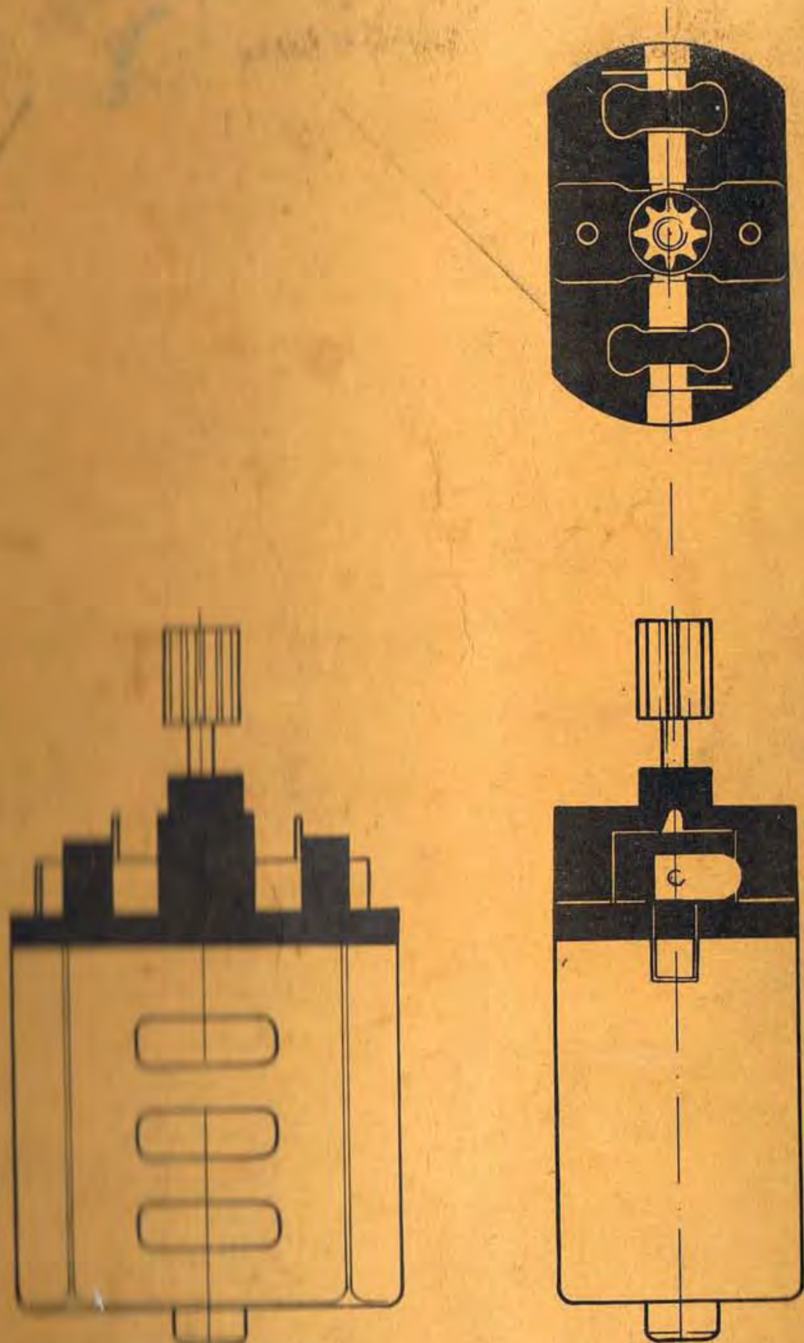
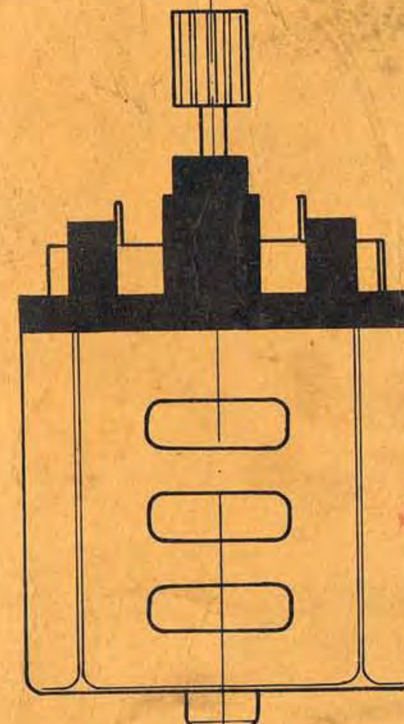


ELECTRIC Round - the - Pole FLYING

Peter Bullivant



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ELECTRIC Round-the-Pole FLYING

by Peter Bullivant

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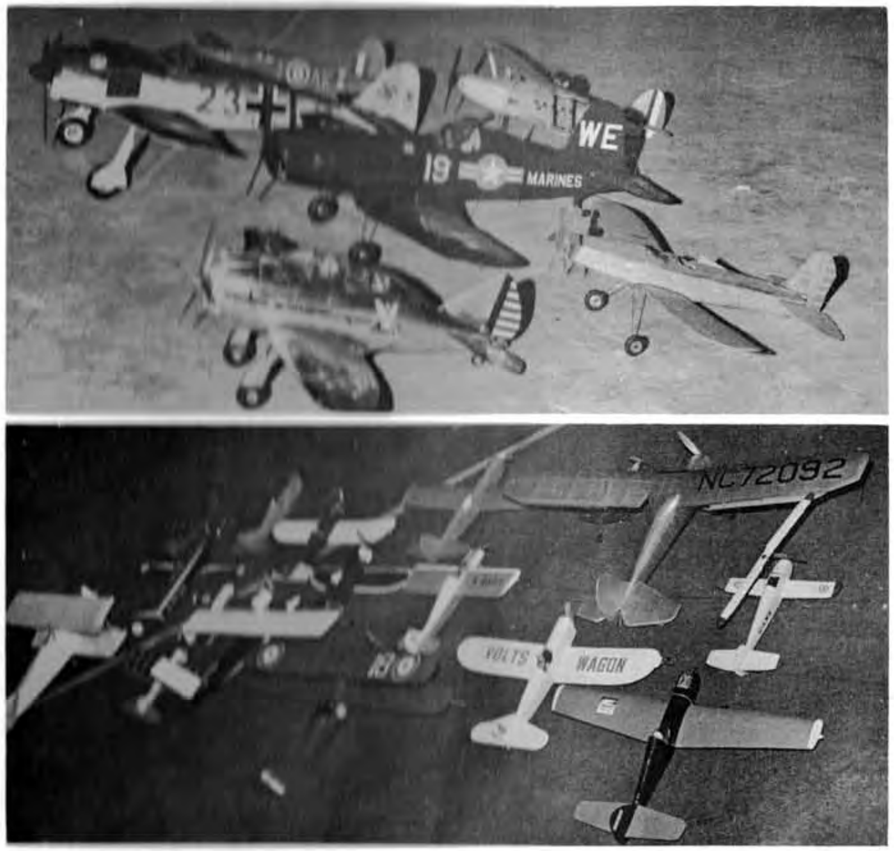

What it's all about — models from the Grantham Club

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contents

Chapter I

Electric Round the Pole Flying — a new idea?

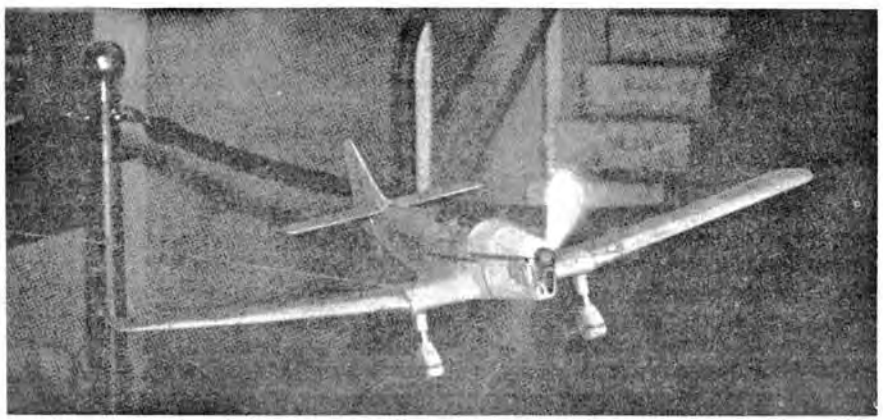
Although electric R.T.P. flying is growing in popularity the concept is by no means new.

For many years aeromodellers have attempted to build and fly electric powered model aircraft, but their efforts have generally been frustrated by the lack of suitable motors. The problem was mainly the difficulty of making electric motors sufficiently light in weight and sufficiently compact, yet still possessing power enough to produce the necessary revolutions for the propellers to generate enough thrust for flight.

Fortunately today the problem no longer exists thanks mainly to the popularity of miniature model "slot car" racing. With the increase in the following for this new sport came the necessary incentive for the development of more efficient electric motors. Model manufacturers strove in competition with each other to produce the *"hottest," "lightest," "most powerful"* power plants that could be fitted into the slender shells of these "Grand Prix" miniatures. The benefits of all this research has rubbed off on the electric model aircraft enthusiasts who are now presented with a large choice of readily available motors quite suitable for airborne use.

The first signs of serious attempts at developing electric round the pole flying became apparent at the early post-war model aircraft exhibitions held annually at the Dorland Hall, Regent Street, London. In January 1945 crowds of people visiting the exhibition were enthralled by the sight of an electric powered model Miles Magister tethered by 7ft. 6in. wires to a central pylon, taking off, circling, and landing back on a specially prepared concrete circular runway. This 1 inch to 1 foot scale model by Mr. J. S. Evans of Kettering flew more than 1,000 miles during the space of a week, wore out a pair of wheels and two electric motors, and left its impression in the concrete, caused by the wear and tear of the tyres!

Below: J. S. Evans' Famous 1/12th scale Magister in flight



Members of the public were invited to try their hands at flying the Magister in return for a small donation of 6d. per flight, the grand accumulated sum of £35 was presented to the R.A.F. Benevolent Fund at the close of the exhibition.

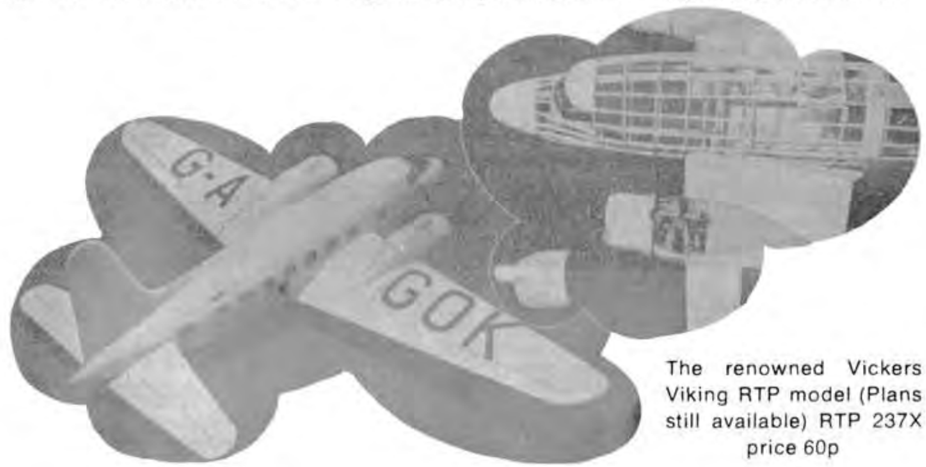
So popular was this spectacle, that in the following year, 1946, it was decided that two circular Perspex runways would be constructed, one mounted above the other to facilitate simultaneous electric flying.

Again Mr. Evans thrilled the crowds, this time with a 40 inch wingspan scale Vickers *"Viking"* airliner weighing 2½lbs. This superb model was powered by two 9oz. 18-volt motors, each developing 3,000 r.p.m. (plans for these, RTP238X: 50p) with a flying speed of 25 m.p.h. The *"Viking"* incorporated a retractable undercarriage and was controlled from a panel which ingeniously included a red warning light coupled to a warning horn should the model nose down for a landing with the undercarriage still in the "up" position. The red light was automatically cancelled by a "green" the moment the undercarriage was safely locked down. During its exhibition the Viking flew a distance of well over 3,000 miles.

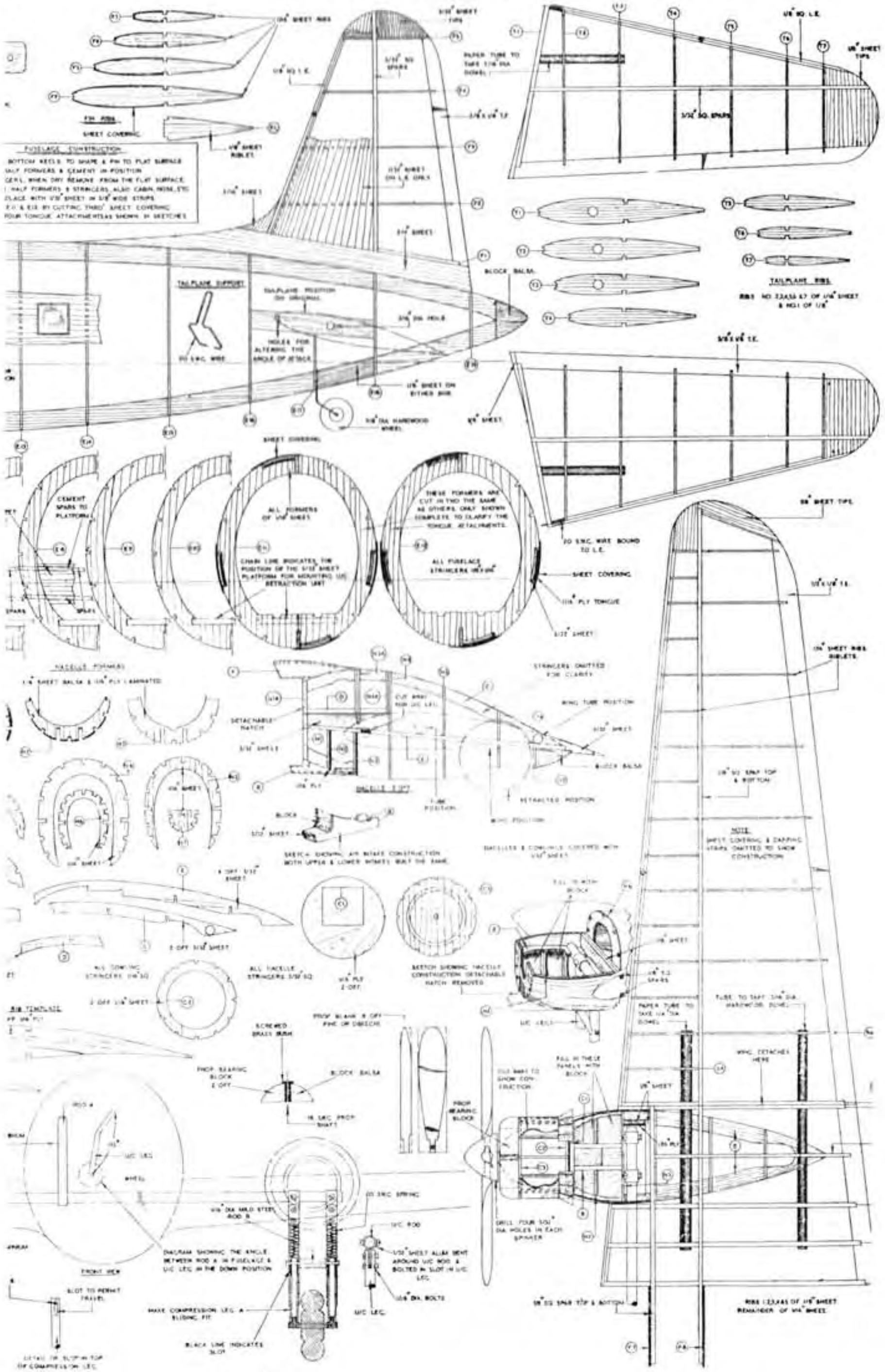
Flying from the lower Perspex circular landing strip, a 7oz. design by Flt. Lt. Tucker, "Vertric," demonstrated the use of elevator control. Wool tufts were attached to the wing tips to illustrate the effects of "tip vortices" to the audience, supported by a commentary.

Although plans of Mr. Evans' Vickers Viking appeared in the "Aeromodeller" for the months of May and June 1946, and many of these plans (still available as RTP237X: price 60p) were sold through the Aeromodeller Plans Service, electric R.T.P. flying did not at that time gain the popularity that was hoped for. For many years electric R.T.P. remained somewhat the "Cinderella" of the world of aeromodelling, no doubt due to the complexity of having to produce one's own electric motors.

Undoubtedly "specialists" were still experimenting with this type of flying, and in September 1963 scale model enthusiast Doug McHard published a most enlightening article on the



The renowned Vickers Viking RTP model (Plans still available) RTP 237X price 60p

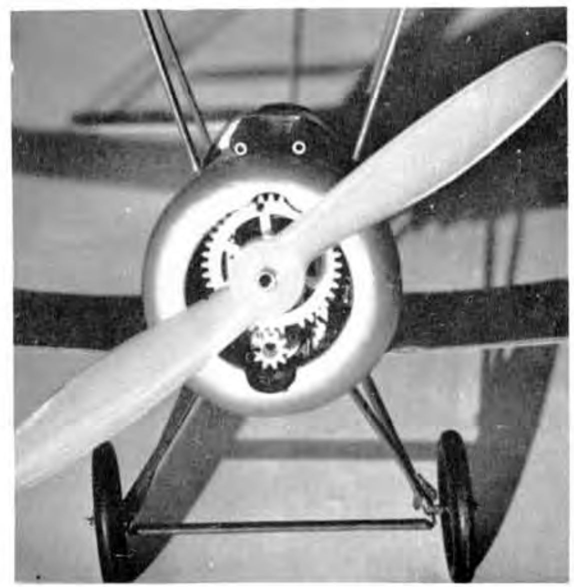


subject in *"Model Aircraft."* Mr. McHard described his experiments using low voltage imported Mabuchi 25 electric motors incorporated in those evergreen popular cheap free flight rubber scale Keilkraft kits. His models were flown on 6ft. 32 s.w.g. enamelled wires, the power being led out to the aeroplane from a model train mains transformer/controller via a central pylon which incorporated an electrical distributor. Undoubtedly this article did much to inspire many modellers to pioneer this new form of flying.

The 1968 *Model Engineer Exhibition* at Seymour Hall, London, showed a revival of interest in this comparatively untouched branch of aeromodelling. Perfectly standard *Frogflite* kit

Above, and at right, two views of Doug McHard's Sopwith Camel which performs well with a 16D type motor and 4:1 gears driving a KeilKraft nylon 5 x 3 prop.

Opposite, a clipping from the Aeromodeller Plan for the Vickers Viking, Plan RTP 237X, Price 60p



models had been adapted to take Riko "Whip" 16D slot car motors, and flown by the staff of Model & Allied Publications Ltd. on .030in. shellaced copper wires, the models received applause from the enthusiastic audiences.

Following a series of experiments in a local school hall by the staff of Model & Allied Publications Ltd., a heartening article on electric R.T.P. flying appeared in the March 1969 *"Aeromodeller"*. Conclusions reached were that any standard *Frogflite* kit model could be successfully adapted to fly with the aid of an electric slot motor, and larger more sophisticated model aircraft could also be modified to fly "electric" by modellers of limited building experience. The secret in this case was the use of simple reduction gearing in the region of 4:1, this permitting the use of larger propellors.

The same year, 1969, saw the publication of another informative article by American electric R.T.P. exponent Pat March. Included in his article in the *"American Aircraft Modeler"* for August, were plans of his highly successful sport design "Voltswagon" details of which appear elsewhere in this book.

The effective results of all this published "know how" became apparent in 1970 when electric model flying clubs and groups began to spring up in many parts of the country. One such group of flyers, a branch of Grantham and District Model Aircraft Society, were fortunate in having obtained the regular use of a large R.A.F. drill hangar. With so much available space they were able to "spread their wings", starting at the beginning with lines of 15 feet they progressed rapidly until the sight of four models flying simultaneously around one central pylon on 40ft. lines was just a weekly occurrence!

1970 was significant to all electric enthusiasts. The demonstrations of electric model flying at the *Model Engineer Exhibition* were of remarkably high standards. The central pylon carrying the power wires to the model aircraft was erected on an "island" in the centre of a large circular model boating pool. The runway strip surrounded the pool and added "interest" to the landings and take-offs, the misjudgement of which quickly converted the aircraft to an unfamiliar role — that of submarinecraft!

This outstanding display of modelling ingenuity left even the sceptics of the modelling fraternity with not the slightest doubt that electric R.T.P. flying was "growing up". Keen R.T.P. flyers from Bristol, Debden, Grantham and Luton turned up in force with a selection of models, the equivalent of which had never been seen before, scale, stunt, speed, multi and novelty models, all driven by slot motors. An example of the sheer ingenuity and originality displayed was an electric powered Republic "Lancer" P.35 which American modeller Pat March had shipped across the Atlantic for the Grantham lads to exhibit. This beautiful metal foil paper covered scale fighter incorporated a retracting undercarriage operated via a polarity reversing switch.

We have barely "scratched the surface" of this comparatively untouched field of aeromodelling. If you like exploration, read on!

Three Frogflite kits which adapt easily to Electric power are the Ryan PT.20, D.H. Chipmunk and the Hawker Fury in photographs opposite. Each uses the 16D size motor and has been employed at the Model Engineer Exhibition displays

Chapter II

Setting up — the "ELECTRICS"

Before describing the electrical components required for the operation of electric R.T.P. model aircraft, let it be understood that the electrical circuit is simplicity itself, but, like all matters "electrical", it is essential to ensure that everything is "fire proof". Incorrect wiring to the mains transformer/controller or to 12 volt batteries can rapidly cause short circuiting, overheating, and possible combustion. Similarly, hand speed controllers must be "man enough" to cope with the current to be used. If doubtful, you would be wise to consult a qualified electrician, or someone with reliable electrical knowledge.

Let us begin by studying the circuit diagram (fig. 1) to understand the "plumbing".

From the power source (usually 12 volts direct current, or more) the current passes through a suitable controller, a rheostat along twin flex to a central pylon which acts as a distributor for the power supply to the model.

From the central pylon the current is supplied to the electric motor in the model aircraft through a pair of 28 s.w.g. to 30 s.w.g. fine shellaced copper wires. (These are attached to the

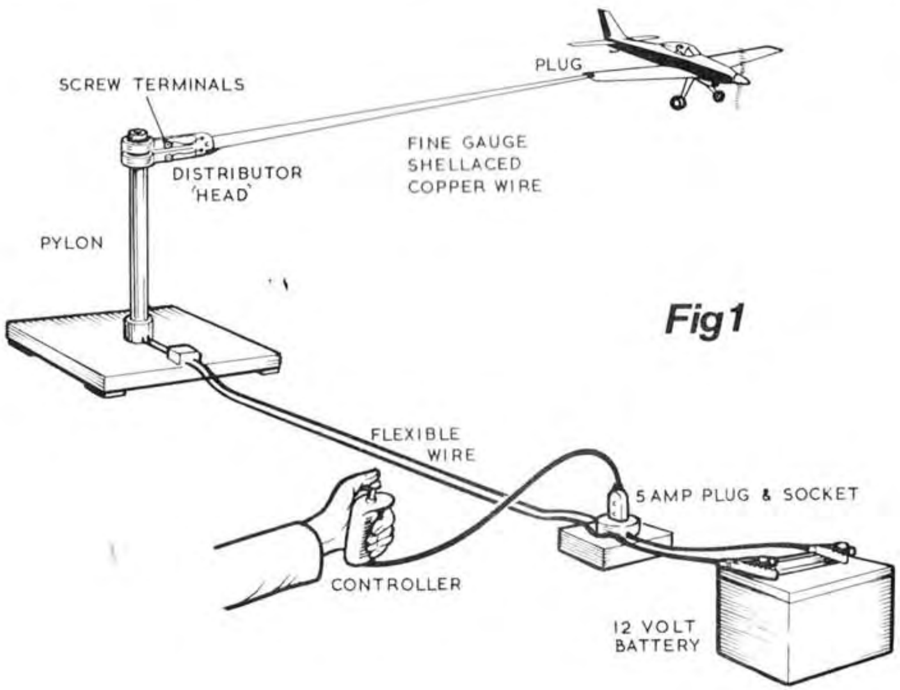


Fig 1

screw terminals on the pylon at one end, and to a suitable plug or terminals mounted in the wing tip of the model at the other end.).

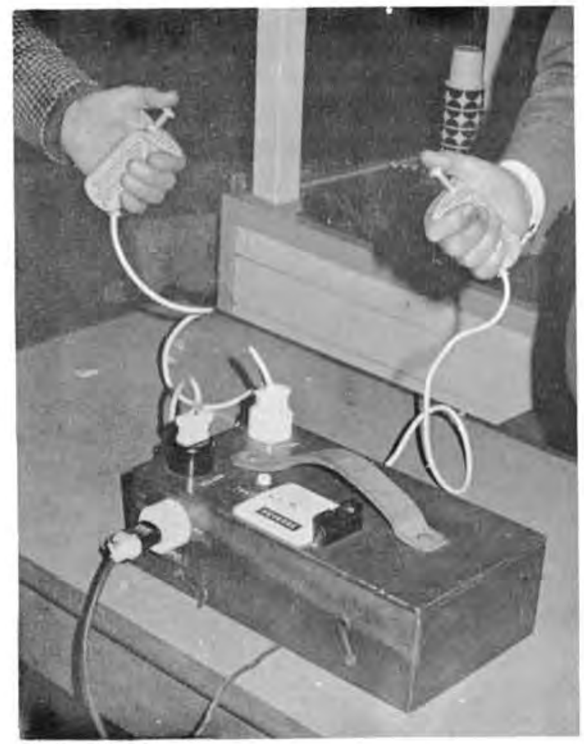
Having completed the circuit to the model, the current is then returned from the pylon to the original power source via the twin flex.

THE POWER SOURCE

This can be either a transformer/rectifier suitable to convert the household mains down to between 16 and 12 volts d.c. or one or more 12 volt batteries connected in series. The current required depends on the amount the Voltage is reduced by the resistance of the fine shellaced wire to the model (The longer or finer the gauge of the wire, the greater the voltage drop).

If a transformer/rectifier is to be used as the power source, care must be taken in the selection of a suitable type. Certain types of transformers, of the kind used for model railways, are totally unsuitable for model aircraft flying as they incorporate automatic overload cut out switches which can be quite disastrous, particularly as they usually cut out at the precise moment maximum power is required for the model. A transformer/controller with an output of at least 1.5 amps is generally quite suitable.

The use of 12 volt car batteries is in many ways simpler and more reliable. The obvious drawback is that they are bulky and heavy to carry and liable to be spilt. However, suitable carrying cases can easily be made, or use made of converted wooden crates, fitted with handles, or strong webbing straps for ease of transportation.



Two Riko push-button speed controllers linked into the main control box as used by the Grantham Club

If more than one car battery is to be used, then they should be connected in series by the use of reliable heavy duty cables fitted with suitable crocodile clips of the kind readily available at most garages or hardware stores.

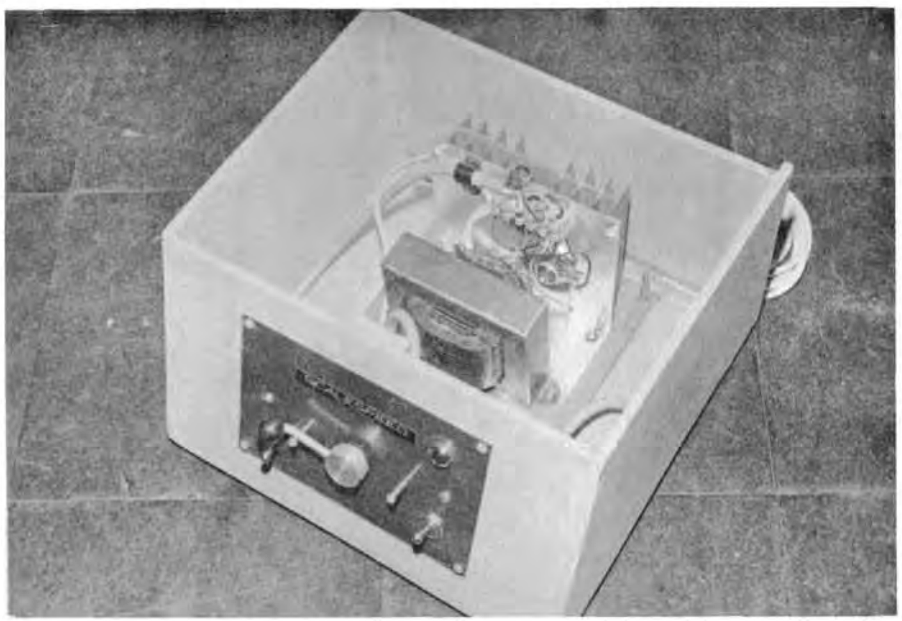
THE CONTROLLER

The speed controller or rheostat is a very important component, the type selected for use must be capable of providing wide variations of current output to the model, without danger of overheating or failing.

For flying on moderate length lines up to 20 feet with a maximum current of 24 volts the *Riko* 7.5 ohm push button controller is an admirable choice. This slot car controller is supplied commercially with a three pin plug, this should be removed and substituted by a similar sized two pin plug, and the "brake" feature disconnected. A simple two pin 5 amp "Woolworths" plug is quite suitable for use with a matching socket which can be incorporated at a suitable distance along the twin flex leading from the power source to the pylon.

For ambitious flyers who may wish to fly more than one model simultaneously from the same pylon, it is a good idea to construct a control panel to which the desired number of 5 amp sockets are screwed. It is then necessary to multiply the number of electrical circuits to the pylon which itself must incorporate the same number of distributor heads. The panel can incorporate a simple "throw" switch to reduce the landing run of the models by reversing the current polarity.

Experiments carried out by the Grantham club using 40ft. lines, resulted in the necessity to step up the current to the model due to voltage losses. It was found that the Riko hand controllers were overheating after repeated use with 48 volts power source (four car batteries in series). To overcome this problem it was decided to use a suitable heavy duty rheostat of the type used for dimming theatre lights. This proved very satisfactory, and the rheostat had the additional advantages of a sliding lever control, which provided subtle control at low speeds,



and the facility to leave the lever in any desired position allowing the model to fly "automatically" or "ticking over" on the ground.

For readers who intend "flying electric", and who wish to progress to long lines, a very suitable rheostat with a rotary control movement is available from Messrs. G. W. Smith & Co. (Radio Ltd.), 11-12 Paddington Green, London, W.2. Price: £1.37½ plus 7½p (postage). It is necessary to modify this type of rheostat to include a suitable handle, as they can get very hot to hold after only very short periods of operating. For this purpose a 9in. flat strip of mild steel can be bent into a right-angle at its centre, ¼in. drilled at one end, then fitted to the centre of the rheostat over the spindle, and locked with the nut provided. Alternatively the rheostat can be mounted on a panel or in a small wooden box. Finally a suitable (radio type) knurled operating knob must be obtained and fixed to the spindle by use of the grub screw provided.

The PYLON

This can be a fairly simple affair and there are already a variety of designs in use by different groups of electric flying enthusiasts.

At the 1968 *Model Engineer Exhibition* the Aeromodeller staff successfully designed and operated a simple pylon head developed from standard Meccano parts. This head was

Left, the controller made by "Scale speed" for Aeromodeller to use at the Model Engineer Exhibitions. Right, Peter Hunt operates the easily adapted 25 Ohm F100 Heavy duty Rheostat described above in the text

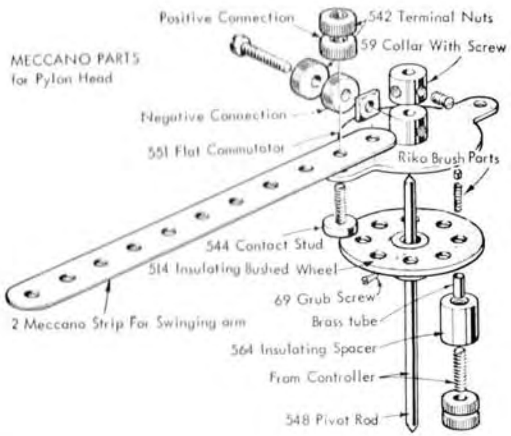


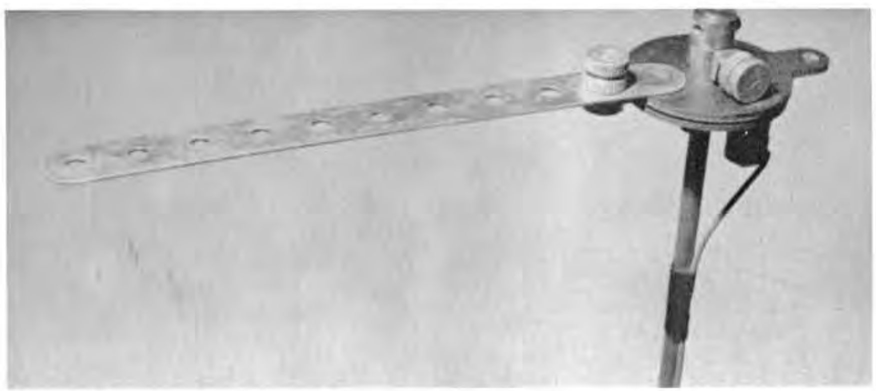
Fig 2

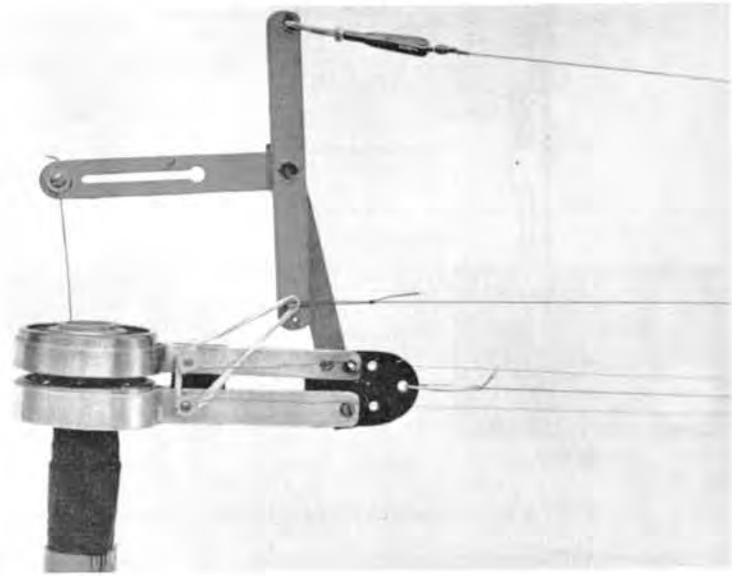
mounted at the top of a pylon mast which was firmly fixed to a sturdy base (see fig. 2).

Another group of flyers who also use *Meccano* for their pylon, the "Bristol Bulldogs", also incorporated provision for elevator control. The joystick unit, which is used in conjunction with the pylon, is operated from outside the flying circle. The joystick incorporates a very useful line trimming device, and a throttle lever controller based on electric train principle which can be pushed past a neutral position to reverse the current direction and thereby provide reverse thrust for shorter landing runs (Fig. 3).

A very reliable and cheap pylon, originally designed by well known modeller Doug McHard, and used extensively by Grantham club, is shown in the accompanying photograph. (See also fig. 4). Details of construction are as follows:

A sturdy plywood or metal base is used to support a hollow pylon made from either plastic, wood, bamboo, or similar non-conductive tubular material. (Giant size plastic knitting needles are ideal for the purpose). Slightly imperfect used ball races can usually be purchased from a local garage and used as the main swivel contacts of the pylon head. The wires or twin flex from the power source should be passed through a hole in the base, then taken up a groove filed in one side of the pylon tube. The wires should be soldered one to each centre of the two ball races. The races should then be force-fitted over the top of the pylon tube slightly





Above: The Doug McHard pylon made for use in the Grantham Club, with bell-crank addition for model control.

Right: Meccano parts are used for the Aeromodeller Pylon, details also seen in photo opposite and sketch at top of page.

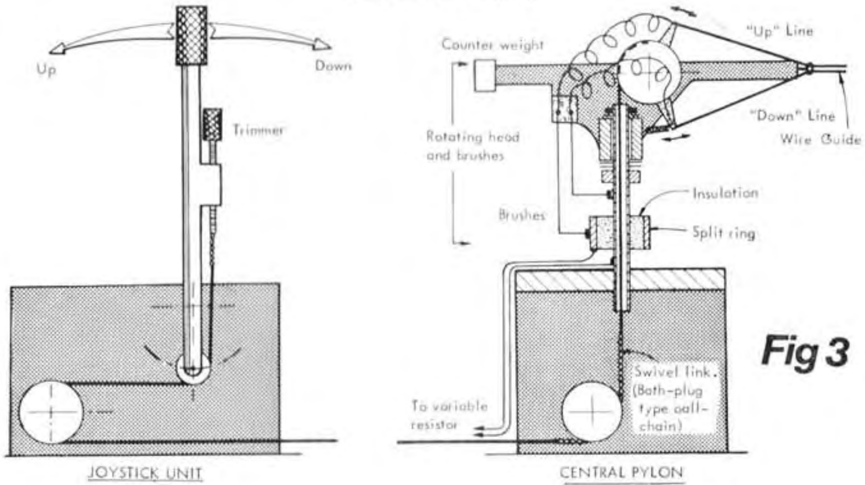
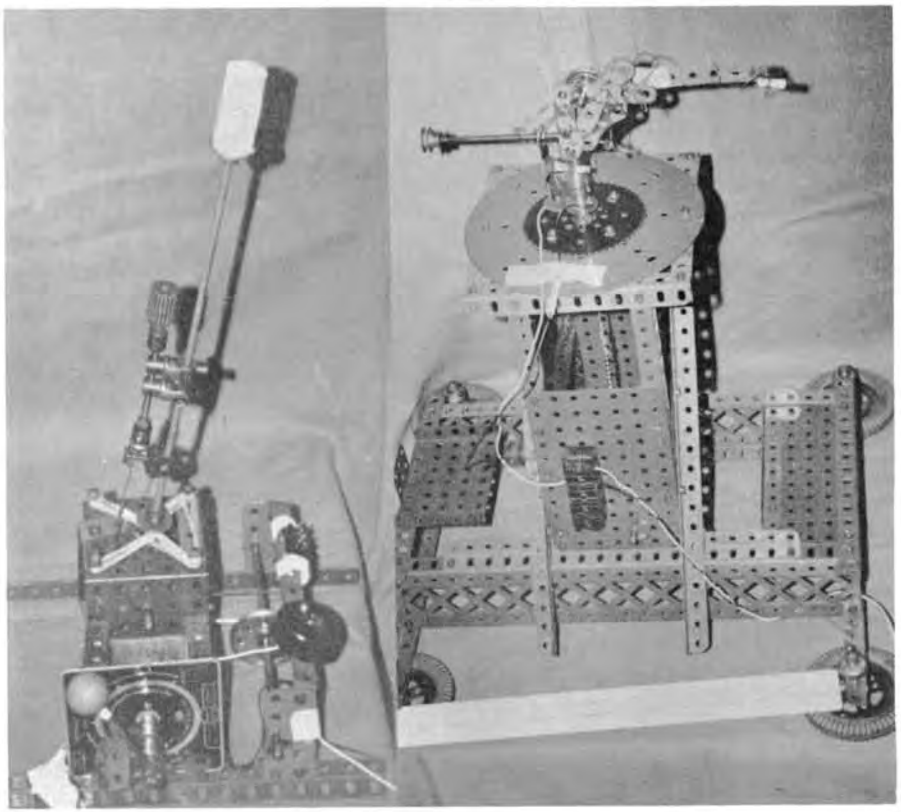


Fig 3

Details of the pylon made from Meccano by R. Redman of Bristol



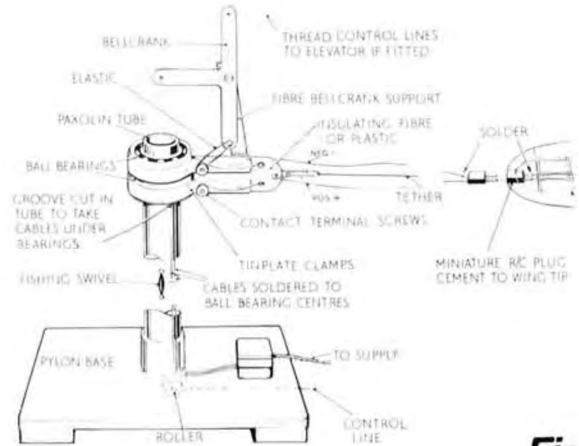
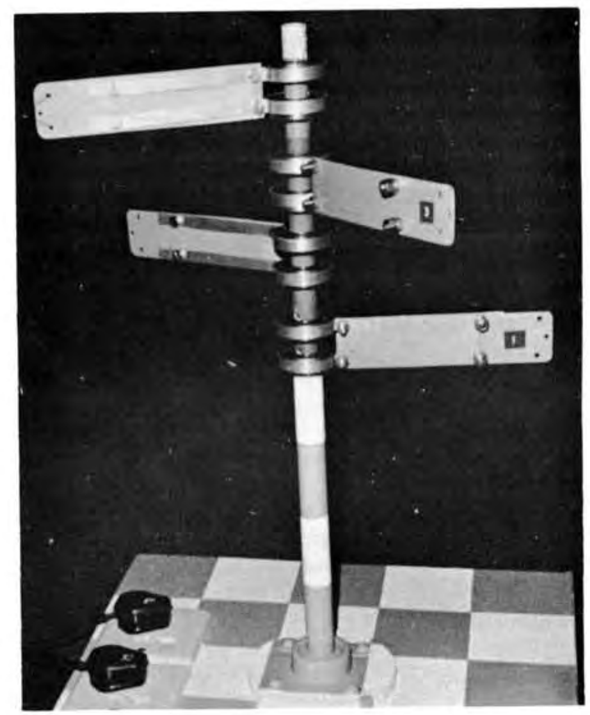


Fig 4

Diagram above shows the application of a bellcrank for elevator control on the Grantham pylon made by Doug McHard.



At right, a development of the pylon sketched above is this "four-headed" used for duration flying by Grantham Clubsters.

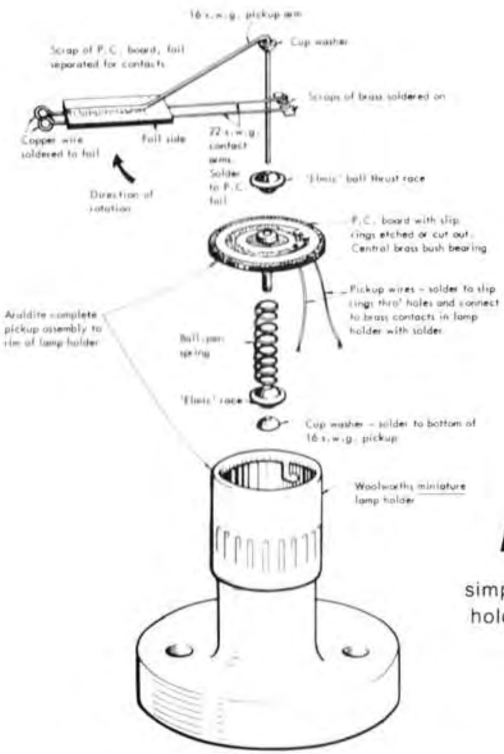


Fig 5

simple application of a lamp holder by John Simmance

separated from each other. Two contact strips of tin plate or duralumin cut to suitable length, are next formed by bending around the ball races and secured to a piece of insulating Paxolin, fibre, or plastic strip, which acts as a distance piece between the two arms formed by the contact strips. Suitable terminal screws also help to secure the contact strips in position around the ball races.

Only a simple conversion of the head is necessary to provide the facility for elevator control of the model plane. Fit a bellcrank to the head as shown in the diagram (fig. 4). A rubber band can be used to provide a self-centring action at the bellcrank. A control line is attached to the bellcrank and is passed down through the hollow pylon, attached to a fishing line swivel, then continued around a suitable fairlead or roller, out under the base close to the ground to the outside of the flying circle to a "joy stick" control. Alternatively the control line can be run through an eyelet in a piece of curved "styrene" card taped to the ground, thence to the operators' hand.

A more advanced pylon incorporates no less than four distributor heads as shown in the photograph on previous page. This pylon, made by Peter Hunt, of Grantham, provided his fellow club members with countless hours of exciting racing and formation flying, four up!

If you prefer to construct an alternative pylon to all these, how about the ones shown on figures 5 and 6? The pylon, designed by American electric model exponent Pat March, has been very successfully used by the Tri-County Club in the U.S.A. since 1966. The pylon (fig. 6) was first built using a piece of Plexiglas (Perspex) shaped by hand drill and file. The head was fitted to a wooden beam screwed into a base.

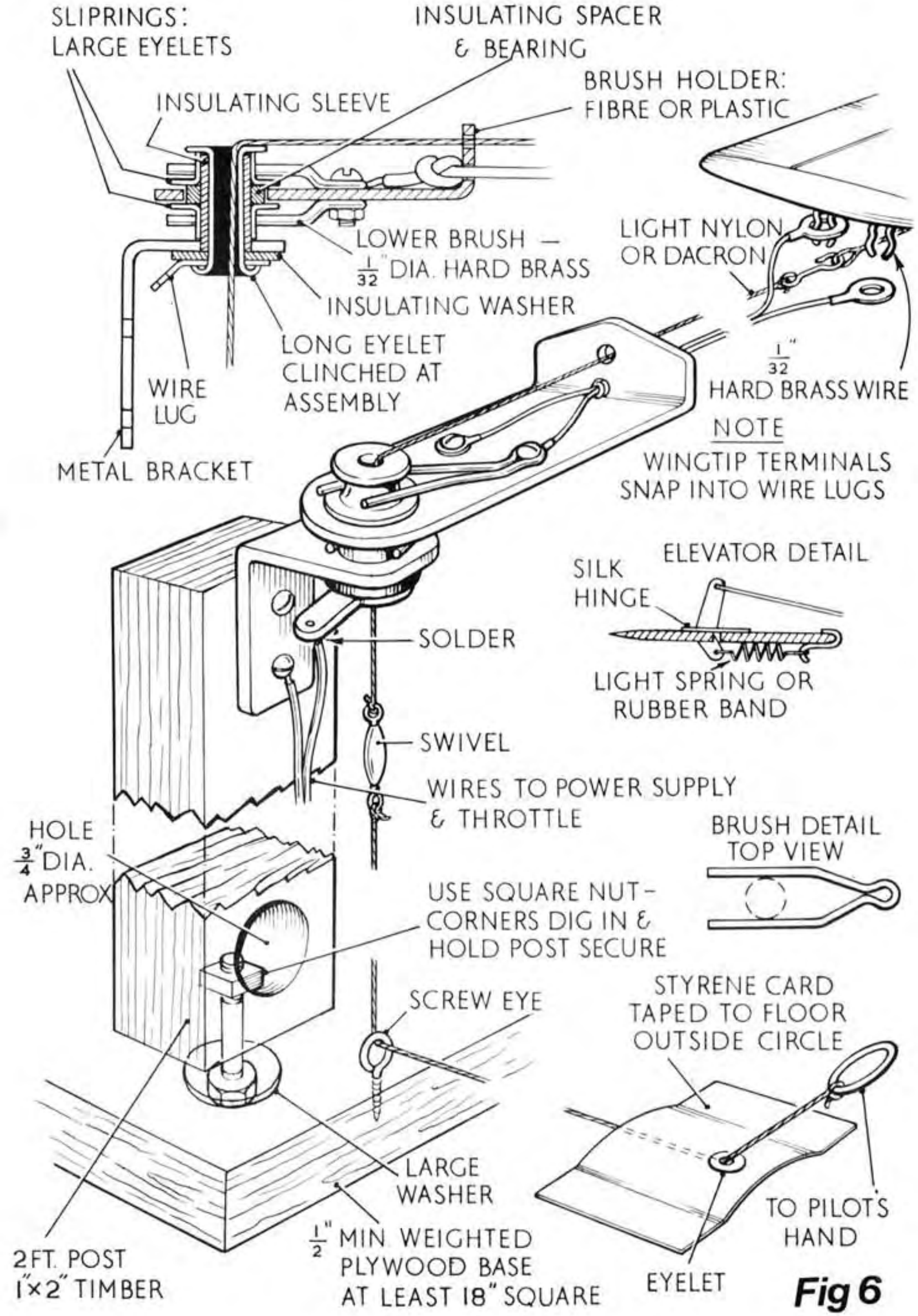
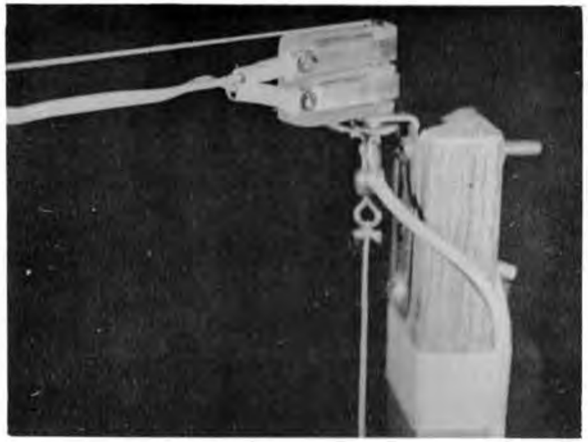


Fig 6



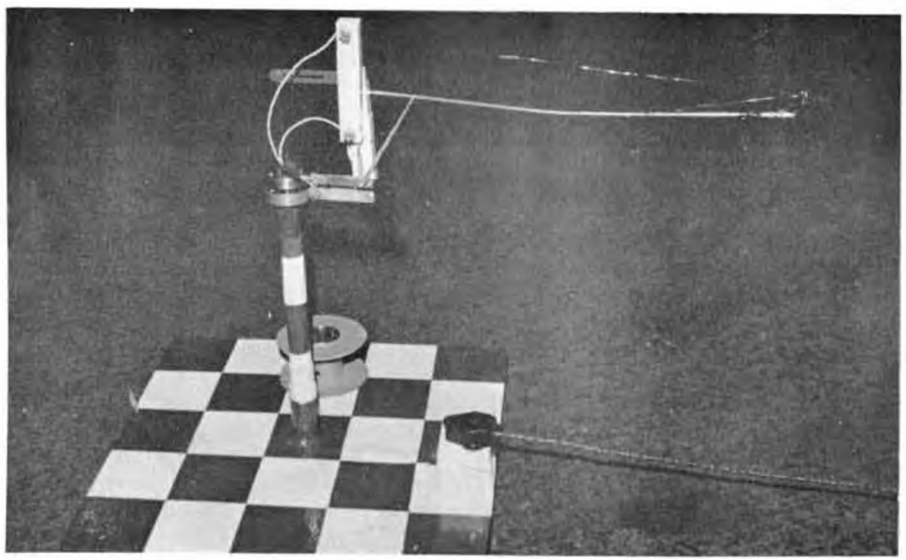
Original Perspex pylon head by Pat March (U.S.A.). Compare with development in sketch on previous page (Fig. 6).

Below, the Grantham pylon with an outrigger or extension rod for improved control.

Both designs incorporate provision for elevator control: the nylon line is connected to a spring (or rubber) loaded self centring "up only" elevator in the model, it passes down through the centre tube or eyelet which forms part of the head and through a screw eye in the wooden base, and from there close to the ground, to the outside of the flying circle, to a piece of taped down "styrene card similar to that mentioned earlier in the text. This simple system of control appears to be quite efficient and provided a certain amount of "feel" for the pilot.

During experiments at flying electric "control line" stunt models in Grantham clubs' large hangar, certain problems were encountered.

The two fine shellaced power wires were connected to the terminals on the pivoting bellcrank (acting in the place of the conventional C/L handle) fitted to the swivelling head of the pylon. The power wires acted as control lines and were connected to the conventional bellcrank system at the model to operate the elevator. When "up elevator" is given, the model



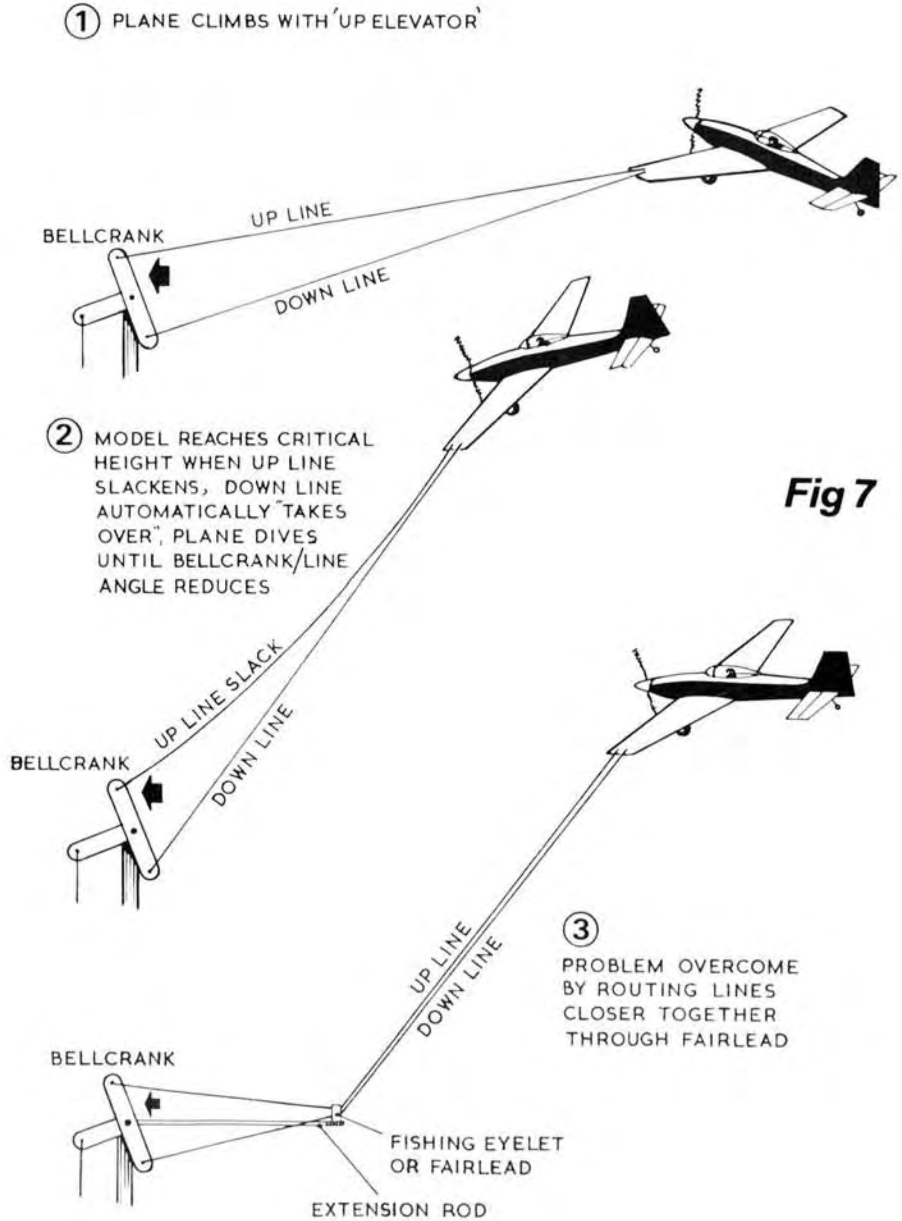


Fig 7

rises rapidly but unlike conventional control line flying with the operator using a handle, the bellcrank (handle) at the pylon end is unable to anticipate the movements of the model. Thus the model, in climbing high, shortens the "down line" producing "down elevator" resulting from the unequal geometry of the lines acting at an angle to the bellcrank at the pylon head. (See fig. 9).

This problem has been largely overcome by fitting a standard fishing rod "eyelet" or "fair-lead" to the end of a 12in. rod, which in turn is fitted to the swivelling arm of the pylon head. The control wires are thus kept closer together, and the unequal geometry reduced to a minimum by passing the wires from the bellcrank at the pylon through the fishing eyelet and to the model. Bristol club use a similar system for their pylon head.

The flying LINES (and attachments)

These are simply two thin shellaced copper wires of suitable length and gauge, 28 s.w.g. or 30 s.w.g. gauge is quite suitable, and the length can be anything from 6ft. to 50ft. depending on the available flying space and power supply.

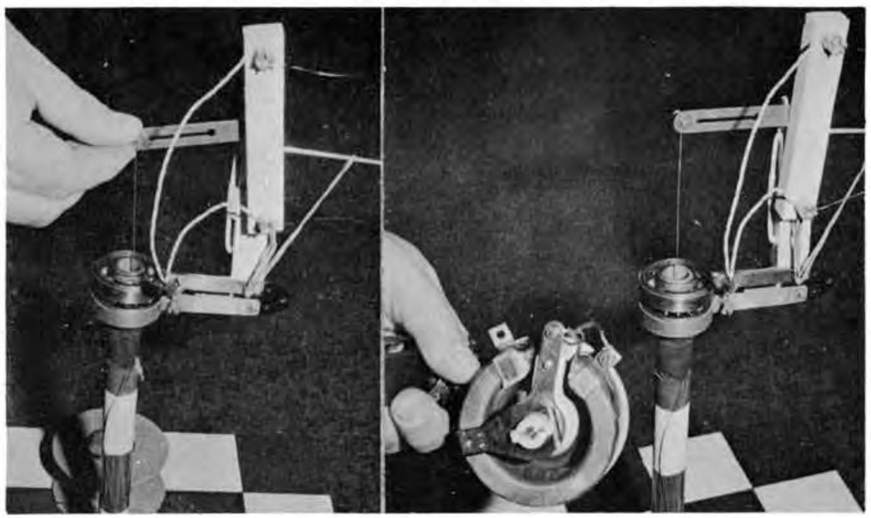
Both ends of the wires should be bared either by rubbing with fine emery cloth, or better by burning off the shellac coating with a cigarette lighter or match, one end of each wire is connected to the screw terminal at the pylon head, the other end soldered to a suitable plug or fastener for attachment to the model.

A very suitable plug is the miniature Radio Control two-pin type, the *male* of which is soldered to the copper wires. The *female* part of the plug is mounted in the right hand (starboard) wing tip of the aircraft, thence through the mainplane.

To eliminate stress on the power lines caused by the centrifugal force exerted on the model in flight, a separate cotton tether of slightly shorter length than the power lines may be used. The tether may be attached to a "built-in" strong point in the wing tip (m.m. ply drilled with a 1/16in. hole is quite suitable) the other end to the pylon head.

As an alternative to the radio control plug, dressmakers' press studs may be used. These are particularly useful if the shellaced power wires are also employed as control lines, thus eliminating the need for a cotton tether.

Elevator control (below), with rotary Rheostat for motor control



Chapter III

Choosing the MOTOR

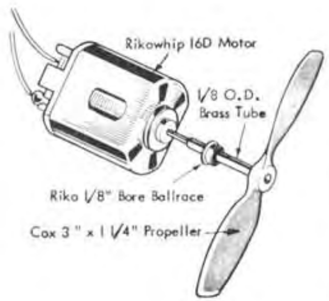
With such a profusion of different types of slot car electric motors on sale in the shops today, the newcomer to electric R.T.P. flying could be excused for feeling somewhat bewildered and hesitant in his choice of a suitable power plant for his model.

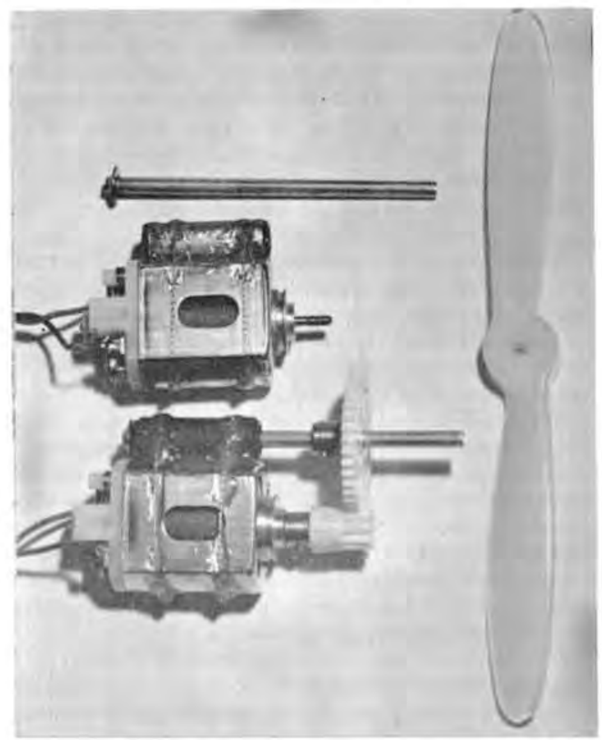
This is not a treatise on the subject of electric motors, but simply an attempt to save the "fledgling" electric flyer both time and unnecessary expense by discussing one or two fairly inexpensive and quite adequate motors.

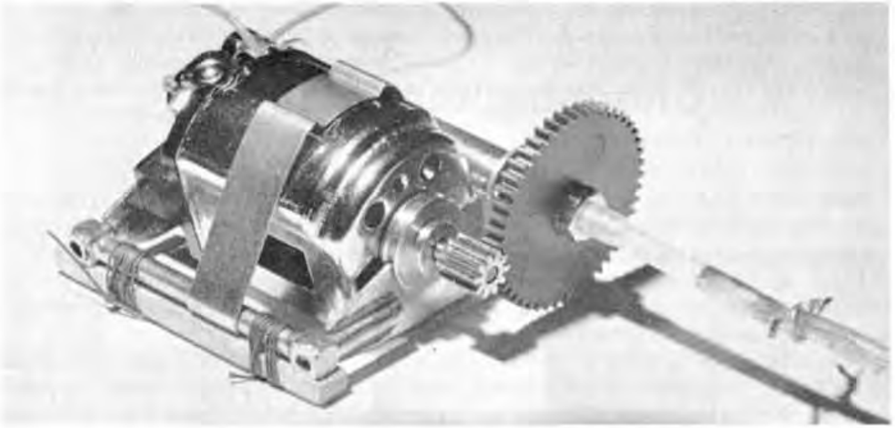
Considerations to be borne in mind from the outset are, the size of the model the motor has to cope with, the probable weight and drag of the model, and the power available. Generally speaking, there is not a great difference in the overall size of most slot motors, but the amount of power they produce in relation to their weight (power/weight ratio) varies considerably.

Certain motors have the ability to "slog" comparatively large propellers around hour after hour using direct drive from the spindle without showing any signs of overheating or failing, whilst others are strictly "high speed" units, only satisfactory when spinning small propellers at high revolutions. In many cases it is possible to adapt the latter type of units to drive larger propellers by the use of simple reduction gearing.

Below: The direct drive use of a standard "Can" motor and at right, conversion with a tube bearing epoxied to the case to carry a layshaft and 4:1 gears. This enables one to use a more efficient larger propeller.







Geared 26D motor mounted on a sub-frame for Corsair

At the high revolutions and often higher voltages required for electric flying, many motors, quite suitable on the race track, tend to overheat, shed parts, or "throw" their armature windings when airborne. In many cases the more sophisticated and expensive motors prove to be less suitable than the cheaper "cooking" variety.

If it is your intention to construct a small light model aeroplane with a wingspan of up to about 24 inches, then provided the design of the nose area is reasonably slim or streamlined to prevent "blanketing" of the propeller, a good choice would be either a *"Rikochet"* Mk. 1, a Riko *"Rocket"* or a Riko *"Wildcat"* (not generally obtainable now, but a really excellent little motor). Matched with a Cox 3in. x 1¼in. propeller any one of these combinations are quite suitable for speeds ranging from slower "scale" type flying to high speed racing. The Riko *"Rocket"* is more suited to moderate currents not exceeding 12 volts so care would have to be exercised not to overload this otherwise satisfactory ittle motor. All three motors are quite light, just under 1½oz. in weight.

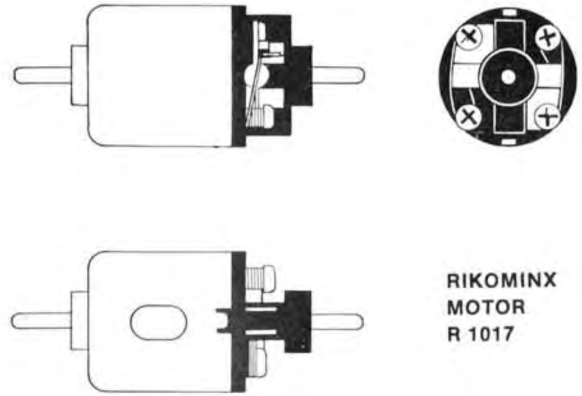
A disadvantage with this combination is that the very small propeller is quite unsuitable for use with scale model aircraft with radial engines and cowlings *(e.g. Gloster Gladiator)*. The small Cox propeller blades do not extend beyond the cowling and are thus rendered inefficient by being "blanketed" by the large nose area, besides looking sadly unrealistic. If larger, more suitable propellers are to be used with either the *"Rikochet," "Rocket"* or *"Wildcat"*, then the use of reduction gearing is necessary.

The modification to carry suitable reduction gearing is quite straightforward. Two miniature ball races are soldered or epoxy glued, one on each end of a ¾in. length of suitable i/d metal tube. The assembly is soldered or epoxy glued to the casing of the motor, with additional support provided by locking wire wrapped around the whole motor casing and metal tube. A layshaft is fitted through the tube supported by the ball races. Two thrust washers are soldered or epoxy glued to the layshaft, one each end of the tube assembly to prevent movement longitudinally. Ripmax 4:1 ratio nylon gears are fitted, the smaller gear being locked on to the motor spindle by its grub screw, the larger gear to the layshaft which in turn acts as the main propeller mounting shaft (see photo).

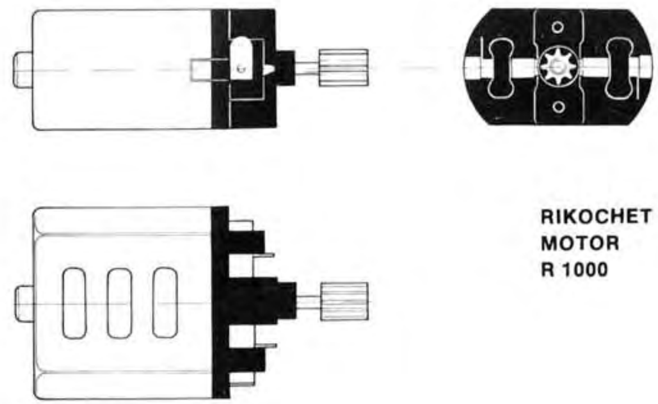
Other makes of gear wheels may be quite suitable at the same or similar ratio, the reduction assembly should be quite suitable for driving 5¼in. x 4in. (Topflite) propellers or even larger.

For aeromodellers who like to specialise in the construction of miniature or sub-miniature model aeroplanes with wings of under 15 inches span, a suitable lightweight electric motor is

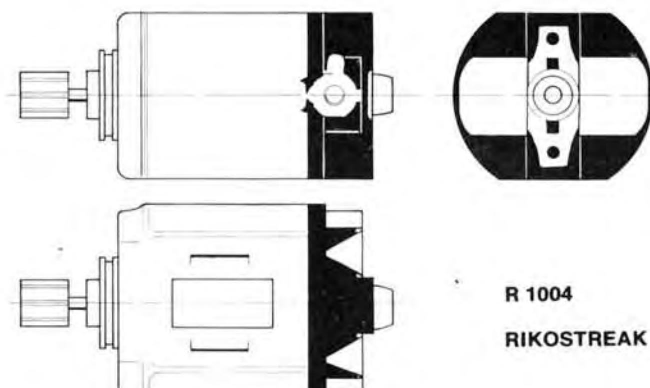
ALL DRAWINGS ARE ACTUAL SIZE



RIKOMINX MOTOR R 1017



RIKOCHET MOTOR R 1000



R 1004

RIKOSTREAK Mk II

MOTOR	DIMENSIONS	PROPELLER	APPROX. WING SPAN	REMARKS
"RIKOMINX" R. 1017 Distributor: RICHARD KOHNSTAM LTD. 13/15 HIGH STREET HEMEL HEMPSTEAD	WIDTH ¾" (Cylinder) LENGTH 15/16" SHAFT DIA. 5/64" USABLE SHAFT LENGTH ¼" (Both ends	COX 3" x 1¼" (Direct Drive) or similar	15" or less	Excellent little motor. High power/weight ratio. Useful for conversion of almost any of the smaller "Keilkraft" or "Veron" rubber scale models or similar. 96p.
RIKO "ROCKET" R. 1018 Distributor: RICHARD KOHNSTAM LTD. (address above)	WIDTH 11/16" LENGTH 1 . 9/16" HEIGHT 15/16" SHAFT DIA. 5/64" USABLE SHAFT LENGTH ¼"	COX 3" x 1¼" (Direct Drive) or similar	15" to 24"	Tested by Grantham group. Shed armature windings at high voltage, quite satisfactory if supply voltage of 12 volts not exceeded. £1.50
"RIKOCHET" Mk. 1 R. 1000 Distributor: RICHARD KOHNSTAM LTD. (address above)	WIDTH 15/16" LENGTH 1 . 15/32" HEIGHT 21/32" USABLE SHAFT 11/32" SHAFT DIA. 5/64"	COX 3" x 1¼" (Direct Drive) Larger props with 4:1 gearing	15" to 24"	Suitable for small models mostly sport flying. Would power most "Keilkraft" or "Veron" rubber scale models or similar. 66p.
RIKO "WILDCAT" FT26D (BALLRACE) R. 1016 Distributor: RICHARD KOHNSTAM LTD. (address above) No longer available	WIDTH ¾" LENGTH 1 . 5/16" HEIGHT ¾" SHAFT DIA. 5/64" USABLE SHAFT LENGTH ¼"	COX 3" x 1¼" (Direct Drive) Larger props with 4:1 gearing	15" to 24"	An extremely versatile powerful motor. Useful for speed, racing, stunt, etc. Suitable to power small rubber kits. No longer available to retail trade but still stocked by certain dealers.
RIKO "STREAK" Mk. II R. 1014 Distributor: RICHARD KOHNSTAM LTD. (address above)	WIDTH ⅞" LENGTH 1 ⅝" HEIGHT 1¼" SHAFT DIA. 3/32" USABLE SHAFT LENGTH 5/64"	4.6" x 4" or 5¼" x 4" (Topflite) Larger (up to 7") with gears	24" to 36" 40" or larger	Suitable for larger models, inexpensive general purpose motor. £1.26
MABUCHI FT-36D 22120 Distributor: E. KEIL & CO. LTD. WICKFORD, ESSEX	WIDTH ⅞" LENGTH 1 ⅝" HEIGHT 1¼" SHAFT DIA. 3/32" USABLE SHAFT LENGTH ¼"	4.6" x 4" or 5¼" x 4" (Topflite) Larger (up to 7") with gears	24" to 36" 40" or larger	Tough hard working all purpose motor. Suitable for larger models. 25p. approx. Limited stocks at certain dealers.

essential. The *Rikominx* R1017 motor is highly recommended for this purpose. It is a very powerful little motor, particularly good for use with a Cox 3in. x 1½in. propeller, light in weight (under 1oz.) and has a cylindrical casing measuring ¾in. (dia) x 1 5-16in. (length).

With all electric motors it is important that adequate provision is made for air cooling when the motor is mounted within the model. The *Rikominx* should be mounted with the spindle and brush casing assembly facing forwards, that is, towards the oncoming relative airflow. The free unrestricted passage of air both into and out of the engine compartment is of great importance.

The power/weight performance of the Minx is so impressive that it presents the ideal power plant for many of the lightweight flying scale kits available in so many model shops.

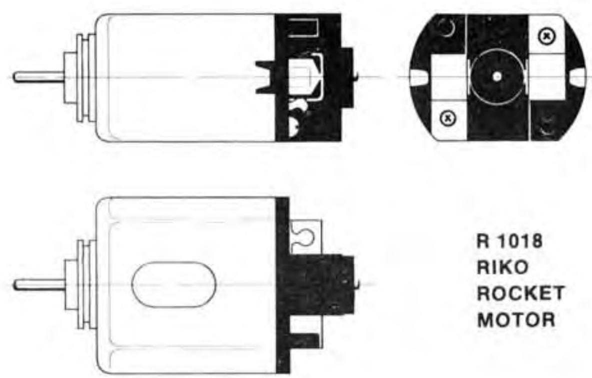
For larger and somewhat heavier models of between 24ins. and 36ins. wing spans a natural choice would be either a *Mabuchi FT-36D* (22120) or a "*Rikostreak*" Mk. II (R1014). These motors are larger and in the case of the FT-36D proved to be rather too bulky and slow for slot racing, but are both admirably suited to driving propellers of from 4.6ins. diameter x 4in. pitch to 5.5ins. diameter and 3in. pitch (direct drive).

Combined with suitable reduction gearing both of these motors are quite capable of swinging much larger propellers, 7ins. x 4ins. for example. The FT-36D weighs 38 grammes and produces 0.01 h.p. at about 10,000 r.p.m.

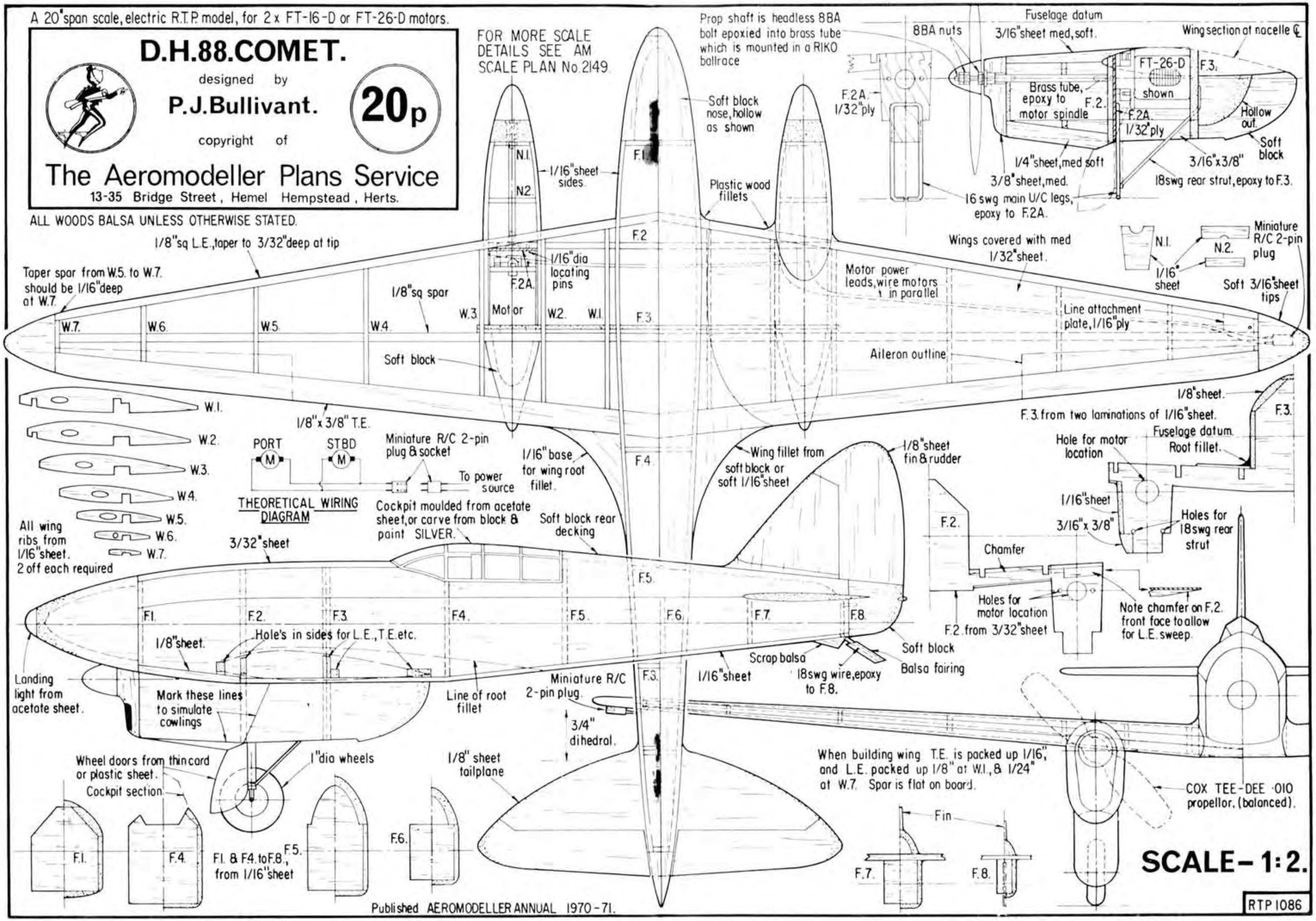
Model aircraft spanning 40ins. or more are well within the capability of these two motors. Fortunately both motors are cheap to buy and are available in quantity in this country. If you decide that you require a good all round "slogger" one of these should be your first choice.

A very useful hint from American modeller Pat March to readers is to take note of the identification numbers when purchasing Mabuchi motors as they are of definite significance. For example, the Mabuchi FT-36D 22120: the first two digits after the D indicate the wire size in hundredths of a millimetre, and the following digits show the number of turns per pole.

Other good motors for electric R.T.P. are the FT-36D 27110, and FT-26D 2675 and the smaller FT-16D 18110. Pat March warns us that there are at least two versions of each of these motors, indistinguishable by inspection, but the lower powered versions are quite worthless for R.T.P. work. The only test is by using an ammeter. Power units named *Miura* Group 20, *Champion Black Power*, and *Big Chief* have all been well used for R.T.P. work, with success.



R 1018 RIKO ROCKET MOTOR



A 20"span scale, electric R.T.P. model, for 2 x FT-16-D or FT-26-D motors.
D.H.88.COMET.
designed by
P.J.Bullivant.
20p
copyright of
The Aeromodeller Plans Service
13-35 Bridge Street, Hemel Hempstead, Herts.
ALL WOODS BALSA UNLESS OTHERWISE STATED.
FOR MORE SCALE DETAILS SEE AM SCALE PLAN No.2149.
1/8"sq L.E., taper to 3/32"deep at tip
Taper spar from W.5. to W.7. should be 1/16"deep at W.7.
W.7.
W.6.
W.5.
W.4.
W.3.
W.2.
W.1.
1/8"sq spar
Motor
1/16"dia locating pins
F.2A.
N.1.
N2.
1/16"sheet sides.
Soft block
1/8"x 3/8" T.E.
F.1.
F.2.
F.3.
F.4.
F.5.
F.6.
F.7.
F.8.
Soft block nose, hollow as shown
Plastic wood fillets
Prop shaft is headless 8BA bolt epoxied into brass tube which is mounted in a RIKO ballrace
8BA nuts
F.2A. 1/32"ply
Fuselage datum
3/16"sheet med, soft.
Wing section at nacelle ℄
FT-26-D shown
Brass tube, epoxy to motor spindle
F.2A 1/32"ply
Hollow out.
Soft block
1/4"sheet, med soft
3/8"sheet, med.
3/16"x3/8"
18swg rear strut, epoxy to F.3.
16 swg main U/C legs, epoxy to F.2A.
Wings covered with med 1/32"sheet.
Miniature R/C 2-pin plug
Soft 3/16"sheet tips
1/16" sheet
Motor power leads, wire motors in parallel
Line attachment plate, 1/16"ply
Aileron outline
1/8"sheet.
F.3. from two laminations of 1/16"sheet.
Fuselage datum.
Root fillet.
Hole for motor location
1/16"sheet
3/16"x 3/8"
Holes for 18swg rear strut
All wing ribs from 1/16"sheet. 2 off each required
PORT
STBD
Miniature R/C 2-pin plug & socket
To power source
THEORETICAL WIRING DIAGRAM
1/16" base for wing root fillet.
Wing fillet from soft block or soft 1/16"sheet
1/8"sheet fin & rudder
Cockpit moulded from acetate sheet, or carve from block & paint SILVER.
Soft block rear decking
3/32"sheet
Chamfer
Holes for motor location
F.2. from 3/32"sheet
Note chamfer on F.2. front face to allow for L.E. sweep.
1/8"sheet.
Hole's in sides for L.E., T.E. etc.
Scrap balsa
1/16"sheet
18swg wire, epoxy to F.8.
Soft block
Balsa fairing
Landing light from acetate sheet.
Mark these lines to simulate cowlings
Line of root fillet
Miniature R/C 2-pin plug.
3/4" dihedral.
Wheel doors from thin card or plastic sheet.
Cockpit section.
1"dia wheels
1/8" sheet tailplane
When building wing T.E. is packed up 1/16", and L.E. packed up 1/8" at W.1., & 1/24" at W.7. Spar is flat on board.
COX TEE-DEE ·010 propellor. (balanced).
Fin
F1. & F4. to F8., F5. from 1/16"sheet
SCALE – 1:2.
RTP 1086
Published AEROMODELLER ANNUAL 1970-71.

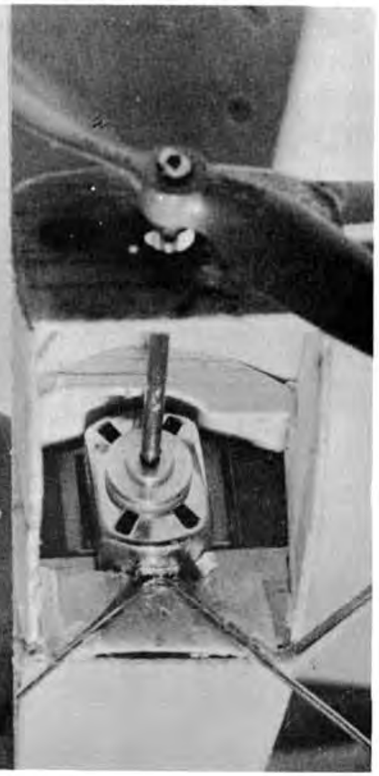
Chapter IV

Installing the MOTOR

Before starting the construction of the model, the plan should be studied to determine the position of the motor installation and this should be sketched in lightly with a pencil.

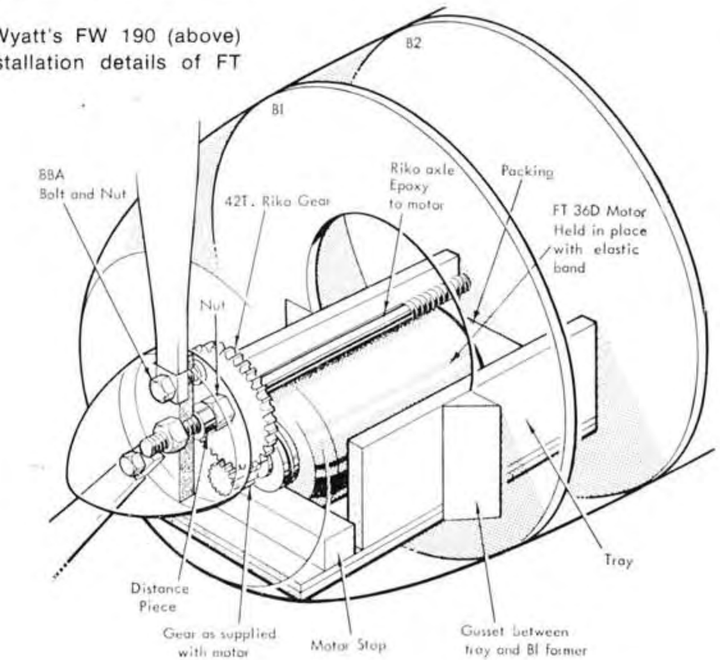
Quite a satisfactory motor mounting can be made by forming a box of 1/16in. balsa around the motor, the box being supported between formers as required. For additional strength a platform can be cut from millimetre ply and glued inside the balsa box to form a strong floor. The sides of the mounting box should be drilled and filed to provide large enough holes for motor cooling purposes. If possible one side of the box should be detachable to permit removal of the motor for general servicing, if the motor has to be permanently installed, it is wise to make it as accessible as possible. If the box is constructed to about twice the length of the motor, adjustments may be made until the motor is located in the correct position in relation to the centre of gravity **(C.G.)**.

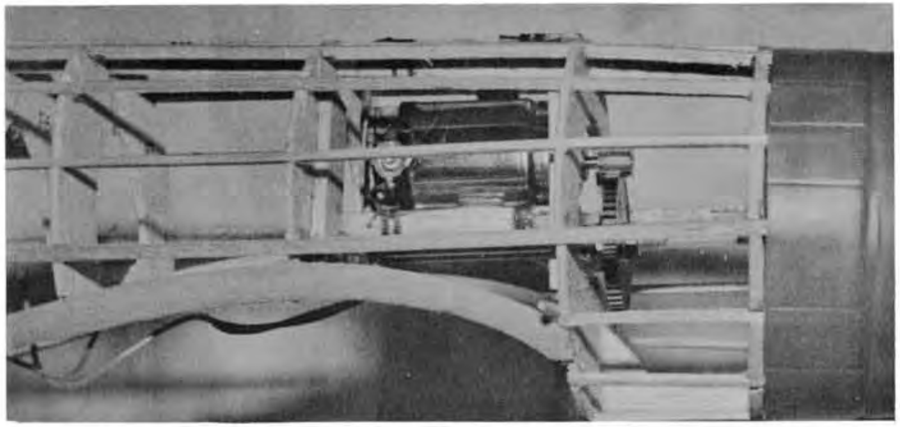
Author with his twin engined DH 88 Comet (Plan on previous pages) and at right, a 16D motor in a Frogflite Cessna with extension shaft



Many electric motors are so designed that the circular housings which contain the main spindle bearings at the front and rear of the motor, protrude slightly. The motor can be "sandwiched" between two formers with the spindle bearing housings slotted into similar size holes drilled and filed in the formers. (A "rat tailed" file is ideal for the purpose). A thin "veneer" of millimetre ply cemented to one face of both of the formers provides additional strength and support for the motor.

David Wyatt's FW 190 (above) and installation details of FT 36D

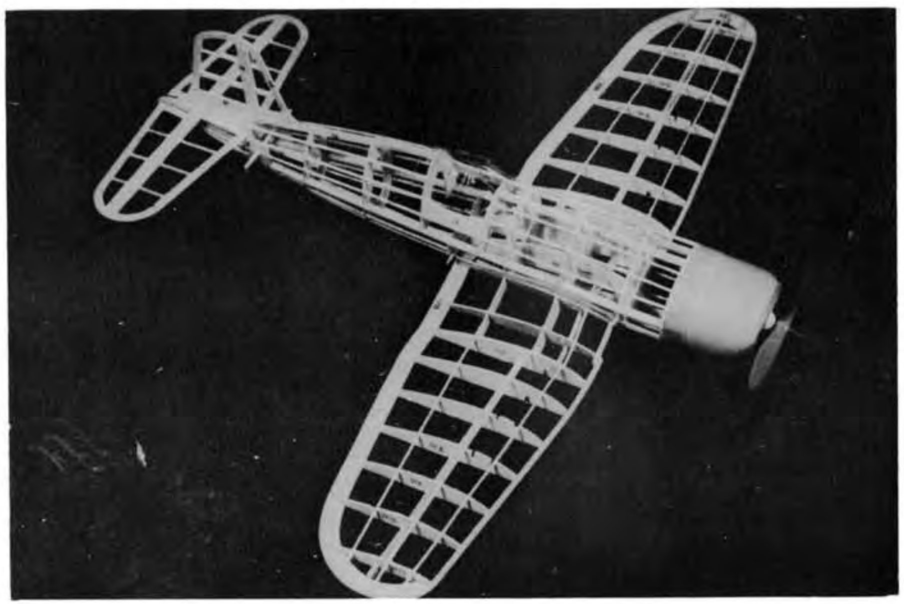




Regular readers of the "*Aeromodeller*" may have read the April, 1971, edition, in which an article by David Wyatt, of Grantham, described his simple conversion of a 25¾in. span (Guillow kit) *Focke-Wulf 190* to electric R.T.P. The F.-W. 190 graced the front cover of the *Aeromodeller* together with another excellent scale subject — Pat March's *Republic P.35 "Lancer"*.

Apart from such things as replacing the undercarriage wire with 14 s.w.g., rubber tyred wheels at all three points instead of the plastic ones supplied, and a covering of 1/32in. sheet overall, Dave described his modifications for the installation of the Mabuchi FT-36D motor; he retained the original 10-tooth pinion which is supplied with the motor, and a 42-tooth gear

A Guillow Corsair kit, modified for Electric power, with motor buried in fuselage, driving the prop via an extension shaft

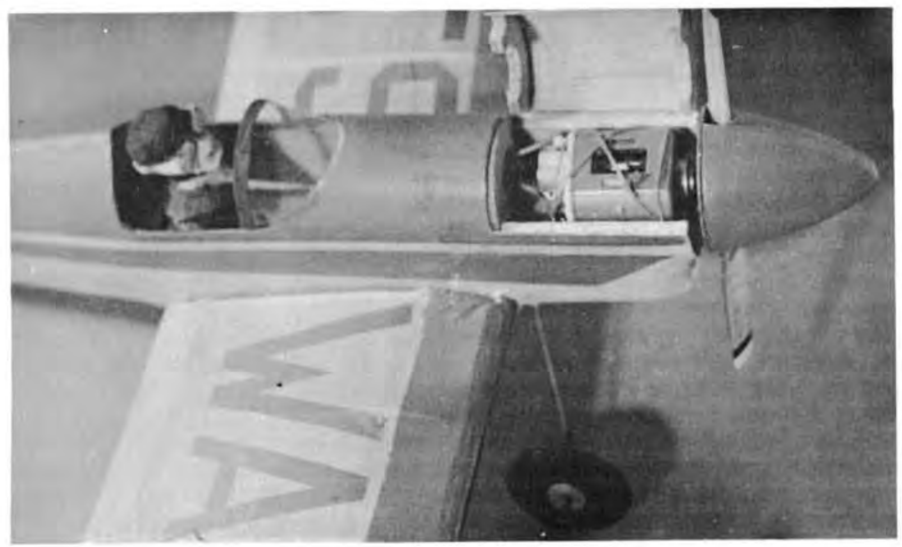


Right: 4:1 gears on a 16D motor to power a "Mister Mulligan" racer which has performed regularly at each of the Model Engineer Exhibitions.

Below: Pat March's "Volt-swagon" has a simple direct drive arrangement with motor retained by rubber bands.

wheel was fitted to a Riko slot car axle which is sold as a propriety part, consisting of a brass tube and split axle. The whole axle assembly was epoxy glued to the motor casing.

The first former was cut down to take a balsa wood tray made up of two laminations of 1/16in. for the base, the 1/8in. sheet sides of the tray were taken to just over half the depth of the motor when the motor is lying on the tray. Holes were drilled in the bottom of the tray to assist motor cooling. The tray was made long enough to fit inside the cowling to former B2 to which it was attached. A small piece of packing was fitted behind the motor to bring the propeller shaft through the cowling. A bush was fitted to enable the propeller to clear the



cowling. Dave constructed a three-bladed scale propeller from Duralumin, each blade was cut separately and bolted to a piece of three-ply cut to the same diameter as the spinner, enough room being left to fit the airscrew retaining nut.

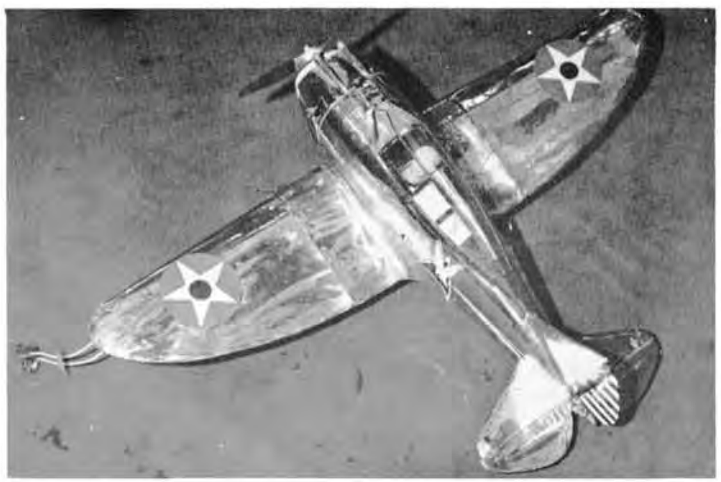
WHICH WAY TO FLY Clockwise or Anti-clockwise?

One of the factors to be taken into consideration when mounting the motor is that of a phenomenon known as "Gyroscopic Precession". The rapidly rotating mass of the armature of the electric motor can be compared with a gyroscope. Consequently any force applied to the "flat" face of the gyroscope behaves as if that force was applied "90egrees removed in the direction of rotation", and thus causes the gyroscope to "dip" or "precess". Hence it can be seen that the yawing force that a tether fixed to the right wing exerts on the "near side" (i.e. nearest pylon) of the front face of the armature, results in the removal of that force through 90 degrees in the direction of rotation to the bottom of the front face of the rotating armature, thus in turn causing the whole armature (thus the model) to pitch forwards. The longer the tether, the less the yawing force, and subsequently the less the forward pitch of the model. The example above is made with the assumption that the propeller is the usual type sold commercially, that is, that it rotates anti-clockwise when viewed from in front of the nose of the model. If the opposite (i.e. left) wing is tethered to the pylon, gyroscopic precession produces a "nose up" pitch. For this anti-clockwise direction of flight, the motor must be located sufficiently far forwards for the weight of the motor to counteract the upwards pitch under power. However, when the motor is "idled" the model has a very steep and poor glide as the centre of gravity is now well forwards.

With the model fitted out for clockwise flight (right wing nearest pylon) the motor must be mounted further aft (often as much as 1-in-2 inches) for reasons explained above, but although an extension shaft is necessary from the motor spindle to the propeller, this arrangement is far more satisfactory. The model is slightly tail heavy when gliding, but this results in better "attitudes" for landings. Increased power settings cause a nose down "couple" by gyro recession and this in turn "dampens" any tendency for the model to zoom and stall.

Another by-product of clockwise direction of flight is that propeller torque tends to turn the model away from the pylon, thus keeping the lines taut.

Pat March's Republic P-35 "Lancer" covered with foil



Chapter V

Fitting the PROPELLER

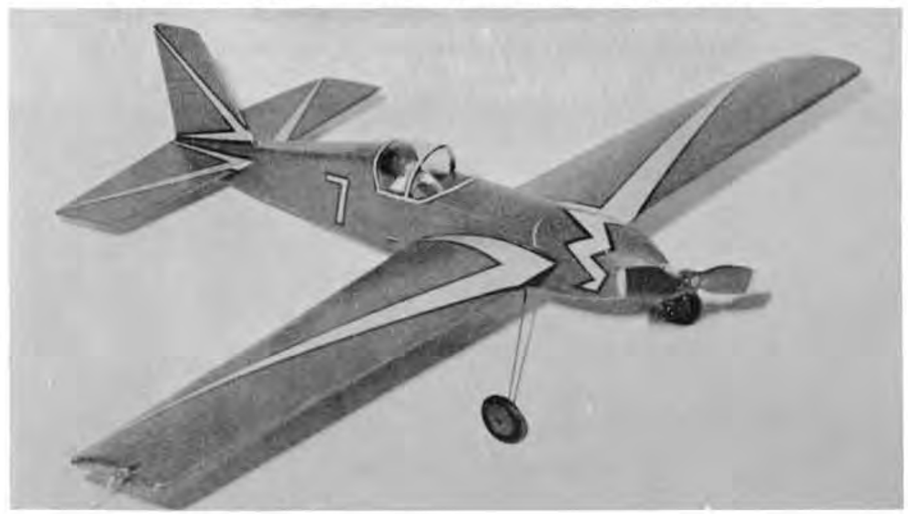
Apart from its occasional use with suitable larger intermeshing gears for driving large propellers by reduced gearing, the pinion fitted to the spindle of most electric slot motors is generally quite useless for electric flying, and can be discarded.

Care must be taken with its removal as the mistaken method of using a screwdriver or similar "lever" to force the pinion from the spindle can very easily cause irrepairable damage to the motor. One method of removal is to place the pinion in the metal vice and crush the splines at intervals around its circumference until the pinion finally cracks and loosens on the spindle. Care must be taken not to damage the motor and spindle when employing this method of removal.

If the propeller is to be mounted directly on to the motor spindle a problem becomes immediately apparent, that the diameter of the hole already present in most commercially obtainable propellers is too large to fit the motor spindle.

If the propeller to be fitted is the diminutive Cox 3in. x 1¼in. (normally supplied for use with the Tee Dee .010 glo motor) the necessary modifications are quite straightforward. A short length of suitable gauge brass tube is soldered or fixed with epoxy glue to the motor spindle. If solder is used, a suitable piece of metal should be used as a "heat shunt" to dispel excess heat from the magnets in the motor to prevent their damage. The propeller should be tested for balance and the heavier blade reduced in weight by careful trimming, then the propeller should be force-fitted over the brass tube and spindle, and finally epoxy glued and aligned. Larger propellers present more of a problem when direct attachment to the motor spindle is required. Unfortunately at present there are no suitable adaptors available on the market (large hint to slot motor manufacturers!) for this purpose, and the electric flyer is forced to produce his own. This can be done by obtaining a bolt which fits snugly through the

Vic Smeed's "Wattsname" used "fixed-fit" propeller. Epoxy helps!



Hawker Hurricane conversion from a KeilKraft kit by Tom Walker uses a three-bladed propeller of scale shape.

hole in the centre of the propeller, drill through the length of the bolt with a twist drill the size of the motor spindle, then cut the bolt to a suitable length using a hacksaw, thus leaving a threaded bush. This is then soldered or epoxy glued to the spindle, the bolt head nearest the motor.

The propeller is then fitted over the drilled bolt and locked against the head of the bolt (or bush) by a suitable nut and washer. Using this method, various types of propellers may be fitted or removed for experimental purposes.

If the motor has to be mounted further back near the centre of gravity an extension shaft running forward to propeller is necessary. This can be made by using a suitable piece of piano wire or silver steel shaft (usually 16 s.w.g.) soldered to the motor spindle with the aid of a piece of brass tube as a sleeve coupling. The shaft can be threaded at one end and the

Frogflite Cessna Bird-dog is one of the better kit subjects with high wing position.

Frogflite Beagle Pup has tricycle landing gear which is an advantage for take-off and landing, also helps balance with the weight of one wheel forward.

propeller mounted by using locknuts. An alternative system is to cut a suitable piece of brass tube to length, epoxy glue one end to the motor spindle. Use an 8 B.A. screw for the propeller end of the extension tube, the head of the screw should be sawn off, then the screw epoxied into the tube. The propeller can be fitted on to the screw and locked with 8 B.A. nuts.

The bearing at the forward end can either be a miniature ball race, a piece of 18 s.w.g. brass tube, or an Oilite bearing epoxy glued into the nose block. If the total shaft length does not exceed $2\frac{1}{2}$ inches, a bearing will not be necessary.

Various other methods of propeller fitting and shaft extension have been tried from time to time, but in almost every case the solution is not easy, and in the end one has to rely on the ingenuity and "expertise" of the aeromodeller.

It is to be hoped that this problem will soon be examined by model manufacturers and suitable adaptors mass produced for sale to electric flyers.

Modified Ryan PT 20 Trainer from a Frogflite kit. Prop is epoxied to shaft.

Chapter VI

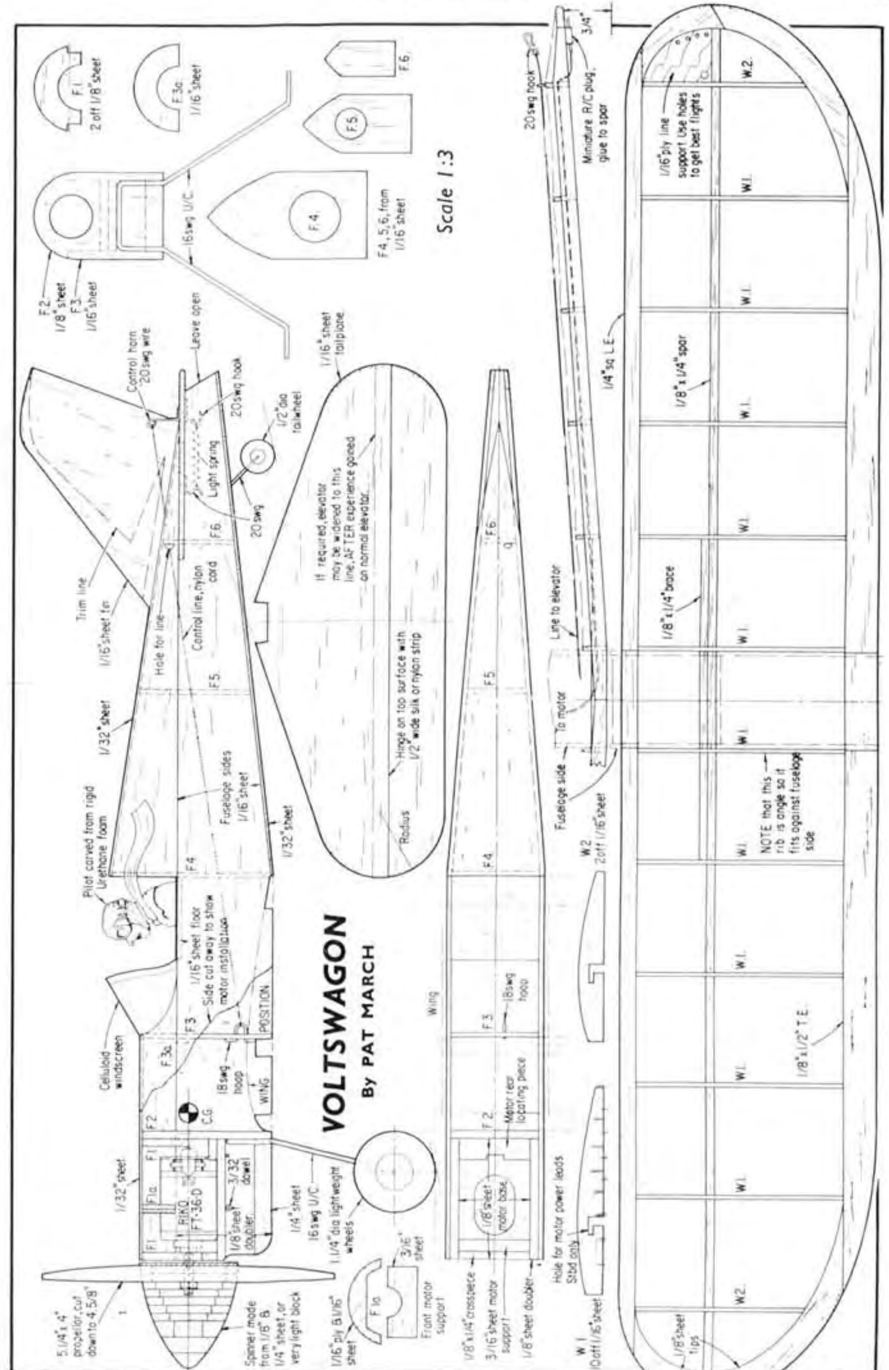
What can be Flown?

Electric R.T.P. flying has so many unique attractions, it is a comparatively new and untouched field of flying, and offers such a wide scope. Models can be single or multi-engined, scale, sport, or experimental, "tractor" or "pusher", jets or autogyros, capable of low and high speeds, aerobatics, and can incorporate working flaps, elevators, retracting under-carriages or lights. Wingspans can be as small as 4 inches or as large as 5 feet.

Events can be held to cover racing, duration attempts, scale fidelity, glider, streamer or banner towing, carrier landing, formation flying, combat, or bombing competitions. For the scale enthusiast, electric R.T.P. offers an unlimited source of designs with the additional advantages that they remain clean, unspoiled by fuel stains and that the motors can be neatly hidden within the scale contours of the model without that ungainly and unrealistic cylinder head protruding offendingly through the cowling.

The "sky is the limit", but how do we start? The newcomer to electric R.T.P. flying could do no better than to choose a simple model guaranteed to fly well with no vices. A "quicky" kit possessing these virtues and easily converted to electric is *The Frogflite RYAN P.T.20.* Power this model with a Riko FT-26D *"Wildcat"* R1016 (Ballrace) motor or a *"Rikochet"* Mk. 1 or a *"Riko Rocket"*. Combine any one of these motors with a Cox 3in. x 1¼in. propeller mounted on an extension shaft from the motor through a suitable Oilite or similar bearing in the nose. The motor should be mounted between two formers as near to the centre

Most popular of all the RTP plans is that for Pat March's Voltswagon. Plan No. RTP 1105 price 25p plus 5p post



of gravity as possible. Use thicker gauge wire to "beef up" the undercarriage. This should be epoxy glued and sewn to a 1-32in. plywood bulkhead. A little weight and "up aileron" on the outer (left) wing together with slight rudder offset away from the pylon, will ensure stability on the lines. Ripmax ¾in. rubber balloon wheels can be substituted for the plastic wheels supplied with the kit. All that remains is to strengthen the underside of the wings by using two ⅛in. square balsa main spars attached by P.V.A. glue.

An ideal choice for a second slightly more advanced model would be that "maid of all work" — *VOLTSWAGON*. This model was originally designed by American modeller Pat March who has used it as a trainer, motor test bed, carrier landing experimental model, glider tug and "blind flyer" (using landing lights in the dark). An advantage with this design is that a larger motor FT-36D or Rikostreak can be mounted right in the nose to spin quite large propellers (up to 6ins.) any choice of which may be fitted directly to the motor spindle.

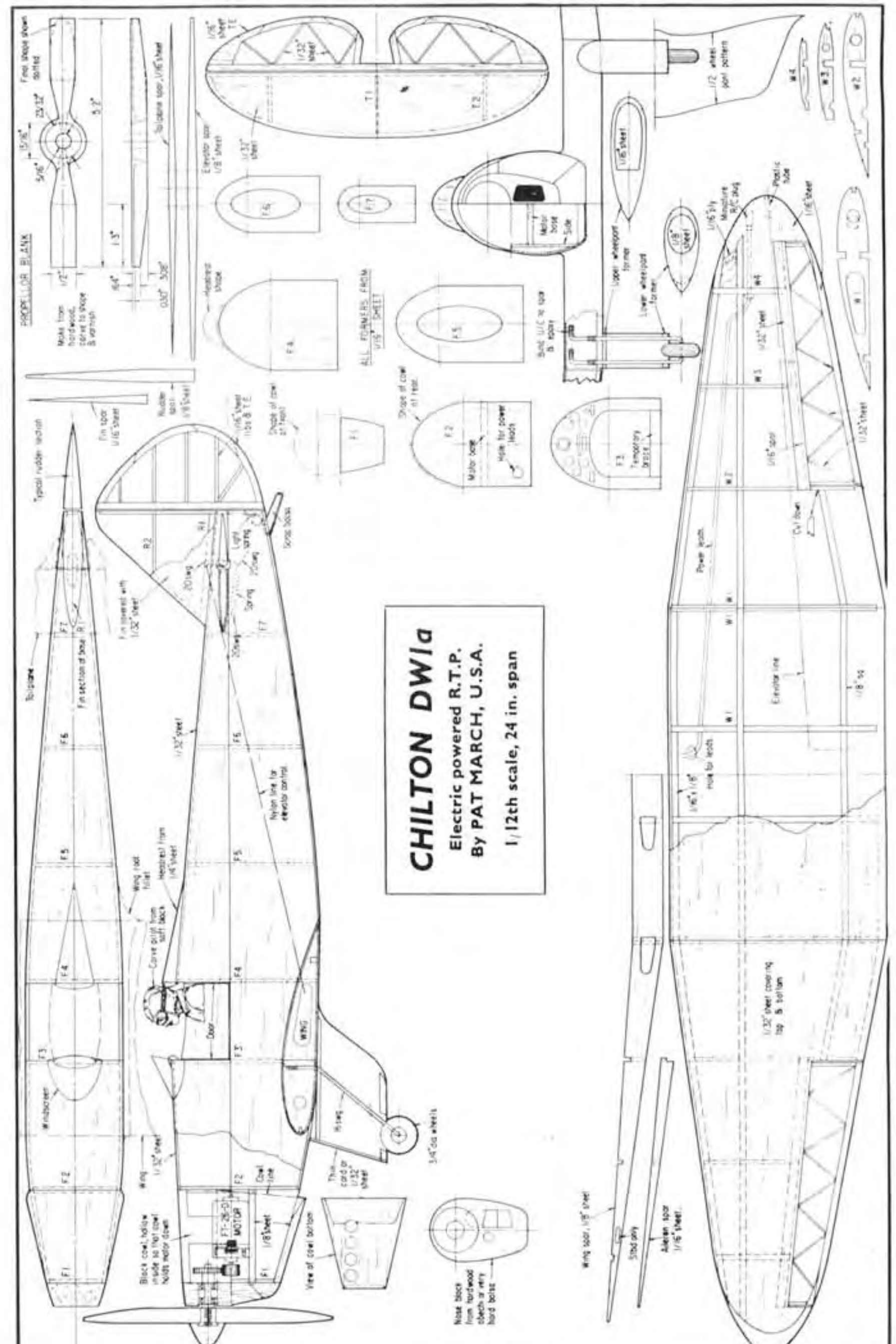
A very fast little model, the prototype of which unfortunately disintegrated following a broken tether line, is the "*WILD WASP*" designed by the writer. This model is capable of speeds over 40 m.p.h. when driven by a Riko FT 26-D *"Wildcat"* or a Riko FT-16 *"Rocket"*. It makes a good choice for your first racer.

The very elegant *"Chilton" D.W. 1a* shown in the accompanying photograph, was the product of modeller Dave Wyatt of Grantham. This slightly more advanced scale model was built to try out a plan supplied to the *"Aeromodeller"* by Pat March, of Ohio, who built the prototype. The Chilton has been flown using a combination of split trailing edge flaps and "up" elevator control but it was found that this made it rather sensitive on "pitch". The model has flown regularly for the past eighteen months on anything up to 40ft. lines. Colour scheme is red, black and white and it is a replica of the full-size aircraft which can be seen at the Shuttleworth Trust, Old Warden. Those very small wheels are strictly to scale by the way! See plan.

If you like something just a bit different how about a "twin"? The *De Havilland "Comet" 88 Racer* has always been a firm favourite of mine, with its sleek lines so advanced compared with its 1934 contemporaries, little wonder it won the England to Astralia race that year! The 21in. model prototype carries two Riko FT-26D *"Wildcat"* motors using brass extension shafts running through ⅛in. ball races supporting the 3in. x 1¼ Cox propellers. The scale landing light mounted in the nose automatically illuminates when the power is supplied to the motors, and provided a fascinating diversion when flown in darkness! See plan.

Copies of the plans mentioned above can be obtained from the *Aeromodeller Plans Service*.

Chilton DW1a plan is RTP 1104, 20p plus 5p post. Wildcat comes with Voltswagon Plan



A Wild Wasp variant at full speed. Plans included with Voltswagon RTP 1105, price 25p plus 5p post

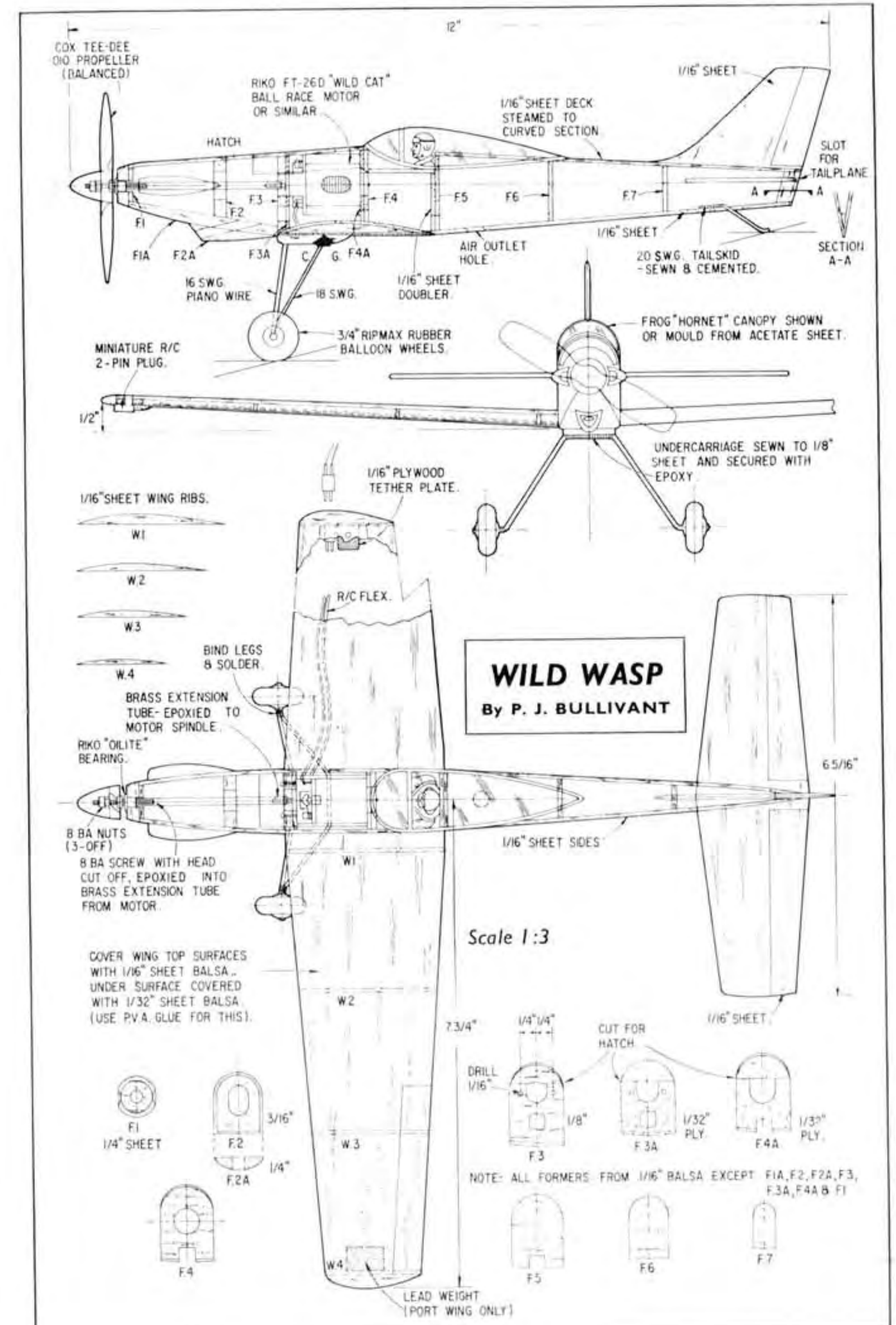
Scale enthusiasts who prefer to build from kits should have little trouble in selecting a suitable subject for R.T.P. conversion from the large range of rubber powered flying scale kits readily available on the market. A list of just a few has been appended to this chapter, selected from "Veron" Tru-flite, "Keilkraft", "Sterling" and "Guillow" kits. (The Guillow kits must generally be ordered from a source in the U.S.A.).

Readers may be interested to know a few details of some of the models which come to mind, all of which have been successfully converted and flown R.T.P.

KEILKRAFT

The 16in. span *SOPWITH CAMEL* was converted by scale expert Doug McHard who used a modified Mabuchi 26 motor driving one of the beautifully fashioned wafer thin propellers supplied with "Sleek Streak" stick models. He later used a larger motor geared down to drive a 6in. prop. The motors in both cases were mounted in the fuselage in a position just aft of the leading edge of the lower wing, near the C of G. Providing large enough propellers extending well beyond the 3in. diameter cowling are used, the Camel makes an excellent subject for R.T.P. Dave Wyatt has successfully flown Keilkrafts' 16in. span *S.E.5.a* using an FT-26D motor geared down 3½:1. Several of these were to be seen flying at the 1970 "*Model Engineer*" exhibition, mostly by a young group of electrical R.T.P. flying enthusiasts from Debden. The *Keilkraft 18in.* span "WESTLAND LYSANDER" is a very suitable aircraft for conversion to R.T.P. Jack Ward of Grantham uses a FT-26D motor mounted in the

The KeilKraft Luscombe Silvaire converted by Peter Hunt



cowling to spin a Topflite three-bladed propeller. This arrangement makes the C.G. rather far forwards but he compensates this by tail ballast and slight up elevator. It would be interesting to try the little *Rikominx* R1017 in this aircraft as it is lighter than the FT-26D but has ample power to fly this little 18in. model.

The Keilkraft 20in. span *"HAWKER HURRICANE"* has been modified by several aeromodellers for R.T.P. work. One version by Tom Walker flies satisfactorily powered by a *Rikostreak* with a 5in. x 3in. propeller fitted to an extension shaft from the motor. A superb 40in. span Keilkraft *"LUSCOMBE SILVAIRE"* flies regularly on 44ft. lines in Grantham clubs' large hanger. Peter Hunt converted this Keilkraft Super-Scale rubber kit by installing a Mabuchi FT36-D geared 2.4:1 and mounted within the cowling to drive a 7in. propeller.

VERON Tru-flite

The "Swordfish", "Buster", "Wildcat", "Cosmic Wind" and "Chipmunk" have all been successfully converted and flown using FT-36D motors. The "Buster", shown in the accompanying photograph, uses a FT-36D mounted at the C.G. position to drive the propeller via an extension shaft. The "Cosmic Wind" employs a Revell *"Fireball"* motor, driving a Cox 3in. x 1¼in. propeller and is quite "happy" on 43ft. lines.

STERLING

The Sterling *"SPITFIRE"* by Tom Walker flies well using a FT-36D motor to directly drive a Keilkraft 3-bladed propeller. Tom's Sterling *"CORSAIR"* flies fast on 40ft. lines powered by the FT-36D combined with Riko brass reduction gears 3:1 ratio driving a Tornado 6in. x 3in. 3-bladed propeller. Another from his "stable", the Sterling *"THUNDER-BOLT"* performed well with a *"Rikostreak"* driving a 5in. x 3in. prop. Alas, this model finished its days on the girders of the hangar roof after a "burst" of excessive power!

Mick Clarke and his modified Veron "Buster" kit. Opposite is his Guillow De Havilland 4

GUILLOW

For sheer elegance of flight at slow scale speeds, Mick Clarkes' Guillow *"D.H.4"* takes a lot of beating. This 27½in. span scale World War I bomber is powered by a Mabuchi FT36D mounted in the nose and directly drives a 5in. x 3in. propeller. The electric conversion of Dave Wyatt's Guillow's *"Focke Wulf 190"* has already been described elsewhere in this book, suffice to say that this model World War II hard-hitting fighter lives up to the familiar maxim — "if it looks right, it flies right"!

There are so many excellent electric R.T.P. models in existence today that it would be impossible for me to do them justice in the chapters of this book. However, one or two outstanding models come to mind which are "different" and show originality of thought on the part of their designers:

Michael Bellamy of Grantham normally concentrates on speed models, one in particular uses a drop off "dolly" and clocks 45 m.p.h. with a Riko FT26D driving a Cox 3in. x 1¼in. prop. At the other end of the scale Michael has achieved what can be described as near "hovering flight" with his delightful little **Autogyro.** A *Rikowhip* FT16D motor combined with a Cox 3 x 1¼in. propeller is used to power this eye-catching subject. The model was based on drawings originally published in the 1957 "Aeromodeller Annual". The Autogyro frequently "takes a short cut" across the flying circle with its power lines hanging loosely down to the central pylon — almost electric free flight!

Outstanding at the 1970 *Model Engineer Exhibition* were many ultra lightweight electric designs by Roger Redman, "King" electric flyer of the "Bristol Bulldogs" club. Roger also displayed a highly detailed *Hawker Typhoon* R.T.P. design which could have scored highly in a "solid" scale contest, it was that accurate!

John Harvey, keen electric flyer from Luton club, flew a very original and impressive twin-engined P.38 "Lightning", this little tricycle undercarriaged beauty flew consistently well throughout the exhibition. John also flew a very fine replica of the French W.W.I. "Nieuport" scout.

Chapter VII

R.T.P. Progress in the Clubs

To give some idea of how popular this new "scene" of electric R.T.P. flying is becoming, readers may be interested to learn of the progress of one or two keen groups of electric flyers. Similar groups are "springing up" all over the country and it is to be hoped that in the foreseeable future electric R.T.P. "fly-ins" and inter-club contests will be held regularly. Who knows? electric R.T.P. flying may even become a feature in the great annual event — "The Nationals".

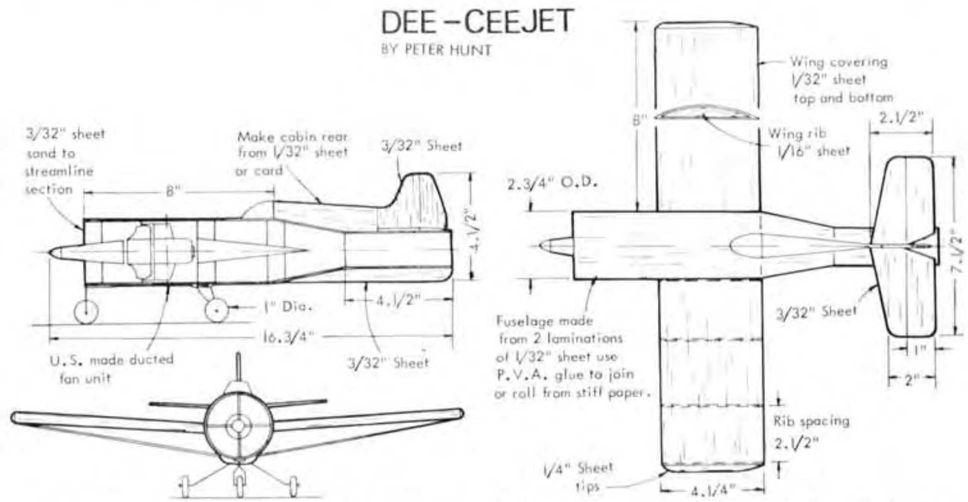
In the U.S.A. the *TRI-COUNTY MODEL CLUB* electric flying section had its foundation in Cincinnati, Ohio, in July, 1963, when club members rigged a small model to a counter-balanced rod on a pylon. The pylon was fixed to the top of a car which was to be used in a street parade. The model plane circled the car roof on its counterbalances arm throughout the parade powered by a slot racing motor and current from the car's battery. The parade entry was a great success and led to a controversy within the club which in turn started members talking seriously of electric round-the-pole flying.

Early experiments proved the necessity of carefully matching the propeller and motor. During one of the early flights, the motor, overloaded by a 6in. (rubber type) propeller, ignited the model's covering. While all watched aghast, the model circled in flames, then crashed in a smoking ruin.

The club was fortunate in obtaining a supply of Mabuchi FT-36D-22120 motors. These were rather large, but were powerful enough to swing quite large propellers and therefore little consideration was given by members to the possibility of using gearing.

The club's flying site was a basement that would permit a flying circle of only 13ft.

The Tri-County Model Club (U.S.A.) and their various models



diameter, with 8ft. head room. Main leader and electric "pioneer" Pat March, described one of his early epic flights with his "Demoiselle" as rather hair-raising, ending up with a direct hit and total destruction of an overhead electric lamp bulb.

Some of the earliest models were built for speed. The first official record of the club was 22 m.p.h. and their latest 43.5 m.p.h.

Experiments with elevator control within the club using only up movement proved successful. Down movements of the elevators proved rather disastrous on the short lines used. Normally the model is fitted out for "up" movement of the elevator only, and a spring is used to return the elevator to neutral. Using this system, the club were able to achieve quite reasonable aerobatics including mild wingovers and occasional loops. The smallest model in the club is a speedster with only 4in. wingspan! It flew at 19 m.p.h. on 2ft. lines powered by a Mabuchi ST. 02 motor turning a 1½in. x 1in. propeller.

The largest model is a scale *LOCKHEED GALAXY* spanning 56in. (¼in. to 1ft. scale). The model weighs about 1½lb., flies on four FT-26D motors turning ducted fan impellers in scale pods. The motors are connected in series and take a current of 2 amperes at 50 volts, to fly at 35 m.p.h. Three other ducted fan designs have been flown, one was put into production by the Kenner Products Company.

DUCTED FANS

A sample ducted fan unit comprising a Mabuchi FT-36D motor and two-bladed impeller was sent to the Aeromodeller Offices by Pat March. The unit was in turn passed on to the *GRANTHAM & DISTRICT MODEL AIRCRAFT SOCIETY* for flying trials. A simple jet-like design was quickly produced by Peter Hunt to prove the practicability of this sort of propulsion unit. The model was reluctant to "lift off" when attached to short 15ft. lines, but after considerable trimming it has since flown successfully on 25ft. lines.

The Grantham club electric R.T.P. section began in September, 1969, following frequent discussions on the feasibility of flying "electric". The final decision to get the equipment made and try it out was "sparked off" by two articles which had appeared on the subject, one in the march 1969 *"Aeromodeller"*, the second by Pat March in the August 1969 *"American Modeler"*, which the writer had brought home following a visit to Canada.

The first task, to construct a suitable pylon was completed within a few days, adopting an idea pioneered by the Aeromodeller staff, a pylon made from *Meccano* parts. Two other pylons were constructed afterwards using a different arrangement involving the use of ball races at the distributor head, an idea featured in the *"Model Aircraft"* back in September, 1963. One of these pylons incorporates a facility for control line flying. Since then a fourth pylon equipped for "four up" flying has been constructed and is in regular use (see photo), combined with a control panel equipped to receive four plug-in hand controllers (see photo).

For several weeks the club was content to fly on lines of 15 feet in length, but more "venturesome" types became restless, and 25ft. radius became the target. This was so successful that it was decided to see just what the limit could be. By this time the club was holding regular weekly electric R.T.P. meetings in a 90ft. wide Royal Air Force drill hangar, a facility generously afforded by the Station Commander. So the lines were gradually extended until the present 44ft. limit was reached, a limitation only imposed by the dimensions of the hangar.

Team races have been popular within the club. Competitors have to fly on 25ft. length lines over a predetermined and timed number of laps (generally 100), during which "enforced landings" have to be made into a marked out area, once every 25 laps. The pilot has to "field" his own model after completing one of these enforced landings by placing it at the rear marker before take off. Fastest model to date has been a simple racer constructed entirely of sheet balsa made by Mick Bellamy, and clocking 43 m.p.h. using a Riko FT-26D motor with a Cox 3in. x 1¼in. propeller.

Carrier events became popular with the club, models landing on a simple deck made from wooden battens and cardboard, but the flying was of a non-competitive nature and soon gave way to the more popular formation flying, using up to four aeroplanes at once. Pilots have developed such skill that they regularly fly mere inches apart, a spectacle which can only be achieved with considerable practice and often a lot of patience in repair work.

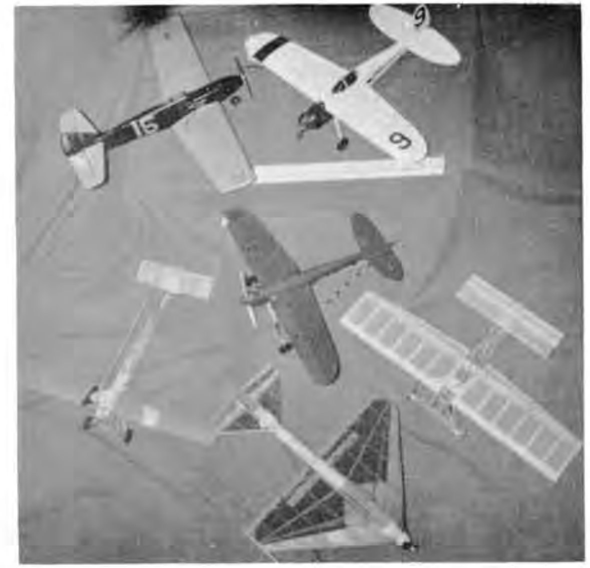
The section secretary, Peter Hunt, has devised an exciting competition, the rules of which may be of interest to other R.T.P. Flyers, and which are outlined at the conclusion of this chapter.

Apart from these competitions, Grantham flyers are busy developing stunt models. Standard control line system is employed with the current directed down the wire control lines. Small lightweight stunt designs have proved successful, particularly when powered by the lightweight Rikominx motors, with which they have been looped.

The *"BRISTOL BULLDOGS" M.A.C.* are keen electric flyers who mostly work for the British Aircraft Corporation wind tunnel department.

These enthusiasts have been developing electric flying for some time under the leadership of pioneer Roger Redman.

Roger started by flying models in his lounge on 4ft. lines using 34 s.w.g. shellaced copper wire with 25 volts (open circuit) at the controller giving 10 to 12 volts at the motor. Several of



Bristol Bulldog's models No. 8 (on left) a flying test bed for just about everything. No. 5 speed model for R.T.P. only, no elevator control, No. 9 a sport/racer, No. 10 (on right), No. 15 with trike U/C, No. 18 the tailed delta with trike U/c.

his friends became interested, one of them started building an extra pylon. To the relief of their wives, flying sessions moved from their dwellings into the B.A.C. Filton canteen. First flights in the canteen were on 10ft. radius lines of 30 s.w.g. wire using 40 volts supply (12 volts at the model).

The emphasis with this club is speed and elevator control. A particularly attractive sports design ("No. 9" — top right in photograph) incorporating elevator control, flies rock steady at 30 m.p.h. at ground level, or climbs to almost 8ft. altitude with just a touch of "up elevator" from a joystick outside the flying circle. Low speed performance of this model is good — as low as 10 m.p.h. using a fair amount of power and quite a lot of up elevator, but it has a vicious stall.

Another of Roger's "electroplanes" (No. 10 — bottom and right in the photograph) has a built-up plank wing with end-plates, coupled elevators and flaps, symetrical wing section and 60 sq. in. wing area with half-chord tail movement. This model is very responsive on 10ft. lines, but although it will fly on 15ft. lines with voltage stepped up, control is a bit vague at low speeds or high altitude.

A neat little 16in. span tricycle undercarriage design by Roger (upper left in the photograph) is No. 15. This model weighs 3oz. and has a 50 sq. in. wing. The model originally incorporated a retractable undercarriage, but this was only partially successful. The propeller is fitted to an alloy extension which is fitted to the motor shaft using a grub screw.

A "hot" speed design by Roger using a drop off dolly has clocked 35 m.p.h. on a modified *Scalextric* motor in Roger's lounge. Tailplane incidence is adjustable by using a dowel swivel. This model has great speed potential with its drop off dolly undercarriage and could nearly top the forties if given a better motor.

As with the other two clubs, the Bulldogs are concentrating on scale and stunt designs, one model has performed successful loops on 12ft. lines with a 70 sq. ins. wing using direct drive.

There are many other active electric R.T.P. groups and clubs, Luton and Debden to name but two. I have omitted mentioning their current (forgive the pun) activities but judging by their excellent performance at the *Model Engineer Exhibitions* I have little doubt that they will be "cooking up" even bigger and better "electroplanes" each year.

John Harvey of Luton Club is a regular demonstrator at the Model Engineer Exhibition in London each January. His Lockheed P38 Lightning is a spectacular subject for electric RTP flying. At right, Ron Moulton's Mister Mulligan in full flight over the elevated track used in 1970.

Below: Though the style of track may change each year, Electric round the pole flying is almost a regular feature of every Model Engineer Exhibition. Interruptions come when models take to water as in this 1971 scene, or tangle with overhead wires!

Appendix I

Building the Voltswagon
by Pat March
(see Page 39)

Construction of this model is straightforward with only a few special points to observe. The propeller mounting method is to use a brass machine screw drilled through the centre as an adaptor. Solder it to the motor shaft. This drilling is easily accomplished with a metal lathe, but is nearly impossible otherwise. Any small machine shop should be able to drill out a screw at little or no cost. A good prop to use is a 5¼ diameter by 4 pitch Topflite, drilled to fit, and clipped to 4⅝ inch diameter to avoid a motor overload.

The spinner can be made from a balsa block, using your motor as a lathe for finish sanding. Force the adaptor screw into a hole in the rough-carved spinner and sand with very light pressure. Blow sanding dust out of the motor frequently to prevent overheating. Cut a cavity to fit the prop hub and notches for the blades. To mount the spinner dead true, cut an accurate disc from fibre or light cardboard with a hole in the centre fitting the No. 10 screw. Fit this behind the propeller and cement the spinner to it.

Make the "engine room" by tracing off and cutting out a pair of doublers, a firewall and a shelf from ⅛in. hard balsa. Don't skimp on the holes in the shelf and firewall. These motors release a lot of heat, and need every bit of cooling air they can get. Assemble these parts as shown on the drawing. Add cross blocks to the shelf, notching them to fit the front and back ends of your motor. Fit wire hooks fore and aft for a rubber-band motor holddown.

Make the fuselage sides from medium 1-16 sheet balsa and cement to the motor mount assembly. Add formers, then sheet in the underside from the tail to the wing trailing-edge position. Make sure the two side planks do not come quite together at the rear. A ¼in. gap is about right. Cover the upper portion of the fuselage with 1-32 sheet. Make an engine hatch with two ⅛ sheet formers, and 1-32 sheet covering. Hinge the hatch to the fuselage with a bit of tissue. Make sure the hinge is on the left side of the airplane so that centrifugal force will hold it closed. Form the landing gear strut from 16g. wire and mount on the firewall. Finish off the fuselage by fitting a ¼in. thick block to the underside of the cowling, whittling and sanding to shape. Go over the completed fuselage with sandpaper and dope, then cover with tissue. Carefully cut the engine hatch open. A tail wheel (from a plastic model) adds a nice touch.

Cut the tail surfaces from 1-16 sheet. Form a control horn over the drawing. A paper clip works fine. Cement the control horn to a notch in the elevator. Hinge the elevator to the stabiliser. A spanwise strip of tissue on the top only serves this function since the elevator will be pulled up only, not down. Affix a hook to the bottom of the stabiliser and fit a very light spring or rubber band between the hook and the lower loop of the control horn. Use some of the same cord you used on the pylon for the elevator control-line. Route the control-line from the control-horn through a hcle into the fuselage, through a wire loop fastened to former F-1, and out through the hole in the left side of the fuselage over the wing. Alternatively, the line can be run outside the fuselage.

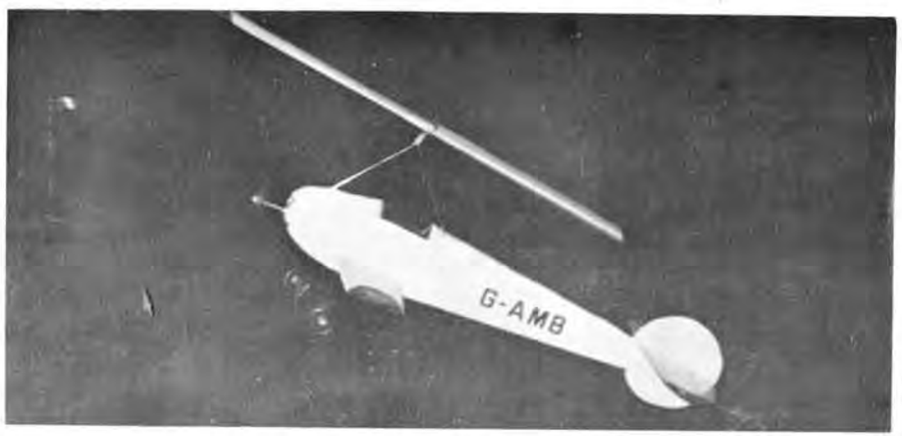
Wings are of standard construction using 1-16 ribs, ¼ sq. leading edge, ⅛ x ¼ spar, ½in. trailing edge stock, and ⅛ sheet tip bows. Run some of the speaker wire from centre to tip of the left wing through notches in the ribs. Solder paper-clip wire terminals, formed as shown on the drawings, to the tip end of the wire. These should snap into the lugs on the electric line, and firmly grip the lugs tightly for safety and conductivity. Cement these solidly to the tip bow.

The wing may be built flat in one piece if desired. However, the dihedral shown looks good in flight and minimizes chances of bashing a wing tip. Splice the wing wires to the motor leads within the fuselage, taping at least one of the splices. Add a small wire line guide to the last rib of the left wing after covering.

Finish off your Voltswagon with 1¼in. wheels, a pilot carved from foam plastic or balsa, and a windshield. The original was covered with white Jap tissue, with blue tissue trim on the upper fuselage, blue tissue lettering and red dope trim on wings, fuselage, sides and fin. The model should balance somewhere between the leading edge and the spar for smoothest performance. Hook up power-pack and throttle control as shown on the diagram: hook up wires and control cord to the plane. Tape the card at the end of the cord to the floor outside the flying circle. Try a bit of power to see if the prop rotates correctly. Don't forget to weight down the pylon with at least ten pounds. Three half-gallon bottles filled with water will do. Don't forget to check for obstacles. If no amount of juggling of the pylon lines will leave you a clear flying area, you can shorten the flying radius by knotting the power line shorter.

Grip the throttle control in one hand, the control line in the other. Leave the control line a little slack. Add power gently. Voltswagon should roll easily with the tail coming off the ground quickly — then a smooth powered take-off, the plane will be flying in a horizontal circle.

Mick Bellamy's Autogyro in flight — a remarkable sight



Most of the time you should fly with no elevator control applied. Light, quick pulls and releases of the control line can be used to level the flight path. For your first few flights, strive to master the art of level flight. When this has been accomplished, try a fully stalled flight: ease power up to full, simultaneously easing up to full elevator. You will be treated to the spectacle of a slow, stately nose-up flight. To recover, ease off throttle while holding elevator, and land the plane: or ease off on the elevator while holding full throttle to return to level flight.

Try this: fly level at full throttle. Allow several laps to gain speed. Hit and release the elevator, but be ready to hit and release again on the other side of the circle to recover from the dive.

Landings? Simplicity itself. From level flight, either chop the throttle or ease off. Voltswagon will land itself. Or, flying full speed, chop the throttle, ease in full elevator and drop it in. A bit of elevator at touchdown may be needed to avoid a noseover if you are flying from a carpet or a rough surface.

Appendix II

Building "WILD WASP"
by Peter Bullivant

(see Page 43)

Designed for speed or team racing events this little "electroplane" has a good stable fast performance. The original flew many hundred "sorties" until it "angrily" tore itself loose from the tether and disintegrated. Insufficient attention had been given to strengthening the wing tip with a 1/16in. plywood tether plate.

Fuselage construction is simple. The motor drops in between formers F3 (cemented to plywood former F3A) and F4 (cemented to plywood former F4A) which in turn are cemented between the 1/16in. sheet sides. Two 10B.A. screws secure the front of the motor to F3A. Then cement formers F2 and F5 into position, a doubler is made and cemented to F5 for additional strength. Then cement remaining formers F6 and F7 into position joining the fuselage sides at the rear by inserting two 1/8in. wedges leaving a 1/16in. slot for tailplane insertion (see section A-A). Nose former F1 is made from ¼in. sheet with a smaller 1/16in. former cemented to the rear to support fuselage sides. A 1/8in. Riko slot car oilite bearing is "Araldited" into the ¼in. hole in the nose block. Carve and cement F1A to the bottom of F1 and F2, then add air intake F2A. Drill through for air scoop. A brass propeller extension tube is Araldited (or soldered) to the motor spindle. The head is sawn off from an 8B.A steel screw and the screw then Araldited into the brass tube. The propeller used is a 3in. x 1½in. Cox as used with the Tee Dee .010 glo motor. The propeller is secured by three 8B.A lock nuts and finally a spinner is made and cemented on. (I used a Woolworth's sample plastic lipstick holder sawn off at the end and with slots cut for the propeller blades by using a hot balsa knife blade). The cockpit floor was added, then 1/16in. sheet fuselage decking was cut, steamed and cemented into position. A hatch was cut out of the front fuselage decking for access to the motor, the hatch was secured internally by rubber bands. To complete the fuselage add the pilot, canopy, exhaust manifolds, and finally sew and cement the tailskid to the 1/16in. fuselage bottom sheet, then cement in position.

The 1/16in. sheet tailplane is next cut and sanded to shape then cemented in the slot in the rear of the fuselage. Next shape the 1/16in. fin and rudder and cement in position on the fuselage decking.

The entire lower wing surface is cut from 1/32in. sheet balsa and the eight wing ribs W1-W4 glued in position on each side using PVA glue (balsa cement tends to cause warping). The ribs W1-W4 on the right hand wing are drilled to allow the fine power wires from the motor to pass through. The wires should be routed through small holes in the right hand sheet undersurface at the wing tip. Next Araldite a suitable lead weight to the left wing tip and a 1/16in. plywood tether plate should be cemented to the right hand wing tip. Score the centre line of the sheet under surface of the wing, crack and bend gently upwards and cement to allow for the dihedral (½in. at each wing tip). Cover the top surface of each wing independently by using 1/16in. balsa steam curved to shape and fixed with PVA glue. The 1/16in. sheet covering should "butt" fit at the centre line. Pin and leave to dry. Add the wing tips made from soft balsa and finally solder a miniature Radio Control two-pin (female) plug to the wires and Araldite to the undersurface of the wing tip. Glue the entire wing to the recess under the fuselage.

The undercarriage legs are bent to shape from a piece of 16 s.w.g. piano wire to which a rear support is bound and soldered. The support is made from 18 s.w.g. wire. Use fuse wire to bind these legs together. The undercarriage unit is then sewn and Araldited to the 1/8in. shaped block and finally cemented to the underside of the wing. Solder on the ¾in. Ripmax rubber balloon wheels.

The wings and tailplane of the original model were covered with white Solarfilm. (Lt. Wt. tissue can be used). The fuselage was covered with tissue then given a coat of sanding sealer. Finally black and yellow diagonal enamel stripes were added along the entire fuselage length. Spinner and exhausts painted white.

Appendix III

Electric Round-the-Pole 'Manoeuvres' Contest

General

This is a contest for any electric powered model, using a standard line length of 25ft. 0in. (Length can be adjusted to suit available conditions). This contest was devised around Pat March's "Voltswagon" (RTP.1105), but is suitable for most electric models capable of flying on these length lines. It is a contest which would depend on skills of the pilots, while performing several limited types of manoeuvres, and in his ability to produce a model capable of the different requirements of the contest.

The pilot to score the *least* number of points is the winner.

1. *BALLOON BURSTING (OR SIMULATED ALTERNATIVE)*
The pilot has an unlimited number of laps, in which to burst one balloon, after he has nominated his start. Each lap will score one point.

2. *NOMINATED HEIGHT*
The pilot will fix the adjustable height marker to the height he nominates, and will attempt to fly four consecutive laps after announcing the start with his wing tip level with the centre graduation mark. This carries nil marks. There are three further graduation marks above, and below, the centre graduation, and for each one there is a penalty score of 5 points. If the pilot should miss the graduation altogether, he will score 20 points.

3. *OVER AND UNDER*
This will consist of six consecutive laps, after start nomination, in which the pilot will attempt to fly over a fixed pointer at 6ft. 0in., and under a fixed pointer at 3ft. 0in. in each lap, the pointers being diametrically opposite. 5 points are scored for each failure at each height.

4. *SECTOR LANDING*
The sector will be of an agreed size, and landing must commence and finish within these boundaries. One point will be scored for each foot of sector taken up in landing, measured from first boundary to centre of wheels. If touch down occurs before first boundary, a penalty of 20 points will be given, and each foot inside the boundary will count as 2 points. If model carries past last boundary, 2 points will be scored for each foot taken outside boundary.

5. *SPEED RUN*
This will consist of ten laps to be timed from pilot's nomination. Score one point for each second. The faster the run, the least number of points scored.

6. *SLOW RUN*
In an effort to score minimum points, the slower the flight the better, as the time taken in seconds is deducted from a nominal 60 seconds, and a point given for each second of the result. In this instance, points may be positive or negative, and will be added to, or deducted from, the progressive total for the flight.

7. *TOUCH AND GO*
Three attempts will be made, not necessarily in consecutive laps, and will take place in the landing sector used in section 4. 5 points will be scored for each failure.

8. *SPOT LANDING*
Using the "start" line as a marker, one point will be scored for each foot from this line when stopped. No throttle change will be allowed after touch down. Failure to stop will score a penalty of 25 points.

During the contest, the model must not touch down except where this is part of the manoeuvre. Any unauthorised touch down will score 2 points.

Flying Scale Kits, suitable for conversion to Electric R.T.P.

KEILCRAFT
JUNIOR FLYING SCALE SERIES

AUSTER ARROW	21"	LUSCOMBE SILVAIRE	21"
BEECHCRAFT Bonanza	20½"	MESSERSCHMITT Bf.109	17"
CESSNA 140	19½"	MUSTANG	18½"
D.H. CHIPMUNK	20"	NIEUPORT SCOUT	15½"
ERCO ERCOUPE	20"	PERCIVAL PROVOST	19"
FAIREY GANNET	20"	PIPER FAMILY CRUISER	21"
FAIREY JUNIOR	18"	PIPER SUPER CRUISER	18"
FOCKE WULF Fw 190	18"	S.E. 5A	16"
FOKKER D VIII	16"	SOPWITH CAMEL	16"
GLOBE SWIFT	20"	SUPERMARINE SPITFIRE	18"
HAWKER HURRICANE	20"	STUKA Ju87	20"
		STINSON STATION WAGON	19½"
		WESTLAND LYSANDER	18"
		PREFECT SAILPLANE	24"

KEILKRAFT SUPER SCALE

CESSNA 170	36"
LUSCOMBE SILVAIRE	40"
PIPER SUPER CRUISER	40"

KEILKRAFT "EEZEBILT"

CESSNA SKYLANE	18½"
MESSERSCHMITT Bf.109	16½"
MUSTANG	16"
PIPER SUPER CRUISER	19"
PIPER COMANCHE	18"
SPITFIRE	16"

FROGLITE QUICKBUILDS
(15" to 19" span)

CESSNA BIRDDOG
D.H. PUSS MOTH
D.H. TIGER MOTH
DORNIER D.27
GLOSTER GLADIATOR
HAWKER FURY
PIPER PACER
RYAN P.T.20 TRAINER
AERONCA SEDAN
AUSTER AUTOCAR

(ALL KITS ARE PRECUT PRINTED SHEET SEMI-SCALE "QUICKIES")

VERON
TRU-FLITE

AERONCA CHAMPION	23"
AUSTER A.O.P.	22"
BEBE JODEL	18"
BUSTER	16"
CHILTON	18"
COMPER SWIFT	18"
COSMIC WIND	16"
D.H. CHIPMUNK	20"
FOCKE-WULF 190 A3	18"
FOKKER D VIII	18"
HARVARD	21"
HAWKER FURY	17"
HAWKER HURRICANE	18"
LUSCOMBE SEDAN	24"
MESSERSCHMITT 109.G	18"
NIEUPORT SCOUT	20"
SEAMEW	20"
S.E. 5A	15"
SKYHAWK	23"
SOPWITH CAMEL	18"
Sopwith triplane	17¾"
SUPERMARINE SPITFIRE	18"
SWORDFISH	18"
TIGER MOTH	18"
WILDCAT	20"
PREFECT SAILPLANE	30"
(Has been towed R.T.P.)	
VERON KWIK FIX	
CESSNA SKYWAGON 182	23"

STERLING

AERONCA C-3	36"
ANSALDO SVA.5	19"
BEECHCRAFT BONANZA	22"
CESSNA BIRDDOG L-19	17"
CESSNA 180	17"
CORSAIR F4U-5	24"
CURTISS HAWK P.6E	16"
FOCKE WULF Fw 190	24"
FOKKER E-III EINDECKER	25"
FOKKER D VII	24"
FOKKER D VIII	21"
GREAT LAKES SPECIAL	24"
Ju 87 STUKA	20"
MESSERSCHMITT 109	17"
MUSTANG P.51D	24"
NIEUPORT 17	24"
PIPER SUPER CUB	18"
PIPER CUB J.3	30"
S.E.5A	22"
SOPWITH CAMEL	24"
S.P.A.D. XIIIc	24"
SPITFIRE Mk. 1	24"
STEARMAN P.T.17	22"
TEXAN AT-6	18"
THUNDERBOLT P.47	20"
ZERO	24"
SCHWEIZER 2-32 SAILPLANE	42¾"
(can be towed R.T.P. using about 10ft. nylon thread)	

GUILLOW

WORLD WAR II (ALL 16½" SPAN)

CURTISS P-40 WARHAWK
FOCKE WULF Fw 190
GRUMMAN F6F HELLCAT
HAWKER HURRICANE
MESSERSCHMITT Bf.109
SUPERMARINE SPITFIRE

WORLD WAR I (ALL 18" SPAN)

FOKKER D VII
FOKKER D VIII
NIEUPORT 28
S.E.5A
SOPWITH CAMEL
S.P.A.D.

(ALL 24" SPAN)

AERONCA CHAMPION 85
CESSNA 170
CURTISS ROBIN
DE HAVILLAND PUSS MOTH
FIESLER STORCH
NIEUPORT 17
PIPER SUPER CUB
RUMPLER C.V
S.E. 5A
THOMAS MORSE SCOUT

DE HAVILLAND 4 (27" SPAN)