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.

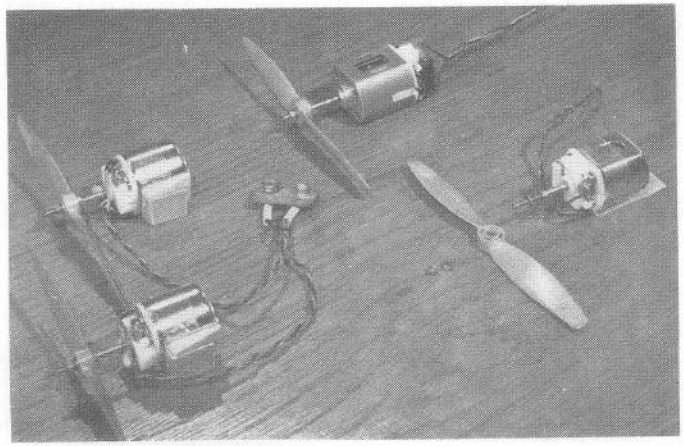
This was one of the motors used in the Esher DMFC indoor RTP sessions. I promptly sent off for a set of Saft VRO5AA batteries, full of high hopes for the following weekend. Such is optimism. After several phone calls, the order finally arrived in mid March. I dug out my calculations and dusted off the 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.

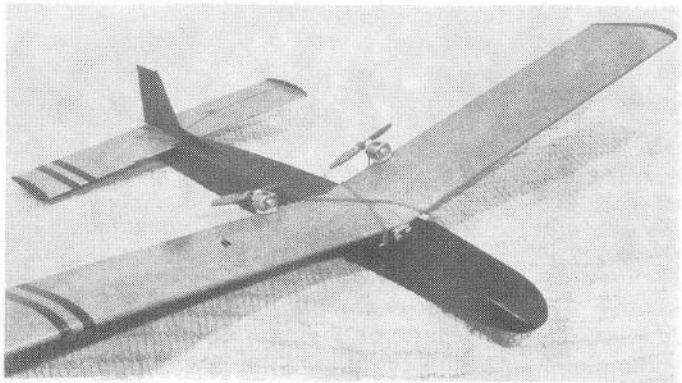
Considering the batteries first. The capacity of VRO5AA cells is rated at 500mAH for a full charge at the ten hour rate. Bearing in mind the current I would be taking from them it would be better to calculate the battery capacity in terms of amp/minutes. Therefore the VRO5AA cells had a capacity, on 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.

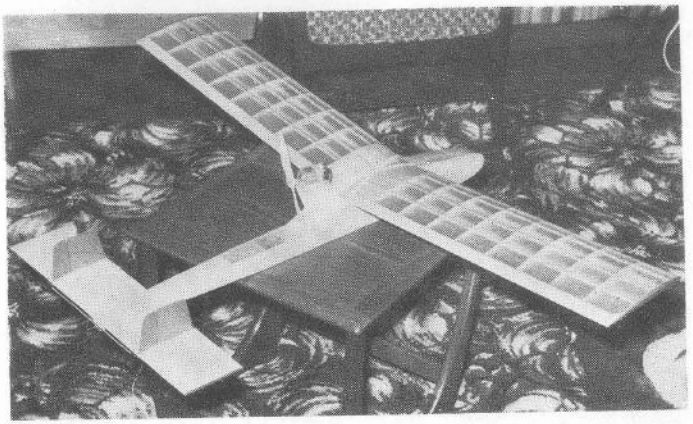
consumption of 6 amps. Using strictly 'rule of thumb' methods I estimated that the model design I had in mind would fly adequately with an all up weight equal to four times the thrust in ounces. While some modellers might favour a more scientific approach, I think there is a time and a place for lengthy 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 $6\frac{1}{2}$ oz. motor/drive battery combination which leaves $3\frac{1}{2}$ 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.

The radio gear I intended to use was the single channel MacGregor MR50

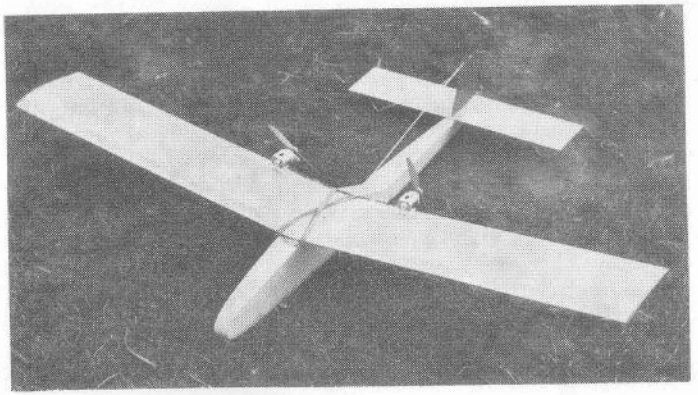
Pic. 3



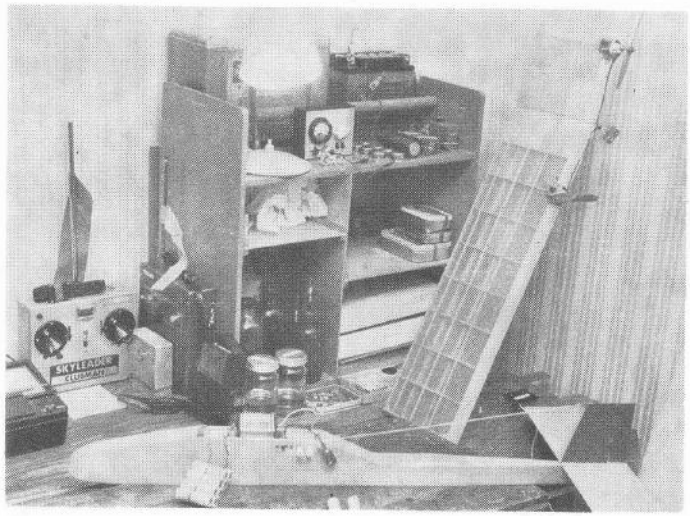
Single motor model, used Mabuchi 36D motor, held on pylon with rubber bands.

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 $7\frac{3}{4}$ 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 $\frac{1}{2}$ 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.

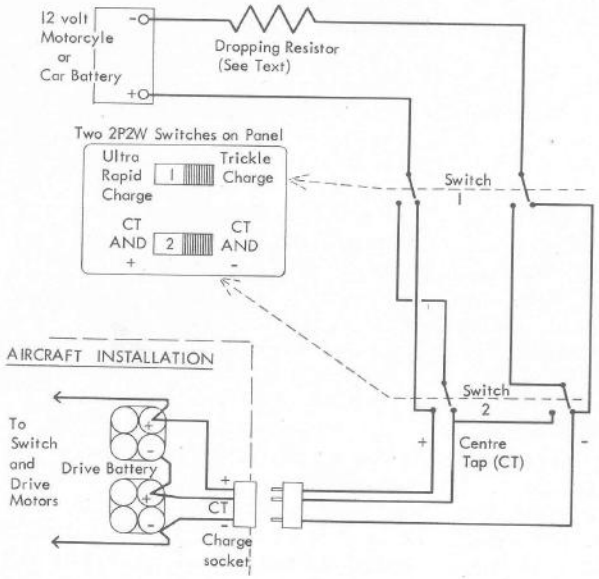
While I was waiting, I carried out more flight tests, during which it became obvious that, in contrast to the static bench tests at home, the 36D and the Scalextric motors were more effective in the air with a Thimbledrome $4\frac{1}{2} \times 2$ prop, than with the 6×4 I had been using up to then. Another 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

CHARGING CIRCUIT

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.

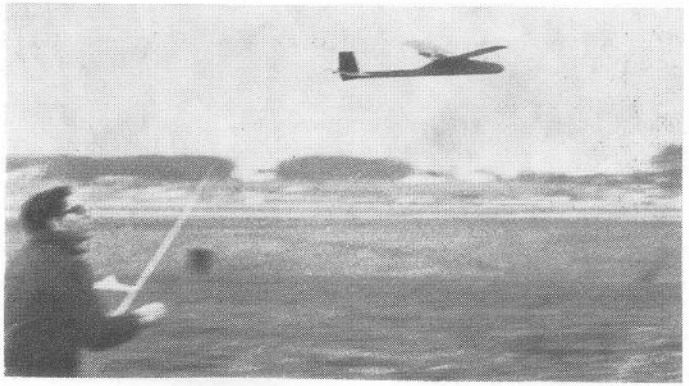
One snag remained. This concerned the Ultra Rapid Charging procedure on the flying field. My flying field charging power source is a 12 volt 7 amp/hour Yuasa motor cycle battery. This fits neatly into the small holdall which also serves to carry the rest of my flying gear. When the voltage of the aircraft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

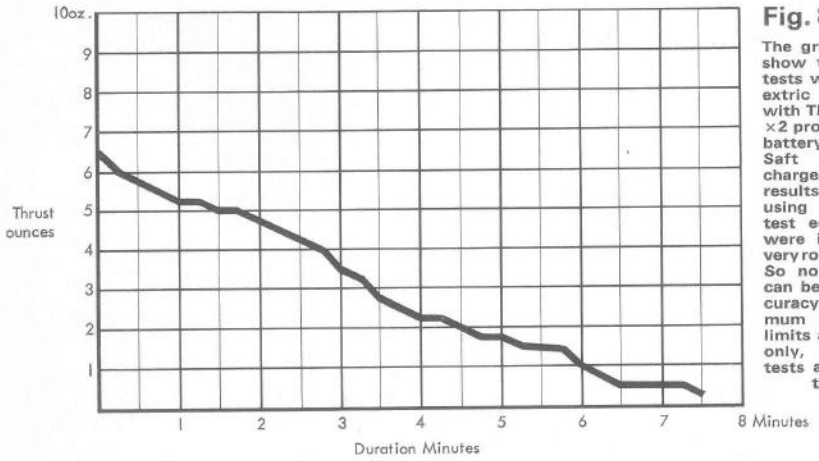


Fig. 8A

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 VR05AA 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

Fig. 8B

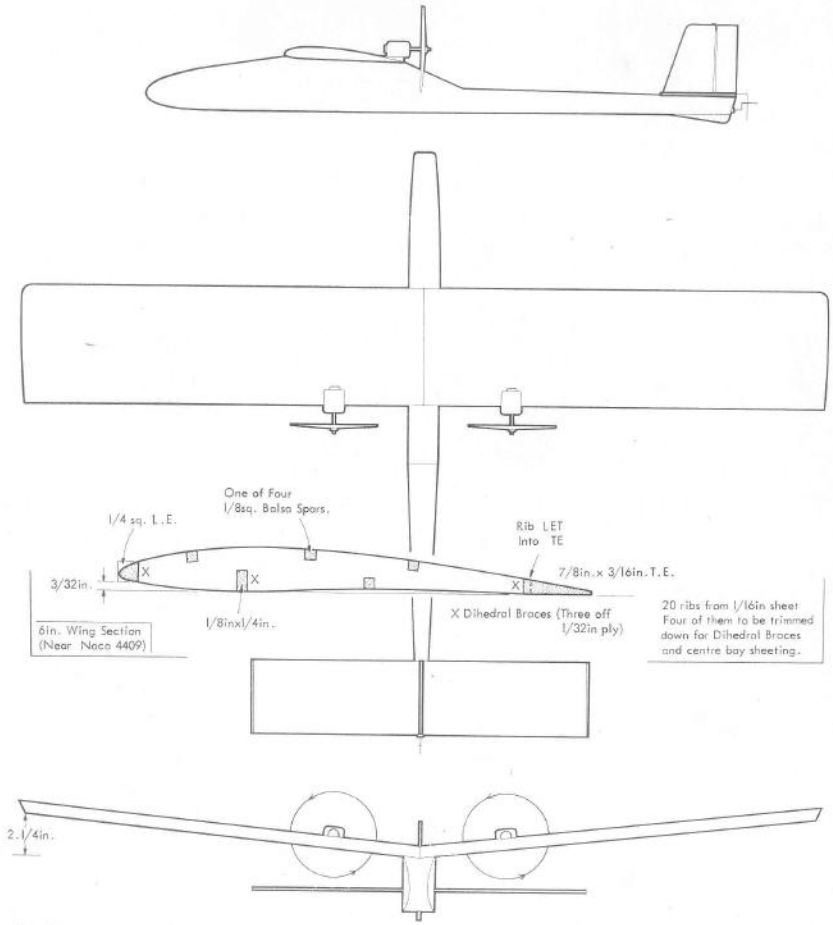
BATTERY PACK VR05AA CELLS	NOMINAL VOLTAGE	INITIAL PEAK CURRENT AMPS	INITIAL PEAK THRUST OZ.	2 MOTORS + BATTERY PACK WEIGHT OZ.	AIRCRAFT MAXIMUM ALL UP WEIGHT LIMIT. OZ.
2	2.4	1.7	3/4	5	3
3	3.6	2.7	2	5.3/4	8
4	4.8	3.7	2.3/4	6.1/2	11
5	6.0	4.7	4	7.1/2	16
6	7.2	5.7	4.3/4	8.1/2	19
7	8.4	6.6	5.1/2	9.1/4	22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

* SEE GRAPH ABOVE

Proton

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

Scale 1:10



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.

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

Fig. 1

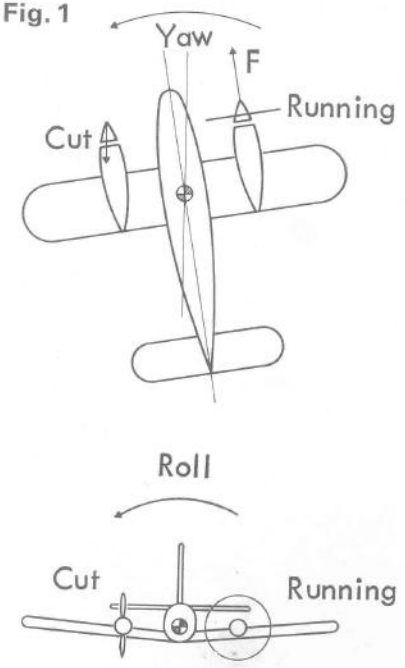
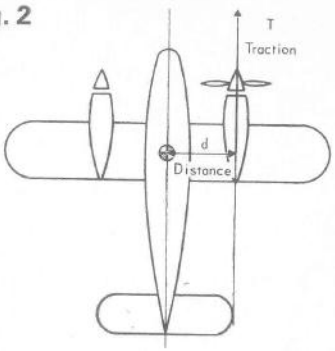


Fig. 2



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.

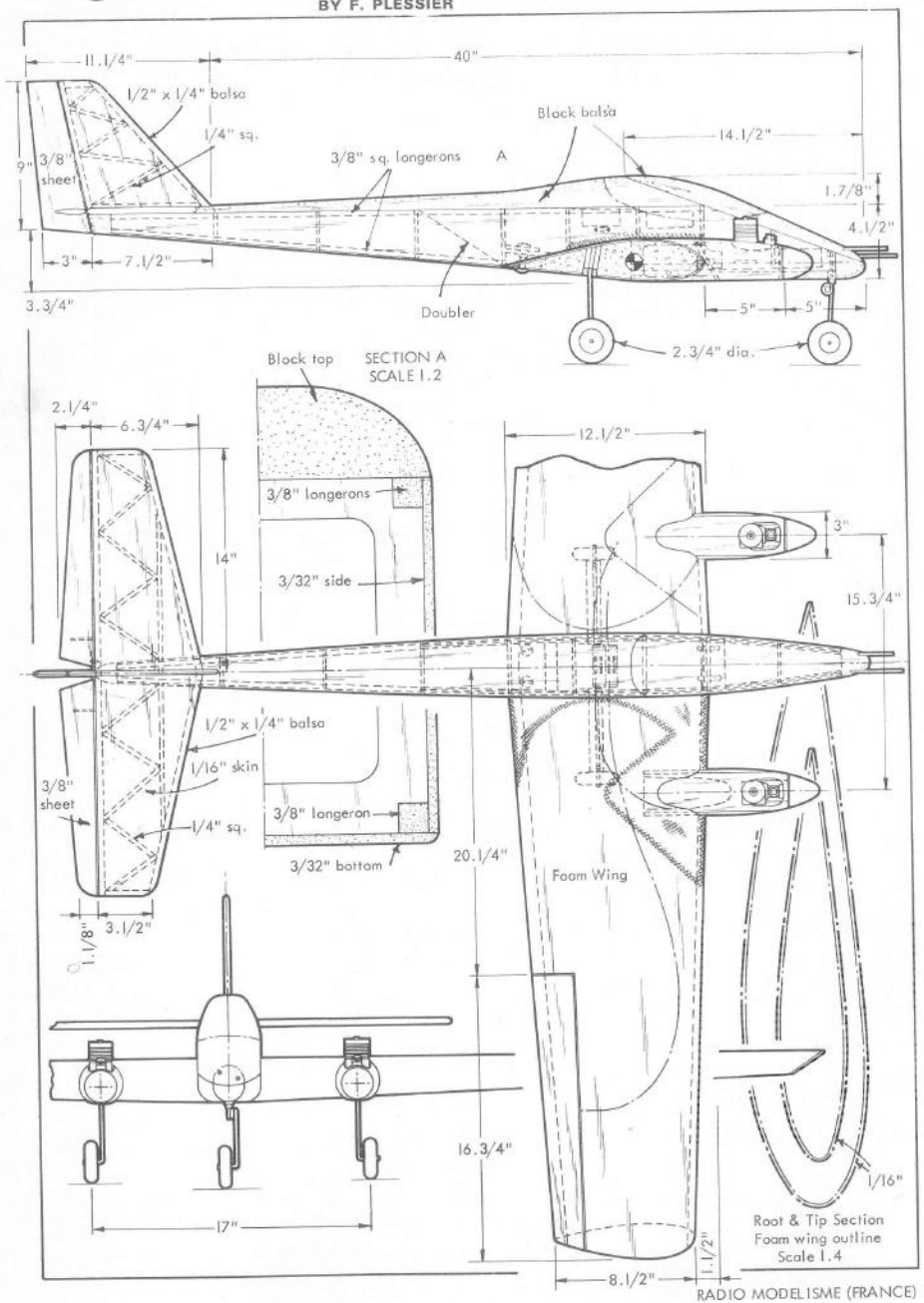
It is important to appreciate that the turning moment, calculated on the product of thrust X distance from the centre of gravity, is inversely proportional to speed, or decreases with increase in speed, since the power output of the motor is constant. On the contrary, aerodynamic effects of the rudder 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

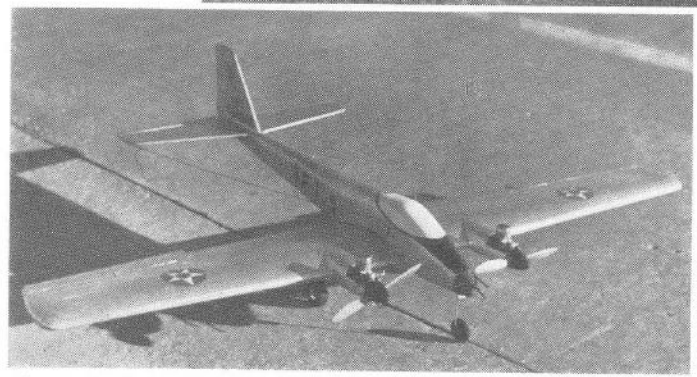
Twin-engined aerobatic R/C model for two 5 c.c. motors.

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 re-capping; 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 tail-plane, 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 weather-vane 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

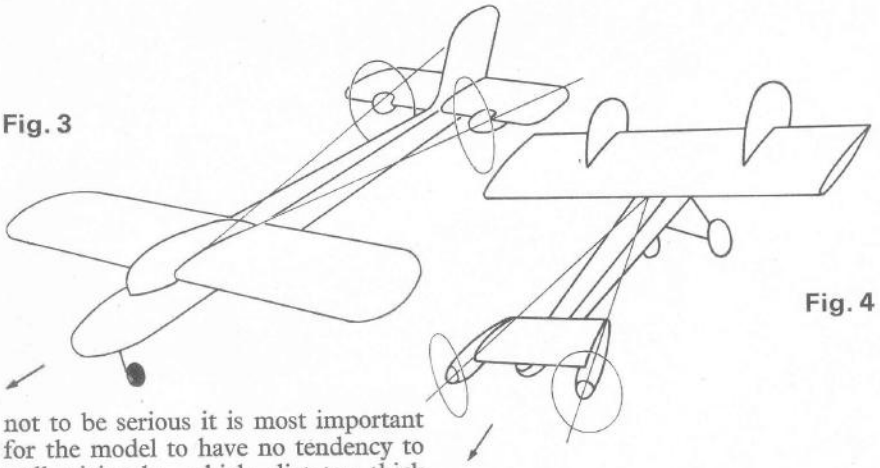


Fig. 4

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

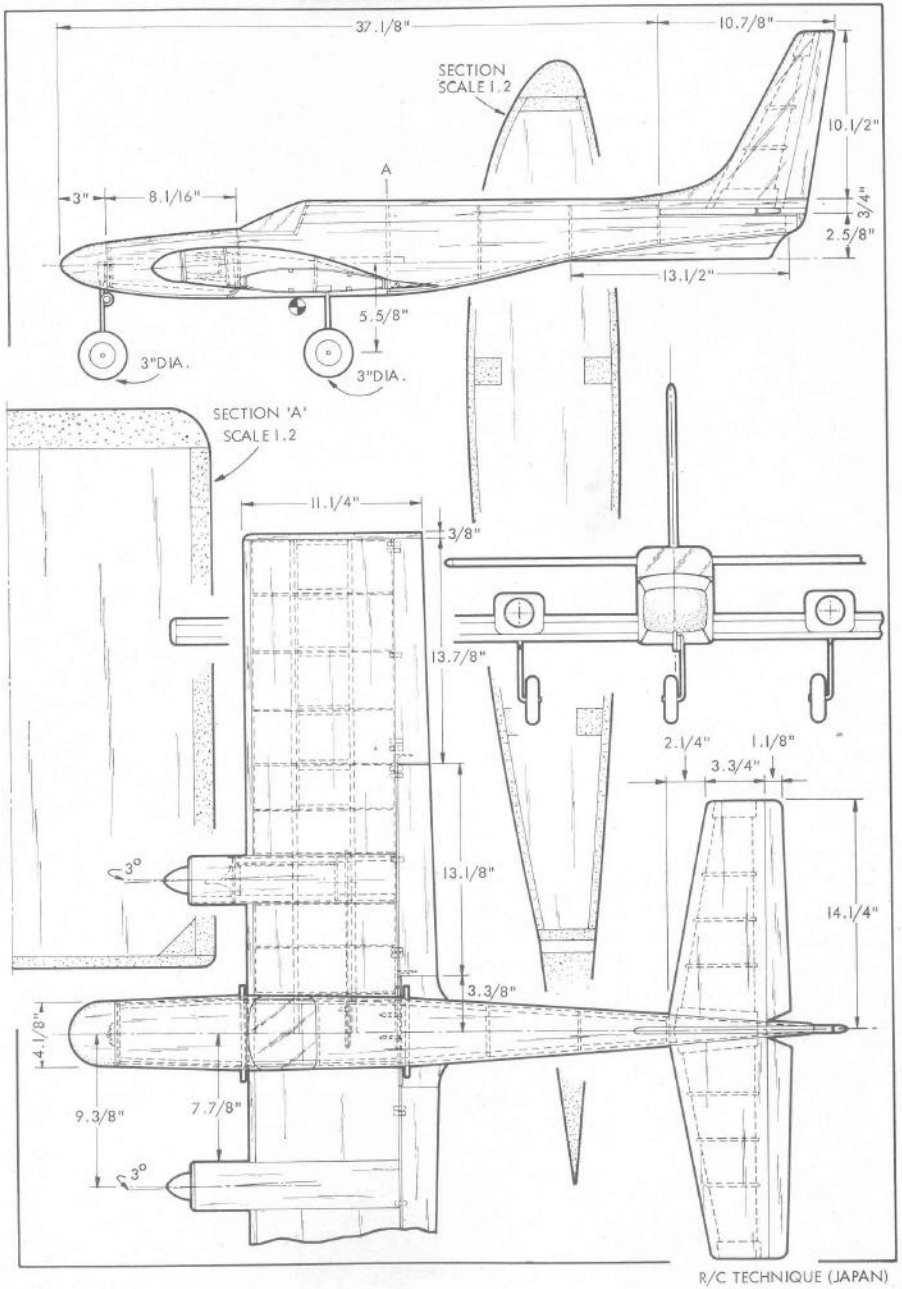
This is very critical as it dictates the final size of the model, which is itself dependent on the rise of the radio equipment. Using a conventional modern proportional system, it is difficult to produce an aircraft of less than 60″ span and weighing less than 5½ lb. particularly with the extra weight 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.

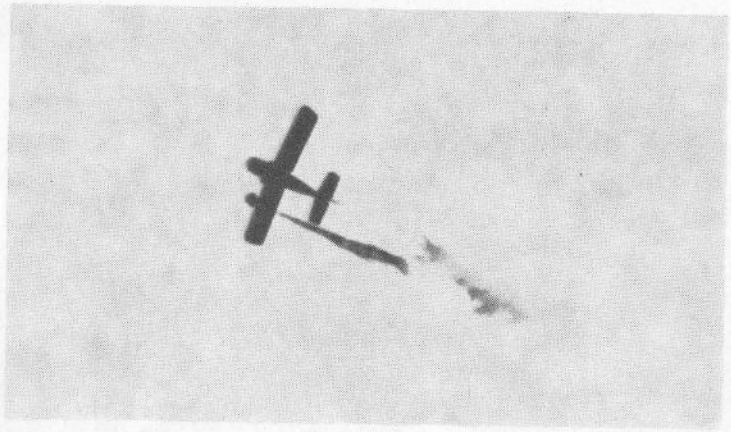
The author has even succeeded in releasing two parachutes tied together, though opening is still automatic. It is very tempting to progress to a stage of greater evolution, and to practise delayed opening.

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.



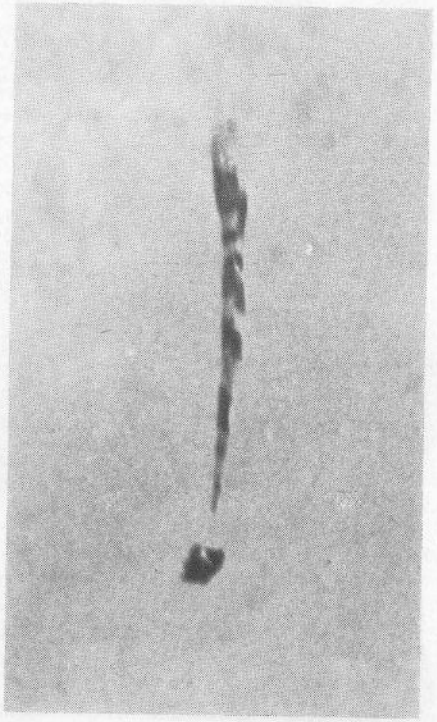
1

Left: parachutist at moment of release from carrier model.

The drop sequence!

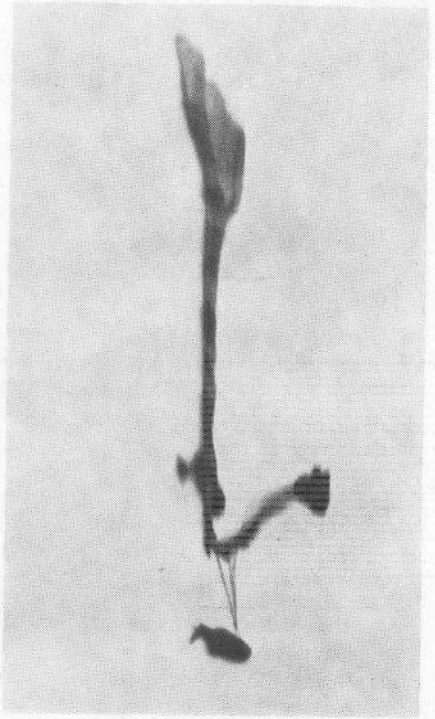
Below: parachutist in free fall after transition to vertical descent.

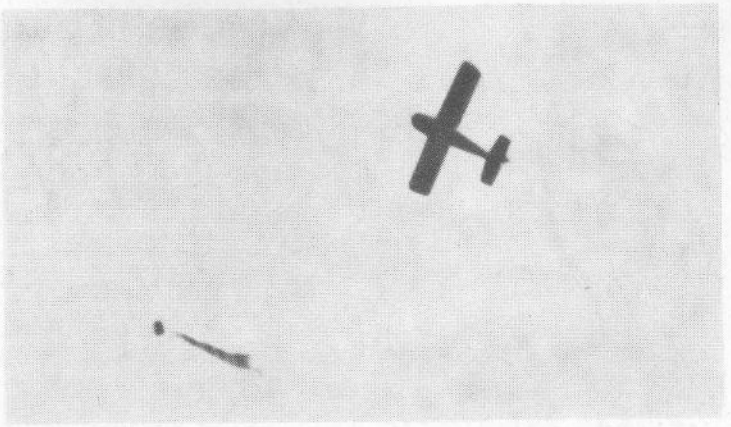
3



Below: parachutist at moment of deployment of the parachutes.

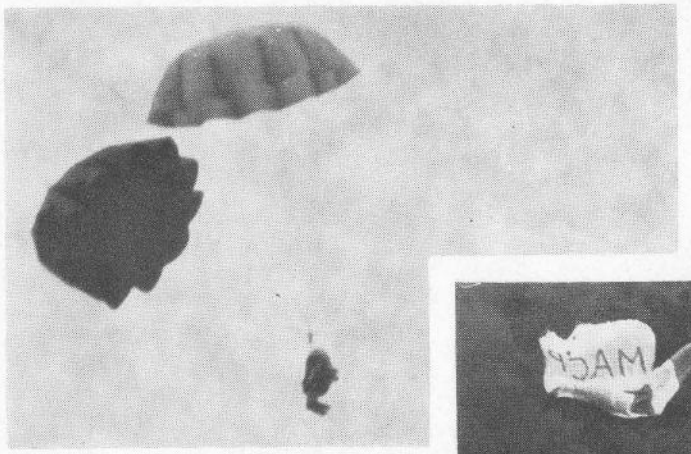
4





2

Right: parachutist falls free from aircraft with streamer visible.

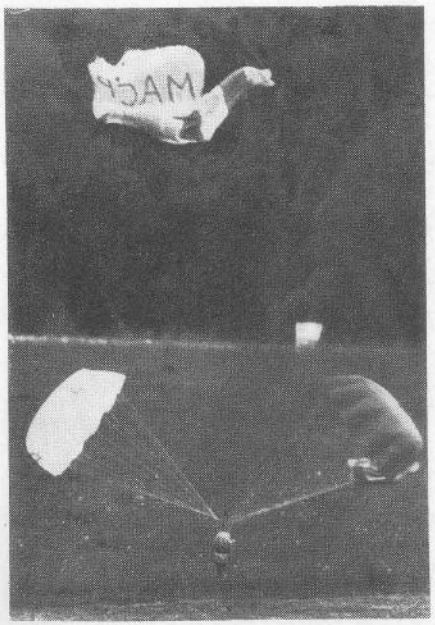


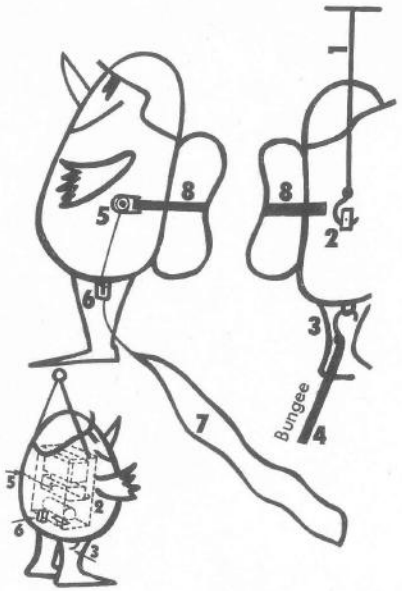
5

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.

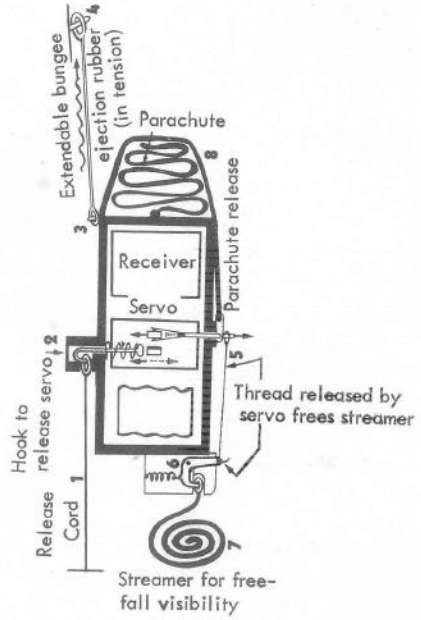
Although this sequence is described for use with a linear output servo, a rotary drive servo may be used.

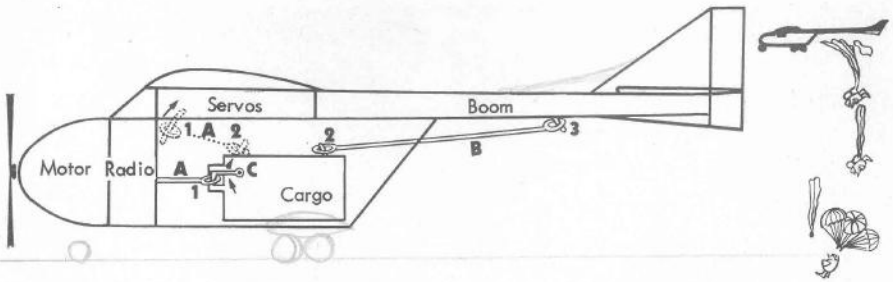
Operation

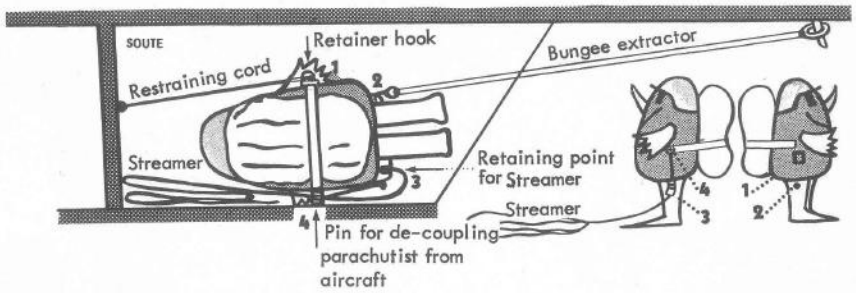
Push: the lock (2) pushed by the servo, releases rod (1). The rubber tensioner stretched between 3 and 4 extracts the parachutist from the hold of the carrier aircraft and is lost in the process (must be replaced for each ejection).

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.



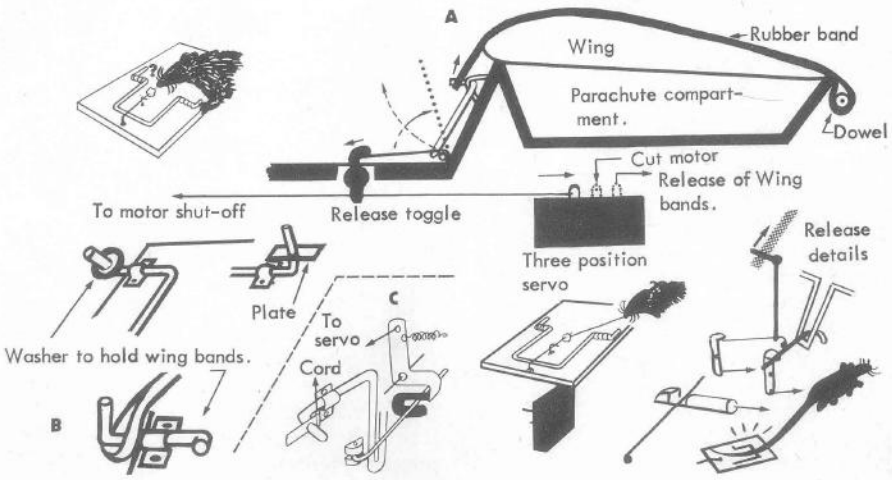




EXIT OF CARGO FROM HOLD (top diagram)
When dotted ring (1) is released by carrier aircraft pilot from anchor point, bungee (B) extracts load from hold (rings 2 and 3 come off their pegs) and the bungee is lost.

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.

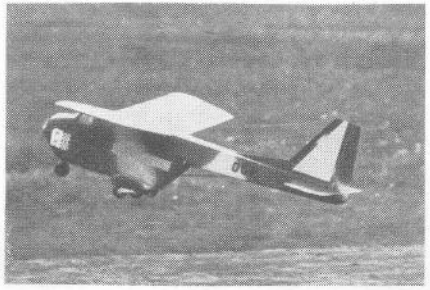
3. Development of a container allowing instantaneous release of the parachute. It is best to avoid deep storage compartments with their problems of disgorging their contents. Better the certainty that the parachute will open immediately. Delayed opening is not out of the question provided altitude is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

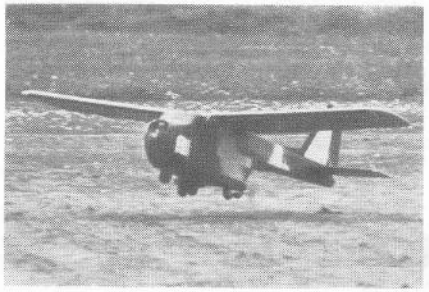
The prototype was made from an old fuselage in which a container of about $6\frac{1}{4}″ \times 7\frac{7}{8}″ \times 2″$ was fitted. The wing was positioned directly above this, held in place by conventional rubber bands.

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).

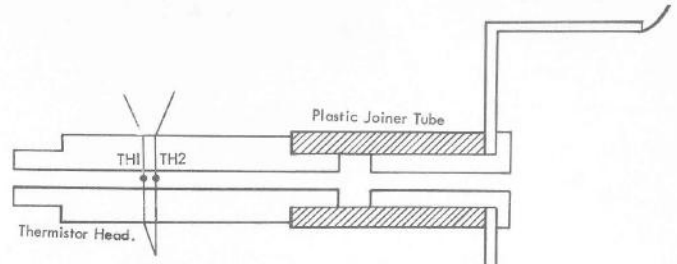
How & Why

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.

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

Fig. 1



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.

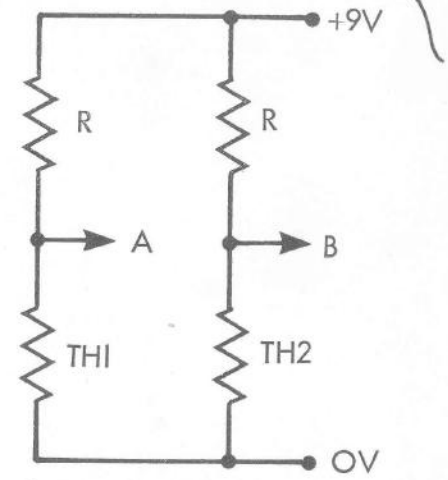
We now have a d.c. voltage proportional to rate of change of height. This voltage is amplified in a differential d.c. amp. to provide a larger voltage swing and is then fed into a voltage controlled oscillator i.e. the frequency of its output is proportional to the d.c. input voltage signal. (Fig. 3).

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

Fig. 2



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—

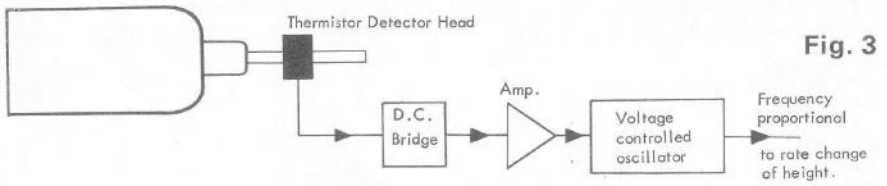
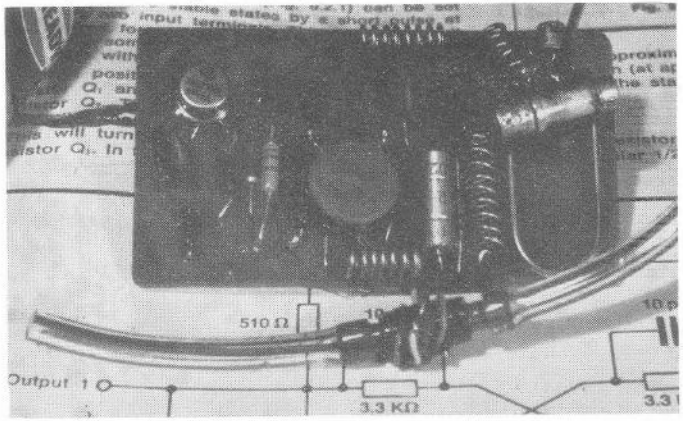


Fig. 3

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 $\frac{1}{4}$ 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

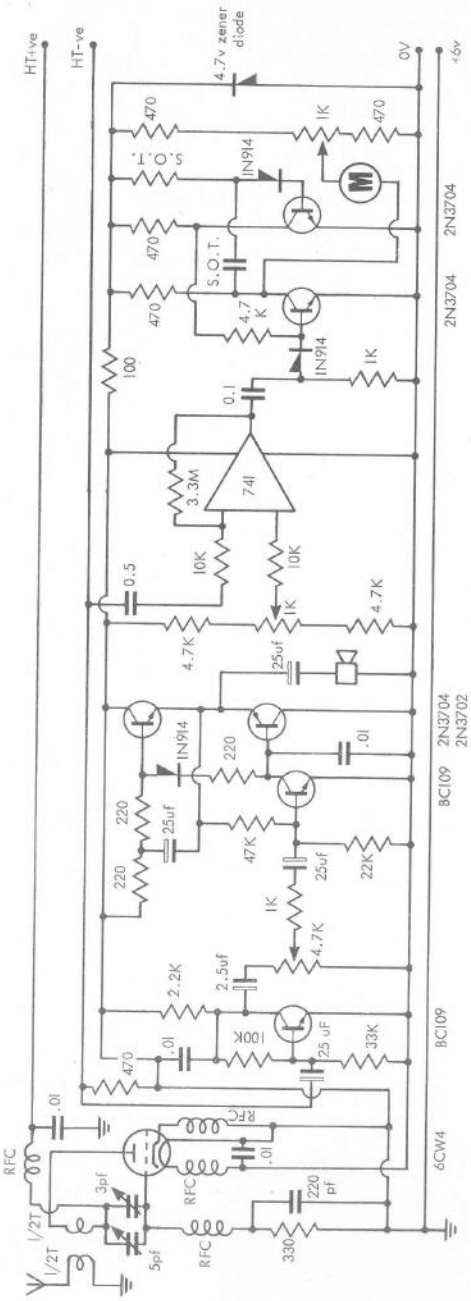
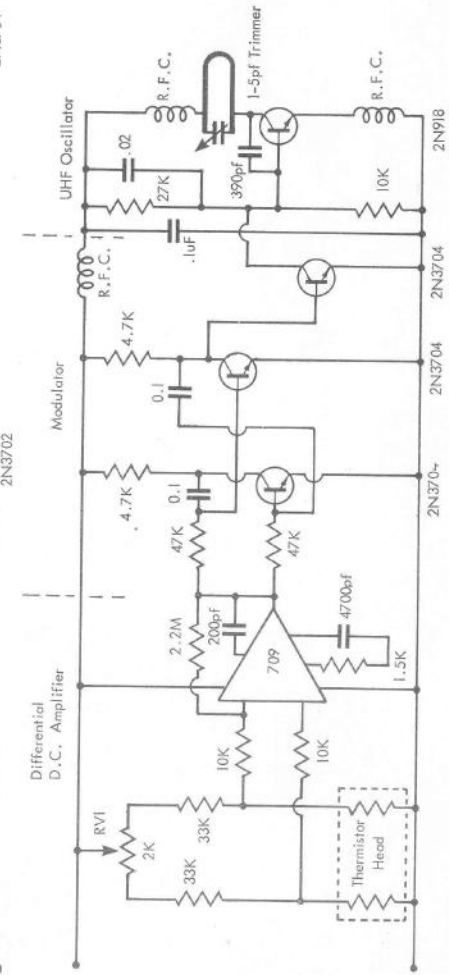
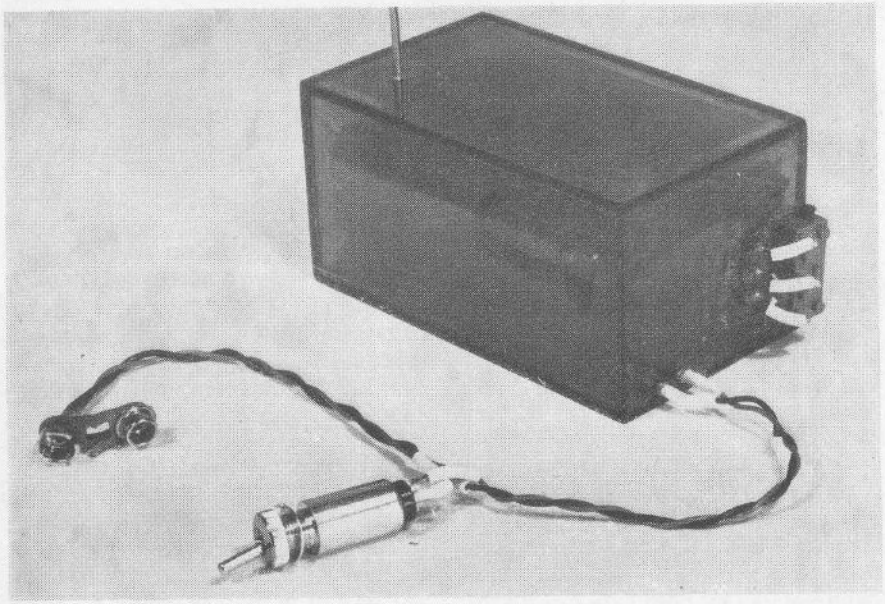


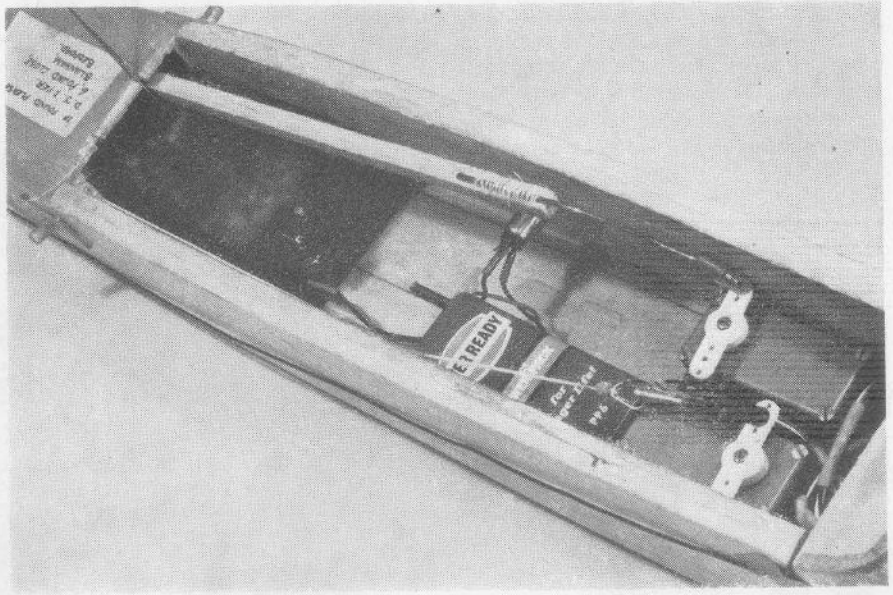
Fig. 4 transmitter theoretical circuit





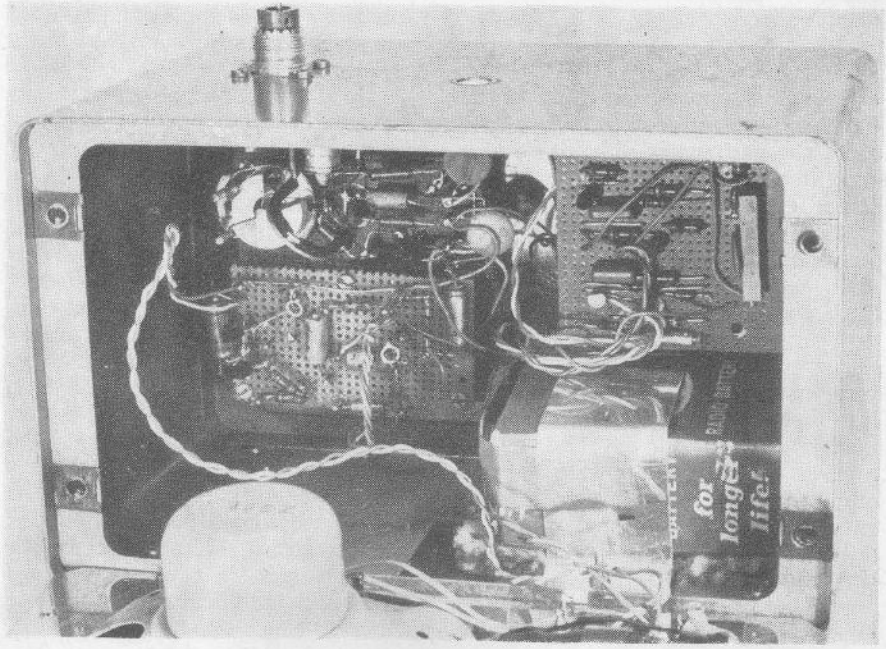
Above: The complete Variometer in made-to-measure container ready for installation in thermal soarer. Note the vertical aerial, battery leads and on/off switch.

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 Veroboard.



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.

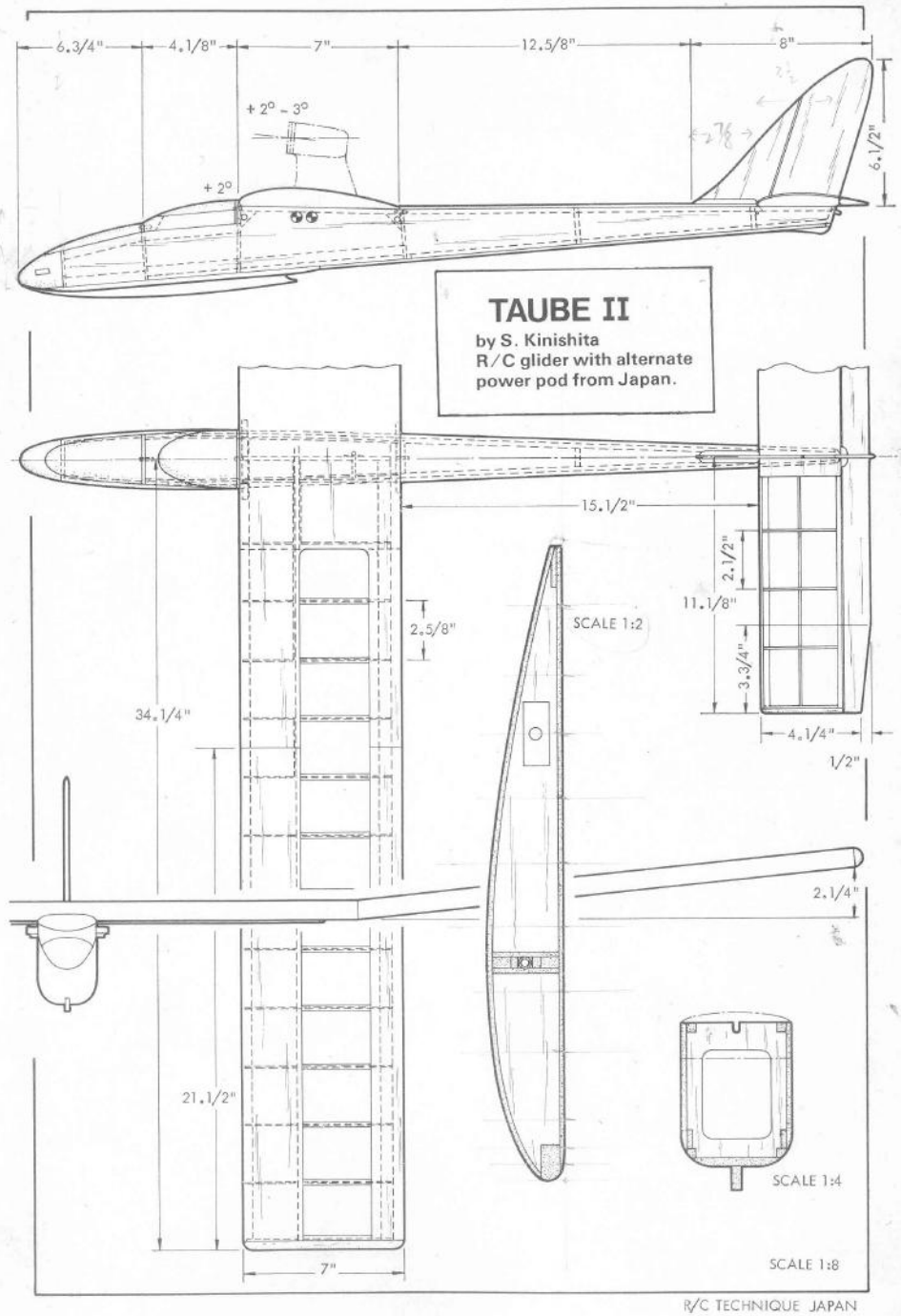
With the Vario it should now be possible to fly a more highly loaded model which will have better penetration and thus the pilot will be able to use the more ideal flight pattern of circling up in lift and moving with that lift downwind, subsequently penetrating back upwind to contact further good air.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

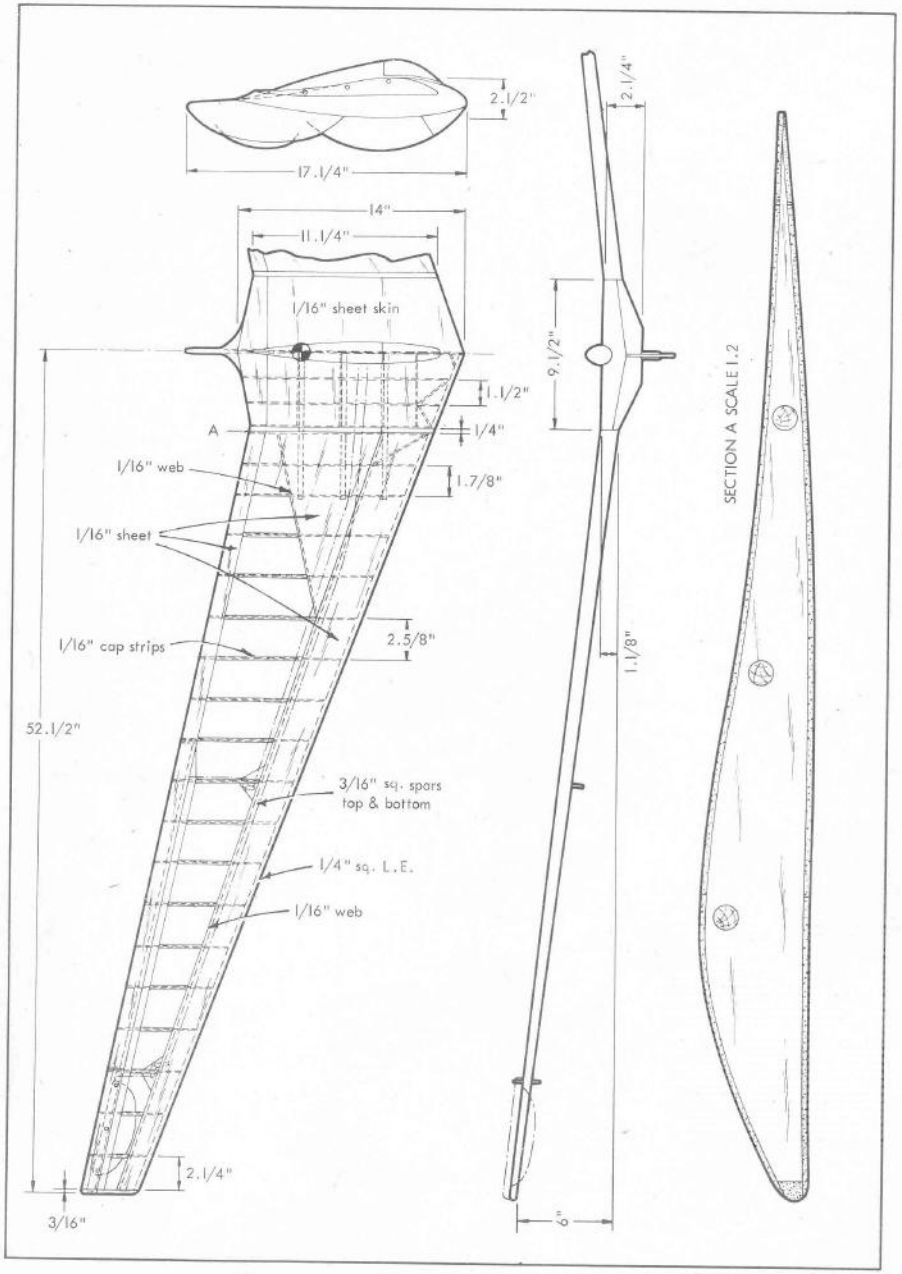


R/C TECHNIQUE JAPAN

Horton IVB

Semi-scale flying wing glider from Japan

Scale 1:12

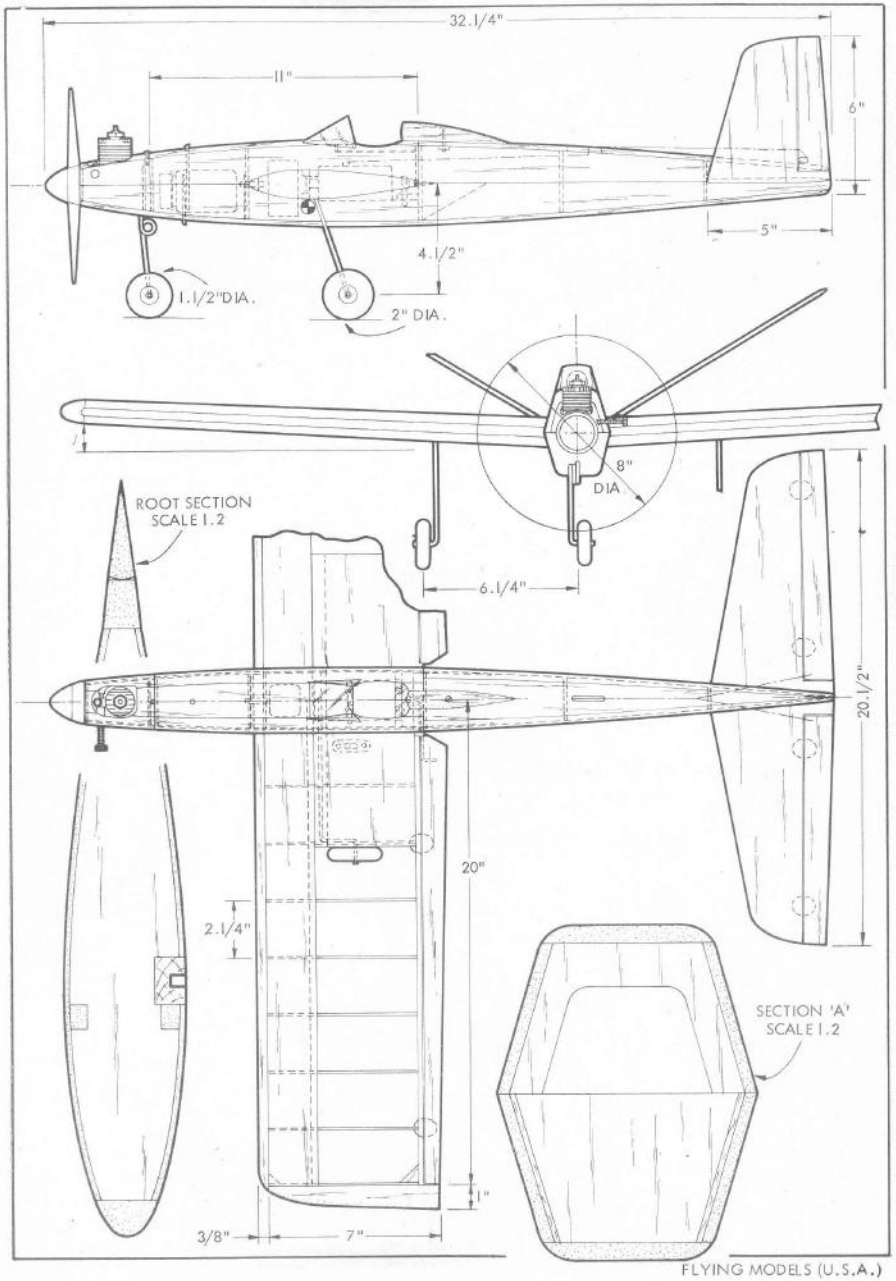


R/C TECHNIQUE (JAPAN)

Sprinter

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

Scale 1:8

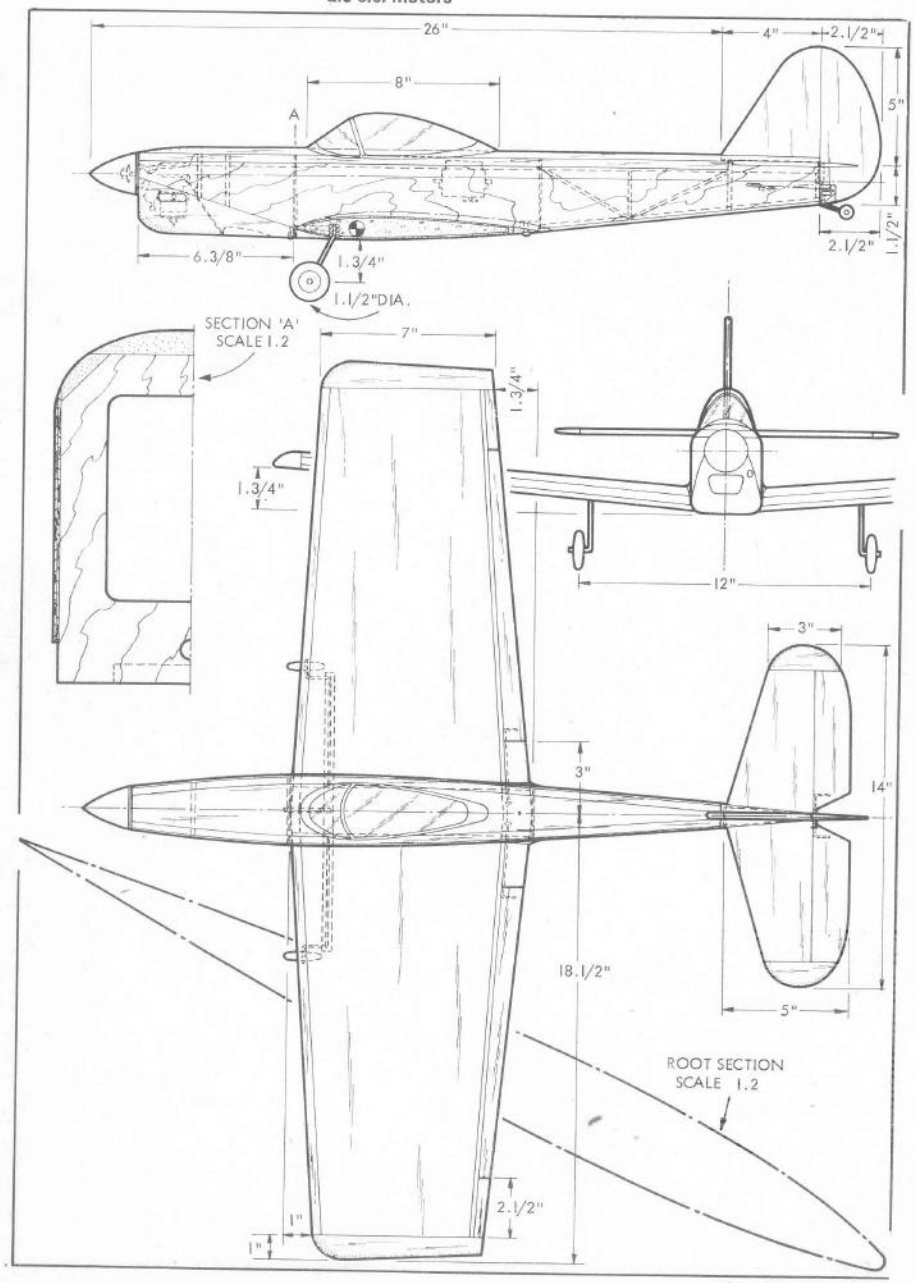


FLYING MODELS (U.S.A.)

XP-40Q Snafu

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

Scale 1:8

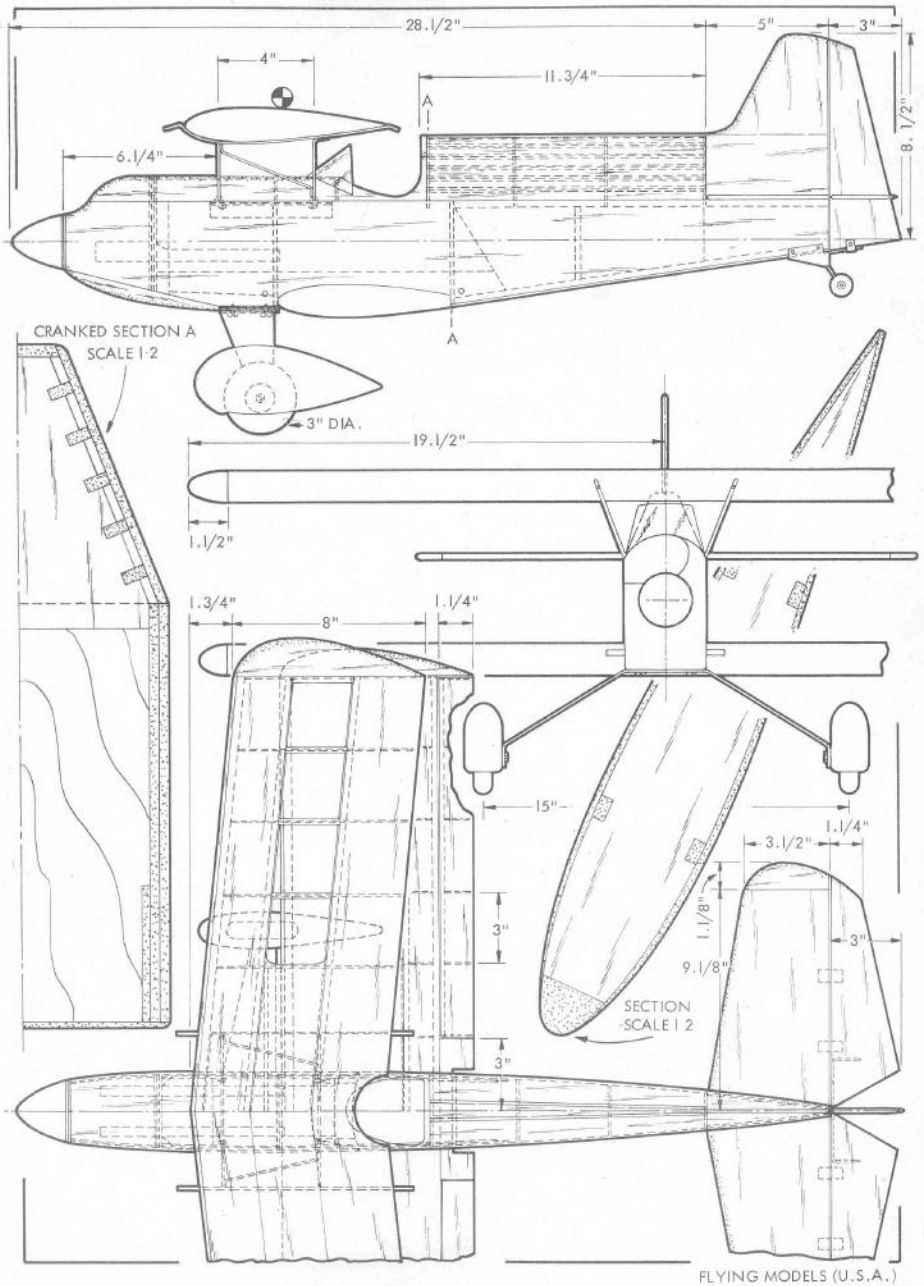


R/C MODELER (U.S.A.)

Dreamer

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

Scale 1:8

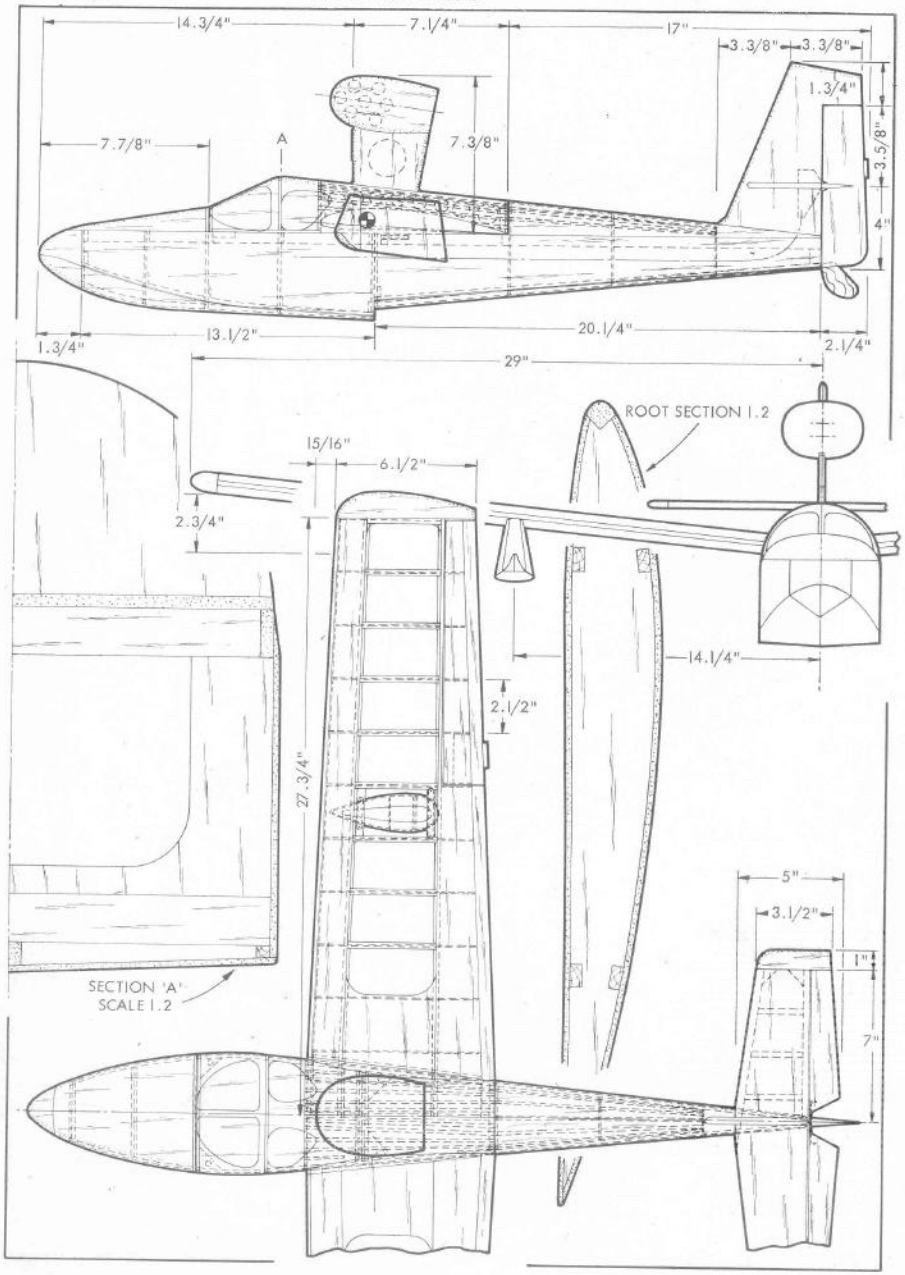


FLYING MODELS (U.S.A.)

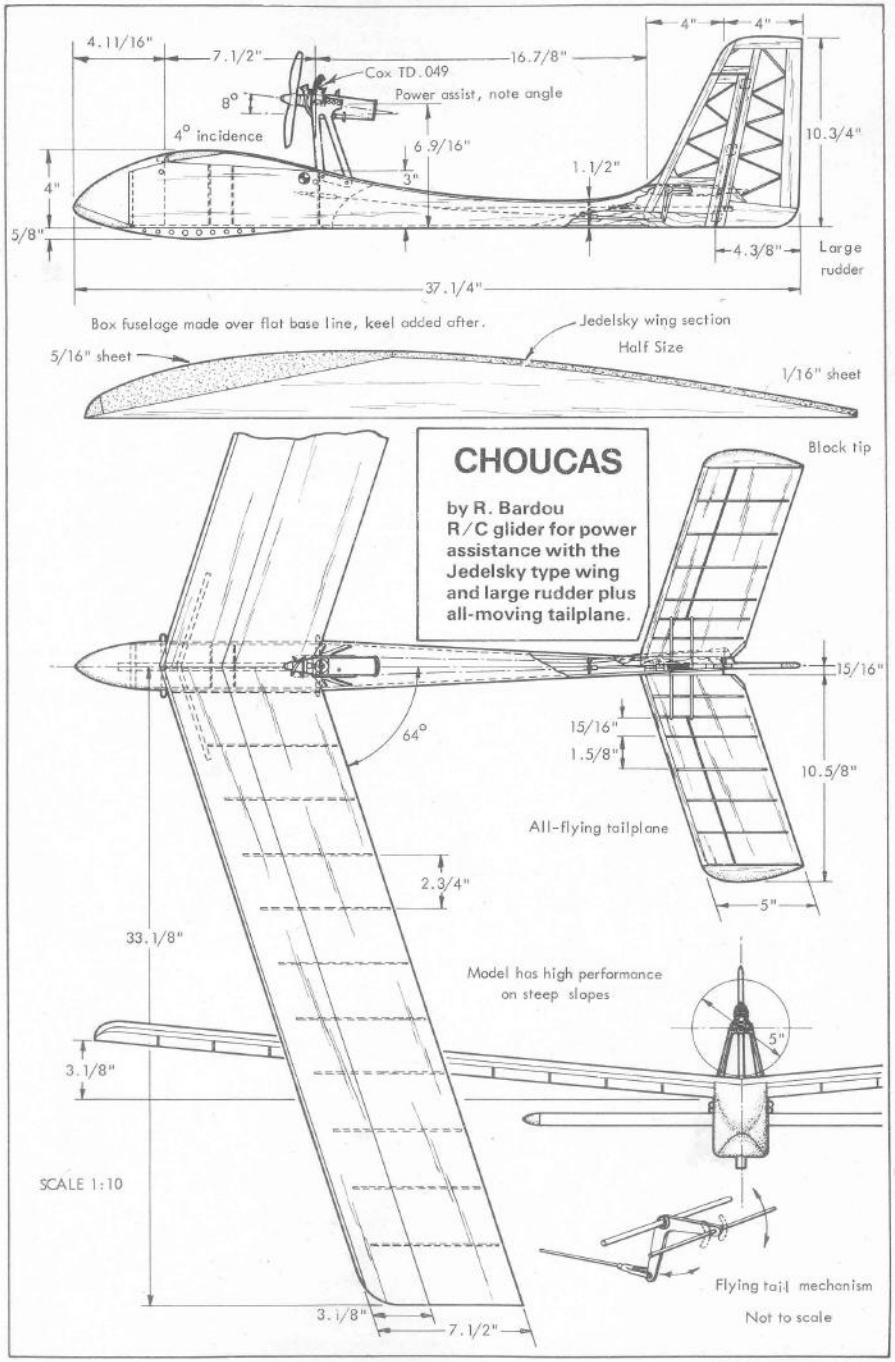
Lake Buccaneer

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

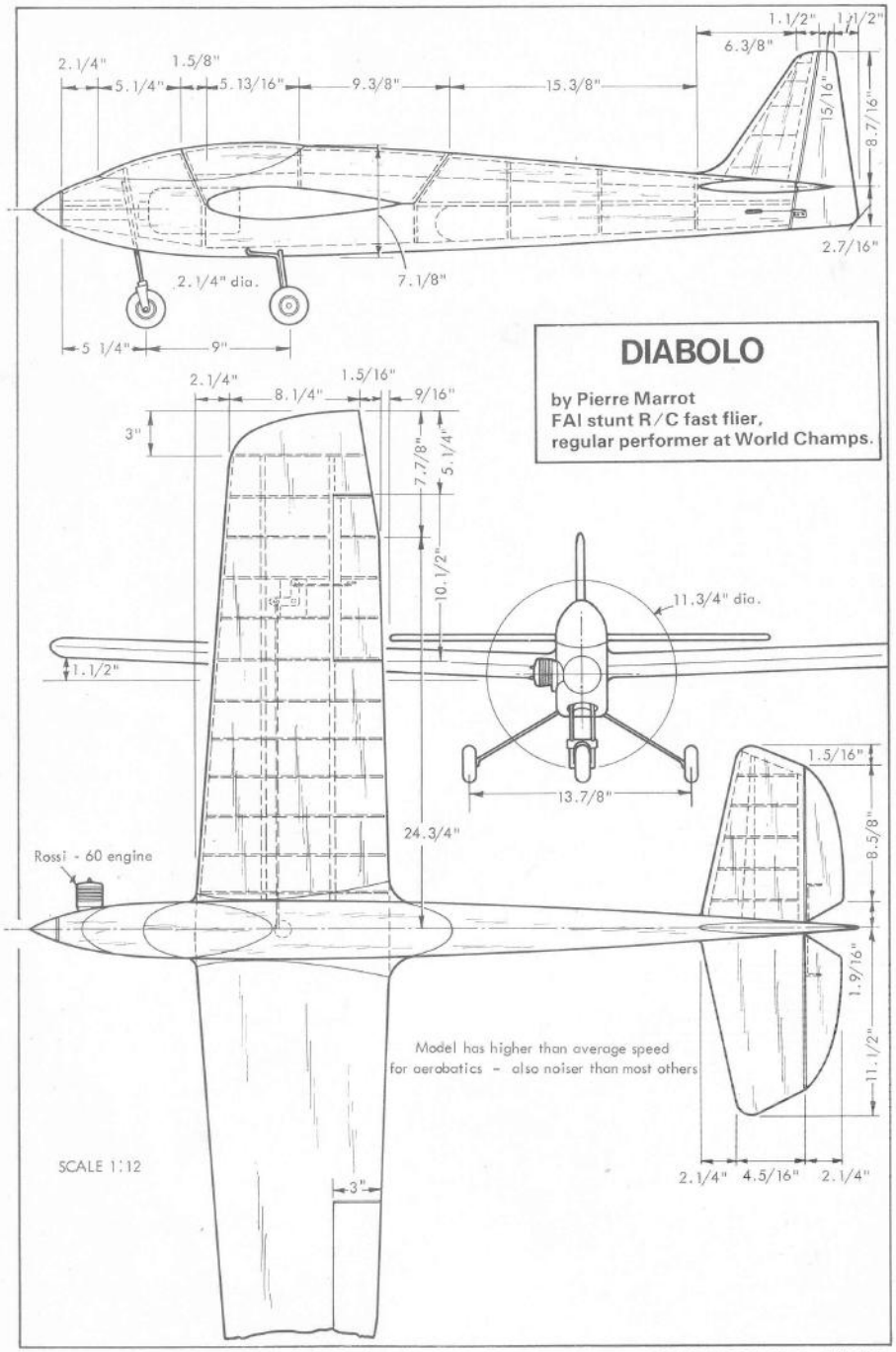
Scale 1:9



FLYING MODELS (U.S.A)



MODELLISTICA ITALY



DIABOLO

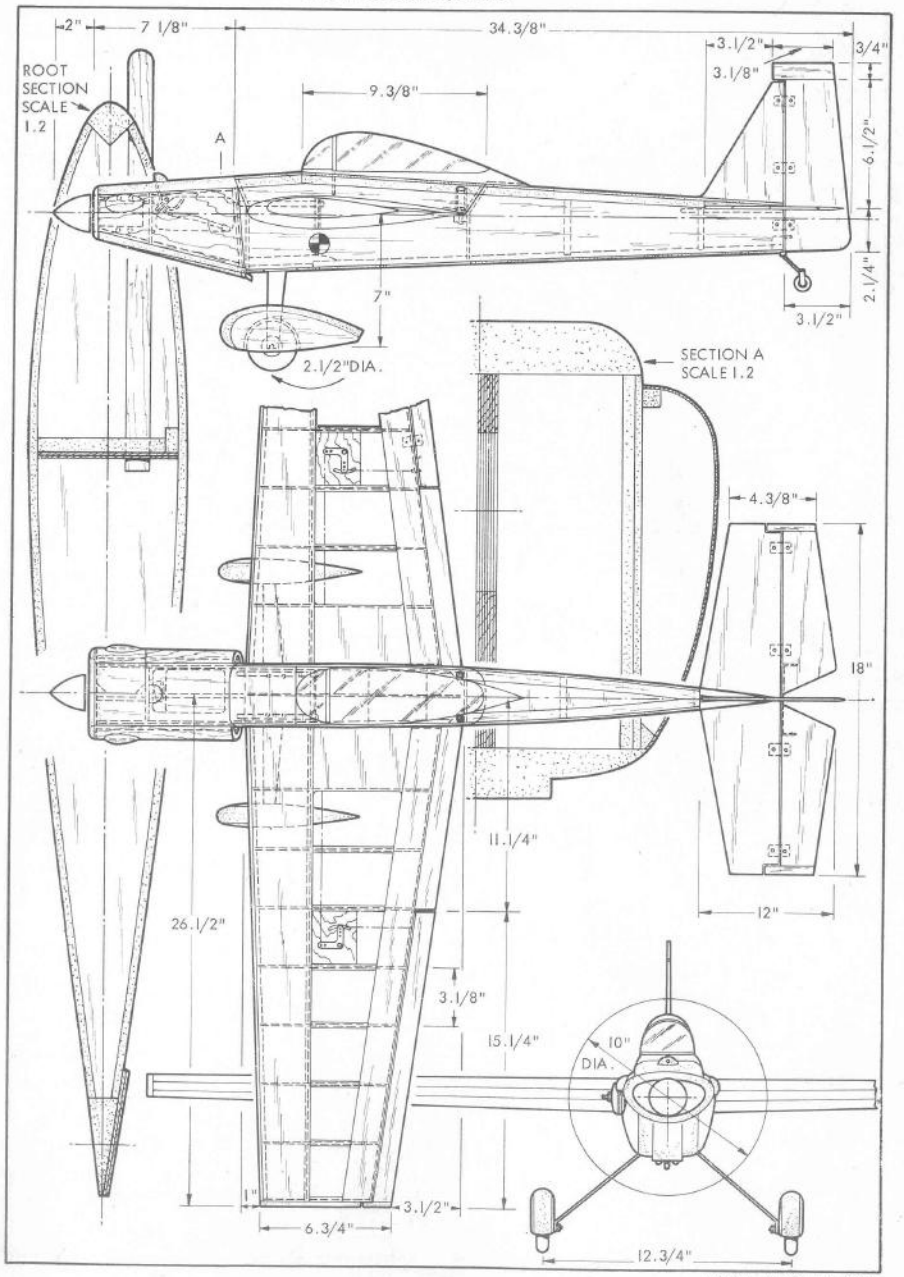
by Pierre Marrot
FAI stunt R/C fast flier,
regular performer at World Champs.

RADIO MODELLISME FRANCE

Stephens Acro

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

Scale 1:10

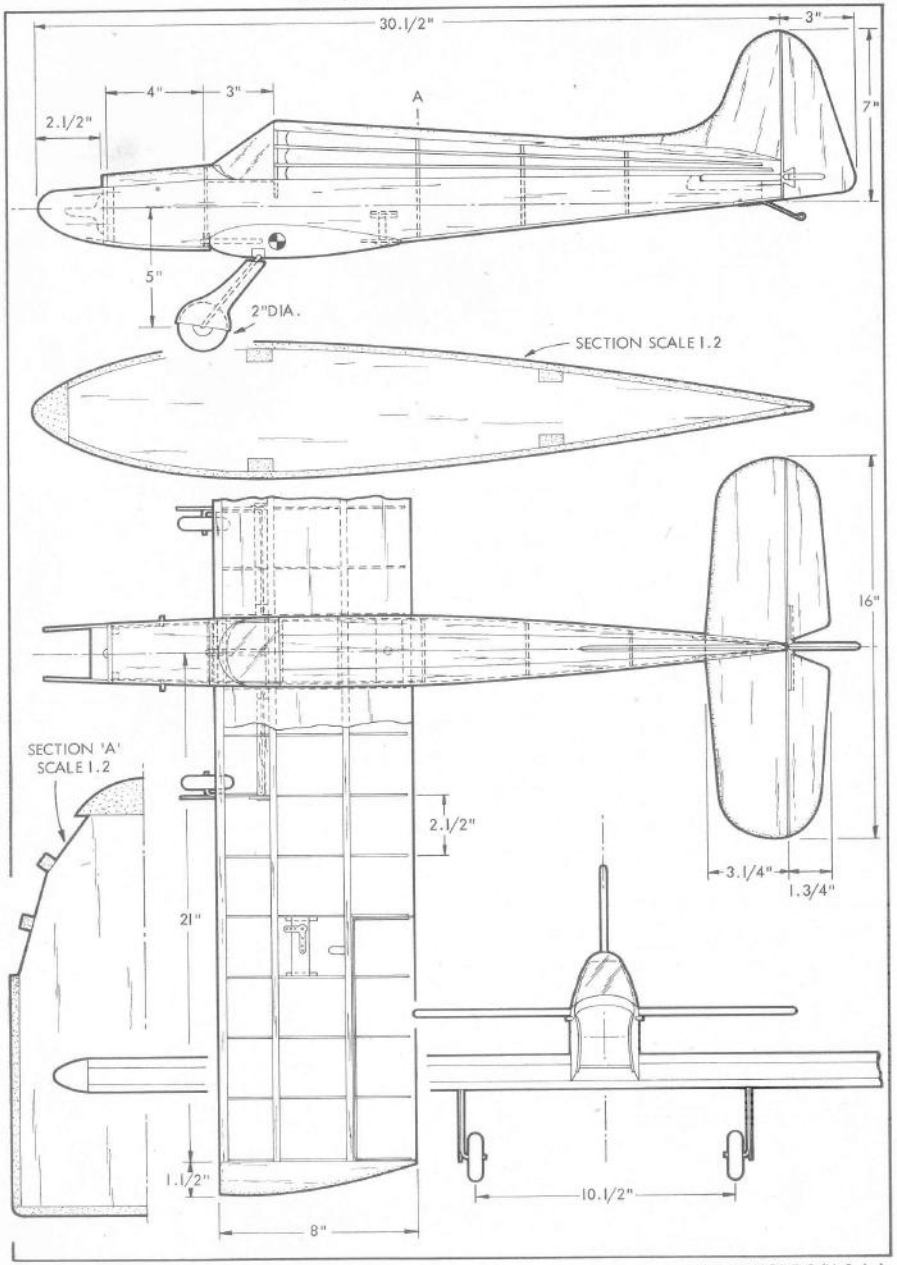


MODEL BUILDER (USA)

D.D.T.

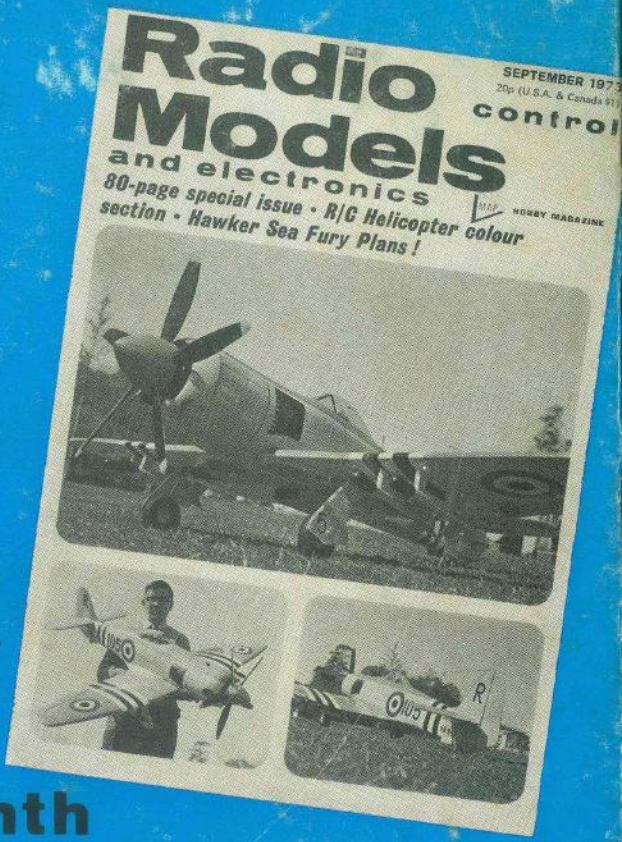
Small size sports stunter of 0.10 cu. in. motors

Scale 1:8



FLYING MODELS (U.S.A.)

TAKING IT UP?



Enjoy the hobby more every month with the

KING SIZE

Published 2nd Friday of each month

Radio control Models and electonics