All about MODEL AIRCRAFT

by P.G.F. Chinn

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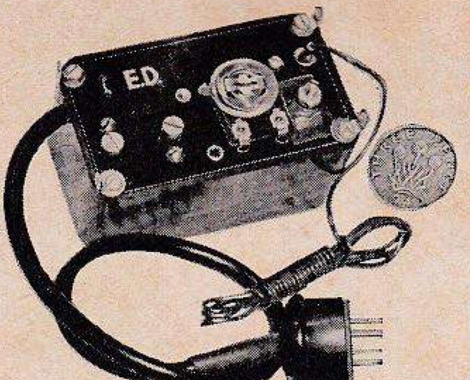

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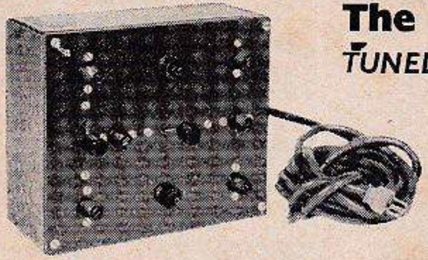

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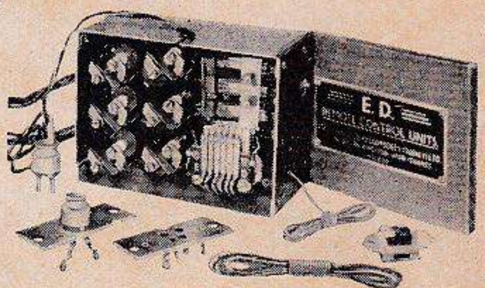

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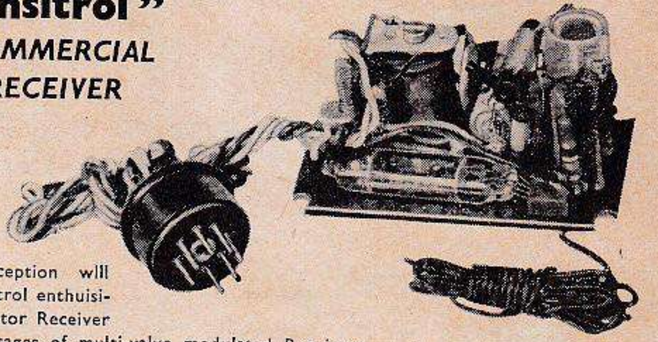

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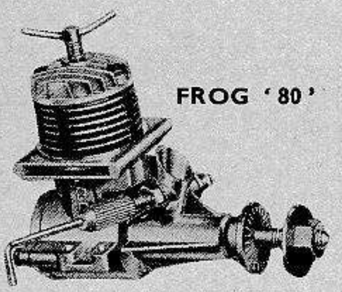

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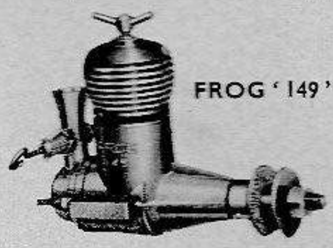
(55/- BARE *inc. tax***)**



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Price **56/-** *inc. tax*

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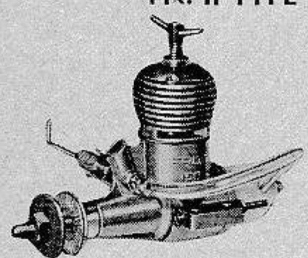

A really "hot" contest engine at a low price. The "150" Mk. II Type "R" has a performance equal to any ball-bearing engine in production. Especially suitable for ½A team-racing and power-duration models. Using a Frog 7 in. x 4 in. nylon airscrew 72 to 77 m.p.h. can be easily obtained in a team-racer.
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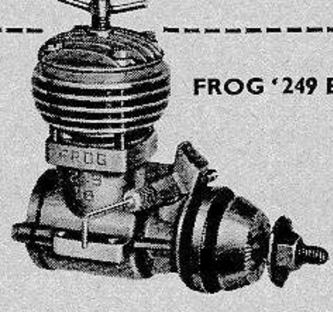

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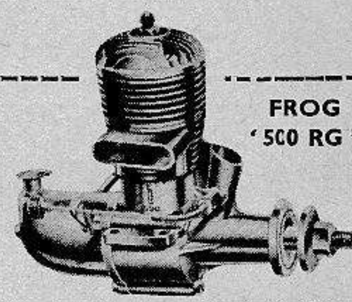
This is a special "super" performance version of the "249" embodying a different cylinder liner and modified timing. Even higher output with no loss of easy starting qualities. The cooling fins are anodized red to distinguish it from the standard "249" *Price* **94/9** *inc. tax*



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All about

MODEL AIRCRAFT

by

P. G. F. Chinn

A MODEL AIRCRAFT ***Handbook***

FIRST PUBLISHED - - - - - AUGUST, 1958

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Contents

Foreword

" All About Model Aircraft " is just what its title implies. There is no other book published at the present time which covers the subject so completely, presenting each type of model in turn and describing their characteristics and construction in easily understood form—and at a price which all can afford.

This new book, consisting of twenty-four chapters, totalling over 50,000 words and with nearly 400 illustrations, has been made possible by using material previously published, during 1956-58, in *Model Aircraft*, the popular monthly magazine. It supersedes, and extends the scope of, the previous best-selling book by the same author, " How to Make Model Aircraft," which has been read by more modellers than any other book on this subject.

In dealing with model aeroplane construction, " All About Model Aircraft," like the earlier volume, is primarily intended for the guidance of newcomers to the hobby, but the more experienced model builder will also find much of interest in the latter half of the book and in such chapters as those dealing with radio-control, engine care and maintenance and fuel blending.

The author is known to modellers throughout the world. His articles appear regularly in *Model Aircraft* and the American model press and have also been translated and reprinted in many other countries.

Chapter One
INTRODUCTION

EVERY year, the hobby of building and flying model aeroplanes attracts thousands of newcomers and, every year, the range of different model types gets a little bigger and a little more bewildering to the beginner.

Just a generation ago, a model aeroplane was simply a " model aeroplane " and was easily recognisable as such, and its functions easily understood. It usually consisted of a wing and a tail-unit on a simple fuselage, propelled by a rubber motor. One simply wound it up and heaved it into the air and, with a little luck, it would fly, after a fashion, for perhaps twenty or thirty seconds.

Nowadays, our model aeroplane appears in a score or more of different guises. Its rubber motor has given way in most instances to an internal-combustion engine: it may be propeller driven or jet propelled; it may weigh just a few ounces or several pounds; it may span ten feet or less than one foot; it may fly at 15 m.p.h. or 150 m.p.h.; it may remain in the air for a minute or an hour; it may perform elaborate aerobatics under full control or it may lift a payload several times its own weight; it may be a scale model of some full-size aircraft or a strictly functional machine designed to do one particular job in the best possible manner. Finally, it may be flown free, or tethered or under radio control. No wonder beginners find the sheer scope of the hobby a little overwhelming and have difficulty in discovering where they should start.

We propose, therefore, to first describe and differentiate between the many types of aircraft now being built.

One thing we must make clear at the outset is the fact that, in spite of their impressive appearance, the sort of models shown in some of the accompanying photographs are *not* the work of genius. Model aircraft is not a hobby for the dullard or the featherbrained, but, given a reasonable amount of patience and commonsense, anyone can build a successful model and, with further experience will be capable of constructing quite advanced machines. This is because the material largely used in model aeroplane construction—balsa wood—is exceedingly quick and simple to work with, while the construction methods adopted, especially the widely used system of assembly over a full-size drawing, make for easy and accurate work.

It is difficult to divide all types of model aircraft into precise groups because many of these overlap one another. Basically, however, we have three distinctly different groups, namely:

1. Free-flight models.
2. Control-line models.
3. Radio-controlled models.

The first includes all types of models which are flown quite " free ", depending upon their own good flying characteristics to maintain stable flight.

The second includes all models which are flown in

A typical modern rubber-driven competition model. Note the folding propeller. Built by Czechoslovakian enthusiast, V. Kutil.

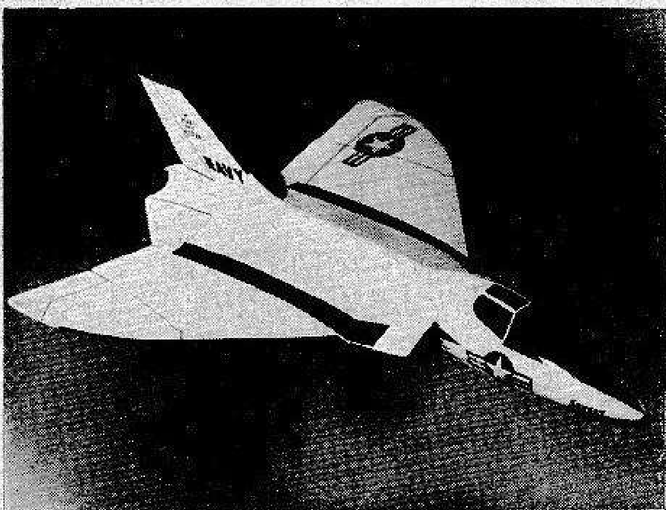
A free flight tailless power model being hand launched; note the tip fins and tricycle undercarriage.

a circle, tethered by means of a pair of thin control-lines. These lines are attached to a special handle held by the operator, while, at the aircraft end, they are coupled by means of a simple linkage to the elevators of the model. Thus, in addition to keeping the model captive, the control-lines, through movement of the control handle, serve to keep the model in stable level flight or, alternatively, to guide it through various manoeuvres, such as loops and inverted flight.

The third are essentially free-flight models in conception, but carry radio receiving equipment by which means they can be controlled by a transmitter operated from the ground.

Free-flight Models

(a) *Gliders.* Gliders, which are sometimes known also as sailplanes or soarers, are, of course, motorless aircraft. They can be launched by various means: by hand-launching from a suitable hillside, by catapult, by a winch and long towline, or by a running towline launch. The latter method is the most popular, a 50 metre (164 ft.) thin nylon or fishing line being most commonly used, which



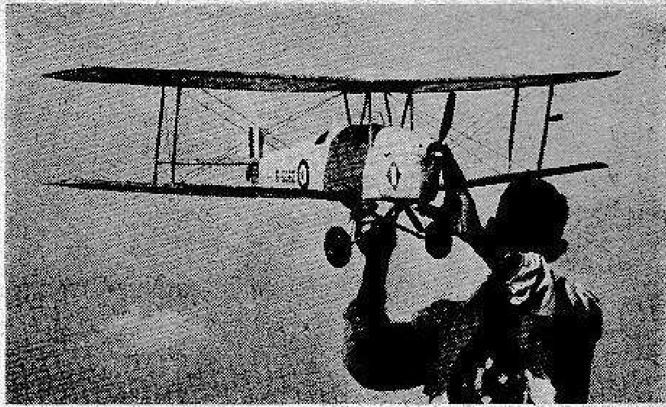
An attractive free-flight scale model of the U.S. Navy Skyray fighter. It is powered by a Jetex 50 motor and is available as a prefabricated kit.

allows a medium sized model to attain an altitude of around 150 ft. before release.

A popular glider of high performance is the International A2 type, which usually spans 5 - 6 ft. and weighs $14\frac{1}{2}$ oz. For a first model, however, the beginner is recommended to build something smaller, i.e. of 2 - 3 ft. wingspan.

(b) *Rubber-driven Models.* Once the mainstay of the hobby, the rubber driven model has now been superseded in popularity by the engine driven model, but still has a place in international competition, where the Wakefield Trophy contest attracts some of the world's most capable model-builders. Rubber-driven models include, also, small, lightweight duration types and simple scale models.

(c) *Power-Duration Models.* The power-duration model is one of the most popular types of model aircraft. Seldom having much resemblance to a full-size aircraft, it is designed to climb to as great an altitude as possible in a given time (usually not more than 15-20 seconds) and to then glide for as long as possible. A typical contest type is the "International" class, limited to engines of 2.5 c.c.



Model flying is encouraged in the R.A.F. Here is Leading-Aircraftman Lock with his fine free-flight model of the well-known Tiger Moth R.A.F. trainer.

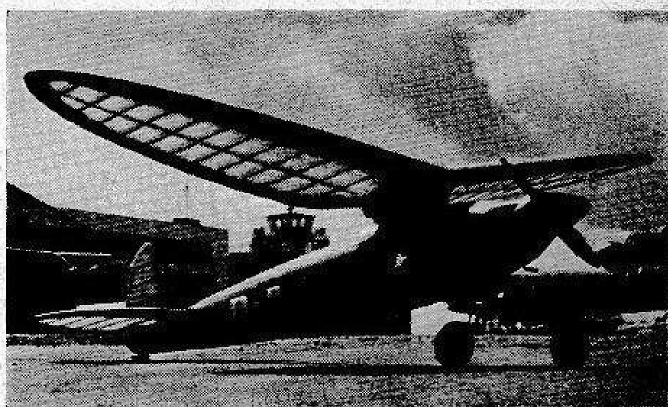
capacity. Some of these models climb faster than many full-size aircraft.

A development of the power-duration machines is the PAA-load type, built to a competition specification laid down by the Pan-American Airways. In this type of contest (for which P.A.A. award handsome prizes) the model is required to lift a regulation "payload" and a further development is the "Clipper-cargo" model, in which the winner is the model which can take-off and fly with the greatest possible load. A model powered by an engine of only .049 cu. in. (0.8 c.c.) capacity has, in one of these Clipper Cargo contests, lifted more than seven times its own weight.

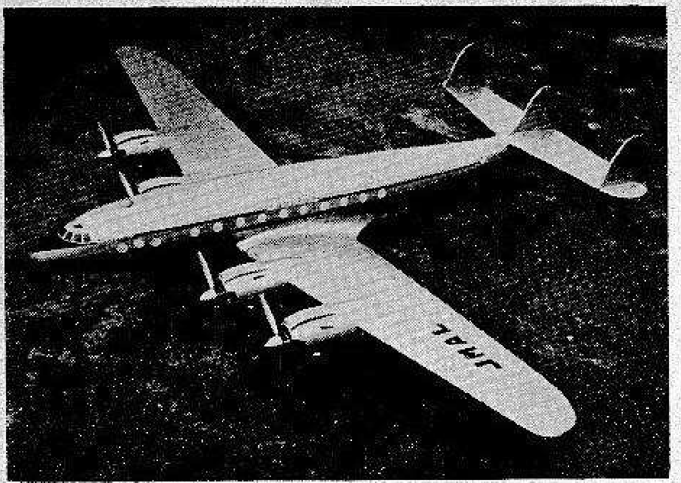
(d) *Free-Flight Scale Power Models.* These are models accurately scaled from full size aircraft, generally to a scale of 1in. or $1\frac{1}{2}$ in. to the foot, producing models of 3-5 ft. wingspan and powered with motors of .5 c.c. (.03 cu. in.) to 2.5 c.c. (.15 cu.in). They are not recommended to the beginner, because they are more difficult to build and fly.

(e) *Beginners' Power Models.* There are now a number of non-scale, non-competition types of free-flight power models which are more suitable to the beginner than either of these previously mentioned types. Usually of semi-scale appearance, and easy to build, they are powered with motors of the "Half-A" class (.049 cu. in.) or up to a maximum of 1 c.c.

(f) *Jetex models.* The "Jetex" motor, which is available in several sizes, is a small type of jet or rocket motor. It burns a solid fuel pellet and is very suitable for small



Pictured against a background of full-size aircraft, at a Norwegian airport, is this attractive free-flight model powered by a 2.5 c.c. engine.



A fine example of a multi-engined scale controlline model. Built by a Japanese enthusiast, this impressive Lockheed Constellation airliner has four 5 c.c. engines which deliver a total of nearly two horsepower.

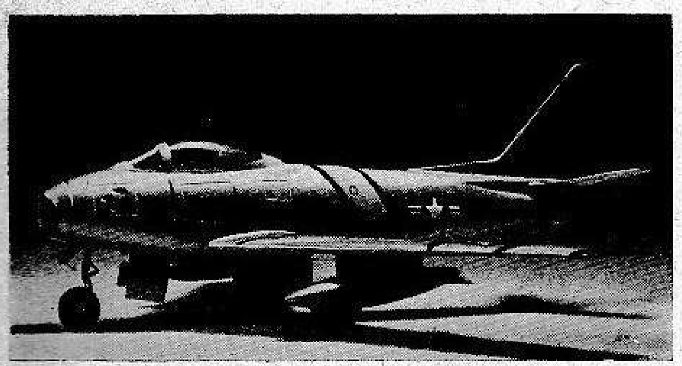
scale models (up to about 20 in. span) of modern jet aircraft or for lightweight duration designs.

(g) *Miscellaneous Types.* In addition to the previously mentioned models, there are many related and unorthodox types. For example, most free-flight power driven models can be equipped with float gear for rise-off-water flights. Alternatively, where one has access to smooth stretches of open water, the model flyingboat is a great attraction. Among the less conventional types are to be found helicopters, tailless and delta-wing aircraft, and almost every type of unorthodox full-scale aircraft has also had its counterpart in the model world. Such models are to be seen at most model meetings.

Control-line Models

(a) *Trainer Models.* The simplest controlliner can be built from solid balsa wood because all control-line models are heavier and faster-flying than free-flight types. Such models are quick and simple to build and easily repaired if damaged, and are therefore ideal for learning the rudiments of flying a C/L model. These models have a wingspan of 20-24 ins. and may be powered by an engine of up to 1.5 c.c. or .09 cu. in.

(b) *Stunt Models.* The aerobatic or "stunt" model is designed to perform quite complicated manoeuvres, such as loops, outside loops, inverted flight and vertical and overhead figures-of-eight. A typical modern American stunt model flies at 65-70 m.p.h. on 60-70 ft. long steel

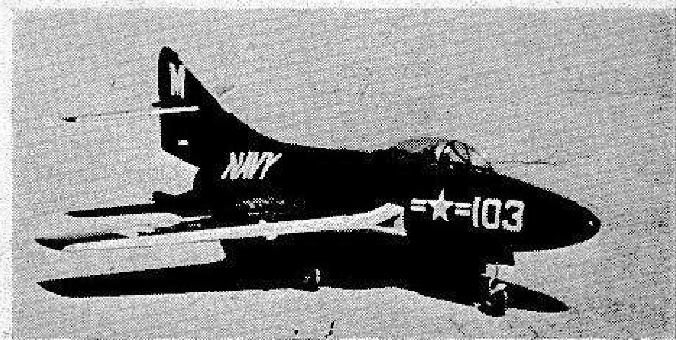


An excellent example of the scale modeller's art: an accurate and beautifully finished model of the American Sabre F.86F jet fighter with authentic markings.

control-lines and weighs $2\text{-}2\frac{1}{2}$ lbs. It is generally powered by a glowplug-ignition engine of up to .35 cu. in. displacement (5.8 c.c.) developing about 0.5 horsepower. Its wingspan is usually about 50 inches and it can be recognised by its relatively large wing area and short fuselage. European models are mostly of somewhat smaller dimensions due to the smaller capacity engines available. Very considerable skill and judgement are exercised in successfully flying a stunt model through an elaborate pattern of manoeuvres.

(c) *Combat Models.* A popular development of the stunt model, usually of simpler design, is the combat machine. Two combat models are flown by their pilots in the same circle, each trailing a paper streamer, and the object is to pursue one's opponent and to cut as much as possible from his streamer with one's airscrew. Over-enthusiasm on the part of the pilots sometimes leads to spectacular mid-air collisions, and a model which is easy to repair, therefore, has much to commend it.

(d) *Speed Models.* Speed models are flown in various classes according to engine size. The most powerful are the 10 c.c. or .60 cu. in. engined models which achieve speeds as high as 160 m.p.h. from engines running at 16,000 to 18,000 r.p.m. and developing in the region of $1\frac{1}{2}$ horsepower. Even tiny "Half-A" (.049 cu.in.) models have, however, now reached 100 m.p.h. Models built to

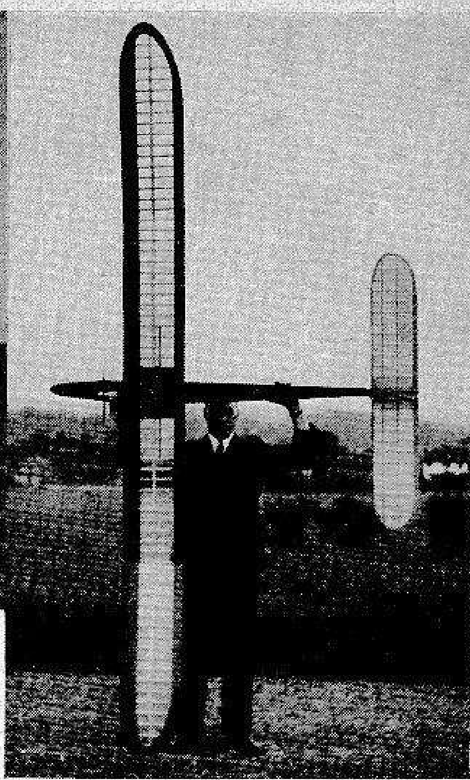


A true scale model of the Grumman Cougar jet fighter. Powered by a Dynajet pulse-jet engine of 4 lb. static thrust, it weighs $3\frac{1}{2}$-lb. and has a speed of approximately 80 mph.

the F.A.I. World Championship specification have 2.5 c.c. engines and reach over 120 m.p.h. Speed models are quite small, even the largest being seldom more than 18 in. span. Much depends on reducing air drag to the minimum and to this end, a special mono-line system of control has been developed.

(e) *Team Racers.* In team racing, two, three, or four models are flown in the same circle simultaneously, the object being to cover a given number of laps (equal to five or ten miles) in the shortest possible time. Pure speed models, however, are not eligible for this type of event, as models have to fulfil certain minimum dimensions, be of scale appearance, and are permitted only a limited fuel tank capacity, which entails refuelling stops about every 40 laps. "Pit crews" refuel and restart the models during the race and with smart pit work, a fast .29 engined model will cover a ten mile race in less than 8 minutes, averaging 75 m.p.h. including the two refuelling stops required.

(f) *Scale Controlliners.* Scale control-line models are among the most impressive model aircraft. All types are constructed, from single-engined fighters up to four-engined airliners and bombers. Since control-line scale models can be so much heavier than their free-flight counterparts,



All types of aircraft are tackled by enthusiastic modellers. Here a successful power-driven model helicopter makes a flight over the Osaka baseball stadium in Japan. Centre: The "combat" model is designed for manoeuvrability and speed, rather than appearance. Here, Cpl. Godfrey of the R.A.F. displays his colourful model powered by a 5 c.c. engine Right: With a wingspan of more than 11 ft., this radio-controlled model represents many months of work.

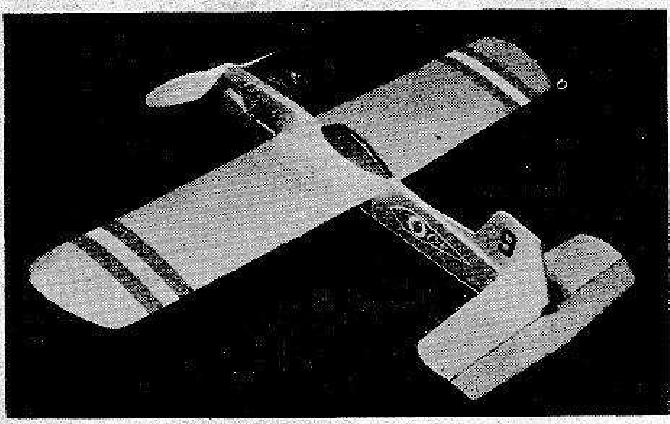
these models are often highly detailed, with working retractable under-carriage, etc. Such models are often in the super-scale class may be covered entirely with metallised paper, which gives an exceptionally realistic finish.

g. *Pulse-jet Models.* The pulse-jet is a powerful and extremely noisy power unit based on the principle of the German wartime V.1 " buzz-bomb ". Speeds approaching 180 m.p.h. have been reached with models so powered, but the most useful application of these engines is, undoubtedly, in scale models of modern jet fighters. In most countries, the use of these engines is restricted to control-line models only.

Radio-Controlled Models

The radio controlled model is regarded by many as the ultimate in model flying and, without doubt, there is tremendous satisfaction to be gained from watching a model, flying at several hundred feet, respond to one's signals from a ground transmitter.

A simple 20 in. span all-balsa controlline trainer designed by the author for a range of American engines. Such a model can be built in a matter of four or five hours, and is the ideal type of machine with which to commence control line flying.

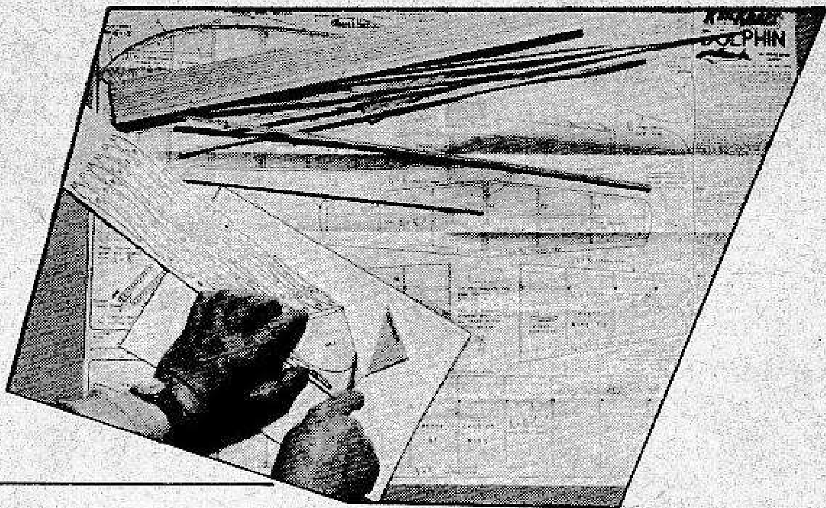


Radio models are divided into two types for competition purposes; (a) those having a " single-channel " control, which usually operates the rudder only, and (b) the " multi-channel " models in which engine speed and the elevators are also included in the control system. Miniature radio-control equipment for this type of model flying can be bought ready-made or one may build one's own transmitting and receiving equipment. In most countries the authorities have allocated special frequencies for the use of the radio-control enthusiast.

Looking just like a full-sized airliner about to land, is this twin-motor controlline scale model of a SAAB Scandia of Scandinavian Airlines.

To sum up, then, the model builder has an immense range of types from which to choose. While the majority of enthusiasts become so engrossed in their own particular sphere that they have little time for other types, it will be seen that there is, in fact, always something new to try, such is the scope of this fine hobby.

Making a Start



CHAPTER TWO

All model aeroplanes are built with the aid of full-size drawings or plans. These are a tremendous help. In most cases, the components of the models—fuselage, wing and tail-unit—are built directly over the plan. That is to say, the various strips of wood are pinned down over the plan and the glued joints allowed to set before each assembly is removed.

This system almost eliminates the need for measuring and marking the numerous wood strips, and greatly speeds and simplifies assembly work. It is also far more accurate and can be compared to the "jig" system of construction used in full-size aircraft manufacture.

The first requirement, therefore, is a full-size working plan of the model you wish to make. These can be obtained in three different ways. Firstly, you can buy a kit of materials and parts which will also include the required drawing. Secondly, you may build the model from a magazine plan (although this may require enlarging to full-size unless the model is quite a small one) or you can buy a full-size print from the publishers. Thirdly, you can design and draw up your own model.

Obviously, the latter course cannot be undertaken without a thorough knowledge of model aeroplane design and construction. Therefore, we need concern ourselves only with the first two and, of these, the kit model usually offers the greatest advantage to the newcomer.

Building from a manufacturer's kit is usually no more expensive, and, for a first model, is invariably a good deal cheaper than buying one's own materials. This is because balsa wood, etc., is sold only in standard lengths (usually 3 ft.) and, if a large number of short lengths of different widths and thicknesses is called for, it may be necessary to buy more wood than is strictly necessary.

Another point in favour of a kit is that it eliminates some of the more repetitive work which the beginner may, at first, find a little tedious. For example, whereas, when building from bare materials, it is necessary to transfer patterns from the drawings or to make templates of sheet wood parts, these parts, in a kit, are usually printed direct on to the appropriate sheets of wood or are even ready cut out.

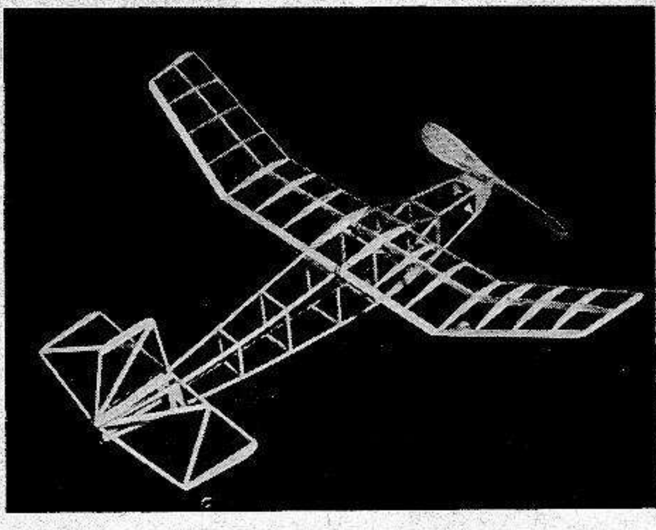
When buying your first kit, however, do not make the rather common error of choosing something advanced and complicated merely because the appearance of the finished model appeals to you.

All model aircraft construction is really quite simple. All you need is a little patience and some practice. Therefore, build one or two simple and cheap models to start with. This advice may seem to be rather superfluous, but it is a fact that many beginners are apt to overlook the necessity for learning the simple techniques of model construction and, in doing so, to attempt something which would stand a much better chance of being successfully completed if left until some experience has been gained.

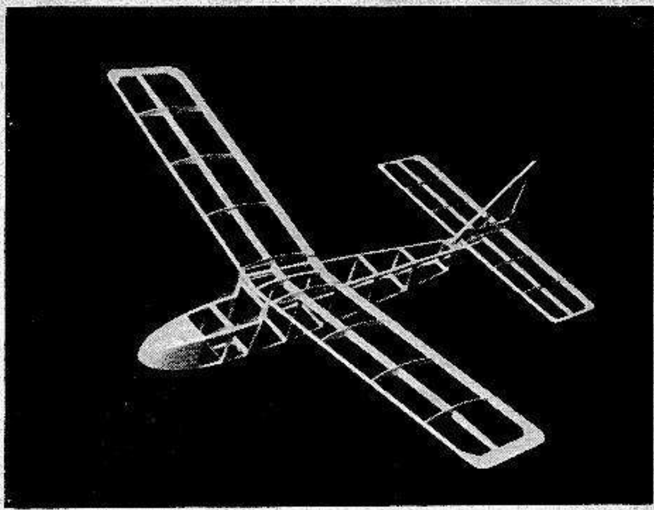
The type of model suggested for a first attempt is a simple built-up glider of 24-30 in. span. It is, of course, possible to make something even simpler, such as an all-sheet balsa glider, but only when you have built up a framework and covered it, can you really be said to have acquired some knowledge of model aircraft construction. There are on the market a number of built-up glider kits suitable for the beginner and new kits are being introduced by manufacturers continuously.

A word now about the basic materials used in model aircraft. The most important of all, of course, is balsa wood. Balsa is wonderful material, it is very light and

TYPICAL BEGINNER'S BUILT-UP GLIDER KIT



Rubber-driven model with built up fuselage. (Skyleada Fledgeling.)



Beginner's glider with built-up fuselage. (Mercury Magpie kit.)

quite soft, so that we rarely need anything more than a razor blade to cut it. Yet it is strong and rigid enough for our purpose because, where necessary, quite thick sectioned balsa can be employed without risk of making the model too heavy, and impairing its flying qualities.

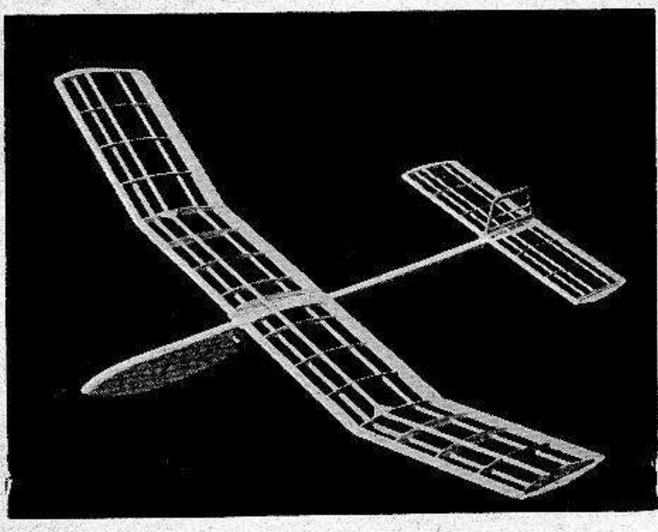
Balsa is sold in so many different sizes that it is very seldom that we even need to plane or saw it. The most popular strip sizes are the 1/16 in., 3/32 in., 1/8 in., 3/16 in. and 1/4 in. square sections. Flat sections, such as 1/16 in. × 1/4 in. and 1/8 in. × 1/2 in. are also obtainable. Larger sizes are also available, but, when more than 1 in. square, are usually classified as "block," rather than strip, balsa. "Sheet" balsa, usually 2 in. or 3 in. wide and 3 ft. long, is also very widely employed and is available in various thicknesses, 1/32 in., 1/16 in., 3/32 in., 1/8 in., 3/16 in. and 1/4 in. being popular.

Balsa for model use is also sometimes graded into various "weights" and "cuts." Balsa wood grows in tropical climates, much of it being imported from Ecuador and it varies a good deal in density and also (depending on the direction in which the logs are sawn to produce different grain formations) in the rigidity or flexibility of sheet stock. However, this is of no immediate importance to the beginner: hard balsa is heavy and soft balsa is light and, at this stage, we need concern ourselves only with the choice of "hard," "medium," or "soft" wood, as and when specified in the plans or instructions.

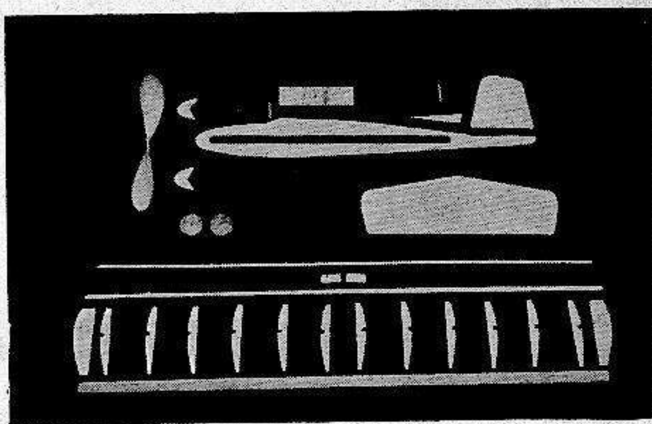
Thin, high-quality bonded plywood (known as "aircraft ply") has certain uses, particularly with larger models and power driven types. It is generally sold, at model shops, in small panels and in thicknesses of 1/32 in. upwards.

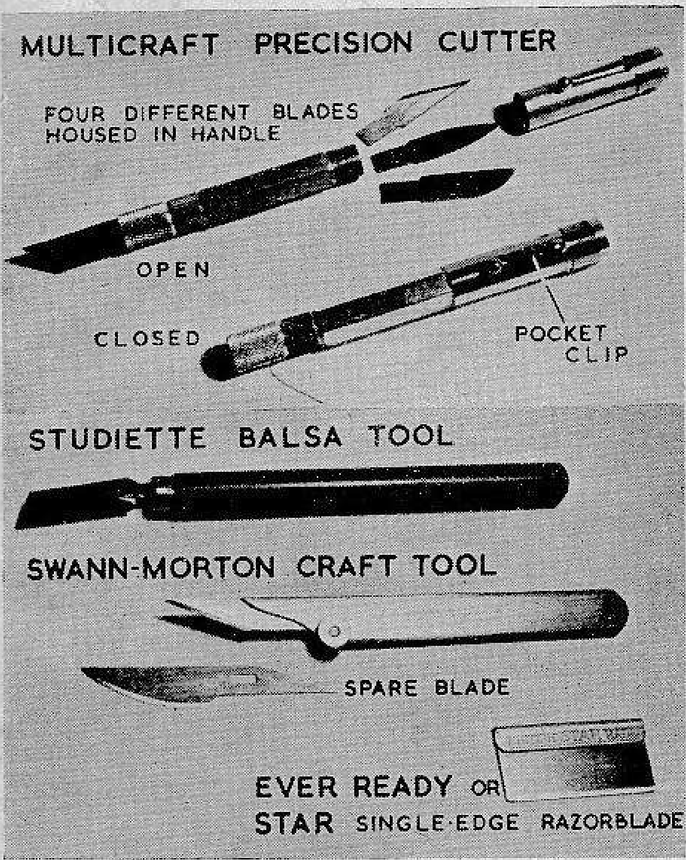
Other woods have only very limited uses in model aircraft work. Obeche is occasionally used by some designers, being available, like balsa, in strips and sheets, but its usefulness is limited, as it is two to three times the weight of balsa. Spruce and birch, much stronger in small sections than balsa, are used by some Continental modellers for wing spars in the thin sectioned wings of high performance competition gliders. Ash and beech are often used for engine bearers and the latter wood is also widely employed, by manufacturers, for power model propellers.

Thick spring-steel wire of 1/16 in. to 1/8 in. diameter is employed for undercarriage structures and for rubber model propeller shafts. Medium wire (1/32 in. to 1/16 in.) is used for rubber models and for control-line model control systems. Very thin wire, down to .006 in. diameter, is used for control-lines and for small springs, etc. Other metals, mainly brass, aluminium and duralumin in sheet, strip and tubular form, have useful applications, particularly in power models.

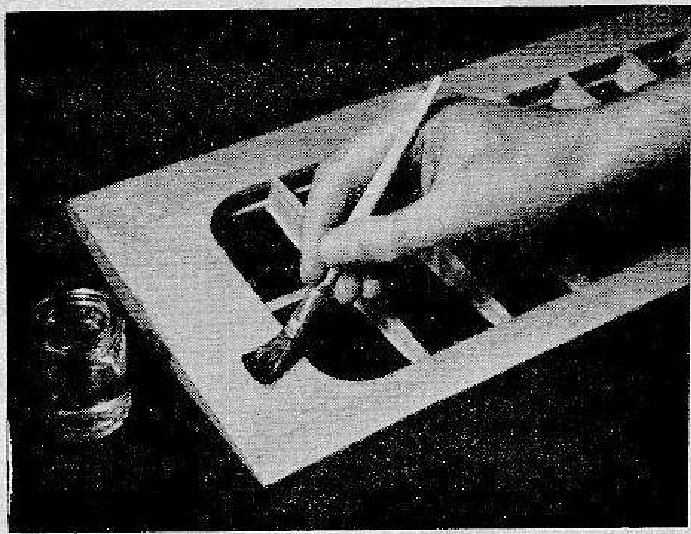


Left: Beginner's glider with profile fuselage. (Mercury Gnome kit.)
Below: Beginner's rubber-driven model with profile fuselage. ("Model Airplane News" magazine plan.)





Various types of model knives and the ubiquitous razor-blade.



Brushes. Buy good quality for doping the covering, but a cheaper variety is good enough for bare wood.

Second only in importance to balsa in helping us to make models quickly, cleanly and accurately, is the type of "glue" used—actually an extremely quick-drying cellulose cement. A simple butt-joint made with balsa cement is dry in a matter of a minute or two and hardens rapidly. Because of this, assembly can be carried out more or less continuously, there being no occasion to "wait for the glue to dry."

Covering materials consist of lightweight (Japanese) silk, nylon and various types of tissue papers, including the special tissues for model work, such as "Modelspan" (British) and "Silkspan" (American). These latter are available in special "heavyweight" grades for the larger types of power models.

Silk is not generally employed in F/F models weighing less than 2 lb., but can be used profitably (being stronger than the tissues) on C/L models of 20 oz. weight and upwards, and also on radio-controlled models. Nylon has the greatest strength and can be employed to great advantage on large R/C models.

These covering materials are attached to the framework with various types of adhesives, which will be described later. After covering, the material is water shrunk and is also "doped" to give it a smooth drum-like surface which, incidentally, also greatly strengthens and stiffens the structure, and renders it airproof.

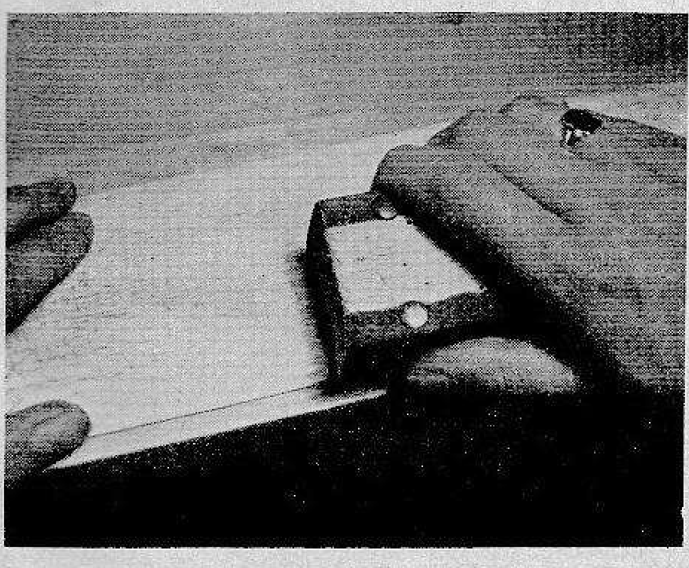
The model aircraft builder is fortunate in that his hobby requires the use of only a very modest tool kit.

To build an elementary kit model, for example, will require an old razor-blade or modelling knife, a small piece of sandpaper (sometimes included in the kit) and a brush for applying the dope. The use of a pair of pliers may be required if there are any small wire parts—such as towhooks—to be bent to shape.

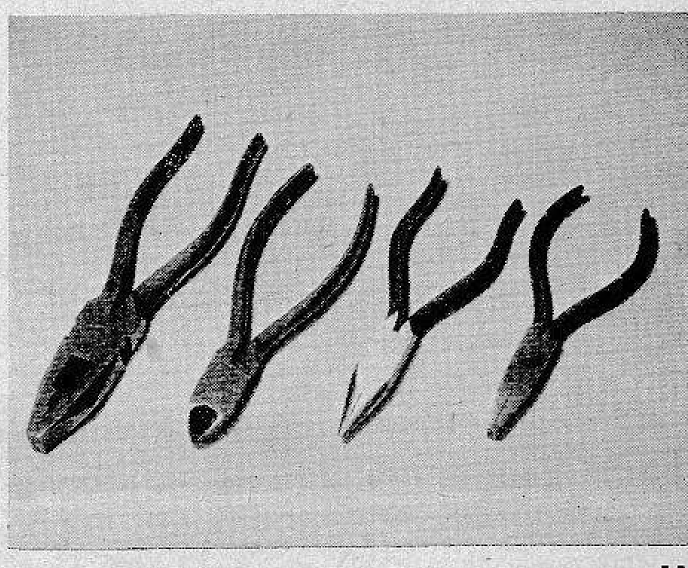
However, as the modeller progresses, especially if he begins to specialise in power models, a few simple tools will be found useful.

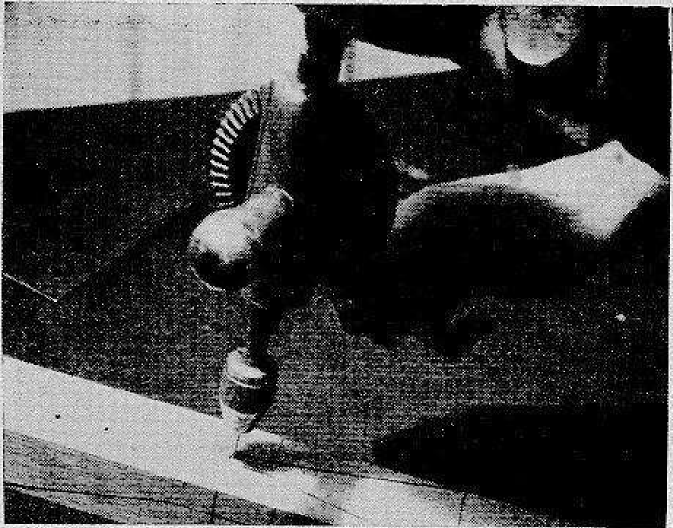
We have mentioned the razor-blade. This is, in fact,

Second in importance to the razor-blade, the sandpaper block.



Comb. pliers, side-cutting nippers, round-nose and flat-nose pliers.





A small hand-drill will be found useful.

still one of the most commonly used tools. Even if one possesses a most comprehensive range of modelling knives, the steel-backed single edged razor-blade is still one of the most useful items. However, for getting into corners and rounding sharp curves, a pointed blade is sometimes required, and here one of the wide selection of modelling knives, such as the "X-acto" series, "Studiette," "Ragg," "Multicraft" and "Swann-Morton" will be found very handy. Saws are seldom needed, but a useful tool for making straight, smooth cuts in block balsa or for cutting plywood and other harder materials is the "X-acto" razor-saw. Uses for a fretsaw or coping saw may occasionally be found.

A small supply of sandpaper of the finer grades is invaluable. In most cases, the sandpaper should be pinned around small blocks or strips of wood. For use on balsa, sandpaper blocks will usually take the place of files and rasps, although one or two small files will come in handy for use on metal parts.

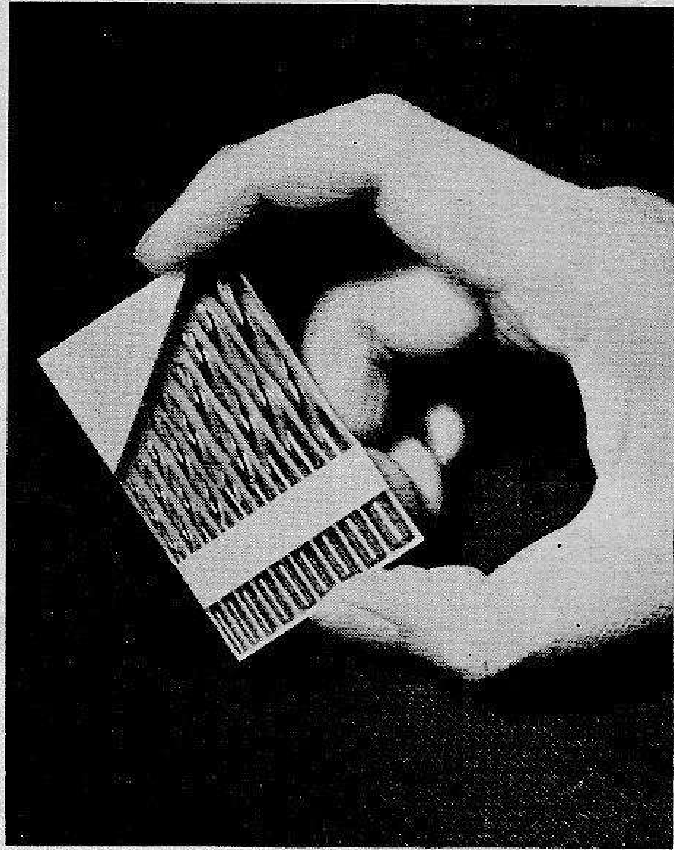
A small hand-drill, having a 1/4 in. chuck, is a worthwhile addition to one's tool kit. Drills should be of the smaller sizes, the most useful being 1/16 in., 5/64 in., 3/32 in., 7/64 in., 1/8 in., 5/32 in. and 3/16 in. Instead of buying these separately, it is possible to purchase, much more cheaply, a set of "short" modeller's drills.

Brushes for finishing should invariably be of the soft sable or camel hair mop type, but a cheaper kind can be employed for applying dope and grain filler to wood surfaces. One or two small artists' brushes are handy for applying decorative trim.

A bench vice is a useful item and, except for bending very heavy steel wire (such as for large power model undercarriages), one of the "universal" pattern, in which small parts can be held in almost any position for cutting, filing or bending, is a pleasing addition to one's gear.

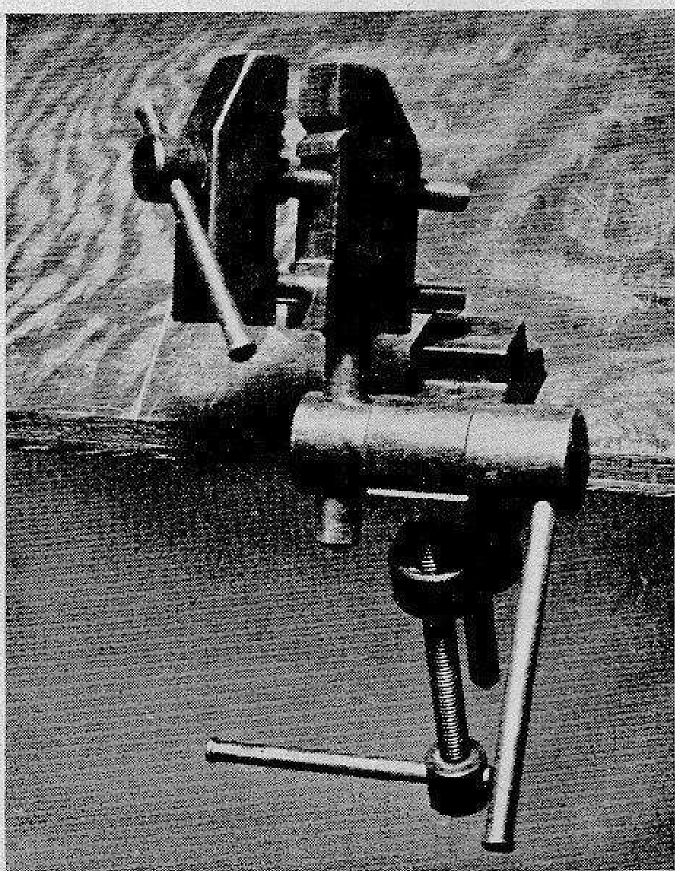
A good strong pair of combination pliers can generally be found in most households. Beyond these, a pair of round-nosed, or "radio," pliers are of great help in forming small wire fitments, and a worth-while luxury is a pair of really good side-cutting nippers which will bite through medium and thin wire cleanly.

If one later specialises in power driven models, one or two simple tools will be required for work on engine installations, etc., namely a small screwdriver and one or two small spanners (usually B.A. sizes in Britain) for engine mounting bolts, etc.

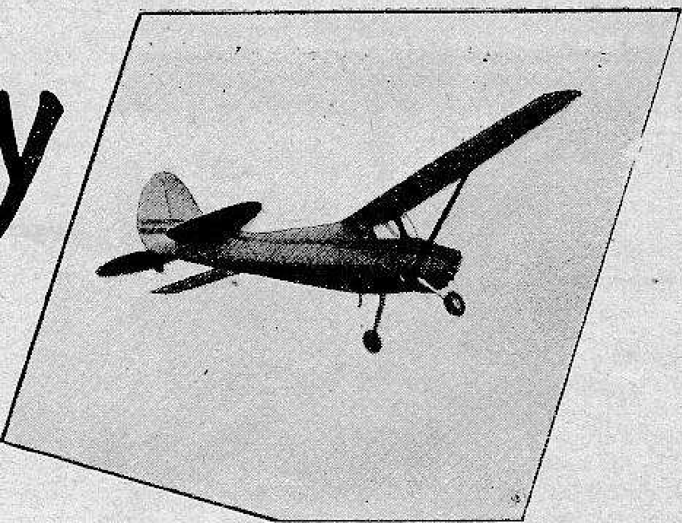


Above: A set of inexpensive short twist-drills suitable for model use.

Below: If a vice is to be obtained, the universal type shown is well suited to the model-maker's requirements.



Flight Simply Explained



CHAPTER THREE

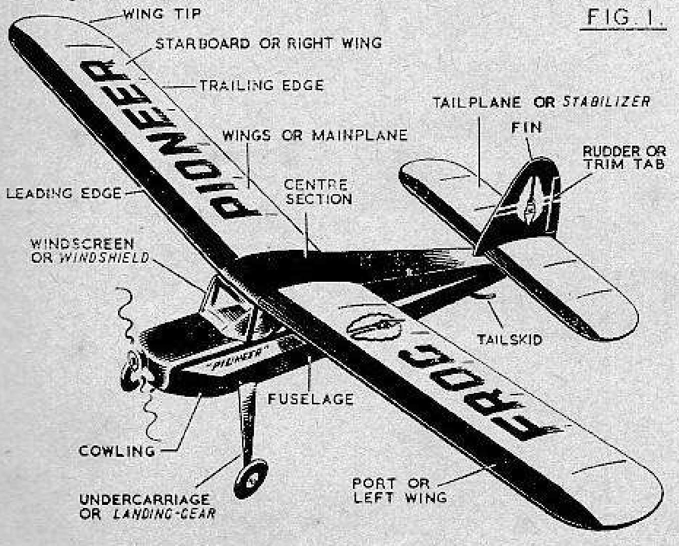
IN the previous pages, we described various types of models, building methods, materials and tools. In this third chapter, it had been our intention to go straight on to the building of an elementary glider. Instead, we have decided, at the risk, perhaps, of disappointing some of our new readers, to first introduce a chapter on the elementary mechanics of flight—in other words, to simply explain how the aeroplane flies.

Our purpose here is twofold. Firstly, it enables us to introduce to the reader the names of the various parts of an aircraft, so that he will be familiar with these without our having to explain them in later chapters. Secondly, as some idea of the basic principles which govern stable flight is essential if one's first effort is not to be quickly reduced to a pile of wreckage, this seems to be the best point at which to bring them forward; i.e. *before* building a model, so that, even if you do not thoroughly digest, now, everything we have to say here, and even though we shall not deal with detailed trimming adjustments until later, you will be forewarned on one or two points. Most newcomers to the hobby are anxious, just as soon as they have built a model, to go out and fly it without more ado, and one can, perhaps, forgive the over-enthusiasm which causes them to read about the hows and whys of flight only *after* they have attempted to fly a model.

In Figs. 1 and 1a are shown the names of the main parts of an aeroplane. In some cases, there are two or more names for the same part. This is often due to differences in British and American usage. For example, the landing wheels and struts are usually known in Britain as the *undercarriage*, but, in the U.S.A., *landing-gear* is the term more commonly applied. Similarly, the English *tailplane* becomes the American *stabiliser* or " stab." American seamen do not talk of " port " and " starboard " and these, which, like so many aviation terms, were derived from nautical terminology, have, in any case, become rather less commonly used in model aircraft circles, so that it is quite permissible, instead, to talk simply of " left " and " right."

In our hobby, too, there is considerable freedom in the use of alternative names for certain parts. A side strut between two longerons, for example, may be called a

Figs. 1 and 1a. The basic parts of a model aeroplane.



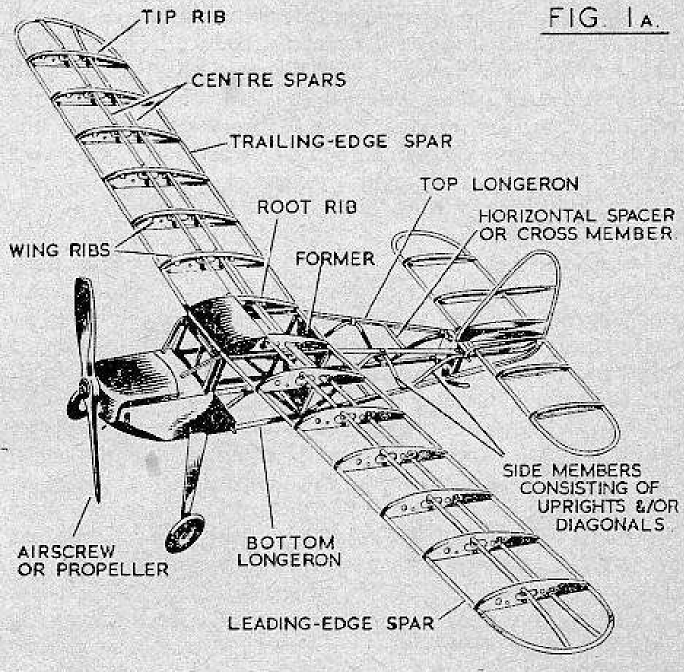


FIG. 2.

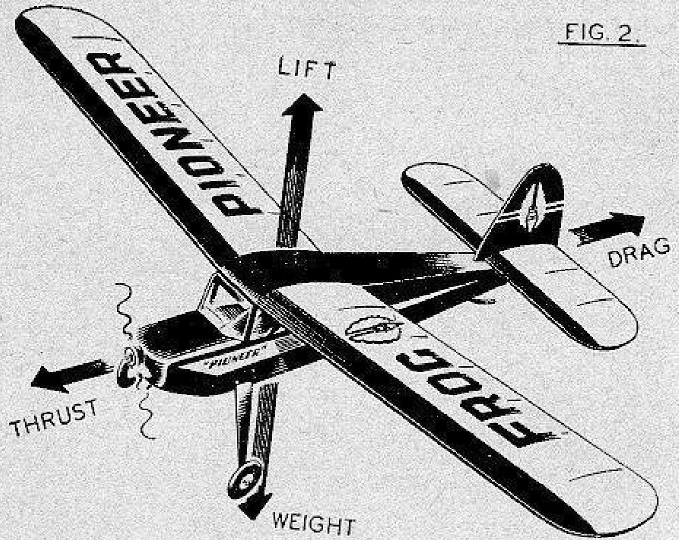
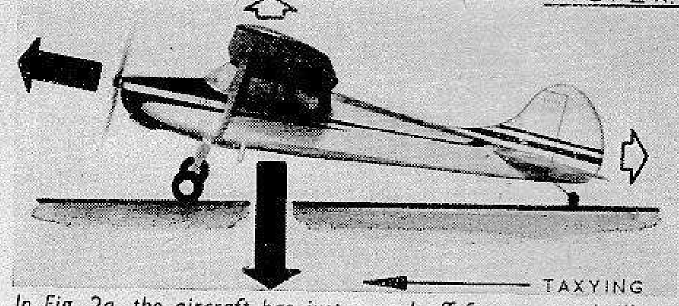


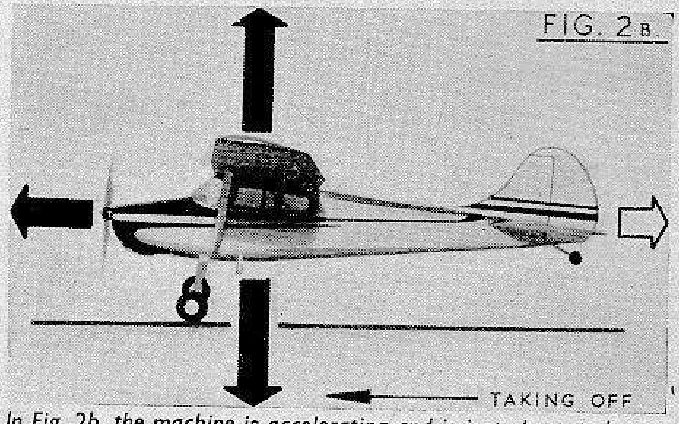
Fig. 2. The Four Forces. In steady flight, drag equals thrust and lift equals weight.

FIG. 2A.



In Fig. 2a, the aircraft has just moved off from a standstill and lift and drag are small due to low speed.

FIG. 2B.



In Fig. 2b, the machine is accelerating and is just about to become airborne.

FIG. 2C.

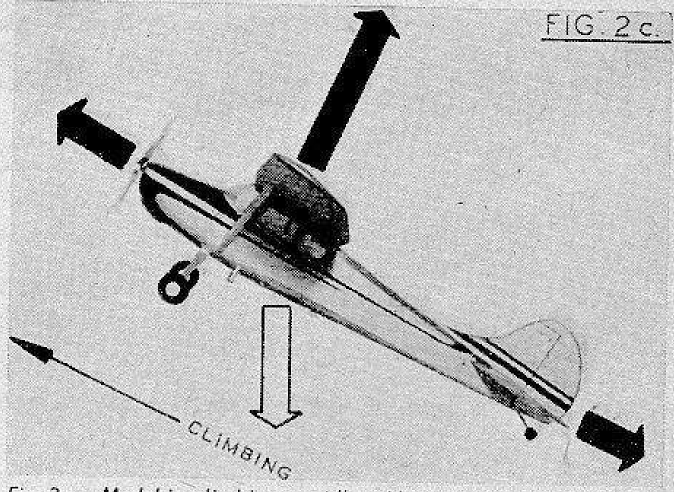


Fig. 2c. Model is climbing rapidly. Note that the "lift axis" is not truly vertical.

FIG. 2D.

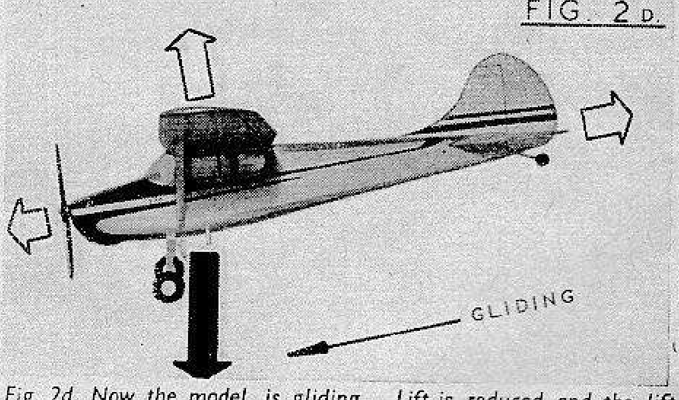


Fig. 2d. Now the model is gliding. Lift is reduced and the lift axis is inclined forward.

vertical spacer, an *upright* or a *side member*, or even variations and combinations of these terms. *Longerons*, however, which are main longitudinal members, should not be confused with *stringers*, which are light auxiliary longitudinals whose main purpose is to support the outer covering and preserve the external form of the fuselage or other component.

The Four Forces

We have said that this will be a chapter on the elementary mechanics of flight. What we want to do is to explain as simply as possible the basic principles of aeroplane flight without getting the reader too involved with aerodynamics. Any treatise on the first principles of aerodynamics usually starts off by describing, with the aid of diagrams, the reaction produced by moving a flat plate through the air and develops the theme from there. We have discarded this rather formal approach by starting, instead, with the four main forces acting on an aeroplane. From this we shall show how stability is obtained and we have illustrated the various points with photographs.

Fig. 2 shows the four main forces acting on an aircraft in flight. First, there is the *thrust* (produced either by an airscrew or jet motor) which moves the whole craft through the air. In opposition to this force is the *drag*, the resistance to forward movement produced by the air. Thirdly, we have *lift*, which is the upward force generated by the wings due to their movement through the air. Lastly, we have *weight* or the force of *gravity*, acting downwards.

In steady level flight, the forces of thrust and drag are equal and the lifting force equals the weight. Read this sentence again. Some people find it difficult to understand that this should be so and assume that thrust must be more than drag and that lift is more than weight. Let us explain in more detail.

When an aeroplane begins to taxi along the ground, the thrust is many times the drag and the weight many times the lift. (Fig. 2a.) As the aircraft moves faster, however, the differences are lessened. When a certain speed is reached, the lift equals the weight (Fig. 2b) and then exceeds it and, immediately this happens, the aircraft leaves the ground and begins to climb. Now that ground resistance is eliminated, the aircraft continues to accelerate until the drag equals the thrust. The speed will now

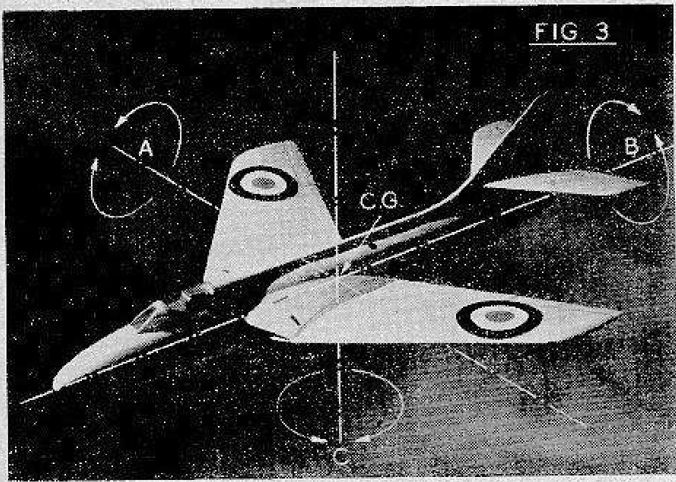


Fig. 3. The Three Axes about which Longitudinal, Lateral and Directional Stability are obtained.

remain constant and so will the rate of climb. Therefore, we now have thrust and drag equal, but the lift force greater than the weight. (Fig. 2c.)

Now here is the essential difference between a model and the flight of a full-sized aeroplane. Our model goes on climbing until the engine stops. The pilot of the full-sized aeroplane, however, who is usually interested only in getting from one point to another, levels out his aircraft and reduces his engine speed until lift equals weight and the aircraft flies at a constant speed and altitude.

Suppose now that the engine of our model stops. Thrust is lost. Drag will slow up the aircraft and lift will thus be reduced. Weight will now cause the machine to descend. Will it just plummet to earth? No, because drag will limit its speed and the wings will still generate enough lift to cause a gradual descent, i.e., a *glide*, provided that the aircraft continues to travel nose first and does not become unstable. (Fig. 2d.)

How is this stability ensured? For this we have to look to the Three Axes.

The Three Axes

Like every other solid object, the aeroplane has a *centre of gravity* (see Fig. 3) and whenever it points upward, downward or sideways, or rolls to the left or right, it does so with the centre of gravity as a pivot point. And so, for the purpose of studying stability, we declare the aeroplane to have three *axes*, marked *A*, *B* and *C* in Fig. 3.

Axis *A* is known as the *lateral axis*. The nose-up and nose-down movements that that aircraft makes with this line as a centre point are called *pitching*. Axis *B* is the *longitudinal axis* and when the machine banks left or right, this is called *rolling*. Axis *C* is called the *normal axis* or *vertical axis* and directional movements left or right are called *yawing*. Pitching, rolling and yawing. Once again, terms of nautical origin.

Longitudinal Stability

Now, our first requirement is longitudinal stability, which concerns pitching. A little confusing, perhaps, but we must remember that this takes place about the lateral axis—not the longitudinal axis.

We have seen that a wing produces lift when moved through the air. The amount of lift it produces depends primarily on the speed at which it travels and its angle to the airstream, called the *angle of attack*.

Now, there is a point, relative to the width or *chord* of the wing, through which the lifting force is concentrated. This is called the *centre of pressure*. The position of the centre of pressure is not constant. At a zero angle or very low angle of attack, the centre of pressure is near the mid-chord point. At high angles of attack it is nearer to the leading edge. At negative angles of attack, the centre of pressure moves towards the trailing edge.

We can see that this presents rather a problem.

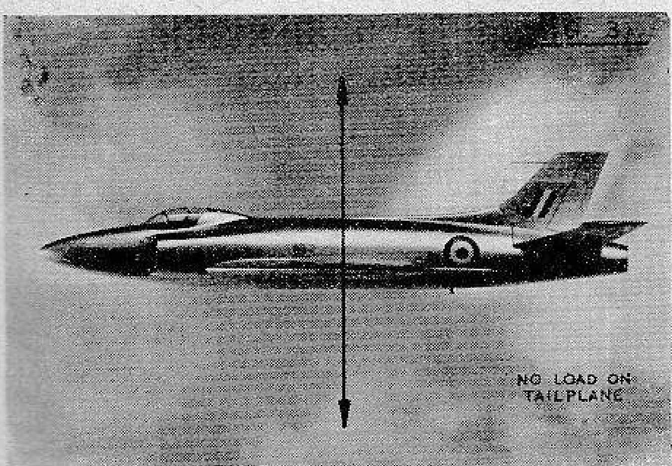
Let us suppose that we have balanced the aeroplane so that the centre of gravity is immediately below the centre of pressure at the required angle of attack. The two opposing forces are now in equilibrium: the lift directly opposing the weight.

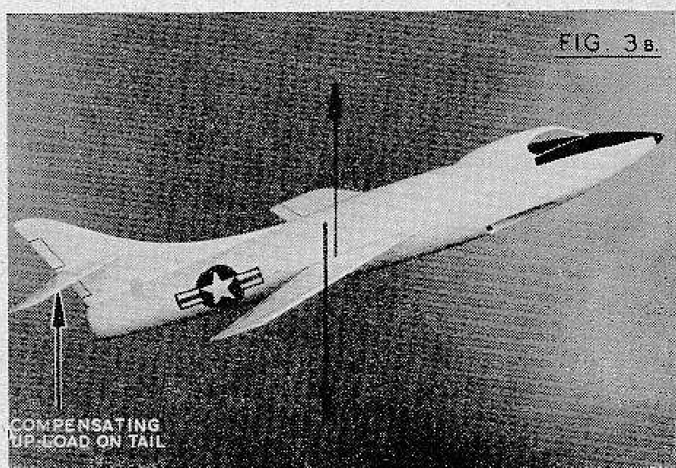
However, if anything occurs to alter the angle of attack, i.e., if the aeroplane pitches, stability will be lost. If the nose rises, the centre of pressure will move forward in front of the c.g. *and thus tend to lift the nose still more*, in turn causing the centre of pressure to move yet farther forward, so that the wing will tend to rotate completely and turn the aeroplane over on its back.

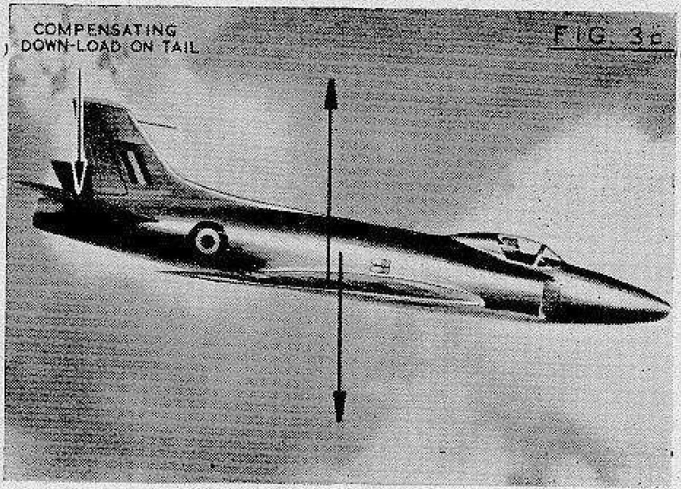
This is where the *stabiliser*, as the Americans so sensibly call it, or *tailplane* comes to the rescue. The tailplane is merely another, much smaller, wing attached to the rear end of the fuselage, to *stabilise* the main wing.

In constructing our aeroplane, we can now mount the wing on the fuselage at a suitable *rigging angle*, or *angle of incidence* so that, in normal flight it is inclined at such an angle of attack as to produce the required amount of

In Fig. 3a, we see steady flight with the centre of lift immediately above c.g. In Fig. 3b, the nose has been deflected upward, resulting in the centre of lift being moved forward. Upward corrective force by tailplane restores balance.







In Fig. 3c, nose is deflected downward. Centre of lift moves back. Downward corrective force by tailplane restores balance.

lift. We can then arrange that the c.g. should approximately coincide with the centre of pressure at this angle of attack and we mount the tailplane at zero degrees so that it merely " floats " in the airstream. (Fig. 3a.)

Now, suppose that flight conditions are disturbed in such a way that the nose is raised. As before, the centre of pressure of the wing moves ahead of the c.g. and tries to make matters worse. But now, our tailplane, which, hitherto, has had no hand in the proceedings, is also inclined at a positive angle and also begins to generate lift. And because it is situated at the end of the fuselage, it exerts great leverage which, acting through the lateral axis, restores the aircraft to level flight. (Fig. 3b.)

Conversely, if the nose of the aeroplane should drop, the tailplane will now assume a negative angle and generate a downward load behind the lateral axis, thus restoring level flight again. (Fig. 3c.) And so we have achieved longitudinal stability.

Lateral Stability

Lateral stability is achieved in quite a simple manner. If you look at an aeroplane head-on, you will see that the wings are not usually horizontal from tip to tip, but are inclined upwards at the tip to form a shallow *dihedral angle.* (Fig. 3d.)

Now, it is not too difficult to grasp the fact that the more we incline the wings upward like this, the less will be the lift in a vertical direction that they generate. However, a roll to right or left also causes a sideslip in the direction of the roll. This is due to the fact that a small sideways force is introduced by the entire lift being inclined sideways instead of acting in direct opposition to gravity.

Dihedral now acts as the correcting force. In moving sideways as well as forwards, the lower surface of the wing presents considerable resistance to the inclined airstream and thus tends to roll the aircraft back on to an even keel.

Directional Stability

The basic method of ensuring directional stability is to place more side area behind the vertical axis than in front of it. This is the reason for fitting a vertical tail fin. The principle can be likened to that of a weather vane.

When an aircraft is thrown off course and yaws to one side, it continues momentarily in the same line of flight and is therefore flying slightly crabwise. Thus, the airstream is striking one side of the aeroplane and, in striking the considerable area of the fin, the machine is turned back in line with the direction of flight, just as a weathervane is swung into the airstream when the direction of the wind changes.

The C.G. and How to Find it

Some modelling wag once wrote a treatise picturesquely entitled (if memory serves correctly) " The Elusive Cee-Gee Crittur " . . . Facetious comment on how to find the c.g. and what to do with it when you have found it are legion in modelling circles. Every sort of humorous suggestion—from imprisoning the c.g. in a matchbox and hanging it from the undercarriage, to doing away with it altogether—has been put forward.

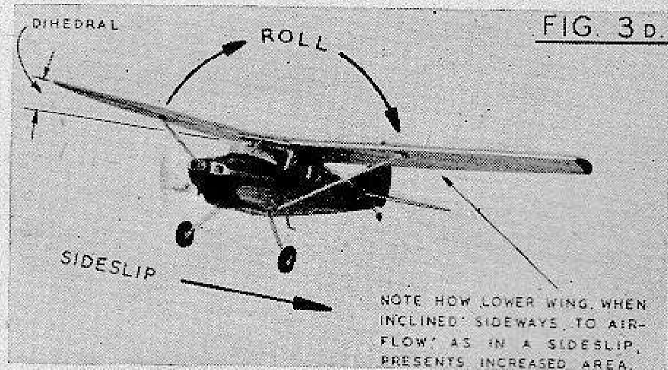
But, seriously, as we have said, every solid object has a c.g. and, so far as aircraft are concerned, we usually need to know where it lies. It is the first thing we need to determine, for example, before we attempt to fly a new model, when, if necessary, we ballast the model in order to re-locate the c.g. according to the design requirements.

When talking of models, one frequently refers to the position of the c.g., relative to the wing chord; for example: " 40 per cent. chord," meaning that the c.g. is vertically in line with a point four-tenths of the distance back from the leading edge. The simplest way of finding out whether a model is correctly balanced longitudinally is, in fact, to lift it with the finger tips placed in the appropriate position under the wing. However, this establishes the balance in one dimension only and, though we may assume that the aircraft is properly balanced about its longitudinal axis, we still do not know the vertical position of the c.g. It is sometimes desirable to know this precisely, especially, for example, when determining the tow-hook position on a glider. The process is simple and is as follows.

Firstly, hang up the model slightly in front of the estimated balance point. The machine will hang at an angle, tail downward. From the point of suspension, draw a vertical pencil line down the side of the fuselage—preferably with the aid of a simple thread plumb-line.

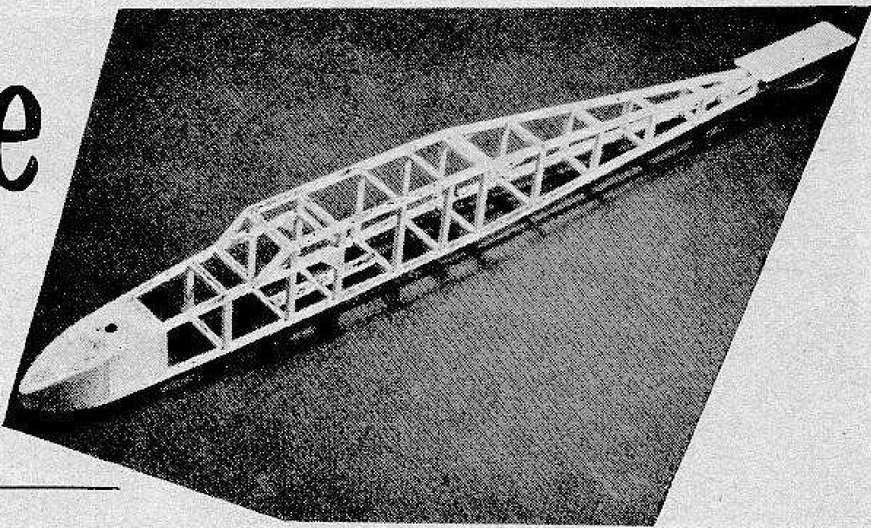
Now suspend the aircraft from a point rearward of the estimated balance point. The model will now hang at an angle, nose downward. From the point of suspension, draw another vertical pencil line down the side of the fuselage.

Where these two lines intersect, establishes the c.g.



In Fig. 3d, we see how the lateral dihedral angle of the wings maintains lateral stability. (Models used in photographs for this chapter: Keilkraft " Cessna 170," Jetex Hawker " Hunter," Supermarine " Swift " and Douglas " Skyrocket.)

Making the Fuselage



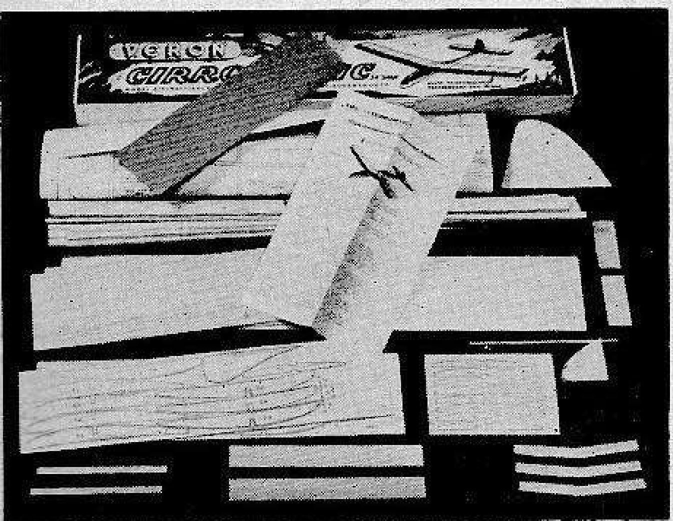
CHAPTER FOUR

THE most widely used form of fuselage construction is the simple box framework. For rectangular section fuselages, it is the standard method employed and is also commonly used where other cross-sectional shapes are involved. In the latter case the addition of stringers, with or without extra formers, over the basic box structure, completes the skeleton framework.

There are, however, many other types of construction—in fact, the variety is almost limitless. Popular in the early days of model aeroplanes was the "stick" or "spar" model in which the "fuselage" was nothing more than a thin wooden stick. Nowadays, equivalent simplicity is obtained with "profile" models, the fuselage consisting merely of thick sheet balsa wood cut to a suitable side view shape. There are also variations on this idea, one example being the Mercury *Gnome* glider in which the nose part of the fuselage is built up as a flat outline of $\frac{1}{8}$ in. × $\frac{3}{8}$ in. balsa sandwiched between two $\frac{1}{16}$ in. sheet balsa sides, but with a solid spar tail boom. A little more advanced is the system used on the Veron *Cirro-Sonic* in which the complete fuselage is made up of a simple framework of $\frac{1}{8}$ in. × $\frac{3}{8}$ in. strips assembled on edge over the plan and then covered by $\frac{1}{16}$ in. sheet balsa sides. This produces a very strong structure, is easy to build and has a better appearance than the normal profile fuselage. The *Cirro-Sonic* kit is, in fact, an excellent choice for a first or second model. It is easy to build and, with a wing area of over 200 sq. in., a good performance is assured if reasonable care is taken to build accurately.

Another form of fuselage construction is the semi-sheet balsa type, which uses sheet balsa sides connected by formers and cross members. Popular with some designers is "crutch" construction in which a flat base structure of two longerons and a number of cross members is first built up and to which is then added formers and additional longitudinal members.

The "backbone and half-former" method of construction is a short step from here and consists of top and bottom "backbone" and "keel" members to which are added half-formers and stringers. Alternatively, the half-formers can be "planked" or sheet covered with thin strips or sheets of balsa. Similar to this is the method of semi-prefabricated construction now used for flying-



The 34-in. Veron Cirro-Sonic, a well-produced kit which builds up into a simple but high-performance glider.

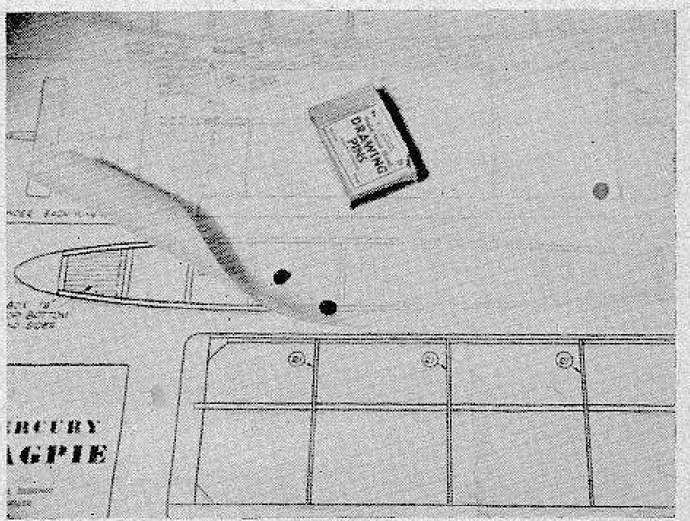


Fig. 1. Cover plans with translucent waxed paper to prevent frames adhering to them.

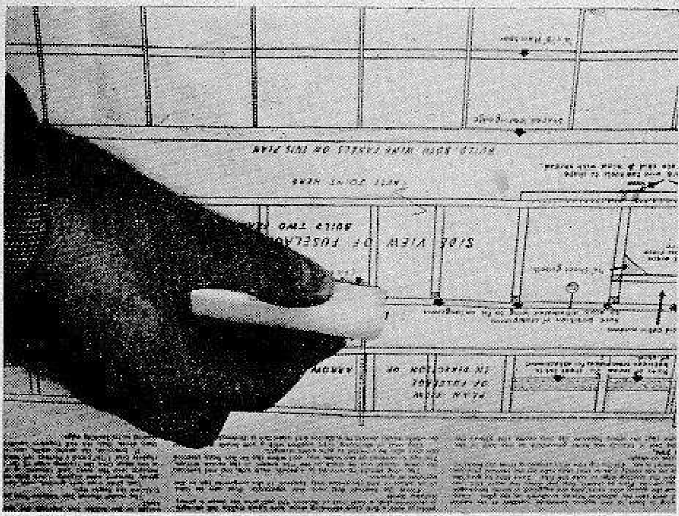


Fig. 2. An alternative method to Fig. 1 is to rub the drawing with candle wax or soap.

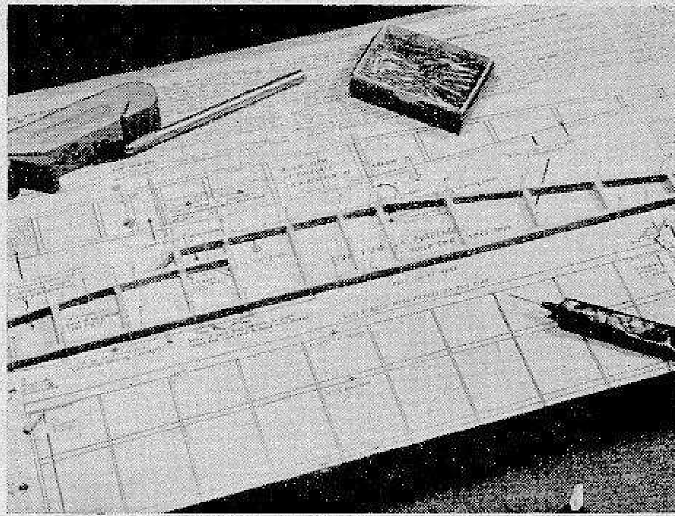


Fig. 4. After fitting the spacers, the second side of the fuselage is built over the first.

scale models by some British and American kit manufacturers, in which moulded sheet balsa shells form complete fuselage sides. For some types of C/L models, hollowed block balsa is used.

As we have said, there are countless different types of fuselage structures, all using balsa. The variety is even further expanded when we take into account the metals and glass-fibre-plastics used by some designers.

In this chapter on basic fuselage construction we have chosen the simple built-up box frame for our photographic sequence for two main reasons. Firstly, as we have said, it is the type of structure most commonly encountered by the model builder. Secondly, while we are admittedly concerned at this stage with your first model, which should obviously be a simple one, no very useful purpose would be served by devoting our space to a profile or similar ultra-simple fuselage since our main object is to equip the reader with sufficient knowledge to enable him to tackle, eventually, the more advanced models that may appeal to him.

Building a Box-frame Fuselage

Our photograph sequence is based on a typical beginners' built-up glider of orthodox design, the 30-in. span Jasco *Tutor*. Representing good value at only 6s. 5d., the kit contains all necessary materials, including cement and tissue.

As with all fuselage structures of this type, the two sides are first built and then joined together with the top and bottom cross members. The sides are built by pinning the wood strips to the side view of the drawing of the fuselage, the drawing being secured on a flat surface.

The first requirement, therefore, is a building board (unless you have a bench or table top into which it is in order to knock pins). The most suitable material for a building surface is a piece of well-seasoned, planed softwood, such as pine, which is free from warps and is at least ½ in. thick and preferably ¾ to 1 in. A piece 8 or 9 in. wide and 3 ft. long will suffice for all but the largest models.

Fix the drawing to the board with drawing pins or cellulose tape. Leave an area of the board exposed for a cutting surface (to avoid slicing holes in the plan with your modelling knife or razor blade) or, better still, have a piece of cardboard handy for this purpose. Don't use hardwood as this will soon dull the edge of your tools.

To prevent the frame sides sticking to the drawing where the cemented joints are made, it should be pro-

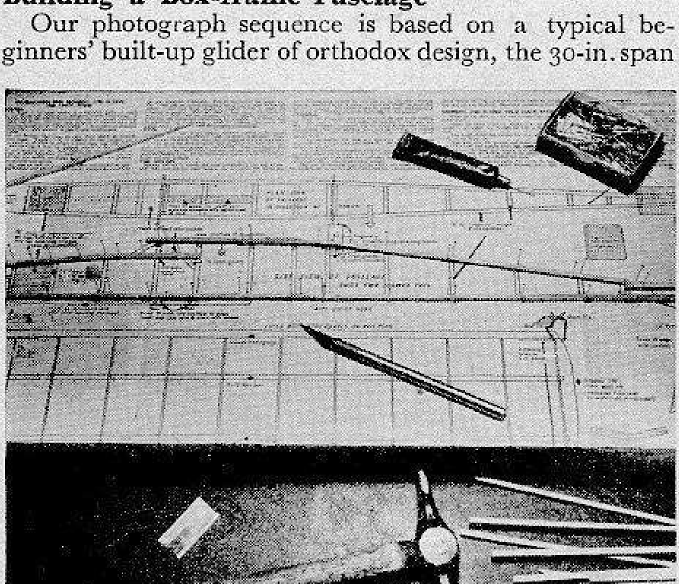


Fig. 3. Position the longerons on the drawing with pins either side of the strips.

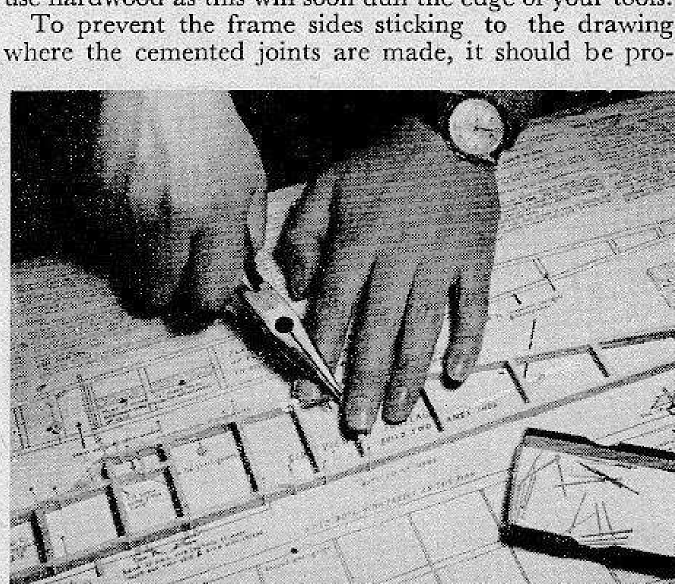


Fig. 5. Hold the structure down firmly when removing the pins from the building board.

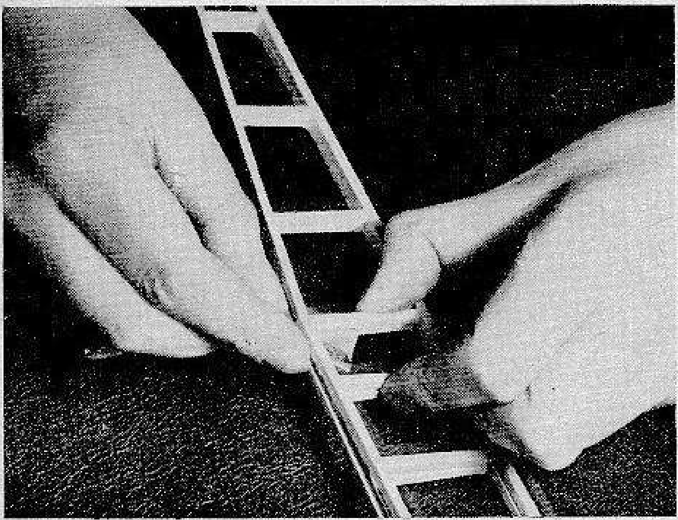


Fig. 6. The two fuselage sides should be carefully parted with a razor blade.

tected with a sheet of translucent waxed paper over the section on which you are working. (Fig. 1.) Alternatively, a thin protective film can be rubbed on the drawing at these points with a candle (Fig. 2) or a piece of soap.

In most kits there is some variation in the hardness of the balsa strips supplied. Before starting the construction, therefore, sort out the fuselage strips, selecting the harder material for the longerons and front spacers and setting aside the softer material for the tail end. Try to select strips of equal flexibility for the longerons, as this helps to make for accuracy of alignment. Hardness and flexibility can be tested by finger-nail pressure, and by holding the strips at one end and gently waving them up and down to observe their bending tendencies. (Although these methods may seem to be somewhat "rule of thumb," they do with practice become quite reliable methods of selection.)

Another thing to watch is that the strips are of equal thickness, for, although $\frac{1}{8}$ in. sq. strip should, of course, by $\frac{1}{8}$ in. × $\frac{1}{8}$ in., this is not always the case; there can be fractional differences between the dimensions of nominally identical sizes. Small differences of this nature, although unimportant individually, tend to build up into larger errors in the final assembly.

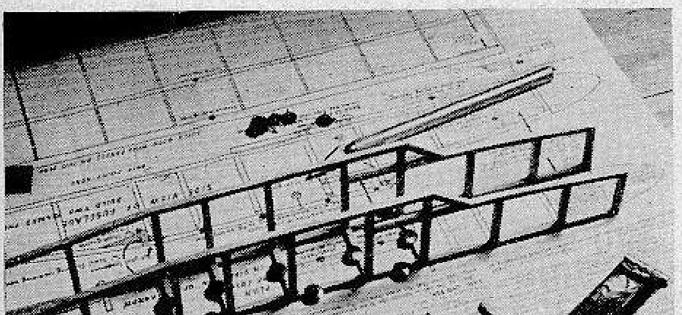


Fig. 7. Erecting the fuselage sides vertically on the plan view and inserting the spacers.

The method of setting the longerons on the plan is to position them with pins either side of each strip. (Fig. 3.) Ordinary 1 in. plated household pins, which can be knocked in with a small tack hammer, or special bead-head modelling pins can be used. Pins should be used on the outside of the longeron at each spacer station as well as where bends occur. Place the inside pins near to the positions of the outside ones where the longerons are straight, in order to avoid any risk of distorting them.

Longerons can usually be bent to conform with mild curves, but if any difficulty is experienced with more acute bends, they should be pre-formed by steaming. Take the two longerons, bind them lightly together with cotton and steam them over a kettle, gently bending the curves where needed.

Fuselage spacers are invariably butt-jointed to the longerons and should be cut in pairs so that an identical set is available for the second side. For the actual cutting, there is nothing better than the ordinary steel-backed single-edged razor blade. The accepted method is to hold a length of strip across the longerons in the required position for the spacer and make shallow preliminary cuts with the razor blade held at the desired angle, then

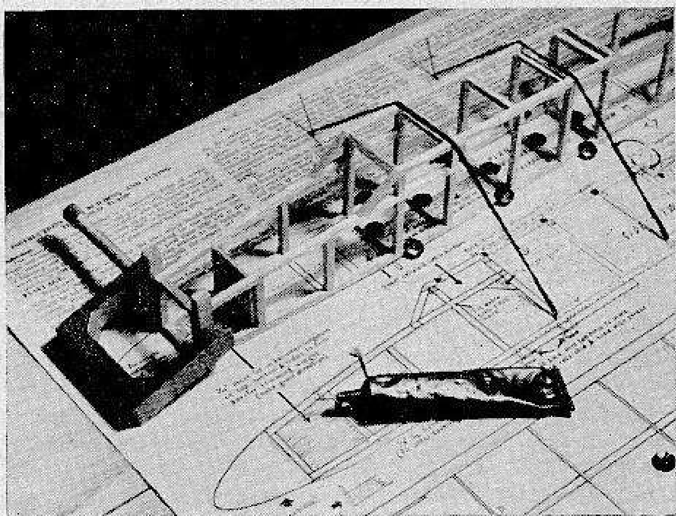


Fig. 8. Using rubber bands to assist alignment and an X-acto clamp to hold the nose section.

to slice through vertically on your cutting surface. After checking the fit of the new spacer, a duplicate is cut, using it as a pattern.

In making a butt joint, particularly where (as in the case of spacers to longerons) end-grain surface is involved, the surfaces should always, in the interests of strength, be "pre-cemented"—i.e. a coating of cement should first be applied and allowed to dry before applying a second coat and fitting the parts together. Make sure that the spacers are inserted squarely and flush with the longerons.

When the fuselage side has been completed, do not remove it or the pins from the plan but, instead, build a second side on top of it. Make sure the pins are secure and vertical and then insert the longerons of the second side. Here you may either insert small scraps of waxed paper between the sides, where the spacer joints occur, to prevent their sticking together, or you may omit these and slit the sides apart afterwards with a razor blade as in Fig. 6.

When both panels are completed, leave them pinned down to the board for half an hour or so, in order to let

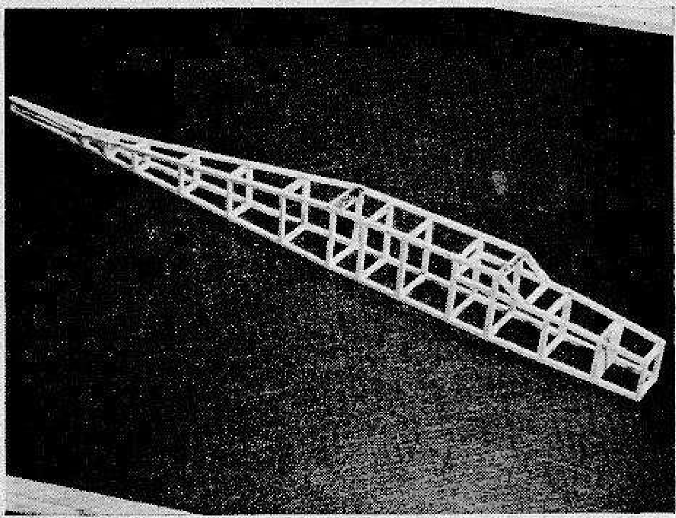


Fig. 9. The basic framework removed from plan when dry.

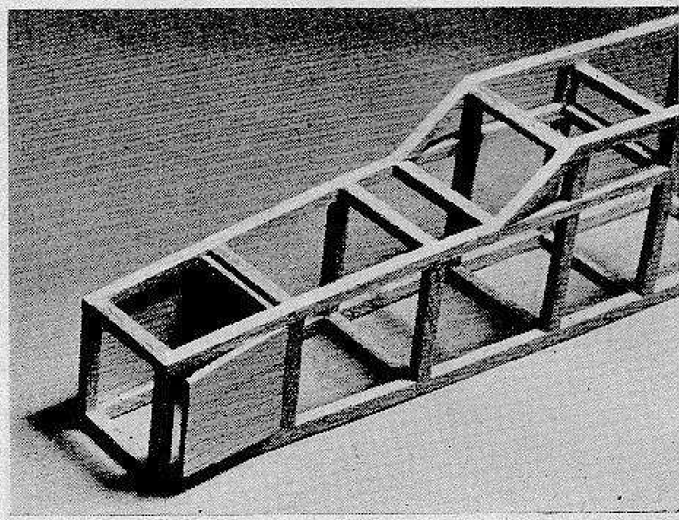


Fig. 10. Fitting the sheet balsa fill-in panels to the nose section

the whole assembly set hard. Meanwhile, the upper and lower spacers may be cut, using the plan view of the fuselage to obtain the correct lengths. When the fuselage sides are ready to be removed from the plan, first withdraw all the pins with a pair of pliers, placing a finger on each side of the longeron to avoid risk of lifting and damaging joints. (Fig. 5.) The next stage is important and it is advisable to constantly check for accuracy.

First erect the sides vertically on the plan using drawing pins, as in Fig. 7, and cement the widest bottom spacers in position. You can, if you prefer, erect one side only and cement the spacers to this side before adding the second side. Now drive two pins into the building board at an angle, 2 or 3 in. either side of the fuselage as shown in Fig. 8. Insert at least two of the top spacers at this position and then stretch two long rubber bands across the fuselage and over the angled pins.

By carefully adjusting the tension of the rubber bands on each side, it will now be possible, with the aid of a set-square, to get the two sides absolutely upright and true. Use plenty of cement around the joints at this time.

Now cement the tail end together and insert the remaining spacers, working towards the tail. The nose section is left till last, being usually the most tricky part, because it has to be drawn in more sharply, and so the rest of the structure is stiffened up as much as possible first. When cementing in the nose spacers (sometimes a sheet balsa former or bulkhead is fitted, too) it is helpful to have a clamp to hold the sides in while the cement dries. An "X-acto" clamp is handy here, Fig. 8.

Once again, allow the joints to set hard before removing the structure from the plan and, before removing it, sight through the fuselage to make sure that all cross members are in line. If any of them should be out of alignment, the joints can be sliced through with a thin razor blade and recemented. It is a good idea at this stage, incidentally, to add a minute fillet of cement in each right angle formed by the spacers and longerons.

Quite often the front bay of a rectangular section fuselage is boxed in for added strength and/or to provide a ballast weight compartment. Fig. 10 shows how to do this, the sheet balsa being accurately cut to fit flush.

Finally, the noseblock can be fitted. First lightly cement the block in position and mark the required outlines with a ball pen or soft pencil. (Fig. 11.) The block can then be roughly sawn or carved, then recemented in position and sandpapered to the precise shape. A sandpaper block, such as the "X-acto" illustrated (Fig. 12), or one improvised from a small block of wood, is necessary here.

Fig. 11. Marking the noseblock, which is then roughly sawn or carved to shape.

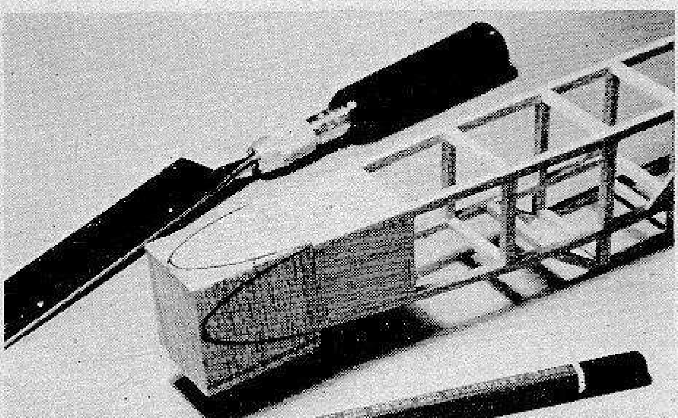
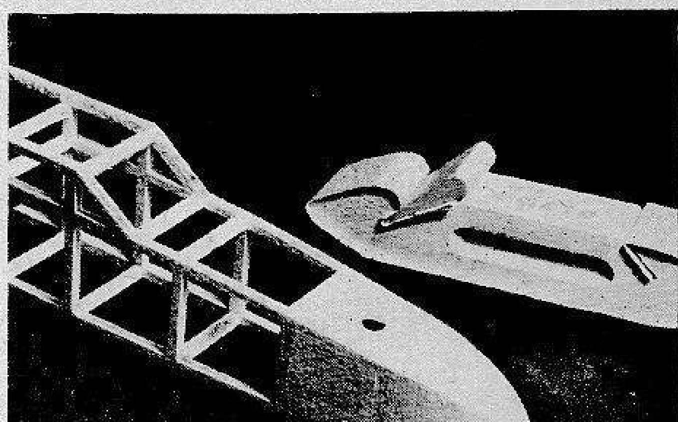
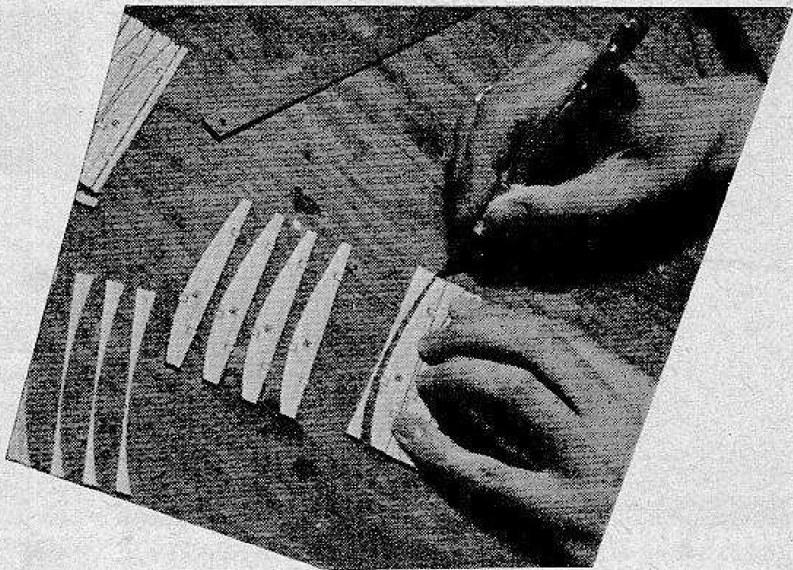


Fig. 12. Final shaping is effected with a sanding block. Hole is for lead shot ballast.



Building the wings and tail



CHAPTER FIVE

ONE of the essentials of a beginner's model is a robust and easily constructed wing and tail unit design. Another is that the wing and tail are built accurately. A model will never perform satisfactorily with warped flying surfaces. Therefore, having chosen a model design with a simple but strong framework, every effort should be made to assemble it carefully and accurately.

It would be a mistake to suggest that any one part of a model aeroplane requires less care and attention than another, but one of the reasons for beginning your first model with the fuselage is that it gives you the initial experience in simple assembly procedure which is of especial value when constructing the wing and tail. The fuselage must be as well built as you can possibly make it, as it is the component to which all the other parts of the model are attached. Having done this, redouble your efforts to make a good job of the flying surfaces.

As with the previous chapter on fuselage construction, the photograph sequence is based mainly on the Jasco *Tutor* beginner's glider which is of 30 in. wing span.

The first thing to do is to prepare the wing ribs. When building from a kit, the ribs will be supplied in one of three forms. Firstly, they may be printed on sheets of balsa wood, thus requiring to be cut out with a razor blade or modelling knife. Alternatively, instead of being printed, the sheets may be die-cut, requiring only that the ribs be pressed out (although possibly requiring to be released, here and there, by application of the model knife) or, thirdly, the ribs may be supplied ready made and finished.

One of the first requirements of accurate wing construction is that all ribs should be absolutely identical. This does not merely apply to the outline shape. Just as important, if not more so, is that they are all exactly the same length (assuming the wing to be of the parallel chord type) and that the positions of the spar slots are the same on all ribs.

In some kits having printed or diecut stock, the ribs are positioned exactly one above the other on the sheets. In this case, you can make sure that the lengths of the

Fig. 1. Using a chisel-point knife for cutting spar slots in ribs.

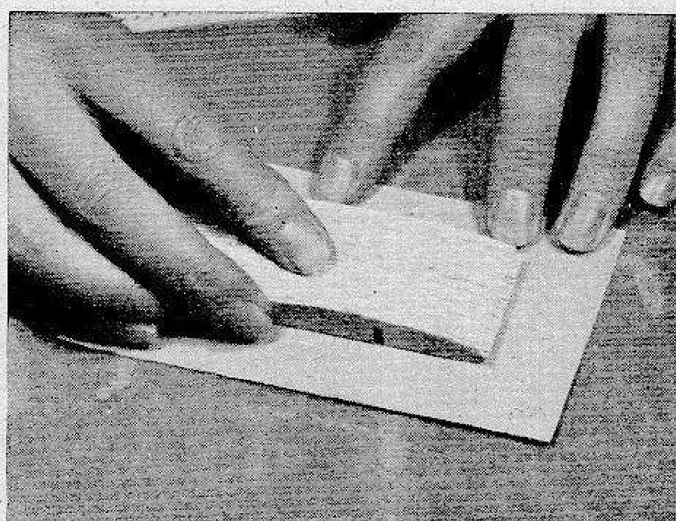


Fig. 2. Smoothing down a block of ribs on a sheet of sandpaper.

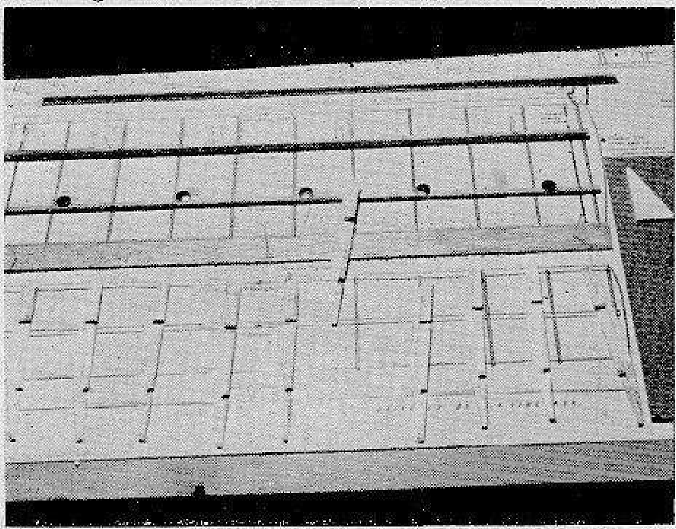


Fig. 3. Laying out the spars on the plan, ready to receive the ribs.

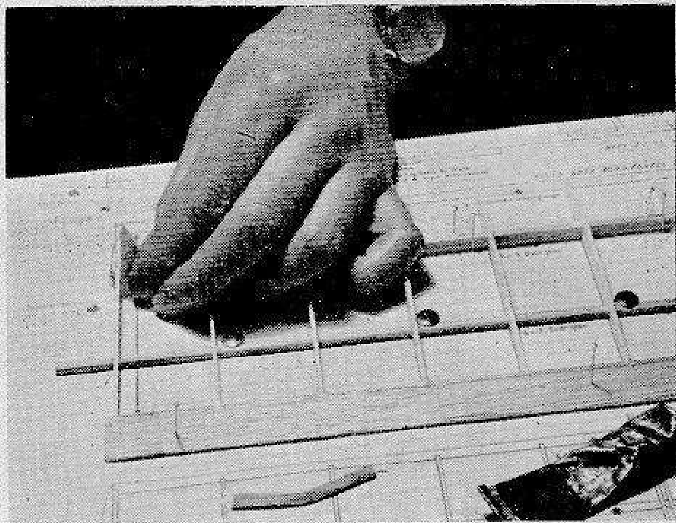


Fig. 4. Using a sheet balsa template to align the centre section rib.

ribs are identical by slicing straight across the sheets against the grain, with the aid of a straight-edge. Use the straight-edge, too, when cutting the flat bottom surface although the cambered top must be cut free-hand.

Spar slots on printed wood can be cut in two ways. If you are satisfied that they are marked accurately, they can be cut individually as in Fig. 1. Here it is useful to have a chisel-point blade in your knife, such as the "X-acto" No. 17 blade.

Alternatively, all the ribs can be pinned together in a block and the spar slots made by cutting them *en masse*, preferably with a razor saw. In any case, it is a good idea to pin the ribs together for final shaping (especially if the die-cutting is not very clean) so that they can be smoothed down on a level surface (see Fig. 2). Where ribs are supplied ready finished, this is not, of course, necessary.

As in the case of the fuselage, the drawing is pinned or taped down to your building board. Incidentally, make sure that the drawing is pulled out flat in order to avoid any wrinkles or ridges that would prevent the framework from lying perfectly flat. The same applies to the waxed paper covering if you should use this method of protecting the plan instead of rubbing with candle wax or soap. It is usual, with most models, to build the wing in two halves, which are then joined at the centre section after assembly.

Position the centre spars on the plan with pins either side of the wood and check the fit of the ribs on them. The slots should be a close but easy fit. (If the fit of the ribs is excessively tight—especially if the spar is a deep one—there is a danger of the ribs being bowed upward when removed from the plan. Alternatively, if the slots are too big there is a danger of the cement causing the gap to shrink so that the ribs will tend to be bowed downward. Do not omit to check, also, the fit of the leading edge spar against the nose of the ribs.

With some wing designs, the ribs are let into slots in the trailing edge spars. If this should be the case, the trailing edge should first be marked and slotted (a small file is useful here, although a steel backed razor blade can be used) and then pinned in position on the plan. Incidentally, it is quite permissible to pin *through* the wood in the case of trailing edge stock as it is wide and will not split easily (Fig. 3).

The next step is to position the ribs on the spars as indicated on the drawing. Pre-cement them and then cement each in position securely, making sure that it is upright and that it is well pressed down so as to make contact, all along its bottom edge, with the building board.

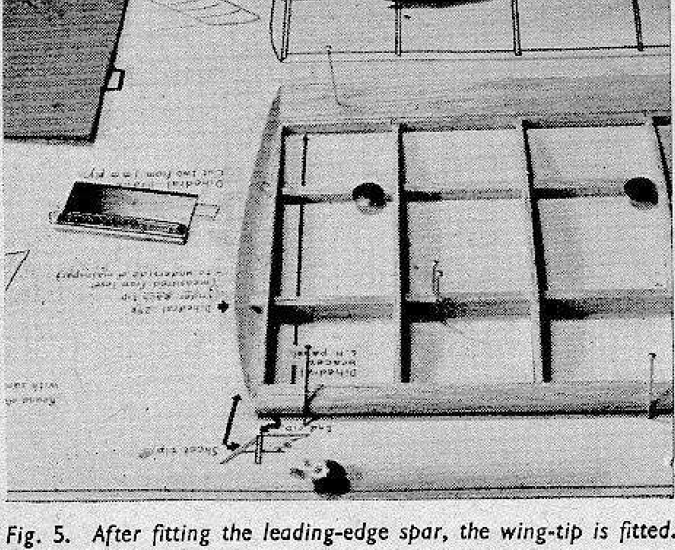


Fig. 5. After fitting the leading-edge spar, the wing-tip is fitted.

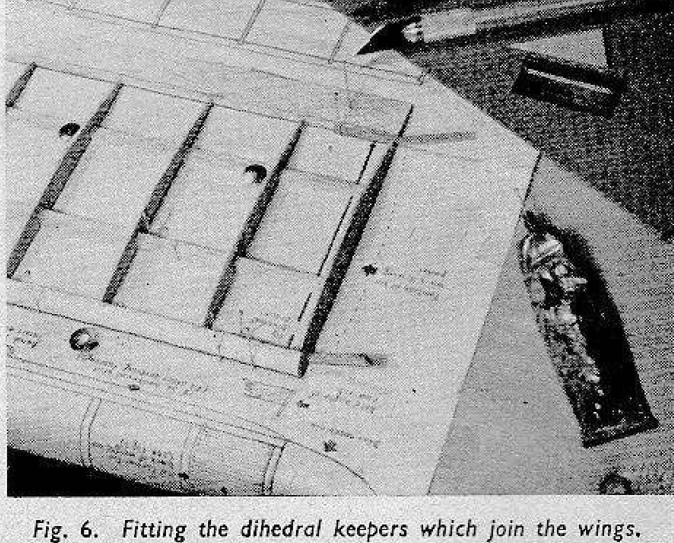


Fig. 6. Fitting the dihedral keepers which join the wings.

Usually, root or centre section ribs are inclined slightly so as to be vertical when the wing panels are raised to the correct dihedral angle. Therefore, it is a good idea to make a simple sheet balsa template against which the rib can be tilted to give the correct slope, as in Fig. 4.

When all the ribs are in position, the leading edge spar may be fitted. Many kits nowadays contain ready shaped leading edges. In others a square (usually set on edge) or oblong section spar is used. In the latter event, the strip may be roughly rounded off before fitting, but it is more usual to leave this until the wing is completed and has been removed from the plan, when the leading edge can be carefully shaped up with a sanding block as in Fig. 9 (Mercury *Magpie* model).

Wing tip construction is in various forms and the inclined sheet balsa type tip as shown is only one of many. In general, however, this blunt type of wing tip is more widely favoured, especially for elementary models, due to its greater strength and simplicity. The sheet tip should be finally shaped up with a sanding block after fitting.

Some means of connecting the two wing halves together and at the correct dihedral angle is, of course, necessary. On some small models, the two panels are merely butt jointed at the centre with plenty of cement. Usually, however, it is necessary, in the interests of strength and accuracy, to connect them by means of dihedral braces or " keepers," which are shallow V-shaped plates of plywood (sometimes balsa on light models). These go through the centre ribs and are cemented against the spars. Fig. 6 shows how these are attached to one panel of the *Tutor* wing.

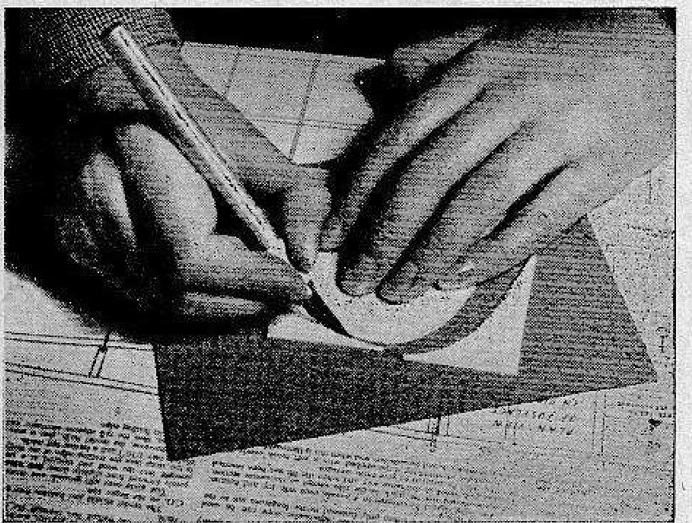


Fig. 8. Cutting out the tail fin and rudder from $\frac{1}{16}$ in. sheet balsa.

When both wing panels have been built, it is a good idea to leave them pinned down to the building board for as long as possible, or for at least half an hour following the completion of the second panel. The first half wing should be set by this time and can be removed from the plan ready for joining to the second panel, which can be left pinned down. Cut away the root rib where necessary in order to accommodate the dihedral keepers and slip the first half into position. With the aid of blocks or books, support the wing so that the tip is raised by the requisite amount (i.e. twice the tip rise specified for each wing). This can be checked by means of a set-square or ruler.

Now remove the panel again and pre-cement all contacting surfaces. When dry apply more cement and set up in position as before, using pins to ensure even contact between the surfaces joined together. Check dihedral again and also check to see that one wing is not twisted in relation to the other. Do not be afraid of using cement fairly liberally at this point. Then set the whole assembly aside for at least two hours (Fig. 7).

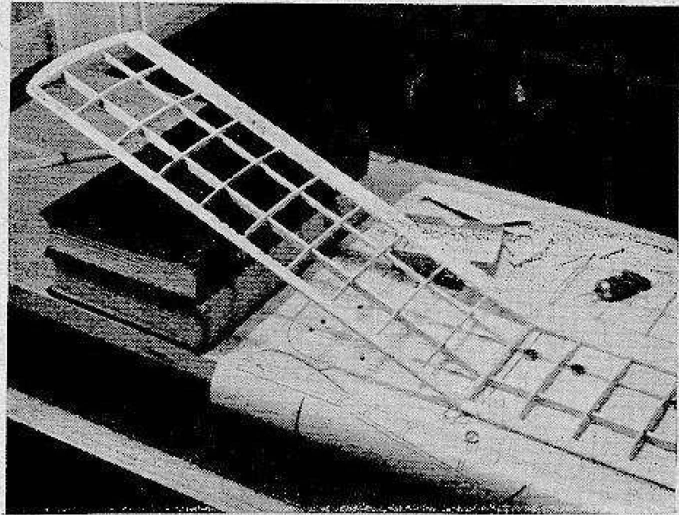


Fig. 7. The two wing halves joined and set up at the correct dihedral angle.

The various tail unit parts such as the fin and rudder (Fig. 8) and tailplane ribs, can now be cut out. On the *Tutor*, as on many models of this type, a sheet balsa fin is used. It has a simple trim tab or rudder which is attached to the fin by means of simple " hinges." These hinges are merely pieces of thin aluminium about $\frac{3}{4}$ in. long × $\frac{3}{16}$ in. wide which are inserted into the adjacent edges of the fin and rudder and allow the latter to be bent to the left or right (Fig. 10). A preliminary cut should be made with a piece of broken razor blade and the " hinge " inserted with cement. Material for the hinges is not included in the kit and something a little stronger than the aluminium bottle caps suggested by the manufacturers is to be preferred. In the absence of suitable thin metal, soft copper or iron wire (such as florist's wire) may be used.

The tailplane is constructed in much the same way as the wing and needs little comment. Make sure that the

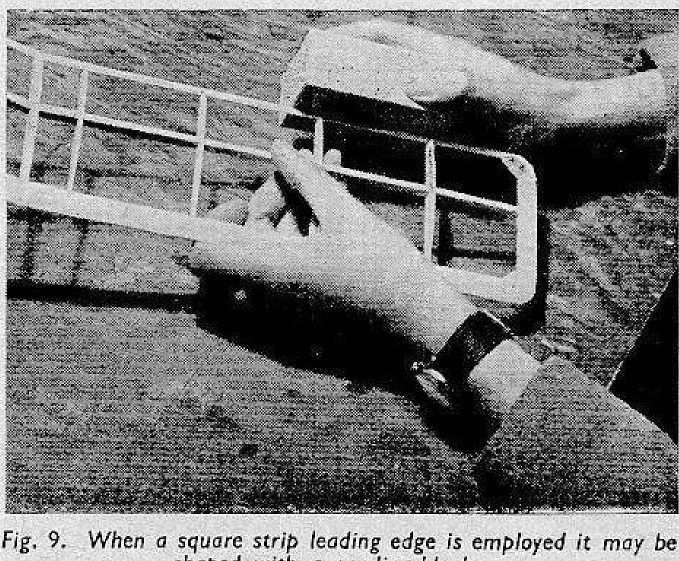


Fig. 9. When a square strip leading edge is employed it may be shaped with a sanding-block.

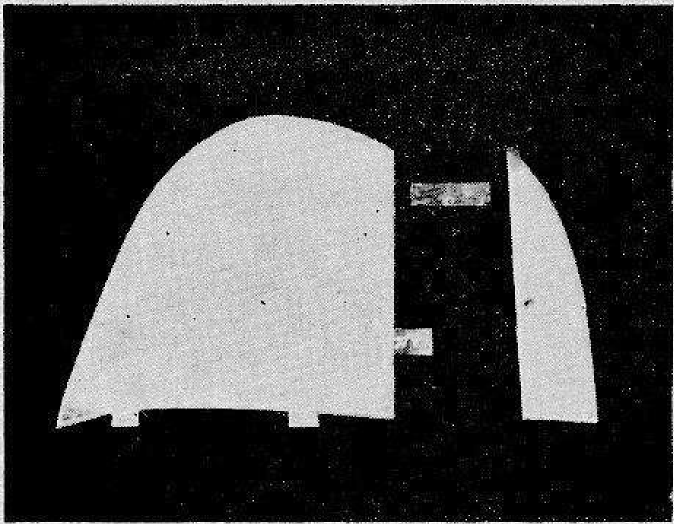


Fig. 10. The rudder is "hinged" to the fin with thin strips of soft metal.

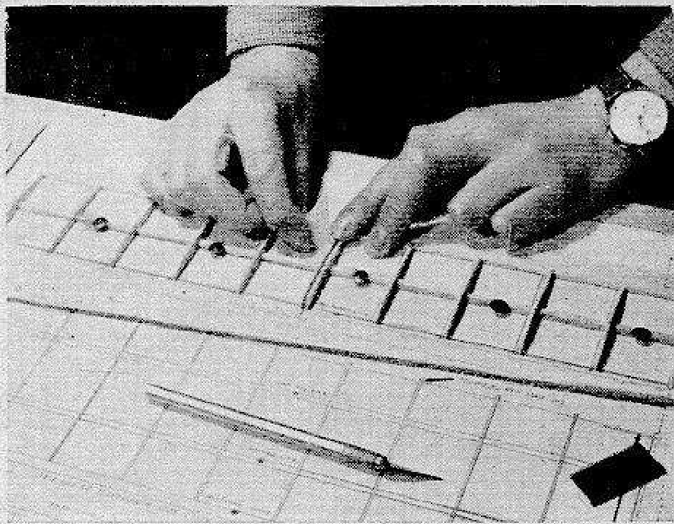


Fig. 11. Aligning the tailplane centre-ribs to ensure accurate positioning of the fin.

two centre ribs are spaced accurately to receive the fin and ensure that they are perfectly vertical so that the fin, when subsequently fitted, is held perpendicular to the tailplane. To make sure of this, cut a right-angled template from scrap balsa sheet, against which each rib can be aligned (Fig. 11).

This completes the assembly of the wing and tail surfaces (Figs. 12 and 13). They may now be gently sandpapered all over in order to remove any slight roughness and to prepare them for covering.

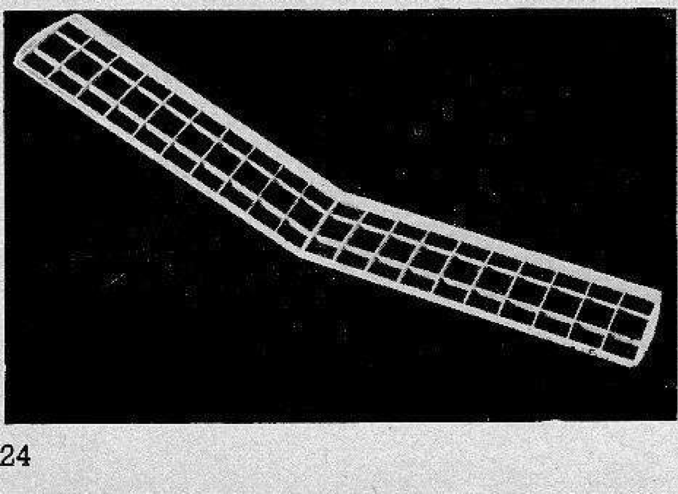
The majority of model wings employ sheet balsa ribs, with shaped strip balsa leading and trailing edges and rectangular section supplementary spars, as in our beginner's model. However, differences will be found in other types, notably in the spacing of the ribs, the type, number and positioning of the spars, the wing tip design and the type of dihedral. For example, on larger and heavier models where stresses are greater, ribs become more closely spaced and spar depths are increased to carry greater bending loads. Sometimes the leading edge portion of the wing, extending back about one-quarter of the chord, is covered with sheet balsa which, if properly used, can result in a substantial increase in resistance to vertical bending loads as well as increasing torsional stiffness.

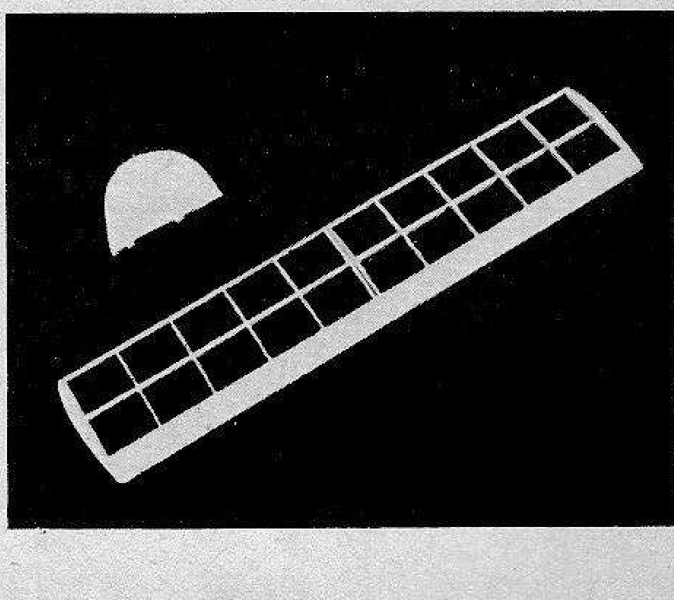
Another type of structure having considerable strength is that featured by some large R/C models and C/L types in which flat spars are let into the top and bottom surfaces of a wing, one immediately above the other, and are then webbed or boxed between the ribs so that the complete spar actually extends to the full depth of the wing section. When this is combined with the sheeted leading edge previously mentioned, so that, in effect, the nose section of the wing forms a complete hollow spar in itself, very great strength and rigidity can result.

In former years, spars (sometimes of box- or I-section) passing *through* the ribs (i.e. not let in either from top or bottom) were favoured in some quarters, because they avoided the slight ridge in the covering which a spar that is flush with the ribs on a curved upper surface will cause. However, modern high performance models have shown the need for strong and rigid wing construction, so that this theoretical aerodynamic advantage is considered less important than the improved structural design otherwise made possible.

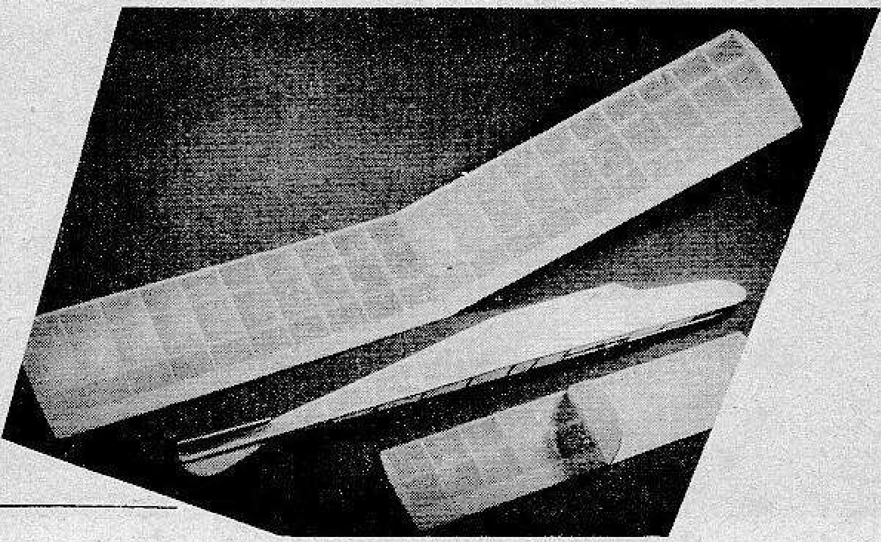
The choice of suitable grades of materials for the wing and tail is important if a serviceable model is required. In general, medium-hard, straight-grained balsa is desirable for the spars. If a thin, square-sectioned leading edge is used, for example, this should be fairly hard to resist breakage. If the leading edge is of thicker section, however, and the ribs are more closely spaced, a medium grade is permissible.

Fig. 12 (below). The completed Jasco "Tutor" wing has a span of 30 in. Fig. 13 (right). The completed tail unit. The fin fits between the centre ribs of the tailplane after covering.





Covering and Doping



CHAPTER SIX

IN scarcely any field of human endeavour does one expect to start off by doing a new and strange job perfectly, at the very first try, and the hobby of building and flying model aircraft is no exception to this rule.

Perhaps, so far, you have made a good job of the framework of your model and are duly encouraged and ready for the last stage: covering and doping. In this case, let us add a warning not to relax your efforts to make an equally good job of the final stage. Covering a model really well at the first try is not an easy matter, and the fact that the model is now nearly finished should be accepted as an added incentive to take extra care, rather than as an encouragement to rush through the job in order to see what it looks like.

When you have built two or three models you will find that covering a model neatly is quite a simple and straightforward business. If your first attempt does not turn out to your liking *don't*, therefore, be discouraged. Most of us were by no means satisfied with our first attempts, but if you persevere you will soon find yourself producing neat and satisfactory jobs.

Fortunately , nowadays, we are aided in our efforts by the availability of covering materials with which it is much easier to make a good job, than with those used in earlier years. Modelspan and Silkspan covering tissues are easier to apply and generally shrink evenly over the framework with a single coat of dope. In the past, preliminary water shrinking was necessary and, due to a pronounced "grain" formation, tightening occurred very much more in one direction than in the other.

These improved covering materials are sold in a variety of colours, although white only is included in most kits and it is therefore worthwhile to consider spending a few pence on obtaining fresh tissue for the desired colour scheme. A most effective colour scheme, incidentally, is yellow and red; yellow being for the fuselage and red for the wing and tailplane.

This scheme has the advantage that the red flying surfaces can be most clearly seen when the model is well up overhead, while the light coloured body enables it to be seen against a dark background if the model should drift

Fig. 1. A selection of dopes. Shrinking dope, thinners, banana-oil and coloured dopes.

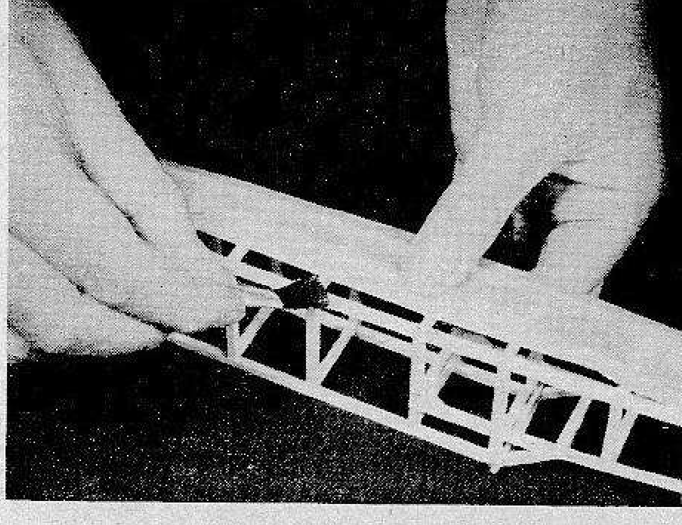


Fig. 2. Apply adhesive to the longerons after attaching the covering to the nose and tail.

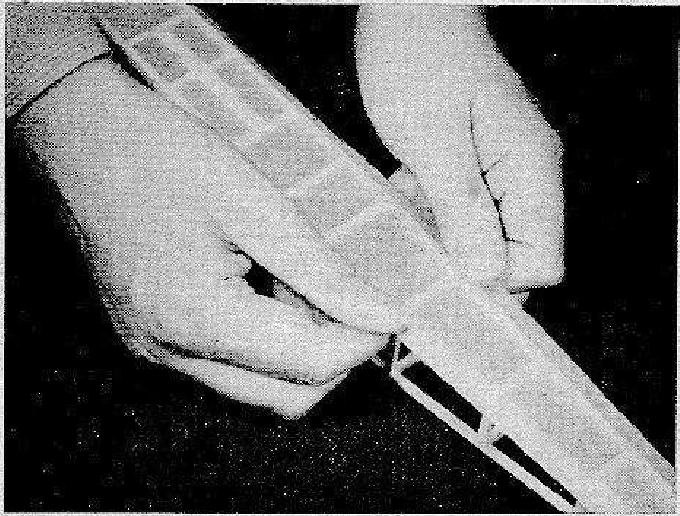


Fig. 3. *Drawing the tissue down onto the longerons with a steady even pressure on both sides.*

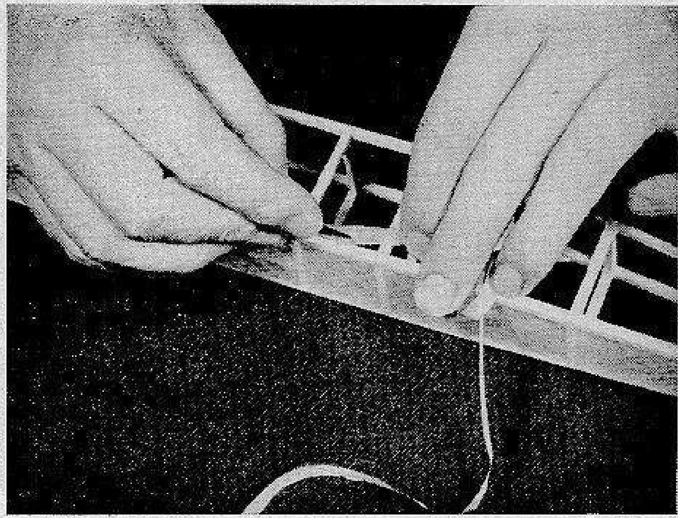


Fig. 4. *Trimming the tissue, leaving a small overlap, which can be doped down afterwards to seal the edges.*

a fair distance before landing. (If, at this stage, we appear to be unduly optimistic about the long-flying qualities of our finished model, it is worthwhile remembering that, during the summer months, even a model of quite modest performance may easily have its flight extended by a thermal up-current, and so it is as well to be prepared.)

In addition to the covering tissue, you will also require some adhesive, dope and brush. Various types of adhesive are used for covering. Most American modellers, for example, use ordinary model dope which has been thickened with balsa cement. Many British builders, on the other hand, use a hard dextrine paste, of the "Gripfix," "Dex" or "Kodak" type and we would suggest this latter as being more suitable to the beginner as it does not dry quite so rapidly and thus allows more time to get the covering positioned properly.

The dope required is of the clear, shrinking dope type and a 2-oz. bottle will be ample for our needs. You can obtain ready thinned "model" dope, or a "full-strength" dope. In any case, however, it is worthwhile to buy a bottle of cellulose thinners with which to dilute the dope to a reasonable brushing consistency and to clean your brushes. As regards brushes, a $\frac{1}{2}$ in. wide soft brush, obtainable at a model shop, is all that is required, plus a small, cheap artists' brush for sealing the edges of the tissue when covering. You may, of course, use a super-soft sable doping brush if you wish, but these, generally, can be reserved for applying coloured cellulose lacquers for decorative purposes, which need not concern us at the moment.

Before starting on the actual covering, it is advisable to go over the framework with a sandpaper block to smooth out any roughness and to remove any blobs of dried cement, etc. At the same time, check all joints to see whether any have become broken and, if so, carefully cement them up again. It does not greatly matter which part of the model is covered first, but we suggest either the tailplane or fuselage so that if you are dissatisfied with your initial attempt at applying the covering, it is not too much trouble to strip it off and repeat the process and very little material will have been wasted. Let us assume that the fuselage is to be covered, starting with the bottom.

Clear your work table, giving yourself plenty of elbow room. Lay out the various items you will need: tissue, adhesive, small artists' brush and a new razor blade or *sharp* modelling knife. (Generally, a razor blade is to be preferred, but we have found that an X-acto blade, such

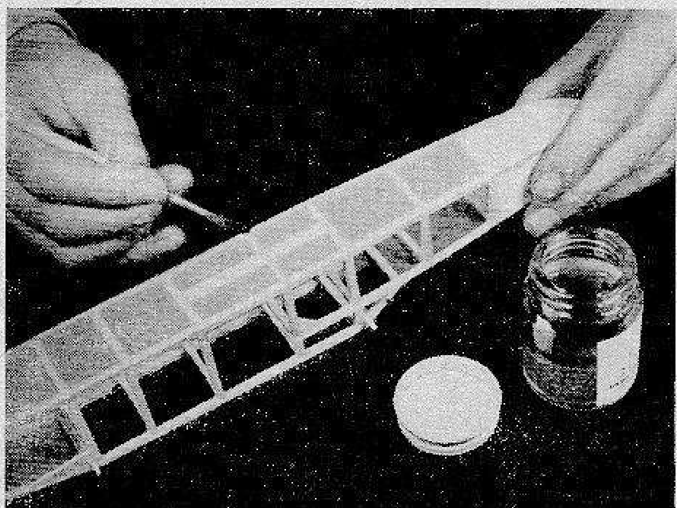


Fig. 5. *Sealing the edges of the tissue with dope.*

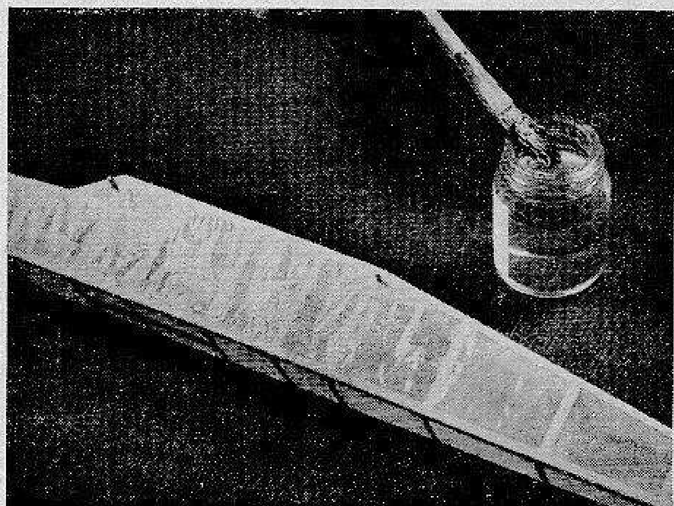


Fig. 6. *When newly doped, the covering goes slack, as shown.*

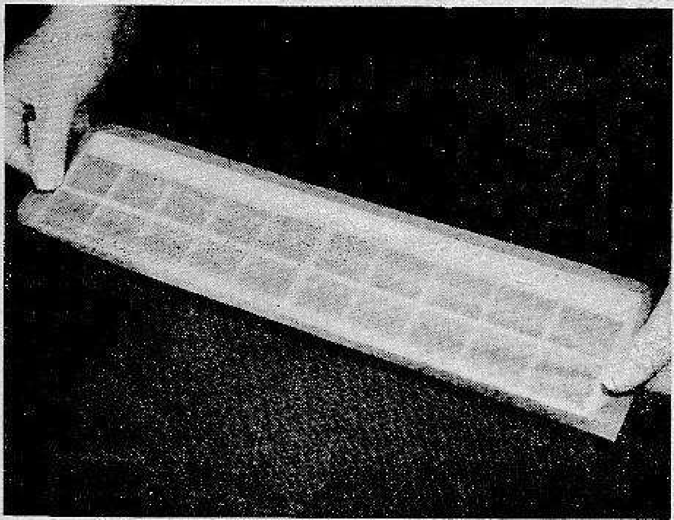


Fig. 7. The first stage in covering a tailplane.

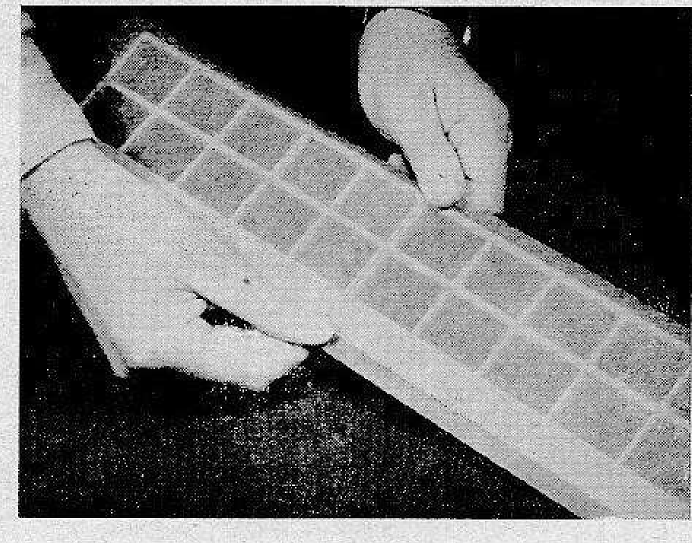


Fig. 8. Second stage: stretching across the chord at the centre.

as the straight edged No. 11, is also satisfactory.)

First cut a piece of tissue to the required size, allowing about ½ in. overlap all round. Apply paste to the nose and tail of the fuselage. Take up the tissue, holding it lengthwise and lay it squarely on the bottom of the fuselage, stretching it from nose to tail and gently pressing it down on the pasted wood.

Now, with the edge of the tissue folded back, apply paste along the two longerons, as in Fig. 2. (You could, of course, have applied the paste all over the framework in the first place. The only reason for doing the pasting in two stages is to simplify matters and avoid the possibility of the tissue adhering to the longerons before being properly positioned.)

Gently stretch the tissue across the fuselage at the centre (Fig. 3) then work towards the nose and tail, carefully working out the wrinkles. Set the work aside for a few minutes, then, with the fuselage on its side, and the surplus tissue drawn around the longeron, carefully trim off, as in Fig. 4, so that a margin about 3/32 in. wide is left which can be doped down onto the longeron. This latter operation can be performed with the small brush and some unthinned dope.

Cover the top in the same manner. Usually it is unnecessary to cover that section of the fuselage upon which the wing rests. The side panels complete the job. Once again, a small overlap should be left after trimming, which is sealed down with dope, as before. (Fig. 5.)

The entire unit can now be doped. Do not attempt to use dope which is too thick. It is better, and just as economical, to dilute with cellulose thinners and to apply two coats rather than one thick coat. The pores of the tissue will then be more evenly filled and the finished apearance will be better. As the surface of the tissue is doped, it will take on a translucent appearance, and will slacken (Fig. 6). After it has dried, however (about half an hour), it will become drum tight, adding considerable rigidity to the component.

Let us now go over the procedure, briefly, once again; this time referring to the covering of the wing and tail surfaces. The tailplane can be covered with two pieces of tissue; one on each of the two surfaces, top and bottom. The wing is best covered with four pieces; top and bottom, left and right.

Fig. 7. (Tailplane.) Paste the bottom of the framework. (Trailing edge first, as this has the greatest area and allows the longest time for the paste to dry, followed by the tips and the leading edge last.) Lay the tissue out

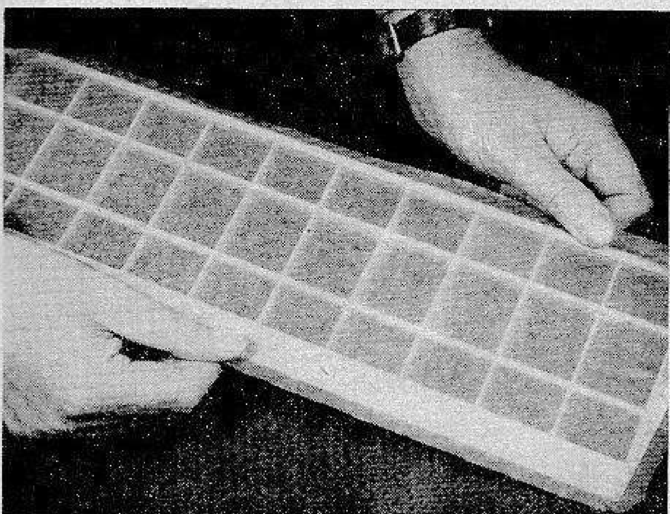


Fig. 9. Third stage (this time shown on wing). Drawing out the tissue towards the tips.

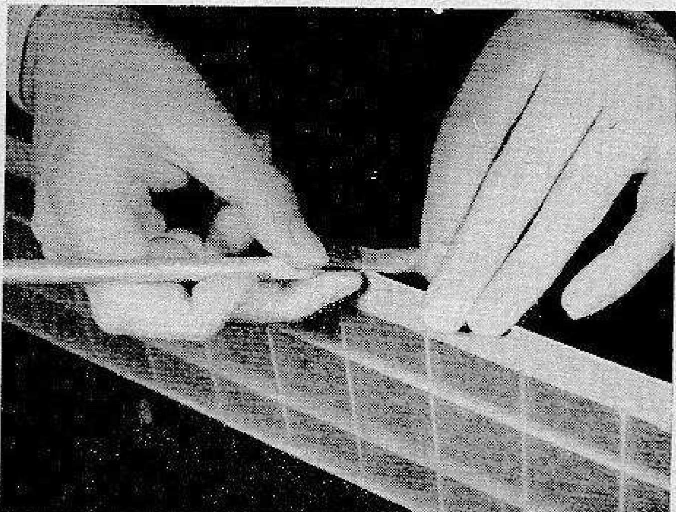


Fig. 10. Trimming off the trailing edge; be careful not to cut into the wood with the knife edge.

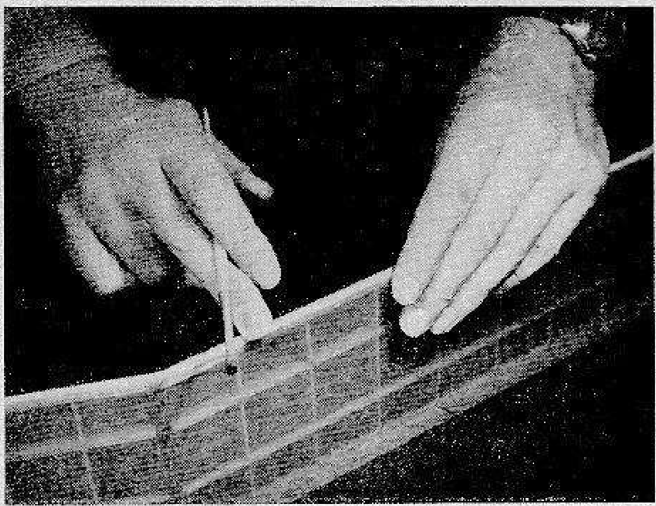


Fig. 11. Sealing down the edges of the tissue with dope by rubbing along them with the finger.

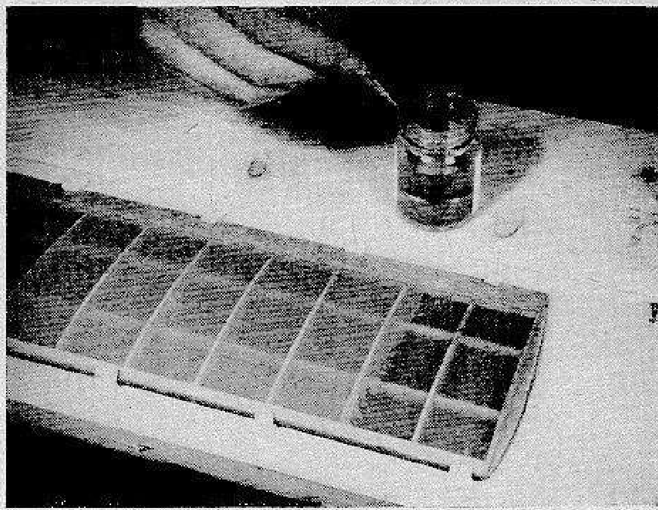


Fig. 12. Wing and tail surfaces should be pinned down when doped to prevent them from warping.

flat and drop the pasted bottom surface of the frame on it. Holding the component in both hands, stretch the tissue lengthwise.

Fig. 8. Now pull out across the chord at the centre.

Fig. 9. (Wing.) Work diagonally out towards the corners. Do not attempt to get the tissue exceptionally tight: you will only succeed in producing wrinkles across a section you have previously stuck down and you will have to keep raising the covering again to pull these out.

Fig. 10. Trim off with a razor blade or *sharp* modelling knife. (It is unnecessary to fold over the trailing edges, incidentally.)

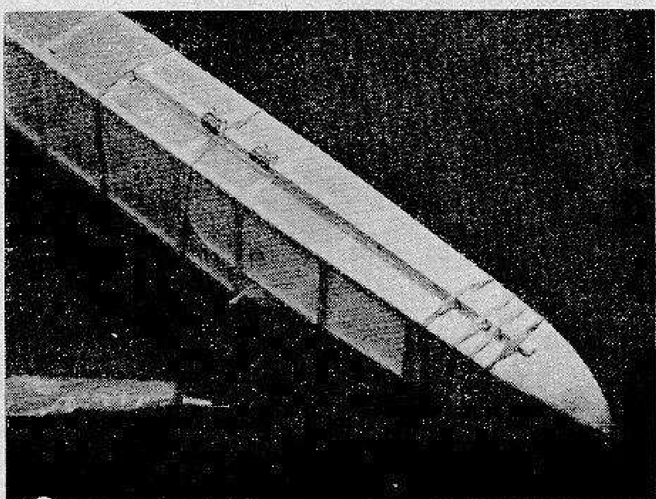
Fig. 11. Seal the edges with dope.

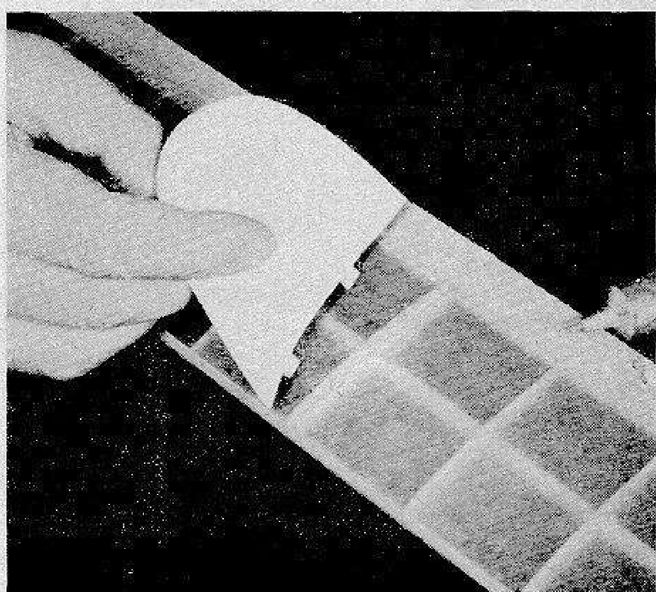
Fig. 12. It is most important to pin down flying surfaces while they are drying in order to prevent warping. Dope the underside first, then, supporting it on a number of scraps of $\frac{1}{16}$ in. sheet balsa, pin it down with drawing pins or scraps of balsa and household pins as shown. Then dope the top surface while it is in this position. Leave the surface pinned down as long as you can. It is a fact that any new structure takes some time to settle into shape and the first few days after covering and doping are especially critical and it is worth while to keep your flying surfaces pinned down while they become duly " inoculated " against the effects of atmospheric changes while held true.

It will be noticed that only the outline frame of any component is treated with adhesive—never the cross-members or ribs. It is necessary that the covering is eventually stuck to the entire framework in order to brace the complete structure, but the dope will do this, later, by soaking through the tissue and bonding it to the wood. To have adhesive over the entire framework when actually applying the covering will only hinder operations. The sole exception to this rule concerns wings with a concave undersurface. It is then necessary to use glue or cement on the bottoms of the ribs to ensure that the tissue follows the required curve and does not pull away when shrunk.

Exposed wood parts of the model may be treated with two or three coats of clear dope or, alternatively, a non-shrinking dope, such as " banana-oil," which also gives a pleasant gloss, may be used. Banana-oil may also be used as a final coat on tissue covered surfaces.

Below. On the " Tutor " glider, the nose skid, with towhooks, is cemented on after covering and can be held in place with rubber bands until dry. Right. Fitting the " Tutor " fin to the completed tailplane.





Trimming and Flying

IF we were asked: "Which is the most important stage, building a model or flying it?" we would be tempted to reply: "Neither!" because in between completing a model and flying it, there is a certain amount of checking and adjusting to be done which is without doubt the most crucial stage of all.

CHAPTER SEVEN

Trimming, as we call this procedure, does not take very long and with a model glider is quite a simple business if tackled correctly. Properly carried out, it can result in a highly satisfactory performance—even from a model which is by no means an exhibition piece as regards constructional neatness. On the other hand, the most beautifully made model can be quickly reduced to a wreck if vital adjustments are ignored.

Let us assume that we have before us the completed *Tutor* glider components: fuselage, wing and tail unit. The first thing to do is to give each of these a final check. We have already mentioned the importance of avoiding warped flying surfaces during the covering and doping stage. Check the wing and tailplane again to make sure that neither of these has since developed a warp.

To do this, hold the unit in both hands at arm's length with the trailing edge towards you (Fig. 1). By lowering the leading edge slightly, you can now sight across the chord (lower surface) and note whether the trailing edge is precisely parallel with the leading edge, as it should be. An alternative method, of course, is to lay the component on a perfectly flat and true surface—if such is available.

There are two main types of warp. The first, a longitudinal twist, means that one part of the wing will be inclined at a different angle to the airstream from another. The second is a longitudinal curvature and generally means that the wing or tail is bowed upwards slightly.

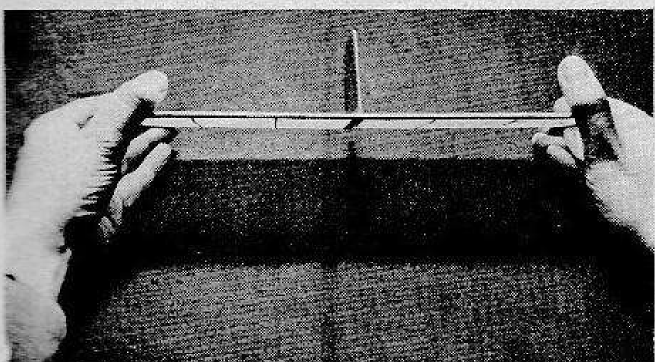
The most likely warp to be encountered in a wing is the twist in which the tips are at a different angle from the centre section. In a few cases, a slight warp of this type *can* be tolerated. If, for example, the trailing edge at *both* tips is turned upwards slightly (*not more than* $\frac{1}{8}$ *in. in the case of the "Tutor" glider*) and to an equal extent in both tips, this may be ignored.

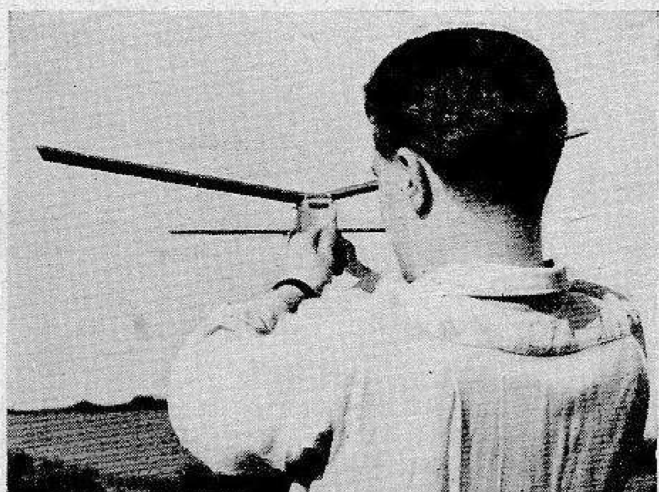
Any other twist must be corrected.

A slight upward curvature from tip to tip (not uncommon with certain types of tailplane structures) may

Fig. 1 (below). *Checking the tailplane for warps by lining up the leading and trailing edges.*

Fig. 2 (right). *Checking the alignment of the flying surfaces on the fuselage.*





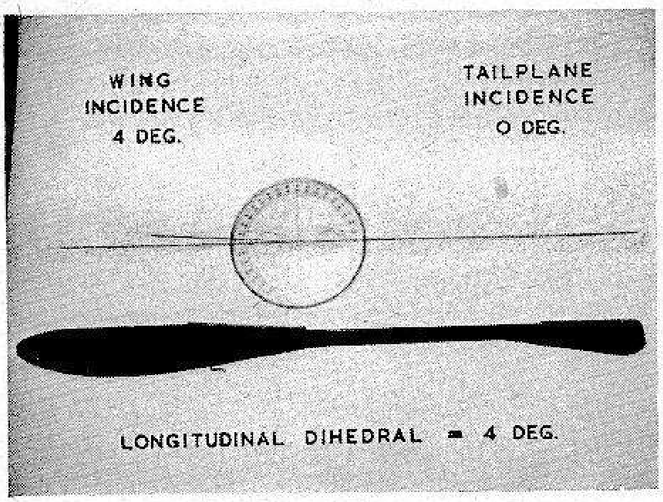


Fig. 3. The meaning of longitudinal dihedral. (Mercury "Gnome" glider fuselage.)

also be ignored—*provided that the surface is not also twisted longitudinally.*

While it is best to avoid warping at the outset by careful attention to covering and doping and leaving the unit pinned down as long as possible, a twist can be taken out as follows.

Hold the unit comfortably in front of you with both hands across the chord and positioned at each end of the section to be straightened. Exert sufficient twisting action to bring the surface back in alignment, plus a fraction in the opposite direction. Now hold it thus in front of an electric radiator, or some such similar source of heat, for about 20 to 30 sec. so that the whole section becomes slightly warmed. You will probably feel a slight tendency for the surface of " relax " at this point. The surface should then be transferred (while still holding it set) to a cool part of the room for a minute or two. On release, it will be found that the offending warp has been removed. You will soon find it quite a simple matter to reset surfaces true by this method.

The next thing to do is to check the alignment of the wing and tail on the fuselage. First make sure that they are level on the fuselage—i.e. that one side is not lower than the other and that the wing and tail are in line with one another. The quickest way to check this is to hold the model at arm's length in front of you as in Fig. 2.

Now hold the model vertically in front of you to check that the wing and tailplane are not " skewed "—i.e. that they are at right angles to the centre-line of the fuselage in plan view. If you do not have a very good " eye " for this sort of thing, a simple check can be made with a pin attached to a length of thread. First push the pin into the tail of the fuselage and measure the distance to a convenient point on the wing tip. Check this against the corresponding point on the other wing tip. (On the *Tutor* fairly accurate alignment of the wing is ensured by the fact that the V centre-section is cradled between the top longerons.) The same method is used for aligning the tailplane. In this case, of course, the pin is pushed into any convenient centre point on the fuselage, towards the nose.

To enable alignment to be quickly re-established at any time, it is a good idea to mark the respective components with suitable centring lines. Alternatively, in the case of tailplanes with fixed vertical fin surfaces, a better method is to " key " the tail unit on to the fuselage so that it cannot move and upset directional trim.

The simplest way of doing this is to cement four small pieces of $\frac{1}{16}$ in. sq. balsa on the underside of the tailplane so that they butt against the sides of the tail platform, front and back, on both sides.

Both wing and tail surfaces are usually held in place on the fuselage with rubber bands. These form an effectively firm, yet shock-absorbent, method of attachment. Make sure that you have sufficient rubber to prevent the surface from lifting during flight, and remember that strong bands, lightly stressed, are better than thin bands stretched to their limit.

The essence of successful flight is stability. In Chapter III we discussed the general principles of aeroplane flight and how stability is obtained in various directions, namely longitudinal stability, lateral stability and directional stability. The latter two, we discovered, were effected by the *dihedral angle* of the wings and the rearward *vertical fin area* respectively. Both these features are readily apparent in our elementary glider model. Longitudinal stability, we found, was obtained by rigging the wing at a larger angle of attack than the tailplane.

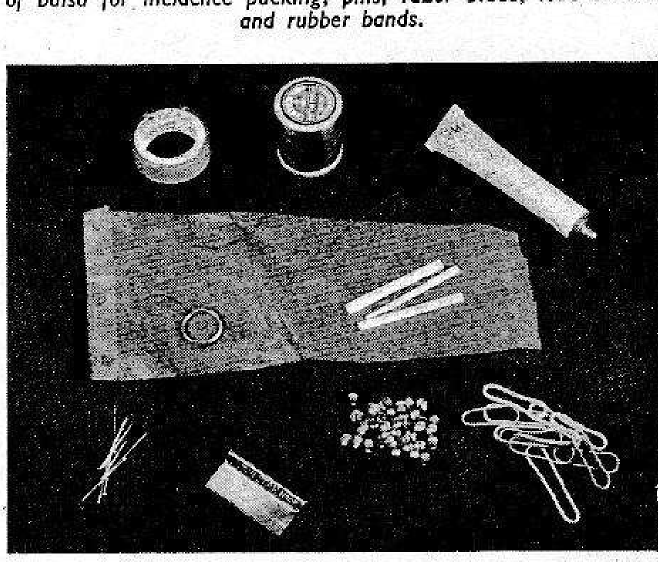
Referring to Fig. 3, we see how this can be checked. The model used in this illustration is a Mercury *Gnome* glider. The fuselage was laid on a sheet of paper and lines were drawn parallel to the tailplane and wing platforms. Using a protractor as shown, the wing angle of incidence was found to be 4 deg., while the tailplane was at zero degrees.

Sometimes a model may have only 3 deg., 2 deg. or even slightly less, difference between the wing and tail angles of incidence—the angular difference being known, as the *longitudinal dihedral angle.* The essential point to remember, however, is that a longitudinal dihedral angle must be preserved and that it is unwise, therefore, to make changes to the wing and/or tail incidence that will seriously reduce the longitudinal dihedral, when trimming the model.

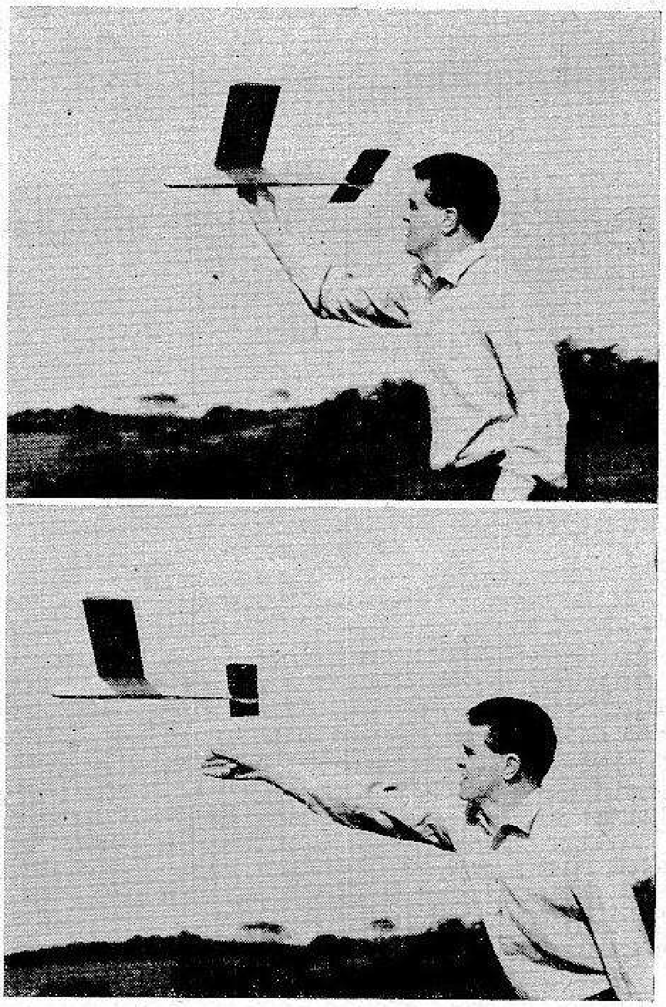
To avoid this possibility, the model is provided with a nose ballast box. By this means, longitudinal trim may be altered merely by adding or taking away weight, to adjust the centre of gravity position.

The plans of the *Tutor* show the balance point (c.g.) at about 38 per cent. chord—i.e. a little under 2 in.

Fig. 4. A simple field kit: cellulose tape, button-thread for tow-line, cement, coloured tissue pennant, towing ring, thin strips of balsa for incidence packing, pins, razor blade, lead ballast and rubber bands.



Figs. 5 & 6. An expert test-glide hand-launch. Note how the model is smoothly projected into its natural flying attitude.



back from the leading edge of the wing. On the test model it was found that, in fact, the model flew satisfactorily with the centre of gravity about half an inch farther back, with a consequent saving in ballast weight. It is suggested, therefore, that ballast is added to the weight box until the model balances at about 50 per cent. chord. If subsequent test flights indicate that this is not sufficient ballast for your particular model, it is a simple matter to add some more.

We are now ready to gather together the various small items of " field kit " needed for our test flights (Fig. 4). The first requirement, of course, is the ballast weight we have already mentioned. Lead shot is very suitable. Alternatively, you can use air-gun pellets as shown, about 3-4 dozen 0.177 calibre being required, or you can chop up any old bits of scrap lead or solder that you might have handy. To seal the ballast box hole and prevent inadvertent changes of trim due to accidental loss of shot, some cellulose tape is useful—or a simple plug can be devised.

For a towline, some strong button-thread is all that is required. Tie a curtain ring or hoop of wire on the end and cement a pennant of coloured tissue—about 6 in. × 4 in.—to the thread a few inches down. The pennant has a number of uses : it enables one to determine the exact moment when the model is released (of particular importance for precise flight timing); it assists in disengaging the line from the towhook and it is helpful in locating the towline should this be dropped in the grass.

Further useful additions to the field kit are a tube of cement, some strips of 1/32 in. balsa, some spare rubber bands, pins and a razor blade.

Needless to say, a calm day is essential for test flying. Fresh or strong winds are not only dangerous for the model, they also make it extremely difficult to judge the effect of different adjustments. Often it will be found that the evening, or early morning, is the best time. Don't fly the model near trees, thick hedges or buildings. Long grass or soft turf are the best spots from which to conduct initial tests.

Assemble the model, check alignment and make sure that the rudder tab is central. Hold the model slightly behind the balance point and with the nose into the wind. (The word " wind " is not to be taken too literally, of course; as we have said, calm conditions are the rule for testing.) Point the model downwards very slightly. Do *not* point the nose skywards.

There is a knack in getting a smooth launch. One does not need to run with a model of this size, but it should not be merely tossed into the air. Launch as smoothly as you can, letting go of the fuselage as your arm is extended to its fullest extent and with a follow-through action. Figs. 5 and 6 show this action precisely.

The model should glide down gently on an even keel. If it should veer left or right, look again for warps and check fin alignment. If necessary, use the rudder tab to counteract excessive turn (Fig. 7).

It is difficult to say how far the model should glide when correctly adjusted since this depends on the strength of any wind present. An almost imperceptible air movement will shorten the distance, but, in conditions of dead still air, a good model should touch down ten or a dozen yards away when it is launched from a height of between five and six feet.

Fig. 7. Any tendency for the model to veer left or right can be corrected by slight adjustments to the rudder tab.

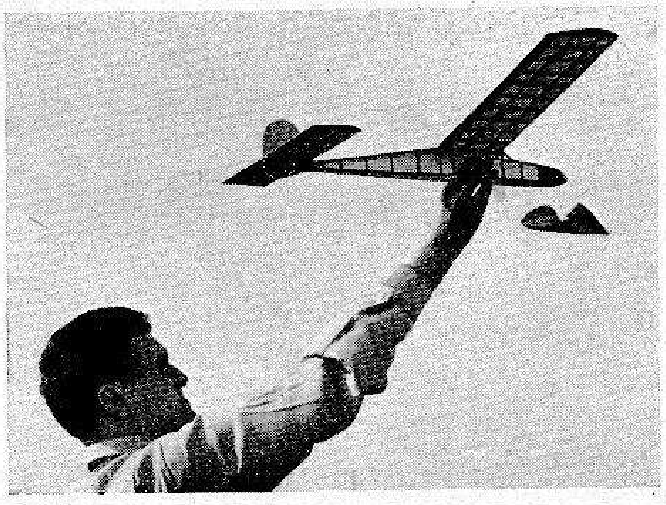


Fig. 8. The position for towline launching: wings level and nose slightly raised.

If you can launch from atop a slight slope, so much the better. This will give a longer flight that will give you a better opportunity to check the effect of adjustments.

If the model stalls, i.e. raises its nose, slows up and then dives, this may be due to your having launched it too fast, or to the wind being too strong, or to a little of each. Therefore, check this again before making any adjustment.

If the model continues to stall, you can do one of two things: add ballast or pack up the leading edge of the tailplane. On the *Tutor*, it is inadvisable to increase the angle of incidence of the tailplane as the longitudinal dihedral is small and adding further ballast is, therefore, the preferred method. If, however, the model tends to dive, the trailing edge of the tailplane should be packed up with thin strips of balsa until the model just begins to stall.

Fig. 9 (below). Ready for the start of a towline launch. Note how the operator is indicating to his helper that he is ready to proceed.

Two courses are now open to you. Either you may remove a little packing (or add a little ballast) sufficient to iron out the slight stall, or you may adopt the contest-flier's method of setting the rudder tab over to give a slight turn. This latter is the more popular for towline launched flights. The turn will automatically dispose of the slight stall and the model will be flying very close to its minimum sinking speed.

Basic towline technique needs a little practice but is really quite simple if you observe the rules. For this you will require the services of a helper.

Use only 25-30 ft. of line to start with. Slip the towing ring over the rear hook. The model should be held straight into the wind as for a hand launch, but with the nose inclined upwards slightly (Fig. 8). Your helper should now hold the model in this position while you take up the other end of the towline.

On a given signal, your helper should be prepared to release the model as you trot away, towing the model behind you. Keep an eye on the model while you are towing. It should climb fairly briskly at first, but if it fails to climb and merely slips off the hook, you are not towing fast enough. Try again.

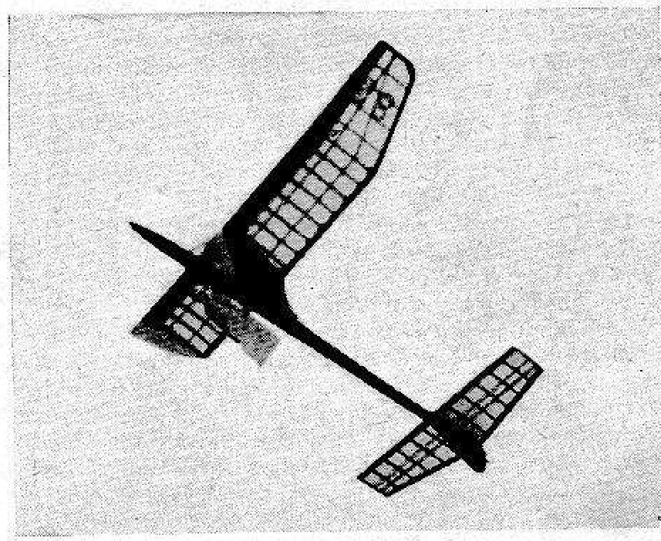


Fig. 10. Going up. A typical climbing attitude a few seconds after release.

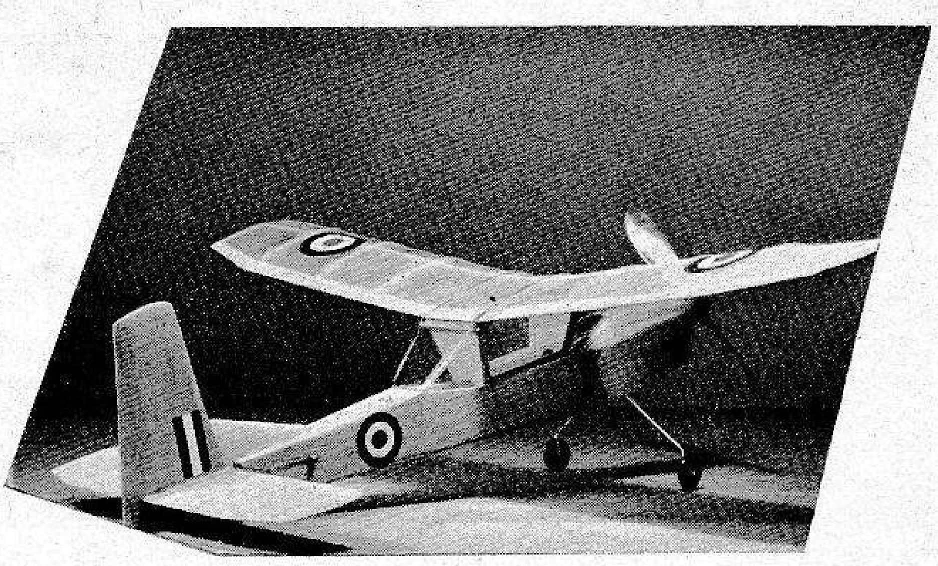
Slow up your tow when you feel the model pulling strongly. If the model turns off one way, run in that direction so as to line up the model with the direction of the tow.

Eventually you will reach a point where the model cannot be persuaded to go any higher. This point is dependent on the design of the model, the position of the towhook relative to the c.g. and on your skill. At this point you should stop towing and let the line go slack. It will slide off the hook and the model will begin its glide.

We have purposely avoided mention of the finer points of towline technique. These really go with more advanced models and need not concern us in our present ground work.

You will observe that most model gliders are fitted with two or more tow-hooks, or an adjustable hook. The rearward positions are for calm weather towing, while the forward hook can be used under more windy conditions. When you have gained some practice, the towline length may be gradually increased to 100-150 ft.

Rubber Driven Models



WE began our series of construction sequences by recommending and describing the building of a simple medium sized glider. We did so because we are of the opinion that this is the best type of model with which to learn the construction principles common to most models, while, at the same time, providing the newcomer with a finished model which can be expected to perform reasonably well in his rather inexperienced hands.

A glider can provide a good deal more interest than many beginners realise. Nevertheless, there will be some readers who prefer the idea of a propeller-driven aircraft or who, having built a glider, now wish to try their hand at a rubber powered model.

CHAPTER EIGHT

Rubber driven models are of various types, ranging from the simplest stick models, through small and medium sized scale, semi-scale and duration models, to large Wakefield class contest models.

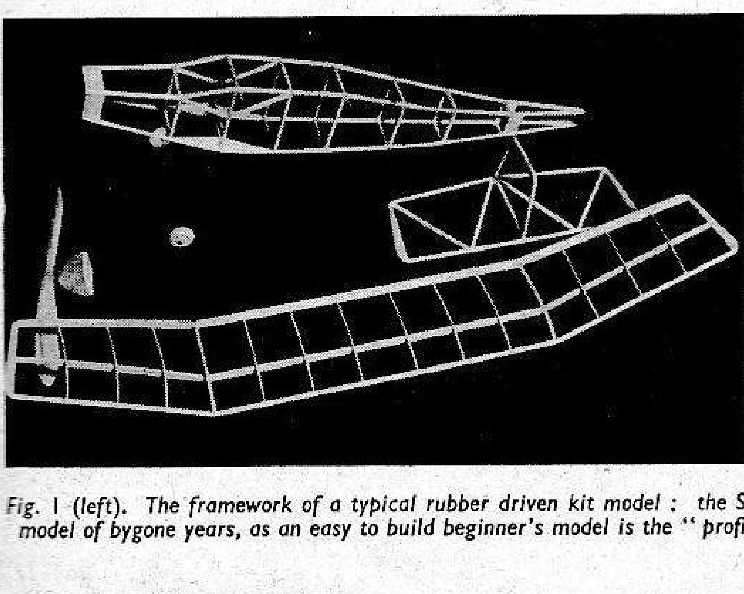
In the medium sized duration model category there are a number of designs in which the construction is basically similar to that of the glider dealt with in Chapter 4, 5 and 6. There is, in fact, very little difference between the structure of the 30 in. span Jasco *Tutor* glider featured and its companion rubber model, the Jasco *Triumph*.

Other kit models of this class include the Keilkraft *Ace*, *Ajax*, *Achilles* and *Senator*, the Skyleada *Fledgling* and *Husky*, the Veron *Rascal* and *Sentinel* and the Frog *Goblin* and *Minx*. These models range from 24 to 36 in. wing-span, and have an excellent performance.

The main points of difference between the *Tutor* and rubber models of this type are to be found in the addition of an undercarriage, stranded rubber motor and airscrew, while the noseblock is made detachable and is drilled to support the propeller shaft. The ballast box is, of course, omitted.

The undercarriage on a rubber model is usually very simple, of steel wire, and bound and cemented to the framework. Make sure that it is well secured. It is much easier to fix an undercarriage properly while the model is being built, than to have to strip off the covering and refit it later.

Remember that, unlike the glider, the rubber model fuselage has not only to support the other components, but has also to resist the twisting force (and, to a lesser



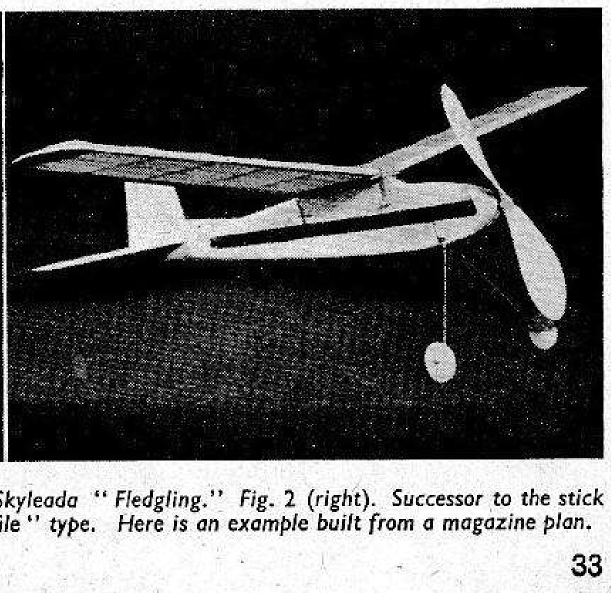


Fig. 1 (left). The framework of a typical rubber driven kit model: the Skyleada "Fledgling." Fig. 2 (right). Successor to the stick model of bygone years, as an easy to build beginner's model is the "profile" type. Here is an example built from a magazine plan.

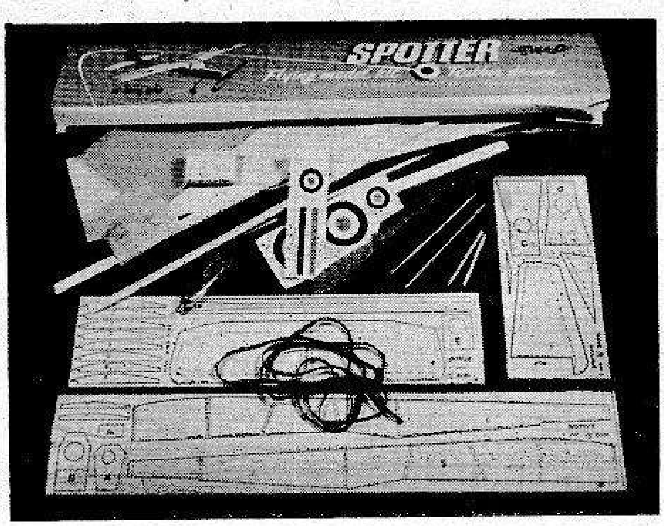


Fig. 3. Scale and semi-scale models are very popular. Shown here is the kit for the Jasco "Spotter," a completed model of which is shown in the heading photo.

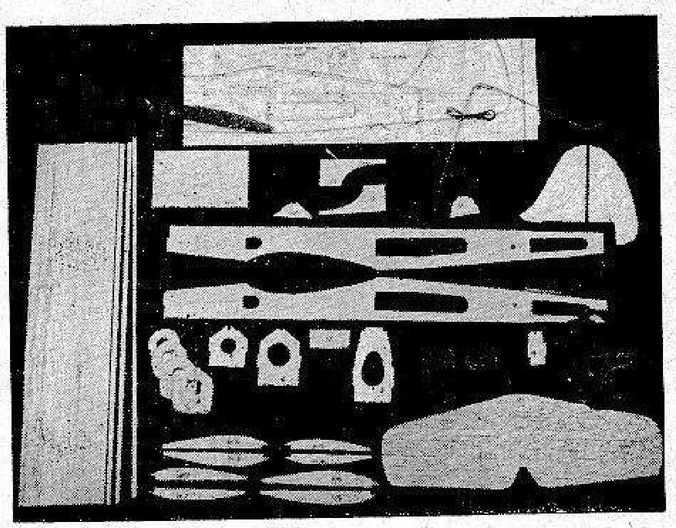


Fig. 4. Other examples of inexpensive small rubber model kits are to be found in the Frog Senior series, which include many ready formed parts.

extent, compressing action) of the rubber motor when wound up. Extra care should therefore be taken to ensure that all joints are strongly pre-cemented, especially at the front where the noseblock fits in.

Care should also be exercised in the drilling of the noseblock for the propeller-shaft bushing so that the thrustline is at the proper angle.

Rubber strip for the "motor" is made in two thicknesses (1/24 and 1/30 in.) and three widths ($\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ in.). In some small kits (notably Frog) the strip is supplied in loops of the appropriate length, but in nearly all cases, it is necessary to join the ends of the strip to make up loops or skeins. The most satisfactory method of doing this is to tie them in a reef knot (Fig. 5) and to then secure the ends close to each side of the knot with a few turns of thread—while the rubber is stretched out.

Before use, the rubber motor should be washed, using a mild soap, and then thoroughly rinsed. When dry, it should be treated with *rubber lubricant*, a preparation consisting basically of pure soft soap and glycerin and available in tubes and jars from model shops. A little of the lubricant should be smeared on the palms of the hands and then thoroughly rubbed into the motor. As an emergency measure, castor-oil may be used in place of rubber lubricant. On no account, however, must ordinary lubricating oil be used as this will rapidly cause the rubber to deteriorate and break.

Before fitting the rubber motor to the model, wire hooks, such as that linking the motor to the propeller shaft, should be covered with rubber (bicycle-valve) tubing or plastic (Neoprene) tubing, in order to prevent the wire cutting into the motor. An alternative here, used with larger models, is the "run-true" bobbin.

Rubber should never be exposed to strong sunlight for longer than necessary, or to extremes of temperature and, when not in use, is best stored separately in a closed tin. If dust should be picked up by the strands, it is best to wash the motor and then relubricate it before re-use.

During the past ten years, duration type rubber models of the size we have mentioned and up to the largest (Wakefield) size, have declined in popularity due, mainly, to the wide use of small engines suitable for F/F models of 30 in. span and upwards.

More recently, however, there has been renewed interest in small quickly-built models that can be flown in restricted spaces. Kit manufacturers have responded

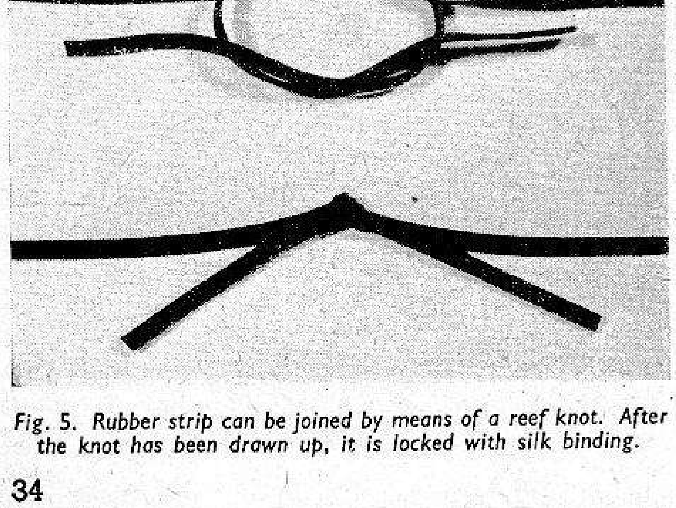


Fig. 5. Rubber strip can be joined by means of a reef knot. After the knot has been drawn up, it is locked with silk binding.

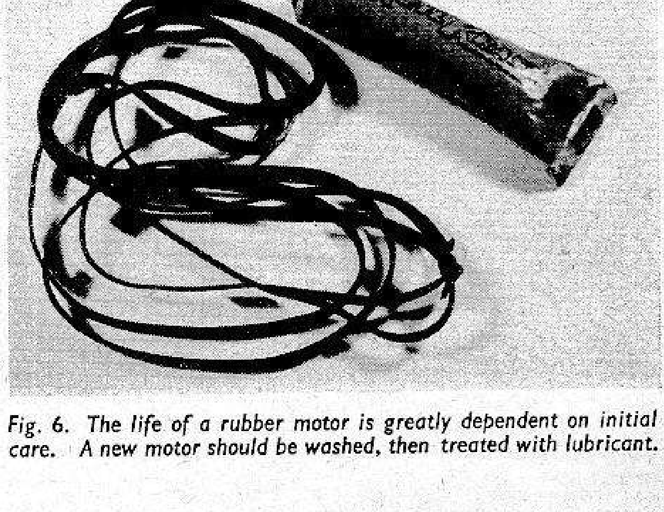


Fig. 6. The life of a rubber motor is greatly dependent on initial care. A new motor should be washed, then treated with lubricant.

with a large variety of designs in which many parts are ready formed, resulting in models that can be assembled in a matter of two or three hours.

Among models of this type are a number of good designs of 18 to 20 in. span and often of semi-scale appearance. These are to be found in the popular Frog "Senior Sports" series, the Mercury "Starflight" series etc.

Five steps in the construction of one such kit model, the Frog *Raven*, are shown in our photographic sequence Figs. 7 to 11. Much of the structure of these Frog models consists of diecut sheet-balsa parts and, with the exception of the wings, is put together without the need of pinning down to the assembly drawing.

These diecut parts are supplied in sheets from which they must be detached. Do not merely try to push out the parts from the sheets. Most diecutting is accurate but it is advisable to separate the parts with the aid of a razor blade to prevent ragged edges and splitting.

Most rubber model kits include a finished or semi-finished propeller. With the smaller models, many kits now contain finished props of moulded plastic. In the case of medium size and duration models, however, the prop is generally of the semi-finished, so-called "saw-cut" type.

It is also possible to buy finished balsa propellers in various sizes. However, where one is building from a magazine plan, and particularly in the case of Wakefield and other high-performance contest models, it is usual to carve one's own propeller from a solid block of balsa.

This is a good deal easier than might be imagined. The secret is in the simple process of first cutting the block to a given shape before starting to carve the blades. The dimensions, or a template for this, the "blank," are usually given on the plans of the model. Figs. 12 to 17 show the sequence of operations in carving such a prop.

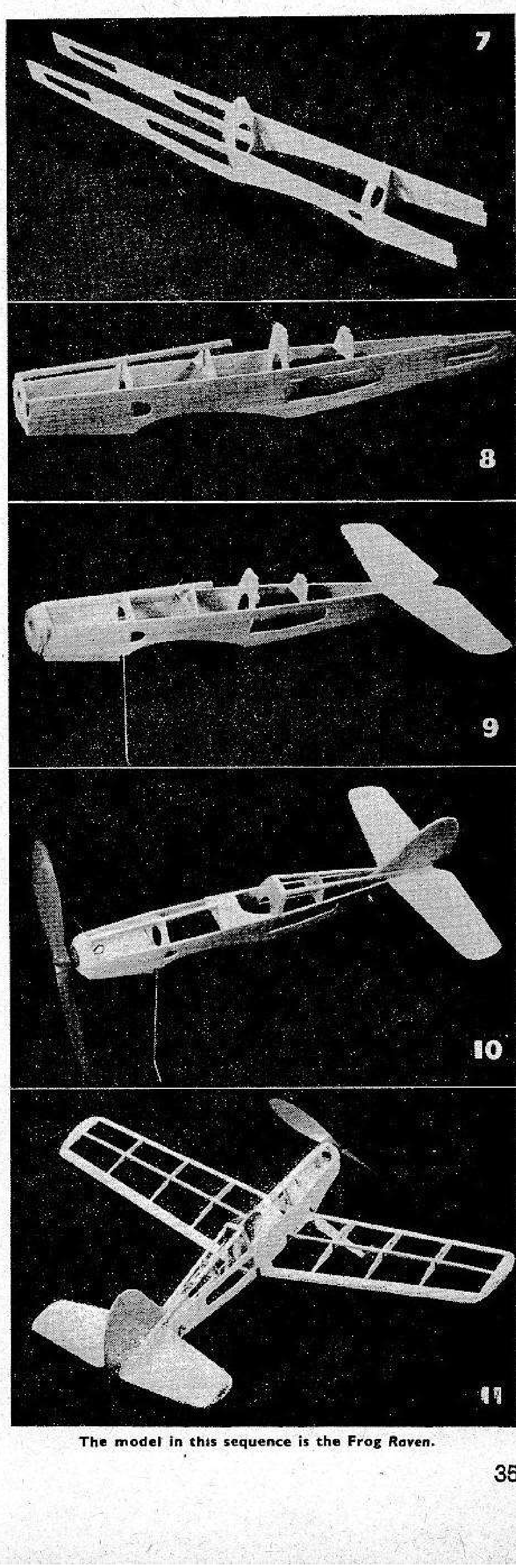
The first requirement is a piece of balsa as near to size as possible. The propeller shown in the photographs was of 18 in. diameter and called for a block 2 in. wide and $1\frac{1}{2}$ in. deep—a size easily obtainable. Choose a piece of wood which is of even texture throughout and not soft at one end and hard at the other.

A cheap ball pen is ideal for marking out the blank but if this is not readily available, a pencil can, of course, be used. First scribe the centre lines and other lines running around the block. Mark all four sides. From these the various tapers can then be marked off (Fig. 12).

Before beginning to cut out the blank, the shaft hole should be drilled. If you have access to a bench drilling machine, so much the better as this will ensure that the hole is bored truly vertically through the block. Most modellers, however, will have to use a small hand-drill.

Use first a $\frac{1}{16}$ in. drill and, with the block laid on a flat and level surface, centre the bit and, if possible, have an assistant to advise you whether you are holding the drill quite vertically. Drill only about one-third through the block, then reverse it and repeat operations from the other side. Then feed the bit through from each side until the two holes meet. Finally, ream out the hole with the appropriate size drill.

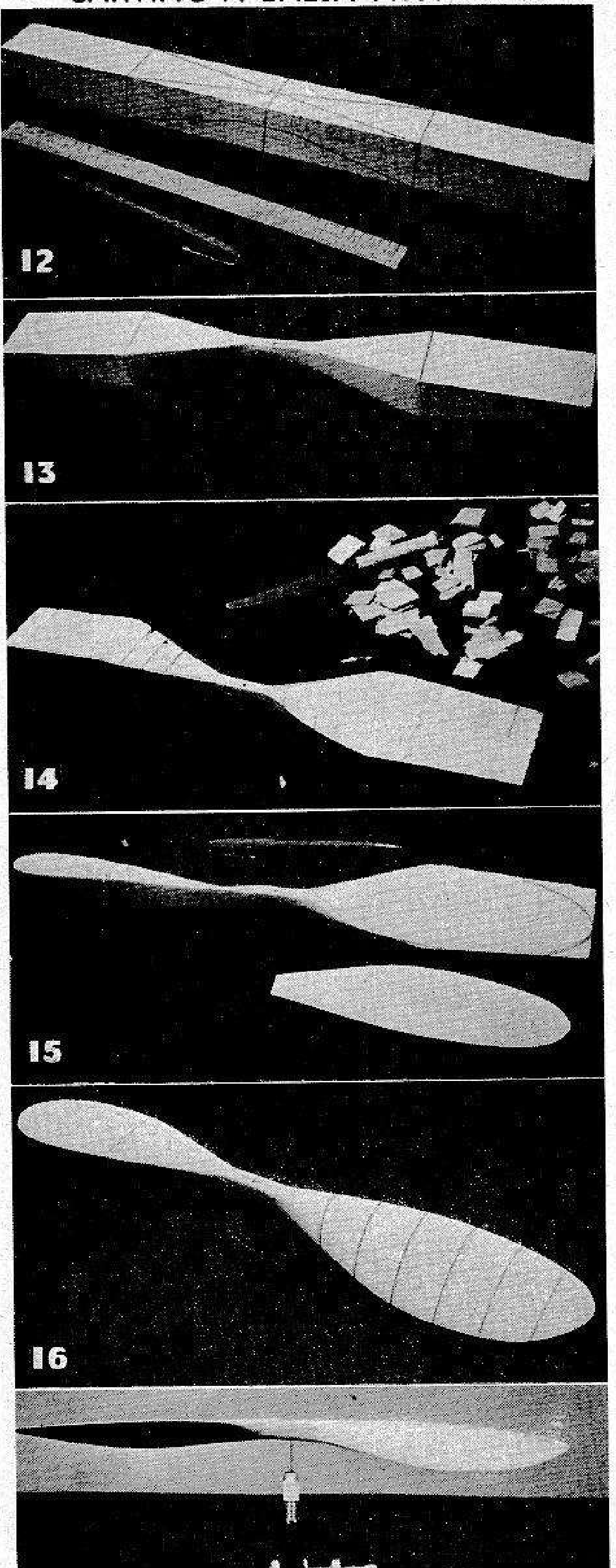
Start shaping the blank by cutting the end tapers—preferably with a tenon saw. These are followed by



Figs. 7-11. Five stages in the assembly of a Frog "Raven" show: basic assembly of two side panels and two main bulkheads (7); addition of nose and tail bulkheads, formers and front stringer (8); addition of noseblock, undercarriage, cowl block and tailplane (9); completion of tail-unit, cockpit sides and rear stringers (10); addition of built-up wing, cockpit canopy, undercarriage fairings and wheels (11).

The model in this sequence is the Frog *Raven*.

CARVING A BALSA PROPELLER



cutting the hub taper at the back. Cut slightly outside the guide-lines and rasp down level with them using a coarse sandpaper block. Now cut the centre tapers and shape up the blank to the lines with coarse, then medium, sandpaper blocks. Final shape of the blank immediately prior to carving is shown in Fig. 13.

Commence carving with the back surfaces of the blades. To assist accuracy and avoid risk of splitting off too much wood, it is a good idea to make a series of diagonal sawcuts through the back of the block, from leading to trailing edge of the blade to be cut. Run a $\frac{1}{16}$ in. pencil margin around the block and work to this to avoid sawing into the actual leading and trailing edges. For the actual carving, a modelling knife is not very suitable (except for small props) due to inadequate blade length.

When both back surfaces have been roughly carved to shape, they should be trued up with a straight sandpaper block, after which the required undercamber is put into each blade using the curved part of the knife and sandpaper. Check with a straight-edge to ensure equal undercamber on each blade. Next, mark out the required blade shape using a card template as in Fig. 15. Cut the remainder of the blank away to this shape.

Now carve the front surfaces of the blades so that a thin aerofoil section is obtained. This is really much easier than it sounds and you will be able to see and feel any unevenness in blade thickness as the work progresses. In Fig. 16 a series of parallel lines has been drawn across the blade showing the pitch graduation and gradually thinning blade section towards the tip.

Most beginners make the mistake of leaving their props much too thick, especially towards the tips. Don't be afraid to thin down the blades. The same applies to the saw-cut prop, which needs to have the blade section shaped and the trailing edge thinned down. Do not forget the hub of the prop. The blades should be cleanly moulded into it with a progressive taper for maximum strength and minimum weight. When you are satisfied with your two blades, the prop must be balanced.

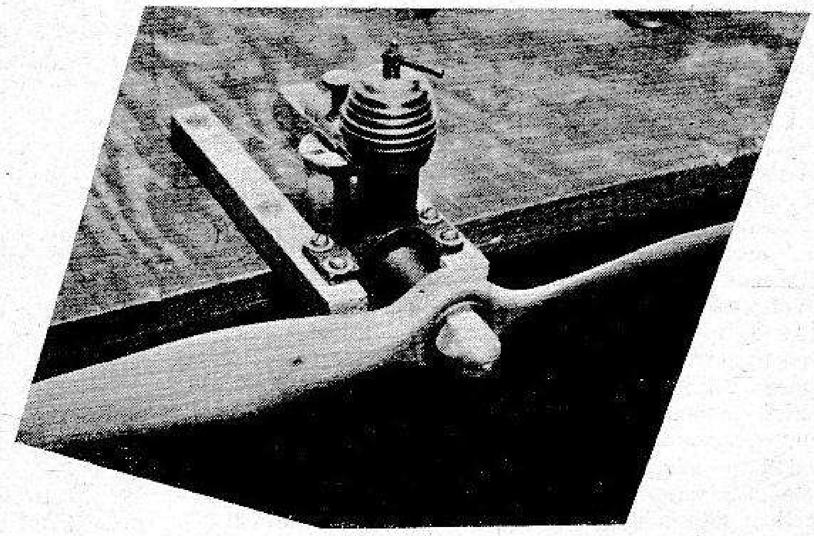
A rough check is obtainable by balancing the prop on a piece of wire through the shaft-hole but, for greater accuracy, it should be balanced on a knife-edge (Fig. 17). Horizontal balance is not necessarily true balance, however. Like a properly balanced wheel, a prop should stay in any position in which it is left and should stop in any position after spinning and not run back. If necessary, the leading edge of one blade and the trailing edge of the other will have to be sanded slightly to achieve this balance.

The whole prop can now be given several coats of banana oil to harden the surface and fill the pores of the wood. By rubbing down between each, about six coats can be brushed on without adding excessive weight and a good durable finish obtained. For rubbing down, use a very fine sandpaper. A final rubbing with No. 400 silicon-carbide paper will give a really smooth scratch-free surface.

Finally, a light application of wax polish, such as "Simoniz" or "Johnson's Wax," will preserve a smooth glossy finish.

Figs 12-17. Six steps in the carving of a balsa propeller for a duration model: marking out the blank (12); the blank cut to shape, drilled and ready for carving (13); carving the backs of the blades after diagonal sawcuts have been made to prevent splitting (14); marking and shaping the blade outline with the aid of a card template to ensure identical blade shapes (15); carving the front surface of the blade (16); when completed the airscrew should balance on a knife-edge (17).

Your first Engine



CHAPTER NINE

A FEW years ago, power modelling was very definitely for experts only and would have been quite outside the scope of this series—at least at this stage. The coming of small diesel and glowplug engines in the late nineteen-forties and of small, simple C/L models, however, altered all this. Nowadays, in fact, it is quite permissible (if not always financially practicable!) for the young beginner to start his modelling career with an engine-driven model.

Model aircraft engines manufactured today are nearly all of either the diesel or glowplug type. The advantage here is that there is no high-tension ignition system to go wrong, both types of engines operating by simple auto-ignition system. In general, modern model engines are easy to run and maintain and are very reliable.

It should not be assumed from this, however, that every model engine is suitable for the newcomer to power flying. This is far from the case. The hard school of contest flying has resulted in the development of engines of increasingly greater performance and many of these are too powerful, too big, too expensive or too tricky for the beginner to handle successfully.

Obviously, the newcomer to power modelling requires an engine that is easy to start and of a performance suitable for the types of models he will be building. Fortunately, there are many such motors.

In Fig. 1 is shown a selection of engines from many parts of the world. Six of them are diesels and six are glowplug models, and they come from six different countries: Great Britain, the U.S.A., Germany, Italy, Norway and Japan. It is fairly certain that, no matter what part of the world you reside in, you will be able to obtain at least one of these, for most of them are also exported to many other lands, including those countries which do not have their own model industries. British modellers should note, however, that foreign model motors are not at present generally available in Britain. This is of no great importance, of course, since the British market includes some ideal beginners' types.

Especially worthy of attention here are the Mills "75"

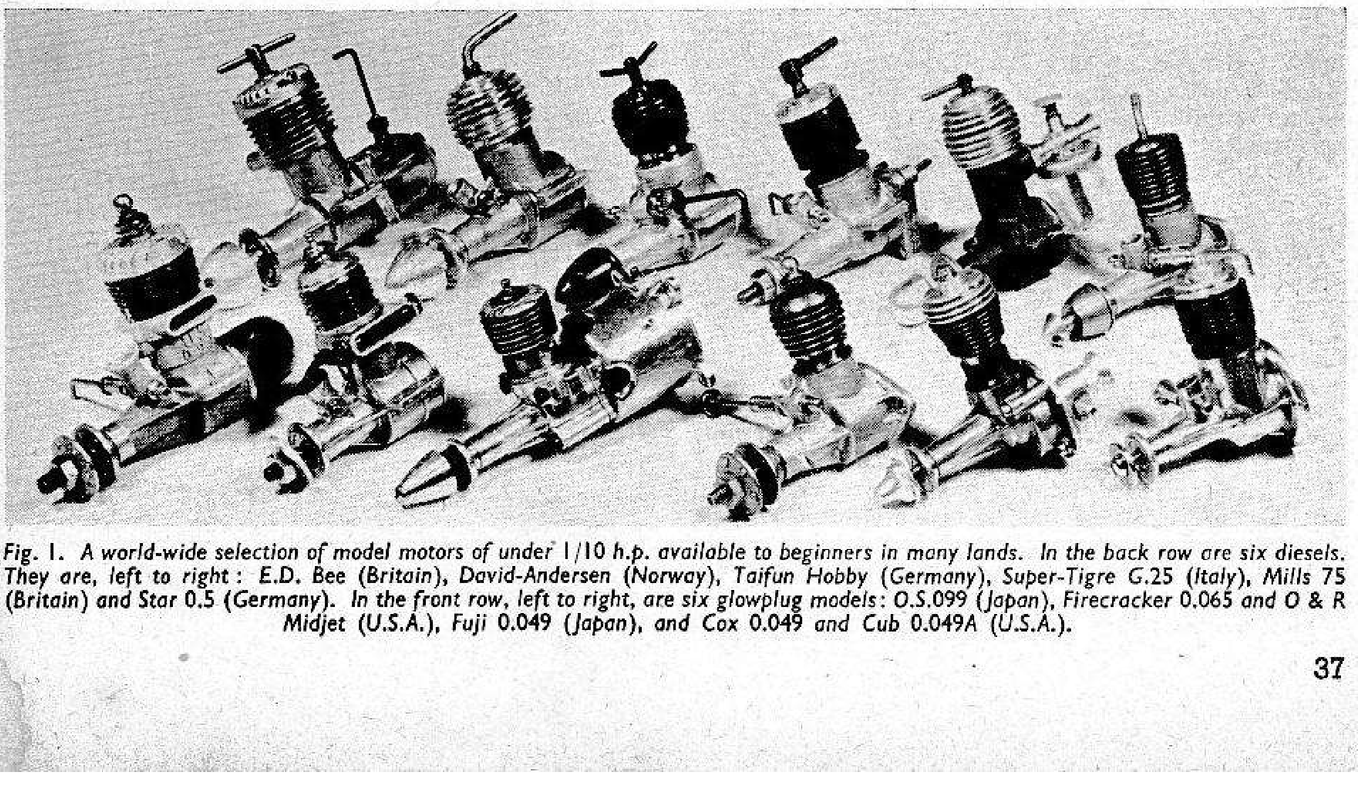


Fig. 1. A world-wide selection of model motors of under 1/10 h.p. available to beginners in many lands. In the back row are six diesels. They are, left to right: E.D. Bee (Britain), David-Andersen (Norway), Taifun Hobby (Germany), Super-Tigre G.25 (Italy), Mills 75 (Britain) and Star 0.5 (Germany). In the front row, left to right, are six glowplug models: O.S.099 (Japan), Firecracker 0.065 and O & R Midjet (U.S.A.), Fuji 0.049 (Japan), and Cox 0.049 and Cub 0.049A (U.S.A.).

and E.D. "Bee" models. The Mills "75," of 0.73 c.c. capacity, is the smaller of the two and is admirably suited to the many beginners' model designs on the market.

We shall be dealing with simple C/L models, suitable for engines of this size, in the next two chapters, afterwards going on to F/F models for which the same type of engine may be used.

These two engines are both of the compression-ignition or "diesel" type. It is not the purpose of this book to deal with the principles of internal combustion engines in detail, but, for the benefit of anyone totally unfamiliar with present day model motors, it should be mentioned that the model diesel has no sparking plug or electrical system. Instead, it has a high compression cylinder which detonates the fuel charge automatically. The compression-ratio (which is two to three times as high as for an ordinary petrol engine) is adjustable by means of a *compression lever* on top of the cylinder head which in turn moves a *contra-piston* in the top of the cylinder. See Fig. 2. Most European model motors are of the diesel type.

In the other type of engine, the glowplug motor, ignition is achieved differently. Here, a plug carrying a small platinum wire filament is fitted in the cylinder-head in the same way as a sparking-plug. This plug is simply connected to a 1½-2 volt battery, which causes the filament to heat up to a bright red colour. The engine is then started and the battery removed, the heat derived from combustion now being sufficient to keep the plug glowing continuously and provide ignition for each fresh intake of mixture.

Both types of engines are, of course, of the simple two-stroke type and both are fitted with a needle-valve type carburettor control. This simple device controls the amount of fuel admitted and thus the strength of the air/fuel mixture reaching the cylinder. If the mixture is either much too weak or much too strong, the engine will not work. Therefore, we adjust the needle-valve to get the correct mixture.

On a glowplug engine this is, in fact, the only control we have to worry about. On a diesel, however, as we have seen, there is an extra control: the compression lever.

The real purpose of this control is to adjust the timing of the ignition of the fuel charge. This is necessary in order, firstly, to assist starting, secondly to enable different propellers to be used (which cause the engine to run at different speeds) and, thirdly, so that the natural warming up of the cylinder (which will cause the fuel vapour to ignite too soon) can be compensated by reducing compression.

The fuel we use in our diesel is a special blend containing ether, which, when vaporised or atomised, ignites easily when compressed and ensures easy starting. Many good branded fuels are available, usually costing about 3s. for an 8-oz. bottle, but if you are some way from a model shop and cannot get a proprietary blend, a good substitute can be made with equal parts of ether, paraffin (kerosene) and castor oil. Glowplug engines require a different fuel consisting, mainly of methanol and castor oil with certain additives.

Every modeller finds his first engine an absorbing interest in itself, quite apart from the interest attaching to its future use as a means of propelling models, and it is natural to want to try out the engine before building a model for it. In fact, this is a good idea in any case, since, by first running the engine on a bench, the modeller will soon learn how to handle it.

Most model engines are of the beam mount type with flat lugs on either side of the crankcase, permitting them to be bolted down on to two wooden bearers extending back into the fuselage. For bench running, these bearers, which should not be less than ⅜ in. square in section, may be screwed down to a bench, as shown in Fig. 4. Use small machine screws and nuts (not woodscrews) through the engine lugs with washers to fix the motor.

An alternative method of beam mounting is to use a flat piece of wood in which a U-shaped cut-out is made to fit the crankcase of your engine, as in Fig. 5. A third system is a special engine stand such as that shown in Fig. 6. Such a mounting can be purchased from your model shop and is adjustable to take various size motors.

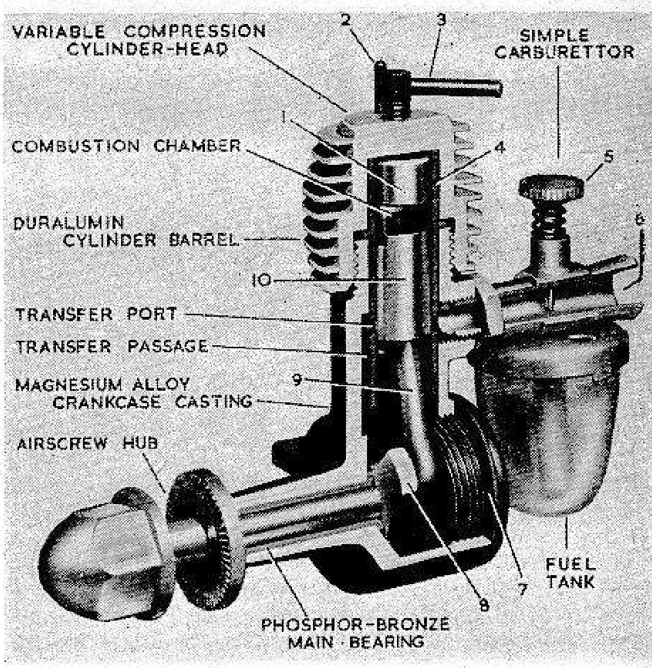


Fig. 2. A MODEL AIRCRAFT cutaway drawing of the British Mills 75 diesel motor. In addition to the main features indicated, parts are as follows: 1—contra-piston, 2—compression stop, 3—compression lever, 4—cylinder liner, 5—needle-valve control, 6—air intake, 7—crankcase backplate, 8—crankshaft web, 9—connecting-rod, 10—piston.

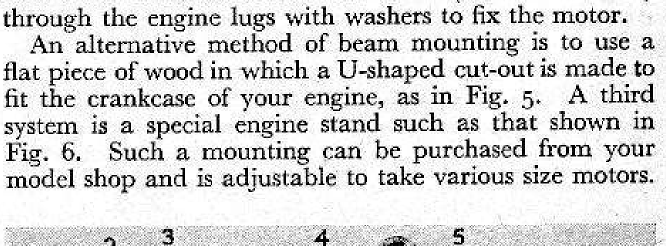


Fig. 3. The parts of a typical small glowplug engine. 1—glowplug and washer, 2—cylinder, 3—cylinder-head, 4—crankcase, 5—carburettor spraybar, 6—crankcase backplate and gasket, 7—needle-valve, 8—propeller screw, 9—prop drive hub, 10—prop washer, 11—crankshaft, 12—connecting-rod, 13—piston, 14—gudgeon-pin.

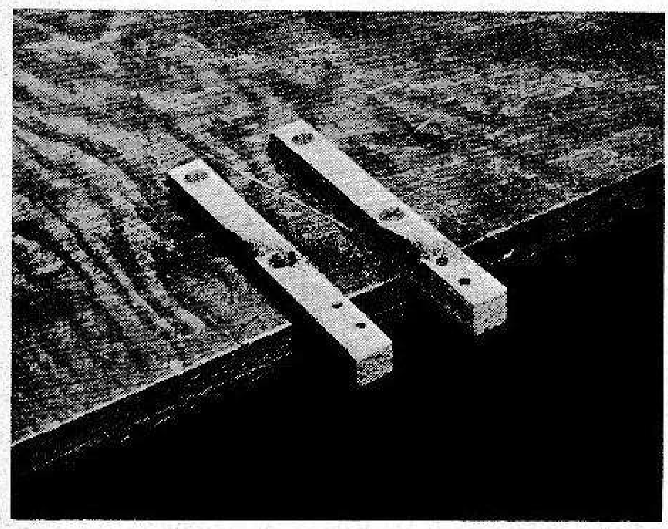


Fig. 4. The usual method of mounting is by means of two hardwood bearers. For initial testing they may be screwed to a bench.

Engines having bulkhead or radial flange type mounting can simply be bolted to a suitable piece of wood, which is then gripped in a vice or screwed to the bench.

When fitting the propeller, tighten it on the shaft in such a position that when one blade is brought gently up against compression, the airscrew rests in an approximately horizontal attitude. (See heading photo.) By this means, we can ensure that when a model is gliding down after the engine has stopped, the airscrew is in the best position to avoid a blade being broken off on rough ground, or the engine shaft being bent. This is also a good position to aid starting, as, standing to the left of the engine, it allows a good strong swing or " flick " to the prop, with the right hand, which then follows through towards the body.

To flick the prop effectively, place the forefinger (or forefinger and middle finger if you wish) fairly close to the boss or hub of the airscrew as in Fig. 8. In this position, one gets the most rapid and efficient flick for a quick start and the fingers are well out of the way when the engine starts.

As regards actual prop sizes, let the maker's instruction leaflet be your guide. For learning to start a Mills 75 we would recommend an 8 in. diameter, 4 in. pitch prop. For the Bee, the manufacturer's 7¾ in. × 6 in. prop is very suitable. Err on the large side, rather than the small side, when learning to handle your engine. For small glowplug motors, however, a smallish propeller is to be preferred as these engines are happiest at somewhat higher speeds. A 6 in. × 3 in. prop is the usual recommendation for a 0.049 (0.8 c.c.) glowplug engine.

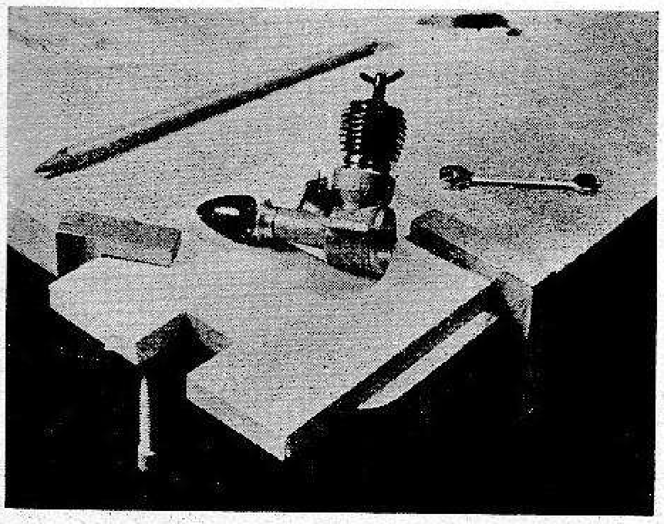


Fig. 5. Another mounting is a flat piece of wood with a cutout for the crankcase and secured to the bench with X-acto clamps.

When first attempting to start your new model engine, you may be rather discouraged by the results of your efforts. *Don't worry about this at all.* Model engine starting is, very definitely, something that has to be learned. The more you persevere with your engine, the quicker you will acquire that " engine sense " by which you will automatically begin to do the correct thing. By touch and ear alone, you will then be subconsciously guided in making the right movements. This is worth far more than any amount of words and the following notes are, therefore, intended only as a guide to setting you on the right course, by which you may learn for yourself, the correct handling of a model engine.

We are confining our notes on starting to model diesels,

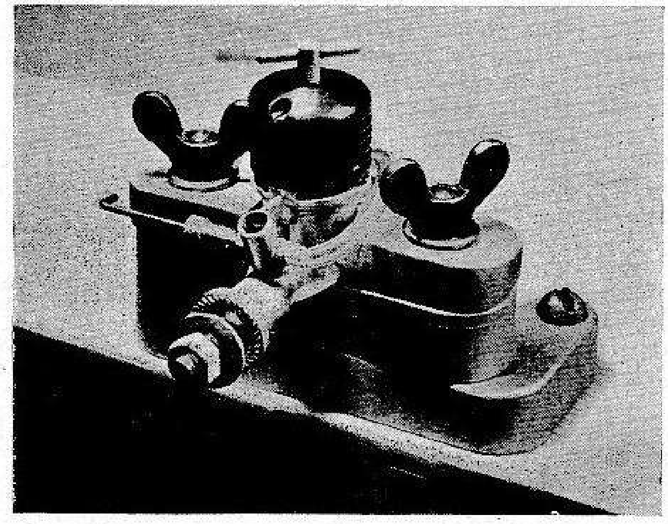


Fig. 6. An aluminium, adjustable bench mounting which is suitable for all types and sizes of beam mount engines.

at this stage. Many of these recommendations are also applicable to glowplug motors, but further information concerning glowplug engine characteristics will be found in Chapter 16.

First, check that the control settings are in accordance with the maker's instructions. Flick the engine over several times. Take notice of how the engine feels and sounds while you are doing this.

Now fill the fuel tank, place a finger over the end of the carburettor air intake to completely choke it and turn the prop three or four times. (Fig. 7.)

Uncover the intake and flick the prop once or twice. You will note that it now sounds " wet " and that there is a slight sucking sound in the carburettor. You may, if you are observant, also notice that the engine turns a little more freely—due to the lubricating action of the fuel which loosens any gummy residual oil.

The engine should now start within a few smart flicks of the prop. If it does not fire within, say, 20 flicks (we are tending to err on the generous side to avoid risk of flooding), choke the intake again for a couple of flicks and try again.

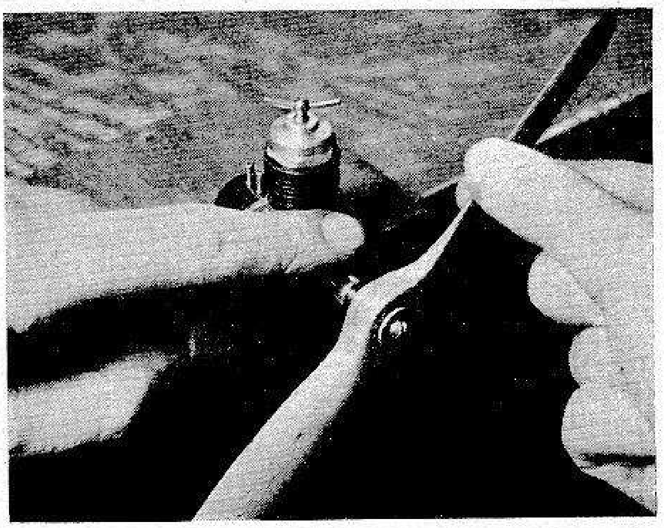


Fig. 7. "Sucking-in" prior to starting. The forefinger of the left hand covers the carburettor intake.

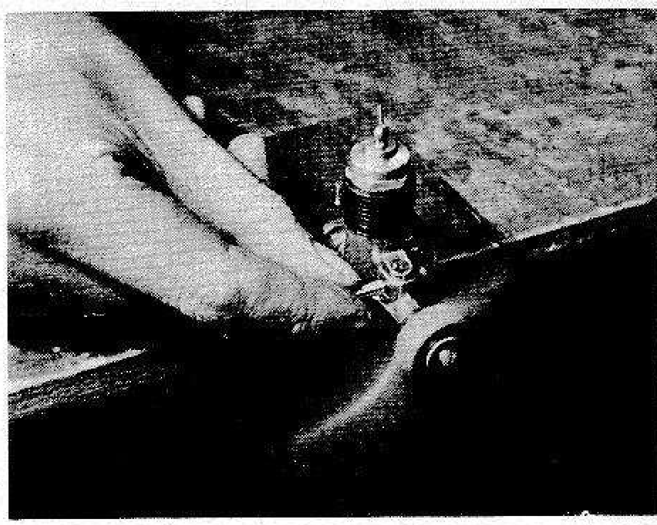


Fig. 9. Best performance is obtained with a relatively fine needle-valve opening.

If the engine still does not fire, increase the compression very gradually until it does. If, when the engine fires, it will not now continue to run, reduce the compression slowly. It is possible that, in the process of finding the starting compression, an excess of fuel has been drawn into the crankcase which is now being thrown up into the combustion chamber each time the engine fires. As it is used up, so the lever can be screwed down again until the engine is running satisfactorily.

The best performance is obtained with a relatively weak mixture and high compression. Therefore, we close the needle-valve gradually to obtain this. (Fig. 9.) It is less likely that an increase in compression will be required because, as the engine warms up, so the ignition point becomes automatically advanced for higher speed. It may, in fact, be necessary to slacken off the compression slightly. The necessity for this is indicated when the engine begins to slow up. Reduce the compression until a slight misfire is heard, then increase it again until the miss just disappears (Fig. 10.). Running the engine with excessive compression should be avoided.

In general, it should be remembered that the critical needle setting hardly alters with speed or load (i.e. depending on the propeller used), but that the compression adjustment does depend on these factors. Also, to get the engine to run slowly on any prop, all we have to do is slacken off the compression.

To conclude, here is a brief summary of the most common starting troubles and the remedies for them:

1. Engine starts but peters out again after a brief run. Cause: mixture too weak. Remedy: open needle-valve about one-quarter turn more, choke intake for a couple of flicks and re-start.

2. Engine slows down and/or oscillates back and forth or stops. Cause: mixture too rich and/or compression too high. Remedy: close needle-valve, reduce compression, flick prop to work off excess fuel, open needle-valve to lower setting and re-start.

3. Engine runs but misfires. Cause: insufficient compression. Remedy: increase compression.

4. Engine runs but with smoky and oily exhaust, irregularly and with reduced power. Cause: mixture too rich. Remedy: close needle valve slowly until running improves.

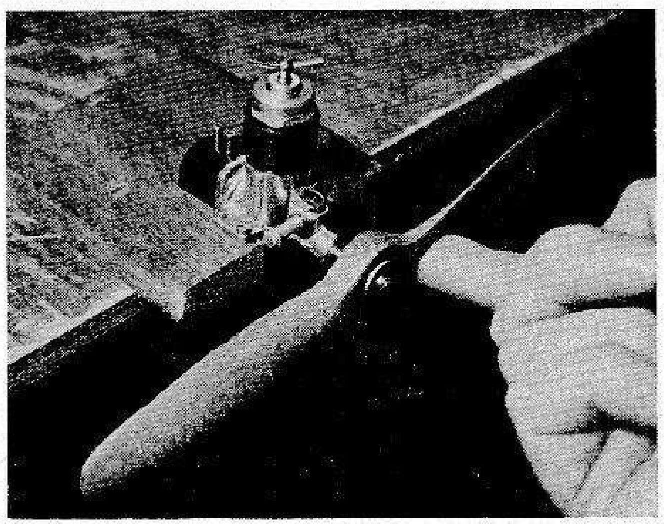


Fig. 8. To start, flick the propeller vigorously with the finger close to the hub.

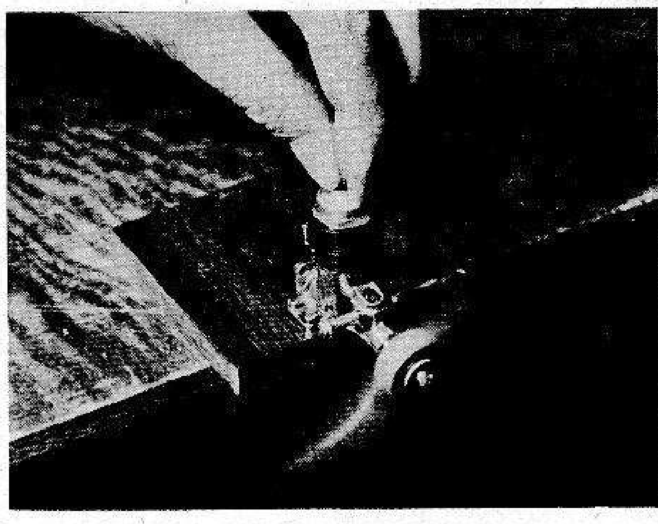
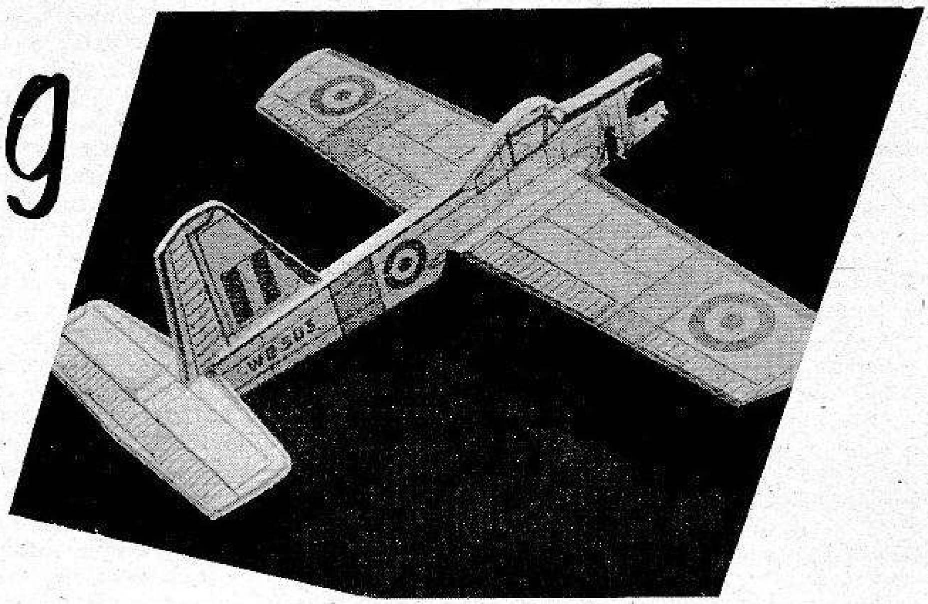


Fig. 10. A degree of speed adjustment is obtainable by turning the compression lever.

Building a C/Line Trainer



CHAPTER TEN

CONTROL-LINE flight is a development of the tethered flying of model aeroplanes which dates back to the late 1930s. In Britain, for example, r.t.p., or "round the pole," became quite popular as a means of flying small rubber models indoors, in halls or large clubrooms. The models were tethered with thread from a wing tip to a pole fixed in the centre of the room. Meanwhile, in America, Victor Stanzel introduced a system, which he called "G-Line," for flying power-driven models. In this, the line was attached to a pole held by the modeller. Then in 1940, Jim Walker, of the American-Junior Aircraft Co., announced "U-Control," which, instead of being merely a means of flying a model in a restricted space, gave, for the first time, actual *control* of the model via a linkage to the tail elevators.

In place of a single line, U-Control uses a pair of lines connected to a pivoted *control-plate* or *bellcrank*. Pulling on either one of these lines causes the bellcrank to swivel, moving, in turn, a push-pull rod coupled to it. The other end of this rod is linked to the elevator. The two lines, which can be of thread or nylon (small models) or thin steel wire (more powerful models), are secured to the top and bottom of a simple handle. Thus, by tilting the handle forwards or backwards (i.e. in much the same manner as the control-stick of a full-size aircraft) the model is made to climb or dive, to perform loops and to fly inverted. The normal radius for C/L flying is between 25 and 70 ft.—the longer line length being used only for fairly powerful models.

Virtually all C/L models use this, the Jim Walker patented "U-Control" system. The only note-worthy exception is the Stanzel "Mono-line" system favoured by some modellers—notably for speed models. In this, a single wire is used and control is effected through rotational movement of the wire. It is of especial value in speed flying, due to the lower drag of a single wire as opposed to two wires for

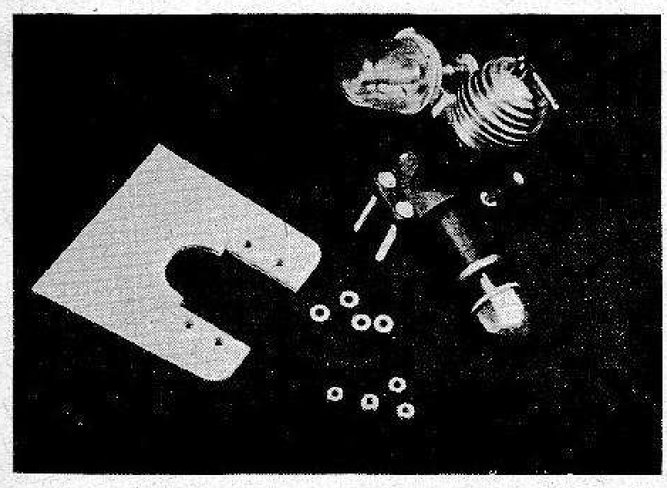


Fig. 1. Trim the engine mounting plate to fit the engine to be used and drill mounting holes accurately.

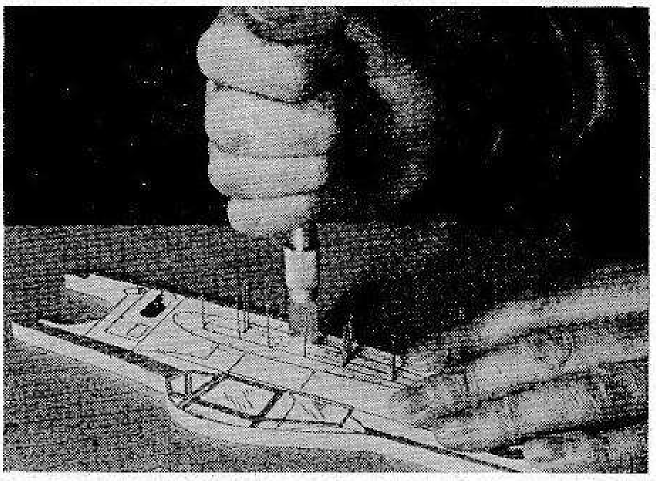


Fig. 2. Cut wing slot carefully, making sure that the tool is held perfectly upright.

the " U-Control " layout.

All C/L models are, of course, quite different from F/F models. For a given engine size, they are always much smaller and very much faster. Except in very specialised types, such as speeds models, it is also usual to find them resembling full-size aircraft more closely than most F/F models. They are always a good deal more solidly made than F/F models.

C/L flying is something that has to be learned. It takes a little practice to get used to controlling the model and the first time you try it, you will almost certainly lose control and crash the model once or twice. For this reason, it is very necessary that you first build a suitable *trainer* model, NOT an elaborate and highly vulnerable scale model, or a hot stunt job or speed model.

Fortunately, there are many suitable small trainer models for which kits are available. These are usually of the " profile " type with solid balsa wings and tail-units and are extremely easy and quick to build. Even if you have never constructed a model aeroplane before, you should have no difficulty in building up any of the kit models of this type.

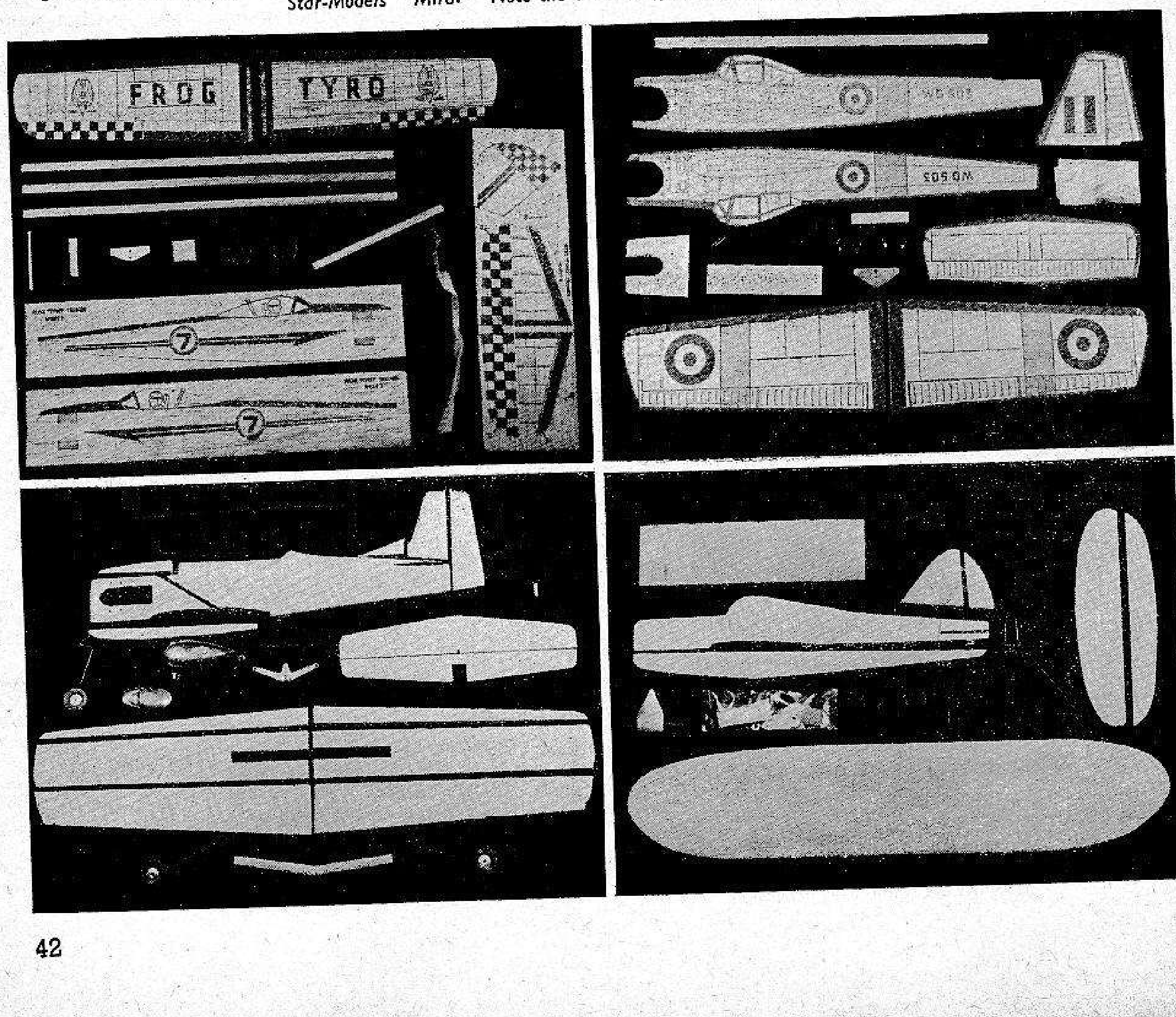
This type of model is offered by a number of manufacturers. Fig. 3 shows the contents of four such kits. The British made Frog *Tyro* and Veron Percival *Provost* are obtainable from any model shop in Britain and in many other countries also. In addition are shown the Jim Walker *Firebee*, popular in America, and a new German model, the *Mira*, which is now available to Continental modellers. Other popular profile models are the Keilkraft *Champ* and the Jasco *Trojan*.

The model we have chosen for our photographic sequence is the Veron *Provost*. This, of course, is a semi-scale model based on the Percival *Provost* R.A.F. trainer aircraft. It has a span of 18 in. and is suitable for the up to 1/10 h.p. motors we recommended in chapter nine. The kit is of the prefabricated type, all parts being ready cut out and such items as the steel wire undercarriage struts are ready shaped. It is also " pre-decorated "—i.e. the balsa panels are printed with R.A.F. markings, etc., so that merely clear doping the finished model will suffice. If desired, of course, the model can, instead, be colour doped in the usual way.

This model differs from some other profile fuselage models in that the " fuselage," instead of being made from one piece of thick sheet balsa, consists of two $\frac{1}{8}$ in. sheets with a simple outline frame between them. In most respects, however, the model is similar to others of this type and the following notes, while not applicable in any detail to other designs, can be regarded as covering models of this type in general.

The first thing to do is to check the plywood engine

Fig. 3. Four typical profile trainers. Left to right, top to bottom: Frog " Tyro," Veron " Provost," Jim Walker " Firebee " and Star-Models " Mira." Note the extensive prefabrication of these kits.



mounting plate against the engine to be used. The motor is, of course, side mounted and, if necessary, the slot in the mounting plate must be trimmed so as to fit the crankcase properly. We chose the Mills 75 motor to power the model and this entailed widening the slot slightly as shown in Fig. 1. At the same time, four bolt holes were bored, using a 3/32 in. drill. Make sure that you get the holes correctly aligned. The best way to do this is to first position the engine and mark one hole. Drill this, then fit the engine in position with a single bolt and nut and mark the other three.

Next, pin the two sides together temporarily and cut out the slots for the wing and undercarriage mounting. The best way to do this is to use a chisel point modelling tool and to first drive pins vertically through the two sides along the lines marking the wing slot. Make sure that the pins are vertical and in line. Using the pins as a guide, it is now a simple matter to cut straight through the two, using a tool such as the X-acto No. 5 handle with No. 18 chisel point blade. (Fig. 2.) Alternatively, a steel-backed "Ever-Ready" razor blade can be used if care is taken to ensure that it is held quite vertically.

The two side panels, still pinned together, may now be smoothed along their edges, top and bottom, with a sandpaper block, to ensure that they are identical.

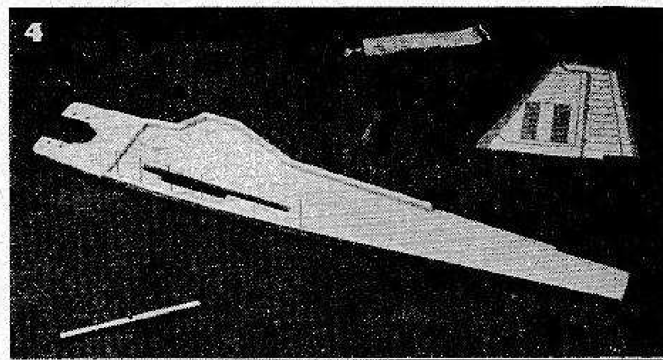
Unpin the two sides and lay the right (starboard) panel on the building board, printed side downwards. Position the plywood engine mounting on the side panel and then pre-cement both surfaces. While these are drying, pre-cement a length of $\frac{1}{8}$ square balsa on one edge and also pre-cement a border $\frac{1}{8}$ in. wide around the edge of the side panel. Always rub the cement well into the grain when pre-cementing.

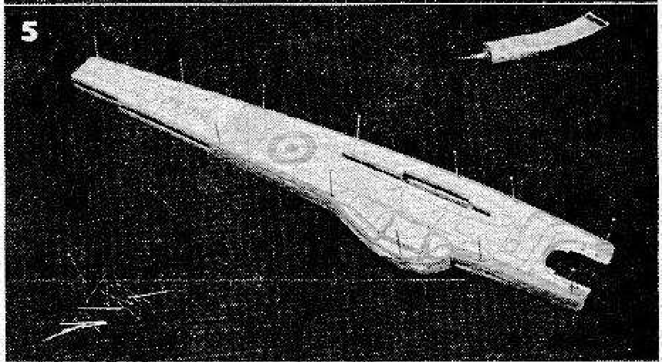
Coat the engine plate again with cement and press firmly into place on the side panel. Now add the $\frac{1}{8}$ square outline strips as shown, pinning the curved bottom strip in position. (Fig. 4.) Finally, add the second side (remembering, of course, to pre-cement bare wood surfaces) using pins to hold the panel securely in position while the cement hardens. (Fig. 5.)

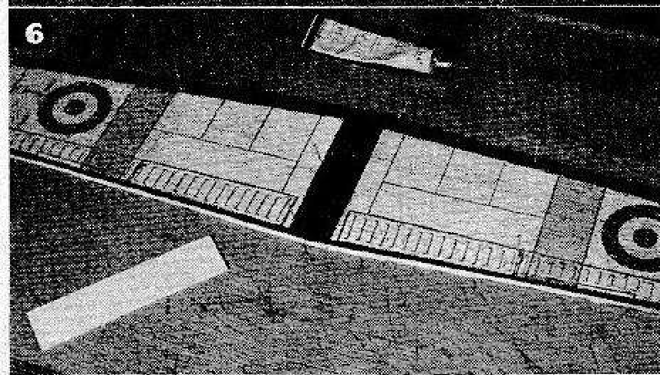
The wing is supplied in two panels which must be joined at the centre with the 4 in. × 1 in. plywood plate supplied. Liberally pre-cement the two adjoining edges and pin one wing panel flat on the building board. When the cement coating is dry, apply the second coat and firmly butt the second panel against the first, pinning this, too, to the building board as shown in Fig. 6.

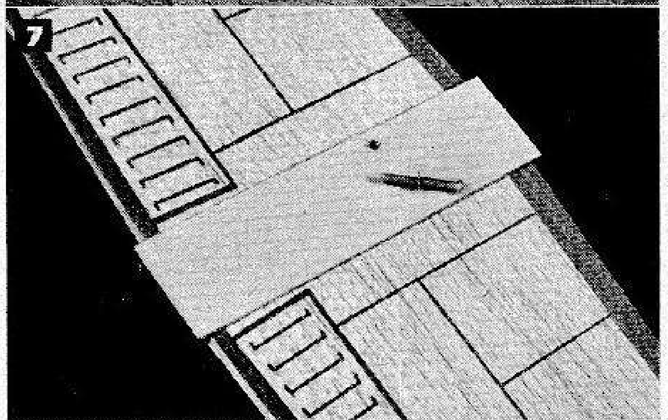
Before the ply plate or gusset is fitted, it should be drilled for the bellcrank pivot bolt and while the wing is drying, therefore, the other plywood fittings can be cut and drilled. These consist of two line-guides, an elevator horn and a small reinforcing plate for the bellcrank pivot bolt which is cemented to the lower surface of the wing. The two holes for the undercarriage fixing bolts can also be drilled at the same time. These are all seen in Fig. 8. Also, drill the pivot hole through the wing in the indicated position.

Liberally pre-cementing the two surfaces, fit the ply plate to the centre section of the wing and allow ample









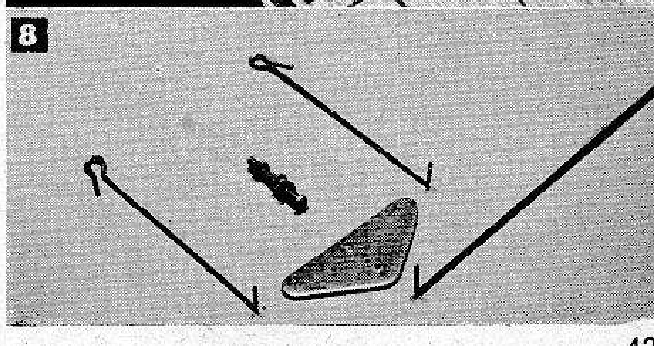


Fig. 4. Fit the motor plate and fuselage panel.

Fig. 5. Fit second side, pinning while cement dries.

Fig. 6 Butt joint wing panels at centre after pre-cementing edges liberally.

Fig 7. Firmly cement plywood centre section plate over wing joint. Align holes with bolt.

Fig. 8. Parts of the bellcrank assembly showing the two lead-out wires, pivot bolt, pushrod and control-plate.

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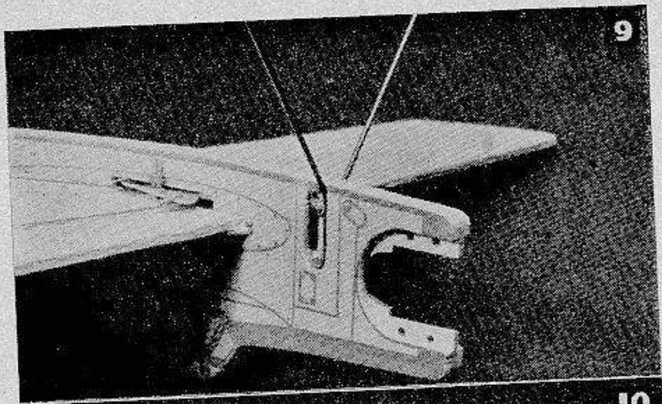
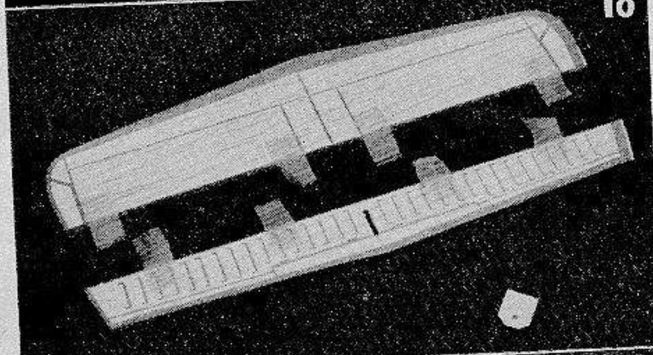
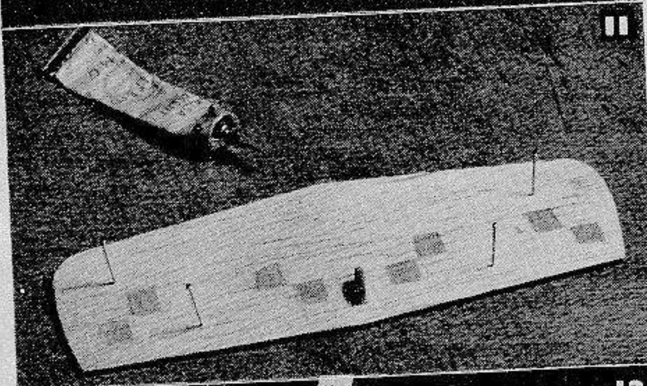
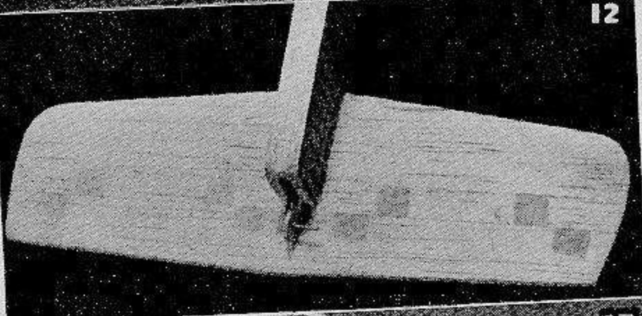
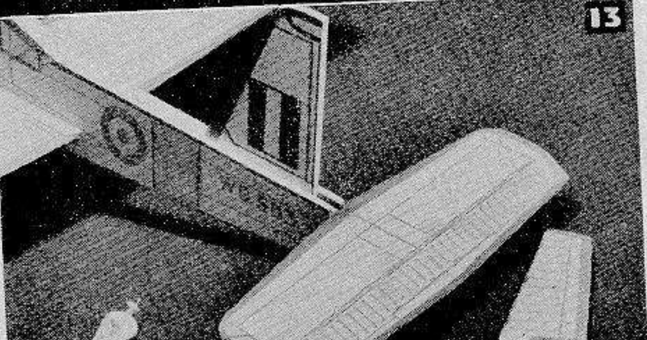










time to dry before removing from the building board. Make sure that the pivot holes are correctly lined up by temporarily inserting the bellcrank bolt. (Fig. 7.) Then fit the small bottom ply plate and the two ply line guides to the wing tip.

The bellcrank components are seen in Fig. 8. Cement the wing in the fuselage slot, making sure that it is at right angles to the fuselage. Insert the push rod through the fuselage and engage the bent up end with the bell-crank, having previously fitted the two lead out wires to the latter. Now insert the pivot bolt through the wing from the top and secure it to the wing with a nut between the bellcrank and the bottom surface of the wing. Add a washer and nut so that the bellcrank is free to swivel but without wobbling about. Set this adjustment with a second nut locked against the first. The complete assembly can be seen in Fig. 9. It should be stressed here that the bellcrank must move absolutely freely. If the lead-out wires should tend to bind in the fuselage slot, trim away the wood at this point to allow unrestricted movement.

The next thing to do is to fit the undercarriage struts. This is a simple matter and is shown in Fig. 9. The wheels are retained with washers soldered on the ends of the axles, or special wheel retaining clips, obtainable at some model shops, can be used.

The tailplane should be cut cleanly along the hinge line with the aid of a straight-edge. Cut out the slot for the elevator horn also. The tailplane and elevator are connected with cloth hinges as shown in Fig. 10. Tape is supplied in most kits for this purpose. Our personal preference, however, is for silk or nylon hinges, as shown, so as to keep the control system as free as possible. The method of fitting the hinges will be evident from study of Figs. 10 and 11. After cementing them to the top surfaces as shown in Fig. 10, the tailplane and elevator are turned over and brought together with the hinges folded upwards. With the tailplane and elevator pinned down to the building board, the protruding ends of those hinges are now cemented to the upper surface of the tailplane are now cemented to the lower surface of the elevator, and vice-versa. The ply elevator horn is also cemented in position, using plenty of cement.

The tailplane is now fitted in position on the fuselage. (Fig. 12.) Before cementing it, however, check that, with the pushrod end inserted through the elevator horn, the elevator is level when the controls are neutral. You may find that the elevator is slightly " up " or " down." If so, the tailplane may be repositioned slightly, forward or backward, so as to correct this tendency.

Finally, divide the fin and rudder, again using a straight-edge, and securely cement the fin in the fuselage slot. (Fig. 13.) The rudder is cemented in position with an offset to the right—see heading photograph.

After lightly sandpapering any rough surfaces, such as the underside of the wing, the *Provost* only requires doping to finish it. We suggest two or three coats of banana-oil as very suitable. It must be understood that doping of some kind is essential, otherwise the model will be quickly ruined by oil, blown out of the exhaust.

Fig. 9. The undercarriage legs are fixed with two bolts and nuts to the ply engine mounting plate.

Fig. 10. Tailplane and elevator, showing hinges and elevator horn.

Fig. 11. The underside of the tailplane assembly showing how the hinges connect the elevator and tailplane.

Fig. 12. Cement tailplane to fuselage, ensuring that elevator is level when bell-crank is centralised.

Fig. 13. Cement the fin in position, then fix rudder with offset.

Flying your C/L Trainer

Heading photo shows the completed Veron Provost and (left) another excellent C/L trainer, the Jasco Trojan

CHAPTER ELEVEN

MOST people, on first witnessing a control-line flight, want to ask the pilot : "Don't you get dizzy, turning round like that ?" The answer is yes, but only at first, when learning.

Most control-line models, apart from pure speed models and team racers, make one lap about every five seconds. This figure holds good for both large and small models because the bigger and faster machines are flown on proportionately longer lines. A useful indication of suitable line length is, in fact, "one foot per m.p.h.," e.g. 30 feet for a 30 m.p.h. model, 70 feet for a 70 m.p.h. model.

The majority of learners experience some dizziness at first, but after a few flights this is soon overcome. If dizziness appears to persist, make sure that you are not flying on lines that are too short, or against a background that is too close. Other rules for avoiding giddiness are (a) keep your eyes on the model constantly and (b) start off by making short flights of not more than four or five laps.

In the previous chapter we dealt with simple profile trainers, including the construction of a typical example, the Veron *Provost*, in which we used a Mills 75 Diesel.

Fig. 1 shows how the Mills 75 is installed in this model, utilising the existing fuel tank. The locknut securing the carburettor venturi is slackened and the entire carburettor unit and tank is then merely rotated so that the fuel bowl is vertical when the engine is side mounted. Note that the engine is installed with the cylinder to the right—i.e. the outside of the circle. This is most important, for the weight of the cylinder helps to balance the weight of the control-lines on the inside. Some models have a small lead counterweight built into the outer wing tip for this purpose.

In some other types of models, and when using an engine without a suitable integral fuel tank, a separate installation will have to be made. Fig. 2 shows such an installation. The model is a Jasco *Trojan* (another very simple profile trainer which can be highly recommended) powered by a German Taifun Hobby engine of 1 c.c. capacity. In this, a metal wedge-shaped fuel tank of the 15 c.c. Class A team-racing size is fitted to the fuselage by means of a sheet aluminium strap and two screws.

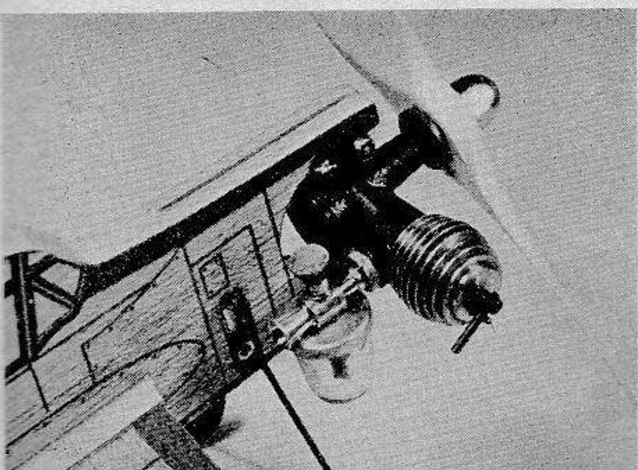


Fig. 1. How the Mills 75 is installed in the Provost using the standard Mills tank turned through 90 degrees.

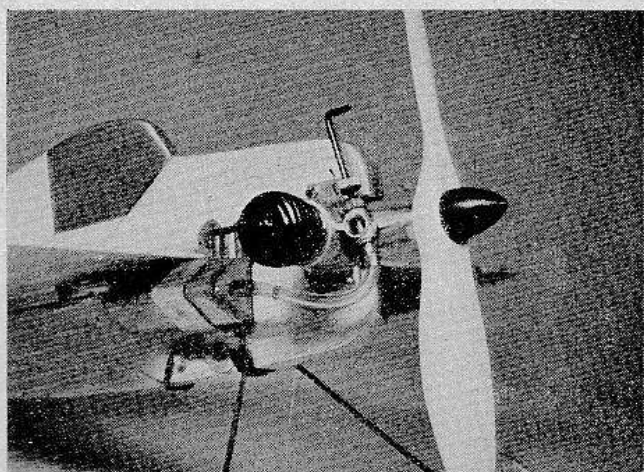


Fig. 2. A typical installation where a separate tank is used. Model is the Jasco Trojan fitted with a 15 c.c. teamracer tank.

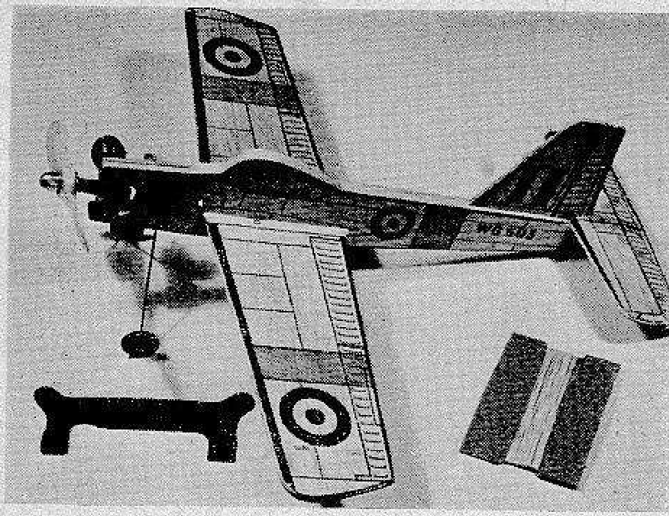


Fig. 3. The Provost trainer, as detailed in our previous chapter, ready to fly. Shown also is a simple control handle made from sheet fibre.

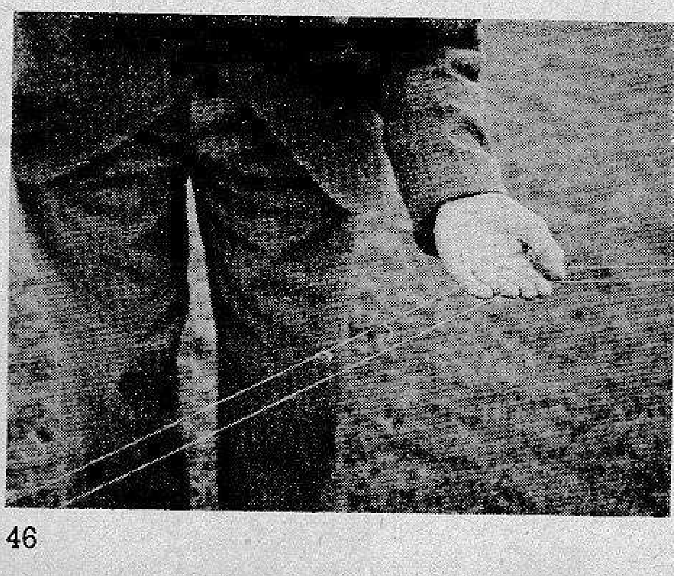
Before fitting the engine, make quite sure that all woodwork has been adequately doped. If you have built the *Provost* and elect to leave it in its natural printed wood colours, it must have at least two or three coats of No. 1 (thick) banana-oil. Brush the dope on liberally and well into all corners and joints.

If the model is to be colour doped, it should first be treated with two coats of " sanding sealer " to fill the grain, which, after rubbing down with fine sandpaper, can be followed by two thinned coats of coloured dope, put on with a soft sable brush.

The ideal final protection against deterioration by fuel is a fuelproof varnish. This, while not strictly necessary with diesel engined models, is essential where a glowplug engine is being used, on account of the tendency for methyl-alcohol based glowplug fuels to dissolve cellulose based dopes. Most of these " fuelproofers," as they are popularly called, are sold with a small, separate bottle of " hardener " which is added to the proofer just before brushing it on to the model.

Proofer is much more economical than dope and only a very little is needed to cover a complete model. Therefore, you will need to mix only a small quantity at a time.

Fig. 4. Always check the condition of the control lines before flying the model. They must not be frayed or weakened.



Pour a little of the varnish into a small container—the lid of a dope jar will do—and stir in not less than 10 per cent. hardener. You can safely use more hardener than this, but don't try to cut the amount down because, if you do, the varnish may remain tacky indefinitely and make the model a terrible mess.

In the United States, fuelproof varnishes have largely been superseded by special fuel-resistant butyrate dopes. A fuelproof coloured dope of this type is now also available in Britain. It is known as " A.F.P." and is made by Messrs. Hamilton Model Supplies.

If possible, all doping, etc., should be completed at least a day before you intend to fly the model. This will give the finish plenty of time to harden before handling and fitting the engine, etc.

The engine is, of course, mounted with small machine screws and nuts. It is preferable, also, to have small washers under all screw-heads and nuts and, to prevent the possibility of the nuts working loose with vibration, it is advisable either to use a second nut on each bolt, locked against the first, or to use a special type of " shake-proof " nut, such as the " Oddie " or Simmonds " stop-nut."

Fig. 5. With the aid of a helper, the pilot should check the controls for free movement and correct centring.

As regards propellers, the beginner cannot do better than to purchase one of the flexible plastic types, such as the Frog, " Tru-flex " or E.D. plastic pattern. Unlike wooden props, which break easily, these flexible airscrews will survive innumerable crashes and hard landings. For the Mills 75, we chose an E.D. $6\frac{1}{2} \times 7$ prop. A 7×6 prop would be equally suitable.

Before you can fly your first C/L model, you must, of course, have a C/L handle and lines. You can purchase a good handle from your model shop which will also serve for all your future C/L models. Alternatively, you can make one very cheaply from plywood or fibre. A suitable shape is shown in Fig. 3. The distance between the two control-lines where they are attached to the handle should be approximately 4 in. Shape, or otherwise mark, the handle so that the top is easily distinguished from the bottom.

The type of control-line used today depends very much on the model being flown and, for most types, thin steel control-lines are used. These have two advantages. Firstly, being thinner, for equivalent strength, than any

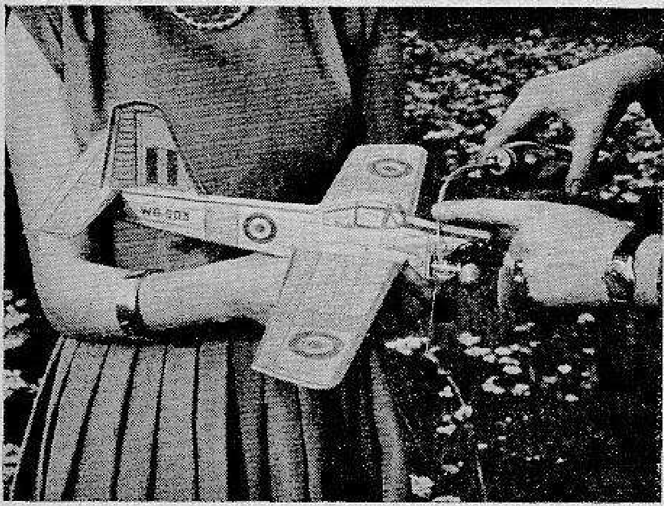


Fig. 6. Do not overfill the fuel tank for your first few flights. Have sufficient only for three or four laps.

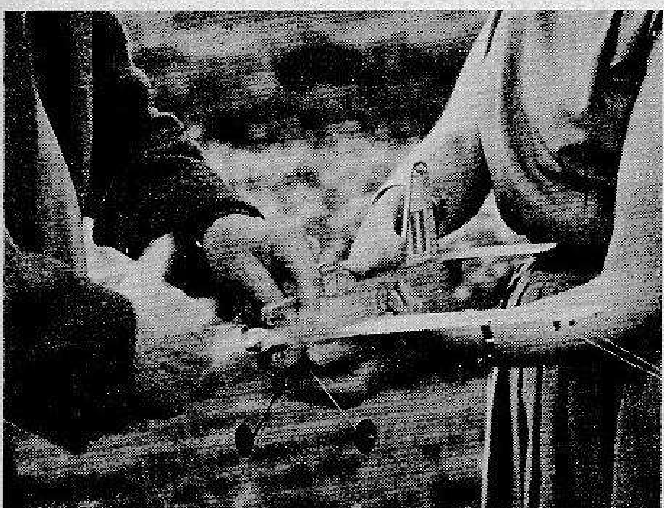
other material, they present minimum drag, thus permitting the highest performance. Secondly, for aerobatic work, they still maintain control (by sliding over each other) after being twisted together by a succession of loops and other manoeuvres.

For small trainer models, however, a thin fishing line or strong carpet-thread is quite adequate. Heavy lines should be avoided. The length should not normally be less than 25 feet. In calm weather, this can be increased up to 30-35 feet.

The thing to remember about line length is that it has to be a compromise. If the lines are short, the model laps much faster, is closer to you and seems even faster and you have to think and act more quickly. Long lines, on the other hand, give you a more leisurely flight, but also a tendency towards less positive control due to reduced line tension.

Line tension is of the utmost importance. If the lines become slack, the elevator control will become ineffective and, if the model is high and sideslips towards the centre of the circle, a crash is then a certainty. Most C/L models, with the exception of speed models, therefore incorporate certain features designed to augment the

Fig. 7. When starting up, your helper should hold the model firmly. The wearing of a wristwatch is not recommended, however, because of fuel blown back by the slipstream.



action of centrifugal force in keeping the model pulling outwards.

The most common of these features is the offset rudder. Another most effective system is the positioning of the bellcrank pivot behind the centre of gravity. Some designers also offset the engine thrustline outwards.

Other safety features sometimes used are weighting the outer side (as previously mentioned) and making the inner wing panel of slightly larger area than the outer wing. These do not rudder the machine outwards but, instead, tend to bank it away from the centre of the circle if line tension should be lost.

When you are ready to make your first attempt at C/L flying, try to find a helper who is familiar with control-liners. If he is an experienced C/L flier, let him check over your model. In fact, if you have seen him in action and have confidence in his ability, it is a good idea to get him to test fly your model. Probably the first thing he will do is to check your controls by working the leadouts back and forth. These should move absolutely freely.

One other point. Don't attempt to learn to fly on a

Fig. 8. The arm position generally recommended when learning. Correction of climbing or diving is made by moving the arm down or up from the shoulder.

windy day. Wait for calm conditions and, for preference, pick a field of long grass or soft weeds.

Lay out your control-lines, attaching them securely to the handle and to the leadout wires from the bellcrank on the model. Make a habit of inspecting the lines before use to ensure that they are not frayed or otherwise weakened (Fig. 4).

Now get your helper to hold the model aloft. Take up the handle and try the control movement (Fig. 5). Note how the elevator rises and falls as you move the handle. As already mentioned, the controls must move smoothly and freely. With the handle held upright, the elevator should be neutral, i.e. level and in line with the tailplane. Adjust the line length until this is so.

The lines should be laid out so that the take-off or launch is made *downwind*. If the launch is made upwind, like a F/F model, there is a danger of the model climbing too high and with too little speed during the first quarter of the circuit and then being blown inwards by the wind as it turns side on.

Lay the handle down where you can easily see it and prepare to start up. For the first few flights it is not

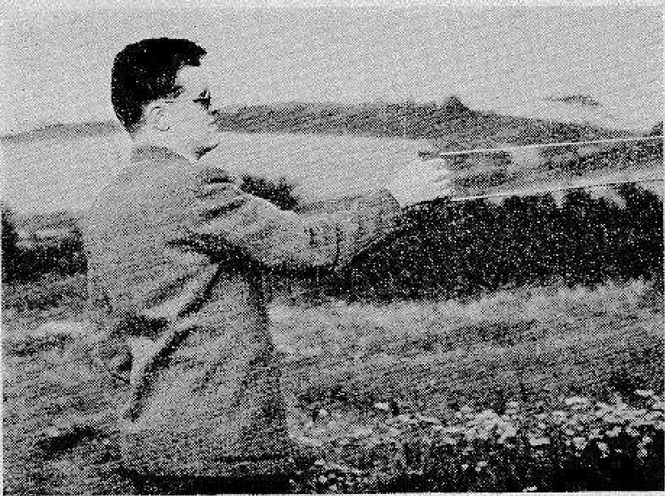


Fig. 9. A more relaxed attitude which is naturally acquired when one has mastered the art of holding the model on a steady course.

advisable to have too much fuel in the tank: enough for one minute's running time is more than enough and will allow you 30-40 seconds to adjust the running of the engine and to get back to the handle and settle yourself for the take-off. You should not attempt to fly the model for more than 15-20 seconds for each of your initial flights. *Make sure that you are holding the handle the right way up.*

The simple fact that you must keep before you at this time is that the model, even though it is only a simple trainer, is quite sensitive to the movement of the elevators. A slight movement of the wrist (Fig. 10) and the model will immediately climb or dive. Until you are used to C/L flying, your anticipation will be slow, with the result that you will tend to *over-correct, too late.* You may quickly find yourself in trouble, with the model going all over the sky and your responses quite unable to keep up with it. There is only one sequel to this. Seconds later the model will dive straight into the ground.

The first thing to do to avoid this kind of trouble is to keep your arm, and especially your wrist, quite stiff and to control the model by movement of the arm from the shoulder only (Fig. 8). When you start off, do not forget this. Keep your arm stretched out straight in front of you and slightly in front of the model. During these first few flights, try only to keep the model *level.* If it begins to sink too near to the ground, raise the whole arm a few inches and the model will come up again. If it climbs too high, bring your arm down.

Fig. 10 The tendency to attempt to control the model by wrist movements must be strictly avoided by the beginner.

Your *only* concern during these first few flights should be with letting the model fly a steady, level course. As yet, you are really quite unfitted to *control* the model. You must first get used to the *feel* of the model as it flies round on the end of the lines you are holding. Forget all about " stunts "—even those of the mildest type. These will come later easily enough, but only when you are able to keep pace with, and in fact anticipate, the model, so that you are, in effect, controlling the model instinctively.

You can either take the model off the ground (in which case you need a really smooth and level take-off strip) or you can get your helper to hand-launch it for you (Fig. 11). In either case, the lines must be taut and the model directed straight out at a tangent to the circle and not *into* the circle. Your helper should, of course, always await a pre-arranged signal from you to indicate that you are quite ready, before he releases the model.

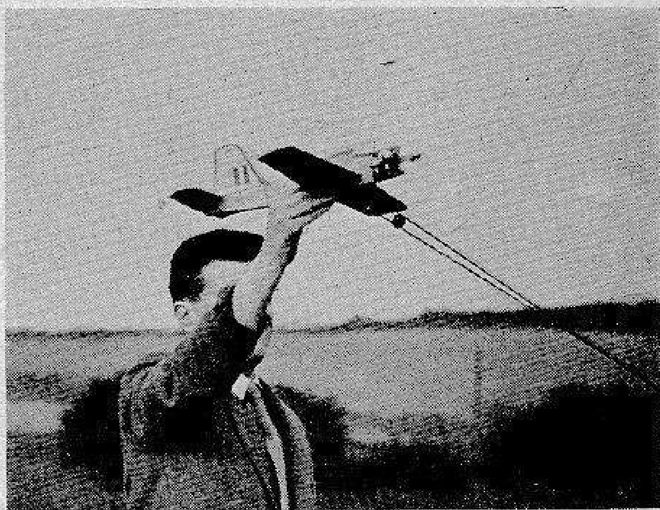


Fig. 11. Hand launching. The model must be launched downwind and at a tangent to the circle so that the lines are kept taut.

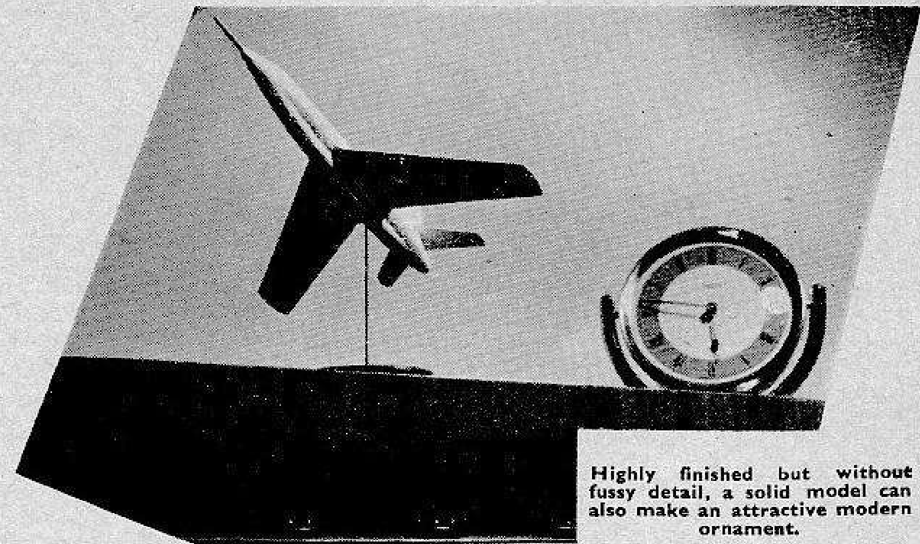
If while you are flying the machine, you feel the line tension slacken, take a quick pace or two backwards. If done promptly this will prevent loss of control. *Do not* merely pull the handle towards you or back over your shoulder.

Incidentally, an excellent way to learn to fly a C/L model is to have an experienced " pilot " in the centre of the circle with you. He can take the model off, transfer the handle to you when the model is level and take over again if you get into difficulties.

When you go flying, don't forget the accessories. Nothing is more frustrating than to find that you have forgotten some small tool and cannot get on without it. Remember to take a prop spanner or tommy-bar, screw-driver, pliers and a piece of rag. If you add a tube of cement, some pins and a small roll of cellulose tape, you may also be able to effect a quick repair on the spot if you have the misfortune to damage the model.

Finally, two safety " don'ts " concerning C/L flying in general. Firstly, don't fly anywhere where spectators cannot be warned or otherwise controlled. Secondly, never fly near overhead power cables.

Solid Scale Models



Highly finished but without fussy detail, a solid model can also make an attractive modern ornament.

CHAPTER TWELVE

WHEN people take up aeromodelling, they generally do so for two reasons. Either they have a keen interest in full-size aeronautics, which leads them to want to own models of their favourite aircraft, or they make models mainly for the enjoyment of building and/or flying them.

There are, of course, a few model builders who have little or no interest in full-size aviation, but, generally speaking, not even the keenest exponent of the " functional " type model is oblivious to the fascination of an accurate and well-finished scale model.

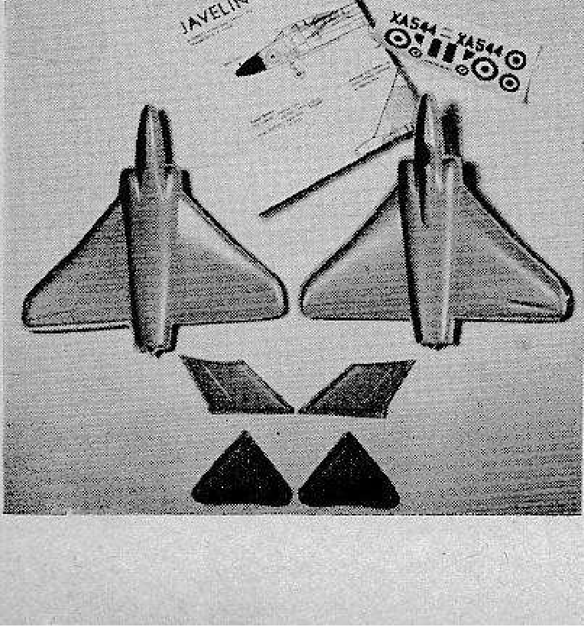
Our purpose in this chapter, therefore, is to discuss the non-flying scale model : the " solid " or " display " model.

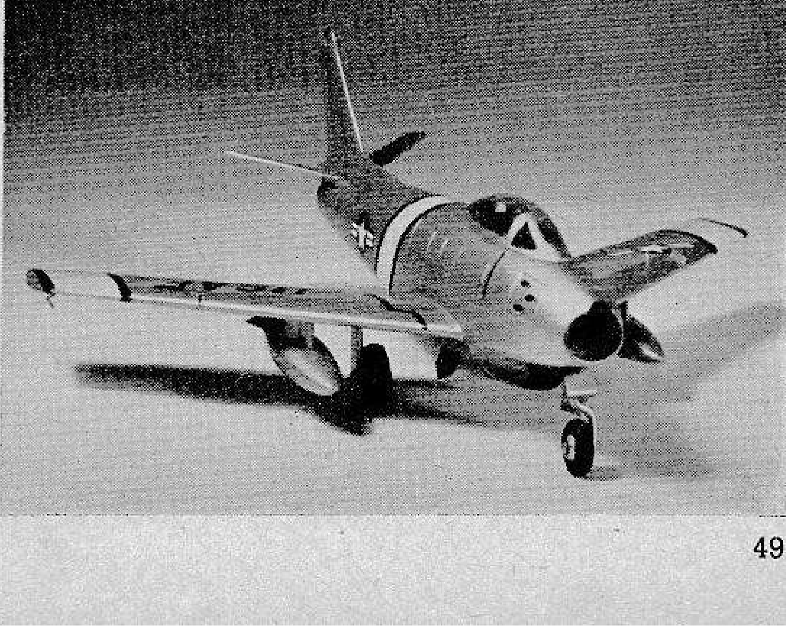
So far as the model industry is concerned, the solid model is one of its earliest products. Long before flying model kits came on the market, enthusiasts were buying hardwood kits of World War I favourites : Sopwith *Camels*, Fokkers, S.E.5a's and the like. When balsa-wood flying model kits came along in the mid-nineteen-thirties, many model builders turned to flying-scale models and to other more functional types, but the " solid " has never lost its appeal to a hard core of keen modellers and was particularly popular during the war years. Recently, solids have been making a strong come-back assisted by the new moulded plastic kits.

In Great Britain and the United States there are now hundreds of different kits and plans available for solid models. The kits are mainly in three types : those of balsa construction, to which a few diecast metal or moulded plastic parts such as propellers, wheels, etc., are added ; those in which a harder wood is substituted for balsa ; and those employing ready-made plastic mouldings throughout, which are joined with special cements.

Most modern balsa kits have all components partly pre-shaped. That is to say, the wing and tail surfaces are ready cut to the correct planform, while the fuselage block is also cut to the outline shape in plan and side elevation. Except when symmetrical circular-section

Fig. 2. Alternatives to the popular 1/72 scale are the 1/144 scale Wimco Hollow kits (left), easy to make from moulded polystyrene parts. Allowing a more detailed treatment (right) is a hardwood 1/48 scale F-86F " Sabre."





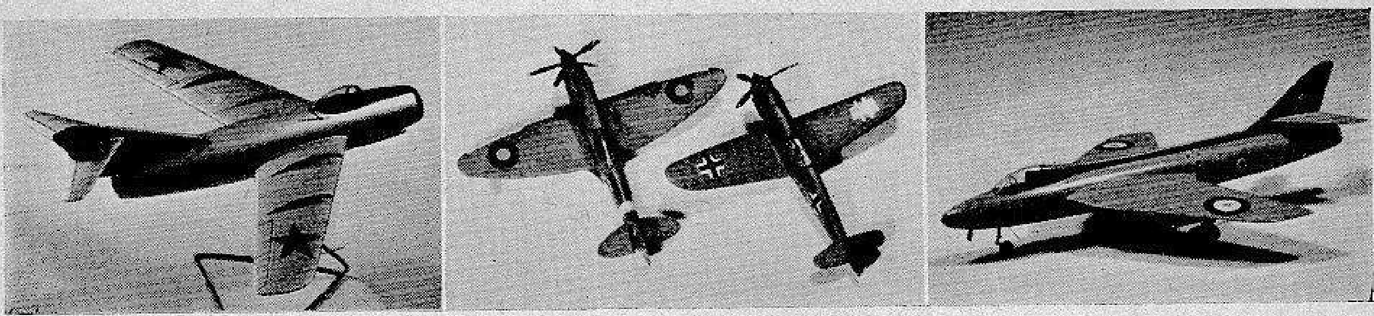


Fig. 3. Where it is desired to assemble a collection of models to the same scale, 1/72 is a convenient size. Many kits and plans are to this scale. Shown, left to right, are four models built from Veron kits: "Mig 15," "Spitfire XIV," "Me.109G" and "Hunter."

fuselages or nacelles are features of the prototype (in which cases these may be supplied turned to shape), it is necessary, however, for the modeller to shape all parts to the correct cross section.

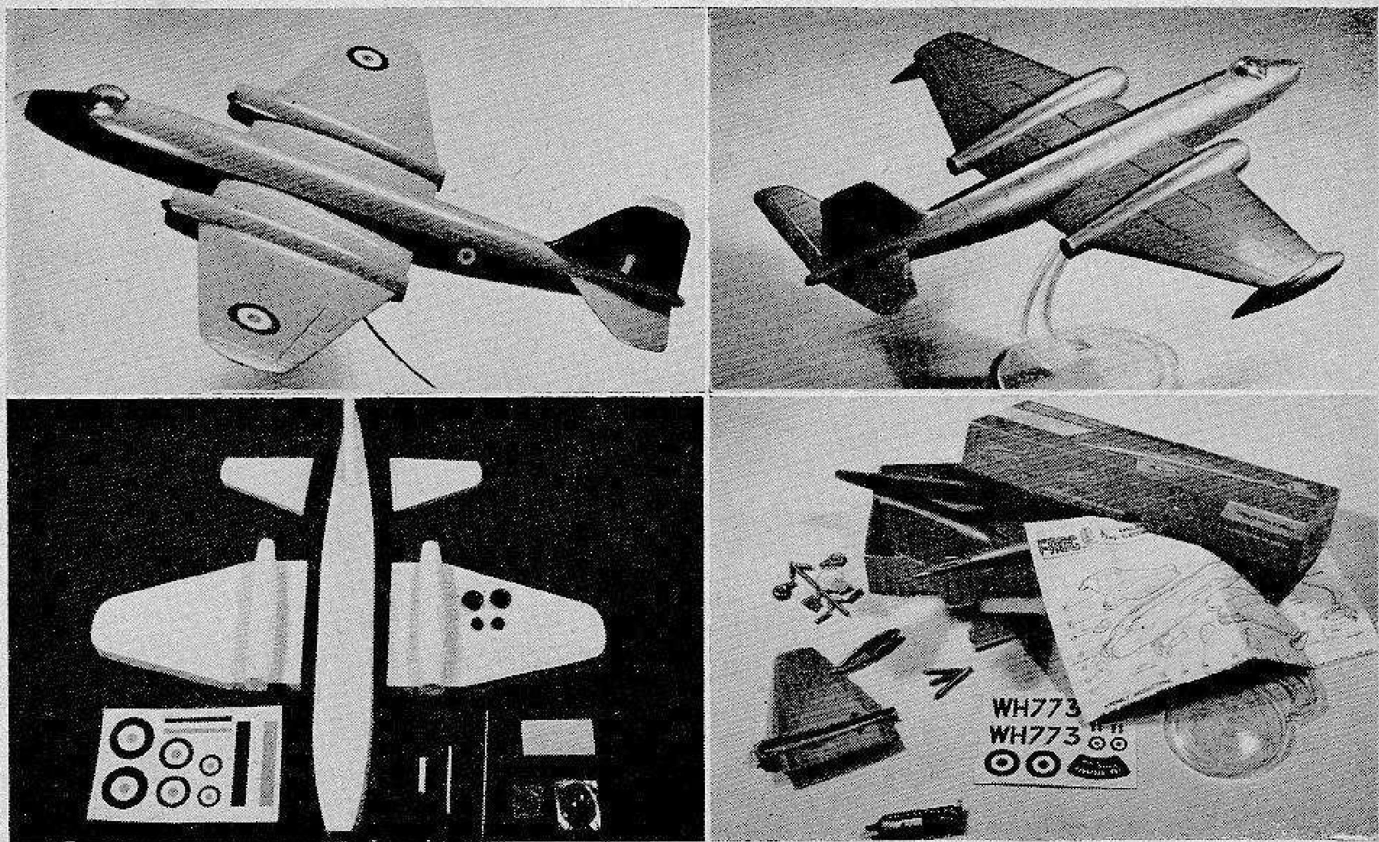
One of the advantages of balsa is that it can be carved and sanded to shape very easily due to the softness of the wood, but this also means that the model will require very thorough grain filling treatment and also that the finished product will be somewhat less resistant to dents and chips than one made from a harder wood. Most of the better solid kit manufacturers are careful, therefore, to choose only a relatively hard grade of balsa, which remains easy to work but produces a durable model.

This is taken a stage further by those kits in which an alternative to balsa, often obeche, is employed. Professional model makers also favour more serviceable woods such as basswood and pine, and examples of their art are to be seen in the many models made for the airline companies, travel agencies, etc.

Moulded plastic kits, which have been gaining immense popularity, first in the United States and now in Britain, have been criticised by some serious model builders as being too easy to make and demanding little or no skill. In fact, while much of the more difficult part of solid modelling is eliminated in these kits, the plastic model nevertheless will, in its finished appearance, repay the attention of the skilled and careful modeller, just as with any other model.

The material used for the parts of these models is usually high impact polystyrene and two methods of manufacture are employed. In the first of these, the parts are pressed shells of polystyrene sheet. This is the form of construction used in the Wimco "Hollows" kits manufactured by Sebel Products Ltd., the pressings being made from flexible 0.025-in. styrene sheet throughout. The second method (as seen on the Sebel Vickers *Viscount*, the Frog series, and many American kits) employs injection mouldings of polystyrene. This allows much more detail and an accurate and simple means of interlocking assembly. It is, of course, somewhat more

Fig. 4. The solid enthusiast has a choice of conventional wood construction or the new moulded plastics. Left is a Veron "Canberra" kit and the model built from it (balsa). Right is the Frog "Canberra" (moulded polystyrene).



expensive, but even so, prices are only a little more than those of traditional wooden solid kits. Some of these models, too, are moulded in a metallic grey polystyrene having almost the appearance of aluminium and, where appropriate, can be left in this very effective natural finish instead of being painted.

A large proportion of non-flying scale models both wooden and plastic are made to a scale of 1 in. = 6 ft., i.e. 1/72 of full size. The choice of a scale depends largely on whether you intend to make a collection of models to the same scale and on the sort of aircraft you propose to include in this.

For example, if you wish to assemble a collection to illustrate the history of the single-seater fighter, you might well choose a scale of 1/48. A *Hunter* will then have a span of 8.4 in., a Bristol *Bulldog* will span 8.5 in., a *Spitfire* 9.2 in., a *Sabre* 9.3 in., and a *Hurricane* 10 in. Such sizes will allow reasonable attention to detailed fittings and markings without making the model look too fussy. If, however, you should want to extend the collection to include bombers to the same scale, this would mean a *Lancaster* of 25.5 in. span, a *Valiant* of 28.5 in. and a 35 in. *Superfortress*, and thus a good deal more bulk than the average collector can cope with for display purposes. In this case it would be better to adopt a 1/72 or smaller scale.

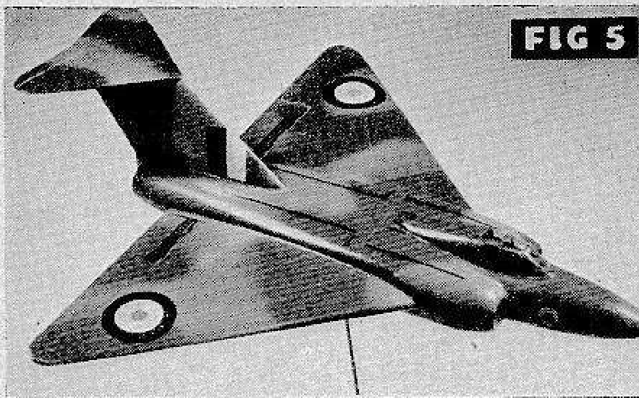
At the present time, by far the largest number of different prototypes of which solid kits are available are those represented by the ordinary balsa kits and it is appropriate, therefore, to deal with these first.

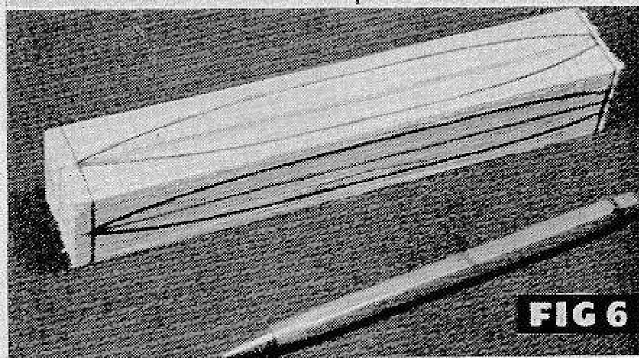
Generally speaking, the beginner will be well advised to seek the advice of a reputable model shop when choosing his first kit. A few of the solid kits on the market are not of the best quality, sometimes having roughly cut parts and inaccurate plans, and since a good kit may cost no more, it is obviously best to avoid the inferior ones.

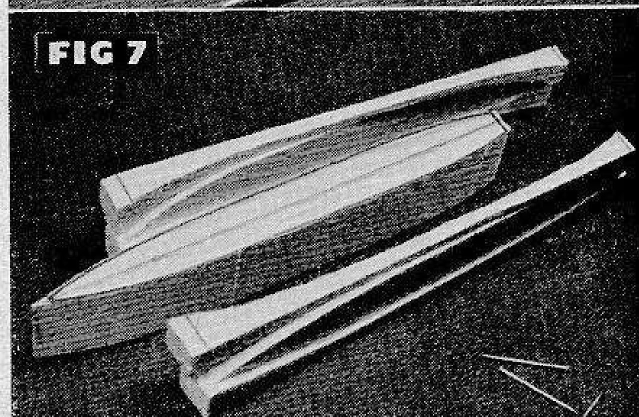
Most wood solids follow the same general design, with wings and tail butt jointed to the fuselage or fitted in a cut-out in the fuselage. In a few cases, such as in the Keilkraft kits, accuracy of assembly is somewhat simplified by the inclusion of a "jig-spar"—a short stub spar joining the wing panels at the correct dihedral angle (if any) and aligning them with the fuselage.

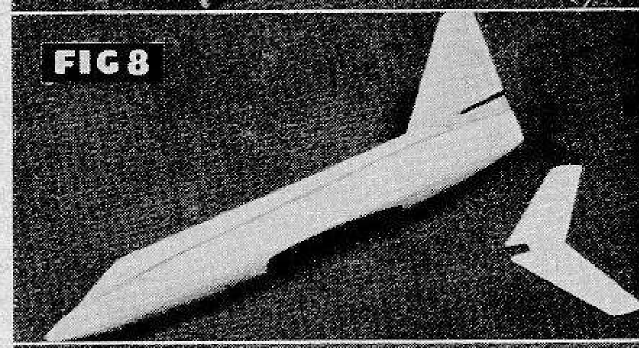
The raw beginner will certainly be well advised to start with a model of simple lines and a minimum of detail. Some types of modern single-engine jet fighters are a suitable choice here, and the Veron MIG-15 comes to mind as a good example.

The practised modeller, on the other hand, may elect to make a model direct from a scale plan, rather than from a kit. Accuracy in marking out the blanks is the keynote here. Taking the fuselage first, this should have the centre-lines marked, followed by top and side outline shapes. (Fig. 6.) The preferred method of then shaping the blank is to use a power jig-saw or fret machine, which will ensure a truly vertical cut, but a coping saw or fretsaw, if used with care, is satisfactory. When the two sides of the blank have been cut to shape, the two offcuts are pinned back in place to restore the blank to its original shape. It can then be turned over and the top and









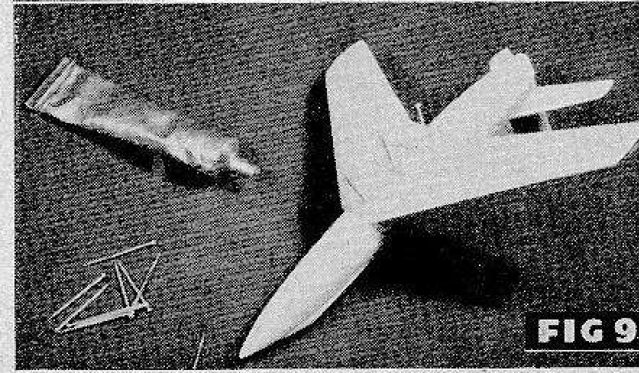


Fig. 5 (top). Another fine Veron kit model, the Gloster "Javelin." Figs. 6-9. Steps in the construction of a simple solid model. 6—Marking out the top and side fuselage outlines. 7—The fuselage outline can be sawn to shape, as shown, or carved. 8—The fuselage carved and sanded to correct sections and interlocking tail surfaces added. 9—The wing is fitted into the fuselage taking care to align it properly.

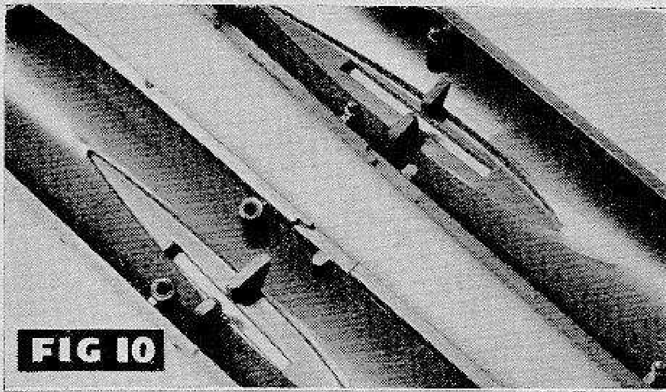


FIG 10

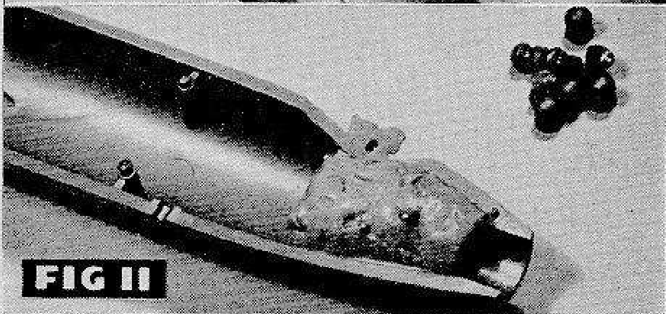


FIG 11

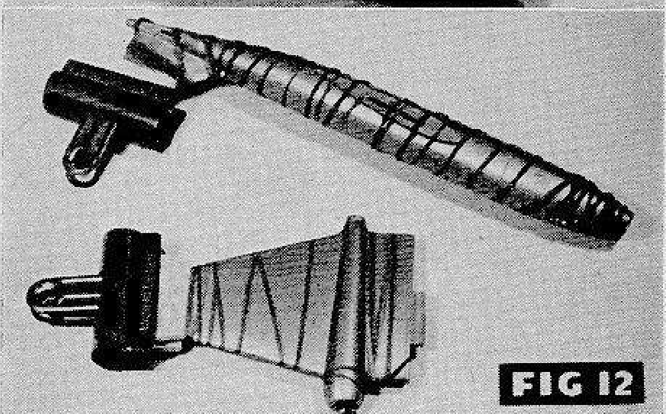


FIG 12

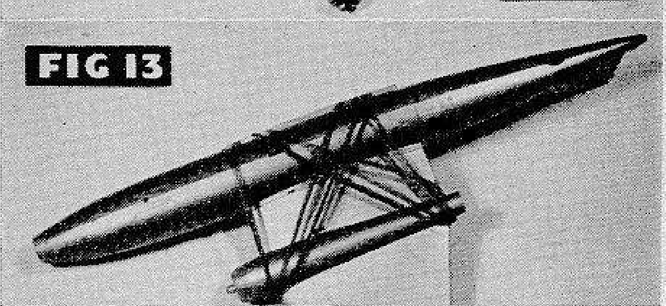


FIG 13

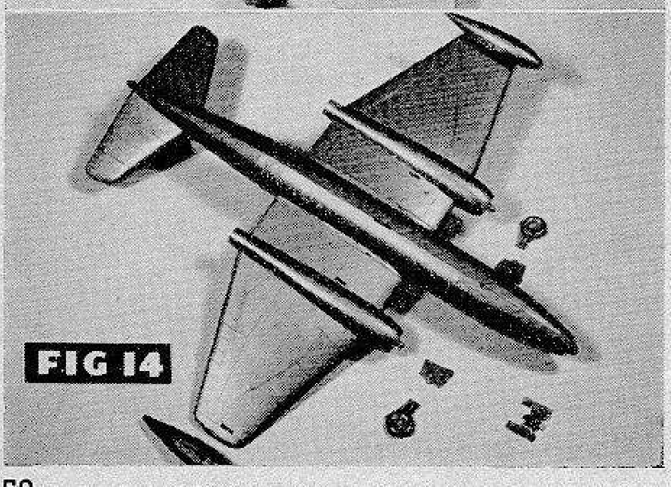


FIG 14

bottom lines sawn keeping outside the line (Fig. 7.)

Where suitable tools for sawing to shape are not available, the blank may, of course, be carved, in which case it is necessary to trace the outlines on both top and bottom surfaces of the block and to then trace the side view shape on both sides of the semi-finished blank. Whichever method is used, the initial shaping should be to the *outside* of the marked lines and the blank finished to size with a sanding block.

Obtaining the correct cross-sectional shape of the fuselage, as well as the aerofoil sections, is facilitated with suitable templates. Most plans show the cross-section at various points and card templates are cut to fit these.

Accuracy and a good finish are the hallmarks of a good solid model, not an excess of detail. When you are satisfied that your model is accurate, give it a coat of clear dope, followed by a coat of sanding sealer. This, by giving the model a matt, one-colour finish all over, will show up any slight imperfections. Rub down smooth with very fine sandpaper and then give another coat of sanding sealer and rub down again when dry. Repeat this process two or three times. Use the sanding sealer properly thinned and keep rubbing down.

When the grain is no longer visible, the colour coats can be applied. The same procedure is adopted of thin coats followed by rubbing down. Use ordinary coloured cellulose model dope, thinned up to 50 per cent. and rub down with silicon-carbide No. 400 wet-or-dry paper. This can be purchased from a garage and is the same as that used by coachbuilders to obtain a high finish on cars. It must not be used " dry," but should be dipped in water and lubricated with a smear of soap.

After several coats, the resultant finish will be beautifully smooth and even, and to achieve a final shine the last coat can be burnished by rubbing with a light application of " Brasso " metal polish and a soft cloth.

In Figs. 10-14, we show the construction of a typical moulded polystyrene model, in this case the 1/72 scale Frog *Canberra* PR.7. The excellent surface of the parts, which even includes rivet lines, is noteworthy, as, also, is the manner in which all parts fit accurately together.

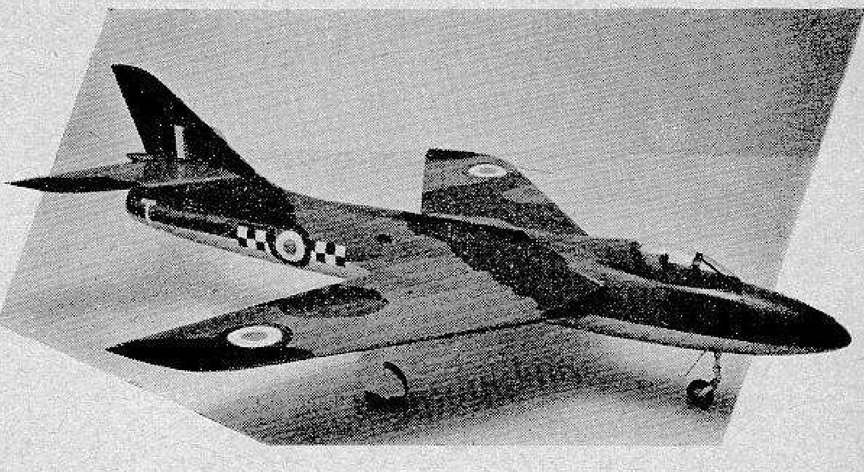
Cellulose cements and lacquers must not be used with styrene and for these kits special polystyrene cements are marketed. These cements have the effect of bonding the components by partially dissolving the surface of the adjoining faces. For this reason considerably more care must be exercised in cementing polystyrene than normal wood models.

For example, if too much cement is used, this will be squeezed out of the joints and efforts to remove the surplus will almost certainly result in damage to the surface of the model.

The answer is to use cement only very sparingly and to hold parts together under pressure until they are properly bonded together. It is advisable to carefully check the fit of all parts before cementing together as it is almost impossible to separate and re-cement a joint satisfactorily. Final cleaning up can be done with a metal scraper or the edge of a piece of glass.

Figs. 10-14. The assembly of a typical polystyrene plastic model. 10—Half-shells are aligned and locked together by simple plug and socket fitting. 11—Where ballast is required for balance, lead shot can be held in place by embedding in plasticine or putty. 12—Use cement sparingly and hold parts together under pressure with strip rubber or suitable clips. 13—Clean up wing roots for close fit and lash with rubber while cement dries. 14—Tailplane, wing tanks, etc., complete the assembly. Undercarriage may be omitted if the model is to be mounted on stand.

Jetex Motors & Models



A Jetmaster-powered Hawker "Hunter" built from one of the larger scale Jetex kits. This particular model was built for Sir Sydney Camm, designer of the full-size Hunter jet fighter.

CHAPTER THIRTEEN

PRACTICALLY every type of aircraft has its counterpart in model aeronautics and the jet plane is no exception. Three distinctly different types of jet propulsion have been seen in models up to the present time : the pulse-jet, the ducted fan and the solid-fuel rocket motor.

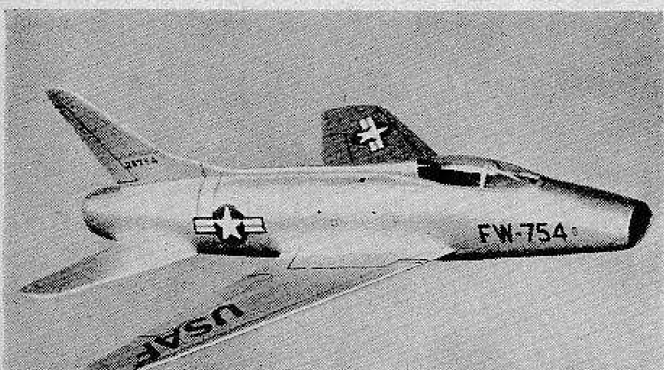
The first of these, the impulse-duct or pulse-jet, is a true jet engine of a simplified type, running on petrol and operating on exactly the same principle as the power plant used in the German wartime V.1, the so-called "Buzz-bomb." These engines, of which the American Dyna-Jet is the leading example, are mostly between 18 and 24 in. long, are very powerful and very noisy. Their use, mainly for reasons of safety, is generally restricted to C/L models, where speeds in the region of 80 m.p.h. can be reached with 1/12 scale jet fighters and more than double this figure with pure speed models.

The ducted fan system, on the other hand, employs an adaptation of the conventional model piston engine. The engine drives a small diameter, multi-blade propeller or fan entirely enclosed within the fuselage, the high-pressure air stream so produced being emitted through a suitable tailpipe. Small, lightweight glowplug engines capable of 15,000-20,000 r.p.m. are best suited to models of this type and a commercial application of the system is to be found in the "Imp" propelled *Sabre* and *Lavochkin* scale F/F kit models produced by Veron.

By far the most widely used model jet power-unit, however, is the Jetex motor, which is actually a miniature solid-fuel rocket motor. It is easy to operate, light in weight and safe, and is available in various sizes suitable for small and moderately sized lightweight F/F models.

The Jetex motor is a very simple affair and consists, basically, of a cylindrical aluminium case or body into which the fuel pellet is loaded. A length of copper-cored fuse, or igniter-wick as it is called, is then partly coiled up and is maintained in contact with the fuel charge by means of a small disc of wire gauze pressed down upon it. The motor has an end-cap with a jet hole in the centre through which the gases generated by the burning fuel are emitted, providing the propulsive thrust.

Four sizes of Jetex motor are currently produced. These are the "Atom-35," the "50" and "50B," the "Jetmaster" and the "Scorpion." (See Fig. 11.) The



Another Jetex powered scale model, this time of the North American F.100 Super-Sabre and powered by a Jetex 50B motor with augmenter tube which increases thrust up to ⅝ oz.

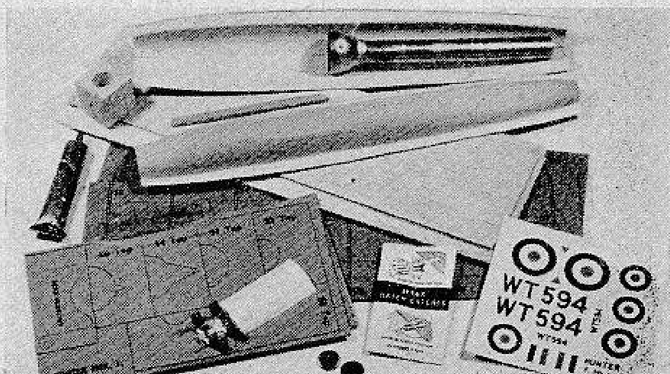


Fig. 1. A typical Jetex scale kit, showing the moulded balsa and resin laminated fuselage shells, together with the aluminium augmenter tube. Kit is the "50" version of the "Hunter."

Atom-35, the smallest of these, is 1.7 in. long and weighs only $\frac{1}{4}$ oz. loaded and is suitable for tiny models of a foot span or less. The 50 and 50B are slightly larger and weigh approximately $\frac{3}{8}$ oz. loaded, the 50B being intended for use with the special augmenter tube supplied with this model. The Jetmaster weighs one ounce and can also be used with an augmenter tube, which increases its nominal thrust from $1\frac{3}{4}$ oz. to $2\frac{1}{4}$ oz. The largest model, the Scorpion, delivers a thrust of 5.5 oz. for a weight of 2 oz. and can also be used with an augmenter tube.

Augmenter tubes are in the form of a large-diameter tailpipe of thin gauge aluminium, into which the gases from the jet are discharged. The tube is bell-mouthed at the entry so that the Jetex unit positioned there does not restrict the passage of air from the front. The addition of the tube not only helps performance, but also makes the whole installation ideally suited to scale models, in which the motor must be enclosed within the fuselage.

Kits for Jetex models, both duration types and scale designs, are available and the manufacturers of Jetex motors also make a number of excellent kits of modern jet aircraft. These Jetex kits, which are of unique design and excellent quality, have so far been produced in two size groups, the larger for the Jetmaster motor with augmenter tube and the smaller for the 50B with augmenter tube.

For our construction sequence we have chosen one of the latest of these kits, the Jetex 50B powered version of the Hawker *Hunter* fighter. This little model is of all-balsa construction with hollow, sheet balsa wings. There is also a larger version of it (20 in. span and 25 in. long) for the Jetmaster, with built-up, tissue-covered flying surfaces.

The most interesting feature of these Jetex kits is the fuselage structure. Models of modern jet aircraft, with their streamlined, rounded-section fuselages, usually call for a somewhat complicated internal structure of formers and longitudinal members and, in order to preserve an accurate representation of the plating and true rounded shape of the prototype, balsa planking, rather than stringers and tissue covering, is to be preferred. Unfortunately, planking is a rather tedious operation and usually means more weight than is desirable with a small F/F model, and the Jetex system of pre-moulded sheet balsa shells is an ingenious solution to the problem. The shells are made of two plies of thin sheet balsa wood with a sheet of special thermo-setting resin film between

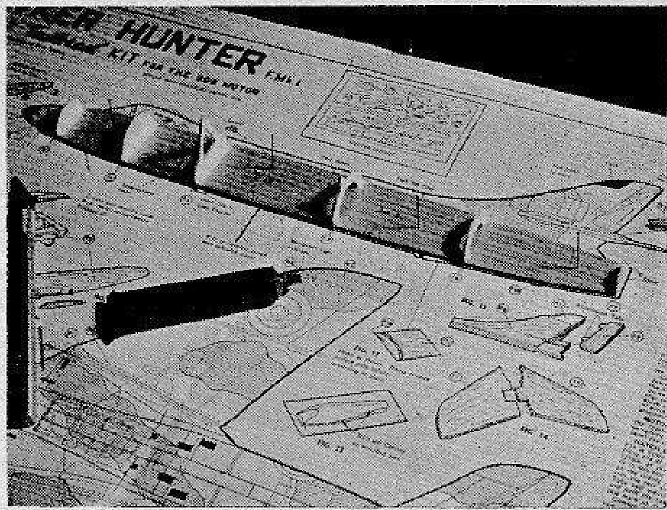


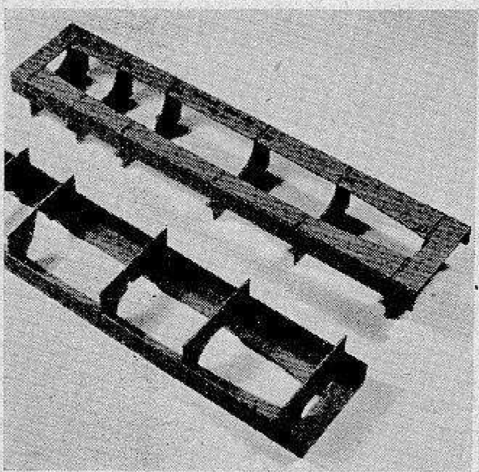
Fig. 2. Balsa keels or backbone members are attached to the plan and half-formers cemented in position as shown.

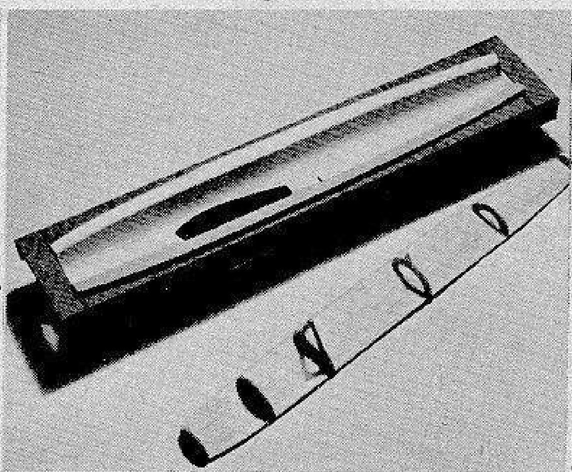
them. Heated and pressed between suitably shaped dies, the plies emerge as perfectly contoured half-shells. In this form they are supplied in the kit, requiring only a simple internal structure. Accuracy of assembly is assured by the use of special jigs also supplied in the kit.

All sheet balsa parts in the kit are ready diecut. Unlike that found in some kits, the diecutting is exceptionally clean and accurate, but parts are not marked and before detaching them from the sheets, it is advisable to number them in accordance with the layout shown on the kit plan.

The construction is started by attaching the plan to your building board in the usual way, then pinning each fuselage keel in position and cementing the formers to it as shown in Fig. 2. Note that the keel centres are left intact at this stage.

The next step is to make up the cardboard fuselage jigs. (Fig. 3.) Parts for these are diecut but require the use of a modelling knife or steel backed razor-blade to separate them cleanly. The fuselage shells are then trimmed to length and the wing root openings and wing root slots are cut in them. Outlines for these are clearly marked by indentations on the outer surfaces of the shells and these indentations can be relied upon as being accurate and correctly located.





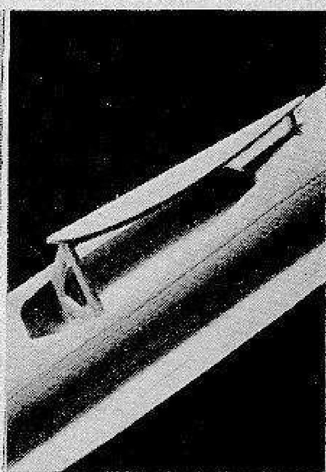
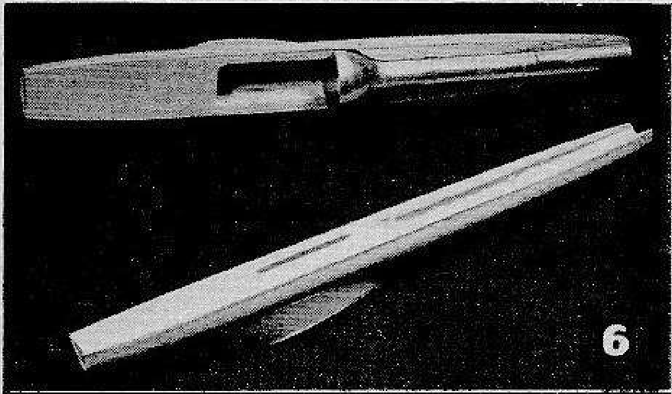
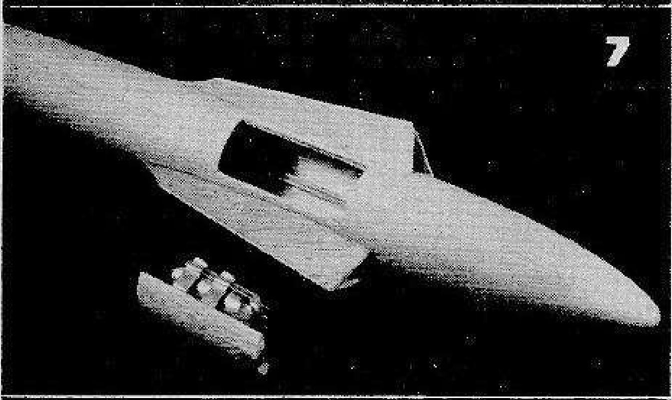
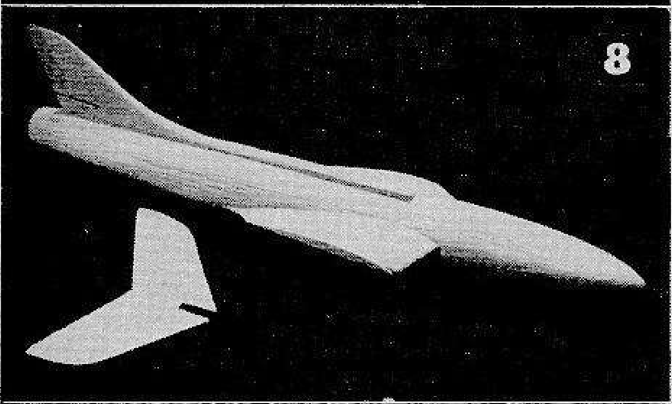
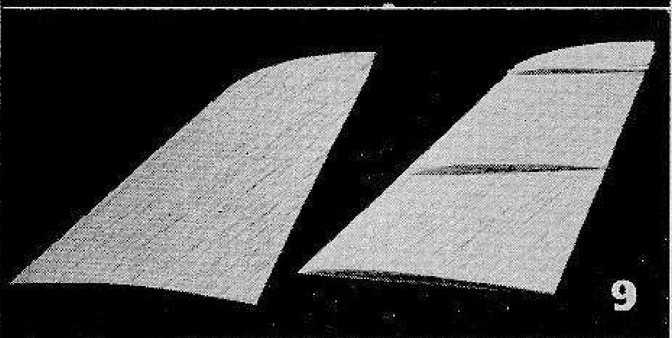


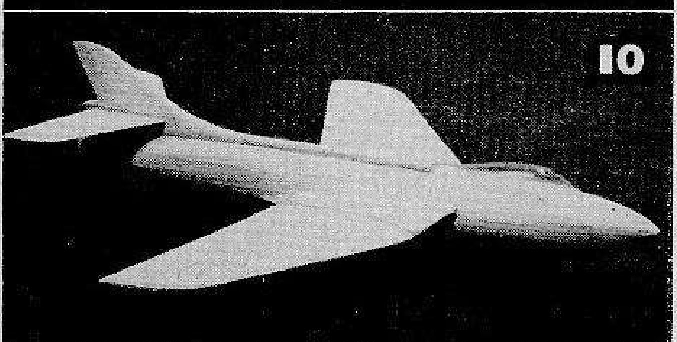
Fig. 3 (left). Showing the cardboard jigs, in which the fuselage sides are assembled. Fig. 4 (centre). Fuselage shells are laid in their respective jigs, and keels, with half-formers, are cemented to them. Fig. 5 (right). After removal of the fuselage sides from the jig, wing root ribs are positioned as shown and fairings added.











With the shells placed in their respective jigs (Fig. 4), the keels are removed from the plan and, after applying cement to their edges and to the formers, are fitted into the shells. Make sure that they are pressed well home. If necessary, lift the shell from the jig temporarily to check this. Leave plenty of time to dry.

The first step after removal of the fuselage halves from the jig is to cement the root ribs in position (Fig. 5), followed by the 1/32 in. sheet balsa fairing panels. When these are set, trim the excess flange from the fuselage shells (we found an X-acto miniature plane handy here) and rub down carefully with sandpaper until level with the keel surface.

The keel centres are now removed and the augmenter tube fitted in position. (Fig. 6.) Check the fit of the two fuselage halves, then cement them together, wrapping with strip rubber until set.

A rectangular block of balsa is supplied for the nose-block. This has a recess at the back into which the two noseweight discs provided should be fitted. To make sure that these are held securely in position, cut a piece of scrap balsa and cement in the recess after the nose-weights. Then, after liberally pre-cementing, fix the noseblock in position. Carve and sand to shape when dry and sand the fuselage to a smooth finish all over.

The motor hatch aperture is now cut out as marked on the bottom of the fuselage and the reinforcing strips fitted. The pre-shaped hatch block is bevelled to fit snugly in the aperture and is held in place with the special Jetex hatch catches supplied. If necessary, lightly sand the bottom surface of the fixed part of the clip (before assembly) so that it will slide easily. Double pre-cement the hatch cover slot before fitting the catch, then fit the latter with a minimum of cement so that it does not get between the sliding surfaces. Finally, cement the motor clip to the hatch cover, checking the alignment of the motor by sighting down the augmenter tube. (Fig. 7.)

The rest of the construction needs little explanation. The tail fin is made from four laminations of $\frac{1}{16}$ in. balsa and then sanded to shape. Make sure that it is truly vertical when cementing in place. The rudder is attached with tabs of thin aluminium (supplied) and the tailplane is slotted into the trailing edge of the fin. (Fig. 8.) The wings consist of a flat undersurface of 1/32 in. sheet balsa to which ribs are cemented, the curved upper surface then being added. (Fig. 9.) The wings should be built up over the plan, the upper surface being pinned down around the edge while the cement dries. The complete wing panels are butt jointed to the centre-section. Make sure that they are aligned with the fuselage (Fig. 10.)

The complete model should be sanded all over and given a coat of clear dope. A model of the *Hunter's* small size and relatively high wing loading cannot be expected to perform like a duration model : its flight is necessarily fast and brief, but if you require the best possible per-formance, avoid adding too much weight with too many coats of dope. As a compromise, a coat of sanding sealer, well rubbed down, followed by two thin coats of

Fig. 6. After trimming shell flanges, keel centres are removed and augmenter tube fitted, then the sides may be cemented together.
Fig. 7. With noseblock cemented in place and shaped, the motor access aperture is cut out and the hatch and motor clip fitted.
Fig. 8. To the completed fuselage, the fin and rudder are now added, followed by the tailplane.
Fig. 9. The simple wing structure consisting of 1/32 in. sheet covering over $\frac{1}{16}$ in. ribs.
Fig. 10. The complete "Hunter" structure, ready for finishing.

dope, is suggested. The model may be doped all-aluminium colour, or grey and green camouflage on the upper surfaces. A complete set of transfers is included with each kit and other details can be marked with dope or indian ink.

As regards actual flying, the model should be test glided in the usual way after checking the balance in accordance with the instructions. The rudder is intended as a means of correcting any tendency to turn off course and it will be found safest to adjust for a straight power flight or shallow turn and not to attempt a circling flight.

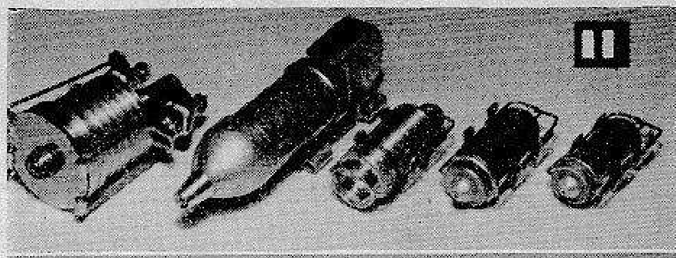
A word now about Jetex motors and their operation and maintenance.

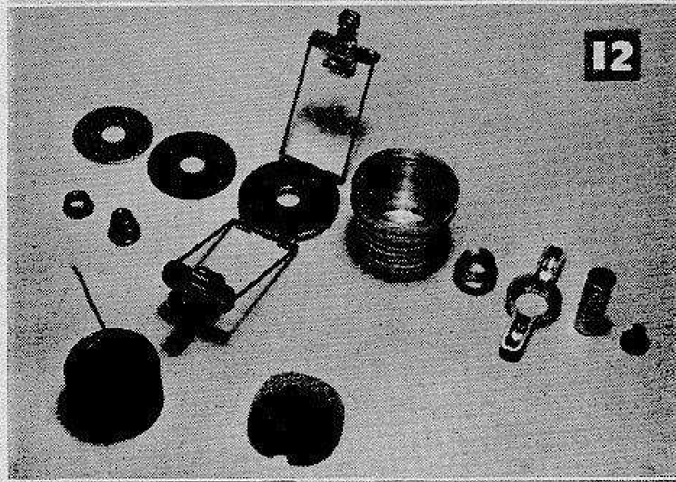
Fig. 12 shows a Jetex Scorpion dismantled. The smaller motors contain the same essentials but are of simpler design. All Jetex motors embody an end-cap secured with spring-clips. The purpose of the spring clips is not merely to hold the end caps in place but to act as a safety valve. The gas generated by the burning charge accumulates in the free space behind the end cap and acquires considerable pressure. Release of this pressure normally takes place, of course, through the jet, but should the jet become blocked while the charge is burning, the resultant build up of pressure would tend to burst the casing unless some kind of relief valve were provided and this is achieved by the spring clips, which allow the cap to lift if the pressure becomes excessive.

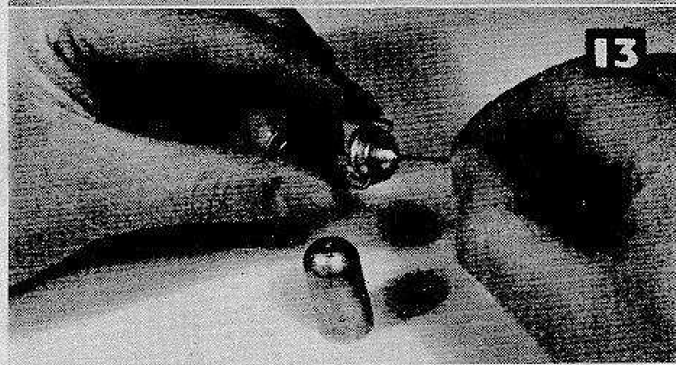
A jet may become blocked or restricted by carbon or a fragment of gauze or igniter wick. To guard against this, a number of rules should be observed. Firstly, the jet should be re-sized after every flight by means of the short wire rod or reamer supplied for this purpose. (Fig. 13.) Secondly, the gauze which presses the coiled end of the igniter wick onto the fuel pellet should be in good condition and not burnt through. Normally a gauze will last for about five firings, after which a new one should be used. Thirdly, the revised method of installing the igniter wick (as now recommended by the makers), in which a short, separate length of wick is inserted through the jet, should be used.

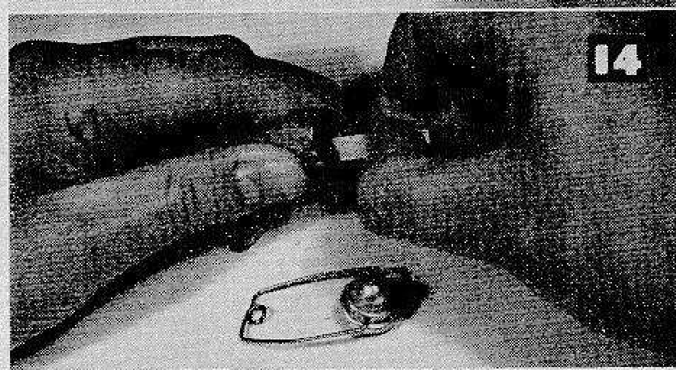
All Jetex motors get quite hot as the charge is burned and need to be allowed to cool for a few moments before handling. This heat may also cause the end-cap washer to stick to the case, and so as not to damage the gas seal, it is recommended that the body and end-cap are not merely pulled apart abruptly after releasing the spring-clip. Instead, the two parts should be pressed together and rotated as in Fig. 15.

Finally, remember that cleanliness is of the utmost importance with all Jetex motors. After each flight, the deposit which accumulates inside the case should be scraped out with the wooden scraper supplied. (Fig. 14.) The motor should also, occasionally, be thoroughly cleansed by dismantling and scrubbing in hot soapy water. The makers recommend that this be done after every twenty firings, or whenever you are not expecting to use the motor for a while, so as to avoid the risk of corrosion.









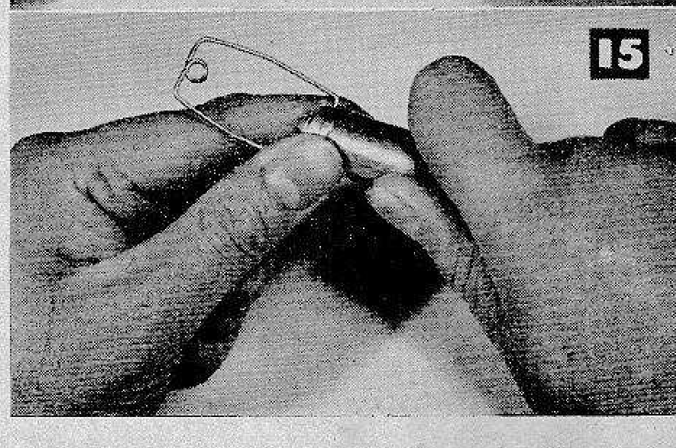
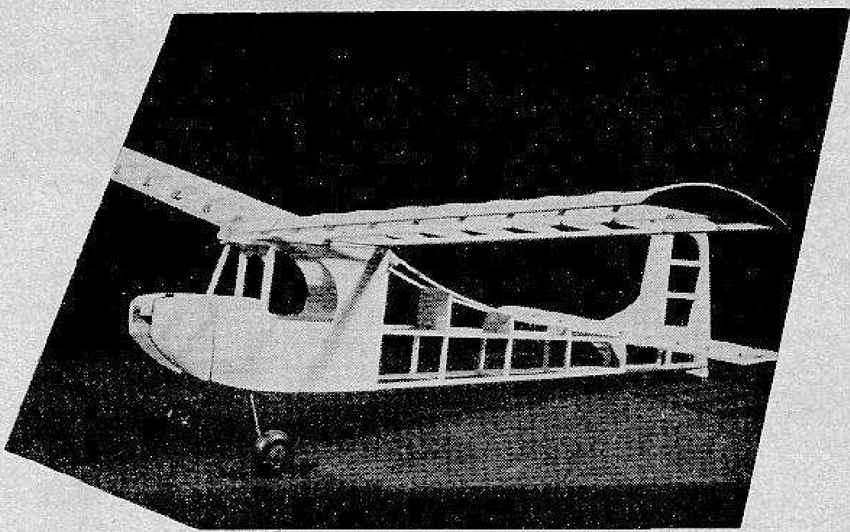


Fig. 11. The Jetex range of motors includes (left to right): the Scorpion, the Jetmaster, the 50, the 50B and the Atom-35.
Fig. 12. The Scorpion motor completely dismantled. The Scorpion is the most powerful Jetex motor to date.
Fig. 13. After firing, the jet must be cleared with the wire rod.
Fig. 14. Carbon deposit in the case, left by the combustion of the fuel, must be scraped out before recharging.
Fig. 15. When removing the end-cap from the case after use, the two components should be rotated against each other to prevent damage to the sealing washer.

Free Flight Power



CHAPTER FOURTEEN

LESS than sixty years ago, all that was known about aeroplanes and heavier-than-air flight could have been contained in a single volume. Today, the subject is so immense and complicated, that any one book which aims at serious study must necessarily be restricted to one very small part of the vast science of aeronautical engineering.

On a smaller scale, the same applies to model aeronautics and it would be an easy matter to devote a sizeable book to F/F power models alone.

F/F power models, as a group, embrace a very large selection of types. First we have the strictly functional, lightweight competition type, usually with a pylon mounted wing and slim fuselage, and designed for a fast climb and flat glide. Some of these are quite simple to build, but are usually a trifle too tricky for the beginner to fly safely, although a smaller and less powerful engine can sometimes be employed to overcome this difficulty. Such models, however, are not very attractive in appearance to newcomers to the hobby, and one of the more robust and very popular general-purpose type power models is generally a better proposition.

These latter models are mostly of the high-wing cabin type, of around 35 to 50 in. wingspan and for engines of 0.75 to 1.5 c.c. They include such well-known British kit designs as the Veron *Cardinal* and *Deacon*, the Davies-Charlton *Ballerina*, the Mercury *Magna* and *Matador* and the Keilkraft *Pirate* and *Bandit*. Most of them are easy-to-build designs, well within the capabilities of anyone who has followed this series and has built one or two models previously.

In the general classification of F/F power, there are also the scale power models and a typical small example is the very attractive 36-in. *Cessna* 170 by Keilkraft and shown below. Scale models are, however, among the most difficult to build and fly and we would definitely not recommend one to be attempted until a little more experience has been gained. The same remarks apply to most of the less conventional types, such as delta-wing models, flying-boats, helicopters, ducted-fan models, etc.

In this chapter, therefore, we are confining our construction sequences to two popular general-purpose cabin models.

The first of these is the 36-in. Veron *Cardinal*, a well-established kit design which has enjoyed great success as

When a little more experience has been gained, other types of free-flight power models can be attempted. Shown (top) is a 36 in. Cessna 170, available as a Keilkraft kit. While below we have a 45-in. flying boat designed by the author.

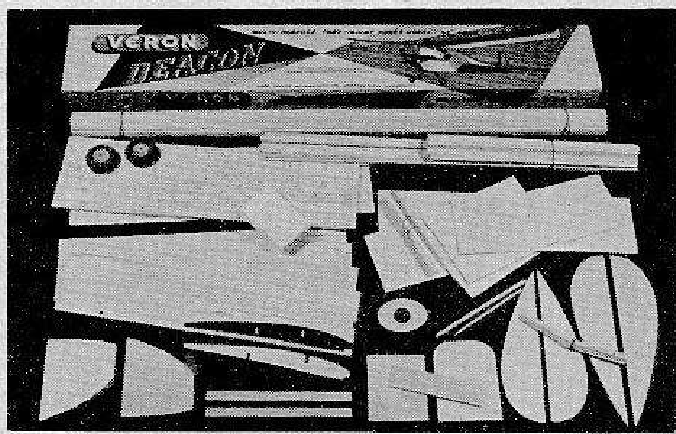


Fig. 1. The Veron Deacon kit. This builds up into a fine, easily-constructed, easy-to-fly, 53 in. span cabin model. The Deacon can also be used for payload contests or adapted to lightweight, single-channel radio-control.

a beginner's power model for several years. There is no doubt that this kit is an excellent choice for a first attempt at F/F power. Its construction has, however, already been dealt with at some length in an earlier volume* and for this reason and also for the benefit of those readers who would now like to tackle something a little larger, we are also featuring the *Cardinal's* "big brother," the newer *Deacon* of 53-in. span.

The two models are of generally similar appearance as will be seen from the accompanying photographs. The construction of the *Deacon*, however, is a little more detailed. The *Cardinal* is intended for engines of up to a maximum of 1 c.c., but is best suited to motors of the up to 0.8 c.c. capacity group (0.049 cu. in.) such as the Mills 75, Allbon Merlin 0.76 c.c. and Frog 80, as well as most of the American "Half-A" class glowplug motors.

The *Deacon* is adaptable to an equally large variety of engines, ranging from a minimum of 1 c.c. to a maximum of 2 c.c. Units in the popular 1.5 c.c. class, such as the Allbon Sabre, Frog 149, etc., are, perhaps, the most suitable. Smaller motors, however, such as the powerful 1 c.c. Allen-Mercury 10, the 1.3 c.c. Mills Mk. II and the 1 c.c. Allbon Spitfire, will provide adequate power, as will the 0.099 cu. in. class glowplug engines.

Both these kits include a number of ready cut parts. The contents of the *Deacon* kit are shown in Fig. 1. Wing and tailplane ribs are supplied in diecut sheets and wing tips are cut to outline shape, as are the plywood parts, dihedral gussets, nose formers, etc. The *Cardinal* kit, in addition, includes ready shaped fuselage side panels of sheet balsa, shaped fin, etc. (see Fig. 2). Both kits include a pair of $1\frac{1}{2}$ in. dia. sponge-rubber tyred wheels. In the case of the *Deacon*, however, a pair of 2 in. airwheels can be substituted.

* "How to Make Model Aircraft," Percival Marshall, 3s.

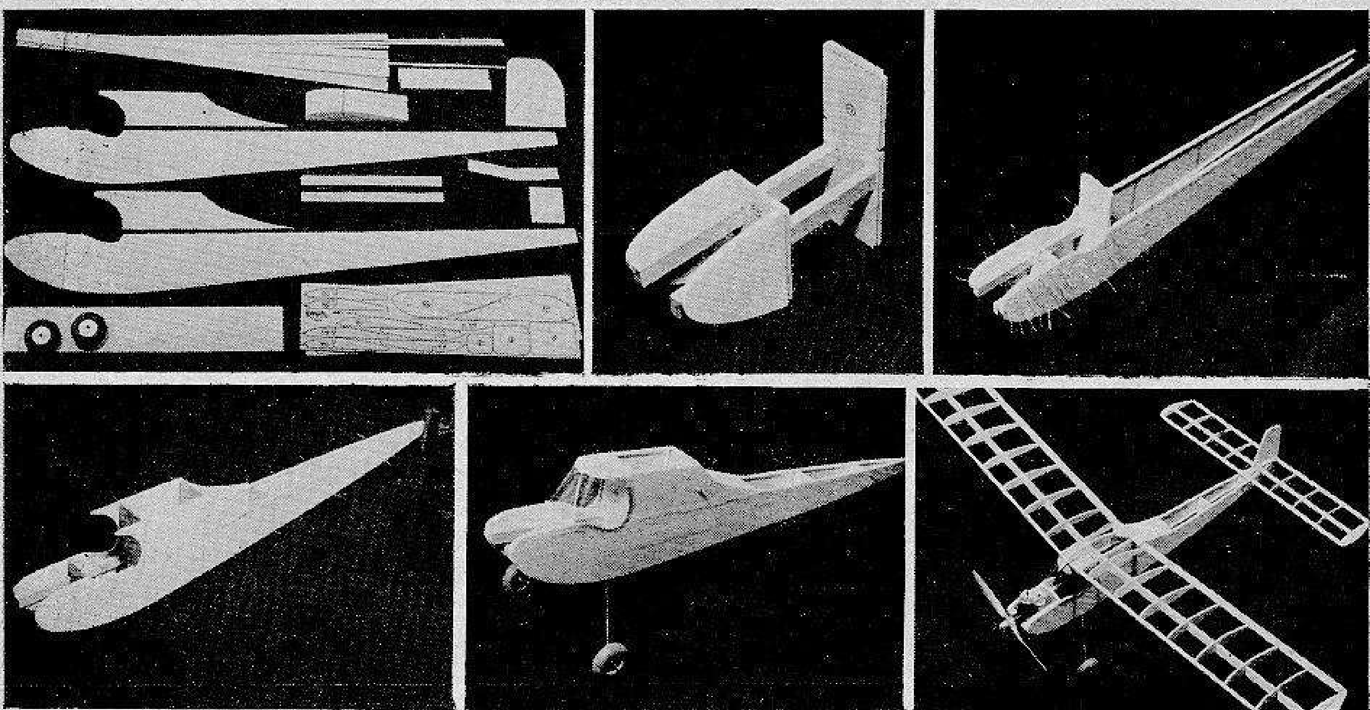
Building the *Cardinal* is very straightforward, although a little different from most models of this type. Construction is started by making up the nose sub-assembly, as shown in Fig. 3, consisting of two formers, two hardwood engine bearers and two cowling side-pieces. Make sure, by using a set-square, that the formers are correctly aligned at right angles to the bearers. Use plenty of cement around the joints and while the assembly is setting, the longerons can be cemented to the two $\frac{1}{16}$ in. sheet balsa fuselage sides and the position of the formers marked on them. When these are dry and after pre-cementing both surfaces, attach the sides to the nose assembly as shown in Fig. 4.

The next step is to add the remaining fuselage formers, chamfering off the longerons at the tail end and holding them together with a suitable clip (Fig. 5). The two sheet cabin sides can also be added at this stage.

The undercarriage struts are bent to shape from a single piece of spring-steel wire, preferable with the aid of a bench vice. Work slowly and carefully, when bending the wire, so as to make sure that the struts are the same length and axles properly aligned. The undercarriage is attached to a ply former. Mark its position and drill a number of holes through the former, then sew the wire to the former with strong thread, afterwards liberally smearing cement over the thread. (See Fig. 14 for the way in which this is done.)

The complete undercarriage unit is now cemented to the second fuselage former. Liberally pre-cement the two surfaces and clamp the two formers together. Wheels can next be fitted to the axles and retained in position by small washers soldered on to the axle ends.

The fuselage structure is completed by adding the various dowels and fitting the windscreen and pieces of sheet covering, etc. (Fig. 6). Covering on the top and bottom of the fuselage is applied with the grain of the



Six photographs showing the construction of the popular Veron Cardinal 35-in. beginner's model. Fig. 2: the kit contents, showing the ready-cut fuselage side panels. Fig. 3: the nose sub-assembly, comprising front formers and engine bearers. Fig. 4: attaching the side panels to the nose assembly. Fig. 5: the basic fuselage structure with rear formers and cabin sides added. Fig. 6: the finished fuselage structure with undercarriage fitted. Fig. 7: the completed Cardinal, ready for covering and showing the Mills 75 engine with 8 x 4 propeller.

wood running transversely so that it will follow the curves of the fuselage without splitting. When fitting the windscreen, use first a template of stout paper, cut to the pattern on the plan, to check for correct fit, before shaping the celluloid itself. Chamfer off the edge of the cabin top at the front so that the screen will maintain proper contact and when cementing it in place, start at the centre and work around towards the sides, pinning the celluloid in position while the cement dries. Do not use an excessive amount of cement or this may squeeze out over the inside of the screen and look unsightly. If you first pre-cement the wood, only a thin application of cement will then be required to bond the two together.

The wing is constructed over the plan in the normal way and is a very simple structure. Pin all the ribs together first and sand them down slightly to the precise section so that the trailing edge fits accurately. The wing is built in two halves and joined at the centre and strengthened with the plywood dihedral gussets. Pin one side down and set up the other tip 5 in. to give the correct dihedral angle.

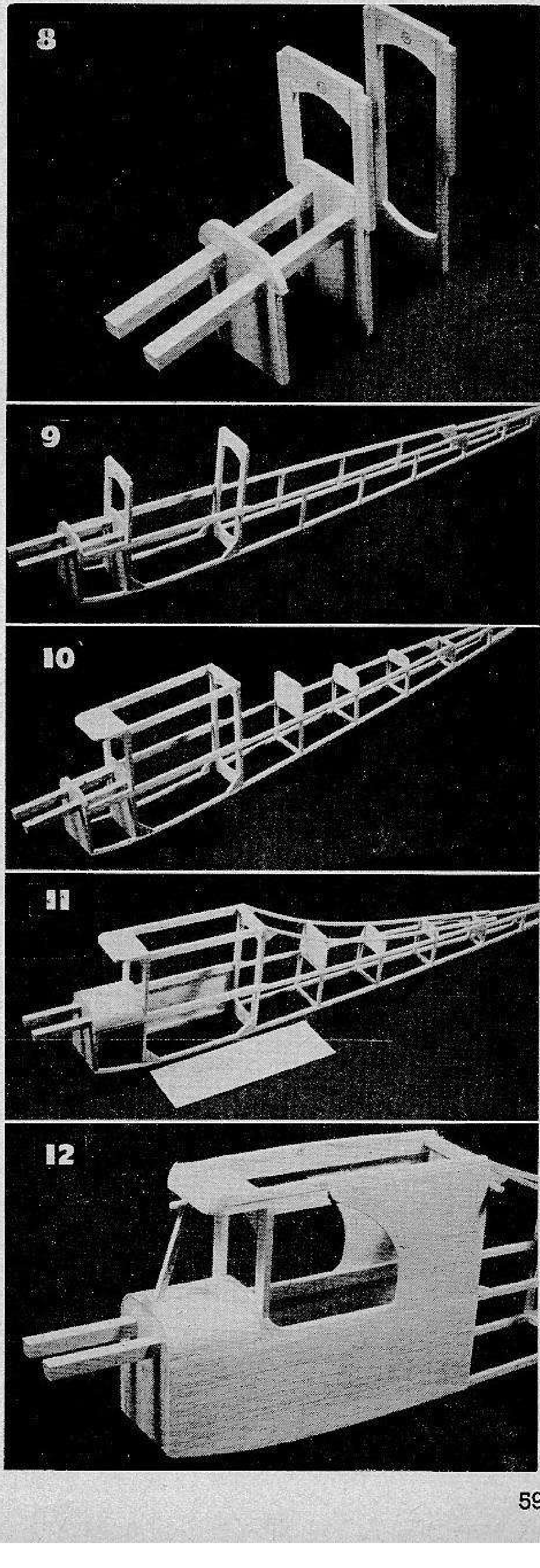
The tailplane structure is equally simple and is similar to the wing except that, instead of sheet tips, two soft balsa blocks are used which are carved and sanded to shape. Space the two centre-ribs accurately to receive the fin and ensure that they are perfectly upright so that the fin, when fitted between them, is held vertically. A trim tab is attached to the trailing edge of the fin with two short " hinges " of soft sheet metal or wire, such as aluminium, copper or soft iron.

The completed and uncovered structure of the *Cardinal*, with Mills 75 engine fitted, is seen in Fig. 7.

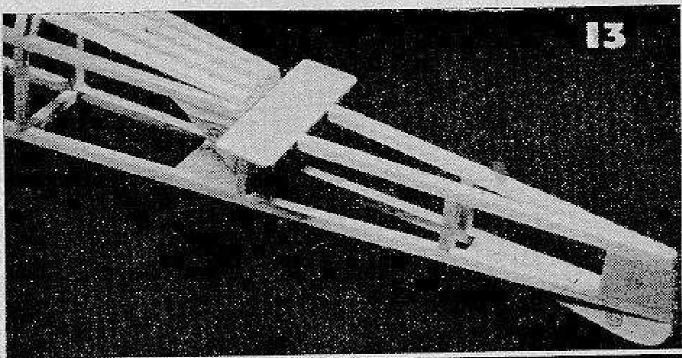
Much of the general layout of the *Deacon* will be seen to resemble that of the *Cardinal*. However, a little more work is entailed in making this model. Two $\frac{3}{16}$ in. sheets of printed wood parts are included in the kit and the first thing to do is to cut these out. This is rather hard work with an ordinary modelling knife and we found an " X-acto " razor-saw to be a great help here.

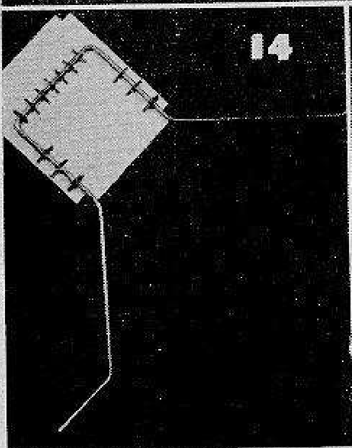
The next step is to check the bearer spacing necessary for the engine you propose to use. The standard bearer location given on the plan fits a number of popular engines, including the Allbon Sabre and Javelin, Elfin 1.49, Frog 149 and 150, E.D. 1.46, Allen-Mercury 10, Allbon Spitfire and E.D. Bee. If an engine with a crankcase wider than $\frac{7}{8}$ in. is used (such as the Mills 1.3) the bearer slots in the formers must be repositioned. Bearer slots are best cut out with a chisel point modelling knife. Make sure that you cut these slots *accurately* as the correct alignment of the front of the fuselage depends on this.

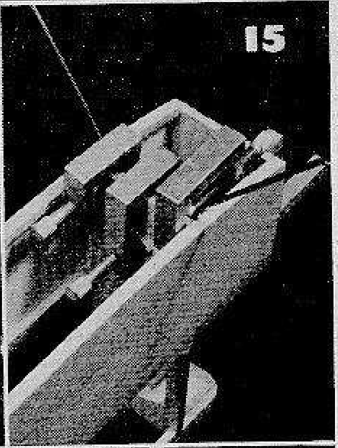
The two cabin section vertical frames and top (horizontal) frame are first built up over the plan. The two hardwood (melawis) engine bearers are then trimmed to length and inserted in the slots in front frame " B," perpendicular to the building board. Use a set square to make sure that these are truly at right angles to the former and cement the joint strongly. When dry, slide the front bulkhead F.1 onto the bearers and cement in position, checking to make sure that it is parallel to frame " B."

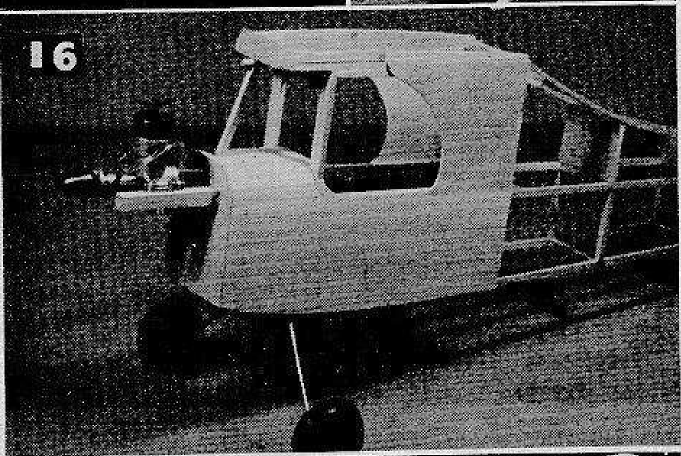


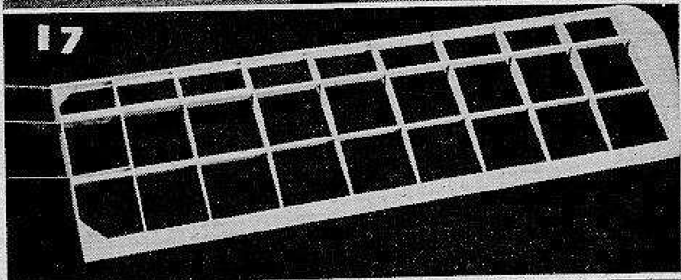
Building the Deacon: 8—The nose and cabin formers with engine bearers in place. 9—After building up the fuselage side frames over the plan, these are attached to the formers as shown. 10—The next step is the addition of the cabin top frame, rear cross members and formers. 11—Rear stringers are laminated and the cabin section is covered with $\frac{1}{16}$-in. sheet balsa as shown. 12—A close-up of the completed cabin section.

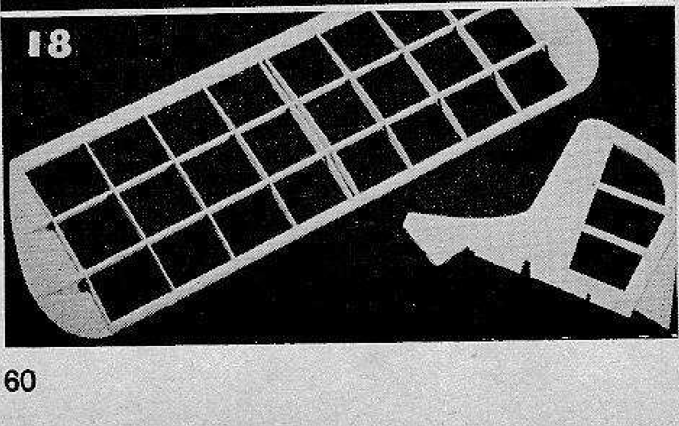












Unlike the *Cardinal*, the *Deacon* uses built-up side panels of $\frac{3}{16}$ in. sq. section balsa strip. These are constructed over the plan in the usual way. The front section of the two lower longerons will require steaming to shape. This is best done with the two strips temporarily bound together with cotton. The two sides are, of course, built one over the other on the plan to ensure maximum accuracy.

When the side panels are set, the cabin formers and nose assembly (Fig. 8) can be joined to them. Carefully check alignment over the plan and pin in position while the joints dry. The tail ends of the side panels are chamfered off and joined together. The basic fuselage structure will now appear as in Fig. 9.

The next step is to fit the cabin top frame and the cross-members to the after part of the fuselage, followed by the rear formers. The structure will now appear as in Fig. 10. A small lining former, F.4, is next fitted to the front cabin frame, forming a rim for the $\frac{1}{16}$ in. sheeting over this section. Use cement liberally when attaching the sheet and pin down, working out from the centre. Follow up by attaching the side sheeting, as in Fig. 11, and the laminated rear stringers.

Fig. 12 shows the final steps in the construction of the cabin section, with upper sheeting added, front and rear wing dowels fitted, also the wing supports and windscreen centre pillar. This is followed by attention to the rear end of the fuselage, adding the tail bumper, fin fairing slot, tailplane platform, etc. (See Fig. 13.)

Undercarriage construction is shown in Figs. 14 and 15 and is similar to that of the *Cardinal*. "X-acto" clamps are being used in Fig. 15, with suitable wood packing pieces, to press the ply undercarriage plate in firm contact with the front cabin former while the cement dries.

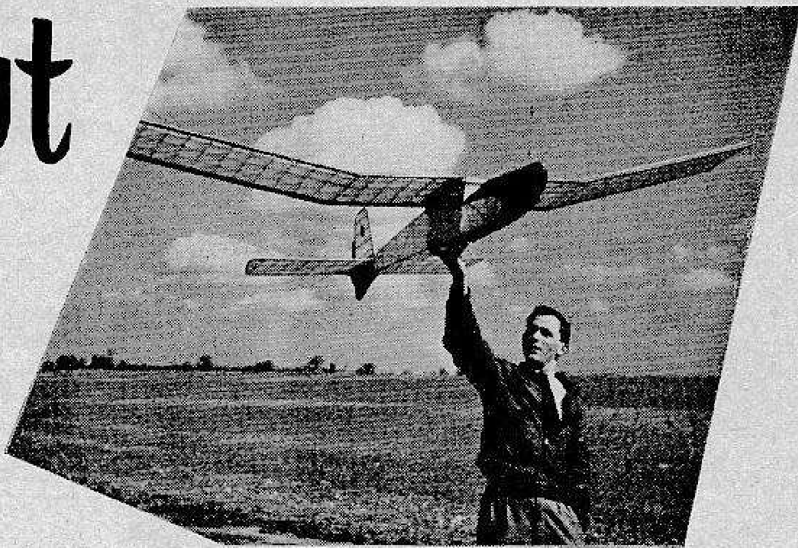
The next step is to very carefully mark and cut out the bearer slots in the plywood "firewall" and cement this securely to the front bulkhead. See Fig. 16. The wheels shown in this photograph are 2 in. M.S. pneumatic airwheels and the engine is the 1.49 c.c. Allbon Sabre diesel.

The engine may be mounted upright or inverted according to the builder's preferences. Two balsa cowling blocks are provided which are cemented to the front bulkhead and to the sides of the engine bearers and are rounded off to shape as shown in the heading illustration. Where it is decided to invert the engine, the top and front of the cowling may be enclosed and a spinner fitted to the airscrew. (We preferred to use the simpler upright arrangement in order to allow various engines to be fitted to the model.)

Wing and tail construction is straightforward and calls for no comment above the usual recommendation to check the fit of ribs against the spars before beginning assembly. These components are shown in Fig. 17 and Fig. 18.

Building the Deacon: 13—The tail end of the fuselage, showing the tailplane platform, etc. 14—How the undercarriage wire is bound to the plywood plate with thread. 15—The undercarriage plate must be firmly fixed in place and clamped while the cement hardens. 16—A ply facing is fitted to the front bulkhead, after which the engine may be positioned and wheels fitted. Allbon 1.5 c.c. engine illustrated. 17—The wing construction is conventional except for a laminated leading edge. 18—The completed tail-unit showing the simple construction.

More about Free Flight



CHAPTER FIFTEEN

IN chapter seven we dealt with the trimming and flying of a simple built-up glider. The same basic procedure is followed with larger types of gliders and with powered F/F models, but with the addition of further stages which we shall describe here. To jog your memory on the main points, it is suggested that chapter seven "Trimming and Flying" is re-read in conjunction with the present article.

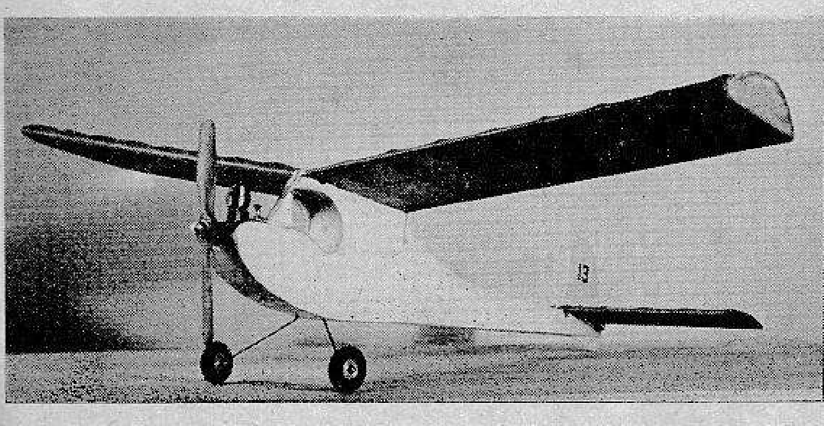
Once again, the importance for waiting for calm weather before attempting to fly a new model and of carrying out a careful "final inspection" cannot be over-emphasised. Check the wing and tail surfaces for freedom from warps and make sure that they are accurately aligned on the fuselage. Power-driven models are especially sensitive to warped or misaligned surfaces. It is also important that your first F/F power model should not be overpowered. For the 35 in. span Veron *Cardinal*, for example, a 0.75 c.c. to 0.8 c.c. engine is quite large enough. You can, in fact, use an engine of this size in a 40-45 in. span model quite satisfactorily. For the 52 in. *Deacon* and similar models, an engine of not more than 1.5 c.c. is advisable and even a 1 c.c. beginner's engine such as the E.D. Bee will provide quite enough power.

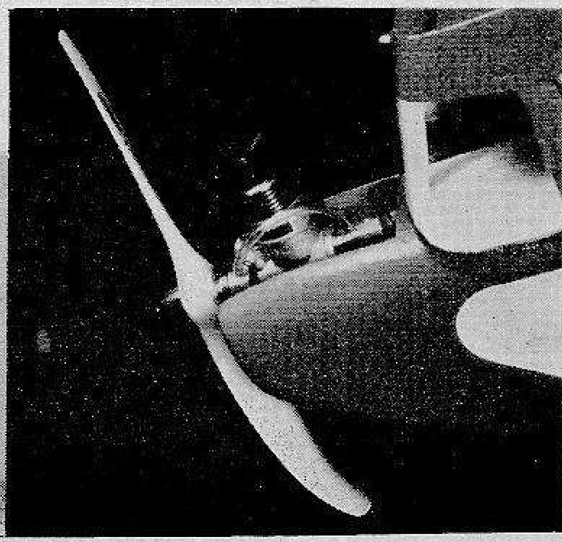
The point to remember concerning the choice of an engine is that no useful purpose is served by employing more engine power than is just required to climb the model at a shallow angle. Anything in excess of this means that the model will fly faster, and be more tricky to trim. It will climb more rapidly and although this may sound more exciting, it also means that you will only be able to allow a short engine-run on each flight. A short spectacular climb is only necessary with contest models and this kind of model should be attempted only when some experience with a more docile type of power model has been gained.

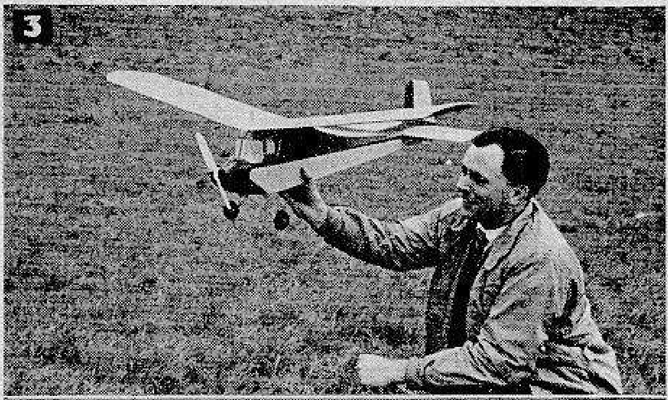
Ideally, the choice of a propeller depends both on the engine and the model, but with our general-purpose type model, this is not over-critical. For the *Cardinal*, when fitted with an engine such as the Mills 75, an 8 in. diameter prop., of 4 in. pitch, is very suitable. For 1 c.c. engined models, a 9 × 4 prop can be used. Where a 1.5 c.c. motor is used, in a model

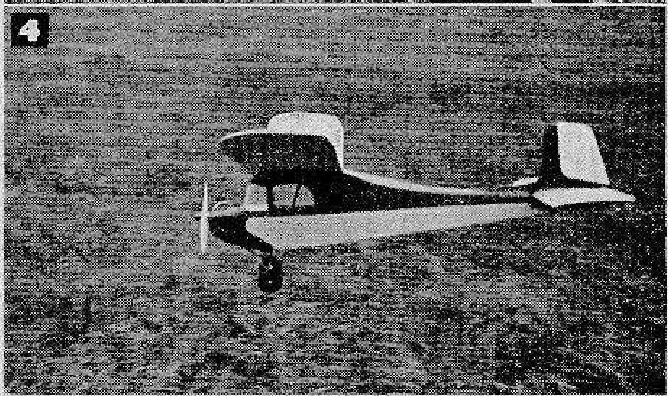
Fig. 1. (below) The popular Veron "Cardinal," fitted with a Mills 75 engine; an ideal beginner's combination.

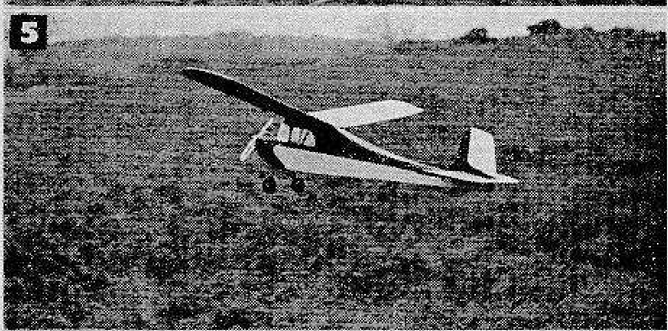
Fig. 2. (right) For all general-purpose flying, a plastic propeller will save the cost of frequent replacement.

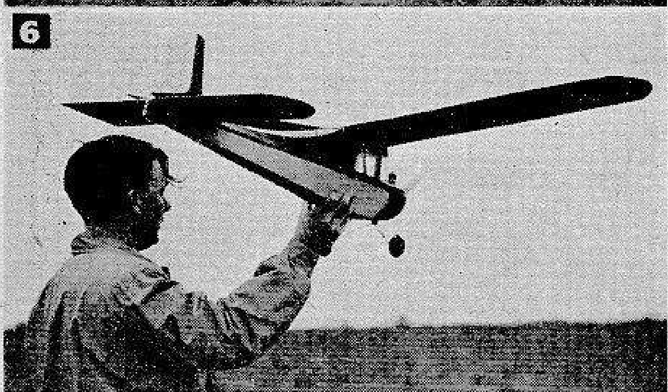


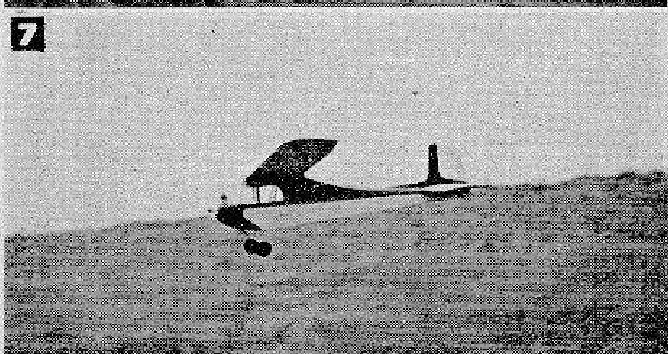












such as the *Deacon*, a 10×5 or 9×6 prop is advised. These sizes will hold the revolutions of the engine down to a suitable figure. Do not fall into the error of using a small propeller, such as would be used with a power-duration or C/L model. Incidentally, the use of a flexible plastic prop for your first power model is strongly recommended. Shown in Fig. 2 is a Frog nylon prop.

Having checked your new power model thoroughly, fitted the wings and tail and, if necessary, corrected the point of balance, with the addition of ballast, the first test glides can be made. Try to find a decent area to test and fly the model. Don't risk damaging it by flying near trees, hedges, etc., and remember that the model is capable of flying a good deal farther than your first models, so don't fly near a built-up area.

Start off by hand launching from waist level by kneeling down as shown in Fig. 3. A power model will descend a little more steeply than a glider, but the glide angle should not be steeper than in Fig. 4. If it is steeper than this, pack up the *trailing* edge of the tailplane with a piece of $\frac{1}{16}$ in. balsa and try again.

If, on the other hand, the model levels out and loses speed, as in Fig. 5, and then drops its nose, a tendency to stall is indicated and a little ballast weight can be added to the nose. Adding weight to the nose is preferable to packing the *leading* edge of the tailplane (or reducing the wing angle of attack) as, with models having a small longitudinal dihedral angle, the latter practice may reduce longitudinal dihedral to a point where longitudinal instability is induced.

Launching from waist level is a precautionary measure only and as soon as you are satisfied that the model shows no dangerous tendencies, all further test gliding should be from head level as shown in Fig. 6. Short test glides carry with them the risk of wrongly interpreting the model's trim if the model is launched too slowly or too fast, since there is insufficient height for the model to settle into its normal glide path.

The ideal final test glide set-up is to find a gentle slope of, say, 1 in 12 and launch the model down this. Such a slope was, in fact, found for our test glides with the *Deacon* and the model, with trim "spot-on," is seen gliding almost parallel to the slope in Fig. 7.

Needless to say, the model should descend on an even keel and with no tendency to bank left or right. A warped wing or misaligned tail unit may cause this, but any slight turn can be usually corrected with the rudder.

General purpose type power models are usually trimmed, initially, to fly straight, both in the glide and under power. Due to the torque of the engine tending to bank and turn the model left, it is usual to install the engine at a slight angle (about 2 degrees) inclining the thrust angle to the right as shown in Fig. 8.

For the first power flight, the engine should be slowed down as much as possible. With a diesel, this can be done by slackening back the compression screw and opening the needle-valve. See Fig. 10.

Glowplug engines cannot be throttled down so easily as diesels, but running the engine with the needle-valve opened widely, to produce so-called "four-stroking," will reduce r.p.m. somewhat and a further slight reduction

Flying the "Deacon": 3—The first few test-glides should be from a low level as shown. 4—In this picture the model is gliding a trifle too steeply. 5—Here, the model is slightly tail heavy, has lost flying speed and is about to drop a wing to the right. 6—Test gliding is continued by launching from shoulder height. 7—Gliding the model down a gentle slope is excellent for checking on final trim.

in thrust can be obtained by putting the propeller on backwards so that the back surface of the blade faces forwards. (See Fig. 11.)

The transition from glide tests to power tests should be as gradual as possible. In other words, to start with, all the model has to do is to just maintain height under power, or enter a very shallow climb as in Fig. 12.

Needless to say, only enough fuel for an engine run of about 10 sec. should be in the tank. Alternatively, the model can be fitted with one of the engine-run limiting devices on the market. These usually consist of a small pneumatic cylinder which operates a fuel cut-off valve after a preset delay period. A very simple and effective version of this is the Elmic Mini-Timer shown in Fig. 18, which can be fitted in any convenient place between the tank and carburettor. This timer dispenses with the need for a separate fuel valve, since it is arranged to squeeze the plastic tube to cut off the supply to the engine.

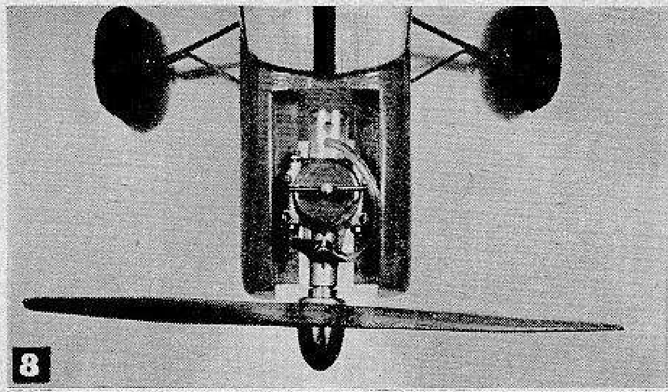
It is unlikely that you will experience any trouble with your first reduced-power flight. For each successive flight, increase engine revolutions very slightly and watch the model carefully. The climb should be straight or slightly to the right and, when the engine cuts, the model should continue circling gently to the right as it descends. The rudder tab can be set to give the required turn, but be very cautious how you use the rudder and move it only about $\frac{1}{16}$ in. at a time, otherwise the model may be forced into a tightly banked turn which may develop into a spiral dive. This applies most particularly when you have restored engine r.p.m. to their normal level.

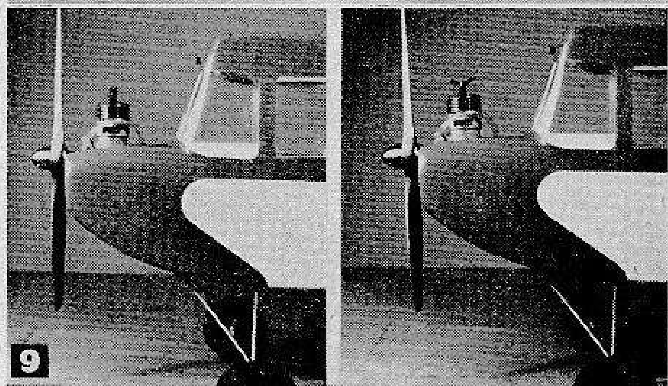
Never make an adjustment and increase power at the same time. If, for example, the model is not turning sufficiently, make the rudder adjustment and fly the model again before increasing engine r.p.m.

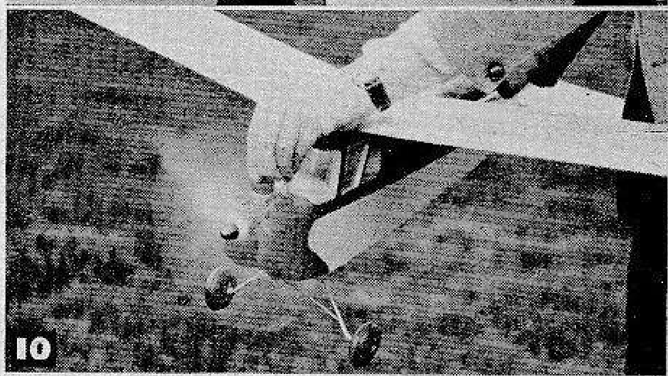
Usually it is best to avoid making any readjustment to balance or to wing and tailplane angles during the power tests. These should be approximately correct following the glider test adjustments. However, when flying in a circle, as opposed to straight flight, there is a tendency with all models, for the nose to drop very slightly and if it appears that insufficient height is gained or the subsequent glide is unduly steep, it is permissible to reduce the nose weight slightly or pack up the trailing edge of the tailplane until this is improved. Use no more than 1/32 in. packing at a time.

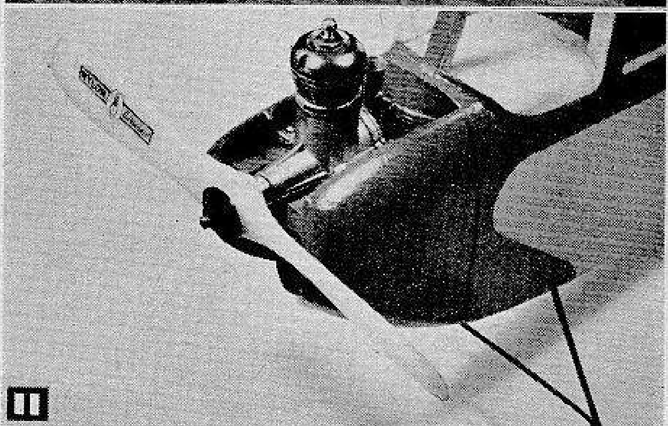
As soon as you have the model flying to your satisfaction, make a note of any adjustments found necessary so that the model can be correctly set up on the next outing. Any packing strips used to adjust flying surface angles can be cemented in place. Most power modellers make a practice of a brief check with a test glide at the beginning of each flying session and this is particularly advisable when the model is new because newly constructed airframes sometimes acquire minor warps and changes of shape during their first month or so.

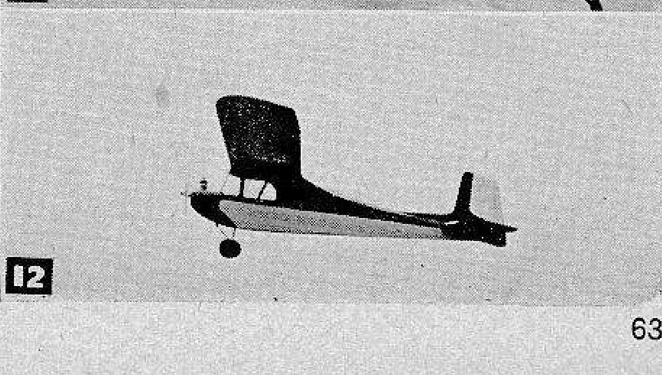
So far we have not mentioned dethermalisers. Nowadays, most F/F models are fitted with these devices and you will be well advised to use one with your first F/F model, especially during hot weather or if you allow the model to climb to over 100 ft. Under these conditions



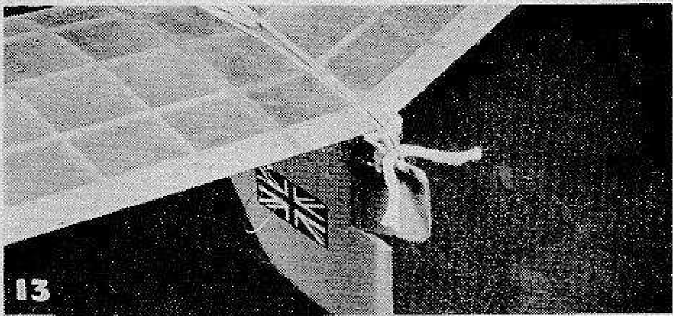


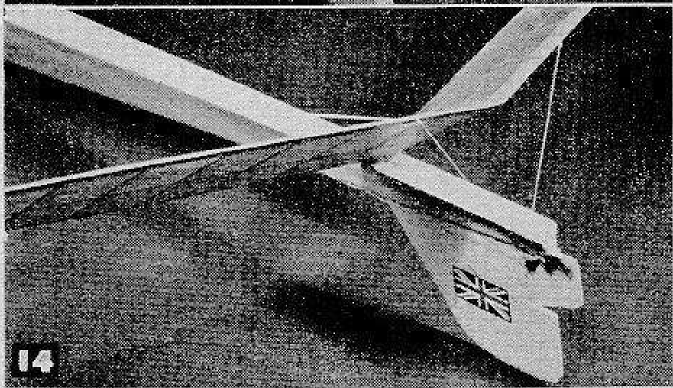


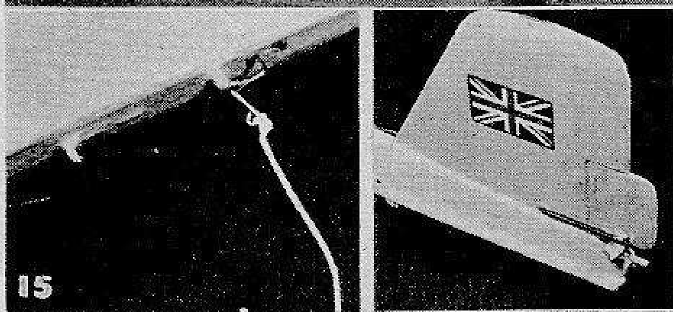


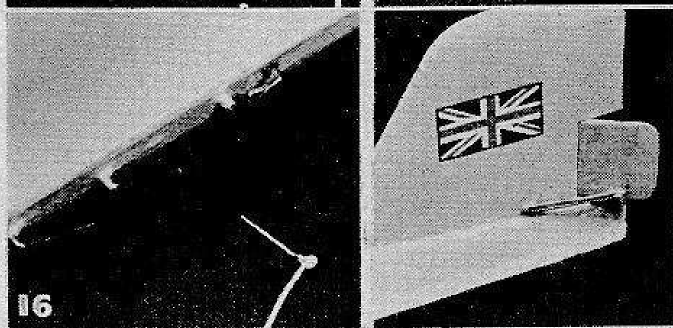


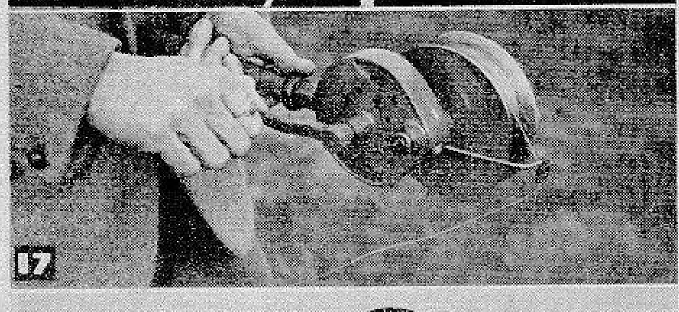
Flying the "Deacon": 8—Slight right thrust will help to overcome the left turn due to engine torque. 9—A small downthrust angle of 2-3 degrees is usually recommended. 10—For initial power flights, the engine should be slowed down by reducing compression. 11—If a glowplug engine is used, thrust can be reduced by fitting the propeller backwards and running the engine on a rich mixture. 12—First flight! Under reduced power, the model climbs away steadily at a shallow angle.

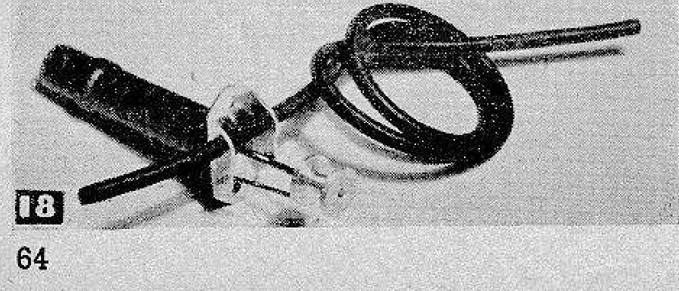












any F/F model is liable to be caught in a thermal up-current. This may merely extend the flight for an additional minute or two, or, on the other hand, the model may easily be borne upward until it is out-of-sight and may be lost.

A dethermaliser is designed to remove the risk of loss by bringing the model down after a predetermined period—usually 3 min. There are various types of d/t. One employs a small parachute which, when opened, slows up the model and causes loss of lift. The most popular type, however, is the "pop-up" tailplane. In this, the whole tailplane is pivoted at the leading edge, and tensioned with rubber so that, when released, the trailing edge pops up and inclines the tail at a negative angle of about 40 deg. This results in a complete stalling of the wing and the model will descend on an even keel almost vertically.

The usual method of releasing the trailing edge is by means of a fuse between the strands of a separate rubber band holding the trailing edge down. The best fuse material is a small diameter lamp-wick. It is lit, of course, just before the model is released.

A typical dethermaliser layout is seen in Figs. 13 and 14 on a Nordic A2 class towline glider. Note the thin steel wire bracing which limits the tailplane movement to the required angle. The extreme rear of the fuselage is covered with asbestos paper to prevent damage from the smouldering fuse.

A device which is widely employed on towline gliders, especially those of the contest type, is the auto-rudder. The purpose of this is to hold the model on a straight course during the tow, which then becomes circling flight as soon as the model is released from the towline.

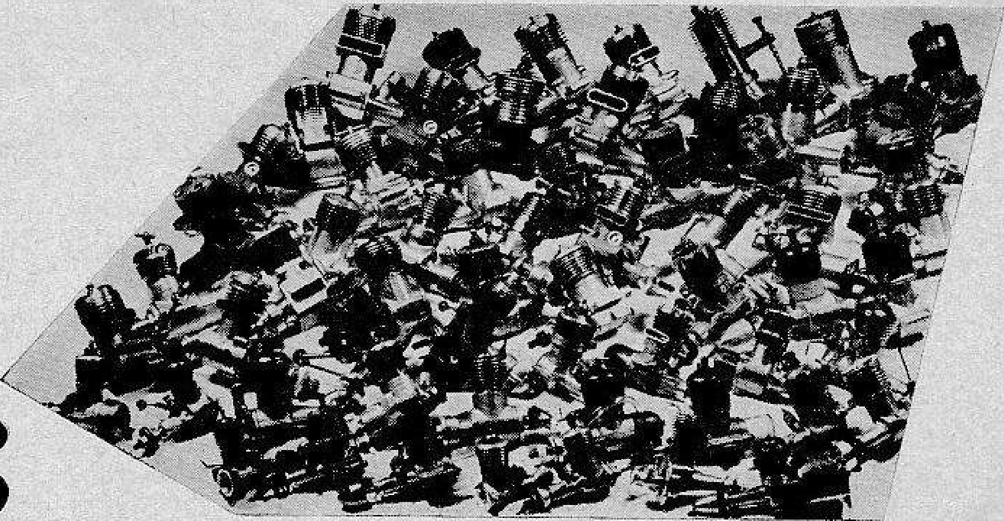
The operation of a typical auto-rudder is shown in Figs. 15 and 16. The rudder is tensioned by means of a rubber band against a stop suitably positioned to give the required turning radius. On the other side is fitted another stop, against which the rudder is centralised by the pull of a thin steel wire or nylon line, leading forward, through the fuselage, to a position just behind the tow-hook. Here a sliding trigger is fitted which can be locked in the forward position by means of a pin as shown. This pin is attached to the towline ring by means of a loose length of strong thread. Thus, when the towing ring slips from the towhook the pin is jerked out and the rudder snaps over.

In conclusion, one final word regarding trimming a power model for circling flight.

The main object of circling flight is to prevent a model from flying too far and going out of sight (which it may easily do if allowed to head in a straight line) and an adjustment which gives one right-hand circuit about every 20 sec. is about right. However, you may find that, with the rudder set for this in the glide, the model has an excessively tight right turn under power. In this case, reduce the amount of side-thrust on the engine.

Fig. 13. A typical dethermaliser installation. The fuse is placed between the rubber bands holding down the trailing-edge. 14—When released, the tailplane rises to a negative angle of approximately 40 degrees. 15—A typical auto-rudder installation on a towline glider showing the release-pin in place and the rudder centralised for towing. 16—When the model is cast off, the release-pin is automatically withdrawn, allowing the rudder to move over for circling flight. 17—For towline gliders, a winch is invaluable. Shown is an excellent geared winch made from a hand bench grinder. 18—The fitting of a flight timer and fuel cut-off valve is strongly recommended for free-flight power models. Shown is the Elmic Mini-Timer/cut-out.

More About Motors



IN chapter nine some suggestions were offered concerning the type of model engine with which the newcomer to power flying should begin. These were followed by explanations regarding the starting and operating procedure for a typical small diesel motor.

If your interest remains in the strictly "fly-for-fun" type of F/F model (as opposed to competition types), in F/F scale models, or in the smaller types of C/L models, you may never be concerned with the many larger or more specialised model motors on the market. But if this is so, you will certainly be a most unusual modeller!

CHAPTER SIXTEEN

Model aero-engines in themselves, quite apart from their employment in powering models, have now claimed sufficient interest from all sections of the model-making fraternity to virtually constitute a hobby within a hobby. Few serious modellers are content to carry on with the same motor indefinitely. Funds may not always allow them to buy every new engine that appeals to them (still less to amass a collection such as that shown above!)—but, in model clubs especially, there is much buying, selling and exchanging of used motors among enthusiasts. In this way, keen newcomers with slender purses will sometimes have an opportunity of acquiring, at a substantial saving, one or two engines suited to the particular branches of model flying in which they wish to specialise.

When we step out of the "beginner-engine" class, a most impressive array of different types and sizes awaits us. Generally, model engine sizes run in groups, according to cylinder capacity classes and you may be slightly bewildered by casual references to "two-point-fives," "oh-nine-nines," "fifteens," "two-four-nines," "two-nines," and "three-fives," not to mention an occasional "four-nine," or "sixty." These can be perplexing to the beginner because they may refer to capacity in either cubic centimetres or cubic inches. Thus, a "2.5," a "15" and a "249" may all be of the same nominal capacity, but a "three-five" may mean a 3.5 c.c. engine or a 0.35 cu. in. motor which, of course, is much bigger—actually 5.7 c.c.

To clarify the position, it must be mentioned that the official internationally recognised classes are based on cubic centimetre capacity and there are three groups only; viz., Class I: up to 2.5 c.c.; Class II: 2.5 to 5.0 c.c. and Class III: 5 to 10 c.c.

In the United States, on the other hand, the size groups are based on cubic inch measurement, and are four in number, namely, up to 0.05 cu. in. (0.82 c.c.),

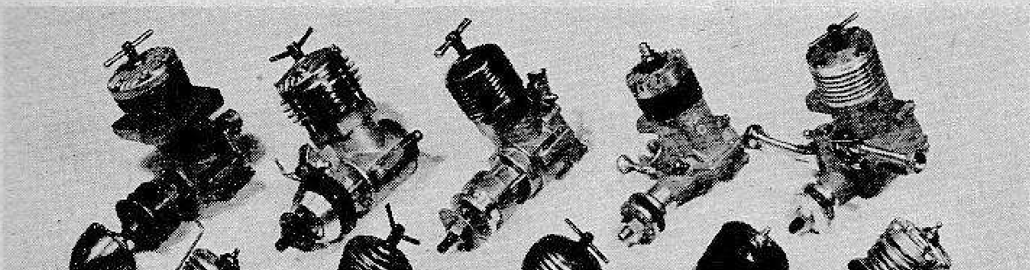
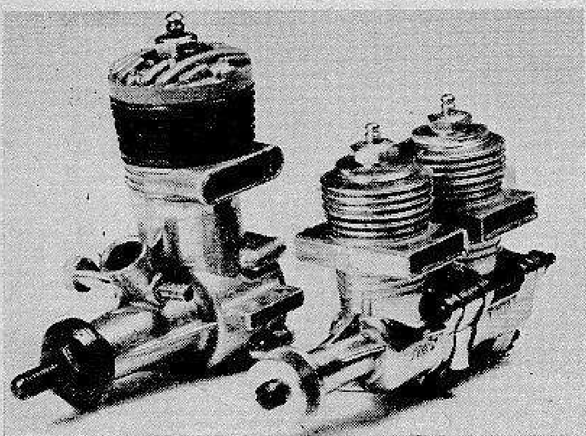


Fig. 1. A most popular size model engine is the 2.5 c.c. "International" class. Shown here are six diesels and four glowplug engines from various countries. They are (back row, left to right): E.D. 2.46 Racer, Frog 249 BB and D-C Rapier, all from Britain, and the Japanese O.S. Max-15 and Enya 15-D. In the front row, left to right, are the Webra Mach-I Glo and Taifun Tornado from Germany, the Sabre 2.5 from Australia and the Barbini B.40TN and Super-Tigre G.20 from Italy.



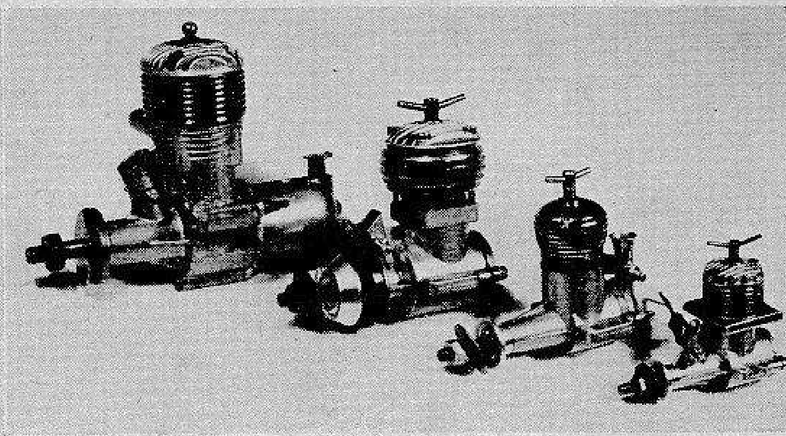


Fig. 2 (left). Nearly all model engines are of the single cylinder type. An exception is the K&B-Allyn "Fury-Twin," an extremely compact unit as can be seen by comparison with the K&B-Allyn "Torpedo-15" of similar capacity. Fig. 3 (right). An indication of the relative sizes of model engines of different capacity classes. Left to right: 4.92 c.c. Frog "500," 2.49 c.c. Frog "249 BB," 1.48 c.c. Frog "149" and 0.81 c.c. Frog "80."

0.05 to 0.20 cu. in. (3.28 c.c.), 0.20 to 0.30 cu. in. (4.91 c.c.) and 0.30 to 0.65 (10.65 c.c.). These are known as Classes "Half-A," "A," "B" and "C."

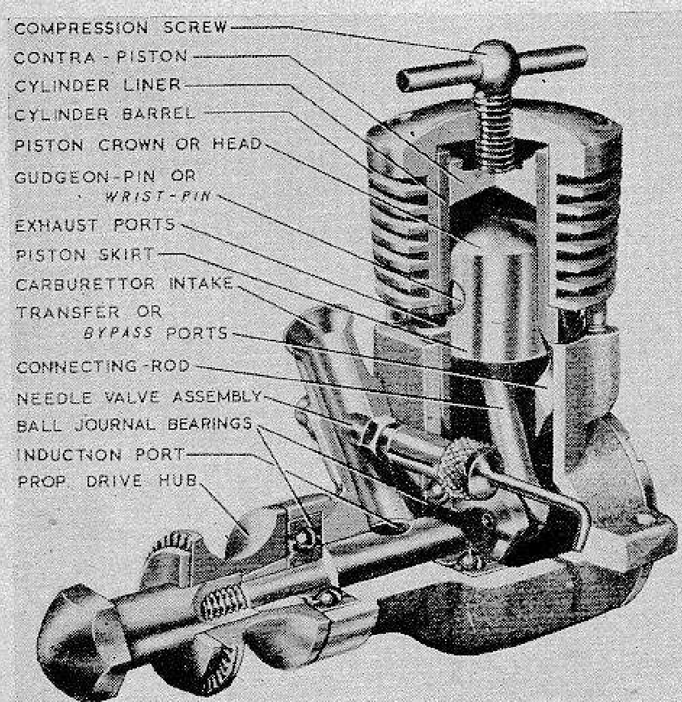
In Britain, motors are officially grouped in cubic centimetre capacities and in accordance with the three international classes, but there are also a number of "in-between" sizes which have survived from a now somewhat outdated system of speed record classification. These include 1.5, 3.5 and 8.5 c.c. In addition, British manufacturers have also responded to the demand for 0.8 c.c. engines in the American "Half-A" class which has become popular in many other countries also.

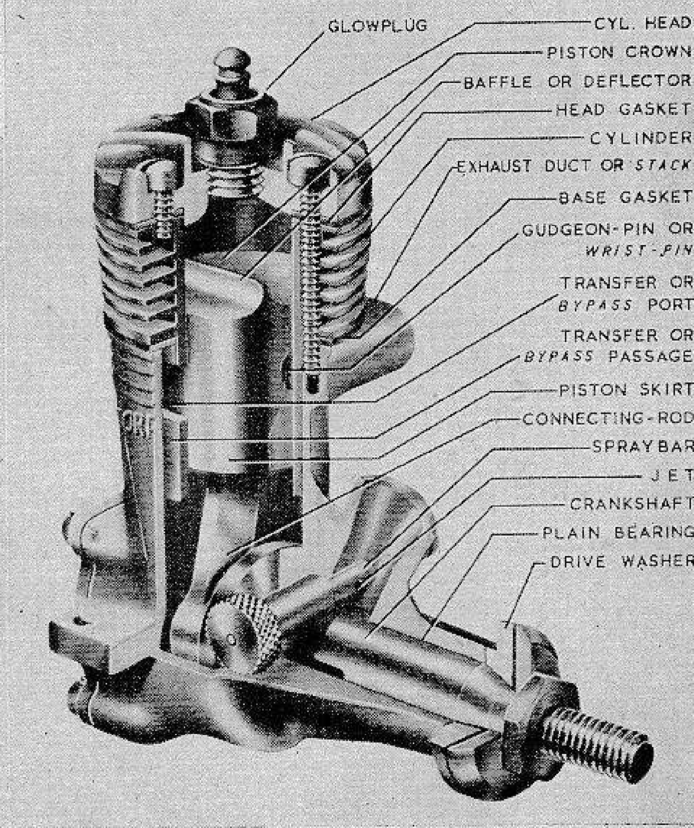
The most universally popular size outside the small, beginner's engine classes, however, is undoubtedly the 2.5 c.c. class. Engines of this size (mostly ranging from 2.43 to 2.49 c.c. to be precise) are made throughout the world and the class has been adopted by the *Federation Aeronautique Internationale* as the official International class motor for World Championship events.

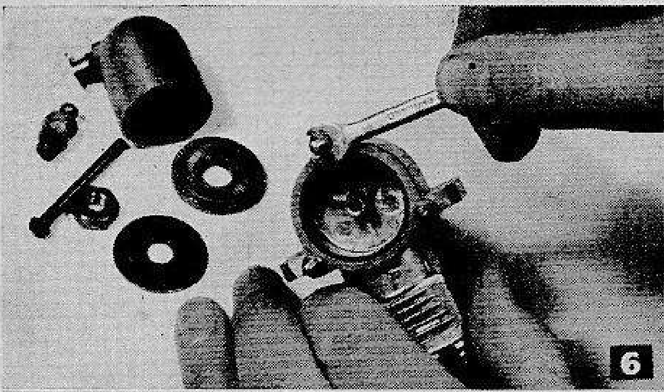
Most 2.5 c.c. engines are of the diesel type, although glowplug models from the U.S.A., Italy and Japan have been very successful in recent World Championship events. All types of designs are represented in the 2.5 c.c. group. Some engines are fitted with plain or bushed main bearings; others have one or two ball journal bearings, while one (the Italian Barbini B.40 TR/TN) has a roller bearing.

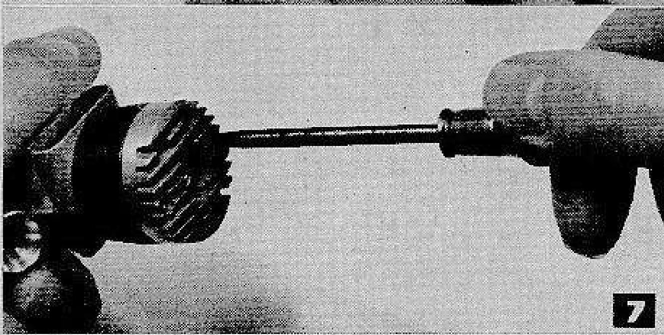
Between the beginner's engines and the 2.5s are the 1.5s. These are, perhaps, a better choice for the modeller who is mainly interested in F/F but who is hesitant about tackling the larger models (5 ft. span or so) required for a 2.5 c.c. engine. At the same time, a good 1.5 c.c., such as the Frog 150R or Allen-Mercury 15, is quite powerful

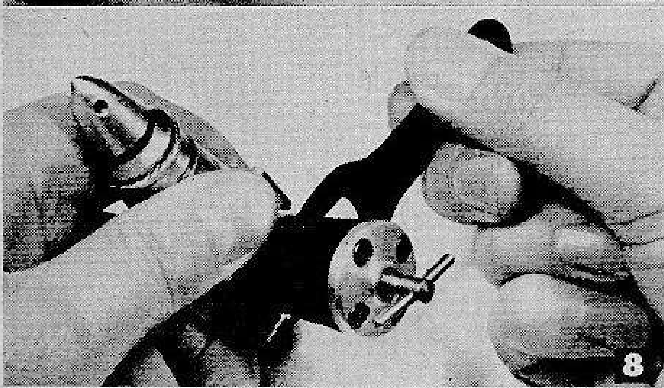
Figs. 4 & 5. These cutaway drawings show the various parts and constructional features of two well-known 2.5 c.c. engines: the British Oliver Tiger Mk.III diesel and the American K&B-Allyn Torpedo-15 glowplug motor, both of which have excellent competition records.

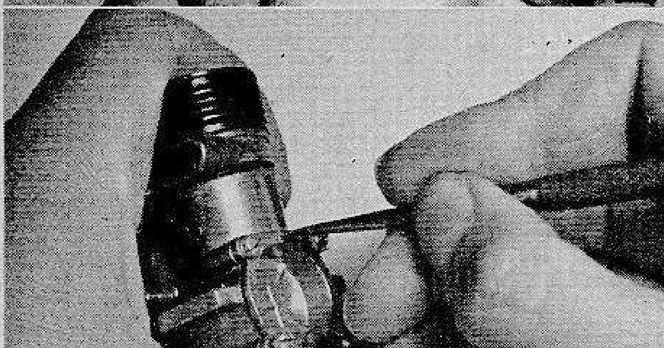


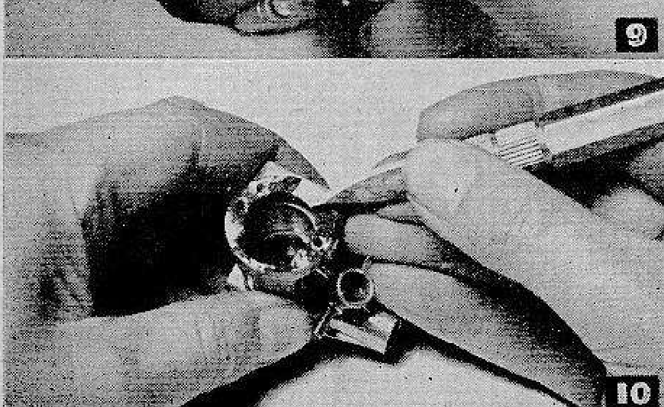












enough to provide a satisfactory aerobatic performance with a stunt model of suitable size.

We have mentioned the purchase of a "used" or "secondhand" engine. Naturally, some caution will have to be exercised here but, fortunately, it is not too difficult to detect whether or not an engine is sound. Obviously the safest course is to see the engine actually running and to start it and operate it yourself, but a mere inspection of the exterior alone will often give a good indication of the treatment the engine has previously had.

Modern model engines do not *wear out* easily. It is seldom that a new-looking exterior conceals a badly worn cylinder or bearings. By far the greatest number of unserviceable model engines become so due to careless handling; to improper use of tools and needless dismantling, and to crash damage. If an engine bears the scars of this kind of treatment, it is best rejected no matter how cheaply it is offered.

The essential differences between diesel and glow motors were stated in our earlier chapter. Always remember that the glowplug engine is a high speed engine. Never fit a propeller that overloads the engine —i.e. reduces its speed to less than 7,000 r.p.m. Different engines run best at between certain r.p.m. limits and there are far too many types to permit us to list suitable prop sizes for every engine, but where the maker's specific recommendations are unknown, the following will serve as a guide:

1.5 *c.c. or* 0.099 *cu. in. glow motors*: 8 in. dia. fine pitch, or 7 in. dia. medium pitch, or 6 in. dia. coarse pitch.
2.5 *c.c. or* 0.15 *cu. in. glow motors*: 9 in. dia. fine pitch, or 8 in. dia. medium pitch or 7 in. dia. coarse pitch.
0.19 *cu. in.* (3.25 *c.c.*) *glow motors*: 10 in. dia. fine pitch, or 9 in. dia. medium pitch, or 8 in. dia. coarse pitch.
0.29 to 0.35 *cu. in.* (4.9-5.7 *c.c.*) *glow motors*: 11-12 in. dia. fine pitch, or 10-11 in. dia. medium pitch, or 9 in. dia. coarse pitch.

The fine pitch propellers are, of course, mainly intended for F/F applications, the medium pitches for C/L stunt work and the coarser pitches for faster C/L models, such as team-racers, etc.

Don't try to start your glow motor with a poor battery. Most glowplugs are rated at $1\frac{1}{2}$ volts, except Japanese glowplugs, some of which are for 2 volts. Use either a pair of $1\frac{1}{2}$-volt bell cells connected *in parallel* or a 2-volt accumulator (connection to *one* cell of a car or motor-cycle battery will do). When you use dry cells, they must be fresh enough to provide a bright red glow at the plug element. (Remove the plug from the engine to check this.) If you use a 2-volt wet cell, however, it is advisable to employ extra-long leads from the battery to plug, so as to create a resistance that will cut down the applied voltage at the plug to about $1\frac{3}{4}$ volts—otherwise the plug element will glow almost white hot and soon burn out.

We now come to the question of model engine maintenance, which, for the most part, merely consists of keeping the motor clean and always using the proper tools—even when this is confined merely to tightening

Use utmost care to dismantle your engine. Fig. 6. Use spanners and screwdrivers that fit properly. Fig. 7. If your engine has Phillips-head screws, you must use the correct Phillips screwdriver. Fig. 8. Do not attempt to remove a screw-in cylinder unless you have the required special wrench for the job. Fig. 9. Where there is a risk of a component being incorrectly replaced, it is advisable to scribe a mark before removal. Fig. 10. Gaskets, where used, may become stuck to crankcase or cylinder. Scrape off carefully and do not scratch metal.

the propeller or changing the plug. This may sound elementary, but it is surprising how carelessly some people treat model engines. Some manufacturers supply a tool for tightening the propeller nut and/or glowplug, but if this is not provided, always use the correct size spanner. *Never use pliers!*

Dismantling, or partial dismantling, of your engine is permissible only if you do the job properly. Generally, it will not be necessary to take your engine apart if you exercise care in keeping it clean. Always keep dirt and grit away from the air intake and exhaust ports by plugging them with tissue paper or by wrapping a cloth around the nose of the model. Try to ensure that the engine runs itself dry of fuel after use: raw fuel left in the crankcase may, in some cases, form gummy or jellied deposits, or, under conditions of dampness, have a corrosive action on certain component parts.

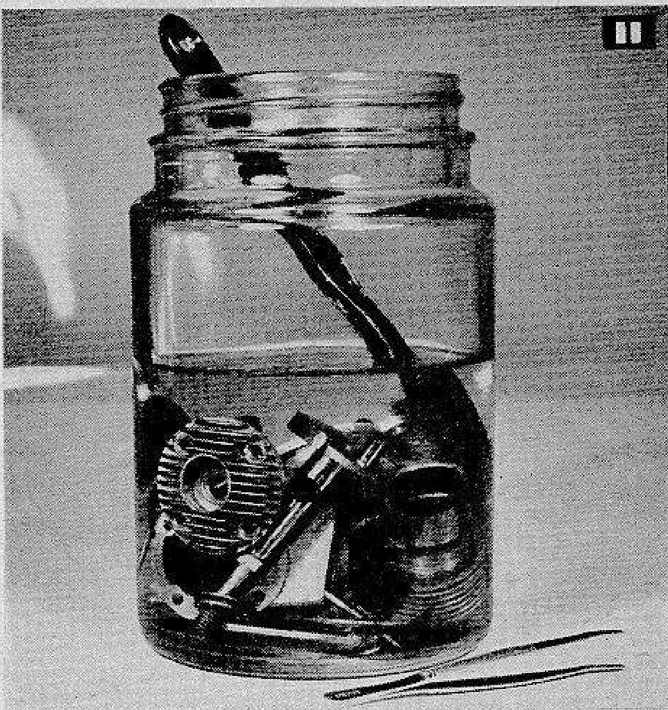
If you should have the misfortune to crash your model into sandy soil, it is very probable that dirt will get into the ports, and merely immersing the entire engine in petrol will not be enough to ensure that every speck of grit is washed out. If, for this or any other reason, you need to dismantle your engine, you should observe the following.

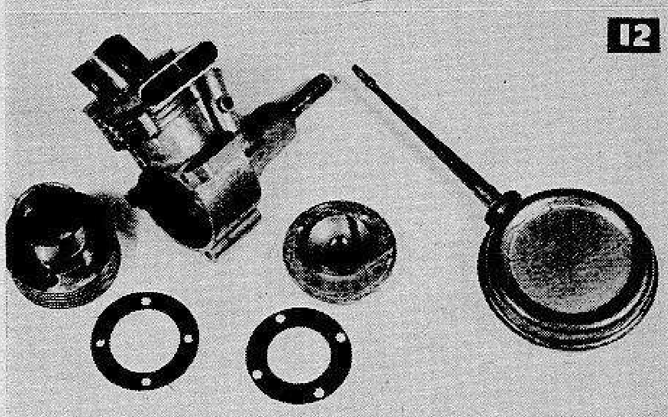
Firstly, make sure that you have the tools to do the job. Spanners and screwdrivers must fit properly. Secondly, work slowly and methodically. Thirdly, mark adjoining faces of components so that there is no risk of your wrongly reassembling them. Even when a part can be replaced in one of two or more different ways, it is always wiser to replace it as originally fitted.

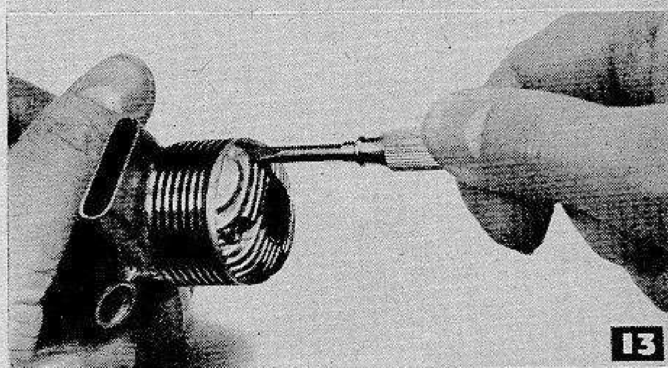
Some engines, such as the Frog 500 featured on this page, are assembled with screws and are easy to dismantle with ordinary tools. Others have components threaded and screwed together and often require the use of a special spanner to unscrew cylinder from crankcase, etc. Some American and Continental manufacturers include a special wrench for this; a practice which, however, is rare among British makers. If no suitable tool is available, the parts are best left alone. *Never* clamp any part of an engine in a vice. *Never* use pliers or a Stilson wrench. *Never* put anything through the exhaust ports of a radially ported engine to turn the cylinder.

To clean the parts, immerse them in a 2 lb. jam jar, half-filled with petrol. *Keep away from naked flame.* To dislodge dirt between cylinder fins, use an old toothbrush. If the engine is very dirty, rinse again in a fresh supply of petrol, then lay out all parts on a sheet of clean white paper to dry. If the engine is equipped with gaskets, it may be necessary to replace them, especially if they have become stuck to the metal and have been damaged during dismantling. Use only the correct replacement gaskets as supplied by the engine manufacturer.

Reassemble the engine carefully, lubricating each component with machine-oil. Make absolutely sure that parts are properly aligned and when tightening cylinder-head screws, always do so progressively: i.e. turn one screw a little, then turn the screw on the opposite side an equal amount, then another screw, then the one diametrically opposite and so on, repeating the sequence until the head is tight.







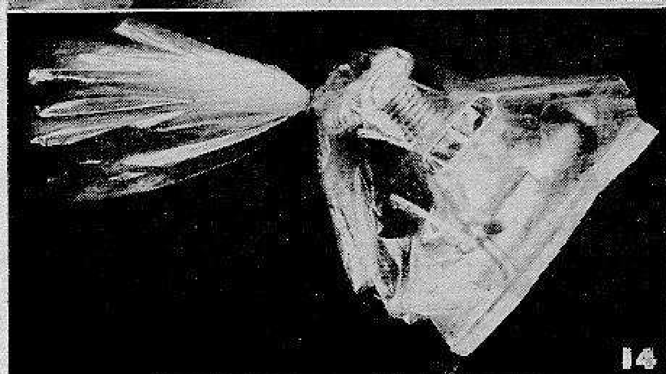


Fig. 11. Wash components in jar of petrol. A pair of tweezers is useful for extracting small parts. Fig. 12. Lay out parts on clean white paper. Lubricate each with machine oil and fit new gaskets where necessary. Fig. 13. Tighten cylinder screws a few degrees at a time, working diametrically across head. The same applies to crankcase screws. Fig. 14. To protect your cleaned engine from dust and damp, wrap in polythene bag.

Control line Stunt Models

CHAPTER SEVENTEEN

IT is probably true to say that the goal of most people who take up C/L flying is to successfully fly an aerobatic model. Once you have confidence in your ability to control a C/L model in level flight, you will almost certainly feel the urge to try a few stunts.

Most trainer models are capable of simple manoeuvres, such as wing-overs, loops and inverted flight, but it should be remembered that the majority of C/L beginners' models are intended to be relatively insensitive to control and thus of limited manoeuvrability, and you will most certainly need a fully aerobatic model if you are to learn to stunt properly.

The ideal way of graduating from a simple C/L trainer to a fully aerobatic model is to build a stunt trainer. Such a model will be of light, but strong construction and not too fast, in order to stand up to an occasional " prang." It may not be particularly good looking, but will be fully responsive to control, yet at the same time have a " safe " aerodynamic trim that will maintain line tension under extreme conditions.

Unfortunately, this type of model is not readily available in kit form at the present time. The demand for realistic appearance in order to qualify for bonus points in aerobatic contests—in itself a good rule since it has largely eliminated the ugly box-like lines of some of the early C/L stunt models—has now also spread to the intermediate stunt-trainer classes, as a result of which these models tend to be more vulnerable to crash damage than is strictly desirable in a stunt trainer. However, there are ways and means of partially overcoming this difficulty.

Probably the most critical phase in learning to stunt is in the early stages: the first loops and learning to control the model in the inverted position. If, therefore, you have a trainer model still in flying condition, it is a good idea to make use of it to try out these manoeuvres. You can, if necessary, improve the " stuntability " of your trainer by a few simple modifications.

Some trainers are fitted with a control-system which is adjustable for sensitivity. There may, for example, be an extra hole for the push-rod in the bellcrank. In this



Contest-winning stunt models. Left is a Monarch, slightly modified, from a Mercury kit. Centre is an Eta 29-powered design by J/Tech. Higgins of the R.A.F. who is seen here after winning the Model Aircraft Trophy and aerobatic event at the R.A.F. Model Championships. Right is a "Stunt-Queen," a replica of a former Gold Trophy winner and built from a Keilkraft kit.

case, re-fit the push-rod in the outer hole so that more push-rod movement is obtained. It is possible, too, that the elevator horn has two or more holes and, by repositioning the push-rod in the inner hole, you will obtain more elevator movement for a given push-rod movement. The combination of these two adjustments may effect an increase in the maximum elevator movement from 15 or 20 deg. or so to 40 deg. More control is also possible by enlarging the elevator area: this can be increased to about 50 per cent. of the total tailplane area. Centre of gravity position also affects the manoeuvrability of a model. If the c.g. is ahead of the front control-line where it joins the bellcrank, it may be moved to a position level with the front line.

One other item may need attention in the conversion of a trainer for stunting: the fuel tank. If the tank is an ordinary F/F type with the fuel feed taken from the bottom, it is obvious that this will not work when the model is inverted. A simple "wedge" shaped fuel tank should therefore be fitted. The tank should be mounted so that the point of the wedge (in which the fuel feed pipe is fitted) is towards the outside of the circle. This ensures that the feed pipe will always pick up the fuel, since the fuel in the tank always surges towards the outside due to centrifugal force.

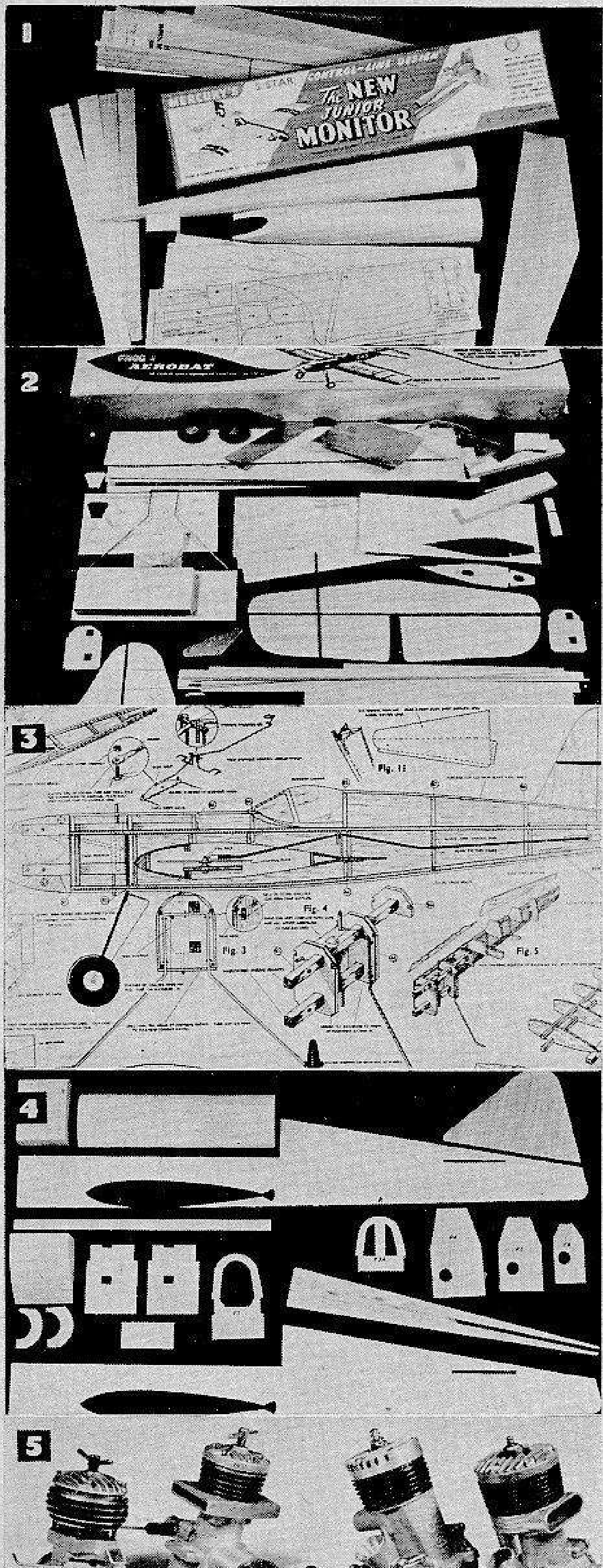
When you first fly your modified trainer, use caution. Remember that it will now be somewhat more sensitive to control handle movement, so concentrate, initially, on keeping the model straight and level, as you did when you first learned to fly.

A true stunt model is, of course, a highly specialised machine and is a type which has been brought to an advanced state of development by leading exponents of C/L aerobatic design. Many of the most successful innovations in stunt model design can be traced to American influence, of which a major part has been contributed by the notable stunt expert Bob Palmer.

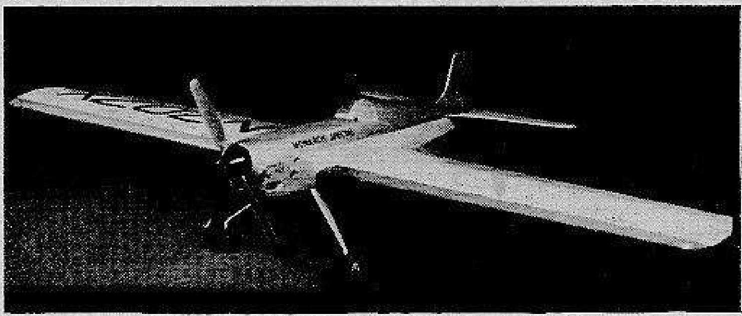
The typical American type stunter is a fairly large machine of about 50 in. wingspan, 500 sq. in. wing area and weighing about $2\frac{1}{2}$ lb. It is powered by a glowplug engine usually of 0.35 cu. in. (5.7 to 5.8 c.c.) capacity, turning a 10 × 6 in. propeller and developing about 0.5 horsepower in the air. Flying speed is generally 65-70 m.p.h. and line length 70 ft.

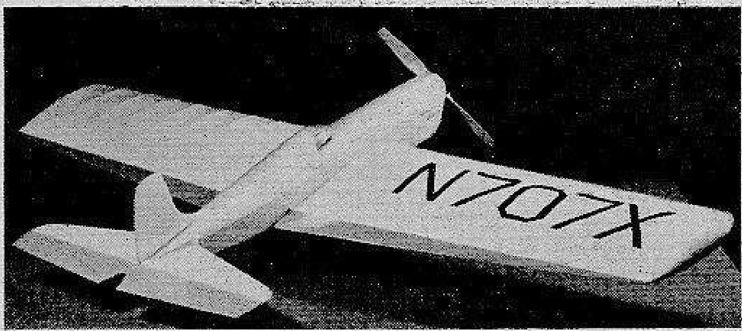
The model is usually of the low-wing or mid-wing type, with a thick symmetrical-sectioned wing and coupled trailing-edge flaps. These latter usually extend from root to tip and are coupled into the control system in such a way as to work in opposition to the elevator—i.e. when the elevators are "up," the flaps are "down," and vice-versa. The purpose of these flaps is to provide extra lift during certain aerobatics. They allow tighter manoeuvring (especially valuable in performing vertical-figure-eights and rapid pull-outs from dives) and avoid the necessity for an ultra-short tail movement arm and the unrealistically short fuselage that this involves.

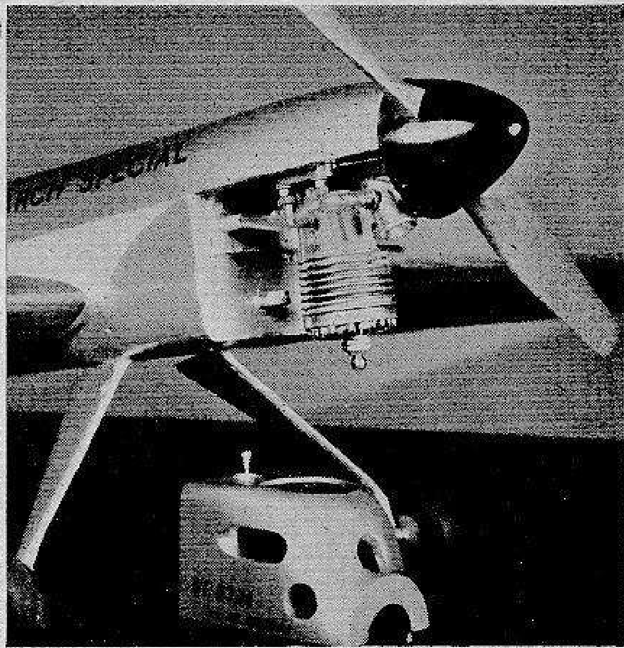
It will frequently be noticed, with this type of model, that the inner wing is about 2 in. longer than the outer panel. The purpose of the extra area is to provide



There is extensive prefabrication in most modern stunt kits. 1. The Mercury Junior Monitor Mk. II, a 30 in. short-coupled, non-flapped model with hollow-log type fuselage, for 2.5 c.c. motors. 2. The Frog Aerobat, also for 2.5 c.c., but with built-up fuselage and wing-flaps. 3. A section of the excellent assembly drawing for the Aerobat. 4. The ready-shaped fuselage parts of the Mercury Marvin. 5. Examples of engines favoured for stunt work: the Frog 249 and E.D. 2.46 diesels and O.S. 35 and K. & B. 35 (both 5.8 c.c.) glowplug motors.







Left: two views of the Monarch stunt model built for this series. The model was sprayed grey and silver with red leading-edge, flaps and elevator and black lettering. The entire undersurface of the wing and tail are red in order to provide a suitable contrast in the air Right: showing the installation of the Veco 19 glowplug motor and detachable cowling.

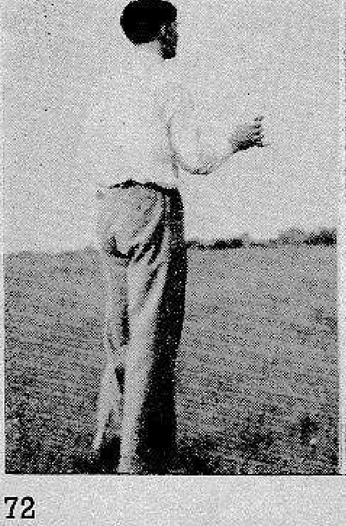
located so that the delivery pipe is approximately in line with the carburettor jet, in order that an excessive variation in the " head " of fuel does not occur between level and inverted flight (due to gravity) or between take-off and maximum speed (due to centrifugal force).

The elementary rules applying to the preparation of C/L models, which we mentioned in Part 10, also apply to stunt models. The use of steel lines is now advised, however, since they are much less likely to bind on each other when they become crossed after a succession of loops. Plain single strand wire can be used but this needs care when unwinding and you will find it easier to use braided wire such as " Light Laystrate." The ends should be looped through suitable clips and twisted together and soldered.

Begin by getting to know the feel of the model. Fly it for several laps at different attitudes, then try some gentle climbs and dives. On your next flight, take the model higher in your climbs and merge them into the dive so that the model is performing a sort of oblique wing-over. *Make sure the wind is always behind you!* By gradually steepening this manoeuvre you will eventually have a complete vertical wing-over, entering the manoeuvre in a vertical climb on one side of the circle which takes the model straight up overhead and into a dive on the other side. Pull out fairly early at first, practising the wing-over until you are able to pull out more sharply and more close to the ground.

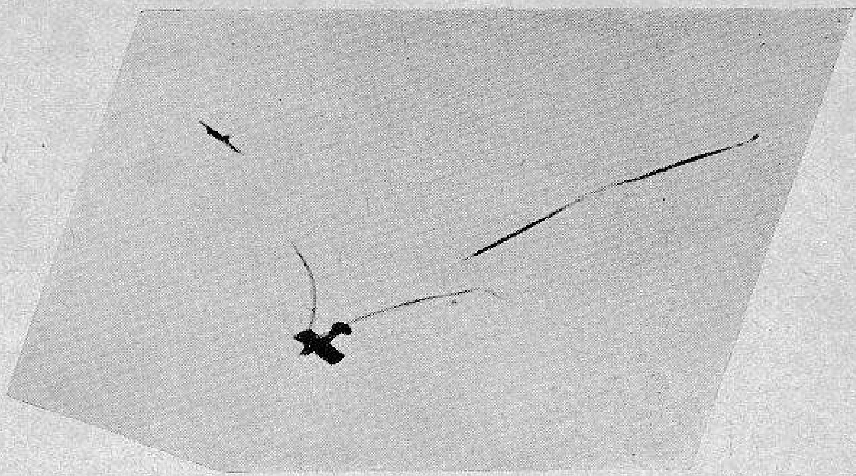
The first real step to stunting is the loop. You know how your model responds to being pulled out of a dive so you really have nothing to worry about. Take the model round for a couple of laps at about 15 ft. then swing your arm up to put it into a steep climb. Increase the amount of " up " and the model will go over on its back. Hold the " up " position until the model comes round and is practically level again then bring your arm down to the level flight position.

Your first loop will probably be a bit shaky: by no means round and with the model pulling out too early —just to be on the safe side. Spend your next few flying sessions in perfecting your loops and in practising what you have so far learned.



An expert stunt pilot in action. Note the easy, relaxed attitude: feet together when using the full circuit, or feet apart stance when performing manoeuvres on one side of the circle. Fingers are curled securely around the handle but not so tightly as to destroy the feel of the controls.

More about C/L



Our heading photo shows combat flying in progress. Diving model has just intercepted opponent's streamer, which was severed by prop a fraction of a second after this photo was taken.

CHAPTER EIGHTEEN

YOUR first loops will probably look something like that shown in the sketch on the next page—or worse. Keep practising them until you are confident and can open them up into something more like that shown in the next drawing. A perfect loop—i.e., one that will score top marks in a contest—should be circular and the recovery should be at the same height as the entry. You will, eventually, be able to make the model complete several consecutive loops, all following exactly the same path.

The next step is inverted flight. It should be attempted only after you have gained plenty of practice in loops and wingovers and have become accustomed to the feel of your model through these manoeuvres. The only difficult part about inverted flight is getting used to reversed controls. A good aerobatic model will fly just as well inverted as upright, but, as with full-size aircraft, the elevator control now gives the opposite response and "up" becomes, in effect, "down" and vice-versa.

By the time you are ready to try inverted flight it will be found that a more relaxed attitude has been adopted quite naturally. You will no longer be conscious of the necessity of keeping your arm absolutely stiff from the shoulder. Safe but more responsive control by means of forearm movement and even wrist movement is now possible and this will be valuable in inverted manoeuvres.

The inverted flight position is entered merely by doing a half loop and levelling out by giving "down" elevator at the top. Keep the model fairly high so that you have more altitude in which to recover if you involuntarily give the wrong control.

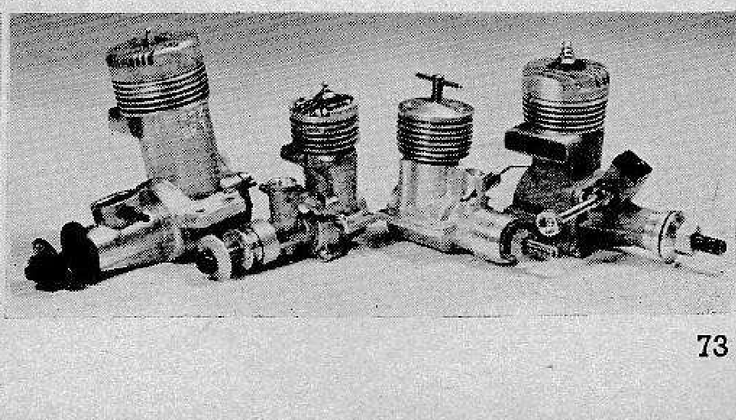
The model is, of course, now travelling in the opposite direction (i.e. clockwise) and this does serve as a reminder that "up is down" and "down is up," quite apart from the appearance of the model itself in profile. But you will have to concentrate hard at first, in order to avoid repeating the now-instinctive "natural" corrective movements when the model is losing height or, alternatively, climbing too much.

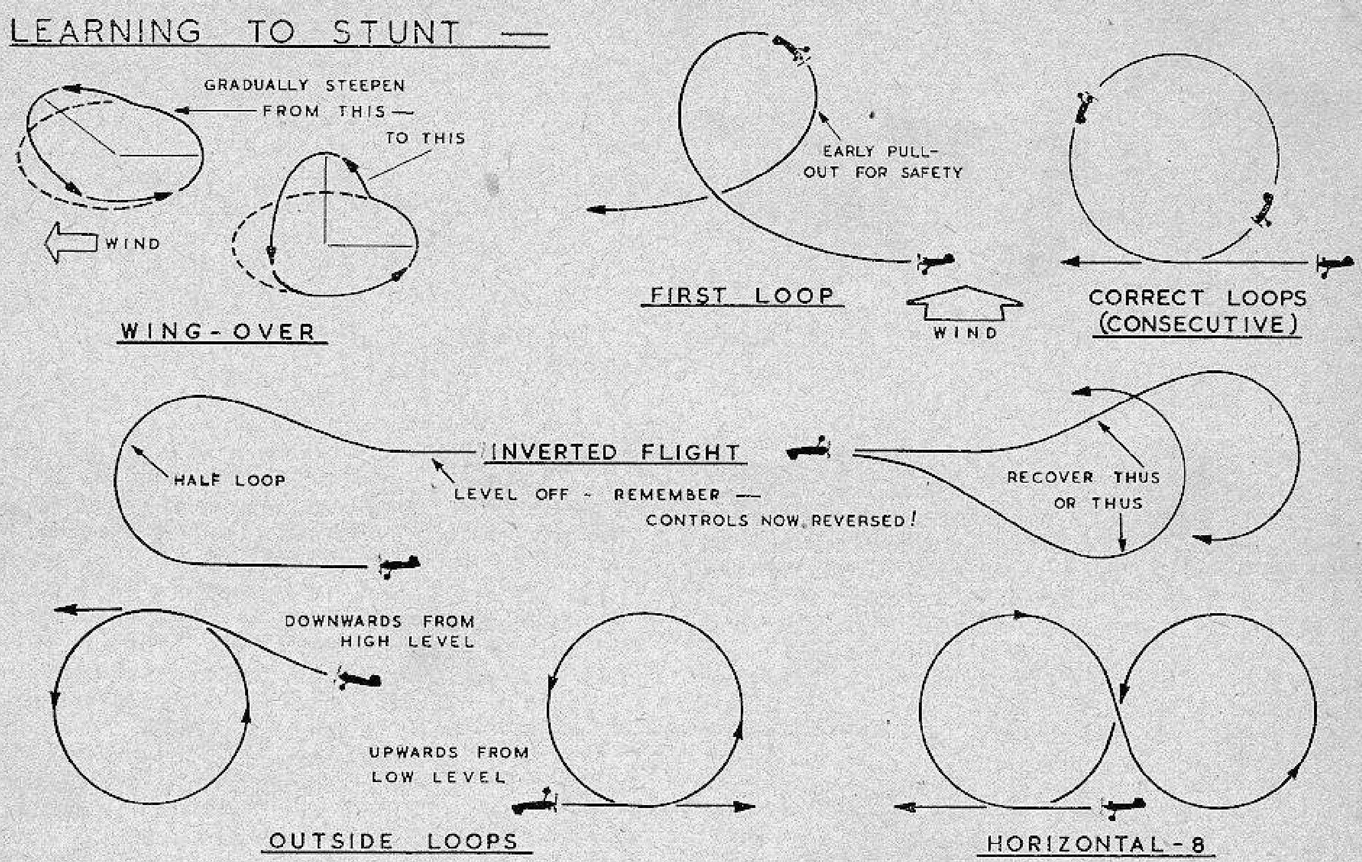
It is best to learn inverted flying on a day when there is no wind. It is then possible to safely make a quick recovery to level flight anywhere in the flight circle if you should get into difficulties. Recovery can be made by completing the remaining half of the inside loop with which you commenced the manoeuvre (making sure that you have sufficient altitude) or by giving full "down" elevator to bring the model up and over in an outside half-loop.

From here you can go on to the outside loop. This can be entered from a high level and commenced downwards, or alternatively, you can fly the model inverted and enter the outside loop upwards. Consecutive outside loops should cover the same path as inside loops.

The horizontal figure-of-eight is a combination of

A team race in progress. Upper model is just about to overtake lower one. Third model (not visible) is being refuelled while pilot kneels. Right: a selection of engines for C/L competition: the American 5 c.c. Fox 29R racing engine, the Italian 2½ c.c. Super-Tigre G.20S racing engine, the British 2½ c.c. PAW-Spl. for team racing and stunt, and the Japanese 5 c.c. Enya 29-3, an all-round contest engine of excellent performance.





inside and outside loops, side by side, as shown in the sketch and is quite easy, once you have mastered the previous manoeuvres. Start off by practising your "eights" with the model well up and don't worry about their not being perfectly rounded at first. When you have a good pattern you can then bring it nearer to the ground and, after this, move it gradually higher until you have an "overhead eight."

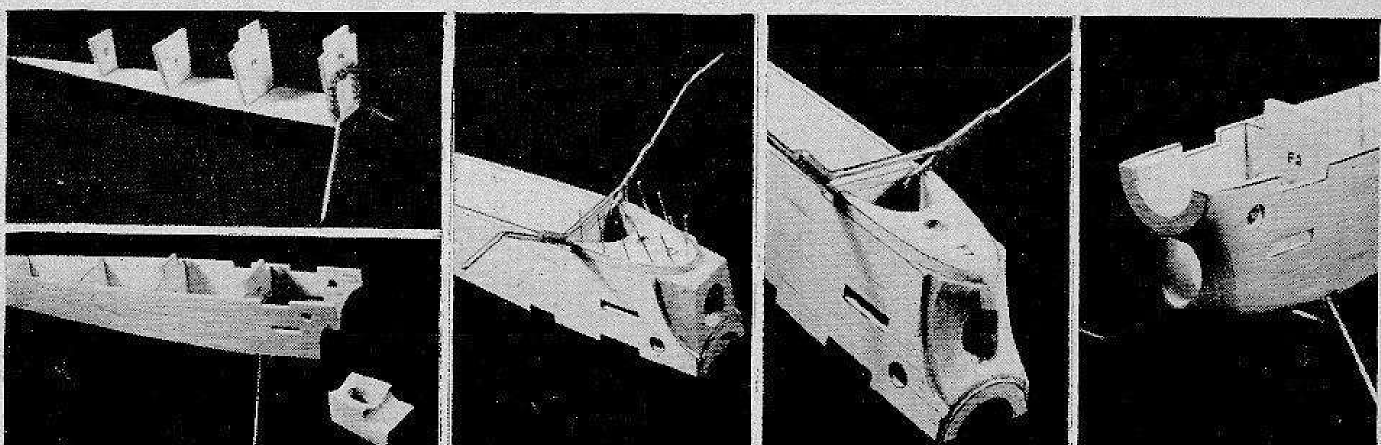
The vertical eight is rather more difficult since it consists of inside and outside loops one above the other. You must have a good model, capable of turning tightly, to perform the manoeuvre safely.

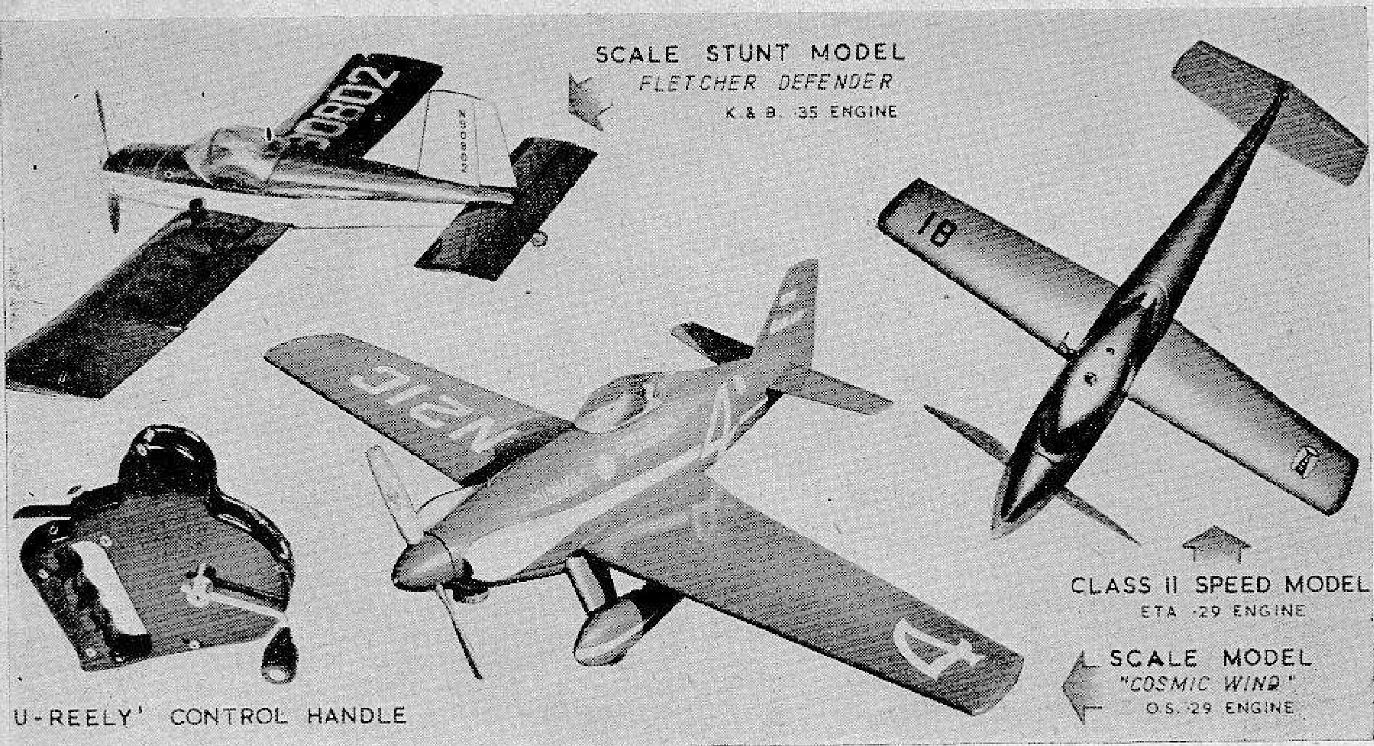
When contests for C/L models were first organised, they were divided into two types of event only. One was an aerobatic contest, the other a speed event and, from the early general purpose type C/L model, two widely differing types of model emerged. The stunt model is big with a very large wing area and may bear some resemblance to a full-size aircraft. The speed model, twice as fast for a given engine size, is tiny, beautifully streamlined but has little or nothing in common with the appearance of a full-size machine.

Speed models have one purpose only; to make a short flight of a given number of laps against a stop-watch. This can be very exciting for contestants, but for the spectators one speed run is very much like another and, some years ago, a group of speed enthusiasts in California got together to formulate rules for a new type of contest model: the team-racer.

Here, the object was for two, three or four models

Building the Mercury Mac team racer. 1—The fuselage floor with formers and undercarriage mounted. 2—The fuselage sides added, with noseblock partially shaped prior to fitting. 3—The noseblock in place and front former added. 4—The noseblock partially shaped. 5—Final shaping.





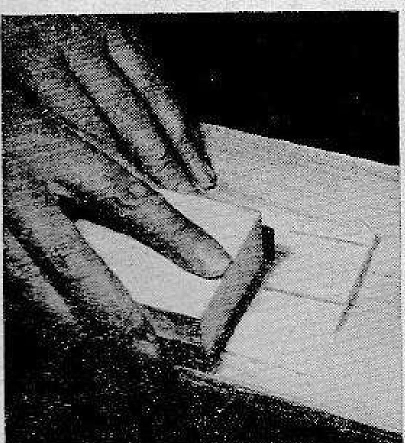
Various types of C/L models. Scale stunt model, designed by John Chinn, has 50-in. span and weighs 40-oz. In contrast, speed model, by the author, has 16-in. span weighs 17-oz. True-scale 36-in. model, centre was built by Shokichi Takagi of Nagoya Model Club, Japan. An elaboration of the usual C/L handle is the "U-Reely" with self-contained lines.

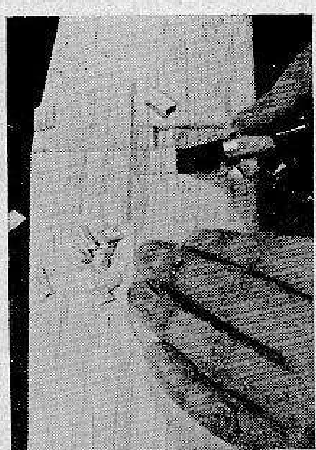
to be flown simultaneously (their pilots being grouped together in the centre of the circle) so that the contest would be a genuine race between the models. To add to the interest the races were over a distance of ten miles (140 laps using 60 ft. control-lines) and fuel-tank capacity was restricted to one fluid ounce, so that each model would have to make about three "pit-stops" to re-fuel. Each model was allowed two mechanics to re-fuel and re-start the model or to make any quick repairs or adjustments. In addition, the model itself was to be of semi-scale design, of a certain minimum wing-area and powered by an engine of under 0.30 cu. in. (4.9 c.c.).

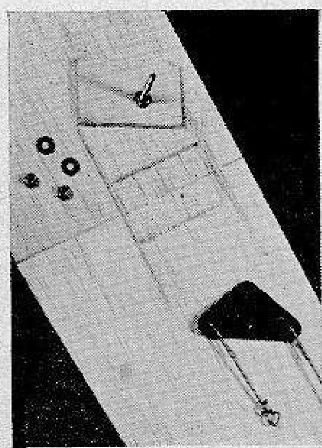
Team racing was an instant success and soon spread to Britain and other countries. Today, these team-racers are capable of 100 m.p.h. and a ten mile race has been completed in the remarkable time of 7 min. 9 sec., an average speed of nearly 84 m.p.h. including stops for re-fuelling. Team-racing is now far more popular than pure speed flying and there is also a class for smaller models with 2.5 c.c. (0.152 cu. in.) engines.

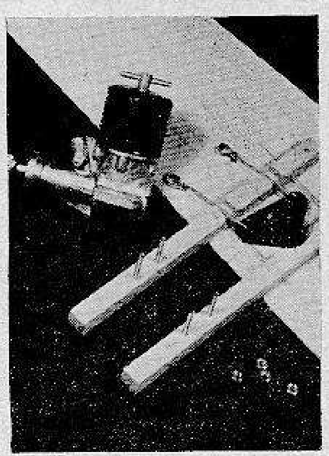
Team-racing demonstrated the practicability of flying more than one model in the same circuit and, from this highly successful offshoot of speed flying, stemmed the idea of "combat-flying," a two-in-the-circle event for aerobatic models.

In combat flying, each model trails a long paper streamer and the idea is to "attack" your opponent by cutting his streamer with your prop. There is a tremendous amount of fun in combat, but, not surprisingly, mid-air collisions and crashes are rather frequent and it is advisable to have a simple and robust (as well as fast and manoeuvrable) model for this sort of event.

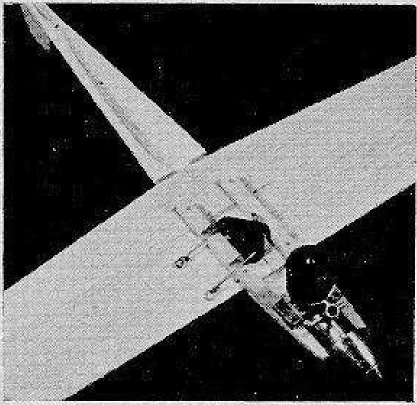
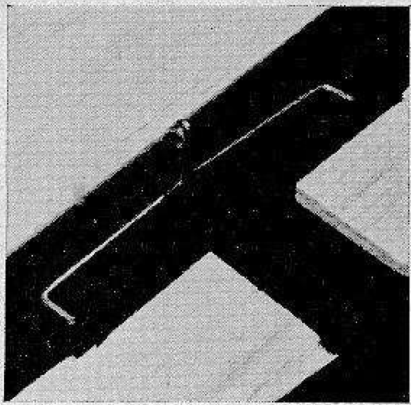
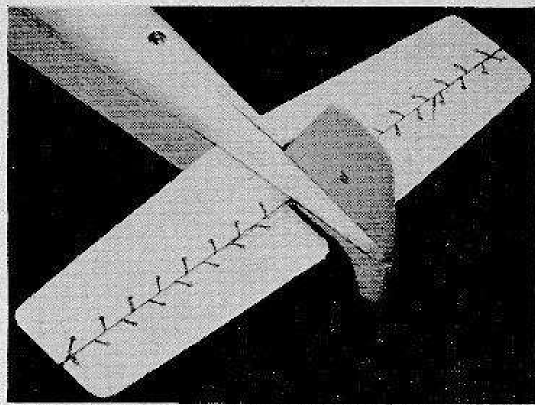








6—Shaping the wing section by means of a sanding block and a piece of board. 7—Chiselling out the recess for the bellcrank mounting plate with an X-acto No. 18 knife. 8—The bellcrank and mounting plate assembly ready for fitting. 9—Engine bearers, pre-shaped, are dowelled and cemented to the bottom of the wing. (AM-25 engine shown).

10—Upper fuselage block is added to the wing and bearers. 11—The elevator horn is bent carefully to the shape shown. 12—Instead of tape hinges, the elevators are stitched with thread.

Some contestants now favour a "flying-wing" type model—i.e. one in which the fuselage is virtually non-existent, the engine being mounted at the front of a low-aspect ratio wing having an elevator attached direct on to the trailing-edge. This allows maximum strength to be built into the model for minimum weight and also gives a manoeuvrable model capable of tight turns.

One of the big advantages of C/L (as compared with F/F) is that true scale models of almost any type of aircraft can be successfully flown without the slightest alteration to wing and tail areas, sections or dihedral angles. Twin or multi-engined scale models, too, are far more practical as C/L models.

True scale C/L models are usually built purely for pleasure rather than contest work, although of course, there are *concours d'elegance* events for models of this type. However, with minor alterations, certain full size designs have served as a basis for some excellent aerobatic scale models. Preferred choice here is a single-engined mid-wing or low-wing aircraft having relatively large flying surfaces, such as the *Grumman Guardian* or *Fletcher Defender*.

Another type of contest open to scale models is the U.S. Navy Carrier event. This requires that the engine be fitted with a throttle control operated via the control system, or a third line, because the model is timed to make high-speed and low-speed runs and to land on a dummy aircraft-carrier deck using an arrester-hook.

Remember, when you are building your C/L model, especially if it is a stunter or combat model, that, one day you are pretty sure to pull out too late and make contact with terra firma somewhat abruptly. Whether you are then left with a heap of balsawood or a model that is only slightly damaged, depends not only on the structural design of the model, but on how well you have built it. Precementing of all the joints is of the utmost importance. A model that is poorly made with "dry" joints, can fall apart on impact even when the motor has stopped. Yet the same model, strongly and intelligently built, may withstand a power dive into soft ground with nothing more than a broken prop.

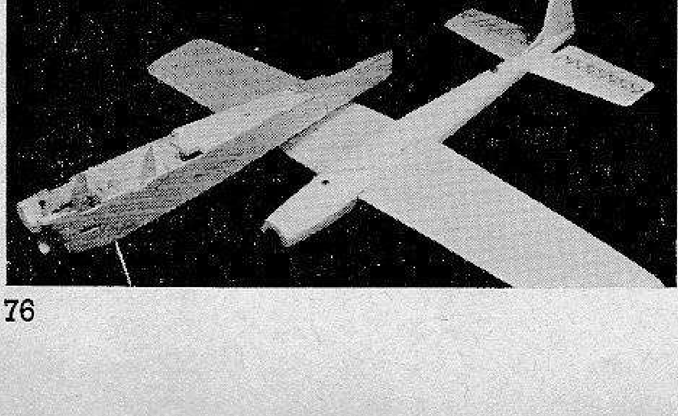
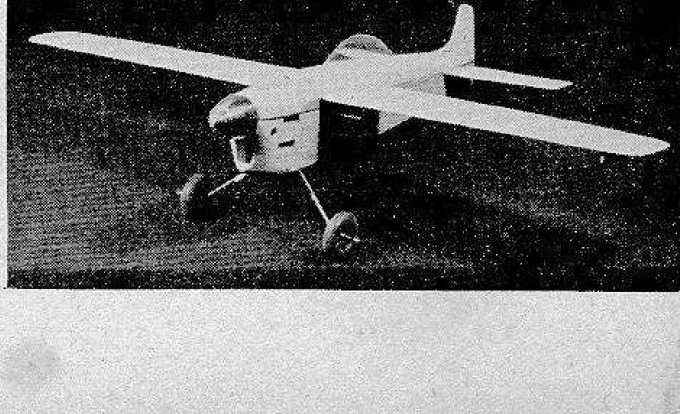
Don't forget when you are flying a stunt or combat model, that each loop twists the control lines together. When you are using steel lines it is possible to make up to a dozen loops without the lines binding together but do not forget to untwist them again after each flight.

Don't, in the excitement of the take-off, grasp your C/L handle the wrong way up! Preferable here is a handle with a grip shaped for the fingers. Some handles, incidentally, such as the "U-Reely" illustrated, have built in line-reels that allow line length to be varied while the model is in flight.

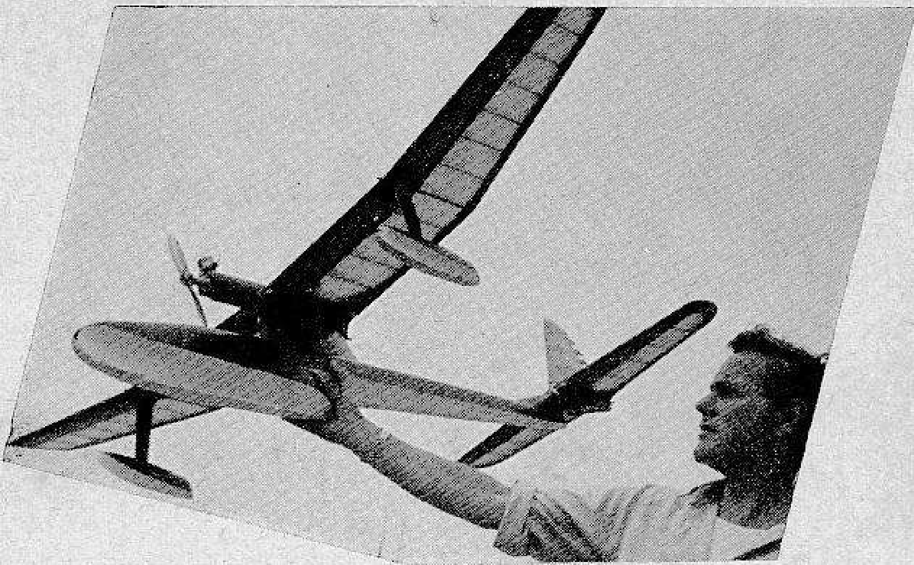
Never forget that your model will remain under control only as long as the lines are taut. Be ready, always, to step back quickly if the lines go slack and, if the motor cuts in the middle of a manoeuvre, get ready to move rapidly. If the model is inverted, near the ground when the motor cuts don't attempt to half loop it into level flight: just let it glide around, holding off as long as possible to lose speed. If you are flying over long grass you will most likely be able to land intact.

For our photo-sequence we have chosen the Mercury *Mac* team racer. The *Mac* is for Class A team-racing—i.e. for engines up to 2½ c.c. and using a 15 c.c. capacity fuel tank. Fitted with the moderately priced but well-built AM-25 diesel of 2.35 c.c., the model is capable of 70-75 m.p.h. and is excellent training for anyone wishing to take up team racing. The model is of quite simple construction as can be seen from the photographs.

13—The Mac fuselage separates at the centre-line, the engine and control system being mounted in the upper section. 14—The completed model, ready for doping and finishing.

R/C in a Nutshell



CHAPTER NINETEEN

OF radio-controlled model aircraft, an expert F/F and C/L modeller was once heard to remark: "A hundred hours' work for ten minutes' flying."

There was once more than a grain of truth here: partly through the fault of R/C enthusiasts themselves and partly because of the very nature of radio-controlled model flying. Some of the people who have taken up R/C flying in the past have been radio experts and not model fliers. They have often tended to underestimate the importance of a thorough knowledge of F/F model aircraft, as the sorrowful sight of many a heap of splintered balsawood and wrecked radio apparatus has testified. Equally to blame were the modellers who thought they could enjoy radio-controlled model flying with no more attention to servicing and pre-flight checking than they would give an A-2 glider.

If your only interest in the hobby is to see your model finished as quickly as possible and to fly it without more ado, you are advised to forget all about R/C and stick to gliders or control-liners.

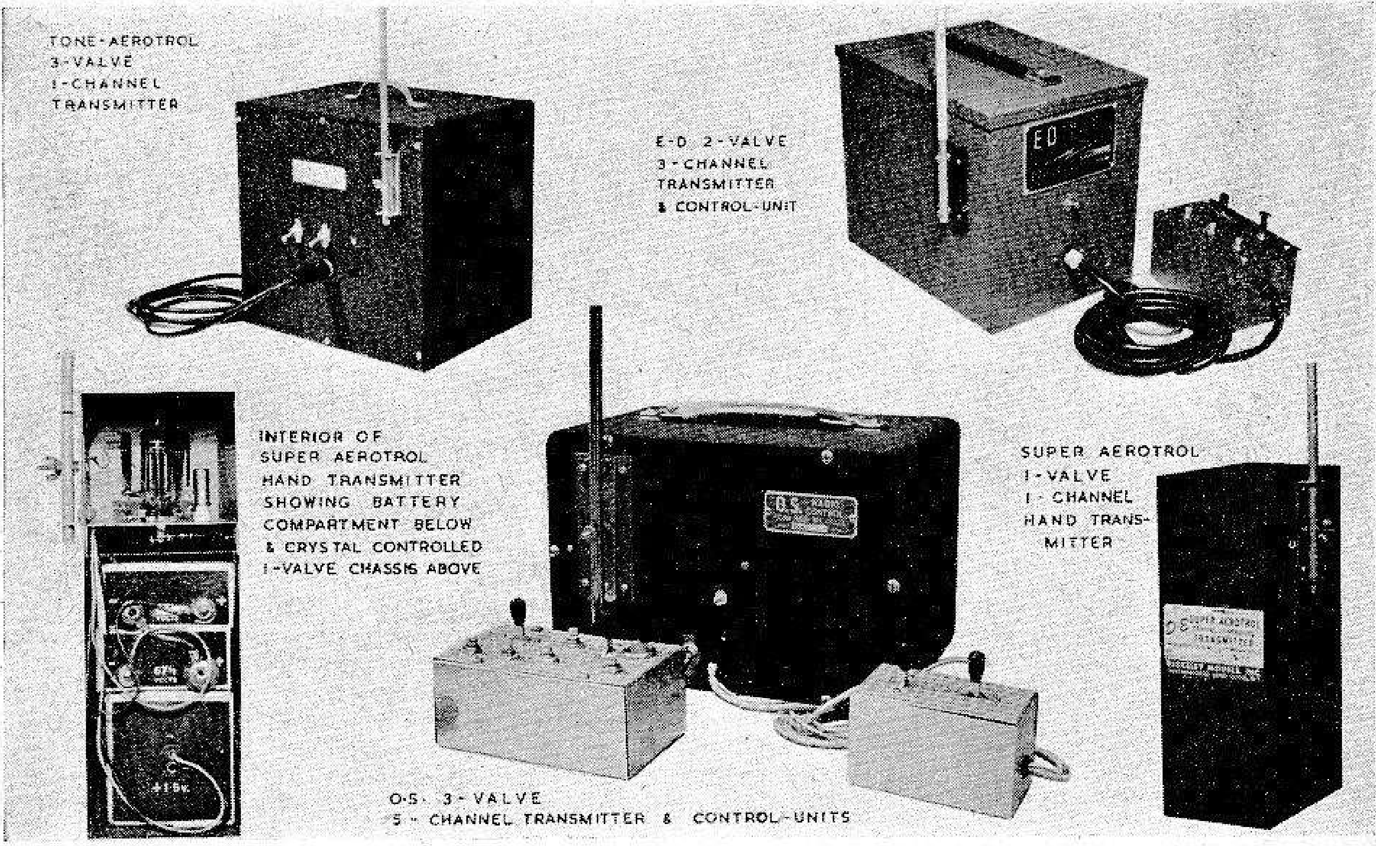
If, on the other hand, you are happy in spending several weeks of spare time building a model, installing the equipment with care and thought and, when you get to the airfield, are prepared to fly only if and when everything has been checked and rechecked and found perfect, then there is absolutely no reason why you should not join the growing band of enthusiasts who are enjoying what is, undoubtedly, the most satisfying branch of model aeronautics. You do *not* need to know all about radio theory. A knowledge of radio will help, but, today, most commercially-built model R/C apparatus is sufficiently reliable to enable anyone to install and operate it without difficulty.

R/C models are now becoming clearly separated into a number of different types, ranging from the simple, lightweight, single-control machine, adapted from a standard F/F design, to big, specially-designed, multi-channel aircraft equipped with everything from engine throttle control to wheel brakes.

The most advanced R/C model flying seen to date has been in the United States—particularly in California. Here, aided by weather conditions which permit all-the-year-round flying and, therefore, much valuable practice, a number of highly skilled modellers have succeeded in performing the sort of flights which have been the dream of model aeroplane enthusiasts ever since the hobby started.

The type of model used by these experts is invariably a "multi-channel" job. That is to say, the R/C equip-

Our heading photo shows a fine R/C model flying-boat, the American Berkeley Sea-Cat. Left: a small British kit design for lightweight single-channel control, the Veron Skyskooter. Right: one of Europe's most outstanding R/C modellers, Karl-Heinz Stegmaier, with his 8-channel model fitted with pneumatically operated controls. It has rudder, elevator and engine control, plus a nosewheel brake and parachute release.



ment is of a pattern which permits independent movement of a number of different controls, supplementary to the standard rudder control. Usually, these extra controls include elevators and a throttle, or similar mechanism, to alter engine speed. In addition, the model may be fitted with ailerons, wheel-brakes and a steerable nose or tailwheel.

With such a set-up, the expert starts his engine, throttles down and taxies the model away from the transmitter under its own power. When it reaches the take-off point, he turns the model into the wind and then, under full power, sends it speeding down the runway to lift off and climb swiftly and steadily to 1,000 ft., or more. Next, " down-elevator " and the model is in a screaming dive, the engine note rising, 40, 50, 60 miles an hour. The pilot neutralises the controls, moves the elevator to " up " and the model loops, once, twice, thrice. Now the model is climbing again, this time to peel off into a true vertical spin, wings rotating about the fuselage as it plunges earthwards. The pilot pulls out, reduces engine speed and brings the aircraft back over the runway. It turns, settles on to the concrete for a " touch-and-go " landing and, as the pilot presses the motor control button to open the throttle, quickly takes off again. Now, a wide climbing turn, then the machine rolls over on to its back, cruising along in inverted flight. Back on an even keel, another circuit and now a barrel-roll. More climb and then, something not permitted with most full-size aircraft, and outside loop. Back to the runway, engine throttled back, the model touches down smoothly, slows, is taxied back to the transmitter and braked to a standstill as the motor is cut.

Such is the standard of radio-controlled flying that has been reached among the leading U.S. exponents. But it has taken years of development work on both aircraft and radio equipment and, most important of all, practice, practice and more practice in flying the models. Such models are, very definitely, not for beginners in R/C, no matter how expert they may be in other branches of model flying. For the newcomer, the wisest choice is a relatively simple model equipped with rudder control only.

This type of machine can be basically a F/F type, inherently stable and thus capable of recovering quickly when left to its own devices. The type of control used is a simple self-neutralising system, operated by a single press-button key on the transmitter. Holding the button down causes the rudder to move over a fixed amount. When the button is released, the rudder springs back to the central position again. If the transmitter key is pressed again, the rudder moves an equal amount in the other direction, returning to neutral as soon as the button is released. Thus we have a simple sequence: left, neutral, right, neutral, left, neutral and so on.

It may be thought that this simple three-position rudder permits only directional control, but, in fact, a " rudder-only " model can be made to perform numerous different manoeuvres, including loops. This depends on the design of the model itself and on the " rudder-power " used, i.e., the size and angular movement of the rudder.

At first you will be well advised to use low rudder-power; a rudder that is not too big and has a small movement—perhaps $\frac{1}{8}$-in. or $\frac{3}{16}$-in. each way. Even with this small amount, however, you will notice that the model automatically banks in the direction of the turn. This, of course, is because the inner wing is moving through the air at a slightly lower speed than the outer wing and, consequently, suffers a slight loss of lift. If the rudder is now adjusted to give a tighter turn, it will be found that, by holding the control button down, the model will bank steeply and enter a spiral dive. This should be attempted only from a safe altitude (say, 500 ft.) and the model can then be made to spiral down for four or five revolutions during which time it will pick up considerable excess flying speed. If the transmitter button is now momentarily released and pressed again to give opposite rudder, the model will be brought out of its spiral and the excess flying speed and extra lift of both wings will quickly cause it to zoom upward into a climb. If the rudder is now neutralised and the timing judged correctly, the model will climb past the vertical and complete a loop.

Many other manoeuvres, such as stall turns and Immelmann turns, are also possible with a rudder-only model, although, if the utmost stunting ability is required with rudder-only control, a specially designed model, rather than one suitable for beginners, is, of course, preferable.

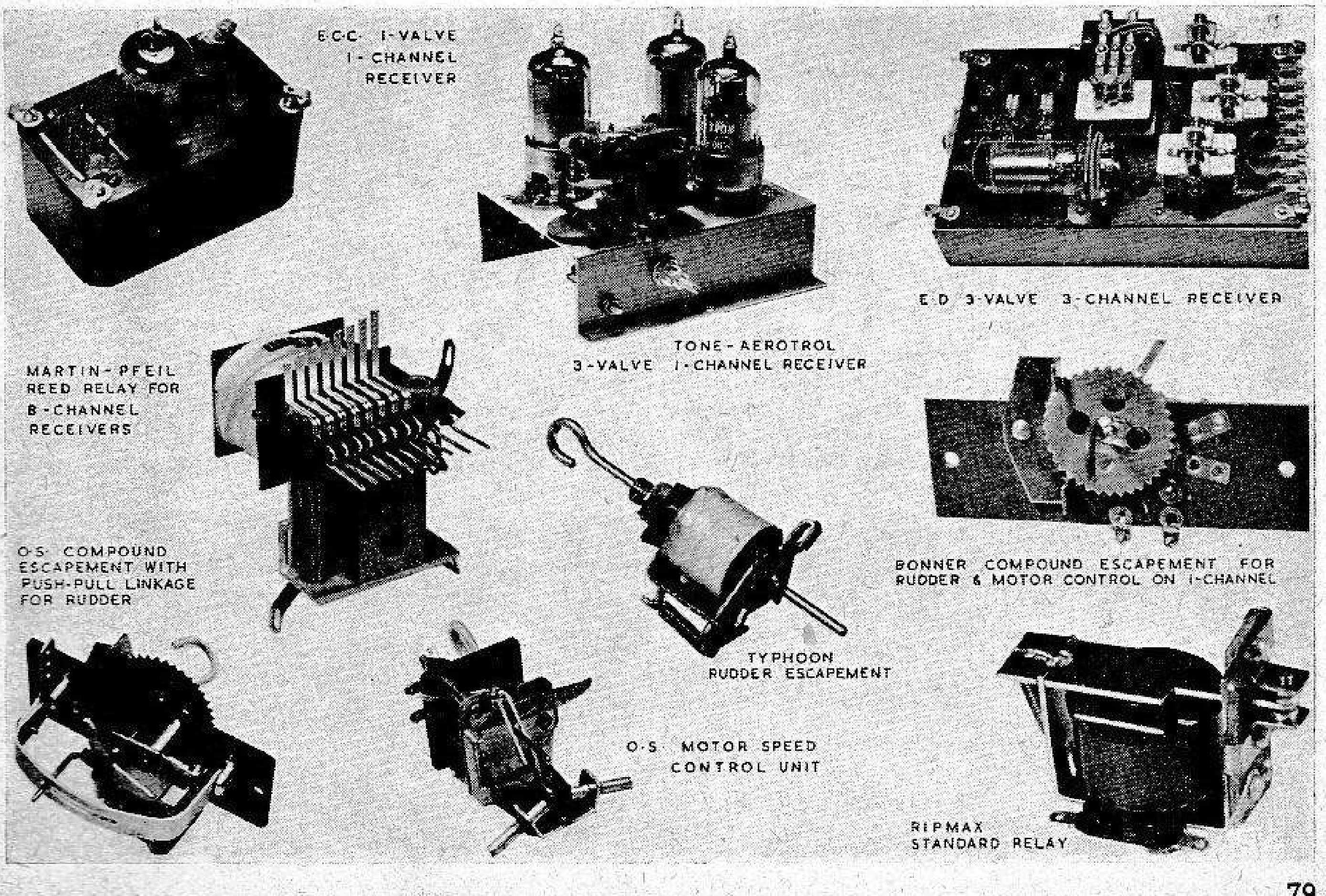
The simplest type of R/C system consists of (1) a *transmitter*, for generating and radiating the radio signal; (2) a *receiver*, installed in the model for picking up the signal and converting it into electrical energy capable of operating an electro-magnetic switch, known as a *relay*, and (3) an *actuator*, an electro-mechanical device, which is switched on and off by the relay, and operates, in turn, the rudder.

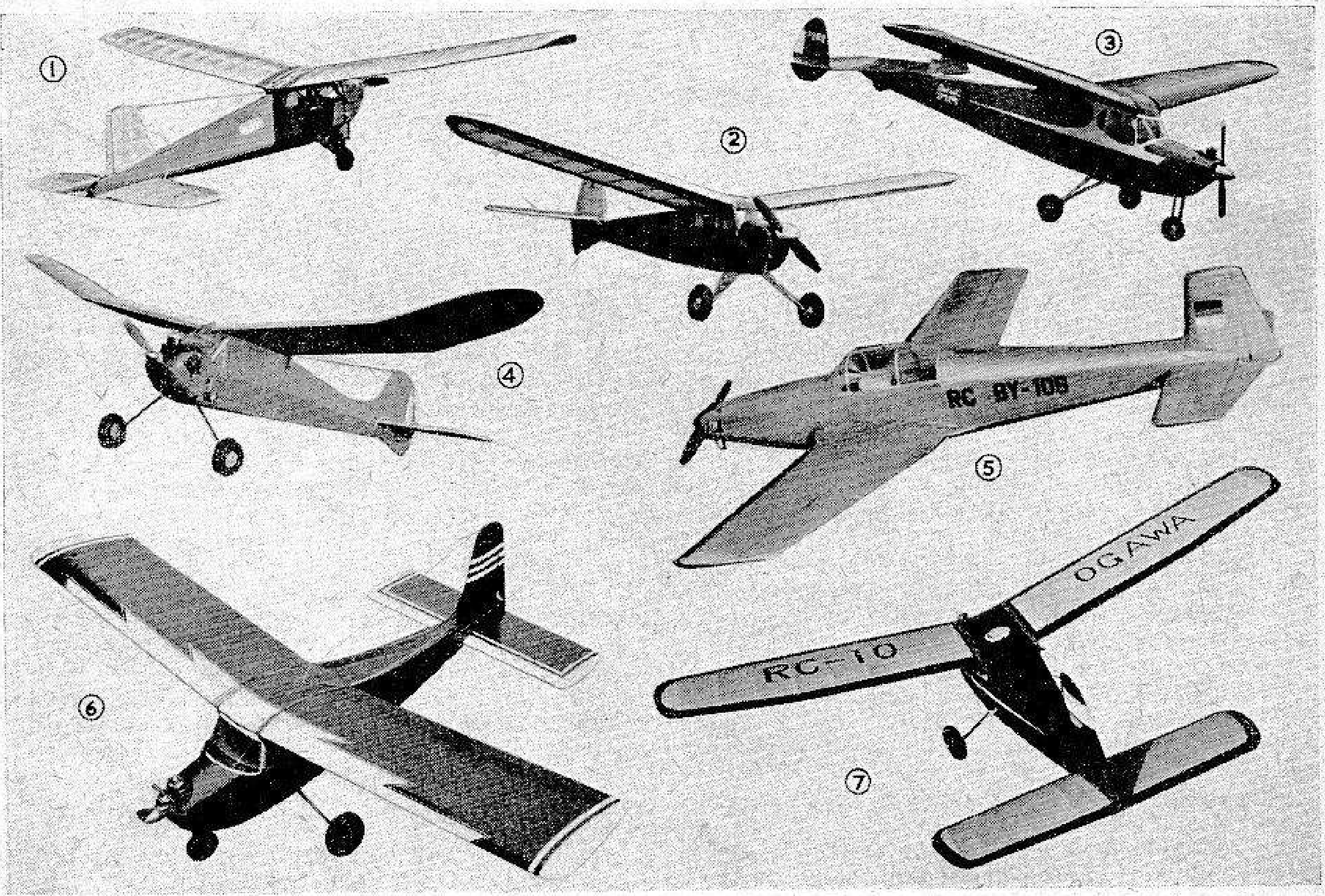
The transmitter is usually a simple one or two-valve self-contained portable unit housed, complete with batteries, in a metal or plastic case which has a sectional or telescopic aerial fitted to it. It may be placed on the ground and connected to the push button sending key by means of a flexible lead, or it may be constructed in the form of a lighter, hand-type set with the keying button fitted to the case. Dry batteries, of the type used for portable wireless receivers, are usually employed, the h.t. voltage being 90-150, and the l.t. being 1.5 volts.

Receiver types are somewhat more varied and may utilise one, two or three miniature or subminiature valves, or may incorporate transistors. The weight of a typical single-channel model aircraft receiver may be no more than 3 or 4 oz., the batteries required for operating it adding a further 3-5 oz. According to the type of receiver circuit, an h.t. supply of between 45 and 90 volts is most commonly employed, obtained by coupling together $22\frac{1}{2}$-volt or 30-volt hearing aid batteries, while the $1\frac{1}{2}$-volt l.t. is obtained with two or more pencells coupled in parallel, or a flashlamp cell.

Actuators are now in many different forms including various types of electric motor driven servo mechanisms, while, in Germany, an ingenious engine-driven pneumatically operated system has proved highly successful. However, these are mainly intended for multi-controls and the simple rubber-driven electro-magnetic escapement is the usual choice for rudder-only models. This device consists of a solenoid and a pawl system, arranged in such a way that, when the coil is energised, an armature is pulled in and the pawl is permitted to rotate a quarter of a revolution. Motive power for rotating the pawl is supplied by a simple rubber motor. When the current is cut off, the spring-loaded armature moves out again and the pawl rotates another quarter revolution. It is, of course, quite a simple matter to couple the pawl spindle to a rod which will move the rudder left or right each time the actuator circuit is energised by the receiver relay.

Most escapements require a minimum of 3 to $4\frac{1}{2}$-volts ($4\frac{1}{2}$-6 volts being preferred) and the weight of the complete control actuating gear will be in the region of 3-5 oz. depending on the size of battery that can be carried in the model. It will be seen, therefore, that the complete





Examples of R/C models. 1—A famous American design, Dr. Walter Good's 74-in. Rudderbug. 2—A popular British kit model, the Keilkraft Junior-60. 3—An attractive 6-ft. span rudder-only model by Sqn. Ldr. Ware, R.A.F. 4—A well-known American rudder-only kit model, the Berkeley Super-Brigadier. 5—A German scale type multi-control model by H. Bernhardt; it has eight-channel equipment controlling rudder, elevator, ailerons and engine speed. 6—A typical example of the modern trend in R/C design, a 48-in. Japanese built model, having relatively high wing-loading (20 oz./sq. ft.), fitted with rudder and 2-speed engine control. 7—Another Japanese model: of 59-in. span, it has O.S. equipment, including compound escapement and motor control.

radio installation for a simple rudder-only layout can be achieved within a weight of about 12 oz. (It is possible, by using the lightest available receiver and escapement and the smallest batteries, to reduce total weight to 8 oz., or less, but this means reducing battery capacity to the minimum and to a level which means frequent replacement in the interests of safety.)

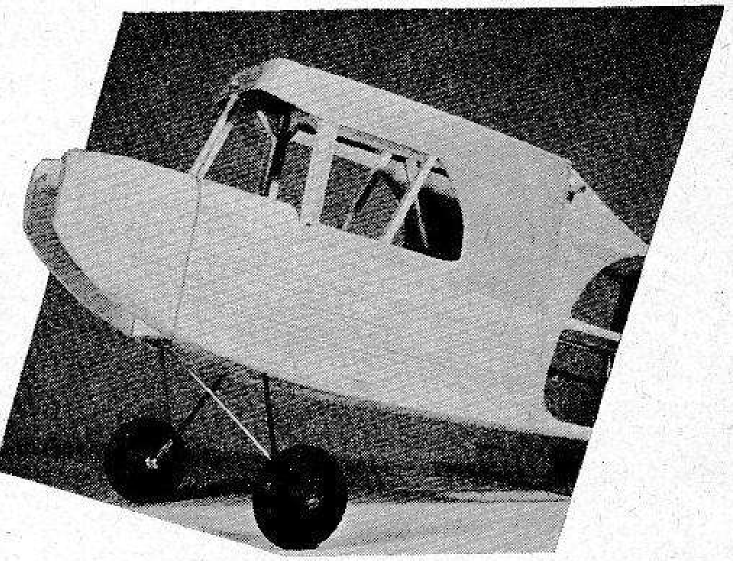
To ensure the preservation of a reasonable degree of robustness, the model, should, preferably, have a bare weight of about twice that of the radio equipment it is required to carry and the minimum size of our R/C model will, therefore, be dictated, to some extent, by these requirements. For a total weight of 36 oz., a wing loading of 12-13 oz./sq. ft. is reasonable and would require a wing area of between 400 and 432 sq. in. This suggests a model of 50-54-in. span with a mean chord of 8-in.

Such a size is, in fact, an excellent choice for a beginner. Not too large, it is, nevertheless, big enough to give a smoother flight than a very small model.

Between "rudder only" and "multi-channel" models, there are various types of "intermediate" control systems. Usually, these take the form of accessories designed for use with inexpensive single-channel equipment. They offer the addition of an engine-speed control and/or elevator control by means of a mechanical sequence system instead of electronic selection. One of the most well-known of these is the Bonner Compound Escapement, an elaboration of the standard electro-magnetic rubber-driven escapement. In addition to left and right rudder and an automatic return to neutral, the compound escapement provides an extra control position which brings a secondary escapement into operation. The secondary escapement generally takes the form of a "motor-control-unit" which changes the speed of the engine from "fast" to "slow" or vice-versa. At the transmitter, the pilot selects the required control by pulsing the sending key: one pulse giving left rudder, two pulses right rudder and three pulses motor control.

To permit R/C enthusiasts to operate model aircraft, boats, etc., without the need of a radio amateur's technical examination, special transmitting frequencies have been allocated for model R/C work by the authorities in various countries. These frequencies are in the h.f., v.h.f. and u.h.f. wavebands, the 27 Mc/s h.f. band being the most widely adopted, (e.g., 26.96-27.28 Mc/s in Britain, 27.255 Mc/s in the U.S. and 27.12 Mc/s in Germany). The maximum permitted transmitter power is 5 watts and, needless to say, all commercially made model equipment conforms to these various requirements. The only other regulation is that the operator's should be registered with the radio communications authority and for this, in the case of British modellers, licences costing £1 for five years, are issued by the Radio Branch, G.P.O. Headquarters, London, E.C.1.

Converting the Deacon to R/C



CHAPTER TWENTY

IN Chapter 19, we suggested that, allowing a radio installation weight of approximately 12 oz., the best sized model for the newcomer to R/C would have a weight of about 36 oz. and a wing area of 400 to 432 sq. in.

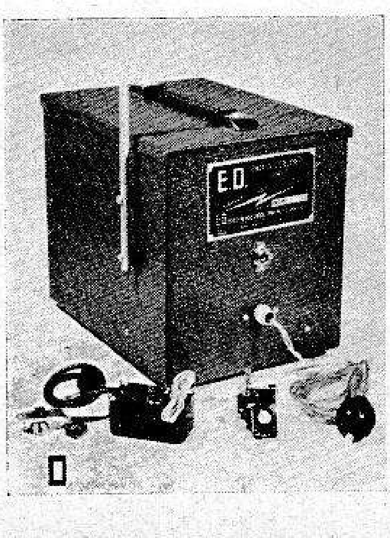
A kit model which falls precisely within this specification, when suitably adapted, is the 53 in. Veron *Deacon.* As we have dealt, in some detail, with this model in our F/F section (Chapter 14), it was decided to use this same model for conversion to simple single-channel, "rudder-only" control, as an introductory R/C project.

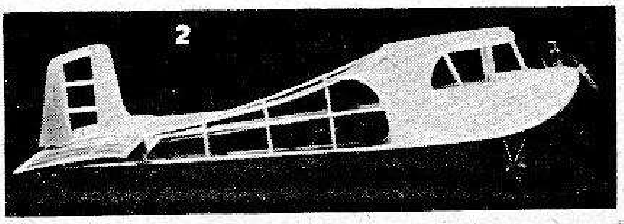
The *Deacon* is essentially a lightweight model in its basic F/F form and, for R/C, it is advisable to strengthen the framework a little, in order to cope with the model's higher wing-loading and higher landing-speed when loaded with radio equipment. Reference to Chapter 14 will show how the *Deacon,* in its original F/F form, differs from the strengthened version into which it was subsequently modified before covering.

Firstly, the undercarriage was reinforced because, in a radio-controlled model, single leg struts all too frequently become bent back when landing. We used 14 s.w.g. steel wire, bound and soldered to the main struts and connected to the front bulkhead. For this latter a piece of 14 s.w.g. wire was bent to a "U" shape and securely bound to a plywood former which, suitably packed with scrap balsa and backed by a piece of hard $\frac{3}{16}$ in. sheet balsa, was then strongly cemented and clamped to the back of the front bulkhead and to the fuselage sides. To connect these two wire members, a $\frac{1}{2}$ in. wide strap of tinplate was soldered around them with a rubber pad at the apex of the front legs. (See Fig. 9.) A simpler method would be to suitably shape the front legs so that they could be bound direct to the ply former and then soldered to the front legs after fitting. Whichever method is used, be sure to install the gear really strongly.

When modifying the undercarriage, it is necessary to have the bottom of the fuselage open and this also enables us to deal with the hatches giving access to the radio gear and batteries—a most important point.

The first fuselage bay behind the engine—i.e. that between the two u/c bulkheads—is just large enough to accommodate the HT, LT and actuator batteries. This is a good position for the batteries since it is forward of the centre of gravity and helps compensate the weight





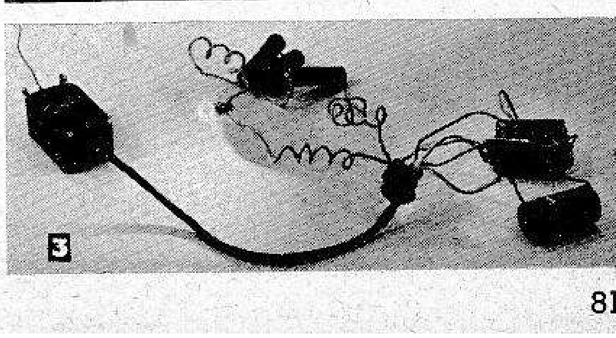
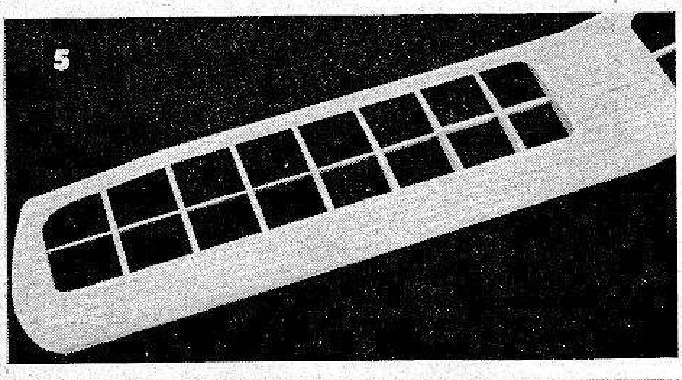
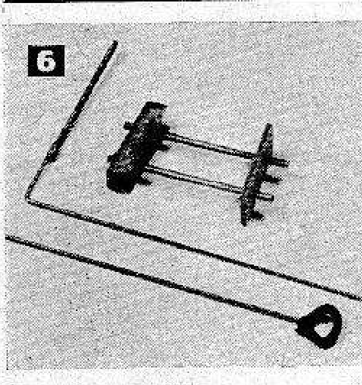
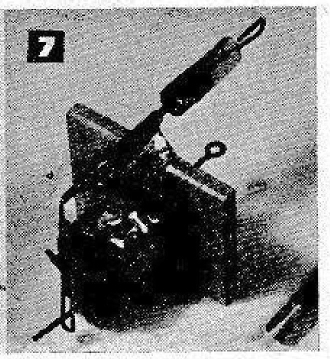
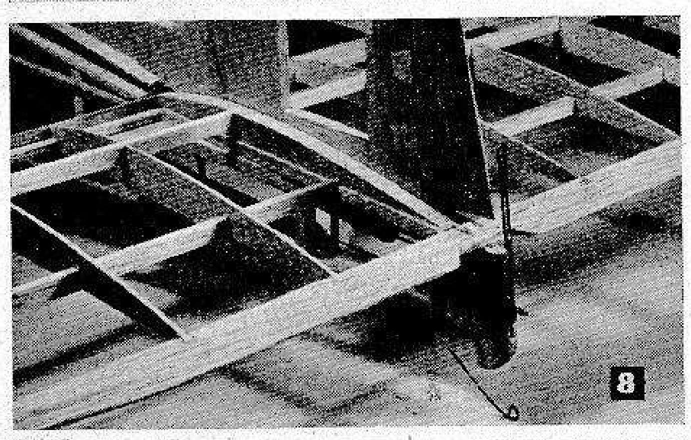


Fig. 1. The E.D. Transitrol outfit: transmitter, receiver (with socket and double-pole switch) and standard escapement. 2. The converted "Deacon" fusel age, ready for covering. 3. A temporary hook-up using a 4.5 v. bulb to test the receiver.









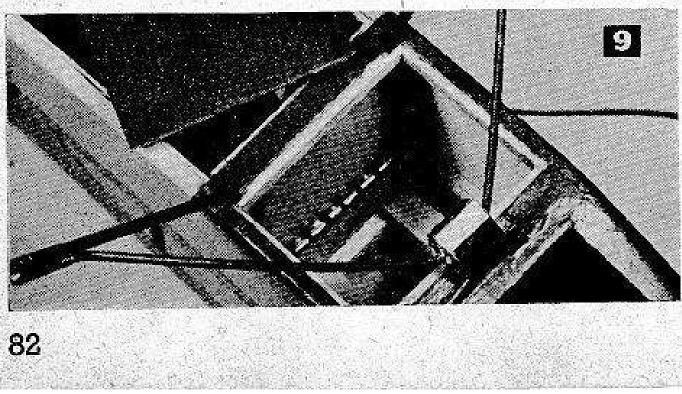


Fig. 4. Batteries required. Large HT and LT for transmitter, with receiver HT (2), LT (1) and actuator (3) batteries in foreground. 5. The "Deacon" wing sheeted and cap-stripped for added strength. 6. Rudder arm, rear hook and bearing assembly. 7. Escapement and semi-rotary linkage ready for installation. 8. Tail unit showing rudder arm and pin with winding loop below. 9. Undercarriage reinforcement and battery hatch prior to lining.

of the actuator and rudder linkage. Aft of this is the cabin and, as will be seen in a moment, it is helpful to have a full-length hatch here also. Accordingly, strips of $\frac{3}{16} \times \frac{1}{16}$ hard balsa were cemented along the outside edges of the fuselage bottom, leaving a $\frac{1}{16}$ in. rebate into which the flush-fitting hatch covers could be inserted. (See Fig. 9.)

The hatch covers consist, basically, of $\frac{1}{16}$ in. hard sheet balsa, with the grain running across the fuselage, and lined with $\frac{3}{16}$ in. sheet to fit between the longerons and bulkheads fore and aft. To further stiffen the main hatch and also to preserve its curvature, two suitably shaped side rails of 3/32 in. hard balsa, $\frac{3}{8}$ in. deep at the centre, were glued along the edges.

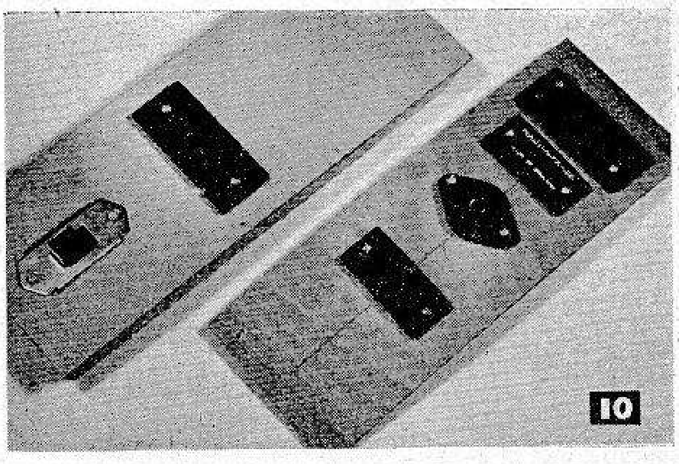
The cabin section of the *Deacon* can be strengthened considerably. As will be seen from the photographs, a number of extra upright and diagonal members were added to the sides and the area around the windscreen and cabin windows was stiffened by gussets and by additional $\frac{1}{16}$ in. sheeting. To avoid local weakness behind the cabin and also to eliminate covering irregularities, the sheet balsa covering was extended slightly beyond the rear cabin bulkhead and was scalloped to mould smoothly into the longerons as shown. In addition, a $\frac{3}{16}$ sq. dorsal stringer was fitted, supported on $\frac{1}{8}$ in. sheet formers.

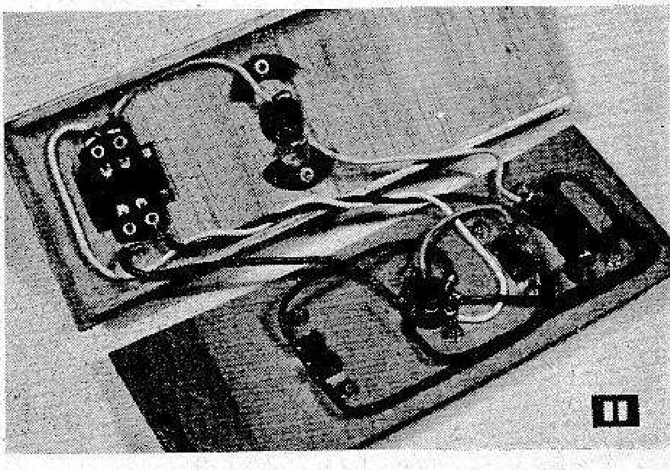
The wing was strengthened by the addition of $\frac{1}{16}$ in. medium-soft balsa sheet covering over the leading edge as far back as the front spar. The trailing edge was stiffened with a 1 in. wide strip on the upper surface only and the ribs were capped between with $\frac{1}{16} \times \frac{1}{4}$ balsa. The centre-section and tips were also sheeted. (See Fig. 5.) To improve appearance and also give a built-in incidence wash-out, a slight taper was applied to the trailing-edge, starting from the third rib from the tip and widening to $\frac{1}{2}$ in. at the tip rib. A piece of $\frac{3}{16}$ in. sheet was then added between the last two ribs from below and the trailing edge restored by sanding the bottom surface only. Finally, strips of 3/32 in. sheet were added to the sides of the ribs, underneath, to modify the undercambered wing-section to a flat undersurface.

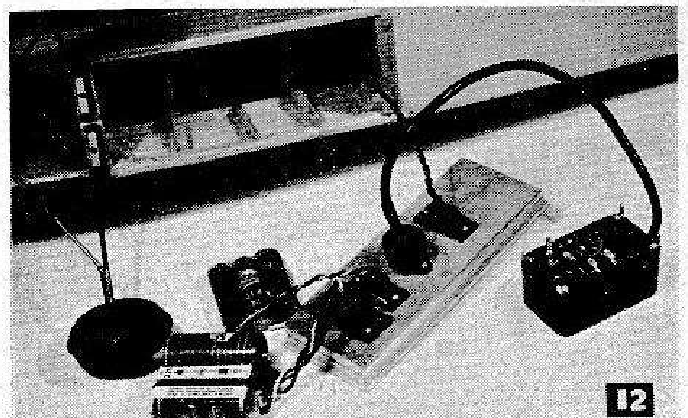
The tailplane was unaltered, except for a similar slight tip taper treatment to match the wing and a small section cut out of the trailing-edge at the centre in order to keep the retaining rubbers well clear of the rudder linkage. The trailing edge of the fin, however, was rebuilt to accommodate a 4 in. high, tapered rudder of $3\frac{1}{2}$ sq. in. area. This was attached with hinges of nylon tape. A slightly lengthened dorsal fin was fitted and an 18 S.W.G. wire skid was fitted to the tail bumper as shown in Fig. 8.

The complete model, including all sheet and block balsa surfaces, was covered with lightweight parachute silk and given three coats of clear dope, followed by colour finishing, in accordance with the instructions given in Chapter 23. Before covering the fuselage, however, the actuator and rudder linkage was installed.

In order to permit the longest possible rubber motor length for the escapement type actuator (and thus allow







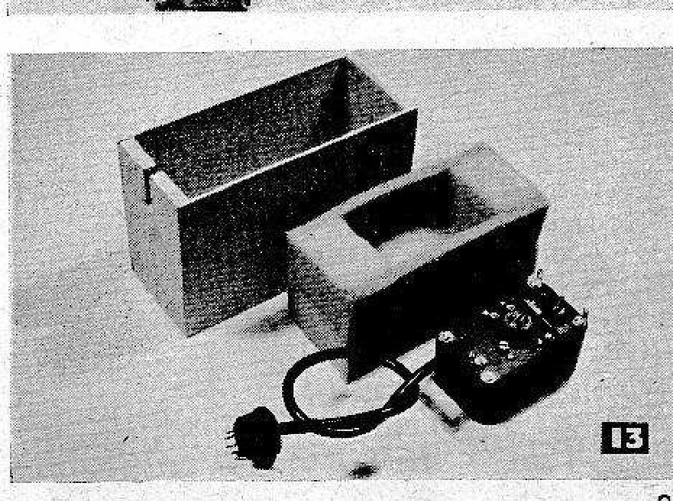


Fig. 10. Fuselage bottom hatch and distributor panel prior to assembly. 11. Inside of the distributor panel and hatch-cover after wiring and before cementing together. 12. Components and batteries can be plugged into distributor panel outside model for testing and adjustment. 13. The receiver box, showing the foam lining.

a wide safety margin on the number of rudder movements available per flight) it was decided to use a return linkage system. With this method, which is very popular in America, the escapement is positioned well forward in the fuselage, the rubber drive being taken to the tail end of the fuselage (instead of being led forward) where it can be easily rewound by means of a hand-drill. The crank is on the actuator itself and imparts a semi-rotary motion to a torque-rod extending back through the fuselage above the rubber motor. This rocking motion is then conveyed to the rudder by means of a vertical arm which moves a pin attached to the rudder. Another advantage of the system is that the rudder pin can be re-positioned higher or lower and thus increase or decrease rudder movement according to the required degree of control sensitivity in flight.

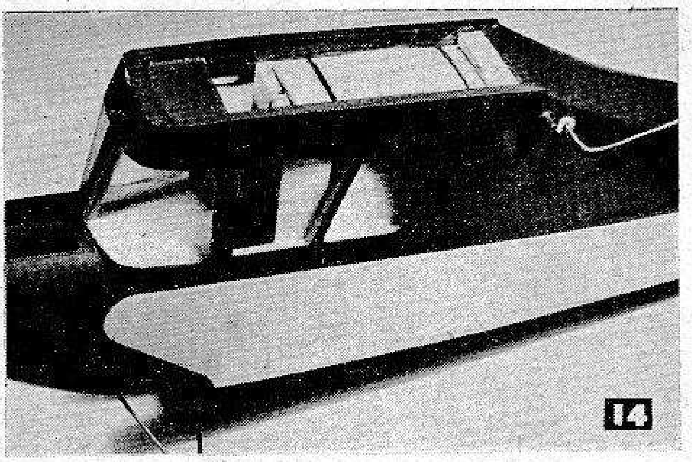
A general idea of the system will be gained from reference to the photographs, particularly Nos. 6, 7, 8 and 15. The escapement shown is actually an American "Super-Aerotrol," which is not at present generally obtainable in the U.K., but a similar type, the Dutch-made "Typhoon," is available, or, of course, a standard British type, such as the very reliable E.D., although a little more bulky, can be suitably adapted for the *Deacon*.

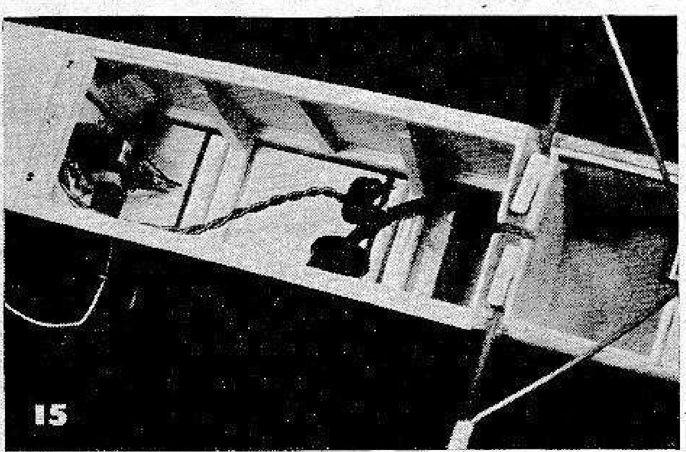
To facilitate servicing, it is helpful to have the actuator removable, but the mounting must be rigid. For our model, the escapement and semi-rotary link and bracket were attached to a $\frac{3}{16}$ in. plywood plate. (See Fig. 7.) Runners of $\frac{1}{8} \times \frac{1}{2}$ hard balsa were cemented to each side of the rear cabin frame, extending 2 in. up from the bottom and braced by gussets, to provide a channel in which the ply plate would slide.

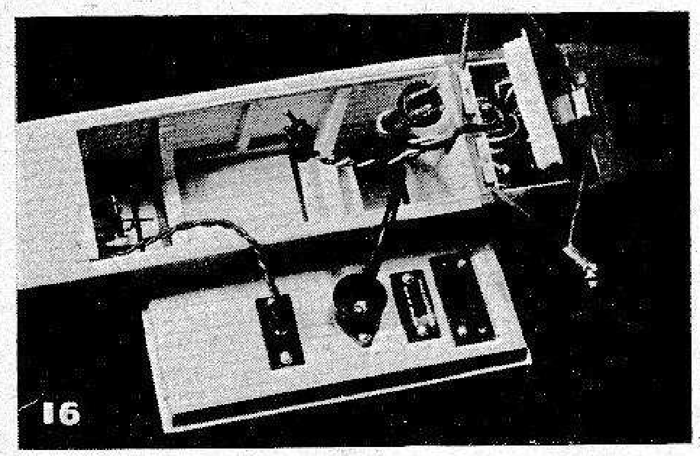
Components for the rear linkage and bearing assembly can be seen in Fig. 6. Two 19 S.W.G. bore brass tubes were positioned $\frac{3}{8}$ in. apart and soldered into a tinplate bearing support, $\frac{3}{4} \times \frac{3}{4}$ in., channelled to fit around the rear end of the fuselage. The tubes were pushed through suitably drilled holes in the rear end and well cemented, their front ends being supported by a $\frac{1}{16}$ in. plywood plate cemented to the fuselage spacers G.4. The 19 S.W.G. (0.040 in. dia.) wire L-shaped rudder arm was bent to form a 1 in. long slot and soldered. It was then passed through the upper tube (in which it must be a free fit) and its end bent back with needle-nose pliers and secured to the torque-rod.

The torque-rod consists of a hardwood dowel, not less than $\frac{3}{16}$ in. dia. It can be bound to the rudder arm, but, at the escapement end, it is helpful to have a detachable connection if the escapement is made removable. Fig. 7 shows a way of achieving this. The torque-rod is carefully slotted and the doubled end of the semi-rotary link spindle (19 or 20 S.W.G.) forms a tongue which slips into this. A short length of large-diameter Neoprene tubing is used to secure the joint by sliding tightly over the tongue and slot. The tube is mounted on the wire spindle by means of smaller diameters of Neoprene force fitted over a brass tube core.

The rear rubber anchorage and winding spindle is inserted from the inside after bending the motor hook and covering it with rubber or plastic tubing. It should







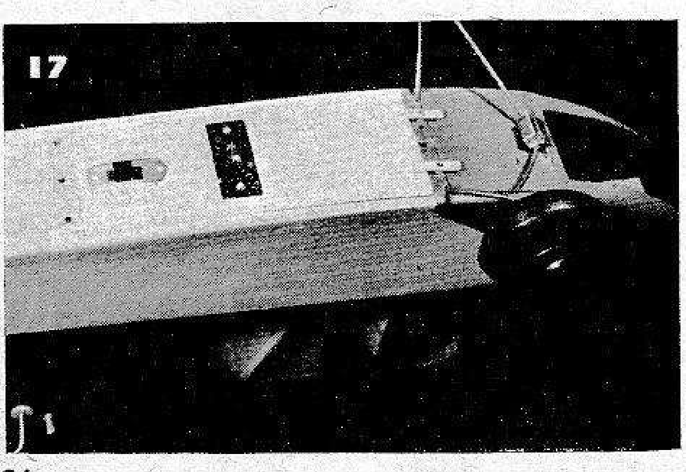


Fig. 14. The receiver installation, well insulated from shocks and crash damage. 15. Underside of fuselage: note foam-plastic lined battery compartment, also receiver and escapement leads. 16. Underside of fuselage, batteries installed, receiver and escapement connected to distributor panel. 17. Distributor panel in position and battery hatch closed.

be about 4 in. long, so as to be well clear of the torque-rod connection above, and may then be bent into a small diameter winding loop, the free end being bent forward to engage the side of the tinplate bearing support and prevent rotation. For winding, of course, the spindle is pulled back.

One disadvantage of the *Deacon* for R/C is its rather narrow fuselage, making it difficult to work with the hands inside the cabin. Our radio installation was therefore planned in such a way as to allow the entire equipment *and wiring* to be quickly removed for servicing as necessary.

Figs. 10 to 17 show how this was done, including the somewhat unusual departure of using the removable cabin floor as a distributor-panel to which the various components are connected by miniature plugs and sockets.

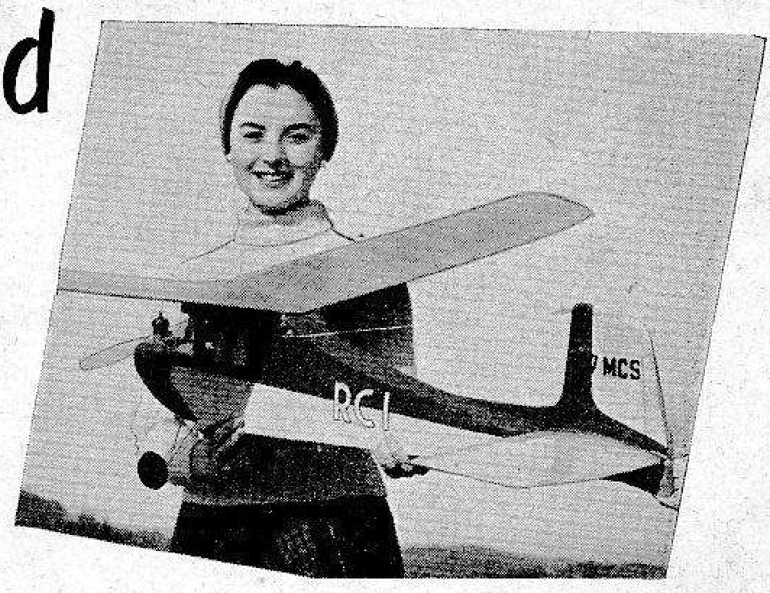
Receivers must, in all cases, be flexibly mounted to reduce risk of crash damage and to absorb engine vibration. One method of doing this is to sling the receiver between rubber bands hooked to the corners of the cabin. With the *Deacon*, however, there is some risk of the receiver hitting the sides of the cabin, when so suspended, and it was decided to encase our E.D. Transitrol receiver in foam plastic material within a balsa box that would slide through the open cabin top and rest in the upper part of the cabin on two suitably braced and padded cross-members, as shown in Figs. 13 to 16.

The cabin was also lined with strips of $\frac{1}{4}$ in. thick foam and a $1\frac{1}{2}$ in. "crash-pad" of sponge rubber was interposed between the receiver box and the front cabin bulkhead.

The battery compartment was completely lined with $\frac{1}{4}$ in. foam plastic (Fig. 13) including the underside of the hatch cover. The two B.122 "Batrymax" (HT) and U.11 (LT) receiver batteries, together with either three ($4\frac{1}{2}$ v.) or four (6 v.) pen-cells for the escapement, fit into this compartment exactly. These were soldered up into two packs with four-pin and two-pin polarised plugs, respectively, the bulkhead between the battery compart- and cabin being slotted to take the battery leads. (Fig. 16.)

The E.D. Transitrol receiver is, of course, sold complete with a wiring diagram and the manner in which this was used to wire up the distributor-panel-cum-hatch-cover can be seen in Figs. 10 and 11. On the outside of the hatch-cover, towards the rear, are the double-pole slide switch and meter socket, while, attached to the $\frac{1}{16}$ in. plywood inner panel, are four-pin, two-pin, seven-pin and two-pin sockets for, respectively, receiver batteries, escapement battery, receiver and escapement. Obviously, care must be exercised to ensure that components are wired correctly and the use of coloured stranded radio wire will help here. The ply panel is cemented to the side rails of the hatch-cover after making sure that all soldered joints are secure and that none of them touch when the two panels are put together.

Preparing and Flying your R/C Model



DEPENDABLE R/C and worry-free flying can only be possible if you are determined to leave nothing to chance.

Having already built and flown F/F models, you will be familiar with general trimming and adjustment procedure and will avoid the pitfalls that trap the unwary: the temptation to fly during windy weather or in unsuitable locations. But there is now also the radio equipment and control system to consider. It is no good thinking that, if it doesn't work properly on the first flight, you can put things right next time. There may be no next time, for, if the rudder locks over in a turn and you cannot release it, you will almost certainly wreck the model, or a large part of it, in the ensuing spiral dive. Even if the radio fails and the model goes "free-flight" with the rudder in neutral, it may well fly outside your safe landing area and be damaged by a collision with a building, tree or some other obstacle.

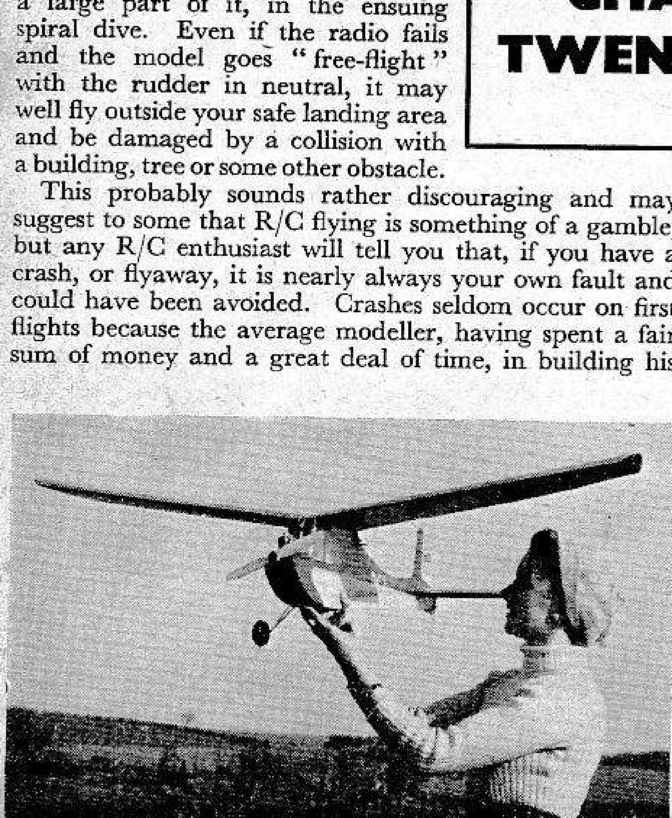
CHAPTER TWENTY ONE

This probably sounds rather discouraging and may suggest to some that R/C flying is something of a gamble, but any R/C enthusiast will tell you that, if you have a crash, or flyaway, it is nearly always your own fault and could have been avoided. Crashes seldom occur on first flights because the average modeller, having spent a fair sum of money and a great deal of time, in building his model, takes heed of such warnings as we have just given and is extra careful. The danger period is when, after a few successful flights, the modeller may begin to think that he has been over-cautious. If he then relaxes his pre-flight checking routine, a small thing, such as forgetting to check and replace a battery or rewind the escapement motor, may spell disaster. If you want to avoid such misfortune, you must, as we said at the beginning, leave absolutely nothing to chance and observe this rule at all times.

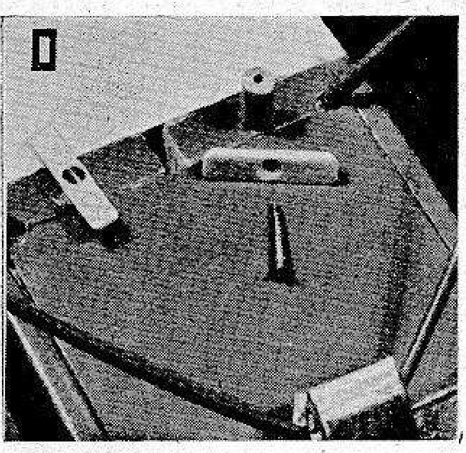
However, before we are ready to journey out to the flying field, there are a few details to tidy up, following the general installation procedure covered in our last chapter.

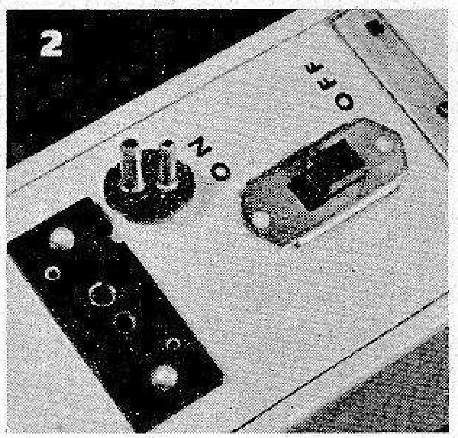
Firstly, to deal with the question of securing the cabin and the battery compartment hatches. Especially where these are used to support or retain some part of the equipment (as in the converted *Deacon* model featured) wire clips are not too satisfactory and something more substantial is advisable. Some modellers use rubber bands across the hatch and attached to pegs or wire hooks. The only objection to this, apart, perhaps, from the question of appearance, is that residual diesel fuel causes rather rapid deterioration of the rubber, thereby adding to the items requiring our frequent attention. For the *Deacon*, therefore, the simple turn-buttons shown in Fig. 1 were devised. These, of plastic, or aluminium or brass, are mounted with $\frac{1}{2}$ in. × No. 0 woodscrews on $\frac{1}{2}$ in. lengths of $\frac{3}{16}$ in. dia. beech dowel, well glued and forced into suitable holes drilled in the bulkhead. The other end of the hatch can be secured with a strip of $\frac{1}{16}$ in. ply as shown in Fig. 2. This picture also shows the shorting plug which must always occupy the meter socket except when the receiver is being tuned.

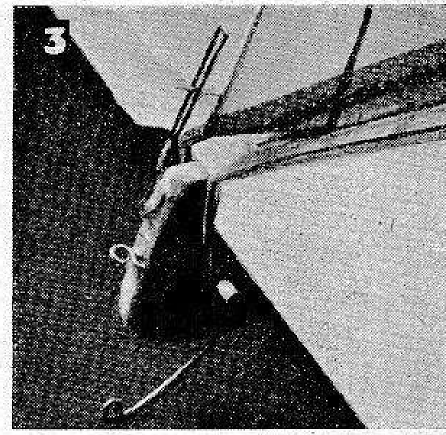
Complete freedom of movement in the control linkage is most important. The rudder pin should be a free fit in the slotted rudder arm (see Fig. 3) and this latter should be angled slightly so that the sides of the slot do not bind on the pin in either the full-left or right positions.



Check the model for balance and alignment as for a F/F machine.







1—Simple and serviceable turnbuttons for securing hatches. 2—Mark "on" and "off" positions of switch. Make sure shorting-plug is tight and cannot vibrate loose. 3—Fit the rudder pin low on the rudder for your first few flights to reduce control sensitivity.

The fitting of the aerial deserves a little thought. It should be led out through a suitable grommet in the fuselage sheeting near the trailing edge of the wing. The method shown (Fig. 4) utilises two $\frac{1}{16}$ in. plywood discs and a 1 in. length of plastic tubing. The aerial is threaded through this and knotted on the inside so that no strain is imposed on the connection to the receiver. The free end is then attached to the rudder with a quickly detachable shock-absorbing connection consisting of a small rubber band stapled to the leading edge and a short piece of plastic tubing (Figs. 5 and 6).

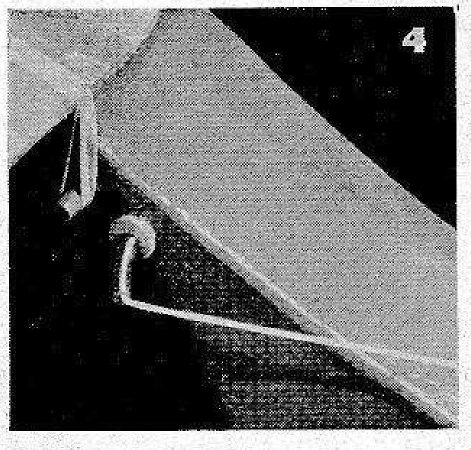
For winding the escapement motor, an ordinary hand drill is best. In order to avoid straining any part of the rear bearing assembly, however, a flexible connection is desirable between the chuck and winding hook. A piece of ordinary coiled-wire curtain rod serves this purpose and can be seen in Fig. 8.

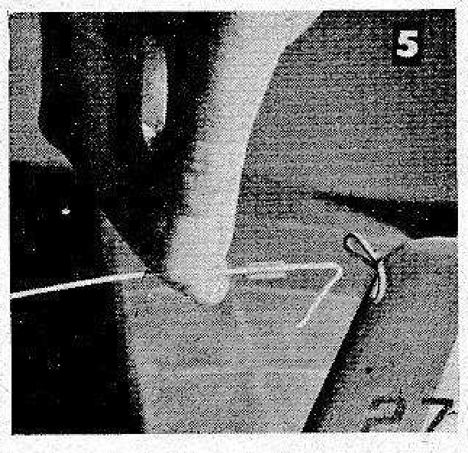
If you are using the standard E.D. transmitter, you will note that, after installing the two batteries, there is still some space left. As the lid of the case is quickly detachable, this space can be usefully employed to carry the keying switch and lead, the milliammeter and a tuning key for the receiver and a spare set of receiver and actuator batteries. See photo. To prevent any part of these coming into contact with the transmitter chassis proper, some full-depth pieces of hardboard or thick millboard should be used to divide off the compartments, foam plastic or crumpled paper being used as packing around the batteries. Incidentally, a good quality milliammeter can be obtained from Messrs. Ripmax, the radio control specialists, for 25s. This instrument is shown in use in Fig. 10.

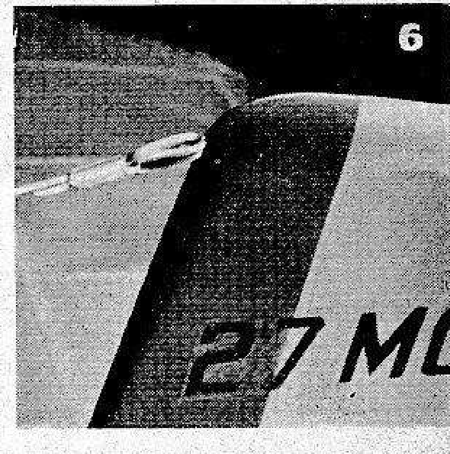
As stated in Chapter 19, you must be licensed with the appropriate authority before you can use model radio equipment on either of the special frequencies that have been allotted for model control. This is merely a formality and, unlike the licensing of amateur radio stations, involves no technical examination. In the U.S. these licences are issued by the Federal Communications Commission and, in Great Britain, by the G.P.O. Licences issued by the G.P.O. are for a period of five years and cost £1. Remittances should be sent to the Accountant General's Department, General Post Office, London, E.C.1. You will receive in return a "Model Control Licence" issued under the provisions of the Wireless Telegraphy Act of 1949 and entitling you to use your equipment within a five-mile radius of your home or such place as you may specify as your "station." You may, of course, use the equipment outside the selected area, but you are then required to give notice of the occasion to the post office telephone manager of the area in which you wish to fly. If this seems rather a bother, remember that it is in your own interests to do so: there is just a possibility that other emissions are being made in that area that may upset your receiver. If you fly regularly from a site outside your area, you can make a "standing notification" to the telephone manager.

Unlike your F/F power models, your radio model will be relatively heavy, so that with the use of an engine of only moderate power (a 1.5 c.c. unit such as the Frog 149 is suggested for the converted *Deacon*) its flying characteristics are somewhat different. Compared with

4, 5 and 6—This method of shockproof fitting, also allows the aerial to be quickly detached.







a F/F contest model, the R/C job will be slower under power but faster in the glide and it is desirable to make sure that the alignment and trim of the model is as near perfect as possible, before glide testing.

First of all, check the tail-unit on its mounting, ensuring that the tailplane is accurately aligned and that the fin is not offset to one side. By keying the transmitter, check also that the two neutral positions of the rudder are, in fact, neutral. As with F/F models, it is helpful to add two small pieces of $\frac{1}{16}$ in. balsa to the underside of the tailplane each side of the tailplane platform to ensure that the tail-unit is always properly keyed in position. Now check the wing. It must, of course, be free from warps and correctly aligned on the fuselage. It also needs to be securely lashed with strong rubber bands. There are available, from stationers, large parcel bands, approximately $\frac{3}{8}$ in. wide which, doubled, can be used for this, or you can make up suitable loops from $\frac{1}{4} \times 1/20$ in. aero strip. The front pegs, incidentally, should face forward so that any collision impact will allow the wing to fly off the fuselage, thus reducing the risk of damage to both components.

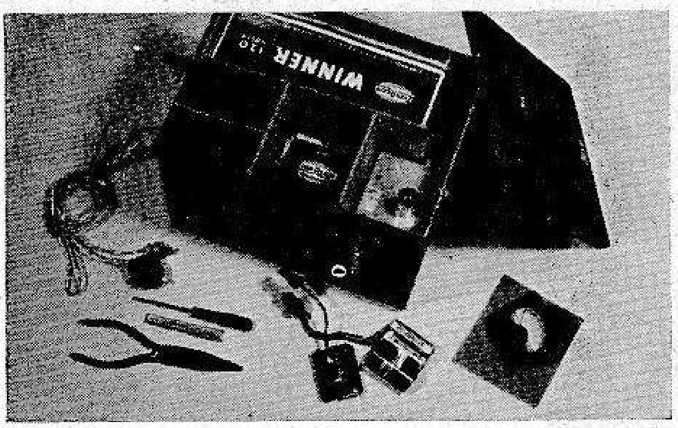
Make sure that the engine is bolted in securely, using fibre stop-nuts or a second nut locked against the first. The fuel tank will need to be large enough to permit engine runs of several minutes and if a tank of suitable capacity and shape cannot be bought ready-made, it will be necessary to make one. A clear plastic tank is preferable so that its contents can be visually checked.

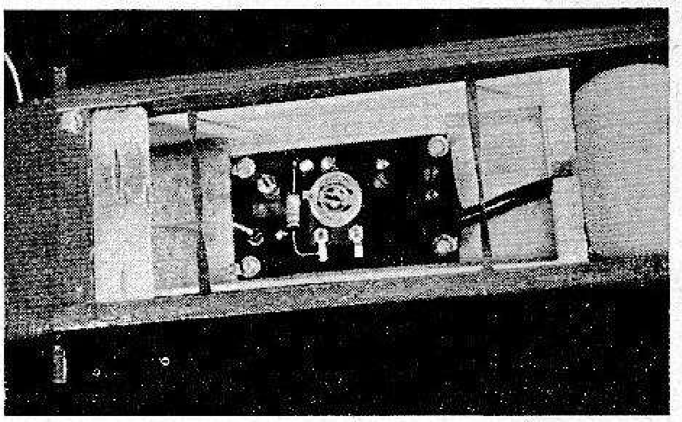
After ascertaining that the receiver and actuator gear are functioning correctly, it is necessary to make a second check with the engine running. Sometimes, engine vibration will cause the receiver relay to "chatter," resulting in a continuous or intermittent flutter of the rudder. Adequate insulation of the receiver from the airframe (see previous chapter) will usually absorb the normal level of engine vibration, but excessive vibration can be caused by an unbalanced propeller, or may be due to the engine having an inherent vibration period at that particular speed. In this case, first try another, similar prop, then one of a slightly different size, allowing the engine to run faster or slower.

Present day model R/C units are factory tuned and usually work satisfactorily immediately on installation. No trouble was experienced with the E.D. Transitrol set used in the *Deacon*, which operated "straight out of the box" after making the necessary battery connections and without touching either the tuning adjustment or sensitivity control. If your set requires tuning, this should be done in accordance with the instruction leaflet issued with your particular set, but, in any case, it will be necessary to make a range check and, possibly, re-tune the receiver at the flying site.

It goes without saying that you will need a helper on the flying field. If you have a willing friend who is experienced in R/C, so much the better, otherwise ask someone on whom you can depend and agree upon a simple code of hand signals.

Plug in the milliammeter, switch on both receiver and transmitter and first make a check within easy hailing distance so as to familiarise yourselves with the hand signals. Your assistant should be stationed at the transmitter and merely has to key the transmitter signal on and off as you raise and lower your arm (Fig. 9). Another signal, such as pointing your arm straight above your head, will indicate to him that he should hold the button down continuously for the "signal on" position while you re-tune the receiver. The range check should





Top. The transmitter case with hardboard divisions added, leaving storage space for keying lead, milliammeter, tuning keys and spare receiver batteries.

Access to the Transitrol receiver is gained through the cabin top after removing foam pad. Tuning adjustment is via small screw and locknut, upper left. Centre is sensitivity control.

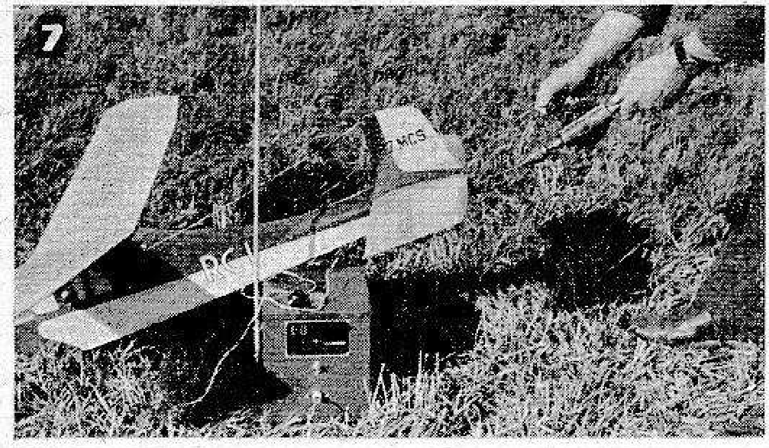
be made at progressively greater distances up to about 300 yards from the transmitter.

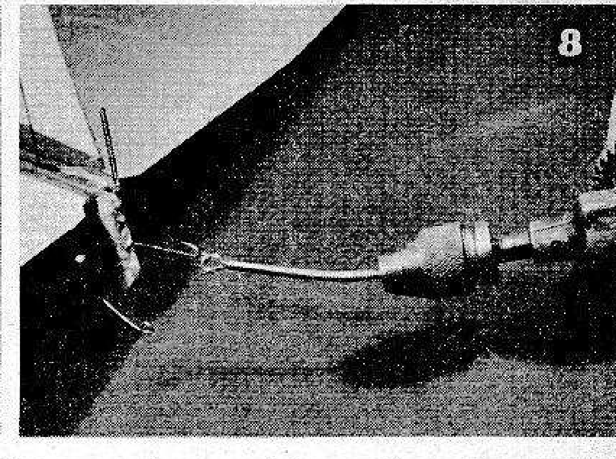
If the flying site is also in use by other R/C enthusiasts, you must, of course, make sure that all other transmitters are switched off while you make your range check. Similarly, you must not operate your transmitter while another model is in the air.

It now remains to determine the trim of the model with a few test glides, having first checked its balance. Due to its higher wing loading, the R/C model will require somewhat more vigorous launching. Do not merely hurl it forward, but run into the wind until the model flies itself out of your hand.

Now a final check before your first radio-controlled flight. Are there enough turns on the actuator motor? Perhaps your test glides jarred something out of adjustment. Check to make sure. Is the shorting-plug secure? Are the wing and tail rubbers O.K.?

When you are positive that you have done everything within your power to ensure the model's safety, put enough fuel in the tank for about $1\frac{1}{2}$ minutes' running time and start the engine. Allow it to warm up for 20 seconds or so, then throttle back to reduce power very slightly. Switch on both transmitter and receiver and check that the rudder is responding properly to the transmitter key. Now watch the rudder sequence as you press the key: left, neutral, right, neutral, left, neutral. Leave it so that the first signal in flight will move the rudder to the right. The engine now has enough fuel for





about 30 seconds' flying. Don't get flustered. Launch the machine carefully and get back to the transmitter, or, if your helper is sufficiently experienced, let him launch the model.

Ideally, the model should just fly straight out in front of you in a shallow climb. If it turns, this will probably be slightly to the left, due to engine torque. This is where your " right rudder " first signal comes in. Press the button and watch. The model will swing right and in two or three seconds will be back into the wind again. Release the button, then, immediately, give a quick press and release to cancel out the left rudder position which follows. Try right rudder again briefly just to make sure that left rudder was, in fact cancelled, *then cancel left again.* The idea is to keep the model heading into wind and, when it turns away left again, to never get caught with " left " instead of " right " next in sequence.

The signals you send during your first flight should only be those required to keep the model heading upwind until the fuel runs out. This will give you the feel of the controls, but your primary aim at this stage is only to see your model safely back to earth again.

If, by any chance, there is virtually no wind, keep the motor run very short for your first flight. If the model should get rather too far away from you in this or any succeeding flight, you should turn it back towards the transmitter *only if you have at least* 50 *ft. of altitude.* Do not attempt to turn the model through 180 deg. or more in one movement. Make a quarter turn and neutralise, then another quarter turn and neutralise (always remembering to cancel the opposite control after each neutral). Don't wait until the model is nearly back to you before turning it back into the wind. Complete the 360 deg. turn so that the model is still in front of you.

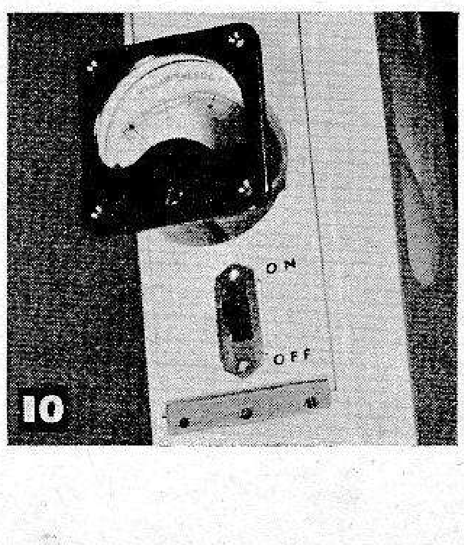
7—Make sure you have enough turns on the escapement motor before each flight. 8—Flexible curtain rod used in drill chuck aids winding.

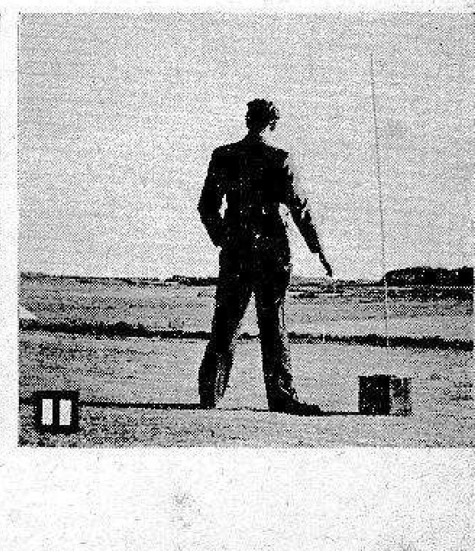
When the motor cuts, remember that the effectiveness of the rudder will probably be reduced by half, due to the absence of propeller slipstream and the model will therefore take longer to respond to your commands. Keep the model heading straight into the wind and try to avoid making turns when near the ground.

Having sucessfully brought your precious model down again, switch off the transmitter and receiver and carefully check everything before attempting another flight. Also, give a few moments' thought to your first flight. Was the model's trim satisfactory both under power and in the glide ? Or did it tend to stall or turn off one way ? Use your knowledge of F/F trimming to get the model properly adjusted before trying more revs or a longer motor run.

The rest is up to you. As explained in Chapter 19, a great deal can be done with a simple rudder-only R/C model, but, take care and never attempt manoeuvres without plenty of height. If you get confused and lose control of the model, this will not matter if you have plenty of altitude: you merely have to drop the transmitter key and wait for the model to level itself out. Never, never take risks and remember your " cockpit drill " always and check everything meticulously before each flight.

9—Checking receiver reception. Increase distance from receiver to transmitter to 300 yards and re-check. 10—Standing current on the Transitrol receiver is 0.2–0.4 mA. as shown, which is increased to 4 mA on receipt of signal. 11—Concentrate on keeping the model in front of you and heading upwind during your first flights.





Soldering for the Modeller

CHAPTER TWENTY TWO

EXCEPTING a few elementary glider models, almost every type of model plane calls for soft soldering somewhere in its construction.

For example, most models are fitted with a wire undercarriage and 99 per cent. of these have the wheels retained by soldered washers. Where a vee type steel wire undercarriage strut is used, the joint is invariably bound and soldered. C/L models usually have soldered control linkages and soldering is the safest and simplest method of securing the ends of the steel control-lines. Where special fuel tanks are required, soldering up from tinplate is the usual way of making them. Soft soldering is also the advised method of making all kinds of electrical joints. For engines having electrical ignition systems, it is the best means of obtaining safe and trouble-free connection and if and when you take up R/C, you will find a knowledge of soldering essential.

Of recent years, soldering has tended to become one of the less essential subjects of the average home handyman's repertoire. Soldered pots and pans and other utensils having given way to modern ones of spun aluminium and moulded glass and plastics, he is seldom called upon to mend a leaky kettle or baking tin. As a result, few have more than a hazy idea of soldering practice. Many go under the mistaken impression that there is nothing much to learn about it anyway. If you have any such notions, we urge you to read on.

How many models have you seen with really neat soldered joints? Make a point of checking on a few soldered axle ends. More often than not you will encounter an ugly blob perched precariously on the end of the wire, or an awkwardly balanced cup-washer spilling solder over one side. How frequently, too, do we see, or hear of, models shedding wheels on take-off or landing. Electrical joints are the easiest of all, yet many a radio model has been wrecked because of a "dry" soldered joint.

First, let us see what is meant by "soft soldering."

Soldering is a general term used to define various processes by which metals are joined by alloys having melting points somewhat below those of the materials united. There are various types of soldering alloys for different metals and various methods of applying the heat essential to the process. These range from very soft solders with melting points below the boiling point of water (such as are used in pewter work), to "silver" solder and brass "spelter" used in *hard soldering* and *brazing*. *Soft* soldering is performed with a heated soldering-iron or "bit," or, when more convenient, by the direct application of heat from a spirit lamp or gas flame. *Hard* soldering requires the use of a bunsen-burner or gas-blowpipe, while *brazing* requires the greater heat of a special brazing lamp or oxy-acetylene apparatus. From here it is, of course, only a short step

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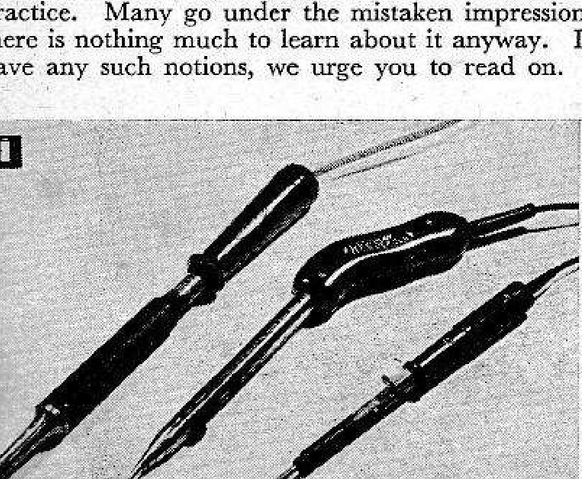

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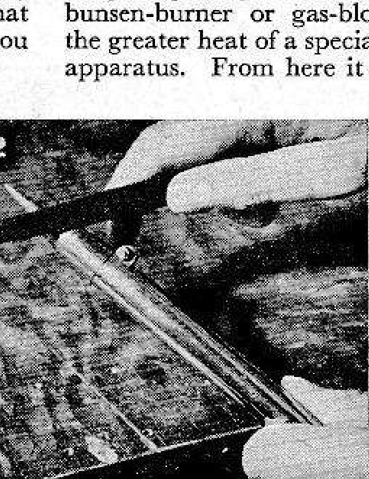


Fig. 1. Three types of electric soldering iron suitable for the model builder. Left is a Rawlplug iron of 115-watts rating for general structural work, while, on the right, is a Solon 25-watt instrument iron for electrical and R/C jobs. Between them is an 80-watt iron which can be used for both types of work. Fig. 2. Cleaning up a copper bit prior to re-tinning. Heading photo above: Tinning a new bit. Keeping the bit clean and properly tinned is of the utmost importance.

to oxy-acetylene welding as used in heavy industry.

Generally, soft soldering is intended for use with fairly soft materials such as brass, copper, tinplate, etc., but, by intelligent application, we can also make it serve with hard steel, such as undercarriage wire. Soft soldering, therefore, will suffice for virtually all the model aircraft enthusiast's requirements and only one type of solder is called for, *tinman's* solder, which is an alloy of lead and pure tin. Best quality tinman's solder contains 50 per cent. tin and is easier to work with than inferior grades having an excessive lead content.

So far as the modeller is concerned, soldering jobs can best be treated as falling into two main groups: electrical and structural. Each requires a different technique, different materials and, preferably, different tools.

As regards tools, the first requirement, obviously, is the soldering-iron. In its simplest and cheapest form this merely consists of a solid copper block, suitably pointed and known as the " bit," attached via an iron shank to a wooden handle. The bit is then heated in a gas or spirit flame. The snag with this type of iron is that it continually needs reheating (except with very small jobs) and for the serious model builder an electric soldering iron is the obvious choice as it is far quicker, simpler and cleaner to work with. There remains the question of size.

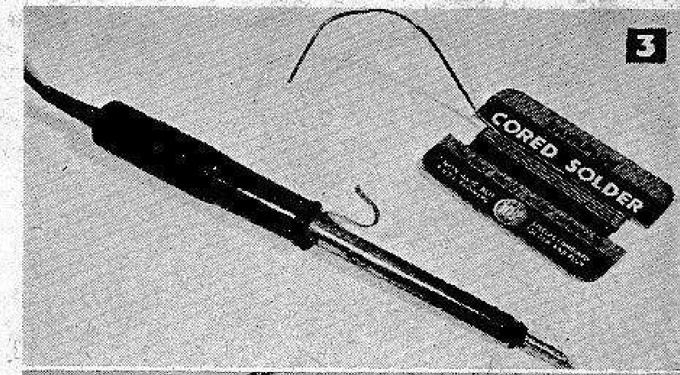
For electrical work, especially when making R/C joints in confined spaces, or when working close to delicate components which may be damaged by excessive heat, a small iron of about 25-watt rating with a slim pencil bit and known as an instrument iron is the ideal choice.

For general structural work, however, especially on heavy $\frac{1}{8}$-in. undercarriage wire or fuel tanks, an instrument iron is quite useless. Its small heat output is rapidly dissipated through the surrounding metal and it is often impossible to get the entire joint area hot enough to run the solder properly. Here, an iron of nearer 100-watt rating is the preferred choice.

In other words, the ideal set-up is two irons, but if you are obliged to make do with one iron, try to get one of about 80-watt rating, but which has a sharply pointed conical bit. This will generate sufficient heat for the bigger jobs but is not too cumbersome for the delicate electrical work.

In addition to the actual solder, a *flux* is needed in making a soldered joint. The purposes of the flux are three-fold: to clean the surfaces to be soldered; to prevent the formation of an oxide and to assist the flow of the solder. Flux is indispensable, since the essence of good soldering is absolute *chemical* cleanliness of the joint surfaces. There are many types of flux, but we need only be concerned with two of them: acid and resin-base types.

Resin base fluxes, which include the popular " Fluxite" paste, are the only fluxes which should be used for



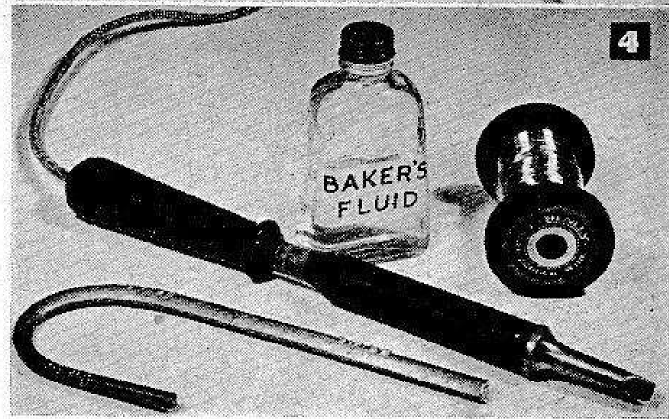
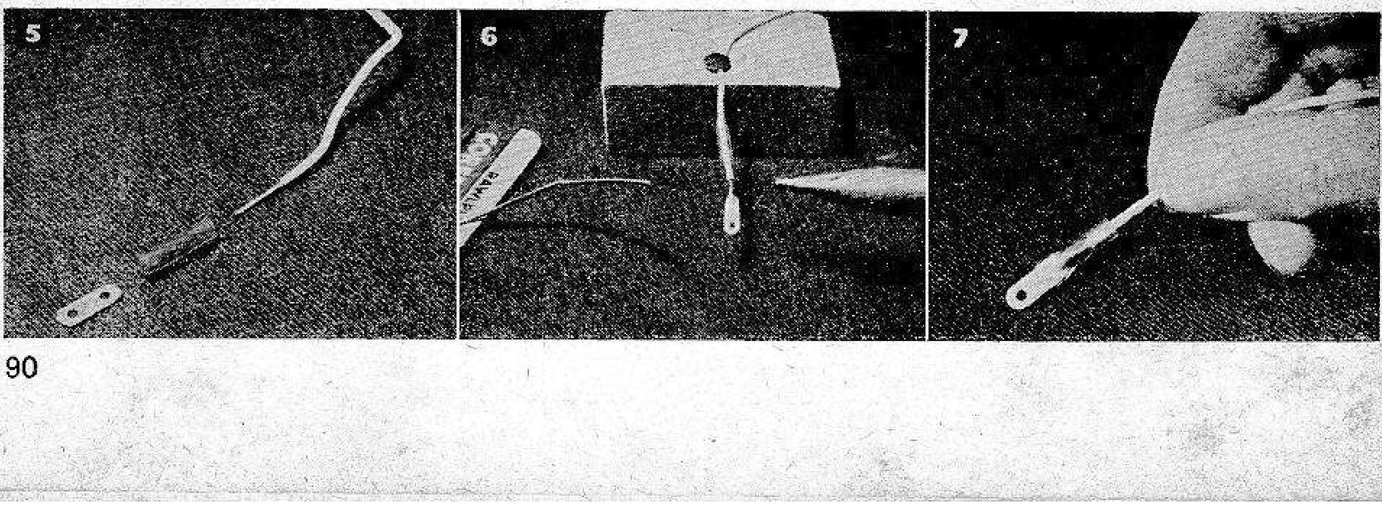


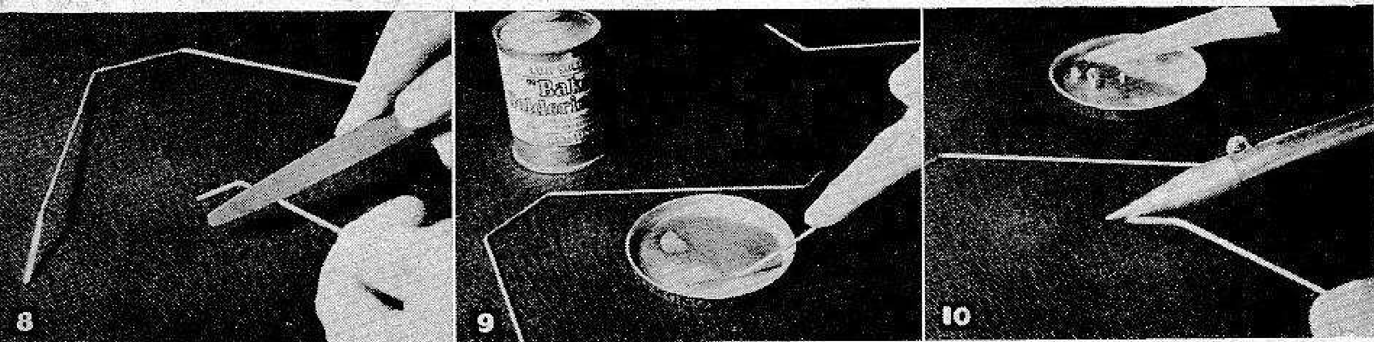
Fig. 3. For electrical work, a small iron and cored solder will generally be sufficient. Fig. 4. For undercarriages, fuel tanks, etc.: large soldering-iron, " Baker's Fluid, " solder stick and tinned wire for binding joints.

electrical connections. Special brands of solder in the form of wire, instead of sticks, are now commonly used which actually contain resin flux in a core through the centre, a typical product being " Rawlplug " cored solder. These render the use of a separate flux unnecessary and are especially convenient when making small electrical joints.

For other work, however, particularly steel wire undercarriages and tinplate or brass sheet fuel tanks, the use of an acid flux is recommended, as it has a more positive cleaning action, does not leave a resinous deposit and generally results in a neater joint. Zinc chloride, known to the tinsmith as " killed spirits," is the most widely used preparation of this type and the well-known " Baker's Fluid " is a proprietary brand which can be thoroughly recommended. Never use acid fluxes on electrical joints, however, as they have a corrosive action which will corrode the adjacent wire and cause a fracture.

Figs. 5-7. Three stages in making a strong cable end.





Figs. 8-10. *Cleaning and tinning wire undercarriage parts.*

Incidentally, a small tin of "Baker's Fluid" will be enough for all your modelling requirements for a couple of years or more, but, in this time, the fluid will corrode the tinplate container and collect rust, and may eventually cause a leak. Therefore it is a good idea to decant it into a bottle, which, needless to say, should be clearly marked. The bottle shown in some of our photographs is an ex-"Ronsonol" lighter-fuel bottle having a retractable glass spout in the cap which is rather useful.

In addition to the items so far mentioned, it will be helpful to have some tinned copper fuse wire for binding parts together prior to soldering, emery or glass paper for cleaning the sur aces to be soldered, a smooth flat or three-square file and a piece of clean rag.

Now for the actual procedure.

The first thing to do is to "tin" the iron if this has not already been previously done. To be properly tinned the bit must be coated, at all times, with a thin layer of solder, for about half its length back from the tip. If the iron is not properly covered, you cannot expect to do a good soldering job and also the life of the bit will be shortened.

If the iron is dirty or corroded and has not been left properly tinned from the previous job, it should first be cleaned with a few strokes of the file to remove old solder, resin or pitting. Do not file more than is sufficient to just expose a new clean copper surface.

Now plug in, switch on and allow the iron to warm up. Don't forget to support it in such a way that it will not burn the bench top. (Useful here is a crude stand such as that shown in Fig. 17. It consists merely of two 5-in. nails driven into a block of softwood 6 × 4 × 1 in.)

For tinning it is useful to have a shallow pan, such as a tin lid. Into this pour a little "Baker's Fluid" and, with the aid of a spill of blotting paper, paint the hot bit liberally while holding it in the pan. The fluxed part will appear bright. Take the solder stick, dip in flux and rub over the bit until it is completely coated. Provided that the bit is clean and hot enough, the solder will run smoothly over its surface producing a bright "plating." (See heading photograph.) We are now ready to tackle our first soldering job.

Figs. 5 to 7 show the sequence in making a simple cable end such as might be used for wiring an earthing point to an engine for glowplug or spark ignition. Merely twisting the wire round the engine mounting bolt and locking it with the nut is not a very satisfactory method: eventually the wire will fray and break just in front of the insulation, due to vibration, and a far better method is to use a flat tag of copper or brass reinforced with Neoprene fuel tubing.

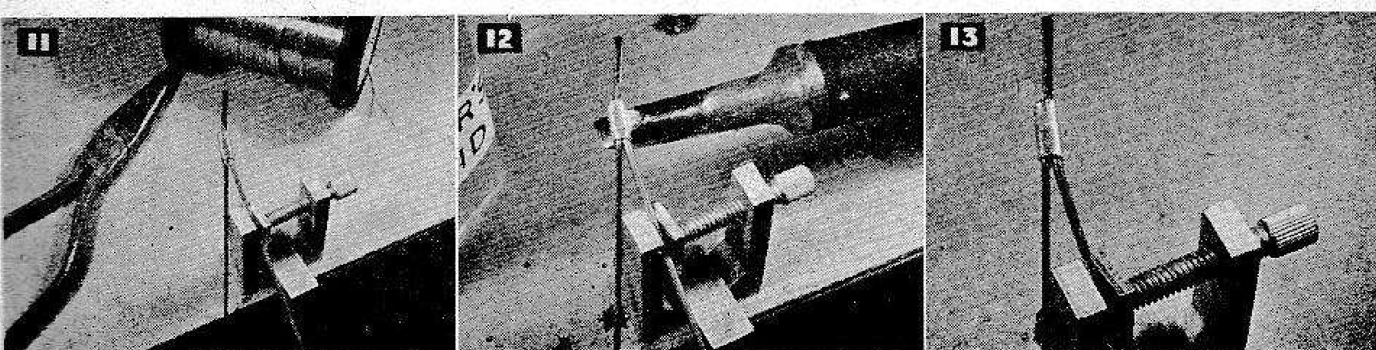
First, the wire should be carefully bared for not more than $\frac{1}{2}$ in. and the strands twisted together. About $\frac{1}{2}$ in. or $\frac{5}{8}$ in. of Neoprene tubing is now slipped back over the insulation. The diameter of the Neoprene should be such that it fits closely around the insulation and the tag shaped so that the other end of the Neoprene fits tightly over it after soldering.

Clean the tag with emery paper, then pass the bared wire through one hole and fold it back. Apply the hot iron from below and after a few moments, just touch the resin-cored solder to the joint. The solder will run over the wire and tag on both sides. Remove the iron after a few seconds, and when the joint has set, slide the Neoprene sleeve forward over it. (It will be found that, when still warm the tag will soften the Neoprene slightly on contact, enabling the tubing to be drawn forward easily.)

It will have been observed that in making the joint, we first heated the metal with the iron then applied the flux and solder direct to the *joint* and *not* to the bit. This is a habit that should be cultivated for it is absolutely essential that the metal is brought up to the melting point of the solder.

Many people make mistakes here, thinking that it is only necessary to apply solder to the joint with the iron and prod it about until it appears to stick. Small wires

Figs. 11-13. *Binding and soldering an undercarriage joint.*



can often be soldered together almost instantaneously merely by the application of a hot well-tinned iron, but this will never work with heavy gauge undercarriage wire or a fuel tank, for, when the iron is applied, much heat is lost in the surrounding metal before the joint becomes hot enough to keep the solder fluid.

Figs. 8 to 13 show various stages in the making of bound and soldered undercarriage joints such as are common on many power models. The first thing to do is to clean the surfaces to be soldered with emery paper. To make a neater job, some modellers prefer to file a slight " flat " on the adjoining wire surfaces. The iron, meanwhile, has been heating and is properly tinned and after fluxing the parts by immersing in " Baker's Fluid," the bit is dipped in the flux and then slowly stroked over the surfaces to be joined. As the wire is brought up to the right temperature, a very thin deposit of solder will be transferred to its surface.

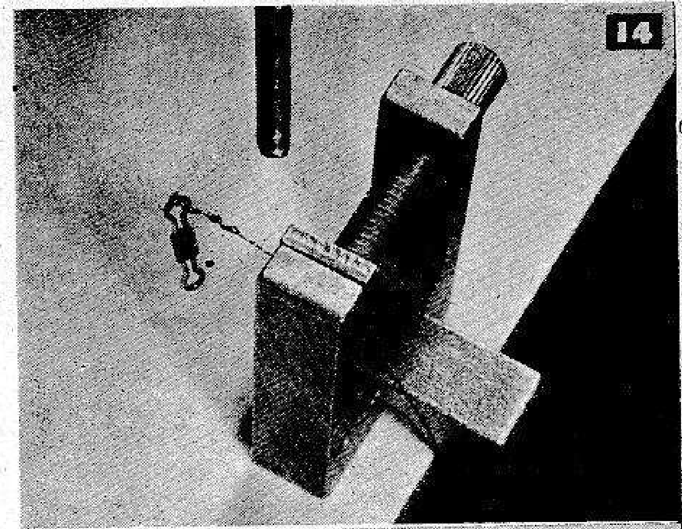
The two struts are now neatly bound together with fuse wire and set up in a vice or clamped to the bench with a pair of " X-acto " clamps as shown in Figs. 11-13. Once more, " Baker's Fluid " is applied to the joint and the hot iron is then brought up *beneath* the joint (see Fig. 12). The solder stick is now applied to the *top* of the joint and a properly made joint will be assured by the fact that only when the wire is hot enough will the solder begin to flow.

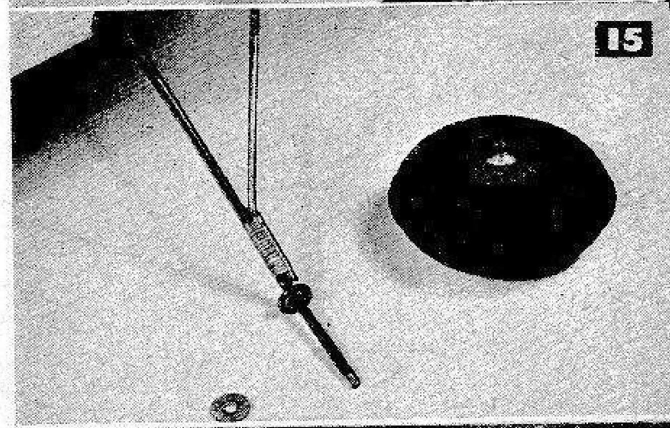
Some modellers omit the initial pre-tinning operation and, provided that the solder runs under the fuse wire binding and well into the joint, this does not result in any noticeable loss of strength. When dealing with such items as fuel-tanks, however, pre-tinning is essential. This, too, is where a good heavy-duty iron is useful. Always use " Baker's Fluid " and make sure that the iron is hot before you apply it to the sheet metal. Use a minimum of solder and run the bit up and down the surface until you have a very thin fluid coating of solder. (If the surface is allowed to become too heavily coated, difficulty may be experienced in making the parts fit together properly.) After tinning, the joints are fluxed and assembled in the required position. External application of the iron (Fig. 16) will then cause the lapped joints to be " sweated " together.

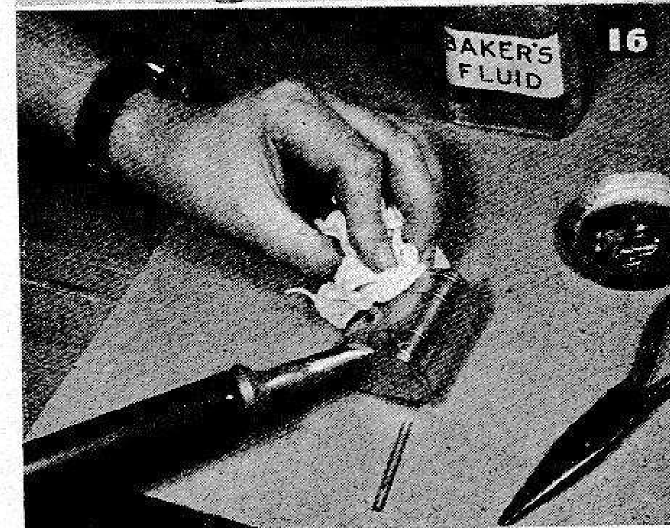
When making a fuel tank, incidentally, always punch filler, delivery or vent holes before trying to solder the last seam otherwise there will be a tendency for the final seam to blow or for the tank to buckle when cooling. To finish off, solder can be run round the outside of each seam, but *do not* expect this to make up for ill-fitting parts—make sure that your tank is accurately developed, cut and bent before soldering up.

When soldering washers onto wheel axles care has to be taken to avoid damaging the wheel or tyre, but to facilitate a neat and strong job, it is worth exercising some discrimination in the selection of the type of wheel to be used. Plastic wheel hubs tend to soften and distort from heat transmitted through the axles, and aluminium or dural hubs are preferable.

Remember, the prime essentials of successful soldering are: (a) complete freedom from grease or oxide on the metal surfaces and (b) adequate heat to the joint.







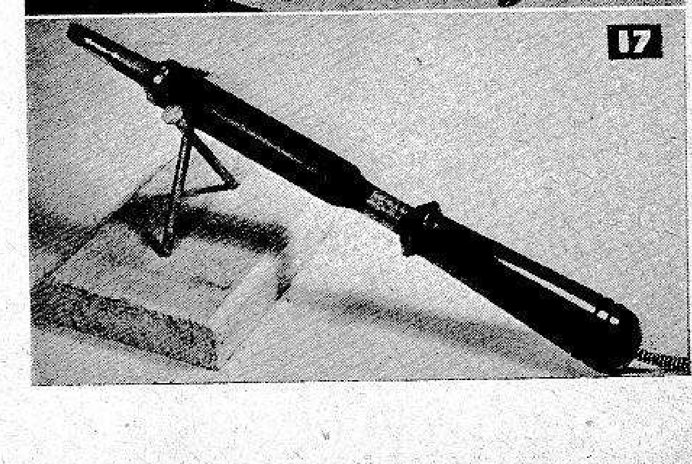


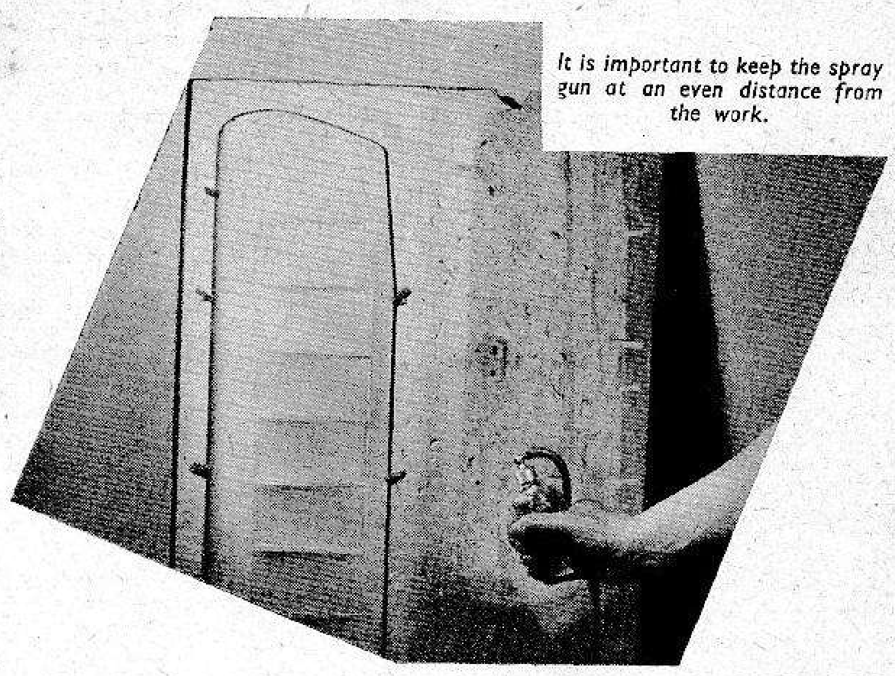
Fig. 14. For safety, control-line wire should have the ends twisted and soldered as shown. Use resin flux.

Fig. 15. Wheels with aluminium, rather than plastic, hubs allow plenty of heat to be used to solder retaining washers securely.

Fig. 16. Soldering a fuel tank. Parts are first tinned, then assembled and sweated together by external application of heat.

Fig. 17. A crude, useful stand, for holding the hot soldering iron.

Silk Covering & Colour Finishing



It is important to keep the spray gun at an even distance from the work.

CHAPTER TWENTY THREE

IN Chapter Six we dealt with the fundamentals of covering and doping, following the construction of a simple built-up glider. This basic procedure, involving the use of special lightweight coloured tissue paper covering materials treated with clear dope, is the same for all lightweight models such as gliders, small and medium-sized F/F contest power models and all rubber-driven models.

When, however, one progresses to other types, especially C/L models and also F/F models other than pure duration types, the process of finishing becomes a somewhat more varied and extended operation and, in many cases, alternative covering materials, for example silk or nylon, may be used.

Many readers will have reached the stage where they have started building a power model, such as the "Deacon" described in our previous chapter, or are contemplating a C/L stunt or scale model. Accordingly, we are devoting this article, firstly, to a description of how an alternative and stronger covering material, lightweight silk, is applied and, secondly, to the various methods of colour finishing. It is undoubtedly true that the average model which has been colour doped seldom looks as good as it might and this is certainly due to the fact that few model builders stop to think that colour finishing goes somewhat beyond the acquisition of a brush and a jar of dope.

First, however, we must deal with the question of the various methods of covering.

Lightweight paper-type covering materials, such as Modelspan and Silkspan, are, of course, ideal for all lightweight models. For larger models, however (roughly speaking, all types weighing upwards of 25 oz.), a somewhat more serviceable covering medium is desirable. This can be one of the heavier grade paper type covering materials available, or, alternatively, silk or nylon.

Paper type materials are, of course, the least expensive. On the other hand, all three materials soak up much more dope than ordinary tissue and it is necessary to remember that the cost of dope and coloured lacquer, for a given model size, can amount to just as much as the cost of silk for covering the same aircraft. Therefore, since a paper type covering is much more prone to split and tear when your model meets the inevitable obstruction, it is often worth the extra cost of silk or nylon to have a stronger material which will more effectively preserve the finish on which you have spent both time and money.

Silk and nylon are available in various grades, but the most widely used is lightweight parachute silk. This is the kind used for the small, 14-ft. dia. parachutes employed for supplies dropping by the armed forces, and a few model shops do, in fact, still offer surplus 'chute panels for model use. Alternatively, a similar or slightly stronger grade silk can be bought by the yard.

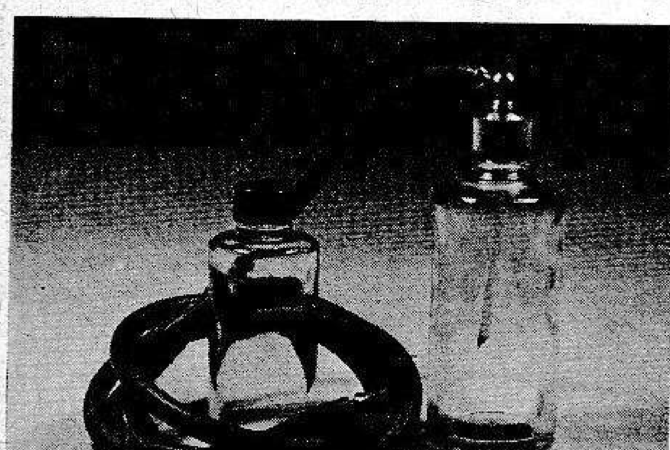
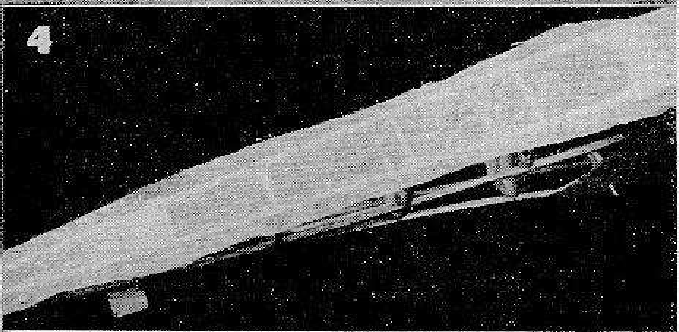
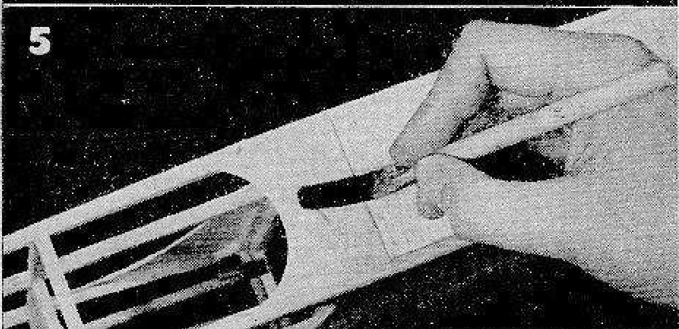
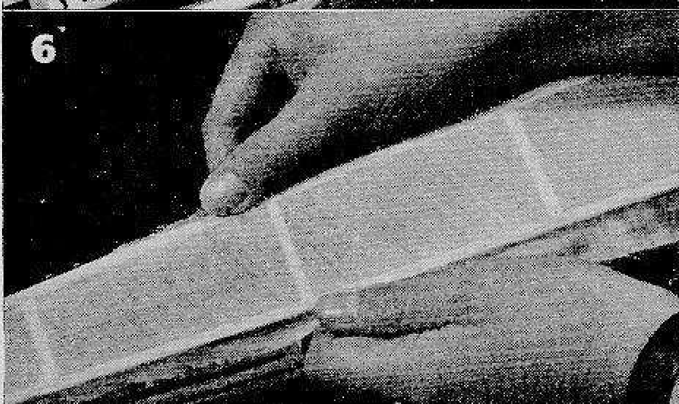


Fig. 2. Colour finishing is greatly simplified by the use of the inexpensive, tyre-pump operated Celspray gun; 2 oz. or 4 oz. containers may be used and a hand-bulb operated model is also available.







When using silk, it is necessary to be even more careful about the preparation of the framework than when using paper. Slight splinters, blobs of cement or other rough spots will snag silk more readily than paper. It is advisable to paint the entire framework first with clear dope, lightly sanding it all over afterwards. Where extensive areas of sheet or block balsa are to be covered (as with a nose section), it is worth while, too, to apply a couple of coats of "sanding sealer." A good sanding sealer can be made by adding talcum powder to clear dope.

Another thing to remember is that, when silk is shrunk over a framework, it pulls much more strongly than paper. If tissue is put on too tight, it will tend to split when shrunk, but silk will tend to warp the framework instead. Do not, therefore, silk cover a weak framework.

Important, too, is the "grain" of the silk, which should not run diagonally, as this will tend to warp the surface, causing a difference in angles of attack between the tips and centre-section. It is necessary to remember this when cutting the silk for the various panels. Generally speaking, it is best to have the maximum shrinkage lengthwise on a component, i.e., from centre to tips on wings and tails and from nose to tail on fuselages. This will ensure a minimum of "sag" between ribs on flying surfaces, while, in the case of fuselages, there will not be an excessive inwards pull on the longerons or stringers.

Silk can be applied dry or wet. The main advantage of applying silk wet is that it can be made to follow a double curvature without wrinkling. Fixed to the framework while wet, the silk tends to dry out more taut than when applied dry and water-shrunk afterwards.

As with paper covering, the type of adhesive used may be either a solid dextrine paste, such as Gripfix, or a thickened dope. We have always found the former entirely satisfactory and a good deal more economical. If dope is used, it may need to be thickened by the addition of up to 50 per cent. of balsa cement. Some thick dope should, in any case, be available for sealing the edges of the silk after a panel has been drawn taut over a framework.

When using silk dry, the same general procedure applies as for tissue covering, described in Part VI of this series. Pull the silk lengthwise and then work out the wrinkles across the component. Seal the edges by folding them over and doping down and then trimming off.

The advantage of using silk wet is especially appreciated when covering a rounded fuselage or a rounded and tapered wing tip. The piece of silk to be used should be cut to size, then folded and completely immersed in water. It is then squeezed out (do not wring out as this may stretch it out of shape), carefully unfolded and hung from the edge of the bench or work table. It does not matter if some of the excess moisture evaporates during the minute or two required to apply ad esive to the frame; if the silk is too wet when it is applied to the frame, the paste will be kept soft and will not dry before

Fig. 3. Badly crumpled silk may require ironing. Use minimum heat, i.e. lowest thermostat setting on auto-controlled irons.

Fig. 4. Cut silk so that there is an adequate overlap.

Fig. 5. When using the dry silk process, first apply adhesive to the ends of the frame.

Fig. 6. Pull silk tight, end to end, on the framework, then apply adhesive to longerons and pull out sides.

Fig. 7. When using the wet silk process, soak as shown, then gently squeeze out as much water as possible.

the silk has begun to dry out and shrink. In any event, to guard against this, the edges of the silk should be doped down as soon as the panel has been smoothed out and made wrinkle-free.

Silk is ideal for use in conjunction with a sheet balsa covered cabin section and balsa block engine cowling. Fig. 8 shows how a single piece of silk, used to cover a cabin section, can be formed around the windscreen frame and around the double curvature of the cowling. In this case the silk will normally be applied wet, although it is also possible to obtain similar results by "doping on" the silk, provided that the latter is well saturated with dope in the process. Silk over balsa sheet greatly strengthens it, while to block balsa, it gives a far more serviceable surface, resistant to chips and dents.

Before applying shrinking dope, it is advisable to spray all covered frames with water and pin down all flying surfaces to avoid warping during the drying out. All silk covering needs a minimum of two coats of clear dope, preferably three, and more if you use the dope thinned. Follow the same procedure as for tissue, pinning down wing and tail surfaces as usual. Doped silk takes longer to dry than paper and slackness may, therefore, take some time to disappear.

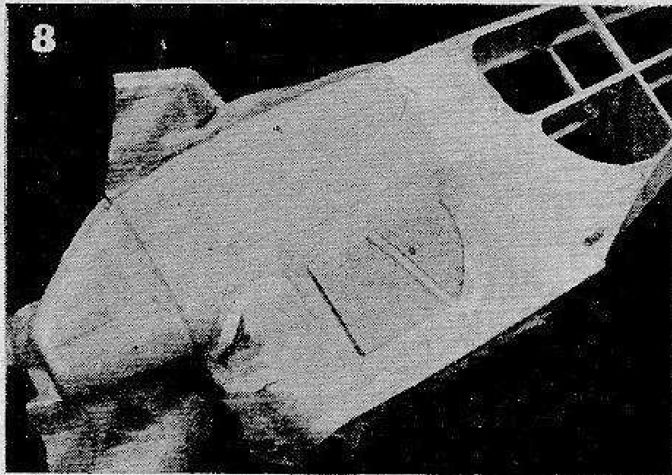
We now come to the question of colour finishing. Undoubtedly, the best way to apply coloured lacquer is with a spray-gun rather than with a brush. Previously, spray equipment has mostly been beyond the means of the average model builder—even a spray-gun of the type which operates from a vacuum-cleaner costs more than many enthusiasts wish to spend, but, happily, the requirements of the modeller are now most adequately and inexpensively met by the Celspray type unit.

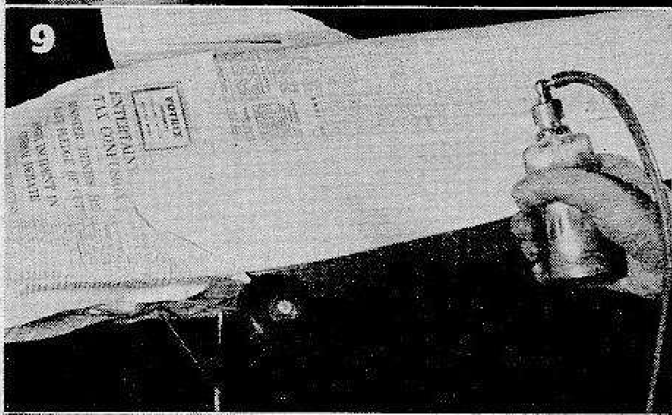
The Celspray is available in two types, the first being equipped with a hand-bulb, while the second is designed to operate from a tyre pump.

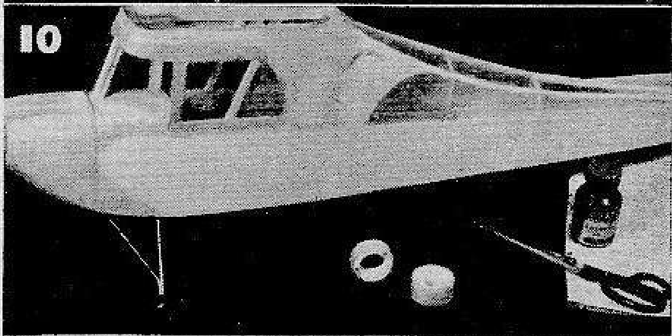
Provided that the silk has been adequately filled with clear dope, considerably less coloured lacquer than clear dope will be required. For a 54-in. span model, for example, 8-10 oz. of clear dope may be used for the expenditure of no more than 4 oz. of coloured lacquer. Spraying calls for a plentiful supply of cellulose thinners and a half-pint, costing about 2s. from any garage, is advisable.

Different coloured dopes or lacquers have varying covering powers; a component finished in one colour may thus weigh more than an identical component finished in another colour due to the extra coats required. Aluminium or silver lacquers are the best in this respect and will go four or five times as far as a light colour such as yellow. Dark reds, blues, etc., come between these two extremes. Incidentally, silver dopes, in particular, benefit from sprayed application.

Most model lacquers require thinning about 30 per cent. for use in the spray-gun. The technique adopted in spraying depends on whether any after-treatment (i.e. cutting down and polishing) is to be used. Normally, this latter will only be employed if the surface is wood or metal based—such as in a speed model, C/L scale model,







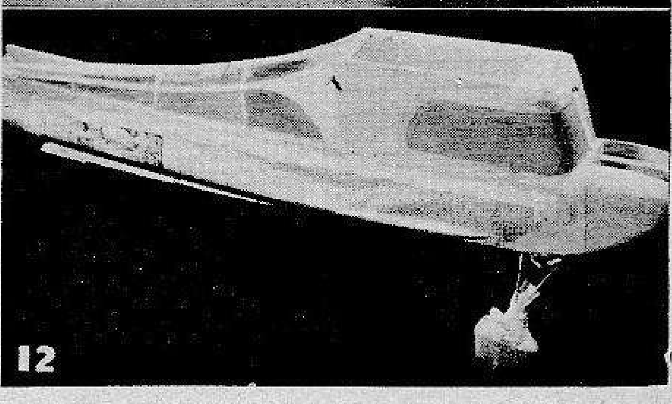


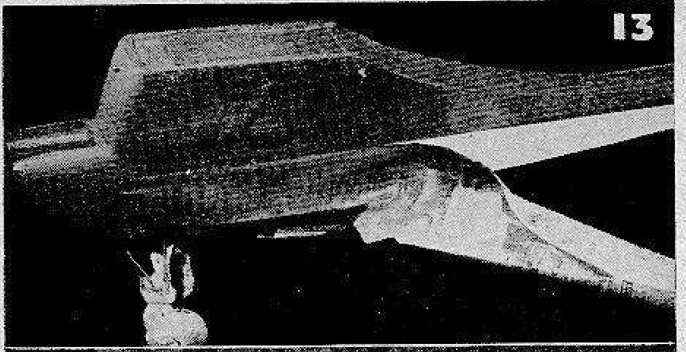
Fig. 8. Advantages of wet silk are most appreciated when covering rounded nose and cabin sections.

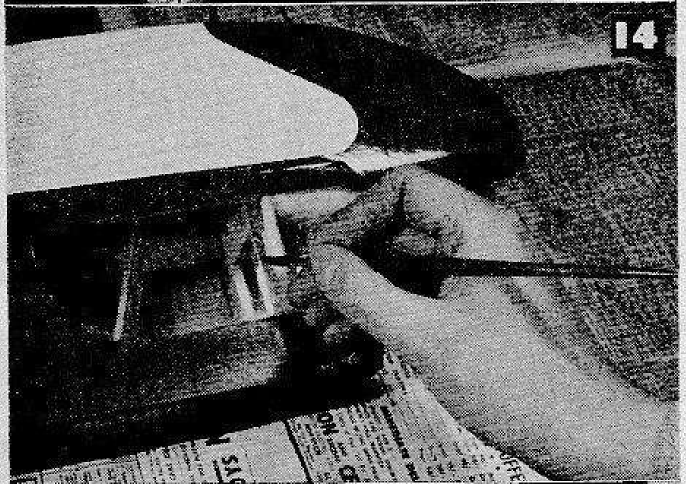
Fig. 9. After three coats of clear dope, the fuselage is masked for the first colour coats.

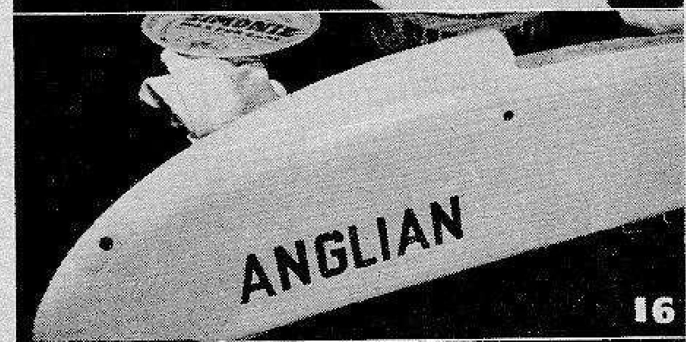
Fig. 10. The fuselage after spraying on the lighter colour.

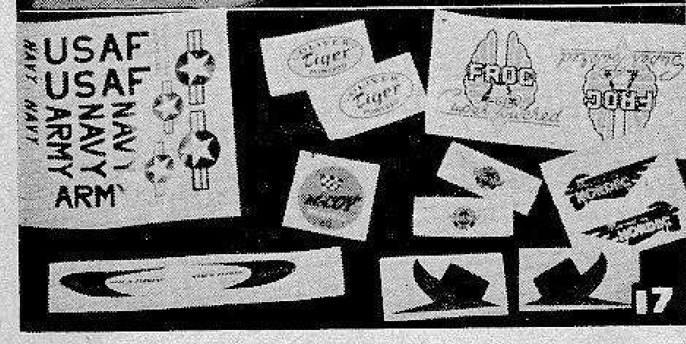
Fig. 11. Before masking for the second colour, the raw edge left by the first coat should be feathered down.

Fig. 12. The fuselage masked for final spraying. Cellulose tape, newspaper and gummed paper strip are used.









the fuselage of a stunt model or, perhaps, an exhibition scale model. Here, after the surface has been carefully prepared, filled where necessary and rubbed down with fine sandpaper, it is sprayed with a succession of thin coats (preferably with grey "primer" to start with) and then, when dry, "cut down" with silicon-carbide paper, this being dipped in water and lubricated with a smear of soap.

The object is to get the surface perfectly flat and smooth. Two or three coats of colour are then sprayed on and the cutting down process repeated. The spray-gun is moved across the work sufficiently to prevent the lacquer from gathering on the surface and acquiring a "wet" appearance. As many as twenty or thirty thin coats may be applied in this way, by which time, with frequent rubbing down with No. 400 silicon-carbide paper lubricated with soap and water, the surface will be beautifully smooth and ready for polishing.

This is best carried out with Brasso metal polish. Applied with a soft cloth, the Brasso cuts another thin layer from the lacquered surface, removing the minute scratches left by the silicon-carbide paper and leaving, instead, a highly polished surface, marred only by still smaller scratches left by its own abrasive action. These, in turn, are removed by the application of a good car polish, such as Lifeguard and, as a finishing touch, the surface can be treated with a wax polish such as Simoniz.

"Cutting down," however, cannot be satisfactorily practised with fabric covering and the usual method here is to use a slightly different spraying technique to obtain a glossy finish. A number of coats are sprayed on, as before, until sufficient depth of colour is obtained, then a final spray over with a very thin solution (at least 75 per cent. thinners) is used to "run out" the minute "hills and dales" of the sprayed finish.

With practice, spraying can produce a matt, satin or glossy finish. A matt finish, such as would be used for a camouflage scheme on a scale model, is produced by spraying as "dry" as possible, i.e., keeping the gun moving and spraying on a succession of quick coats with not too much thinners in the lacquer. A satin finish (which often gives the neatest appearance on a fabric surface) is obtained by using a thinner consistency and spraying with a steady movement that just allows the lacquer to appear slightly wet on the surface.

Where two or more colours are required on a single component, this is easily obtained by masking, as shown in the photographs. Spray on the lighter colour first, roughly masking off the remainder. To produce a clean, straight dividing line, cellulose tape is positioned so that the darker colour slightly overlaps the lighter. Before applying the tape, feather down the raw edge of the light colour, as shown, with No. 400 paper, used wet. After spraying the remaining coats, leave to dry properly before attempting to remove the masking.

Numbers and other markings and decorations can be produced by masking, or with transfers, as shown.

Fig. 13. *Showing how a clean line is obtained with cellulose-tape masking.*

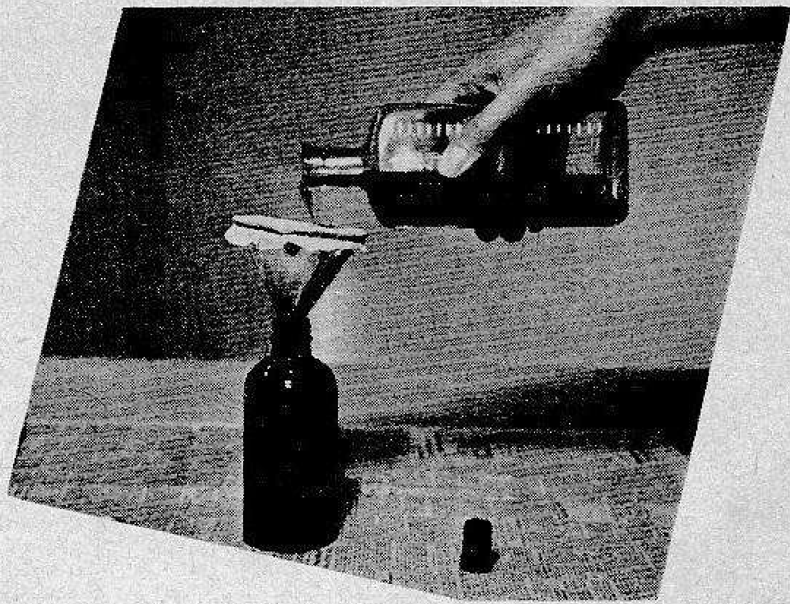
Fig. 14. *Windows may be masked separately or as a whole and a brush used to paint uprights afterwards.*

Fig. 15. *A "cut down" finish on an A2 glider fuselage. The rubbed surface is finished with car polish.*

Fig. 16. *A quick method of applying lettering and other decorations is with transfers.*

Fig. 17. *A selection of transfers, including some of those issued by model engine manufacturers.*

Fuels—and how to make them



CHAPTER TWENTY FOUR

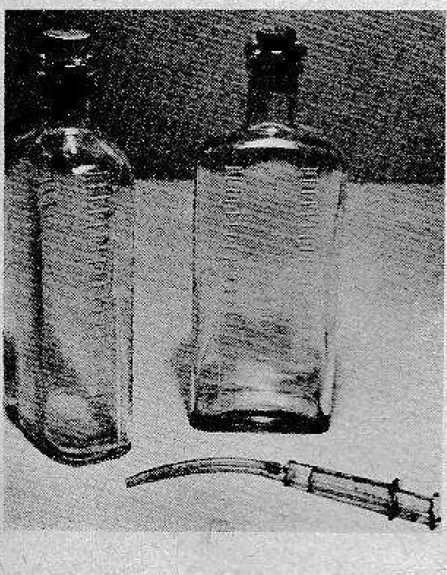
THERE are three basic types of model engine fuel: petroil, diesel and glowplug fuel. The first, consisting of a mixture of petrol (gasoline) and heavy motor-oil and intended for spark-ignition engines, is only very occasionally required nowadays. The second, comprising various mixtures but all containing oil and ether, are the most commonly employed model fuels in Britain and on the Continent, where diesel motors are the most popular type of model engine in current use. The third group embraces a wide variety of formulae based on methyl-alcohol and castor-oil (or synthetic oil) for the many types of glowplug motors in use in America and elsewhere.

Atmospheric conditions can have a serious effect on model engine performance, but, fortunately for British modellers, in the temperate climate of the British Isles, this does not normally present any serious difficulties. For this reason, most of the commercially available model engine fuel mixtures will be found adequate for use throughout the year. However, where optimum contest performance is required under a given set of conditions, blending the fuel to suit the engine can be expected to yield best results.

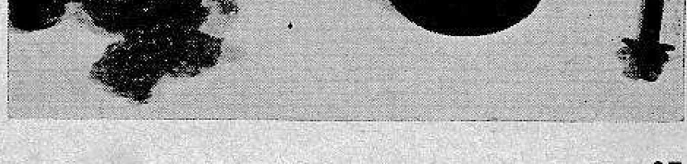
Another thing in favour of mixing your own fuel is the question of cost. Generally speaking, you can make up a fuel for less than half the cost of a ready bottled equivalent from a model shop. Your own mixture can be every bit as good as the branded fuel which, inevitably, must have its retail price somewhat inflated by labour and distribution costs.

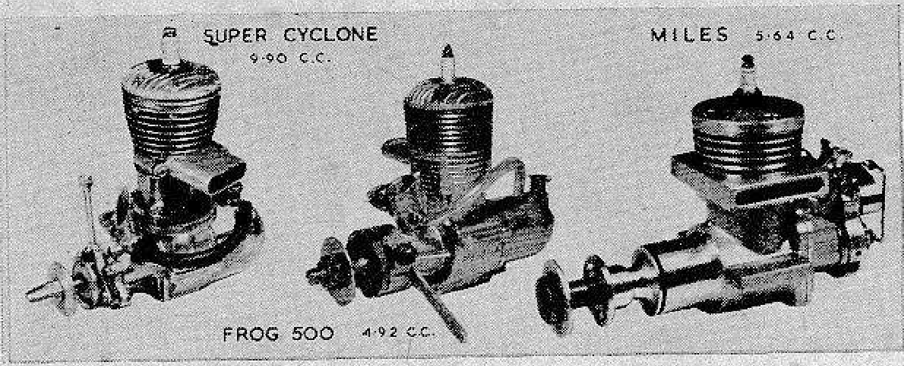
When mixing your own fuel, you can ensure, at the same time, that it is pure and free from any foreign matter, by filtering it as it is bottled. Only very simple equipment is necessary for filtering and blending. As quite small quantities are involved, a 12-oz. medicine bottle will generally be found adequate. These are obtainable graduated in ½-fl. oz. divisions and if ½-pint (10 fl. oz.) of fuel is made up each time, these ½-oz. graduations each conveniently become equal to 5 per cent., enabling the correct proportions of the constituents to be quite easily measured.

No matter how careful you may be, or how clean your materials and containers appear to be, there is an ever-present danger of picking up dirt or fluff which, if left in the final mixture, may cause annoying trouble when the fuel is used by clogging the carburettor jet. For filtering, a piece of parachute nylon is very effective. However, where commercial paraffin is used, this sometimes contains a sediment—usually minute particles from



Left: For measuring and mixing fuels, ordinary 12 oz. medicine bottles, graduated in ½ oz. are excellent. For measuring small quantities of additive, a graduated syringe is useful. Right: The unfortunate results of poor formulation in a commercial fuel, and failing to empty the tank after use. Coagulated deposits removed from a small diesel.





Cheapest fuel is petroil used in spark-ignition engines. Where higher performance is required, a methanol base fuel can be employed.

inside a rusty or dirty drum—and in such cases it is advisable to first filter the paraffin only through a filter paper. Suitable papers can be obtained from a retail chemist.

To avoid spillage and for use with the filter materials, a small funnel will be required. One with a rim is preferable, as a rubber band can then be used around it to hold the filter material in place.

Finally, you will want one or two bottles in which to decant your mixture for use on the flying field. These should preferably be of the screwcap pattern.

Fuel constituents and their uses

Technical Ether BSS.579 Anaesthetic Ether	Diesel. Also sometimes used in small quantities in other fuels to help winter starting.
Power Blending Methanol Methyl-alcohol	Base material of nearly all glowplug fuels and racing fuels. Cannot be mixed with mineral base lubricants.
S.B.P.4 Industrial Spirit Commercial Grade Petrol (white gasoline) Lighter fuel	All spark-ignition engines except where very high compression ratios make alcohol base fuels preferable.
Paraffin or Kerosene, including standard grades such as: Shell Royal Standard or 1st quality burning oil such as Aladdin Pink, Esso Blue, etc.	Diesel fuel base.
Light distillate fuel oil such as Iranian gas-oil or DERV	As above. No advantage over paraffin except that a smaller lubricant percentage can be used.
Nitromethane	Additive for methanol base fuels for giving substantial power increase and/or improved combustion under "cold" conditions.
Nitrobenzene (Oil of Mirbane)	Stabiliser and coolant for racing fuels where large percentages of nitromethane are used. Also used as an inexpensive substitute for nitromethane.
Amyl-Nitrate	Ignition control additive for diesel fuel.
Amyl-Nitrite	Ignition control additive for diesel fuel. Cheaper and less effective than Amyl-Nitrate.
Acetone Amyl-Acetate	Additives for methanol/castor-oil fuels to ensure homogeneous mixture. Not necessary if pure lubricant and water-free methanol are used.
Heavy mineral motor-oils such as: Castrol Grand Prix or Essolube Racer and others of SAE.50 to SAE.70 viscosity rating.	Lubricant for petroil and standard diesel fuels. Not suitable for alcohol fuels.
Compound motor oils, containing castor-oil and including: Castrol R and Shell Super Heavy	Lubricant for all types of diesel fuels. Not suitable for alcohol fuels.
Castor oils, including: Castrol M, Duckham's Racing Castor, Pratt's Racing Castor, Baker's AA, Castor-Oil B.P.	Lubricant for all methanol base fuels.

Petroil Fuels

Nearly all model aircraft engines produced during the past few years have been of the diesel or glowplug type. However, there are a few exceptions, two British examples being the spark-ignition version of the Frog 500 and the 5.6 c.c. Miles engine. There are also some older American spark-ignition types still in use, including the famous Super-Cyclone, Anderson Spitfire, Forster 99 and Ohlsson models. Spark-ignition petrol engines are preferred by some modellers, for R/C in particular, because they offer accurate and positive speed control by means of the ignition contact-breaker advance and retard control.

The standard fuel for use in engines of this type consists of a simple "two-stroke" mixture of petrol (gasoline) and motor-oil, commonly referred to as "petroil." Ordinary petroil mixtures as used in two-stroke motor-cycles, mopeds and scooters, however, are not suitable, due, mainly, to their low oil content. A mixture of 1 part motor oil to 4 parts petroleum spirit is best for most types, a proportion of 1 part oil to 3 parts spirit being preferred for a new engine.

The motor oil should be the heaviest engine-oil obtainable from your local garage and not less than XXL quality or SAE 50 viscosity rating. Better still is Castrol "Grand Prix" or Essolube "Racer," such as is sold by the motor-cycle specialists. As regards the petroleum spirit content, there is no advantage in using high-octane ratings and a cheap commercial grade petrol, or, alternatively, S.B.P.4 industrial spirit will give excellent results.

Diesel Fuel

Model compression-ignition, or diesel, engines depend on a fuel having a low self-ignition temperature. They require a fuel which, merely through the heat obtained from the compression stroke, will ignite spontaneously, instead of being ignited by means of a spark or glowplug.

This requirement is fulfilled by using ether, which has a very low self-ignition temperature, as one of the main constituents in our diesel mixture. The other essentials consist of a burning oil and a lubricating oil. The first can be either paraffin (kerosene) or diesel fuel oil. The paraffin may be the popular "Aladdin Pink" or "Esso Blue" or any similar oil sold especially for use in domestic heaters, but the ordinary white grade, such as "Shell Royal Standard" is equally effective.

Some engine manufacturers specify the use of diesel fuel-oil. Numerous tests have shown that no real advantage is to be gained by the use of fuel-oil as opposed to kerosene; in fact, fuel-oil tends to produce a dirtier exhaust, but, where used, fuel-oil should be a gas-oil of the type sold for use in modern high-speed true diesels and known commercially as "DERV" or diesel-engined-road-vehicle fuel. Where obtainable, Iranian gas-oil would appear to be the best grade to use. When using this, incidentally, it is permissible, due to the lubricating properties of the gas-oil itself, to reduce, by up to 5 per cent., the lubricating-oil content in the mix.

The lubricating oil can be a heavy grade motor oil such as has been recommended already for spark-ignition engines. Alternatively, castor-oil, or a castor-base racing oil, or a castor type compound oil may be used. Castrol " R " is an oil of this latter type that is widely favoured by contest enthusiasts. Castor-oil is, of course, well-known for its excellent lubricating properties and, in view of the small quantities involved, the very slight extra expense of using castor base oils can be well justified.

Castor oils (which, of course, are of vegetable derivation) and petroleum products, such as paraffin and fuel-oil, will not mix, but, fortunately, the ether content of our basic diesel mixture, here plays a secondary part by acting as a "stabiliser," dissolving both vegetable and mineral products and ensuring a clear, homogeneous mixture. Ether is available from any pharmacist and it is not necessary to insist on the anaesthetic grade, technical ether (preferably to British Standard specification 579) being cheaper and just as good for our purpose.

The most widely favoured additive for diesel mixtures is amyl-nitrate. This has the effect of making the fuel " hotter " and lowering the compression ratio required to achieve auto-ignition. As we learned in an earlier article, light propeller loads and higher speeds require ignition timing to be advanced accordingly and, in a model diesel, we normally do this by increasing the compression by means of the compression adjusting screw so that the temperature within the combustion chamber is brought to the self-ignition point earlier in the cycle. However, the extremely high compression ratio now tends to be excessive for smooth combustion. This is particularly evident in the larger capacity engines because the best compression ratio for any internal combustion engine is also a function of the cylinder bore.

We find, therefore, that most small diesels of around 1 c.c. capacity, as recommended to beginners and usually operated at speeds of 7,000 to 9,000 r.p.m., will operate perfectly satisfactorily on a plain mixture of ether, paraffin and oil.

Contrasting with this is the typical 2.5 c.c. competition diesel, operated at, perhaps, 12,000 r.p.m. or more, and, also, still larger, though slower-revving engines, such as the 3.5 c.c. E.D. Hunter. Here, about 2 per cent. amyl-nitrate will be required to ensure even running.

A few high-speed contest diesels may require even more nitrate and the two most prominent examples of this are the Oliver Tiger and Frog 249-BB, which require 3 to 5 per cent. amyl-nitrate, especially if required to reach their peak horsepower, which is delivered in the region of 14,000 to 15,000 r.p.m.

Thus, a simple mixture of equal parts of oil, ether and paraffin can be used in any small diesel and also as a running-in mixture for the first hour or so with new engines of larger type and when speeds are held to less than 10,000 r.p.m. In most cases the paraffin content can, for the sake of economy, be safely increased after running-in, to 1½ to 2 parts (i.e., 40 to 50 per cent.).

In general, however, 25 per cent. ether should be regarded as the minimum. Some engines require a higher ether content of 30, 35 or even 40 per cent., especially when new and when the heat generated by the friction of new parts is higher. The same applies when the fuel contains amyl-nitrate. The extra ether here acts as a coolant by absorbing heat as it evaporates.

The only purpose of the oil content in the fuel should be lubrication; anything over the quantity required for this is only being wasted. This does not usually matter as only relatively small amounts are involved and an excessively oily exhaust at least indicates that the cylinder is being adequately lubricated. When actual fuel consumption is a major consideration, however, as in team racing, it is to the modeller's advantage to experiment and reduce the oil content to the safe minimum. With a well-run-in, ball bearing diesel and employing a good castor oil, 20 per cent. is usually adequate.

Amyl-nitrate, normally available through a retail chemist, is difficult to obtain in some countries and an alternative is iso-amyl-nitrite. Nitrite is cheaper and slightly less effective than nitrate. It requires a higher compression setting (but one which is still less than when using plain fuels) and, compared with nitrate, about 50 per cent. more nitrite as an additive.

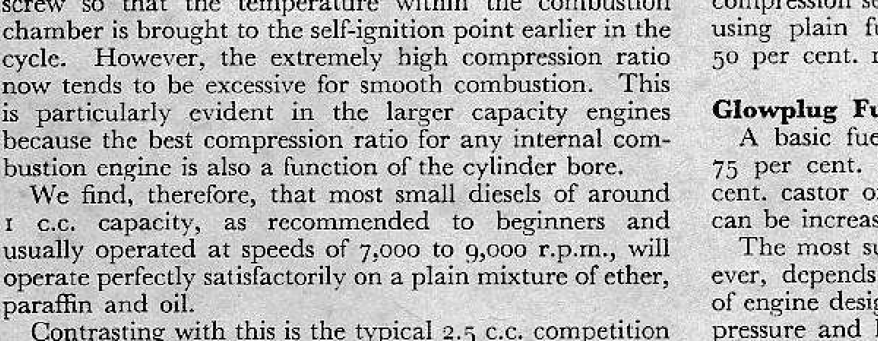
Glowplug Fuels

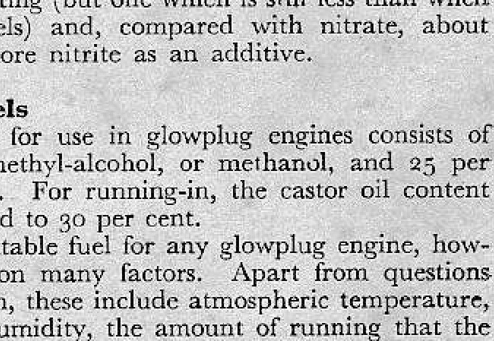
A basic fuel for use in glowplug engines consists of 75 per cent. methyl-alcohol, or methanol, and 25 per cent. castor oil. For running-in, the castor oil content can be increased to 30 per cent.

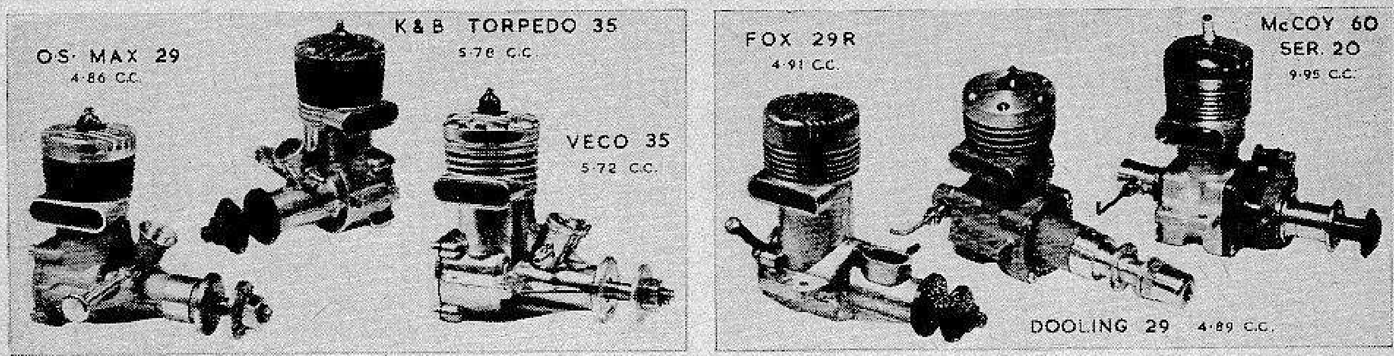
The most suitable fuel for any glowplug engine, however, depends on many factors. Apart from questions of engine design, these include atmospheric temperature, pressure and humidity, the amount of running that the engine has received, the type of model in which it is to be installed, the speed at which it is to be run and the type of glowplug used. The whole question of glowplug engine fuels is, in fact, too complex to be dealt with in detail here, but the following will serve as a guide.

Most modern American engines, for example, are designed to make use of fuels containing an oxygen liberating compound (nitromethane). Some of these engines (especially the small "Half-A" class motors)

Simple three-part ether/oil mixtures can be used in most small diesels. Three to five per cent. amyl-nitrate additive is essential for high r.p.m. with the Oliver Tiger and Frog 249-BB.







"Hot" fuels, containing 30 to 60 per cent. nitromethane, are used in racing engines where conditions permit. "Mild" glowplug fuels containing not more than 10 per cent. nitromethane are adequate for most stunt type engines.

tend to run too "cold" on a plain methanol/castor fuel and will slow down or stop when the starting battery is disconnected. In this event, the use of not less than 10 per cent. nitromethane will usually effect a cure.

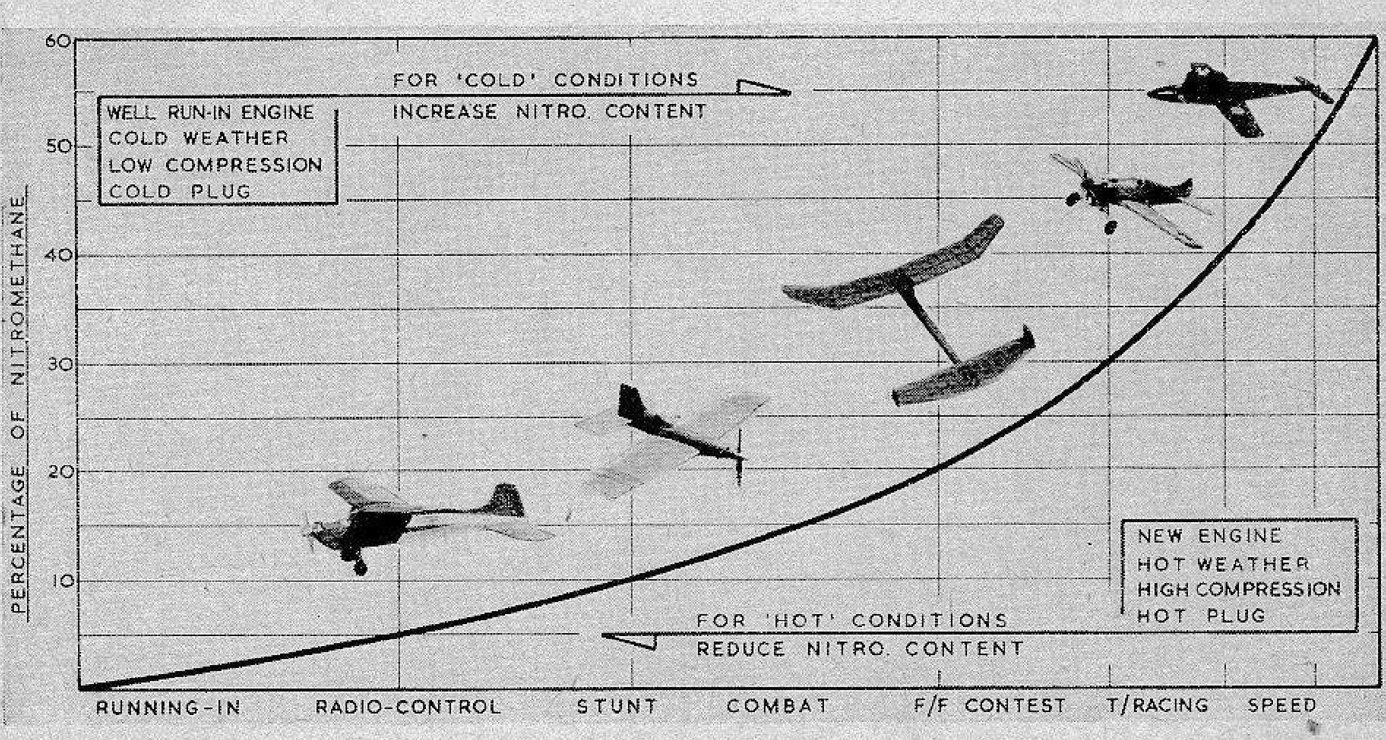
After running-in, most glowplug engines give their best all-round performance with a nitromethane content of between 10 and 30 per cent. The addition of nitromethane to a plain methanol and castor fuel gives a substantial increase in power, but, beyond a certain percentage, will cause over-heating and care should therefore be taken to increase the nitro content only as far as the point beyond which no further gain in performance is obtained.

Unless absolute maximum power is essential, however, it will generally be found that about half the optimum nitro-methane percentage will give excellent performance. This reduction may be desirable for two reasons. Firstly, nitro-methane is (except in the U.S.A.) very expensive, costing in the region of £1 per lb. Secondly, during very hot and sultry weather, it may, in any case, be necessary to reduce the nitromethane to avoid overheating.

Some engines will not tolerate high nitro fuels. Loss of power, or overheating to the point of seizure, or pre-ignition (sometimes to the extent of kicking the propeller loose) may all indicate an excessively "hot" fuel. Such tendencies are especially noticeable in certain of the larger lightweight stunt engines of the "29" and "35" class, such as the K. & B. Torpedo, Veco and O.S. models illustrated. These engines are designed to provide all the power required for a large aerobatic C/L model without recourse to expensive fuel mixtures and 5 to 10 per cent. nitromethane is adequate, although higher quantities can be used after several hours' running.

Very highly nitrated fuels, however, are the rule with racing engines used in pure speed models where it is essential to extract the utmost power from the engine. In contest work and record breaking, the blending of fuel to match a specific combination of conditions then becomes a highly complicated process. Generally, a nitro content of at least 30 per cent., and often 40 to 50 per cent., is used in engines of the Dooling and McCoy type, while, with the Fox 29R, 60 to 70 per cent. has been used. In order to prevent overheating and pre-ignition, and also to maintain a homogeneous mixture, the nitromethane is combined with 5 to 10 per cent. nitrobenzene.

In conclusion, we must point out that most of the fuel constituents we have mentioned are poisonous, as well as highly inflammable, and great care should, therefore, be exercised when handling them.



Glossary
OF MODEL AIRCRAFT TERMS

ACTUATOR. A device, electro-mechanical or pneumatic, used to move the controls of a radio-controlled model.

AEROFOIL SECTION, also **AIRFOIL** (U.S.). The outline of a cross-section through a wing.

AIR INTAKE. The aperture through which air is drawn into an engine to provide the fuel/air mixture.

AIRSCREW, also **PROPELLER** or **PROP.** Rotated by the motor, is used to provide the thrust and thus forward motion.

ASPECT RATIO. The ratio of wing-span to average chord.

AUTO RUDDER. A device, fitted to gliders, which keeps the model straight while towing, but applies turn when released.

BALSA. Extremely light weight wood used for building model aircraft.

BANANA OIL. A dope used for air-proofing and waterproofing covering material.

BEARERS. Hardwood beams used to support the engine in a power model.

BOBBIN. A small flanged (plastic) reel, used on rubber motors to prevent chafing by the hooks.

BOOM. A spar of wood or light metal tube used to support the tail unit in certain types of aircraft not having a full length fuselage.

BULKHEAD. A main structural member in the fuselage. A flat vertical plate placed laterally in the framework, supporting longerons and stringers and to which engine-bearers, undercarriage, etc., are usually attached.

CAMBER. The curved (convex) surface of a wing. **UNDER-CAMBERED** sections, in which the wing has a slightly concave under-surface, are widely favoured for free-flight models.

CAPACITY, also **DISPLACEMENT** (U.S.) or **SWEPT VOLUME.** The volume displaced by the piston(s) in an engine between the top and bottom of the stroke. Used to classify engine sizes and measured in cubic centimetres (Europe) or cubic inches (U.S.A.).

CAP-STRIP. A thin narrow strip of wood laid along the top and/or bottom edge of a rib.

CEMENT. A quick-drying cellulose base adhesive extensively used with balsa structures.

CENTRE OF GRAVITY or **C.G.** The point at which a model will balance in all directions.

CENTRE SECTION. That part of the wing which is attached to the fuselage and to which the main wing panels are joined.

CHORD. The shortest measurement between the leading and trailing edges of a flying surface.

CONTRA PISTON. In a diesel engine, it is the movable top to the cylinder-liner which can be screwed up and down to vary the degree of compression.

CONTROL-PLATE, also **BELL-CRANK.** In a control-line model, a pivoted plate to which are attached the control wires and the pushrod operating the elevators.

DETHERMALISER. A device fitted to a high-performance free-flight model, usually operated by a fuse, to bring it quickly to earth at the end of a predetermined period. This is a safeguard against the model being carried beyond recovery by a rising thermal air current.

DIESEL ENGINE. A very popular type of model aero engine which operates on the compression-ignition principle.

DIHEDRAL ANGLE. The angle at which the wings are inclined upwards from the horizontal when the aircraft is viewed head on.

DOLLY. A wheeled cradle used for launching speed models. When flying speed is reached, the model lifts out of the dolly, which remains on the ground.

DOPE. A cellulose lacquer used to tighten covering materials and to airproof them.

DRAG. The retarding force that the air exerts on a body passing through it.

DUCTED FAN PROPULSION. A propulsion system devised for scale models to stimulate turbojet performance. A small diameter multi-bladed fan or rotor is fitted, in place of the airscrew, to a high-speed model piston engine and the whole enclosed within the fuselage, which is suitably ducted.

DURATION MODEL. A high efficiency model built for contest flying and designed to stay aloft as long as possible after a limited motor run, either rubber or power.

ELEVATOR. A horizontal hinged control surface at the tail of an aircraft by which it is made to climb or dive. In models, generally found only on C/L and R/C types.

ELEVATOR HORN. The member by which the elevator is linked, in a control-line model, to the pushrod.

EMPENNAGE. The surfaces of a tail assembly termed as a whole.

EVEN CHORD. When the leading and trailing edges in wings or tailplanes are parallel.

F.A.I. Federation Aeronautique Internationale. The international body governing aviation (including model) matters.

FIN. Vertical tail surface which assists in maintaining directional stability of an aircraft.

FIREWALL (U.S.). Front bulkhead or former dividing the engine from the rest of the fuselage.

FLAP. A hinged movable surface attached to the trailing-edge of a wing and used to change its lift characteristics. Often found on aerobatic control-line models.

FLOAT, also **PONTOON** (U.S.). The component which, in a seaplane supports it on the water.

FORMER. Part of a fuselage structure that gives it its cross-sectional shape.

FREE FLIGHT. Embracing those classes of models not controlled by tethering lines or by radio.

FUSELAGE. The main body of an aircraft and which connects the main component assemblies.

GLIDER. A motorless aircraft.

GLOWPLUG ENGINE. A self-ignition motor, similar to a diesel, except that a plug is fitted in the top of the cylinder bearing a platinum wire coil. A methanol base fuel is used and an electric current to make the coil glow for starting, after which it continues to glow when the battery is disconnected.

HELICOPTER. An aircraft in which the lifting surfaces are in the form of a large diameter horizontal propeller or rotor, power driven and thus enabling the machine to rise or descend vertically.

INCIDENCE, ANGLE OF. Applied to wing and tailplane, the angle, relative to a common datum line, at which these surfaces are inclined.

INDOOR MODEL. Small, light model usually covered with micro-film for use indoors.

JAP TISSUE. A light tissue of fine grade for lightweight models.

JETEX MOTOR. A commercial jet or rocket propulsion unit using solid pellets of fuel.

LAMINAR FLOW. A smooth flow of air over a steamlined object.

LEADING EDGE. The front edge of a flying surface.

LONGERON. A main member of the fuselage frame, running from nose to tail.

MAINPLANE. Main lifting surface. Wing.

MOMENT ARM. (Tail). The measurement between the C.G. and the centre of lift of the tailplane.

NORDIC A2 SPECIFICATION. The standard glider specification for World Championship competition.

PARASOL MODEL. A high-wing aircraft in which the mainplane is mounted on struts above the fuselage.

PITCH. The theoretical distance travelled forward by an airscrew in one complete revolution, and dependent on the twist of the blades. Propellers are usually described by their diameter and pitch, thus 9×6 means 9 in. diameter and 6 in. pitch.

POLYHEDRAL. A type of dihedral in which an extra angle is given to the outer panels of the wing.

PULL TEST. A test of the safety of a control-line model, imposed by exerting a measured strain on the control-lines and bellcrank installation.

PYLON MODEL. In which the wing, usually on a power duration model, is raised above the fuselage on a mount or pylon.

RIB. Structural member of a flying surface, usually running fore and aft and cut to the aerofoil section shape from sheet balsa wood.

R.O.G. Rise-off-ground, as opposed to hand launch.

RUDDER. Hinged vertical tail surface used for directional trimming.

SAILPLANE, also **SOARER** (U.S.). A glider, usually of high performance type.

SCALE MODEL. A model constructed with a full-size machine as a basis of its aerodynamic design.

SPAN, wing. The distance from wing-tip to wing-tip.

SPAR. Spanwise members of a flying surface.

SPEED MODEL. A control-line model designed purely for speed trials and record breaking.

SPINNER. A streamlined cap or fairing covering the boss of a propeller.

STALL. If an aircraft loses speed, the airflow over the wing will eventually break down and lift will be lost. It is then said to be stalled.

STRINGERS. Light longitudinal fuselage members laid over the formers to maintain correct contours.

STUNT MODEL. A control-line model designed purely for aerobatic flying.

TAILPLANE, also **STABILIZER** (U.S.). Fixed horizontal tail which assists in maintaining longitudinal stability in flight.

TAIL UNIT. Complete tail assembly comprising fin, rudder, tailplane and elevators.

TEAM RACE. A contest for a specialised type of high speed control-line model in which two, three or four models are raced against each other over distances of five or ten miles or kilometres.

TEMPLATE. A pattern, usually of metal or plywood, used in scribing or cutting the outlines of ribs, formers, etc.

THERMAL CURRENT. A rising current of warm air.

THINNERS. A solvent used for diluting dope, lacquer, etc., to assist application.

THRUST. The force by which any type or powered aircraft is propelled.

TORQUE. The turning force exerted by the motor and which tends to revolve an aircraft around its longitudinal axis.

TRAILING EDGE. The extreme rear edge of a flying surface.

UNDERCAMBER. The lower surface of an aerofoil which describes a concave arc.

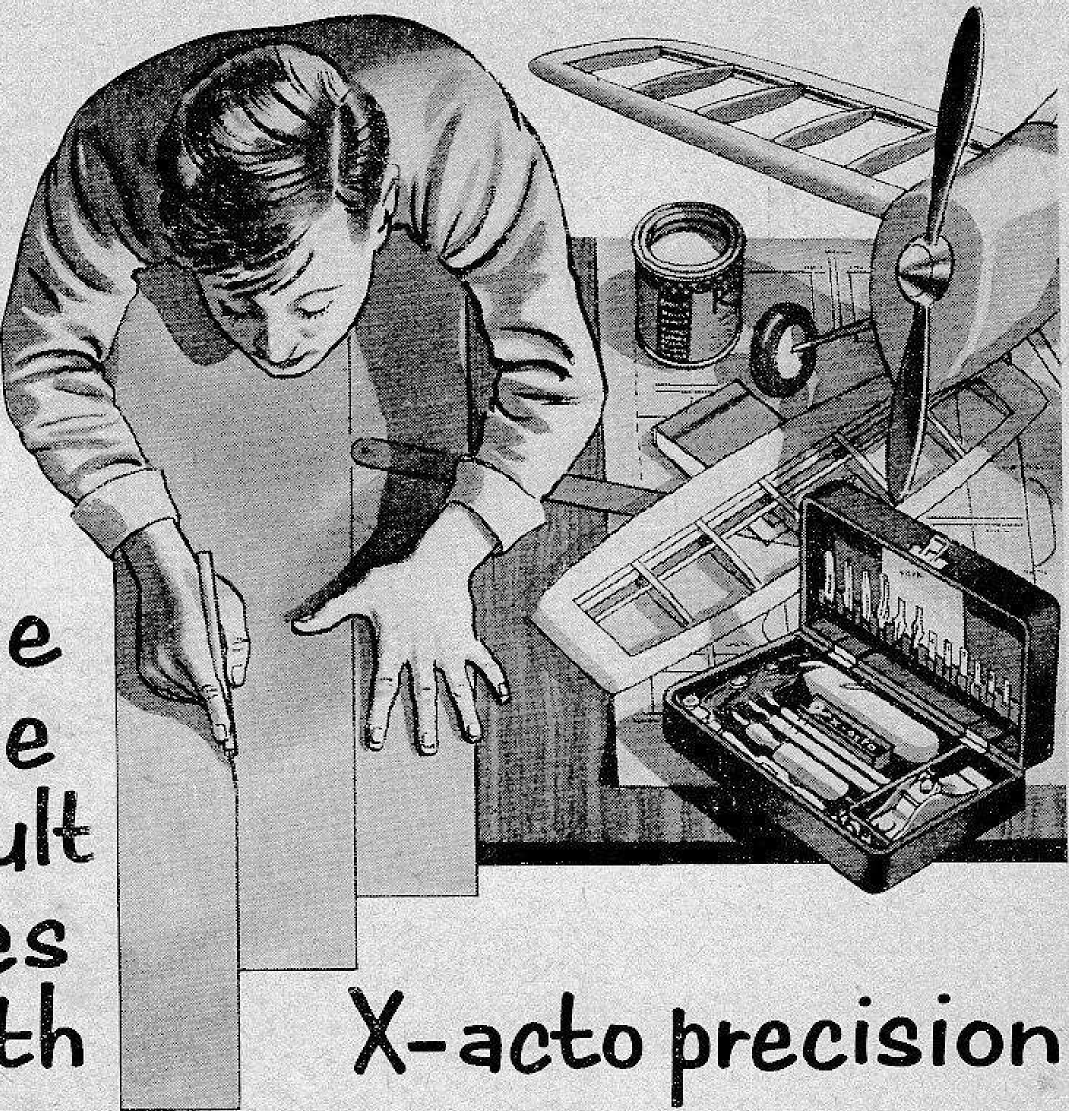
UNDERCARRIAGE, also **LANDING GEAR** (U.S.). The wheel assembly which supports an aircraft on the ground.

WAKEFIELD. A high performance rubber powered duration model, constructed to certain specifications laid down for the Wakefield Trophy competition.

WASH-IN. A longitudinal twist to a flying surface giving an increase in incidence at the tip.

WASH-OUT. A longitudinal twist to a flying surface giving a decrease in incidence at the tip.

YAW. A movement in which the aircraft turns from the normal line of flight, to left or right.



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