetering radio used for Clear Air Studies, installed in model.



Below: the autopilot, which measures 1 × 2 3 in. and weighs approximately 3 ozs. Some of the components used are fairly expensive.



You should not try to fly during a thunderstorm. Apart from the fact that the autopilot might turn you inverted or crash your model, it is a bit unsafe to be standing in an open field with a transmitter antenna poking into the sky during a thunderstorm. We have flown in drizzles, in high gusty winds, at night and over water and it works fine. If your flying field is in a valley between tall mountains, there is no guarantee that the device will make your airplane fly level. It could, instead, cause the model to try to fly parallel to the face of the mountain. Flying close to smokestacks with electrostatic precipitators on them could also cause a crash.

The principles employed in electrostatic stabilisation provide only for roll and pitch control. There are no means to derive heading information from this particular device. However, over short distances such as in speed runs or pylon races, it could provide smooth and straight flight without noticeable deviation from its initial course. I can envisage the possibility of flying a pylon course without having a pilot on the control stick. If I'm successful at this, I might finally get into pylon racing! Among other things, my ears can't stand the noise out there in the middle of the course. But if I could fly it from ¼ mile away with a prerecorded tape of a good race, that's something else! But this is a long way off'. Simple employment of the device to assist pylon pilots in flying a smooth course is not without complications. Special modifications to the circuitry will probably be needed for these high speed and highly manoeuvrable craft.

This device will have limited usefulness in aerobatic models. It could help on those straight and level entries and exits and it could help on straight inverted flight. It also makes smooth automatic landings in spite of gusts. But when you turn the stabiliser on, you cannot roll, loop or spin. The craft simply does a mild sweeping turn or a shallow climb or dive under full stick command. So flying an aerobatic pattern would be a process of turning the stabiliser on and off many times during a competition flight. There are other ways to use this device for aerobatics whereby it would be possible to programme the whole stunt flight with no assistance from a human pilot. This would take extensive circuit modifications that are not included here. I see little point in trying to develop such a modification as it would sure take the fun out of aerobatic competition.

We have not done it yet, but it is pretty obvious that the system ought to make helicopter flying a lot easier. There are some technical problems too. The reader should be advised that this is a very new device and that there are unknowns left to be examined. This article is presented for those who are experimentally inclined and curious about new things. I will try to provide answers to questions or explanations for problems that you might encounter, but please be patient with me if you don't get an instant reply. This thing has me pretty busy. I hope that those modellers who do try it will report back any unusual experiments or improvements that they achieve as this kind of information will be a valuable help to progress with this new device. We'd like very much to gain experience in various climates, locations and altitudes with a variety of airplanes so please do let us know how you're doing. You can write to the author in care of *Flying Models* or at The Johns Hopkins University. Applied Physics Laboratory 8261 Georgia Avenue, Silver Spring, Maryland 20910.

Acknowledgements

Very special thanks are due to John Rowland for originating an experiment that became a key ingredient in the combination of circumstances under which this invention was conceived. I am also very grateful for subsequent technical assistance that he provided during development of practical devices.

Ben Givens has been my electronics right arm in many previous radio-controlled airplane projects dating back to 1960. His unique combination of talents was again very effective in this project. He is well aware that I value both his technical help and his personal friendship very highly.

Valuable technical advice was provided by a number of people both in and outside of APL. Among these are William H. Avery, Raymond H. Cramer, Walter A. Good, Tom M. Albert, M. Stone and Alfred J. Zmuda of APL, John S. Foster Jr., Department of Defence Research and Engineering, and William A. Hoppel of Naval Research Laboratory, their assistance is appreciated, as is the help of Raymond C. Cole, Jacqueline A. Hentgen, Barbara S. Keck, Christian A. Keller, Stephen R. King, Frederick W. Klein, Joseph L. Lew and Roger O. Weiss who worked hard and accomplished many unusual tasks during this project.

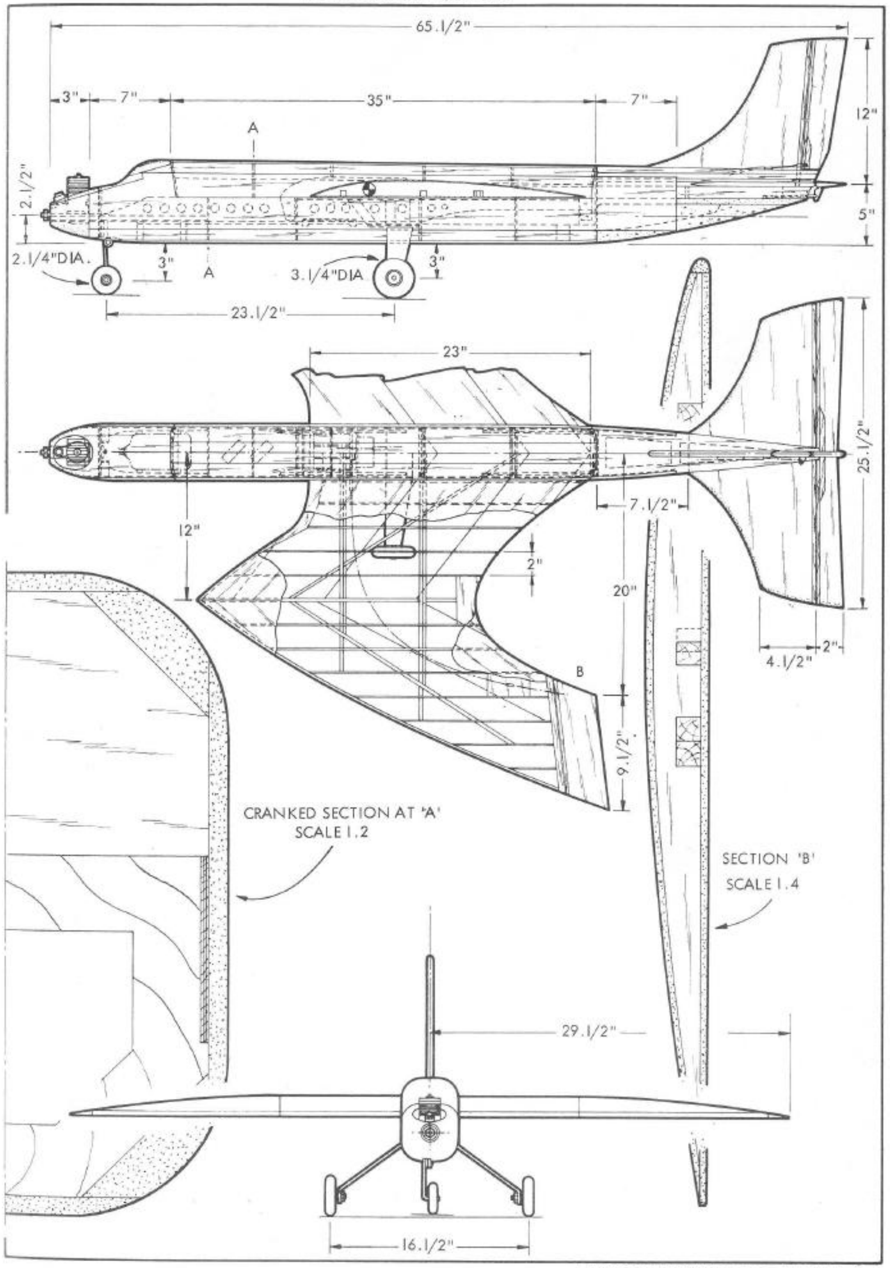
I am also indebted to John Worth and Frank Ehling of the headquarters staff at the Academy of Model Aeronautics for providing technical information regarding unusual aeromodelling techniques as well as to Don Lowe and Dennis Ingerbretson, WPAFB, for supplying information gained during flights in a different location from ours.

The ongoing support of Col. Herbert M. Federhen and Col. William Kirlin of the Advanced Research Projects Agency is gratefully acknowledged.

RC X4

Radical, bat winged, eyecatching RIC machine
BY M. SCHMIDT, U.S.A.

Scale 1:16



AMERICAN AIRCRAFT MODELER (U.S.A.)

ALL ABOUT HI-STARTS

By Ray Smith

A HI-START is as important to a glider guider as an engine is to a power flyer. A power modeller looks for an engine which will give him a good power and last longer than others. An active power modeller will spend £20 to £30 for an engine which lasts two seasons. For a modest sum, a glider pilot can purchase a good hi-start which will last several active seasons.

The rubber used in the hi-starts I have is made to meet a rigid Government specification. It consists of a mixture of natural virgin rubber and polyisoprene rubber compound to give maximum stored energy and long life. It has an elongation of 200 per cent of the slack length. In order to meet the Government specifications it must withstand 35,000 cycles. The cord must also withstand an aging test of 160 degrees (F) for seven days with a 20 per cent decrease in strength. This aging test is equivalent to about 5 years of use under normal conditions.

Cheaper power cord can be made from surgical tubing and it does an adequate job for smaller gliders. Since rubber is exposed to the sun it will not last nearly as long as the exerciser cord, but it can be very satisfactory over a short period of time.

In Table 1 are some general guidelines for gliders being flown today using a 600 feet tow line.

The above chart is based on having a breeze of about 7 m.p.h. With less breeze, use an additional 40 feet of power cord. With more breeze, don't pull it back so far. The average glider being flown today has a span of about 9 feet and a wing loading of 10 ounces per square foot and will require a 160 feet power cord.

Proper storage of the Hi-start will lengthen the life of the power cord. Since the power material is a good grade of rubber, heat will cause deterioration. Store the power cord in a place where the temperature stays at room temperature. Don't store it close to a heat source such as furnace or hot water heater. Sooner or later, your Hi-start will get wet, most likely because of dew on the grass or a sudden rain storm. When wet, store the power cord where the air can freely move around all parts until it is dry. If stored in a box while wet, the cotton jacket will mildew and rot. It won't hurt the power cord to get wet provided it is properly dried when you get it home.

One question I hear being asked is: '*How far do you pull the Hi-start back before launching?*' Assuming you have gone through the necessary training period, you will want all the power you can get out of your power cord. The power cord I use has a stretch of 200 per cent. The useful stretch of the cord itself is limited by its modulus of elasticity. Stretch the rubber up to that point and it will spring back to almost its original slack length. Stretch it past that point and a permanent elongation will occur. Stretch it still further and at some point the strands will break.

The jacket on a good power cord will serve as an indication to you. The jacket is woven around the rubber strands so that the jacket can get longer as the diameter gets smaller—up to a point. After that point, the jacket fibres themselves stretch.

On a well designed power cord, the material elongation process stops before you reach the critical stretch of the rubber strands. You can feel the tension suddenly increase when you reach that point. Since the jacket fibres themselves are somewhat elastic, there is a natural desire to keep pulling until it won't stretch further. This is a mistake and seriously effects the life of the power cord.

Within some limits the height you get on a Hi-start launch is a function of total stored energy. After a year or so of use, a noticeable decrease in total power will develop depending on how much it is used, care in storage, how much it has been over-stretched and other factors. It isn't necessary to buy a new power cord to bring the power back up. Just snap on a short additional section, and the power will be the same or greater than when new. As a power cord ages, the total potential stored energy is less. Add on a length of new power cord, and you can bring the total stored energy back up.

When fully stretched, the Hi-start has about 20 pounds pull, the same force as a 20 pound bow. If the tow ring is let go, it is a pretty potent missile and could really hurt someone. Don't let people stand along the tow while it is stretched out. Even if the ring doesn't hit them, the tow line can cause a nasty cut or burn.

When pulling the tow line back, don't put the cord over your shoulder. If the line should pull loose at the ring, the line could cause a bad cut or at least a burn. I saw it happen and it burned through the man's shirt and caused a burn on his back.

A misconception exists on the use of Hi-starts for small or lightweight gliders. First, we have said in the past that for small gliders, you can use a shorter power cord. If you stop to think it through however, a short power cord develops the same initial force when fully stretched as does a long one. This initial force gives too much power for the small glider. It results in either an extremely fast launch or breaks the wings.

The initial force at launch is proportional to the amount of stretch in the power cord. For smaller or lightly constructed gliders, don't pull the cord back so far.

The total stored energy in a power cord is also proportional to the amount of stretch. So if you decide you want 70 per cent of the maximum initial force, the total energy will be about 70 per cent of the maximum that can be stored at full stretch. You can get the same stored energy with less initial force by adding additional power cord.

In summary, for a small glider use 120 to 160 feet of power cord and don't pull it back so far.

TABLE 1

Glider	*Span*	*Wt. lb.*	*Wing Loading Oz./Sq. Ft.*	*Rubber Length*
Kurwi 33	8′ 4″	4 lb.	12	160 feet
Kurwi 68	12′	5 lb.	10	160 feet
Osprey 84	7′	2¼ lb.	9	120 feet
Osprey 98	8′	3 lb.	12	160 feet
Osprey 120	10′	6 lb.	13	200 feet
Osprey 168	14′	10½ lb.	12	(2 strand) 200 feet
Orrus	8′ 4″	3½ lb.	9·4	160 feet
Ormulus	8′ 4″	3 lb.	9	160 feet
KA 6E	12′	11 lb.	24	(2 strand) 200 feet

SLOPE SOARER AEROBATICS

By Ken Binks

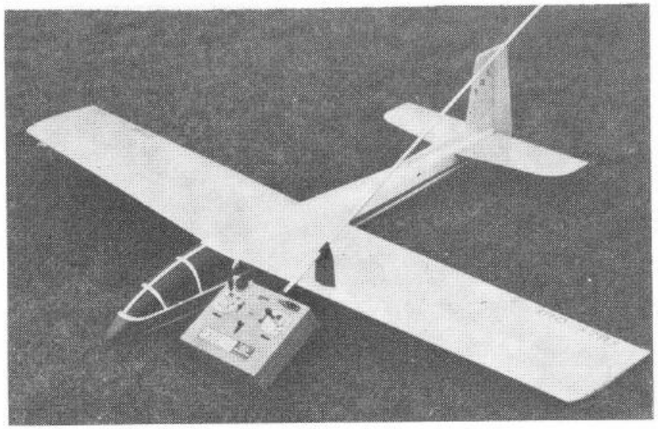
SLOPE soaring started way back when free flight was the most common means of flying. Models were launched off from the top, half way down or near the bottom of the hill, depending on the wind strength. These models were trimmed to fly in a straight line and weathercock into wind, so that a maximum flight duration could be achieved actually soaring on the ridge, rather than just disappearing off down wind, which I'm afraid eventually happened. Another method that was adopted was magnet steering which enables a model to stay directly off the hill by using a magnet to maintain its heading, this operating an auto rudder.

Although still in use today, this was soon superseded by single channel radio control on rudder only. This then enabled the pilot to fly a model up and down the ridge and stay in the hill lift. Duration was dependent on the number of turns one could get on the rubber loop which powered the actuator, this being the popular means of controlling a rudder at that time. Then, with the more sophisticated reed multi-channel outfits coming along, slope soarer models began to appear with rudder and elevator controls. These were the very basic primary functions and continued for some while. But now with the more reliable (comparatively) proportional systems and greater control offered, any model becomes a practical proposition.

Models at this time were still semi-scale in appearance, high aspect ratio, very much after the lines of their big brothers the full size gliders. But gradually with the introduction of more sophisticated radio control the pilots demanded greater manoeuvrability from their models. So there had to be a change in the general outlook and design thinking of the modellers, and the aspect ratio of the wings was then cut down from anything above 10, down to 8 and 7, or even 6.

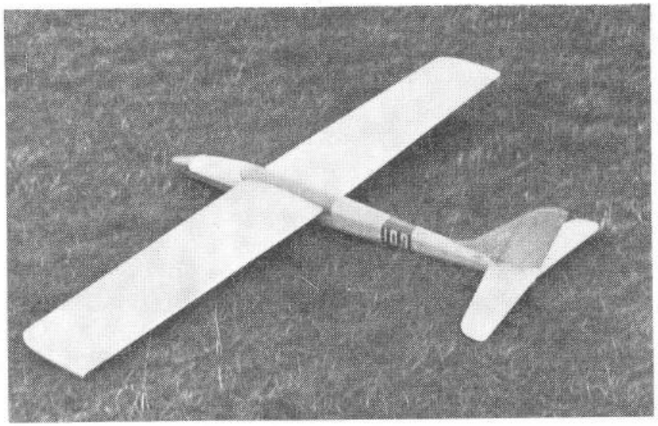
In the first instance, these lower aspect ratio wings were tried without ailerons and some fair aerobatics were possible with the model just fitted with rudder and elevator. When I say elevator, all moving tail would be more to the point as, due to models being fitted with semi-symmetrical wings, it was found at that time that negative manoeuvres were quite hard and all moving tails came into fashion, to get over this problem. But compared with today's models, of course, they were pretty pathetic. Although cutting down the aspect ratio of these models made them capable of barrel rolls, even axial rolls were possible. This was at a time when contest schedules demanded both barrel rolls and axial rolls, perhaps two in sequence. But this is not quite the case now and competitions are asking for 4, 6 and 8 point rolls, so greater control in the rolling plane was necessary and hence the use of ailerons.

Right: author's current aerobatic slope soarer design, the Suzy Que Mk. 5, soon to be kitted by Model Flight Accessories. Design uses rudder, elevator and aileron controls.

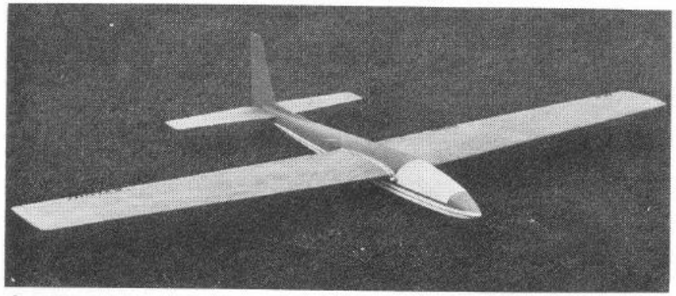


In the elevator plane, more and more negative manoeuvres were being called for and this necessitates going to very thin fully symmetrical wings which then make the model capable in the negative plane but, of course, reduce their performances in the normal positive lifting plane. So these models were then poorer in low lift conditions.

These models were working at quite high wing loadings and this also was a contributory factor, in their poor marginal performance. Development then tended towards attempts at Variable Section wings, about a third of the chord of the wing could be drooped or raised, depending on whether the model was flying inverted or upright. This was to improve the lift co-efficient of the wing while looking for lift and doing positive and negative manoeuvres. But when rolling manoeuvres were required the wing could be returned to the symmetrical state thus giving better axial rolls etc. These models were developed for about 3 years and for the work and time



Right: Sleek 'Phase Four' design by top glider aerobatic pilot Chris Foss has slim fuselage for minimum drag.

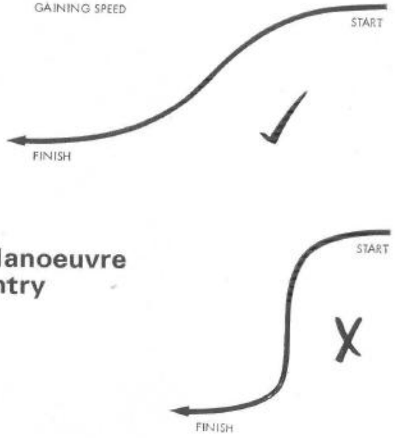


Attractive 'Xyloid' aerobatic slope soarer by M. Baker is similar in shape to author's 'Suzy Que' machine.

that was involved weren't all that successful.

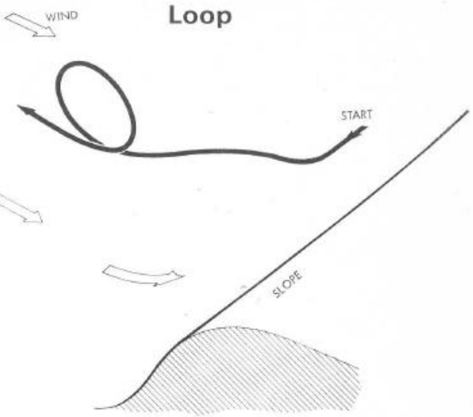
The off-shoot of these experiments were models with flaps akin to old control line and indeed present control line practice, in that the wings had flaps which work in opposition to the elevators and provide greater lift in turning and lifting manoeuvres. This now is about as far, I think, aerobatic slope soarers can go. They can do any manoeuvre. So for the purpose of this article I will be assuming that the flyer has a model of this type i.e. fully aerobatic and correctly set up. As slope soaring gliders have no means of propulsion whatsoever, except the wind, and gravity, and are using these entirely to stay up and to provide necessary speed to do manoeuvres, I think its very important to understand how to build up excess speed and also how to use the wind to your advantage. Now this will become apparent in the positioning of manoeuvres, relative to where the judges are standing for competitions. The most important point to understand is how to get excessive speed out of the glider to enable manoeuvres to be done. Now this can vary from gaining the speed before you start the manoeuvre, to use of the lift to enable you to gain some more speed during the manoeuvre to complete it, for example, in consecutive loops or bunts (outside loops).

Before commencing any manoeuvre one cannot just apply the control deflections and expect the correct result. In reasonable lift conditions the best way to build up speed is to initiate a very shallow dive, not a sharp vertical dive with a sharp pull out, but a shallow dive resulting in a shallow recovery, at which point a good deal of excess speed will be gained which can be used in the manoeuvre. If the sharp dive, sharp pull out technique is used, all the speed gained in the short dive is lost in the sharp recovery due to high drag in the sharp pull out. So begin with a nice shallow dive before starting any of these manoeuvres to gain excessive speed which will carry the model through the manoeuvre. It should be emphasised that except for square and sharp manoeuvres, the smaller the control deflections that can be used, the greater the speed left for the manoeuvre.



Manoeuvre entry

Let's start with the perennial favourite of all non-aeromodellers, the loop.



Loop

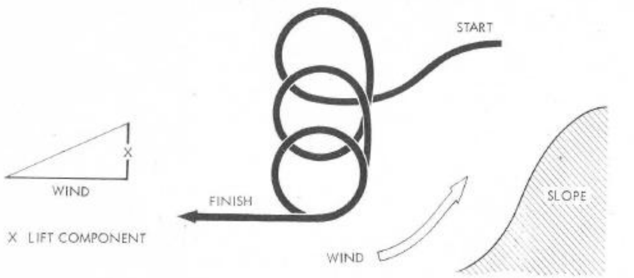
Loop

This should be performed *into wind* and so that the roundness can be observed necessitates positioning off to one side from where you are standing on the slope. To start a loop, we must first gain speed and this must be done as mentioned before. Then after levelling out call 'loop'. Pull gently into the loop and as the top of the loop is reached, ease off slightly since the elevator tends to become more effective at the top due to the gravity effect on the model. Then, as the model goes past the three-quarter point, gradually pull out and finish up at the same altitude as entry. Exit in straight and level flight calling, 'finish'.

That's all very simple for one loop, but now when it comes to consecutive loops the problem is one of good superimposition and it is a good idea to get a bit more speed initially, then start the first loop as before.

At the three-quarters position when the model is diving back towards the ground before the final pull out, the model must be allowed to dive just a little bit more than you would normally to gain a little excess speed, which is then used for the second loop. This must then be superimposed on the first loop and again try to gain speed after the three-quarter position when the model is diving down. All this has to be equated against the lift available at the slope. If the lift is very strong it is easy to superimpose the loops because the ground relationship is for the loops to be rising up the slope. So by diving the model at the three-quarter position it is possible to keep up the speed, making possible as many loops as are required. But it is

'Long Nose' aerobatic soarer by Ricky Shaw is another slender fuselage, minimum drag machine.



Consecutive Loops

dependent on the lift strength to achieve as much speed as possible during the manoeuvre. Again when you have finished the set number of loops, exit level with the initial entry level. This manoeuvre is very hard to perfect.

Outside Loops

Sometimes called a 'bunt', this manoeuvre has to be performed *down wind* in the same position as the inside loop. That is, off to one side so that the manoeuvre can be observed from the side. It is still necessary to gain speed in a shallow dive, but level off coming towards the slope about 50-70 yards out. Then, push the nose down and under. It is necessary to gain ground upwind in the inverted position before climbing back up for the second half of the outside loop.

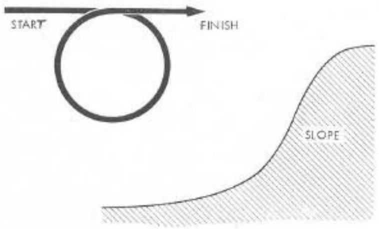
So, from a shallow dive, push the nose down, flatten off at the bottom slightly and then push in more elevator to climb back up the other side finishing up at the same altitude as entry.

The model is now flying towards the slope and you must either do a half roll pull out, or a half bunt and half roll out to get back into wind, the latter being preferred.

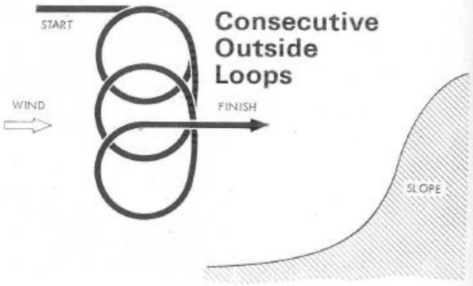
Now for the consecutive outside loops. The same principles apply as before but more speed is necessary in the shallow dive. Start the outside loop using the diving position to gain speed, and the inverted position to gain ground upwind, to achieve consecutive outside loops.

Stall Turns

These should be performed *cross wind*. For a stall turn to the left it is necessary to use the wind to help swing the model in this direction. Therefore, for a left hand stall turn the model must be going from left to right across the oncoming wind, so that when the model is pulled up into the vertical climb and it slows down, the wind is blowing from the left hand to the right hand wing tip. Therefore, as the model stalls the fin and rudder area will cause the model to weathercock assisting the stall turn which you are trying to perform.

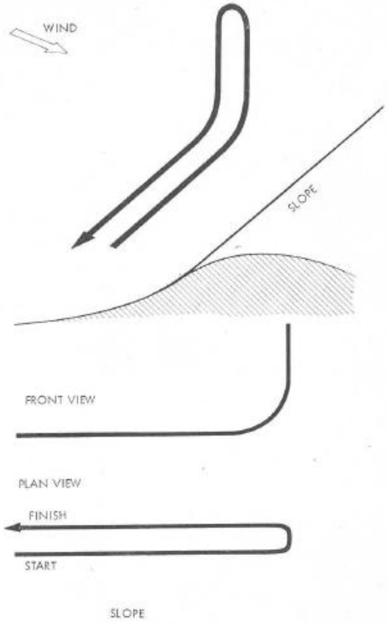


Above: Outside Loop



Consecutive Outside Loops

Stall Turn



For a left hand stall turn, start with a little bit of extra speed and fly from left to right pulling up into a vertical climb smoothly. Maintain the straight vertical climb, then as the model slows down, push the rudder fully over to the left. This, coupled with the weathercocking effect of the wind as the model stalls will accomplish the turn. The model retraces its path to a level pull out at the same altitude as entry.

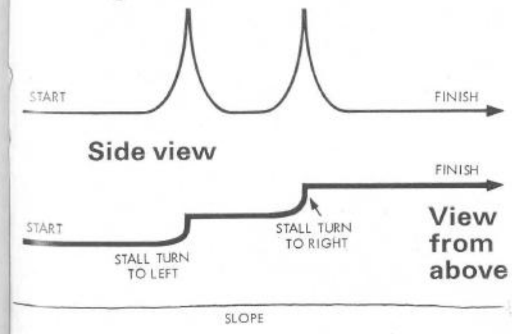
It follows that for stall turns to the right the model must be going from the right to the left, so that when it is in its vertical climb and stalling, the wind is going from the right hand to the left hand wing tip and will assist you in doing stall turns to the right. It also follows from this that the Chandel or wing over is possible, but this is just a matter of applying the rudder before the model has completely slowed down so that a wing over i.e., a turn in excess of two wing spans is accomplished.

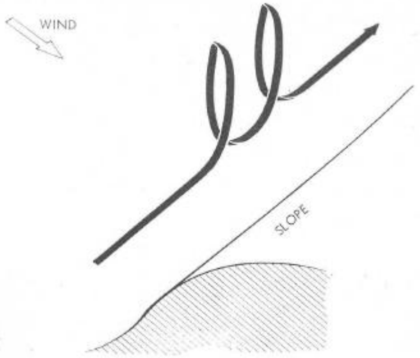
Rolls

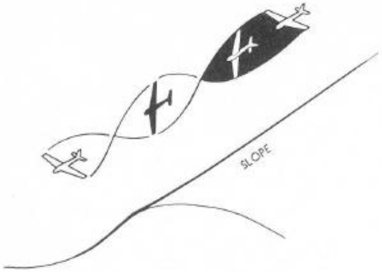
These are performed *crosswind* so that the start, finish and altitude can be observed.

First we will take one axial roll. This should be performed after a shallow dive and levelling off. Full ailerons are applied and as the model reaches the inverted position, slight down elevator is required to maintain the altitude at which the manoeuvre was started. Then as the model is passing through the inverted position, elevator is released to return the model back to the upright position without losing altitude. This should be started and finished with the wings level.

Figure 'M'

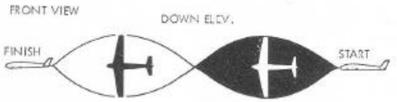


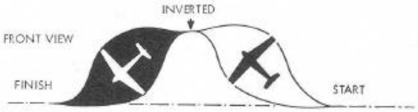




◀ Axial Roll

▼ Barrel Roll





Barrel Roll

To do a barrel roll, the model must be maintained in positive G throughout the manoeuvre. That is to say that no down elevator is applied but the manoeuvre is started with a slight climb. The ailerons are applied and slight up elevator is applied simultaneously. This will keep the model positive throughout the manoeuvre and a corkscrew type path is scribed. Such is a barrel roll.

Two point Roll

It then follows that a two point roll is possible by stopping an axial roll at the inverted position.

So, after a shallow dive, half roll, introduce slight down elevator and hold the inverted position after releasing the ailerons. After perhaps, a two second interval, re-apply the ailerons and roll back to the upright position. This should be spaced out so that the first half roll and the inverted and the second half roll are roughly the same length in time.

Four Point Roll

It also follows that we could stop the manoeuvre at every 90°, but when we do this, there is nothing maintaining the model in a level altitude. So we must use top rudder. For a right hand roll, from a shallow dive, level off, apply the ailerons and release so the model scribes exactly 90°. At this point left rudder is introduced to maintain altitude. This is then released as ailerons are applied to pass the model through another 90°, at the same time progressively putting in down elevator to maintain altitude in the inverted position. Then apply ailerons to return the model to the three-quarter position and apply right top rudder. Finally release the rudder and apply the ailerons to return back to level flight.

This manoeuvre is initially quite a sweat but once a bit of practice is gained the manoeuvre is completely automatic and instinctive. You just do a 4 point roll and your thumbs are pushing the sticks in all the required directions without even thinking about it.

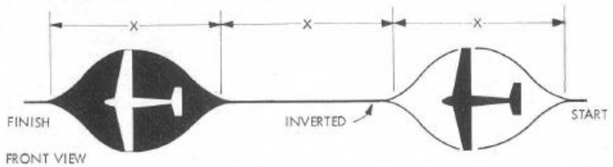
Eight Point Rolls

An Eight Point Roll is possible, stopping every 45°, but in the 45° points top rudder and elevator are both required to maintain altitude and to keep the manoeuvre exactly axial. This is really a matter of practice.

Three Point Roll

The same applies to a Three Point Roll which is stopped every 120° and, providing it's only one roll, not too much top rudder and elevator are required. Careful judgment in stopping every 120° is required.

Two Point Roll



Inverted Straight Flight

Inverted Straight Flight should be performed *crosswind* and should be started from a half roll. This should be done with a little excess speed to make the entry nice and crisp. Then maintaining level altitude, the model is kept inverted for the requisite 5 or 10 seconds, before rolling back to the upright position in the same direction as the entry roll, to complete the manoeuvre.

Inverted Circle

For an inverted circle, we start at the into-wind position. Taking the inverted circle to the left, the model starts the manoeuvre by rolling to the right, with the half roll, not quite 180° but with the model on the angle of bank necessary to take it round the inverted circle. In the case of the left hand inverted circle we roll to the right, because this is the shortest distance to the angle of bank required for the turn. Then, maintain altitude with ailerons and elevator to complete the inverted circle, remembering that more elevator and ailerons will be required on the down wind leg because the model increases its ground speed as it flies toward the slope. As you come round to complete 360°, roll out in the opposite direction to the entry with a half roll to the left, since this is the shortest path back to level flight, and looks much more professional than a 190-200° roll the opposite way.

That's some of the more basic manoeuvres, now we should go on to more complicated manoeuvres which string some of these basic manoeuvres together.

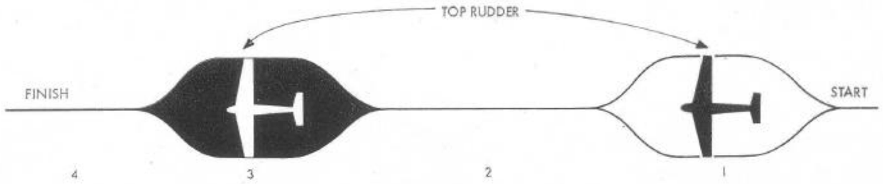
Cuban 8

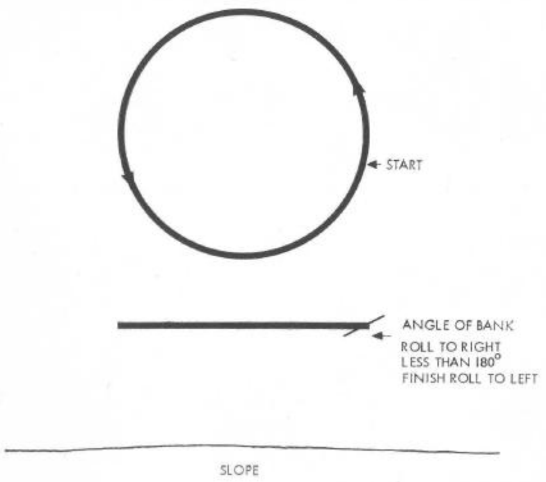
Enter this going *crosswind*. Taking it from the top, start with a fair turn of speed after a shallow dive. Pull up elevator and go over the first part and then hold a 45° drop after three-quarters of a loop. At a pre-determined intersection point, half roll, continue down and start your second three-quarter loop with the bottom of the loop level with your entry. Pull over the loop, back down at 45°, half roll at the inter-section point again and finally recover to finish the manoeuvre. As I said this is easiest performed going crosswind.

Horizontal Eight

This also is easiest to perform going *crosswind*. So starting off with a fair

Four Point Roll





Inverted Circle

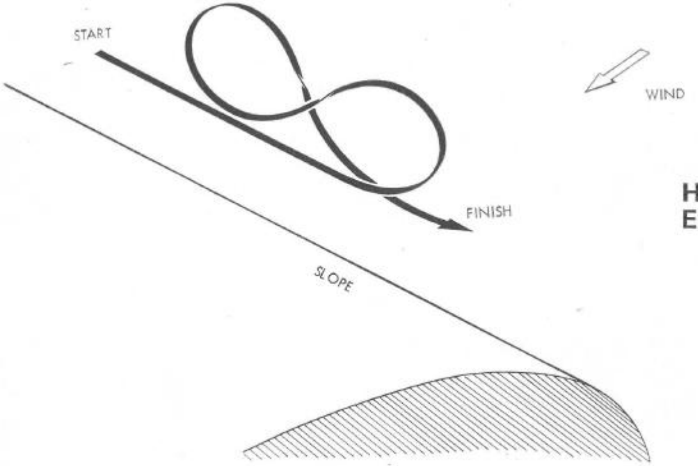
turn of speed, level off, pull up into a three-quarter loop. Then, when in the vertical position squeeze in down elevator to do a complete bunt, to pull out level with entry. This is basically just a case of stringing a loop and a bunt together, making sure to maintain even size between the two and level exit and entry points.

Vertical Eight

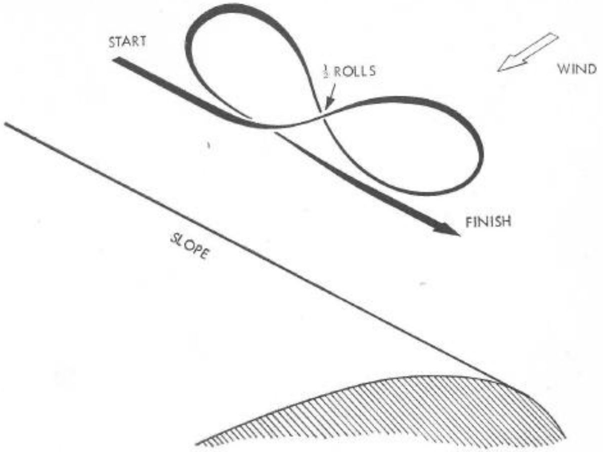
This is just a matter of rotating a Horizontal Eight through 90°, performing a loop and then a bunt as before.

Double Immelman

This is probably best performed *crosswind,* pulling into a half loop, and half roll, then diving into the half bunt with a final half roll to finish. This manoeuvre requires a fair turn of speed because large aileron deflections are required at the top of the half loop.



Horizontal Eight



Cuban Eight

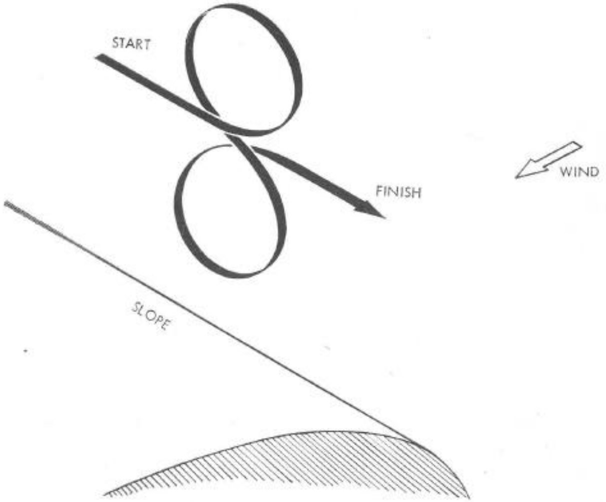
Single Immelman's, can be either positive or negative. The negative version can be performed going towards the slope with a half bunt and a half roll out, or a positive one can be performed going into wind then pulling up into a half loop and a half roll out of the manoeuvre.

Variations

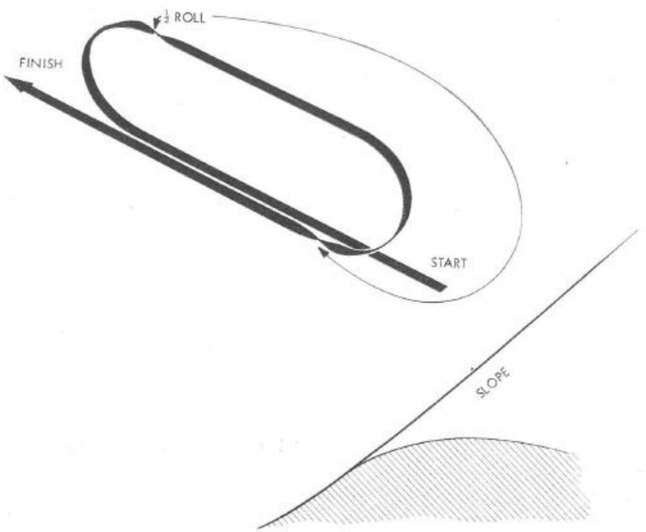
Taking a few of the more complicated F.A.I. manoeuvres, we will look at the *Figure M* first. This is basically just two stall turns linked together with a half bunt. It should be performed cross wing with a stall turn to the left, followed by a negative pull out back up into the vertical position and a stall turn to the right. Follow this with a level pull out, level with the entry at the bottom of the half bunt.

Top Hat

A great deal of speed is required and this manoeuvre must be performed into wind, because after the first half



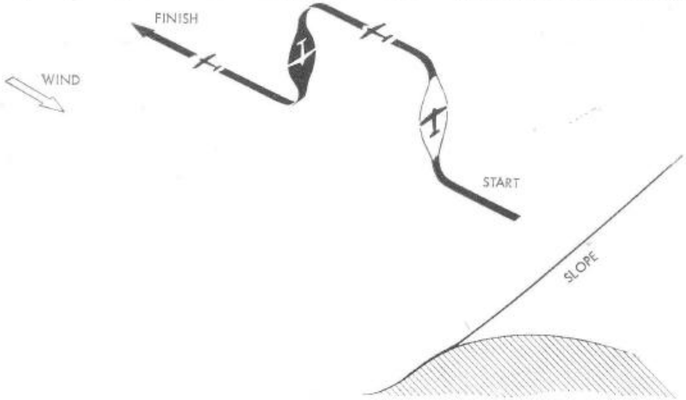
Vertical Eight



Double Immelman

roll, up elevator is required to level the model off into the inverted position and you must have enough flying speed here to prevent a stall. So if we can do the manoeuvre into wind and increase the air speed over the wings by the positioning of this manoeuvre, it is to our advantage. So start with a good deal of speed, dive, level out then make a nice gentle change through 90° into the climbing vertical attitude. A quick half roll is then followed by a change of 90° with the up elevator, to fly inverted across the top. Pull up elev. to bring the model into a diving altitude, then half roll to finally exit upright, straight and level.

The only problem with slope soarers is that the speed through this manoeuvre doesn't remain constant. Its not quite so pretty as is possible with a powered aircraft but it is a manoeuvre which is fully within the capability of the modern slope soarer.



Top Hat

That just about covers the more conventional manoeuvres. There are many manoeuvres which can be done in free style type competitions, such as Negative Cuban 8's, flick manoeuvres incorporated with loops perhaps, and these are really up to the flair of the individual pilot.

Most flick manoeuvres rely on very fast control movements which are also very effective. If you want a positive flick manoeuvre, its a matter of putting rudder and ailerons the same way with up elevator. If you want a negative flick roll you use opposite ailerons and rudder with down elevator. This has to be done very sharply, say, at the top of a loop and necessitates equally quick recovery to complete the second part of a loop. Such stunts are impressive if achieved with accuracy. I feel that actually describing many more manoeuvres is not really practical because if a pilot has the ability to do those already described, he will also have the ability to evaluate these things for himself and add and subtract them from any schedules he might perform.

Contest Technique

Because of the way slope soaring contests in Great Britain are run (i.e. many individual clubs run national competitions all of a different nature and to different rules), one must use the rules and regulations applicable to each competition to your advantage.

This may sound obvious but it's amazing how many people don't do manoeuvres in the required order to gain maximum points. So it is very important when entering competitions to read the rules thoroughly and note exactly the designated order of the manoeuvres to gain the maximum points. This, coupled with little subtleties such as relaunching etc. is not really cheating, but accepted competition tactics.

For competitions, positioning of manoeuvres might have to be modified to suit the judges. That is to say if you persist in flying your manoeuvres right in the sun you can't expect the judge to mark something he can't see. So take into account quite a few things before actually positioning your manoeuvres, such as the wind direction, position of the sun, and your own ability to do the manoeuvres. You will find most top fliers do all their manoeuvres CROSS WIND for the judge even though it is harder.

One final point concerning nomination of manoeuvres and informing the judge exactly when you are going to start and finish the manoeuvre. You don't want your initial speed gaining dive to be judged as part of the manoeuvre, so a typical nomination would be 'Next manoeuvre—loops; starting now . . . finish now;'

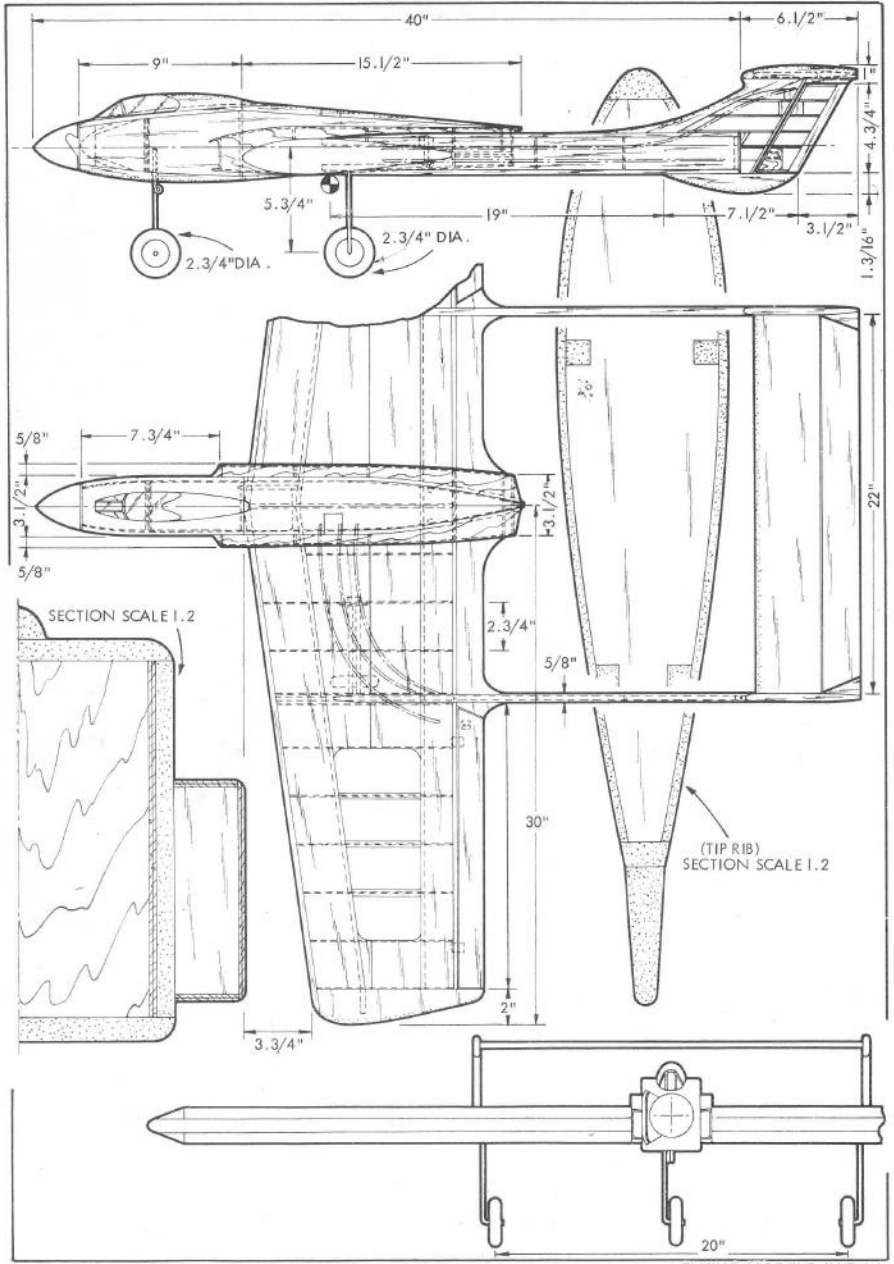
In free style, it's usually the one or two rather complicated manoeuvres which are impressive and influence the overall marking. This, combined with a consistent and crisp flight pattern coupled finally with a good landing right at your feet, does create an overall impression which will add to the marks awarded. It all boils down to showmanship, and inverted launches and like things are all methods of gaining points and doing something which is different from your competitors. Such is the only problem with free style, to think up all the new ideas!

With the lack of enthusiasm for the formation of the slope soaring side of the B.A.R.C.S. (British Association of R/C Soarers), it would appear that the average slope soaring modeller doesn't want to be regimented into any sort of order. They prefer competitions with all the different set ups, giving a little touch of individuality rather than a set schedule for aerobatics which will become boring and repetitive, as is the F.A.I. schedule in power R/C. I believe that slope soaring appeals far more to the average type flyer who flies for fun and doesn't want to get too seriously involved.

Sea Vixen

Semi-scale twin boom aerobatic R/C model
By Jack Sheeks

Scale 1:11

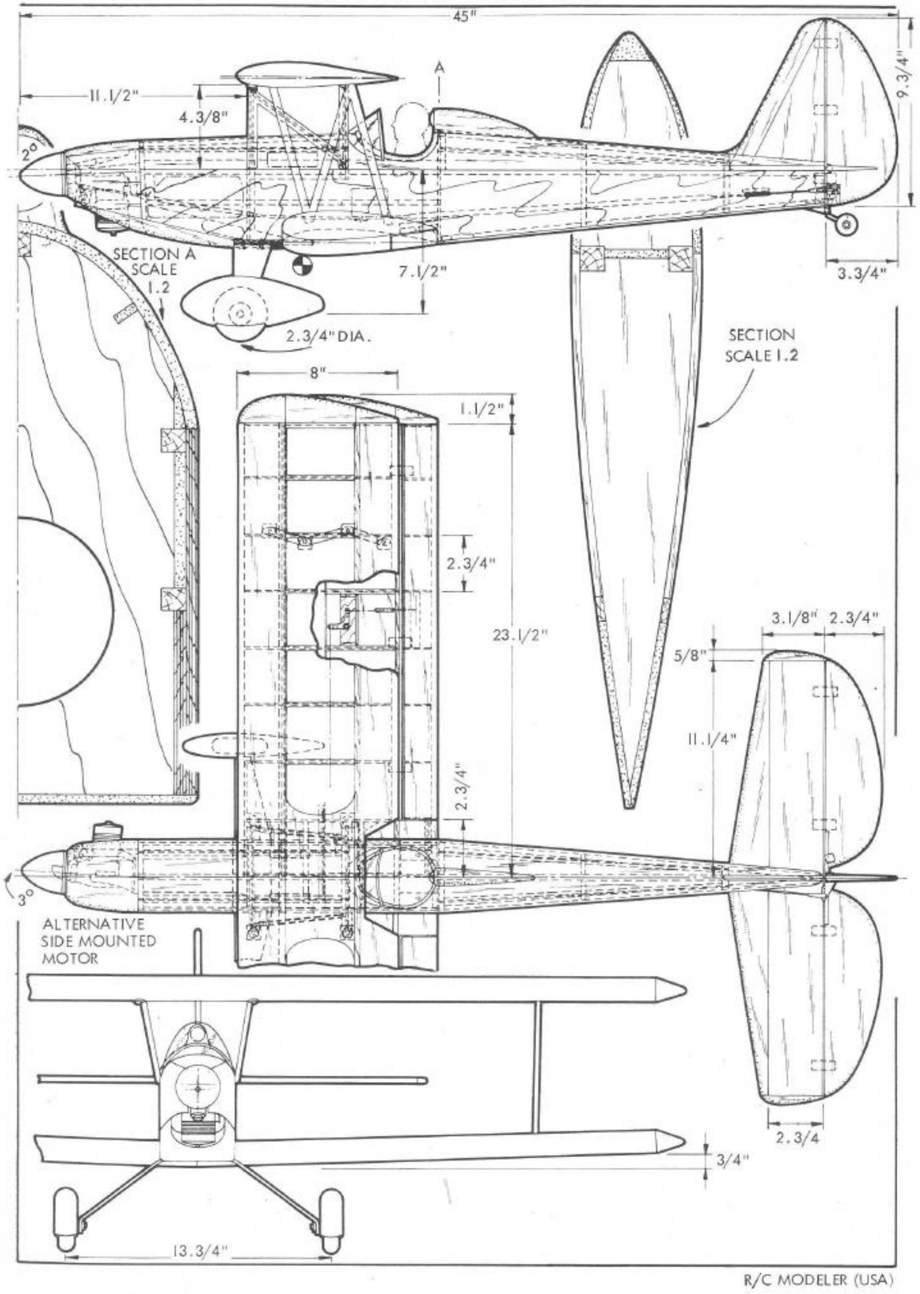


FLYING MODELS (U.S.A.)

Acro-Star

Purpose-designed, fully aerobatic biplane
By DON DEWEY and LEE RENAUD

Scale 1:10



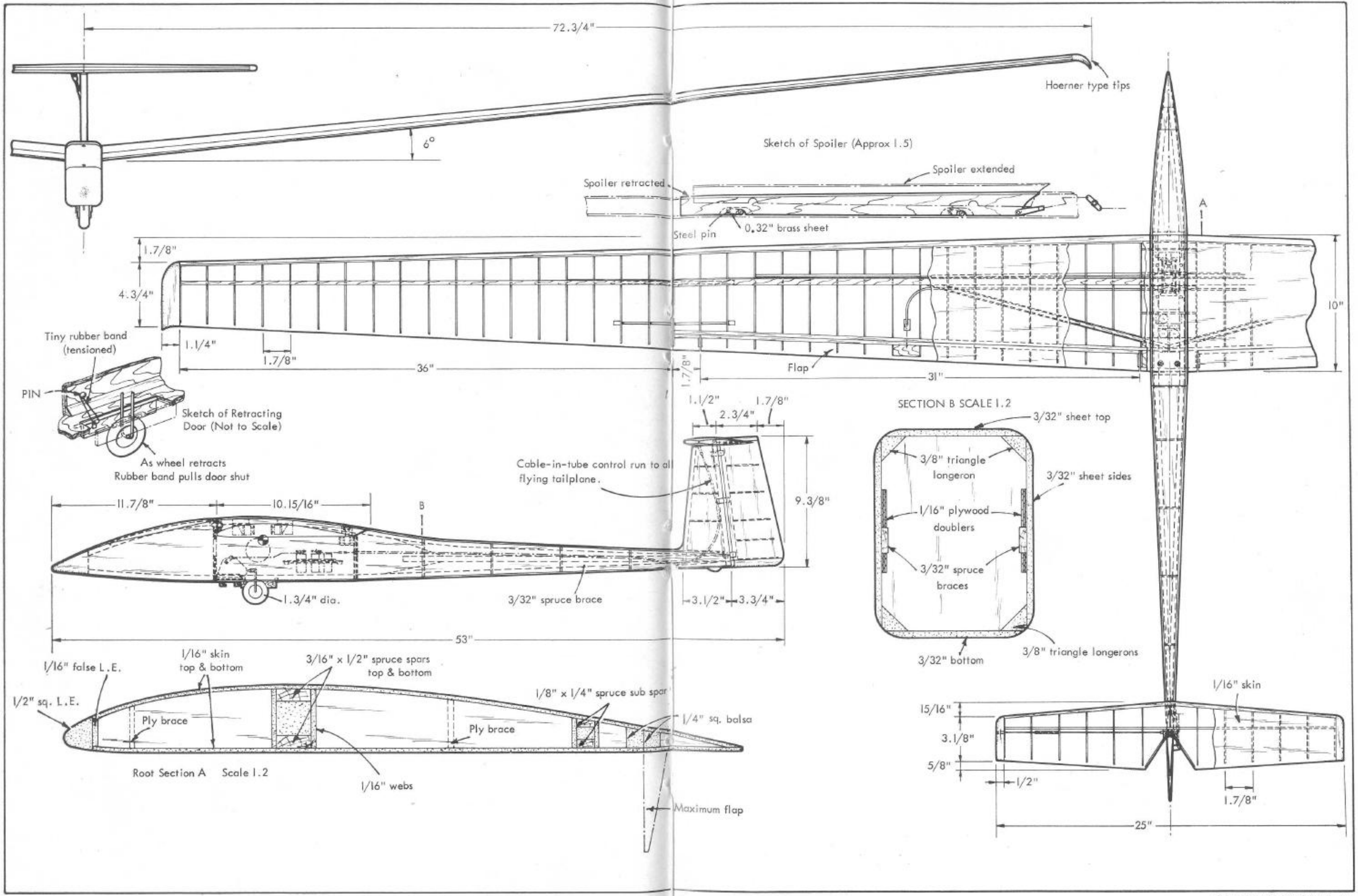
R/C MODELER (USA)

Quasoar

High performance thermal soaring glider featuring flaps, spoilers and retracting undercarriage

BY NIEL LIPTAK

Scale 1 : 10



FLYING MODELS (U.S.A)

EXPERIMENTS IN R/C STOL (Short Take-Off and Landing)

By Peter Russell

'STOL', the initial letters of 'Short Take-Off and Landing', is a bit of aeronautical jargon which, with the associated terms 'VTOL' (Vertical take-off and landing') and 'QTOL' or 'QSTOL'—the Q is for quiet—is appearing more and more in technical conversations and writing, and for good reason. As land values continue to increase and ecological considerations become more important, aeroplanes, other than intercontinental airliners, that are capable of operating from relatively small areas will become increasingly important. Just how important can be gauged from the fact that when De Havilland Canada were setting up the design criteria for their new DHC-7 inter-city airliner, an ability to operate from a 2,000 ft. strip was considered one of the first essentials, based on the premise that in years to come, land and building costs were likely to make this the maximum economical, and perhaps the maximum *possible* size for the large town or small city airport.

What is likely to be a problem for full-size money-making operations is bound to be even worse for the enthusiast who flies for pleasure and indeed, it already *is* a problem for many of us. So what can be done about it? Fortunately, a lot can be done about it, and some of us are already making R/C models that can fly at below 20 m.p.h. and operate from areas many times smaller than those normally used for R/C models.

'STOL' is a term that has come into prominance fairly recently, but Stol aeroplanes have been around for a long, long time. Gerhard Fiesler might be considered to have started the trend in the mid-thirties with his Fiesler 'Storch', but as far as operating from small fields is concerned, it would be pretty fair to say that Tom Sopwith was building Stols (the 'Tabloid', for instance) before World War I. In World War II, there were two specially built Stols, the 'Lysander' on our side and the 'Henschel 126' of 'theirs', but neither was very successful. The main snag with both of them was that a higher-than-average pilot skill was needed to realise the Stol potential, and flown by the average squadron pilot they were just cumbersome low-performance aeroplanes. Later in the war the 'Army Co-operation' and communications functions were taken over by much less sophisticated but more versatile 'light' aeroplanes like the 'Auster' and the 'Storch', not to mention the various U.S. light planes that were pressed into this role.

So much for the historical side, it is really in the last ten or fifteen years that most progress has been made. Not so much from the point of view of reducing landing and take-off runs to a minimum in absolute terms—helicopters have taken over in this sector—but more in order to allow relatively big, load carrying aeroplanes to operate from small 'farmer Giles'-type fields.

Model aeroplanes, R/C variety, have developed along lines uncannily similar to those of their full-size equivalents, and the modern high-powered aerobatic model can be considered the counterpart of the jet fighter. It's handling qualities are remarkably similar in many respects, and in particular, it is at it's best when operating from smooth tarmac runways. A skilled pilot can land the average aerobatic model *across* the usual R.A.F. type runway, which means about 150 feet of concrete, particularly with the help of a bit of wind. But this is not the same as saying that the model could be operated from a 150 foot square—far from it. On the average approach, the model will be down to ten feet or less three hundred feet back from the touch-down point, and at the 1973 British Nationals, where competitors *were* landing across the runway, with the 'spot' in the middle, no model was able to stop in the 75 feet of runway left after the touchdown point was reached, and this includes models fitted with brakes. Since these models were flown by the country's most skilful pilots, it follows that the average pilot would want a big margin over the figures mentioned to allow for errors of judgement, so putting it in round terms it is safe to say that for average pilots a field or strip at least two hundred yards long is needed for everyday operation. In practice, the average club pilot finds operation from a football pitch even with fairly clear approaches, distinctly taxing.

The writer's interest in reducing the space needed for R/C operation came about during a period of immobility during 1971. With a lawn 140×35 feet, it seemed it would be an interesting and worthwhile project to see if it would be possible to design and build a model that could be operated, on a regular basis, from this area. There were, it seemed, two possible approaches. One was to build a more or less standard aerobatic model, fitted with sophisticated high lift devices. Plain flaps would help, but would give nowhere near the extra lift necessary for this kind of operation, so that some kind of complicated area-increasing flap, possibly with leading edge 'droop' as well, might be necessary. Since there are other houses quite nearby, the project had to be 'Qstol', not merely 'Stol', and the use of the usual '60' size engine might be a problem in this direction. The *other* approach was to build a light, simple aeroplane, with a simple high lift wing, using relatively low power (to keep the noise down) but with the light weight still giving a high power: weight ratio. From previous experience with sport type models it seemed that three pounds would be the absolute maximum permissible weight for the project to be successful with the preferred '19' size engine. No sweat so far, but now further questions arise. Is it economical sense to build a plain *flying machine* capable of operating out of the garden, full stop? Answer 'no'. To be worthwhile, the model would have to be reasonably interesting and lively, at least semi-aerobatic, and with plenty of 'stretch-potential' for those odd jobs like banner towing, glider towing, flight photography and such like. As for the structure, 'modern' methods involving all sheet/block construction leave a lot to be desired from the point of view of strength : weight ratio, whilst the 'quick build' propensities of these structures are largely illusory due to the amount of carving, sanding and finishing involved. So after all this cogitation, it is not surprising that the 'Stol Mark One' when it finally appeared in the May 1973 *Radio Control Models and Electronics* (q.v.) had a distinctly nostalgic look about it.

Stol Handling

Flying this model was very much like any other 'sport' model except that, because of its light weight, it was a good deal more 'lively', whilst the average club pilot would find the controls a good deal more sensitive than usual. This is because, at the unusually low air speeds at which it was hoped to operate, 'ordinary' controls would be near useless—literally. After a good deal of practice on a marked area on the normal airfield, the model was successfully flown out of the lawn already mentioned, looped and rolled, flown inverted, and landed back on the said lawn. This, on a flat calm summer evening in 1972. Whilst the 140×35 feet 'strip' might not seem particularly small to an experienced pilot—in ideal conditions quite a number of existing designs would probably be able to use it, but it is a 'one-way-in, one-way-out' strip, i.e. all take-offs are on a heading of 310 degrees and all landings are on the reciprocal 130, so that if there is any wind at all you are either cross-wind, or either the take-off or landing is *down*-wind. As it happens, mostly it is the landings that are at least partly down wind, the worst possible situation for the most critical part of the flight. However, in calm conditions, the 'Stol I' flew on a number of occasions from the lawn, without accident—as far as is known, the first model to fly 'back garden' operations, repeatedly at any rate.

The technique of flying in these conditions is quite a bit different to 'airfield' operation. Apart from the fact that when you are running down a 35 feet wide strip with trees lining the sides, you can't allow much of a 'swing' to develop, take-off presents no problems, and the 'Stol' has frequently got off in less than half the available length, even with a slight tail-wind. The landing is the bit which needs knowledge of Stol handling techniques, practice and concentration as well as a suitable model. Basically the technique is to set up the model for a slightly longer than average final approach, reducing speed quite early. Here an engine with really good throttle response and a reliable idle is absolutely essential, as is the ability to fly your model accurately quite near to the stall. To fly at this sort of speed, quite a lot of power is needed beginners will be surprised to hear, whilst powerful elevators are necessary to hold the model in the required pitch attitude. The only practical way, as well as the correct way, to fly the final approach leg, is to control the rate of descent with the throttle and the speed with the elevators. The practice of some pilots of using the elevator as the up-and-down control on the final approach, leads to big variations in speed, and holding a steady airspeed, just above the stall, is the vital factor in Stol landings.


Writer's 'Stol Mk. 1' demonstrates vivid short take off and steep climb out, using optimum 20 degrees take-off flap setting 48 in. span, three pounds weight, O.S. 19 engine heavily muffled.

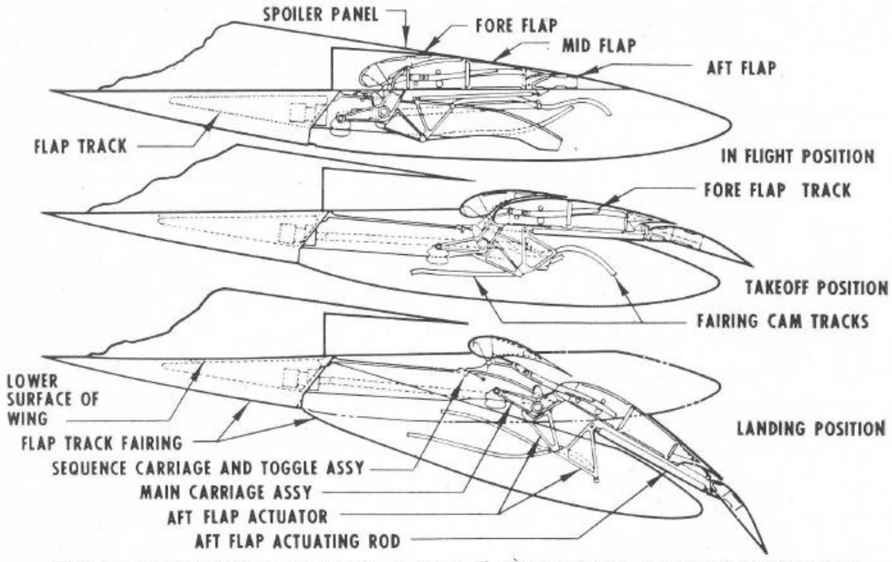

Stol Mk. 1 again, this time on finals with full 85 degree flap setting. Although in level attitude, model is in fact descending steeply, very near to the stall with engine at about one-third power.

With the 'Stol Mk. I', providing that all the above had been flown accurately, the final flare was performed in the usual way, and, after a short 'float' the model would land and stop well within the allowable 140 feet. Come in just 5 knots too fast, however, and the float phase alone would use up all the 140 feet. Any down-wind component makes matters worse as well. The reason for float being such a problem is that, although not what would be described, aerodynamically, as a 'clean' model, at the sort of speeds involved the drag is very low indeed. To this must be added the fact that with the high thrust / weight ratio of the lightweight model, even at idle the engine is still producing enough thrust to prolong the 'float' phase of the landing quite significantly.

So the 'Phase One' Stol was a limited success in that it had done all that it had been intended to do, but 'limited' in the sense that the whole operation of 'back garden' landings was very critical and limited to ideal conditions—i.e. flat calm.

'Phase Two'

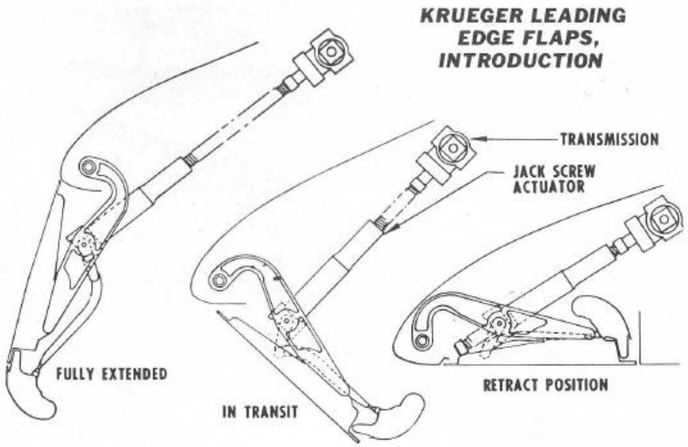
The idea of the original experiment was to see if the lightweight, high-power (relatively speaking) and high-lift 'simple' approach would deliver the goods. When it became obvious that the answer was a very qualified 'yes', the next step seemed to be to investigate the properties of the various lift and drag producing appendages and decide which would be most appropriate. Basically, the main need was for more *drag* to deal with the troublesome 'float', but any increase in *lift* would also be useful in that it would enable the approach to be even slower. Flaps of some sort would have to be fitted, but what sort of flaps? Reference to full size publications showed a bewildering number of configurations, as well as considerable divergence of opinion on the properties of the various types. The diagrams and graphs represent an average of several different sources, and from these I deduced that the split flap would give me the best compromise in terms of lift: drag and complication: effectiveness. Slotted flaps are now increasingly popular in full size, but it seems this is mainly because, with the widespread use of flap for take-off, reasonably low drag is important. As stated above, with the model take-off is no problem anyway, and high drag is needed to reduce float. 'Fowler' flaps are very good, but again produce



TRAILING EDGE FLAPS, TRIPLE SLOTTED, INTRODUCTION

more lift than drag, and introduce linkage problems which would involve a significant weight penalty. The jet airliner deal with the triple slotted flap and leading edge droop is really appropriate only to that type of flying machine, which, without them, would be completely impossible. As a matter of interest the increase of lift with this kind of set-up is variously described as 'double' or 'triple'. Even the elaborate Boeing 707 wing, which has a slat on the leading edge of the slotted flap plus the 'Kruger' leading edge flaps, represents a mere intermediate stage in the aerodynamic chicanery necessary to allow these things to fly. When the requirement for the short haul Boeing 727 included operation from 5,000 ft. runways—about half the normal jet runway—Boeing took the 707 wing apart and eventually came up with the fantastic triple slotted flap with Kruger flap inboard and leading edge flap-cum-slat on the outboard section all of which added up to successfully achieving the 'field performance' required. Even this is not the ultimate. Many aeroplanes now have 'blown' flaps in which high pressure air is bled-off from the compressor stages of the engine and blown over the top of the flap—all of which is very interesting by way of an aside, but scarcely applicable to model aeroplanes. In fact, after a careful review of the many factors involved, a simple split flap was fitted to the 'Stol Mk. 1'. This involved little complication and the additional servo was the only weight penalty. Earlier experience with slots had indicated that these were not particularly effective and hardly likely to 'pull their weight', so these were not used.

Flight tests with the flaps showed them to be very effective, rather more so than full size experiences with similar flaps would have indicated. The expected nose-up trim change was very marked but could be handled by rigging the elevators so that full nose-up trim was needed for normal (flaps-up flight), making the full trim range available when the flaps were put down. A co-pilot would be useful to apply full flap and full nose-down trim at the same time, and so avoid the somewhat twitchy situations when the pilot tries to do this *and* fly the aeroplane at the same time. As for the landings, a new snag now became apparent. With full flap, the model could now be flown slower than before, due to the significant increase in lift, and at the speeds that were now possible, yaw and roll stability deteriorated to a serious extent. Fortunately, the control response was still entirely adequate, even at these speeds, but after about a dozen landings, simple leading edge slats were fitted and this completely cured the low-speed stability problem. As a further indication of their effectiveness, The Stol Mk. 1, which would previously spin quite readily and was in fact once spun *accidentally*, became, with the slats, quite spin-proof.



KRUEGER LEADING EDGE FLAPS, INTRODUCTION

In this configuration, regular 'garden flying' became quite practical, even in choppy winds of up to 12 knots. Downwind landings with the wind up to 10 knots are not difficult, and even 'flame-out' landings have several times been made without too much strain though it must be admitted that luck, as well as good management is needed for these emergencies!

The flaps give a number of useful advantages. First, the extra lift, which is considerable, enables a lower airspeed 'over the fence', or, put another way, it isn't necessary to fly it *quite* so near to the ragged edge of the stall in order to be sure of stopping in the available landing run. Second the increase in drag is useful in several ways. It *steepens* the approach path, so that apart from the obvious advantage for coming in over obstructions, there is the slightly less obvious but equally definite fact that the steeper the approach path, the easier it is to judge the touch-down point. It is also possible to fly the approach with more power on. This increases the effect of the elevators and rudder, as well as increasing the flow of air over the flaps. Equally important is the reliability factor in that a fast idling engine is less likely to stop than a slow idling engine. This is very important because if the engine stops during one of these drag-it-in-on-the-point-of-the-stall type approaches, the aeroplane stops flying immediately, which is unfortunate if it happens to be twenty feet up at the time. Finally the extra drag cuts out the float entirely if

R. M. Pilgrim built this Super 60-based Stol which has D.F.S. type airbrakes as well as large area, 85 degree split flaps. Very 'Stol' but some control problems at ultra-low airspeeds. Note bracing wire, highly recommended by author.

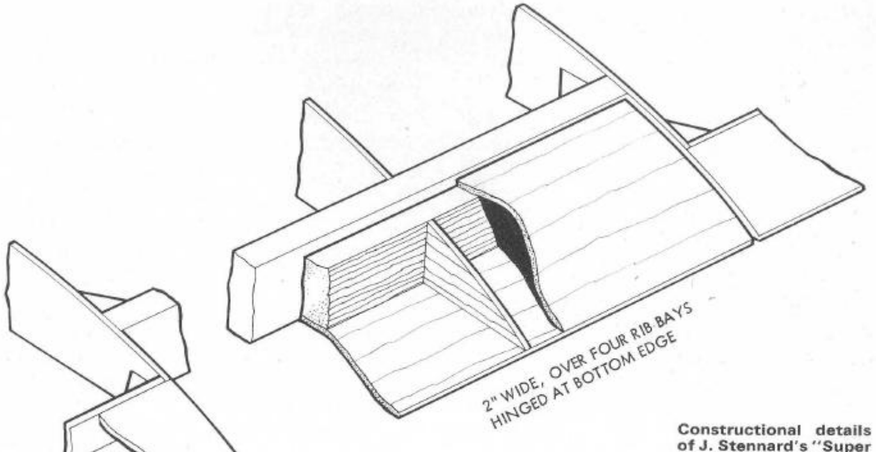
the approach speed has been held accurately, and dramatically reduces it even if you come in too fast. The best technique with these very slow engine-on approaches seems to be to leave the power on until the touch down, so that it can help with the flare.

Though not originally considered as a take off aid, the flaps can help here too, particularly when the slats are fitted. Anything up to about half-flap can be used (more than that gives an uncontrollable pitch-up when full power is used) and the take-off run, already short, becomes even shorter, whilst the angle of climb (see picture) becomes almost unbelievable for a fairly big model with a mere 19 engine.

Other STOL experiments

Mention of these experiments and the ultimate publishing of the plans of the 'Stol 1' in the *Radio Control Models and Electronics* magazine led to a good deal of correspondence. Many wanted to discuss the purely theoretical aspects of the exercise, but about a score were actually flying models intended for confined space operation. The first of these was John Bridge, famous later for his R/C scooter, whose Merco 35 powered model had slats and plain flaps. John got all the usual handling qualities, including the strong pitch up when the flaps went down and the running out of control at the 'ridiculous' airspeeds of which the model was capable. He concluded his letter: 'As for flying in and out of the back garden this is not on at the moment as I need more yaw/roll response at low speed and more power to give a better climbing angle—it's a nice thought, though!'

John Addison sent some diagrams of some very simple split flaps that he had applied to one of his models and said: 'As you will see they could hardly be simpler, but then comes learning to fly with them, which is another matter altogether'. Mr. Addison found the nose-up pitch a nuisance but taught himself to fly approaches holding the stick forward—an uncomfortable situation, model or full size—most pilots, for some reason or other, are quite happy holding a bit of back pressure in an aeroplane that is trimmed nose-heavy, but feels uneasy when the situation is reversed. Mr. Addison's conclusion is 'Using a fairly small flying field with lots of obstructions, I find that flaps give me slower, safer take-offs and landings, and slower, steeper approaches so that trees and other obstacles can be avoided'.



Constructional details of J. Stennard's "Super 60" plain flaps.

Jo Ivens reported that he had been using flaps on models with high wing loadings, some of them biplanes and said that he genuinely found it easier to land, using them. He makes the unusual comment, 'My experience firmly contradicts your comment that all models get a nose-up change of trim when the flaps are lowered. All mine go nose down, which is what you should expect, begging your pardon!' Of all the correspondents who had actually flown flapped models—as reported, about twenty—only Mr. Ivens reported a nose-down-pitch when the flaps were lowered. An earlier impression that most full-size aeroplanes go nose-down when the flaps are lowered turned out to be far from true. In fact many full size aeroplanes

J. Stennard's 'Super' Super 60 incorporates all 'Straight & Level' modifications, but also has large area 60 degree plain flaps. Uses O.S. 40 engine.

share the nose-up pitch of the models,' including some very famous ones, Wellington, Lancaster and Canberra, for instance.

Looking into this trim change business a bit deeper, it becomes obvious that the whole subject is much more complicated and unpredictable than might be thought. Basically, any *wing*, considered alone, will pitch nose *down* when flaps are put down. But when you nail the wing onto the rest of the aeroplane, the downwash from the wing—which is always present when the wing is lifting and more pronounced with flap application—then hits the tail and whether the complete aeroplane then pitches up or down depends on the relative magnitude of the two forces. The layout of the aeroplane itself seems to be the main factor. The type of flap doesn't seem to make much difference. For instance, the three wartime heavy bombers, Lancaster, Halifax and Stirling were basically the same layout, four-engine, mid wing, moderate aspect ratio, and about the same size and weight. They had very different kinds of flaps, however. The Lancaster had split flaps, the Halifax plain flaps, and the Stirling had the more sophisticated Short-invented 'Gouge' flaps which were similar to Fowler flaps, in that the flap moved backwards and downwards, increasing the wing area, but the flaps themselves were of a curved section which gave a better overall wing section when the flaps were down. In spite of this wide variation in flap design, all three aeroplanes pitched nose-up when the flaps were lowered.

By comparison, the Boeing 747, which, with the 727 has one of the most complicated wing-flap configurations in civil aviation (*triple* slotted flaps with Kruger leading edge flaps and upper surface 'lift dumper/speed brakes') has, as would be expected, a much more involved trim-change sequence. From 'full-up' to about 10 degrees down, there is a slight nose-down pitch. From 10 to 20 degrees there is a pitch up, and from there to maximum down, which needs to be only 30 degrees because the flaps are so big and because lift is the main consideration, there is a marked pitch nose *down*. Reference to the drawings of the 747 flap configuration will indicate just how much development on the plain flap idea there has been.

It seems that the reason for the model trim change being usually nose-up is something to do with the low pressure area behind the flap reducing the tendency of the upper-wing airflow to early separation which increases the lift and the downwash, which, hitting the tail plane, is the cause of the nose-up pitch. Apparently in full-size scales the tendency to separation is much less, so the effect is not so noticeable.

Mr. J. Stennard, who is an English teacher in Rinteln, W. Germany, wrote, 'After reading the various references to the "Super 60" and recommended modifications thereto, I decided to build one, with the mods. suggested, but also with (plain) flaps, maximum deflection about 50 degrees. As you can see they are quite big. The model is very nice to fly, with the O.S. 40, as yours originally was, but the flaps make it just that bit more fun. With the engine throttled back the nose rises when the flaps are lowered but the trimmer takes care of that. The angle of descent is steeper than normal and (with practice!) you can land in a matter of yards. With the motor cut back and the flaps down, low, slow flying is really great. For take-off, with a bit of flap she is off the ground and climbing like a lift after a very short run. Truly the "60" is a great fun model and with the flaps even more so'.

Martin Reed's second thoughts on Stol design. This one has a 54" span, Merco 35, full span L.E. slats, slotted flaps and ailerons.

R. M. Pilgrim of Teeside is another who used the 'Super 60' as a basis for his Stol experiments, but his mods go a bit further. The span is increased to 76 inches and ailerons are used. In addition to split flaps, he also has D.F.S. type (glider) airbrakes sprouting from the top and bottom surfaces of the wing. He says, 'For short take-off about 15 degrees of flap in an 8 m.p.h. wind gives lift-off in about ten feet with another 20 feet or so to clear a 15 feet obstacle.

'When the brakes are selected (non-proportional) the nose pitches down and full trim plus about $\frac{1}{4}$ back stick is needed to balance this, which, with the high rate of descent, means that I have not enough elevator left to round-out which leads to heavy landings. With the *flaps* (only) down, the situation is reversed in that full down trim plus $\frac{1}{4}$ stick *forward* is needed. Round out is possible by releasing the forward pressure on the stick, but it is tricky and the landings tend to be a bit bouncy. With flap *and* brakes, the technique is to select brakes first, then apply sufficient flap to bring the model back to trim. The throttle is then used to control the rate of descent. This is normally high, but controllable. Roll response deteriorates at low speeds and demands concentration.' He says he now needs extra control power to deal with the ultra low-speed condition, and might try slats too.

Martin Reed of Loughborough's original Stol was based on the M.A.P. 'Electra' 54 inches span, and fitted with full span slats and slotted flaps, both of novel section. Mr. Reed gets round the trim change problem by having the flaps fixed in the down position, though this, of course, limits performance in other directions. He says, 'At normal speeds the model behaves like any trainer but when throttled back with up elevator it will remain airborne at about 15 m.p.h. In a breeze it can be hovered overhead indefinitely or lowered vertically onto the runway. In the latter manoeuvre it just starts to move forward as it gets into the ground effect air and the actual landing run in these conditions is about four feet! For take-off, in still air it needs about thirty feet to get flying speed and then it can be "leapt" into the air up to about fifteen feet altitude.'

Mr. Reed's development of this model had zero dihedral in the wing and ailerons were fitted, the longitudinal dihedral was reduced to zero, to improve handling and a stronger undercarriage was fitted with the 'Sokol' type 'reversed tricycle' layout. He says this one will leap almost vertically the first twelve to fifteen feet after take-off 'when a quick burst of full down is applied, before it starts to come backwards, and away we go! The reduced longitudinal dihedral means that I don't have to constantly use down elevator when the speed goes up. I was a bit worried that the ailerons, which are also slotted and drooped, might be ineffective in the low-speed/high angle of attack situation, but they have proved to be effective at all speeds. No doubt this effectiveness at low speed is due to the factor you mentioned—that slotted flaps, and, presumably, slotted ailerons as well, give lower drag for a given amount of lift. I enclose a drawing of the wing section used. Manoeuvrability in normal fast flight is good and the model can be rolled and flown inverted. In short the model will fly as slowly as the earlier one but now has the ability to perform quite a few aerobatic manoeuvres. The speeds and other figures quoted are approximate as no timed runs have yet been made.'

Mr. Reed's last remark about timed runs raises the interesting point about estimating speeds. This is extremely difficult and can be widely off the mark. The writer's 'Stol Mk. I' seems to be the only one of the models mentioned that has been so timed and the following figures, based on averages of many runs on several separate occasions, can be taken as accurate to 1 m.p.h.

	m.p.h.
Maximum speed	50
Minimum speed, flaps up	21
Minimum speed, flaps down	12

This speed range of 4:1 will handsomely beat almost any model flying, and beats quite a number of full-size Stols with much more sophisticated geometry. The Cessna 150, whilst not exactly Stol, is a very good aeroplane for small field operation with its big flaps, tricycle undercarriage and good brakes, and for comparison the relevant figures are:

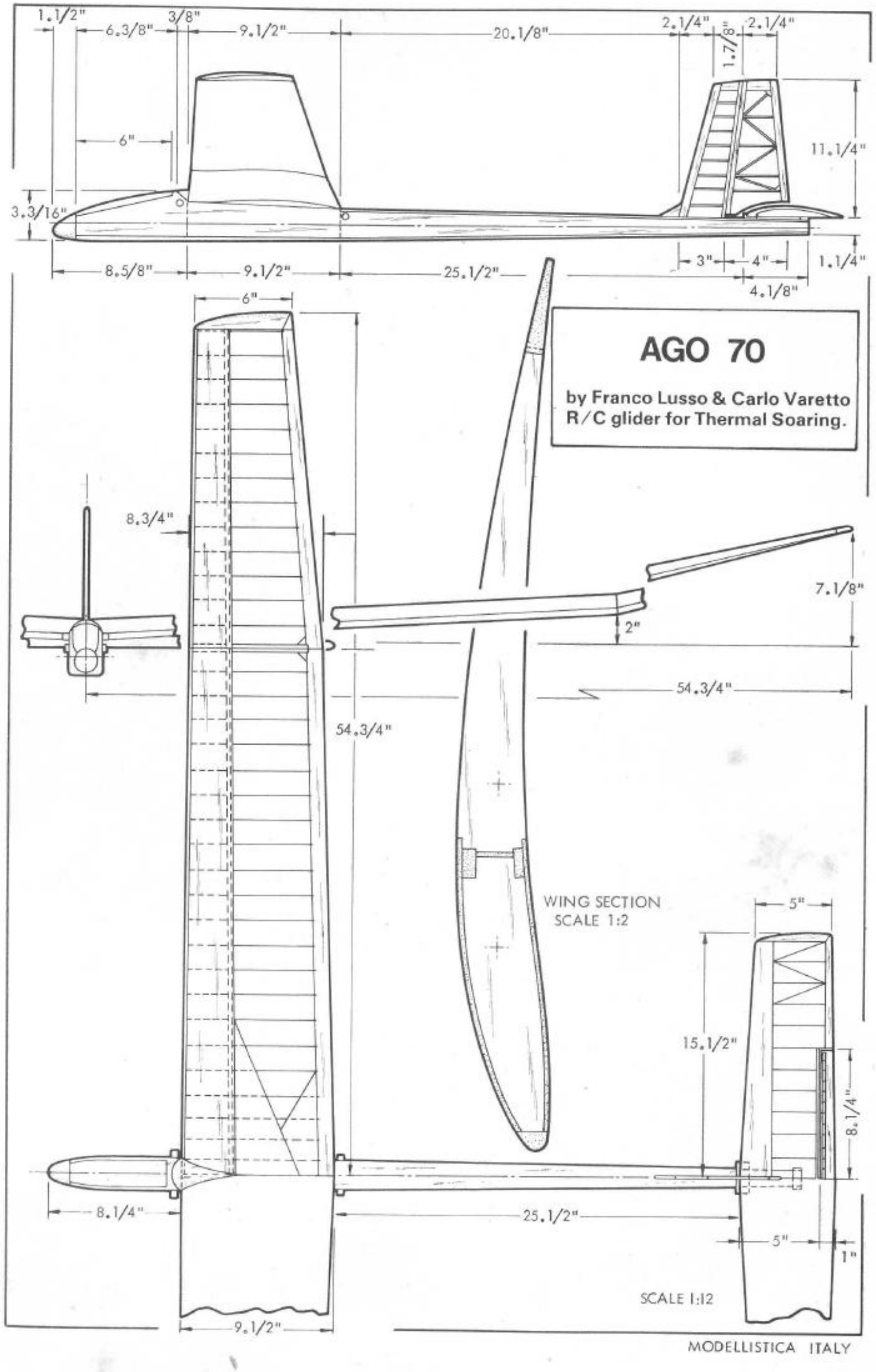
	(approx.) m.p.h.
Maximum speed	128
Minimum (stall) speed, flaps up	44
Minimum (stall) speed, flaps down	37

Relative to the Stol Mk. I, the much smaller difference between flaps up and flaps down speed will be noted.

What next?

From experience already gained, it would be entirely feasible to build a fully aerobatic model, of a similar layout to those currently in use, but with a lightweight structure, and using split flaps and built in 'letter box' slots, that could be operated from the same sort of area that the Stol Mk. I is now using. Its only forseeable handicap, relative to the 'normal' aerobatic model would be in its lower wing loading which would make its gust sensitivity higher, sacrificing that highly desirable 'smoothness' which is the outstanding feature of the current generation of eight and nine pound contest aerobatic types.

Of the pure Stol types, no doubt even the 12 m.p.h. of the Stol Mk. I could be improved upon, but at this speed the model becomes very sensitive to even mild gusts, and it is doubtful if there is any point in trying to fly slower still. What *might* be profitable would be to use more sophisticated flappery to allow models with a substantially higher wing loading than the Stol, to be able to land at the same speeds, and the writer would be glad to hear from modellers experimenting in this direction with a view to compiling a later review on Stol developments.



A MODELLER'S APPROACH TO RPVs (Remote Piloted Vehicles)

(Reprinted from American Aircraft Modeller) By Ken Willard

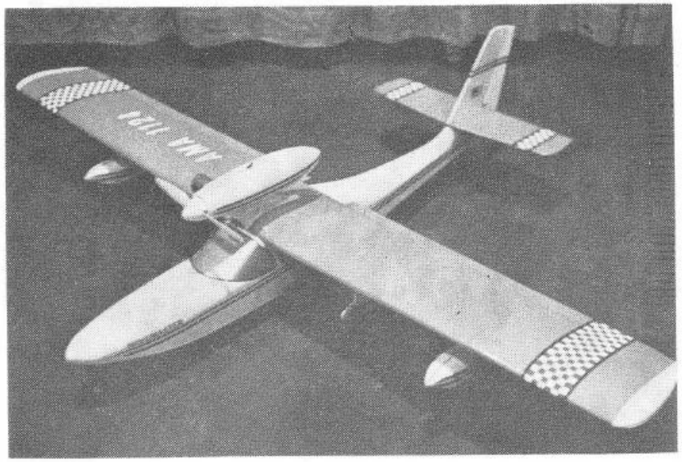
EARLY in 1971, I received a call from old-time modeller Bob Palmer who works for the Lockheed California Co. They were undertaking a programme of research on remote piloted vehicles (RPVs) as potential combat vehicles. For government oriented research, it was a very low budget effort.

As a feasibility demonstration, they proposed to undertake an approximate 1/10th scale flight demonstration programme to learn more about the capabilities, and limitations, of RPVs. How precisely can the flight path be controlled? Is air-to-air combat feasible, or would the initial target acquisition be too difficult? There were many other questions too.

Lockheed had earlier developed a small, lightweight experimental TV camera, and a matching lightweight transmitter. So, the idea emerged—mount the camera and transmitter in a radio-controlled airplane, and try to fly the airplane entirely by reference to the picture transmitted by the camera to a monitor screen receiver installed inside a mobile van.

Bob called me, on behalf of the Programme Manager, to inquire about the availability of a couple of *Wavemasters,* the amphibian 6 ft. R/C airplane which I had designed and which is produced in kit form by King R/C Distributors.

We talked about the problems—space envelope, weight and balance, power requirements, structural beef-ups. The Wavemaster is designed to fly at weights ranging from eight to nine lb. in normal use. With the TV camera installed (including transmitter and power pack), it would have to fly at around 15 lb., according to original estimates. Actually, by the time all the modifications were added, the flying weight turned out to be closer to 20 lb!



Author's Wavemaster amphibian R/C model is large and was used as a test bed for RPV experiments.

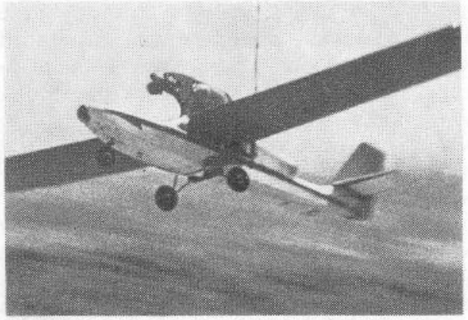
At the time of Bob's call, I had just completed most of the flight test programme on the *Wavemaster* and had two prototypes available. As soon as we determined the camera would fit in the nose (ahead of the propeller as desired) and there was room for all the equipment, I shipped the two airplanes down to the Rye Canyon test facility. There they modified the landing gear to carry the added weight and also extended the wing to 8 ft. span. This concerned me, as I feared the percentage of tail area might be marginal. But flight tests eliminated the need for any concern—the airplane was very stable.

To perform the actual flight programme, two of the best known and best qualified R/C pilots in the world were selected. Larry Leonard and Bob Smith, familiar names to all R/C enthusiasts, took on the assignment. Although the plane was able to fly with a 61, even weighing nearly 20 lb., it was understandably a bit sluggish. So an 80 was installed. This gave the plane good performance and a speed of about 60 m.p.h., or 1/10 the projected full-scale speed of 600 m.p.h. A model air field was constructed to 1/10 scale, and the feasibility tests were ready to start.

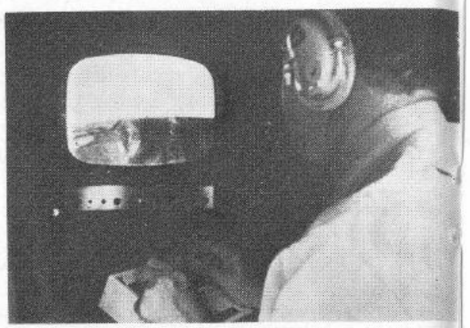
Larry took up his position, as 'pilot' inside the control van, looking at the TV screen on which the picture from the TV camera in the nose of the Wavemaster would be projected. Bob was outside, alongside the makeshift runway. Bob, having visual contact with the plane, held the master transmitter; Larry had the 'slave' or 'buddy box' transmitter in the van. Thus, Bob could position the Wavemaster until Larry, looking at the TV screen, achieved ground, horizon, and target acquisition. Then control shifted and Larry flew the model on the starting runs.

A second experiment was simulated air-to-air combat. A semi-scale P-51 R/C model, flown by a third modeller, was chased by the Wavemaster with Bob Smith at the controls until the P51 appeared on the TV monitor screen. Then Larry took over, got on the P-51's tail and closed in to firing range.

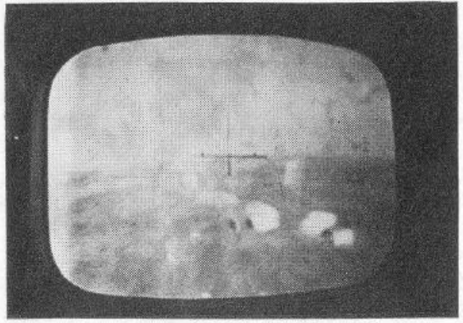
The Wavemaster after modifications to take the RPV equipment. Note the TV camera mounted on nose. Power pod was stripped to take larger fuel tank.



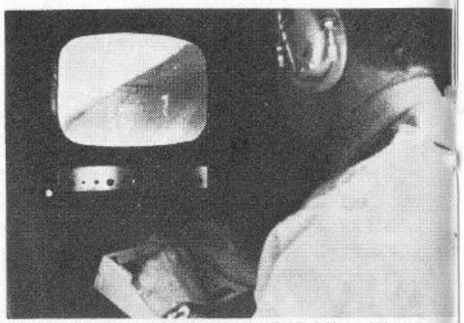
The Wavemaster takes off at an all-up-weight of some 20 lb. Model had a level speed of about 60 m.p.h.



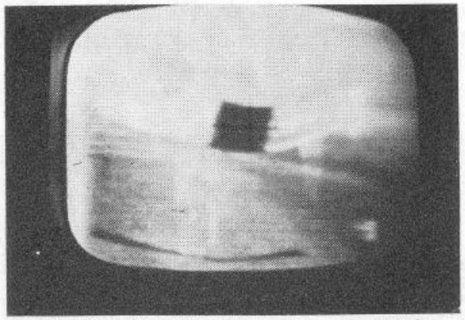
After take-off control was switched to TV-guided pilot. TV monitor here has target in sight.



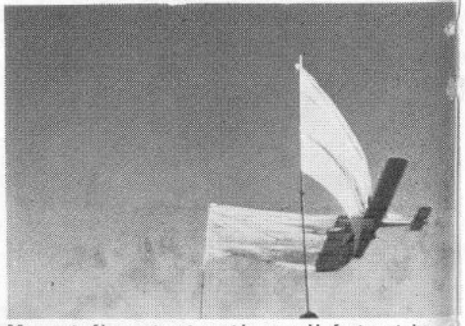
TV monitor picture of 15 ft. 'Strafing run' over sealed down 'airfield'.



TV monitor here shows view of 'field' as Wavemaster attack craft climbs out after 'attack'. When horizons disappear, visual pilot takes over.



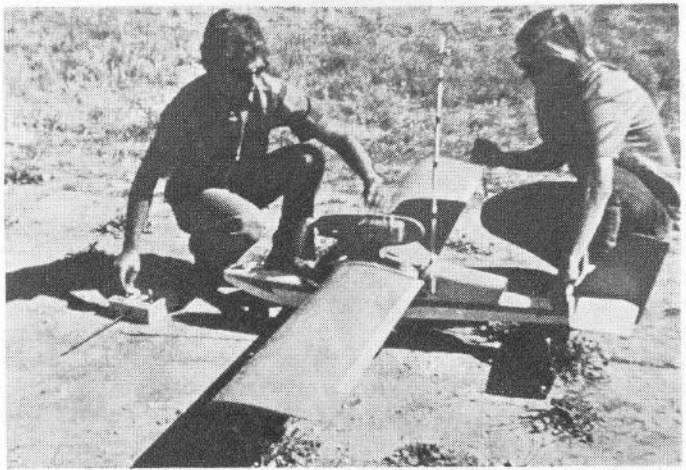
Pilot accuracy test took form of head-on attack on crepe banner seen in middle of TV screen as model rushes towards it.



Moment of impact on target banner. Unfortunately the target won by wrapping itself around the model!

Finally, a simulated 'Kamikaze' mission was performed. A crepe paper barrier, approximately 15 ft. wide and three ft. high was strung between two poles. A bull's eye was painted dead centre. The Wavemaster was flown into acquisition position by Bob Smith. Then Larry, flying by reference to the TV monitor, directed the model towards the banner and scored a direct hit. The motion picture which recorded this is spectacular—to say the least—especially to an R/C audience.

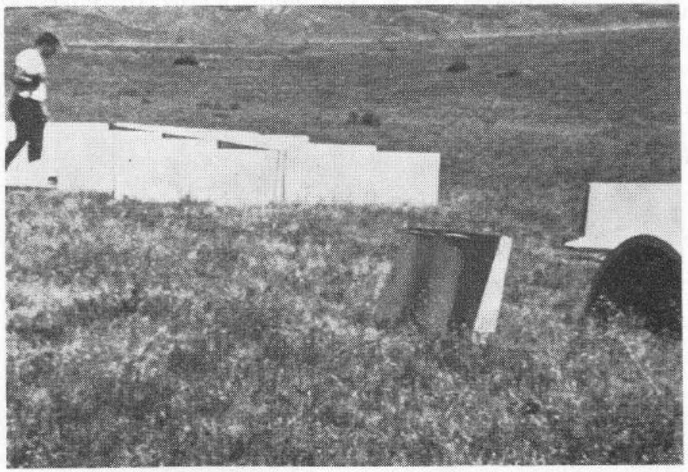
Once again, the techniques of the sport of R/C flying were utilized to pursue an important objective of the U.S. Department of Defence; at a great saving to the programme, and in turn to the American taxpayer. This low-cost feasibility demonstration showed both the capabilities and the limitations of the concept and pointed the way towards further sophistication required in order to increase the capabilities. All this at a cost less than one tenth of similar programmes.



Active U.S. West Coast pylon race fliers Larry Leonard (left) and Bob Smith (right) acted as test pilots for the experiment, seen here preparing model for flight.

An 'off-the-shelf' R/C model, modified to accommodate the airborne TV camera and controlled by an 'off-the-shelf' R/C transmitter and receiver, demonstrated that there is, in addition to its recreational value, a technical and scientific utility capability of R/C whose potential is only beginning to achieve a measure of recognition. It is this aspect of R/C—which doesn't get headlines—that R/C enthusiasts must continue to foster, promote, and publicise. And progressive companies, like Lockheed, who are using some of our equipment in research and development, are helping to improve the image of R/C modelling at the same time they're saving money.

It's a good deal all round, and its fun, too.



The target—a simulated, 1/10th scale 'airfield', with hangars and revetment, is here prepared for the coming 'attack'.

ELECTRIC POWERED RADIO CONTROL FLIGHT

By Peter N. Bragg

THE electric driven model aircraft has been a dream of aeromodelling enthusiasts for many years and those of us whose memories go back to 1957, will recall the interest created by the Taplin flight that year. Since then there have been various attempts to produce a practical electric aircraft for the average modeller, but these have only had limited success. Students of the type will not need reminding that the main problem is the weight of the electricity required. In other words, each ounce of battery will deliver so much power and no more. Rechargeable batteries were desirable to keep costs down, but initial costs and high weight discouraged much experiment. Over the years a few models have appeared both free flight and R/C, some items like the free flight 'Electra' which was powered by a 'one shot' water activated battery, were actually marketed for a time. While most of them could be rated as a considerable achievement, their cost and limited performance reduced their appeal to the average aeromodeller. Aeromodelling however is one of the last strongholds of the 'rule of the thumb' engineers, who tend to substitute imagination and informed guesstimation for slide rules and graphs. We get a great deal of pleasure out of having a try at the impossible, even if the project eventually fails. Success makes it even more worth while.

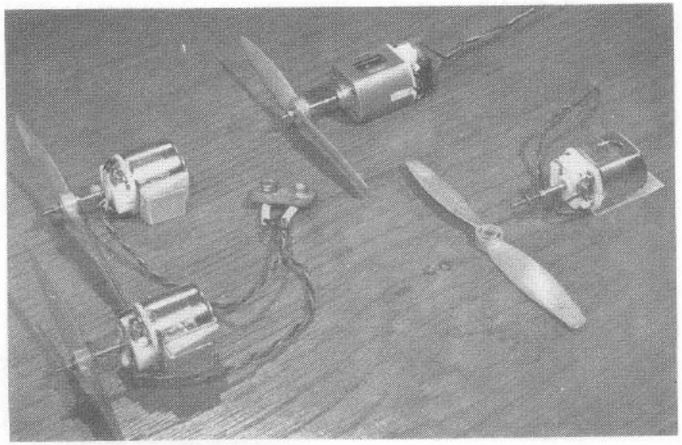
It would not be easy to write a complete instruction that would enable the reader to build an electric flying model mainly because the availability of items such as suitable electric motors may vary according to where the reader lives. However I feel certain that anyone living within reasonable distance of a good model shop or ex-government surplus store would have little difficulty in duplicating or even improving on the R/C flights I have made so far. For this reason I have confined this to a description of what I did (and the clangers I dropped) in addition to detailing, where possible, the essential equipment used.

For some years I had wanted to try my hand at electric powered R/C flying. Reading Philip Connolly's article in '*Model Boats*', March 1972 issue, on the new rapid rechargeable Saft cells gave me inspiration. I started the project in early November 1972. First consideration was a suitable motor. The 'Sea Wasp' boat motor looked promising, but price quotes for motor and batteries I required came out at nearly £35, rather high for an experiment which might not work. Besides, as a penny-pinching skin flint, I have a reputation to keep up. So I started a session of hunting around shops for cheap electric motors and reducing those I possessed to little better than scrap. By the beginning of February 1973, I had a promising motor, a Mabuchi 36D, rewound with 28 swg wire, plus some hopeful calculations, based mainly on dry battery performance. This was one of the motors used in the Esher DMFC indoor RTP sessions. I promptly sent off for a set of Saft VRO5AA batteries, full of high hopes for the following weekend. Such is optimism. After several phone calls, the order finally arrived in mid March. I dug out my calculations and dusted off the motor, gave the cells a full charge at the ten hour rate and hooked up and switched on. Looking at my notes I knew I could expect an increase from the 11 watts produced earlier. Even so I was a little surprised to find I was holding a handful of instant hurricane turning over at about 27 watts. The budgerigar was even more surprised when the propeller came adrift and crossed the room even faster than he could.

At this stage I decided it was rather a waste of time to classify performance on the basis of wattage. This might be OK for boats and RTP planes, but R/C model aircraft have different requirements. The all up weight of the model would be limited essentially by the thrust produced by the motor combination used. The current consumed by the motor would decide the powered flight duration. These were the two important factors.

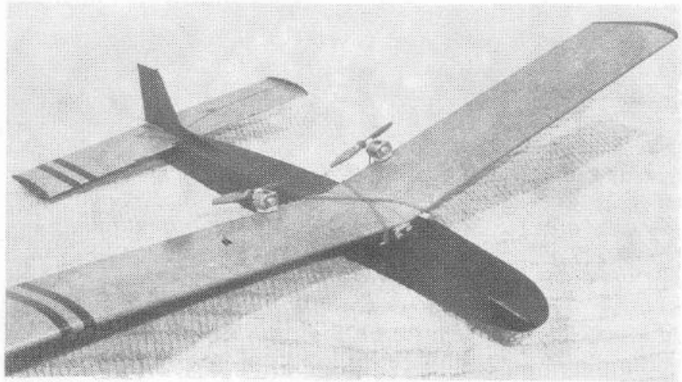
Considering the batteries first. The capacity of VRO5AA cells is rated at 500mAH for a full charge at the ten hour rate. Bearing in mind the current I would be taking from them it would be better to calculate the battery capacity in terms of amp/minutes. Therefore the VRO5AA cells had a capacity, on full charge of 30 amp/minutes. This may sound a lot, but it should be remembered that capacity drops if a rapid recharge rate is used. According to information from Saft, the capacity of the VRO5AA cell drops to 40% for a three minute charge, at the recommended Ultra Rapid Rates. Therefore after a three minute charge at 5 amps, the drive battery should have a capacity of 12 amp/minutes and in theory could supply 6 amps for two minutes. Of course the battery does not work quite like this. It would start at a high current and tail off over a longer period. This is fine for flying, the high initial current getting the model up there and the diminishing power helping to stretch the glide.

Although the motor appeared to be quite ferocious on the hand held run, the thrust when checked on a simple test rig was just 2½ oz. for a current



Pic. 1

Motors used. Mabuchi 36D at rear. The three others are Scalextric. All show 8BA threaded rod shaft extensions, as described in text. The left hand pair of motors have aluminium clips and wedges made from balsa TE offcuts and are ready to be fitted straight on to a model as shown in Pic. 2. They are both wired in parallel to the PP3 press stud type plug, which will link them with the switch and drive battery in the fuselage.



Pic. 2

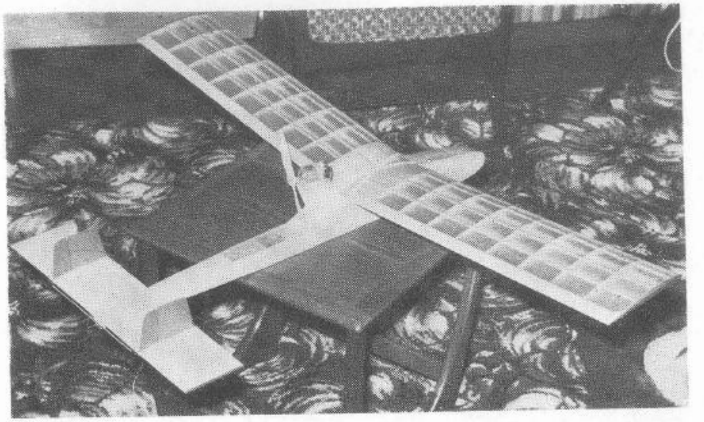
The temporary test installation in the 42″ span 'Mij' soarer. Switch and charge socket were left loose as shown. The 'Mij' weighed 26 oz. complete with S/C radio, motors and 6 volt VRO5AA drive battery. Intended for powered glide tests only, not powered flight. Did eventually stagger into the air for a very brief flight at nearly 30 oz. with a 12 volt VRO5AA drive battery.

consumption of 6 amps. Using strictly 'rule of thumb' methods I estimated that the model design I had in mind would fly adequately with an all up weight equal to four times the thrust in ounces. While some modellers might favour a more scientific approach, I think there is a time and a place for lengthy mathematical calculations but for this particular project they would prove little and achieve less. Besides, such calculations need to be based on results obtained from superior and therefore expensive test equipment to have any real meaning. Having worked out that the model should have an all up weight of 10 oz, one then subtracts the weight of the 6½ oz. motor/drive battery combination which leaves 3½ oz. for the model and radio !!! Not very encouraging but it was at least a start. I decided that at least I could produce a free flight model which was half way there and as I am a free flight sports flier as well as R/Cer, I decided that it was good enough for a start. I would fit it with radio and try power glide tests to decide how to proceed from there.

The type of design to use was a simple decision. A simple semi-glider type with a pusher engine on a pylon, would make the most efficient use of the limited power output. Alternatives considered were, pusher motor mounted on fin, untidy and might cause CG problems, or two pusher motors mounted on the wing trailing edge, better but I only had one Mabuchi 36D and could not obtain another at that time. A conventional nose mounted (tractor) motor installation was not considered because it would require an undercarriage, a flexible motor linkage and bearing for the prop shaft and worst of all, the motor output would be restricted by the fuselage. All this could wait, better to keep experimental models as simple as possible at first. Experience gained with the old valve R/C outfits years ago helped. It is a similar situation, a light weight model required to operate with a heavy battery load.

The model was constructed almost entirely from medium/soft $\frac{1}{16}$″ balsa sheet. Obvious exceptions were the wing spars, TE and LE. The motor was pylon mounted on a $\frac{1}{32}$″ ply platform. Tip fins were used to help prevent the $\frac{1}{16}$″ tailplane warping, these were simply $\frac{3}{16}$″ wide strips of hard $\frac{1}{32}$″ balsa. The model was covered with light weight Modelspan tissue and finished sparingly with clear dope, banana oil and colour dope trim.

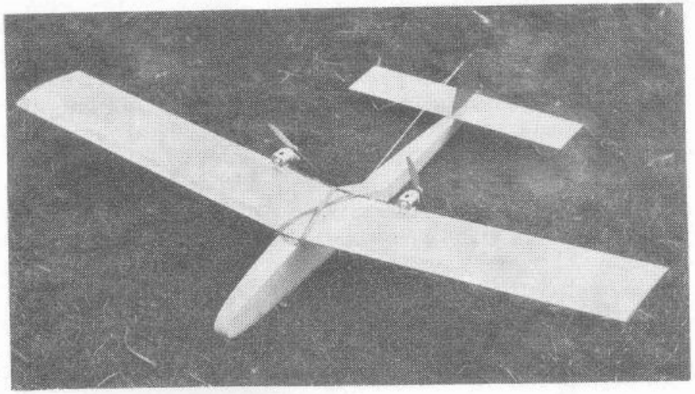
Pic. 3



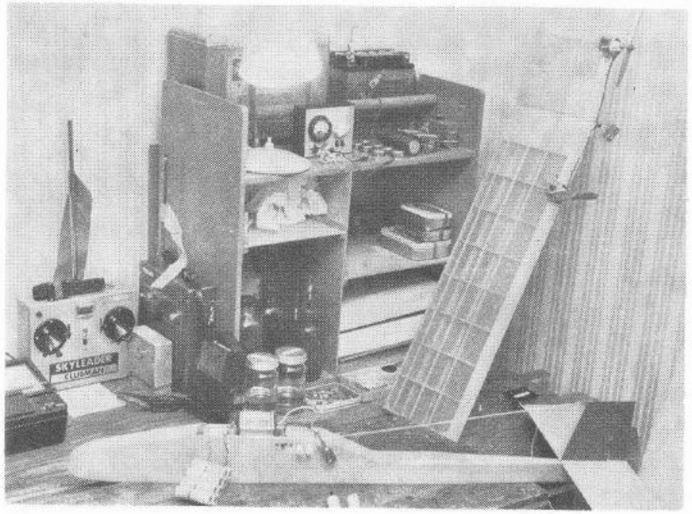
Single motor model, used Mabuchi 36D motor, held on pylon with rubber bands.

The radio gear I intended to use was the single channel MacGregor MR50 superhet receiver. To check interference rejection I draped the receiver aerial over the drive motor, switched everything on and all functioned correctly. The control setup I would be using was rudder only, operated by the Instant Rudder system, which was described in RCME March—July 1972 issues. I have never had to worry too much about radio weight before, but I would have to reduce it to a minimum for this model. Obvious target for weight reduction was the servo and its battery, as the receiver battery (9 volt PP3) and receiver weighing 3 oz. together, are virtually at an irreducible minimum. Usual arrangement in most of my models is to use a 4·8 volt DKZ 500 for the servo. Using DK 225's instead would reduce the weight of the battery pack by approximately 3 oz. Apart from this, I found it difficult to cut the weight without reducing the reliability and performance of the servo. So I settled for a total radio weight of 7¾ oz. for the time being. After all I might be wrong about the power available, the model might soar like a bird, even with nearly ½ lb. of radio for all I knew, although I suspected it would fly like a concrete slab. By now I was halfway through constructing the model described, when by a stroke of luck I came across a large supply of cheap ex-slot car

Pic. 4



Electric R/C flying model aircraft powered by two Scalextric motors capable of six minute plus flights.



Pic. 5

Twin motor electric R/C flying model dismantled for servicing.

motors labelled 'Scalextric'. I bought several and carried out some tests. I found that two connected in parallel to the 6 volt Saft battery were capable of producing 4 oz. thrust from about 5 amps current. This was so promising, I decided to try this combination for the first air tests, using my 42″ span S/C soarer. At 26 oz. all up weight I did not expect the model to fly, but I hoped it would give me some idea of what to expect. I was able to use the most efficient setup of all, twin pusher motors on the wing trailing edge. Before the two motors were mounted on the model they needed to be fitted with propeller shafts. First the prop shaft was made by extending the motor shaft with a length of steel threaded rod (8BA) soldered into a short length of brass tube, which is then soldered onto the motor shaft. Before the propeller was bolted onto this, the motor had to be run on low power to check that the prop shaft was running true. By placing a file flat on the end of the prop shaft while it was running, it was possible to get a turned finish that would indicate the direction and amount of any error in the prop shaft rotation. This job and that of balancing the propeller, are both quite important. A prop shaft out of true, or an unbalanced propeller, can reduce the thrust by as much as 20 per cent. Next the two motors were fitted to the wing TE. These were very simply mounted by taping each to an aluminium strip and then bending each strip to form a clip, to fit around the TE. This clip was at first only taped in place until the model's flying trim was satisfactory, then the clip was fixed in place with a spot of epoxy. A scrap of TE offcut glued to the wing TE, was used to level the motors so that their thrustline was roughly parallel with the wing rib base line. The absence of fuel and heavily vibrating moving parts makes a light weight mounting like this quite workable. A pair of PP3 type press stud connectors linked the motors on the wing to the battery and the switch in the fuselage, enabling the model to be dismantled easily for packing. The motors of course were wired in parallel and both rotated in the same direction. All wiring had to be kept as short as possible between the

motors and the drive battery, otherwise power would be lost.

So the great moment arrived and I stood on Epsom Downs ready for the first test hop hoping that no member of the Esher or Epsom clubs would turn up and laugh himself sick at the latest folly. Up to now I had kept quiet about my latest project. They are a very conservative lot round here, with few exceptions. If your model does not look something like a 'Kwik Fli' you are way out man!! Let's face it, I could think of plenty of convincing reasons why an electric model would never fly, myself. In this pessimistic mood I switched on the radio and then the motors and launched the model. The results were very encouraging indeed. Although as I rightly expected, the motors had insufficient power to keep the model airborne, they were capable of prolonging the glide sufficiently to get a good idea of flight characteristics. Using twin motors appeared to present no flight control problems. The power output varies considerably over any one flight, but as the motors are connected in parallel circuit to a single battery, they remain 'in step' over the whole speed range. As a free flight sports model enthusiast, I can see that this arrangement has great potential. Scale free flight would also benefit. Think of all the twin types that can now be modelled. However I digress. While it was certainly evident that a free flight model could be flown, I was aiming at R/C. Even my lightweight and more efficient model still on the building board looked as if it would be still a bit under powered. I decided to order more batteries. This time I was assured that the order would be dealt with promptly by return of post. I only had to wait three weeks for it.

While I was waiting, I carried out more flight tests, during which it became obvious that, in contrast to the static bench tests at home, the 36D and the Scalextric motors were more effective in the air with a Thimbledrome $4\frac{1}{2} \times 2$ prop, than with the 6×4 I had been using up to then. Another important point which became apparent during the series of tests, was the ability of the batteries to produce heat and lots of it. Hardly surprising when you consider the power they store and the rate at which they can discharge it. The batteries can get quite warm when the motors 'run them dry' during a normal flight. The danger arises if they are shorted out or overloaded. This condition can occur if the motors are stalled while the batteries still have power. So be warned, it could be a fire risk. When this happened to my heavy test model, the couple of minutes it took me to reach it and switch off, were sufficient to burn out a motor and char the ply doublers inside the fuselage black.

In the meantime, I was now finishing the model mentioned earlier. As far as the motor layout was concerned, obviously the twin motor layout was going to be the more efficient, but as I had nearly finished a single motor version, I might as well try it.

When complete the electric model (Pic. 3) weighed a fraction under the target weight of 20 oz. and this time the powered glide was considerably prolonged, not quite powered flight in fact. After a few more tests, I decided to convert the model from single pylon mounted motor, to the more efficient twin pusher layout. Once I had installed the two motors on the wing TE, the twin fins on the tail became an unnecessary handicap and were promptly removed and then replaced by a larger single fin. The model now looked as shown in the three view drawing and Pic. 4. Again the trip to Epsom Downs after work. By now the regular fliers there were

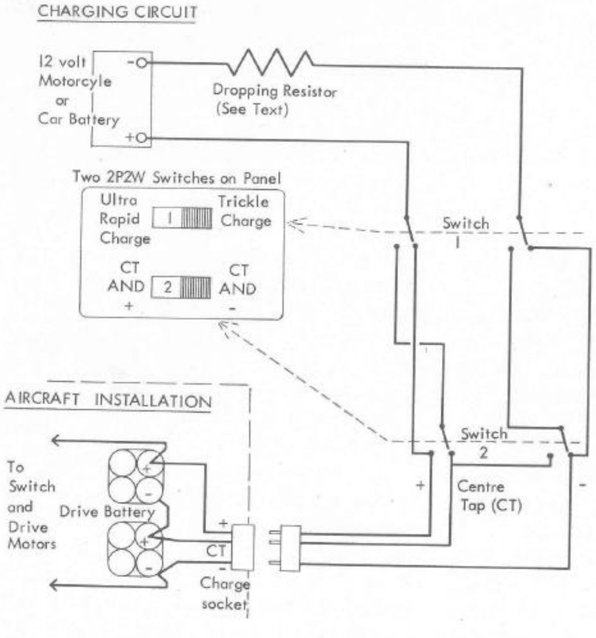


Fig. 6

The two switches are double-pole, two-way, types mounted on a paxolin panel. They should be able to switch 5 amps at 12 volts. I used a polarised plug for the aircraft charging socket, to prevent firework displays. The dropping resistor is made from an electric fire element, as described in the text. The correct length had to be found by trial and error, using a 0-10 ammeter range.

probably getting used to yours truly and the non flying machine. A quick check, switch on and launch. Marvellous, it flies, just! After a hundred yards or so, it sank to the ground, only the shortlived battery peak would keep the model airborne. Although the flight was short, a bare transition from the powered glide of previous tests, I now felt that I had made a successful flight. All I had to do was to increase the power without increasing the weight, which was now nearly 21 oz. with the two motors. Not easy but there was an answer. I would have to swallow my dislike of sequential actuators and use a rubber escapement at least for the moment. Trouble is that S/C sequential and selective actuator systems are much more vulnerable to outside interference, than the simple pulse rudder only system I use and such a heavily loaded fragile model would be wrecked by the lightest crash even from only a few feet up. Despite my opinions, I possess a tiny but very reliable rubber driven escapement, which I made about ten years ago. Substituting this for the pulse actuator and switcher helped to bring the weight of the model down to 17½ oz., but the arrival and installation of three extra VRO5AA drive battery cells, pushed it back up to 20 oz. I had managed to increase the power from 6 volts to 9·6 volts and still reduced the weight by one ounce. Better still, a brief check on thrust produced showed that it was now just over 6 oz. Things were definitely looking better.

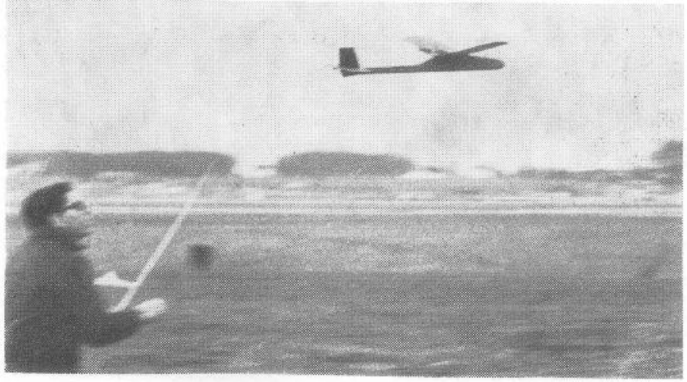
One snag remained. This concerned the Ultra Rapid Charging procedure on the flying field. My flying field charging power source is a 12 volt 7 amp/hour Yuasa motor cycle battery. This fits neatly into the small holdall which also serves to carry the rest of my flying gear. When the voltage of the aircraft batteries was

raised to 9·6 volts the 12 volt power source could no longer produce enough current for the Ultra Rapid charge. One solution to this was to buy another 12 volt battery and raise the charging power source to 24 volts, but the object of the exercise was low cost and simplicity, so lugging two motor cycle batteries around the flying field didn't appeal much either. Simple answer was to split the aircraft battery pack with a simple centre-tap and charge each half separately, for the same length of time. Two double pole two-way switches were mounted on a small paxolin panel and wired up as shown in Fig. 6. This switch arrangement enabled the charging battery power source, to be connected to either half of the aircraft battery or across the whole aircraft battery for the purpose of trickle charging it. A dropping resistance was required to bring the charging current down to the 5 amps required to Ultra Rapid charge each set of four VRO5AA cells. Four strands of electric fire element were twisted together to make one. It can get very hot as it dissipates about 35 watts, and should be mounted so that it cannot burn anything.

Having just finished the charging arrangements, I packed up the model and flying gear early one Sunday evening and headed for Epsom Downs once more. I checked the model and then I was ready to launch. All clear on yellow, switch everything on and launch. Model dips a bit, then appears to maintain height. I apply rudder to bring it back before it lands, obviously no great improvement on previous flights. Suddenly I realised it was gaining height. By the time it passed overhead it was 30 ft. up and climbing. Then followed a couple of minutes of slow but steady climb. The only other engine running at that time cut out and all that could be heard was a whispering beat of the twin electric motors. The model landed after 6 or 7 minutes and was promptly recharged again for another two minutes. This time clubmate Brian Faithful was on hand with the camera. Once again it was airborne for several minutes. I have had a lot of enjoyment out of the last 23 years of continuous aeromodelling, but these couple of flights were among the best moments.

What comes next? Well, obviously there are more improvements to be made and I am still both flying and experimenting with electric model aircraft at the time of writing. The simple graph and table, Fig. 8A and B illustrate the results obtained so far, using the successful twin motor model. Observe that the table gives the initial peak thrust only. Although it would

Pic. 7



Author P. Bragg flying twin-motor electric powered R/C model.

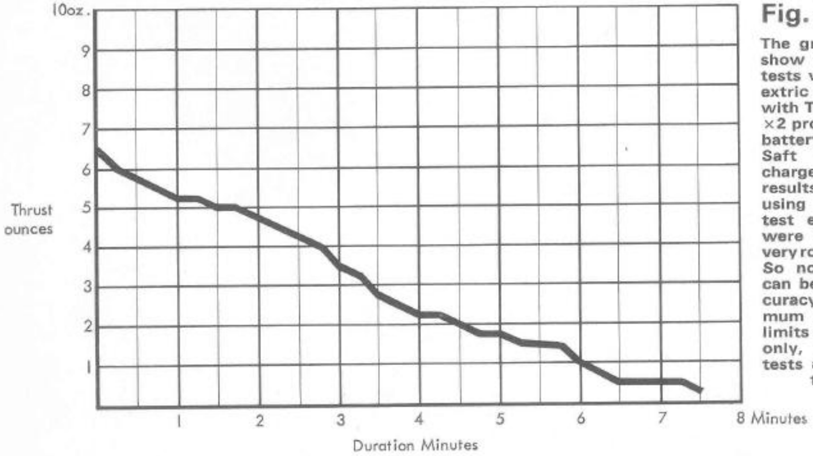


Fig. 8A

The graph and table show the results of tests with two Scalextric motors fitted with Thimbledrom 4½ ×2 props and run off battery packs using Saft VRO5AA rechargeable cells. The results were obtained using very limited test equipment and were intended as a very rough guide only. So no great claims can be made for accuracy. Aircraft maximum all-up weight limits are theoretical only, but practical tests appear to bear them out.

appear that the 9·6 volt/twin motor combination would fly a 26 oz. model, reference to the graph will show that this would produce only a short flight. The 20 oz. model will produce a six minute plus flight, but obviously the first couple of minutes are the most effective, output after that merely assists the glide. As far as motors are concerned, the twin Scalextric motors came from Proops of Tottenham Court Road, London. They are obviously second hand slot car types and I hand picked a few as some looked a bit ropey. However all those I have used have given the same results with no modifications, special matching or rewinding necessary before flying them. I feel sure that there are other motors that can be used. The slot car types are probably the best choice. Some may cost more or require rewinding but may even produce better results. Some time I might try some. The real breakthrough is the batteries. Saft were very helpful with information and deliver promptly, but they will not deal with orders under £10 at the moment.

Electric powered model aircraft have a long way to go yet, but offer plenty of opportunities to those who enjoy experimenting with something different. Their development so far, might be compared with the early gas models. At the moment it is a question of design plus a search for suitable motors which can use the batteries available now to the greatest advantage. With restricted time and little in the way of test instruments, it is difficult to compare performance with conventional IC motors, but from experience the performance of the model described suggests an initial power thrust equivalent to my old Mills 75. Of course this is with power unit(s) weighing 10 oz. and delivering a slowly declining thrust output, like that of a rubber model.

Perhaps before long, we will see better batteries. Research is already intensifying in that direction. With the growing concern about the worlds dwindling resources and pollution problems, the development of electric storage batteries will become a priority. Aviation has always been based on oil fuels. It is an interesting thought that the electric powered model aircraft of today, like so many products of this particular hobby may be the forerunners of the air transport of the future.

BATTERY PACK VR05AA CELLS	NOMINAL VOLTAGE	INITIAL PEAK CURRENT AMPS	INITIAL PEAK THRUST OZ.	2 MOTORS + BATTERY PACK WEIGHT OZ.	AIRCRAFT MAXIMUM ALL UP WEIGHT LIMIT. OZ.
2	2.4	1.7	3/4	5	3
3	3.6	2.7	2	5.3/4	8
4	4.8	3.7	2.3/4	6.1/2	11
5	6.0	4.7	4	7.1/2	16
6	7.2	5.7	4.3/4	8.1/2	19
7	8.4	6.6	5.1/2	9.1/4	22
8*	9.6	7.3	6.1/2	10	26

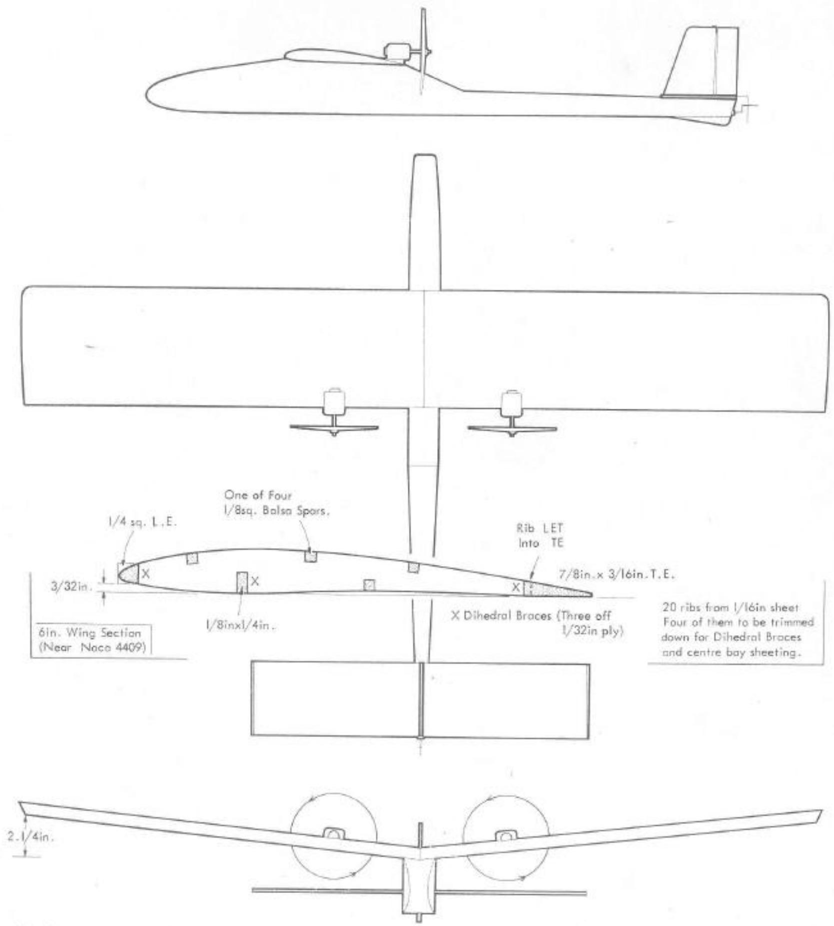
Fig. 8B

* SEE GRAPH ABOVE

Proton

42 in. span electric
powered R/C model
BY PETER BRAGG

Scale 1:10



TWIN-ENGINED MODELS

By Francis Plessier

IN this article, I should like to discuss some of the problems encountered in radio controlled twin-engined aircraft. I use the term 'twin-engined' in the conventional sense, rather than to describe 'in-tandem' types such as the Matra-Moynet, Do335, Cessna 337 etc., in which the problems are less difficult to resolve.

Why twin-engined? In larger full size aircraft, one is forced to employ more than one engine, not only for safety and reliability reasons, but also in order to have more power available. This doesn't apply where the total cylinder capacity is limited to 10 c.c.:—two 5 c.c. engines will together create new problems, while developing no more power than one 10 c.c. unit.

There are two good reasons however, for indulging in twins: first, to be different from everybody else, and secondly where the model must look authentic. Radio controlled twins are very spectacular: the noise is unforgettable, while it is a thrilling enterprise getting them to fly, in view of the numerous difficulties. These are reviewed here, with remedies where possible.

Vibration

This is the first problem, since the engines in a twin are fixed to the wings, where structure is lighter and less rigid than the average fuselage. Vibration is then less dampened and the whole wing forms a 'resonance box'. With two motors turning at even slightly different speeds, the combined vibration (fluttering) can reach considerable amplitude. While a two-cylinder engine vibrates less than a large single cylinder, two engines vibrate more than one by itself.

It is essential to use all available means to overcome that destructive vibration. This begins with the choice of engines; some vibrate more than others. Balanced wooden propellers must be used; unbalanced spinners should be avoided. Engine-mounts must be sufficiently heavy and strongly reinforced with glass-fibre, and should be built well into the wing using many stiffeners. Best results are obtained if the wing itself is a core of expanded polystyrene skinned with balsa, rather than of conventional construction, which though light, is more subject to vibration. In addition, great care must be taken in the installation of radio equipment to avoid damage—mounting servos, receiver and cut-out switches in foam rubber. All wires, connectors etc. should be protected flexible material, and insulated with plastic foam, thereby eliminating the possibility of breaking of a wire due to vibration.

Asymmetric Power

Sooner or later, one engine is going to stop in flight, but this need not necessarily result in disaster. We need to analyse what is happening under asymmetric power.

Both performance and flight characteristics are affected at once. From the point of view of performance, loss of half the power means that the aircraft no longer flies level. On our models which are generally somewhat overpowered, there is still enough power from one engine to maintain flight. On the other hand, there are many problems associated with flight characteristics. Suppose the aircraft has just lost an engine—although on two engines it was flying straight, there is immediate loss of traction on, say, the left, plus the drag of the dead engine and its stationary propellor. This sets up a turning moment in the direction of the stopped engine. Fortunately, by a weathercock effect, the drift is able to maintain the aircraft on its course, but produces a strong drag, so the aircraft flies crabwise. This is not awkward in itself, but as in general an aircraft has dihedral, the drag is translated into a roll, and the aircraft tries to incline itself towards the stopped engine. This effect is aggravated by the loss of lift brought about by reduced airflow over the wing on account of the stopped propellor. This is very serious, as the wing drops, and the aircraft gets out of control, spelling disaster at low altitude.

Fig. 2

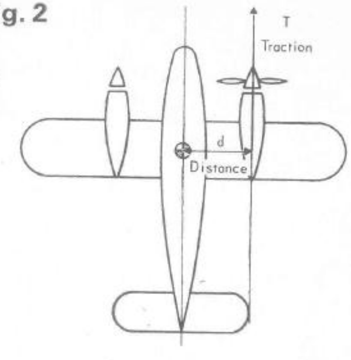
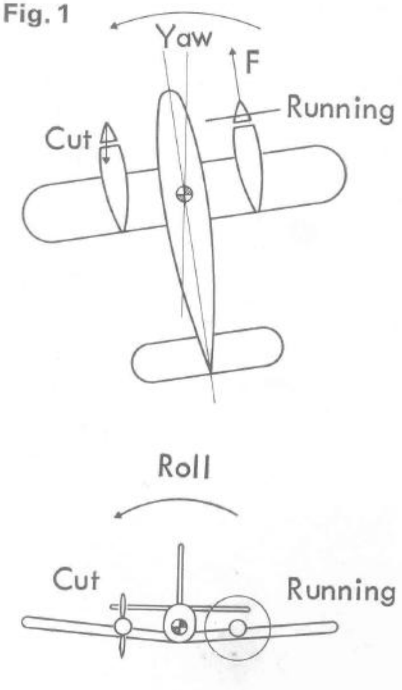


Fig. 1



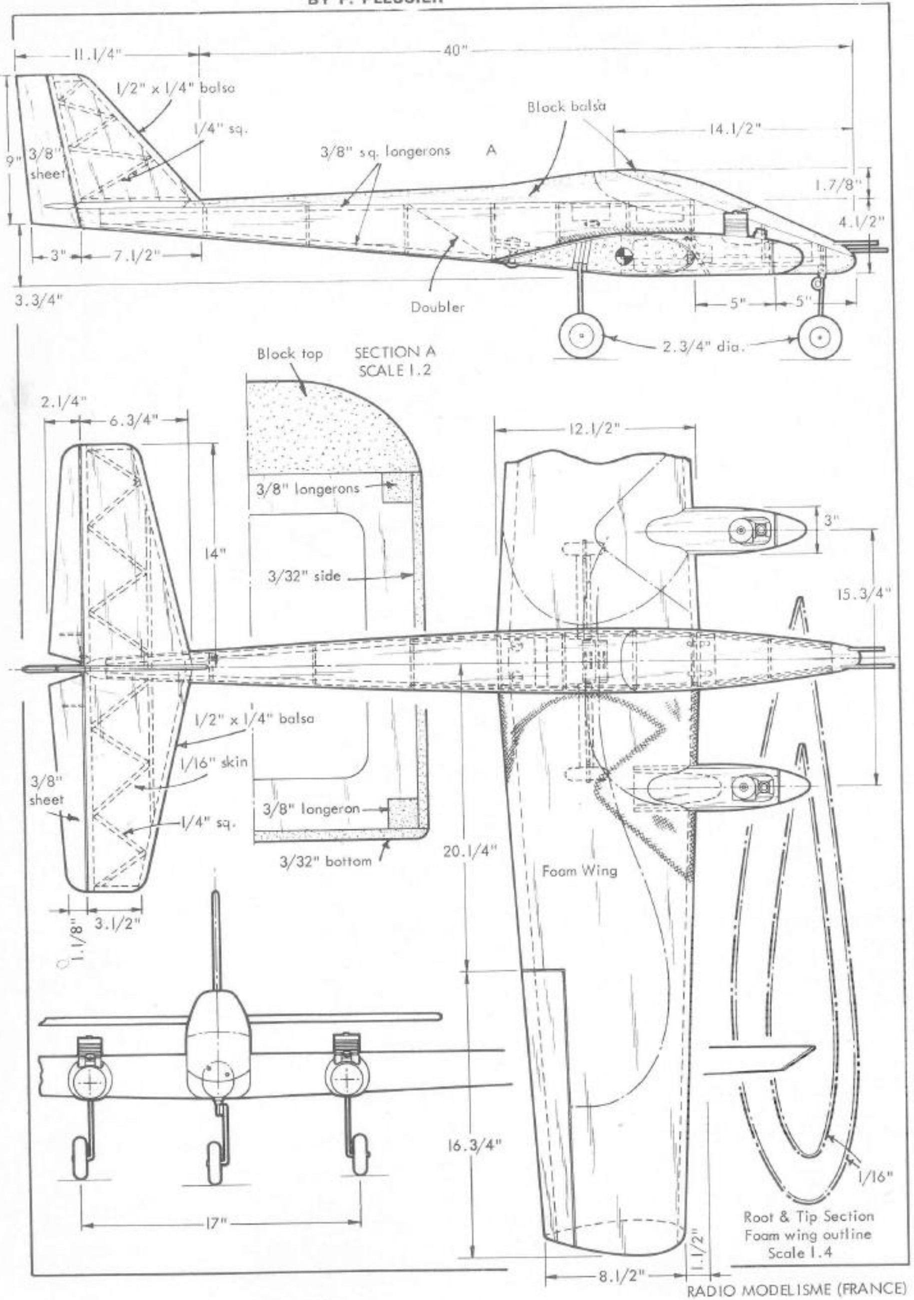
It is important to appreciate that the turning moment, calculated on the product of thrust X distance from the centre of gravity, is inversely proportional to speed, or decreases with increase in speed, since the power output of the motor is constant. On the contrary, aerodynamic effects of the rudder and aileron tail off strongly with speed, and the controls become lighter. It is therefore easy to understand how the asymmetry can be readily corrected at high speed, but becomes more and more serious as speed is reduced. There comes a moment when it is no longer possible to maintain control of the aircraft. This corresponds to the minimum controllable speed which every twin-engine pilot must know exactly, for if his airspeed on one engine drops below this, he is as good as dead. This kind of accident was frequent on 'bad' twins, but every effort has been made to reduce the critical airspeed as much as possible. The problem is solved if this can be brought below stalling speed, in which case control can always be main-

Cougar

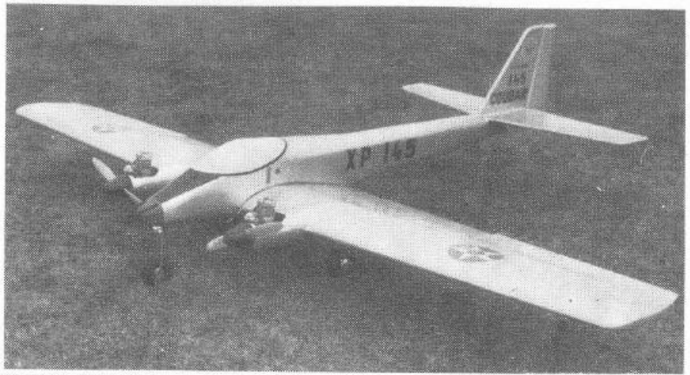
Twin-engined aerobatic R/C model for two 5 c.c. motors.

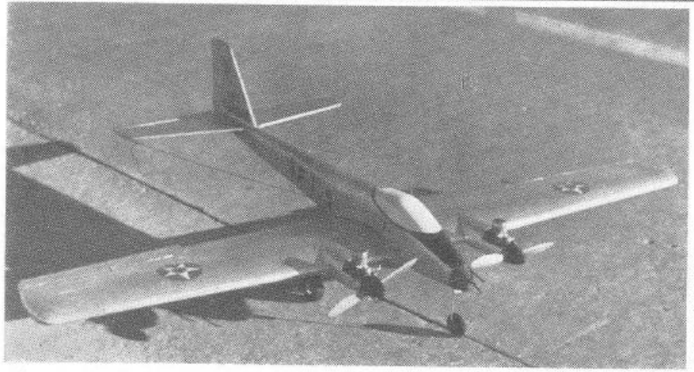
BY F. PLESSIER

Scale 1:12



RADIO MODELISME (FRANCE)





Two views of Francis Plessier's 'Cougar' twin-engined R/C sports model. Offers good aerobatic performance. Note the engine nacelles, placed close to centre line.

tained. Flying technique is the same on single engined models—it is worth recapping; on only one engine, keep an eye on speed at all costs.

Given sufficient speed therefore, the aircraft will fly on one engine. It is necessary to trim the rudder to correct the drag, and similarly to apply opposite aileron, to prevent loss of control. The trim controls can be sufficient for this, the plane flying crabwise, tilted slightly on the side of the good engine.

Improvements

An obvious way to reduce the asymmetric effect is to reduce the turning moment. Orientation of the motor axes outwards has practically no effect, as the axis/C.G. distance remains virtually constant. The motor axes should be made as close to the fuselage as possible, necessitating small or three-bladed propellers. There are also various full size aircraft designs, with the engines aft mounted on the tailplane, oriented towards the centre of gravity (Fig. 3), or after the fashion of a 'canard', with engines on a forward fixed plane (Fig. 4).

Retaining a conventional design, two factors are favourable; increase the yaw by giving the rudder a generous surface, with good leverage; this reduces drag by increasing the weathervane effect.

The alternative solution consists of reducing, and if possible eliminating, the dihedral effect (induced roll), by avoiding high wing with considerable dihedral. The ideal is a low wing aircraft with practically no dihedral, which in spite of drag, will fly crabwise without losing control. For the drag

Fig. 3

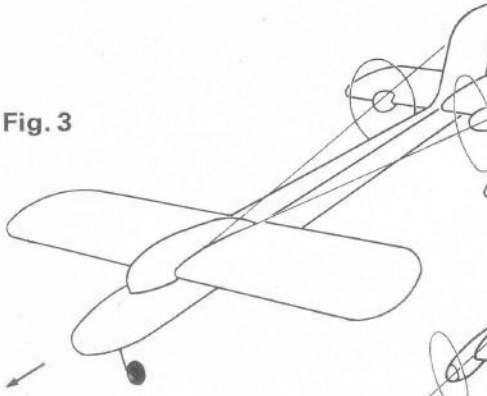
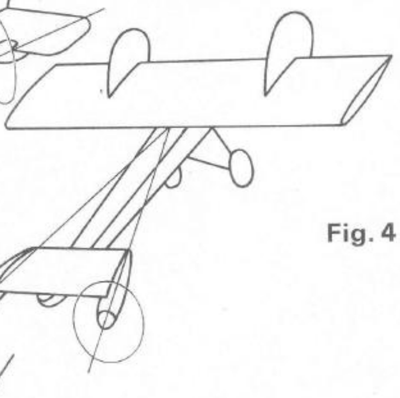


Fig. 4



not to be serious it is most important for the model to have no tendency to stall viciously, which dictates thick wings, well-rounded leading edges, with if possible slight washout at the wing tips.

Absence of induced roll implies an ineffective rudder: rudder application will make the aircraft crab, but that's all. Aileron control is essential, but the rudder is useful for taxiing and for reducing drag in case of a stalled engine. These then are the broad guidelines for twin design, which exclude almost all exact replicas of actual prototypes, with their strong risk of being dangerous on one engine. It would be better to come to terms with the problems of a functional model before embarking on a scale model.

As for the examples presently on the market, there are very few. Several, like the Lockheed P.38 Lightning and others are very difficult to get to fly. Then there is the Skylark, by Goldberg. This is a training aeroplane, of low wing available in various versions, single or twin-engined, steered by rudder or aileron. This kind of compromise intended to satisfy everybody can only result in a problem in that there is effectively too much dihedral, whence come difficulties on one engine. I have one flying on two Cox 1·5 c.c. Medallion engines but it is extremely dicey on one engine (especially as it is equipped with an old non-proportional radio system.)

Choice of Engine

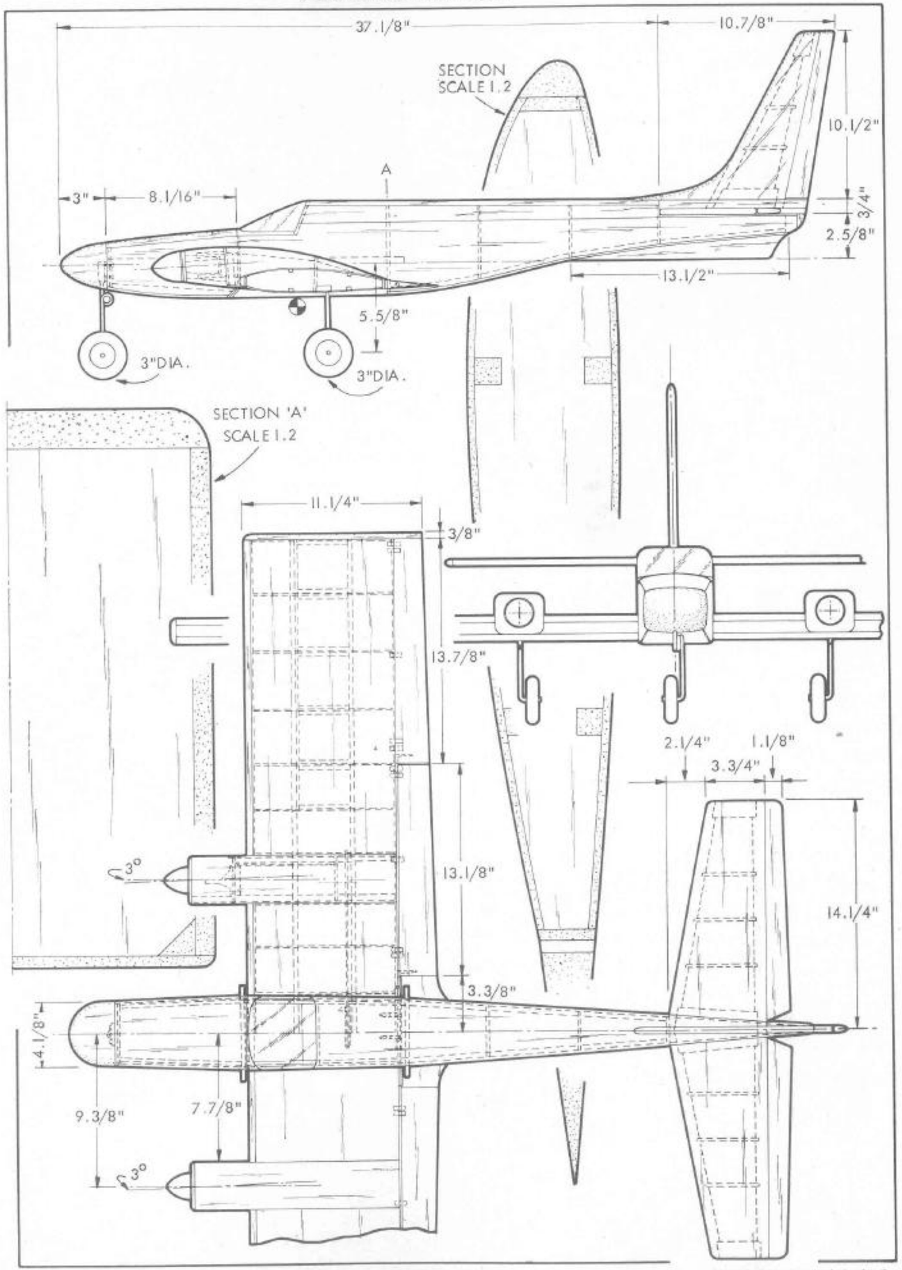
This is very critical as it dictates the final size of the model, which is itself dependent on the rise of the radio equipment. Using a conventional modern proportional system, it is difficult to produce an aircraft of less than 60″ span and weighing less than 5½ lb. particularly with the extra weight of two engine nacelles. Total power should be at least that of a ·40, either two ·19 cu. in. or two ·23 cu. in. motors. Few good radio controlled engines of medium power exist, and in practice, as one needs a reliable, smooth running, powerful, vibrationless engine, one is led to choose two Super Tigre ·23 (4 c.c.) or two OS ·25 or OS ·30's then reaching the upper legal limit of engine capacity.

With two Super Tigre ·23's an aircraft of about 60″ to 63″ span is possible, weighing 5½ lb., if possible, definitely preferable to the Cougar, which has Taurus dimensions, 69″ span, weighing 7¾ lb., powered by two S.T. ·40, which is overpowered, and can manage aerobatics on one engine.

Twin Hunter

Twin engined sports R/C model for two 5 c.c. motors from Japan

Scale 1:12



R/C TECHNIQUE (JAPAN)

PARACHUTERIES!

A novel and spectacular application for radio control from France

WHY not try, for a change, to get off the beaten track, and make fuller use of the enormous possibilities of radio control, so frequently limited by routine. This is the intention of this article, focusing on research by D. Crevelli, a modeller from the early days who has always been interested in the out-of-the-ordinary model experiment.

Dropping miniature parachutes is nothing new. D. Crevelli began his efforts in 1947, when control-line was still in its infancy. A small tissue paper parachute was folded into a streamlined balsa container placed under the fuselage. A third wire controlled the release. This device worked very well, but the low altitude did not allow spectacular drops.

Attempts were restarted in 1966 at Montesson, France, this time making use of the possibilities of radio control. The contrivance consisted of a parachute 36″ in diameter, with cotton shroud—lines sewn onto the edge of the twine with adhesive tape reinforcement. The parachutist was an expanded polystyrene figure about 25 cm. tall, complete with pack and harness.

The whole assembly was fastened under the fuselage with an elastic band, which was released by the throttle servo. This works very well, giving effective descents.

This very simple release mechanism can be adapted for any equipment provided with a throttle function. A special servo is unnecessary since parachute release follows throttling back.

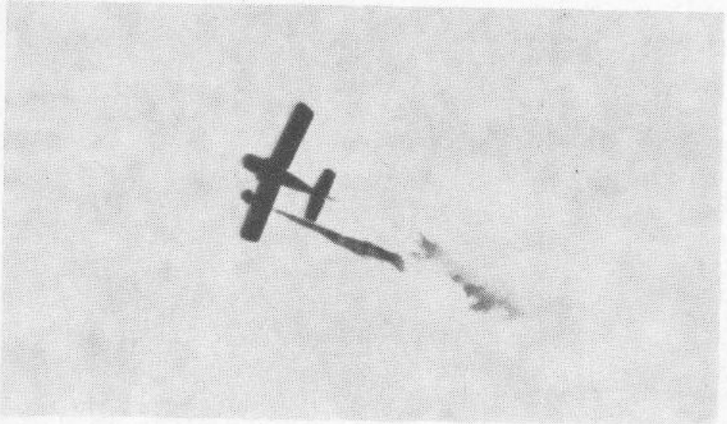
The author has even succeeded in releasing two parachutes tied together, though opening is still automatic. It is very tempting to progress to a stage of greater evolution, and to practise delayed opening.

To do this, a home made time-switch arrangement, housed in a balsa container built into the underside of the fuselage is triggered off at the time of separation, and commands the opening of the parachute after a fixed interval of 6 seconds. On the first attempt, release was affected too low—the dummy parachutist hit the ground before the delay could operate. Fortunately, damage was limited, and repair speedy.

At the second attempt, the model was released very high, with a strong wind blowing. The parachutist jumped over the River Seine, and after free fall, fixed this time at three seconds, the 'chute opened but failed to descend. Instead it flew downwind at high altitude and disappeared over the horizon.

The equipment was not recovered, but the results were conclusive, and prompted a follow-up experiment using, this time, radio control of the descent stage. A new parachute 38″

'Greco' the intrepid birdman! Carved figure 'parachutist' easily accommodates single function R/C gear, removable pack for which is seen installed top left. On/off switch arrangement seen at left and parachute pack below.



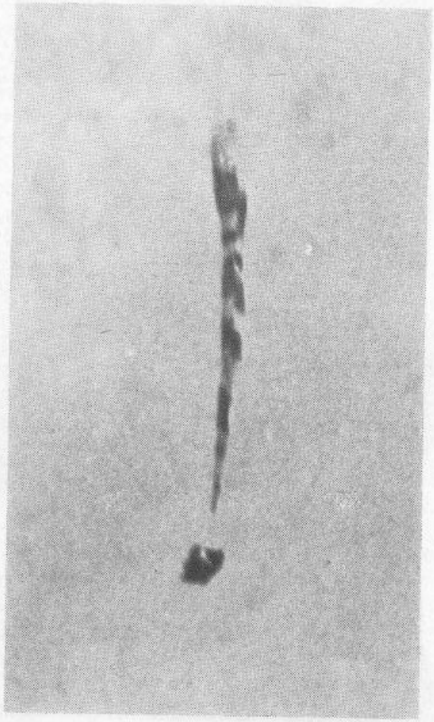
1

Left: parachutist at moment of release from carrier model.

The drop sequence!

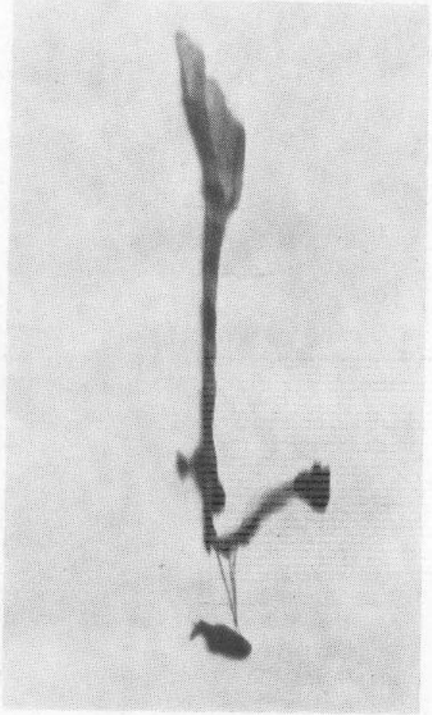
Below: parachutist in free fall after transition to vertical descent.

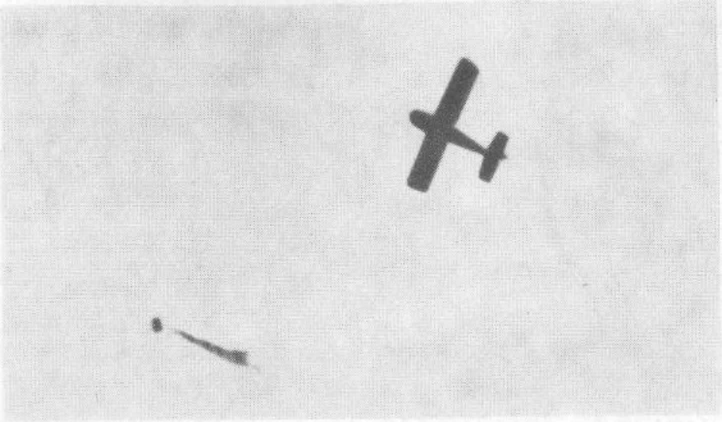
3



Below: parachutist at moment of deployment of the parachutes.

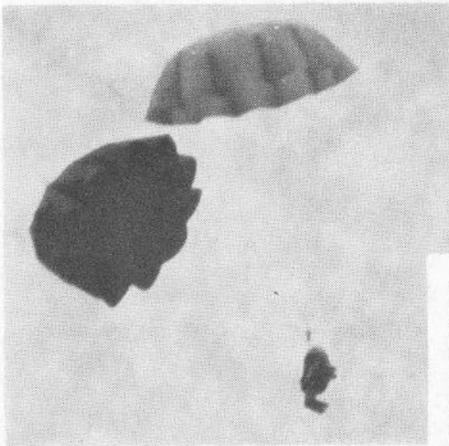
4





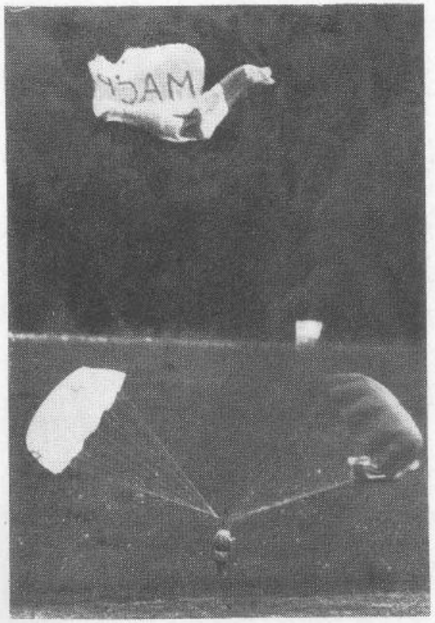
2

Right: parachutist falls free from aircraft with streamer visible.



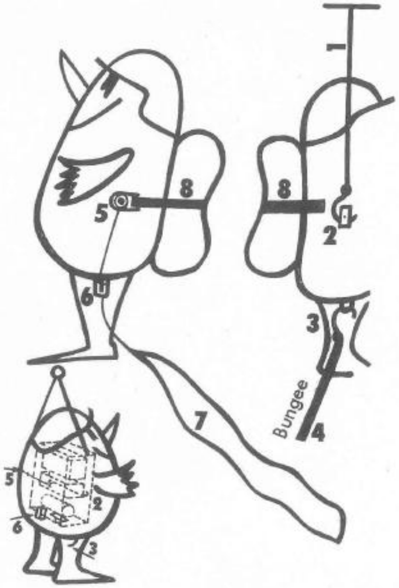
5

Above: parachutist in descent with three parachutes deployed.



Right: Moment of impact as one of the 'chutes' is released.

6



Mode of action of the parachutist

With the servo centred, movement of the servo drive arm first one way, then the other, enables two successive operations to take place in sequence: the lock (2) pushed by the servo, releases rod (1). The rubber band stretched between (3) and (4) extracts the parachutist (or cargo) from the hold of the model and the rubber band is lost in the process.

The streamer (7) unrolls itself immediately on exiting the model and aids visibility. The rod can then be returned to its centred position.

When the rod is pulled, needle (5) first disengages the thread retainer hook (6) which releases the streamer (7), THEN releases the strap (8) retaining the parachute.

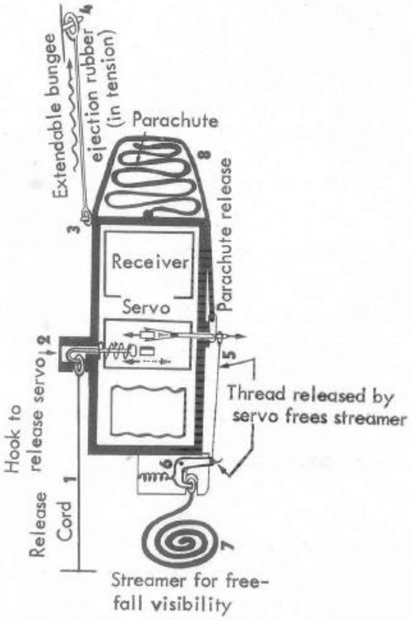
Although this sequence is described for use with a linear output servo, a rotary drive servo may be used.

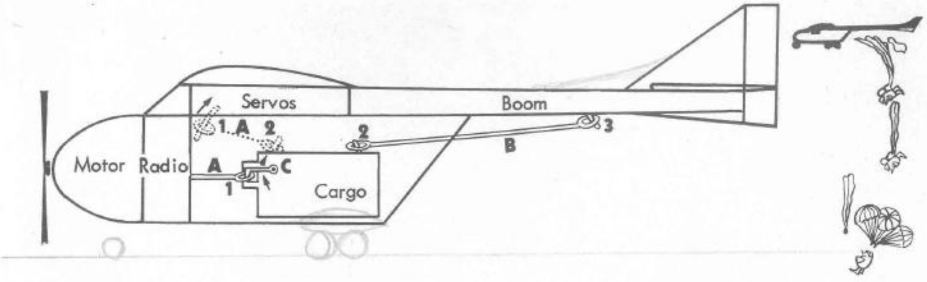
Operation

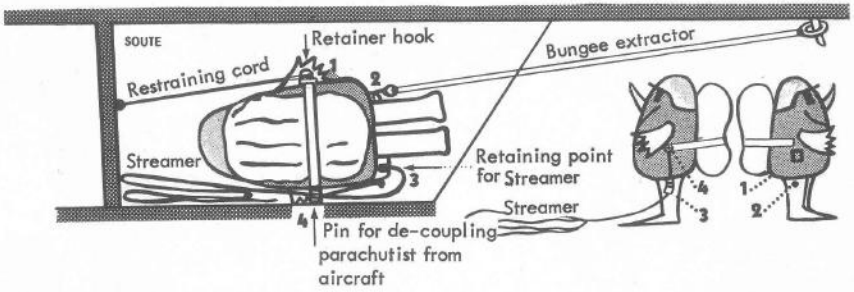
Push: the lock (2) pushed by the servo, releases rod (1). The rubber tensioner stretched between 3 and 4 extracts the parachutist from the hold of the carrier aircraft and is lost in the process (must be replaced for each ejection).

The streamer (7) unrolls immediately the parachutist exits from the aircraft and aids visibility during the free fall period.

Pull: Needle (5) first engages the thread retainer hook (6), which releases the streamer (7). THEN releases the strap (8) retaining the parachute.



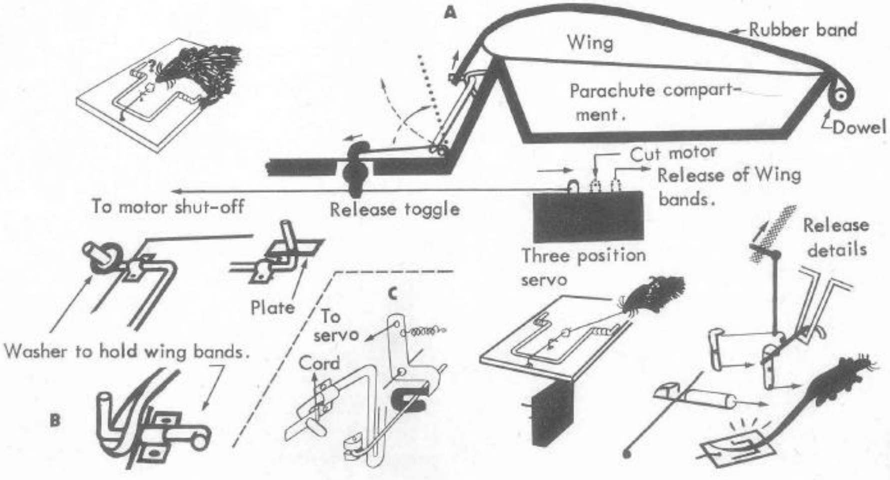


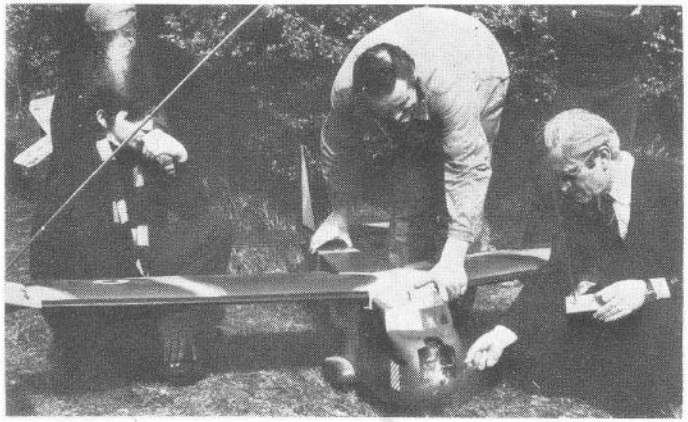


EXIT OF CARGO FROM HOLD (top diagram)
When dotted ring (1) is released by carrier aircraft pilot from anchor point, bungee (B) extracts load from hold (rings 2 and 3 come off their pegs) and the bungee is lost.

For release of cargo by its own radio link, solid line rubber restrainer (A) is released by hook (C), followed by extraction of load by bungee (B).

DISINTEGRATING AEROPLANE SEQUENCE
(A) Principle of wing-release mechanism.
(B) Detail of lever retaining wing.
(C) Detail of complete release mechanism.





The big Carrier 'transport' aircraft is prepared for flight.

in diameter was made out of spinnaker material thus producing lift far superior to its predecessor. It weighed $8\frac{1}{2}$ oz.

In any case, the preceding tests had shown that the time release only allowed a risky result; only radio control would allow any sort of precision. The figure was made of expanded polystyrene, with flexible plastic limbs. An *Airlite 6* receiver was housed in the hollowed out body, with a nickel-cadmium cell and a servo ensuring simultaneous release and opening. On the prototype, this was controlled by a separate transmitter working at 72.250 MHz: this independence of release is for two reasons. First, if ejection is in the hands of whoever controls the parachutist, safety is enhanced. Secondly, if the ejection goes well, the radio equipment must be functioning, so the parachute is bound to be released a little later.

Once the parachutist has 'jumped', it only remains to actuate the draw-bar deploying the 'chute, a moment which always gives rise to a certain apprehension. Now that a complete and working parachutist was available, a carrier aircraft was designed for the job by the Author. A large open hold at the back afforded numerous possibilities. For the first attempt at a drop, the 'cargo dummy' was still not ready, so the sky-diver was stowed on a conventional biplane. Take-off and climb were rather difficult, and the aircraft discharged its load at low altitude. The parachute was opened at once, two being deployed immediately in response to the signal, and the apparatus returned to earth safe and sound, proving that the control system was adequate.

The second attempt, with the cargo airborne was entirely successful. On activating the push rod, ejection resulted immediately followed by an impressive free fall. On activating the draw-bar, the two blue and red parachutes opened without a hitch. It works!

To enhance visibility the doll was fitted with a streamer enabling the fall to be seen. Above 300 ft. altitude, a small object 10″ tall is difficult to follow. In addition the slight drag due to the pennant makes the speed of descent more realistic and it has been possible to have more than 25 seconds free fall before opening. It is also possible, by stopping movement of the

lever after releasing the pennant to continue in entirely free fall before 'opening the umbrellas'. In competition 'jumping conditions', the entire weight is $19\frac{1}{2}$ oz. with a 3rd parachute added to slow down descent.

Finally, as a variation, but staying within the realm of parachutes, it has been possible to make a 'disintegrating aircraft'. It consists of a conventional aeroplane on which it is possible to order the engine to stop, and separate wings and fuselage, the latter returning to earth without damage on a large parachute. It remains to recover the wings which have come down slowly by autorotation, to refold the parachute into its container to reassemble the whole and one is ready for another flight-spectacular.

Any high wing aircraft can be adapted for this entertaining manoeuvre; only three important requirements need to be observed.

1. Stopping the motor or slowing it right down.

2. Free release of the wing fastenings.

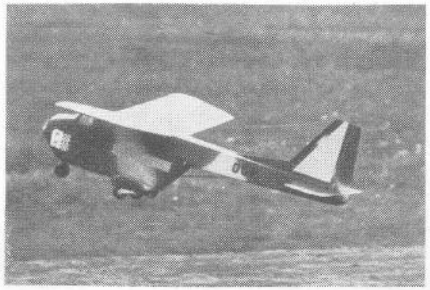
3. Development of a container allowing instantaneous release of the parachute. It is best to avoid deep storage compartments with their problems of disgorging their contents. Better the certainty that the parachute will open immediately. Delayed opening is not out of the question provided altitude is sufficient, but rotation of the fuselage could prejudice deployment of the 'chute and result in violent impact.

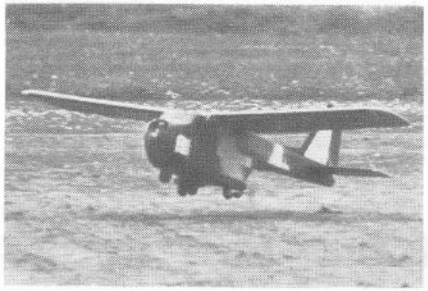
The prototype was made from an old fuselage in which a container of about $6\frac{1}{4}'' \times 7\frac{7}{8}'' \times 2''$ was fitted. The wing was positioned directly above this, held in place by conventional rubber bands.

The parachute was folded and compressed into this compartment and escaped immediately upon release, giving instantaneous deployment of its 1·50 m. diameter. For even greater diversity, one can envisage parachute competition;—duration of free fall (easy to control with the streamer), precision of landing; even group jumps and many more . . .

It should be emphasised cost is low. The author's prototype models were equipped with a proportional receiver only for his personal convenience and a 'Roman Candle' on one attempt resulted only in a broken crystal. Single channel could be made to suffice, although it goes without saying that any equipment used must be of the 'superheterodyne' type, capable of functioning alongside the radio equipment of the transport plane.

Carrier aircraft takes off for a 'drop'. Pod and boom fuselage arrangement well evident here.





A VARIOMETER FOR MODEL USE

By Dave Dyer

To truly thermal-soar one must first find the lift area. At present the most common method of thermal recognition is to sense the pull on the towline during launch, or after launch to study the models disturbance pattern as it flies.

This method is fine for actual lift contact but after a time the model will tend to be pushed away from the lift into surrounding sink and the only time you will probably notice this is after the model has lost a great deal of altitude. If one had a device which actually measured rate of climb/sink then it should be possible to hold a lift area and when in sink to move away.

All sounds idyllic; but this is how thoughts were going at the beginning of 1970. In full size gliding a device called a VARIOMETER is used. Originally of mechanical construction, but more recently electronic, these devices give the pilot a visual readout, in the form of a graduated scale, of rate of climb/sink. An addition to the electronic type is an audio signal which varies in pitch proportional to rate of climb.

From information published in the American magazine *'Flying Models'* a variometer designed for model use was constructed but when tested it was found that it was not sensitive enough for practical use in U.K. type lift, which is usually varying between a sink rate of −2 f.p.s. to say +2 f.p.s. (Obviously one contacts stronger lift here but these are an estimate at the most common rates).

How & Why

The variometer works on the principle that atmospheric pressure reduces with altitude. At ground level pressure is approx. 14·7 lb./sq. in. and at 20,000 ft. approx. 7 lb./sq. in. It should be noted that this reduction is not linear but for our purposes this does not really worry us.

If one has an instrument that will measure rate of change of pressure then it is apparent that this information can be interpreted as rate of change of height. Consider a volume of air in a bottle. In the end of the bottle is a pinhole. At rest, at ground level, the pressure of the air outside will be the same as the pressure inside. Now move the bottle vertically 10 feet and stop. Because the external air pressure has now fallen, air will flow out of the bottle in order to maintain equilibrium. The converse will of course apply if the bottle is moved down again. To use this information we detect this very small airflow moving through the pinhole by means of a pair of thermistors mounted in a fine bore tube which is attached to the bottle as in fig. 1, the two thermistors are then connected into a D.C. bridge as in fig. 2.

Fig. 1

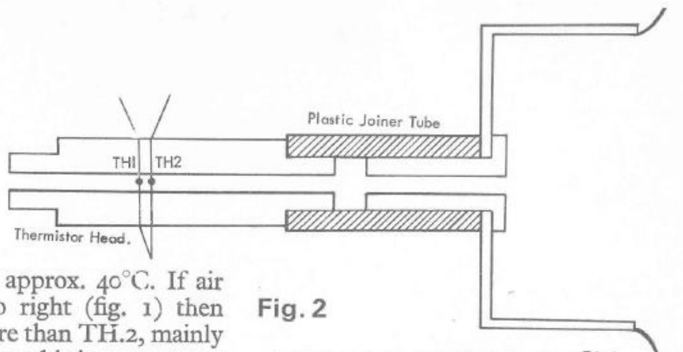
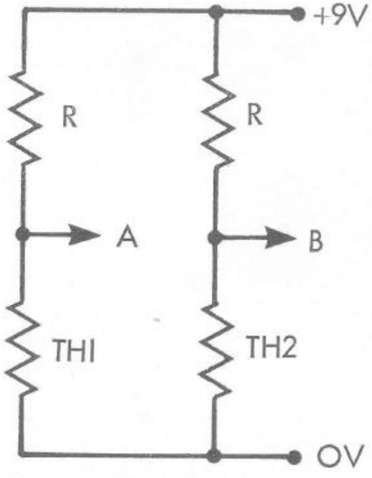


Fig. 2



Thermistors are temperature sensitive resistors which usually have a negative temperature coefficient i.e. heat them up and the resistance goes down. By adjusting the value of the fixed resistor in series with each thermistor, the ambient temperature of the thermistors (due to the self heating) is set in this case at approx. 40°C. If air flows from left to right (fig. 1) then TH.1 will cool more than TH.2, mainly due to shadow effect, this in turn causes an increase in the resistance of TH.1 which will tend to make the voltage measured at A more positive than the voltage measured at B (fig. 2). Conversely, air moving right to left along the tube will cause the voltage at B to be more positive than that at A. It will be seen that this effect is also proportional i.e. the higher the airflow speed the greater will be the voltage excursion.

We now have a d.c. voltage proportional to rate of change of height. This voltage is amplified in a differential d.c. amp. to provide a larger voltage swing and is then fed into a voltage controlled oscillator i.e. the frequency of its output is proportional to the d.c. input voltage signal. (Fig. 3).

Theory Applied

As mentioned earlier the system constructed originally was not as sensitive as desired, to even bring it to an acceptable level a 300 c.c. bottle was required. This obviously being too big, a smaller bottle with a max. volume of 150 c.c. would have to be used to fit into our current breed of models.

To increase the sensitivity a new detector head with a smaller bore was constructed by Geoff. Dallimer and the tiny thermistors (20 thou diameter, 2 thou leads) mounted inside. I should mention here that whilst it is possible to make these assemblies on the kitchen table it helps enormously to work under a microscope!

The original differential amplifier was replaced by an integrated circuit operational amplifier which enabled us to use a higher gain, also the voltage controlled oscillator was changed to a simple multivibrator for no good reason at all! A variable resistor RV.1 was also added to enable the output frequency to be pre-set under static conditions. We had now arrived at a suitable detector system, all we needed now was a means of conveying the information from the model to ground level!

Various systems of flags/streamers and audio transmission were considered but finally discarded as impractical for weight or drag reasons—

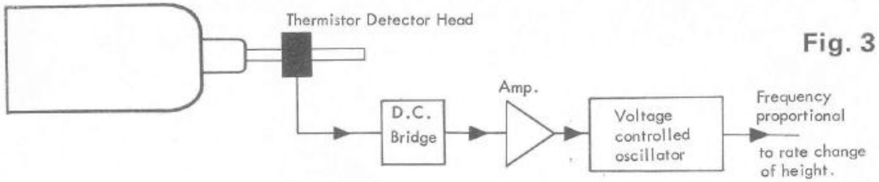
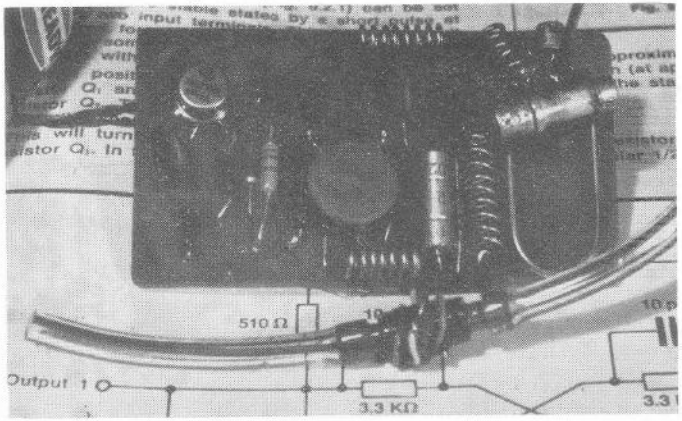


Fig. 3

they would probably have reduced overall performance! It seemed the only practical solution was an R.F. link. Experiments were conducted using a low power Tx. at the extreme opposite end of the 27 MHz band to that of the control Tx. This idea seemed to have possibilities but was ultimately discarded because of glitching problems at extreme range. Another obviously important point was that using two frequencies would have been rather anti-social and in fact would definitely preclude competitive use of the unit. An interesting method of using 27 mHz would be to use the same frequency for telemetering as that of the control system. This can be done by switching a telemetering Tx. on and the control Rx. off and transmitting a short frame of digital information during the normal sync pause. Similarly the ground Tx. is switched off during this period. This idea has definite possibilities but obviously requires a fair amount of development—maybe someday! Anyway the only avenue left seemed to be to try and utilise the 459 MHz control band. A search for information on low power UHF Tx.'s yielded very little but eventually a simple oscillator was found to work extremely well (see fig. 4).

To keep the airborne package simple and thus its weight low it was decided to use as sensitive an Rx. as possible. The obvious choice here was a superregen unit, it was found that transistor units did not give very good sensitivity and in fact far superior results were obtained with a Rx. built with a Nuvistor (see Fig. 5). This system was duly built up and mounted into a suitable box along with an audio amplifier and loudspeaker. Tests showed we had about ¼ mile range which seemed to be adequate. Geoff undertook to package the Tx. and detector unit and came up with the excellent idea of the ship in a bottle principle (see photo). This gave us an integrated unit which only required a small 9v. battery and switch extra. As can be seen from the photographs the



Variometer transmitter component board, complete and ready for installation in purpose made container to be built into model.

Fig. 5 receiver theoretical circuit

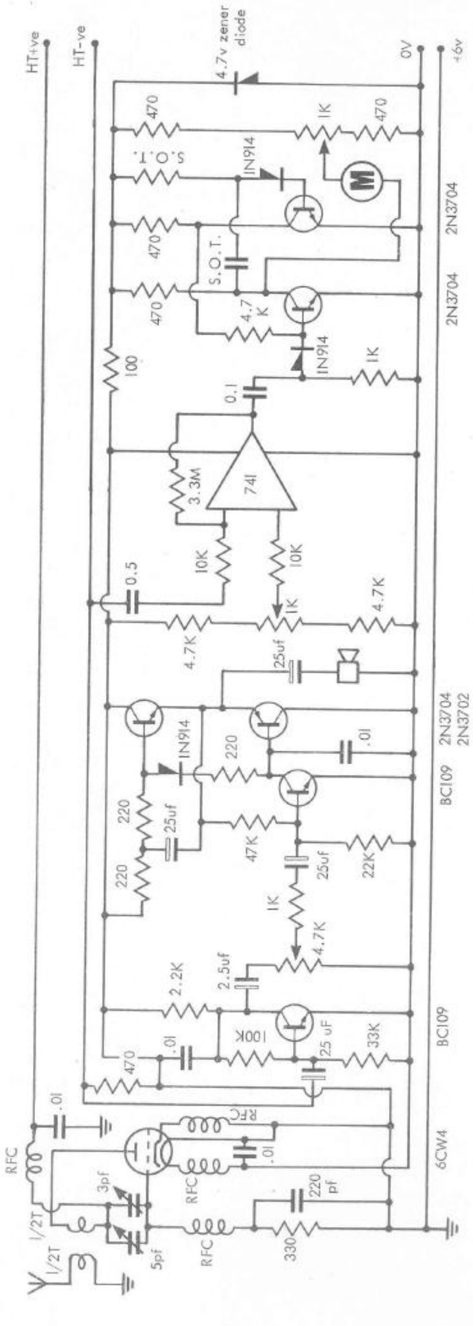
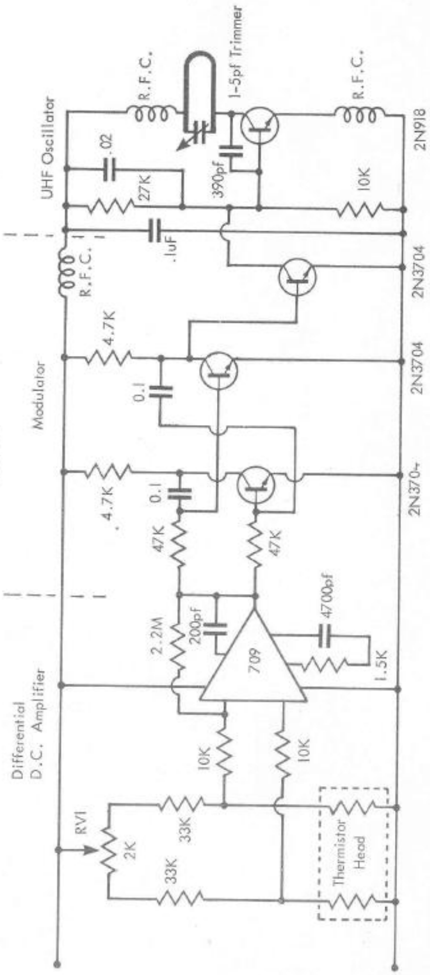
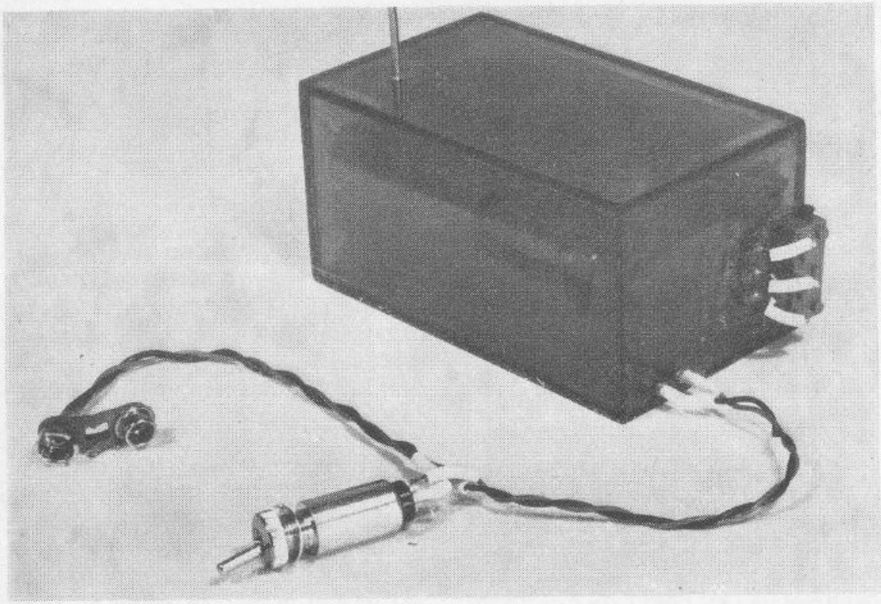


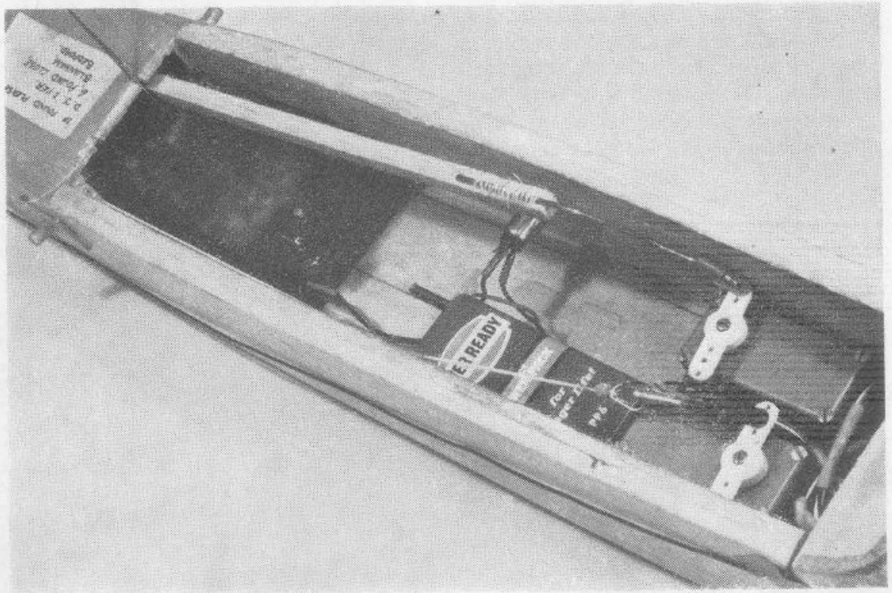
Fig. 4 transmitter theoretical circuit





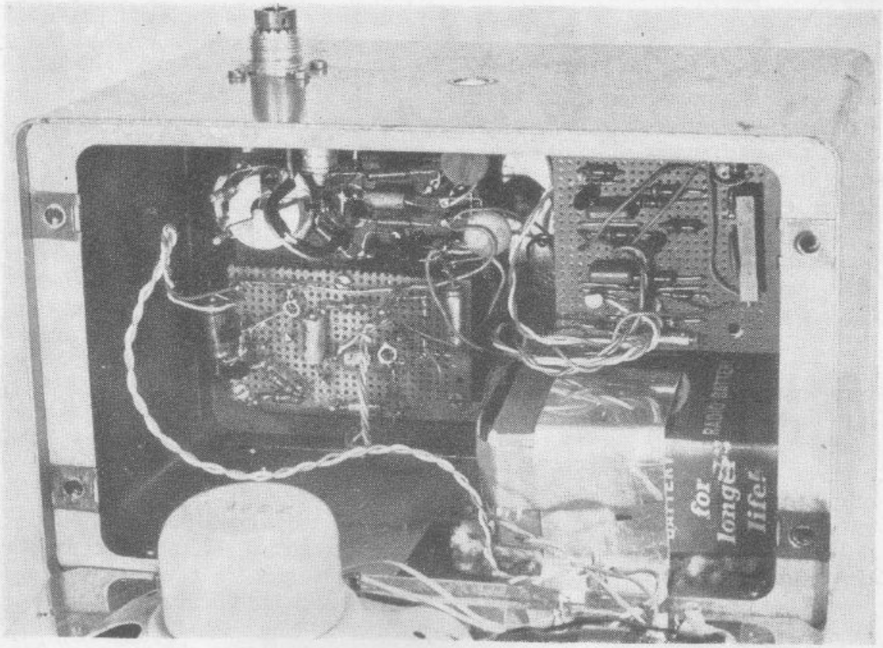
Above: The complete Variometer in made-to-measure container ready for installation in thermal soarer. Note the vertical aerial, battery leads and on/off switch.

Below: Variometer installed in model at rear of radio installation bay. Piano wire aerial stands vertical (extra drag?)



The receiver—a professional looking job in instrument case. Finished job looks very technical.

Below: rear case cover of ground based receiver removed to reveal circuit construction on Vero-board.



¼ wave aerial (made from 16 s.w.g.) is fixed directly into the box and by placing the box at the rear of the wing cut-out the aerial protrudes just behind the wing. This unit came out at 3 oz. and along with the 9v. battery made for a very light airborne package which was even suitable to fit into our *Tri-Tri* and *Thermal Rider* designs.

To enable a zero sink reference to be given when the model was in a normal flight path a frequency discriminator was added to the Rx. and this enabled a meter readout of rate of climb to be used, before flight the meter is zeroed out with the model static. The only disadvantage with this system is that a further helper is required to occasionally read out climb or sink rates, perhaps a head up display or a meter attached to the Tx. would be the answer here! When the Tx was mounted in a model it was found that moving piano wire pushrods adjacent to the unit caused tuning problems, this was cured by substitution with non conductive nyrods.

Flying

A small amount of test flying of the unit has been undertaken. When first used, the variometer did not seem a great deal of help because the system sensed each disturbance in the flight pattern of the model and as a consequence the audio note varied in pitch continuously which, to say the least, was confusing! To alleviate the problem, a damping venturi was introduced into the detector head. This is a very small bore (2-3 thou) restriction in the end of the tube from the thermistor to the outside air. The restriction has the effect of slowing the rate of change of air flow through the tube and thus damping or smoothing the output signal.

A disadvantage of the vario presented here is its inability to compensate for flying speed variations. Because of this problem it is necessary to fly as smoothly as possible (in itself not a bad thing!) in order to keep the errors to a minimum. Consider a model flying undisturbed on its flight path with no lift or sink. Application of elevator control will vary the model's apparent sink rate because of the climb/dive initiated. In full size Varios a total energy unit is introduced which in fact necessitates a pitot head which when considered is rather a complicated addition for model use.

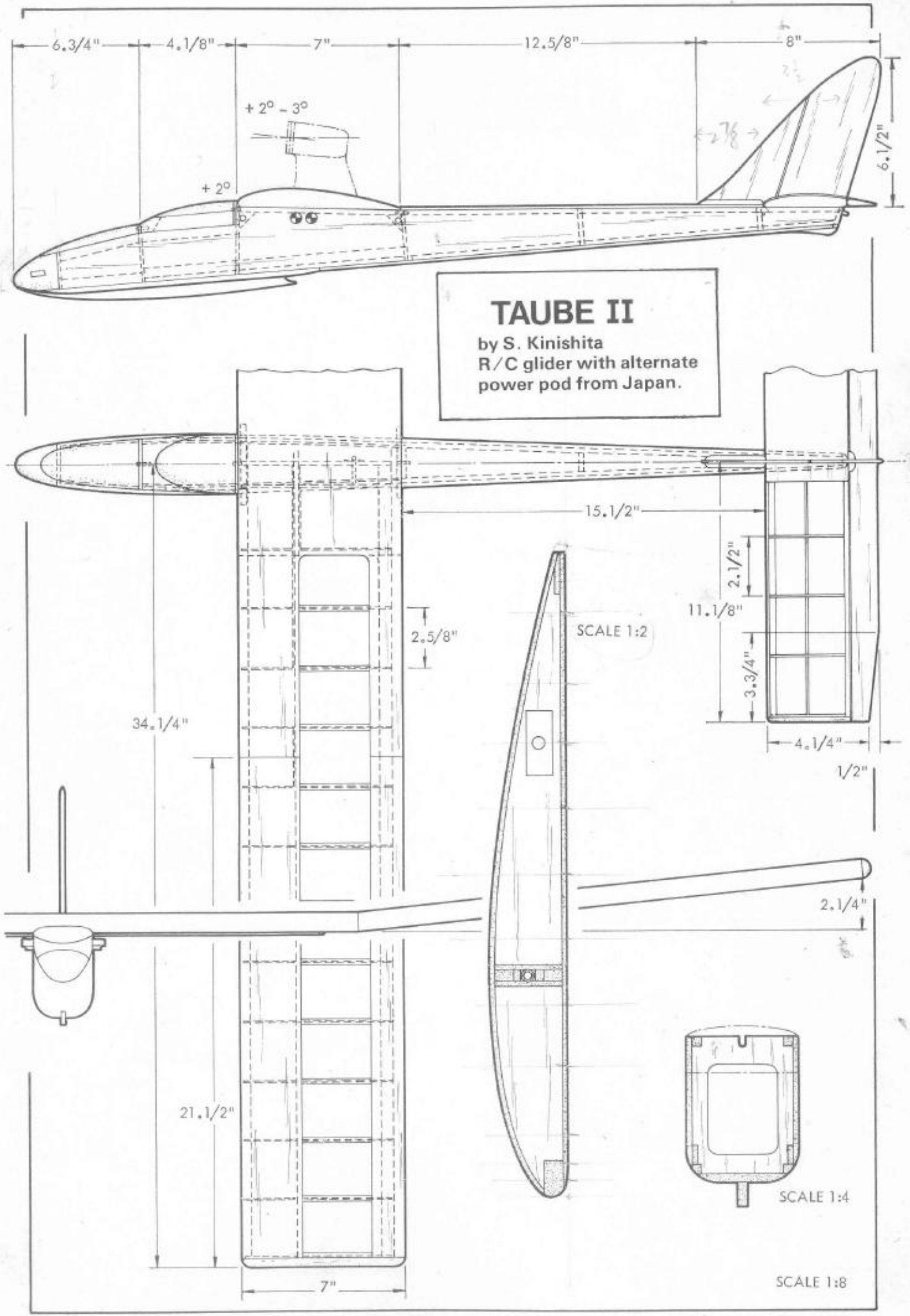
With the Vario it should now be possible to fly a more highly loaded model which will have better penetration and thus the pilot will be able to use the more ideal flight pattern of circling up in lift and moving with that lift downwind, subsequently penetrating back upwind to contact further good air. It should also be possible to identify lift/sink conditions and thus vary the models flying speed to suit.

To decide whether the Vario has any real practical effect it will be necessary to analyse a large sample of flight times both with and without the Vario operational.

It should be appreciated that whilst developing the system described, we corresponded with the Ministry of Post & Telecommunications as to its legality when used under the existing model control licence regulations. After lengthy exchanges it was concluded that whilst the present licence does not exactly preclude airborne transmission, it does not specifically permit it either!

Because of this development, we ceased to use the unit and obviously, before any more work is carried out, further investigation into licensing will be necessary.

It should also be appreciated that the system is presented here primarily as interest material for the experimenter and is not intended as a constructional article, since the circuits are capable of further development.



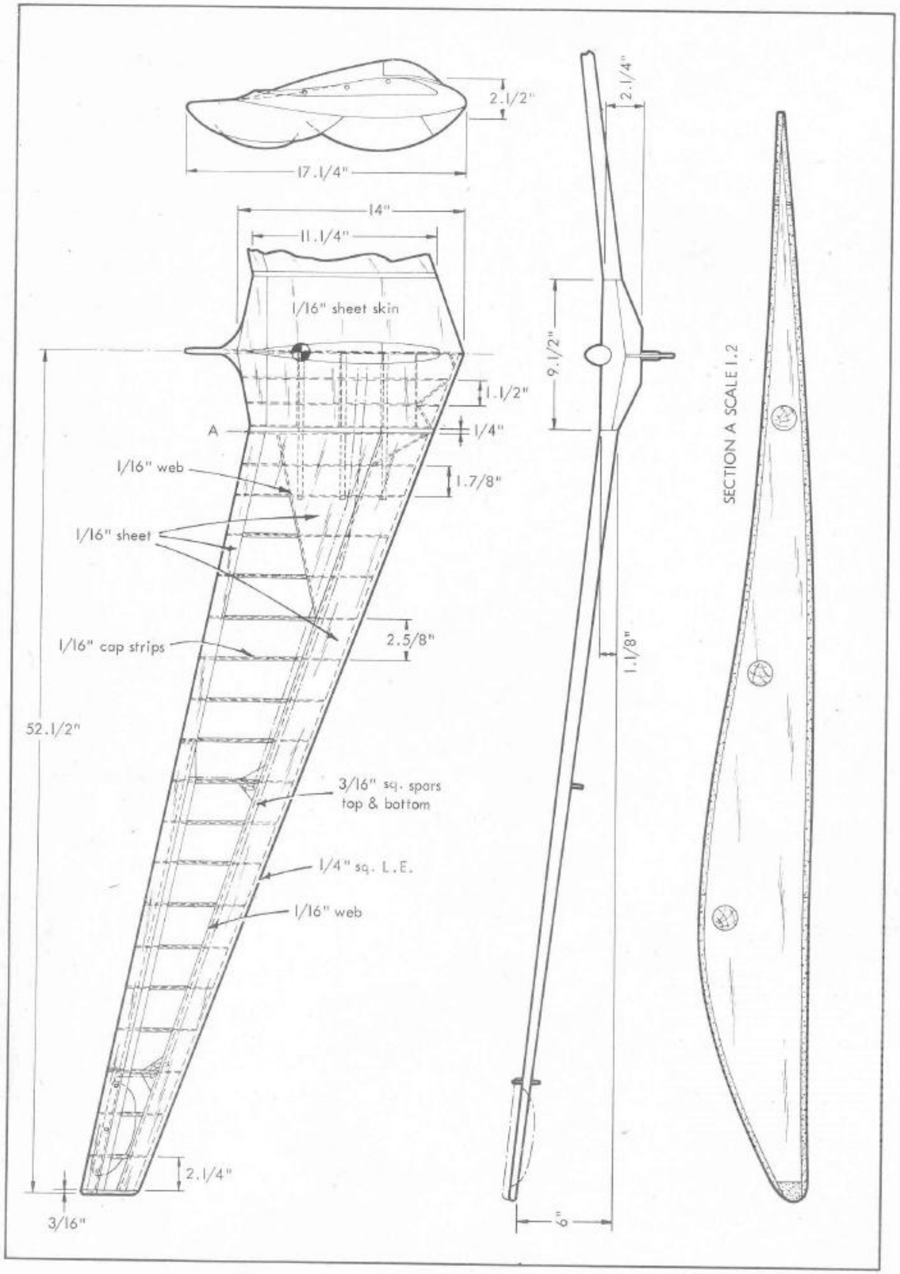
TAUBE II
by S. Kinishita
R/C glider with alternate power pod from Japan.

R/C TECHNIQUE JAPAN

Horton IVB

Semi-scale flying wing glider from Japan

Scale 1:12

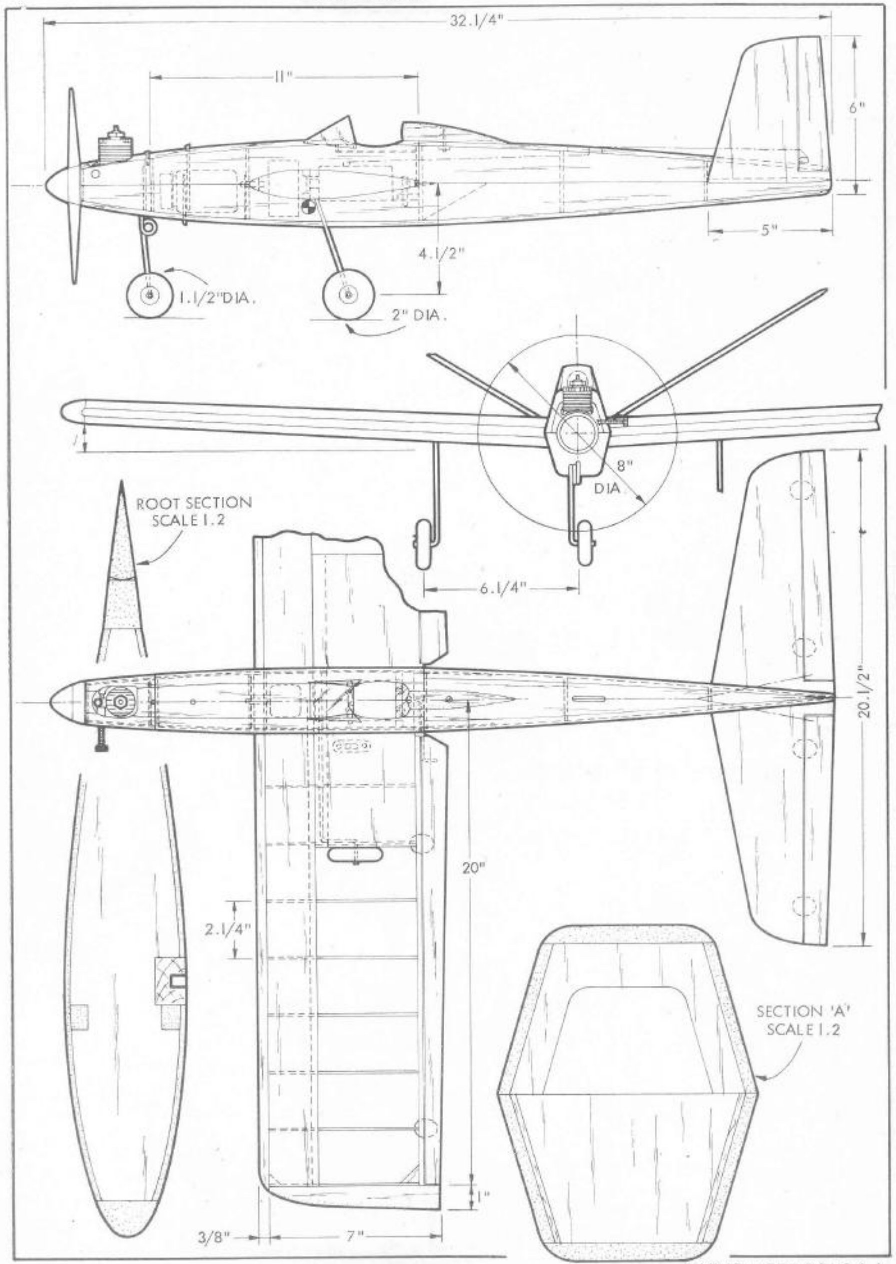


R/C TECHNIQUE (JAPAN)

Sprinter

Butterfly tail R/C sports model for 2.5 to 3.5 c.c. motors

Scale 1:8

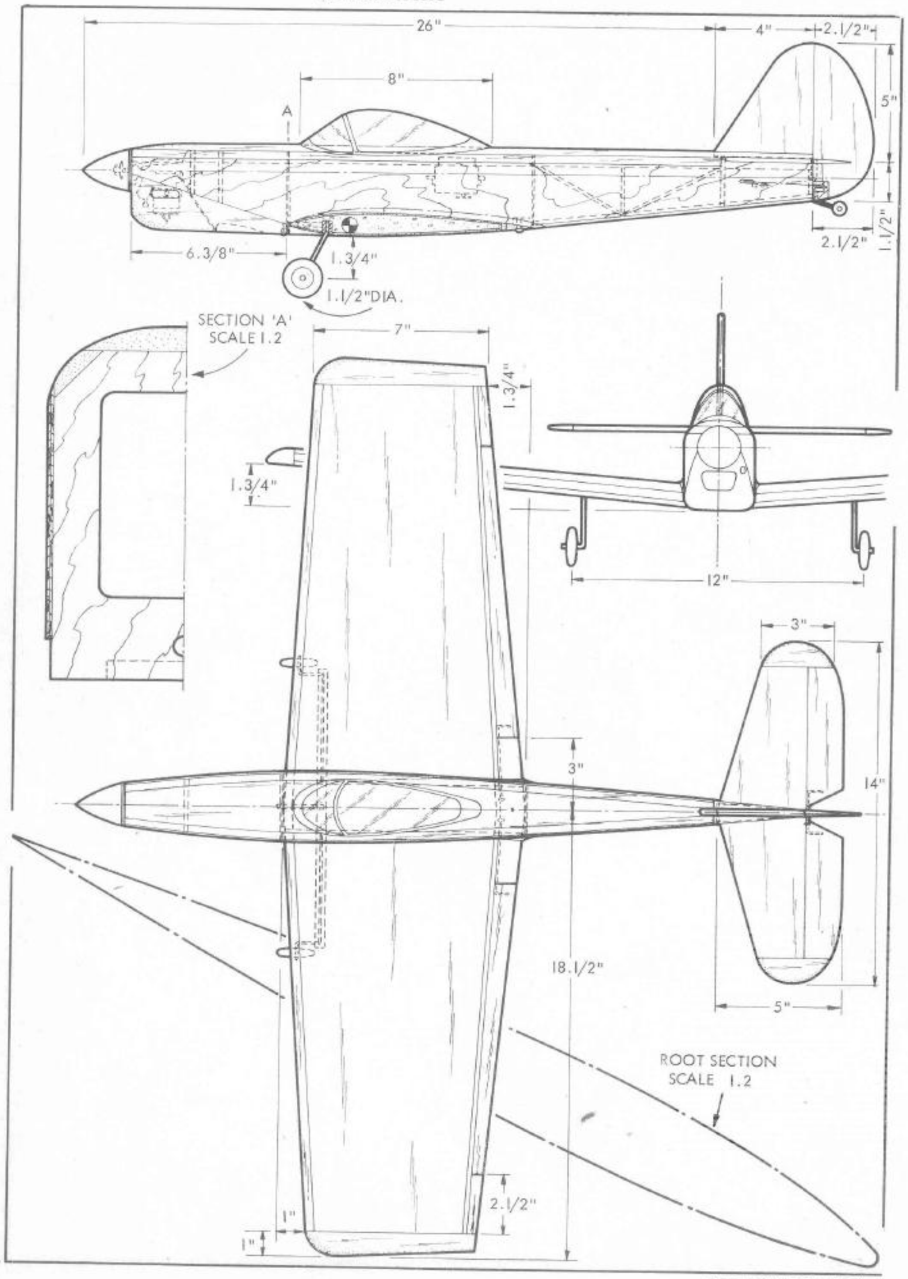


FLYING MODELS (U.S.A.)

XP-40Q Snafu

Successful Quarter Midget R/C Pylon Racer for 2.5 c.c. motors

Scale 1:8

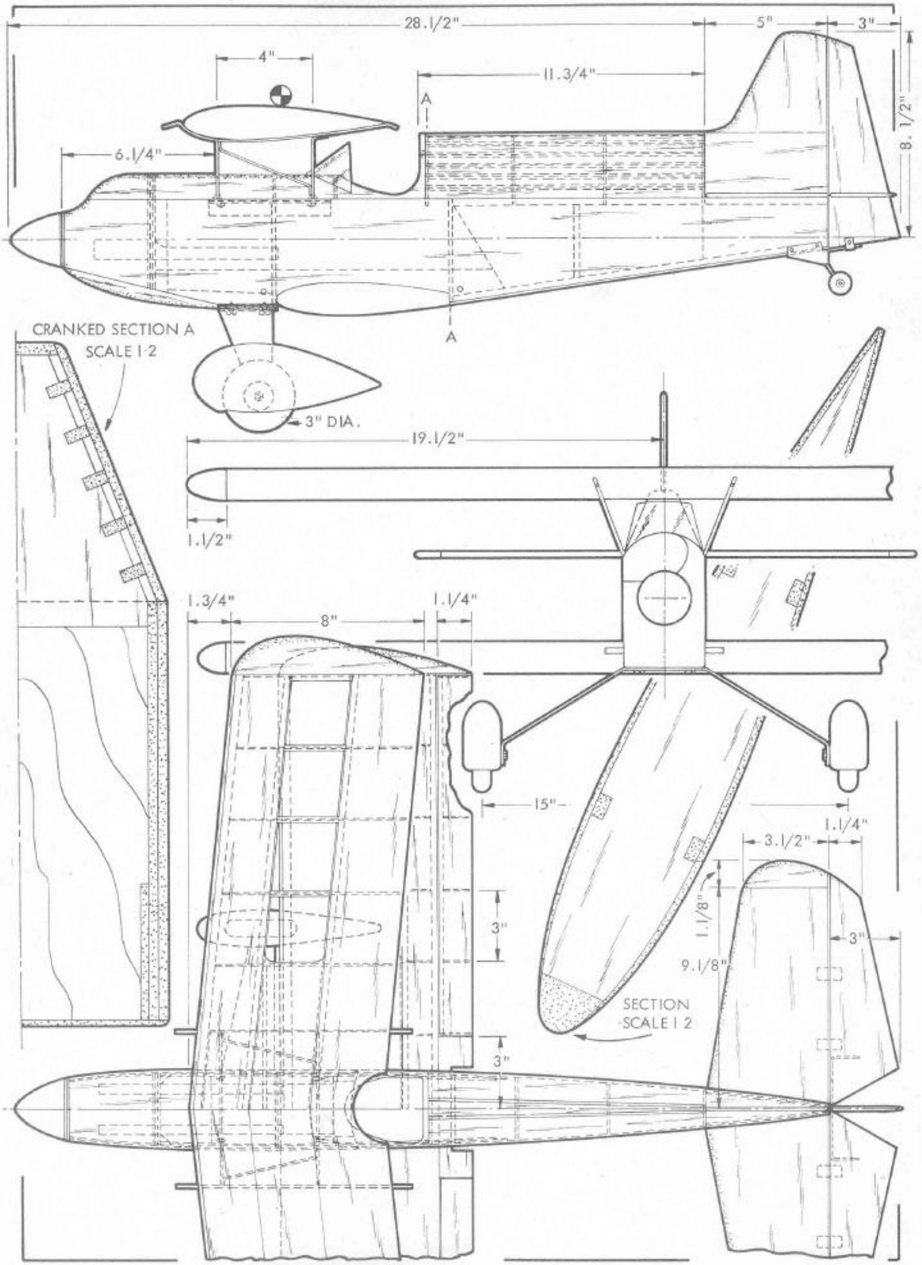


R/C MODELER (U.S.A.)

Dreamer

Compact R/C biplane for sport R/C flying and aerobatics

Scale 1:8

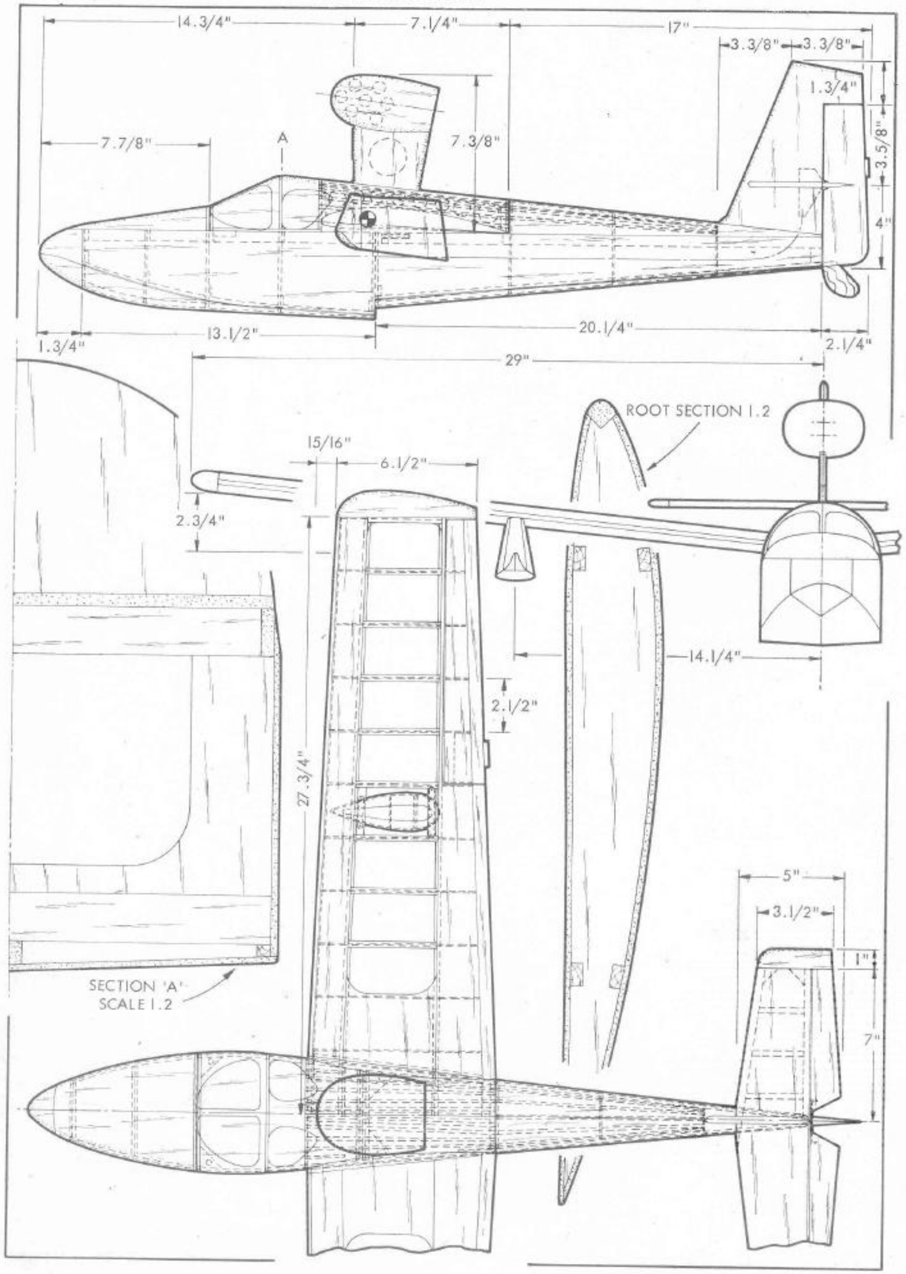


FLYING MODELS (U.S.A.)

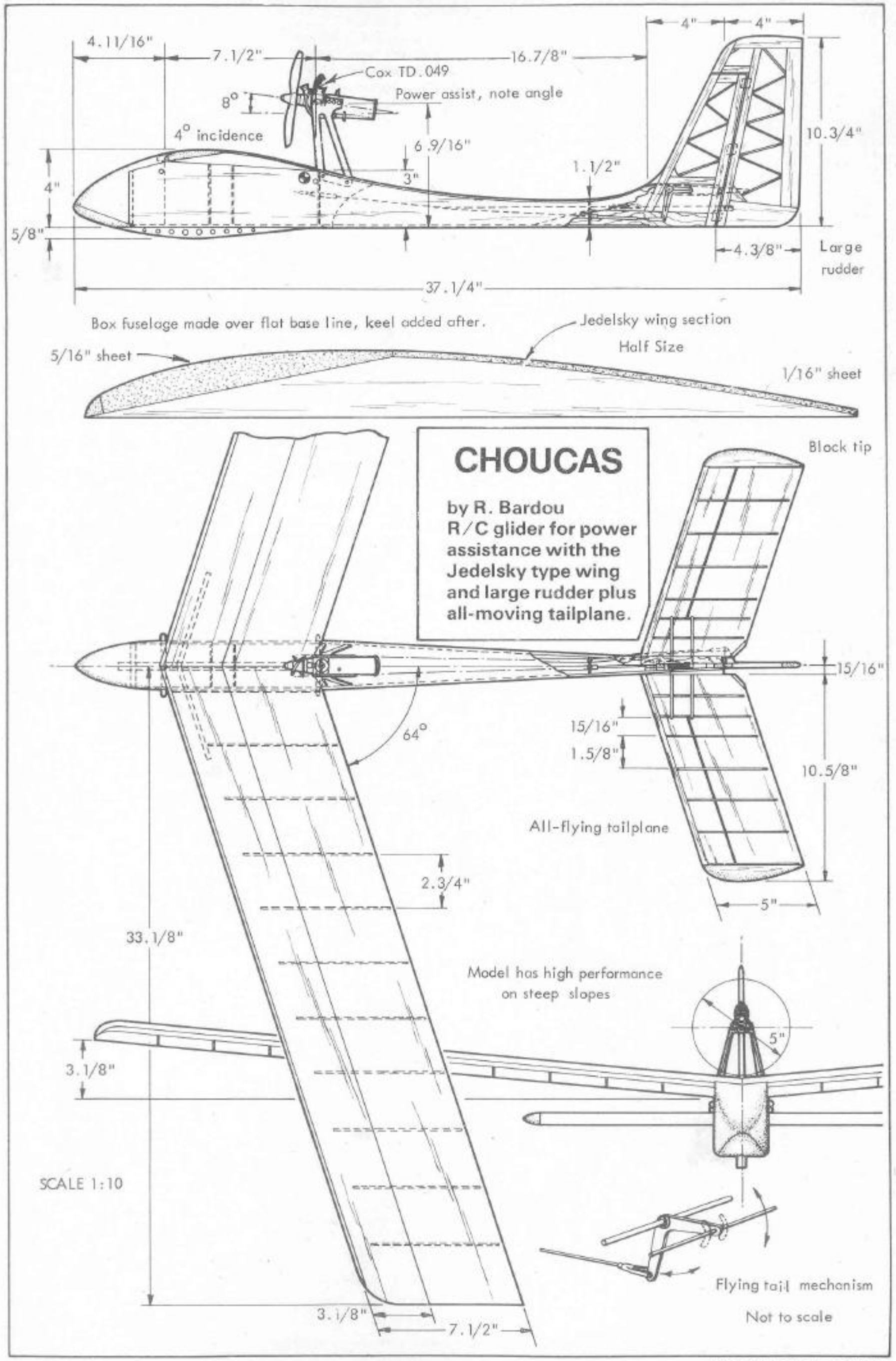
Lake Buccaneer

Near scale R/C flying boat for 3.5 to 5 c.c. motors

Scale 1:9



FLYING MODELS (U.S.A)



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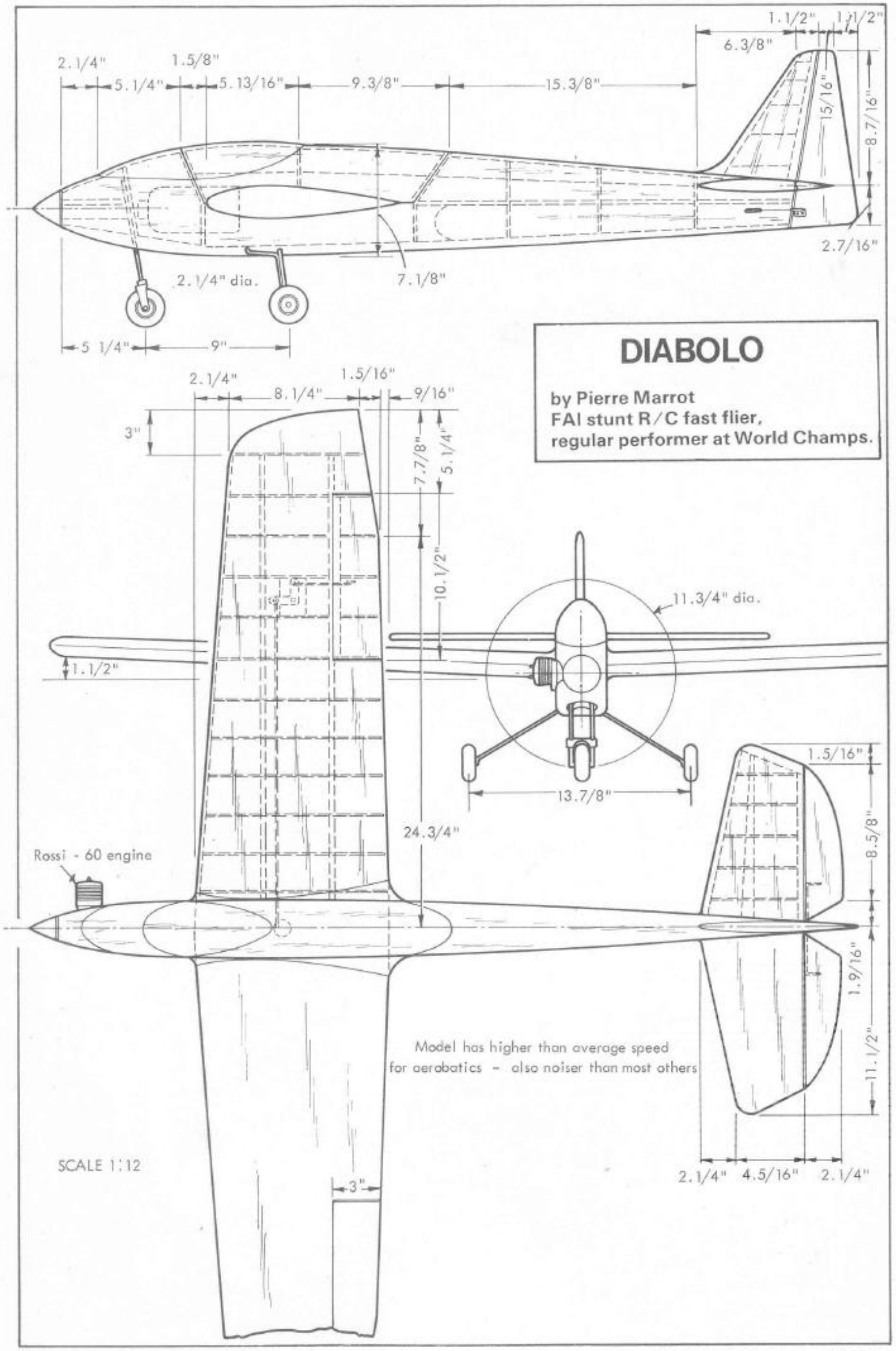


DIABOLO

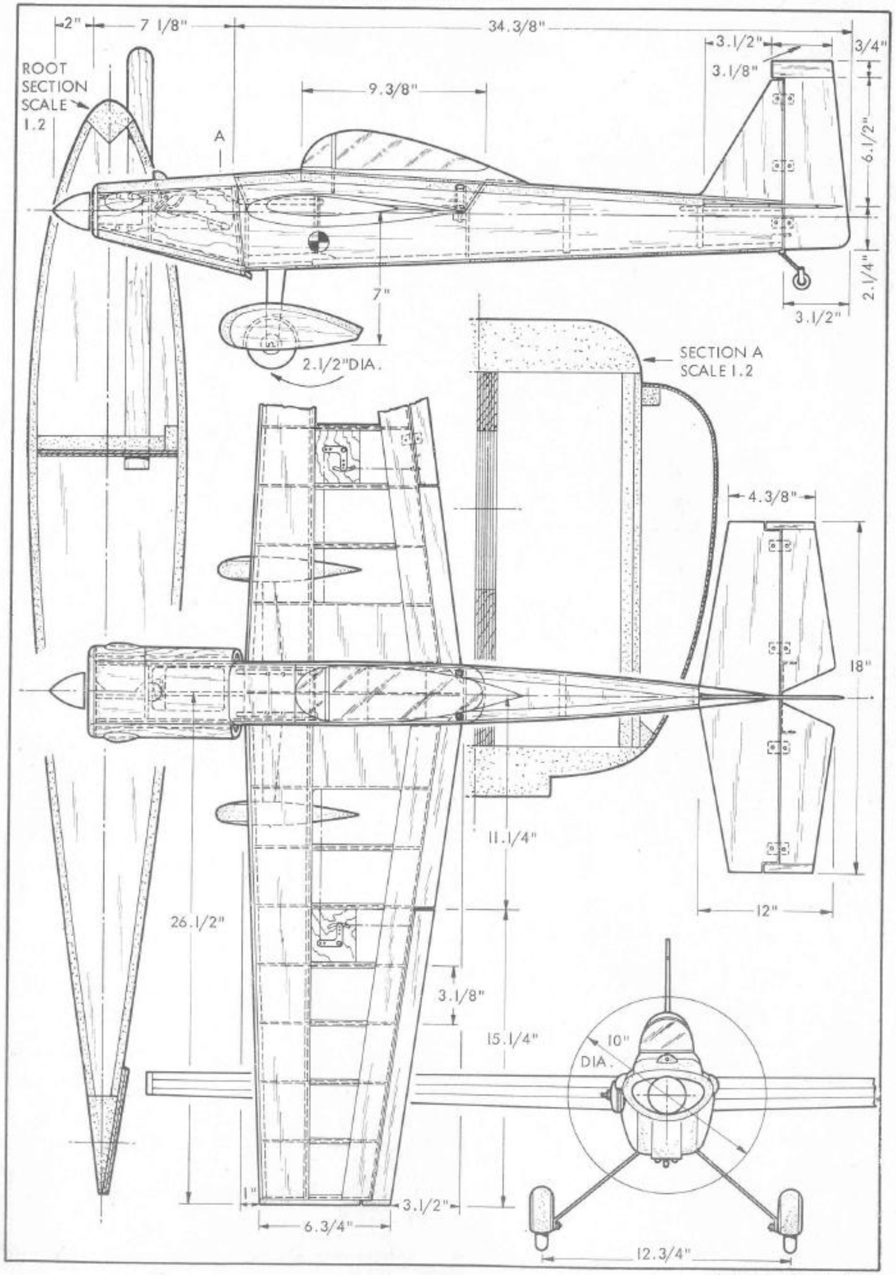
by Pierre Marrot
FAI stunt R/C fast flier,
regular performer at World Champs.

RADIO MODELLISME FRANCE

Stephens Acro

Stand-off scale model for .35-40 cu. in. BY B. SHEPARD, U.S.A.

Scale 1:10



MODEL BUILDER (USA)

D.D.T.

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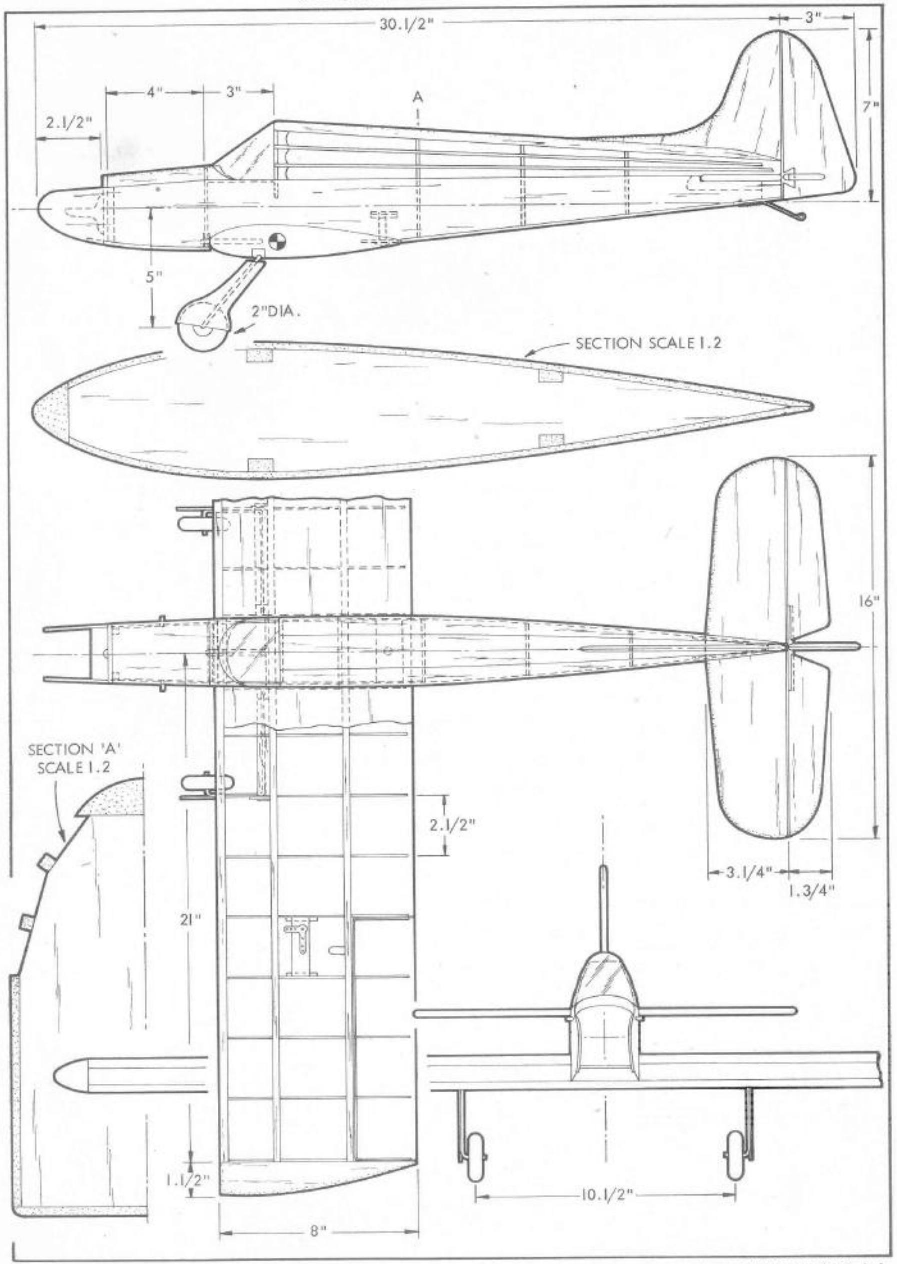
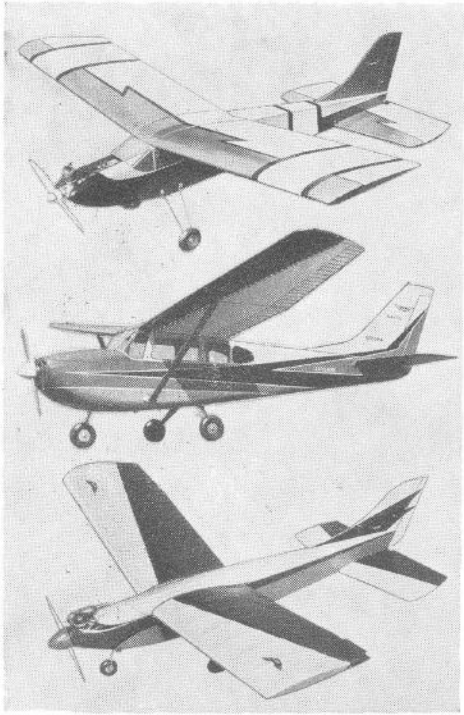


FLYING MODELS (U.S.A.)



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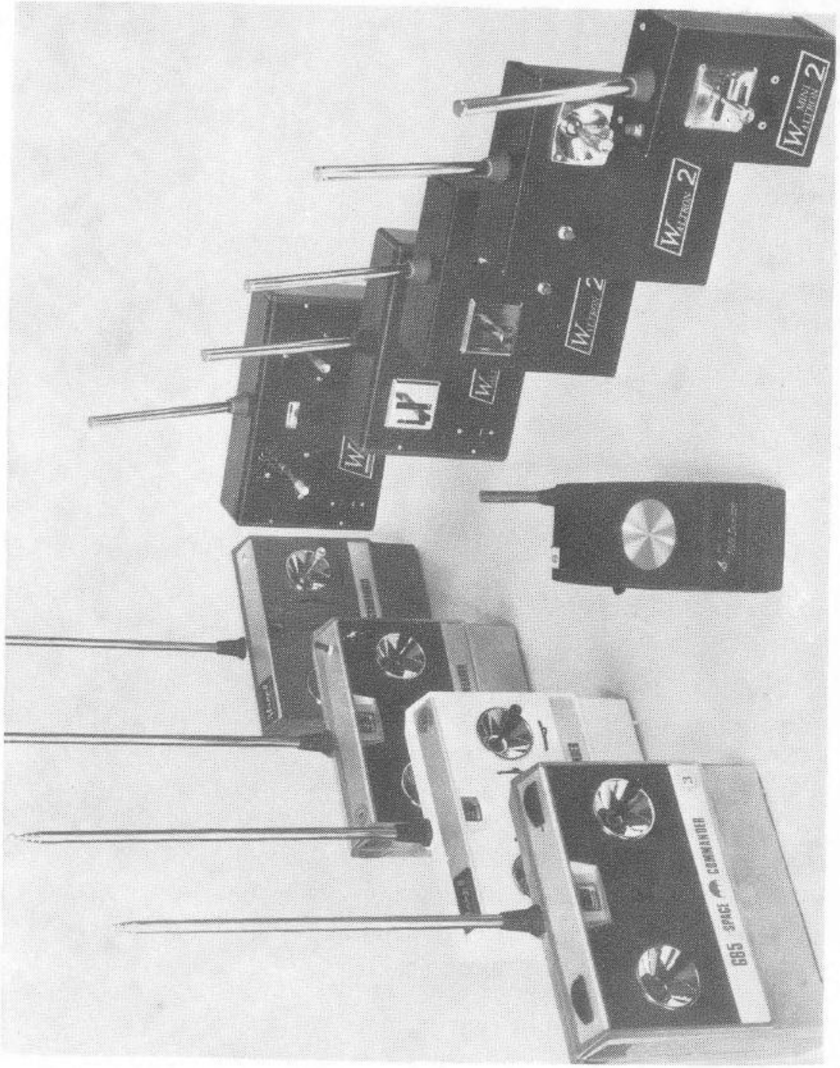

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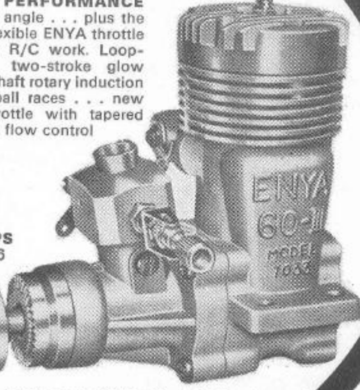

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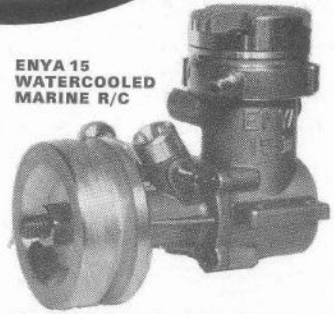

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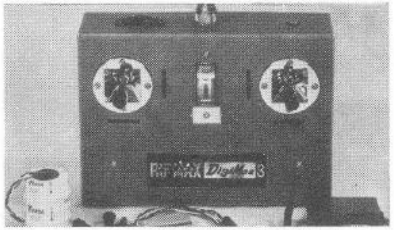

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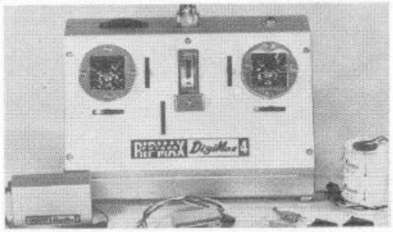

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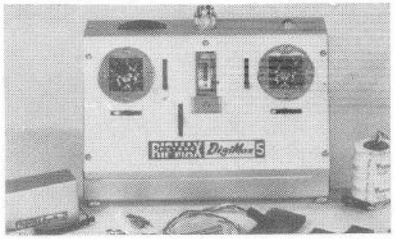

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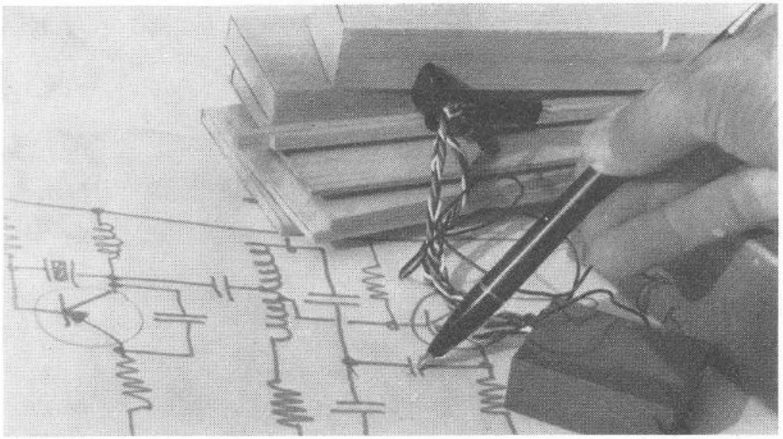

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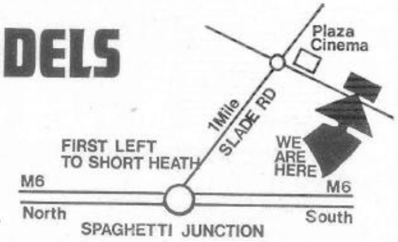
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M6
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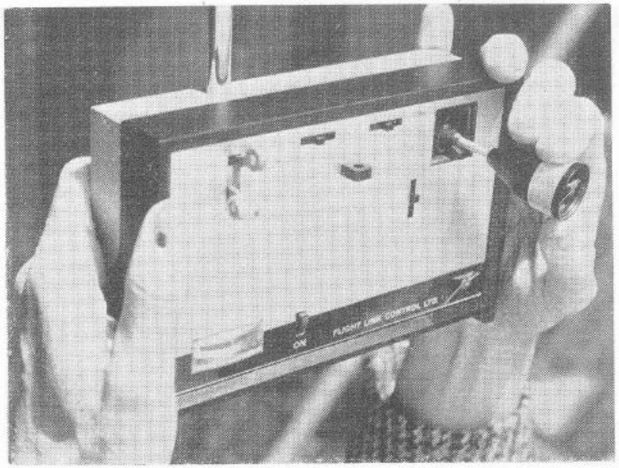
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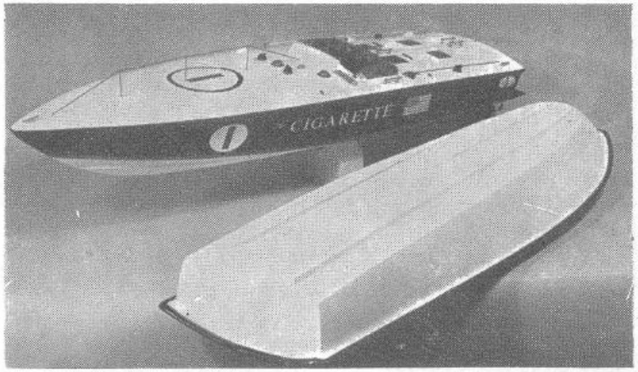

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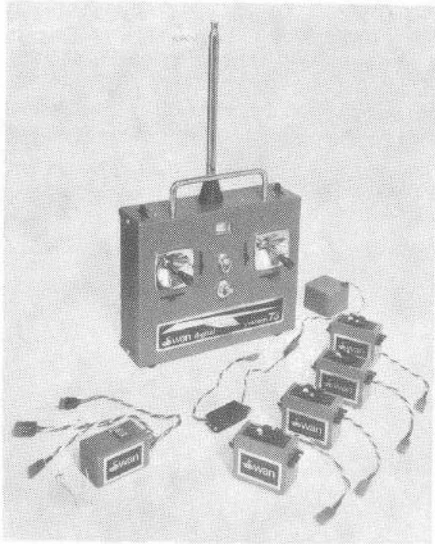

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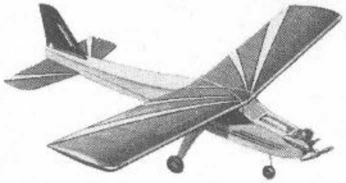

OUTLAW Single Channel Sports Model that also accepts proportional radio. Wingspan 45″.

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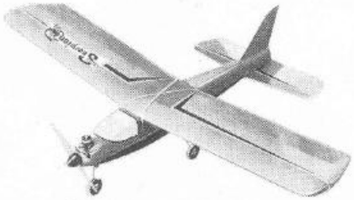

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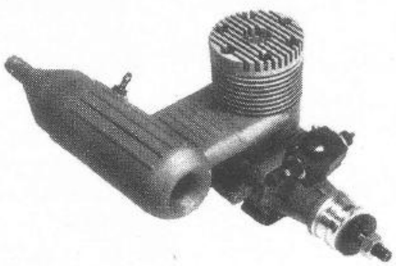

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The Veco .61 'Europe Series' is, by any standard, a superb piece of model engine craftsmanship . . . magnificent die-castings . . hyper-precision internal engineering.

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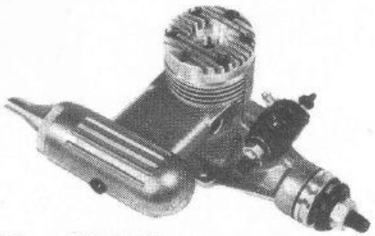

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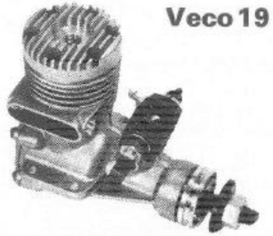

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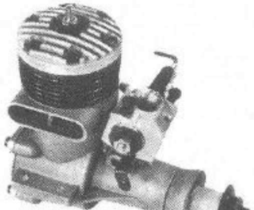

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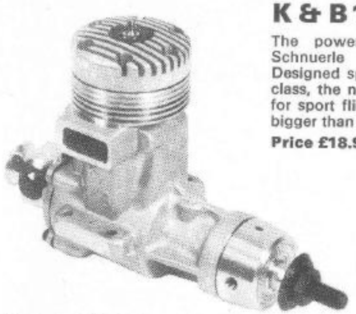

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The powerful one among R/C .15's features Schnuerle porting for maximum performance. Designed specifically for the ¼ midget pylon racing class, the new K&B 15 also offers top performance for sport fliers, with its Perry carb. unit. Will pull a bigger than average model for its size.

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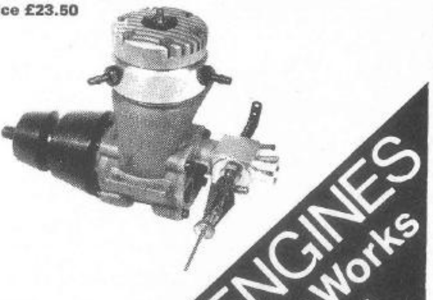

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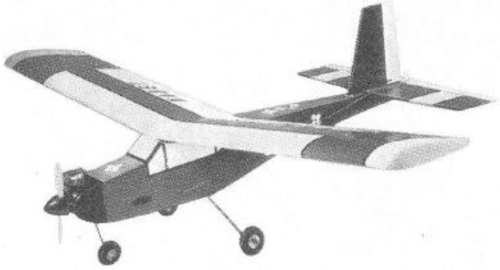

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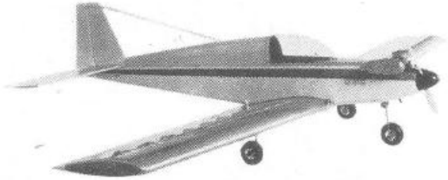

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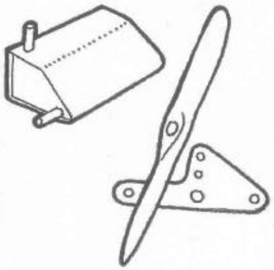

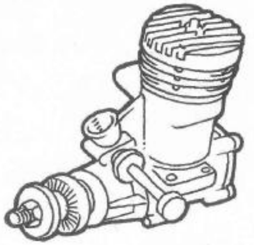

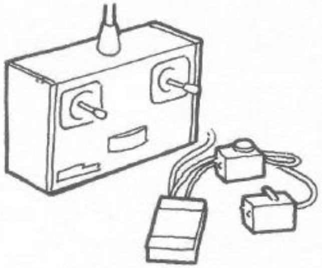

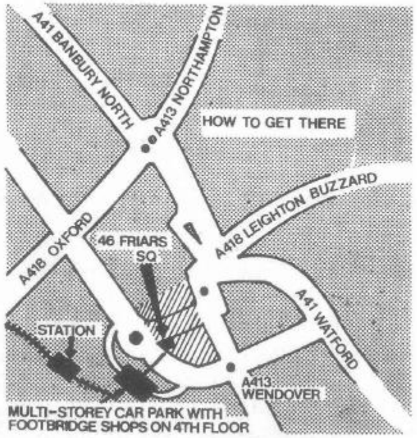
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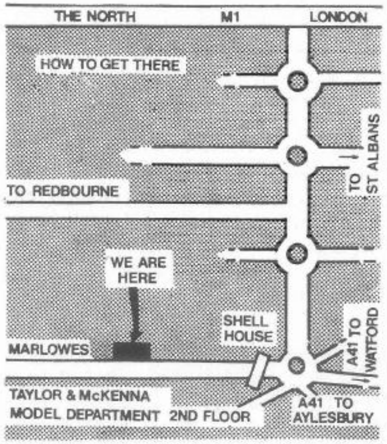
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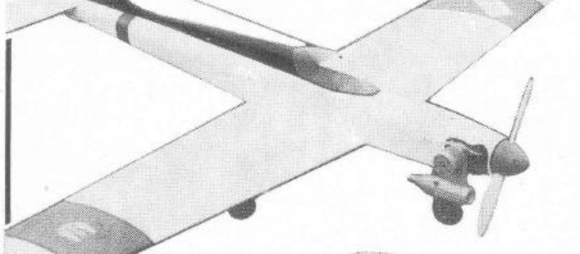

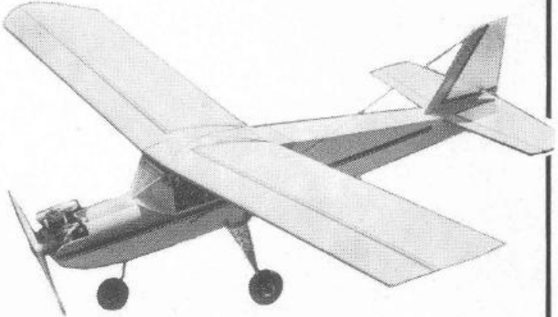

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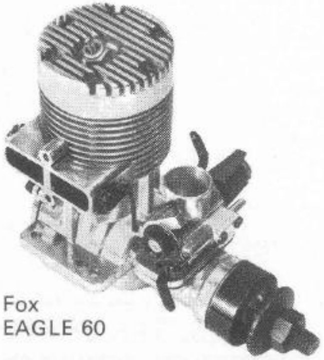
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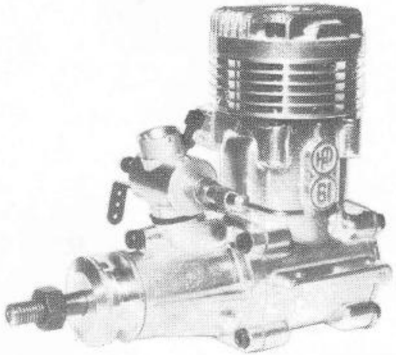

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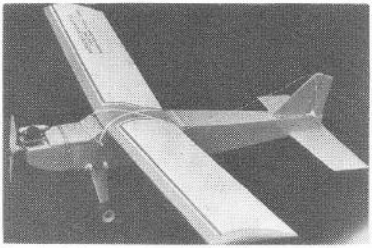

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