run freely. The shafts are put in place and cup washers soldered on to leave just a little end play, but must be adjusted so that the gear wheels line up with each other. One shaft is cut short and the other left long for the propeller.

We might mention here a method put forward by Mr. S. E. Capps for getting the spindle holes in the right place without a lot of bother and experiment. We put the gear-box back-plate on a smooth, hardwood block, and lay the gears on top. Where the teeth mesh we put two or three thicknesses of Jap tissue paper, and hold the gears in place with pins driven into the wood. Now we melt sealing wax all round the gears and the plate to hold everything nicely in place while we drill the holes. We must use a sharp drill that just fits the holes in the gears, and drill slowly and carefully, so that we do not make the plate hot, or it will soften the wax and allow the gears to move. See Fig. 57.

Here is a tip. When soldering on cup washers, put a small piece of paper with a spot of oil on it on the shaft first. It prevents the solder sticking the shaft to the brass plate.

Turning from the sublime to the ridiculous as it were, Fig. 58 illustrates about the simplest thing in nose-blocks. To make it simpler we can leave out the spring and the screw. We use two pieces of $\frac{1}{8}$ in. ply, one the size of the fuselage nose and the other to fit just inside the nose. They are glued together and held with a screwed bush and nut. For the propeller shaft we can use 16 s.w.g. wire, bent to form a motor hook at one end, threaded through the bush, a cup washer put on, and the propeller, and the shaft bent over at the end, poked into a small hole in the propeller. The shape of the hook shown is to suit a bobbin, the use of which we shall learn about when dealing with rubber motors. The spring and screw are there to stop the propeller from revolving when the power has run out, and at the same time to keep the rubber from moving

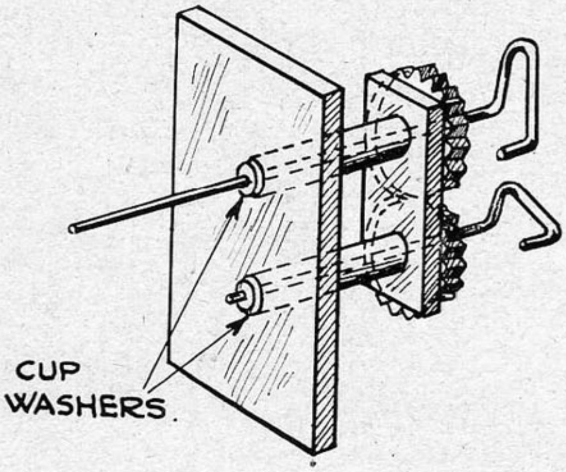


Fig. 56.

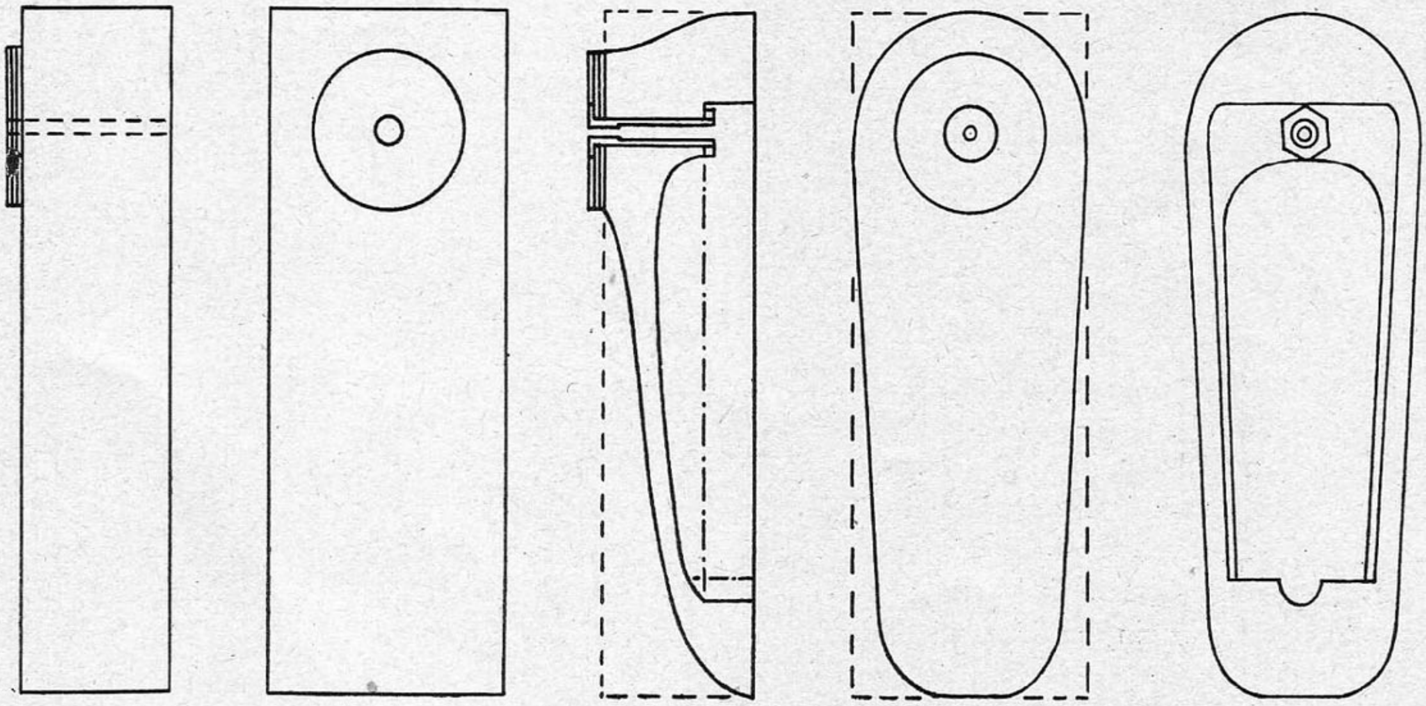


Fig. 55.

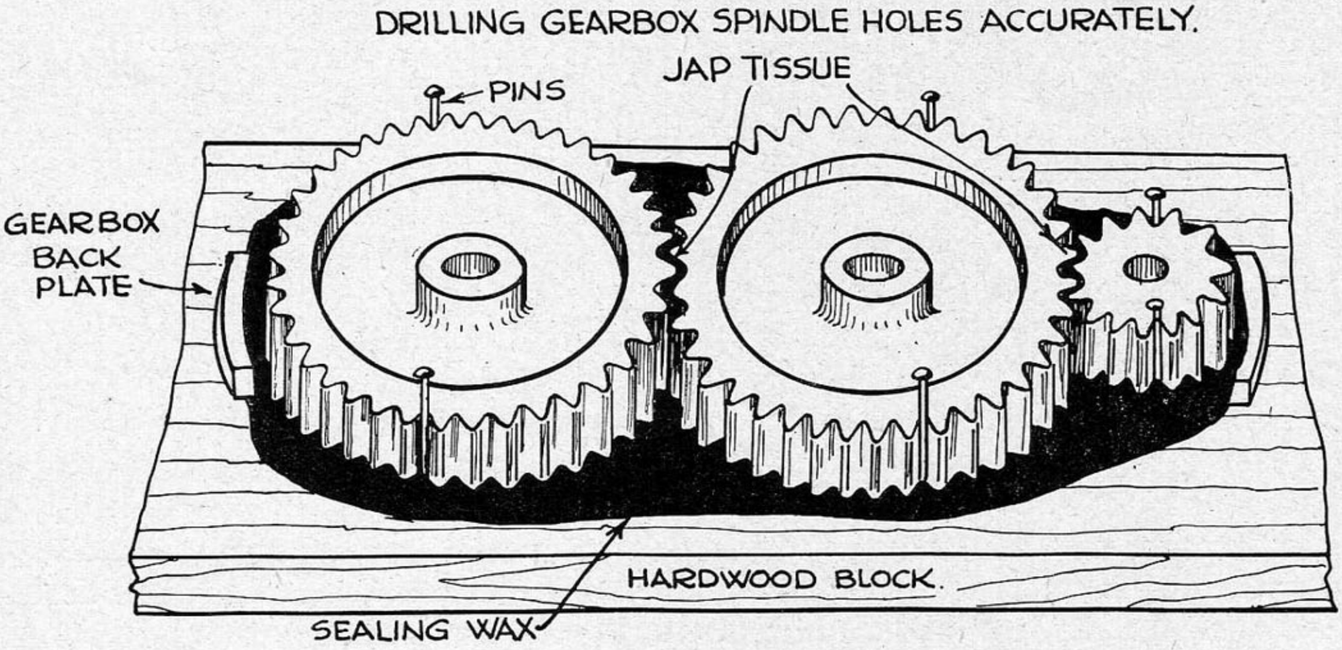


Fig. 57.

about in the fuselage after it has unwound, causing the centre of gravity to alter its position. We put the screw in such a position that when the hook hits it the propeller will be horizontal, to prevent risk of damage when the model lands. We do not want the spring very strong, about 26 or 28 s.w.g. steel wire will do nicely. A suitable piece can be taken from a worn-out cable from a bicycle or motor-cycle brake. The spring is made by bending the wire round a propeller shaft. We grip the shaft and the end of the wire in a pair of pliers, and wind the wire on in a helix (spiral), leaving a gap of about $\frac{1}{16}$ in. between each coil. We must hold the pliers very tightly and keep the wire just tight all the time. When we have about four complete coils, we push them all up together, keeping them tight, and then let go. This helps to even up the gaps between the coils. The spring is finished by cutting off the odd ends of wire and closing the ends of the spring up against the next coil. The screw has to be adjusted to suit the spring, so that when the motor is wound up enough to take up the slack in the fuselage the screw still catches the motor hook; but when it is wound up a little more the pull of the rubber compresses the spring and allows the shaft to revolve.

Now let us consider free-wheel devices. Let us first note the effects on the model. Firstly, about the only time we see a full-size machine land with the airscrew stopped is when it is done at a display to show that an aeroplane can be landed safely if the engine fails, so for looks we must use a free-wheel to let the propeller revolve after the power has run out. Against this there is much less risk of damaging the propeller in a bad landing if we arrange for it to stop horizontally when the power runs out. From a performance point of view things are interesting. When an aeroplane is gliding, the propeller acts as a brake to a more or less extent. If the pitch is equal or greater than the diameter, the braking effect will almost certainly be greater with it stopped than free-wheeling, or, as it is sometimes termed, " windmilling." If the pitch is about three-quarters

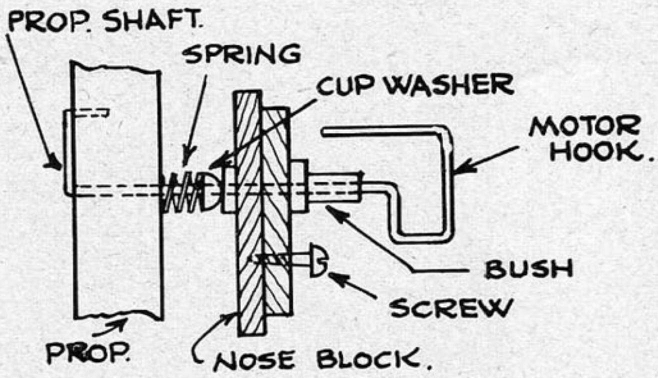


Fig. 58.

or less than the diameter the braking effect will be less with it stopped than windmilling.

Well, then, what happens when we put the brake on an aeroplane? The first thing is that it slows up, and in doing so loses some of its

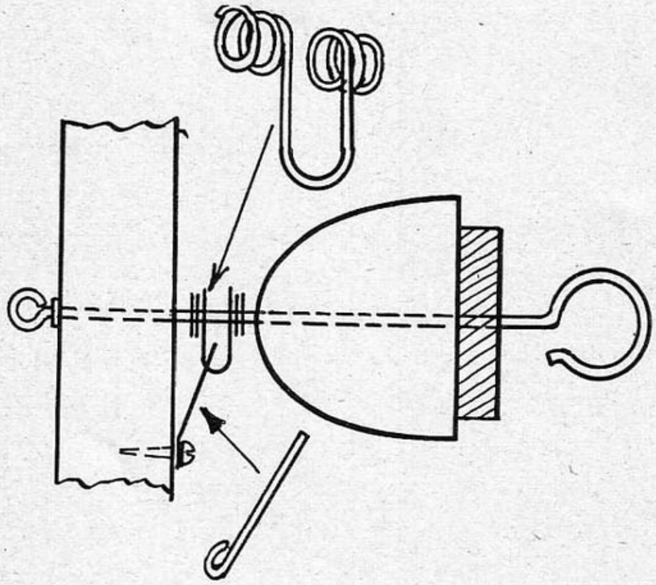


Fig. 59.

" lift." This means that if the machine is gliding it will come down more steeply, and although its speed is less it will reach the ground sooner. To see this more clearly, and to explain another point, let us draw a picture in our minds. Imagine a wall with two ladders leaning against it, with the top of each level with the top of the wall. One ladder has twenty rungs and the other has thirty. The bottom of the short ladder will be nearer the wall than the bottom of the long one. Suppose we walk down the short ladder in ten seconds, then our speed is two rungs per second, and we represent the aeroplane with the brake on. Now if we walk down the other ladder a bit faster, say two-and-a-quarter rungs per second, in ten seconds, we shall have got down twenty-five rungs, so we still have five rungs to go to reach the bottom. Although we have travelled faster down the long ladder, it has taken us longer to get to the ground; it works out at just over twelve seconds.

From this we can decide whether or not we want the propeller to revolve after the power has run out, and, as for some purposes it is an advantage to have a free-wheeling airscrew, we will describe two ways of making them.

The simplest way is shown in Fig. 59. Firstly we make a loop of wire about 28 or 30 gauge. We wind the wire on the propeller shaft for about three turns in the form of a spring, then make the loop and another two or three turns. You can see this more clearly in the sketch. We solder this on to the propeller shaft so that a projection on the propeller pushing against the top of the loop tends to wind up the wire and not unwind it. From a piece of wire about 20 or 22 gauge we make a pin to go through this loop. This pin has an eye-shaped end, made by bending the wire round a nail. It is held on to the propeller by a long, thin nail or screw, and must be free to swing round. It is fastened to the propeller so that the free end will go through the loop and just catch on the shaft.

Another type of free-wheel which is very neat is shown in Fig. 60. Here D represents the propeller shaft and B is a catch made from

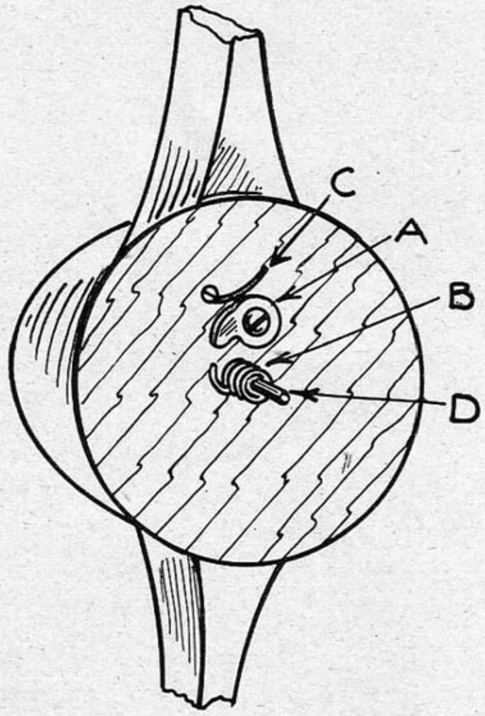
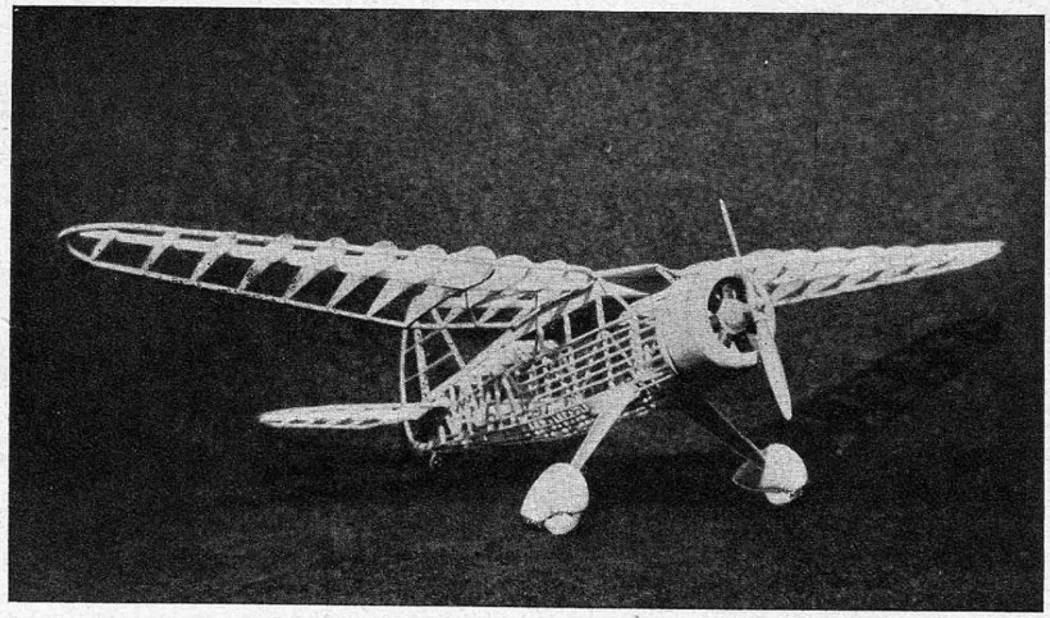


Fig. 60.

a coil of wire of about three or four turns soldered on. A is a pawl that we can make from a piece of sheet brass about 16 or 18 gauge. We drill a hole in it to take a wood screw about

THE MONOCOUPE



This 40 in. span of the Monocoupe, built by Mr. Earry, is yet another example of the beautiful workmanship displayed by aero-modellers. The model has moveable controls, and there are over 100 parts in the scale reproduction of the five-cylinder engine!

No. 2, then cut the outside with tin-snips and file to the shape shown. C is a small piece of spring wire about 30 gauge (a strand from a bicycle brake cable). One end is soldered to a wood screw fixed in the propeller boss. It should be adjusted so that it only just pushes the pawl into engagement with the catch.

When making gearboxes and nose-blocks we want to keep the overall size as small as possible, so that in the event of a bump on the propeller the nose-block pulls out easily, lessening the risk of damage.

CHAPTER XVIII

MOTORS AND FIXINGS

JOINING RUBBER. SELF TENSIONING. LUBRICATION. MOTOR STICKS. ADJUSTABLE FIXINGS. WINDINGS. WINDERS AND COUNTERS.

WE have already considered the use of the rubber motor, and we know that it is in one or more skeins, but we want to know now how to make up the skeins. We shall have to experiment to find out how much rubber is needed for a particular model, in the manner described for trimming the model for flight.

However, having decided on a certain quantity to try, we join the two ends together. There seems to be two methods of joining, both used satisfactorily by the writers. One is to tie a reef knot and bind the ends.

The other method is to lap the two ends of the rubber together with about half an inch overlap, and then bind them together, using thread or " Sylko," the rubber being stretched during the binding.

To assist us in this process, a gadget devised by Mr. R. Colman is shown in Fig. **61**.

A start is made with a base $5\frac{1}{2}$ in. × **3** in. of medium hard wood. In this are cut two rectangular holes $1\frac{1}{16}$ in. × $\frac{17}{32}$ in., these being $\frac{1}{2}$ in. apart and with their longer sides parallel.

Four pegs of $\frac{1}{2}$ in. square hard wood, each **2** in. long, are now cut and paired off—A, B, C and D. One inch from the top of each peg drill a hole—a $\frac{5}{32}$ in. in A and C, and a $\frac{7}{32}$ in. in B and D. Through A and C insert $\frac{3}{16}$ in. diameter bolts $1\frac{1}{2}$ in. long (these being purchased with wing nuts to fit), which are, intentionally, tight fits, to prevent them turning when the wing nuts are tightened. The bolts will be an easy fit in pegs B and D, which must have some movement. To prevent damage to the rubber strip, the top of each peg is bound with thin sheet rubber (bicycle or motor-car inner tube), this being secured where shown, with short pins. The pairs of pegs are next inserted in the base holes.

To operate: Slacken the wing nuts whilst keeping the pegs in the holes, and place the ends of the rubber to be tied between pegs C and D, afterwards tightening the nut. Stretch the rubber and bring it between pegs A and B, and tighten the nut. To obtain the necessary extra tension before tying, a hardwood key (**3** in. long × $\frac{1}{2}$ in. wide and $\frac{1}{4}$ in. thick, with a

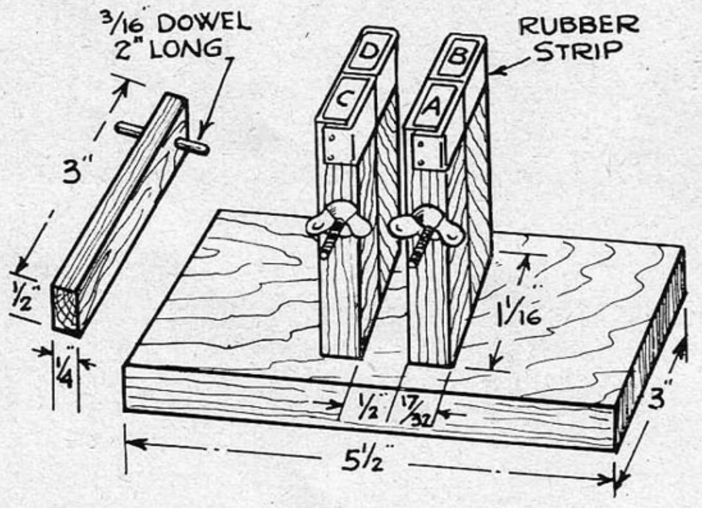


Fig. 61.

2 in. length of $\frac{3}{16}$ in. birch dowel inserted for turning) is placed between the two pairs of pegs and given a quarter turn, thus pushing the pegs and the rubber further apart.

The rubber is best tied with best quality silk, which is taken round the strip three times before tying. A touch of rubber solution to the short ends will make a permanent and non-slippable joint.

This joining, by the way, should be done before lubricating the rubber.

We now loop the rubber into the number of strands required, and it is a good idea to put a bobbin on each end, held with a rubber band, stretched and wound on. The length of the rubber is often greater than the distance between the hooks, and we have already seen how to keep it taut by means of a fitting on the propeller shaft, but there is another method of doing this in the rubber itself. The rubber is wound so that it twists itself up into a shorter length.

Fig. 62.

The simplest way to do this is to make up the motor into twice the length, but with only half the number of turns. In the centre of this we tie a piece of cotton, or fix a bobbin, so that we shall know the exact middle when the rubber is wound up. We attach one end to a fixed hook and the other to a winder of some sort (A in Fig. 62). It is then wound up a few turns. The best number will have to be found by experiment, but you might try about 50 to start with. Fold the wound skein into two, so that you have the correct number of strands for the motor, and put the two ends on a hook or a bobbin. Stretch the skein and then release it, letting it wind itself up, and see if the length is slightly less than the distance between the hooks in the model. If so, all is well, but if it is a bit slack, unhook the ends and wind on a few more turns. If it is a bit on the tight side, try a few less turns. Another method is to wind each loop separately, and so it is equally successful with an odd number of

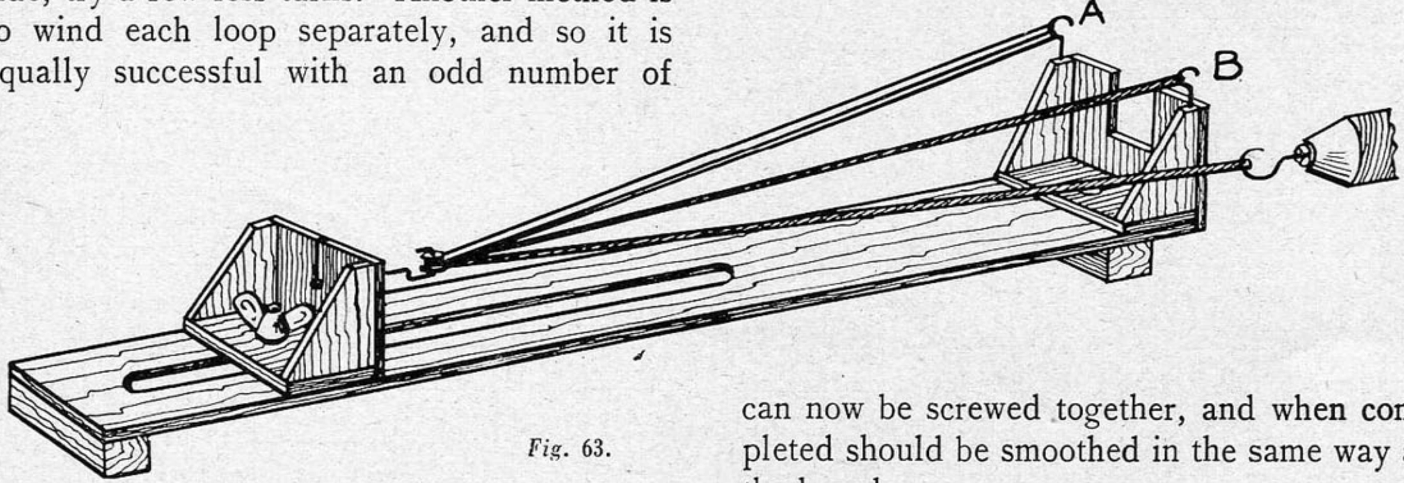


Fig. 63.

loops. In this case a special gadget has been made for winding and testing rubber motors. This is shown in Fig. 63, and we will let Mr. S. E. Capps, the originator, describe it.

The baseboard A is prepared first from a piece of straight-grained deal or pine (any wood will do, provided one is able to work it properly) about 4 ft. long, planed smooth, and the ends carefully squared. The slot is next cut, and is $\frac{3}{8}$ in. to $\frac{1}{2}$ in. wide. This is easily done by first boring a hole at each end and cutting down with a fine saw. Carefully mark off and drill all the holes at both ends. The two cleats, B, should now be made and fitted in place, after which the whole board should be sandpapered all over with No. 0 or No. 1 sandpaper, to remove all sharp corners and edges. This is important, as any sharp edge or corner coming in contact with the rubber would probably cause a small cut, which would eventually result in the fracture of the motor.

Next cut the four diagonal pieces, C, for the sides of head and tail parts. These should be just as carefully made. Cut the two bottom plates, E, and drill the holes shown. These can now be screwed together, and when completed should be smoothed in the same way as the board.

The head or fixed part can now be fitted and fixed to the board with a round-headed bolt. The final parts to be made are the formers, D, to take the nose and tail plugs, G, of the model whose motor is to be tested. These are made of three-ply wood, and after being smoothed are fixed with small woodscrews in the corners. The whole may then be varnished or enamelled.

To use this gadget for tensioning our motor, we put a hook in the tail part and two hooks in the nose part. Refer again to Fig. 63. We put one end of the rubber motor on the tail hook and the other end on hook A at the front. Taking each loop in turn, we wind it up a few turns and transfer it to hook B. We wind them in the same direction as the propeller revolves. When all are wound we put them on the nose of the model, holding the propeller to prevent it turning, and then put the nose into place on the gadget and release the propeller. The rubber will then twist itself up into a sort of rope. If we move the tail anchorage forward till the distance between the two hooks is the same as it will be in the model, we shall see if the loops have been wound up the right amount.

We have not so far said anything about lubricating the rubber motor, which should be done before winding, so let us see what it is all about.

We know that where two surfaces slide against each other they are lubricated to reduce friction and prevent undue wear. For the bearings of engines we use oil, and for a dance floor french chalk is used. For our rubber motors we use a special rubber lubricant. It should be well rubbed into the strands of the motor, so that when two pieces are rubbed together they feel very slippery. Lubricate the rubber evenly and freely.

When putting the model away for a few days, all the lubricant should be washed off the rubber, the rubber dried and stored in an air-tight tin. A little french chalk in the tin also helps to preserve the rubber.

The next consideration is fixing the rubber in the fuselage. This, of course, applies to the rear end, since the front will be attached to the nose-block or gearbox. We can either fix it on a hook fixed to the rear end of the fuselage, or use some form of motor stick. Let us consider the motor stick.

This is an arrangement whereby the nose-block and rear hook are fastened to a rod or " stick " so that all tension and torsion of the motor is taken by the stick. There is then no strain on the fuselage from the rubber. Also we can arrange it so that the motor is wound up before it is put in the fuselage, so that, should we be unfortunate enough to have the rubber break, the model will not be damaged.

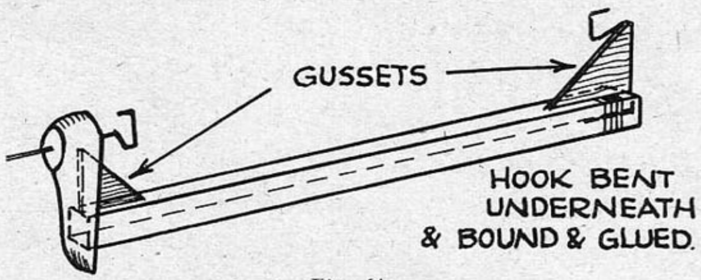


Fig. 64.

Such a motor stick is shown in Fig. 64. It consists of a square or oblong stick of balsa with a hook at the rear and a nose-piece at the front. The rear hook can be made of 18 or 20 gauge wire, bent to form a hook at the top, then bent round under the stick at the bottom and bound and glued in place. A gusset of ply or balsa is glued on to hold the wire upright. At the front the nose-block is also glued on with a gusset. We shall then need some means of keeping the nose on to the front of the fuselage. This can conveniently be a hook fastened to a longeron or cross strut an inch or two down the fuselage, connected by a rubber band to a hook at the bottom of the nose-piece and under the stick.

An improved type of motor stick can be made in the form of a tube, which encloses the whole of the motor. This tube is quite a good idea when we have a fuselage with lots of thin stringers, since it prevents the rubber hitting them. Also it is an easy matter to fit a small nose-block that will easily knock out on landing, and so help to save the propeller from damage. The front end of a motor tube is shown in Fig. 65. Here it is glued to a nose plate that fits up against the front of the fuselage in the same way that a nose-block would fit. In this plate we can have a small removable nose-block. For small models we can make the tube from 1/64 in. sheet balsa covered with paper, and for large models we can use $\frac{1}{32}$ in. balsa covered with silk. To make the tube we soak the balsa in boiling water—in the copper on wash-day is a good idea—until it is thoroughly hot. Then we borrow the broom (since we used the copper!) and wrap the balsa round the handle. When

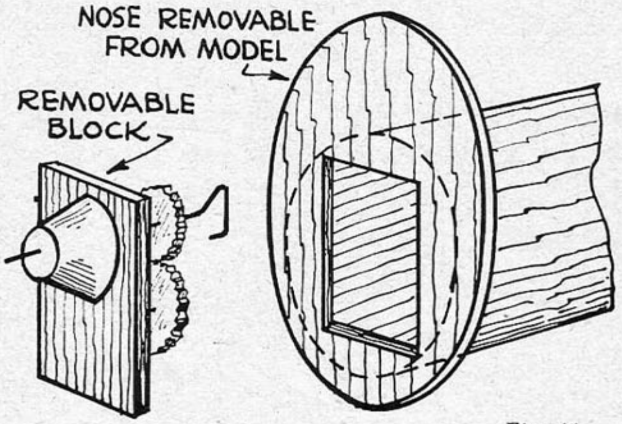


Fig. 65.

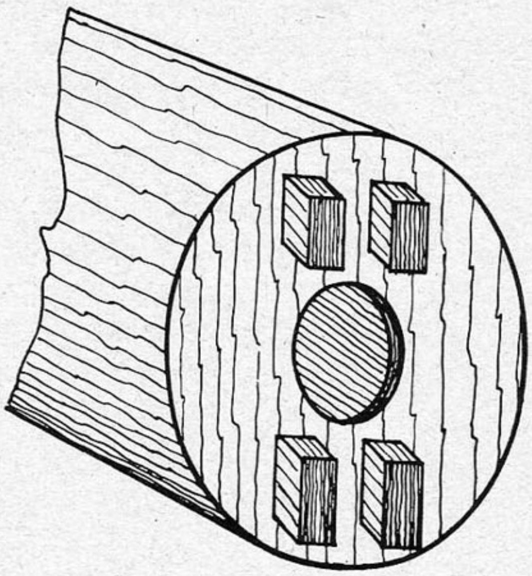


Fig. 66.

it is dry we can lap the edges about $\frac{1}{8}$ in. and glue them together. We want to make the tube as large as we can get in the fuselage, to give as much room as possible to the rubber. For the rear end of the tube we make a disc of balsa from two pieces glued together with the grain crossing, with a large hole to pull the rubber through. To hold the rubber we can use a peg of cane or bamboo, and, to prevent it turning, four blocks of balsa can be glued on as shown in Fig. **66**. If we are using two gears, it would be best to have two holes in the back. With this type of motor tube we can wind up the motor inside the fuselage without fear of damage if the motor should break. A motor stick, or tube, has one disadvantage for scale models, and that is the difficulty of adjusting the position of the rear hook to assist in getting the C.G. in the right place. The only thing to do is to make the stick long in the first place and cut it shorter bit by bit until we get it right.

If we do not use a motor stick we shall have to fix up some means of attaching the motor to the rear of the fuselage. If we turn again to the drawing of the Miles Trainer, we can see two pegs passing through the fuselage from top to bottom, one at the bottom of the leading edge of the rudder and the other just behind the windows. The ends are supported in large blocks of balsa. These two pegs provide two alternative positions for the motor, which is hooked on to a paper tube. To the middle of the tube is fixed a balsa handle for holding the tube in place while we put the peg through. There is a little sketch of it just above the fuselage, in front of the rudder. The tail-plane and rudder are made detachable, so that we can put the tube in from the rear. This is an excellent method of adjustment.

We must remember that there may be a strong pull on the rubber when it is wound up, and there may also be some tendency to twist the fuselage, so where the motor is fixed we must strengthen the fuselage. Small sheets of balsa covering a number of stringers, or across a pair of longerons, are useful here.

Another method for varying the position of the rubber motor in the fuselage, a neat fitting, is shown in Fig. **67**. The ply bulkhead should be fixed in the fuselage about level with, or just behind, the leading edge of the tail-plane, and we need to make the tail-plane removable so that we can get at the bamboo plug. It is usually quite easy to arrange this, as the tail-plane is generally at the top of the fuselage, and can have the rudder fixed on. Unless we have a very small model, it is best to use ply about $\frac{1}{16}$ in. thick for the bulkhead, with stiffeners $\frac{1}{8}$ in. square. The bamboo plug can be about $\frac{1}{8}$ in. diameter. We can make this plug, or any odd bits of small dowelling for that matter, with a very simple piece of apparatus. All we need is a piece of steel plate about $\frac{1}{16}$ in. thick, with a series of holes of different sizes in it. If we cannot find anything better we can get a large hinge—a shiny one is best—and put the holes in that. A set of suitable drills can be obtained for 6d. Need we say where? Now, to make the plug or dowel we cut a piece of wood roughly three or four sizes larger than the finished size we want, and push it through one of the larger holes. Then we push the wood through the next hole smaller, and so on until we have got it down to the right size. Don't try to do a length of more than about six inches at a time, and push a very little at a time. If we can it is best to put the plate in a vice and push with one hand and pull with the other. The next part of the fitting is the sliding block. For this we can use a piece of balsa about $\frac{1}{4}$ in. square, and put a piece of ply about $\frac{1}{32}$ in. thick each side, glued on. The length will depend on the distance between the bulkhead and the rear end or sternpost of the fuselage. With the block as far back in the fuselage as it will go, the front end can be about $\frac{1}{2}$ in. in front of the rear face of the bulkhead. With the block in this position we want a hole through it to take the bamboo plug just behind the bulkhead. From there to the end we drill a series of holes about $\frac{1}{2}$ in. apart. We can put the wire for the rubber hook through the ply and balsa about $\frac{3}{16}$ in. behind the front edge of the block. If we use a bobbin on the rubber motor we can cut away the balsa between the ply, and use another bamboo plug to hold the bobbin in place. The sketch shows two hooks suitable for two skeins of rubber, but two hooks are also useful for one skein. If we put part of the rubber on one hook and part on the other, it helps to prevent the rubber from bunching in the rear of the fuselage. The block should slide fairly easily through the bulkhead, and by putting the plug in different holes we get a very fine adjustment of the rubber, with nothing showing on the outside. If our model should have the tail-plane about half-way down the fuselage we could still use this idea by fixing the tail-plane to the sides of the fuselage and having the top, complete with rudder, to be removable.

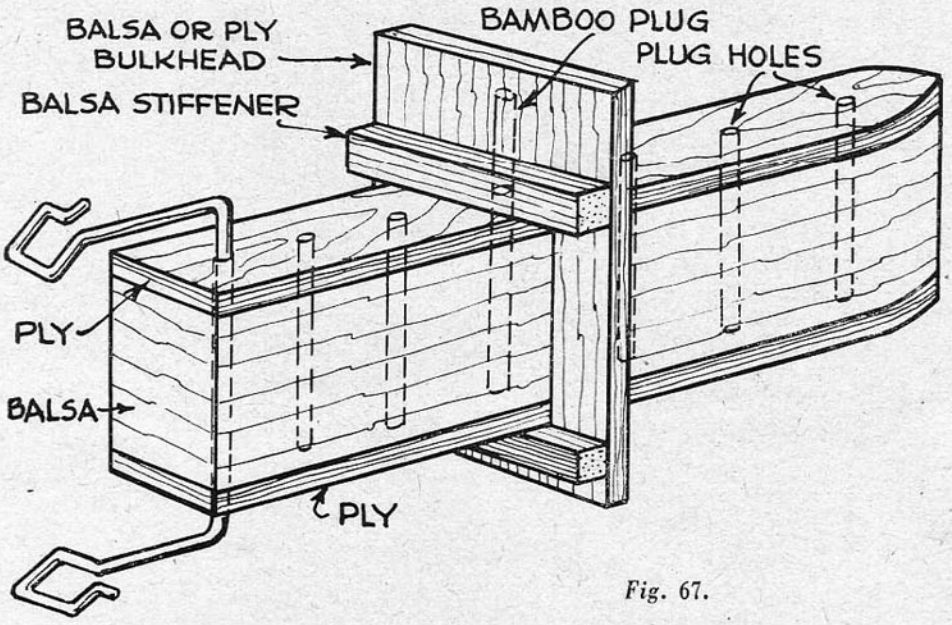


Fig. 67.

For getting this tail-block in position in the fuselage a rod is needed, since the block will have to be put in from the nose. The writer used a piece of $\frac{1}{4}$ in. $\times$ $\frac{1}{4}$ in. hard balsa, though spruce or deal would be just as good, and stand rougher treatment, with two pieces of $\frac{1}{4}$ in. $\times$ $\frac{1}{16}$ in. ply about 5 in. long, held on to one end with rubber bands. This formed a springy sort of fork, into which the tail-block was slipped, complete with motor. The rod was long enough to stick out of the front of the fuselage about 5 in. when the block was in position. The nose-block was held against this end by the tension of the rubber motor. When the dowel was in place in the tail-block it was a simple matter to pull the nose-block off to withdraw the rod.

To wind up the rubber is rather a tedious job if done by hand, so we usually resort to some sort of assistance in the form of a geared winder. Fig. 68 shows one type made from a hand grindstone. This is bought in bits from the sixpenny store, but you do not need the wheel. Instead we have a distance-piece and bar of iron or brass. The distance-piece can be either metal or wood, and could be cut from a cotton reel. The strip of brass or iron can be about $\frac{1}{2}$ in. wide by $\frac{1}{16}$ in. or $\frac{3}{32}$ in. thick, and about six inches long, bent at right-angles at each end, and has a hole in the middle. It is bolted on to the spindle of the grinder, and the two ends should be bound with rubber to prevent damage to the airscrew. The winder is then clamped on to an iron or steel bar about $\frac{1}{2}$ in. or $\frac{5}{8}$ in. square, pointed at one end and bent at right-angles at the other. This can then be pushed into the ground with the foot. It is a good idea to drill a hole for the propeller shaft in the spindle of the grinder, or solder a piece of tube on.

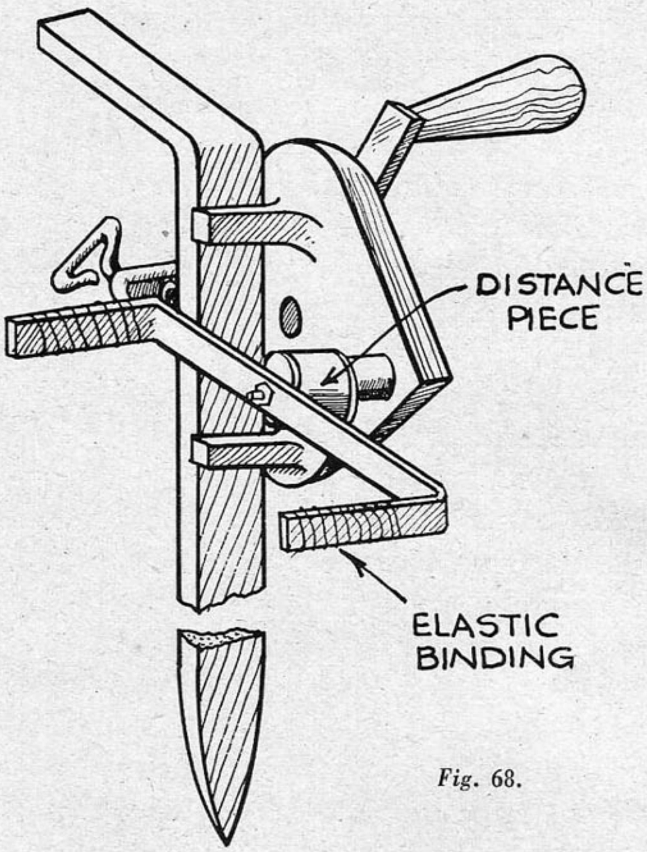


Fig. 68.

Another form of winder can be made from a hand drill. A hand drill can be bought from the 6d. stores (in bits), and all that is needed in addition is a hook or prong arrangement. We can make the hook from a piece of wire or a propeller shaft of a fairly heavy gauge, say about 14. For small models this will do very well, but if we have a lot of rubber to deal with it is much safer to solder the hook in a piece of brass tube, or wind on some thickish copper wire and solder it. The idea is to make a larger diameter for the chuck to grip. For the prong type we can wind two pieces of wire together round a piece of brass tube about $\frac{1}{8}$ in. diameter, bend them outwards and forwards about $\frac{1}{4}$ in. from the front end of the tube and solder them on, opposite to each other, toasting fork fashion. The brass tube is then held in the chuck.

The hook type winder is shown in Fig. 69 with the addition of a revolution counter designed by Mr. J. Youhill. This counter consists of a block of hard wood clamped to the drill frame with two hook bolts made from $\frac{1}{8}$ in. or 4 B.A. screws and nuts. Through the wood is a $\frac{3}{16}$ in. hole, or a brass bush drilled $\frac{3}{16}$ in. to take the 2 B.A. countershaft. At one end of this shaft we have two nuts locked together, or preferably soldered to the shaft, with holes drilled in all six flat faces of one nut, and short pieces of wire soldered in. Two more nuts and a washer are put on the shaft, which is then threaded through the block. Next we put on a spring washer and two more nuts. With the wood block on the drill frame, the first two loose nuts are adjusted so that the star-wheel end is in a convenient position for the striker bar. The two nuts are then tightened against each other so that they will not alter their position. The other two nuts are tightened against the spring washer so that the shaft will revolve easily but will not slip round on its own when shaken. The striker is a piece of wire or a small screw fixed in the large gear wheel so that it will strike each piece of wire projecting from the " star " wheel. A piece of brass plate about 20 s.w.g. is screwed to the wood block so that it projects about $1\frac{3}{4}$ in. This plate either has a slot cut in it or has a piece of wire soldered on to form a slot. Poking through this slot is a pointer, which can be a short piece of wire soldered to a nut that screws easily along the shaft. On the extreme end of the shaft is a terminal nut, fixed on by soldering or with a lock nut. This terminal nut is for returning the pointer to zero after winding up. Turns are counted on the winder hook and the brass plate is marked to suit.

An extremely good looking revolution counter has been designed by Mr. Douglas Young, and we will let him describe it. Fig. 70.

Some Meccano parts and a tooth powder tin are required, and you needn't even solder unless you want to. The cost is around 1s. 6d. to 2s., with the tooth powder thrown in. It is dead accurate, counts up to **950**, and has a zero setting for use at will.

The illustration shows the counter attached to the most popular winder in use to-day. But one screw, apart from the winder jaws, holds it, so it can be adapted to fit any winder.

Get first the handsome- and professional-looking (when it's painted) case, the carbolic tooth powder tin. This one costs threepence, and measures 3 in. × $1\frac{1}{4}$ in. It must not be any smaller. The other parts required are Meccano rods, two **6** in. and two **3** in. long, two worm gears, one 19-tooth × $\frac{1}{4}$ in. gear-wheel, and one **50** - tooth gear - wheel and five collars.

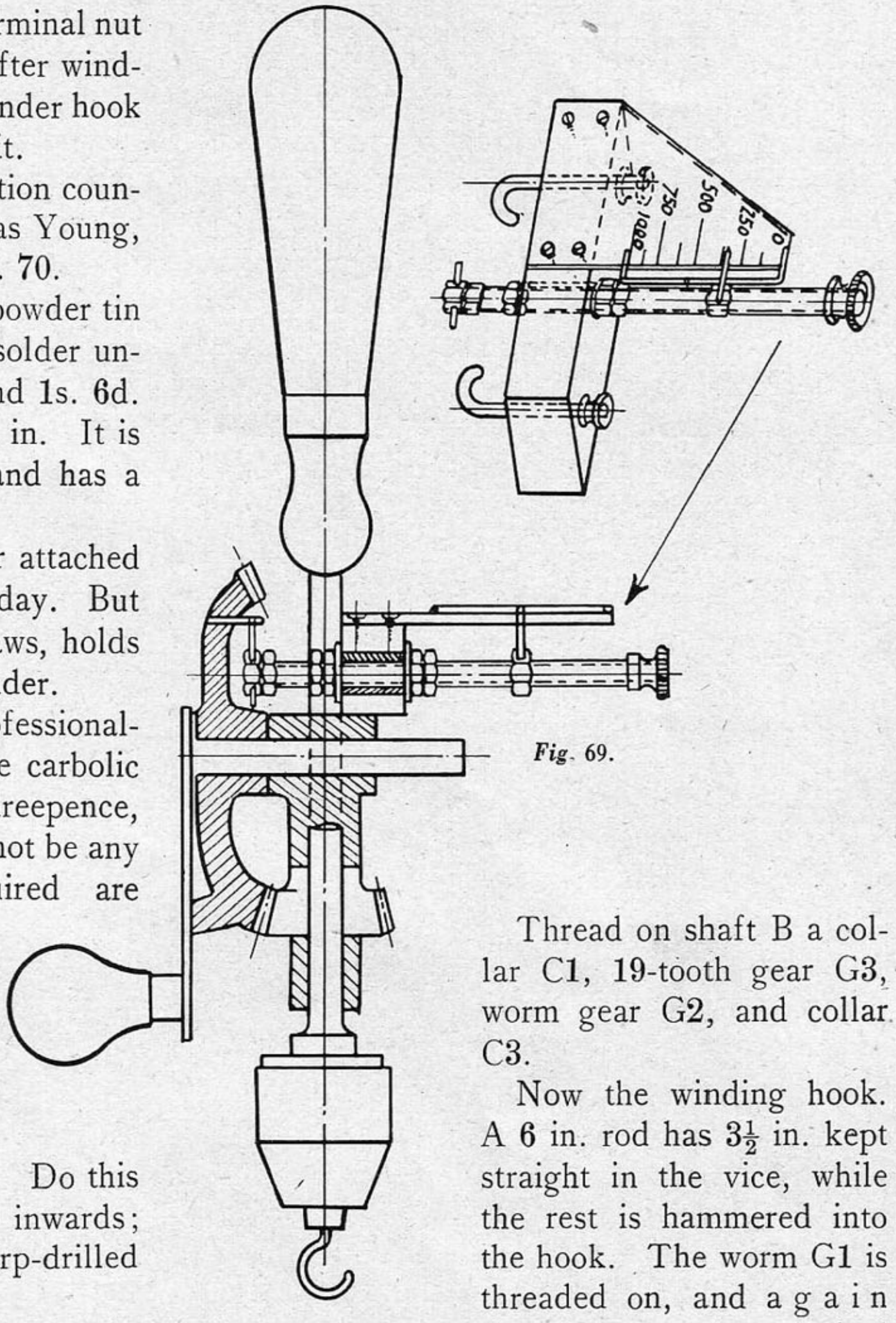


Fig. 69.

Punch a hole in the dead centre of the top and the bottom of the tin. Do this with a spike which burrs the edges inwards; this makes a better bearing than a sharp-drilled hole.

Bend a **3** in. rod at right-angles in the middle, file one of its ends into what you think a smart pointer should look like. The other leg of the right-angle will henceforth be referred to as the centre shaft (P) and must be fitted in the holes just made. Use the bottom of the tin with its raised edges as the " face," and the lid as the " back," which is left removable for inspection.

Fit the **50**-tooth gear (G4) to the centre shaft, bush first. Next comes shaft B, a **3** in. rod revolving in bearings burred inwards at points which can be judged visually. This is not as difficult as it seems, since there is a great deal of leeway provided by the fact that G4 need not mesh with G2 dead on its axis.

Thread on shaft B a collar C1, 19-tooth gear G3, worm gear G2, and collar C3.

Now the winding hook. A **6** in. rod has $3\frac{1}{2}$ in. kept straight in the vice, while the rest is hammered into the hook. The worm G1 is threaded on, and again the tin case is punched to make bearings, this time through the lid-flange. It leaves only $\frac{1}{16}$ in. of the tin outside of the bearings to hold the shaft, but it is enough. The lid will have to be nicked to fit over this, and a similar nick in the lid will have to be cut to fit over rod D, which fits parallel and similarly to rod A. Rod A, of course, revolves, held in position by collar C4, while rod D is fixed. Fixing can be done by soldering collar C2 to the tin and a dab of solder on the point where the rod goes through the tin. While the soldering-iron is hot, put a 5-hole Meccano strip behind the face, with a dab of solder through its outer holes, to reinforce the rather weak tin.

If you are determined not to get the soldering-iron out, leave out this strip and substitute a threaded collar for the plain collar C2, fixing it to the tin with a screw into its end. You will then probably have to use threaded rod in place of plain rod D. Keep rod A at right-angles to rod B, and, as a guide, the measurements between centres on mine are, rod A to centre shaft P, $\frac{9}{16}$ in., P to D, $\frac{3}{8}$ in. A piece of $\frac{1}{2}$ in. tin strip folded over rod D, drilled to fit under a screw conveniently situated on the winder, holds the counter still when it wants to turn, and finishes the mechanism.

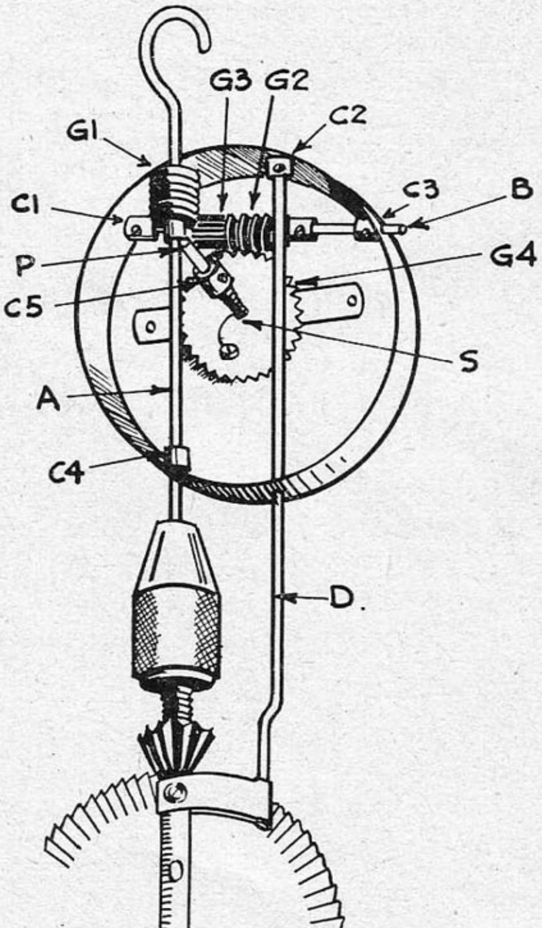


Fig. 70.

The worm gears revolve once to turn the flat gears one tooth, therefore the total reduction is one to $19 \times 50 = 950$. Stick a paper disc on the " face." If you know how to divide it into $9\frac{1}{2}$ divisions, each representing 100, you can calibrate it accurately. If you don't, then start from 12 o'clock, wind 100, and make a mark, similarly all round.

The zero-resetting device is optional, but jolly well worth adding. It consists of spring " S." Don't get scared of making a spring on the score of not being a metallurgist. Heat treatment is not necessary. This was made by unwinding a Meccano spring to get a few inches of straight wire, then winding it round a piece of wire somewhat smaller than the rod, for about six or eight turns. It springs out to a size which grips the centre shaft tightly. When the lower end is secured beneath a screw and nut put through a hole in wheel G4, it allows the pointer to be turned by hand clockwise, but not anti-clockwise. The top end is left free, and collar C5 is to stop the spring riding up. Start the spring from the bottom, coming up clockwise.

You turn the pointer clockwise to zero by hand after each wind, yet, when winding, the pointer positively registers without slip or springiness.

Coloured aero dope finishes the metal, and put plenty of transparent dope on the paper face. Everybody will want to borrow it as soon as you bring it out, so put a clockwise arrow on the face to show which way to set it to zero.

Here are a few reminders to finish the chapter. Lubricate the motor well and truly, but not so much that the lubricant flies all over the place. Don't over-wind the rubber. A revolution counter is a great asset.

CHAPTER XIX

LANDING GEARS

METHODS OF SPRINGING. WHEELS.

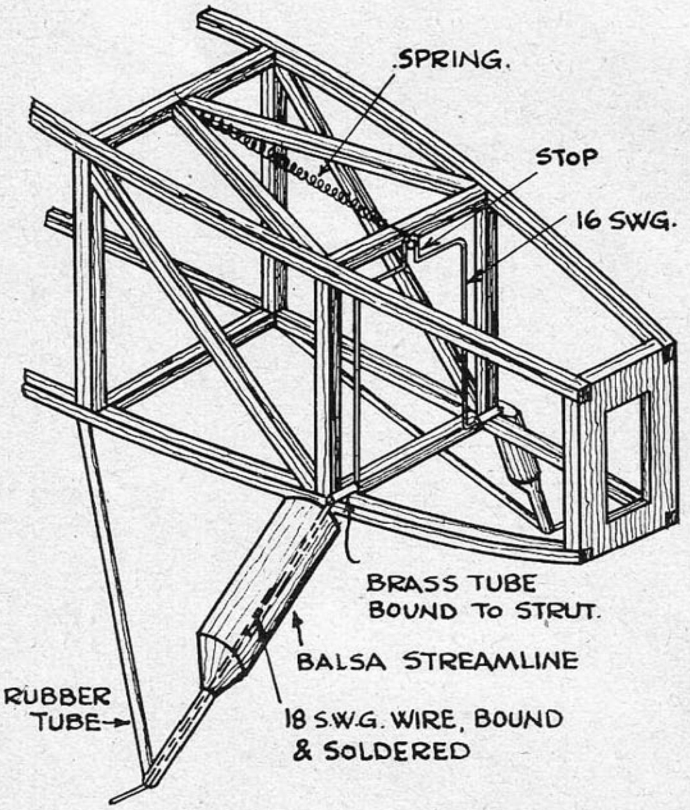


Fig. 71.

WE have already seen that undercarriages are better left off when possible, but there is a considerable number of aeroplanes with fixed undercarts. Where we have an undercarriage, some form of springing is advisable, unless the model is very small and light. Let us turn again to the drawing of the Miles Trainer and see the neat and effective undercarriage leg there. We make this by threading a piece of steel wire through a length of spring curtain rod, soldering it at each end. The bottom end is then bent at right-angles to form the wheel axle, and the top is fixed to the aeroplane. In the case of the Trainer, a U piece is soldered on, and the two ends of the U fit into a balsa block. Another effective undercart is shown in Figs. 71 and 72 and is that fitted to Mr. Hasting's Hawker Fury. Fig. 71 shows the inside works, and we can see how a piece of wire has been bent to shape, with brass tube threaded on. The tubes are then bound and glued to the fuselage structure, and a spring is fixed to the wire at the top. The other end of the spring is fixed to the fuselage, so that it is stretched when the undercarriage legs are pushed backwards. Note that where the spring is fastened to a cross strut two more struts have been fixed between this point and the longerons. Also struts have been fixed up from the bottom longerons to the top, just behind the brass tubes. To represent the rear struts of the undercarriage, a piece of rubber tube or cord is used. This is glued in place with only a slight tension, just enough to prevent it sagging. The front leg is faired with balsa.

A few more methods of springing undercarriages are shown in Fig. 73. The main point is to have as much spring as possible. For instance, a sketch is shown of a wheel sprung inside a spat, but if it is at all possible we shall do best to have the leg sprung also. The chief trouble is that with the spatted type it is the spats that hit the ground. There is also the trousered type, that suffers from the same

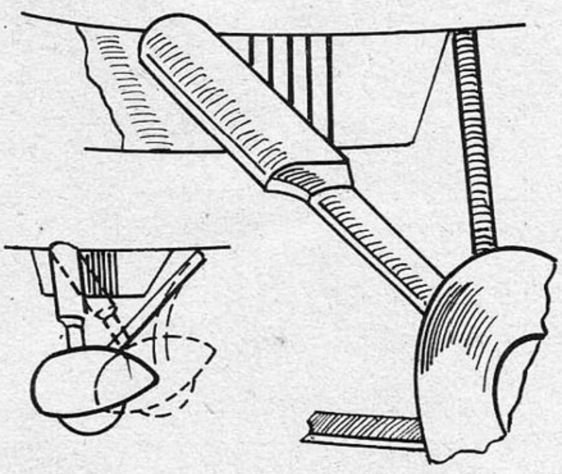


Fig. 72.

trouble. In this type we can have the trousers held against the under surface of the wing with rubber bands that pass over the top. The trousers will then knock off on landing.

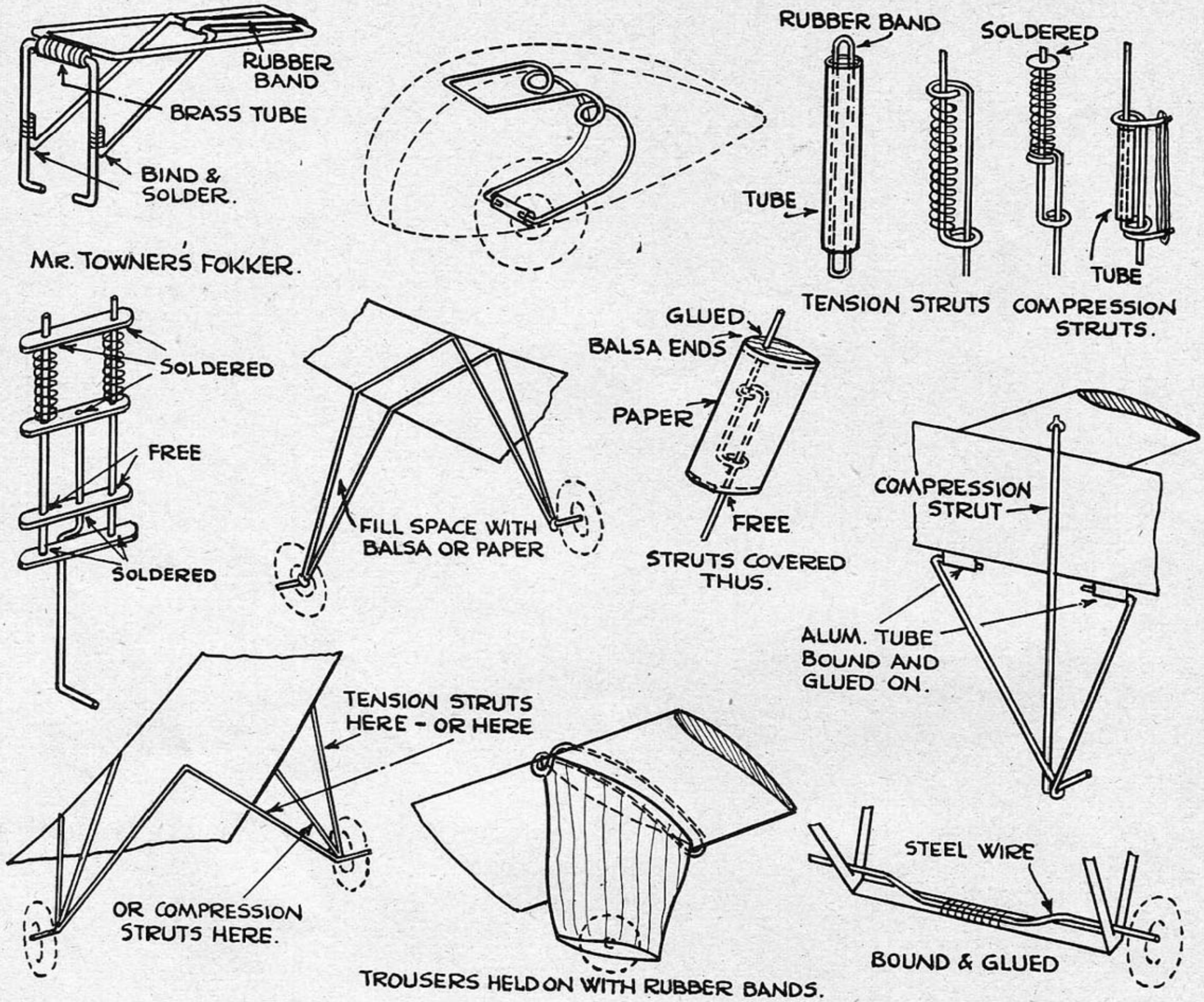


Fig. 73.

In Fig. **74** is a really smart way of springing a cantilever undercarriage leg that would do very well for a model of the Gloster Gladiator. The sketch shows the leg for a large, heavy model, using steel tube with the wheel axle soldered on. But for a smaller model we can use two pieces of bamboo $\frac{3}{16}$ in. by $\frac{1}{16}$ in., with a piece of $\frac{3}{16}$ in. square balsa glued between them. The wheel axle could be bound and glued to the front piece of bamboo. At the top a piece of wire is put across the two pieces of bamboo and rubber bands are attached to it, the balsa being cut away. The rubber bands are fixed to formers in the fuselage at the top and bottom, using wire hooks or loops. The strength and tension of the rubber can be adjusted to suit the weight of our model.

We can see from the foregoing description that steel wire plays a very large part in most undercarriages for strength of the legs themselves and for springing. The wire used varies in thickness according to the weight of the model and the design of the undercarriage. We can, however, quote a few instances as a guide. Let us look at Fig. **73** again, and take some of the examples in turn. The one at the top left is suitable for a twin-engined machine with undercart retracting into the nacelles, and about a ten-ounce model. The wire could be **16** s.w.g. throughout. The one below would do for a **14**-ounce model using **14** s.w.g. wire and an eight-ounce model using 18 s.w.g. The two below and alongside could be 20 s.w.g. for an eight-ounce model, and 16 s.w.g. for a 12-ounce one. For the top middle we could use 20 s.w.g. for a six- or eight-ounce model, and for the bottom right 20 s.w.g. for an eight-ounce machine.

It is best to bend the wire in as few pieces as possible, though there is a limit to the sharpness of any bends. This limit is best found by experiment, and it is suggested that the reader tries bending a few odd bits of wire of various sizes to see how sharp a bend he can get without it cracking. The sharpness depends to some extent on the tools used, since a sharp edge increases the tendency to crack. For bending the wire we can do with two good strong pairs of pliers, one flat-nosed and the other with one flat and one round side.

When we have wire fixed to balsa it should be bound with thread and well glued, but a better job would be made by glueing a piece of thin ply to the balsa first.

Now we come to the wheels. These can be bought or made up. Very good-looking ones can be obtained made of solid balsa or hollow celluloid. They can also be purchased made from sponge rubber, or real pneumatics, in an assortment of sizes. We can make use of the heavier varieties for the main wheels with advantage, and the lighter ones, that is, hollow celluloid, for tail wheels. We could, of course, use the celluloid ones for the main wheels, but a little extra weight is usually an advantage in this position. If we can put an aluminium or brass bush in the main wheels they will run more freely.

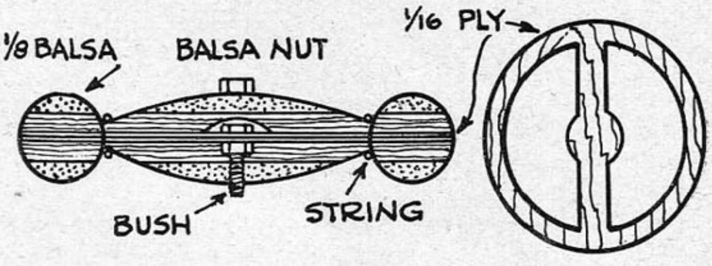


Fig. 75.

The best way of making wheels is to start with a ply disc, as shown in Fig. 75. We can cut away some of the ply to lighten it if desired, and then the rim is glued on. This is cut from $\frac{1}{8}$ in. sheet in circles and is glued on with the grain crossing. A screwed bush is put in the middle of the ply disc, and this bush

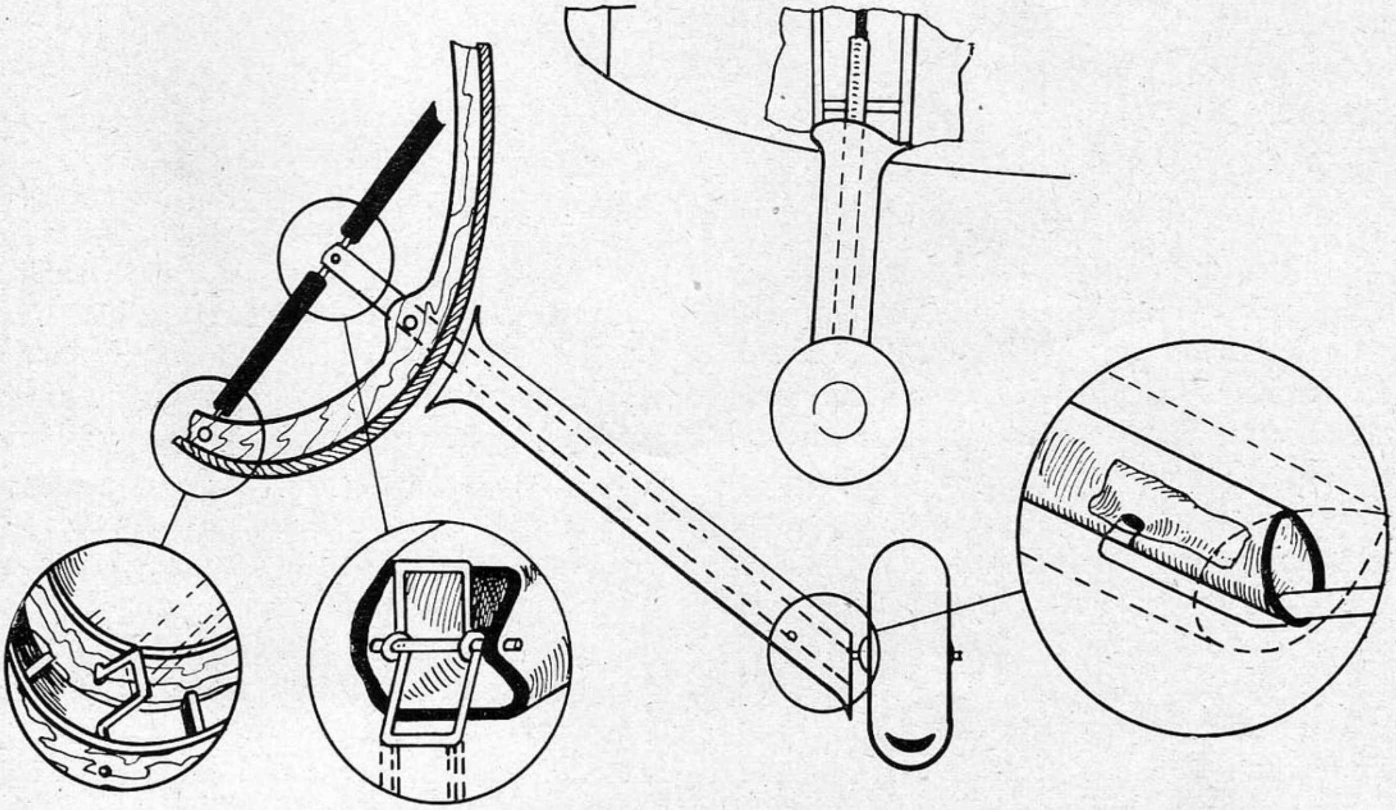
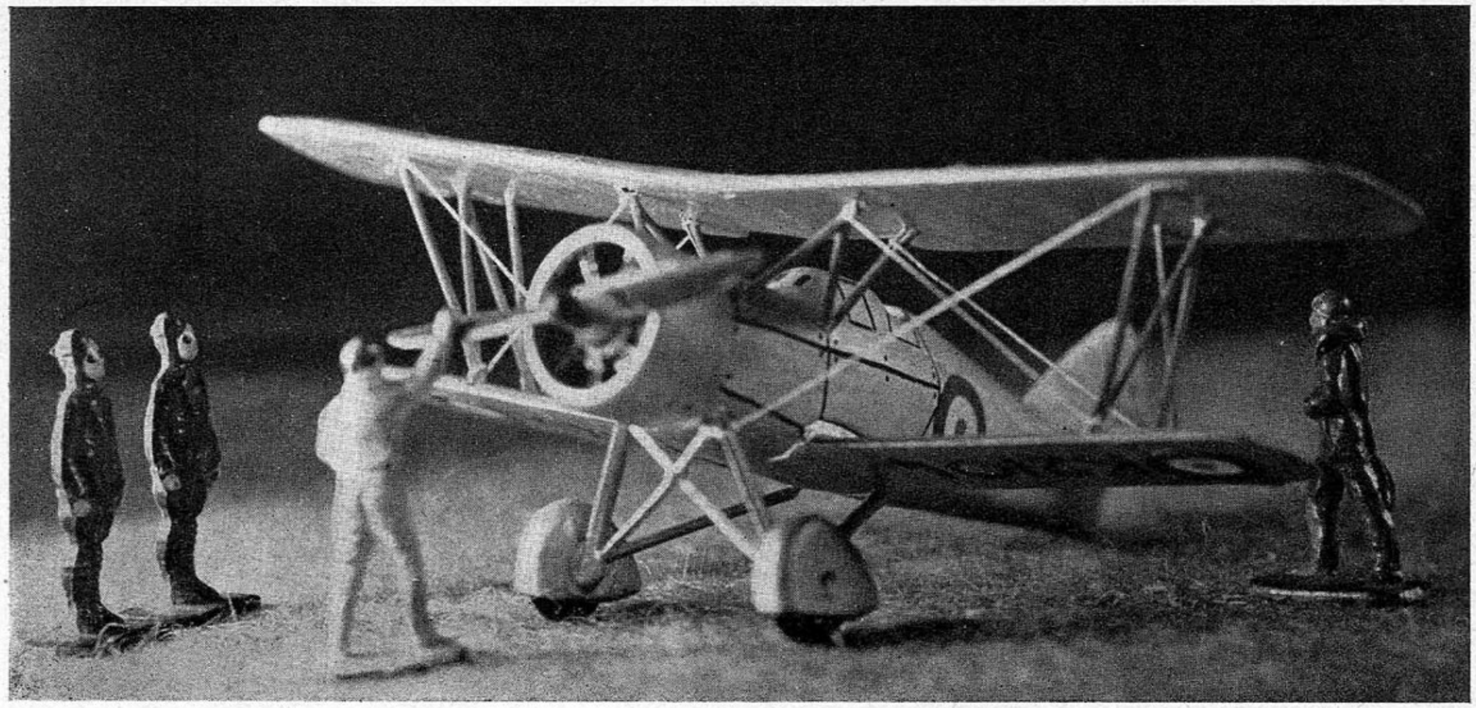


Fig. 74.

"NIGHT PATROL"



Many scale model enthusiasts like to arrange their models in realistic " set-ups." Here is an excellent example of what may be done with a few lead soldiers.

can be held in a hand drill for trimming the rim to shape. The drill should be held in a vice or fixed to a table or bench, and the wheel can be turned, using first coarse and then fine glasspaper to shape the rim. The middle of the wheel can be shaped in this way, but we shall probably have to do the second side on an extra piece of ply. It can then be glued to the ply disc; and, to add a more realistic look, string can be glued round between the rims and middles. On the side opposite the bush it will be a good idea to stick on a nut or washer to prevent wear.

Wheels are best held on their axles by small washers soldered on each side. Should the reader be unable to solder, the next best thing is to bind on a little bit of thread and hold it with a spot of glue. The spot of glue can be pushed to shape with a wet finger if a cellulose type is used.

The usual thing to hold the tail wheel will be a small wire fork with the ends turned in, rather like the top right undercart in Fig. 73. This fork is then bound and glued to a fuselage former or a bamboo strut. When the tail wheel is faired, i.e. a small spat, it can be fixed in with the axle glued at each end to the fairing.

CHAPTER XX

FINISHING

COVERING. DOPING. COLOURING.

AFTER spending many hours in building a model, squaring up each part and generally going to a lot of trouble and patience, very often the builder gives the final covering and finish little attention. Why this should be seems a mystery; unless it is that the builder, having got so far, rushes the last stages to see what the model will look like when finished. But surely a beautiful piece of workmanship deserves a better finish than is often given?

It is hoped, therefore, that in this chapter the model-builder will be encouraged to turn out the job properly, and the extra time expended will amply repay him.

Let us assume that the construction part of the aircraft is all complete and that all longerons, spars, tops and bottoms of formers, etc., are all smooth and make a gently flowing curve.

If, however, they do not, rectify it *now;* any deviation of a stringer from its correct path should be attended to.

The stringer can be cut loose from the offending slot in the former, and with a little bit of packing and cement the whole can be made rigid and of correct formation.

If the front of the model is solid, or planked, or covered with sheet wood, see that there is no abrupt shape to cause a wrinkle when the covering is attached.

Where a round or curved surface is to be covered, such as the sides of an oval fuselage, make sure the stringers project slightly above the formers. The formers themselves can be cut away slightly between the stringers so that the covering does not touch the formers at all, otherwise your sweeping curves will be spoilt by vertical projections where the formers are placed.

Where thin parts are attached to a spar, such as the trailing edge of a wing where the ribs are affixed, it is as well to stick on little paper fillets, which must be flush, of course.

These will help to support the covering right up to the angle formed between the rib and the trailing edge—a great source of wrinkles. In difficult parts, such as a tail unit, where the elevator root ribs touch the fin, it will probably pay to fill in with 1/64 in. sheet balsa. This makes a surface to fix the covering to.

This, of course, applies to all types of fairing, such as that between the wings and the fuselage.

Remember, too, the celluloid used for the cabin-top and sides. Make sure the celluloid is fitted *flush* by cutting away very slightly the former, or whatever it is attached to.

When we are quite sure that everything is as smooth as possible we can commence to cover the job.

Japanese tissue paper is the usual material, and can be purchased in different weights and thicknesses.

It is usual to cover the fuselage in a fairly thick tissue, or even a light type of bamboo paper, using a lighter grade for the wings and tail.

On closely examining the paper it will be seen there is a kind of grain running in one particular direction. This grain should always lie along the straightest part to be covered.

You will remember in discussing the different types of balsa wood, the type with the grain running the full length of the strip could be used for tubular and curved surfaces; that is to say, for instance, a motor cowling with the grain running straight fore and aft.

The same idea applies to the paper as well.

To take the easiest example of covering, let us consider a flat-sided fuselage. Cut the paper the correct shape, leaving about a quarter of an inch to spare on the top and bottom, and then, using a paste such as a photopaste for the adhesive, apply a little to the front former and place the paper in position, with a slight tension at the tail end to make sure it is lying in its correct position. Gently apply a little paste to the top and bottom of the longerons, but not on the face we are covering. The quarter of an inch extra either side of the paper can now be pressed down on the paste, and should adhere to it. Complete by sticking the tail end.

Do not stretch the paper tight, but make sure it is even and that no wrinkles have occurred.

Do the opposite side the same way, then the top and bottom. Trim off the extra, when the paste is dry, with a sharp razor blade.

Gently spray the paper with a very light spray of water or steam, or even a very delicate application of a very soft brush. The action of the dampness will tighten the paper.

Should, however, there remain any slight wrinkles, these can be eliminated in the following way.

Gently damp with water the wrinkle and surrounding paper—perhaps a square inch—and by damping the stringer, or whatever the paper is attached to, where the wrinkle starts, it will be found possible with a gentle working of the finger nail or blade of a knife to draw up the wrinkle. You may find the wrinkle will travel along, in which case, damp a bit more of the paper and keep on very gently stretching the paper until the wrinkle has vanished.

When all is thoroughly dry, do *not* warm in front of a fire to dry quickly, as the frame may distort. Give a very, very light rub with the finest glasspaper or very worn glasspaper along the stringers or formers wherever the paste is, as this may harden in very slight pimples.

The whole is now given a thin coat of dope in a dry atmosphere and a temperature of about 70°.

Such fittings as wings, etc., after having been doped and are almost dry, should be pinned down on a flat board for, say, twelve hours. This is the time during which the final contraction takes place, and if care is not exercised a permanent warp may be the result.

It is all quite simple, but take pains, and take your time.

Do not cover too much at a time, and wherever the contour changes stop and imagine which would be the best way to lay the grain of the paper. Then fix this part of the covering separately.

To cover top decking supported by stringers or any tubular section, cut a separate segment of your paper to fit each space between the stringers, allowing enough, of course, to fix on to the stringers.

Never expect the dope to take out all the wrinkles. Make sure there are no wrinkles there to start with, then all will be well!

No scale job is really complete without its proper colouring. Some of the smaller types under, say, eighteen inches span, can be covered with coloured tissue (but remember that, as a rule, coloured tissue does not shrink quite so much as white), or, better still, natural coloured paper.

Where a painted job is required, we start off with any exposed woodwork, such as engine cowling, legs, etc., and the grain must be filled, or at least treated so that it will not rise when the colour is applied.

There are well-known wood fillers on the market, but they may be too heavy. Banana oil, applied and sanded between each coat, is quite good. Shellac can be used. One coat of shellac or shellac polish, which can be purchased at any hardware store for about 6d., will do. When this is dry, thoroughly sand down with old worn-out sandpaper and make perfectly smooth.

The writers prefer a cellulose enamel as a covering, as the part is easily repairable with a cellulose cement, and in the event of a tear in the paper this can quite easily be cut out, a complete panel at a time, tissue stuck in its place and doped, and then finally a cellulose enamel worked on, and all will more or less run into the surrounding existing colour.

When painting the paper, a thin colour cellulose is advisable, and work fast with a soft mop brush between each panel. Should this not be opaque enough, when all is dry mix up a solution of gold size in water, or a 1d. tube of popular glue will do, squeezed out into a little water, and the whole job lightly painted over with this.

This is to form an insulated coat, so that when dry the next coat of cellulose colour can be applied without dragging the original coat.

Using this method, too, one can impose one colour upon another for decoration without the colours running.

Should you have a tapered coloured line from the front to the rear, either side of the fuselage, this line should be painted in first, and, when quite satisfied, the main coats of paint should be added, and, by using a bold drawing stroke with the brush, a sharp line can be worked to define the edge of the coloured streak.

Of course, lettering and so on has to be added. This can be done by carefully drawing out on thin white paper the desired lettering, and where the streak at the side goes through the lettering this can all be worked out and painted in water-colours, and finally edged with black indian ink. Fix the colouring with a coat of banana oil and cut out.

Wet the underside to make it supple and absorbent and apply some ordinary glue—one 1d. tube will do—and stick firmly in place. A further coat of banana oil will waterproof the whole, and any glue showing can be washed off gently with water.

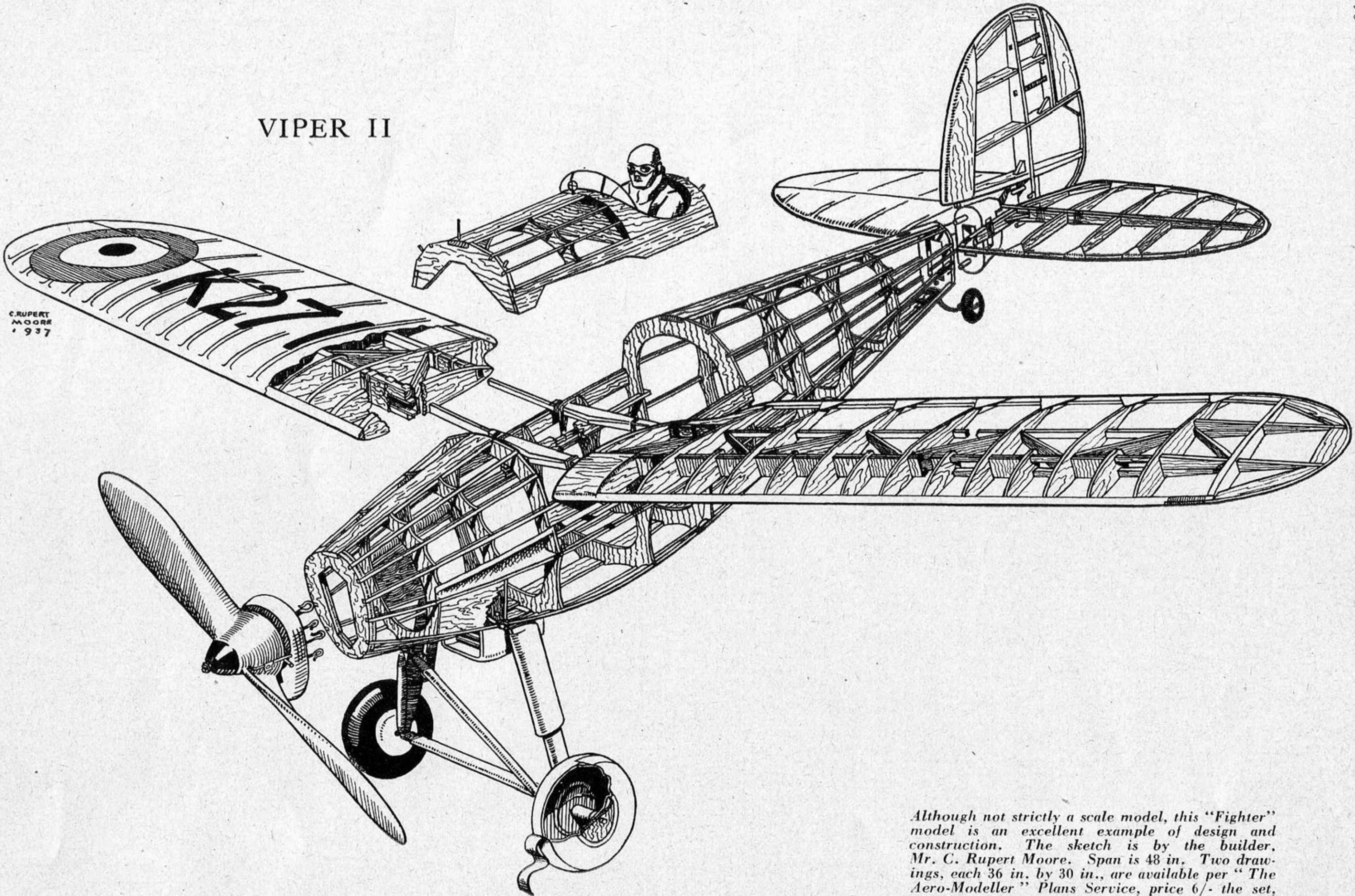
Remember one very important thing: all coloured pigments have weight, and you will be surprised to find that the nose of the machine will probably want another $\frac{1}{2}$ oz. of weight to keep the trim correct after the painting is complete!

In a light machine, if you only colour the fuselage and leave the wings and tail natural, or just the white tissue, it will make a very good effect, and help to keep the weight down.

Watch every little detail. Where rubber bands are used to attach wings, etc., choose a colour that harmonises with adjacent colours.

By persistently sticking at it and improving each model as you go along you will be surprised how "professional" you will become and what an added interest the final finish of a model will give to you.

VIPER II



Although not strictly a scale model, this "Fighter" model is an excellent example of design and construction. The sketch is by the builder, Mr. C. Rupert Moore. Span is 48 in. Two drawings, each 36 in. by 30 in., are available per "The Aero-Modeller" Plans Service, price 6/- the set, post free.

CHAPTER XXI

FLYING

TRIMMING FOR GLIDE. POWER FLIGHT.

The last thing is trimming the model ready for flying. This means getting the angles of incidence of wing and tail-plane correct, and the centre of gravity in the right place. You will no doubt have to experiment a bit, so we will try to put you on the right lines. The most difficult is, of course, the biplane. For a start we have the tail-plane and thrust line parallel. The wings have what is known as positive stagger; that is, the top wing is farther forward than the bottom one, which is the usual arrangement. There are however, a few machines with negative stagger, that is, with the bottom wing farthest forward. With negative stagger the bottom wing would need the most incidence, and a monoplane needs about three or four degrees incidence, perhaps.

These various angles are, of course, arranged when the model is put together, but should be so made that you can alter them without too much trouble afterwards.

To get the centre of gravity in the right place it is usually necessary to add weight in some form or another to the nose. It is best to do this first by strengthening the nose. Any extra weight should be bits of lead or solder, etc., as far forward as possible. With a monoplane it is best to try to get the centre of gravity about one-quarter to one-third of the wing chord back from the leading edge. The best position will have to be found by experiment, as it varies with different wing sections. Another thing to help is altering the length of the rubber motor, and the position of the rear hook, putting it farther forward or backward.

When you have the incidences and the centre of gravity somewhere near right, you can try gliding the model. Try it over long grass or a bed of stinging nettles or something similar that will not hurt the model in a crash landing. Launch the model—don't throw it—forwards and downwards, in the way you would a dart, to hit the ground a few yards ahead. Try this a few times, gently and harder, and see how it behaves. It is unlikely that everything will be all right. If the model is tail heavy, or the nose light, it will try to lift its nose and then fall into a dive, as shown in Fig. 76. Some people get rather confused with this, and think that if it dives it is nose heavy, but if it is nose heavy it will not rise first. If the model is nose heavy it will go straight from your hand and curve over into a dive, even when thrown hard. (Again see Fig 76.) If you do not get the levelling out when thrown hard, but a straight glide, try a little more incidence on the wing. When you get a good glide, wind the motor up a few turns and try again. This should make the glide a bit longer, and more turns should give a level flight. If now the model tries to rise too much, so that it stalls and dives, try fewer strands of rubber on the motor. This may or may not cure the trouble; if not, put a bit of packing in the nose to tilt the propeller downwards a bit. If the model flies all right, except that it does not climb even when fully wound, try more strands of rubber

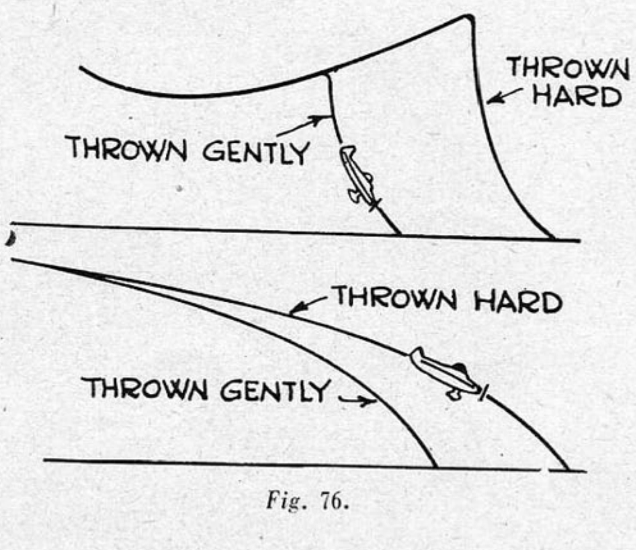
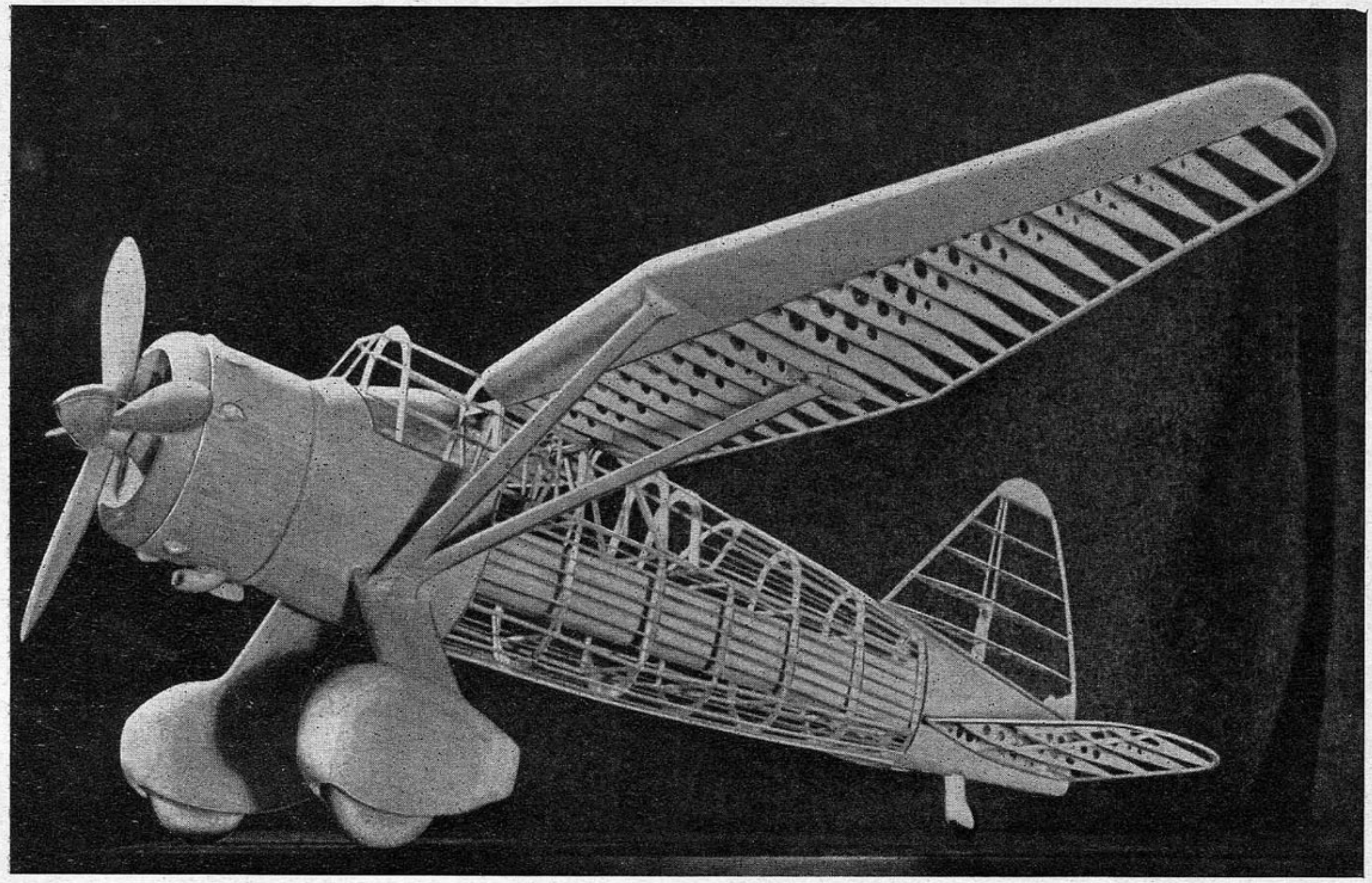


Fig. 76.

THE WESTLAND "LYSANDER"



A 50 in. span flying scale model of the Westland "Lysander" built by Mr. Howards Boys. Mr. Boys took this photo and the others which illustrate his chapter on photographing models.

again. With a low-wing model you may find that adding more rubber makes the model fly faster instead of climbing. In that case, try a little more incidence on the wing, or even tilting the propeller up as a last resort. When making adjustments to the wing or tail-plane, always try the model gliding again before winding up. Working this way, you should soon have the model flying properly, but don't get impatient. Keep at it, trying one thing at a time, and you will learn what is wrong. After all, you learn more from a model that is difficult to trim. When launching a model, always send it slightly downwards to begin with at any rate, and follow through with a swinging movement of your arm, to make sure it goes in the right direction. Some people seem to think that if it does not fly very well, by launching it with the wind the wind will help it along. Well, it just doesn't work! The model has to fly through the air at a certain speed to overcome the force of gravity, and it does not matter in what direction the air is travelling. The speed of the model in relation to the ground is different, but you can imagine a model in the air to be like a goldfish in a bowl. If you carry the bowl of water across the room it makes no difference to the speed at which the fish swims. The bowl of water is like the particular square mile of air your model flies in.

CHAPTER XXII

PHOTOGRAPHING MODELS

By HOWARD BOYS

PHOTOGRAPHY is such a universal hobby nowadays that lots of people, having built a model, will want to photograph it. A photograph will still be good years after we have almost forgotten the model, and it is nice to have evidence to show how we have improved.

There are two ways of photographing scale models; one in which the model is made to represent a full-size aircraft by the inclusion of a suitable background, and the other to use a plain background. The writer prefers the latter since in the first method the model merely becomes part of the picture, and can seldom be mistaken for a full-size machine, but in the latter the model *is* the picture, and there is nothing else to distract the attention.

Practically every article written on photography points out the many variables that have to be taken into account, and gives no definite data as regards exposure. The exposure may be given, but not the lighting conditions, which are just as important. The writer has worked out a method that never seems to fail, and hopes to describe it here, so that anyone with a little intelligence can take photographs, similar to those of the Lysander and Swallow shown, with an inexpensive camera.

The camera is not very important, except that a means of giving time exposures is required, and also some means of getting the model in focus at a short distance. Most cameras have a shutter that can be set to give time exposures, and if there is no focussing adjustment a portrait attachment should be used. This portrait attachment must suit the distance at which we shall work, generally about five feet. If small models are being photographed the camera can be used nearer with advantage, but a portrait attachment for five feet will not do for, say, three feet. The camera must be put on something firm, such as a good solid tripod, box or table.

When using the camera as close as this, do not trust the viewfinder too much. The safest way is to sight along the camera and see that it is pointing straight at the model.

The model can be placed on a table, either a plain or polished top will do. For the background we can use a plain distempered wall, a papered wall so long as there is no very obvious pattern, or a plain curtain or blanket. A buff colour, or something near it, is the most useful. The main thing is to have the background as unobtrusive as possible.

We now turn the model about on the table till we find a view that we like. This will generally be a three-quarter rear view from a little above with a low-wing model, and a three-quarter front view from about the level of the table with a high-wing model. Put the camera in place and see that the whole of the model is included in the view, and that the model does not overlap the background.

If we are using a portrait attachment, we must have the camera just the right distance away from the model to suit the attachment. For instance, if the attachment is for five feet the camera must be five feet from the model, and the distance must be measured. Guessing is not good enough. Measure from the camera lens to the fuselage of the model. With a three-quarter front view measure to the leading edge of the wing, and with a three-quarter rear view use the trailing edge. If you are taking a different view, measure to a point a little nearer the camera than the centre of the model. If your portrait attachment is for five feet, and at that distance the model does not nearly fill the picture space, do not worry, because if the negative is sharp, as it will be by working

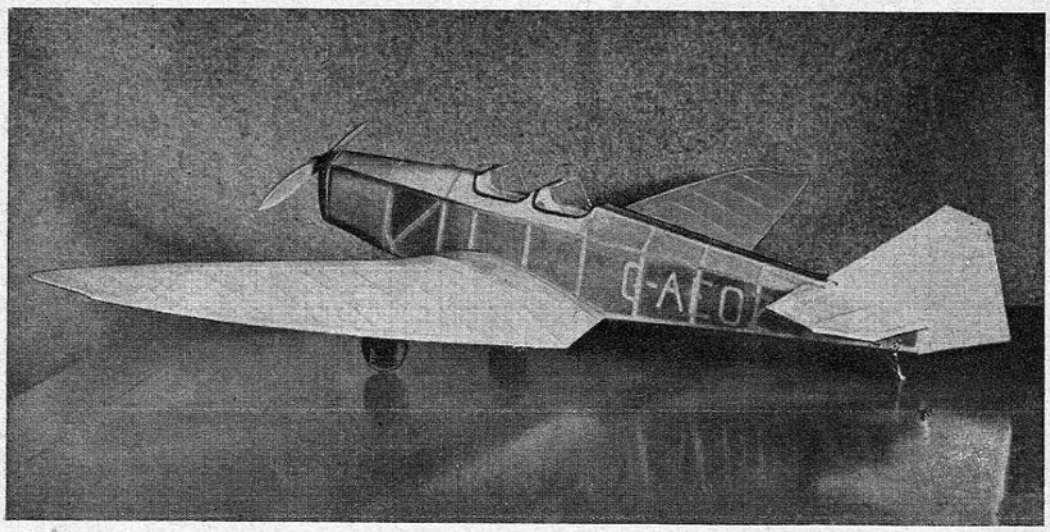


Fig. 77.

at the correct distance, enlargements can always be made. The Swallow and Lysander were no more than an inch long on the negatives, yet exhibition prints 8 in. long have been turned out of the Lysander.

The next job is to arrange the lighting, and this is probably the most interesting part. The best plan is to remove the camera and put a piece of cardboard in its place, with a hole to represent the lens. We can then look through the hole and see the model just as the camera will see it.

For the lights, two or three 100-watt bulbs costing 6d. each can be used, or the more expensive " photofloods." The bulbs are best used with reflectors of some sort, which can be made from sheet tin or thin white cardboard. The writer uses tin ones $10\frac{1}{2}$ in. diameter at the front and $6\frac{1}{2}$ in. long, in the form of a cone. A bayonet socket is fixed in the apex, and a fitting is bolted on to fix it to a tripod or other support. The thing is to be able to adjust the height and move it to the position we find best. One lamp can be used in the ordinary room light, but any shade or reflector should be removed from this, the idea being to get an even light all over the room. With one lamp in its reflector we can move it about to see how it lights up different parts of the model and show them up brightly, and at the same time cast shadows on the background. A good position will be about level with, or just below the camera, and 30 to 45 degrees to one side or the other. This is how the three-quarter rear view of the Swallow was taken. The camera was five feet from the model, and the room light, 100-watt bulb, was about three feet above the camera. A 100 - watt bulb in tin reflector was placed about 6 in. below the level of the camera and about 45 degrees to the right. In this position it lit up the fin, side of fuselage, top of near wing, and propeller. By adjusting it a few inches one way or the other, it left the top and bottom of the nose showing dark, due to its curvature. It lit up the inside of the cockpits but left the top of the fuselage dark behind them. The propeller was turned round to find the best position for showing it up. With the nearer blade higher the further blade could not be seen very well, and with the near blade lower it reflected so much light that it was as bright as the fin. The shadow along the leading edge of the starboard wing came along very conveniently all on its own. After sorting out the lighting the camera can be put back in place and the exposure made. Since readers can copy the photograph of the Swallow with their own models, here are the full particulars.

Model.—Silver wings and tail surfaces. Blue fuselage, nose and centre section. Mahogany propeller.

Lighting.—100-watt room light six feet from model, and 100-watt light in tin reflector about 45 degrees to the right, and slightly below the level of the camera.

Exposure.—Two seconds at f.11 on Selo H.P.2 plate. Using Selo H.P.2 film, or Kodak Super-XX, the exposure would be $2\frac{1}{4}$ sec., and, using Panatomic-X, $3\frac{3}{4}$ sec. Using Selo S.F.P. film the exposure would be 15 sec. These exposures should be considered the least you can give to get good results, and you can give up to twice as much without