CONTROL LINE
MODEL AIRCRAFT

ABOUT THE CONTENTS

CONTROL LINE MODEL AIRCRAFT is intended to offer suitable guidance and instruction to the many thousands of ordinary aeromodellers who are already struggling with the initial stages of flying, or hope to do so in the near future. It does not pretend to teach the expert anything—as if it could do ?—but it will help the newcomer to this fascinating branch of flying to avoid the sometimes expensive pitfalls that can beset him. It answers in its pages many of those questions that have always seemed too obvious for the well-known authorities to even mention ; it takes the would be flyer in easy steps from his first model, usually a kit, to his first loop.

To its compilation has gone the unique resources of the *Aeromodeller* staff, its own flying field and workshops, its many and expert correspondents, and much of practical value gleaned on staff visits to America and Europe.

We have frankly searched the best material available for skilled advice on all aspects and would take this opportunity of thanking our many friends who have helped and the numerous sources which have provided information.

In addition long and painstaking experience was gained the hard way as absolute beginners, learning from our own errors, through a bucketful of broken props to comparative skill.

This book does not tell the reader how to win contests, or how to break speed records, but it does attempt to offer the average aeromodeller all that is necessary to really enjoy the fascinating sport of control line model building and flying.

CONTROL LINE MODEL AIRCRAFT

An introduction to the popular sport of control line flying, with authoritative information on all aspects drawn from British and foreign sources, and the practical experiences of the *AEROMODELLER* RESEARCH STAFF

Compiled by
D. J. LAIDLAW-DICKSON
and Edited by
D. A. RUSSELL, M.I.Mech.E.

A
HARBOROUGH
PUBLICATION

THE AERODROME
BILLINGTON ROAD, STANBRIDGE
Nr. LEIGHTON BUZZARD, BEDS.

1949

Also Compiled by
D. J. LAIDLAW DICKSON
and Edited by
D. A. RUSSELL, M.I.Mech.E.

MODEL DIESELS

AEROMODELLER ANNUAL

Distributors to the Book Trade
HORACE MARSHALL & SON, LTD., LONDON, E.C.4.

Printed in Gt. Britain by
THE CROYDON TIMES, CROYDON, SURREY

FOREWORD

In preparing *Control Line Model Aircraft* we have endeavoured to take a middle course and present a book that is neither too advanced for the beginner nor too elementary for the aeromodeller who has progressed a little on the way. It has been assumed throughout that the reader will have some knowledge of aeromodelling, though not necessarily of control line building and flying. We have made no attempt to provide information or instruction for the advanced or expert flyer; such aeromodellers will normally have a fund of special knowledge of their own and require less text-book guidance than further opportunities to practise on the actual flying field.

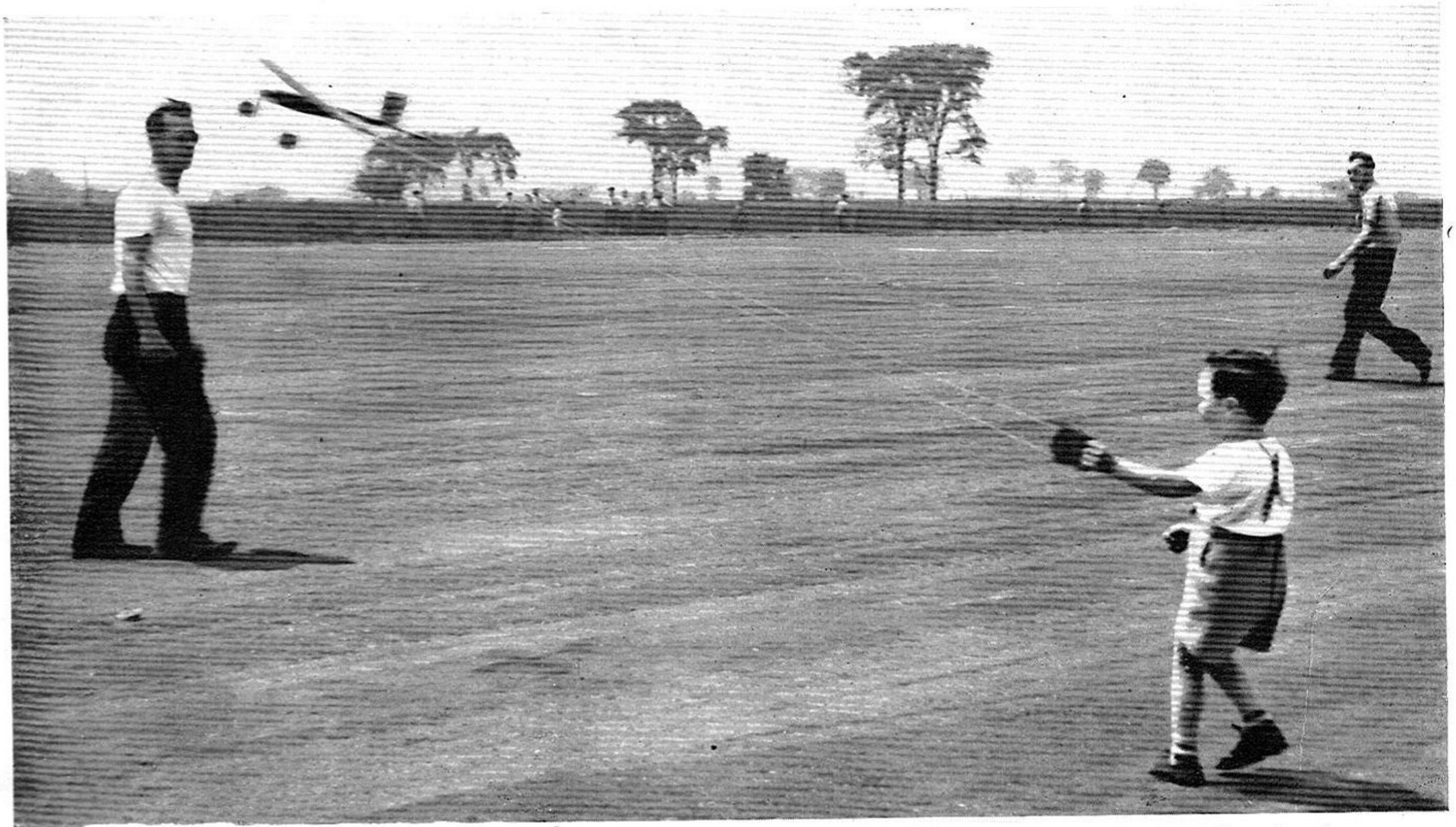
Available American and continental sources have been carefully sifted to provide as much useful information as possible, bearing in mind that the average British enthusiast is limited by the types of engine readily obtainable in this country so that some overseas methods are not always entirely suitable here.

Our advice on flying has been learned the hard way by our staff at Eaton Bray, who have one and all held the lines at some time or other with varying degrees of success. Starting as complete novices, everyone of them made exactly the same mistakes in approximately the same order, despite the example of those flying before them, and we feel justified in assuming that the average aeromodeller will be equally prone to find these same pitfalls in his turn.

We are conscious that much has been left unsaid on the subject of control line flying; that many aspects have been touched upon but lightly; and that certain controversial points may have been left unanswered; but nevertheless do feel that in offering *Control Line Model Aircraft* to our readers, we have at least started them on the right path from their first model to their first loop.

D. J. LAIDLAW-DICKSON

SPRING, 1949 — D. A. RUSSELL



Child's play ! This youngster shows his elders the way it should be done. While proud fathers will be eager to groom their offspring for such performances it is only fair to warn them that the road to success may well be paved with broken prop blades to mention the very least of the horrible probabilities.

CONTENTS

Jim Walker demonstrates the Sabre Dance. This apparently stalling model is in fact doing a vertical jig with aid of motor control conveyed along the insulated control wires. Lead from handle to battery in the trouser pocket will be noted. It takes an expert like Jim Walker to think up a stunt of this nature, let alone perform it, as he has, regularly and safely all over the States.

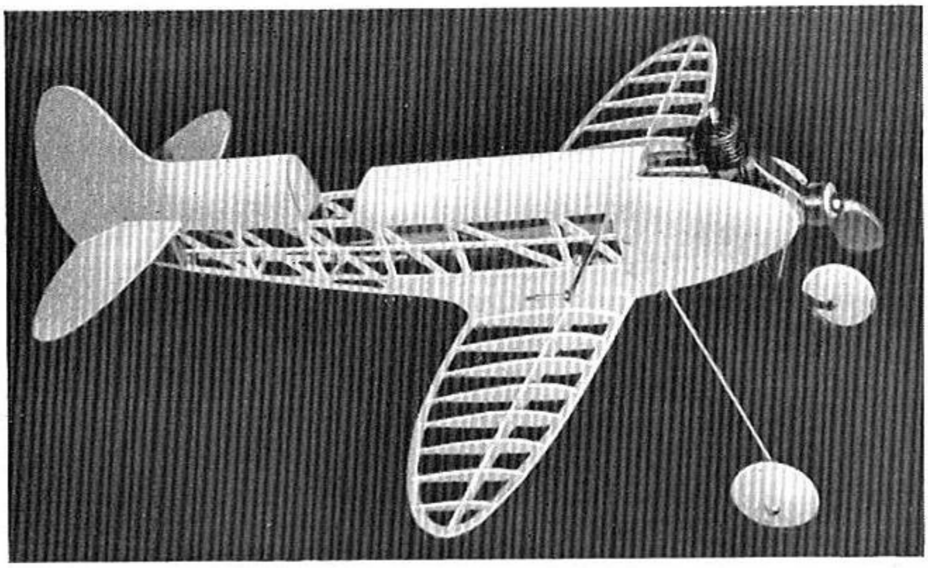
CHAPTER ONE

THE BEGINNING OF IT ALL

EVERY few years some new world shaking discovery comes along in a blaze of publicity and is heralded as mankind's greatest advance since never mind what, and then, after the excitement has died down, the ordinary man in the street shakes his head and says to himself: "That's all very simple, why didn't *I* think of it first?" So, in our small world of aeromodelling, the really clever advances are things anyone *could* have thought of, but somehow left for the other man to do first. Control line flying of model aircraft came along just like that. While American factories were turning out more and more war material for their Western Allies, model engine supplies became progressively less, until the prodigal American power flyers could no longer afford to let model after model go zooming off into the blue, without hope of engine replacement. Then it was that two model firms, who had come, by different routes, upon the same bright idea of marketing models that would not fly away, and, could, in addition, be actually controlled by the "pilot" during flight, began to reap their reward.

Jim Walker, who has long figured amongst America's brightest model enthusiasts, added to his reputation in the model radio control field, with his clever U-control device, which he was able to patent (Filed 26.12.40), and in consequence has since had the satisfaction of seeing more than half his country's control line kits earning him royalties. Vic Stanzel, another inventive model trader, produced his G-control and roller systems which for some time vied in popularity with U-control, but are now considered less satisfactory in some respects.

Just what is this control line flying? The name is delightfully explicit and means exactly what it says. With the aid of two piano wire lines, or stout fishing lines power driven models are flown in fixed circuits round the controller. One end of each line is attached to a pivot which actuates the elevator in an up and down direction, the other ends are held by the operator attached to a U-shaped handle with a line to each arm of the U, inclination of which moves the wires and so alters the elevator trim. Thus the model will climb, dive or fly level as required. In the case of G-line—which incidentally was on the market some time before Jim Walker patented his device—a single line only is employed attached to the plane slightly ahead of the centre of gravity, and at the other end to a light pole held in the flyer's hand. By raising or lowering the pole the model can be made to climb or dive. Whilst very simple this method has its disadvantages in the somewhat sluggish response to the control.



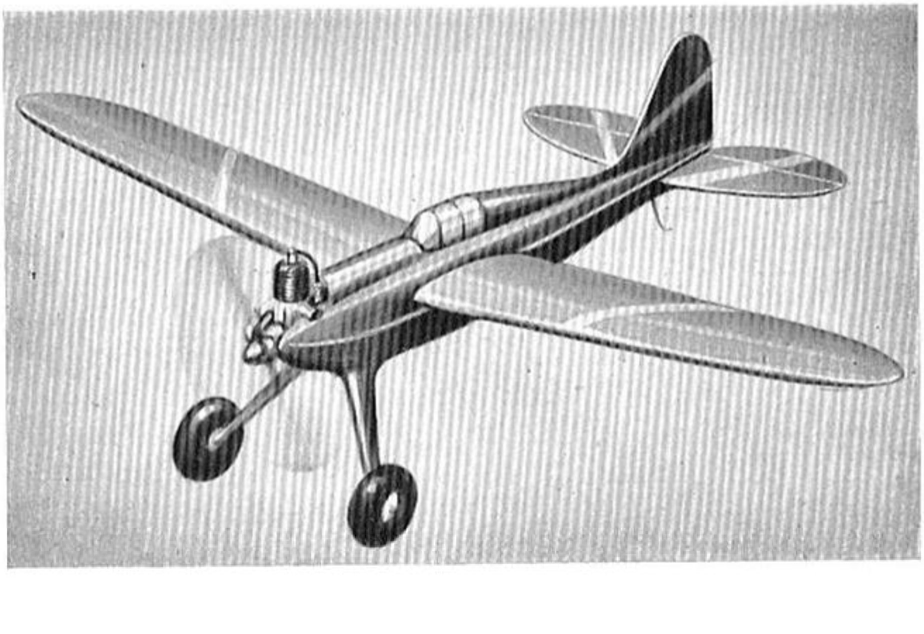
Stanzel Baby Shark, amongst the earliest control line models. This design features the special Stanzel roller control, visible as a projection above the wing root.

In a year or two this freak craze for control line had so prospered as to be a threat to free flight power model flying. In the American model magazines of 1941/2, one comes upon constant and virulent attacks upon this dreadful " swinging a brick on the end of a string " by diehard free-flight fans, and equally powerful letters from the opposition camp proving, by a host of formulae, that it was not flying a brick on a piece of string at all. The entry of America into the World War proved another incentive to control line prosperity. Petrol supplies were short, tyres worn out, and the inevitable family car no longer available to run out to the flying field. But the control liner could fly his model on any odd patch of ground no larger than a tennis court, so who need worry about the distant flying field? In those early years some painful monstrosities saw the light of day in the guise of model aircraft. The smallest possible wing was allied to the largest possible engine, which barely lifted the heavily loaded projectile off the ground, and then proceeded to whirl it round at speeds of over a hundred miles an hour. The enthusiasts were speed hungry and cared nothing for looks. Little by little the thrill of going just a little faster than the next man wore off, and surprised builders found that models could be elegant looking copies of the latest war planes and still fly more than fast enough. Sports models, designed for long life and moderate speeds came into being and the despised " Goats," or converted free flight models, were tried again. Then came the great day when someone discovered that the real future of the sport lay in stunts. We do not know how many models hit the dust before the first loop was achieved ; then an outside loop, square loop, inverted flying and all the fun of the flying circus.

Speed still had its adherents, but the American contest rules were amended to bar the freak, and something more aerodynamically plausible took wing, again mounting higher and higher into three figure speeds. Side by side has grown a healthy appreciation of stunt models with a leaning towards scale or near scale design. Old timers of the First World War have taken the air again : Spads, Brisfits, Camels, S.E.'s and the like are common sights on the model field. Age too has been swept from its pedestal by the skill of a thirteenyear-old, who defeated the flower of the American control line kings in the stunt section and a youngster, certainly no older, in France, who took first place in an international contest. Now the new invasion has come to these shores. How shall we tackle the control line model?

The operative word is surely "control." There are other names for this form of flying, such as "guide line" or "tethered" flying, but we hope we are right in stressing that the future lies in control. Unlike our American friends, we have few engines in this country capable of clocking high speeds—the only really fast machines are those powered by American engines brought back by returning R.A.F. personnel, or acquired through who knows what dubious grey or even black market activities. We should confess at once, that we have had opportunities of trying out the best of the American speed engines, so cannot be accused of sour grapes, but the general run of speed readers will certainly not be able to lay hands on them for a long time. But we do have an unequalled range of small diesel engines that offer trouble-free flight at moderate speeds in all sizes from .5 to 5 cc. A new era may also be dawning for devotees of the older petrol engine with the development over here of the glow-plug, which offers a combination of diesel simplicity with petrol engine flexibility and added urge. Why then should we borrow from overseas when there is the making of an essentially British slant on control line flying? Most of our flying will necessarily take place out of doors—we have few large hangars or armouries available for modellers' use—and so our models must be robust and, again, controllable.

The wind bogey which has led many quite well-known British experimenters to advise against flying in any but the calmest weather, is not really so bad after all. We have consistently flown in all kinds of weather. We have painfully learnt how not to do things to the extent of a bucketful of broken props, and we are firm in the opinion that control line models can be flown on at least half the days of the year, which is more than can be said of free flight. Travel troubles are such that any opportunity for flying without going too far from home is welcome, and here again the control line model can be flown on any school playground, tennis court, or cleared bomb site. The



Old timer Fireball—Jim Walker's first U-control kit model that virtually started the craze for control line flying. With certain modifications the selfsame kit is still selling today after eight years.

only proviso is that the beginner should confine himself to the calm days until he can control his model as instinctively as he rides a bicycle : he will then adjust each circuit automatically against contrary winds.

Two forms of control will be used extensively over here. First favourite is likely to be the Jim Walker style, triangular control plate, moving the elevator with a single horn, and thence by two wires which actuate the control plate. The " flight controller " system may have its adherents on the score of simplicity. This device has no control plate, but a double elevator horn, one part for up and one part for down movement. The two leads are fed through a pair of curved metal tubes and thence to the manipulator. This offers slightly more positive response than the plate, but imposes a greater strain on the elevator. G-control in its simplest form may appeal to some as a training method, but the roller mechanism for advanced forms is trickier to make than the other systems and so may not be so much used.

Will speed flying have a following in Gt. Britain ? Of course it will : for a year or two at any rate. It is easier to learn to fly fast than to perform any great variety of stunts, so the newcomer will quickly gravitate to speed flying.

Already 60–70 m.p.h. has become the commonplace with engines between 1 and 2 cc. ; considerably higher speeds being claimed for such engines as the E.D. Going up the scale, the British made Nordec is regularly clocking round the three figure mark. As this and other British engines in the larger sizes get into circulation, we have no doubt our speed figures will very closely approximate those recorded in America. It should be borne in mind, however, that atmospheric conditions here do not encourage the same speeds from the same engines using the same fuel as in certain of the American states. We are glad to note that at least one famous oil company is conducting research into model fuels suitable for our climate.

But we certainly see more future than sheer speed. There is a grand opportunity for a wide variety of scale models built round some of the truly miniature .5 to 1 cc. diesels. A range of moderate speed stunt models should attract considerable interest. Already we note most of the model manufacturers are turning for kit inspiration to the medium sized engine as the power unit, and offering general purpose designs in preference to out and out speedsters.

It is interesting to consider for a moment how control line modelling has appealed to other European countries, who have learned it from the hands of visiting G.I.'s. France has developed an interest that turns mainly towards the speed model, based on 5 c.c. or larger engines. In this she has been fortunate enough to possess a number of commercial engines of reasonable power, such as the Micron 5cc. diesel, the new Micron 10cc. glowplug and the 10cc. Rea in the petrol group. A limited number of American engines have also been freely imported. The same goes for Belgium, where American kits and high-powered Hornets, McCoys and the like may be had on demand. To that extent, their development has been American, with access to the original power units to encourage that lead. In Italy, on the other hand, where aeromodelling is of sufficient interest to the rank and file to support literally dozens of local aeromodelling magazines, little or no such opportunity was available. In consequence, we find a number of under 5cc. designs, including a delightful scale model with engine amidships and driving its air screw via an extension shaft. Manufacturers have now taken the trouble to develop special engines for their fans, first with the Super Tigre of 5.65cc., a robust production of considerable power, and finally with Movo's latest 10cc. design, which in our opinion will prove, at least, the equal of America's best. It seems then, that as soon as control line enthusiasts are sufficiently numerous to lift up any considerable voice, we may hope British manufacturers will take the tip and produce a real job for those who like speed work. Meanwhile, we should make the most of what is to hand. In this connection, we would add, that a number of British engine manufacturers are already well towards producing such engines as well as conducting research on airscrew design. Their first findings, now coming on the market, offer great promise of ultimate success.

Before leaving the subject of early birds in the control line world we must pause awhile, and speak in praise of British pioneers. Let it not be thought we offer any exclusive bouquets to those responsible for the commercial exploitation of control line flying in America. They were clever enough to make a success of it and through their efforts made a wide range of supplies available to the average aeromodeller. But they were not the *first* by any means. Before miniature petrol engines came into being, lone hands struggled with complicated relays and Bowden cables to achieve controlled flying, quite ignorant that they were doing anything out of the ordinary. In the same way, pre-war illustrations in the *Aeromodeller* show a hardy pioneer flying his petrol model on a line. In the words of Solomon, there's nothing new under the sun—though some of those unknown pioneers must be kicking themselves for the chances they missed !

Control line comes to England ! Ron Moulton, pioneer British control line flyer, starts up his Voetsak—South African-named model in memory of his own initial control line flights over there.

CHAPTER TWO

CHOICE OF A FIRST MODEL

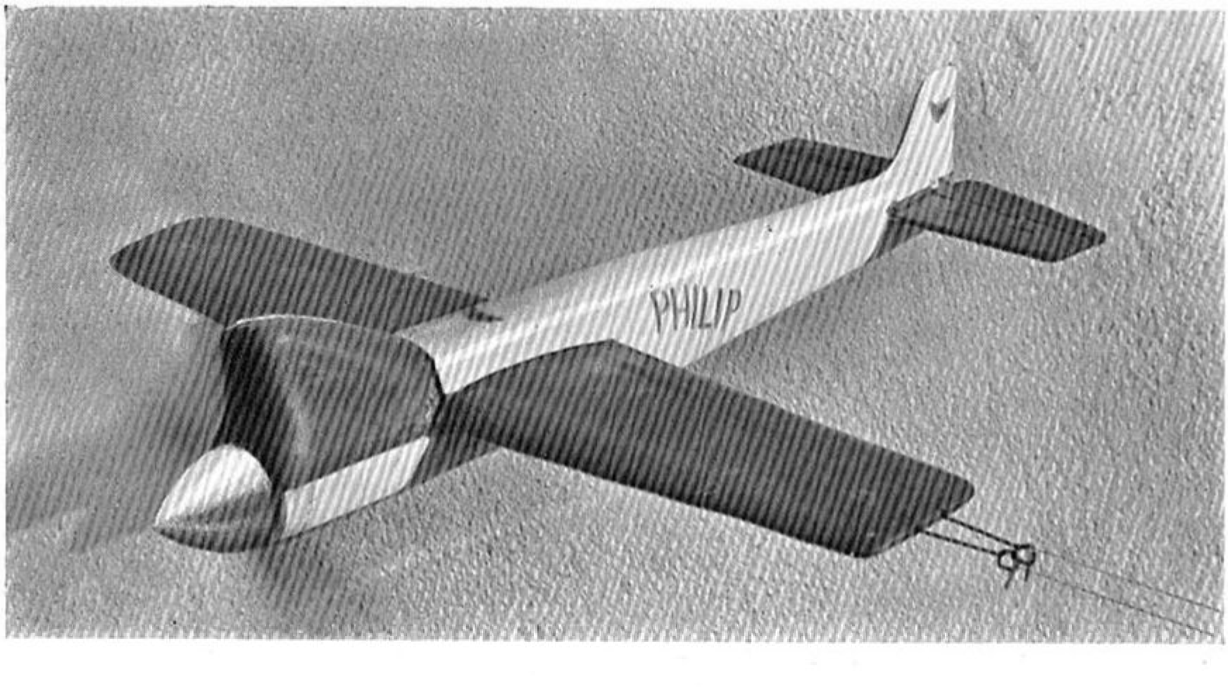
One by one the diehard free-flight power modellers are succumbing to the blandishments of the wicked control-liners and graciously accepting the working end of the lines, if only to demonstrate how easy it all is! It is not surprising, therefore, to find the ranks constantly swelling with enthusiasts from more experienced aeromodellers. Their future presents no special difficulties; they already (we hope) have the technical and manual skill to produce models that fly. It is only a question of changing methods and adapting their ideas to a new flight medium. Usually it takes one or two models to complete the change, and in a few weeks the more ambitious of them are happily sketching new ideas on the back of someone else's coffin.

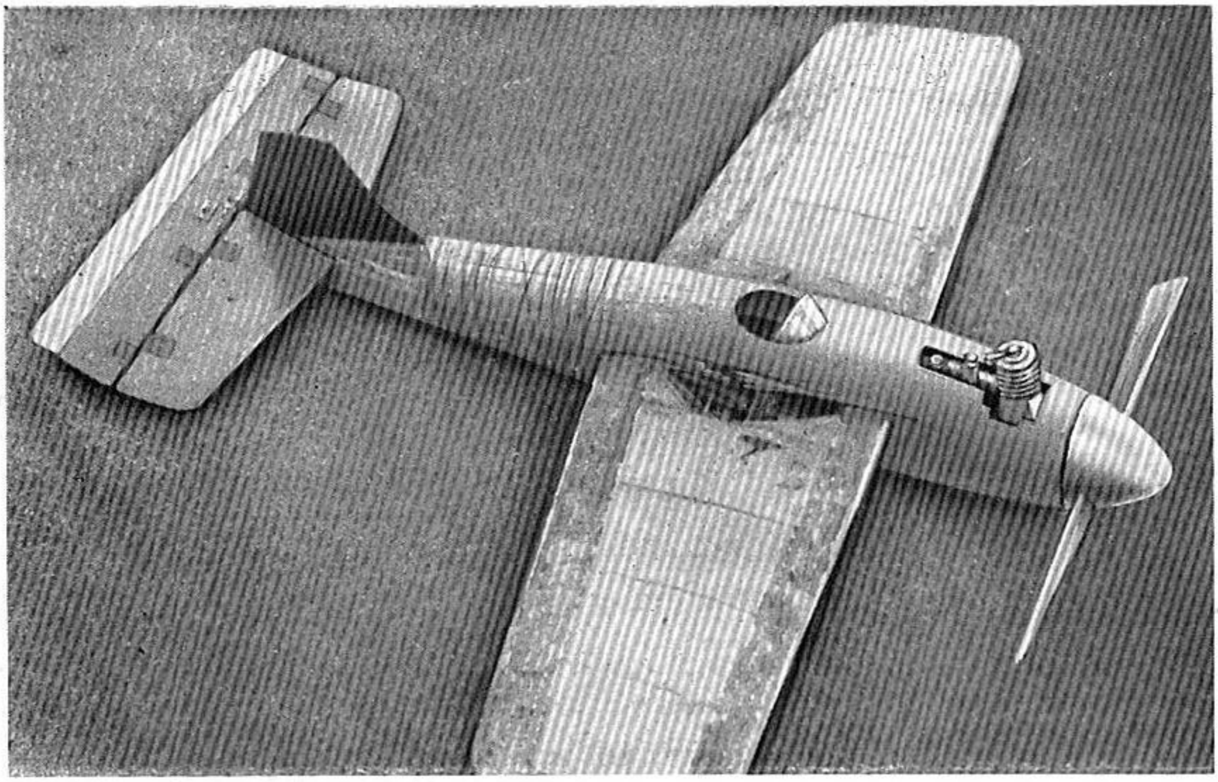
But this semi-experienced group is only a small section of the control line following. Very many are interested in building not only their first control line model—but their first model of any kind! Nowadays it is so very easy, with the modelshop round the corner, to start aeromodelling where the fancy pleases, without any of that painstaking progression from simple rubber jobs via more complicated ones, sail-planes, to the eventual happy day when funds were enough to buy a real engine! Perhaps it is a pity that the glamour of owning an engine of one's own has gone, when it was something to be saved up for and treasured, but life is much more companionable with every next man on the flying field giving a hand and swopping excuses as to why the latest motor won't go though it "went all right at home." There is no reason at all why anyone should not build and fly a control-liner as their first model of any sort. Quite a number of them do manage the building part of it—but the flying side ends too quickly to be anything but a damper on their future progress. We wonder how many of those small advertisements: " . . .Engine for sale, hardly used . . . " must be attributed to this unhappy ending to a first approach. Which of course, is one of the reasons for books like this.

More than half the chances of a successful first model depend on picking the right one to build. By this we certainly do not mean you will never fly Messrs. A.'s kit, but you will be able to get along splendidly with Messrs. B.'s. Because experts perform impeccably with model A does not mean you will be able to do the same: you will probably be far better served with a more modest design that has never shown its prop at a contest. Then later on you will be able to join the experts with something on the lines of that model A which first appealed to you. All that the beginner need worry about for his first model, is something that will fly in smooth regular circuits, exhibit no particular vices of trim or design, be tolerably easy to construct, and just as easy to repair—and moreover, have no parts that, once broken, involve complete rebuilding of some undamaged section to get them back in place again.

We make no suggestion that the control line beginner should even think of designing his own. The hazards are numerous enough to the unskilled without adding the imponderables of an untried design. Our own first model was a nice own design scale Tipsy, that took off in a perfect wingover and landed with a crunch that connoisseurs acclaimed one of the most satisfying they recalled. We have never built another Tipsy; but, in the light of present experience, we know that model would have flown perfectly, if handled with our later acquired knowledge. It was just much too advanced for a first model. Manufacturers are turning out kits at an unbelieveable rate—new ones seem to be bobbing up every week. All of them will fly, but only some of them in the hands of beginners. It is quite impossible to keep track of new kits, though an appendix gives listing at time of going to press, and equally hard for us to suggest one make in place of another. What we have done, to assist the novice, is to give our candid comments on a fairly representative selection of kits suitable as beginner or intermediate stage flying sent to the *Aeromodeller* for inspection and review, where the manufacturer is happy for staff comments to be made. There are, of course, a large number of other kits on the market examples of which have not been sent to us, either from disinterest on the part of the makers or for some other reason, where obviously we are unable to guide the would-be buyer. We hasten to add, quite off the record, that there are some very fine ones amongst them, quite as suitable as any we mention by name—but it just happens, no one has sent one along to us. All the kits described

Halfax Sabre, intermediate speed trainer kit, built by our fourteen-year-old office boy with no other help than advice—often contrary—from all and sundry. This design puts up a very good show in all but the least experienced hands, and is a good choice for a first speed model.





Old Faithful—the much battered Mercury Magnette, second to be built, though with original empennage, that saw most of our staff passed out in their elementary training courses. Note thread binding to hold fuselage together and other honourable scars. Elevator area was increased, as will be noticed, to enable more ambitious flyers to attempt the impossible.

have actually been made up by various members of the Eaton Bray staff and flown on every available occasion to eventual destruction on the very strict understanding, that "who bends 'em mends 'em." Of the more popular models we note that an original tailplane is flying as the sole remnant of one kit—other parts being renewed piecemeal; several fins have survived into the second generation, as have undercarriages, but mortality rate in mainplanes and fuselages seems to have been high, both from hard contact and from inefficient protection against fuel seepage and consequent rotting. This should serve as a guide for future programmes. Building time, incidentally carried out in leisure, that is non-working hours, has been anything from a week-end to a fortnight's evenings; little attempt has been made to get exhibition finish, main anxiety has been to have one ready for after-lunch flying the next fine day.

Starting with the small low priced kits, we would mention NANCY. This we flew as sent, with a Frog 100, using thread lines. It is a pleasant high-wing, slabsided sheet covered model, solid wings of elliptical planform. Taking off from a concrete disc, Nancy has been through everybody's hands as a trainer machine; used for change-overs in mid flight; made the stooge for two in the air at once; and even taught somebody's girl friend (who is now learning to stunt !). Of all our stock, we think this is the model of which most of the original kit has survived. Main damage has been to engine mounting, and a new fuselage will really be a boon.

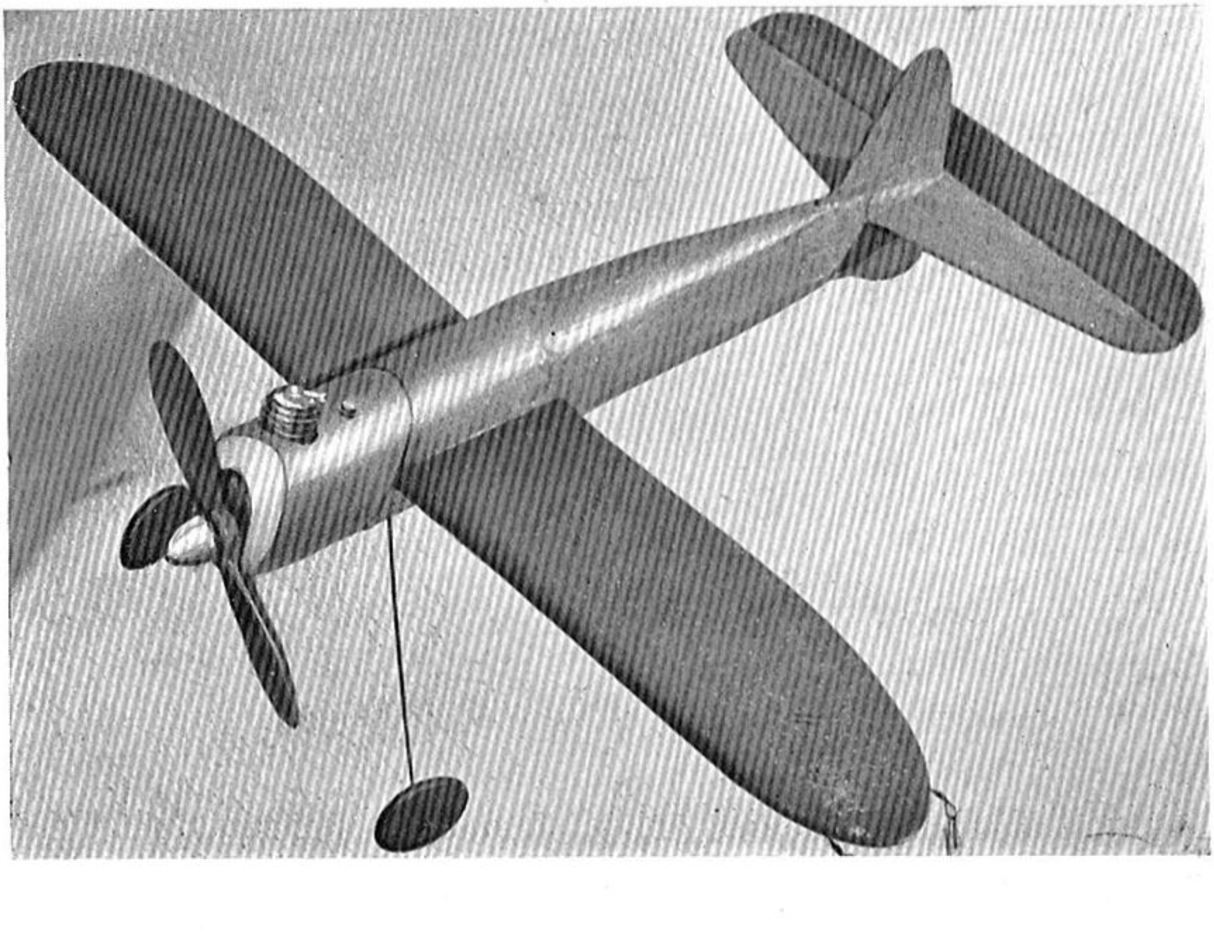
Another low-priced babe that we enjoyed, was Bournemouth's NIPPER. This with most of their other kits is designed by Queen's

Cup winner, Phil Smith, who can make these little chaps do most of the tricks. Last year at the Nationals (he was too modest to enter the Gold Trophy !) he gave a splendid show with this model, and did even better with his biplane STUNTER, and of course the twin-boom SPEEDEE. All these three designs are quite suitable for novices, who need not start with the stunts. Powered with anything over 1cc., however, they are quite hot and should be treated with respect.

Of the beginner-intermediate type, Henry J. Nicholls' MAGNETTE came along about the same time as our first E.D. Mk. III —a combination which proved most successful. First model completed was wiped off completely in a burst of over-confidence ; one or two parts salvaged went to make a second off that lasted quite undamaged longer than any. Half-a-dozen first " wingovers " were produced on the staff Magnette, now literally worn out. Built down to under 16oz. all-up weight Magnette will loop, at 13oz. multi-loop ; but we blush to confess our own specimen was rather obese—tipping the scales at 21 oz. With drop-off under-carriage, this heavyweight *did* manage to get itself safely out of a loop, but we were too fond of the old dear to risk it any more. For those who like an American flavour to their flying, we can best describe MAGNETTE as an original British version of Hot Rock style for 2-3cc. engines

International have produced a fascinating streamlined highly pre-fabricated kit, appropriately called the RADIUS. It is extremely complete, with preformed undercarriage—always a bugbear—and every part really fits where it should. For novice flyers, it has one

Worcraft Monarch—a robust job that we first flew in a near gale. Fitted with an E.D. Comp Special we got some quite sensational flying in before the inevitable. Moulded cabin was omitted as someone trod on it during building operations. Quite within the scope of the average careful beginner.

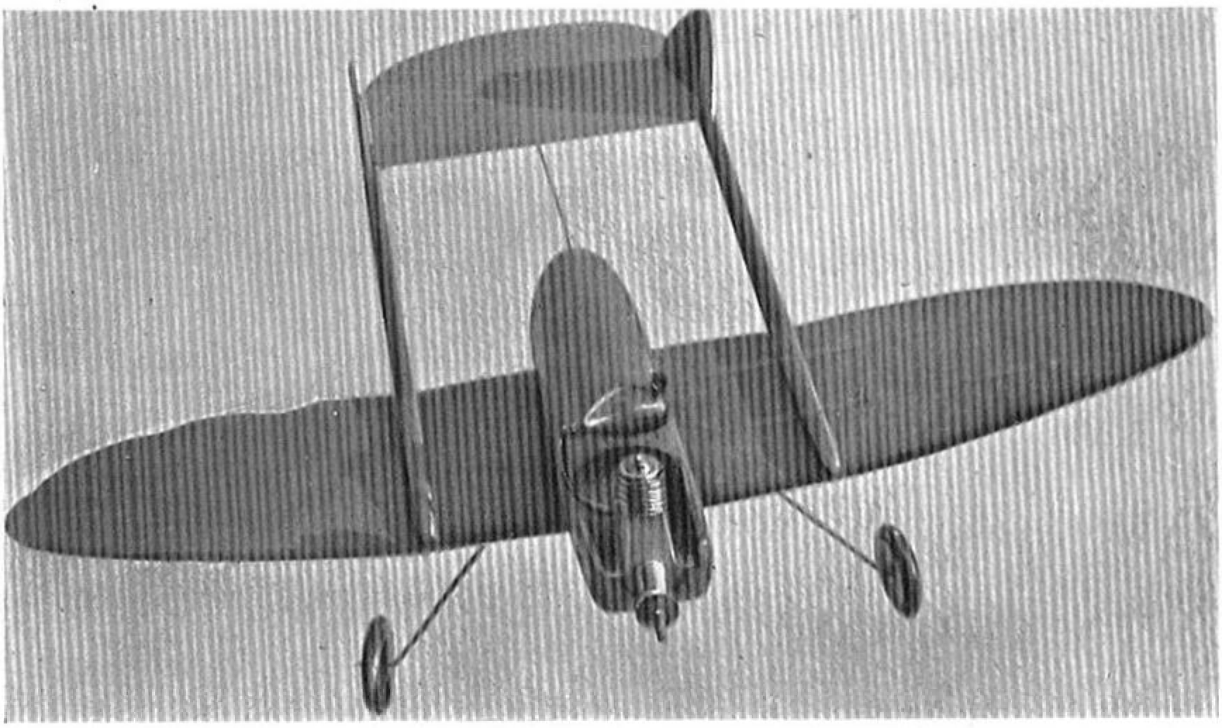


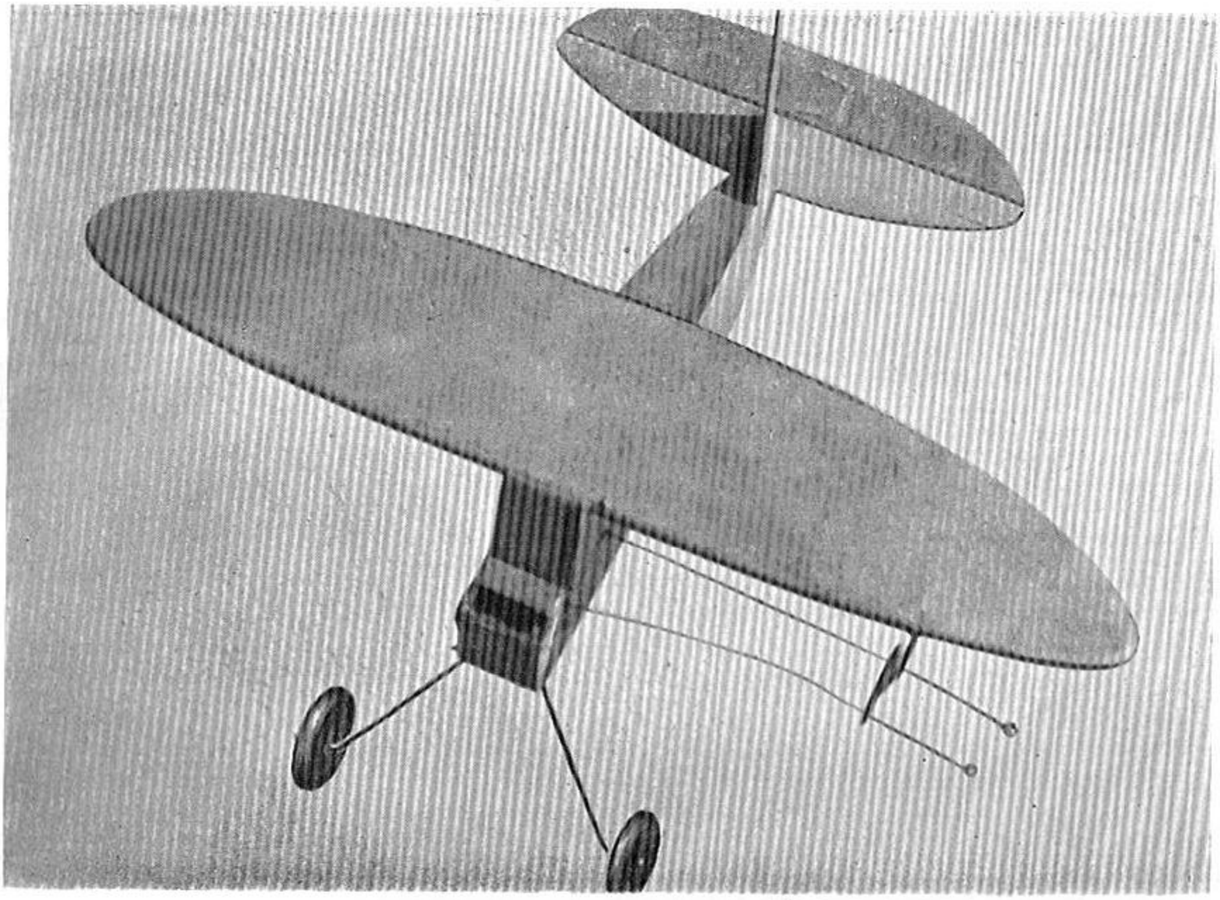
very successful feature, a knockoff elastic fixed engine mounting. Contrary to general usage, we cemented our fuselage halves together—instructions suggest they should be elastic fixed for access to control plate, etc., but cementing them in place makes for a more crashproof job. We cannot do the things the I.M.A. boys showed us half so smoothly as they do, but we can do them on our home ground, and suitably mated with a Frog 100, it is a good little machine. For those who want more urge, the 180, or the glowplug 160 can be used instead.

Halfax have a TRAINER—it was one of the first British kits on the market, and so, not surprisingly, is somewhat outmoded today. Their supporters will not go wrong, however, on Trevor London's latest model, the SABRE. This is described as an advanced trainer and speed model. Fitted with a Mills or perhaps something less potent, it is an excellent first off for those desirous of joining the speed ranks. It gives good response to the controls, and affords splendid training from the start in dealing with a fully cowled-in motor. Then, provided it is still all there, the blossoming learner can fit a somewhat hotter motor and get it buzzing on the lines like a winner.

Those who fancy a dolly take-off and like the biplane layout, could do worse than desert the kit market for a plan—in this case, the A.P.S. TYRO TRAINER—a solid wing speed trainer biplane, intended for a 5cc. Drone diesel, but quite happy with an Owat, Micron, Delmo, or anything else about that size. We built two and really enjoyed the feeling of power and pull on the lines they gave. For those who may do likewise, we give this advice: be sure that the balsa used for the fuselage is really the hardest you can get. We did not take this precaution, and both machines broke in the same place eventually, just forward of the tail—once it occurred in mid-air; the audience

Veron's Speedee, a pleasing little twin boom that is still in flying condition in spite of use and abuse, as scars would indicate. Built for flying rather than looks, the J's tank mounted on the fuselage may offend the purist, but is just the thing for a quick take off in lunch hour circuits.





Original Nancy—with radial engine mounting showing signs of wear, but no other damage. This " baby " served as a first flight machine to many, including girls, and still lives to fly again. Just the machine to train an infant prodigy on—or to last a full season in more careful hands.

was respectfully silent ; we were not. This machine will provide a regular course in speed apprenticeship—top somewhere about 70 m.p.h., good cruising at 50 m.p.h., and fixed undercarriage, drop-off wheels or standard three-wheel dolly can be used.

Worcraft's MONARCH is another simple job for a start—though for an absolute beginner, we would recommend fitting of rather stouter engine bearers—or perhaps we were just unlucky. The Don RIVAL is another extra simple model that seems just made for the beginner, without structural problems or flying difficulties. Some of Watkins' plan packs also make quite useful trainers—we have in mind particularly JINCKER and BAMBARA.

A lot of the beginner's problems will be centred round choice of a kit to suit an engine they already have. In this connection, do try to get a kit specifically designed for that engine, or that capacity. Putting a quart engine in a pint airframe, will be spectacular but short lived. There is no need to be nervous of making a start with a large engine—which means a correspondingly larger model. Such a model is, if anything, easier to fly than a smaller one, not so restricted by weather conditions, and gives more feeling of really flying. But if, or, should we say, when, it crashes, it hits that much harder.

Those without either engine or kit, and so able to get the two together, we would recommended to a middle course, of neither too small nor too large. There is a really grand selection of engines between 2 and 3.5cc., and matched kits to suit them.

Gathering of speed merchants for the American Nationals. These flyers come from Honolulu, Cuba and Mexico, but are alike in the design trends shown. Note only one model has a fin, while that in the grass sports a butterfly tail, a style that is finding more and more support amongst the 120 m.p.h.-plus brigade.

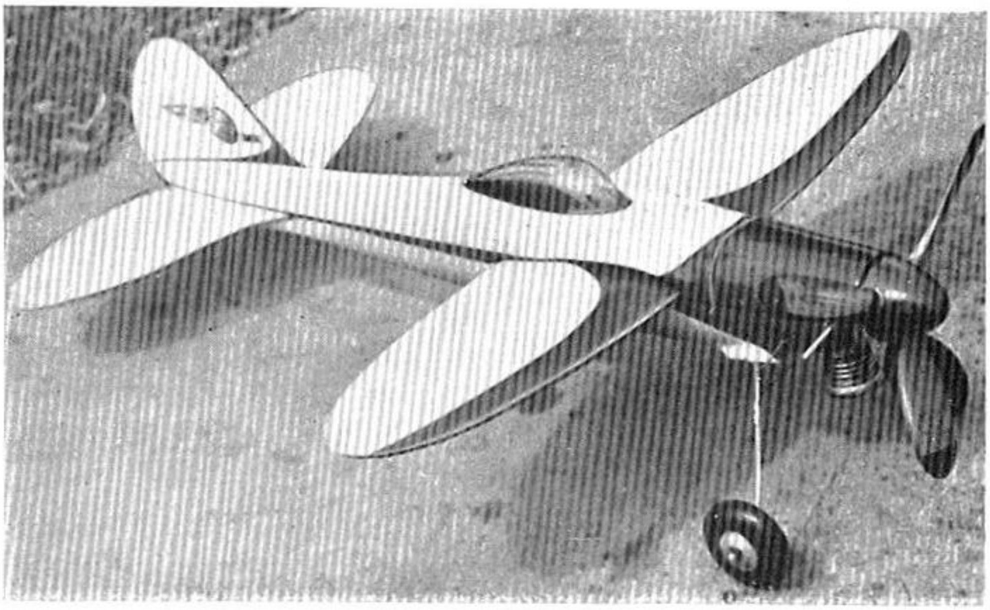
CHAPTER THREE

DESIGN CONSIDERATIONS

THE builder will not remain content with kits and other people's plans indefinitely. Sooner or later he will find the urge to design something for himself irresistible. Then what a wealth of opportunity opens before him ! In the control line sphere there is literally no sort of aircraft he cannot build and fly, given skill and patience. Sleek speedsters, clever trainers, scale designs with one, two or three wings, old timers and modern, single engined or multi-engined, experimental flying wings, tandems, canards, pushers, stunters, jet powered 150 m.p.h. projectiles, they have all been built and flown by inventive control line fans. But, before coming down to specific types, engine sizes and so on, there are a few general considerations that should be known to the would-be designer.

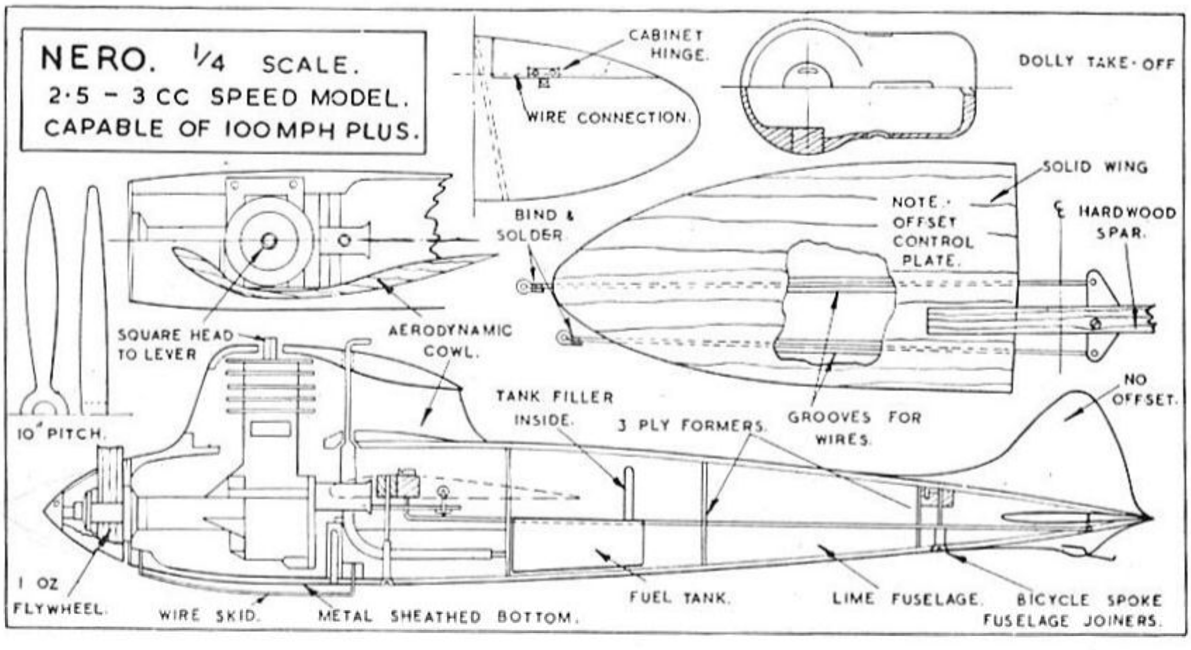
One of the first points that calls for determination, is the moment arm. Are you joining the long moment arm school as exemplified in such famous models as Hot Rock, or do you favour the short moment arm, which makes for lightning quick responses to controls ? Just to refresh our memories on the subject of the tail moment arm as it is properly called, this is, the distance between the centre of lift of the mainplane, which, according to the airfoil section used normally, lies 25-35% of the chord back from the leading edge, and the centre of area of the tailplane. Quite apart from any aerodynamics, it is obvious that the longer this distance is the greater will the lever effect be of any force exerted at the tail to move the aircraft about its centre of lift. This means, that a small elevator placed a long way back will do the work of a large elevator situated nearer the mainplane, and because the tailplane has a longer way to move, up or down, when executing a manoeuvre, the operator has more opportunity to see the effect of his control, correct it if necessary, and damp down the movement smoothly. Conversely, a large elevator placed a long way back will carry out the manoeuvres of a large elevator placed a short way back, but carry them out more slowly due to this long moment arm. This is one reason why it is usual to find super stunt models tend to a short moment arm and speed models, whose very nature demands smooth even control, require a long moment arm. This must not be accepted as a rule, or even a generalisation, but as a design tendency.

The moment arm cannot be indefinitely extended with improving results, nor immoderately shortened. There must be reason in all things. Speed models work well with a moment arm of from one wing span in length to a span and a quarter. With anything much less than a span's tail moment arm, flying conditions are likely to be tricky



French intermediate speed model. Consideration has been given to looks in the moulded cabin and three blader prop, features that must be discarded when going for absolute speed figures.

with a phugoid—or hunting up and down—movement that, once started, will get worse until the model hits the ground. Scale models will have their moment arm fixed already at between one-half and three-quarters of a wing span, with one or two exceptions. As such, they will make good sports machines, sometimes excellent stunters, but not often successful speed models. Which may seem odd when prototypes have possibly been "fastest in service" in their day; but many service types were beasts to fly, and in asking say, 100 m.p.h. of a model Spitfire, scale speed is being exceeded manifold. Stunt models will usually be found in the lower tail moment range of scale models or even somewhat less, though here it is fixed by choice, and not by copying. A point to remember in laying out a design, is that fin area is affected by tail moment arm length in exactly the same way and should be adjusted accordingly, particularly where an offset fin is employed to hold the model taut on the lines.

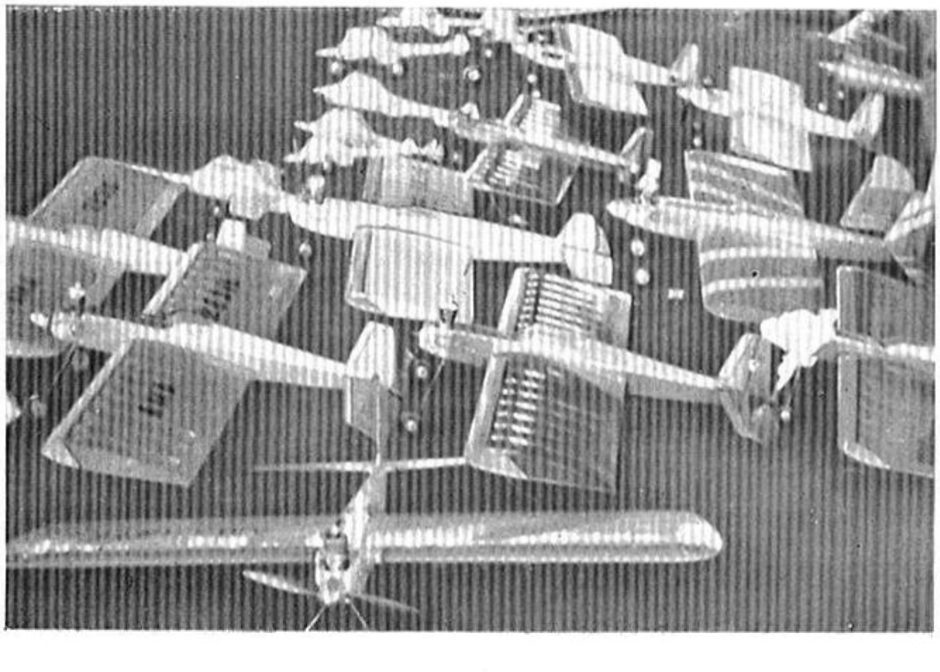


Tail areas are dealt with fully in the chapter devoted to them, as are the percentages of elevator area to tail surface, so we will content ourselves here by saying that areas range from twenty to thirty-five per cent. of wing area, of which any part from fifteen to over fifty per cent. may comprise movable elevator surface.

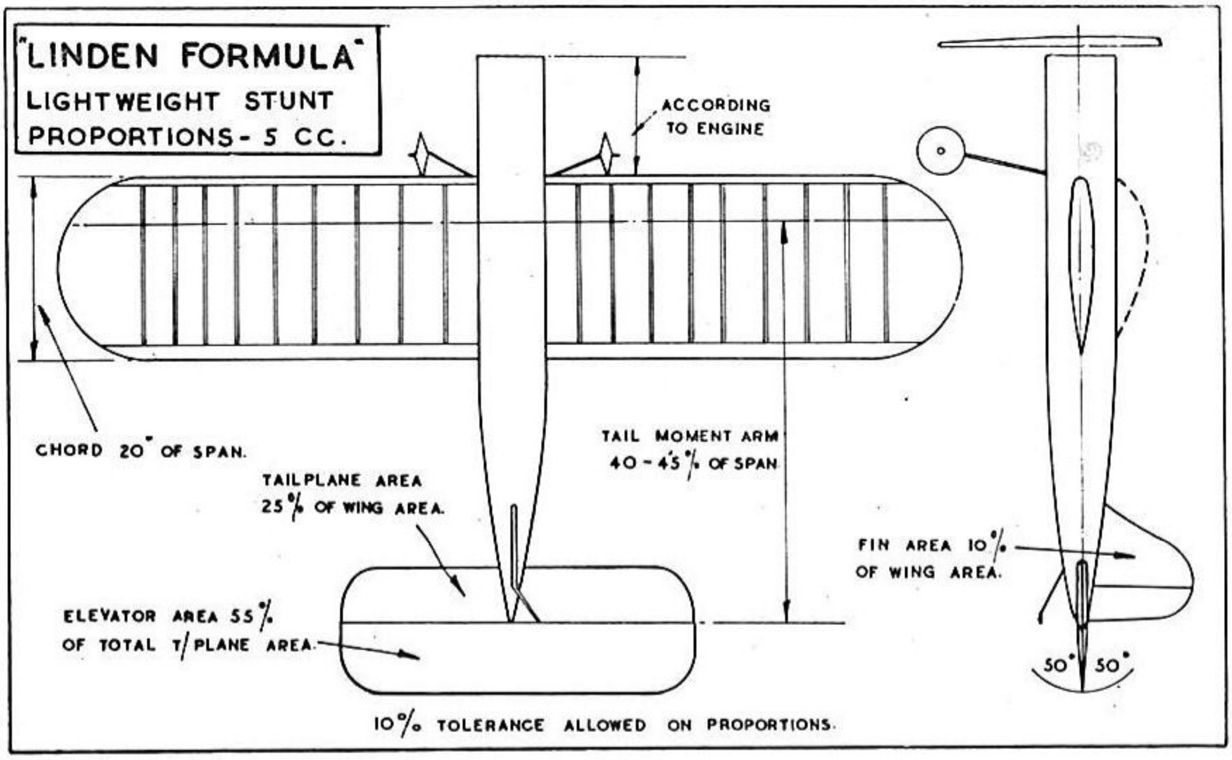
With the present swing towards diesel or glowplug types of engine, the problem of balance is important at the design stage. With spark ignition models, it is possible to be quite vague and indefinite and then trim to required point by shifting batteries. Without them to shift, it is necessary to add dead ballast which is always bad : better by far deliberately to add that weight as extra structural strength. Centre of gravity should be designed to lie in front of control plate pivot point so that forward control wire is on the C.G. Pivot point should be situated just aft of the centre of lift of the mainplane in the case of sports and stunt models. Speed models should locate their centres of gravity midway between the leading edge of the wing and its centre of lift. This will prevent any undue nosing up effect at high speeds. There is a growing fondness to lead out control wires in a slightly backwards pointing direction with all classes of models, so that wire guides in the wing are substantially behind the C.G. This is claimed to make for greater manœuvreability, easier whipping and general handling. On those we have tried like this, the claim seems to be justified, it is after all a development of " whippower " technique.

Landing gears and take-off appliances are discussed in their appropriate chapter. The old free flight practice of considering the undercarriage as a form of protection for engine and airscrew might well be remembered in control line design. Anything that can keep a prop even one flight more, is to be considered !

American enthusiasts have split into two camps on the subject of stunt models. The Californian group go in for large fast models, flying at speeds of from 70-90 m.p.h., powered with 10cc. engines of the Super Cyclone type, and do their flight patterns at flat out speeds. Very nice and very spectacular we agree, if you have the engines,



Imposing array of contest models—brought to a competition by two American flyers only ! This mass production enables pre-contest practice on a hundred-per-cent scale and is general amongst top-flight men.



and the luck to keep everything in one piece. In this country a somewhat toned down variety of this technique has been developed amongst West Essex club members, including such excellent performers as Dennis Allen, Henry Nicholls, and many other up-and-coming contest flyers. Equally of course, the West Essex boys have in their midst a small slow school of thought which has produced one or two notable miniatures featuring Mills and similar engines.

Most British control line flyers, however, will be concentrating on the up to 5 cc. class and for their benefit we publish findings of the Eastern group of American experts as exemplified by the Linden M.A.C. For the record we would mention that young Dave Slagle, won the National Stunt Championship in '46 with a large size fast model, while in '47 Bob Tucker's Hot Rock—small power slow speed—won the day. Linden M.A.C. made a careful study of all their successful stunt models, built during 1947 and powered by motors of up to 5cc., mainly Drone diesels, which are virtually " non-utility Microns," and came to the following conclusions :—

(1) Wing section should be perfectly symmetrical, maximum thickness, one-third back of one-seventh chord thickness (14.3%).

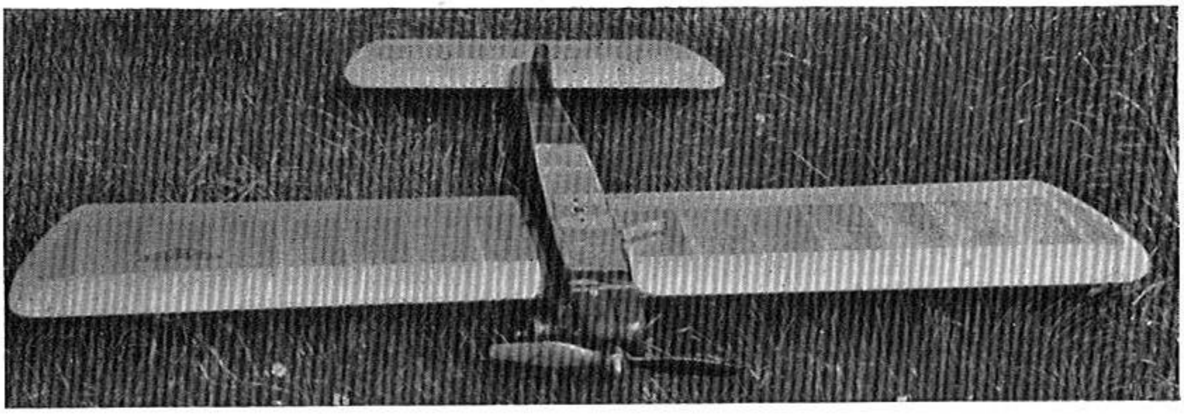
(2) Wing and tailplane incidence 0°, and to be located on the thrust line (5% tolerance allowed for constructional reasons).

(3) Stunt tank essential, placed as near the engine as possible (i.e., short feed line) and—most important—on the same level as the carburettor intake.

(4) Elevator movement to be 50° up and down.

(5) Maximum effective weight for 5cc. diesel engine, 28½ oz., all up ready to fly.

On the subject of speed models, it is difficult to write. The expert will have already progressed so far that our advice would be

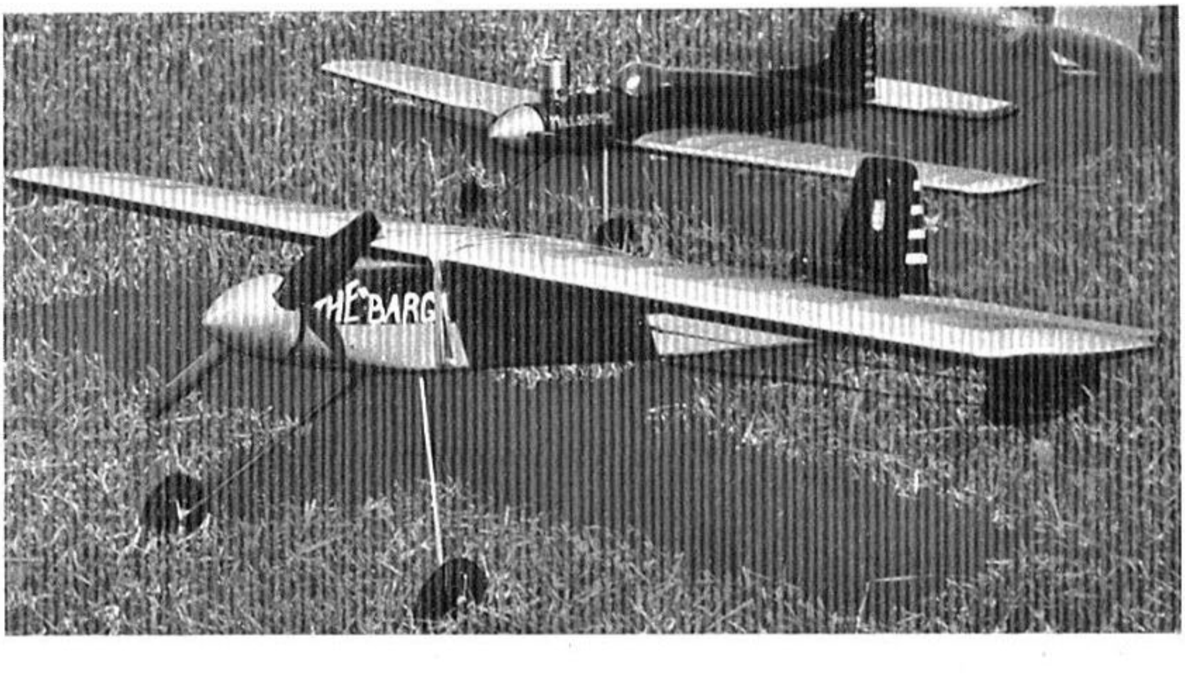


Typical British stunt trend of 1948. Model shown is Dennis Allen's Box-car with which he was unlucky not to achieve top marks in the Gold Trophy.

superfluous, while the less skilled will, no doubt, have grasped the obvious truth that the quest of speed is twofold : first, get the best engine available, then build the ideal fuselage round it. The rest depends on making the best engine just a little hotter, either by an improved fuel mixture, or by—dare we say it—tinkering with the works. If the tinker knows what he is doing, there may be a suitable improvement, if not, far be it from us to encourage him to even lift the pot ! There remains then, only the actual airframe on which we can presume to guide the seeker after high speed.

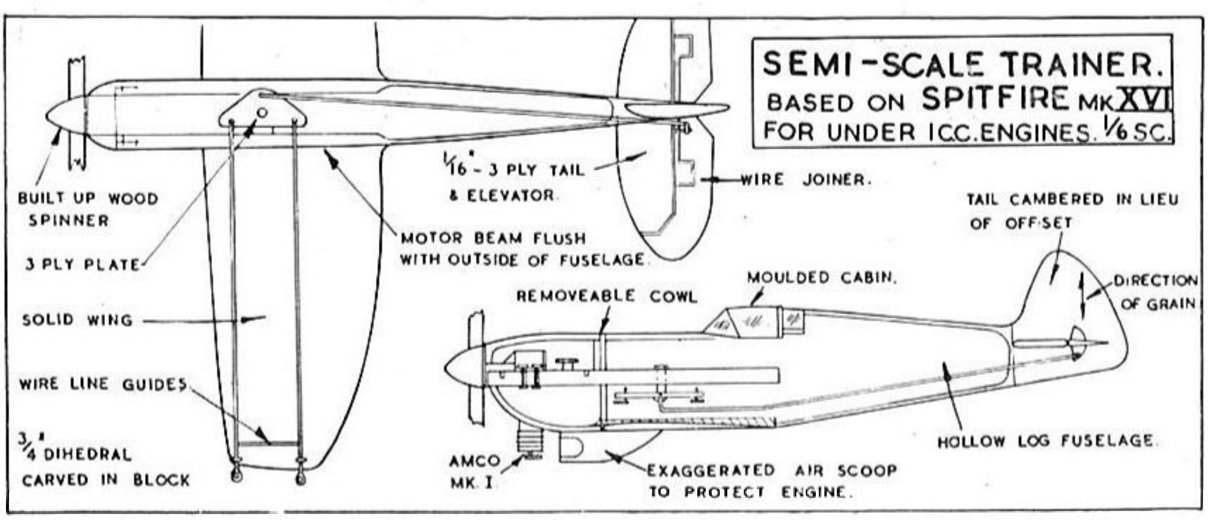
Writing in American *Air Trails*, noted speed and stunt designer, Henry de Bolt, contends, " it requires as much designing and even better workmanship to turn out a contest winning speed control-liner, as it does to produce a free-flighter of equal calibre." He goes on to refer to the days when the smallest and sleekest good 'un would always beat another good 'un, that was just that much bigger, but maintains that, nowadays, models are already built round engines in the smallest possible sizes and that design itself will now decide the future winners.

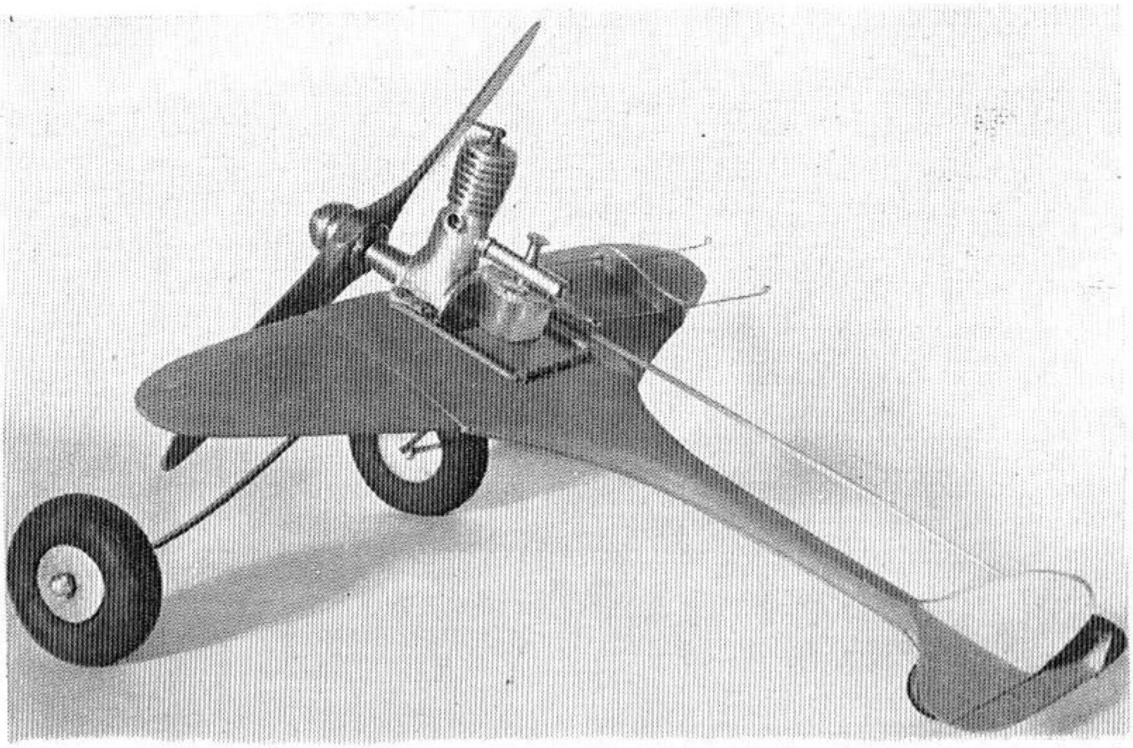
Mills and E.D. engined stunt models by Mike Booth and Jim Gregory that showed up well in 1948 contests. It can be seen that a stunt model need not be ugly to perform.



He speaks, of course, of *American* progress, it is probable that we have still a year or two of making them smaller here to be gone through before we reach the ultimate. Meanwhile, everything that can reduce drag will put up speed. For example, if you are flying with an offset fin to keep the model out, there is not only the drag of the actual fin, but the whole model is crabbing slightly, if only a couple of degrees. At reasonably high speeds, centrifugal force and torque should be amply sufficient to keep the lines taut, so that the whole fin can be omitted ! Again, the slavish cowling in of the pot is all very well, but have you left a vent for the air to get out again after it has cooled the cylinder head ? And what sort of shape is this airflow, does it really help or retard progress ? Then again, would the engine set as a sidewinder, with the cowl faired into the wing be a lower drag proposition ? Some of these problems are dealt with in a following chapter on engines, but strictly speaking, they can equally well be considered as points of design. Finally, is that fuselage smooth as the lines of a modern car and just as highly polished—or must we blushingly confess, it belongs to the treacle factory school ? Any and every model we have yet seen produced for speed flying—with one exception only, that we do not propose to name—could be boosted up at least 5 m.p.h. and probably more by an evening's careful thought on its streamlining, and several more evenings' work making it *really* smooth ! The effects of streamlining begin to be felt at 70 m.p.h. and upwards and as soon as you are in this speed range you must look after them with ever-increasing attention.

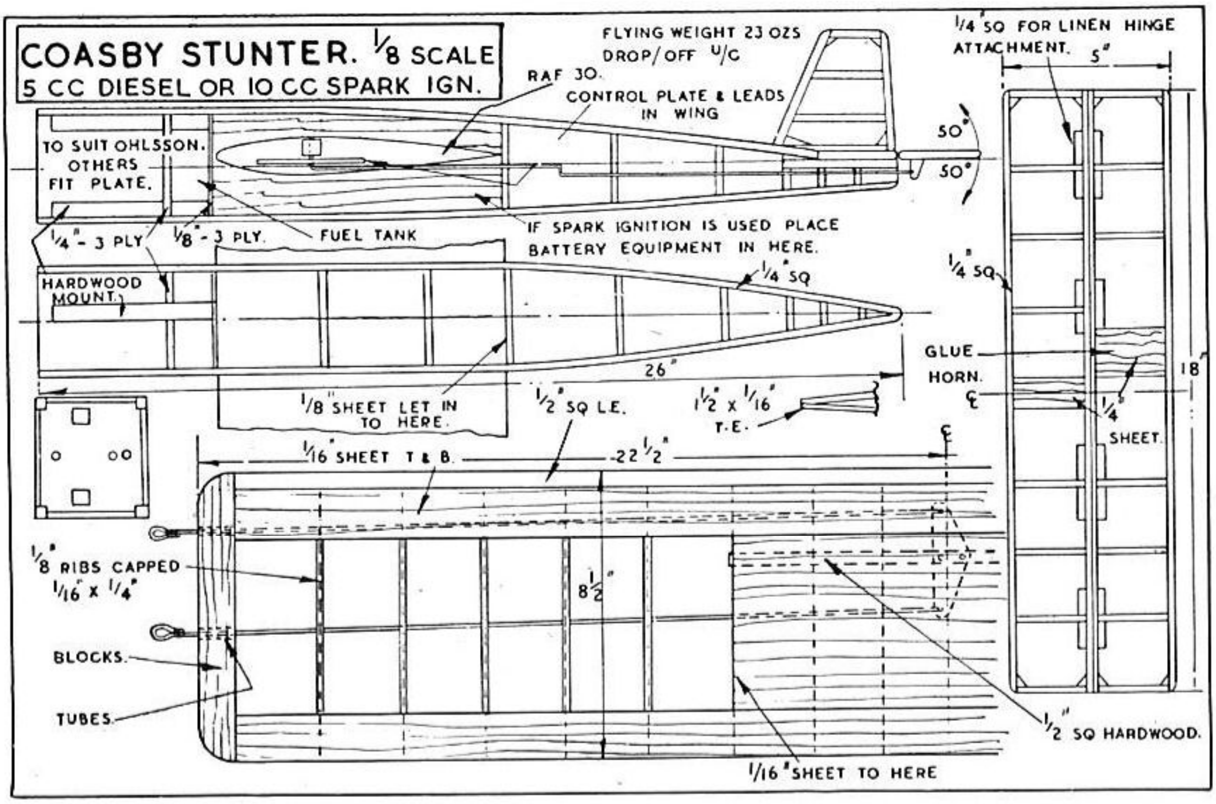
General considerations being duly discussed, let us get down to specific cases of designing control line models. As we have already noted, there is a wide variety of choice of kind of model—which can again be divided up into size of model. Any one of this wide variety can be made with engines of anything from under 1cc. up to 15cc., or following the S.M.A.E. classifications in any one of six size classes. The average enthusiast, however, will not do much running up and down the scale ; having obtained an engine or two, he will soon discover his favourite size and build most of his models around it. Which is a wise decision and will produce specialist knowledge of what is likely to happen to any project almost from its inception.





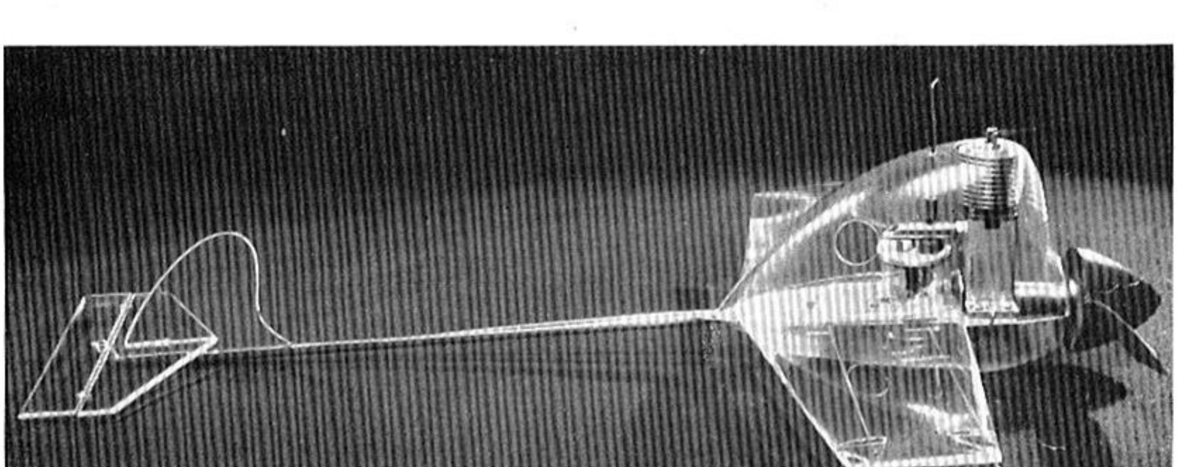
The Hundleby Kipper Mark I—a monstrosity based on Garami's Flounder that caused a lot of amusement, and finally even managed to fly passably well. Engine fitted is a Foursome 1.2 cc.—but it has been flown with a 5 cc. engine !

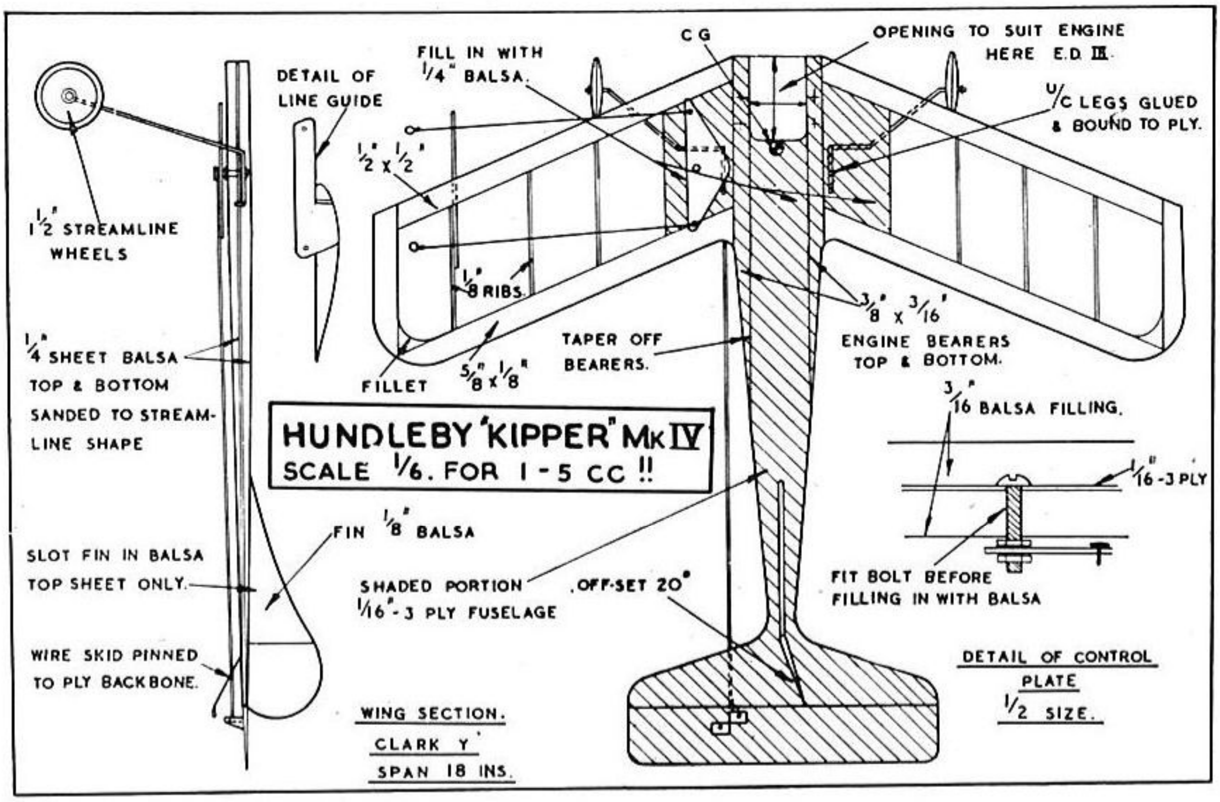
Starting at the bottom, and considering our own favourite pastime of building all shapes and sizes of Spitfires Mk. I—XXII, we offer a half-inch to the foot scale version of the clipped wing Mk. XVI. This was laid out (from enlarged 1/36th scale drawings) as a faithful copy of the original in side elevation and plan. There seemed no reason to change anything. Undercarriage was enlarged and moved forward for the initial model, but afterwards discarded altogether and flown hand-launch. This made a better flyer and a hundred-per-cent better looking aircraft. Hollow-log construction (q.v.) was employed, with the engine bearers set flush with the outside of the fuselage for reasons of space. Power unit was originally an Amco .87cc., which fitted the scale exactly. Subsequent changes to Mills 1.3cc. and Clan .9cc. gave faster flights in worse weather, but destroyed any scale appearance. Original camouflage colours were too good, as the model became unsighted against trees and so on in dull weather and our favourite "Fire Engine Red" colour went on for practical reasons. Purists, who like Spitfires too, could choose photo-reconnaissance types and colour them official blue. In use, certain original details were modified. Standard tank was small, awkward and inaccessible, so a larger celluloid one made with extension filler. Hinged cowling, that split along the centre line, and hinged back about the engine bearers, was replaced by a one piece clip-on type, as it tended to be caught by a careless finger when starting up. A solid former was inserted aft of the engine to protect interior of the model from fuel spray, which was rotting it. Later a larger three-quarter inch to the foot version was built, which took the Mills 1.3cc. without it looking and being unscalishly large. This went faster and better, but did not have the same attraction as the smaller machine.



Sight of Garami's rudimentary " Flounder " in an American magazine encouraged Assistant Editor Hundleby to produce a similar horror called " Kipper." In spite of staff's unkind captioning, an illustration in the *Aeromodeller* brought a number of enquiries from would-be builders, and a number of words of praise. As a matter of fact, after it got over its teething troubles, it went very well and served as engine test bed for engines from 1-5cc. We will not speak of flying it with the largest of these. First trouble was too small a tailplane and too short a moment arm. It required nearly full up to get it off the ground, which had to be maintained to keep it aloft. Next was its habit of shedding a fin in every rough landing, and splitting its thin fuselage in twain. All these faults were met and remedied. The drawings here are of Mark IV Kipper and will provide a serviceable, cheap model.

Fascinating ghost model in " perspex " and dural tube. In spite of its uncanny appearance we are assured that it is capable of fast smooth flight in its designer's hands.





Several larger models for 10cc. spark ignition and 5cc. diesels, were developed after finding Ted Buxton's " Barnstormer " so pleasant a model to fly. Shown here are G/A drawings of J. W. Coasby's Super Delmo powered stunter, which put up some surprising performances. On one occasion, lines snagged immovably in a loop, model continued looping—three in all until the last just failed to clear the ground.

We have considered so far only four general classes of model: scale, stunt, trainer, and beginner's model. Speed is not a really suitable class to explain by example. As already noted, it is simply a question of getting the best streamline shape and then getting it better over a series of only, perhaps, slightly better, almost identical designs. There remain a host of other interesting models that involve no particular hazards to precious motors or spectacular crack-ups in the cause of science. An eaıly unorthodox layout that will appeal for its prop-saving qualities is the pusher.

In this case, main source of trouble is procuring a suitable airscrew for a motor that will run in only one direction—if it runs equally well both ways, then a normal tractor turned round will do the trick ! Usual trouble with pushers is to get at the engine to start it—twin booms seem to get in the way, and prevent the removal of fingers at the crucial moment. Alternative is to build something on the lines of a flying boat power egg, when boom trouble will not arise. This tends to be somewhat high up in case of a normal model, and will therefore be dangerously liable to turn over on its back and still break those props.

We have also tried, in company with P. R. Payne, a number of experiments with canards. Here some quite amusing problems arise with regard to the proper attachment point for control plate and consequently lines. The theoretical C.G. has not proved at all the right place. The models we have tried have all required considerable ballast forward, and a line location well behind the C.G. Only with a nose-heavy machine did we find it manageable in the air. We are by no means satisfied that this is rightly so and, as opportunity offers, will have further trials with this layout.

Another very attractive control line design is the tailless model. That well-known American enthusiast, C. Hampson Grant, has published several of his successful designs along these lines, and they offer some really exciting flying. Contrary to the opinion of many, American designer Charles Cole, declares tailless models excellent for beginners, as they are almost impossible to ground loop, and take off and fly by themselves. Either pusher or tractor arrangements are practical, though the former is recommended, as the usual tailless sweepback to bring C.G. forward of C.L. adds to longitudinal stability. This increases constructional problems somewhat, as the two separate elevator surfaces must be linked together. As a general rule, it would be as well to build some tested tailless design before branching out with original models as there are a number of problems peculiar to them.

Many will also follow the growing trend towards scale models. Nothing could be pleasanter. Any number of plans are available of both modern and old time aircraft and there should be something to please everyone. We note that in France, the control line clubs have just announced a special contest for " historic scale models," by which is meant those, to us, peculiar machines dating back to the days of Bleriot, Ader, Santos-Dumont, Deperdussin, Wright and others. We feel that such enterprise is to be encouraged, and trust the venture receives the support it deserves. Some of these slow flying " vintage " models would lend themselves excellently to small and even ultra small diesel operation. How about a .2cc. Antoinette wafting gently round a circle in the drill hall?

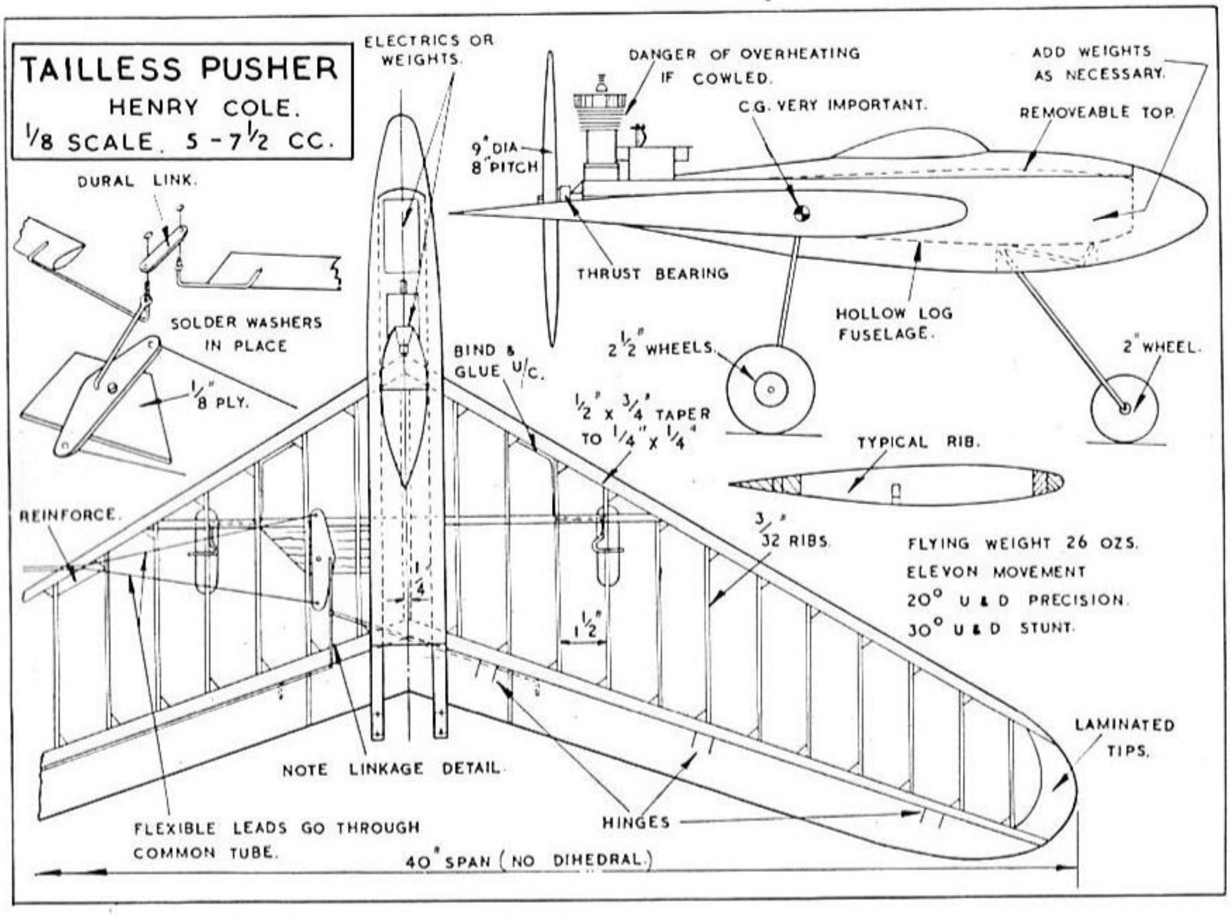
For those who want speed and more speed by the easiest route, the new British versions of such American jet engines as the Dynajet and Minijet, will be welcomed. These engines have now been banned, quite rightly, for free flight, but may still be flown on control line. They are definitely not for the chicken-hearted, or for novices, and should not be flown unless the operator attaches the control handle to his wrist with a safety thong.

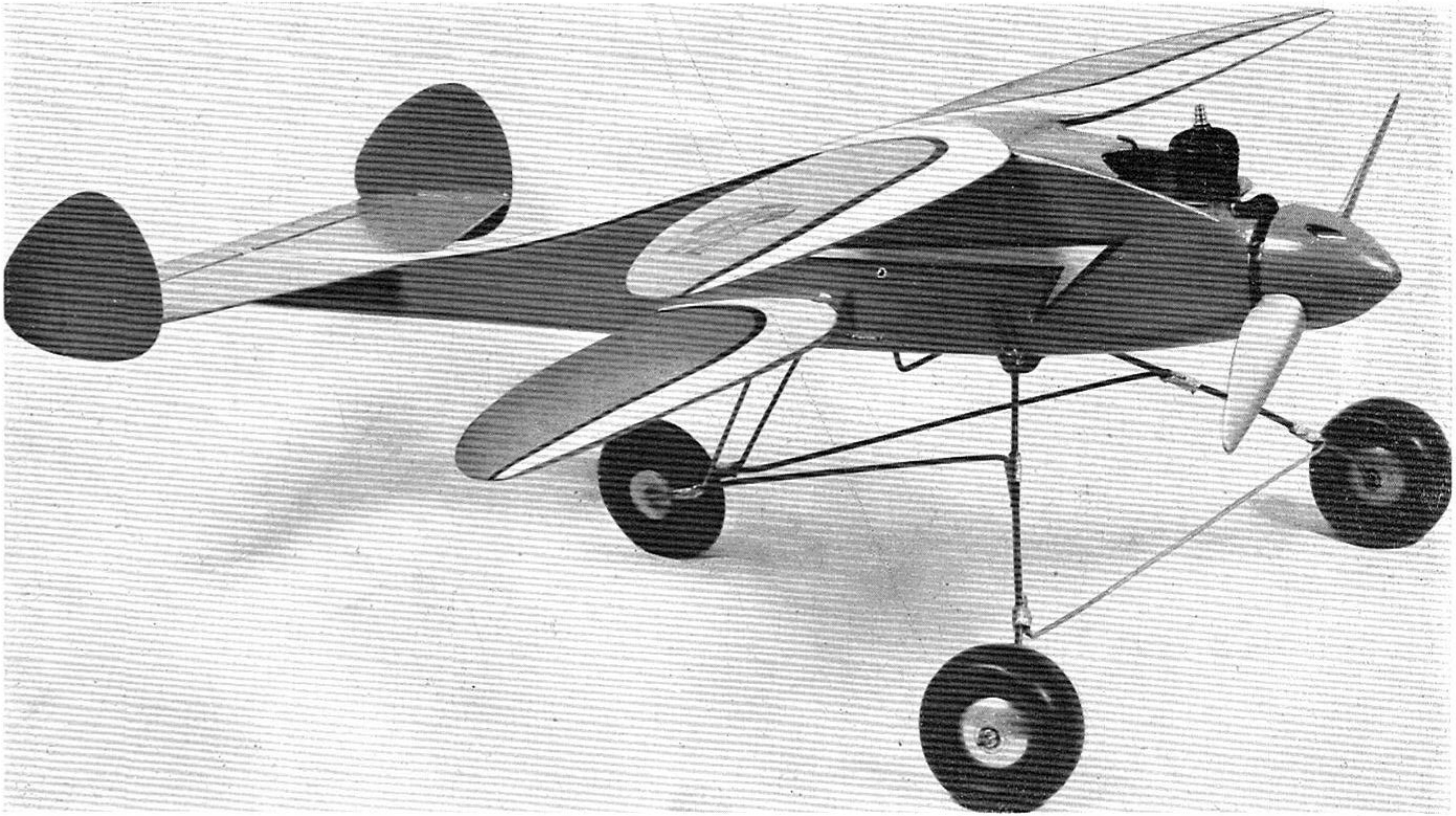
When laying out a design, it is as well to remember that anything directly in the way of exhaust gases will quickly be burnt. Tail surfaces should therefore be raised well above the jet orifice, or the jet pylon mounted on the fuselage. This high mounting which has been typical of first jet powered control line models, is not however, the ideal place. Fuel consumption is relatively high, and makes an appreciable difference to trim as the jet eats it up, making the model tail heavy. High mounted jets also tend to push the nose down when travelling really fast, to add one more worry to the anxious pilot in the circle.

Scale models of jet aircraft are possible and should give better performance than freak layouts. It is practical to enclose the engine entirely in the fuselage, using the hollow log principle, or even a built-up fuselage, with a suitably large detachable section for getting at the works. Nimble take-off drill is desirable as the risks of the engine heating up are much increased whilst it is still on the ground. An airspace should be left round the jet tube, and the exhaust must be given free and adequate access to the open air. We learn that American enthusiasts have proceeded so far in their solution of jet powered problems, that they are even considering stunting such models!

Although the S.M.A.E. formula gives an extremely high wing loading for jet models, it should be possible to build them much lighter, within say the 1½lb. mark, without sacrificing looks or strength.

Those as yet without a diesel engine of their own, or unwilling to risk their precious possession on their first own design, may like to try their luck with a rubber-powered control line model. Construction can follow standard scale or semi-scale lines, with just a suspicion of a speed model, fuselage being well stressed to take a good supply of rubber, well wound up. Airscrew of hardwood should be comparatively small, and if the prospect of gearing is not too frightening, should be geared up say 2/1. Wings and tail surfaces can well be of sheet balsa, span up to 36ins., design proportions as set out for power models, but with torque compensated to some extent by an asymmetrically set wing. Dihedral is unnecessary. Release the model in the usual way, and fly with up to 30ft. thread lines. Duration will necessarily be as short as the motor run, but there is plenty of scope for amusement.





Tyro Trainer, mounted on tricycle dolly. This speed trainer features a sheet fuselage with 3/8 in. thick base to allow shaping at the nose and 1/8 in. top and sides. Using good hard balsa it makes up into a sturdy model that will stand any number of hard landings and ground loops off the dolly.

CHAPTER FOUR

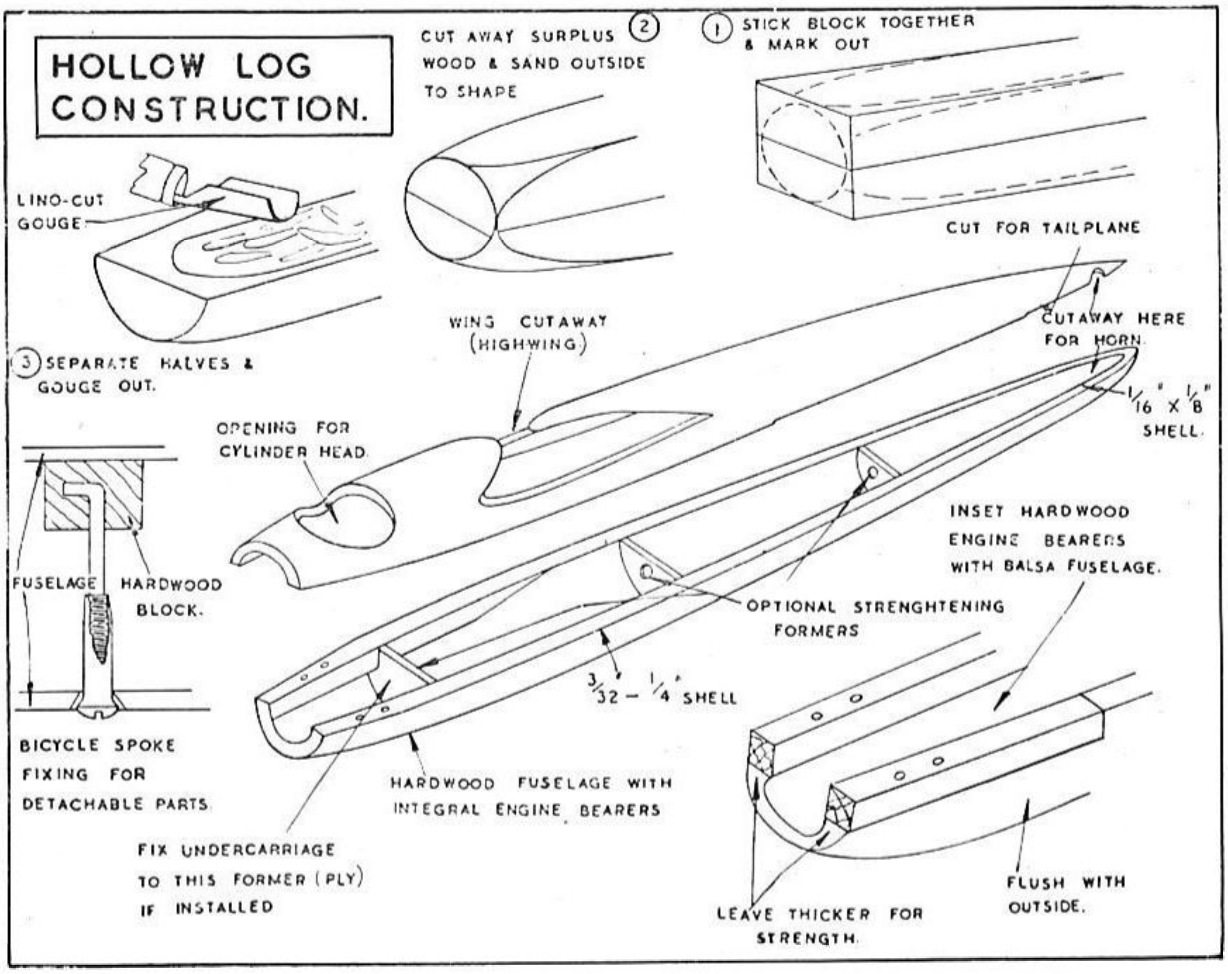
THE FUSELAGE

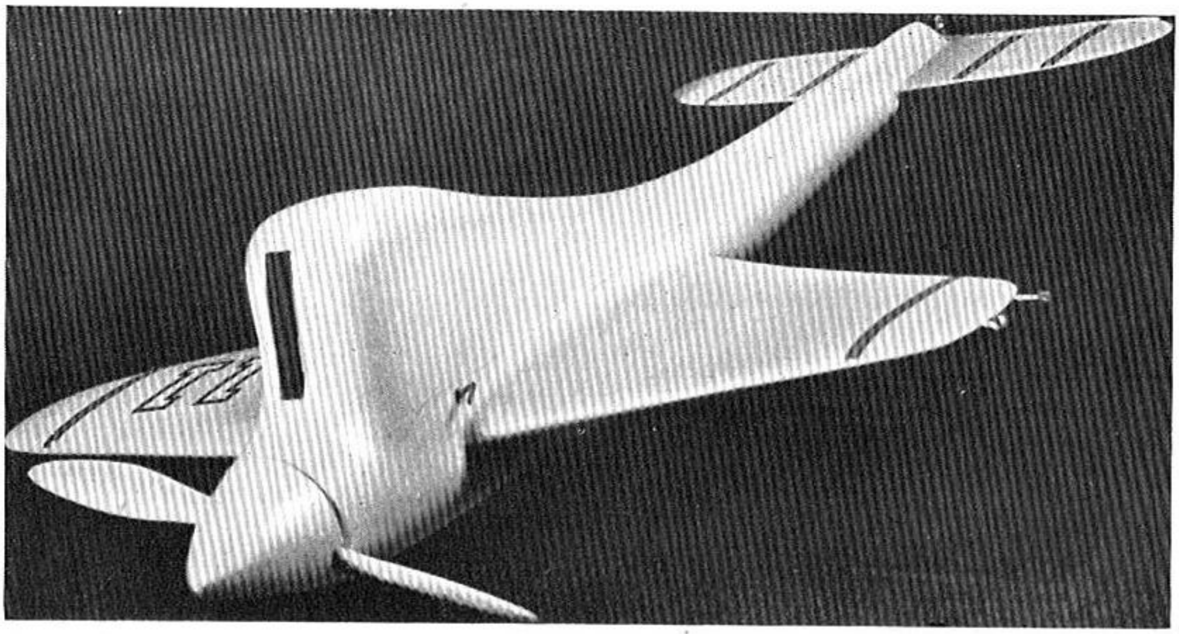
THOSE considerations of added weight which may deter the builder from complete streamlining of free-flight models apply so little to control line designs that they may well be ignored. The only reasons that should legitimately influence the designer are those of simplicity, ease of construction and the time factor for any machine other than scale models where the prototype will naturally determine the ultimate lines. The fuselage in a model appears to have no real justification save as a convenient place on which to fix wings, tail and undercarriage at suitable distances and to house the engine and its accessories. Except in those experimental designs where it is airfoil shaped in the search for added lift it can by no stretch of imagination be said to contribute any useful aid to flight. On the contrary, it merely gives that insidious enemy, drag, one more component to help hold down the completed aircraft. It is logical, therefore, to so shape it that this holding-down moment is as small as possible.

This may seem a needless worry when elsewhere it is pointed out that no considerable amount of lift is necessary or desirable in a control line model, but a little thought will show that it is worth while. If the model is built for speed then every refining of the shape to reduce drag should be considered. For simpler models of the sports or trainer variety every reduction in drag gives that much more safety factor to the engine which has just so much more reserve power to pull it out of the unwise manœuvre, that sooner or later is always attempted. Non-technical types may like to know just what drag is. Without going into a spate of formulæ, it can best be described as the resistance set up by the various parts of an object to forward movement. Thus when cycling there is a noticeable increase in either speed, or the ease with which the machine is propelled, if the rider crouches down, offering as little an obstruction to the air as possible. This is particularly so when travelling against a headwind or at high speed. A similar effect obtains with a model aircraft, and as speeds rise more and more trifling obstructions create a serious degree of resistance or drag. Thus, an immediate increase in speed would be found by polishing a fuselage previously dull and rough.

Other authorities have already worked out relative drag figures for the commoner types of fuselage from which it appears that the round or elliptical fuselage has only about one-quarter of the drag of a square or rectangular cross-sectioned fuselage. While weight often prevents its use for any but larger models if strength is not to be sacrificed, it has at any rate invaded the rubber contest field in the hands of such as Bob Copland, Warring and others. The built up fuselage, however, takes more time than a simple slabsider, and unless the design is very good adds little to the performance and can be just as easily lost out of sight. All of which piles up the agony against the round or elliptical fuselage, but does not apply in any instance to control line models ; They can hardly be lost—their fate is usually to be written off in a last sensational prang. Here the question of strength crops up again. It *is* possible to build a fuselage that is so strong as to be virtually unbreakable in any but 100 m.p.h. crashes, and in this field it is hardly likely there will be a numerous following with the present range of engines. To solace the adventurer who loses his model in this homeric ending we can only pass on the practical advice of a leading American speed king who says, " then you sweep up the pieces and see if there is anything worth saving."

Easiest of all round or elliptical fuselages is the " hollow log " method of building. This, as the name suggests, consists of hollowing out a block of balsa or other wood to comprise the fuselage. Sometimes building instructions leave it there, and so many enthusiasts who might have been tempted proceed no further. It really *is* easy if a routine is carefully followed. First secure two blocks of wood as long as the fuselage and of just over either half the width or height. This makes a difference in the case of elliptical fuselages, as it may be desirable to divide them horizontally to make a lift-off lid or hatch to get at accessories





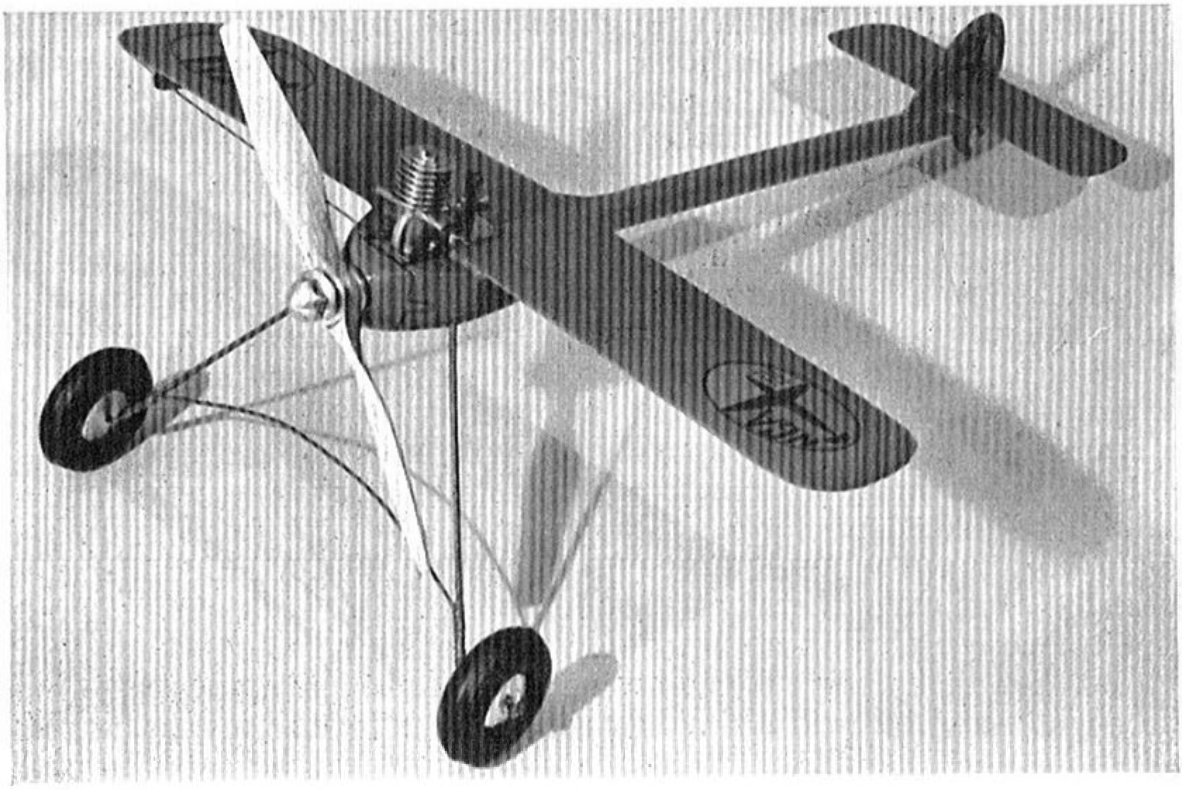
Another of Walter Musciano's pleasant designs—Speed King. This model follows modern practice with streamlined cowling, faired-in spinner and absence of fin. Fitted with a suitably powerful motor should be easily capable of 100 plus !

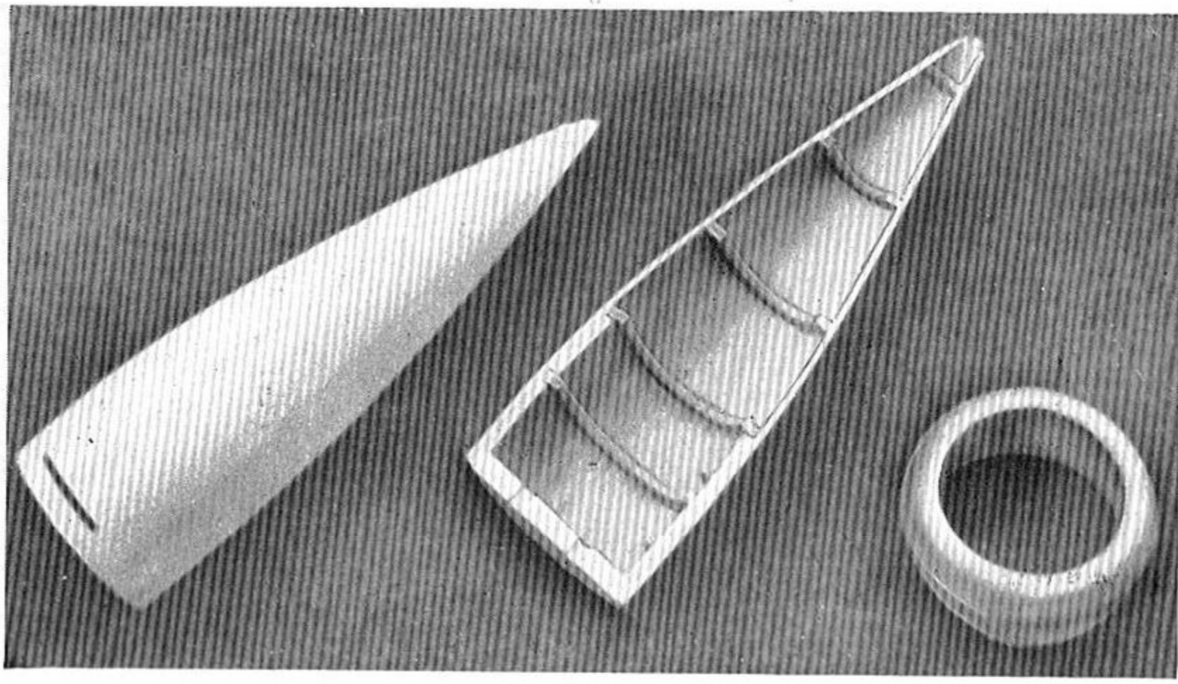
or controls. Here a little planning is helpful to decide the best place to split the two parts. With a truly circular fuselage the only thought is whether to split vertically or horizontally. Having decided this question, the two pieces of wood are lightly glued together to form a single block just a little larger in every direction than the maximum dimensions of the finished job. Some builders recommend that a sheet of thin paper is stuck between the two faces to make it easier to split them apart later, as will be necessary ; this depends on how securely they are cemented together. Next the side elevation is traced on the appropriate side. It can be "pricked" through the plan and the pricks joined up, or traced outline stuck on. The lucky man with access to a bandsaw or jigsaw machine now has only to run the block through in a couple of minutes and his rough outline is done. For others a fret-saw, sharp knife, or even a razor blade must more slowly remove the surplus from each side. The plan outline is then marked on the partly shaped block and a similar procedure followed. The bandsaw man again will have the easier task for he need only replace one of the pieces he has removed with the plan outline traced on its flat surface and put the whole through the saw again. Others will have to take care in tracing their outline to allow for the new projected shape on the block. This work done, the block is finish carved, using templates as necessary and sanded to a smooth finish. It may then be split open and hollowing started. To hollow balsa with an ordinary woodworker's gouge is heartbreaking and almost impossible as with any but sharpest of tools the balsa is just torn. Attractive little sets of balsa knives and gouges can still be picked up for a shilling or two, or, failing this, any good artists' colourman will sell a set of lino-cutting tools for a similar sum. These tools are exceptionally handy for work of this sort, and we prefer them to more orthodox aeromodelling implements.

When hollowing out the interior be sure to leave adequate wood where wings and tail will ultimately seat down ; for the rest a thickness of about 1/8th in. is quite strong enough, going perhaps a little thinner towards the tail if lightness is needed there. It is unnecessary to finish to any degree of smoothness inside as no one will be seeing it, but clearance should be assured for any internal control wires, control plate and so on. It should be noted that a ply bulkhead for attachment of radial mounting engines will *NOT* be strong enough merely cemented to the end grain of the balsa, so that in all cases it is better to run through hardwood beam mounts to make a firm fixing. No apology is offered for this description of hollow log carving, as, in spite of its use for hundreds of thousands of solid models, the flying modeller seems, for some reason, to rather fight shy of it. Time for time it is nearly as quick as a box fuselage; certainly stronger and much better looking, and aerodynamically worth while on the score of efficiency alone. On the debit side is the higher cost of suitable blocks, but compared with the price of an engine this is trifling, say half as much again for the average control-liner fuselage, against the cost of a slabsider with sheeted sides.

This description has considered balsa only and permits the widest possible use of the medium to construct fuselages of either round, elliptical or compound cross-sections. A recent technique of advanced speed model builders has been to design their models with a truly circular hardwood fuselage of pine or similar wood. Instead of carving this laboriously by hand, it is rapidly turned to shape on a lathe, which in addition to fast production gives extremely accurate lines. Those fortunate enough to possess routing attachments can even proceed to the gouging of the interior by machine. Such luxury is not for the average modeller, but many should be able to turn up a fuselage to the outside shape, persuade a friend to do the job for them, or even pay a shilling or two to a local handyman for the work. Lest the enthusiast

A neat approach to the fuselage problem, with pod and boom, though likely to have a tendency to break its back unless the boom is reinforced with a ply backbone.



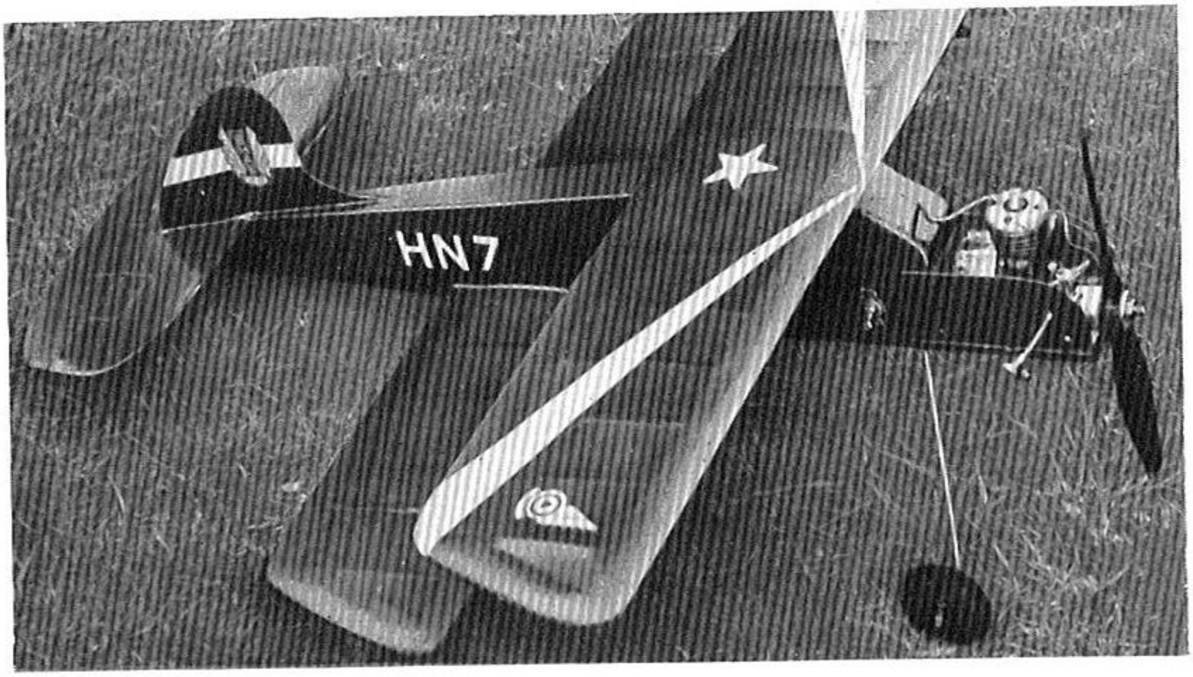


A built-up fuselage as featured in Astral's Hall Racer with half-round formers and medium sheeting. This makes an attractive model at lower cost than by hollowing out from block. Cowl on right is made from four segments cemented together.

wedded to balsa is rather appalled by this vision of unending work, we would mention that it is the common practice in Finland and Russia, where balsa is almost unknown, and pine the common medium, of carving sailplane fuselages, sometimes up to five feet in length, from such woods entirely by hand, and often in the most complex cross-sections. Such a fuselage will last indefinitely in spite of the most sensational disasters, and provide a rigid foundation for wings and empennage that will not warp or twist at the highest speeds likely to be obtained for very many years to come.

A derivative of the hollow log method that may be of some appeal is the well-established monocoque fuselage which gives an equally pleasant outline and opportunity for compound curves, but only at the expense of considerable labour and quite a lot of skill. It is doubtful if the resultant product is any better looking, has taken longer, is not stronger, and will be harder to repair in the event of a bad break.

A suitable, and practical alternative, is what can best be described as semi-monocoque, building up on a keel or keels, with a number of shaped formers, finally sheeting these over with soft 1/8th in., or, in the case of small models, soft 1/16th in. sheet. Such a design was followed with one of our own primary trainers that served as the test bed for a variety of engines ranging from 1.5 to 5 c.c. In spite of providing the first control-line flights ever for all and sundry, who showed little regard for its preservation as they had the comforting thought that " the firm would pay " for any repairs, it survived into honourable retirement. Every single part of this machine was damaged at some time or other, including the engine mounts of hardwood, with the solitary exception of the fuselage which remained to the end in its original state. Those desiring to follow this scheme should sheet in comparatively narrow strips going the full length of the fuselage, where



An early but successful effort by Henry J. Nicholls—his de Bolt Bipe which made a name for itself on the Television programme. All sheet construction will be noted, particularly the humped fuselage to make a suitable resting place for the upper wing.

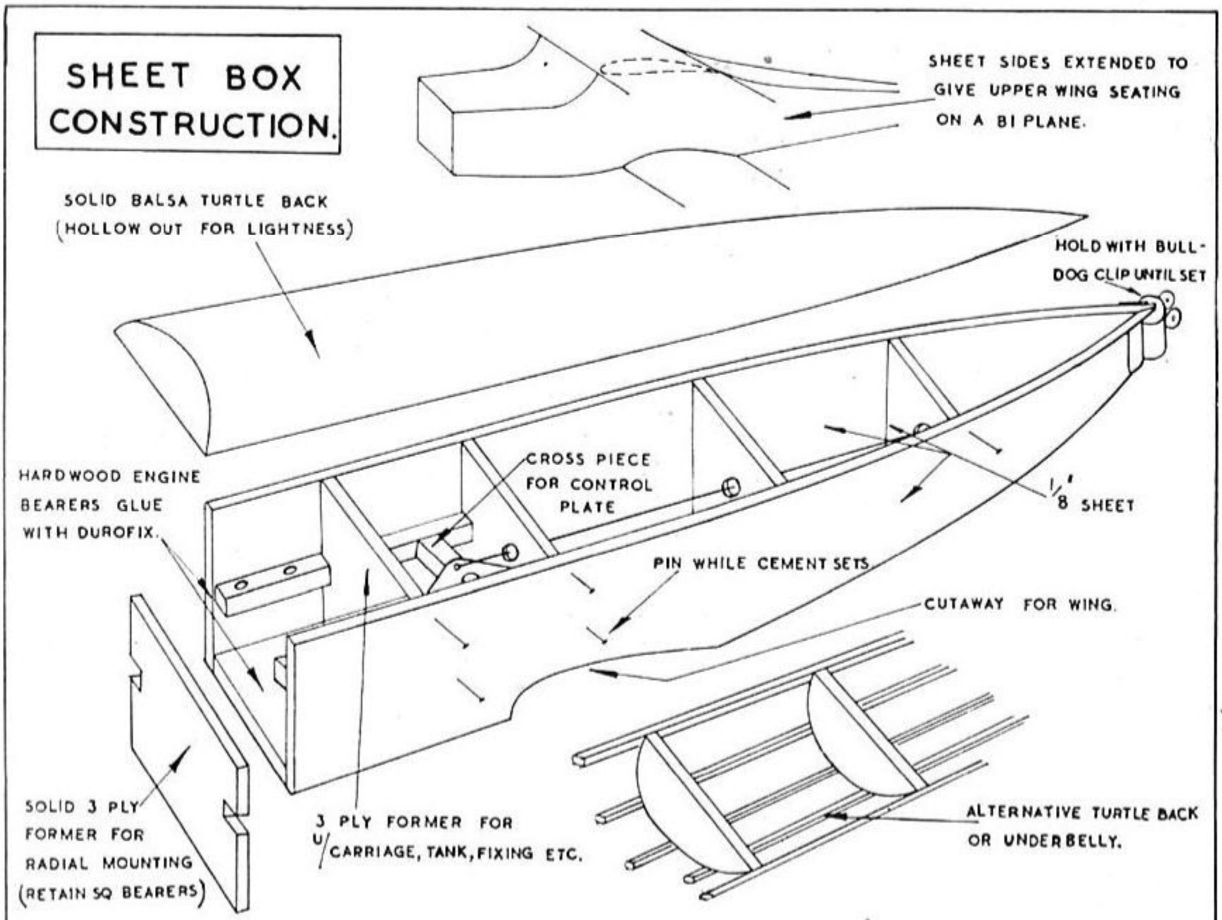
practical, and not endeavour to do the job quickly with a few large sections. In this way they will ensure that every strip is adequately cemented to the formers. To be quite positive that this is so they should be pinned at each former along the length with either large glass-headed steel modelling pins, or the small half inch lill pins that can be bought at the stationers' in quarter-pound boxes. Some constructors find that these grip soft wood better, and on the sharper curves they can be forced right in to the heads. The holes they make do not matter as subsequent filler and sanding will dispose of them. The finished job should be lightly sanded and covered with grey filler or undercoat, whichever is easier to hand. Several coats are required with intermediate sandings until the grain no longer shows through. A final coat or two of the desired colour completes the work. It may then be polished with any of the special cellulose polishes or our old friend Brasso. For speed work every extra glitter may mean another m.p.h., so do not spare the elbow grease.

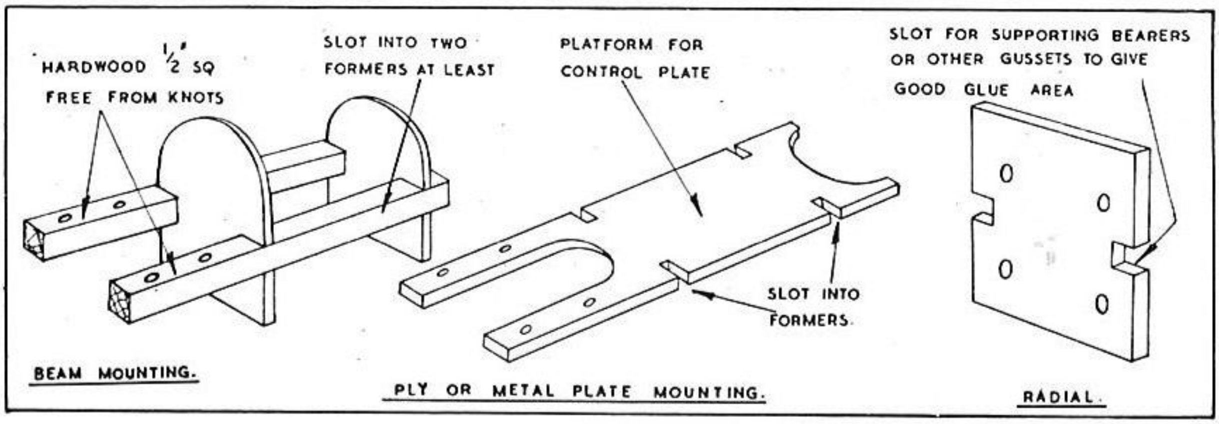
A point which is often forgotten or ignored in both hollow log and semi-monocoque fuselages is to block up the front part of the fuselages to prevent any exhaust liquid—so prevalent with diesels—being blown into the interior to cause deterioration and ultimate rotting of the structure. A ply plate will obviate this in the case of hollow log types, or with the semi-monocoque types a solid first former. Whether it is worth while lightening the others, except for the passage of control wires, is a moot point which must be decided on its merits in individual cases.

A neglected form of construction in this country that surely deserves a better fate is the favourite American crutch system. This ensures that the fuselage is dead accurate longitudinally, and forms a convenient base on which the main structure can be built. If formed entirely of hardwood such as spruce or birch it gives rock hard lines, and the forward legs of the crutch can be arranged to form the engine bearers for beam mountings. Where balsa is preferred, hardwood engine bearers can be scarfe jointed into the rear balsa structure with nearly as satisfactory results. The crutch method is particularly suitable for petrol engined models which contain a number of movable extras in the shape of coil, condenser and battery, thus inviting a fairly large access hatch. Here is a firm fixing for this part ; it can be drilled for location pegs or form a strong seating to which hinges can be screwed.

In the realm of smaller engines a number of stick fuselage designs have been developed since the inventive Garami offered his peculiar looking " Flounder " to the American public. Here a substantial hardwood block forms not only the fuselage and engine bearer, but also the wing roots of the resultant curiosity. Aeromodeller Assistant Editor Hundleby produced his own version of this layout under the name of " Kipper," and provided considerable amusement with his heavily wing loaded midget, which proved immensely strong and *did* fly even in inexpert hands ! This reduces control line flying to the utmost " utility standard " and makes a model an evening a practical possibility. It is so ugly, however, that only the lover of freaks could tolerate it other than as an engine or airscrew test bed.

Whilst on the subject of the unusual, it is worth mentioning two other developments in the fuselage department. One is the cast electron or light alloy crutch, made up in the usual way from wood patterns. The resultant product is filed up, lightening holes added to





taste and drilled to take the engine beams at the front. Final fuselage shell is either composed of thin aluminium sheet bolted in place, or hollowed wood top and bottom similarly fixed. It has the advantage that it is virtually indestructible, cannot warp, and will never vary in a series of identical castings. This is only suitable for high speed work, and will hardly find a place in British methods until some kindly manufacturer provides those hotted-up engines capable of over one hundred m.p.h. in a big way. Another bright American has been flying with a spun aluminium fuselage suitably strengthened within as in monocoque construction. This may have some future for kit manufacturers, but is not possible for the average modeller, and on the score of strength for cost has little to recommend it. For practical flying it is very prone to dents and has little more than freak interest.

For those determined not to go in for this fancy carving there is the usual aeromodelling compromise, a slab-sider with sheet sides and small blocks top and bottom to achieve an oval cross section with somewhat flattened sides. A more nearly elliptical effect can be achieved by using ¼-in. sheet sides and shaping these to a curved contour. Such a job can be quite strong and is simple enough for a beginner to tackle. There seems little point in a free-flight type of box fuselage with tissue covered sides, as it is unlikely to last out even the test flights. Try it and see.

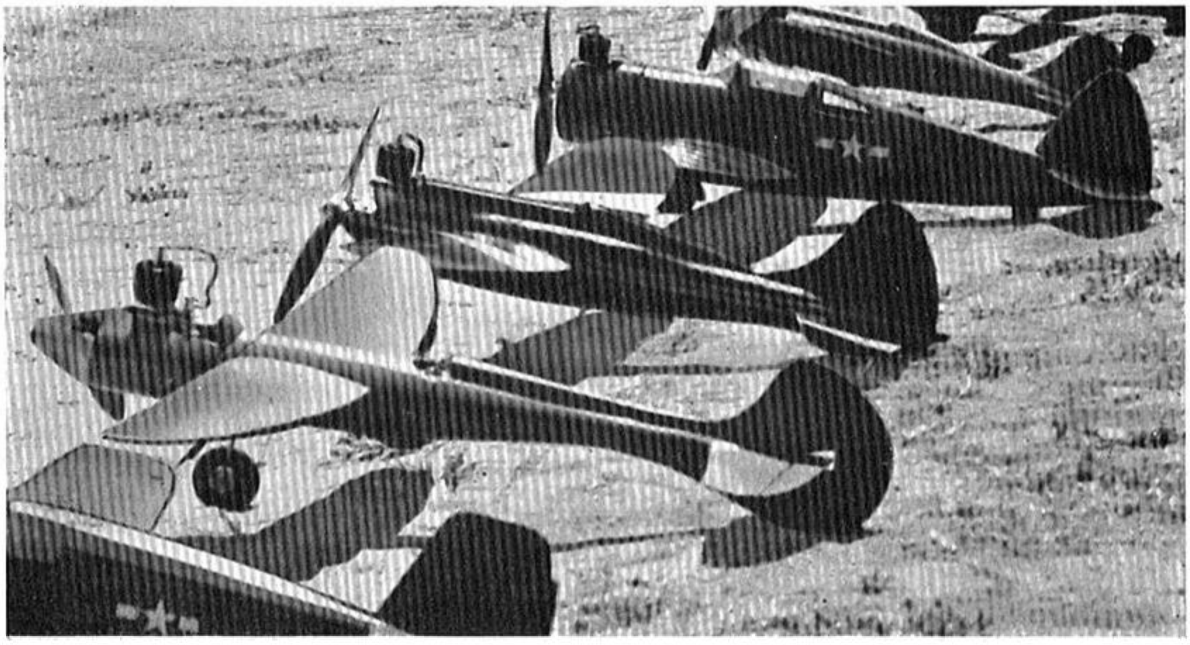
The heavy mortality of airscrews experienced by every newcomer to this branch of aeromodelling has inclined more serious thought towards pusher types than has been in evidence for a long time. Canard designs or pushers seem the only way to keep the engine away from the accident and are worthy of study. In pusher types some form of twin fuselage is necessary, but need offer no new problems. As a general principle each boom requires to be just over half as strong as an equivalent single fuselage. A three-ply backbone, running vertically, with solid balsa fairings is perhaps the simplest solution. Or the fairing in an elementary type may be omitted if say 1/8th in. ply is used. A round hollow boom of 1 mm. ply will also provide a strong if rather more troublesome job, involving fixing complications at each end, though the lead to the elevator horn can be fed down such a structure. In a machine intended for speed and powered by a 5 c.c. engine or larger there is much to be said for dural tubing, which can often be picked up for a song at government disposal yards or from the more canny model supplier.

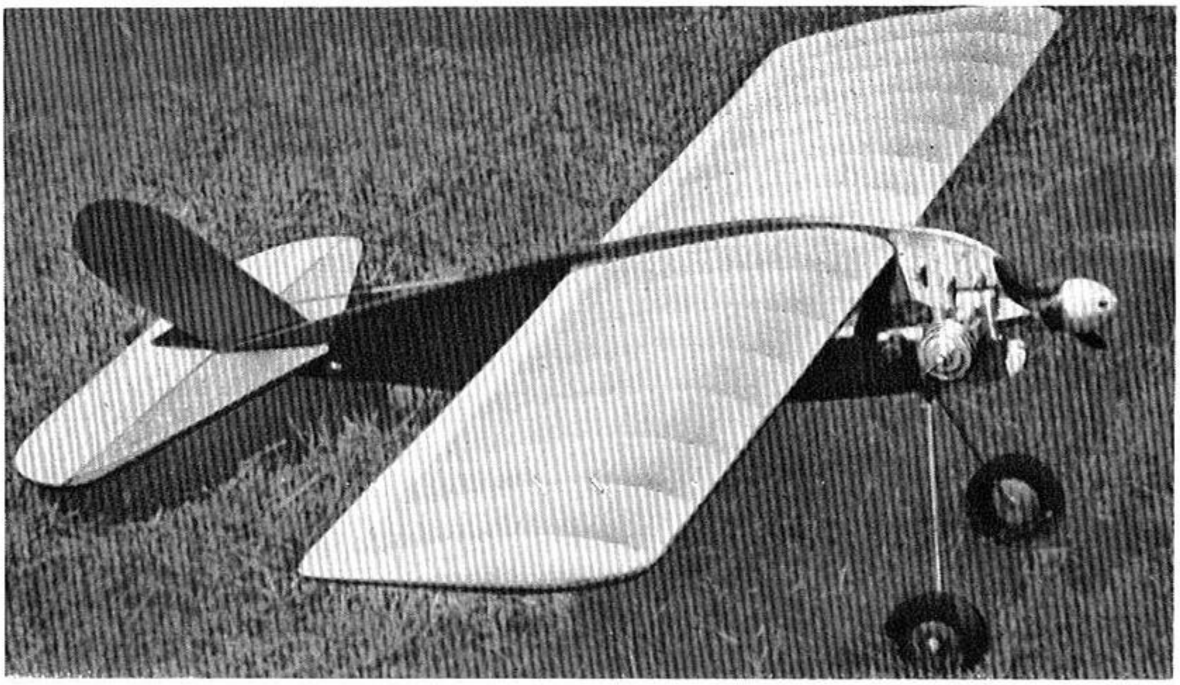
Engine mounts come into two basic classes, beam and radial mounting. Hardwood bearers are the standard answer to the first class, or the smart little pressed alloy mounts now on the market. These can, of course, be easily bent up in the home workshop if preferred. A combination of hardwood bearer and metal engine mounting plate is a useful method, as this enables a variety of engines (assuming the builder has more than one, which seems the growing practice now they can be bought so easily and cheaply) to be tried without any major building changes.

It is important to see that the bearers go well back into the fuselage and are securely anchored to ply formers, or with crutch fuselages are adequately cross braced. Radial mounting is usually made direct to the front bulkhead, but care should be taken to see that convenient access is left for refuelling and choking the intake. As larger fuel tanks will be required in many cases, their location should be considered in relation to fixing. A special radial mounting plate is well worth making up if any difficulty is experienced in this direction.

Except in the very simplest of designs, engines should certainly not be left sticking up or down like sore thumbs. Some builders feel that in inverting an engine they have completed their contribution to streamlining, quite ignoring the fact that the pot still sticks out below, though, perhaps, less than it would have done if left in an upright position. Fitting a cowl for show purposes and taking it off for flight is just not good enough. Speeds are such that streamlining definitely does count, and cowlings must be made for use. The helmet or coal scuttle cowl is simple and does its job reasonably well. It can be made of solid balsa hollowed out, or better, beaten up on a suitably shaped mould from thin aluminium sheet. If it is hinged it should be so arranged as not to catch the hand when starting. The prop will damage the fingers without any supplementary aids. If completely detachable, some positive

arly American line-up with every engine mounted upright and exposed to view. Fortunately this trend s now disappearing with increased speeds and interest in cowling. Only one model it will be noted sports a spinner, others are naked and unashamed.





Pete Cock's Kan-Doo—1948 Gold Trophy stunt winner—is built round the simplest possible "flatfish" or outline fuselage of three-ply. Such a layout, with sidewinder mounted engine lends itself particularly to stunter construction, where initially there will be a more than usual amount of repair work to do.

fixing method is worth thinking up. Provision should be left for suitable exhaust exits and air for intake, or the engine may be starved and fail to give of its best. A built-in engine fairing for inverted engines must also have some means of draining fuel collected in its base. In the anxiety properly to fair in convenient access to needle valve, fuel tank, and intake must not be overlooked. Extensions to some or all of these may be necessary.

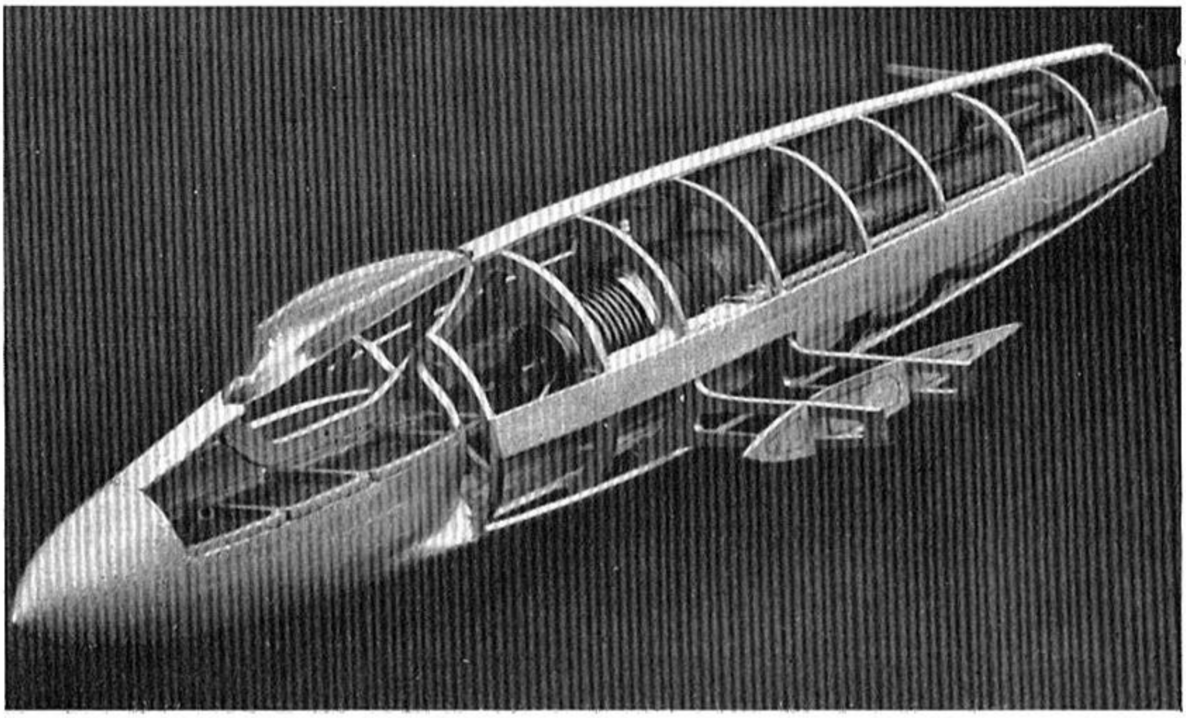
When soldering extensions to the needle valve it is worth remembering that paste fluxes or flux cored solders do not make for an easy joint with steel, where killed spirits will give a simpler, quicker and stronger joint. Surfaces must be washed after work is completed with warm soapy water or hot water with washing soda in it, or the joint will show signs of rust or oxidation within a day or two. An extension pipe to the fuel tank is not always necessary as a longer feed tube from the filler bottle will often solve the difficulty. If the air intake cannot be conveniently choked with a finger it may be simpler to fit a small rubber clapper mounted on a spring loaded lever to close up as required. The fit should be absolutely airtight as some engines are very baulky when inefficiently choked for starting.

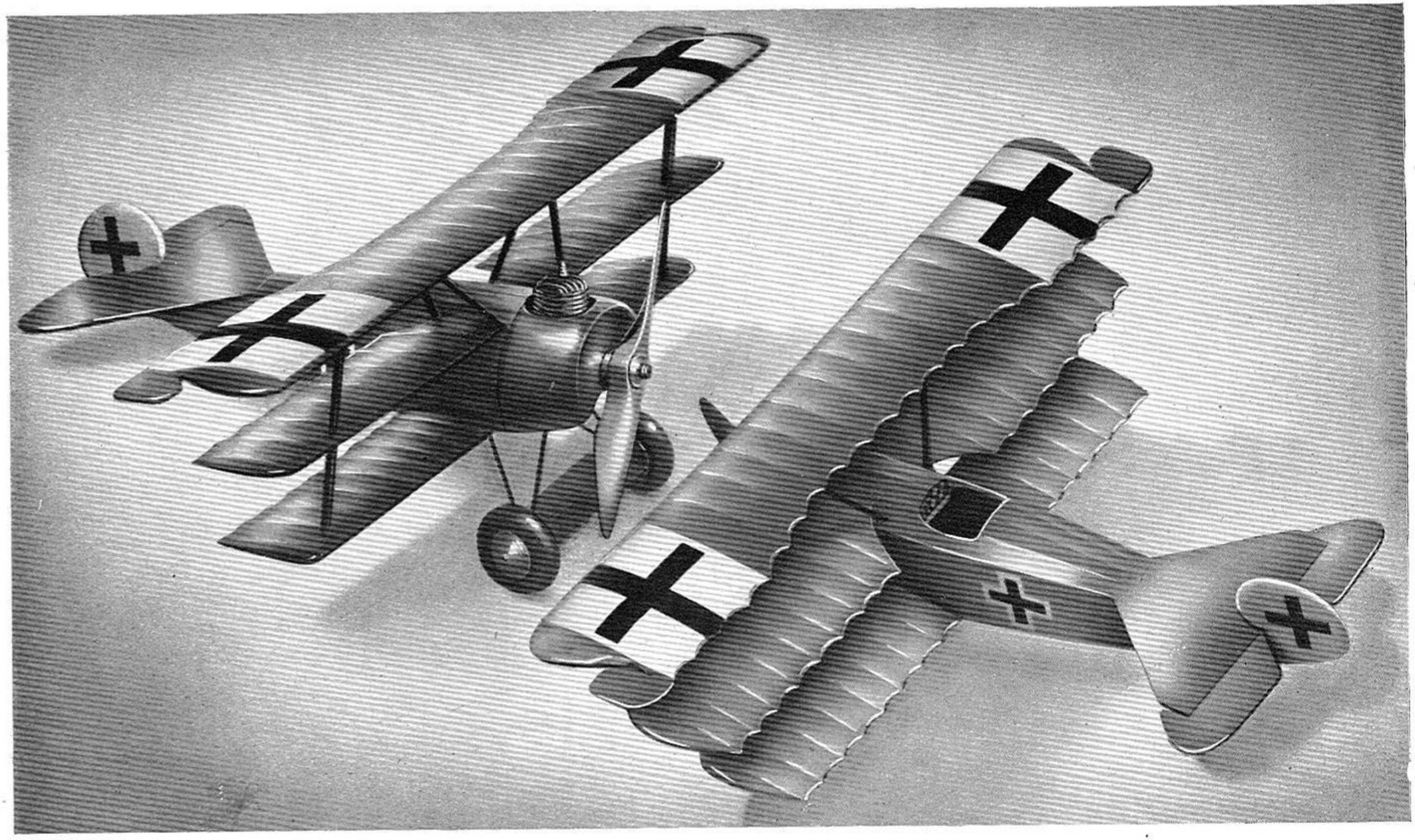
The success of Pete Cock in the 1948 Gold Trophy, first British National Aerobatic Contest, flying his E.D. engined Kan-Doo model has stimulated interest in another fuselage form that has its American following—the "flatfish" or outline fuselage. Here a normal fuselage side elevation is used without any thickness other than the thickness of the sheet employed. Material is usually three-ply of 1/8th in. thickness, or even 3/32nd in., with engine mounted as a sidewinder. The result is strong, light, easily made and thoroughly practical. A variation is to lay out the side elevation as for a normal slabsider, making one side only, then sheet each side with 1/16th in. balsa. This is lighter still, though a little more trouble. After seeing what Pete Cock can do with Kan-Doo it seems superfluous to criticise this form of fuselage, but, in less skilful hands it has one decided disadvantage owing to its lack of frontal area. It tends to horse, that is wiggle about its forward axis, thus losing flying speed and even getting out of control. Shulman and other American designers have overcome this advantageously by building up a shaped fuselage in front, which tapers into the " flatfish " just aft of the wing trailing edge. This makes a convenient housing for the control plate, a firm rest for the wing, or wings, and permits engine installation to be upright, inverted, or as the builder pleases. At the same time frontal area is increased and the horsing overcome. American builders have quite taken to the skeleton outline fuselage even for so-called scale models, which have a faithful adherence to side elevation—and just nothing at all to show in front.

The popularity of the biplane for stunt models is such that some comment on cabane struts is indicated. These may be, preferably, of wire, or hardwood, or a combination of the two, and must be firmly anchored in place. The old-time N-bracing of the cabane struts takes a lot of beating. However, in many cases the builder will be satisfied with the simplest possible U-shaped braces for the upper plane. The lower wing is usually attached direct to the lower surface of the fuselage in a slot cut out for it, and may be finally held firmly by a solid fairing that carries on the lines of the belly.

As a final reflection on fuselages, the designer is urged, at any rate in his early control line models, to build for strength before everything. Later he can take pride in elegance of line and finish. If the fuselage is strong, the undercarriage stoutly secured, and the trim reasonable, there is little that can disturb his early ventures other than a succession of broken props.

An elegant jet fuselage—where the motor is entirely concealed. Apart from fire hazards this is a quite practical method and must be preferred to the common practice of pylon mounting which can only be described as built-in instability.





Famous old timer scale triplanes lend themselves particularly to control line flying. The model of the Fokker Triplane shown here, finished in its authentic brilliant colouring, is a certain centre of attention wherever it is flown.

CHAPTER FIVE

WINGS

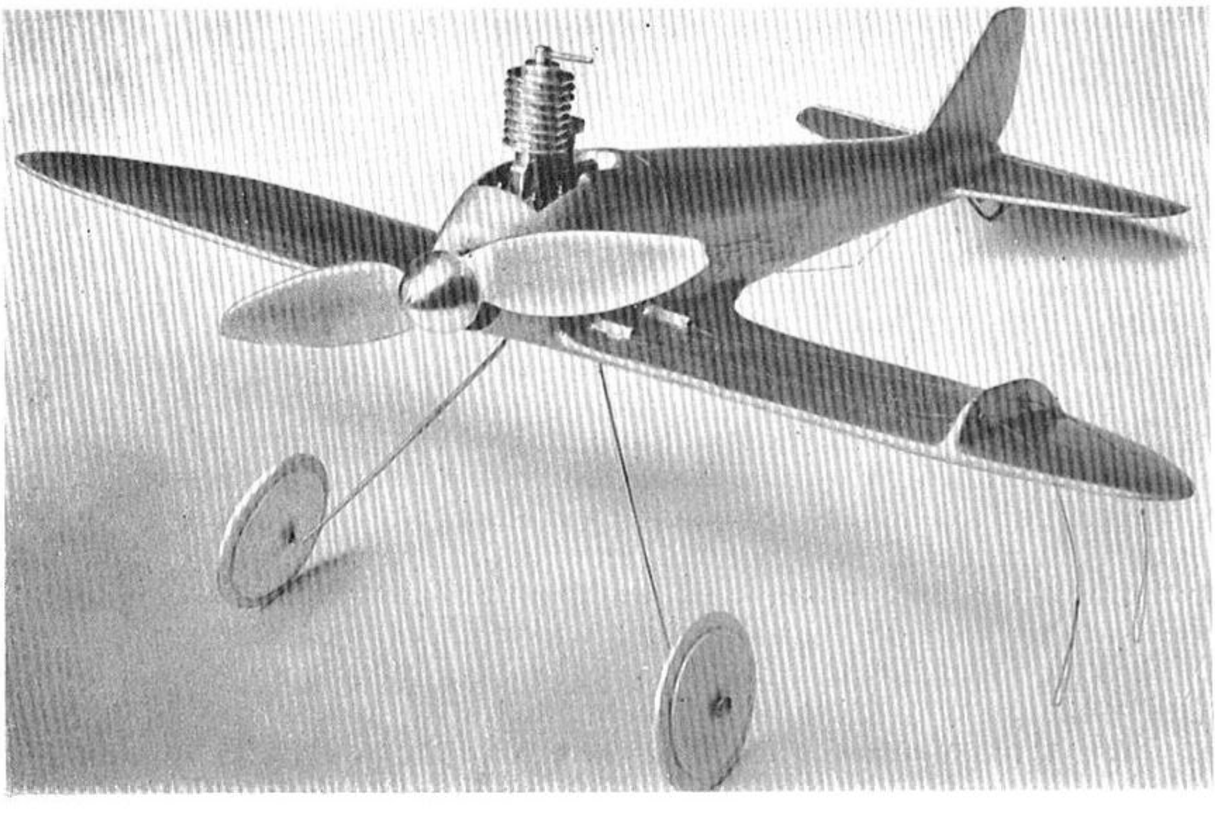
It should not have taken many flights to convince the newcomer that converted free flight machines lack sufficient strength to stand up for long to the hard work involved. Equally it should have been grasped that, except on those rare dead calm days that few of us have the patience to wait for, such machines tend to fly themselves and so get out of control. This naturally suggests that built-in stability is not desirable in a control line model, and may even invite the heresy that wings are an unnecessary luxury. It is not the present intention to go deeply into such a thought other than to state categorically that a model will not fly without any wings at all. High speed enthusiasts have gradually pruned down wings until they are little more than stubs, but have not managed to eliminate them entirely and any study of aerodynamics will convince the reader that, in the light of present knowledge, he will have to endure them for a little longer. We would go further and add that the vast majority of enthusiasts have found that the correct design and construction of flying surfaces contribute more than a little to the success of any model. Except for slow flying models, such as flying scale versions of old timers or light civil aircrafts, an entirely new approach to the subject must be made if a more than normal amount of time is not to be spent patching up breakages.

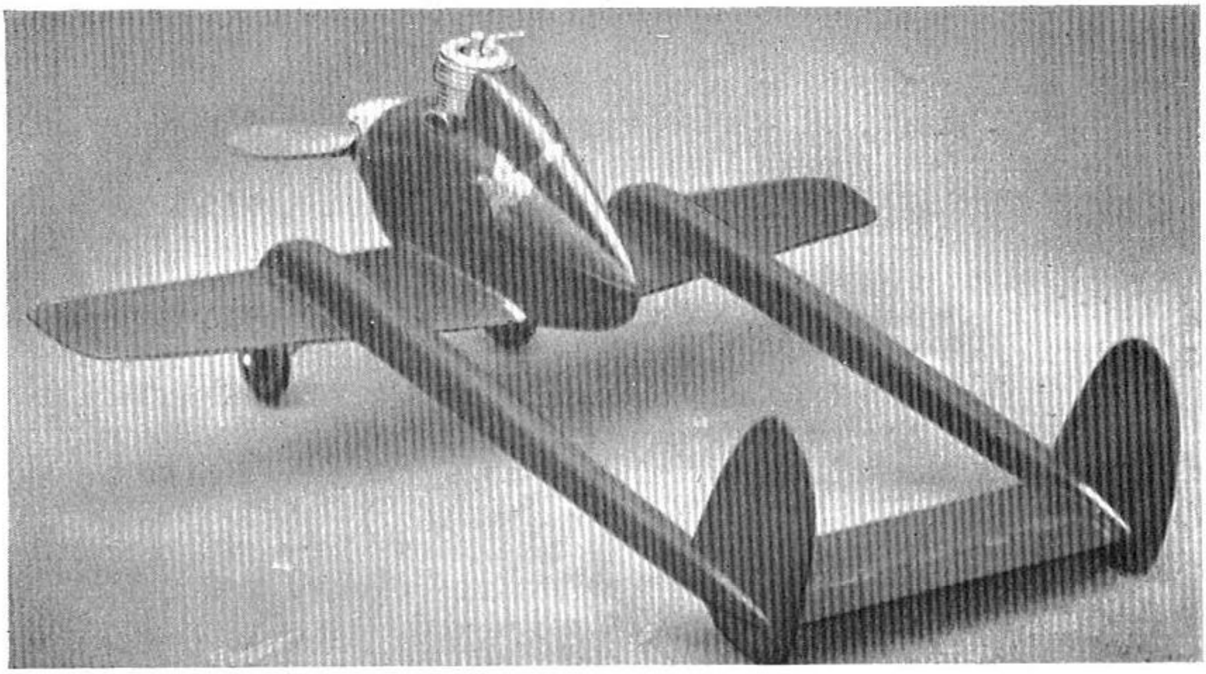
Let us be quite certain what we want in a wing before proceeding to any specific discussion. If we are building a normal " trainer " or " sports " machine, high speed is not essential, and on the contrary rather to be avoided. We have something not so very different from a free flight model responding to our controls instead of relying on efficient trimming and built-in stability. As we shall be making the model climb by an inclination of the flipper there is no call for a high lift section. The model cannot climb higher than the length of line—if it tries to do so then the stage is set for one of those spectacular wing-overs that usually beset the novice flying a goat ; a manœuvre he would be happy to see when achieved by design, but a most unwelcome occurrence when he can hardly do circuits and bumps. Our choice then is limited to a sound airfoil section that in itself is moderate in performance when set at a low angle of incidence. To keep the matter simple a section with flat or only slightly cambered undersurfaces will make for ease of construction. Under this heading will come such old favourites as Clark Y, US 27, N.A.C.A. 4412, or 6412, or N.60. Slow flying sections with undercamber are not recommended, and will in fact be quite impractical as soon as the simpler manœuvres are mastered and the tyro tries a stunt or two. As proficiency is acquired and higher speeds attempted a sleeker and sleeker airfoil section will be desired. This can be achieved without any spectacular calculations simply by taking a percentage of whatever section has already proved satisfactory. For example, 60% of Clark Y makes a start in the right direction. In general any of the so-called fast sections that have been recognised as suitable for model use may be utilised. Some enthusiasts have had good results with a combination of Davis upper surfaces and symmetrical N.A.C.A. undersurfaces. There is no reason whatever for the builder to accept any standard section and get into the rut that has beset certain aspects of the hobby. Let him rather get out pencil and paper and draw up his own idea of a suitable section within the limits suggested above. It may be good, bad, or indifferent, but it will certainly be an effort to produce an original idea.

Before leaving the subject of airfoils it should be pointed out that for advanced stunting a symmetrical section must be used. Otherwise when the machine is flying inverted there will be a tendency to climb " down " at any instant when the flier is not counteracting this urge by up-elevator. The actual instant of commencing so to fly is the critical one, as the controls are reversed and " down " becomes " up," as will be explained in the flying chapter later on, and if the stunt is attempted at low altitude a mistake may only too easily end in a painful write-off. A symmetrical section is not however necessary for ordinary loops where the flight path is circular.

Wing loading has always been a controversial point with power models, and we should hesitate to make any arbitrary statement of limits. We would point out that if a proper degree of manœuvrability

Simple beginner's model with solid balsa wings. These take a lot of hard knocks and are unequalled for training machines. The lead out through tubes is not, however, to be recommended, as it tends to binding of the controls. In practice the lightweight wheels would also soon suffer damage.





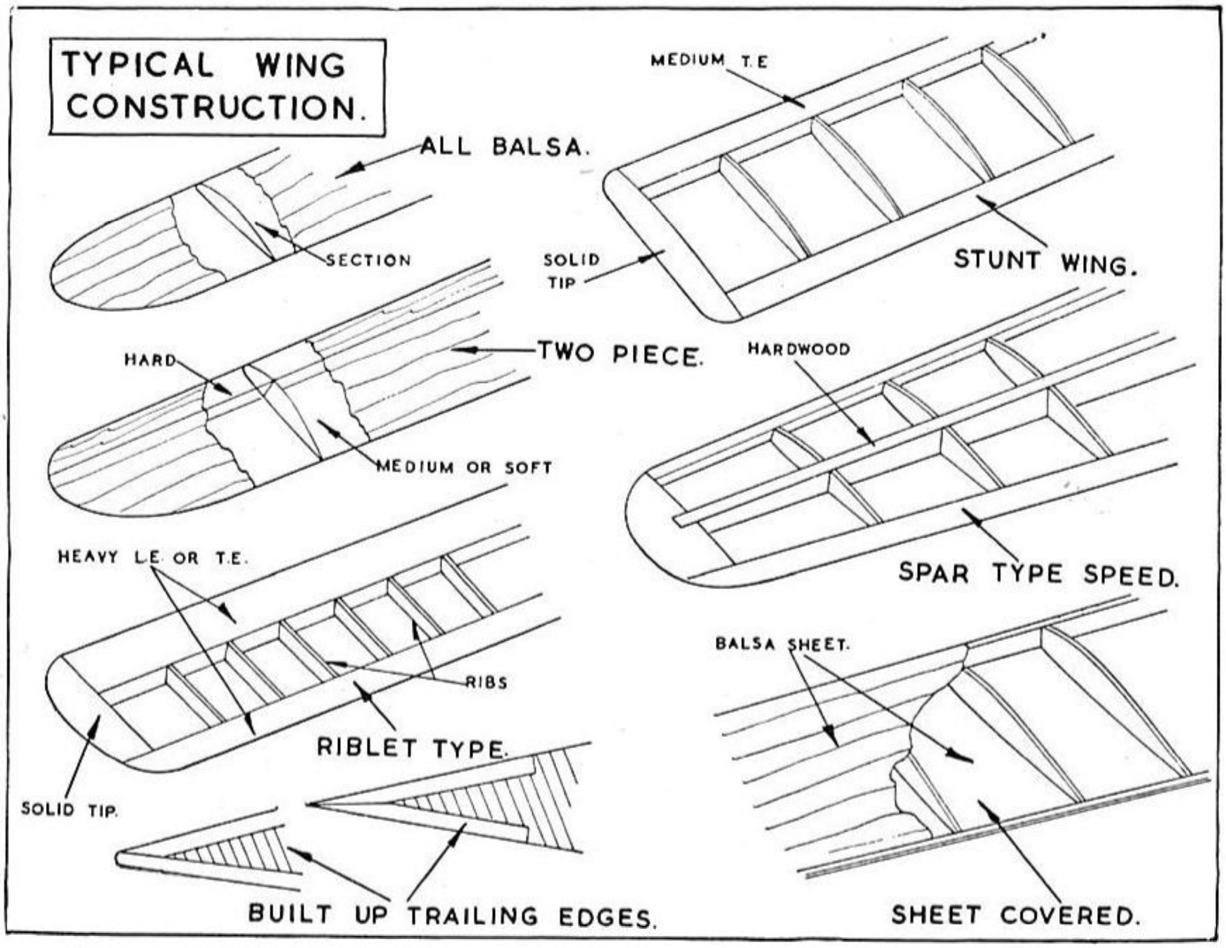
Substantial twin boom model with solid wings, which provide a firm attachment point for the booms. Streamlining of engine is not necessary in a model of this nature which at best would be capable of only 70-80 m.p.h.

is required, then the lift at L/D maximum at a particular Reynolds Number *must* exceed the all-up weight of the model. In other words, you must have a bit of lift in hand if you are not to rely on the rather doubtful assistance given by our old friend centrifugal force. If the builder is content for his model to hurtle round in a flight path barely off the ground at an excessive speed, which will require considerable skill to control, and even more to land in one piece, then such limitations do not apply. Indeed, some of the earlier and more fantastic American speeds claimed might seem to have been obtained by such means. Happily, wiser counsels have prevailed and American flying is now based on sounder aerodynamic principles.

A number of writers on control line flying in this country have fallen into the—to us—curious habit of giving wing loadings per 100 sq. ins. rather than in the more usual per square foot. Free flight models are normally so described, and for the purposes of comparison it seems to us better to retain this system. For speed models a wing loading of from 25 ounces to 30 ounces per square foot seems productive of the best results. An analysis of some of the more successful models finds most of them within these limits. These figures will be noted as approximately twice the wing loading of the heavier type of free flight power models. Higher wing loading naturally means faster flight, and even the so-called slow flying trainer machines, with wing loadings around 18 ounces per sq. ft., will be found flying nearly twice as fast as the average free flight model. One happy result of this increase in flying speed is that many scale designs usually considered unsuitable for models without extensive modification can be built more or less unchanged. The control line fraternity have been quick to grasp this salient point, and many delightful fighter and racing prototypes have been faithfully reproduced. Equally, of course, these increased wing loadings raise new problems of construction. There is no room for slipshod work, and strength must be the keynote of every part—not least of all the wings.

Both for simplification of rigging and to reduce drag a low angle of incidence is desirable. Very many models are built with the mainplanes set at 0° to the datum line. It should seldom, if ever, be desirable to have a positive incidence exceeding $1\frac{1}{2}$°. This does not mean that wings have no lift at this angle, obviously the average airfoil under consideration possesses lift within a setting range of from minus 5° to plus 10°, or even more. Structural advantages of a low wing model with wing set at zero will be obvious, and no advantages accrue from setting it at a positive angle as it would merely tend to climb unduly and have to be restrained with down elevator adding yet more to the sum total of drag.

Just as the elevator controls take care of longitudinal stability, so does the pull of the control wires take care of lateral stability. A control line model is therefore better placed than a full-sized aircraft in that it can *only* be unstable about its longitudinal axis and that subject to the control of the operator. It has the limitation that it can only perform manœuvres about that same axis, whereas the full-size aircraft can perform three dimensionally, but there is nothing we can do to overcome that. It becomes clear therefore that dihedral is not necessary for a control line model. Many models continue to feature it in some modified degree, but, frankly, we can see no more reason for it on the score of necessity than for the plastic cabin that decorates many

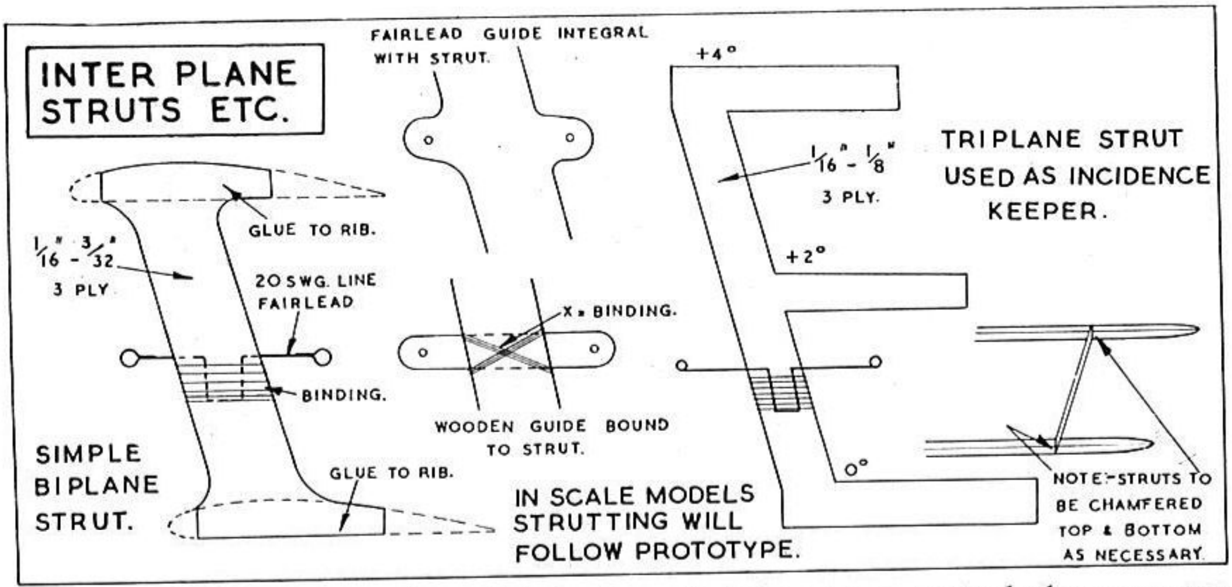


a semi-scale model. The only time it may serve a useful flying purpose is when the model is blown inwards by a gust of wind and becomes momentarily free flying. Such an occasion is always the subject of hasty back-stepping to bring the model under control again, and we have yet to see a model assume automatic stability and go on flying in default of some such action for more than a second or two. Dihedral does occasionally have a structural justification, as for example, to bring a wing tip to the right height to receive fairleads for the control wires without the addition of an unsightly extension piece. Those who build scale models will naturally retain the dihedral of the prototype for true scale appearance. Others may copy designs with elaborate inverted gull and other unusual shapes. For such models it is recommended that the wing is assembled on a single jig. Spans are normally so small that nothing complicated is necessary, and the extreme accuracy of rig desirable for trouble-free flight is thus ensured with little trouble.

Aspect ratio on the average model may seem low from free flight standards. Optimum is from four to six depending on the type of model, that is, trainer, stunt or speed design. There has been a tendency in the last year or two for the experts to develop a higher aspect ratio comparatively slow flying stunt model going up to a figure of seven or eight. No hard and fast rule is suggested for this class as so much more depends on the stunter than the actual model flown. An expert can make a goat do things the novice would shudder at, equally the beginner would find nothing magical about the flying of a winning model in his own inexpert hands. As an equally powerful American group of stunt experts is now concentrating on fast stunt models, the aspect ratio of the stunt plane must rather be thrown on the table as an open question. There is the salutary thought that an unsuccessful stunt taken fast is more damaging than the same taken slow.

For the trainer or general purpose sports type of machine a figure of six gives both pleasing proportions and no untoward structural problems. This will no doubt continue to be the most popular figure, securing the greater proportion of prizes in average events. Speed models, on the other hand, tend towards the practical minimum of four, giving a deep chord and added strength to the thin sections used, which would be unduly fragile if much extended.

One development that may be regarded as surprising is the new popularity of the biplane for control line flying, which enables a fairly low aspect ratio to be employed with, at the same time, an adequate wing area that reduces wing loading. Such a design is a popular layout for stunt machines giving surplus of power to get the model out of any ticklish situations an over-ambitious operator has created. Here the upper plane is usually of greater size than the lower wing, and is supported by a stout streamlined interplane strut only without bracing wires. Gap may be $1\frac{1}{2}$ to 2 chords and stagger up to 50%. Decalage is occasionally 0°, but more often lower plane is set at 0° and upper plane at $\frac{1}{2}$° to $1\frac{1}{2}$° positive. Some of the symmetrical wing section stunt biplanes—notably the de Bolt—have negative incidence of up to 2° on the upper plane, lower being at 0°, which seems to be a thoughtful provision for inverted flying when the model will tend to have more

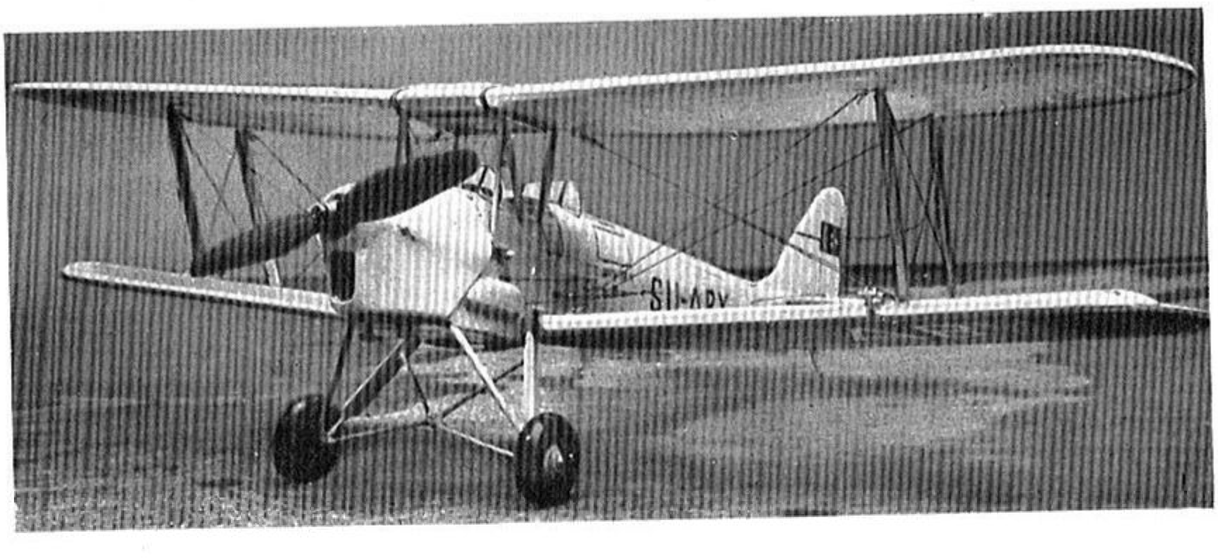


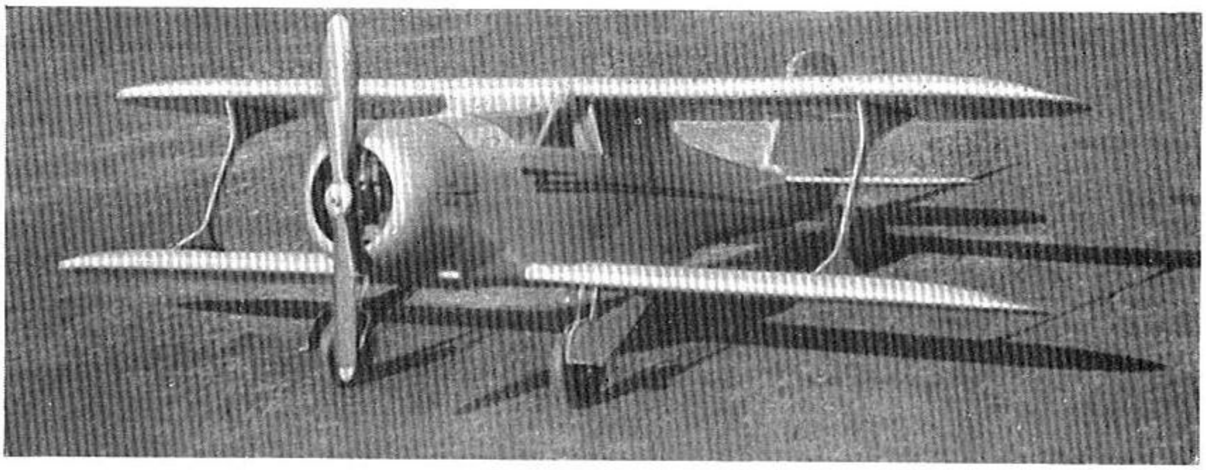
lift than in the normal position, thus helping to counterbalance some lack of dexterity at the inverted controls. From France comes the Dervish—a winning stunter in 1948—which employs negative stagger (Shades of the old Beechcraft !) and again we can see no particular justification for it but the fact that it is easier the other way up !

Many old time favourites such as Nieuports, Bristols, Camels, and even Triplanes such as the Fokker, have proved popular in kit form in the States. There is certainly something about the biplane once any initial prejudice against it on account of difficulty has been overcome. This is non-existent, in fact, and the only biplane second thought that is worth anything is the prospect of making two more wings !

Unlike free flight the control line trend is towards low wing design. Perhaps the early enthusiasm for speed, now giving place to stunt and precision flying in America, may be the reason for this, plus the ease with which the highly publicised war planes during its formative years could be reproduced in model form. For cleanness of outline we would recommend the low midwing, with control wires concealed in the thickness of the wing and leaving fairleads at the wing tip. This is a layout that recent high speed record breakers have followed.

A finely detailed scale model of the famous Tiger Moth that upholds the fine flying characteristics of its prototype on the lines.





Scale model Beechcraft that captures the spirit of its well-known prototype—almost the only full size machine with negative stagger. Bulky fuselage, allowing engine to be completely concealed, makes it particularly suitable for the aeromodeller.

Where a high wing layout is used some form of control wire fairlead must usually be dropped to enable the wires to be positioned correctly for adequate control, as will be explained in the relevant chapter. It follows that, given free rein in design, the builder should locate his wing at the spot most convenient on the varied counts of drag, control wires, position of accessories in the case of petrol engined models, and convenience of construction. In short, the usual aeronautical answer of compromise. The high pylon wing, or even the parasol in any but scale models, seems definitely out.

What shape should the wings be? Here again with stability problems all taken care of, the designer may back his fancy as he pleases. Experts have pointed out already that the most efficient wing form is rectangular—but very ugly! Nature, which abhors straight lines, gets over the difficulty in the case of the more conservative birds by rounding off the corners, and this is the best way with a model where simplicity and efficiency is required. Parallel chord wings with the outer panels blended into any pleasing curve makes another of those satisfactory compromises. There is loss of lift, but we have already agreed that lift is not required to that vital extent. A large proportion of successful designs have sharply tapering wings, with an almost straight leading edge and wedge trailing edge. On the score of looks and structural efficiency a tapering elliptical wing based on the Spitfire shape has our vote.

The span of the model will naturally depend to an extent on the power unit proposed and the length of line likely to be most convenient. In this country it is virtually impossible to obtain a good engine in the 10 c.c. class if we exclude one or two specialist manufacturers who, by the very quality of their products, reduce output to a negligible total. Diesel engines of a maximum of 5 c.c. or petrol engines up to 6 c.c. seem the practical maximum for the majority, while ninety per cent of the builders will be making their debut with a diesel engine of less than 3 c.c. in mind. For this reason we would suggest 40 in. as the maximum span that need be contemplated, with a figure around 20 in. as a useful starting point in the case of smaller engines. Speed merchants will be thinking along the lines of 5 c.c. diesel and 20 in. span, which is quite practical for the expert but deadly for the beginner.

There remain now the practical questions of how to build the wing strong enough and efficient enough to do its job. A primary concern is to maintain the whole wing at the designed airfoil section. Any tissue covered wing will tend to sag between ribs and destroy some of its efficiency and add to drag, which may not matter much at low speeds, but certainly does at high.

An increase in the number of ribs and the addition of riblets with suitable capping strips will help to cure this tissue sag. Sheeting in from leading edge to main spar is another solution to the sag problem. But the question of spar strength remains. Dives and sundry other manœuvres impose special strains apart from unrehearsed contact with Mother Earth. Spars should therefore be the full depth of the section, and not notched to any extent, which is a weakening move. This means that ribs must themselves be cut, a method that has never been very popular. To retain the one piece rib, thicker spars of less than the full depth may be used, or box spars on which the ribs are threaded.

Weight is not quite so important as in other forms of model flight and need not be so large a factor in considering increased strength. A handy solution is to cover the whole wing with 1/32nd inch sheet. This makes a delightfully smooth covering, and will take a high degree of finish if suitably treated with filler before painting. For added strength such wings may be tissue covered and then painted, thereby avoiding weight increase by soaking of filler and paint into the wood, but a really high polish is not so easily obtained. When rubbing down any thin sheeting there is a danger of rubbing too hard over the rib joints, thus weakening the structure and defeating the object of covering. Soft 1/16th in. sheet obviates some of this risk and gives a strong wing that will take a lot of punishment.

Borrowing from the memories of our chuck glider days may be found what many consider the ideal solution, at any rate for wings of moderate span—solid balsa. Using soft sheet, say half an inch thick, the wing may be carved with the aid of templates to a perfect form. Its all up weight will be little more than a sheet covered wing and its lavish use of cement fillets and so on. As the chord will usually be more than 3 in., which is the average maximum width of sheet, it will be necessary to join two or more sheets edge on to make up the width of the wing. A refinement, therefore, is to use hard balsa for the leading edge section and soft balsa for the rearmost part. In the case of a wing wider than 6 in. a final piece of hard balsa for the trailing edge gives the best possible combination of woods. Where dihedral is desired, ply dihedral keepers the full depth of the section should be firmly cemented in saw cuts made with a fretsaw. The whole wing is well sanded, treated with filler, and a smooth drag-free piece of work should result when brush-painted or sprayed. Another consideration which we pessimistically add is that should even this wing be broken the offending section can be swiftly cut out, a fresh piece of balsa grafted in, and trimmed to true profile, provided the original templates have been retained.

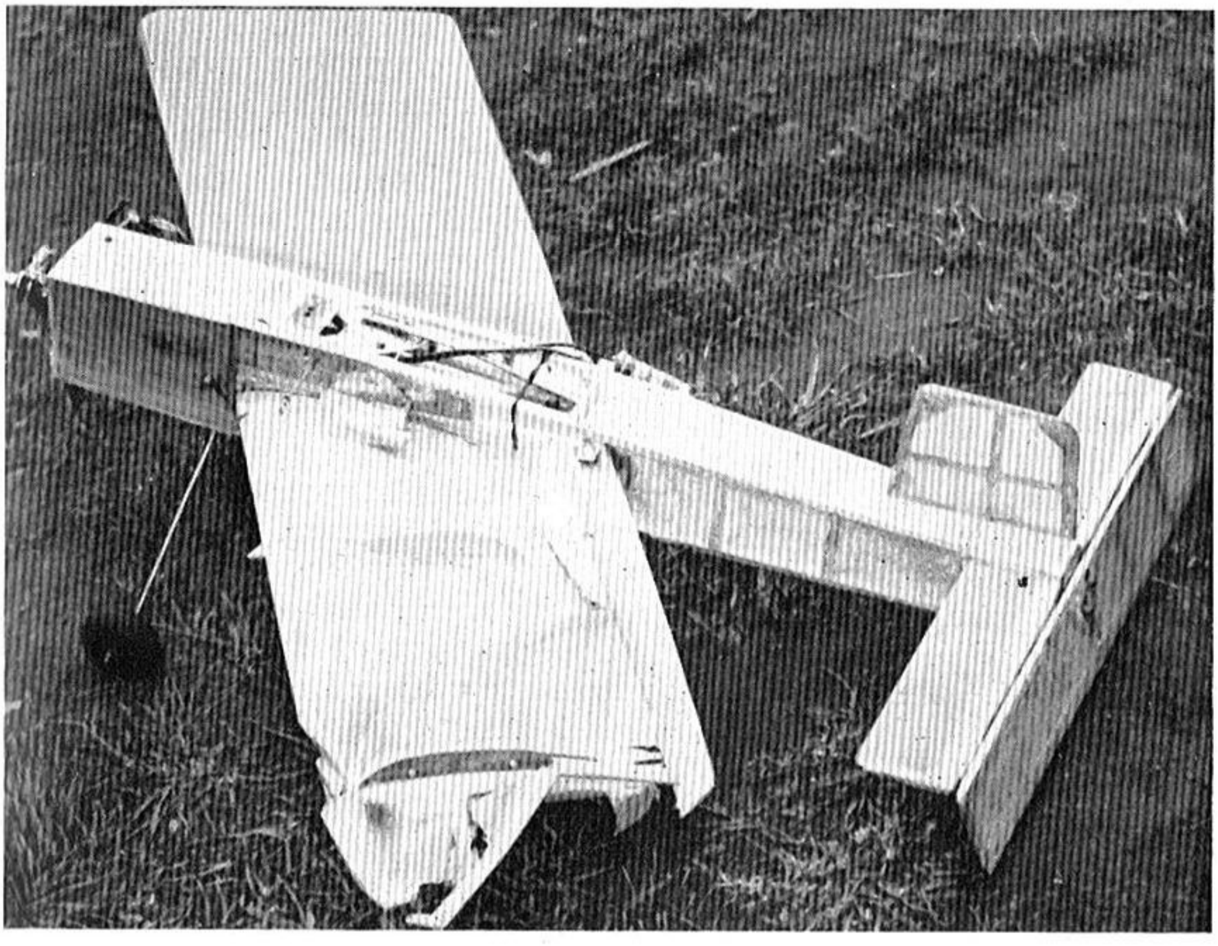
Another modification, is to glue lightly together two sheets each of half the maximum finished thickness, carve to shape, split and hollow out to taste in the same way as a hollow log fuselage.

Reverting again to compromise, solid leading edges about one-third of the chord and similarly stout trailing edges may be used with riblets between. A main spar in this instance is not essential. The Babcocks in their record breaker Jughaid employ such a method, adding, however, a stout one-piece hardwood main spar, through which a locating screw secures the wing to the fuselage, and a 1/16 in. covering goes all over. The hardwood main spar is also in this instance used for attachment of the control plate.

The pull of the control wires is such that rigid wing fixing is necessary. A number of designs have wings fixed permanently in place, but for ease of transport detachable mainplanes are often desirable. Let us consider fixing methods. Where crutch type fuselage construction is employed, and the crutch forms a wing platform, small holding plates attached to its under surfaces will suffice, provided the upper part of the fuselage beds down firmly.

A screw through the upper part of the fuselage mating with a hole or plate attached to the main spar, and screwed into a nut in the lower part of the fuselage offers an efficient and entirely satisfactory answer. Bicycle spokes are useful in this connection, the screwed nipple being the lower retaining nut. Locating pegs are another answer, though such fixtures should always be through hardwood blocks with plenty of " land."

End of the flight. Rubber band fixed wings are always liable to move in flight causing binding of controls—a state of affairs which terminated this model's antics in the inverted position. Little, beyond portability, is achieved by such a fixing for wing has not knocked off, but driven back into fuselage, probably causing more damage than would have been inflicted in a fixed wing model.



CHAPTER SIX

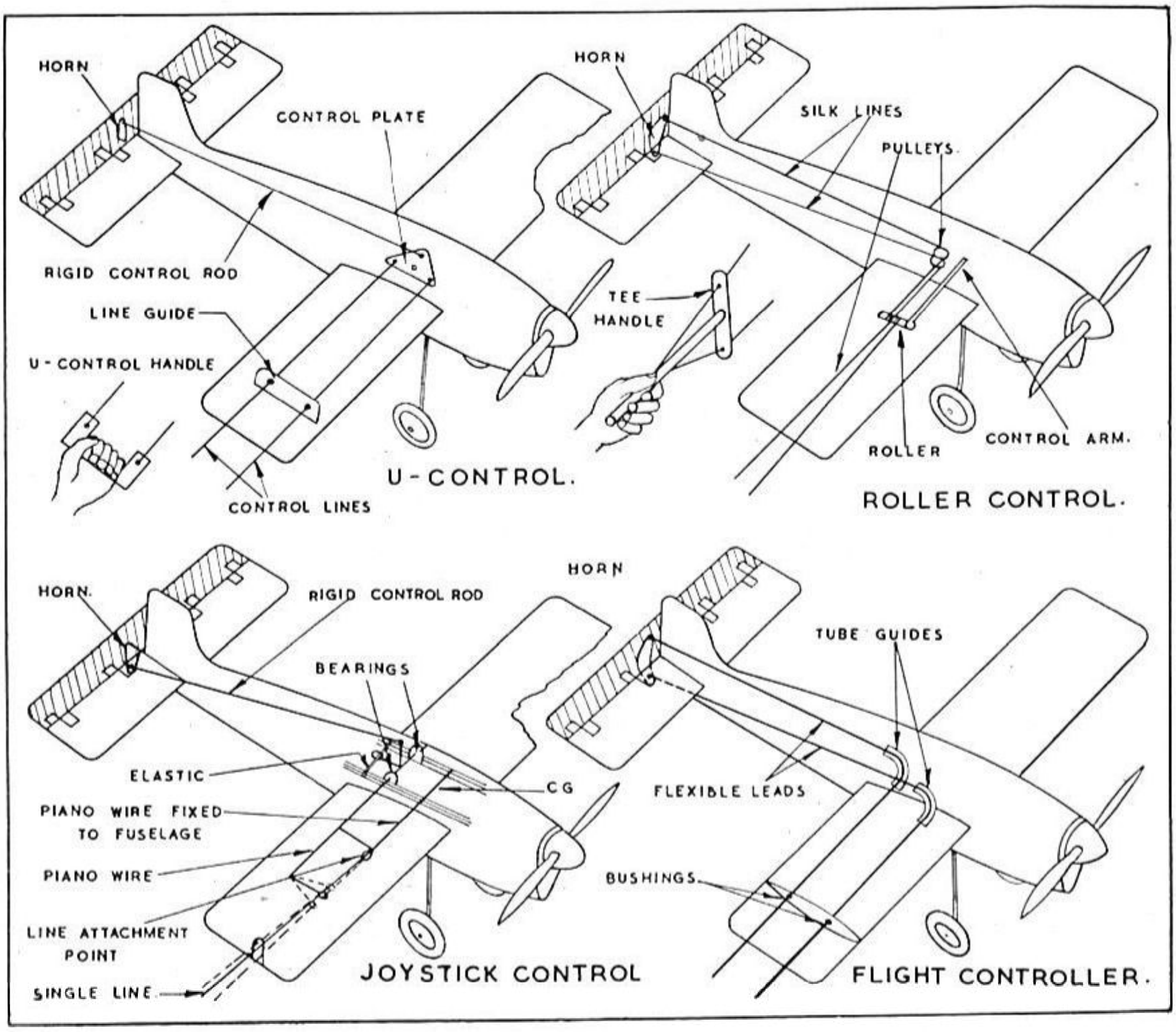
CONTROL SYSTEMS, CONTROL PLATES, ELEVATOR HORNS AND HINGES

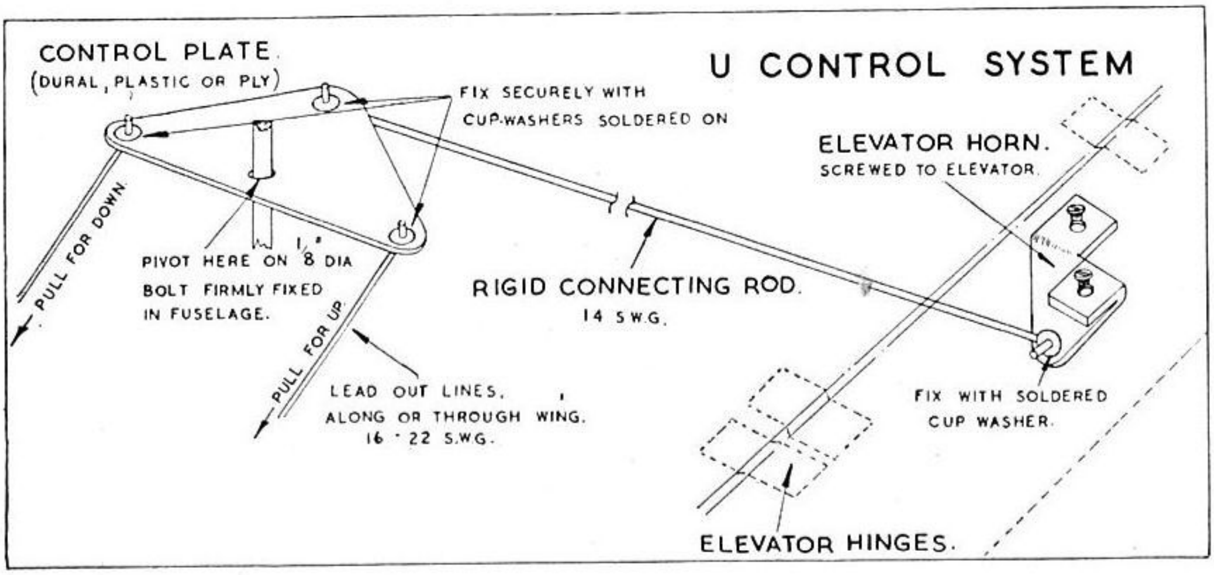
THE introductory chapter dealt briefly with the principles of control line flying, but we propose here to recapitulate the main features. First, the model is flown in circles round him by an operator who retains control of the model by one or more lines, extending from a handle which he grasps to the model, where they, by one or other of several systems, actuate a movable elevator on the tail. Thus an upward impulse to the elevator will make the model climb, while a downward impulse will cause it to dive. Within these limitations a skilled operator can perform all the aerial evolutions that are possible in a two dimensional plane. Thus, imagine the model as a fly walking on the inside of an inverted sugarbowl—every antic it could perform without losing contact with the bowl can be done with a control line model. To make it simpler still, consider that fly as limited to the inside surface of that bowl, but now flying free *on that plane only*; all it does, flying upside down, looping, figure eights, and so on can be carried out deliberately with a control line model. In addition to such " crazy flying," called stunt flying or aerobatics, which forms one branch of the sport, there is another equally important that devotes its activities to sheer speed. Here a different technique is employed, for the model is designed, and the flyer concentrated, on keeping the model flying in level circuits about him—if its flight path is erratic then it is travelling further and as the speed is estimated on the length of a level circuit a figure lower than actual is recorded. The amount of control and the nature of the control surfaces will therefore differ on these essentially different types of models. A further intermediate type of control will be found desirable on training types and general purpose or " sports " models.

A number of different control systems have been devised, but the best, or at any rate the most widely used, is the U-control method invented and patented by Jim Walker in the United States. This employs a triangular shaped control plate, firmly anchored about a pivot point, free to move within limits in a direction at right angles to the line of flight. This in turn is connected to a hinged elevator by a *rigid* rod, usually of piano wire, and via a small horn gives up and down movement to this elevator. Its beauty lies in extreme simplicity, positive action, and the ease with which all components can be fabricated at home, or purchased for a few pence. The length of the rod connecting control plate with elevator horn will influence the amount of up and down movement given to the elevator. The distance of the attachment point of the rod from the pivot point of the control plate, and the size of the horn will influence the fierceness of this movement. Thus speed models will have very little movement, as no violent changes of direction are desired, whilst stunt models will have a considerable amount. This is more simply explained in the accompanying diagrams.

The distance apart of the two attachment holes for the control wires on the control plate will also influence fierceness of movement. The wider they are apart the quicker will be the elevator response. For this reason in beginners' or training models it is advisable to make the most of the various combinations that produce the least possible movement for the greatest movement of the control handle, to which wires are attached. In the early stages, handling will tend to be clumsy, initiating movements which cannot be successfully countered before the model gets entirely out of control. Ways of combating this clumsiness are covered in the appropriate chapter on flying.

The Stanzel type of control has not yet found favour with British modellers. This is perhaps because it is not so simple for the builder to make himself, though, where the complete control unit is supplied, ready made in kits, as in America, it enjoys a following. Basically the system employs *flexible* leads from a double control horn on the elevator, which travel via two horizontally placed wheels, or bobbins, to a roller. From this roller two control lines extend to a handle held by the operator.





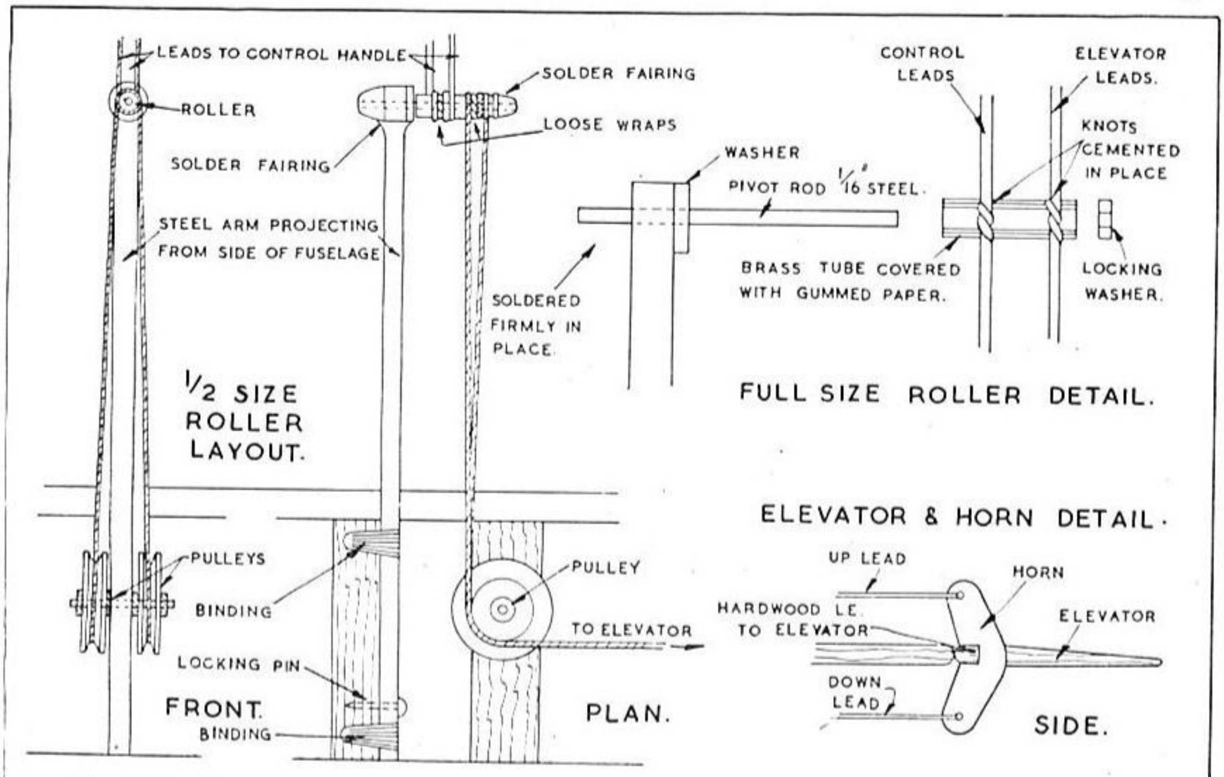
By twisting the roller up and down movement is given to the elevator. Improvements to this method now include a single control horn with rigid connection, and a spring loaded spring type roller, from which a single line gives control. The roller in each case is located outboard from the fuselage on a rigid pylon fixed slightly ahead of the C.G. An advantage claimed for both variations is that this outboard location of the roller mast gives some degree of automatic pendulum stability on a horizontal plane smoother in operation than the Jim Walker method. A further obvious advantage to the improved method is the reduction of drag when flying speed models on the single line. While the manufacturers do not normally intend builders to construct their own roller mechanisms, we include details so that a personal opinion on the relative value of the method can be gauged by the curious. The improved system is basically the same, but the rollers are spring loaded, returning automatically to neutral. Up and down movement is obtained by raising or lowering the control handle. Once more the diagrams serve to explain the method more lucidly than words.

A third system that may have some following here is the flight-controller method. Here the double elevator horn is again used, with *flexible* leads led out to the control lines via curved tubes securely anchored in the centre of the fuselage. A disadvantage of this method is that the control lines are connected directly, via the tubes only, to the elevator on the model, so that the faster the model flies the greater the strain, and consequently the greater the binding effect on the part passing through the tubes. Controls therefore become stiffer and less responsive at a time when, if anything, added sensitivity might be welcome. It is also impossible to vary the *degree* of response such as can be done with U-control by changing pivot holes, and even in the Stanzel system by changing size of rollers. For this reason the system has little support except from a number of commercial kit manufacturers who welcome its simplicity and cheapness, quite apart from saving royalty payments in the United States !

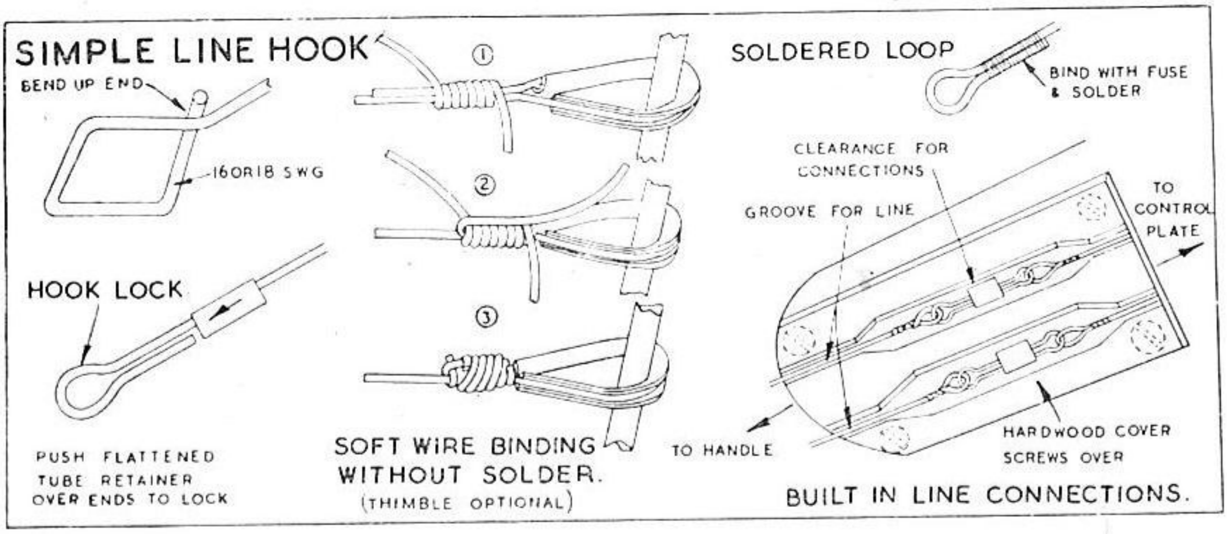
Finally, there is the single line system using a form of " joystick," which is actuated by raising an arm attached on the C.G. line parallel to the pivot rod to which the joystick is firmly soldered. A rigid connecting rod leads from the top of the joystick to a single control horn. The pivot rod returns automatically to neutral when movement is eased by means of centralising elastic band tensioners. Apart from some soldering work, this appears a very simple scheme which deserves greater support than it has received, particularly for use in speed models and on other occasions when low drag is desired coupled with a limited degree of elevator movement only. This, indeed, is the only snag of the system, that movement is somewhat limited, and therefore suitable only for sports and speed types.

It seems likely that most control line flying in this country will favour some form of U-control rather than any of the other systems. For this we must perhaps thank the kit manufacturers who have featured this exclusively, and the technical press who have offered it unceasingly as the ideal method. We fear we must join that number, for to our mind, in common with so many better able to speak with authority, it *is* the best system. Every other system has some disadvantage, either of structural complexity or limitations in use, the U-control system meets with every need of all classes of models, is adjustable, simple to make, and, given a minimum of care in assembly, unlikely to go wrong. We shall, therefore, concentrate our remarks on this method, whilst inviting the curious by all means to " have a go " at any or all the other methods if they feel so disposed.

Builders will soon appreciate that on the amount of up and down movement given to the elevator depends the reaction of the model, other things being equal. In early models there was a tendency to limit this movement with stops. This is, however, a wrong approach, which places undue strain on the system and tends to distort the elevator and " spring " the connecting rod. A better approach is to design a proper ratio of levers in the control system itself. Radius of the arc through



STANZEL ROLLER SYSTEM.



which the control horn moves should be at least $\frac{3}{4}$ in.; coupled with a radius about the pivot on the control plate to the connecting rod hold of not more than two-thirds this distance. On the control plate the two holes for the lead-out control wires should be spaced very little less than the distance apart of the control lines at the handle. The movement of the wrist in controlling models will always tend to be greater than the movement of elevators, and the lever movement should be reduced by every means possible. This may not always apply with aerobatic flying, but is a point to bear in mind at all times. Care and thought must be given then, to a happy combination of control plate and elevator horn, and not haphazard selection of fabrication of any two shapes that " look right."

Keeping a fixed size of control plate, with holes for connecting rod and lead-out wires suitably spaced, the sensitivity of the elevator will be reduced by increasing the distance of the hole in the elevator horn from the hinge, that is, increasing the radius through which it moves. Reducing the distance will, naturally, have an opposite effect. Most commercial horns have three holes drilled for use according to purpose for which they are used or skill of the user. Thus, with a new and untried model it might be advisable to use the most distant hole, only moving into the next when proficiency has been gained and any faults in the model corrected.

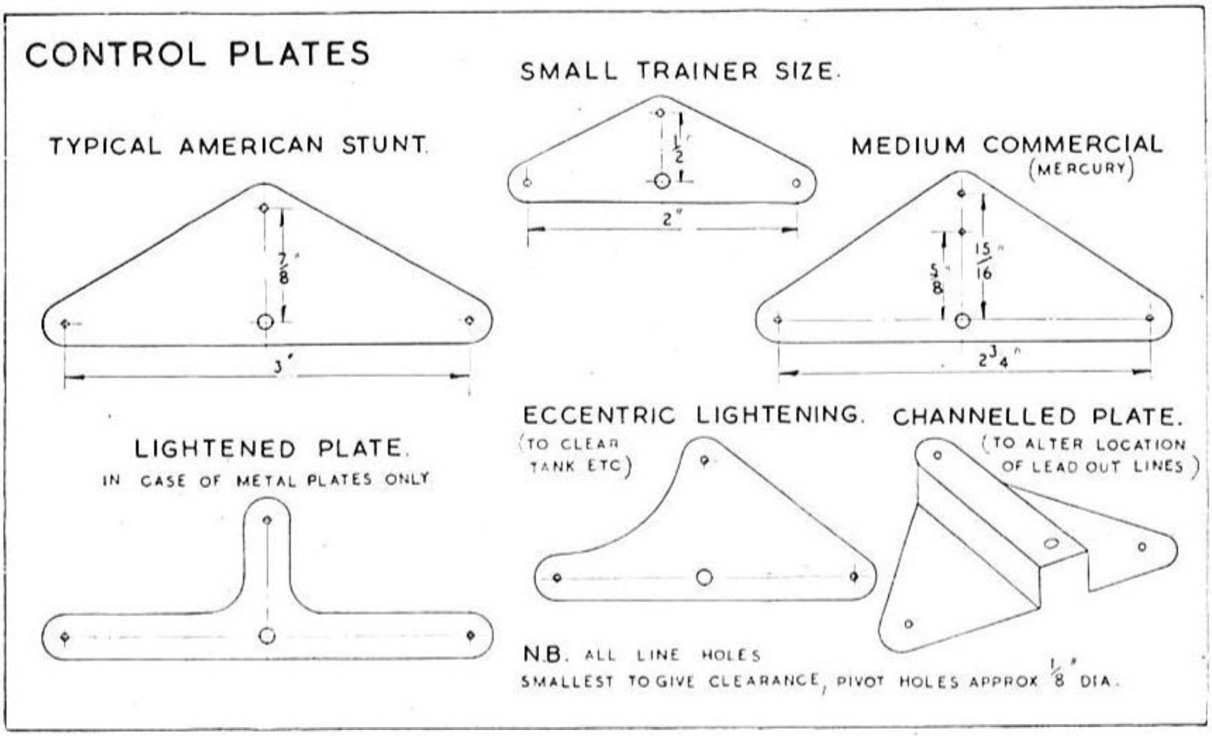
Models will be found with horns attached both above and below the elevator. There is little to choose between the two locations, which will most often be fixed by the design of the model. It is certainly desirable in speed models to have as much of the actuating mechanism concealed in the fuselage to reduce drag, and by varying the position of the horn this can usually be achieved. No such particular advantage accrues with a stunt or sports model where it may often pay to have the actuating mechanism more accessible. Many trainer machines have everything, including the control plate exposed for immediate attention.

Nuts or washers used to retain moving parts in place should always be carefully soldered. Nothing is more disconcerting to find than that a completely concealed nut has unscrewed itself, which usually becomes apparent in flight, and not when controls are being tested. Even a locknut is not to be trusted: solder and be sure. Free movement of all moving parts is important. Where the push rod, or connecting rod, runs through the fuselage it should be led through holes in the formers of sufficient size to let it pass freely, while a tight enough fit to prevent any appreciable whip when on the " push " part of its operation. In the same way there should be no binding of the lead-out wires, whether led through a guideplate on the outside of the wing, or through holes in the wing ribs, and out through tubes in the wing tips. This latter method is the neater and worth the slight extra trouble involved in all models except the box-car type of stunt model.

Quite a lot of the efficient performance of the model will depend on the lead-out wires from the control plate to the wing tips, the nature of the loop here to which the control lines are attached, and the smooth operation of the whole unit.

At the control plate end there is little to better a right angle bend in the lead-out wire, the short end being pushed through the control plate hole, and a washer soldered in place to retain it. Any unnecessary protrusion of the end should be cut off, lest it foul some other part of the mechanism. Some builders using thin wire bend it right over and wrap it round instead of fixing a washer : this avoids a soldering job, but that is all that can commend it other than for emergency field repair work.

The other end of the wire should be formed into a neat loop, bound with fine fuse wire and soldered. The least amount of solder to flow into the binding should be used—a blob is no stronger, looks unsightly and adds to the drag. Alternatively, a $\frac{3}{4}$-in. piece of flattened brass tube can be slipped on the end before bending the loop and this then serves as a neat retainer when the control line loop has been slipped in place. This is used on some well-known kits and is excellent for smaller low-powered models, but not to be trusted for high-powered speedy jobs. Some of the stunt experts bend the ends of their wires into a diamond hook with turned up safety end, rather like a rubber hook



on a duration model. This is satisfactory if 20 s.w.g. or stouter wire is used, with lighter gauges it will tend to pull out when least expected.

Generally, any simple method is sound, provided the amount of strain to be taken is allowed for and, more important this, the attachment of the control wires involves no twisting of them, which will invite unwelcome kinks later on. We have seen an ingenious " corkscrew " type of safety fitting offered as a gadget, but frankly this would ruin the wires in a couple of outings. There is no reason why it should not be used for thread lines. The essence of all fixing methods should be simplicity, strength, and particularly with speed models, low drag.

On the simpler types of models wires will be led out through holes in the side of the fuselage. Such holes should be rectangular in shape along the line of the fuselage, as it will be noted there is an appreciable lateral movement between full up and full down, even in properly designed speed models where the actual elevator movement is small. There is no need to reinforce these openings, and certainly no occasion to bush them as we have seen done, for this is simply inviting them to bind at the first opportunity.

Whether led out above or below the wing, it will be necessary to run these ends through guide holes towards the wing tip. For this, either a ply guide plate or a bent up frame of piano wire serves. It should normally be located at least two-thirds of the way along the wing ; its exact position will be determined more by the design of the wing than anything else. There is no critical position, and reasonable variations will not affect performance. Location of guide holes in the plate should be such as to permit a straight line to be drawn through them, the exit holes in the fuselage and the control handle. Any kink in this line will make for reduced smoothness of control and even binding.

If at all possible it is an improvement to run the lines through the thickness of the wings, making a series of holes in the wing ribs to pass through, or, in the case of all wood wings, a channel of sufficient size to give clearance. This can be capped when installation is finished, taking care that surplus cement does not impede free movement. Where the wires come out through the wing tip aluminium or light brass tubes should be inserted, choosing a size that gives adequate free movement without sloppiness.

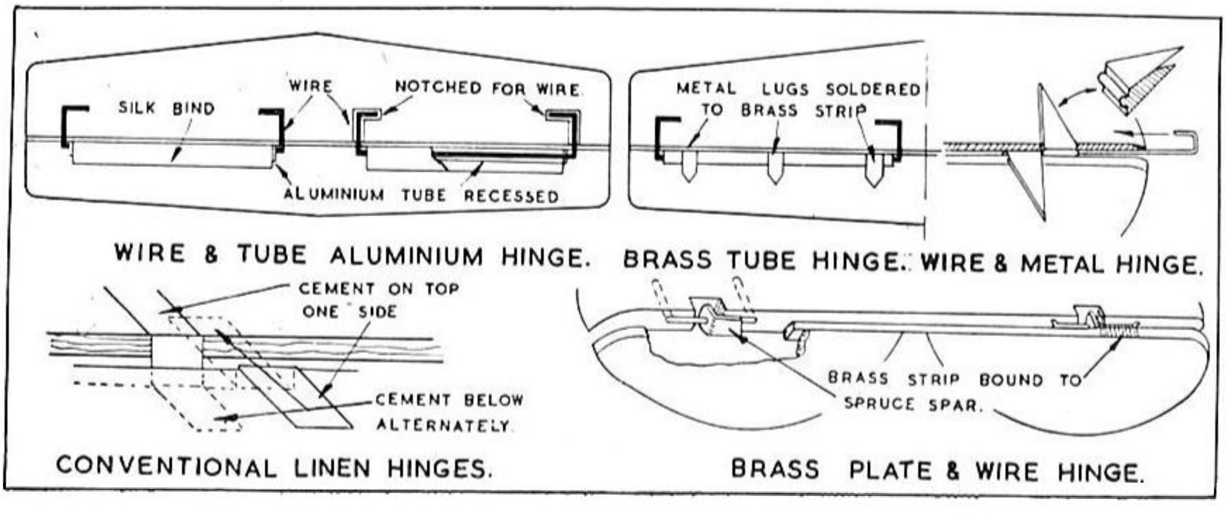
As most models have little or no dihedral there are no real problems of running lines through the wings, except location of the wing in relation to the fuselage. As there seems a growing design tendency towards mid wing models this makes it all the easier. All types can, however, make use of this method of lead-out, including low wing and high wing designs, though they may require some slight modification of the flat type control plate by bending the ends up or down to facilitate it.

Some designers prefer to have very short stubby lead-out wires, extending only half an inch or so through the fuselage. Control lines are then fed through the guideplate and attached in the usual way. This is not so neat a method as the others discussed and is really only suitable when thread lines are used.

Materials used for control plates include hardened dural sheet, three-ply and paxolin, either bushed or unbushed. Soft metals should not be used as the holes drilled will tend to enlarge themselves in use by the rubbing of the steel wire connecting rod and control wires. For this reason three-ply may also be suspect, but in practice it works quite well with the smaller size of model. Any excessive movement, that is, play more than a 1/16th in. is undesirable ; it may cause elevator flutter at speed and make the model uncontrollable in the air. When found, trace the play and replace ruthlessly, though it means cutting open a beautiful fuselage to do it ; otherwise it may be too late for anything except regrets.

The conventional hinge between elevator and tailplane is linen tape, laid alternatively above and below, and stuck on firmly with Durofix or similar adhesive. Silk strips may also be used, or fine mesh muslin. We have also found the stiff buckram-like packing on elastoplast and other self-adhesive wound dressings very suitable. There is an increasing use of hinges that follow the whole length of the join, made by joining two strips of silk or tape along the centre with a machine stitched seam. If the sewing machine operator in the family can be interested this makes a remarkably strong and very neat hinge. With all cloth hinges there is a tendency when the model gets a little older for the material to deteriorate and rip when least desirable. Hinges should be inspected periodically for signs of rot—often brought about by fuel spray—and replaced as necessary. For this reason metal hinges made of wire and brass tube are being used. Care is required in fixing, as there is only a limited amount of gluing area. It will, therefore, often pay to solder a small tinplate lug to the tube to make fixing simpler and stronger. Strengthening the glue joint with a strip of silk or tape to some extent nullifies the advantages of an all-metal hinge.

The ingenious will soon think of many variations on these themes for elevator attachment. A criss-cross sewn hinge of strong thread makes a neat joint, but again the weakness inherent to all perishable materials applies. If ordinary lightweight box hinges of the " cabinet " variety can be obtained they make a splendid job. Many cigar boxes and ornamental cigarette boxes have the very thing, complete with tiny screws which should be carefully removed. Such hinges can also sometimes be bought at shops specialising in accessories for woodworkers, and one model manufacturer at least has just marketed a hinge especially for this purpose.



WIRE & TUBE ALUMINIUM HINGE. BRASS TUBE HINGE. WIRE & METAL HINGE.

CONVENTIONAL LINEN HINGES. BRASS PLATE & WIRE HINGE.