

WORKING MODELS

V. E. Smeed



Building models is something nearly every man or boy has tried at one time or another. In these days of prefabricated kits the opportunities are even greater. This book is for those, however, who prefer to select their own materials. It provides a variety of models, all built from standard, easily-obtainable materials, simple to build, but of good appearance and—most important—of good performance.

Among the models included, there is a Sailplane, a Sport Power Model, a Control-Line Model, a Model Yacht, a Sailing Catamaran, a Free-Running Go-Kart, an Electric Cabin Cruiser and Catamaran, and a Hovercraft, with fully illustrated instructions in each case.

Illustrated

V. E. SMEED

Working Models



LONDON
ARCO PUBLICATIONS
1964

FIRST PUBLISHED BY ARCO PUBLICATIONS 1964

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PRINTED IN GREAT BRITAIN BY

COX AND WYMAN LTD.

LONDON, READING AND FAKENHAM

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Introduction

INVENTION, it is said, is the realization that a question exists. Education is, perhaps, an awakening to those questions which have occurred to inventive or constructive minds in the past, and anything which encourages a mind to wonder is a step towards a better understanding of the reasons for learning and a greater desire to investigate the natural laws governing the world in which we live. In this respect, working models are in something of a unique position; they are attractive in themselves and few people who build them can remain incurious as to their whys and wherefores. Scratch a modeller and nine times out of ten you discover a mind a little brighter and more alert than the average.

All the models in this book are essentially simple and all will 'work' well. They cover a broad field, so that a potential builder of any age should find something close to his personal interests. I hope that some of those readers who build them will want to know more about the principles involved in their design, and thus find opened to them a door to a hobby which can bring them a lifetime of fun and interest.

The Scope of Modelling

BUILDING a model is something which nearly every man or boy tries at some time or other; the success or failure of the first attempt often determines whether he becomes a modeller or turns to some other pursuit. In these days of prefabricated and plastic kits, success is more easily achieved, which is one reason why more and more people are becoming confirmed addicts to modelling. There are always those individuals however, who dislike the idea of building from a kit where much of the work is already done, or who prefer to select their own materials, or who feel that it is cheaper to work from plans and raw materials. This book sets out to provide a variety of models, all built from standard, easily available materials, simple to build but of good appearance and, most important, of good performance. What full-size drawings must be made are on the wood itself or of a very rudimentary nature, requiring a minimum of time and the simple reading of a ruler to produce. Before thinking of these models in particular, however, let us look at modelling in general to see what other people are doing.

Firstly, why do people make models? There are a thousand reasons, but obviously one of the main ones is the fascination that a miniature replica of a full size machine possesses. Models have been made for at least three thousand years – they are, for example, found in ancient Egyptian tombs – though modelling in those days must have been simpler in choice of prototype, at least – it was a choice between a boat of some sort or one of the early forms of land transport such as an ox-cart! From early contemporary models we can get a far better idea of what the prototypes

were actually like; drawing in those days was fairly primitive and an artist could distort a subject considerably, but not so a modeller. It is probable that many models were made by the craftsmen who built the full-size subject, and their models, made without drawings, are nevertheless likely to be far more true to life.

We thus have a second, very important reason for making models – to preserve for posterity a three-dimensional accurate picture of something too big to keep or even something already destroyed; we have the skilled enthusiasts today who are making a tangible record of, say, warships over the last two or three centuries, before what scanty details are available fade into oblivion. Did you know that no accurate records exist of Columbus's flagship *Santa Maria*? Yet by painstaking research and the experience of modellers, several museums now possess what must be remarkably accurate models of this historic ship.

If models can show what something *was* like they can equally well show what something *will* be like; models are playing an increasing part in industry, not only in wind tunnels and test tanks, but also as 'pictures' – for example the shapes and colours of new cars, several of which may be compared before a final choice is made. Oil refineries use models to plan piping runs, thus avoiding a tangle of pipes which, full size, would take twice as long and cost twice as much, as well as being a perpetual headache to maintenance staffs.

These reasons, you may say, apply to *scale* models which are accurate representations of full-size products. What of models which are not 'pictures' but are working, functional machines in their own right? These have their own particular fascination, from the extreme of the beginner who gets so great a thrill out of seeing something made with his own hands actually working, to the serious expert who may be seeking by continual refinement that extra 1 m.p.h. or who may have set his heart on winning a particular competition; there is a special attraction in striving for the ultimate in any sphere.

Functional models are used increasingly professionally – hulls for tow-testing in tanks are an example; these are not scale models of existing prototypes but experimental models which decide the shapes, etc., of many ships yet unbuilt. Similarly, experimental aircraft models in wind tunnels guide full-size designers in future projects. Amateur-built models intended for performance only are used in competition and frequently contribute to full-size progress; two striking examples are the use of varnished Terylene for sails and the automatic vane steering gear, both used extensively for model racing yachts for years before the full-size skippers ‘discovered’ them.

Models are educational, and not only in the fairly obvious way of demonstrating physical principles in practice. A schoolboy who makes models will suddenly find a reason for even simple mathematics, and will improve in those subjects unconsciously, whether it be from working out lap times with racing cars or control-line aircraft, greater familiarity with fractions arising from handling and measuring small sizes of materials, calculation of speeds and areas, the triangle of forces with yachts, etc – all this if he *builds* models. If he tries to design his own his maths. master won’t recognize his work, it will improve so rapidly!

Modelling teaches deftness, the use of tools, planning ahead, how to read a drawing, physical characteristics and methods of work of various materials – a dozen useful things which broadens one’s outlook and interests, but, above all, it teaches patience and method. No wonder schools of all types are at last taking model-making as a serious subject to be included regularly in their curricula!

The main streams of modelling today are aircraft, boats, and cars. One of the biggest hobbies, model railways, is not normally considered under the heading of model *making*, since this is essentially a scale hobby and very few people possess the facilities or skill to make most of the track, rolling stock, etc., from raw materials. There are also the unusual subjects chosen for models – excavators, buildings, and so on – but most modelling comes under the ‘ABC’

headings above. Let us, then, run briefly through the branches of each of those main subjects.

AIRCRAFT

Apart from the solid, plastic, and non-flying scale models, there are six main divisions.

1. *Gliders and Sailplanes.* These may range from small 'chuck' or hand-launched gliders of solid balsa, plastic, or even paper or card, up to giants of twelve feet or more in span. The customary method of launching is to use a light towline (50 metres or 164 ft.) terminating in a wire ring engaging on a hook beneath the body. The launcher walks or runs into wind and the model 'kites' up till overhead, when the pull is eased and the ring and line fall away. The most popular size sailplane is to the A2 international specification, almost universally used in competition, which has a total wing plus tail area of not more than 526 sq. in. and a minimum weight of $14\frac{1}{2}$ oz. A typical model is about 66 in. wingspan, very slender and graceful, and capable of soaring away on the slightest upcurrent of air. Models of under 30 in. span are usually difficult to tow up and considerably less efficient.

2. *Rubber Models.* The rubber motor is still the cheapest form of power, but successful high performance requires more skill than with any other type of aircraft. For sport flying, however, it has much to commend it, though the advent of inexpensive engines and development of the sailplane have tended to overshadow 'the rubber job'. The international Wakefield Trophy is still the cup with the greatest prestige of all; models average 45-48 in. span, must weigh at least 8 oz., but are limited to 50 g. (under 2 oz.) of rubber. Even with this relatively small motor, top competition models can achieve three-minute flights consistently.

3. *Power Models.* Tremendous development has taken place in the last fifteen years in model engines, and model design has kept pace with the power available. A fast-climbing competition model can climb vertically and dis-

appear overhead in a clear sky in under twenty seconds! The present-day duration competition limits the motor run to twelve seconds, and the maximum flight time (this applies to sailplanes and rubber models too) to four minutes. A 'dethermalizer' is therefore fitted – a device to spoil the glide of the model and bring it down quickly but safely.

The non-competition model (or sport model) is considerably easier to fly and has a much more docile performance. In appearance it is usually semi-scale or at least has some resemblance to a full-size light aircraft. There is considerable variation in shape and size of sport models – from 18 in. span to 12 ft. – whereas the competition machine rarely uses anything but the maximum permitted engine size ($2\frac{1}{2}$ c.c.) and minimum weight ($27\frac{1}{2}$ oz.) which produces an average size of about 5 ft. span. Models built for sport flying are seldom used for competition work, except occasionally in a *concours d'élégance*, where the model must prove its flight capability but is judged mainly on workmanship.

Control-Line Models.

Although free flying models have been widely built for nearly sixty years, tethered flying is a comparatively recent development in that it has only been widespread in England in the last dozen years or so. Small engines for aircraft did not appear commercially before the mid 1930s, and though control-line models appeared in America during the war, few engines were available in Britain, so that hardly anything was known of this new branch of aeromodelling in the country until 1946, and it was not till late 1947 and 1948 that it really became established. The basic system of control, used in all but a few models, is the bell-crank device as used in the model described in a later chapter. Two wires connect the bellcrank to the handle held by the flier, and movement of the handle moves the crank. The movement is turned through ninety degrees by the crank, moving a push-rod which operates the elevator via a horn. Up and down control is thus achieved (this includes loops, etc.) and the

model flies in a circle, the radius of which is the length of the control lines. Large models can fly on up to 120-ft. lines, small ones as little as 15 ft.

Types of control-line model are subdivided into (a) stunt, (b) speed, (c) team racers, (d) scale and (e) sport. Stunt models usually have huge wings and small fuselages, and are fitted with flaps as well as elevators; a top model will fly figure eights – horizontal, vertical, overhead – intricate cloverleaf patterns, square loops and bunts, etc., all at 80 m.p.h. Speed models, tiny streamlined bullets dominated by massive motors, can do twice this speed. Team racers, flying three or four in the small circle, fit very tight specifications; there are two British classes, for $2\frac{1}{2}$ - and 5-c.c. engines, and one international class ($2\frac{1}{2}$ c.c.). Speeds of 115 m.p.h. are normal for the larger class, and very little less for $2\frac{1}{2}$ -c.c. models. Scale models we will mention later, and sport models are self-explanatory; they are usually stronger and of lower performance than the other classes.

Scale Models

These offer a challenge, especially in free flight, since a full-size aeroplane cannot be too inherently stable, whereas a model must be stable in order that it shall be capable of righting itself in the air. The exception to this is the control-line scale model which has a stabilizing influence in the lines and virtually any type of aircraft can be flown control-line. This includes twin and multi-engined aeroplanes which are extremely tricky in free flight. Scale control-liners can, in fact, represent some of the higher standards of modelling since the models remain largely under the control of the builder, and are not so likely to be damaged and thus write off months of work. The type of aeroplane chosen for a free flight scale model is therefore one which must lend itself to the inclusion of inherent stability without too much distortion of the basic design. This is why a great number of scale models are of high-wing monoplane light aircraft which are the nearest thing in full size to model layout. A skilled designer and builder could make almost any full-

size prototype into a successful model by incorporating such things as pendulum operated control surfaces, but such models are not for beginners. Competitions for scale models are confined to workmanship and fidelity to scale, but usually the model must prove itself capable of flight.

Radio-control Models.

These types of model are growing ever more popular and quite obviously are one of the biggest fields for future development. Radio-control models using entirely conventional equipment have been built down to as little as $4\frac{1}{2}$ oz. all-up flying weight including engine, radio receiver and actuator, batteries *and* the aeroplane, but it takes an expert to produce such a model. The average model is about 4-5 ft. in span, and weighs 3-5 lb., of which anything up to $1\frac{1}{2}$ lb. is radio-control equipment. The lightest 'simple' equipment means a radio weight of 5-6 oz. which can be comfortably carried by a 36-in. model using a 1-c.c. engine. It is advisable to build a fairly large model for a first attempt at radio control and to use equipment which controls the rudder only. This means that the model can be flown around the flying field and brought back at will, but it does not stop there; a model of correct design will make a complete circle in a tight turn without losing height, but after one circle it tends to put its nose down and come down in a spiral dive, building up speed. By centralizing the rudder the model will come out of its spiral, and with the excess speed zoom up into a loop. If rudder is applied again when the model is on its back at the top of a loop it will roll out into level flight. There are other stunts which can be performed using simply rudder control, once sufficient skill has been acquired.

The next step after rudder only is rudder and engine control, which means that the model can be made to lose height and the engine opened up again, making possible such things as touch-and-go landings. The ultimate in present-day radio control models is to have full rudder, elevator, aileron and engine control, plus brakes, and models so equipped can, with sufficient practice, be made to

do anything that a full-size aeroplane can do. The cost of such a model is likely to be not less than £90, and there are many models which have cost more than twice this flying!

There is some activity in scale radio-control models and this is a field in which growing interest may be expected.

Model Cars.

Ten years ago there was quite a lot of interest in high-speed model cars which were run tethered by a cable to a centre point. A car made to run in this way usually was a functional design intended only for high speed, and speeds of up to more than 140 m.p.h. have been achieved with engines of up to 10 c.c. The second class with engines of up to 5 c.c. has a top speed of 105 m.p.h., and the third class up to $2\frac{1}{2}$ c.c. has reached 90 m.p.h. The smallest class using $1\frac{1}{2}$ -c.c. engines is capable of 70 m.p.h. or so. This sport has, however, now largely died out, although there are still groups of enthusiasts in various countries.

Another form of model cars which now command only small attention is diesel rail cars. With these the cars are powered with up to $1\frac{1}{2}$ -c.c. engines and are secured to a rail. A typical track would have four rails running in a large figure eight, perhaps 90 ft. long, and the cars all fitted with clutches would line up for a start and at the drop of a flag roar away together. Speeds of 50 and 60 m.p.h. are not unknown.

The big model car hobby now, however, is electric car racing and this is one of the fastest growing hobbies at the present time. The normal scale is $\frac{1}{32}$ which produces cars about 5 in. in length, and these are run on a track (up to six cars at a time), which may consist either of small rails which guide the cars or slots sunk into the surface, the latter being by far the more popular. The current is fed to the cars via contact surfaces on the slot sides, and the speed of the car is controlled by the 'driver', who controls the amount of current fed to the car. Driving too fast into a corner can cause the car to leave the track just as in full-size practice, and the most successful way of taking a corner fast is to

'drift' round exactly as in full-size racing. Details of a typical simple car and track construction are given in a later chapter.

Sailing Craft.

Everyone has seen beautiful models of galleons and other non-working craft, but since we are primarily concerned with working models these must wait for another occasion. There are quite a number of people who are interested in actual sailing models of period ships, but these are normally fairly advanced due to the massive amount of detail.

The majority of sailing craft regularly in use in this country are racing model yachts which are primarily designed for racing, and as such do not employ such features as scale cockpits, etc. There are four main classes now regularly sailed in England, the A, the 10-Rater, the Marblehead, and the 36R class. The A Class is the largest, the models being some 7 ft. long by 9 ft. high, and weighing 50-70 lb., 10 raters are usually 6 ft. or so long and weigh about 30 lb. The most popular class is the Marblehead which is 50 in. long and carries 800 sq. in. of sail; the average weight is around 20-22 lb. The smallest are the 36R which are 36 in. in length and weigh 12 lb. There is little difference in the cost and effort in building a Marblehead over a 36, and this to a large extent has led to a falling off in interest in the small class. Two other classes are officially recognized, but so few boats are now built to the rules that we need not go into their characteristics. The boats are raced in pairs and each boat races every other model in the race, so that the total points scored at the end of the regatta determine the winner. Most of the models used what would look to the uninitiated complicated steering gears which, believe it or not, are better than a human helmsman in the accuracy in which they steer the models!

Power Model Boats.

There are a number of different types of model power boat, and just as in aircraft they are divided into those

operated tethered, and those running free or under radio control. Tethered models have four main classes, (a) up to 30 c.c., (b) up to 15 c.c., (c) up to 10 c.c., (d) up to 5 c.c. Top speeds of 95 miles per hour have been reached with these models, though speeds in the seventies are frequently the top speeds at normal regattas. Competitions for free running boats are usually for steering ability, the boat being released to run towards a line of buoys and scoring depending on what buoys it passes between, or nomination events in which the owner states the time his boat will take to cover a given course. Almost any type of model boat can compete in such events from beautiful scale models of warships and ocean liners to simple box-like boats built only for straight running and with no pretence at scale appearance. Radio-control models can again cover a very wide assortment, but the main tendency here is for scale and semi-scale models of fairly small fast cabin-cruisers, etc. The average size of the competition radio boat is about 40 in. in length, powered by an up to 10-c.c. motor, and travelling at speeds of up to 15 m.p.h. There is also the division of this type of model into categories according to the type of power – petrol engine, glow-plug engine, diesel, electric motor or steam. For the average beginner a smaller electric-powered model is the best introduction.

Organizing Bodies.

Most of the main branches of modelling have national bodies which cover all the clubs throughout the country. The names and addresses of these associations or association's secretaries at the time of going to press are given below.

Aircraft of all types:

Society of Model Aeronautical Engineers, Ltd., 10a Electric Avenue, Brixton, London, S.W.9.

Model Cars (for tethered cars):

The Model Car Association, Mr. K. Procter, 1 Meadowside, Thornholme Road, Sunderland, Co. Durham.

Diesel Rail Cars:

Model Rail Car Association, Mr. H. Ogilvie, 15 Claremont Avenue, West Way, Bournemouth, Hants.

Electric cars:

The Electric Car Racing Association, 433 Brockley Road, London, S.E.4.

All Racing Model Yachts:

The Model Yachting Association, Mr. H. E. Andrews, 1159a Christchurch Road, Boscombe East, Bournemouth, Hants.

All Model Power Boats:

The Model Power Boat Association, Mr. J. King, 309 Days Lane, Sidcup, Kent.

It should be noted that the officials of most of these organizations work on a voluntary basis and answer association correspondence, etc., in their spare time, so that communications should only be sent to them when every other method of contacting local organizations has been tried.

CHAPTER TWO

Tools and Materials

THE chief material used in the construction of models in this book is balsa. This wood will no doubt be familiar to many readers as the lightest of all known woods; it comes from various tropical parts of the world, but the best quality comes from Ecuador. Here it is used primarily for the manufacture of rafts to bring bananas down to the mouths of the rivers and the logs are purchased by sawmills sited on the coast. Attempts to cultivate the wood have been almost completely unsuccessful so that our supply of balsa relies almost entirely on the demand for bananas!

The tree providing the timber, *Ochroma Lagopus*, is very fast growing and can attain a height of 60 ft. in five years. Its rate of growth depends on its position with regard to moisture, i.e. a tree growing on a slope will grow slower, and the wood will be harder, than a tree growing in a low lying swampy area.

The logs are sawn and shipped to this country where they are thoroughly kiln dried before sawing into the smaller sizes sold by model shops. The mechanics of sawing produce various types of sheets from the logs, depending on the grain formation in the sheet. The sketch shows how tangential and radial cuts can result in sheets which have either very wide grain and bend or roll easily, or sheets which are very stiff and resistant since they are, in fact, a section through the growth rings of the tree. Best balsa for most uses is quarter grain as shown in the sketch, and this can be distinguished by light golden flecks covering the surfaces.

The colour of the wood in itself is no guide to quality since the tree absorbs mineral stains very easily; the best check on grade of hardness is to press the corner between the

finger and thumbnail; if only a faint mark is left the wood can be considered hard, but if the thumbnail leaves a deep impression with some broken fibres it is obviously soft.

One of the beauties of balsa is that it is so easy to work and it can be cut quite easily with a stiff-backed razor blade or a modelling knife. If you use double-edged razor blades it is advisable to protect fingers by sticking a strip of surgical plaster over one blade edge. Material up to $\frac{1}{16}$ in. thick can usually be cut through in one cut, but if it is very hard it is



better to make two cuts with light pressure than one cut with considerable force. Light cuts mean more accurate cutting and less likelihood of a slip spoiling the work. Similarly, thicker sheets of material should be cut with several light cuts. If a saw is used it should be very fine toothed and the teeth should have the minimum of set or a ragged cut will result. For cutting round sharp curves or small areas generally, a razor blade can be broken to give a sharper pointed blade, or a modelling knife with a sharp taper blade can be used.

It is essential to use glass paper for building a model and only a very fine grade of paper is necessary. Because the balsa fibres choke ordinary glass paper to some extent it is better to use garnet paper if this can be obtained easily. The paper should be pinned to a square block of wood to ensure a smooth sanding surface, and after sanding to near the exact size the surface should be finished with flour paper.

There are many makes of balsa cement available through model shops; these are specially developed for work on balsa and similar fairly porous materials and any of them can be used for modelling. Do not use a vegetable or fish

glue. The strongest joint is obtained by applying cement to the surfaces to be joined and making the joint, then sliding it apart again and allowing the cement to dry. This allows the cement to soak into the wood and gives a very strong key for a second coat of cement to make the final joint. A joint made in this way is eight times stronger and it is well worth a little extra time and trouble to achieve this strength.

The disadvantage of the open structure of balsa is that it is difficult to get a good paint or similar surface on it without adding a tremendous lot of weight. It is usual therefore to cover the surface of the balsa with a layer of light model aircraft tissue, the model then requiring far less colour dope or paint to produce a good finish. The tissue can be laid over the balsa and clear cellulose dope brushed over it; this will soak through the tissue and stick firmly to the wood. When the dope is dry a light rub over with flour paper will remove any fuzz, and three or four coats of cellulose sanding sealer can be applied, rubbing down between each with flour paper. Two coats of colour dope or light oil paint will then produce an excellent finish. If it is desired to produce a natural wood colour, the surface should be treated with several coats of banana oil, rubbing down between each.

The other materials required for models in this book are small amounts of ply (good quality plywood can usually be bought in small quantities from model shops), piano wire, beech engine bearers and dowel, all of which can be obtained from a model or handicrafts shop. Other small items will normally be found around the house.

In addition to a razor blade or modelling knife, it is useful to have one or two small drills, a pair of pliers, a small screwdriver, a few wooden spring clothes pegs (used for clamping) and a packet of steel dressmakers' pins. These pins are hardened and will break rather than bend; they are used for holding various parts together while cement dries, and do not remain in place in the finished models.

If you are using a fairly hard surface to work on, a small hammer to tap pins in is useful, and a steel rule (the back of a

hacksaw blade can be used) will also simplify construction. Some of the models require a building board, but they mostly can be built on an ordinary pastry board, or a piece of flat timber about 3 ft. long and 6 in. wide will be an asset in some cases. Check that it is flat since any warps, etc., will be reproduced in models built on it.

Any special materials or requirements such as small soldered parts are dealt with in the building instructions accompanying each design.

Using the plans in this book.

Where possible all models in this book are designed to use straight lines with only such curved parts as can be drawn full size. To trace a full size part on to the wood, lay a piece of transparent tracing paper or kitchen greaseproof over the plan and draw the required line with a soft, but fairly sharp, pencil. Do not forget to mark the centre line where it is a curve symmetrical about such a line, as in the bow of a boat. Now by turning the paper over and placing it on the sheet of wood, a pencil can be run over the back of the line and the line will be transferred to the wood. It may be necessary to run over the line with a pencil to make it bolder. An alternative method is to lay the tracing on to the wood and run round the pencil line with a pin, making a series of pinpricks which can be joined up with the pencil after removal of the paper. It is also possible to use carbon paper to transfer the tracing on to the wood, but this does not normally allow the wood to be seen, and it is therefore sometimes difficult to get a piece exactly lined up with the centre line. On no account should a tracing be cut out and pasted to the wood as this leads to stretching of the paper and will produce an incorrectly shaped piece.

Where larger curves are unavoidable so that they must be shown at reduced scale, a grid system is used and it is only necessary to enlarge the grid to the required size, e.g. if $\frac{1}{4}$ -in. squares are shown and the scale is one quarter full size it is necessary to draw a grid of 1-in. squares, mark off at the point of intersection of the curve with the grid, and

draw the resulting line in. When cutting two identical parts, e.g. the two sides of a deck, it is possible to cut the first side, then lay this in place on the wood and use it as a template for cutting the second side, thus ensuring symmetry.

CHAPTER THREE

A 40-in. Sailplane

THIS glider is a simple model which can be built fairly quickly and requires only a little drawing to lay out. It has the advantage that the same wing and tail can be used on the power model in the next chapter, so that you need only make one wing and tail to fly two different models.

You will need a large sheet of paper (old smooth wall-paper is suitable, or even a large sheet of brown paper). On this draw a straight line 32 in. in length, and 7 in. from one end mark a point 2 in. above the line. Four-and-a-half in. from the other end mark a point $\frac{1}{2}$ in. high and connect these two points with a straight line. The tail $4\frac{1}{2}$ in. remains parallel to the base line, but it is nice to have a graceful curve in the nose, so $1\frac{1}{2}$ in. from the end mark a point $1\frac{1}{4}$ in. high and sketch a fairly easy curve to connect up the points. You will find that when the wood is pinned in place it will assume a natural curve without difficulty.

Mark verticals along the profile at the distance shown, then pin down $\frac{1}{8}$ -in. \times $\frac{1}{2}$ -in. strip balsa vertically to make a frame as in the drawing. When the cement is thoroughly dry remove the pins and cement the top side of the framework thoroughly and lay in place a sheet of $\frac{1}{16}$ -in. balsa. When dry remove the frame from the drawing by sliding a razor blade beneath, then turn it over, sand off the unsheeted side, and trim the sheeted side to shape. Cover the second side and again trim.

The fuselage is completed by adding the wing platform as sketched, and the two tailplane rests also sketched. Drill holes for the $\frac{1}{8}$ -in. dowels and cement the dowels in place with a small celluloid reinforcement patch to prevent the dowels from tearing the wood in a heavy landing.

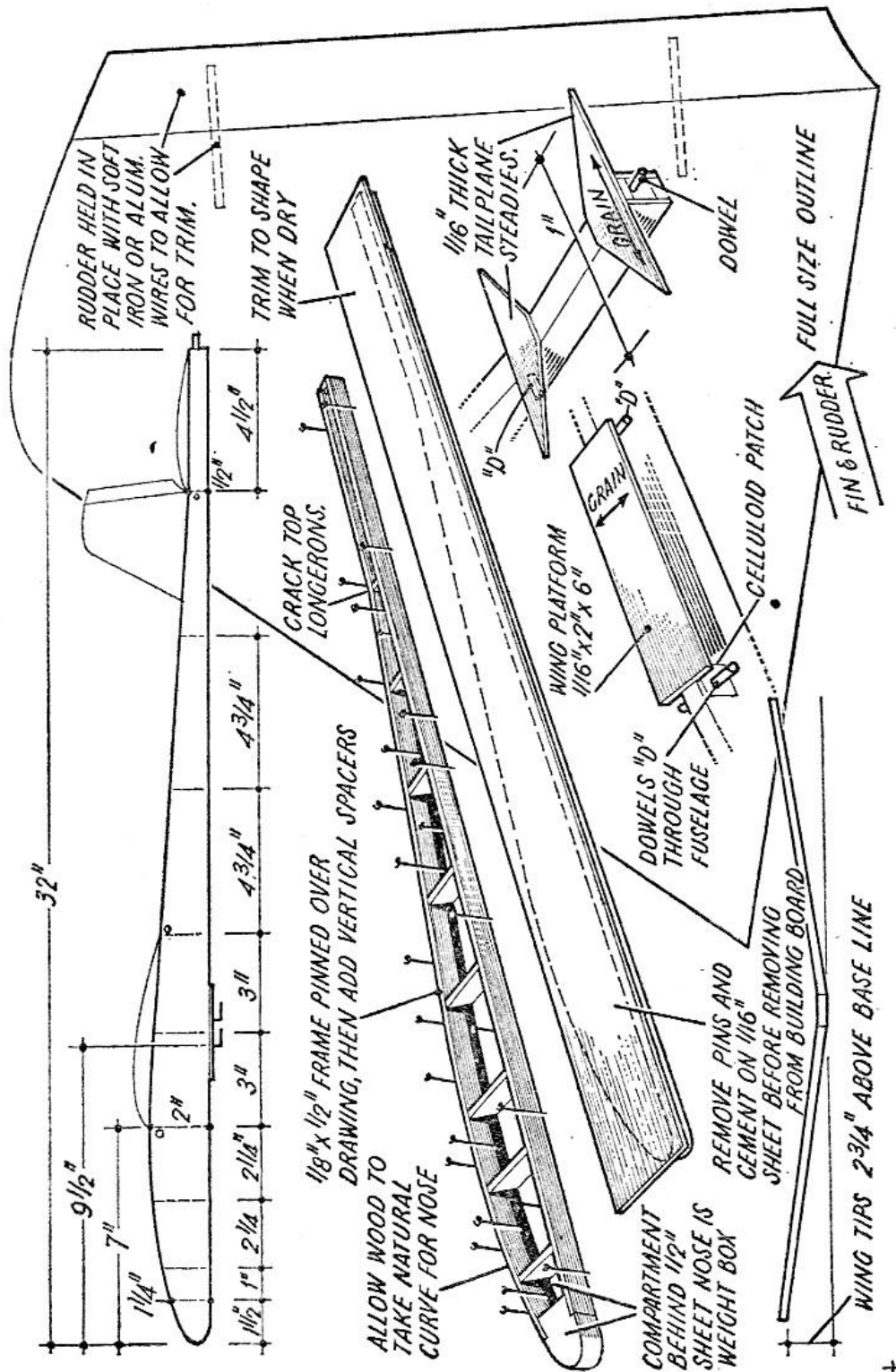
Leave about $\frac{3}{8}$ in. of dowel protruding to hook on rubber bands.

The fin is cut from $\frac{1}{8}$ -in. sheet balsa and a rudder cut separately to join to the fin by piercing small holes and inserting soft iron or aluminium wires. These enable the rudder to be bent to give a turn. Cement the fin to the tail of the fuselage ahead of the tailplane mounting as shown. Make sure that it is upright and in line with the fuselage. Bend the towhooks to shape and bind them carefully to a 3-in. length of hard $\frac{1}{4}$ -in. square balsa which is then glued in place on the fuselage with the front hook $9\frac{1}{2}$ in. from the extreme nose. Sand the whole fuselage thoroughly and tissue cover (see Chapter Six) and finish with dope to taste. Make a small hole in the first bay immediately behind the noseblock, into which weight in the form of lead shot or small pieces of lead can be dropped.

The wing is a simple rectangle 40 in. \times 6 in. Mark the centre and draw a line one inch each side of this. Outside each of these lines draw a further line at $1\frac{3}{4}$ in., then a series of lines at $2\frac{1}{8}$ in. outwards towards the wingtips. Trace the full-size wing rib on to $\frac{1}{16}$ -in. ply and cut out, then use this template to cut the twenty ribs required.

Draw a line immediately below the wing and mark the 2-in. centre section on this line. At a point 18 in. out each side mark a point $2\frac{3}{4}$ in. above the base line, and connect to the centre section. Pin the main spar of $\frac{1}{8}$ -in. \times $\frac{3}{8}$ -in. balsa to the shape shown, so that you have a short flat 2-in. piece and an 18-in. piece each side, rising $2\frac{3}{4}$ in. Cement a piece of $\frac{1}{8}$ -in. \times $\frac{3}{8}$ -in. very hard balsa over the centre section, extending out to each side, and allow to dry. Unpin from the drawing, turn over and trim the surplus balsa away.

Now pin on to the full wing plan a piece of hard $\frac{1}{4}$ -in. \times $\frac{3}{8}$ -in. to align with the leading edge, and a piece of stock $\frac{3}{16}$ -in. \times $\frac{3}{4}$ -in. trailing edge opposite. Mark the rib positions on each of these pieces, then lift the trailing edge, and with a $\frac{1}{16}$ -in. wide file, file a notch $\frac{1}{16}$ in. deep at each rib position. Repin and check that the ribs exactly fit, moving the trailing edge as necessary.



Pin down the rear spar ($\frac{1}{8}$ in. \times $\frac{1}{4}$ in.) using a rib to position accurately, then cement in all ribs for one half of the wing. Cement all the top notches and drop in the main spar, propping the raised end with books or a wood block while the cement dries.

Repeat this procedure for the other half of the wing, being careful when it comes to fitting the main spar in place, since the whole of the opposite half of the wing must be supported. Since 19-in. panels are called for and the standard length of balsa is 36 in., the short pieces connecting the centre section can be cut from the wood left over from either panel. Set the centre section square on the drawing, pinning the wings down at the root and supporting the tips with books. Cement the 2-in. lengths to the leading and trailing edges and the rear spar and allow to dry thoroughly. Sheet the centre section with $\frac{1}{16}$ -in. sheet at this stage.

Unpin the wing and add the gussets at centre and tips. These are cut from $\frac{1}{16}$ -in. balsa and are easily made by cutting $\frac{1}{2}$ -in. squares which are then sliced across the diagonal. Go over the wing carefully, recementing the joints, then sand off to a smooth finish, including rounding the tips very slightly.

The tailplane is made in exactly the same way, except that it has no dihedral angle and therefore can be built flat in one portion. This surface uses a $\frac{1}{4}$ -in. \times $\frac{3}{8}$ -in. leading edge, but only one spar is fitted ($\frac{1}{8}$ in. \times $\frac{1}{4}$ in.) and the trailing edge is stock ($\frac{1}{8}$ -in. \times $\frac{1}{2}$ -in. TE).

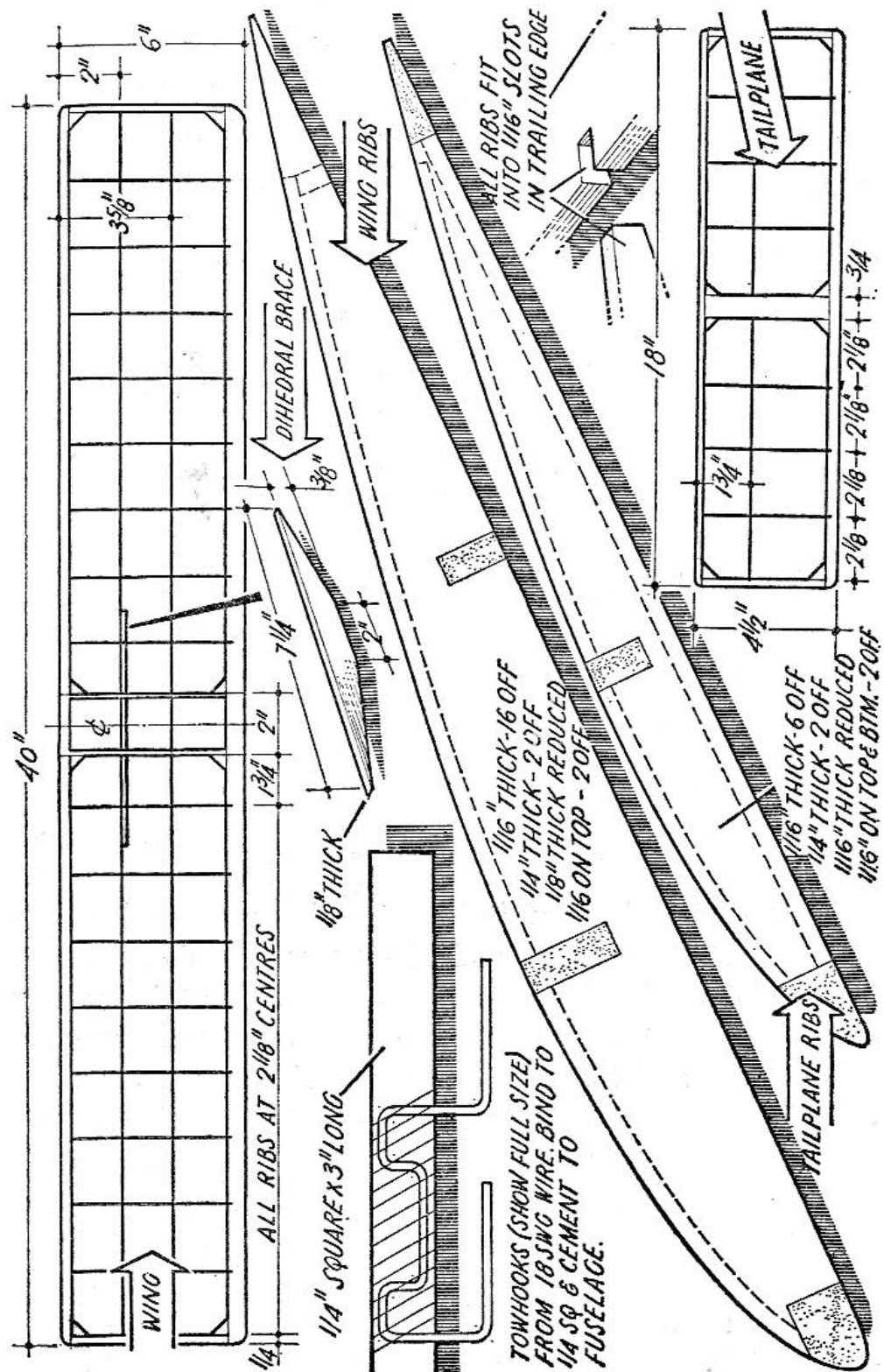
The wing and tail are covered with lightweight Modelspan tissue, and this is best attached with tissue paste or an ordinary fixative such as Gripfix. Cut panels of tissue to cover the largest possible area, i.e. one top and one bottom panel for each wing half and a small piece for the top and bottom of the centre section, and one piece for the top and one for the bottom of the tailplane. Apply the paste all round the outside of the framework of the panel being covered (there is no need to paste over the inside pieces), then lay the panel in place and lightly stretch along its longest length and press down on to the paste. Now spread the end and work-

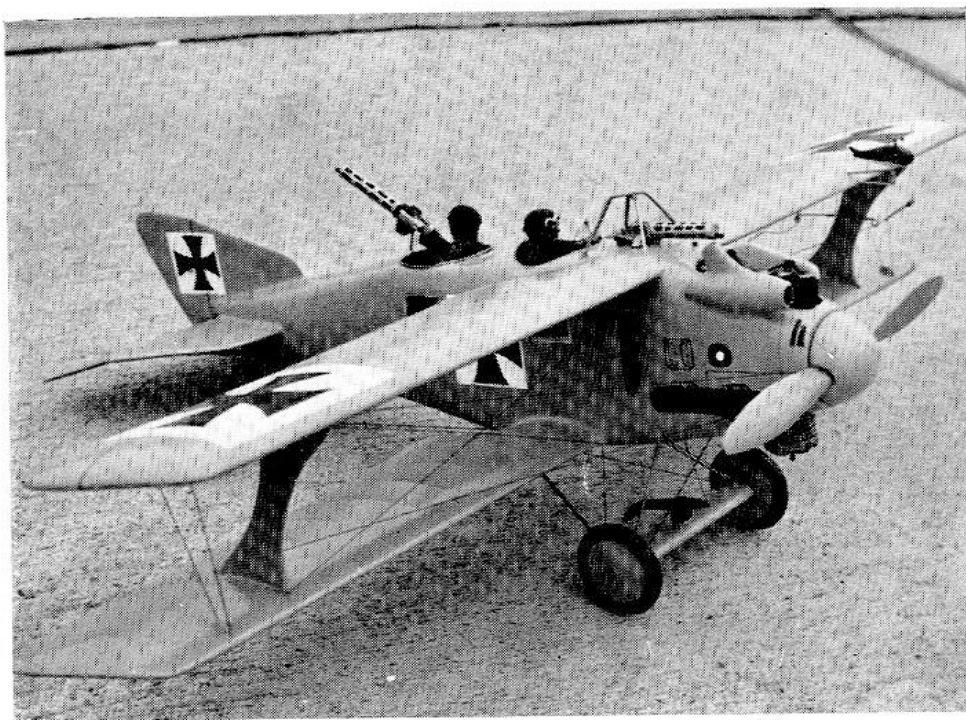
ing along the edges with the thumbs, press the tissue in place, drawing it smooth in the process. It is quite easy to lift a panel and re-stick it if at any point a wrinkle appears. When satisfied trim off the overlap, leaving about $\frac{1}{4}$ in. all round, and paste this $\frac{1}{4}$ in. over on to the other side of the frame. Apply the next panel in exactly the same way; the only spot where any real difficulty is to be encountered is where the wings join the centre section, and for this reason the first rib in the wing half is set a little closer to the centre section. Cover the bottom panels completely first before covering the top.

If the tissue has been applied reasonably smoothly, a good quality cellulose dope applied with a soft brush will shrink the tissue taut. If the tissue is slack it may be advisable to spray it lightly with clean water, using a scent spray or garden spray held some distance away. Only the slightest dampening is required. Leave to dry very thoroughly before applying the dope.

There is always a possibility that the shrinking action of the dope will produce a warp in the structure, and to avoid this it is usual to dope one panel at a time, and to lay it on a sheet of waxed paper, pinning or weighting down all round the edge. When the dope is thoroughly dry, no warps should appear.

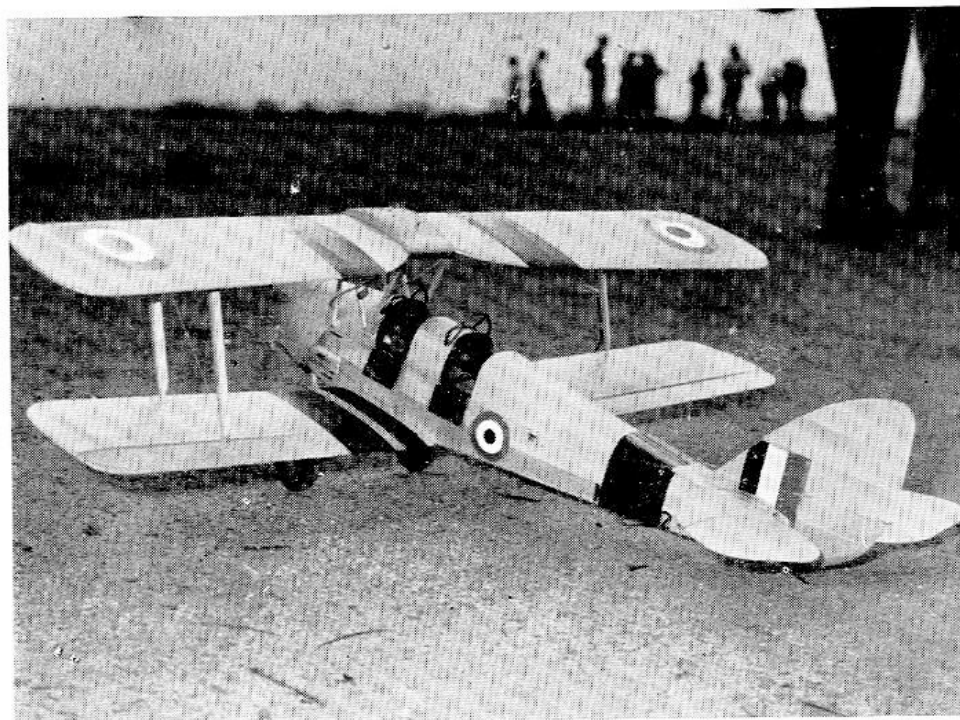
To assemble the model place the wing on the wing platform and hook rubber bands from the front dowel to the rear, using the bands diagonally. At the tail, hook a rubber band on the front dowel, pass over the tailplane, round the back dowel and forward to the opposite end of the front dowel. Make sure that the surfaces are held firmly, but will still be dislodged by a heavy blow. Sight from the front of the model to make sure that the wing sits squarely on the fuselage, and that the tail sits parallel with the wing, and at right angles to the fin. Look at the model from above to make sure that the wing and tail are parallel in this aspect. Add weight to the nose bay of the fuselage until the model balances a little way in front of the rear spar, then try gliding the model into long grass or weeds. Pick a fairly calm day





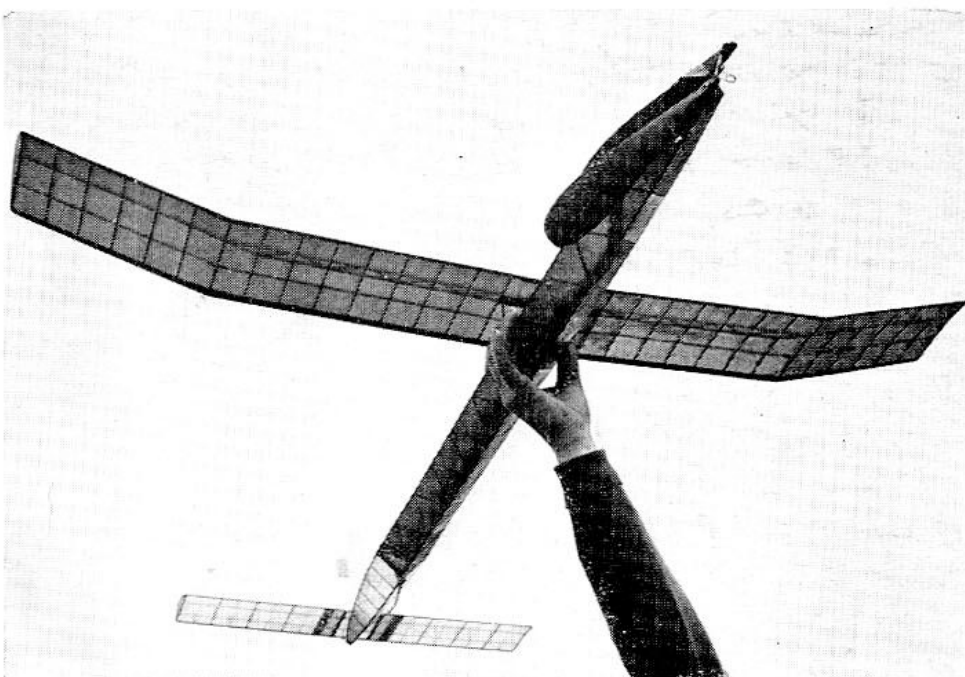
A magnificent scale model of the Roland C.2, a German two-seater fighter of World War 1. Model is 33 in. span, and only the lead-outs, visible at the far wing tip, and the engine indicate that it is for control-line flying.

Free-flight scale models can be tricky; the De Havilland 82a Tiger Moth is one of the best biplanes for this purpose. This model is 44 in. span and is just large enough for lightweight radio control.





Most popular class of sailplane is the International A2, an example of which is shown on the left, held by one of England's top competition fliers. Note slim, small body and long, graceful wings.



Below, a competition rubber-powered model – the rubber can be seen through the tissue covering. Note fuselage is a square 'box' turned on its corner to make a diamond; note also the two-blade propeller in the folded position.

and launch the model firmly, but not too fast, aiming it at a spot on the ground some 50 ft. in front. If the model's nose tends to rise in the air and then fall, add more weight to the nose; if the model dives into the ground, remove some of the weight or slip a piece of $\frac{1}{16}$ -in. balsa packing under the leading edge of the wing. When the glide is satisfactory, hook a short length of light line on to the front towhook, using a brass curtain ring or similar on the end of the line. Point the model into wind and ask a helper to hold it slightly nose up, then take the other end of the line and walk gently into the wind until the model lifts out of the helper's hand. Tow up gently and allow the model to settle on the top of the climb before releasing the line. A tissue flag attached to the line, about a foot from the end, will blow the ring off when the line is slackened. Towing up is something of an art, but with practice you will be able to use a full international length of line of 164 ft.

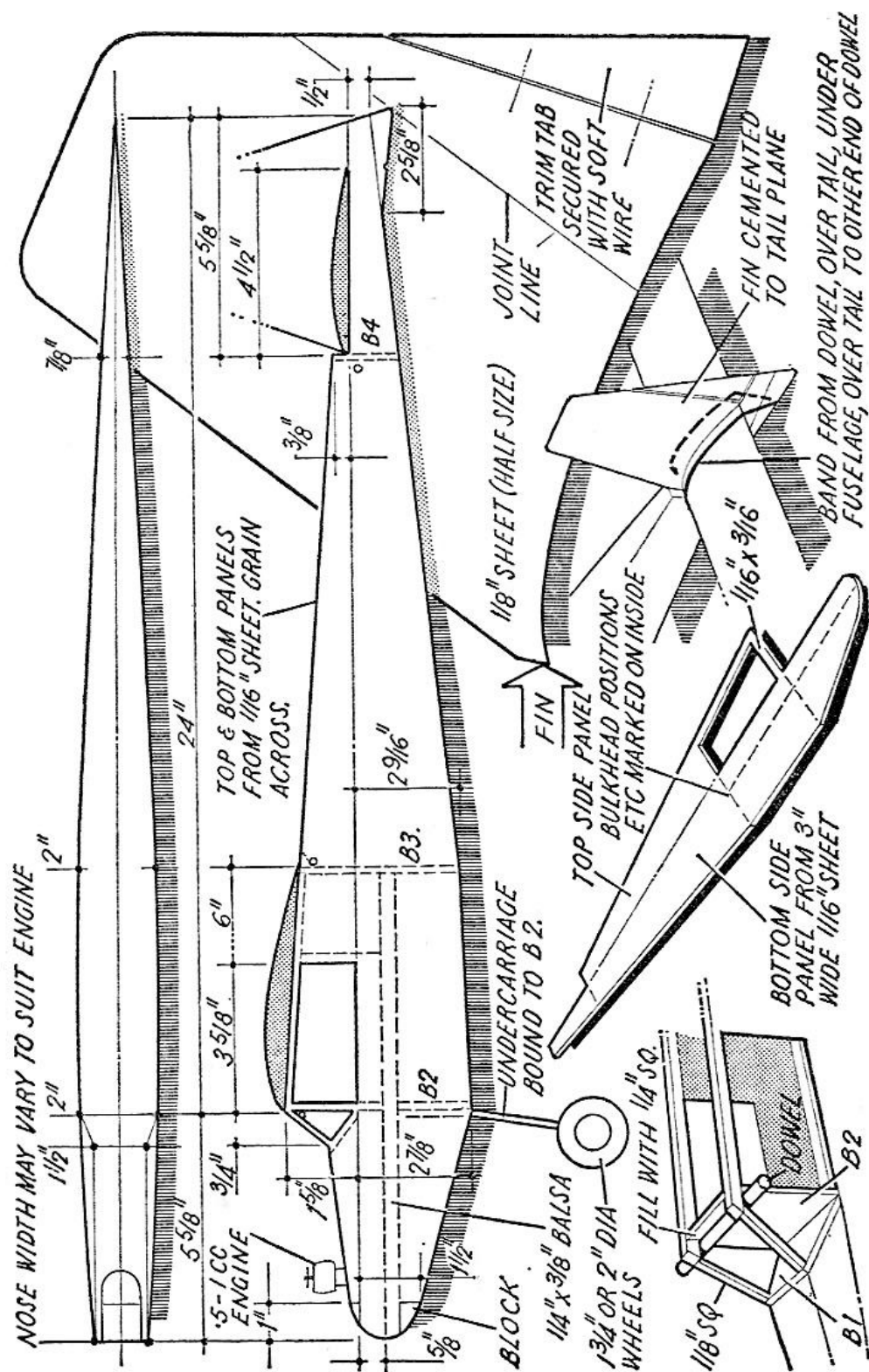
CHAPTER FOUR

A 40-in. Sport Power Model

THIS model uses the same wings and tail as the glider in the previous chapter, but, of course, a different fuselage and fin.

Construction is commenced by marking out on a sheet of $\frac{1}{16}$ -in. \times 3-in. balsa the lower side panel of the fuselage, which is fully dimensioned on the drawing. Note that all straight lines are used with the exception of the small curves of the nose which can be free-handed in. Cut one side panel and use it as a template for the other. Then mark out the top panels, cut, and cement to the lower panels. Mark the bulkhead positions and the positions of the engine bearer supports. Cement in a small vertical piece of $\frac{1}{16}$ -in. \times $\frac{3}{16}$ -in. sheet at the cabin front, then glue a length of $\frac{1}{4}$ -in. \times $\frac{3}{8}$ -in. balsa as a bearer support along each side. Remember to make a left- and a right-hand side. Cement a piece of $\frac{1}{4}$ -in. square balsa along the top edge of the cabin and another piece down the rear edge of the cabin to connect to the bearer support. Trace and cut four bulkheads; B2 is cut from $\frac{1}{8}$ -in. sheet and a second shape cut from $\frac{1}{16}$ -in. ply, these two being glued together and left under pressure. When dry mark and drill for the undercarriage binding holes and bend the undercarriage from 14 s.w.g. piano wire and bind in place. Use plenty of cement to reinforce the binding.

Now cement B2 and B3 to one side of the fuselage, placing the side near the edge of the table to allow the undercarriage to hang over. Add the second side, making sure that the bulkheads coincide with the marks and that a square assembly is achieved. Sheet the top and bottom between B2 and B3 with $\frac{1}{16}$ -in. sheet, grain running across the



fuselage. When dry draw the tail ends together and slip a rubber band round; insert B4 and cement in place. Make sure that the fuselage makes a symmetrical curve, though if you have chosen equal weight and similar grained wood in the sides there should be no difficulty. Sheet the top and bottom of the fuselage, grain across in the same way.

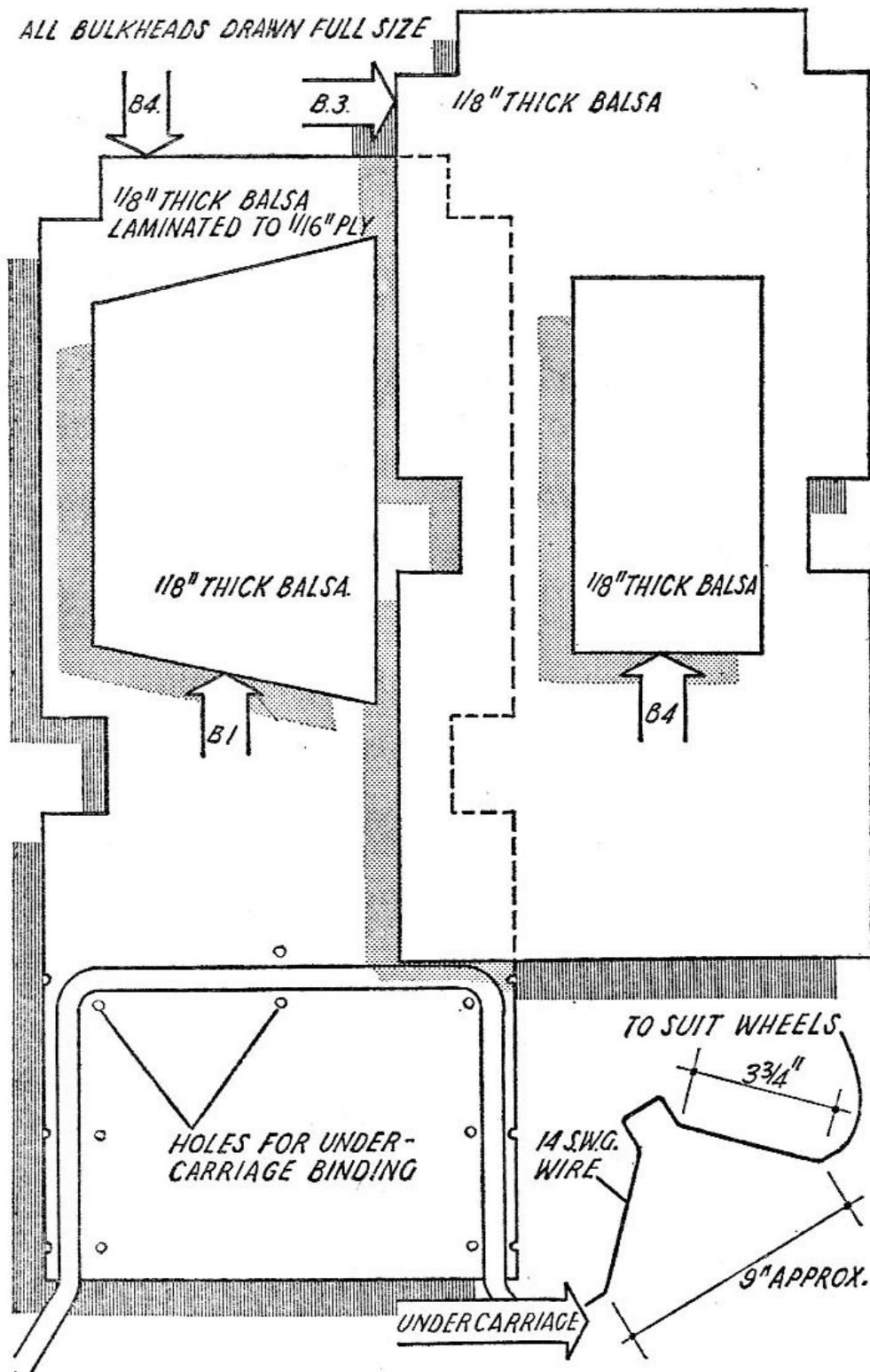
The engine mounting consists of two $\frac{1}{4}$ -in. \times $\frac{3}{8}$ -in. lengths of beech, cemented to the engine bearer supports from B2 forward to the nose. Depending on the particular engine used you may have to draw the nose in slightly or it may be left completely parallel, i.e. 2-in. in width. Cement a small piece of block beneath the bearer supports at the nose and sheet the underside of the nose in the same way as the rest of the fuselage.

Cement B1 in place and cut two triangles of $\frac{1}{16}$ -in. balsa to run forward from this to the nose. Cement these in place, then sheet across the top with $\frac{1}{16}$ -in. sheet. Shape the sheet to allow for easy removal and installation of the engine.

The cabin front requires a cross piece of $\frac{1}{4}$ -in. square and two $\frac{1}{8}$ -in. square strips as sketched to facilitate attaching the celluloid windscreen.

At the tail fit the small skid shown, notching this so that the notch falls immediately beneath the tailplane trailing edge. A half-size drawing of the fin is given and this is simple to double up on to $\frac{1}{8}$ -in. sheet balsa; the rudder is attached as in the previous chapter, but in this case the whole fin requires cementing securely in the centre of the tail-plane. Fit the dowels through the fuselage in the same way as the glider, then sand all over and tissue cover. Cover the cabin windows with thin celluloid or acetate sheet, and attach the wheels to the undercarriage by soldering a washer at the bend of the axle, slipping the wheel in place and soldering a second washer on the outside. It is advisable to proof the inside of the engine compartment with several coats of dope or fuel proofer to prevent the structure from being weakened by oil soakage.

Install the engine and fit the wing and tail. The model should balance slightly ahead of the rear wing spar, but a



little plasticine may have to be added to the nose and tail to achieve this. Glide test on to tall grass in the same way as the glider, using the same methods to achieve a smooth glide.

Use a 7-in. \times 4-in. or 8-in. \times 4-in. propeller, and run the engine slowly for the first flight or two. Set the rudder over slightly to the right and launch the model in exactly the same way as for a glide test. You should get a climb in wide left-hand circles followed by a glide in wide right-hand circles. With the model gaining some height, the glide can be studied and adjustments made either by packing the wing or using a little plasticine ballast. Increase motor speed when the trim is satisfactory – you will find that the faster the motor runs the tighter the model wants to turn to the left. Do not use more than a few seconds' motor run until you have familiarized yourself with the distance the model is capable of flying!

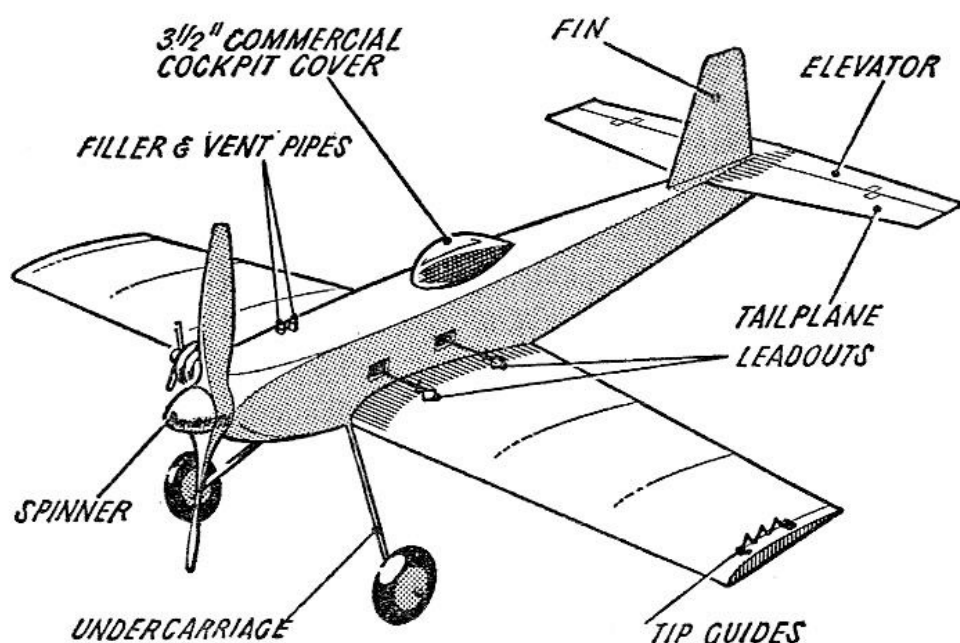
A Control-line Model for $\frac{1}{2}$ -1 c.c.

CONTROL-LINE model aeroplanes can be flown in a much more restricted space than freeflight models, since the main requirement is a circle clear of obstructions, of only about a hundred feet in diameter or, in the case of this little model, a maximum of fifty feet in diameter. For this reason it is usually unnecessary to travel out into the country to fly control line, but by the same token it is easier to cause a nuisance with this type of model; nothing can be more irritating to someone trying to have an afternoon nap than the continual whine of a small engine running near at hand. It must also be remembered that the model can fly overhead to the extent of the lines, and even 25 ft. plus the height of the flier can bring the model in contact with overhead electric wires. About a dozen modellers have been killed or severely burned by foolishly flying near overhead power lines. It therefore pays to find a suitable space away from houses and hazard. It is very nice to be able to take a model off from the ground since this makes control considerably easier if you have never flown one before, but even in a field of rough grass an old piece of linoleum or roofing felt will make an adequate runway.

The method of controlling the model is almost universal; two lines run from a handle held in the hand to two lead-out wires attached to a bellcrank in the model. Movement of the handle swings the bellcrank and at 90 degrees to the lead-outs a push-rod is connected to a horn on the elevator, thus moving the elevator up and down and controlling the model in pitch. A stable model is not therefore necessary provided that balance is within certain limitations. If the model is

capable of staying out at the end of the lines no stability problems will arise.

Start construction by laying out the wing. This is a piece of 18-in. \times 3-in. \times $\frac{1}{16}$ -in. balsa, to the back of which is glued a triangle 18 in. \times $1\frac{1}{2}$ in. at its maximum. The joint should be glued along its whole length, and the wing panel then pinned down on a flat board with a sheet of grease-proof paper covering the board to prevent the cement from sticking to it. Cement a length of $\frac{1}{4}$ -in. square hard balsa to the leading edge, (the straight side of the sheet) then cut the ribs R1, 2, 3 and 4 (two of each will be needed) and cement



in place. A second sheet of 18-in. \times 3-in. \times $\frac{1}{16}$ -in. is now glued over the top of the ribs and a second triangle glued on to the back to complete the wing upper surface. When the cement is completely dry, sand the whole wing smooth and round off the leading edge as shown in the drawings; the tips can also be rounded off slightly.

Now cut two fuselage sides by drawing one out on a sheet of $\frac{1}{8}$ -in. balsa, cutting this and using it as a template for the second sheet. Also cut bulkhead B3, then cement the

fuselage sides over the wing and insert B3. The sides should be completely parallel.

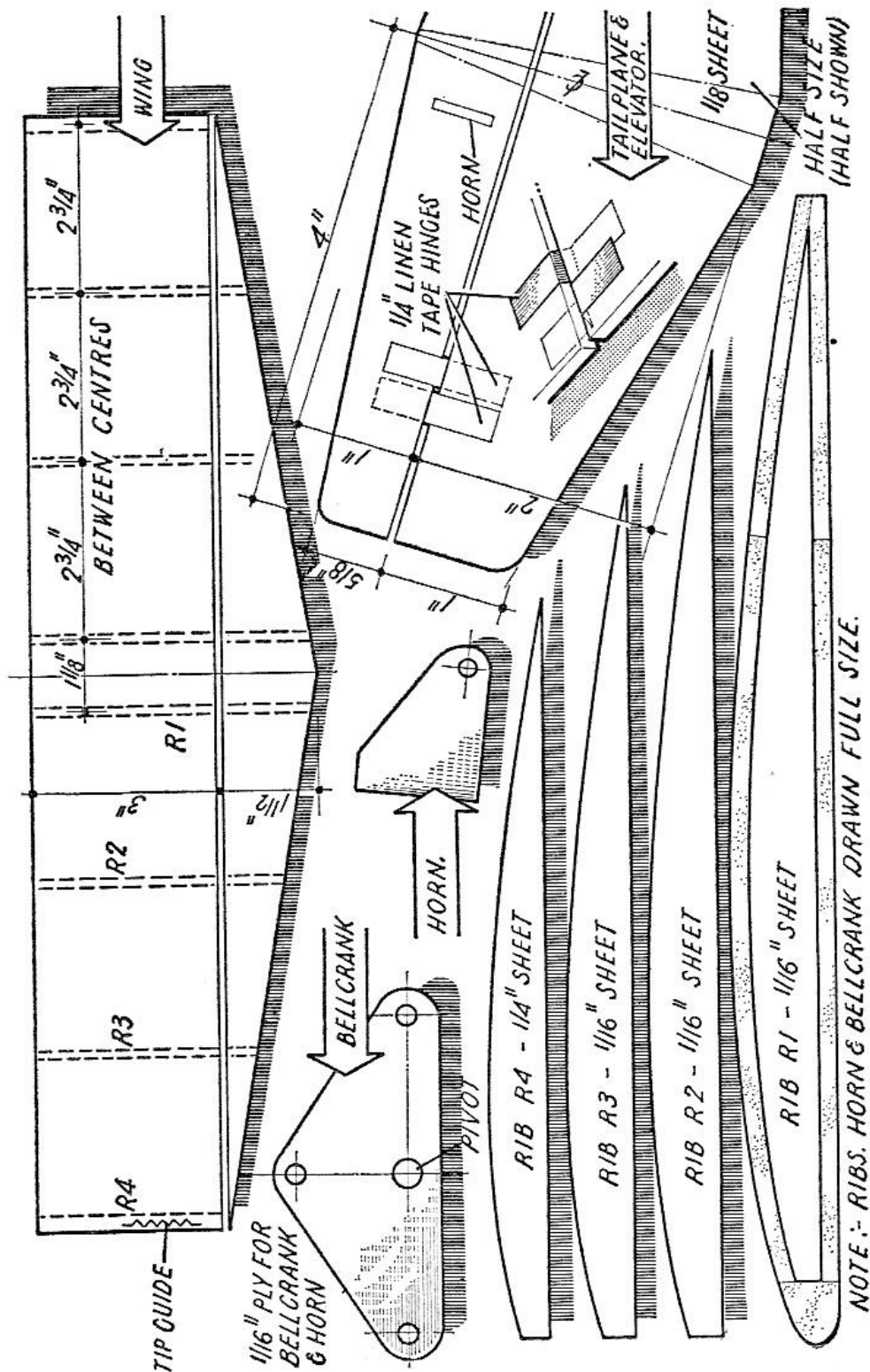
B2 is cut from $\frac{1}{16}$ -in. ply and the holes cut for engine bearers ($\frac{1}{4}$ -in. \times $\frac{3}{8}$ -in. beech or similar) spacing the bearers to suit the particular engine that you wish to use. Any engine of 0.5 to 1 c.c. is suitable. Bend up the undercarriage from 14-gauge wire using a heavy pair of pliers, drill the holes and nick the edges of the bulkhead and bind the undercarriage in place with strong thread, and plenty of cement. Slide the bearers in place and offer the assembly to the fuselage structure. Mark carefully on the wing surface the position of the lower engine bearer and cut a small strip of the top sheet of the wing away so that the bearer fits into the wing. Now slip the bearers out and drill for the engine bolts and also the single bolt for the bellcrank; fit the latter in place and fit on the bellcrank, sandwiching between washers and tightening the nut down so that the bellcrank moves freely without rocking. It is advisable to put a touch of solder on the nut to prevent it from unscrewing, or alternatively a locknut may be used. Fit the wires to the crank (see later). Now reassemble the bearers to B2 and cement firmly into the fuselage. Pack between the fuselage side and the engine bearers with scrap $\frac{1}{8}$ -in. sheet to make a firm job. When dry draw the tail ends of the fuselage sides together and cement. Cut out the tailplane and elevator from $\frac{1}{8}$ -in. sheet and round the edges with fine glasspaper. Cement the tapes in place as shown, keeping the elevator as tight to the tailplane as possible, and keeping vertical parts of the tape free from cement if possible. Cover the tape with cement and rub well in with the finger. When dry a free-moving hinge should be formed, and the weight of the elevator should be sufficient to make it drop. If the hinges are stiff work them in the fingers until the elevator does move freely.

Cement the tailplane in place on the rear ends of the fuselage so that the elevator overhangs clear of the fuselage. Cut a slot in the elevator and fit the horn. Cut the two small apertures in the fuselage side for the lead-out wires, making sure that the lead-outs do not touch the fuselage side at any

point of their travel. Cut a slot in the right fuselage side for the push-rod, then thread the lead-outs and push-rod in place, making sure that the push-rod is of sufficient length for the elevator to be at neutral when the bellcrank is central. It is easiest to fit these wires to the bellcrank before the bellcrank is finally installed, as the best means of laying the wires in place is to bend them to a right angle, pass the tip through the hole in the bellcrank and solder a cup washer underneath. Make sure that the bellcrank movement is completely free.

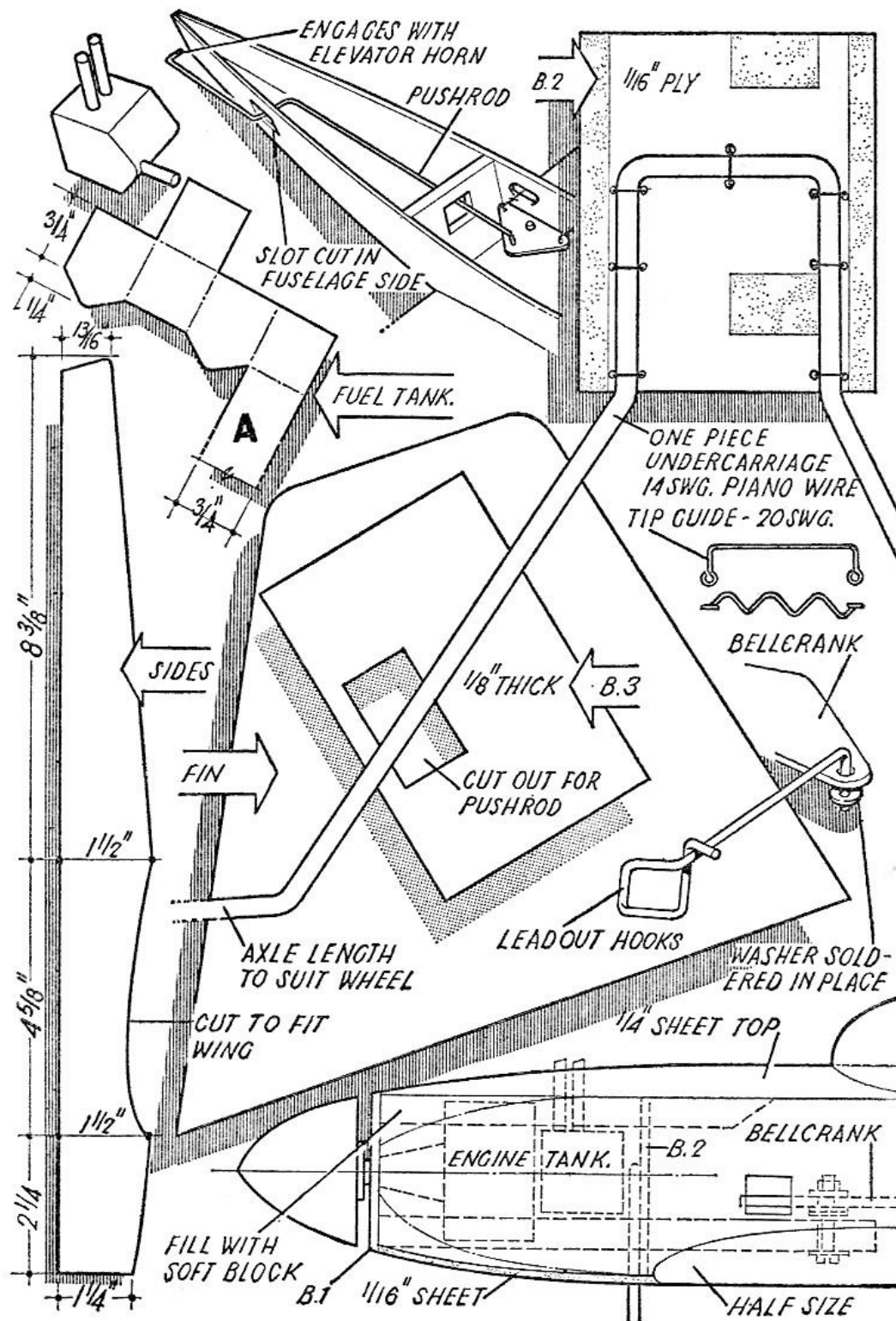
Now add the soft $\frac{1}{4}$ -in. sheet top to the fuselage and glue B1 to the front ends of the bearers. B1 is simply a circle of $\frac{1}{16}$ -in. ply, $1\frac{5}{16}$ in. in diameter with a central hole of at least $\frac{3}{4}$ in. diameter. A method of making a tank is shown on the plan. This can be cut from tinplate and bent up and soldered. Note that the feed pipe must come from the rear outside corner. Alternatively a small commercial tank may be bought. Install the tank and fill in the corners of the engine bay at the front with scrap wood to enable the nose to be sanded off to a nice line. It will be necessary to cut away part of the starboard fuselage side in order to install the engine. Make the cutaway as small as possible.

At the tail the $\frac{1}{4}$ -in. top sheet will either have to be stepped over the tailplane or it can be terminated at the front of the tailplane and a piece of $\frac{1}{8}$ -in. sheet glued over the top. Sand the fuselage to a pleasing shape before glueing the fin in place. Fit the fin at a very slight angle giving an outward turn, i.e., the tip of the leading edge should be to the left of the centre line. Make sure the fin is glued on upright. Solder washers on the axles and slip the wheels in place, soldering further washers on the outside to retain the wheels. The lead-out guides are fitted on the 'inside' wing tip and can be glued to the surface of the wing and a scrap of silk glued over the top to make a strong anchorage. Note that these are not directly in line with the lead-out wires, but angled back slightly. This, coupled with the turn to the outside of the circle imparted by the rudder, helps considerably in keeping the lines tight.



The whole model should now be sanded and lightweight tissue doped over every part; apply several coats of sanding sealer, rubbing down between each coat, and then colour dope to your own choice. Since an additional half-ounce is of relatively small importance, an elaborate colour scheme can be employed, using cellophane tape to mask off and ensure a neat finish. You may also like to give the completed model a coat of fuel proofer to prevent the finish becoming tacky after prolonged use. Now install the motor and fit the propeller and spinner. The motor manufacturer will no doubt have recommended a suitable propeller, but a 6-in. or 7-in. diameter by 5-in. prop. will probably suit most of the motors likely to be used.

The control lines themselves can be made up from a special Terylene line which can be obtained at most model shops, or you can use nylon or light fishing line. Larger models are usually flown on steel lines, but this material is difficult to handle and is not necessary for a model of this type and size. For initial flights lines of about 15-20 ft. should be used; the model end of the lines should be bound securely into loops and the binding cemented. For a handle a simple 'U' cut out of plywood about 5 in. high and with 3-in. arms is suitable; drill a hole in each of the arms and thread the lines through, binding and cementing securely. Make sure that both lines are identical in length. Feed the loops of the free ends of the line through the lead-out guides and hook on to the lead-out hooks. Walk back to the handle and check that the elevator moves in the correct manner; it is advisable to paint the top half of the handle bright red so that you know each time the handle is picked up that an up movement of the handle will in fact give 'up' elevator. Having checked that everything is correct and that the model will be clear of any obstructions, start the engine and have a friend hold the model while you run to pick up the handle. Hold the handle with the arm stiff and point it at the model, and move the arm up and down without bending elbow or wrist, since this gives sensitive control over the model. Do not attempt to do anything but fly reasonably level for the



first flight or two until you begin to get the feel of control. Where take-off is impossible it will be necessary for a friend to hand-launch the model, and he should do this by running round the circle, keeping the lines tight, while the flier should keep the elevator neutral. The model should be launched level at as near its flying speed as possible. Whether taking off from the ground or hand-launching the start of the flight should always be travelling downwind, so that the wind helps to blow the model out to the extreme of the lines for the first half-lap. If the model is launched into wind and the lines are a little slack, the wind will tend to blow the model towards the pilot, which can only result in loss of control. Flying a control-line model is not as easy as it looks, but most people get the knack fairly quickly. Concentrate on the model at all times to avoid giddiness, and do not make your initial flights under windy conditions.

CHAPTER SIX

A 24-in. Model Yacht

THIS little model is capable of sailing very well under normal conditions, and will give a good account of itself in quite a blow. Construction as shown is almost entirely balsa, but a more durable model can be made by substituting $\frac{1}{8}$ -in. ply for the deck and bulkheads and $\frac{1}{32}$ -in. ply for the skin.

The first step is to cut the deck and chine shelf, and these may be cut in two halves each from 3-in. wide balsa sheet, or in one piece from $\frac{1}{8}$ -in. ply. Draw a line 24 in. in length and mark it off in 3-in. stations. At each of these stations mark a point to the dimension given in the plan view. These figures are taken to the nearest $\frac{1}{16}$ in. and a pin should be inserted in each mark. A piece of $\frac{1}{8}$ -in. square balsa or 16-gauge piano wire should now be held against the pins and a pencil run round to give the actual cutting line. The use of a spline in this way will produce a smooth curve. This half may now be cut out and the piece used as a template for cutting the other half; in the case of cutting from $\frac{1}{8}$ -in. sheet ply both outlines must, of course, be drawn.

The chine shelf is drawn in exactly the same way on the material, and the lower row of figures in the plan view gives the offsets for this part. Note that it is $1\frac{3}{4}$ in. shorter than the deck, all of which is taken off the bow end.

Cut the stem and bulkheads from $\frac{1}{8}$ -in. sheet. Full-size drawings for these are given and it is only necessary to trace them on to the wood. Mark the positions of the bulkheads on the chine and deck shelves and cement in place.

Now mark out the keel profile, which is drawn exactly the same way as the shelves, i.e. by using the offsets given on

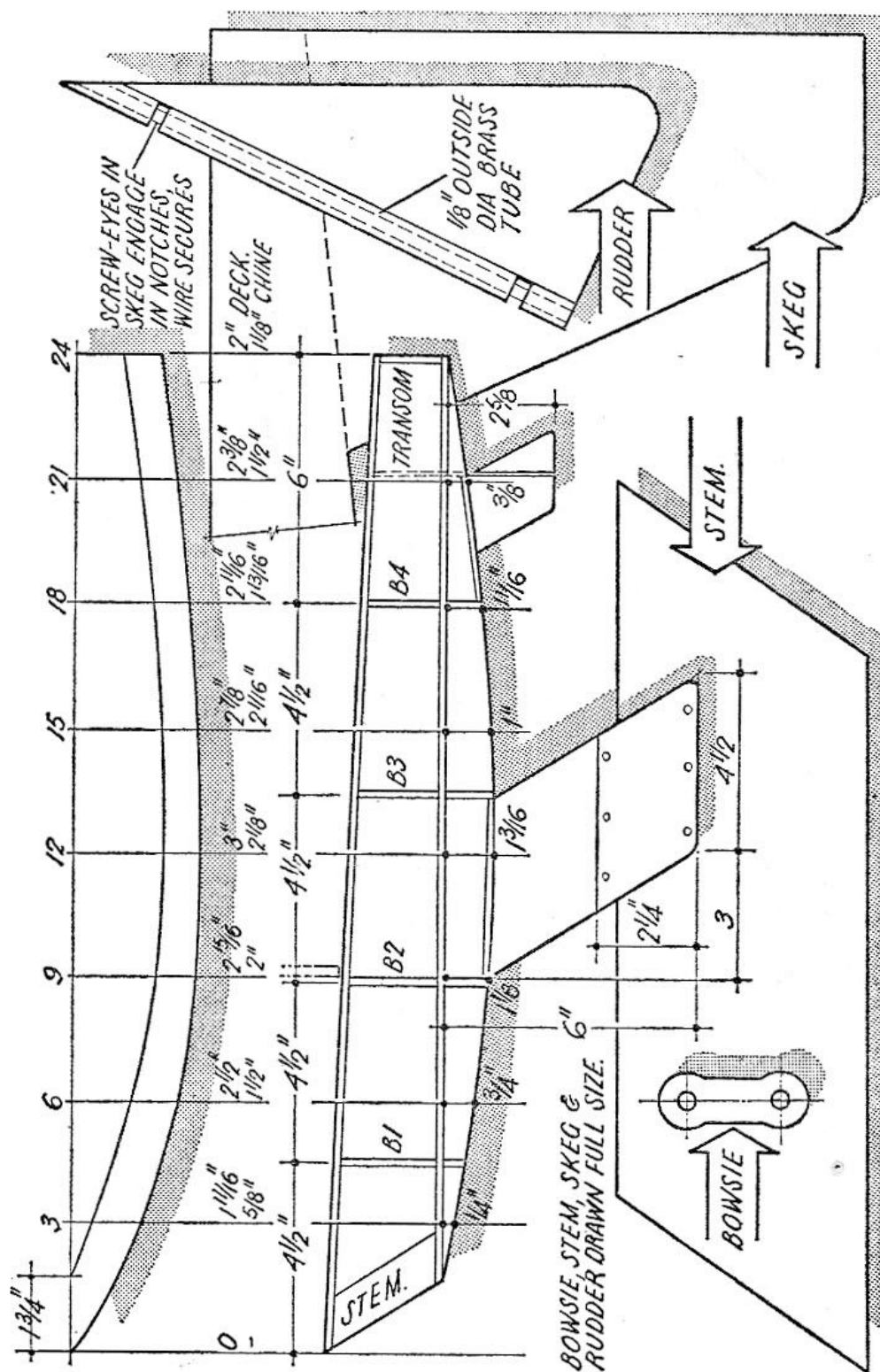
the profile. Only the fore part up to B2 and the part between B3 and B4 need be cut, but if the whole of the keel is laid out the parts remaining can be used as templates for the fin and skeg. Cut to shape and cement along the centre line of the chine shelf. Add the lower parts of the bulkheads and leave to dry thoroughly.

The skeg is cut from $\frac{1}{8}$ -in. ply and includes that part of the keel profile from B4 to the transom. Similarly, the fin is $\frac{1}{8}$ -in. ply and includes the portion of the keel profile between B2 and B3. Using the parts left over from the cut out keel outline, draw in place the skinning line on the two ply parts and cement a small piece of $\frac{1}{8}$ -in. balsa each side, trimmed to this line to provide a fillet to take the skins.

To lay out the fin first draw two parallel lines 6 in. apart and cut them with a line perpendicular to them. Mark a point along one of the parallel lines 3 in. from the perpendicular and another point at $7\frac{1}{2}$ in. Connect a point $1\frac{1}{8}$ in. down the perpendicular to the 3 in. mark and draw a line parallel with this from the $7\frac{1}{2}$ in. mark. The drawing includes these measurements and will serve as a guide. Cement the ply parts in place on the hull and fit a piece of $\frac{1}{4}$ -in. square wood each side at the top to make a fillet. Now sand the hull with a long sanding block and fine glasspaper, chamfering all the edges so that the skins, when applied, will fit snugly in place.

The skins are of $\frac{1}{16}$ -in. balsa and can be applied in short pieces with the grain running vertically on the sides, and across the hull on the bottom; i.e. the model is sheeted with 3-in. pieces of sheet cut across the width of a standard sheet. Work from the stern forward, sheeting the bottom first, and when dry trim the chine edge and sand to match the bevel of the chine shelf. The bottom sheets are butt joined neatly along the keel line, but must, of course, be notched where the fin and skeg enter the hull.

The sides are sheeted in exactly the same manner, but when the stem is reached it will only be possible to fit one side. When dry this side should be sanded to the correct



angle so that the opposite side sheet will make an overlapping joint. This stage is then completed by trimming off excess material.

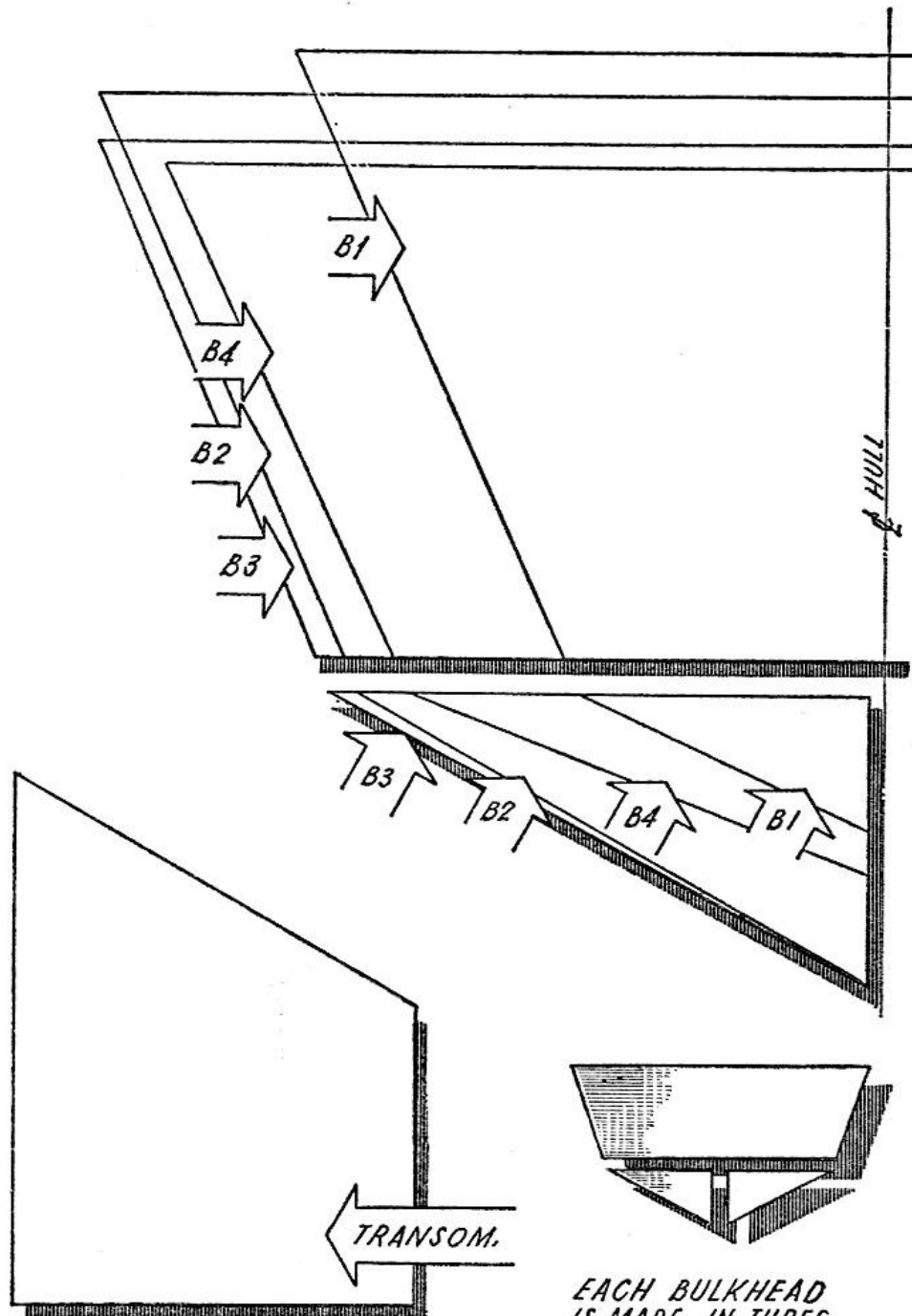
If you wish to sheet the hull with $\frac{1}{32}$ -in. ply it is recommended that a brown paper template be made of each panel to ensure correct fit before cutting the ply. In this case the hull can be covered with four single sheets.

A $\frac{1}{8}$ -in. \times $\frac{1}{2}$ -in. strip of hard wood should now be glued down the centre of the deck, finishing at the transom and being shaped off to conform with the taper in the bow. The hull should now be tissue covered and the method of doing this is to lay the tissue in place over the hull and brush on cellulose clear dope through the tissue. All wrinkles should be worked out and tissue trimmed to a small overlap which is folded round the appropriate edge and stuck down with the dope. When thoroughly dry the tissue should be lightly sanded with a worn piece of glasspaper and several coats of cellulose sanding sealer should be applied.

Make the rudder from a piece of $\frac{1}{8}$ -in. ply to the fore edge of which is fitted a piece of $\frac{1}{8}$ -in. outside diameter brass tube, which should accept a piece of $\frac{3}{32}$ -in. brass wire. The tube is fitted to the front of the rudder by roughening it with a file and glueing in place, then covering the whole unit with a piece of silk well cemented in place. An additional piece of the tube must be fitted through the keel and deck, which calls for some careful drilling. To simplify this matter some builders may care to saw the after keel piece immediately behind the skeg into two pieces before assembly to the hull, and fit the tube in place at this stage, reinforcing with small blocks beneath the skin.

Two screweyes are now inserted into the after edge of the skeg, the rudder laid alongside and the positions of the screweyes carefully marked on the rudder. A fine saw should now be used to cut away the brass tube to correspond with the screweyes so that when the rudder is placed over the screweyes and a wire inserted the rudder swings completely freely on the skeg. Do not fit the rudder permanently at this stage, but include it in all finishing preparations as for the hull.

ALL BULKHEADS ARE DRAWN
FULL SIZE BUT ONLY HALF IS SHOWN



EACH BULKHEAD
IS MADE IN THREE
PARTS AS SHOWN.

The lead weight of the model is simply made from two pieces of $\frac{1}{8}$ -in. sheet lead such as is used for roofing. These are cut to the shape of the fin and should be $2\frac{1}{4}$ in. high. Paint the inside surfaces thoroughly and position on the fin. They are secured in place by $\frac{3}{8}$ -in. No. 4 countersunk brass screws driven through from each side as shown on the plan. Drive the screws in until the tips can be seen from the other side. When the paint has dried the lead can be filed to shape with an old file; all that is necessary is that the front edge should be rounded and the after edge tapered off gently.

The hull can now be painted using either cellulose dope or a flat oil undercoat. Apply two or three coats, rubbing down between each with wet or dry carborundum paper used wet, until a good finish is achieved, then apply a finishing coat, again either of dope or a good quality enamel. Do not use cellulose dopes over oil-based undercoats, though it is quite safe to put oil paint over dry cellulose.

The deck of the model may be included in the painting, but if it is intended to have a stained and varnished deck (which can only be employed with a ply deck), the staining and varnishing should be carried out before the hull is tissue covered. If a plank effect is required on a balsa deck, it is recommended that the deck be veneered with a suitable veneer. The waterline of the hull can be found by floating the model in the bath; put a 2-oz. weight on the mast position to give an approximation of the rigging weight.

The mast of the yacht is a 30-in. length of $\frac{5}{16}$ -in. dowel or it can be planed up from a piece of straight grained beech or similar. The top 9 in. can be tapered down to give an air of delicacy. At the heel of the mast a small cup hook should be screwed in and cut off to leave a straight wire peg as sketched. Drill a hole in the hardwood plank of the deck 9 in. from the bow and two holes spaced at $\frac{1}{4}$ -in. intervals forward of this and aft, giving five holes in all. This allows some adjustment in the position of the mast in order to trim the boat to sail well.

A screweye requires to be fitted $1\frac{3}{4}$ in. from the base of the mast on the after side, another at 21 in. from the base in the foreside and another in the afterside $6\frac{1}{2}$ in. above this. If there is any sign of the mast splitting as the screweyes are fitted, thread binding should be used. The main boom is a 13-in. length of $\frac{1}{4}$ -in. dowel, and it requires a screweye in its heel; this screweye is opened with a pair of pliers and engaged with the lowest screweye in the mast, and then squeezed down again. This makes an adequate gooseneck fitting. At the other end of the boom a fine hole should be drilled and a wire fitted through as sketched. This wire should for preference be brass, but 18 s.w.g. plated piano wire can be used. A further screweye is required in the boom $\frac{3}{4}$ in. along from the gooseneck.

The jib boom is a 7-in. length of $\frac{1}{4}$ -in. dowel and requires a similar wire fitting at the tack end and a single screweye underneath at the opposite end.

Further screweyes are required in the main deck plank, $1\frac{1}{2}$ in. from the bow, $4\frac{1}{2}$ in. from the bow, $7\frac{3}{4}$ in. from the bow, $8\frac{1}{2}$ in. from the stern, 2 in. from the stern and as close to the stern as is practical. In addition a screweye is fitted each side of the hull, 3 in. abaft the mast position; these screweyes should not be screwed into a balsa deck, but a small scrap of hardwood glued securely to the deck and the screweye inserted securely into this.

The sails can be made of any very fine cloth, preferably a cotton rather than one of the synthetic materials which tend to stretch unless specially treated. The best synthetic material to use if you do not fancy machining a cloth sail is polythene sheeting as used for food bags. The main sail needs as small a hem as possible up its fore edge or luff, and a similar hem across its foot. The leach or after edge of the sail needs no hem in polythene, but as fine a hem as possible in cloth. The weave of the material in a cloth sail, incidentally, must run parallel with the leach. At the head of the sail the top 1 in. may be cut off and a small hem turned. A $\frac{1}{16}$ -in. ply or thick celluloid headboard may be made to complete the sail shape, the

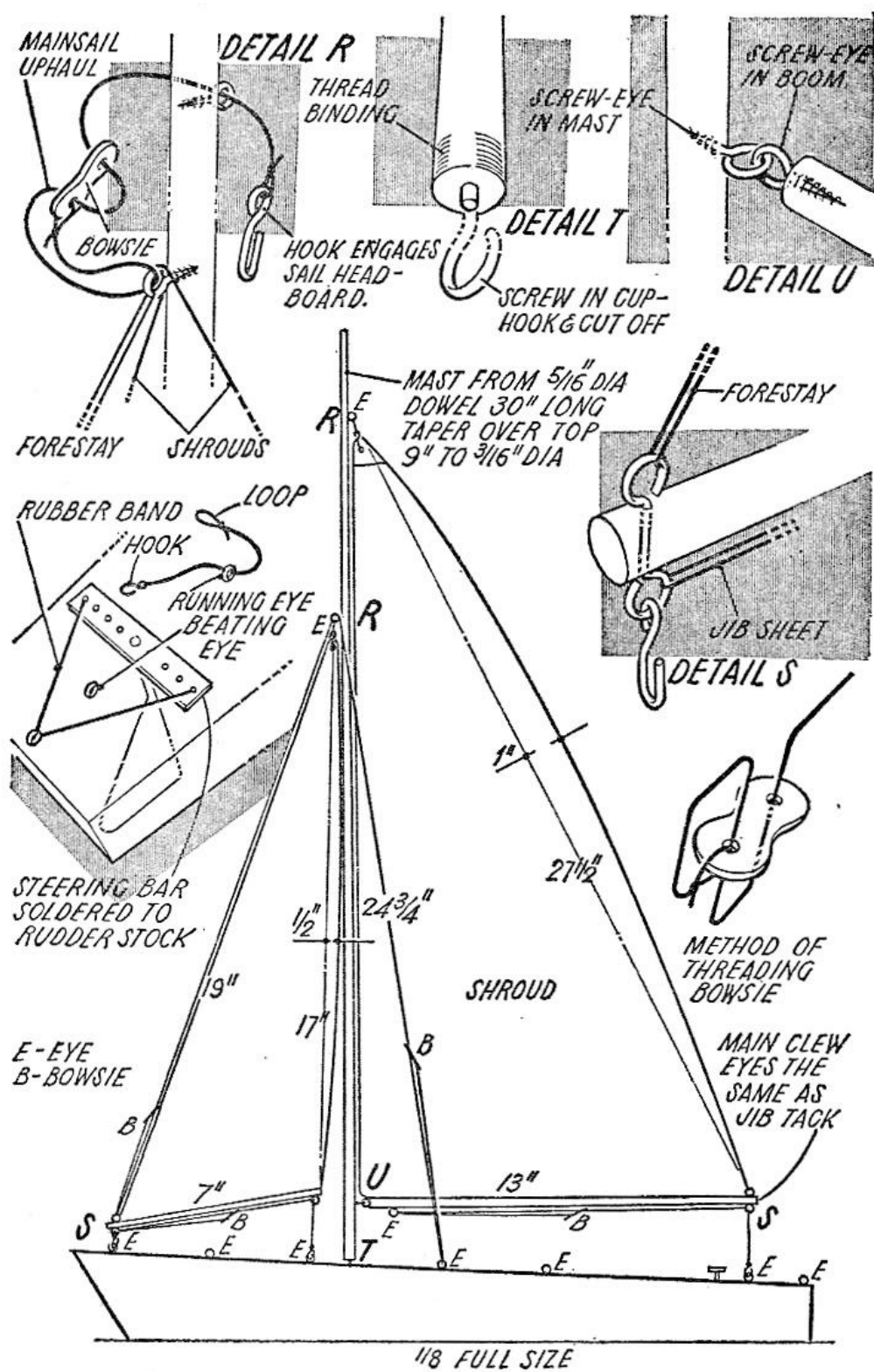
cloth being sewn to this through a series of small holes drilled along its edge.

The same requirements in hems and headboard occur with the jib. In the case of polythene, hems can be made by sticking the polythene down with an impact adhesive or one of the special polythene cements now available.

The mainsail is now sewn to the mast with fairly widely spaced stitches which, while allowing free movement of the sail, do not allow a gap to exist between sail and mast. The foot of the sail is sewn to the boom. A few extra stitches should be passed through the eyes at each end of the boom. The jib is sewn to its boom and then to the forestay, but this latter should not be done until the mast is stepped on the hull and the rigging is almost completed.

It will be seen from the drawing that the tack or fore corner of the jib is provided with a hook which engages in the first eye in the deck plank. A line of fine twine is tied through the hole in the headboard of the sail, the line passed through the eye on the mast, back down through the top eye at the jib tack and is made off on to a bowsie sliding on the downward passing line, i.e. it is necessary to slip this bowsie in place before threading the line through the jib tack eye. When the bowsie is tightened up it will bring the forestay taut and also draw the sail up tightly to its correct position. To prevent the mast from being pulled forward a length of twine should now be tied round the upper eyelet, passed through the side eyes in the hull and again made off into a bowsie each side. These three lines thus form a triangle and adjustment of their tautness positions the mast.

A line is fitted with a small wire hook and engaged in the headboard of the mainsail, this line is now passed through the top eye on the mast, down through the fore-eye just below, and made off into a further bowsie. Tightening up this uphaul brings the mainsail up taut. To control the swing of the sails sheets are fitted and these are further lengths of twine, one end of which is fitted with a hook and engaged with the eyes as shown on the drawing. The free end is then passed through the aftereyes on the booms and



forward to the foremost eyes and again made off into a bowsie. The bowsie should be so positioned that when the sail is drawn absolutely tight, the bowsie is practically touching the clew-eye. This permits maximum adjustment in freeing off the sheets. For running before the wind it may not be possible to free the booms off as much as is necessary and the two spare eyes in the deck plank are therefore used to engage the sheets for running.

All that remains is to fit the rudder in place. A touch of solder should be used to secure the wire in the bottom of the tube, and at the top end a steering bar may be soldered. This is simply a small strip of brass with holes drilled in it at close intervals. A rubber band is secured to one end, passed through the aftermost eye, and made off to the other end of the bar. The rubber should be in slight tension, and if the tension on both halves is equal the rudder will be held securely. By slipping a little rubber band through the eye so that the tension is unequal, the rudder can be biased as required.

For sailing into wind – beating – the booms should be freed off about 30 degrees and the rudder left central. If the boat tends to turn into wind the jib should be tightened a little and vice versa. A little experiment will soon find the best trim.

For reaching (across wind) or running (downwind) the yacht can still be sailed with the rudder central, using whichever eye is convenient for attaching the sheets. However, you may like to experiment with an automatic steering gear and a very simple system using the steering bar is shown in the drawing. A short piece of line fitted with a hook is run through the eye and terminated in a loop. The sheet hook is engaged in this loop and the hook on the steering line fitted into one of the holes in the steering bar. The model is trimmed so that it gradually tends to come up into the wind, and this tendency is stopped by engaging the hook in the hole in the steering bar which gives the appropriate rudder, at the appropriate pressure, i.e. in a strong gusty wind the hook would be engaged in one of the outer holes so that

greater rudder movement was available. Again there is no school like experience, and it is great fun learning to get the best from your model by experimenting with different trims for various points of sailing.

A Sailing Catamaran

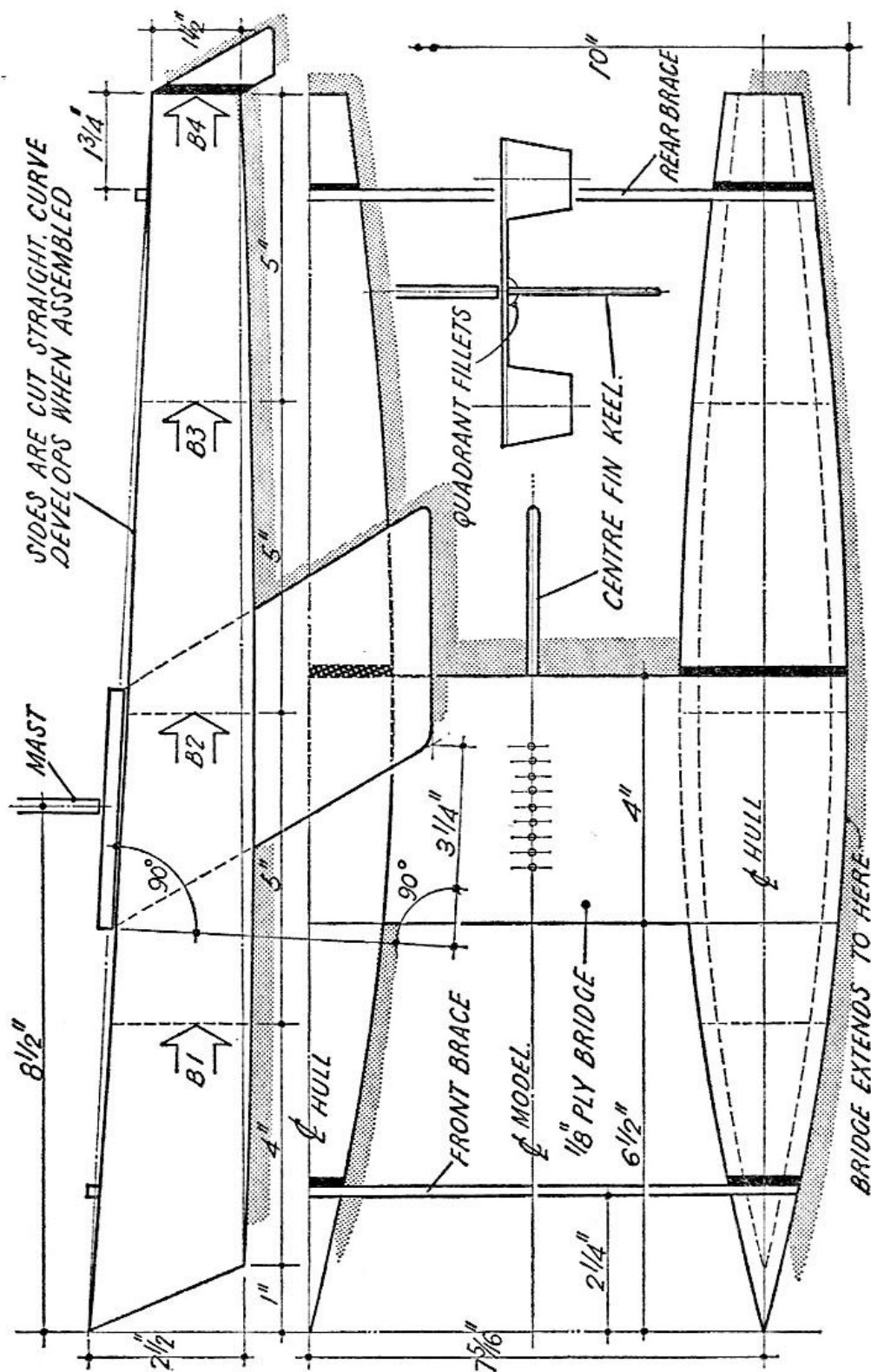
CATAMARANS, unheard of except in the Far East for many hundreds of years, have in the last ten years become extremely popular. They are extremely fast, although they usually have the disadvantage of being wet to sail and not quite so handy for manoeuvre as a more conventional boat.

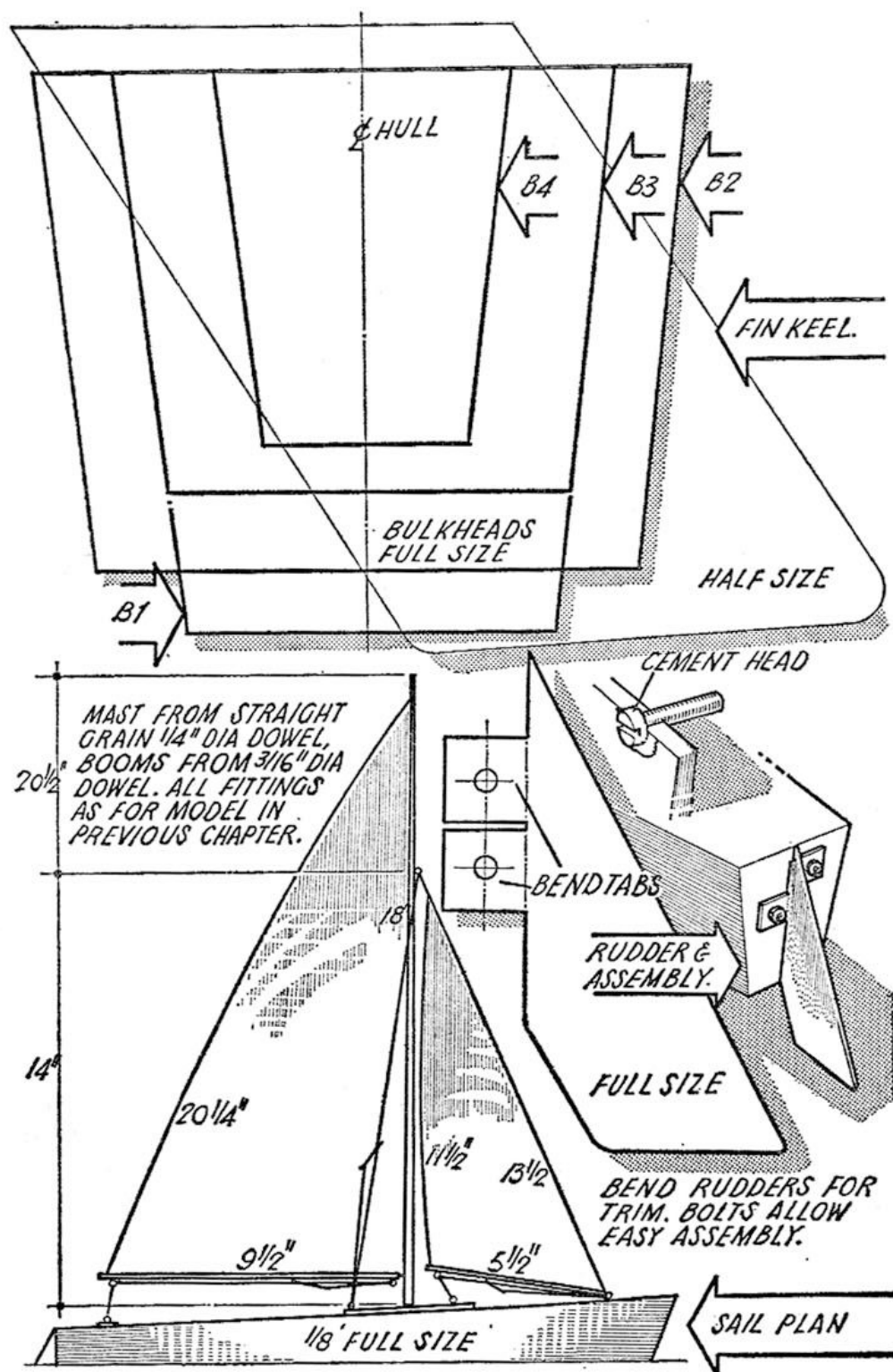
This model is of simple construction, but will give hours of pleasure and quite a startling performance.

Start by cutting out one hull side which is simply a 20-in. length of $\frac{1}{8}$ -in. balsa, $1\frac{1}{2}$ in. deep on one end and $2\frac{1}{2}$ in. at the other. The bow end is cut back 1 in. as drawn. Four such sides are required.

Cut the bulkheads, also from $\frac{1}{8}$ -in. sheet. These are drawn full size and merely require tracing. Two of each will be required. Mark the bulkhead positions on the insides of the sheet sides, and glue and pin in place. Draw the bow ends together and cement. It is stronger to chamfer the insides of the bow rather than stick the two sides together and round off the outside. The hull bottoms are now sheeted with $\frac{1}{8}$ -in. balsa, grain across the hulls, and the tops are treated in a similar manner. The top sheeting can either be finished $6\frac{1}{2}$ in. from the bow and recommenced 4 in. further aft, to allow the bridge to be flush with the decks, or the $\frac{1}{8}$ -in. sheet can be carried right the way through and the bridge cemented on top. The bridge is simply a 4-in. wide strip of $\frac{1}{8}$ -in. ply 10 in. in length with the outer ends shaped to conform with the hulls. $2\frac{1}{4}$ in. from the bow and $1\frac{3}{4}$ in. from the stern a piece of $\frac{1}{4}$ -in. \times $\frac{3}{8}$ -in. hardwood is glued across. Make sure that the hulls are square and level with each other, and leave to dry very thoroughly.

The centre fin is also cut from $\frac{1}{8}$ -in. ply to the shape given;





the angles, etc., can be taken off the half-size drawing if you do not wish to lay it down by the measurements shown. This fin should be glued true and square to the centre of the underside of the bridge, and two small pieces of $\frac{3}{8}$ -in. quadrant ($\frac{1}{4}$ round timber) glued in place to reinforce it.

The rudders are cut from tinplate or thin brass sheet, and may be cemented to the transoms of the hulls or, more elegantly, to bolts glued into the transoms before the top of the hull is sheeted. These rudders can be used for trim adjustment on the model by bending them slightly; bolting them in place means that if they are used frequently, replacement is a simple matter.

The rigging of the model is identical with that of the 24-in. yacht in the previous chapter, the only points worthy of note being that the shroud-eyes can be screwed into the after corners of the bridge and that no automatic steering gear is fitted.

Finish and painting of the hulls is also as the previous model, but no lead weight is required.

A characteristic of most catamarans when they are running downwind in a stiff breeze is a tendency to bury the bows, and you may therefore like to provide yourself with some small weights which can be attached on the deck at the stern of each hull to enable the model to travel faster downwind without trying to imitate a submarine.

Despite its simplicity this model is extremely efficient and its speed will surprise you.

CHAPTER EIGHT

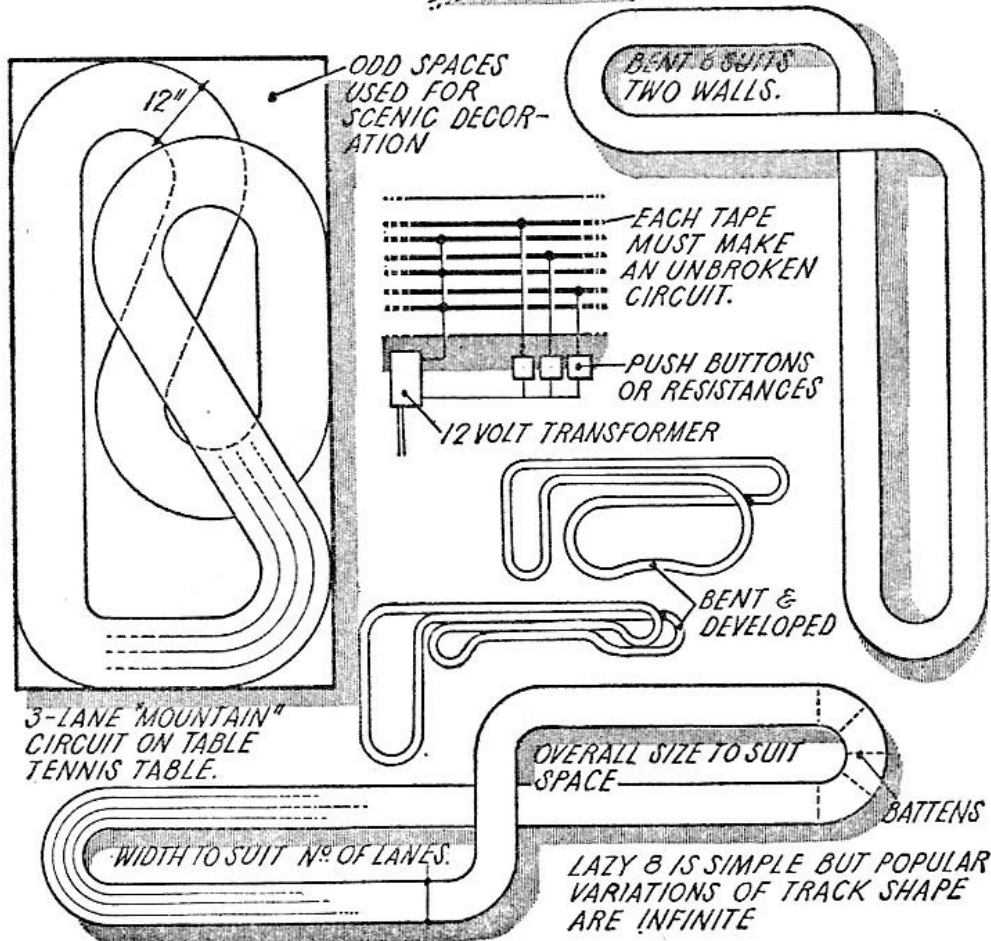
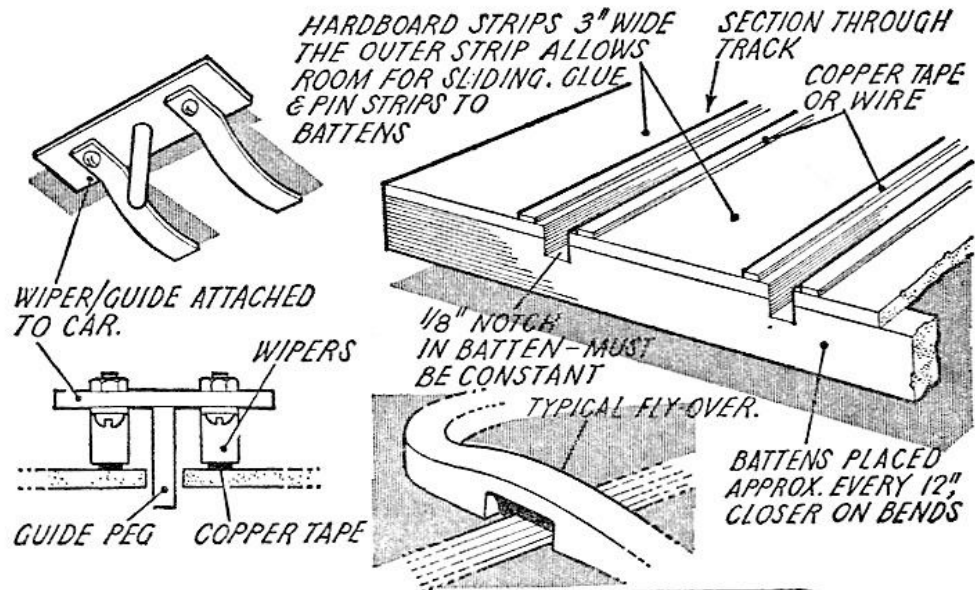
Electric Car Racing

ONE of the fastest growing hobbies nowadays is that of electric car racing, where the models are guided on a track by means of a slot in the surface of the track, and conductors each side of the slot provide the current to drive the car. The amount of current fed to the car is controlled by a push button or resistance operated by the 'driver', so that the speed of the car can be varied. Since the cars are usually far too fast for the track a considerable amount of skill is required to keep the cars from rolling off the track at the corners, and very exciting racing is possible. This hobby was introduced by the magazine *Model Maker* only nine years ago, but now bids fair to rival model railways in popularity.

TRACK CONSTRUCTION

The usual type of homebuilt track is made from hardboard and this is cut into strips and pinned on to a batten framework to make the slots. The usual scale of cars is $\frac{1}{32}$ and a width of 3 in. for the strips and $\frac{1}{8}$ in. for the slots is fairly standard. Slot width is, in fact, laid down by the Electric Car Racing Association as not more than $\frac{1}{8}$ in. wide and $\frac{3}{16}$ in. deep.

Straight stretches are, of course, very easy to make with straight 3 in. wide strips, but some skill is required to cut the curves; it is usual to use two saw blades bound together to cut a $\frac{1}{8}$ in. wide slot, except where curves are actually sections of a circle. In any event when the track has been pinned down it is advisable to go round with a file or rasp and make sure that a smooth $\frac{1}{8}$ -in. slot exists all the way round.



Tracks may have as many lanes as required. Three is usually a desirable minimum since although two cars can be raced quite happily, the fun is more than doubled when there is a third car competing. There are some tracks with as many as eight lanes, but the average club track uses four.

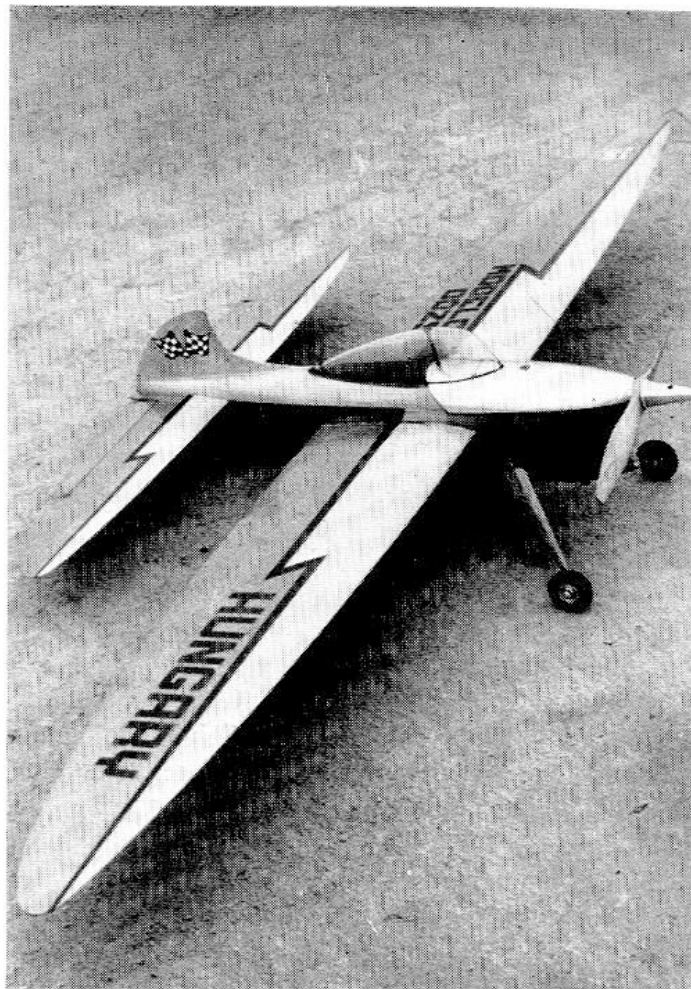
Since if the track is a simple curve or oval, the car on the inside lane would have a smaller distance to travel (although, of course, with sharper curves), it is usual to make the track cross at one point to form a figure eight, either straight or bent. Sketches of one or two layouts are given. The inside radius for $\frac{1}{32}$ scale should not be less than about $3\frac{1}{2}$ in. on a very tight turn.

With the track laid a method of conducting electricity must be arranged, and this can either be flat copper tape (available commercially) glued each side of the slot, or any conducting metal cut into narrow strips and glued in place with an impact adhesive. It is possible to use enamelled copper wire of about 18 or 20 gauge; after this has been stuck down the top is glasspapered to remove the enamel and to allow the car to pick up current.

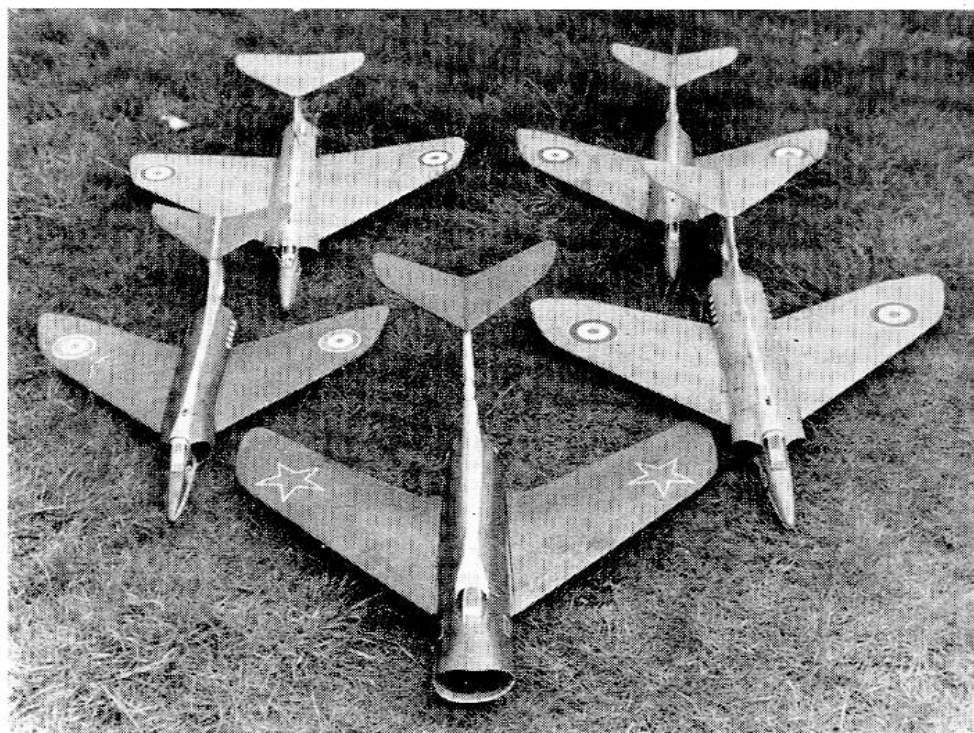
The electricity is usually supplied through a 12-volt transformer of the type used for model railways, and the only requirement is that it should have a capacity of at least $\frac{3}{4}$ amp. for each lane. The negative lead can be laid to one wire of each pair and the positive leads taken separately and each passed through a push button or a resistance before being joined to the rail. With a push button the current is fed in a series of bursts, the car automatically slowing up when no current is being received. Smoother control is obtained by having a variable resistance, either of the linear type or a knob that can be rotated to increase speed.

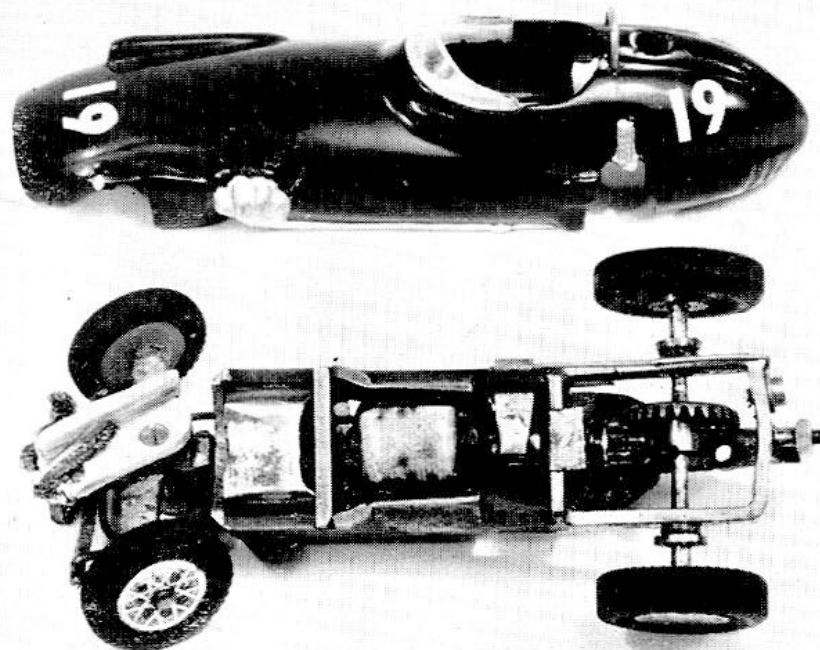
The track must be soundly wired, but once working satisfactorily should not require any further attention. This description is of necessity brief, but covers the essential requirements. Refinements such as lap recorders, trackside scenery, etc., are all possible, but beyond the scope of the present chapter. Similarly, little ingenuity is required to

An international class team racer, powered by a 2.5 c.c. engine and capable of about 120 m.p.h. This Hungarian model was one of the entries in a recent World Championship event; as many as 26 nations take part.



Below, a group of 'ducted fan' models, all based on full-size jet aircraft. The engine is mounted inside the centre of the body and drives a multi-blade fan, drawing air in at the front and expelling it as a 'jet' at the back.





A 1/32nd scale electric slot car. The body screws on to the chassis, which is shown upside down to reveal the slot guide which steers the front wheels and picks up the current. Note contra gear rear axle drive.

A commercially-made electric go-kart posed on the type of track on which it is raced. No national rules exist, at the time of writing, for racing this type of model, but they are good fun to run.



make a track which comes apart into easily stowed sections, a favourite place being behind the wardrobe or under the bed!

THE CARS

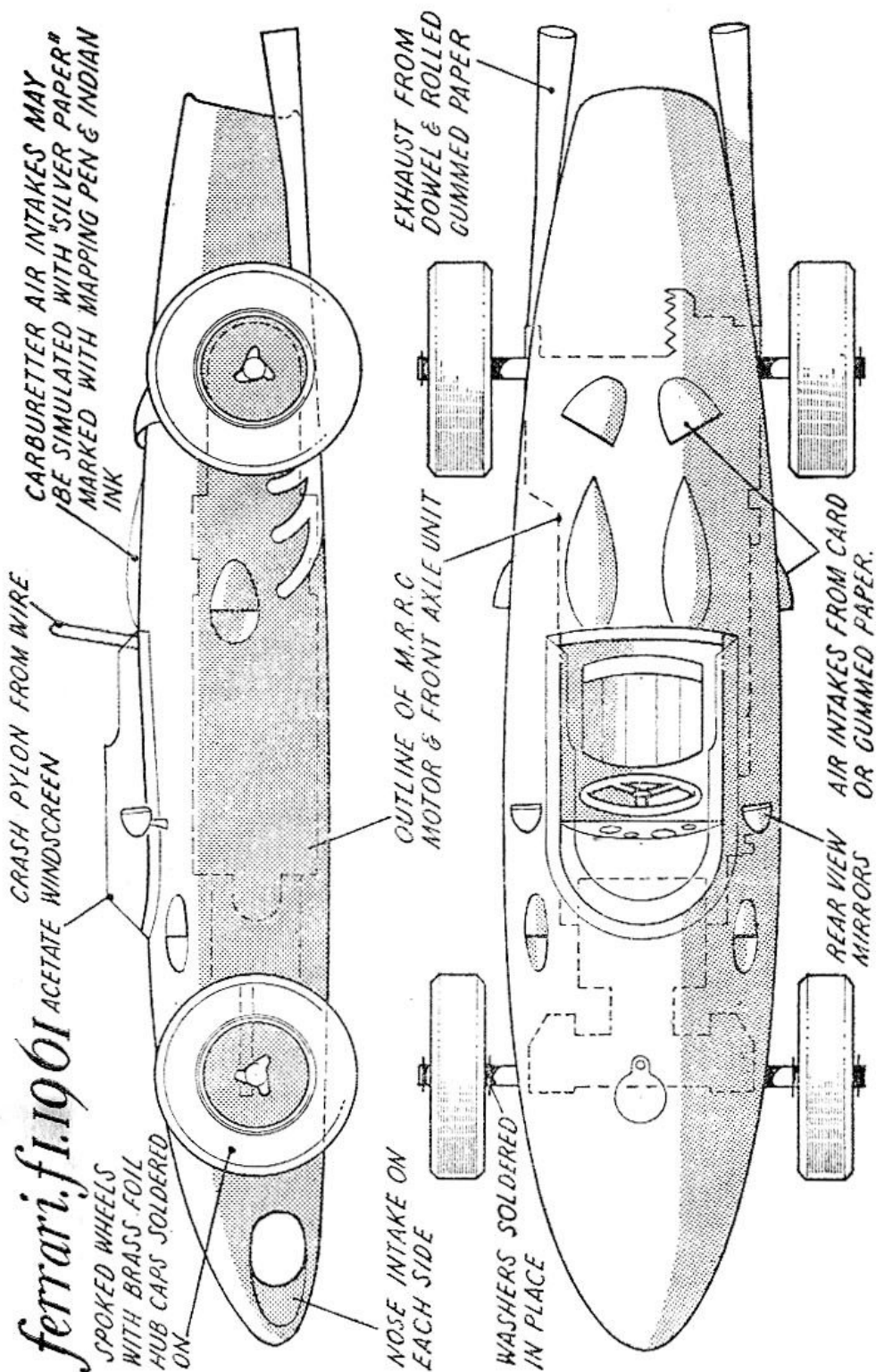
A wide range of commercial components is now available for cars, but it is quite possible to motorize some of the plastic push-and-go models which can be bought in any toy shop. A car can be built for about £1 from scratch, and with the components available very little work is needed to produce a fast and successful model.

Possibly the simplest method of making a car from the outset is to buy an M.R.R.C. or Scalextric motor, which includes the back axle and the drive gears in the motor, etc. If a model railway motor is to be converted, it is necessary to fit a pinion and contrate gear to drive the back axle in much the same way, the difference here being that some form of chassis or plate is fitted, on which to mount the motor and the axle.

Front end steering units are also available, one example being the M.R.R.C. type which terminates in a nylon block. This nylon block fits between two lugs on the front end of the motor, and a hole can be drilled through the nylon so that one 8 BA bolt will secure the steering unit to the motor and back axle on almost exactly the right wheel base of most current Grand Prix cars.

Wheels are also available; these are usually a force fit on the rear axle, and are simply pressed into place. They must run free on the front axles, or stub axles, and in most commercial axles a hole is provided in which a pin can be soldered or the axles are left sufficiently long for a small washer to be soldered on the outside to retain the wheels.

Bodies are also available commercially, a wide range of plastic bodies of most modern Grand Prix and sports cars being produced. These require only light trimming and cut-outs for the axles, etc., plus the addition of a few transfers to make very realistic little bodies. To retain them on the



chassis units, a wood block can be glued into them immediately over the nylon bearing block and a screw passed through the nylon block into the wood. Alternatively wire clips can be bent and glued with small silk patches on to the bodies to clip over the motors.

Wooden bodies prove quite durable in the hurly burly of racing, and the one shown can be built from fairly hard balsa and will stand a good deal of hard use. Tissue covering and finishing as detailed elsewhere in this book is necessary, but many people would much prefer to make their own bodies than use a commercial moulding.

The only tricky part of the cars is the arrangement of the pick-ups; in the case of a car with a fixed front axle, it is only necessary to secure two wipers beneath the car to trail on the contact strips. Thin phosphor bronze or brass shim is suitable for these, and they should be arranged to have a small amount of spring to ensure good contact. In the case of a car fitted with a metal chassis, it is necessary to insulate one wiper and take a lead from it direct to the insulated motor brush.

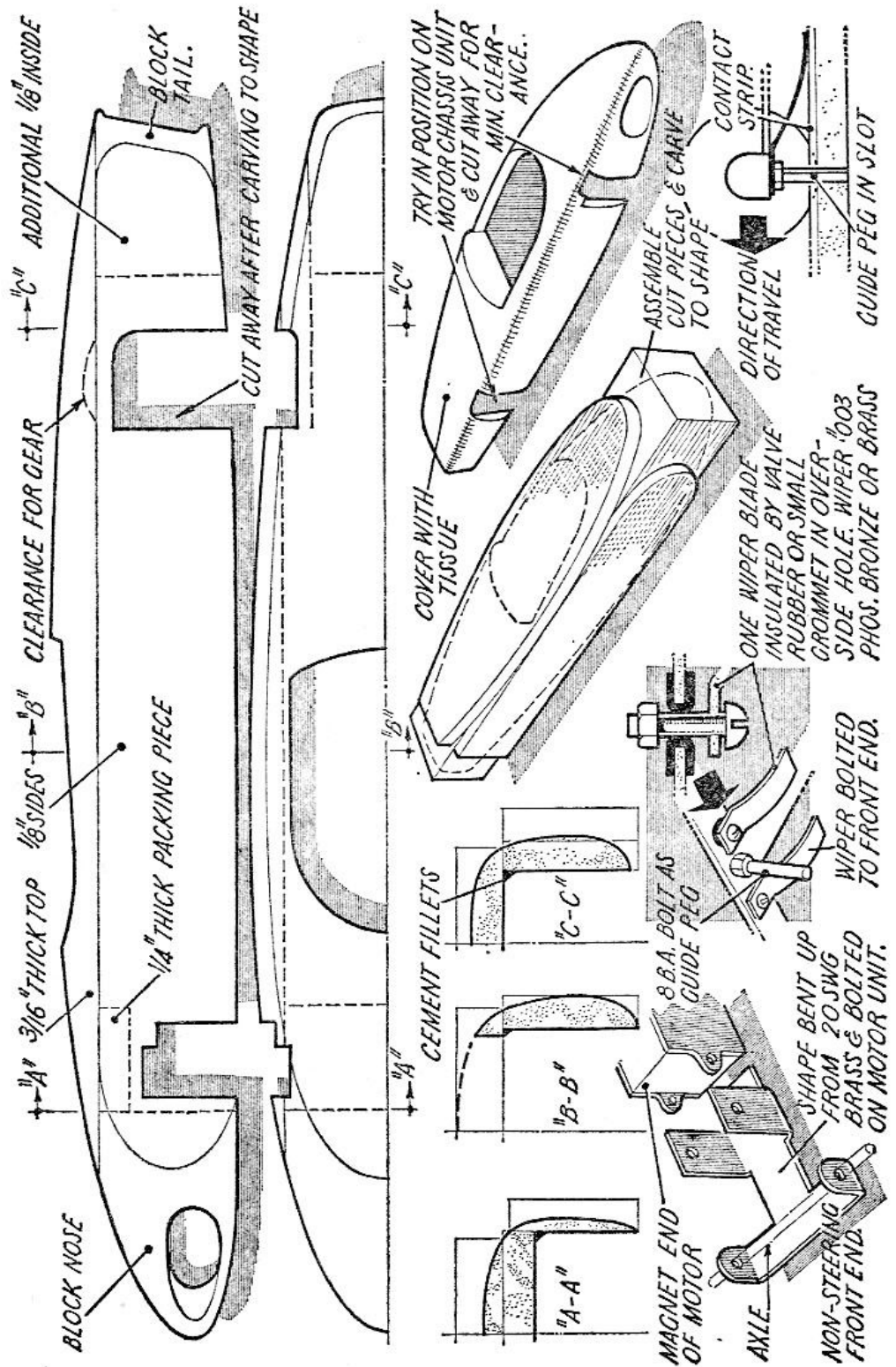
Where a steering unit is used it is usual to mount one wiper each side of the slot guide or peg so that the car can swing on the track without bringing the wipers out of contact. A length of nylon curtain rail or pieces of tough plastic can be used to make the slot guide.

The Charter of the Electric Car Association is reproduced below and explains quite a number of additional points. The full charter does, in fact, include rules for rail car racing in which the car is guided by a raised rail rather than a slot, but this is a form which is rapidly becoming obsolete, although many fine club tracks using this system still exist in various parts of the country.

ELECTRIC CAR RACING ASSOCIATION

RULES GOVERNING CARS AND TRACKS CARS

1. All models, including those built from commercial kits, to be built to $\frac{1}{32}$ in. scale with a tolerance of $\frac{1}{16}$ in. in track and wheelbase, and bodies must also be within reasonable limits.



2. Any one chassis can only be fitted to any one body; i.e. a single chassis cannot be raced in one event with a G.P. body and in another event with a sports or G.T. body even though the track and wheelbase measurements are the same.

3. A single chassis cannot be raced in more than one heat of the same event even though fitted with a different body and/or driven by another driver.

4. No car to exceed a maximum overall width of $2\frac{1}{2}$ in.

5. No projections downwards, capable of guiding the car, other than the steering guide and contacts are permitted.

6. All cars must be models of full-size prototypes.

7. All cars must start a race with a driver securely fixed.

8. All cars must carry clearly legible racing numbers in two places. It is also **recommended** that cars should carry visible major appendages, i.e. steering wheel, mirrors, windscreen, exhaust pipes, identity badges.

GUIDES

Rail

9. Rail guides, either pegs or tunnels, must be parallel when viewed from the front and no in-curve will be allowed. Excessive wear sufficient, in the opinion of the Stewards, to give an advantage on the particular guide rail being used will not be permitted.

SLOT

10. Maximum length of guide in slot measured extreme front to extreme rear must not exceed $\frac{3}{4}$ in. or project, at any point, more than 1 in. forward or rearward of the centre line of the front axle.

11. Slot guides must move freely lengthwise in a slot $\frac{3}{16}$ in. deep.

TRACKS

Rail

12. The track guide rail which also acts as the negative contact to be $\frac{3}{16}$ in. high.

13. The track return positive contact rail, wire, tape or strip, must be laid flat on the track surface on the left hand side of the guide rail and its centre must be approximately $\frac{3}{8}$ in. from the guide rail.

Slot

14. The slot dimensions must be a minimum of $\frac{1}{8}$ in. and a maximum of $\frac{3}{16}$ in. wide by $\frac{3}{16}$ in. deep. There must be one point on each lane where the depth of the slot does not exceed $\frac{3}{16}$ in. otherwise open bottom slot is permitted.

15. The contact surfaces on each side of the slot must be a minimum width of $\frac{1}{8}$ in. and a maximum of $\frac{1}{4}$ in. (metal sprayed

tracks excepted) and at all points on the track there must be pick-up contact $\frac{3}{16}$ in. from the centre of the slot.

16. Looking in the direction of travel, the positive contact must be on the left of the slot and the negative on the right.

17. Clubs must provide accurate lap recording. No additional fittings to the cars should be necessary to operate this.

Rail and Slot

18. All lanes to be supplied with current of equal voltage.

19. Current to be D.C. - minimum 12 volts.

20. Controller plug sockets should be either 2 pin, 2 amp, or bayonet.

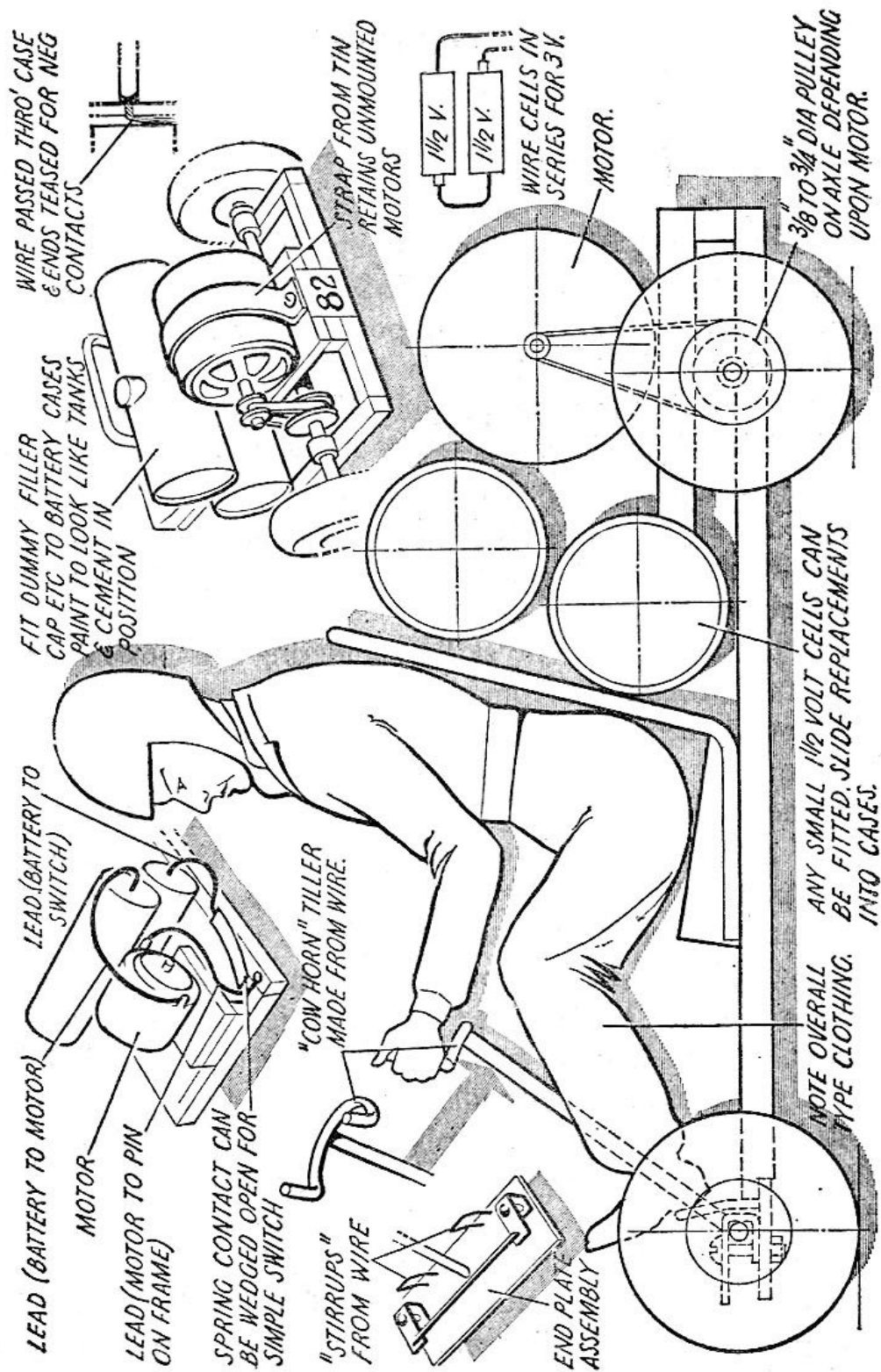
A Free-running Go-Kart

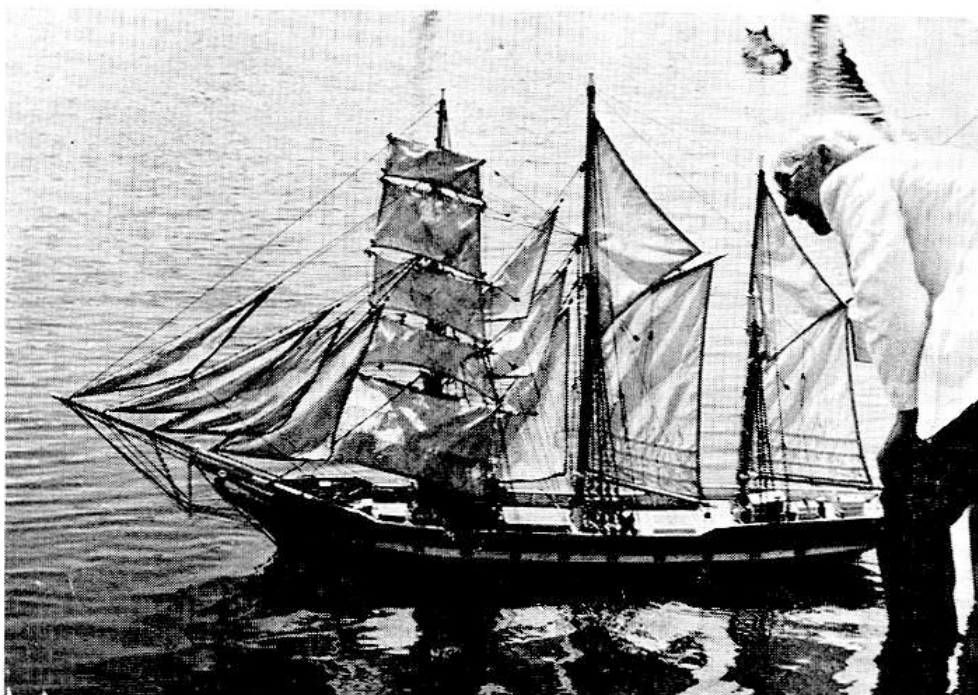
A RECENT craze which seems to be still growing in popularity is Karting, and the simplicity of a full-size go-kart makes it quite an attractive proposition for a model. The only difficulty is that there is nowhere to conceal the batteries, but in the accompanying design they are made as unobtrusive as possible.

Construction is very simple, and can be in one of two forms. If you have a soldering iron it is very easy to make the entire frame from heavy gauge brass wire or even iron wire subsequently painted.

For those who have no skill at soldering it is possible to make the entire model from birch dowel or bamboo scraped to a round section, the difference being only a question of jointing.

Make the basic framework first; alternatives are given for choice of materials, and obviously a metal model will use those parts which can be soldered. The motor mount will to some extent depend upon the type of motor available, and it can either be a tinfoil platform or piece of sheet balsa, the motor being bolted in place if it is provided with a base, or held in place by a metal strip held by two bolts to the platform. A small pulley can be fitted to the motor shaft, but if no really small pulley is available a piece of plastic insulation strip, off lighting flex, can be sliced into tiny segments and two of these slipped on to the shaft (make sure they are a tight fit) to provide a guide for the rubber band. In this case the actual shaft itself forms the 'core' of the 'pulley'. In a similar manner small washers can be soldered on, but care should be taken to grip the shaft in a pair of taper-nosed pliers or to wrap the motor in a damp

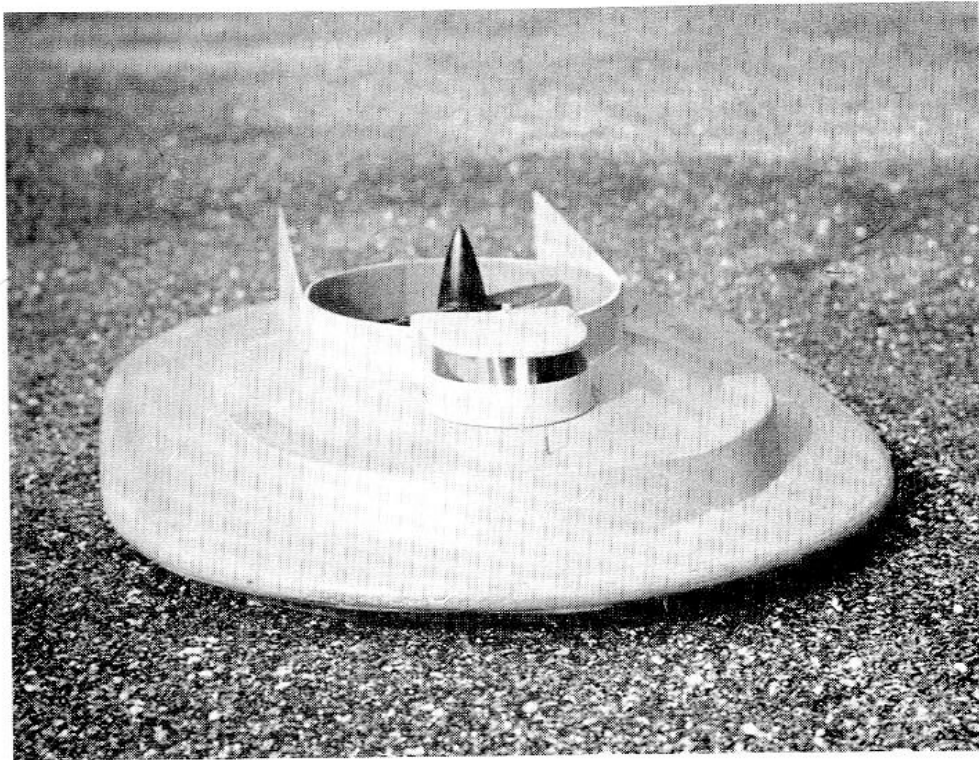




A magnificent model barquentine which is an excellent sailer. Length of this model is about 5 ft, and it is not the sort of project recommended to the beginner, especially as scale sailing vessels are among the hardest to make sail properly.

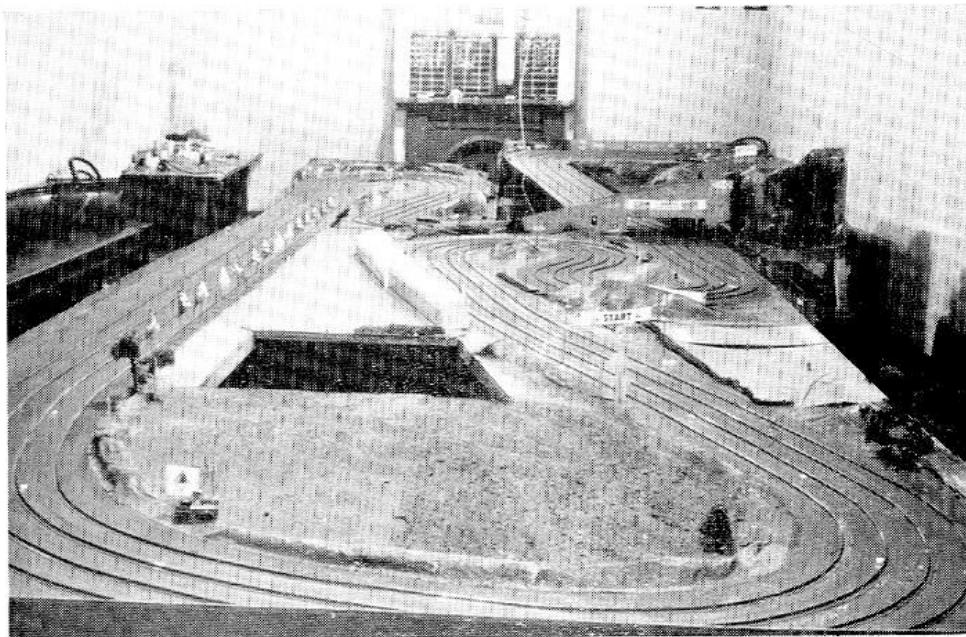
A young enthusiast racing in a competition for Marblehead class yachts. Both boats await the starter's whistle. The extra sail, the spinnaker, indicates that the models are setting off on a downwind course, called a 'run'.





One of the prototypes of a true hovercraft model developed by the author and available in kit form. This particular example had a .19 cu. in. ($3\frac{1}{4}$ c.c.) glow-plug motor and travelled at 12 m.p.h. over a good surface.

An electric car track built by a Northern club. This particular track is for rail racing, a form which is now virtually obsolete, but the same type of layout, with one long straight and a twisty bit, is popular for slot racing.



rag in order that the heat shall not be transmitted along the shaft and damage the motor.

The rear axle is simply a length of piano wire and most model shops can supply pulleys to fit. Make sure that the pulley lines up with the motor pulley, and solder washers to prevent side float in the axle.

The front axle can also be a single length of piano wire, but it is more fun to have a steerable model and a very simple steering linkage is shown. The kingpins and radius arms can be cut from a piece of brass sheet or tinplate with tin snips, but it is also possible to find suitable fittings from some types of old electric light plugs, so that a rake through the scrap box may well save a little work.

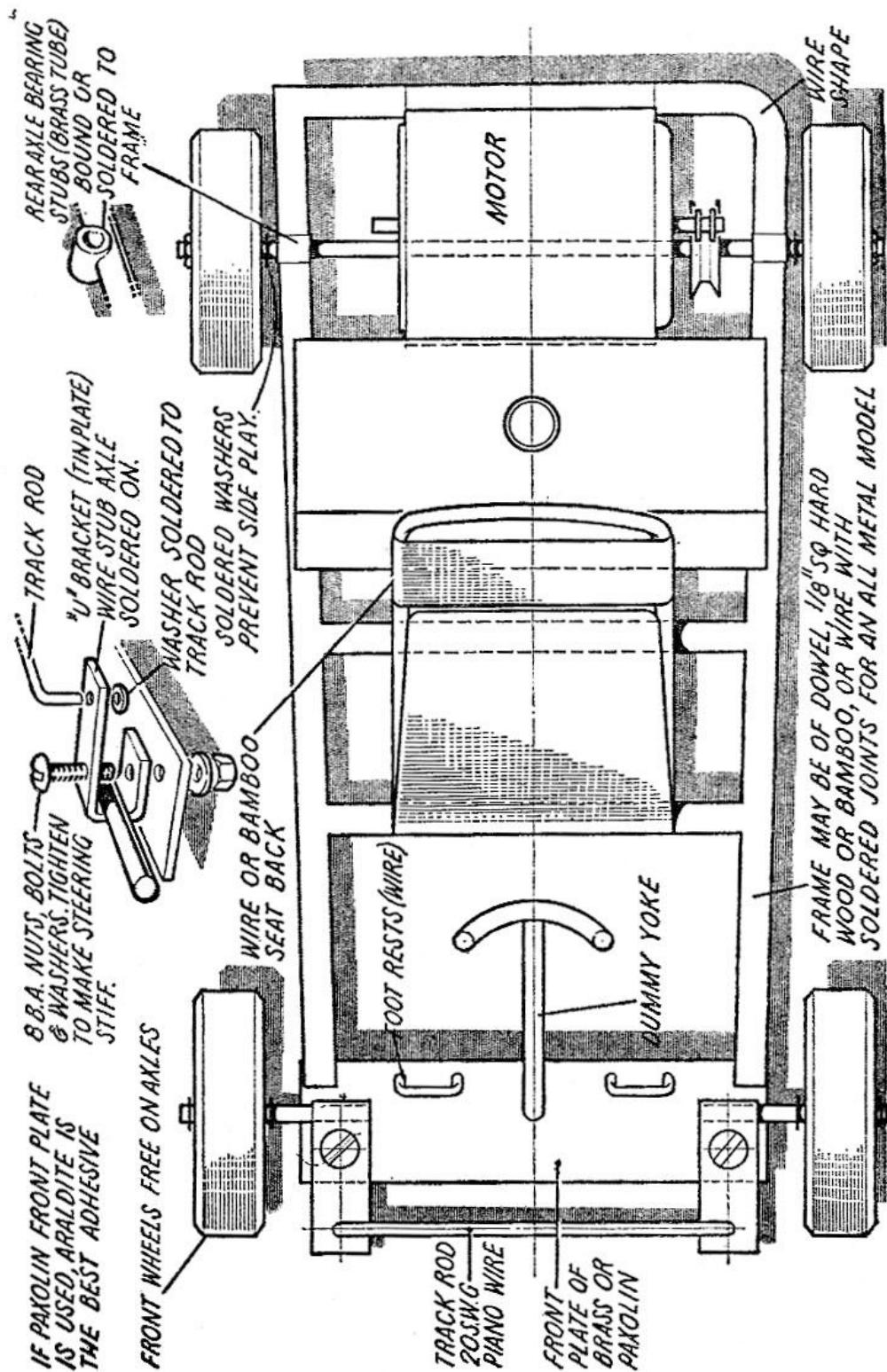
The seat is a simple wire or bamboo frame with a block balsa cushion. An old glove can be used to upholster it for a good effect.

The driver, without which no go-kart is complete, can either be converted from a doll, or made from a soft wire frame with a carved balsa head or a caricature head made from a table tennis ball. The steering yoke is dummy and forms an additional means of attaching the driver. His feet should be sewn or wired with fuse wire to the foot rests, and his hands to the yoke, which will secure him adequately in position. Overalls can be made from a scrap of material and can be cemented together (hems on the inside) if you do not fancy sewing. They are slipped on to the framework of the body, etc., and glued down the back before fitting in position.

Battery storage is clearly shown on the drawing. A spring brass contact fitted over the back axle as shown can be wedged apart with a piece of wood to form a very simple switch.

The normal model car racing type wheels can be obtained from most model shops, but alternatively a glance at some of the small toy cars or tractors in any toy shop or department store may provide you with suitable wheels at relatively small expense.

The car may be run tethered to a nail or pin in the centre



of the floor (drive it in a heavy block of wood if it is a polished floor) or it will run in straight lines or wider circles untethered on any smooth surface, such as a school playground.

On Kites

KITE flying is a fascinating hobby less popular in this country than it was thirty or forty years ago, but still a fascinating form of modelling.

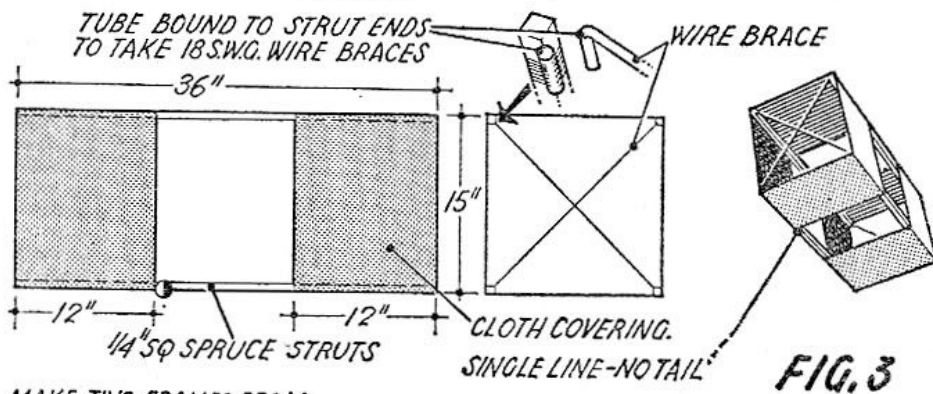
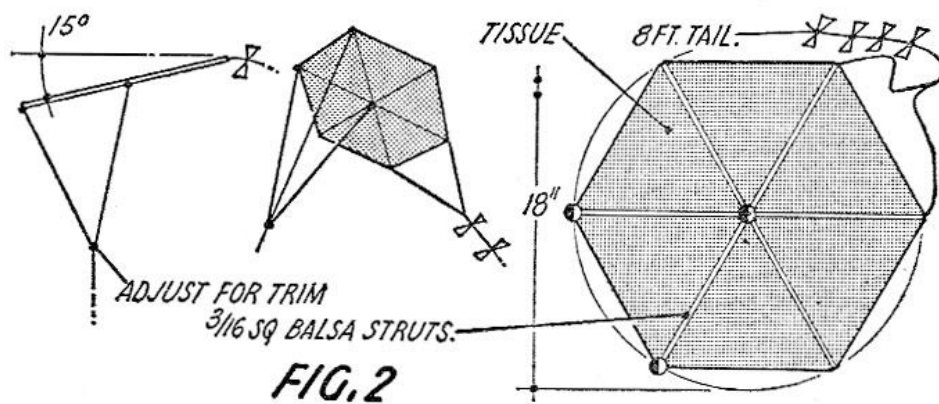
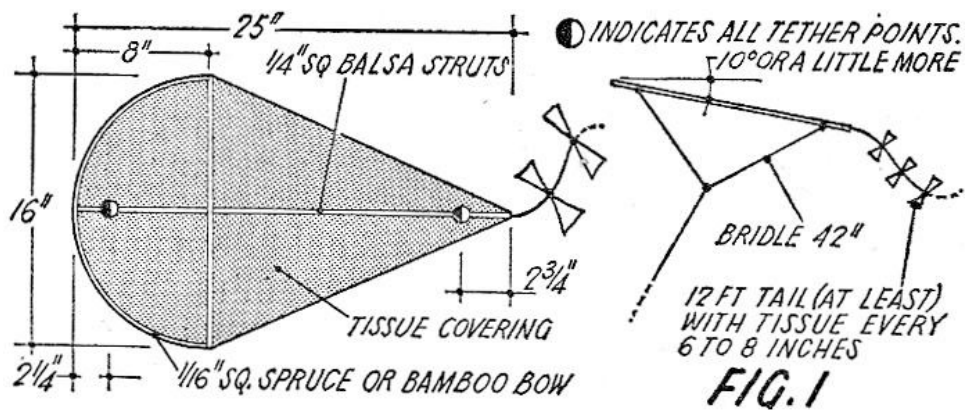
Basically a kite is a simple form of aerofoil deriving lift from the wind moving over it rather than it being moved through the air. Thus many of the problems affecting aircraft can be applied to kites.

The usual form of kite is a bow kite (Fig. 1), which is simply a flat plane held by means of a simple bridle at about 15 degrees to the horizontal. Since it is tethered only by two points it must be balanced both in area and in weight on each side of the line joining the tether points, so that it will fly flat and not dip to one side. Such a shaped kite requires a tail of considerable length for stability, the tail acting in some ways like the tailplane of an aircraft. There are various forms of tail, the most popular being strips of tissue or silk tied at short intervals on the tail string, and this is still probably as efficient a method as any.

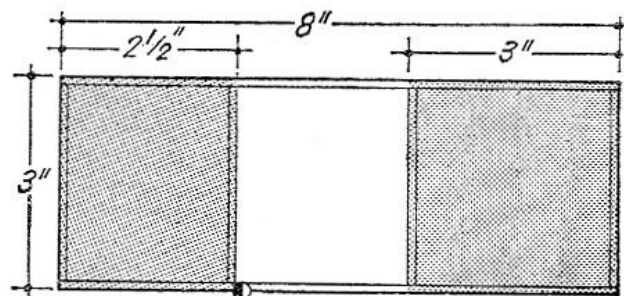
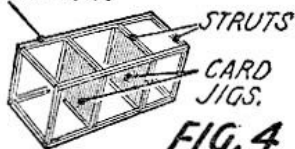
An improvement on this kite is to give the basic flat surface a shape by bowing the cross member when it becomes an eddy kite. There are however, quite a few complications with this type of kite, and for normal flying the average young modeller, to whom kites appeal most, may not be prepared to go to such lengths.

The other two types of kite normally encountered are the hexagon kite (Fig. 2) and the square box kite (Fig. 3).

The proportions given in these drawings can be followed for larger or smaller kites of the same types with corresponding adjustment in material sizes. With any kite of less than about 18 in. in length balsa can be used quite satis-



MAKE TWO FRAMES FROM
1/16" SQ Balsa. ASSEMBLE
WITH AID OF CARD JIGS TO
FORM A RIGID FRAME
TISSUE COVER THE END
SECTIONS AFTER REMOVING
CARD JIGS



factorily for the frame members and tissue as used in model aeroplanes is suitable for covering. Care should be taken to use what is known as 'hard' tissue or Japanese tissue, or if a porous tissue is used to give a thin coat of banana oil to seal the pores.

For kites of 18 in. or over, it is desirable to use hardwood spars, spruce, etc., being quite suitable. Very light cloth such as thin nylon or Terylene, or the material known as nurses' veiling, can be used for covering larger kites.

The covering should in all cases be taut, but not so tight as to distort the basic shape. It is essential that the material be applied evenly all over, since a kite with sagging covering on one side will be out of balance and will never fly successfully.

Naturally the weight of string used has considerable effect since both the weight and drag influence the flying angle and the height to which the kite will rise. The small box kite in Fig. 4 should be flown on a spool of ordinary sewing cotton and in a fairly light breeze is capable of climbing almost out of sight. For larger kites thread should be used, with carpet thread for larger kites up to, say, 30 in. Over this size very light fishing line should be used. There are advantages in using nylon line, but this is extremely hard to keep coiled tidily.

The serious kite flyer will make himself a winch either by attaching a large diameter spool to a hand-drill, or by converting an inexpensive grindstone. One such tool selling for only 5s. or 6s. can be clamped to the end of a stick and will carry quite a large spool (ex-cinematograph film or tape recorder), on which can be stored several hundred feet of line.

An Electric Cabin Cruiser

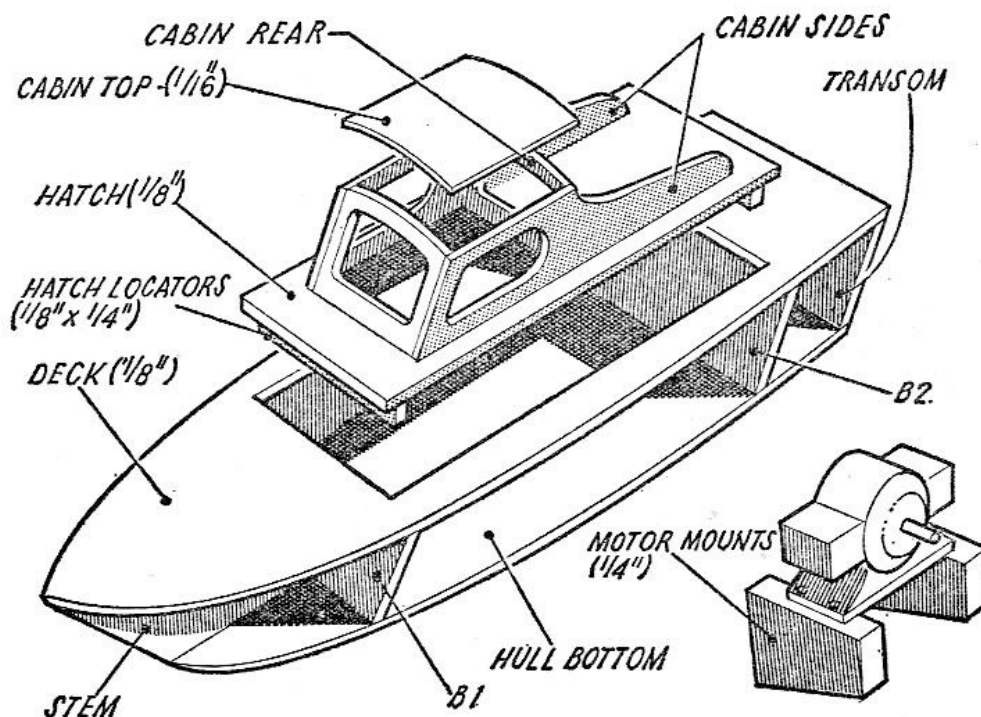
THIS little electric model is capable of giving fast performance and riding on quite choppy water in safety. It is designed to use any of the numerous small inexpensive electric motors now available, and details for a home-made shaft and propeller, rudder, etc., are given, although quite possibly better results can be obtained with a properly moulded propeller, etc., and, in fact, a suitable shaft assembly and rudder assembly can be bought for a total of about 2s. 6d. The cheapest motor available is about 3s. 6d., and the cost of the wood is very small, so that the whole thing can be built for less than 10s., which can be spread over two or three weeks if necessary.

The first step is to cut the deck and hull bottom. A sheet of $\frac{1}{8}$ -in. \times 3-in. \times 36-in. balsa would provide more than enough material for the model, and if this width of sheet is used it will be necessary to cut the deck in two halves; this is actually quite a good idea since it does ensure symmetry. If, however, you prefer to cut the deck in one piece, a sheet of balsa 4 in. wide can be purchased from most stockists.

Trace the deck outline and cut from the sheet. Cut the centre aperture and cement the two halves together. Trace and cut the hull bottom and also the two bulkheads B1 and B2, and the transom. Save a piece of sheet $7\frac{1}{2}$ in. by 3 in. if possible, to make the hatch cover.

On the cut pieces mark carefully the positions of B1 and B2, then cement B1 and B2 in place between the deck and the hull bottom. If you have been a little erratic in cutting and find that these pieces do not fit exactly, this offers no problem since the whole hull will have to be sanded at a later stage and any excess material may be removed. It is

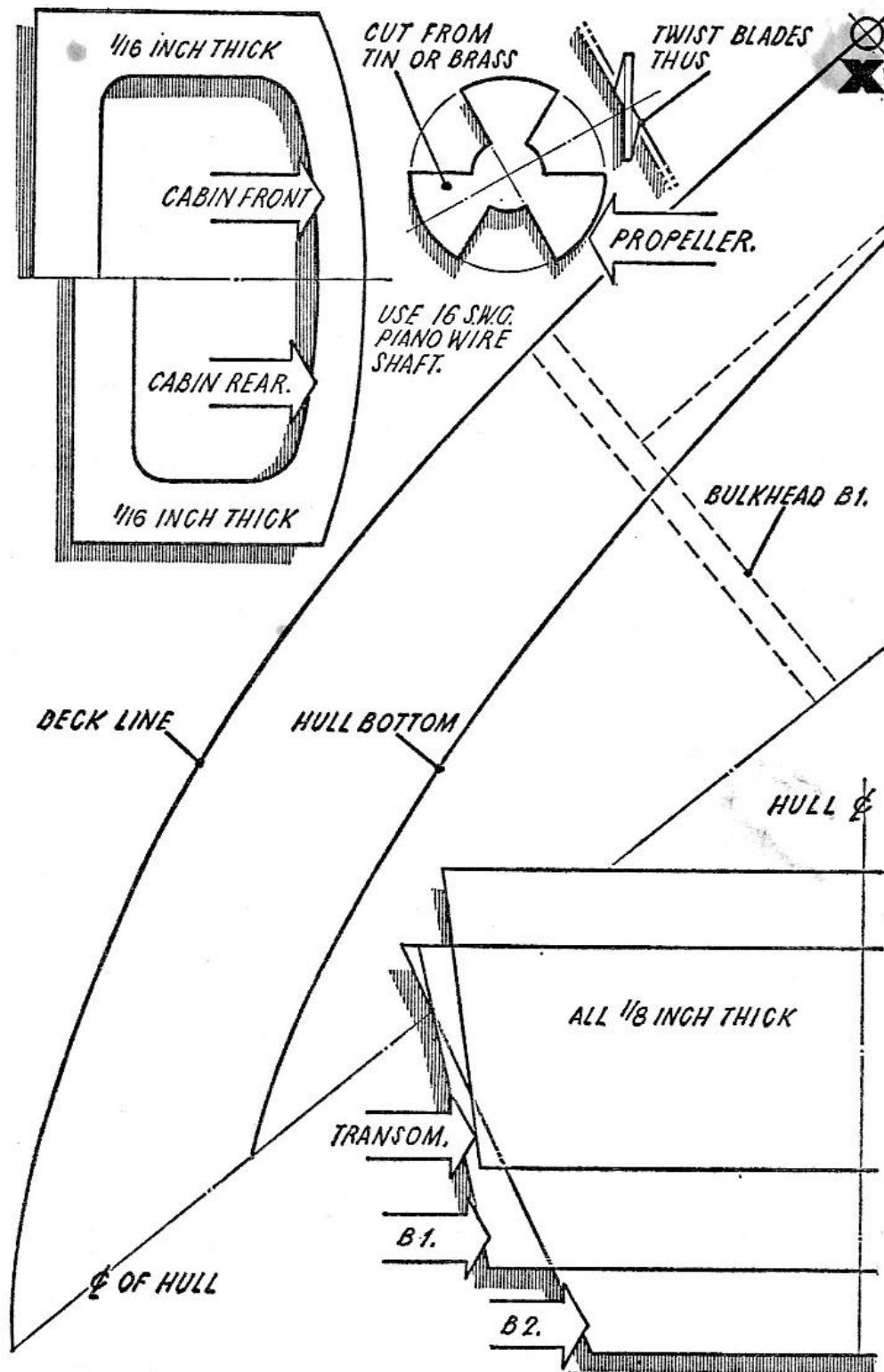
better to wait until B1 and B2 are dry before fitting the transom in place; again this can be set fractionally in from the extreme ends of the deck and bottom, and, when dry, sanded down to a nice flush surface.



When the cement is thoroughly dry take a piece of glasspaper of a medium-fine grade and fold it round a block of wood at least 6 in. long. Now glasspaper round the edges of the deck and hull bottom, keeping the glasspaper block in contact with both edges so that a bevel is sanded in which will exactly line up from top to bottom.

Sand the stem to a point, making sure that the centre line is now truly central.

The sides of the hull are covered with $\frac{1}{16}$ -in. balsa cut in short strips across a 3-in. sheet, so that when cemented in place the grain runs vertically from top to bottom. Start from the stern end and cut one piece. Allow about $\frac{1}{8}$ in. overlap top and bottom. Cement the piece in place, using a pin in each corner to hold it firmly in place. The sides of the



model twist throughout their length, hence the necessity of pinning. Repeat on the other side of the hull, then move forward and cut another piece, cutting it to fit snugly up against the first and leaving the same amount of overlap; cement in place and work forward in this way. Three pieces can be applied without interference each side, but the fourth bow piece should only be applied on one side. Make sure that it is glued firmly to the stem and has at least $\frac{1}{8}$ in. overlap. It is probable that this piece will not reach quite to the tip of the bow, so cement a small scrap in place so that the whole of the side is covered. When the cement is dry trim off the surplus and sand the edge of the sheet against the stem to the same angle as the stem. The other side can now be completed, again leaving an overlap up the stem. When dry the whole of the sheeting can be trimmed along the top and bottom edges and down the stem, and the completed hull can be glasspapered to a nice smooth finish.

Mark the centre line on the underside $2\frac{3}{4}$ in. from the stern, and cut a $\frac{1}{8}$ -in. slot $\frac{3}{4}$ in. in length. The stern tube is cemented into this slot, and the remainder of the slot filled with scrap $\frac{1}{8}$ -in. material. Apply a fillet of cement round the tube both inside and out. The rudder can also be positioned on the centre line, the hole being drilled $\frac{3}{8}$ in. from the stern. In the centre of the deck, also $\frac{3}{8}$ in. from the stern, drill a corresponding hole and fit the rudder tube in position, glueing securely. The rudder and propeller shaft need not be fitted at this stage.

Cut the two motor mounting blocks from scrap $\frac{1}{4}$ -in. material (two pieces of $\frac{1}{8}$ in. each side can be used) and glue the motor mounting shelf in place on the blocks. Mount the motor on this shelf, then place in the boat, slip the propeller shaft in place and line up the motor shaft accurately. It may be necessary to move the mounting forward a little, but the exact position will depend upon the type of motor being used and the height of its shaft from its mounting base. When the position is decided, glue the mounting in place.

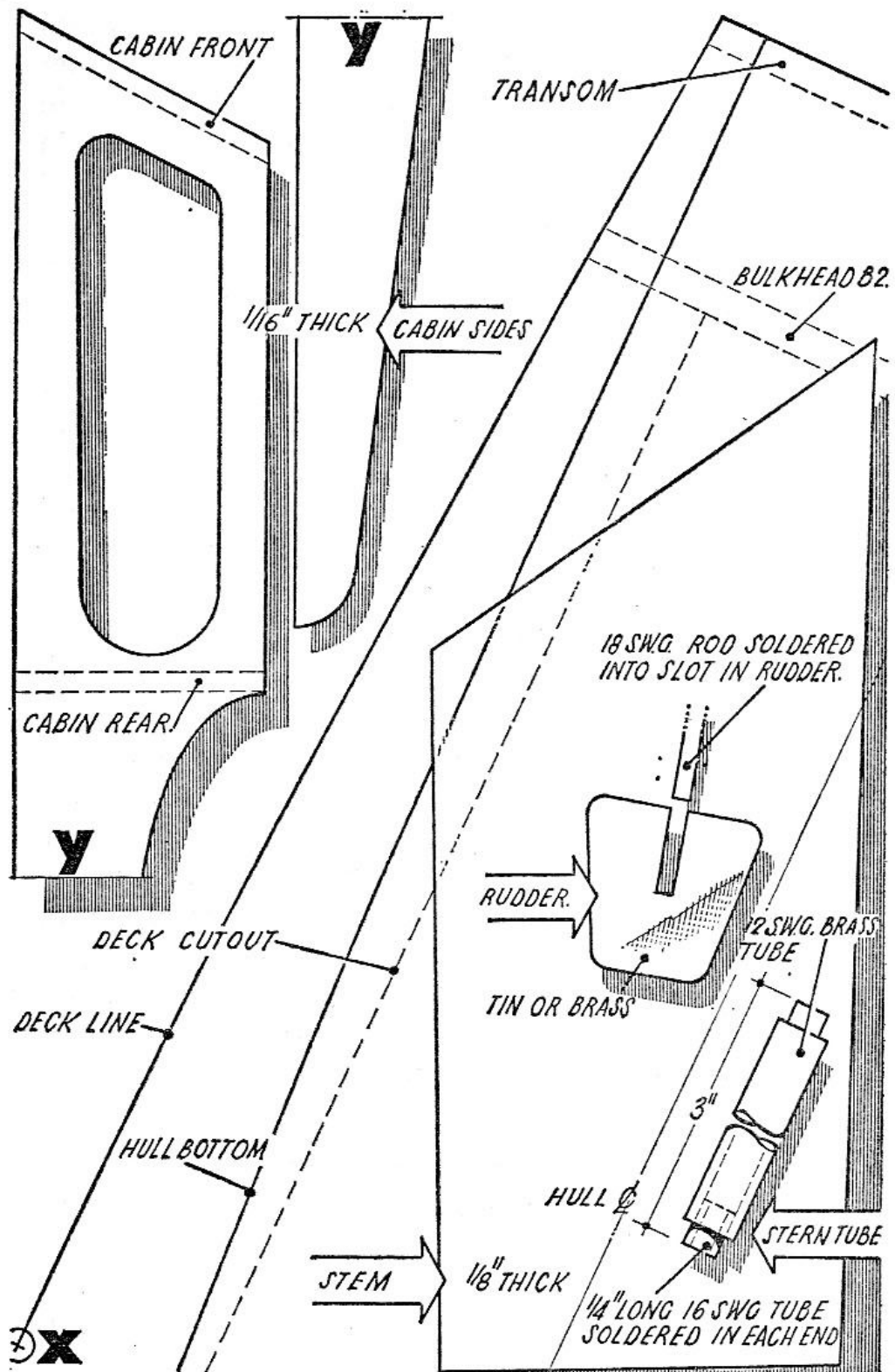
Now take the $7\frac{1}{2}$ in. \times 3 in. rectangle and mark the extent of the deck opening on its underside. Cement a

piece of balsa across the underside at each end, inside the marks, to position the hatch cover over the well. The corners of the hatch sheet may be rounded if desired. Mark on top two lines 2 in. apart central about the centre line; cut the cabin sides and cabin front and rear, and cement in place using the lines as a guide. When cutting the cabin windows use a pointed knife or broken razor blade, and after removing the unwanted material go round the inside of each window with a piece of very fine glasspaper wrapped around a pencil. If you wish to colour or furnish the inside of the cabin this must be done at this stage; in this case it is advisable to finish the outside at the same time, since the windows can then be glazed with thin acetate sheeting, and the cabin top added.

The hatch sheet itself and the entire hull should be covered with model aircraft tissue, doped on with clear cellulose dope followed by several coats of sanding sealer, and a cellulose dope finish to the required colour scheme. Notes on finishing this type of model have already been given in Chapter Six.

Now replace the propeller shaft and connect to the motor shaft with a length of thin rubber tubing. Valve rubber can be used, but if this is too large in diameter and tends to slip, the rubber sleeving used in electric flexes can be used. Rubber is much better for this purpose than neoprene, or the plastic insulation often found on electric flexes, since this is considerably stiffer and furthermore tends to harden. The aim should be a completely true line-up, so that all the motor power is delivered to the motor propeller rather than wasted in overcoming unnecessary friction.

Slip the rudder in place and bend the wire over to locate on the tiller rack. This is not an easy job to do without pointed nose pliers and you may therefore like to solder or cement a washer in place at the top of the rudder wire to prevent too much play. Slip a 4½-volt flat dry battery into the model and place in a bowl of water. Move the battery slightly to adjust the trim of the model, then mark its position and glue one or two scraps of ⅛-in. balsa to the floor



of the boat to hold the battery in the position giving reasonable trim.

The model can be dressed up with fittings carved from scraps of wood or plastic, or purchased from your model shop. A photograph in any of the motor boating magazines will give you ideas on what sort of fittings you can incorporate.

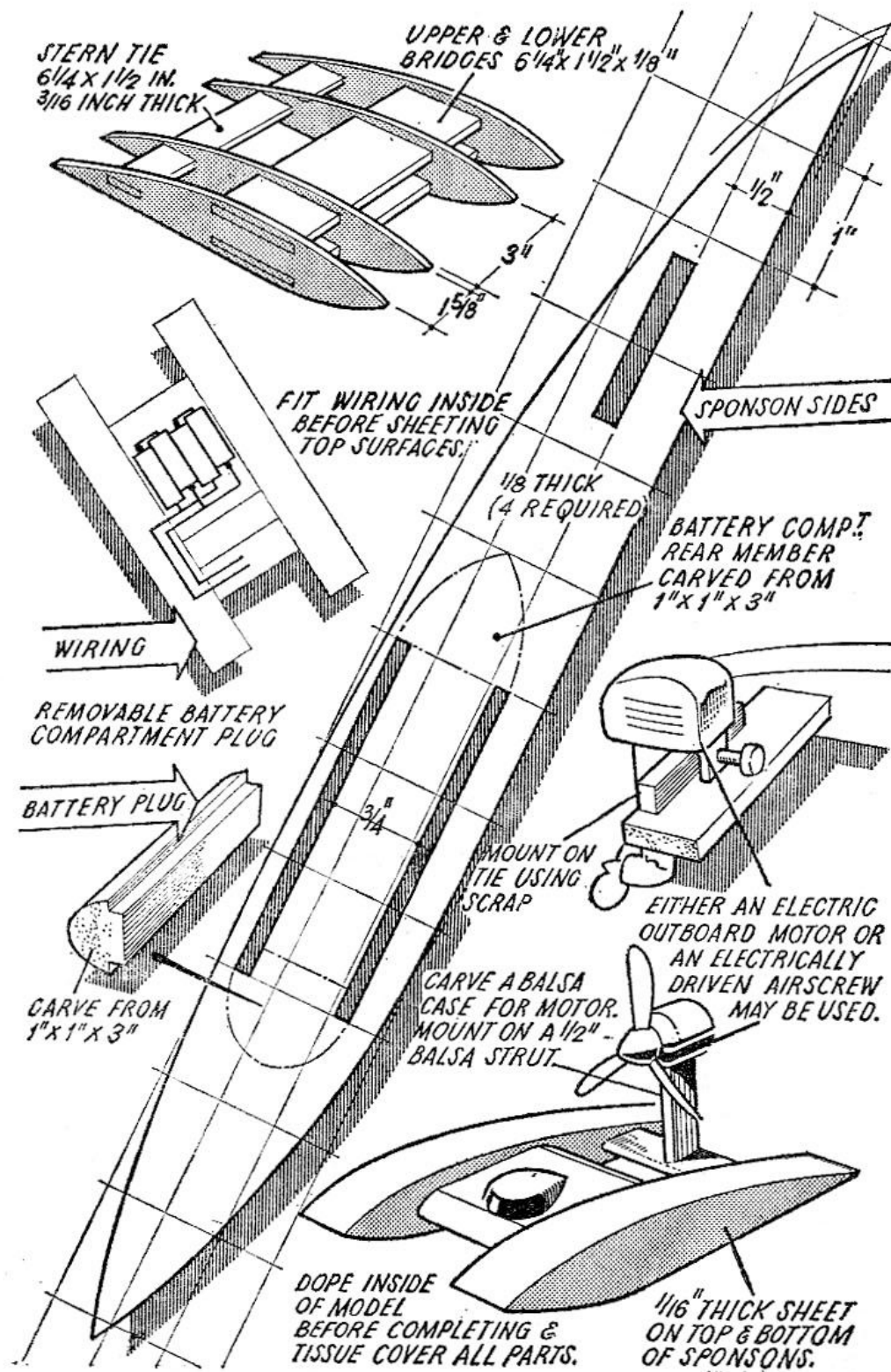
An Electric Catamaran

THIS little model is a powered catamaran and is intended for either electric outboard propulsion, electric airscrew propulsion or diesel airscrew propulsion. It is simple and quick to make and is certain to cause a considerable stir in action.

For an electric powered version use the sketch shown on the drawing. A grid 1 in. \times $\frac{1}{2}$ in. can be laid out directly on to a sheet of $\frac{1}{8}$ -in. balsa and the shape of the pontoon side drawn on. Cut this shape out and use it as a template to cut three more sides. Cut the appropriate slots and slide on to the upper and lower bridges and stern tie which are simple rectangles of balsa as detailed on the plan. If you wish to use a $4\frac{1}{2}$ -volt flat battery instead of four pen cells it will be necessary to make the depth between the bridge pieces a minimum of $\frac{7}{8}$ in.

Cement the sides to the bridges etc. after checking that the whole assembly is square, and leave to dry. When dry sheet the bottom surfaces of each pontoon, using 3-in. strips of $\frac{1}{16}$ -in. balsa with the grain running across the pontoon. Before sheeting in the tops it is advisable to fit the soft block streamlining pip and nose plug on the battery box, installing the wiring as sketched. Suitable spring contacts can be made from springy brass or sufficient wire should be left free inside the compartment for the batteries to be soldered up and slipped in place as one unit. Run the wires through one pontoon and along a slot gouged in the stern tie, leaving a little spare for connection to the motor. Complete the sheeting of the pontoon tops, sand all over, dope on lightweight tissue and apply sanding sealer and colour dope as required.

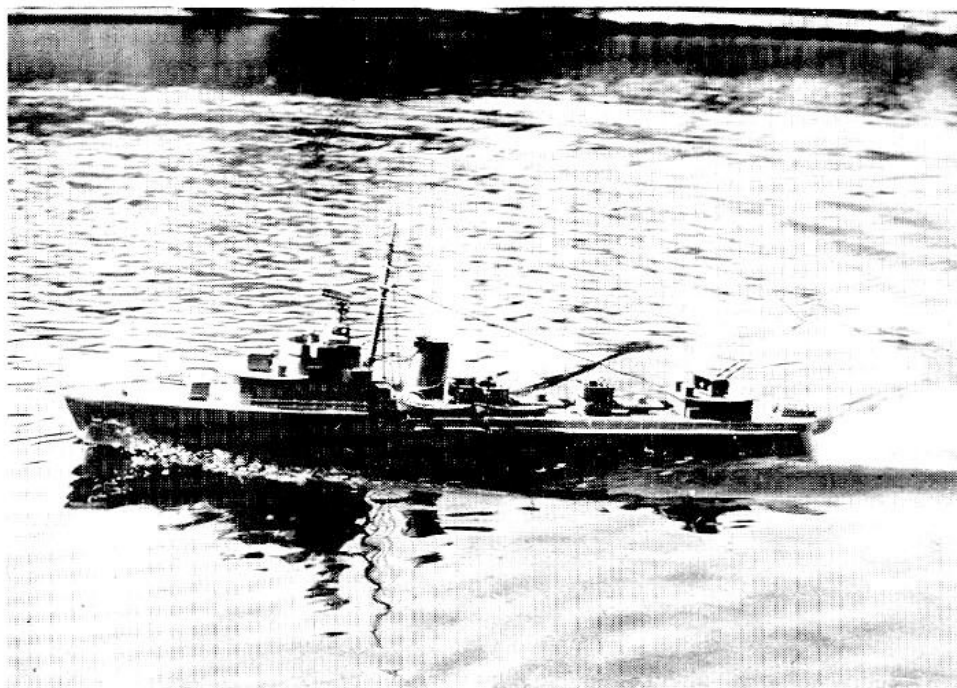
Using any of the small outboard motors a vertical mount-



ing on the back of the stern tie is needed in order that the motor clamps can be engaged. If an airscrew drive is required cement a vertical pylon to the stern tie and fit the motor on top of this, preferably in a streamlined case to suit the particular motor. Note that very high speed cannot be achieved with an electrically driven airscrew. A switch, which can be made from a safety pin, should be installed somewhere for convenience in use, and a small rudder should be extended below the centre tie if an airscrew version is being made.

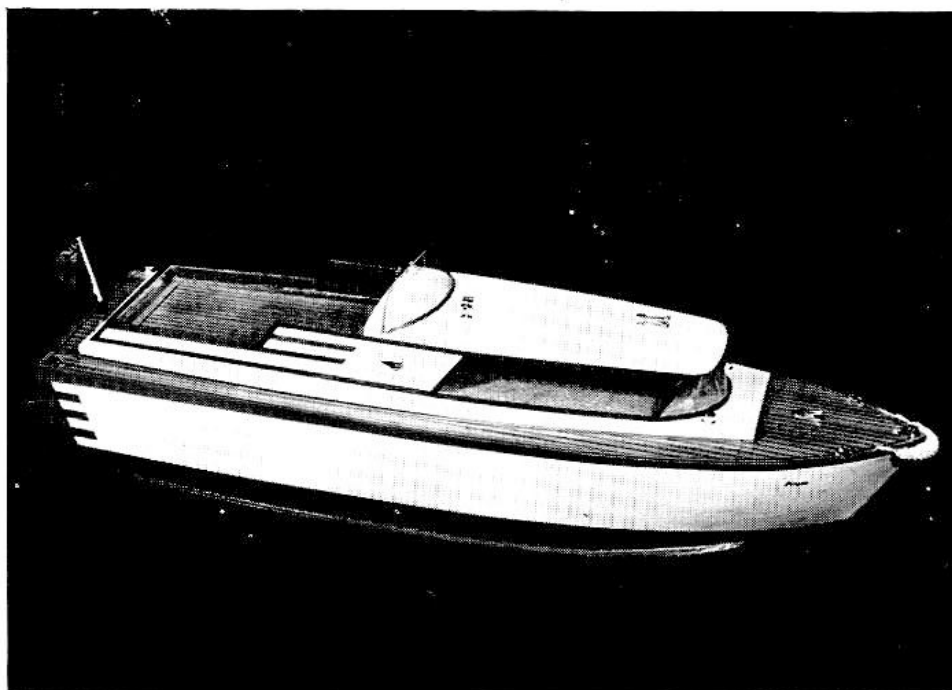
The battery compartment can be decorated by the addition of a small cabin made by cutting a pear-shaped cabin top from $\frac{1}{4}$ -in. sheet; this should be sanded to a gentle curve all over and cemented in place on four small scraps of balsa, following which the strip of acetate can be cemented round. With suitable treatment with colour dope such a cabin is an added attraction to the model.

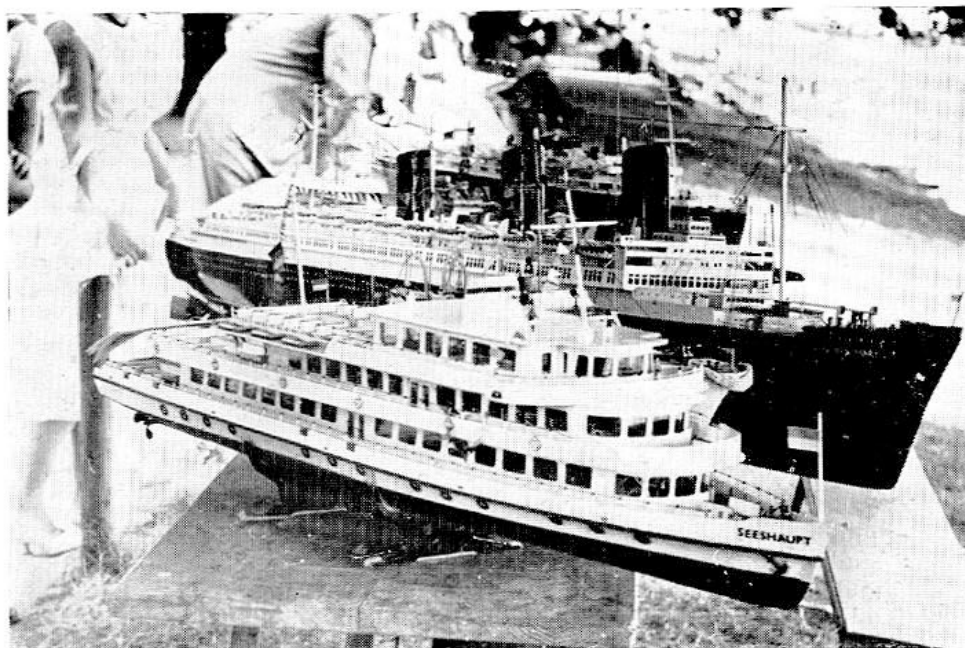
If you wish to install a diesel or glow-plug engine of up to $1\frac{1}{2}$ c.c., scale up the pontoon side, making each square $1\frac{1}{2}$ in. instead of 1 in. as marked; the $\frac{1}{2}$ in. measurement will then, of course, become $\frac{3}{4}$ in. The construction can be of the same materials to make a very light and strong hull, but it is advisable to make the stern tie of ply, and to fit a ply pylon to this with small reinforcing blocks to make a rigid structure. The engine can be side mounted on the ply pylon; it may be necessary to make small alterations to the thrust line to achieve top performance, but with a 1-c.c. motor it should be possible to achieve a speed of 8 or 9 miles an hour. This is very fast for a small model and the spinning propeller also constitutes a danger to unaware spectators. If you do build a diesel version it must therefore be used with considerable care.



A seven-foot destroyer model powered by a two-cylinder 8 c.c. diesel engine and equipped with full radio control. This model was built by the proprietor of a well-known Lancashire model shop and appeared at many regattas.

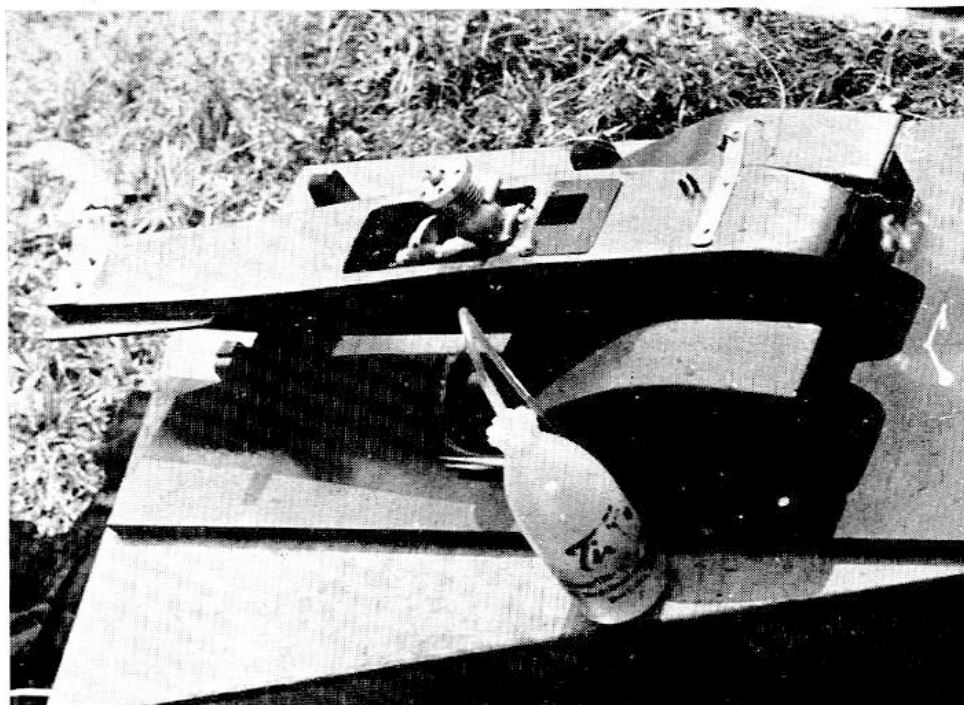
A 3½ c.c. high speed radio-controlled cabin cruiser by the author. Many of these models have been built and modified versions hold several National records as well as the European record for its class.





Part of a wonderful show of scale ship models at a Continental regatta. The front boat is a river steamer and that behind the *Queen Mary*; both are radio-controlled and capable of excellent performance despite the wealth of detail.

A typical hydroplane for tethered running. The fastest substantiated speed for such a model is 95 m.p.h., but speeds of over 100 m.p.h. have been rumoured in the U.S.A. A good average speed is about 70 m.p.h.



CHAPTER THIRTEEN

H.M.S. Lightning

A POPULAR choice of prototype for modelling is the destroyer, and we have therefore chosen a fairly simple version of such a vessel for this chapter. Disadvantages of destroyers are that they are very long and thin, and this usually creates problems in stability in model form except in the hands of an expert. This *Lightning* model is therefore slightly modified to make it more stable, although it retains a close to scale appearance above water. Nevertheless every effort should be made to keep the deck details, etc., light in order that the model shall remain stable.

To suit normally available sizes of balsa a scale of $\frac{1}{12}$ in. to 1 in. has been chosen, which gives a model $29\frac{1}{2}$ in. in length and $3\frac{1}{4}$ in. in beam. The first step is to draw out the approximate profile and plan of the hull; full-size bow and stern shapes are given, and these may be traced direct. From about 9 in. aft of the bow to 5 in. forward of the stern the sides are completely parallel and upright.

The base is cut from a 22-in. \times $\frac{1}{2}$ -in. \times 3-in. balsa sheet; the bow should be tapered as traced from the plan, but the stern end can be left square, since it will automatically assume its right shape when the hull is carved and sanded at a later stage. Two lengths of $\frac{1}{4}$ -in. square balsa are now cemented along the top edge each side, terminating 3 in. from the extreme stern and $2\frac{1}{2}$ in. from the bow. These are glued flush with the outside edge and may be pinned while the cement dries. The bow block must now be carved from a 3 in. piece of balsa, $2\frac{3}{8}$ in. \times $2\frac{1}{8}$ in.; as an alternative this can be made in two pieces split along the centre, and the pieces may be of 1-in. block with a $\frac{1}{8}$ -in. centre lamination to make the full width. Cut first to profile, then draw the top

and bottom shapes on, connect the rear points, and saw carefully down to these lines. There is no need to finish the block completely at this stage. Cement B1 on to the back and cement the block in place at the bow.

At the stern a 6-in. length of $\frac{1}{2}$ in. \times 3 in. is cemented on top of the stern block to the full shape of the stern, and above this a piece of $\frac{1}{2}$ -in. sheet $1\frac{1}{4}$ in. deep and 5 in. long is cemented each side. A stern block 2 in. \times $1\frac{1}{2}$ in. \times $1\frac{1}{4}$ in. fits between these pieces. All this assembly can be left square until the hull is finally shaped.

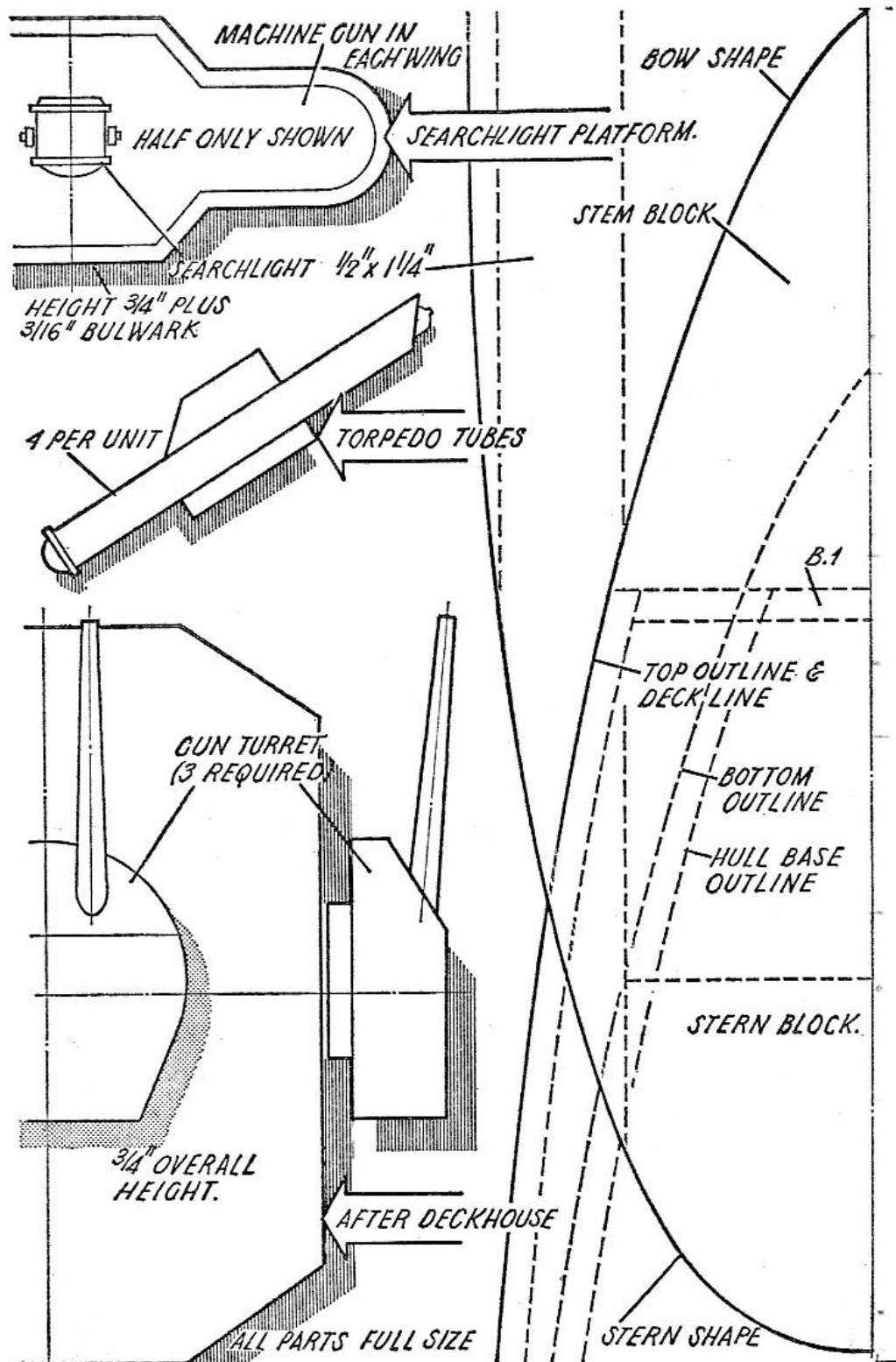
The sides between the bow and stern blocks are from $\frac{1}{8}$ -in. sheet balsa 3 in. wide, and they can be laid out directly on to the sheet, the main length being $1\frac{3}{4}$ in. deep rising to $2\frac{1}{2}$ in. at the break in the deck, and thence to full height at the bow. The bottom edge of each side is straight, but when it is glued in place and twisted at the bow a gap will appear beneath, and this can be filled with a scrap piece of $\frac{1}{8}$ -in. sheet. The sides are cemented in place so that the bottom edge is level with the top surface of the base sheet. It will be found helpful to insert the bulkheads before the cement sides are dry, slipping rubber bands round and pinning while the cement dries.

The resulting structure can now be carved to shape, the bottom being rounded off as in the sketch, and the bow and stern blocks sanded in to a smooth line.

One single propeller will be found most effective on this model and the hole for the stern tube should be drilled; any commercial stern tube of up to 6 in. in length will be suitable, or a tube can be home-made by inserting 10 gauge brass tube stubs into the ends of a piece of larger diameter tube (about $\frac{3}{16}$ i.d. will probably be required).

It is also desirable to fit the rudder tube at this point.

There are many small cheap motors capable of driving the model, and with the $1\frac{1}{4}$ -in. or $1\frac{1}{2}$ -in. propeller recommended, it may be desirable to fit a pulley drive or gears giving a reduction from the motor, so that the propeller turns at approximately one-third the motor speed. This gives considerably more power and more economic battery



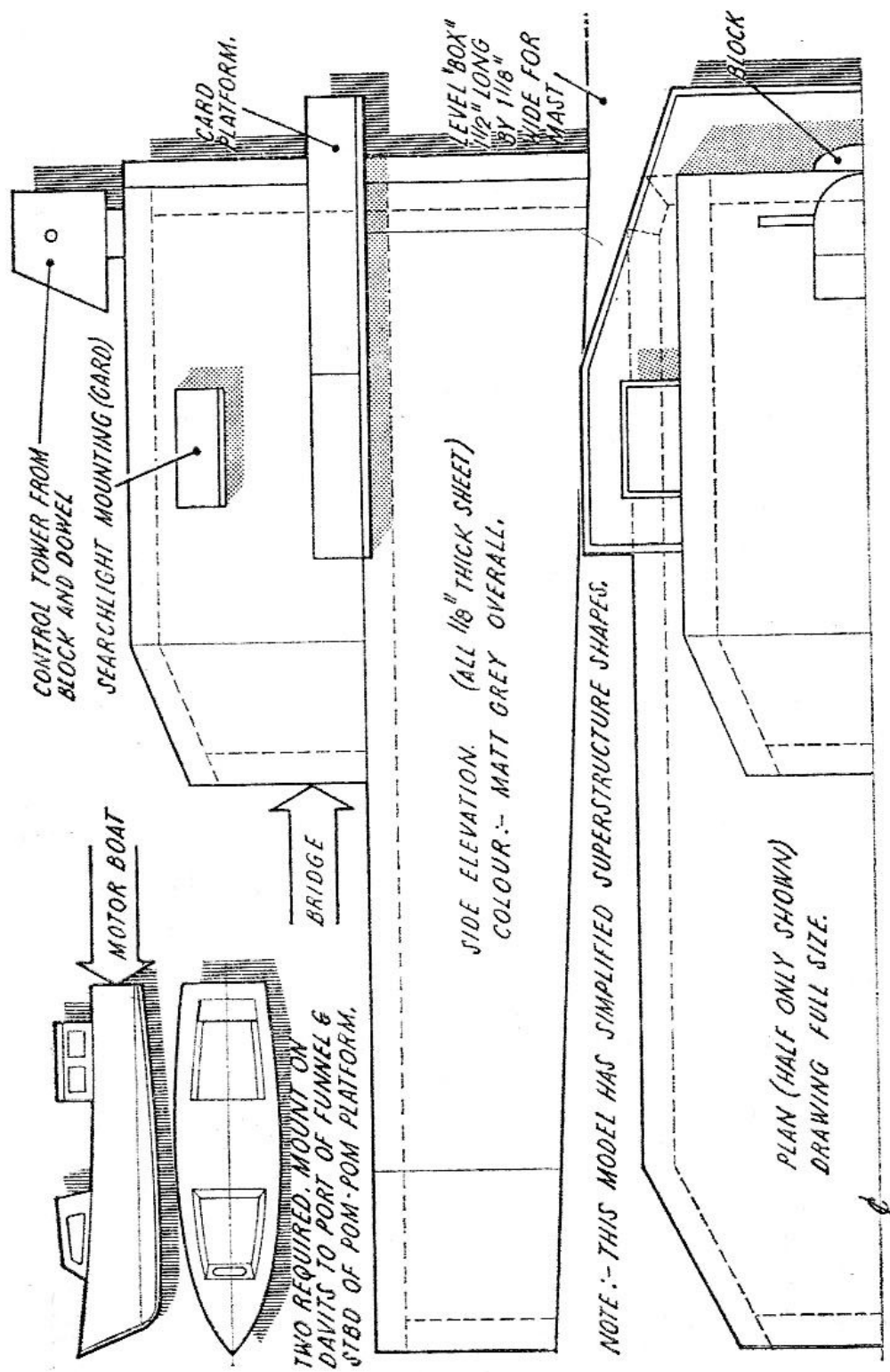
life. Once the motor mounting has been completed the $\frac{1}{8}$ -in. sheet deck may be added, and the outside of the hull finish sanded, tissue covered and painted or doped medium grey all over, black below the waterline. The decks can also be painted largely grey with wooden areas and green walkways painted on; examination of some destroyer photographs will indicate such areas for the detail enthusiasts. The whole of the deck from the funnel casing aft to the after deckhouse should be made removable in a $2\frac{1}{4}$ -in. wide panel as sketched, to allow access for battery replacement, etc. Before finally fitting the deck it is advisable to dope or paint the inside of the hull one or two coats to prevent water absorption.

All the superstructure is detailed full size on the plans, and it is all built from $\frac{1}{8}$ -in. balsa sheet or block. The 'walls' of the deckhouses should be built on the decks themselves and the tops added; where bulwarks are required, these should be made from card or $\frac{1}{32}$ -in. ply.

The individual details will be fairly obvious. Gun turrets are made from $\frac{5}{8}$ -in. block balsa ($\frac{1}{2}$ in. plus $\frac{1}{8}$ in. lamination) with guns fashioned from $\frac{1}{8}$ -in. dowel. The torpedo tubes are each four lengths of $\frac{3}{16}$ -in. dowel set on balsa circles. The funnel should be wound from card or gummed paper, or could be a 1-in. diameter card tube slightly flattened, then thoroughly soaked in shellac and finally painted. A funnel trunk is fitted to the full-size *Lightning* as dotted on the plan, but this is optional and if fitted can be carved from balsa. The mast is shown in detail and is simply a lattice structure; make two sides then set them in a simple card jig and connect them with the remaining cross struts. Use fuse wire for the bracing.

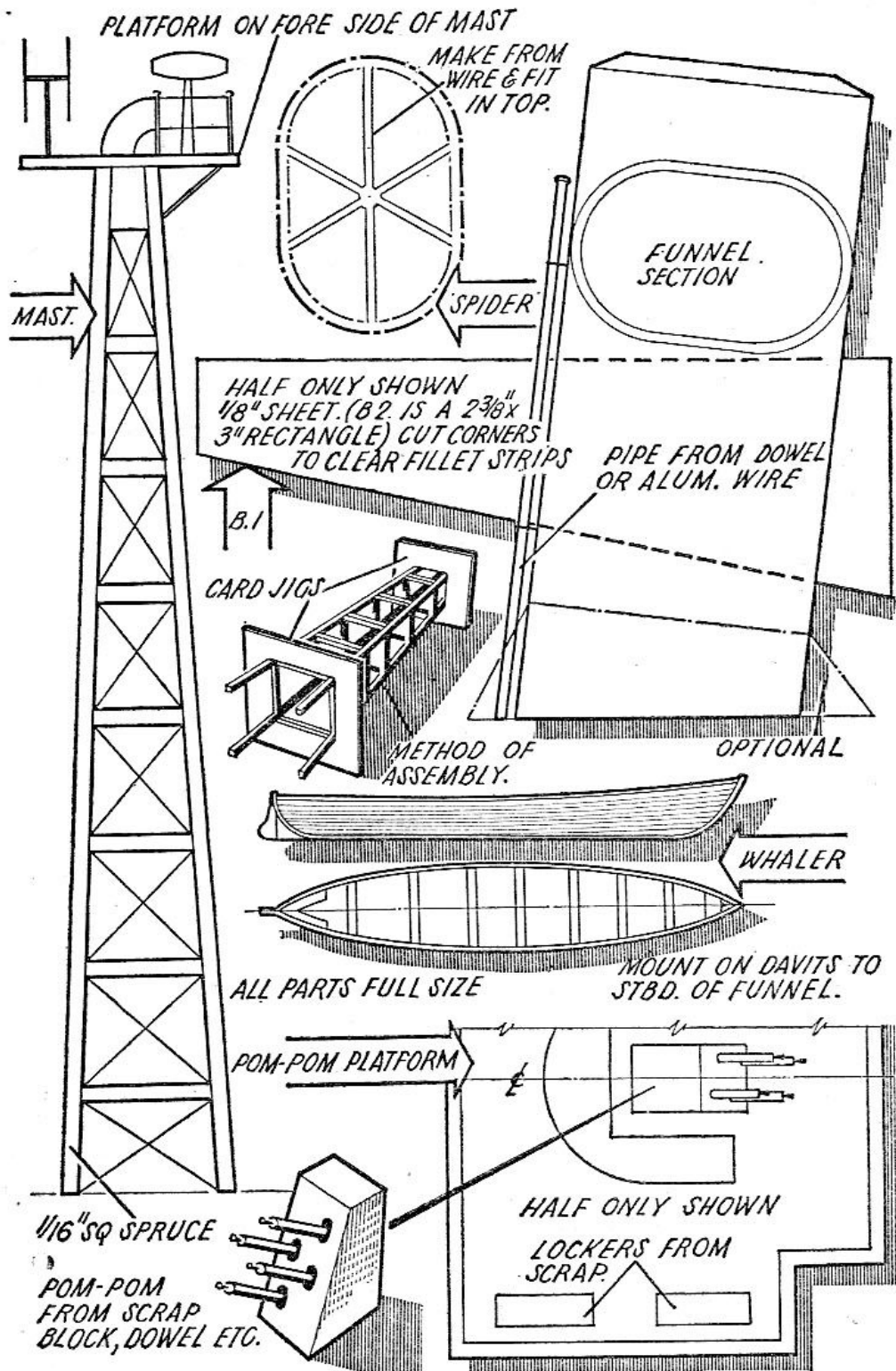
All the superstructure is painted grey, and apart from the deck details the only relief from grey on the model is that the hull is black below the water, and that certain small parts of the superstructure can have a touch of black, e.g. gun muzzles, torpedo tube openings, etc.

In a book of this size it is impossible to go into every detail, but your local public library will include copies of



Janes Fighting Ships and other marine publications, including photographs of warships, so that a few minutes spent looking at photographs will soon provide ideas for further details.

The hull will accept $4\frac{1}{2}$ -volt flat batteries or any similar type of battery that should be thought desirable, but it is essential that the batteries be stowed flat on the floor of the hull to preserve stability. Many models of this type use one of the gun turrets or a similar fitting as a switch for switching on the motor. There is actually enough room for this model to take a miniature radio-control gear, but the total weight of such gear, including batteries, etc., should not be more than about 7 oz.



A Hovering Craft

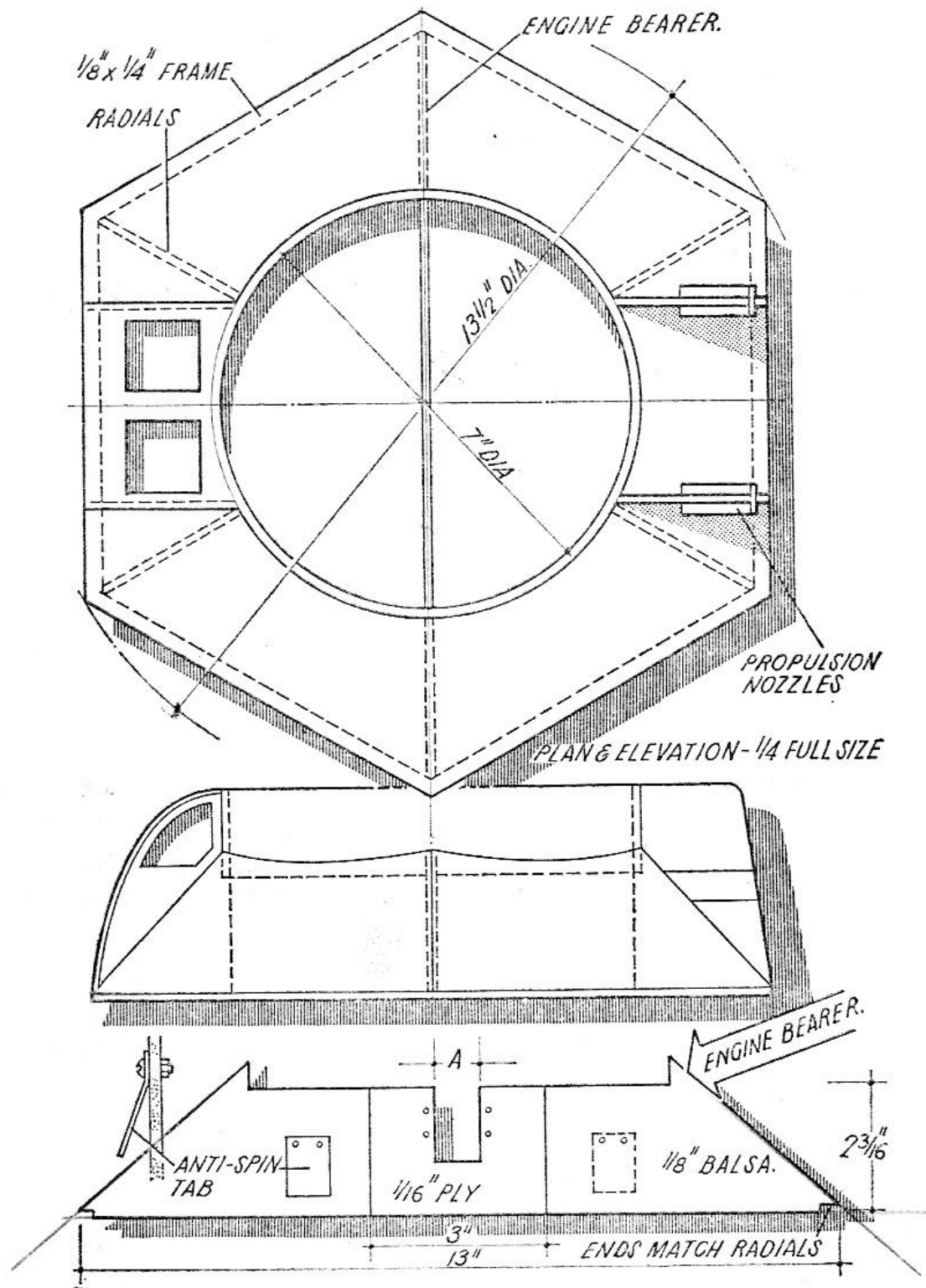
THE hovercraft is the most recent form of transport, and much development work remains to be done to perfect the various applications to which it will inevitably be put in the future.

Basically there are two forms of such craft, the true hovercraft being a machine with a 'floor' round which is a slit from which air is pumped. The slit is angled so that the air is pumped in towards the middle at an angle of about 30 degrees and forms a high-pressure air bubble which keeps the vehicle off the ground. The second type is the cushion craft which has, in fact, a hollow chamber, air being forced into this to form an air bubble between the surface of the chamber and the ground.

For model purposes the second type is much simpler to construct and works quite as well, and our little model is therefore of this type.

Construction commences by drawing a $13\frac{1}{2}$ -in. diameter circle on a piece of plain paper. One diameter is drawn in and four points marked on the circle from each end of the diameter using the compasses set to the same radius as the circle. These points are then connected to produce a six-sided figure as in the drawing. Along each of the six sides is laid a strip of $\frac{1}{8}$ -in. \times $\frac{1}{4}$ -in. balsa flat on to the surfaces, and the joints mitred and cemented to a good fit.

While this is drying take a sheet of $\frac{1}{32}$ -in. \times 3-in. balsa and cut down the middle to leave two $1\frac{1}{2}$ -in. strips. These should be wound on to a 7-in. diameter saucepan or cake tin, cementing the second turn on to the first, etc., to make a solid laminated ring. Strap with rubber bands or string to hold the whole thing tight while the cement dries.



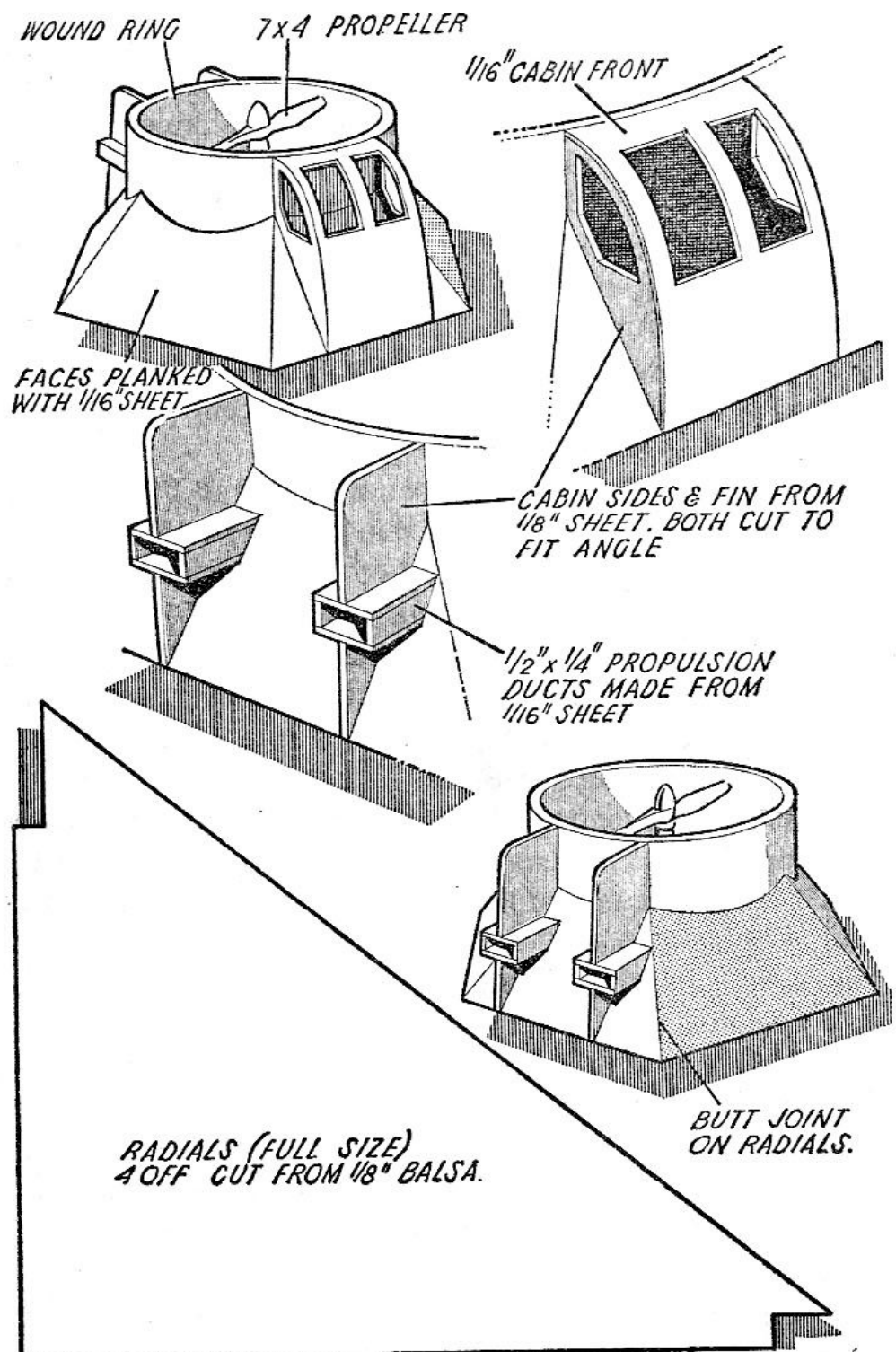
Cut the four radial triangles and the engine bearer plate which is, in fact, simply the radial triangles on each end of a piece of $\frac{1}{8}$ -in. sheet. The centre of this should be reinforced by gluing on a piece of $\frac{1}{16}$ -in. ply, and the ply cut accurately about the centre line to accommodate the engine you wish to use. Any engine up to 1 c.c. is suitable.

Glue the bearer plate and the radials to the basic frame and slip the wound circle off the saucepan and drop in place on the radials, gluing securely. Leave this to dry, then sheet each side with $\frac{1}{16}$ -in. sheet balsa, butt jointing on the radials with the grain running round the model, i.e. horizontal. At the top it will be necessary to cut a curve in the form of a scallop in the sheeting to join on to the centre ring. It is important that all joins are air-tight.

To dress the model a little you may like to fit the front cabin as sketched and also the rear fins. Note that the fins incorporate a small duct, the end of which should open into the centre of the model so that air will bleed off.

The engine is bolted in place on the bearer, packing with slips of ply, etc., to make sure that it is absolutely dead in the centre and that a 7-in. propeller will rotate freely in the ring without touching it at any point. Remove the motor and tissue cover the model all over, applying sanding sealer and dope in the usual way. Do not forget to dope the area round the engine mount thoroughly to prevent fuel absorption.

Remount the motor and fit a fuel tank close to it. This could be made from a small plastic pill case, or there are several suitable commercial tanks. All that remains to finish the model is to cut the anti-spin tabs from tinplate or thin aluminium, and bolt these in place with 10 B.A. bolts as indicated on the drawing. When the engine is running the model will tend to rotate in the opposite direction, i.e. clockwise when viewed from above, and the tabs must be bent to deflect the propeller slipstream and induce a turning force in the opposite direction, so that the model proceeds in a straight line without spinning. Adjustment of the tabs by bending will soon produce a stable balance.



The only point to watch in all this is that the propeller comes approximately half-way up the wound ring – not more than half an inch from either the top or the bottom. This is easily arranged by adjusting the motor position.

To operate the model start the engine (the controls can be reached quite easily from beneath), and place the model on a smooth surface such as a garden path. Trim by bending the tabs until a straight line is achieved. The model will operate over water or short grass, but remember that it is in effect balanced on a bubble, so that the slightest variation in level of the surface over which it is running will induce it to slide sideways. Adjustment for turn can be made by blocking part or all of one of the rear ducts.

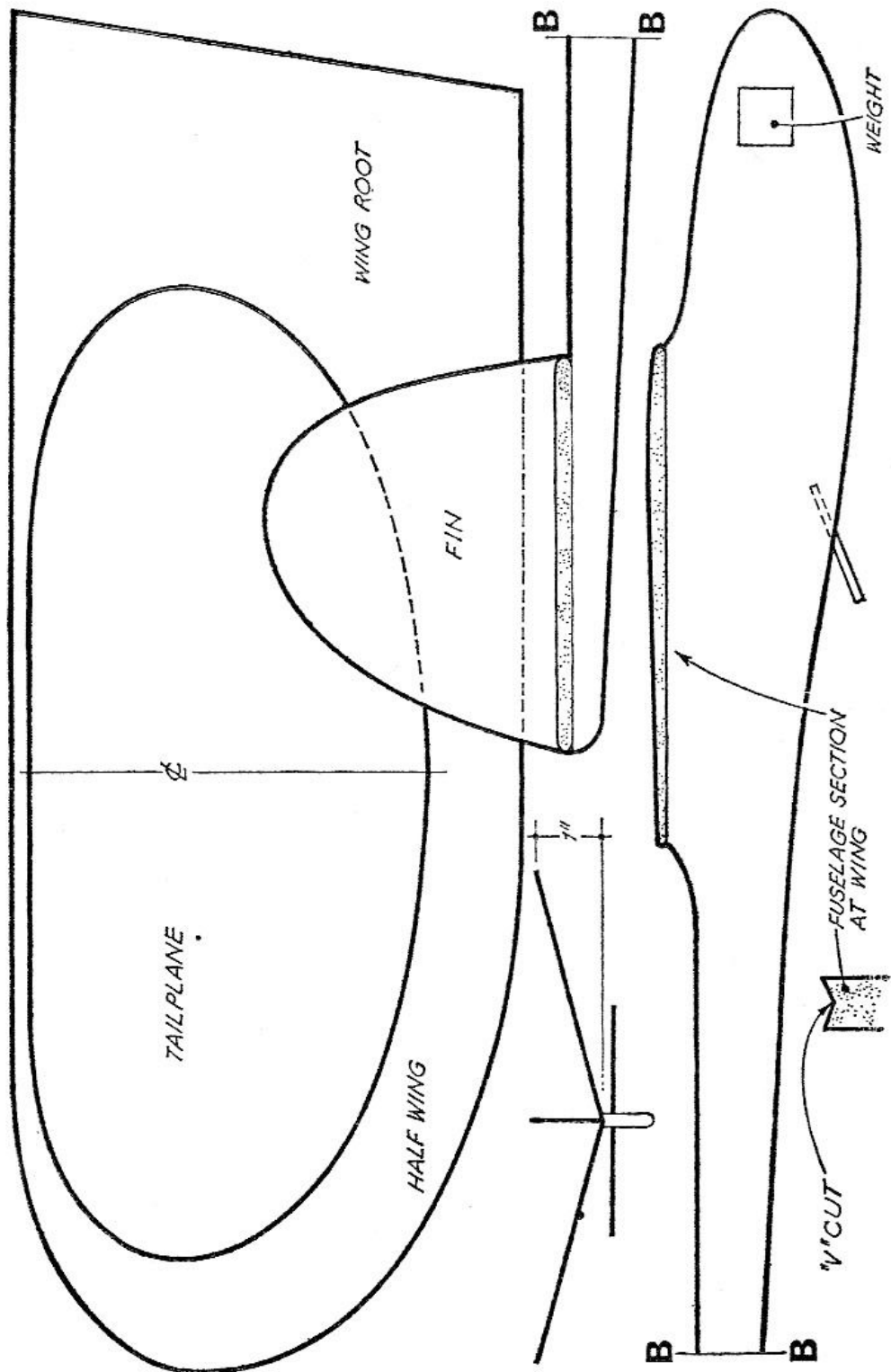
Simple Models

ALMOST all the models in the preceding chapters are ones which will take some few evenings to construct. However, there are a considerable number of simpler models which can be made in the space of half an hour or so, and these can be very instructive as well as good fun.

The simplest form of model aeroplane is known as the chuck glider and it is simply a glider which is thrown from the hand. You may think that this does not produce a flight of any great duration, but in fact, some of these gliders have been known to fly for over half an hour making use of thermal air currents.

When the sun shines on the ground the air immediately above the ground is warmed by the heat absorbed by the ground. When two different surfaces are side by side, for example a concrete road and a grass field, the air over the concrete road is warmer due to the greater amount of heat reflected than that over the grass field. The result is that the warmer air will rise by the normal principle of convection, and will form what is termed a thermal air current. This type of current achieves quite considerable vertical velocities, and if a model descending through the air flies into a column of rising air which is rising faster than the rate of descent of the model, the result will be that the model climbs in relation to the ground, and many models have been lost in this way.

The aim therefore with a chuck glider is to achieve a very low sinking speed, that is a speed of descent through the air, and to make it in such a way that it can be thrown high into the air, since thermals accelerate as they leave the



ground and the higher the model collects its thermal, the more chance of its being carried up.

The little model accompanying this chapter is an example of a small chuck glider which for a normal flight would be in the air for only perhaps ten or twelve seconds. On a good thermally active day, however, flights of longer than this could confidently be expected, perhaps two or three minutes or on a really active day the model could fly out of sight.

The construction is very simple, since it is built entirely from sheet balsa. The plans are full size and need only be traced on to $\frac{1}{16}$ -in. sheet balsa for the wings, tailplane and rudder, and $\frac{1}{8}$ -in. sheet balsa for the fuselage or body. If preferred, harder wood can be used for the body since it may be prone to damage if it flies into the side of a building. However, hard $\frac{1}{8}$ -in. sheet balsa is really perfectly adequate.

Cut out all the parts, then with fine glasspaper sand the model; each half of the wing should be laid flat on the edge of a building board or old table, and the top surface sanded right to a taper towards the trailing edge and the leading edge rounded. The tail and fin or rudder should also be sanded and both sides of each surface should be rubbed completely smooth. The fuselage should have all its corners rounded with the exception of the area in which the wings will seat, and the area in which the tailplane will seat.

Cut a V-shaped groove for the wing seating and cement the inside of this groove and the ends of each wing half, and assemble the model temporarily. Before the cement has dried take it apart and allow the cement to dry with the parts lying separate. Then re-cement the wing seating and the root ends of the wing, and reassemble, pinning the wing halves in place, and blocking up with books or matchboxes or blocks of wood, as in the illustration, to make sure that the correct dihedral angle dries in. The idea of double cementing the wing roots is because this makes a much stronger joint. The first layer of cement soaks well into the wood and dries thoroughly. The second layer thus has a very strong key in the wood since it blends with the first layer of cement and makes a joint which, by measurement,

can be proved to be eight times as strong as a joint receiving only one application of cement. This practice of double cementing is, incidentally, something which can be used successfully with any of the models described in this book.

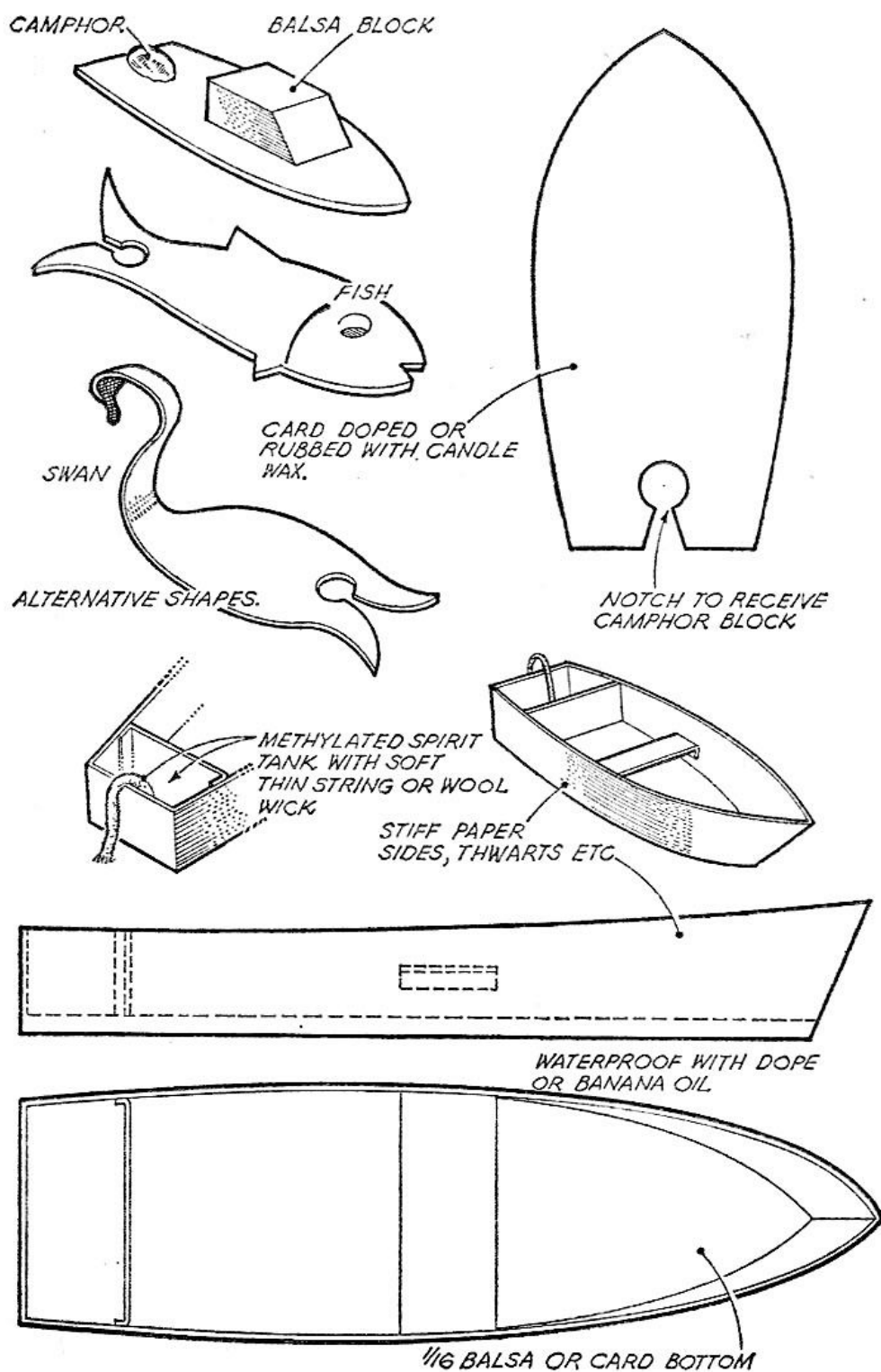
It is desirable to allow the wing to dry out thoroughly, preferably overnight, although balsa cement is usually believed to take only a few minutes to set, before going on with the tailplane and rudder fixing. These two are double cemented in place and allowed to dry thoroughly.

The model should now be rubbed completely smooth all over with what is known as flour glasspaper, and given two or three coats of either cellulose sanding sealer or banana oil, rubbing down between coats with wet or dry carborundum paper, or flour glasspaper. The final coat, when dry and rubbed down, should then be polished with a good quality wax floor polish or similar.

Weight will be required in the nose of the model, and this may take the form of plasticine or modelling clay moulded on to the nose or panel pins driven into holes drilled in the nose, or a strip of thin solder or a flattened cement tube, preferably of the lead variety. Whichever is used the shape should be moulded in smoothly and made as streamlined as possible.

As with any model aircraft glide testing should always be carried out over long grass, which minimizes damage to the model in the event of a heavy landing. It will be necessary to adjust the weight on this particular model until reasonable glide is obtained – if the model dives into the ground the weight will need to be reduced, if it stalls, that is if its nose tends to rise into the air and then dip sharply, it requires more weight. It is not desirable to alter the angles of the wing or tail, either by cutting and recementing or by warping the surfaces, since when the model is thrown from the hand it achieves a speed of some 50 to 60 m.p.h., and any such warp or difference in angle is likely to cause a spectacular aerobatic performance which, however, does not help when it comes to obtaining a good duration.

The model should be launched in its glide test on a slightly



downhill path, that is you should aim at a point in the ground at about 20–30 ft. in front of you and launch the model fairly fast but at what you consider will be its approximate flying angle. Once the correct weight has been determined the proper method of launching may be practised. In this the model is held in the right hand with the fingers and thumb grasping each side of the fuselage and the index finger of the right hand lodged behind the wing of the model. The model is thrown with an underarm motion, banked about 45 degrees to the right and at an angle of 45 degrees or a little more in the air. With practice it is possible to achieve a height of 50 ft. with a model of this type and from that height a glide of considerable duration will be realized. If the model goes over in an enormous loop and strikes the ground behind the launcher, it suggests that some misalignment has been allowed to creep in during construction, and it is necessary to warp the trailing edge of the tailplane down to cure this fault. Similarly any tendency of the glider to dive into the ground ahead of the launcher can be cured by warping the tailplane up and the tendency to turn sharply in either direction can be checked by warping the appropriate wingtip. If the model turns to the left the lefthand wing tip should be warped downwards at the trailing edge. The best way to introduce the warps is to hold the model in the steam of a kettle or in front of a warm fire and before the warmth has gone from the wood, pin it down with the warp induced by packing blocks or scraps of card, etc. It is usually necessary to include twice the amount of warp required since when the model has been left for a few minutes and is cold the warp tends to spring back.

With the model making longer flights from the increased height obtained from the launch it is possible to gauge more accurately if the nose is carrying too much or too little weight. Minor adjustments should be made to get the model flying at its absolute maximum.

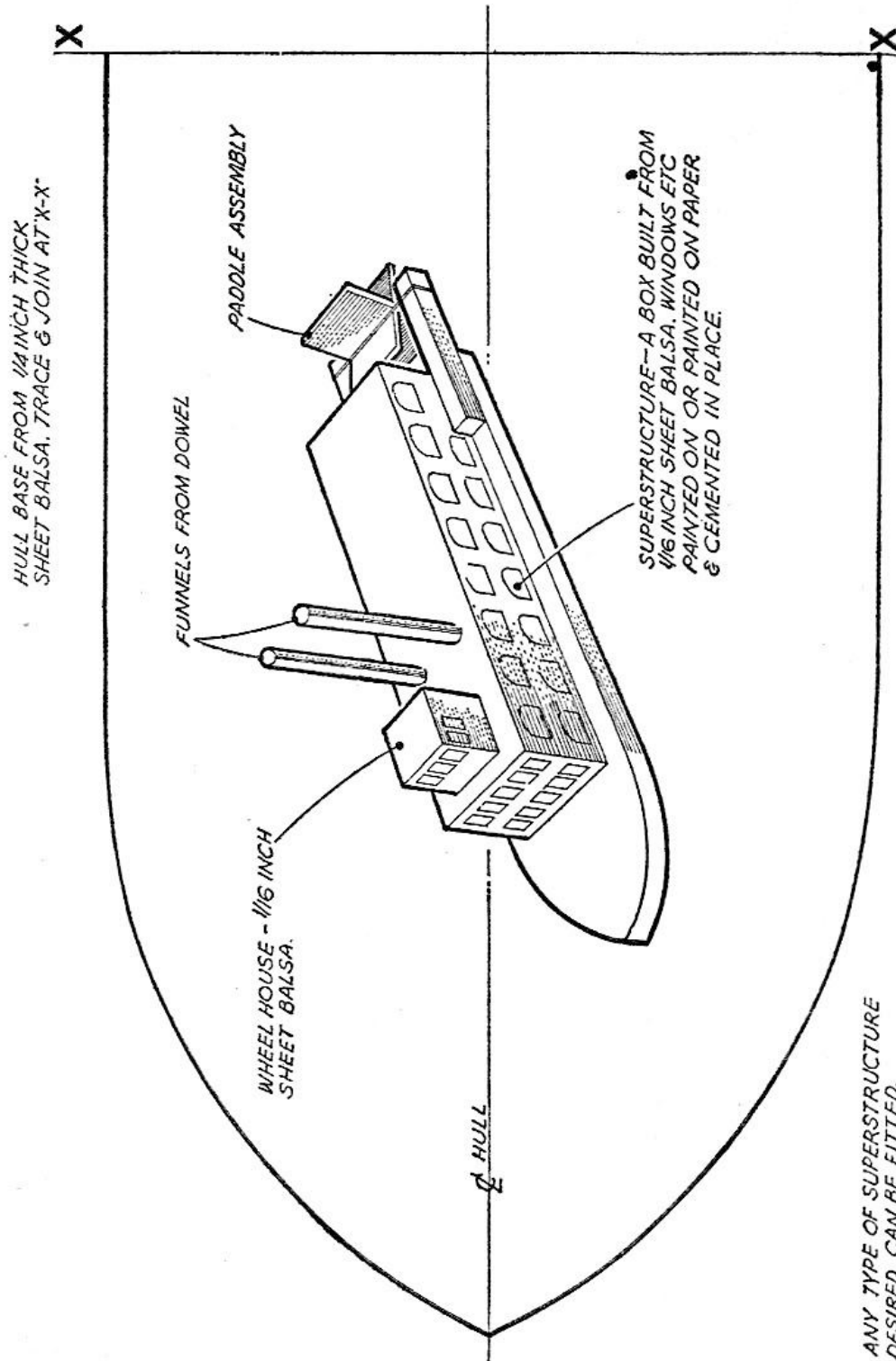
It is surprising just how much interest there is in these small models which can form the basis for simple competitions between two or three builders. There is also plenty of

scope for experiment with individual shapes and proportions based on the same general principle of construction.

It is possible to fit in the bottom of the fuselage a hook which can be bent from a pin or piece of wire and forced into the wood and by means of this hook the model can be catapulted using a long thin rubber band knotted to the top of a short length of dowel or pencil. An alternative type of catapult is to use 30 or 40 ft. of cotton with 10 or 15 ft. of very thin elastic strip tied to it. The end of the elastic is tied to a peg in the ground and a ring on the other, free, end of the cotton is hooked on to the model. The model is then walked backwards to stretch the rubber and released into wind, when it will climb quite slowly but to quite a reasonable height. This method is very useful for larger gliders, especially when one goes out to fly on one's own.

MODEL BOATS

Turning now to simple model boats, possibly the simplest is that shown in the sketch which is nothing more or less than a shape cut out of thick paper or thin card treated with a coat of shellac or sanding seal or banana oil to waterproof it, and fitted with a notch at its stern. In this notch is fitted a small piece of camphor and upon placing in a bowl of water the model will proceed at quite a respectable pace across the bowl. The reason for this is something which most people have learned of in the physics laboratory at school – the surface tension of the water. This is a force which pulls equally in all directions and is equal all round any object floating in the water. The function of the camphor is to break down the surface tension at one point which allows the model to be drawn in the opposite direction by the lack of balance in the tension. A similar sort of thing happens when a blown-up balloon is released. The air pressure is equal all round the balloon, that is the balloon is in a state of equilibrium, with the pressure in the balloon equal in all directions. As soon as the neck is released air is able to rush out and the change in pressure produces a movement of the

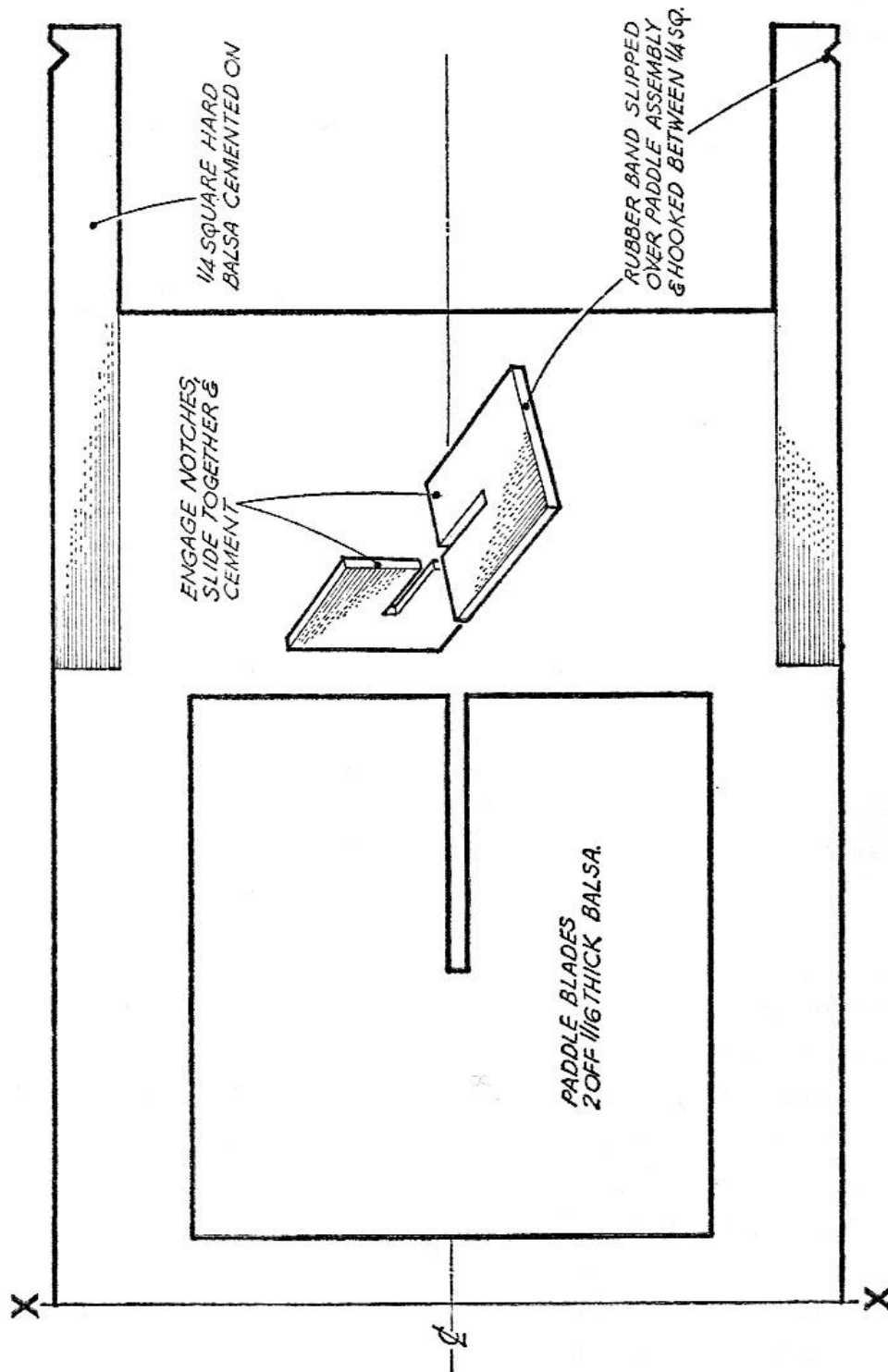


balloon in an opposite direction to the point at which the pressure has been disturbed.

A similar principle operates the more elaborate boat shown in the second sketch. This can be made again from paper or thin card and it should be treated with banana oil or sanding sealer for waterproofing. At the rear a small well is provided into which a few drops of methylated spirit can be poured. A wick made from a piece of soft cotton is dipped into the methylated spirits and allowed to trail over the stern of the model. The methylated soaking along the wick and coming into contact with the water releases surface tension in that area, and the boat moves ahead at quite a fair speed. It is essential that for experiments with models of this nature the water should be clean. Most readers will, no doubt have seen the small plastic models given away with breakfast cereals which operate on a few grains of detergent powder; these use exactly the same principle.

The next form of propulsion for models is, of course, sails, but most people have experimented with various types of sailing craft with square rig and fore and aft sails, etc., using walnut shells for hulls or matchboxes, etc., from a very early age. The plans shown in this book of model yachts and catamarans can be used in smaller scale if anyone wishes to experiment with small sailing craft.

There is probably more interest in small power boats, and probably the simplest form of power for these is a rubber motor. One difficulty with rubber power is that for a very small model only a small propeller can be fitted, and the result of this is that the energy stored in the rubber motor is dissipated with a furious burst of half a second or so which hardly gets the model moving. The answer is to get a much longer model with a longer, less powerful motor, and as large a propeller as can be fitted. If, however, you wish to use simply a rubber band for power then the little paddle model in the next drawing will afford not a little amusement. This uses simply a piece of $\frac{1}{4}$ -in. sheet balsa for a hull and really needs no superstructure. It is quite permissible to use other woods than balsa, though balsa is more favourable



because of its ease of working. If the balsa is particularly soft or if the model is to be used over a period of time, it is suggested that two lengths of harder $\frac{1}{4}$ -in. square wood are glued in at the stern end as shown on the drawing. The paddle is simply two rectangles of $\frac{1}{16}$ -in. sheet slotted so that they fit together to form in end view a cross. These are glued and allowed to dry; a rubber band is then slipped over them and hooked on to the projections at the stern of the hull. The band can be wound (backwards remember) for several turns, two or three dozen at least, and the big area of the paddle prevents it from unwinding too fast, so that a cruise of several yards can be achieved without difficulty.

Obviously this type of model calls to mind the famous Mississippi sternwheelers which, incidentally, also are used (or, in most cases, were used) in various Canadian lakes and rivers, and also on the Nile. The most popular of all paddlers, however, were the Mississippi boats with their very high square decks, slim funnels and palatial appointments. Illustrations of these vessels can be found quite easily in public libraries, etc., and a simple $\frac{1}{16}$ -in. balsa box with dowels for funnels and the windows, stanchions, etc., painted on the box will produce quite an amusing model at quite a low cost and in very quick time.

There are many types of simple model that can be built, and there is no doubt that this book could go on and on in listing them. Perhaps the most difficult of all things to model easily in small size are land vehicles, particularly modern cars with their curved shapes which require either to be moulded or carved and cannot be built easily with simple card and wood materials such as we have been discussing. To find cars easier to model we have to go back to veterans which were built in sheets of metal, normally hand formed, and which therefore have lines rather more severe and better for reproduction in model form with simple materials. However, even with the simpler shapes of the cars the wheels were much more complex and unless the intending modeller is really keen to model cars, he is well advised to leave them until he has gained experience with other forms of model.

Radio Control

No modern book on models would be complete without some reference to the subject of radio control, which is, of course, an ever-growing practice, particularly in the aircraft and boat field. There have been a number of model cars equipped with radio, but at the moment this is rather more specialized a sphere and the greatest development and the greatest numbers of applications are with boats and aircraft.

The first public demonstrations of radio control of models took place back in the 1920s when a model airship was used in a stage show, the controller flying the model round the theatre and dropping such things as postal orders and 10s. notes on the audience from time to time. The equipment used in this model was of very rudimentary form and the signals were transmitted to it by means of a spark transmitter. Most people know that when a spark is generated it produces radio waves over a wide band. This is the reason for interference on normal wireless and television sets when an unsuppressed electric motor is run. The sparks generated by the brushes of the motor emanate radio waves which are picked up by the receiver, causing the familiar crackle or blobs on the screen. This early airship used a spark transmitter with a big fat spark to generate radio waves which were picked up by the simple receiver in the airship. The receiver was what is known as a coherer type and on receipt of the radio signal a number of loose iron filings in a small box were formed into a line, with all their north/south poles touching, by the presence of the radio signal. As a line they could pass an electric current and this switched on the various controls. Naturally once the iron

filings were lying in lines they would tend to remain so unless disturbed, and since there was no other method of disturbing them a tapper was used which tapped the box every two or three seconds and shook up the iron filings until the receipt of the next radio signal.

Modern equipment has, of course, advanced tremendously over this early but entirely practical gear. Radio-controlled models were built by amateur enthusiasts to a small extent in the 1930s, but it was not until after World War II that any great development began to take place. At first there was naturally concentration on valve equipment, but with the development of transistors from 1947 onwards these devices began to be incorporated, at first only in parts of sets but, ultimately, complete sets are now built using nothing but transistors. Many present-day sets, however, do use at least one valve, and this valve is followed by transistor stages for amplification, etc. This applies to both the transmitter and the receiver and at present it is still less expensive to use such a set than a completely transistorized piece of equipment, due to the high cost of one or two of the transistors which are necessary. Transistor development has been so quick that it has never been really worth tooling up for mass production of any particular type. Development has, however, slowed and we can soon expect less expensive transistors since there will be the opportunity for mass production. Transistors mean, of course, a great saving in weight and size and to a large extent a great increase in reliability. Recent British equipment includes a receiver which can take up to ten separate commands, which complete with all batteries necessary and the five servo motors which the commands operate, weighs no more than 20 oz. Single-channel receivers which receive only one command, but which can be used to operate various types of sequential mechanism, can weigh as little as $\frac{3}{4}$ oz. for the receiver alone.

From this introduction it will be seen that there are a mass of new expressions involved in radio control, and although the subject is by no means difficult if taken step by step, the construction of radio gear is not really within the

scope of this book. We will therefore merely content ourselves with an explanation of radio control and this will perhaps give readers an idea of what lies in store for them if they choose to take up modelling as a permanent hobby.

In the first place what does this 'channel' word mean? It means simply that one signal can be sent on a single channel. If four signals can be sent by the transmitting equipment it becomes four channel gear. Single-channel equipment is, of course, the simplest, especially since it can use just a plain radio wave, known as a carrier wave, to contact the radio in the model. The receiver is no more than a switch, and the link between pressing the button on the transmitter, and switching the switch on in the model is achieved by the actual radio waves. Thus it will be seen that single-channel radio control equipment provides us with a switch in the model which can be operated at will from the ground. The switch can control a number of operations in the following manner. If, when the switch is closed once, an escapement is brought into operation, the escapement (which is exactly the same as a clock escapement, but not quite so many-toothed) will move one position. On the next signal it will move a further position. With each succeeding signal it will turn to a further fresh position until, of course, eventually it moves back to the original position. In its usual application only four positions are used on an escapement and these are usually linked to the rudder of the aeroplane or boat, or the steering of a car. The four positions give one neutral, then move to left turn, then back to neutral, then through to right turn, then back to neutral. From this it can be seen that the operator must remember which turn he used last so that he knows which neutral he is on and which turn will come up next. This is a very simply acquired technique, and it is surprising how much can be done, particularly in the case of an aircraft, with such a simple system, as already outlined in Chapter 1.

The next step with any equipment is to use rudder control, or steering control in the case of a car, and engine-speed control. This can be achieved most easily by the use of three

or four channel equipment. In all multi-channel equipment the carrier wave is emitted by the transmitter and superimposed upon it are tones. These tones vary in frequency and are set in the transmitter and the receiver is matched to them. The receiver either closes a series of reeds which vibrate to the frequency of the tones sent, or by the use of special radio filters the tones can be filtered to switch in the appropriate control. Where two channel equipment is employed it becomes possible to add left or right turn at will, with neutral resulting when the signal is discontinued. This, of course, is an advance, and since the complexity of the equipment is not greatly increased by adding a third or fourth channel, it is normal to take advantage of this optional left or right rudder and to use a third or a third and fourth channel for engine-speed control. If a single channel is used for engine speed an escapement mechanism is necessary and we are then back to the business of fast engine, neutral, slow engine, neutral, and there is no intermediate speed available. If two channels are used for it, that is complete four channel equipment, it is possible to use a servo to operate the throttle as well as the rudder. A servo is normally an electrical device, normally an electric motor which can be reversed by a change of polarity in the current supplied to it. Thus one of the channels will supply one polarity to the motor, which will turn in one direction, and the other channel will supply the opposite polarity, producing an opposite rotation of the motor. By ingenious wiring it is possible to arrange for the motor automatically to return itself to a central position on cessation of the signal. This, of course, is not necessary in the case of an engine servo, but is desirable with the rudder of an aircraft or boat, since it means that a straight course can be resumed at the end of the turn without the operator having to hunt for the neutral position. Needless to say, in the case of an engine servo, the motor can be stopped at any point between slow and fast speeds, so that it is possible to vary the engine setting infinitely between its extremes. This is particularly essential with some of the faster boats now being used,

since at full speed it is almost impossible to catch the boat safely on returning to the bank, and at the same time it is not desirable to leave the boat running in the water until the engine stops, since it may stop some way off shore and be difficult to retrieve. A fast boat then must have a means of slowing it down to bring it in at slow speed. The ingenuity of modellers has been demonstrated in this and many other instances; one model for example is fitted with a tiny electric motor and independent propeller which only switches in when the main motor stops. The boat may thus be brought into the side at very slow speed under electric power.

The practical upper limit on channel selection is determined by the separation required in the frequencies which can easily be set for the tones. Thus ten channels are an upper limit for most equipment. Ten channels give an opportunity for five controls, or, if the modeller prefers, one or two of the channels can be used to operate sequential systems. A case in point is a model warship which uses one of its six channels to operate an eleven-position sequential escapement which performs various functions such as switching on the lights, dropping depth charges, firing rockets, firing guns, firing torpedoes, firing flares, etc., all of which work at the command of the operator. In an aircraft it is more usual to use five controls with one channel to operate the control and one channel to reverse the operation. Thus it is likely that a ten-channel aircraft would have rudder control, elevator control, aileron control, engine control and one further control which may be the operation of the undercarriage, steering the model on the ground, the raising and lowering flaps, elevator trim, dropping of bombs, operation of a cine camera, or something of that nature. All these things have been done.

One model in the foregoing chapters which would lend itself to radio control is the destroyer model H.M.S. *Lightning*, which, however, would need very small lightweight radio-control equipment. The power aeroplane in Chapter Three would also be suitable for miniature radio control, using single channel equipment with one of the tiny

transistorized receivers weighing under an ounce mentioned earlier on. The same receiver could be used in both models and the same transmitter could, of course, be used. The difference is only in the type of escapement or servo mechanism fitted into the respective models. In the case of the aeroplane it would be normal to use a rubber driven escapement, that is an escapement driven by a length of $\frac{1}{8}$ - or $\frac{3}{16}$ -in. flat rubber running between the trailing edge of the wing, beneath which the escapement would be mounted, and the extreme tail of the model. On a model of this size it would be possible to have about 250 movements of the rudder before the rubber motor ran out, and this would be long enough for perhaps a fifteen to twenty-minute flight. In the case of the boat, it would be more usual to employ a small clockwork escapement, and one such escapement available commercially would give 200 movements of the rudder, which again would be suitable for a very long cruise. The weight of the equipment in either case would be approximately the same, except that in the case of the boat it would be possible to use slightly larger batteries with an increase in battery life. To the receiver weight would need to be added about $1\frac{1}{2}$ oz. for the escapement, and probably about 4 oz. for batteries, wiring, etc., in other words an all-up weight of say $6\frac{1}{2}$ oz. In either case this would give rudder only control. However, with a four-position escapement it would be possible to use one of the neutral positions to trigger off an electrical circuit operating some different control. In such a case it would be necessary to skip over that neutral if the supplementary control was not required and this would give a keying code as follows: from neutral one press would give right rudder, and following right rudder two presses would be needed to get back to neutral. From neutral to left rudder would need two presses followed by one press to get back to neutral. From neutral to bring in the additional control, two presses would be needed and it is normal to wire into the supplementary circuit a condenser which causes a slight delay in operation so that the supplementary control is not triggered by the escapement passing over this position in

the normal course of a turn. Such a control could well be, in the case of a boat, a change of either motor speed or direction, so that the boat could be made to go astern or cruise at half or full speed. In the case of the aircraft it would trigger a second escapement which would give engine speed control.

In the case of small diesels and glow-plug engines it is necessary to have an engine especially equipped with a throttle mechanism for such control. Normally these small engines have a single running speed which can be varied only marginally, but many engines are available nowadays fitted with special throttle devices which enable the operator to reduce the power, which in the case of a normal model would probably be used for full power causing a climb, low power causing a gradual descent, and half power level flight.

No doubt many readers are interested in the likely cost of equipment of this type, and it is reasonably safe to say that the least expensive simple radio-control equipment, which is reliable and suitable for use by a beginner, is not likely to cost less than £15 for the complete transmitter, receiver and/or escapement mechanism. It should be remembered, however, that with care this equipment will last for several season's operations, and it can be transferred quite easily and quickly from one model to another, especially if separate escapements are used for each model. All that is then necessary is to unplug the receiver and place it in the next model to be used. It is quite possible to build the equipment at home from kits of parts, or from plans, and this obviously represents a considerable saving in the total sum expended. Any operator of radio control, however, must be licensed by the G.P.O. and before operating any equipment a modeller should make sure that he has obtained his licence (which is relatively inexpensive) and notified his local telephone manager that he is operating in the area.

Development at the moment is centred on equipment which can permit several models to operate at one and the

same time, since with much of the present-day radio gear only one transmitter and receiver can be operated at any one time. With slightly more complex equipment, this problem can be overcome, and it is being tackled by the commercial producers of radio so that its price can be brought within reach of the average modellers to whom the ability to fly or sail at the same time as their friends will be a big advantage.

These few words may have whetted your appetite for radio control, but it should be remembered that many simpler models are capable of giving many hours of fun and constructive enjoyment. In the pages of this book are many hidden instructive facts, and it is the ability of a model to teach its owner that makes it one of the most attractive hobbies which can be taken up. We hope to welcome you on the flying field or at the pondside in the near future.

Appendices

1. MODEL YACHTING ASSOCIATION CLASSES

THE following are the principal requirements of the four main yacht classes, expressed in simple terms:

36-in. Restricted Class

The hull, with keel, must fit into a box the inside dimensions of which are 36 by 9 by 12 in. Maximum weight must not exceed 12 lb. Certain prohibitions, e.g. pram bows and centre boards. No restriction on sail area.

Marblehead 50/800 Class

Overall length not to exceed 50 in. Sail area not to exceed 800 sq. in. Some prohibitions, e.g. metal fin and bulb keels. A special restriction is a minimum garboard radius of 1 in., i.e. hull must be faired into fin with a fairing or fillet forming not less than part of a circle of 1 in. radius.

10 Rater Class

Based on the simple formula:

$$\frac{\text{L.W.L.} \times \text{S.A.}}{600} = 10,$$

where L.W.L. is load waterline length in inches and S.A. sail area in sq. in. Thus any increase in L.W.L. results in a decrease of permissible sail area, and vice versa. These two factors are perhaps the most important in determining the performance of a yacht.

A Class

This is a complex but very good rule based on a formula with additional penalty clauses. The formula is:

$$\frac{L + \sqrt{S}}{4} + \frac{L \sqrt{S}}{12^3 \sqrt{D}} = 39.37,$$

where L is load waterline length plus half excess quarter beam measurement, S is sail area in sq. in. and D displacement in cubic inches.

Full rating rules for each of these classes can be obtained price 10d., 1s. 3d., 1s. 6d. and 2s. 3d. respectively from the M.Y.A. Publications Secretary, G. Leeds, 151 Charlbury Crescent, Yardley, Birmingham 26.

An annual fixture list, including details of all M.Y.A. clubs and other information is available price 1s. 3d. from the same address.

2. MODEL POWER BOAT ASSOCIATION CLASSES

Hydroplanes (R.T.P.)

Class A 15-30 c.c. i.c. or up to 16 lb. weight steam

Class B 10-15 c.c. i.c. or up to 16 lb. weight steam

Class C 5-10 c.c. i.c. or up to 16 lb. weight steam

Class D Up to 5 c.c.

Line breaking strains, etc., are subject to certain minima.

Radio Control Speed

Class A 15-30 c.c.

Class B 10-15 c.c.

Class C 5-10 c.c.

Class D 3.5-5 c.c.

Class E Up to 3.5 c.c.

Radio Control Steering

No restrictions except a maximum i.c. engine size of 35 c.c.

Straight Running Boats

No restrictions except that they must not exceed 12 m.p.h.

Insurance is necessary on all models run in M.P.B.A. events. General rules for all craft and competitions are contained in the M.P.B.A. Rule Book available price 1s. 6d. including postage from the Hon. General Secretary, J. King, 309 Days Lane, Sidcup, Kent.

3. ELECTRIC CAR RACING ASSOCIATION RULES

These are detailed, insofar as tracks and cars are concerned, in Chapter 8 (page 67). A rule-book including the full rules for conduct of competitions, etc., can be had, price 1s. 6d. including postage from the Electric Car Racing Association, 433 Brockley Road, London, S.E.4.

4. INTERNATIONAL AIRCRAFT RULES

The following are extracts from the basic specifications accepted all over the world for competition and record model aircraft.

General Models

Total of wing and tail area must not exceed 2,325 sq. in.

Total weight must not exceed 11.023 lb.

Loading of wing/tail area total must be between 3.95 oz./sq. ft. and 16.38 oz./sq. ft. (free flight) and not more than 32.76 oz./sq. ft. (control line) and 24.51 oz./sq. ft. (radio control).

Piston engines must not exceed 10 c.c., and the total weight of jet-powered models must not exceed 2.2 lb.

A2 Gliders

Towline length 164 ft. maximum.

Total surface area of model (wing and tail) to be between 496 and 527 sq. in., minimum total weight 14.46 oz.

Rubber Models

Total surface area between 263.5 and 304.5 sq. in.

Minimum total weight 8.11 oz.

Maximum weight of lubricated rubber motor 1.768 oz.

F.A.I. Power Models

Maximum capacity of motor 2.5 c.c. (.1,526 cu. in.).

Minimum total weight 10.58 oz. per c.c.

Loading of total surface (wing and tail) not less than 6.55 oz./sq. ft. nor more than 16.43 oz./sq. ft.

Control-line Speed

Maximum capacity of motor 2.5 c.c. (.1,526 cu. in.).

Minimum total area 508.2 sq. in. per cu. in. displacement.

Maximum loading 32.76 oz./sq. ft.

Radius of flight circle 15.92 metres.

Control-line Stunt

Maximum total area 2,325 sq. in., maximum motor capacity 10 c.c., and other requirements as under 'General Models' above.

Line length 49.2 ft. minimum, 65.6 ft. maximum.

Control Line Team Racing

Maximum total weight 24.69 oz.

Maximum engine capacity 2.5 c.c.

Minimum total area 186 sq. in.

Minimum dimensions of basic fuselage at pilot location 3.94 in. high, 1.97 in. wide.

Maximum fuel capacity 10 c.c.

Direction of flight anticlockwise, line length 52 ft. 2 in.

There are also a number of rules pertaining to the appearance of the model – fixed undercarriage, semi-scale lines, motor cowled, cockpit or cabin, scale model pilot, etc., etc.

Full rules for models of the above types and others eligible for British National competitions, etc., are printed in a rule book available price 2s. 6d. including postage from the Society of Model Aeronautical Engineers Ltd., 10a Electric Avenue, Brixton, London, S.W.9.

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