

AN INTRODUCTION TO SINGLE CHANNEL R/C AIRCRAFT



Single channel aircraft systems explained, plus full pictorial instructions for building a suitable model from an available plan.

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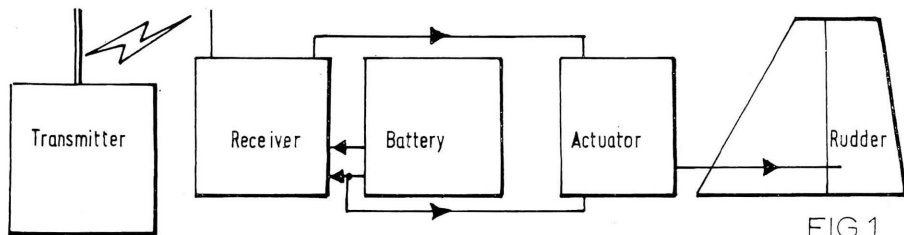


FIG 1

How it works

RADIO control offers a means of remotely controlling many types of model at a distance of up to a mile or more. There are several different modes of control, from a simple one-function to one where six different functions can be simultaneously and independently operated with precision, exactly in proportion to control levers in the operator's hands.

Radio link

The basic equipment comprises (1) a transmitter (Tx); (2) a receiver (Rx); (3) actuating mechanism variously named escapement, actuator or servo depending on type and useage.

Fig. 1 shows the general set-up of a simple control link, known as single channel.

A transmitter produces radio waves on certain specific frequencies or wave-lengths (equivalent to tuning to different stations on the domestic radio). The transmitter is rigidly con-

trolled by a "crystal" whose natural frequency is at one of these levels. Its action can be likened to a tuning fork, for it will only allow the full strength of signal to be transmitted at that level. This is known as the *Radio frequency* or R.F. This signal is radiated more or less continuously.

When a command signal is given by pressing a control button on the transmitter, the R.F. signal is electronically switched on and off rapidly at about 1,000 times a second. This is known as the *Audio frequency* or A.F. Fig. 2 is a pictorial representation of the two types of signal. 'A' shows the Radio frequency and 'B' shows how it is switched on and off to make an audio frequency tone signal. The illustration is similar to the display seen on the screen of an oscilloscope. As its name implies, the audio frequency can be heard as a high pitched humming tone through earphones connected to a receiver. A part of the transmitter known as a *multivibrator* is an electronic circuit which switches the R.F. on and off to produce the A.F. tone. This tone is constant in pitch and is pre-set by the component values. The multivibrator is switched on by pressing the control button, a simple press switch, generally a "normally off" or "normally open" type (N.O.) Some transmitters use a *microswitch* which has a very positive action and makes quite sure the tone is either on or off. The transmitter is generally quite small and can be easily held in one hand, where it should balance nicely. The aerial, which is telescopic, is sometimes made in two main parts joined in the centre with a *loading coil* which tunes it to match the R.F. signal. The length of the aerial is important, for it too must resonate or be tuned to a frequency sympathetic to the transmitter. The centrally placed loading coil (centre loaded aerial) is sometimes replaced by a coil at the bottom end, inside the transmitter case. Fig. 3 shows the relative patterns of signal strength with the two systems.

The transmitter generally works off 9 or 18 volts obtained from dry batteries. Some transmitters use rechargeable batteries; *DEAC* is the trade name of one generally used type. The receiver in the model may be either a *superregen* which means that it will respond to all of the six radio frequencies used in Britain, or a *superhet* which responds to only one frequency, that of its matched transmitter. With a superregen, only one model may be operated, because the

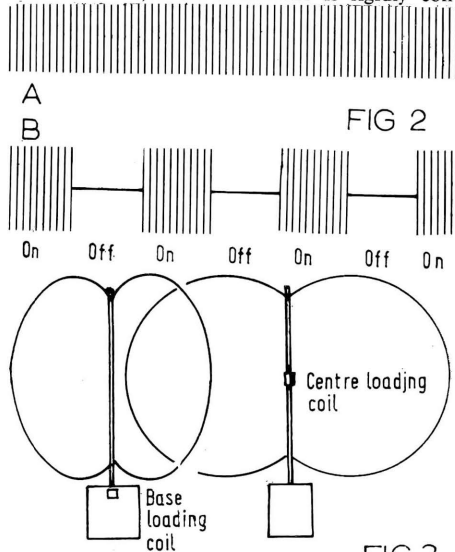


FIG 2

FIG 3

receiver will pick up unwanted signals from other outfits within about a mile range, even though they are on different spot frequencies, or the steady R.F. signal radiated by other transmitters, fills in the "off" spaces in the outfit's own A.F. signal, rendering the control signal ineffective.

A superhet receiver has a special crystal controlled circuit involving many more components. The crystal, like the one in the transmitter, allows the receiver to respond only to the R.F. signal generated by its matched transmitter. Each of the spot frequencies is identified by a coloured flag on the transmitter, as follows:

Brown	26.995	Yellow	27.145
Red	27.045	Green	27.195
Orange	27.095	Blue	27.245

Superregen outfits carry a black and white flag. In this way modellers can see if there is another operator within range on the frequency he wishes to use. Up to six models can be operated simultaneously, independently of each other when they are all superhet equipped. Some years ago one manufacturer produced a pair of superregen outfits which could be operated together. In this case the transmitters did not radiate R.F. until the keying button was pressed, one receiver was sensitive to a very high *audio frequency* and the other a low audio frequency—the only disadvantage being that neither outfit could operate when other radio gear was on the air within range.

Single channel outfits, whether superregen or superhet, are sensitive to the audio frequency imposed on the R.F. Part of the circuit amplifies this tone but is not sensitive to the much higher radio frequency. The following stage in the circuit is sensitive to the presence or absence of tone and this difference is turned into a switched current that is either high or low. This current is fed to a *relay*, which is an electro mechanical device comprising an electro magnet which attracts a metal plate called an *armature* when the current is high and allows a spring to return it when the current is low. A set of electrical contacts is arranged so that a central contact stud on the armature makes contact with one or other of two other contacts, see Fig. 4. The relay contacts are quite separate from the receiver circuit and can be used to switch a motorised *actuator* or rubber driven *escapement*, either of which moves the rudder of the model. Many receivers have an extra electronic switching stage which takes the place of the relay, insofar as it switches an external connection either on or off. Such a receiver is generally used to work an escapement, for to operate a motor driven actuator would need a

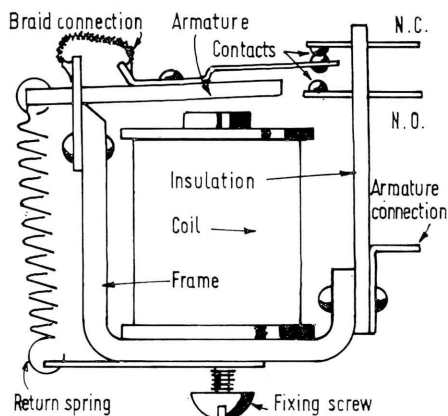


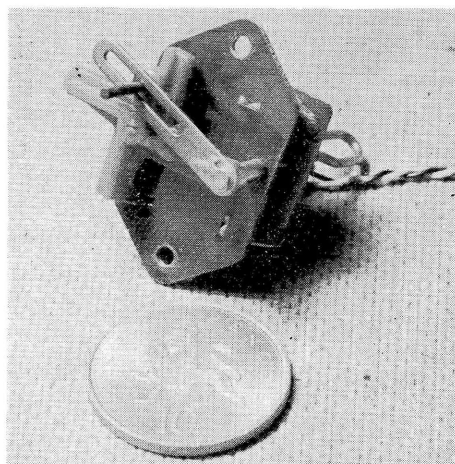
FIG 4

special "double ended" electronic switcher which would pass current through one output wire "On signal" and through another wire "off signal." Most relayless receivers today are a straightforward single ended switch that can also be used to operate an external relay and so provide the type of switching required for a motorised actuator.

Receivers operate on 3 volts, some 4.5, some 6 and some on 9 volts. Small battery boxes containing pen cells (U7 or HP7) are generally used, but some modellers who do a lot of operating prefer to use DEAC rechargeable cells.

Moving the rudder

Escapements are the most simple way of moving the rudder of a model aeroplane or small model boat, they are driven by a twisted skein of



One of the simplest forms of rubber-driven escapement, the Elmic "Conquest," is of the "sequential" or 2-position, 2-neutral type.

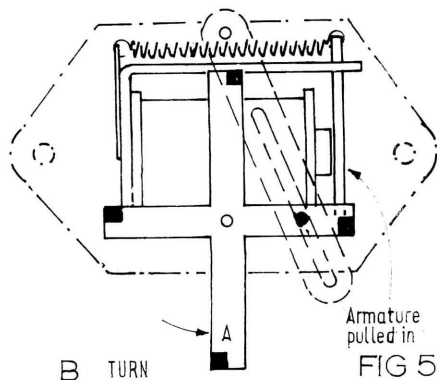
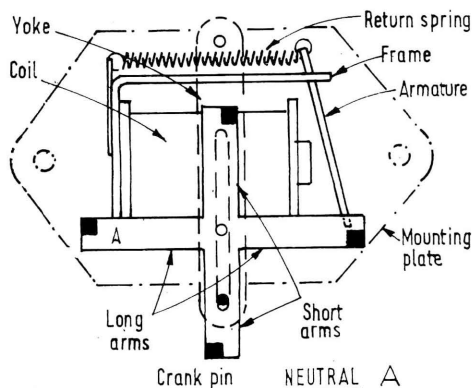


FIG 5

rubber; study, Fig. 5A. An electro magnet pulls down an armature in the same way as a relay but, instead of contacts, the armature carries a claw which, in the "No signal" position, rests against a lug on one of the long arms of a four armed rotor. When the magnet is switched on by a signal, the claw moves down and frees the rotor to make a quarter turn, driven by the skein of rubber, until the next (short) arm strikes the claw (Fig. 5B). In this position a crank pin has moved a yoke over, imparting a twisting motion to a long strip of balsa which has a wire crank and yoke at the tail end to operate the rudder (see Fig. 6).

On release, the next long arm is arrested after a further quarter turn, to bring the rudder back to centre. The next signal will cause the escapement to apply opposite rudder and so on in a sequence of neutral, left, neutral, right, etc. The skein of rubber will take several hundred turns, providing twice as many rudder movements, and will store enough energy to last throughout the flight. This simple device is known as a *sequential escapement*. In operation one has to remember which signal was given last (left or right) to know what will come next. If one

wishes to turn say left, neutral, left again, a quick flick or "blip" given to the transmitter button causes the escapement to flick through the unwanted "right" position so quickly as to have no effect on the flight path. Such an escapement is recognised by the suffix 2P2N (two positions, two neutrals).

There is a type of escapement which is *selective*. This is similar in construction to the sequential escapement, but has only one neutral position, suffixed 2PN (two positions, one neutral) and is fitted with a mechanical brake, comprising a star-wheel and pawl, which allows the crank to turn at a more or less fixed speed. In operation, a sustained signal gives the first position shown as "A" in Fig. 7. This gives left. Releasing the signal the crank turns through three quarters of a turn back to neutral as in "B", passing quickly through right on the way. To obtain right rudder, a short signal is given followed by a brief pause, then a sustained signal. The short signal starts the escapement tuning and the sustained signal causes it to stop three quarters of the way round, passing briefly through "left" and holding on at "right" as in "C", until the signal ceases, whereupon the escapement

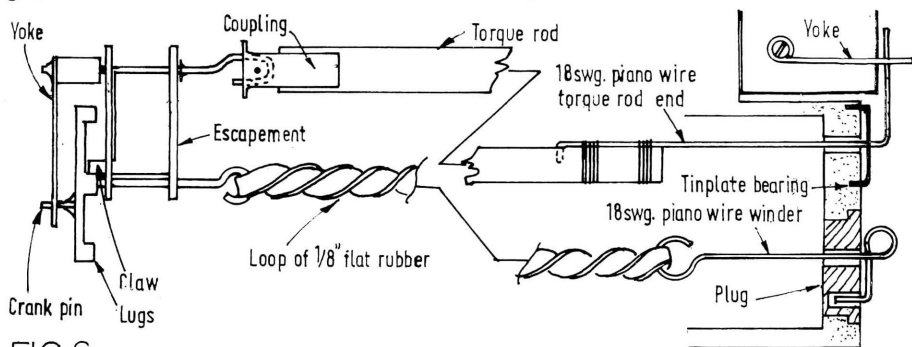
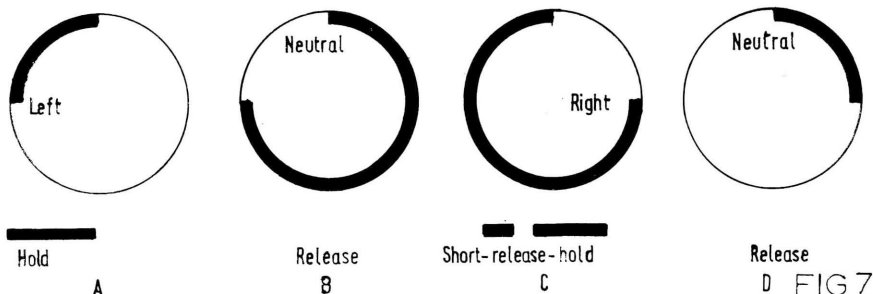


FIG 6



makes the final quarter turn as in "D" to neutral. With this arrangement "hold signal" always gives "left" and "short and hold" always gives "right."

Additional control

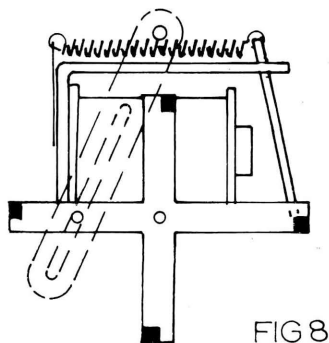
Some selective escapements have an additional position (3 P.N) just before neutral, so that a lever trips the elevator of the model to "up" so that one can loop the model. This additional facility is obtained by giving two short signals and a hold. Other selective escapements may have a *Quick Blip* facility. This is a pair of electrical contacts that come into operation when the armature is in the neutral position, but the escapement has only just left neutral. This contact can be made to operate a further escapement—of the sequential type, for changing engine speed. On this particular type of escapement, the rest or "neutral" positions are made to provide a fast or slow speed position, for the crankpin or yoke are at 90° to those on a normal sequential escapement (see Fig. 8).

In operation, engine speed change is obtained by giving the transmitter button a quick flip or "blip." This causes the rudder escapement to cycle through left and right and back to neutral and the motor control sequential escapement to turn 180° to change from fast to slow engine or vice versa. This system may sound complicated, but once in action this *cascaded* arrangement of escapements is really quite simple, thus one is able to obtain two functions from a single control transmitter. It is the coding of the signal that does the trick. Summing up, use a sequential or selective escapement for rudder control and a selective plus a special throttle control version of the sequential escapement for rudder and engine control.

Japanese modellers have experimented with such systems and some are even capable of providing elevator control in addition by means of a further cascaded selective escapement. Such a system is frankly difficult to handle, one needs to remember to give it up to four signals (short-short-short-long) for down elevation, short-short-long for up elevation, short-long for right, long for left and quick blip for engine speed change. With a fast flying model, one does not have time to think and if the wrong signal is sent, it takes

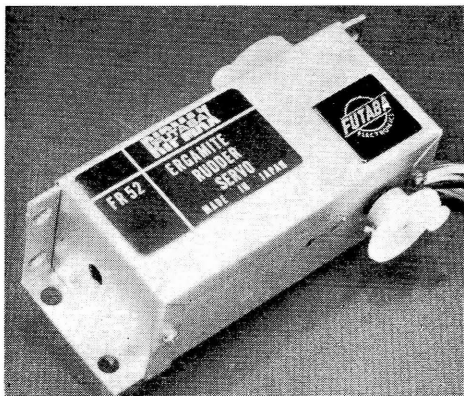
valuable time to repeat the signal correctly.

Japanese manufacturers were quick to spot the need for an automatic coding box which could be fitted to a transmitter to provide the correct sequence of signals when a control stick was pushed in the appropriate position. Unfortunately there are only a few of these about, it seems most modellers prefer something more simple, indeed there are hundreds of modellers using a simple sequential escapement today, most of them operated from a relayless receiver.



Motorised actuators

For model boats or even model aircraft the motorised actuator offers a compact means of operating the rudder. There is no long skein of rubber to get in the way or to be wound, there is no fear of it running down except when the batteries need replacing, and it is only a little heavier and more bulky than the escapement which it replaces. Most motorised actuators for use with rudder control are selective (long signal for left, short-long for right (2 P.N)). Some, the Futaba range, unlike escapements, have a third position or quick blip facility for switching either a rubber driven engine control type of escapement, or a three position motorised actuator (3 P) and perform this function without passing through any rudder positions themselves. Comparatively few operations of the throttle are required in a normal flight, or boat's run, so a short skein of



The Ripmax-Futaba "Ergamite" motorised actuator, or "servo" has twin output discs, and is "selective" in operation.

rubber to operate a rubber driven escapement is still acceptable, in cramped installations.

A motorised actuator needs to be switched by a relay, whether that relay is in the receiver or switched separately by a relayless receiver as in the Ripmax "Pathfinder" outfit. A separate battery powers the actuator, which is started when the signal is received and the relay clicks over to its normally open (N.O.) contact, the motor keeps running until "left" position is reached. A series of pick up brushes made from phosphor bronze bear on a rotating printed circuit disc, switch the motor off, then if the motor coasts on past the required position applies reverse current from another battery to stop it. This is known as "sniff back" and prevents the actuator running on past the stop position. When the signal stops, the relay clicks out on to the normally closed (N.C.) contact and the motor once again starts to turn the output crank or lever briefly through "right" and on to neutral. Whichever position the motor stops in, the "sniff back" comes into action. Additional contact brushes bearing on the printed circuit disc, provide switching for the motor control escapement and/or 3 P actuator. The 3 P actuator does not generally have sniff back as its positions do not have to be so precise. This throttle control actuator can be made to operate either the throttle of a diesel or Glowplug engine or to move switches to give three speeds or forward, stop and reverse on an electric motor in a boat or vehicle. No one has yet standardised the wiring of these motorised actuators so we cannot give a colour coded diagram here to show how it is done, each manufacturer generally supplies his own wiring instructions with the unit in question.

Wiring up

The connecting up of the various units within the model will depend largely on the individual

requirements of each item. Manufacturers each have their own recommended method and generally indicate the correct wiring for a variety of uses. All that can be done in these pages is to give a typical block diagram for different types of equipment. Some come already wired, making life much easier.

Relayless receiver and escapement

Fig. 9 shows the set-up, this is the simplest possible arrangement, the receiver may operate on 3 or 4.5 volts according to manufacture and the same battery powers the escapement which may be a simple sequential 2 P 2 N type or a Selective 2 P N type. A switch is placed in the

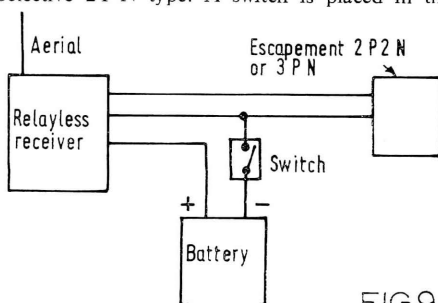


FIG 9

negative lead from the battery in every case. Some receivers have three wires, plus aerial; this calls for a junction to be made in the negative lead. Others have four, plus aerial. In this case the connection has already been made inside the case and two wires go to the escapement and two to the battery.

Relayless receiver, selective escapement and additional escapement

Fig. 10 shows how the circuit is similar in most respects, but there is an additional pair of connections to be made from the selective escapement to the throttle escapement which has its power supply through the selective escapement.

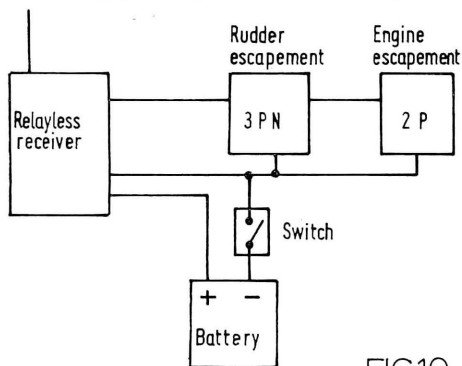


FIG10

Two battery version

Fig. 11 gives the wiring arrangement for relay-less receivers which have separate battery from the escapement—the Ripmax Pathfinder is an example of this type. A separate switch is needed for the escapement battery.

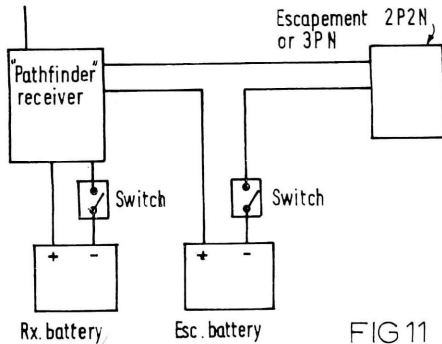


FIG 11

Fig. 12 shows the similar extra connections from the throttle escapement.

Relay receiver and escapement

Most relay receivers depend on a separate battery to operate the escapement, see Fig. 13. Here there are generally five leads, plus aerial on the receiver; two for the receiver battery supply, one each for the relay; armature, normally open and normally closed contacts. For the simple actuator it is only necessary to use the armature

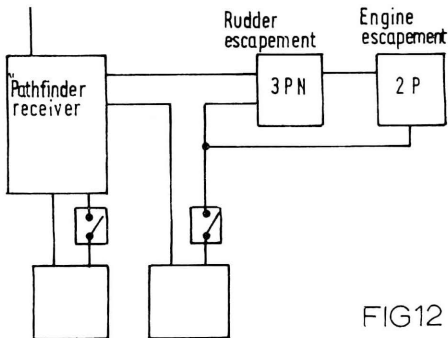


FIG 12

examples shown in Figs. 10 and 12 insofar as the throttle control escapement is shown connected to the selective escapement and battery, see Fig. 14.

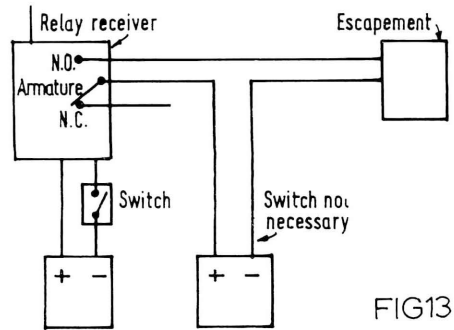


FIG 13

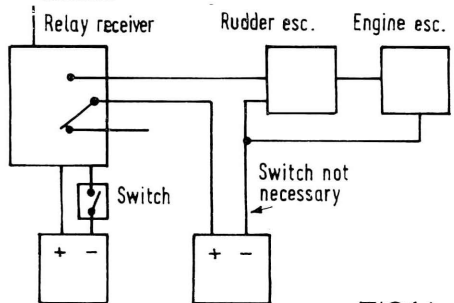


FIG 14

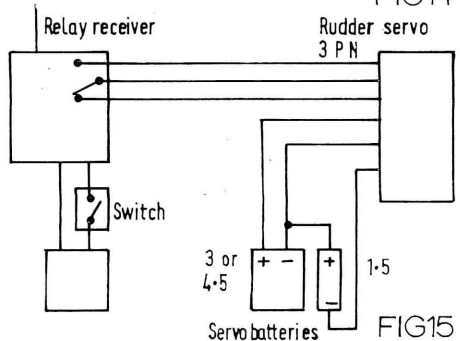


FIG 15

Relay receiver and selective motorised actuator (3 P N)

The motorised actuator will probably have seven wires, one of these is for connection to a motor control escapement or actuator. The remaining six are connected to the three relay contacts, the actuator drive battery and a sniff back battery. A typical example of this arrangement is the E.C.S.1. which uses 3 volts drive and 1.5 volts for the sniff back battery. As before,

and normally open contact. There is no need for a switch in the escapement circuit for the relay contacts are open when the receiver is switched off. The relay normally closed contact wire is not used.

Relay receiver selective escapement and throttle escapement (3 P N)

This arrangement is similar to that in the

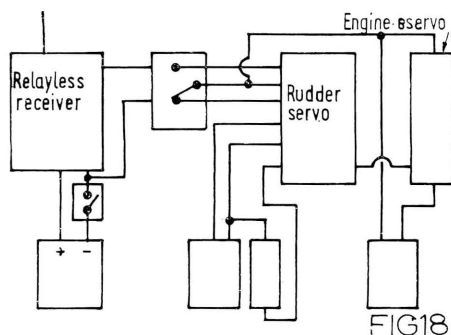
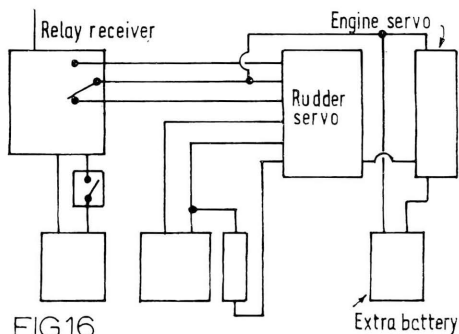
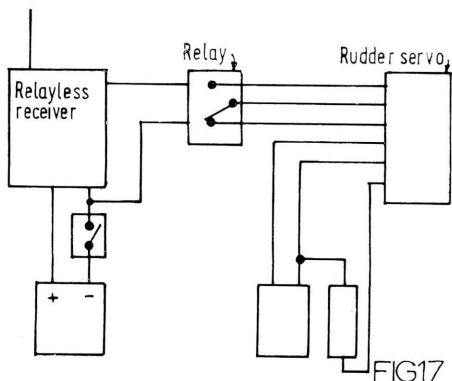


Fig 18, and you will see it corresponds to the last stage of that in Fig. 16. It only differs in the first relay part as does Fig. 17.

Two battery receiver versions of above two examples

The Ripmax Pathfinder is the example shown in Figs. 19 and 20. Here it will be seen that the relay has its own power supply as in Figs. 11 and 12, but here as shown in Figs. 19 and 20 the power supply goes to a relay instead of an escapement and is 3 volts instead of 4.5. The rest of the circuit follows those in Figs. 18 and 19.



the receiver battery is separate, and in this case is 3 volts from pen cells in a pre-wired battery box. Fig. 15 shows the arrangement.

Relay receiver, selective motorised actuator (3 P N) and motorised throttle actuator (3 P)

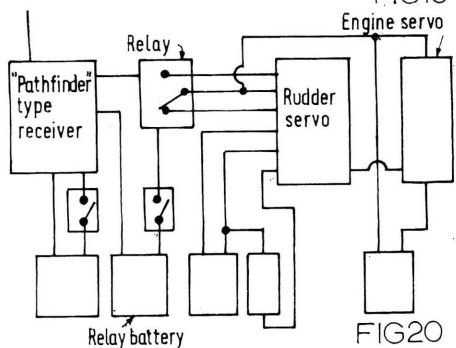
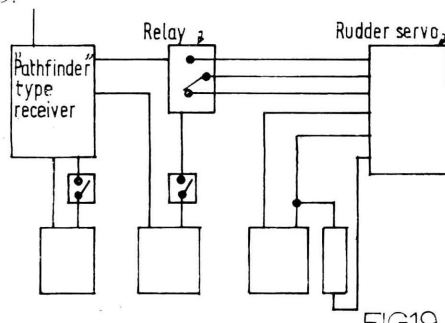
The circuit shown in Fig. 16 shows how the throttle actuator, a 3 P type is wired in to the Selective 3 P N type, and the relay armature. The 3 P actuator has its own separate 1.5 volt battery but no sniff back supply is needed.

Relayless receiver and selective motorised actuator

A relayless receiver cannot operate a normal motorised actuator without the use of a relay added to the receiver or a special electronic switch incorporated in the actuator. In the circuit shown in Fig. 17, a relay has been wired to operate from the receiver in much the same way as a simple escapement. The rest of the circuit from the relay onwards then follows that shown in Fig. 15.

Relayless receiver, selective motorised actuator and throttle actuator

Follow the last stage in the circuit shown in

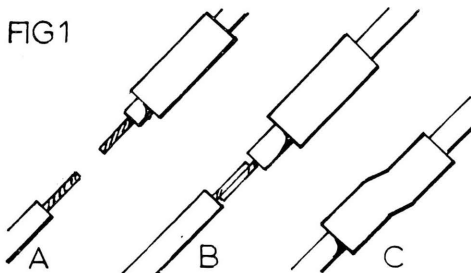


Installing the equipment

With the beginner in mind, many manufacturers make available complete wiring harnesses which enable the receiver, batteries, actuator and switch to be plugged together. This makes soldering unnecessary and avoids failure caused by either incorrect wiring or poor soldering. With a few exceptions, one manufacturer's equipment will not plug into another harness, so it pays to obtain radio gear (transmitter and receiver), actuator or escapement battery box and harness from the same source.

If you already have equipment that is not completely plug-together, or if your model demands a different control set-up, then the basic methods of making connections shown here will serve as a guide.

FIG 1



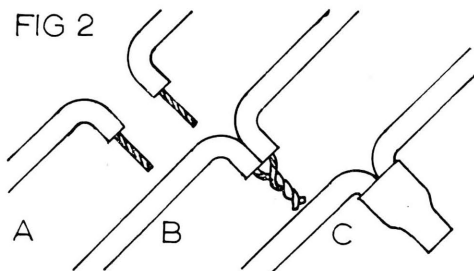
Connections

When joining wires to each other leave about $\frac{1}{4}$ in. of each lead and twist the strands of wire together. Slide a $\frac{3}{4}$ in. length of plastic sleeving onto one wire as in Fig 1 'A'. The sleeve must be a tight fit on the wire covering. It may be coaxied on by warming it.

Tin both wire ends by applying cored solder and the soldering iron simultaneously. Never carry the solder to the job on the iron; the flux will have evaporated before it gets there. Bring the wires together and re-heat with the soldering iron as in 'B'. Finally slide the sleeve over the joint to reinforce it and to prevent the wires fracturing each side of the joint.

An alternative method is shown in Fig. 2. Here the wires are twisted together and soldered, and a piece of plastic sleeving of slightly larger diameter is slipped over the joint. The wires are bent so that they run side by side for about $\frac{1}{4}$ in. before the joint. The sleeve, being just over $\frac{1}{4}$ in. long, holds them together and prevents any strain on the joint.

FIG 2



When soldering a wire on to a tag, such as is found on a switch or some types of battery boxes, extra precautions have to be taken to prevent the wire fracturing due to handling and vibration. Vibration, in particular, can cause the wire to break at the point between where the solder makes the wire rigid and the end of the plastic covering. This potentially weak point must never be unsupported. Fig 3 shows how the connection is made. Both wire and tag are tinned, then the wire is soldered in position as shown at 'B'. Next, the wire is bent back and bound with thread on to the tag as in 'C'. It is important to strip only sufficient covering off the wire to allow it to be inserted in the hole in the tag. It is the insulated part that is bound to take the load off the weak point of the wire. Finally a piece of plastic sleeve can be passed on the tag and doubled back wire to provide faster reinforcement and insulation (a scrap of fuel tube suffices here).

On some items, such as plugs and sockets, there are just thin pins protruding for connection to the wires. Some pins are hollow, and in this case the wire is twisted tight, tinned and a $\frac{3}{4}$ in. piece of plastic sleeving pushed over its covering, as in Fig 4 'A'. The wire is then pushed into the centre of the pin and the pin heated with a soldering iron until the solder flows to make the joint. Some pins have a notch in the side, as shown, and this enables one to apply extra solder to the wire when in place. If the pins are solid, then the wire is soldered on to the side of the

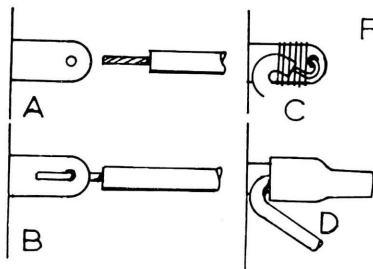
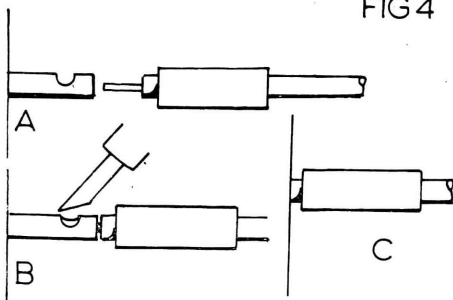


FIG 3

FIG 4

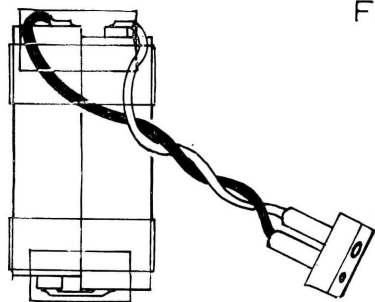


pin, as shown. Thin plastic sleeve is then slid on to the pin to support the joint. Some plastic sleeving may be soaked in cellulose thinners, when it becomes soft and expands to a larger diameter. Thus a smaller initial diameter tube can be used, it slides easily over the wire when expanded by this method and shrinks to a really tight fit as it dries. (It may take some hours for this process of expansion and contraction).

Battery boxes may have either solder tags or a snap fastener for connecting the wires, depending on the make. If no battery-box is used, the batteries (usually pen-cells) are soldered on to a short pair of wires terminating in a socket, into which fits a plug from the receiver and switch as shown in Fig 5. Soldering onto the case of a battery requires a really hot iron, so use a large heavy type, not the tiny instrument variety. Make up several sets of batteries, each with its own socket before setting out for a heavy day's flying or boating (large boats can use heavier batteries, which last longer). The wires are bound to the batteries with Sellotape to prevent fracture of the joints. When the batteries are exhausted a new set can be plugged on, and later the wires unsoldered and used again on a fresh set.

Batteries for a motorised actuator will generally require three connections; one pair for 3 volts

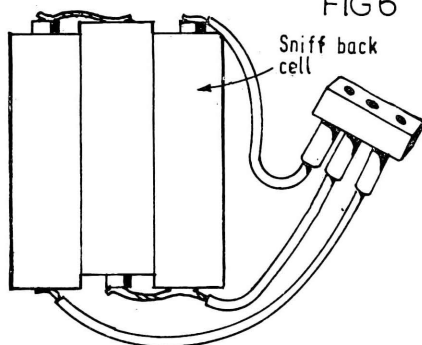
FIG 5



and a third for 1.5 volts on the "sniff back" battery. The three cells are taped together and the connections made as shown in Fig. 6, the leads are then taped to the battery pack as before.

When using a switch, choose a "double pole" type. Most slide switches sold in model shops are of this type and have six tags. Disregard the end two and solder bridging wires between each pair of the remaining four, as shown in Fig. 7. The reason for doing this is to make the two halves

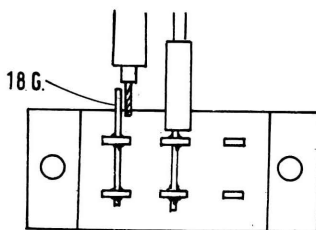
FIG 6



of the switch work in parallel, thus affording an extra measure of safety; if one set of contacts do not "make" properly, the other set will conduct the current. With vibration and fuel seepage at work to jinx the model, one needs this type of "belt and braces" safety. Do not be tempted to use one set of contacts for the positive lead and the other set for the negative. This would make the outfit *four times* more prone to switch failure!

Always fix the switch in such a position that it

FIG 7



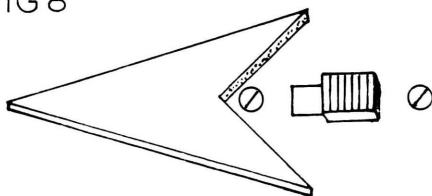
avoids the oil laden exhaust-stream from the engine. In addition, a fairing can be glued on a model aeroplane fuselage to prevent fuel entering the switch, see Fig. 8.

In a model aircraft, it is usual to place the batteries forward of the receiver, wrapped in sponge rubber. The receiver itself may be either wrapped in sponge rubber or stuck to a piece of foam rubber, which is in turn stuck to a remov-

able plywood bulkhead. The actuator or escapement is fixed rigidly to a second plywood bulkhead aft of the receiver. If a separate relay is used, it too must be wrapped in sponge rubber to be free from vibration, see Fig. 9, and installed aft of the receiver.

The wiring should be made into a harness and the receiver wires, particularly the aerial, kept well away from the actuator circuit. This is helpful when a receiver is sensitive to electrical interference produced by the motor in the actuator. In any case other electrical circuits should be kept well away. For example, in a model boat the drive motor and its batteries can be a powerful source of interference in this respect.

FIG 8



Linkages

The escapement must be mounted forward of the trailing edge of the wing, to allow access to hook on a fresh rubber motor. Coupling the rudder up to the escapement or actuator is done with a *torque rod* or a *pushrod* respectively. The

rods themselves are usually $\frac{1}{4}$ in. square balsa.

An escapement has a semi-rotary output. That is to say, the output shaft of the escapement twists from side to side. This twisting motion must be transmitted to the tail-end of the model in order to move the rudder. The Elmic 'Conquest' escapement comes with a special torque rod linkage piece which engages in the hooked end of the output shaft (not the rotating shaft which is connected to the driving rubber skein). The linkage piece is cemented and bound on to the front end of the torque rod with thread, there being about $\frac{1}{4}$ in. clearance inside for the wire hook. A pin is pushed through holes in the side of the linkage piece and bent over to retain the hook. The arrangement makes a flexible coupling to ensure that the linkage does not bind. The other end of the torque rod is terminated with a 18swg. wire shaft, the forward end of which is bent down and pushed into the torque rod, or soldered to another end piece supplied with the escapement to ensure it transmits the drive to the wire. The wire then passes through a small piece of tinfoil, cut down from a tin can, or through a short length of plastic tube cement into the tail-end of the fuselage. See Fig. 10.

With the escapement installed and on neutral, the wire end, protruding some 2in. from the tail-end, is bent up and a wire yoke from 18 to 20swg. wire bent round it and bolted to the rudder. Now, when the escapement output shaft rocks to one side, the bent-up end of the torque-rod end will push the rudder over. By slackening the bolt, and moving the yoke up or down the torque end,

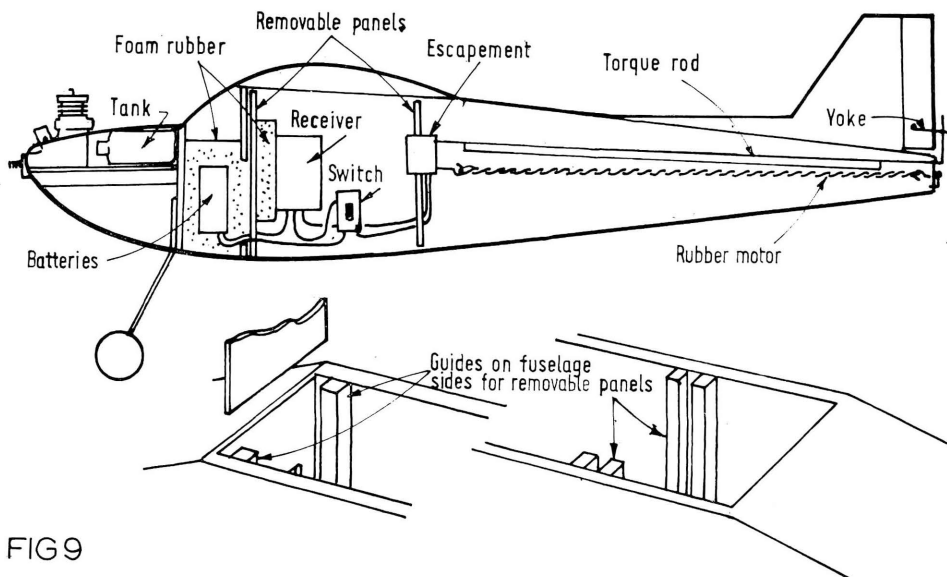
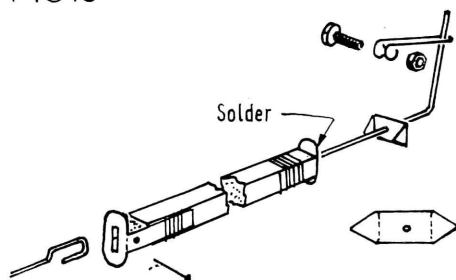


FIG 9

FIG10



rudder movement may be increased or decreased respectively.

A winding hook is situated at the rear end of the fuselage, below the torque rod. This may come out below the torque rod and terminate in a double or loop for winding (a hand drill with a small wire hook in place of a drill makes a good winder for the escapement rubber), in which case a small hatch is necessary to gain access to the

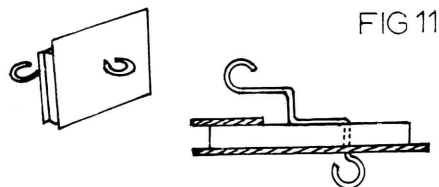


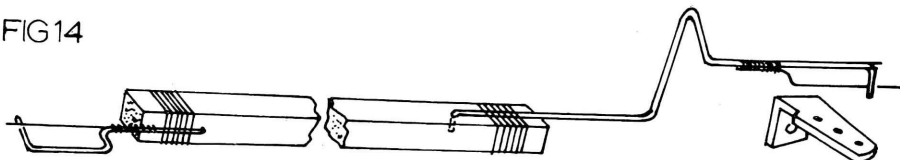
FIG 11

hook for replacement of the rubber skin.

Alternatively, the hook and winding hook can be fixed onto a small hatch in the side of the model. The hatch is lifted out to wind the escapement rubber, which then holds the hatch shut. See Fig. 11.

Motorised actuators have a rotary, or push-pull, output and need to be mounted so that the output lever, or crank, faces upwards. Here again the actuator should be mounted forward of the wing trailing edge to keep the weight near the centre of gravity of the model and to give access to its rear fixing screws. The actuator may be either mounted on hardwood bearers fixed between fuselage formers onto the inside faces of the fuselage, or it may be bolted to a metal bracket which is in turn bolted to the fuselage side.

FIG14



A 1/4 in. square balsa push-rod is used, but the ends are somewhat different from those on the torque-rod. At the fore end, an 18swg. wire hook is made and fitted with a 22swg. wire 'keeper' which is bound to the shaft of the hook with fuse wire and soldered. Its function is to prevent the hook from lifting out of the hole in the output wheel, lever, or crank. This type of coupling can be used on actuators which have semi-rotary outputs or levers. The keeper is sprung clear and slipped over the back of the wheel or lever. Some actuators have a crank which rotates completely. Here the keeper would foul the spindle so the push-rod end must be cranked so that it does not

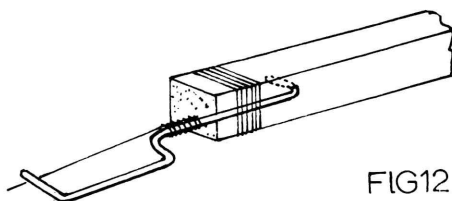


FIG12

slip out of the hole. See Fig. 13. It has a disadvantage in that the actuator has to be unbolted and tilted to free it from the pushrod.

The tail end of the push-rod is also 18swg. wire and is bent to pass through a slot in the top or side of the fuselage. It is kinked so that its length may be adjusted by opening or closing up the kink and its end is fitted with another 22swg. wire keeper which holds it in position on a control horn bolted to the rudder. See Fig. 14. Nylon control horns are obtainable and are superior to metal

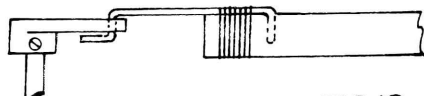


FIG13

ones. As an alternative means of adjusting the length of the push-rod, the adjustable clevis is sometimes used. This is a very neat way of coupling up to the control horn. One form of clevis is the "Kwik-Link" which springs open to fit onto the horn. It has a short length of metal push-rod attached to it. This is bound and cemented to the end of a wooden push-rod as shown in Fig 15.

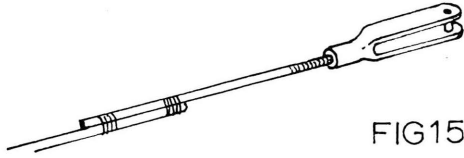


FIG 15

Interference

Interference causes the receiver to operate when no command is sent, or to operate intermittently when receiving a command. This causes miscoding of the signal with the result that the escapement skips or the actuator cycles intermittently. Electric motors which cause interference can be "suppressed" by soldering a .01 microfarad capacitor across the brush connections. See Fig. 16.

Another form of interference is encountered with very sensitive receivers; it is known as "electrical noise" and occurs when two metal parts rub together. A typical example is the lever and yoke in a rudder linkage. The solution is to slip a piece of thin plastic tube over the wire lever so that there is no metal-to-metal contact, see Fig. 17. Another potential cause of metal-to-metal "noise" is the armature return-spring on the escapement. On some escapements it nearly touches the escapement output shaft. Engine vibration causes the spring to vibrate and touch the shaft, so the cure is to wrap a small piece of Sellotape around the shaft at this point. Wherever possible, manufacturers have used plastic components to avoid as much metal contact as they can.

Testing

First make quite sure the batteries are connected the correct way round for, if they are not, the transistors in the receiver can be damaged. If all is well, switch on transmitter and power supplies in the model, and wind 100 or so turns on the escapement rubber, if the model is so equipped. Test with the transmitter aerial retracted when working at close range on the workbench—response should be immediate. Some receivers "swamp" when the transmitter aerial is held too close to them. That is to say, they hold on signal when the control button is released. However few, if any, good commercial receivers do this. The solution is simple—walk back a yard or so.

If the escapement buzzes, but does not turn,

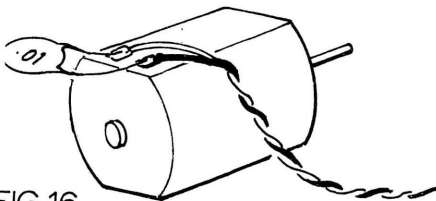


FIG 16

suspect too tight a strand of rubber driving it. If it clicks but does not turn, then the linkage between it and the rudder is too stiff. Suppose the escapement does not even click; if it is operated by a relay receiver, then the relay armature can be pushed down gently. This should bring a response. If it does, suspect the receiver being off tune: if it does not respond, clean the relay contacts by passing a piece of clean paper between them. Naturally, you cannot make this test if there is no relay in the circuit, such as is the case with a relayless receiver.

Receivers are tuned before despatch from the factory, but it may be found that the receiver is slightly mis-tuned at *long range*. It is unusual for an outfit not to work when connecting wires up, so check that the batteries are new and sound,

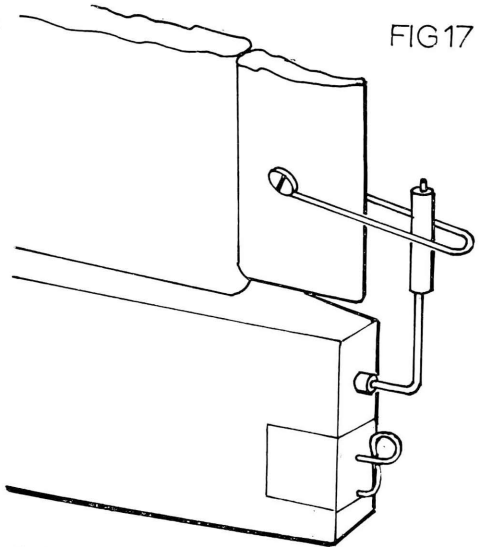


FIG 17

that they are correctly inserted in the battery box and that the *transmitter* battery is connected and sound. If you have a test meter, this is a simple matter.

First check the battery voltage with the equipment switched on, for batteries which are low in power sometimes read the correct voltage, off load. Go over all the batteries, including the transmitter. Next check the load on the batteries by setting the meter on high milliamps and, with the equipment switched off, place the meter probes on the switch connecting tags: this will complete the circuit and give a reading. The transmitter reading will probably drop a little when the control button is pressed and this is to be expected. On the other hand, the same test carried out on the receiver will show a rise or signal. This should be enough to make the escapement pull in or the relay operate.

Tuning

The correct procedure for tuning a model at long range is to get an assistant to hold the transmitter with its aerial fully extended; he then walks away, pressing the control button repeatedly, every second or so. The escapement or actuator in the model should be operating. As the assistant gets further away, the actuator will function intermittently, so the coil in the receiver will need re-tuning. There is a core or "slug" in the coil and this has either a slot or a hexagonal socket in it. Proper plastic tuning tools are available for adjusting the slug, but the end of a plastic knitting needle, suitably filed to shape, will do. Never use a metal screwdriver for the purpose—it gives false results.

Insert the tuning tool and turn the slug clockwise a quarter of a turn. If the actuator stops operating completely, turn the slug half a turn anti-clockwise, when it should continue to operate correctly. Signal to your helper to stop walking, continue to turn the tuning slug in each direction until the escapement stops working, then re-set it midway between these two points. This will be the most sensitive point, so leave well alone. Range varies from outfit to outfit. Half a mile is adequate on the ground, for ground-to-air range will be rather more. In any case, a model is very difficult to see clearly enough to determine whether it is coming towards you or going away from you at such a distance. It is a mistake to operate a model this far away from you when you do get down to flying it. The same rule applies to controlling a model boat; although range over water will be a little less than in the air, about 200 yards is considered sufficient.

The next test is conducted with the engine running. This will show whether the engine vibration is causing any intermittent contacts in the system, or if there is mechanical "noise" present. There is no need to conduct such a test at extreme range. Some outfits "skip" when the glowplug lead is disconnected from the engine. This is unimportant.

If the model has been fitted with a throttle control escapement or actuator, check by operating it, that the engine responds to the change in throttle settings. Sometimes, if the low speed setting is too slow, the engine cuts out when the throttle is opened quickly again, so be content with a slightly faster idle speed.

Test flying

Whereas a simple escapement (2P2N) requires very little practice, obtaining third position on a selective (3PN) type entails some concentration to achieve correct results. You will probably have operated the control system for lengthy periods out of sheer curiosity before reaching the flying field or pond side, but a little intensive practice will avoid mistakes when the model is up and away. For example, never make a turn with an aircraft by simply holding on rudder. An aircraft model will bank too steeply and start to dive,

and when the rudder is neutralised the model will have gained too much speed and will zoom up into a stall.

The correct way to turn, with a simple escapement (2P2N), is to hold for a second or less; release for a second and give a quick signal of opposite rudder, then another second, or less, of rudder. Keep on this sequence, lengthening the space between signals if the turn becomes too steep. In this way, the model will not build up too much speed. *Always fly the model up-wind of the transmitter* before attempting any turns for, once it turns down wind, it will soon be a speck in the distance and you will be confused as to which way it is going. If on the other hand, you fly it well up-wind, you only have to execute a few turns and will soon be overhead again. It is best to choose a calm day for testing and learning to fly. On windy days pack the tailplane to give the model better penetration into the wind. (See "*Trimming free-flight models*", page 20). Some extra down thrust on the engine may also be advantageous.

To make headway into the wind, weave a diagonal course, for each turn will cause the model to drop its nose and temporarily increase its speed as a result. Until you have had some practice, allow the model to climb to a fair height before making any turns, as a great deal of height can be lost in a turn which is too tight. If there is no throttle on the model only put sufficient fuel in the tank for a few minutes' flying time. This will save time if the model needs trimming and it will be safer, for there will be less time for harm to come to the model if it is both out of trim and in the hands of an inexperienced pilot.

Whenever possible, seek the help of an experienced single channel flier, who will be more able to cope with an untrimmed model for its first test flight. When coming into land, try to keep the model facing up wind from a fair height. Don't try to land it on any given spot—a straight approach is more important. Let the model land itself. Last minute corrections can cause the model to bank near the ground, pick up speed and hit the ground in a nose-down attitude, or zoom and stall, with much the same result. With a little experience you should be able to bring the model straight up wind towards a landing spot, then, if it looks as if it will overshoot, weave a more pronounced zig-zag course to lose height and increase the distance covered in the air to the landing spot. See Fig. 18.

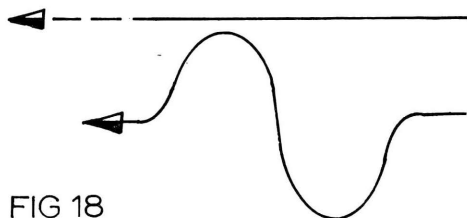


FIG 18

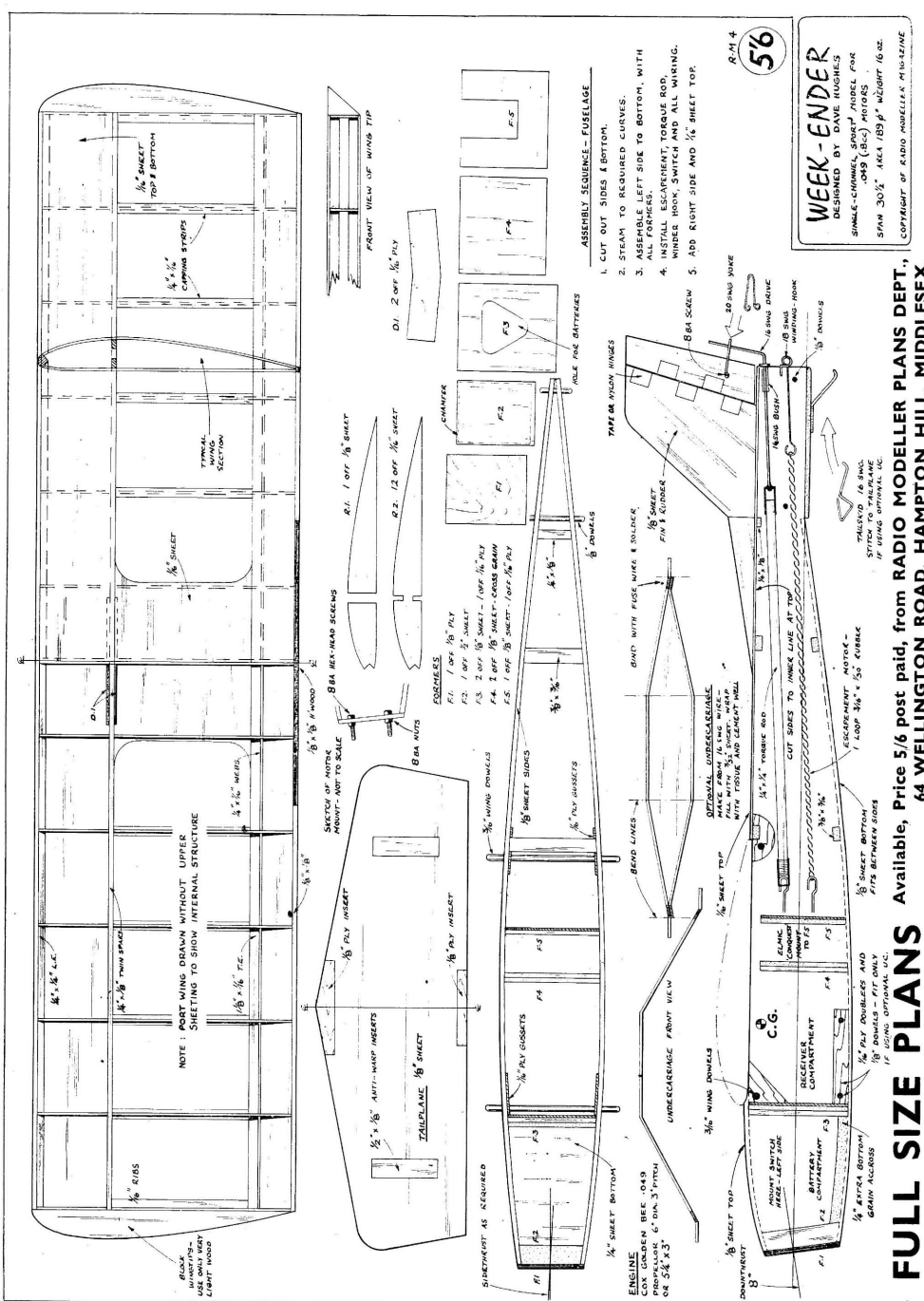
NOW



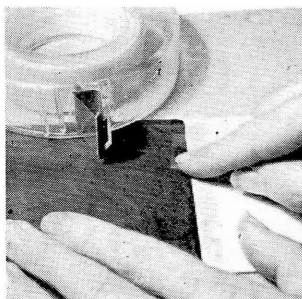
S/C Sport Quickie for '049's

**THE CONSTRUCTION OF A SIMPLE
RADIO CONTROLLED MODEL WITH
BUILT-UP WING CONSTRUCTION
DESCRIBED IN FULL DETAIL**

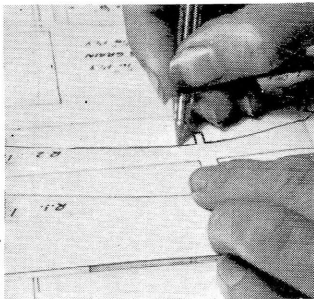




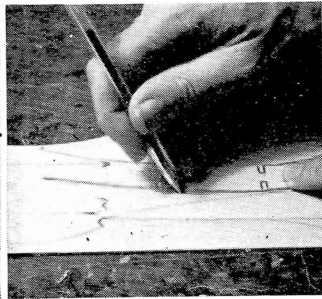
FULL SIZE PLANS Available, Price 5/6 post paid, from RADIO MODELLER PLANS DEPT., 64 WELLINGTON ROAD, HAMPTON HILL, MIDDLESEX.



1 Fixing carbon paper to the balsa with Sellotape prior to placing it under the plan.



2 Using a ball point pen and a keen eye the rib outlines were transferred once onto the wood.



3 Using one cut out rib as a drawing template, the remaining ribs were marked on the sheet.

Building a simple model

WE HAVE taken this example for our ultra simple single channel model because it shows how to build from a plan as opposed to a kit. Whereas a kit generally has the component parts die cut, pre-cut, or ready printed on the balsa sheet to save time and work, the model built from a plan naturally needs a little more work. If you enjoy building, then you will find the extra work involved is an interesting exercise. Naturally, by doing this work yourself, you save money for the only expenses are for materials and the cost of the plan.

There are many plans available from the range produced by RADIO MODELLER for single to more complex scale models

for full multi-control. With a little practice and patience all can be built without special tools from readily available materials. One word of advice—do not embark on a complex model until you have mastered simple construction and learned how to fly. For a first model, it is best to choose a simple design which is strong and easily repaired. The original *Weekender* lasted several years with much use and on-the-spot repairs, so it seemed a natural choice for this month. Incidentally, although this is a radio-controlled model the basic construction sequence we have used is applicable to all models—free flight or control-line.

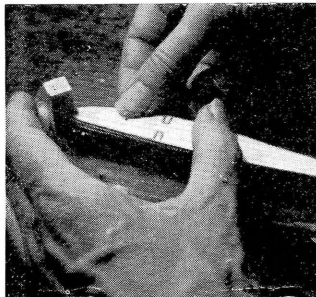
The wing is a good example of built-up construction and has many features which makes it extra strong. It has twin spars, a box section trailing edge, fully sheet covered leading edge and cap strips on the ribs.

The purpose of the box trailing edge is to give strength with lightness and good resistance to warping. The sheeted leading edge strengthens the spars, prevents them buckling and preserves a smooth surface, with no sagging of the covering between the ribs. It also prevents warping and takes the knocks in its stride. The cap strips stiffen the wing ribs and turn them into "H" beams for maximum strength with minimum weight. They provide a greater area for the adhesive when covering the wing for, if the covering is attached to each rib, the chances of large tears is reduced to the size of one panel.

Wing

Start by making the wing ribs. Select a piece of medium $3 \times 1/16$ in. sheet and fix a piece of carbon paper to one end with sellotape. The edges should be flush with the end and one edge

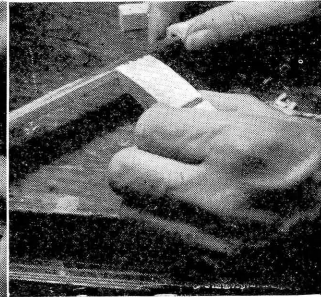
4 With a piece of square balsa in the leading edge notch the ribs were pinned together.

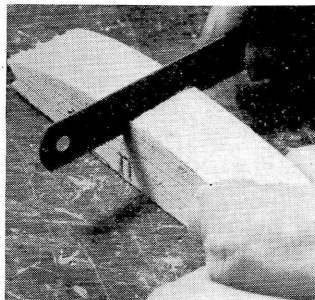


5 Sandpaper on a block of wood smoothed the ribs to the same profile.

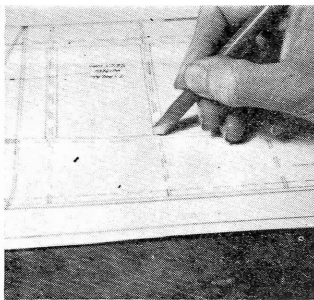


6 A square file was used to true up the leading edge notch to $3/16$ " on each face.

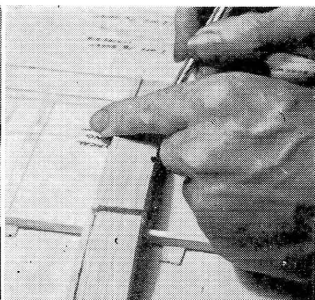




7 After marking, the spar notches were cut with a hacksaw blade.



8 All the joint positions on the plan were rubbed with a candle to prevent the cement sticking to it.



9 The positions of the trailing edges were marked on the ribs before separating them.

of the wood. The carbon face should be next to the wood. Place the wood under the plan and manoeuvre it until the edge and end lines up with the bottom and leading edge of the rib drawing on the plan. This can be done by feeling the ridge through the plan. Using a ball point pen or a sharp, hard pencil, carefully trace over the rib drawing. Be wary lest the grain of the wood underneath guides the pen or pencil off the line, for you need to press fairly hard to get a good transfer on to the wood. Use a ruler to draw the straight parts, but the curve must be done by eye, keeping to the line exactly.

Remove the wood and take off the carbon paper. Using a sharp modelling knife or razor blade, cut out the rib just marked, but leave the spar notches for the moment, cut the leading edge "V" notch. Sand the edges lightly and use this rib as a

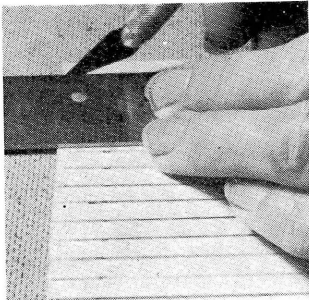
drawing template to mark out the other 11 ribs on the same piece of wood. The grain must be parallel to the straight edge of each rib. By turning the template over, adjacent ribs can share a common base line making cutting time shorter. It will be noticed that the thickness of the pen line will make all the other ribs slightly larger than the template. Do not bother to mark the spar positions. Cut out the ribs and stack them side by side with the template rib on one end and a piece of scrap square wood in the leading edge notch. All the bottoms should be level. Pass a few pins through all the ribs and with a piece of medium sandpaper on a block of wood, smooth all the ribs until level with the template edges. There should be no parts of any rib below the surface of the others. If there is one, then you have cut it badly and the only solu-

tion is to cut a fresh rib and incorporate it in the stack for further sanding.

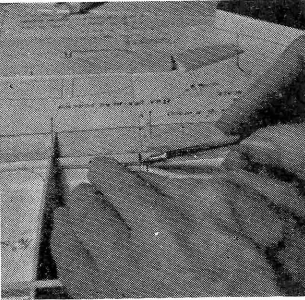
While the ribs are still pinned together, file the "V" notch in their leading edges to a true 3/16in. on each face, then using a square (a corner of a postcard will do), mark lines at right angles across the edges of the stack, from the marked positions of the spars on the template rib. Measure the depth of the notches and mark them on the opposite end rib. Saw out the notches with a hacksaw or razor saw and check the clearance with a piece of $\frac{1}{8} \times \frac{1}{4}$ in. strip, which will be used for the spars. Keep the ribs pinned together.

An extra rib for the centre is marked on $\frac{1}{8}$ sheet. This is cut out, sanded to match the others and cut right across at the positions shown on the plan. The plan should be rubbed with

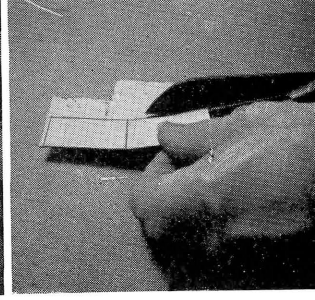
10 After fixing the ribs, strips of 1/16" sheet were cut to space the trailing edge.

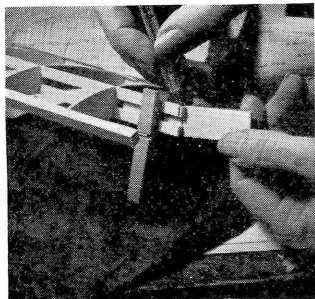


11 One pair of these strips were shortened to suit the centre two bays.

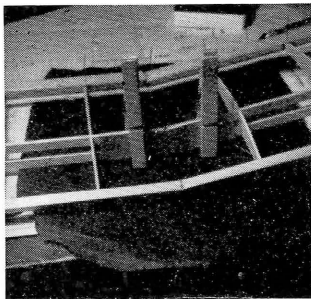


12 The plywood wing braces were easily cut out with tin snips, note the centre line.

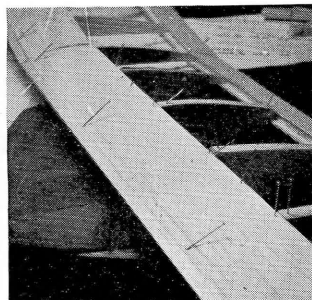




13 Using the centre line as a guide, the spars were marked and cut at the correct angle.



14 Spring clothes pegs were used to hold the dihedral braces onto the spars while the cement set.



15 The leading edge top sheet was pinned down using angled pins into the leading edge. Cap strips can also be seen.

a candle at each joint position to prevent spilt cement sticking to it. The plan should be spread on a flat building board capable of accepting pins, like block-board, and not, say, a Formica topped table!

Mark out and cut two strips $1\frac{1}{2}$ wide \times 1 in. long for the trailing edge and mark a line $\frac{1}{4}$ in. from the edge of one. Cut it on the centre line and pin it onto the plan $\frac{1}{4}$ in. from the trailing edge, with the marked $\frac{1}{4}$ in. facing edge forward. Cut three or four scrap pieces of $1/16$ in. sheet and place them on the plan at the spar position. Pin the bottom spar on edge through these on to the plan making sure it is upright.

Place the stack of ribs over the spar and mark the position of the front of the trailing edge on each end rib. Remove the stack and join up these marks on the top and bottom edges

of the stack, now each rib will have been marked for guidance to show where to cement. Unpin the ribs and spread cement from the tip of the trailing edge, up to the line previously referred to, on the underside and in the notch for the bottom spar. Place each rib over the position shown on the plan. Leave the centre rib for the moment and pin the ribs to ensure that they remain upright. Cement the top spar notches and fit the top spar. Make sure it is flush with the tops of all the ribs.

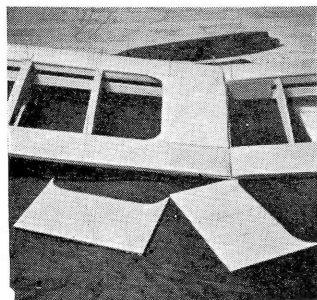
Cut some strips of $1/16$ in. sheet $\frac{1}{4}$ in. wide and chop it into lengths to fit between the ribs. Cement on to the ribs and to the trailing edge on the line marked thereon. These are the trailing edge webs which stiffen it.

Cement the trailing edge of each rib up to the guide line

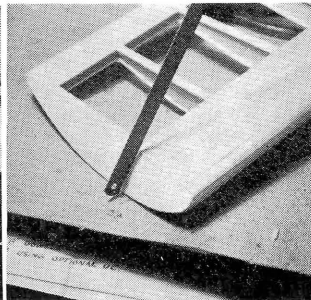
and the tops of the webs and trailing edge of the bottom trailing edge. Work quickly to avoid the cement setting, before you have time to place the top piece of trailing edge sheet in position. It is best to work on each half wing at a time, for the trailing edge has to be cut at the centre to allow for the dihedral angle.

Cement the leading edge notches and fit the leading edge. Pin it in position to make sure it does not slip down. When the wing is set, mark the centre line on the spars and leading edge, remove it from the plan and cut it in half. Cut a pair of dihedral braces traced from the plan on to $1/16$ in. plywood, and mark a vertical centre-line on one. Place this, line inside, against one pair of wing spars, parallel with the top edge. Then, using the line as a guide, cut the spars back to the correct angle. Repeat with the other

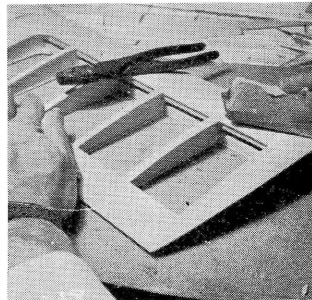
16 The centre section sheeting was cut with swept corners before it was cemented over the centre bays.

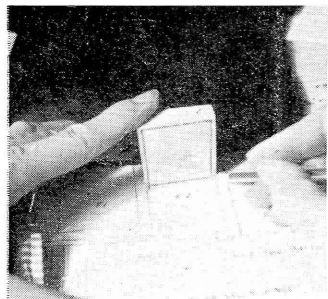


17 The block 'wingtip' pieces were angled by carving away the bottom outer corner. A rule shows the angle.



18 The top of the tips were sanded to conform to the curve of the ribs and the whole wing sanded all over.



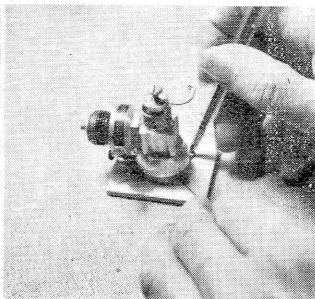
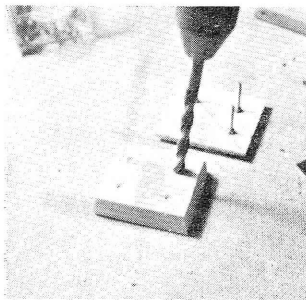


19 Using the plan as a guide, the chamfer was marked on the nose former, which was then carved to shape.

wing. Sand the leading and trailing edges where they butt against each other whilst using the dihedral braces on the spars as a guide to the correct dihedral angle. A block of wood $2\frac{1}{2}$ in. high under one wing tip also helps. Cement the wing halves together and fit the ply braces. Cement and fiddle the centre rib pieces into position exactly on the centre line, and leave undisturbed until set.

Cover the leading edge of the wing with 2 in. wide $1/16$ in. sheet, cemented to each rib and the spars and let in behind the leading edge strip. The bottom sheet is flat for most of its width, but curves up slightly at the front. The top sheet will bend more easily if it is damped on its top outer surface. Sheet each wing half separately, cutting the centre edges of the sheet to meet exactly down the centre of the $\frac{1}{16}$ in. rib. Cut four pieces of $1/16$ in. sheet, each

22 The ply engine plate was pressed onto the $\frac{1}{8}$ in. balsa former to mark the heads, clearance for which was then drilled.



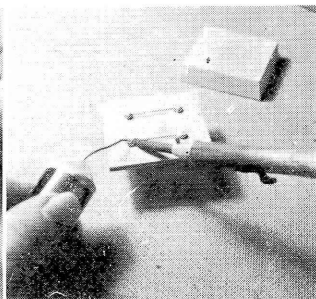
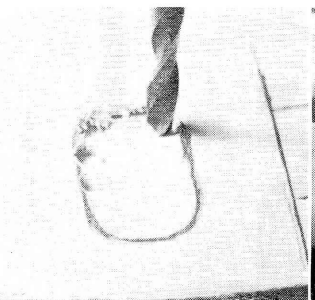
20 Placing the engine centrally on lines drawn from corner to corner, the positions of the bolt holes were marked.

with two swept out corners to cover the two centre panels of the wing top and bottom. Each half of the wing is best pinned down whilst adding the sheet covering, first to the top then, on removing the wing, to the bottom. This ensures that it stays warp free.

Make the cap strips by measuring the distance between the leading edge sheet and the front of the trailing edge and cutting pieces of sheet to fit, grain running parallel to the ribs. Using a steel rule strip these into 20 $\frac{1}{16}$ in. wide pieces and cement them centrally along the ribs, top and bottom. The end ribs have their strips flush with the outer edge.

The wing tips are made from 1×1 in. soft block. The wing is placed on the block and a line drawn round it. The bottom edge is then chamfered off at 45° . It is probably easier to do this after cementing it on to

23 The cut-outs were made in the ply laminations of the formers by drilling holes and linking them up.



21 With the bolts held in place by their nuts, pieces of piano wire were soldered between the slots in their heads.

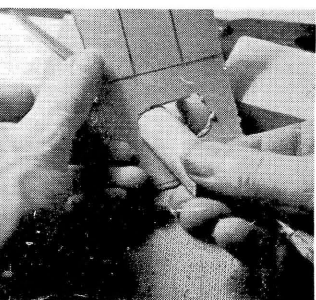
the wing tip. By making the bottom surface flat, the curve shown on the plan view is achieved on the upper surface. Sand the block to conform to the top wing profile.

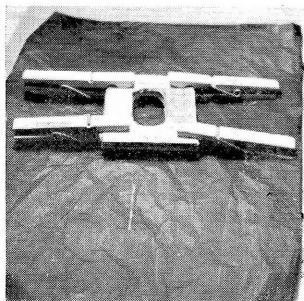
Add a strip of $\frac{1}{8} \times \frac{1}{16}$ in. balsa to the trailing edge and hardwood to the centre part to take the wear of the wing retaining rubber bands, which usually crush unprotected balsa edges as thin as this. Sand the wing all over with fine sandpaper on a block of wood, round off the leading and trailing edges, and make all the sheet joints level.

Fuselage

Transfer the former shapes on to $\frac{1}{8}$ in. sheet, either by measuring them and marking them off with a square on the wood, or by placing the wood under the plan and pricking the corners with a thick pin or panel pin. Cut out the balsa formers using a metal straight edge,

24 The rounded ends of the battery access hole were sanded smooth with sandpaper on a pencil.





25 After cutting out the holes in the balsa laminations, the ply facings were held in place with clothes pegs.

then mark out F3 and F4, again on the wood with the grain running at right angles, using the formers just cut as a template. The 1/16in. ply facings to F3 and F5 are marked in the same way and cut with a junior hacksaw or a fretsaw. The cut-out in F5 is made with a fretsaw, or by drilling holes and joining them up with a knife. F1 is cut from 1/4in. ply with a hacksaw. Draw a line from corner to corner across it to find the centre. Place the engine, which should be a radially mounted type, on this mark, with a line passing through each lug. Mark the position of the bolt holes through each lug, remove the engine and drill the former for 8BA bolts. Push the bolts through and put a nut on each to hold it in place. Clean the heads of the bolts with a file and solder a pair of 20swg piano wire locking pieces into the slots in each pair of bolt

heads. This will prevent them from unscrewing when the former is assembled.

Place F1 centrally over F2 and press it down to leave dents under each bolt head. Drill out the balsa to clear the bolt heads and carve slots to clear the wires. Chamfer the edges of F2 on the front face to the lines measured from the plan, then cement it to F1. Cement all laminated parts of each former together.

Tape more carbon paper to an 1/4in. sheet of balsa, you will need three sheets to make up the length. Place it under the plan and locate it as before. Trace the outlines of the fuselage side and bottom onto the wood. Use a separate piece of wood for the bottom and keep to the inside line for this tracing. When marking out the side, we chose to follow the inner dotted line at the top of the nose. This means that the top sheeting fits over the sides instead of between them: it is easier to fit this way. It also enables the top line of the fuselage to run along one edge of the sheet, which saves cutting.

Cut out one side and use it as a template to make the second side. Mark the inside faces of each and steam them to a curve to match the plan view. Cut out the bottom and steam it to the curve shown on the side view. Cement pieces of 3/8 x 3/16in. and a piece of 1/4in. sheet across the bottom. The grain of the scrap 1/4in. sheet goes across the fuselage—

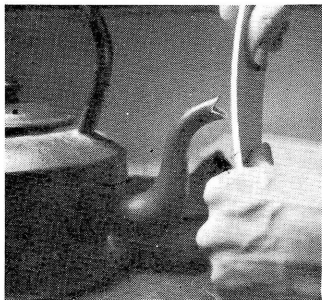
two laminations of 1/4in. sheet would do, if no 1/4in. sheet is to hand.

Bolt the escapement onto F5. Cement down the left-hand edge of the bottom and pin the left side on to it. Cement in all the formers on marks checked off from the plan. Check them for squareness to the top edge by using the corner of a piece cut from a postcard.

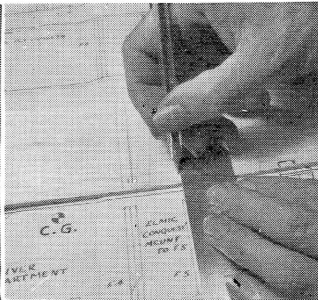
When the cement is set, start installing the radio gear and linkage. Cut pieces of sponge rubber to fit round the batteries and receiver and make a cut-out for the switch, which is bolted on to the left side, forward of the wing. Make up the torque rod from 1/4in. square balsa, with the tinplate couplings supplied with the escapement, bound and cemented on to each end.

A piece of 16swg piano wire is pushed through the hole in the tail end, coupling into the end of the torque rod and soldered to the tinplate. The other end has a slot, which slips over the top hook of the escapement and is secured with a scrap of soft wire pushed through two small holes and bent over. Slip a brass bush over the 16swg wire torque rod end and file out a notch in the tail end of the fuselage side to accommodate it. Notch the other fuselage side to match. At this stage the winding hook can be bent up and fitted, and a loop of 1/8 or 3/16 x 1/30in. rubber, well coated with rubber lubri-

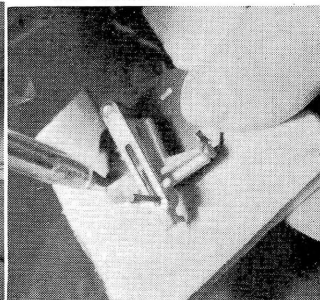
26 The fuselage sides and bottom were steamed to a curve.

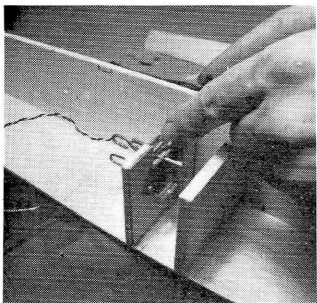


27 The sides were laid on the plan and the former positions marked.

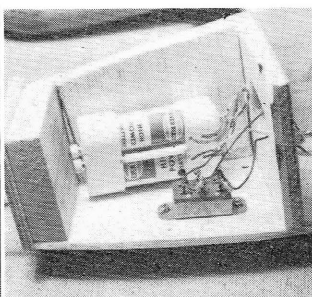


28 With the escapement in the cut-out in the former, its mounting holes were marked.

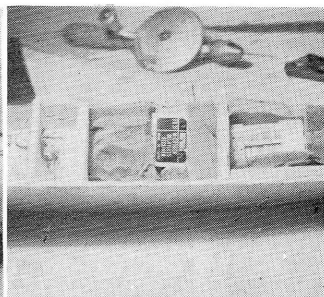




29 Escapement bolted in, the forms were cemented to side and bottom.



30 The switch and all wiring was installed at this stage, while accessible.



31 This was also a good time to cut the foam rubber packing to shape.

cant, installed between it and the other escapement hook. Small notches are made in the fuselage end to clear the winding hook and these are coated with cement to resist wear.

If there is any soldering to be done on the radio installation it is best tackled now, before the fuselage is complete, as it is more accessible. The gear can even be tested in this state, to make sure it is electrically and mechanically operative. The escapement, by the way, is wound clockwise from the rear using a wire hook in a hand drill.

Cement on the other side, cut 1/16in. ply gussets and doublers and cement them in place on the inside of the sides before adding the 3/16 × 3/8in. and 1/4 × 1/4in. top spacers between the sides. Sheet cover the nose with 1/4in. sheet, with the grain running from side to side, then place the fuselage upside down on a piece of hard 1/16in.

sheet and draw round it to make the top, which is then cemented to the sides and the cross pieces. Drill the sides for the dowels. The wing and undercarriage dowels are a tight push fit, so that they can be easily replaced if they break. The tailplane dowels are less likely to break and are cemented in after covering the fuselage.

Tail surfaces

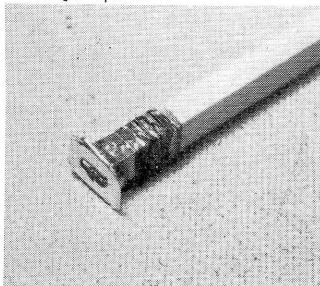
Using carbon paper again, trace the outlines of fin, rudder and tailplane onto 1/4in. sheet. As the tailplane is wider than 3in., an offcut of 1/4in. sheet has to be cemented to one edge, to accommodate the extra width in the centre. Mark out the outlines of the reinforcing pieces on 1/4in. ply and cut them out. Place them on the leading and trailing edges of the tailplane and cut round them. Cement them in place.

Use the same technique with

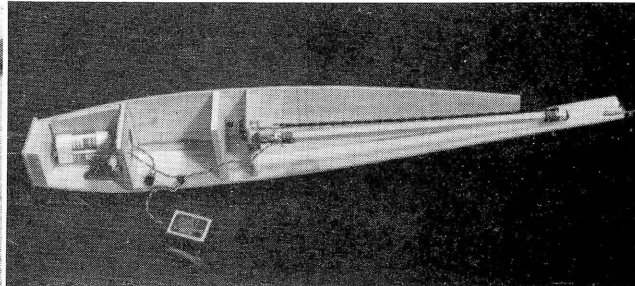
the 1/2 × 1/4in. anti-warp inserts. By cutting round them, a tight fit is assured. Sand the tailplane and fin pieces and round the leading and trailing edges. Hinge the rudder with pieces of 1/4in. wide linen tape, in the same manner of the control line model's elevator, described this month. Cement the fin securely on to the fuselage, and make sure it is upright.

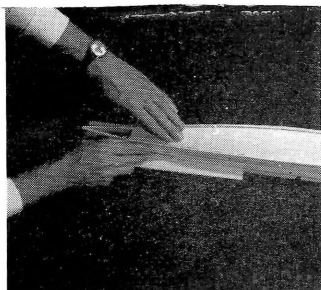
Bend the end of the torque rod up vertically, but inclined slightly backwards, whilst making sure the escapement is on "neutral"—(it should be if there are some turns on the rubber). Bend up a 20swg piano wire yoke and slip it over the torque rod end. A scrap of plastic wire sleeving on the end of the latter should ensure that there is no electrical "noise" to affect the receiver. Bolt the yoke on to the rudder with a short 8 BA bolt. There should be adequate clearance between the yoke and the torque rod

32 The tailplane ends to the torque rod were bound and cemented to a strip of 1/4in. square.

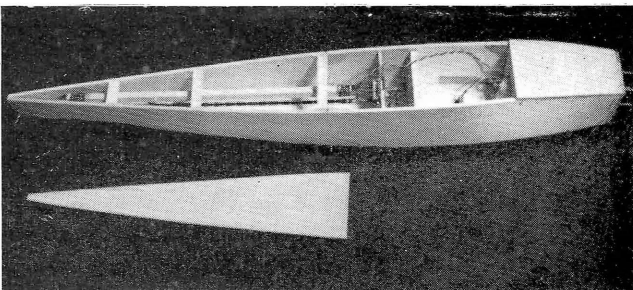


33 The torque rod was then fitted, completing the installation and the other side fitted.





34 The fuselage was laid upside down on 1/16in. sheet to mark the top.



35 Spacers were added across the fuselage before the top was cemented on.

end, so that it does not bind when the rudder is moved to full deflection. Check this with only a few turns on the rubber.

Undercarriage

If the model is to be flown over tarmac, an undercarriage is needed. On grass fields it is better without it, for it only adds drag, and a small model such as this can be hand launched and belly landed. The extra weight of the undercarriage will make the model nose heavy, so the batteries should be moved back slightly into the receiver compartment to re-balance the model.

The undercarriage is easily made by bending 16swg piano wire to the shape shown on the plan, binding and soldering the two pieces together and afterwards bending it to the angles shown in the front view. 1½in. wheels are used and are secured with washers soldered on. Pieces of 3/32in. sheet are let

in between the front and back wires, and bound in place with cement-soaked heavyweight tissue. If the undercarriage is used, it is also necessary to make a 16swg wire tail skid and stitch it to the tailplane with button thread.

Finishing

Give the tail surfaces two coats of clear dope then, when dry, cover them and the fuselage with lightweight Modelspan fixed with thick polycell applied sparingly. Cover the wing with heavyweight Modelspan, and work out any wrinkles by pulling it spanwise. Use four pieces to cover the wing, joining at the centre. Give the whole model three coats of clear dope and pin the wing and tailplane down between coats when touch dry—it is necessary to dope each wing half separately, so that it can be pinned on to a flat surface.

Mark the centres of the wing

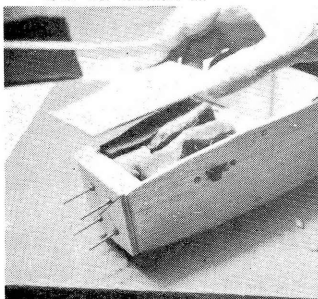
and tailplane on their leading and trailing edges and make corresponding marks on the centre line of the fuselage, so that when the model is assembled it is rigged true. Fuelproof the whole model and fit the engine upright on the bolts, using extra nuts. Add washers under the left hand lugs to give side thrust to counteract engine torque and ensure that the model flies straight under power.

Lead the aerial out under the trailing edge of the wing and secure it with a rubber band over a pin in the top of the fin. Do not shorten the aerial, but let the end trail. Use plenty of strong rubber bands to hold the wing and tail (and undercarriage if fitted) in place.

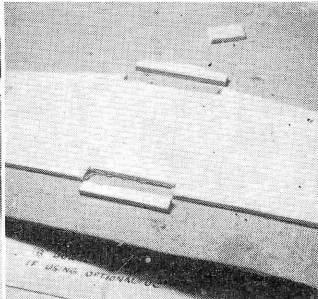
Trimming

Although this is a construction article, a few elementary notes on trimming will not come amiss. Test glide over

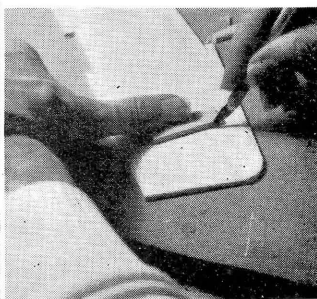
36 With the rubber packing in place in the battery compartment, the front cover was cemented in.

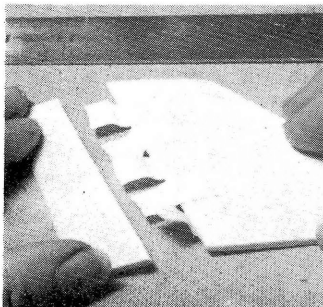


37 ½in. ply braces were let into notches in the tailplane edges.

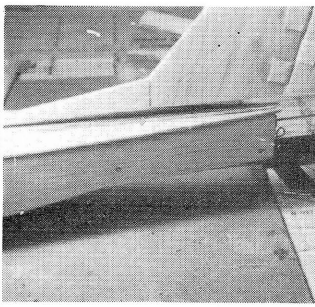


38 After cutting out anti-warp stiffeners, holes for them were cut round them.

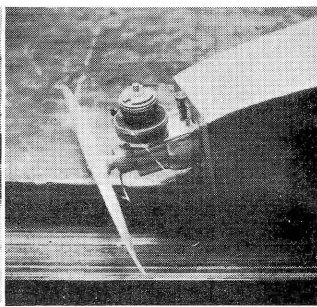




39 The rudder was hinged with tape in a clothes horse type configuration.



40 The fin was double cemented in place on a line drawn down the centre of the fuselage.



41 The engine was mounted on the front former using the bolts installed earlier.

long grass, after adjusting the position of the radio gear until the model balances where shown on the plan. If the grass is short—try a power flight first-time, for the glide from a hand launch can be inconclusive with such a small, comparatively heavily loaded, model.

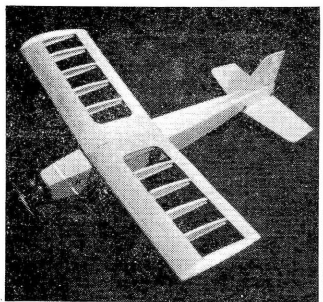
Squirt a small quantity of fuel into the tank, enough for about 90 seconds will do, and launch fast. In calm weather it may need $1/32$ in. packing over the leading edge of the tailplane. The model is designed to

penetrate a wind, so it may descend in a shallow dive from launch. To make sure it gets away, give a few rapid pulses to make the tail end wiggle. This has the effect of presenting first one wing then the other to the airflow at an angle and helps the model into a slight climb.

Let the model gain some height before attempting complete turns. For these give a pulse of about $3/5$ th of a second, followed by an almost instantaneous pulse of opposite

rudder, keep repeating this sequence to keep the model turning level. Never hold the control on, unless you want a spiral dive. For more penetration in a wind, add $1/32$ in. packing over the trailing edge of the tailplane—more than this will produce a dive.

If the model tends to circle under power to the left, add more washers under the engine lugs on this side, if it circles on the glide, bend the torque rod end to give a slight rudder deflection.



Above—

42 The model ready for covering, all nicely sanded and given one coat of dope.

43 After covering the fuselage and fin with lightweight Modelspan doped on, the dowels can be fitted, only the tailplane dowels are cemented.

44 The tailplane was doped both sides and pinned down when touch dry.

Right—

45 The wing was given three coats of clear dope.

46 It was pinned down between each coat on each half of the wing, and the same was done for the tailplane.

