MM Lark D 25

THEORY, CONSTRUCTION & FLYING MANUAL

CONTENTS

ORDERS FOR SPARE PARTS OR ANY CORRESPONDENCE CONCERNING YOUR 'LARK' HELICOPTER SHOULD BE ACCOMPANIED BY THE KIT SERIAL NUMBER –

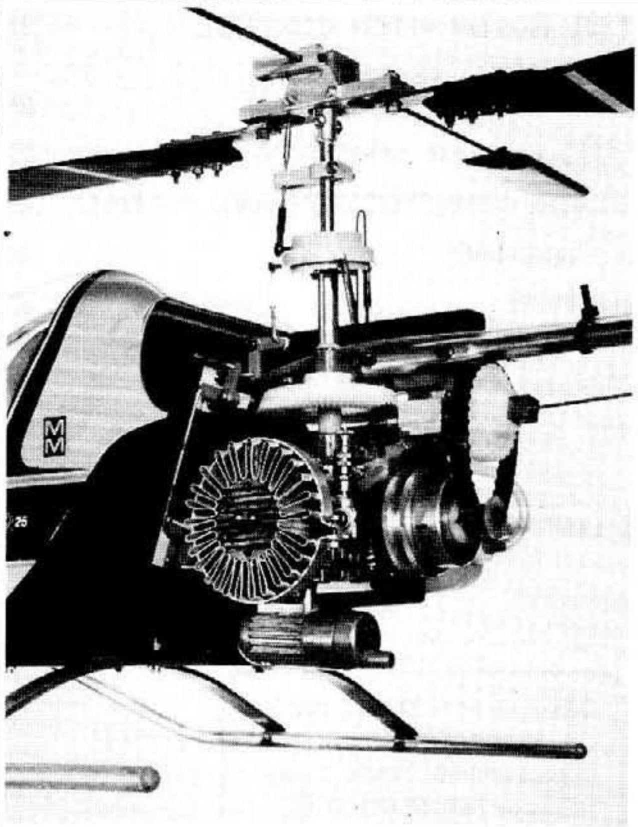
LA2 000066

FOREWORD

We would ask and advise you most sincerely to read this manual through carefully before commencing construction of your Lark. It has in the main been compiled by the designer who has devoted his entire leisure time over the past 6 to 7 years to the development, theory and practice of R/C model helicopters. Even if you consider yourself to be an expert on the subject we are certain you will find the following pages to be of interest and assistance but if this is your first venture with an R/C helicopter then it is of paramount importance that you read, digest and re-read before following the instructions for stage by stage building and flying.

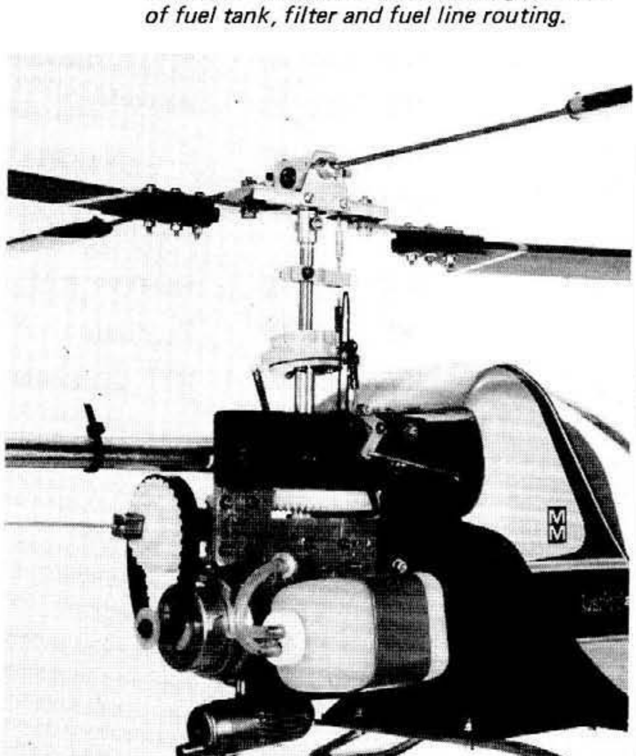
We have tried limiting the tools required in constructing the Lark-2 to those normally in the hands of most modellers viz:- screwdriver, pliers, hand drill and bits, small saw, file, soldering iron (solder is required for linkage only or epoxy may be used as an alternative) etc. Adhesives are not included but we recommend P.V.A. for all wood to wood joints (unless otherwise advised) and for A.B.S. to wood, a good impact adhesive such as Evostik or Dunlop Thix-o-fix and two-part quick drying Epoxy for other bonds as instructed; use Bostik Clear for fixing canopy. Helicopter models are subject to very high vibration and the kit includes Torqseal for locking screws and nuts where recommended in manual.

The Lark-2 has been developed from the Mark 1 version and includes a number of detail mechanical improvements evolved from nearly 4 years' sales and experience together with a new, smooth and attractive, scale-like body style.



ABOVE – Port view showing disposition of mechanical components with heat sink clearly visible at centre of photo.

BELOW – Starboard view showing location of fuel tank, filter and fuel line routing.



The greatest difficulty with model helicopters is in learning to fly them with the minimum of repairs. If there is nobody to help you then the likelihood of a crash is very high. It was with these thoughts in mind that the Lark was created.

The essential features of the design are:-

1. Small size, the .19 (3.2 cc) engine being considered ideal although more modern .25 ci engines such as the H.B. certainly add a sparkle to its performance.
2. The ability to carry the average radio (4 servos are the minimum).
3. The mechanics should be able to survive a crash.
4. Damaged parts are easily and cheaply replaced.
5. Construction is simple.
6. The cost is relatively low.
7. No electric starter is required, though one can be used if desired.
8. It can be carried across the back seat of the car without removing the rotor.
9. The flying characteristics are docile, which makes it ideal for learning.

It is helpful to understand something of the theory of helicopter flight before risking your model in the air.

For those absolutely new to h 'icopters here are one or two basic points to begin with:-

The machine is lifted from the ground by the lift from the rotor.

Altering the pitch of the rotor blades, as they rotate, drives the machine forwards, backwards and sideways. This is called cyclic pitch control.

Two servos are required to control cyclic pitch and they are similar to the elevator and aileron controls on a fixed wing aircraft. The information from these two servos is transferred to the rotor blades via. a mechanical assembly called the swash plate.

Two other servos are required, one to control the engine speed and the other to control the tail rotor pitch.

The tail rotor is used to counteract the torque of the main rotor. Altering the pitch of the tail rotor blades gives yaw control and is similar to rudder control on a fixed wing model.

The tail rotor is driven from the engine via. the main gear train.

The motor control alters the lift of the main rotor. In some model helicopters the lift of the main rotor i. altered by increasing or decreasing the pitch of the blades equally and simultaneously. This is called collective pitch control. To avoid complexity, collective pitch is not used in the Lark. The motor selected for the model should therefore have a reliable throttle response and be preferably run in with a propeller before installing in the model.

The bar at 90° to the main rotor blades is called the fly-bar and the two small air foils at either end of the fly-bar are called the paddles. This assembly acts as a stabalizing giro and is also used to transfer information from the swash plate to the rotor blades by moving the pitch of the paddles. This stability system was pioneered by Hiller helicopters (full size ones) and has, so far, been found to be the best one for models.

Let us examine the control system in greater detail to see how it works.

As mentioned a little earlier, the pitch and roll servos are connected to a piece of machinery called the swash plate. This comprises two discs, one on top of the other. The lower disc does not rotate and is coupled to the servos via. arms at 90° to each other. The whole mechanism is pivoted on a half-ball in the centre so that the servos tilt the lower disc forwards, backwards and sideways. The upper disc follows the tilt of the lower disc but rotates with the rotor shaft. An arm on the edge of the upper disc transfers swash plate tilt information to the fly-bar via. a push rod and crank.

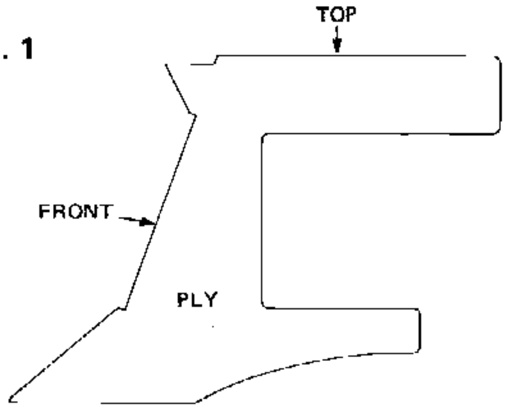
Let us now follow a control right through the system to see how it works.

Suppose we wish to go into forward flight. We push the transmitter stick (the one you usually use for elevator) forwards. The appropriate servo responds and tilts the swash plate forwards. Let us assume that the upper disc of the swash plate has arrived at a position where its arm is facing forwards (main blades fore and aft). Since we have tilted the swash plate forwards, the arm on the upper disc will pull down the rod, which connects it to the fly-bar via. a crank. It can be seen that, as this happens, the paddle sweeping forwards will attain a negative angle of attack and the paddle sweeping backwards will attain a positive angle of attack. This gives the fly-bar an aerodynamic push. Since the fly-bar behaves as a giro, the force is seen at 90° to the aerodynamic push or, when the main rotor blades are sideways across the model. The forward sweeping main rotor blade thus has a smaller angle of attack than the rotor blade sweeping back. This is the condition for forward flight because the advancing blade is travelling faster through the air than the retreating one and so requires a lesser angle to equalize lift over the area swept by the blades. This area is referred to as the disc. However, at the moment the control is applied, there is greater lift from the rearward sweeping blade. Since the main rotor also behaves as a giro, this inequality of lift, instead of tilting the model sideways, tilts the model forwards. As the model tilts forwards the air passing through the rotor, instead of being forced downwards, is forced downwards and backwards thus pushing the model into forward flight. Sideways and backwards flight is achieved in the same way.

Read the above again when you have completed the model; it will be easier to understand.

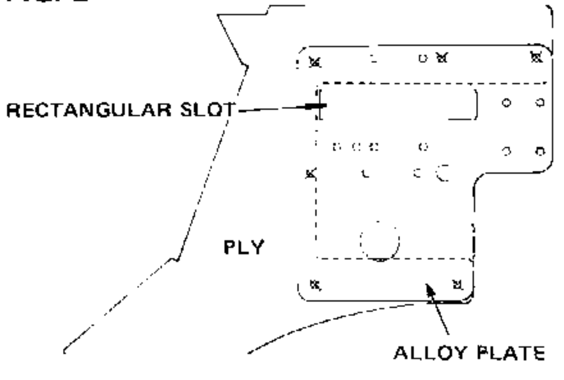
The centre of the whole model is a 3/8" piece of ply as shown in FIG. 1.

FIG. 1



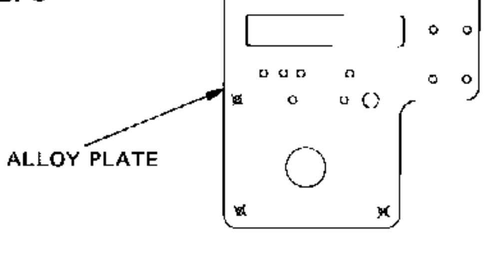
An aluminium alloy plate, which carries the engine, gears, tank etc., bolts to the left (port) side of the ply former. FIG. 2.

FIG. 2



Place the alloy plate over the ply former and, using the holes already drilled in the plate at the positions shown as x, use a pencil to mark the position of the holes to be drilled in the ply former. (N.B. the large rectangular slot in the alloy plate should line up as shown in FIG. 2.

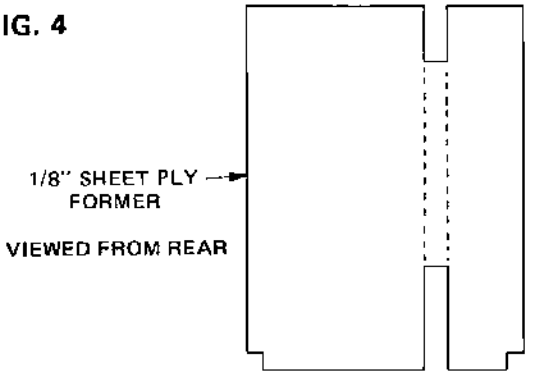
FIG. 3



Obtain two drills 1/16" and 7/64". Use the 1/16" drill to make six pilot holes where the pencil marks were made on the plywood former. Use the 7/64" drill to finish the holes (7/64" is a tight clearance on a 6 BA bolt).

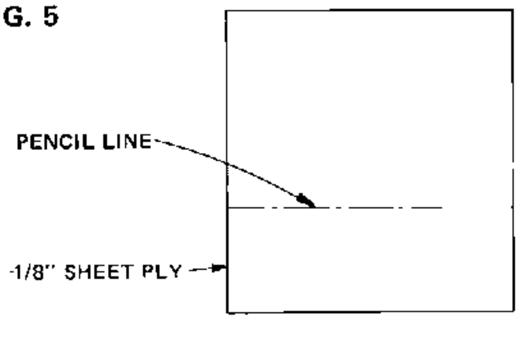
Put the alloy plate to one side.

FIG. 4



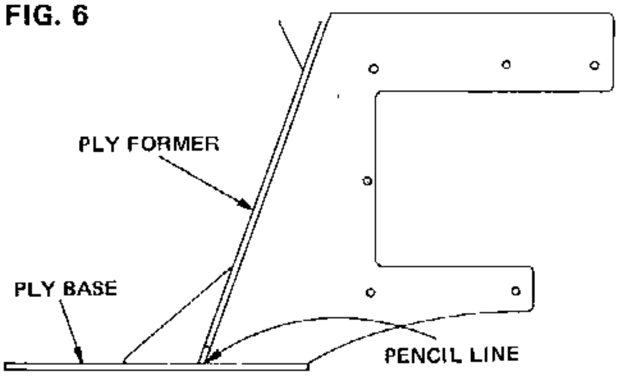
Locate the plywood fuselage back FIG. 4, and epoxy glue it to the previously drilled plywood former. The slots should be to the right (starboard) side of the model so that the rotor shaft is in the centre.

FIG. 5



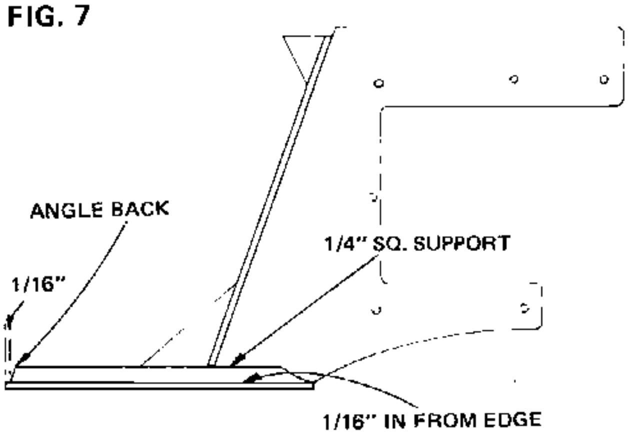
Locate the 1/8" ply fuselage base ($4\frac{3}{4}$" x $4\frac{1}{2}$") draw a line 1 5/8" from one of the shorter sides and parallel with it, FIG. 5. Glue the previous construction to the base using the line as a guide, FIG. 6. The line should correspond with the rear of the fuselage back. Some sanding of the construction may be required before gluing. The fuselage base will overlap the back by 1/16" either side.

FIG. 6



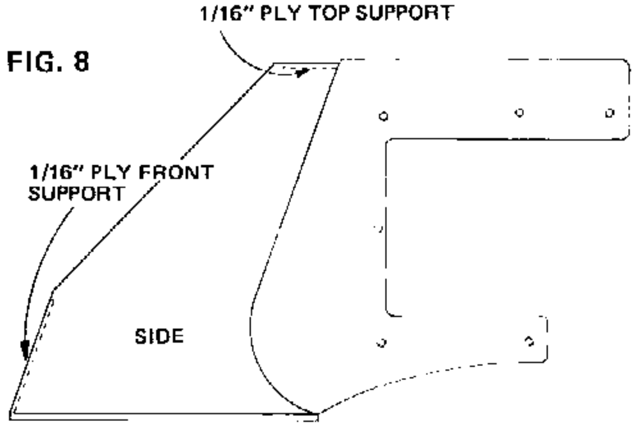
Glue the ¼" square hardwood supports to the base. The ends of the supports should be 1/16" from the front edge of the base. The sides of the ¼" supports should be 1/16" from the sides of the base.

FIG. 7



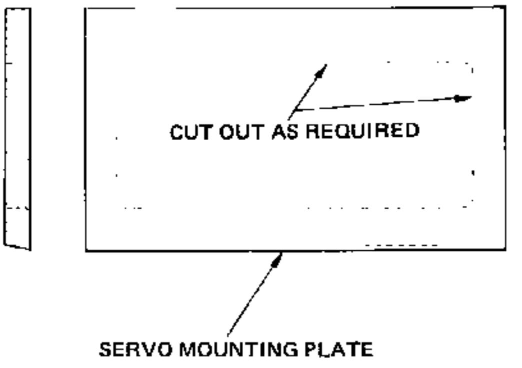
The fuselage sides are now glued in place FIG. 8. The 1/16" ply top and front supports can also be glued in position. These pieces butt against the inside of the sides. The ends of the ¼" sq. hardwood pieces should be angled back before the sides are fitted FIG. 7 - use plenty of glue.

FIG. 8



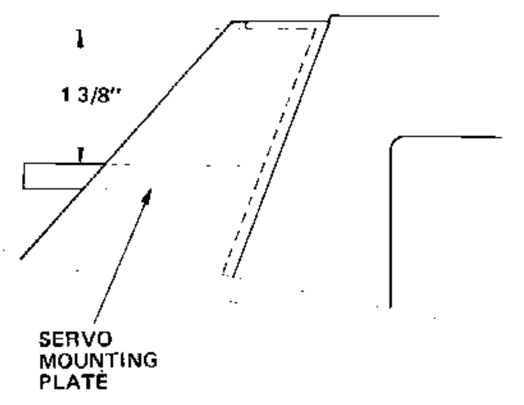
The servo mounting plate (6.5 mm. x 2½" x 4 3/8" ply) shown in Fig. 9 should be epoxied in place inside the fuselage base.

FIG. 9



Before this is done, it will be necessary to cut out the centre of the servo mounting plate to accommodate whatever type of servos are to be fitted. The area will approximate to the dotted line shown in the drawing. The rear edge of the servo mounting plate should be chamfered to butt firmly against the 1/8" ply bulkhead. Fig. 10.

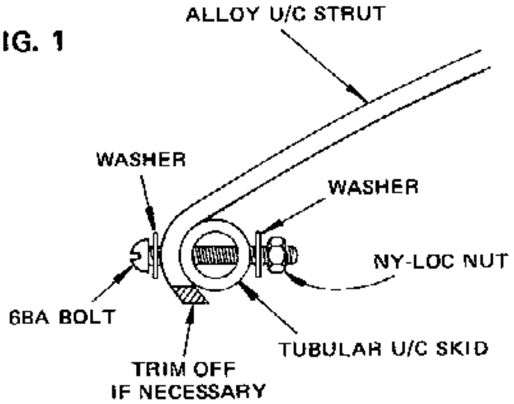
FIG. 10



Sand the whole structure as required.

The skids and struts are easily identified and simply bolt together using ¾" 6 BA bolts, washers and nyloc nuts as shown. FIG. 1.

FIG. 1



The ends of the struts may need trimming with a small hacksaw so that they don't protrude below the bottom of the skids. Do this before assembly.

Four nylon plugs push into the ends of the skids. Use a blob of Evostick to hold the plugs in place.

Offer the undercarriage to the bottom of the fuselage. The bent ends of the skids should be at the front.

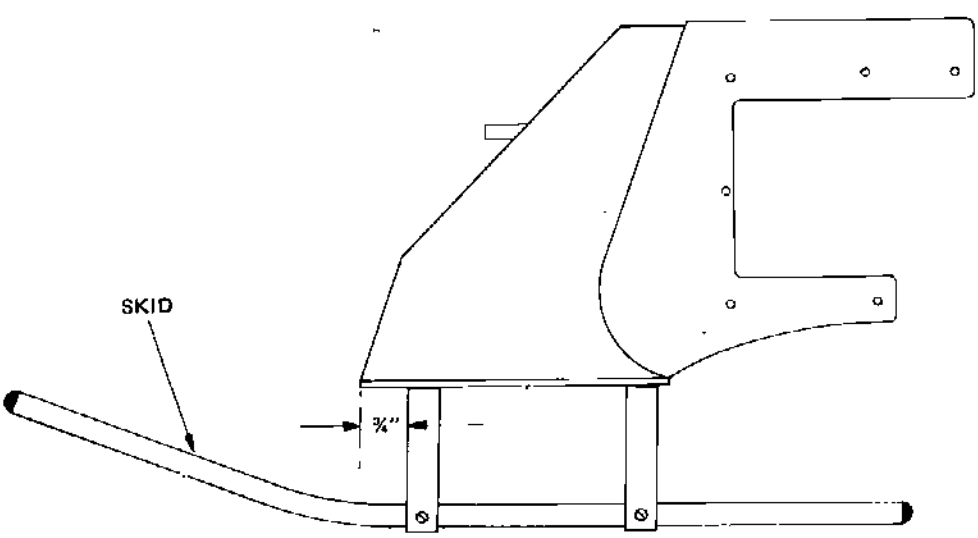
The front edge of the front strut should be ¾" from the front of the base. FIG. 2.

Mark four spots with a pencil using the undercarriage as a jig. Drill the fuselage at these spots using a 1/16" drill as a guide and a 7/64" drill to finish.

Glue the Velcro tape in place as shown on the plan. Use Bostik Clear or other impact adhesive, and allow several days for it to set.

Put the fuselage and undercarriage to one side.

FIG. 2



The fin is constructed from a piece of 1/32" ply sandwiched between two pieces of 1/16" sheet balsa.

The pieces are easily identified and are already cut to shape.

Use P.V.A. adhesive and glue the parts together.

Sand the fin to an aerofoil shape.

Epoxy two 1/32" ply x 2" x 3/8" parts to either side of the fin in the position shown. FIG. 1.

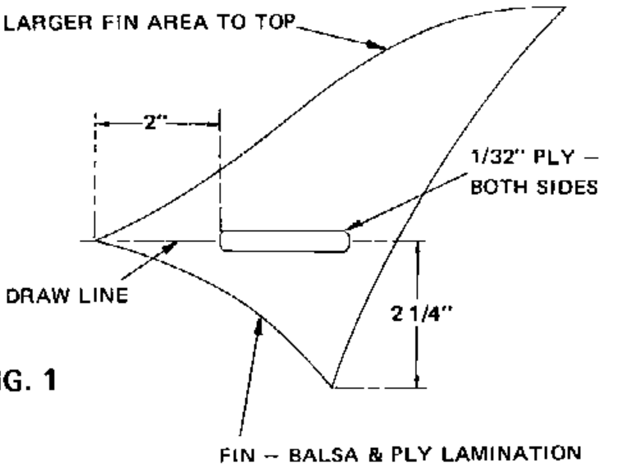


FIG. 1

Put the fin to one side.

Using 6 BA bolts as guides make sure the engine plate fits the fuselage. Relieve any holes that are out of alignment with a 7/64" drill, using the engine plate as a guide. Remove the engine plate when satisfied.

The large nylon crown gear and steel pinion gear are next mounted on the port (left) side of the engine plate in the following manner:-

Take the two main rotor shaft mounts, with phosphor bronze bearings, and trim off any flashing that may be present with a sharp modelling knife. Be careful to avoid cutting yourself should the blade slip. Ensure that any flash is removed from the bearing holes.

Take each bearing separately and, using the ¼" dia. silver steel main rotor shaft insert it through each bearing (one at a time) and move back and forth with a twisting action. This assists the bedding in of the Oilite bearings and the addition of a little light machine oil will aid the process.

The ensuing operations are very important and call for probably the most patience and care of any of the assembly in the Lark Kit. The object is to obtain a perfect mesh of the main nylon crown wheel and steel pinion with both head rotor and counter shaft revolving freely without any unnecessary play in their respective bearings. This requirement is slightly complicated by manufacturing limitations viz:- a very small shrinkage variation in the mounting blocks, a slight curvature induced in the engine plate when it is punched out and the fact that it is not possible when pre-jig drilling these to work to tolerances better than $\pm$ approx .002".

There are two holes in the rotor shaft. The small hole, about 1¼" from lower end, takes the roll pin which fixes the nylon crown gear. The hole at the side of the crown gear boss is countersunk on one side. Push the roll pin through this hole until it is about to emerge into the centre bore of the gear. The edge of your workbench can be used to help it in using gentle pressure and care. Push the crown gear on to shaft (teeth facing downwards) until it reaches fixing hole position.

Holding the nylon gear, rotate the rotor shaft until the small hole in the shaft comes into line with the roll pin hole in the gear boss.

Give the roll pin another push on the corner of your workbench to locate its end in the rotor shaft. When you are certain all is in line, (this is easily seen since the roll pin is hollow) force the roll pin through with the aid of a vice. (N.B. the vice jaws should be either side of the gear boss, FIG. 1).

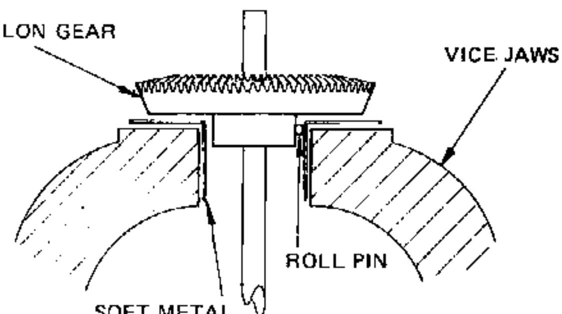
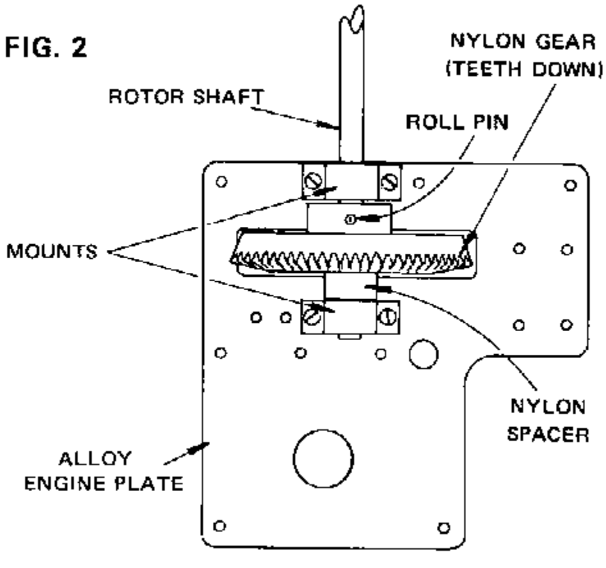


FIG. 1

Slide one bearing on to top end of main shaft the bronze lip facing downwards towards gear, on bottom of shaft slide 7/16" depth nylon spacer followed by second bearing with bronze lip upwards towards spacer.

Place gear into slot in engine plate and insert 6 BA x ½" bolts, with washers under heads, through respective holes in plate (FIG. 2). Add nuts (no washers under these nuts) and temporarily tighten, the shaft must revolve freely. If this is not the case, slacken the nuts a little and try slightly moving the assembly bodily, if this does not still give free rotation of shaft a little judicious work on the mounting holes with a round needle file will give the desired perfect line up of shaft and bushes. Before tightening nuts add a little Torqseal (this takes 3 hours to set so if necessary you can again slacken nuts during this period) do not over tighten or this will cause distortion of nylon mounts — recheck for free rotation of shaft.

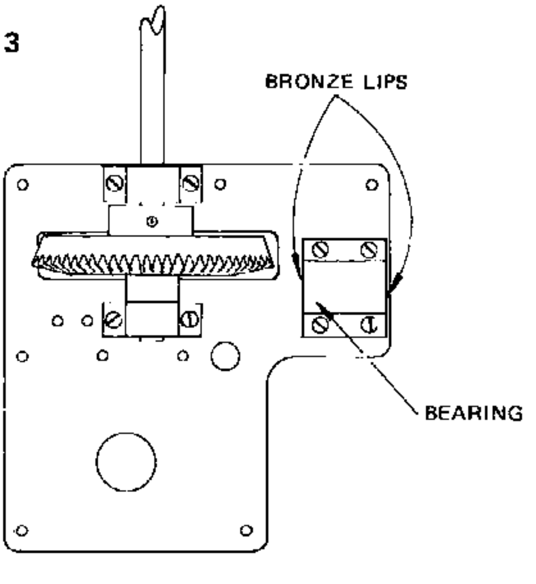
FIG. 2



Now mount the bearing for the counter shaft using 6 BA x $\frac{1}{2}$" screws with washers under heads as for main drive shaft. (Fig. 3). Ensure that oiling hole in bearing block is to the top.

Insert $\frac{1}{4}$" dia. x 2" long counter shaft and try for line-up and ease of rotation. If it is tight and you have access to a $\frac{1}{4}$" reamer, this can be used carefully through both the Oilite bearings until the shaft rotates freely but do not over do it.

FIG. 3



Put the steel pinion in position and slide the counter shaft through. Check the mesh of the gears. If this is not correct then the countershaft bearing can be loosened and adjusted, the above process being repeated.

(N.B. the gears are in correct mesh when there is a small amount of play between them. Small inaccuracies in the crown wheel could cause binding, so rotate it to make sure there is none).

Add dabs of Torqseal to the countershaft bearing fixing screws and re-tighten nuts, but again, it is important not to over-tighten.

The 25 tooth pulley goes on the other end of the counter shaft. Two flats must be filed on the counter shaft to provide seats for the grub screws in the pulley and pinion. (Don't tighten the grub screws until these flats have been made or you won't be able to remove the pulley and pinion).

To find the position of the flats mark the counter shaft with a pencil through the grub screw holes with the pulley and pinion in position on the mounting plate.

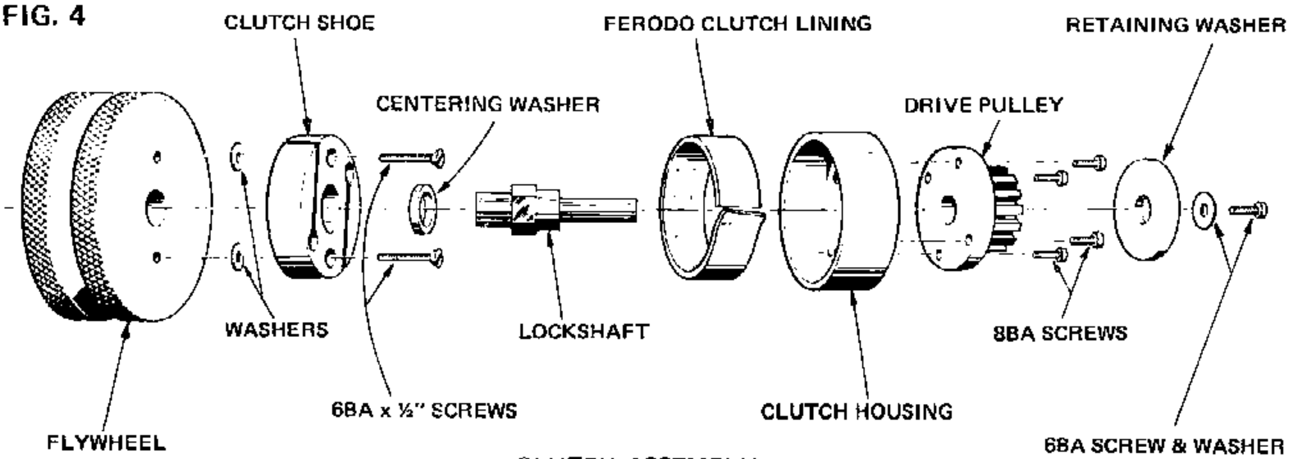
Hold the counter shaft in a vice when filing but use a soft material between the shaft and vice jaws to protect the bearing surfaces. Aluminium sheet angle brackets are ideal.

Slide the counter shaft through the bearings and through the pinion. Tighten the grub screw with the Allen key provided. Make sure it tightens onto the flat.

Fit the 25 tooth pulley on the other end of the counter shaft as for the steel pinion. The entire assembly should now rotate freely with gears meshing smoothly and virtually no side movement in bearings.

A good reliable engine, not one which has been worn out, is of paramount importance. Any modern engine of reputable manufacture from .19 to .25 c.i. is considered suitable.

FIG. 4



CLUTCH ASSEMBLY

If the engine hasn't been run in then do it now, with a propeller, to the manufacturers instructions. Next, carry out the following instructions for fitting clutch to engine. See FIG. 4.

Epoxy Ferodo clutch lining to inner circumference of clutch housing. Use the adhesive sparingly and trim off surplus liner.

Select correct lock nut/shaft to suit your engine shaft thread. Two are supplied, one is for 6 mm. threads such as Enya .19, the other for ¼" U.N.F. for Veco .19, O.S.20 or .25 and most other types of suitable capacity motors.

Remove lock nut supplied with engine, (this is not used but keep safe in case you wish to use engine for other purposes) place flywheel on shaft, holes facing outwards. Slip the centering washer on the lock shaft and then screw this unit to the shaft ensuring that the centering washer is against the flywheel - tighten with a box or ring spanner. It is a good idea to score the back of the flywheel where it fits against prop driver on engine, this reduces the chances of flywheel coming loose when starting engine. Fix one-part shoe to flywheel using spacer washers as shown FIG. 4. Fix 8 tooth pulley to clutch housing with the 4 x 8 BA x 3/16" screws supplied, first making sure that any small flash on rear face of pulley is trimmed off. Slide this unit on to shaft and over the clutch shoe.

Press nylon washer on to end of shaft and add 6 BA x ¼" retaining screw with steel washer under head, to end of shaft and tighten.

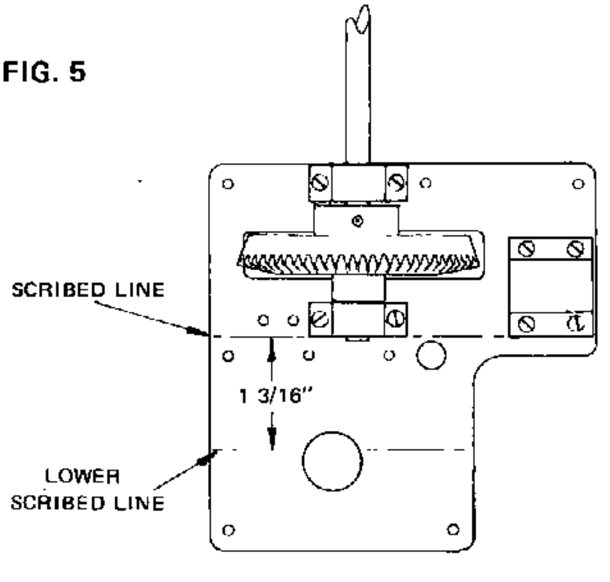
Since no two makes of engine are alike the mounting holes have to be drilled by the builder.
The following method is recommended.

With the aid of a straight edge and the tip of your modelling knife, scribe a line across the mounting plate, parallel with the bottom edge and in line with the side of the feet of the counter shaft bearing blocks. FIG. 5.

Scribe another line parallel with the first and 1 3/16" below it. FIG. 5.

It doesn't matter if the line doesn't cross the centre of the hole.

FIG. 5



Measure the distance X between the back of the teeth on the 8 tooth pulley on the clutch housing and the centre of one of the front engine mounting holes. FIG. 6.

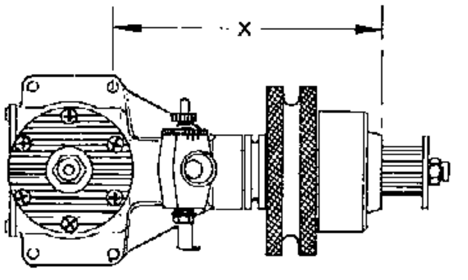
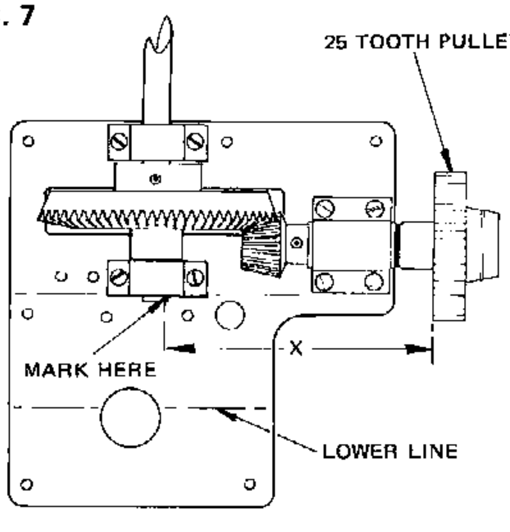


FIG. 6

Measure off the same distance X from the back of the teeth on the 25 tooth pulley along the upper scribed line on the mounting plate. Make a mark on the upper line. FIG. 7.

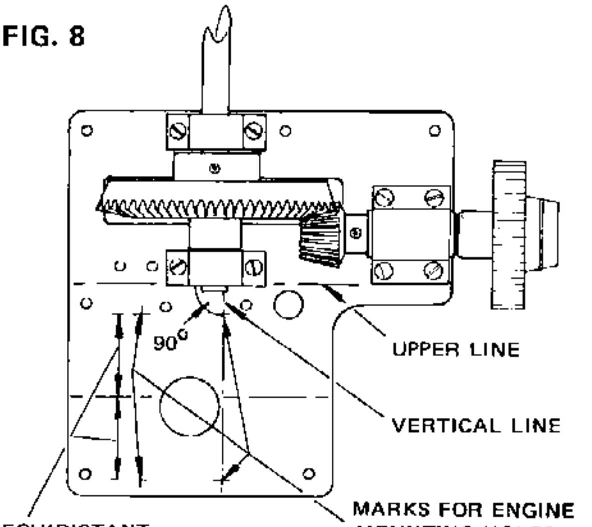
FIG. 7



Scribe a line at 90° to the mark to cross the lower scribed line. (Use a set square). FIG. 8.

The lower line is the centre line of the engine and the new line crossing it is the centre line of the front engine mounting holes (i.e. front of the engine not front of the model).

FIG. 8



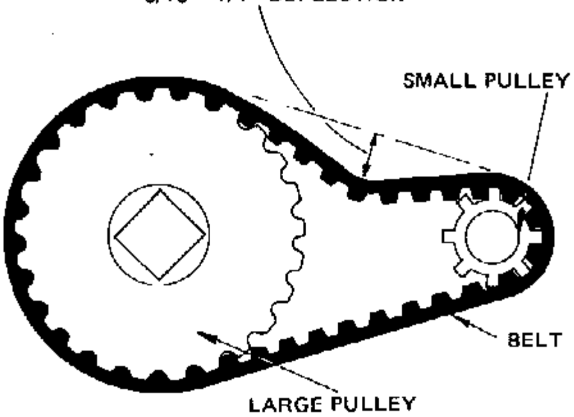
Measure the distances between the engine mounting holes and make four marks on the mounting plate to coincide with these using the scribed lines as a reference. You should have two marks equidistant from the lower scribed line on either side of it. FIG. 8.

Drill four holes at these marks using a 1/16" drill as a starter and a 7/64" drill to finish.

Mount the engine using the aluminium alloy pillars ¼" x 3/8" x 5/8" and 6 BA bolts. (The silencer should be removed from the engine for this). Don't use washers. Slightly tighten the nuts.

Fit the rubber toothed belt over the pulleys.

FIG. 9



The belt should have a slackness of 3/16" to ¼". FIG. 9.

If all is correct, loosen off the nuts holding the engine. Put a dab of Torqseal on the mounting holes and bolt threads and tighten the nuts at the same time checking the belt for correct tension. This all requires a little patience. (If the correct belt tension can't be achieved then the engine mounting holes will have to be relieved with a small file in the direction required. The Torqseal will fill the oversize holes).

4 off .003" shim spacer washers are supplied. Should a minor re-alignment of the 8 tooth and 25 tooth pulleys be necessary, these can be used as required between the layshaft bearing and 25 tooth pulley. See Fig. 10.

Fit the engine silencer with the efflux facing to the rear of the model (i.e. the opposite way it fits on the engine to usual).

Using 6 BA bolts as a guide offer the completed drive unit to the fuselage. Make indentations in the 3/8" ply main bearer with the ends of the bolts which attach the upper rotor shaft bearing and the lower engine mounting pillars.

Remove the drive unit.

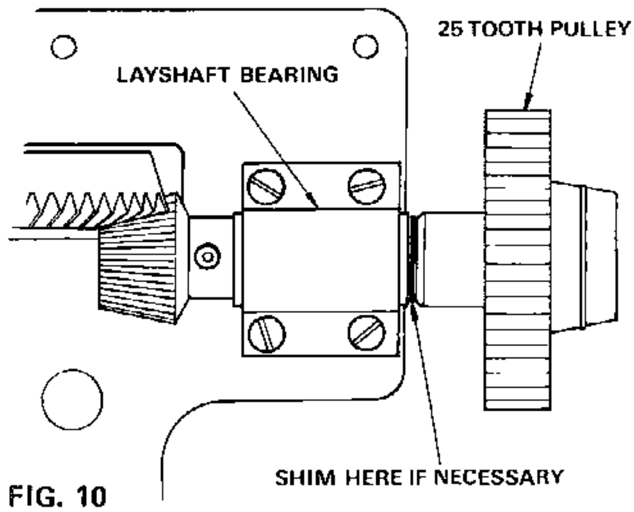


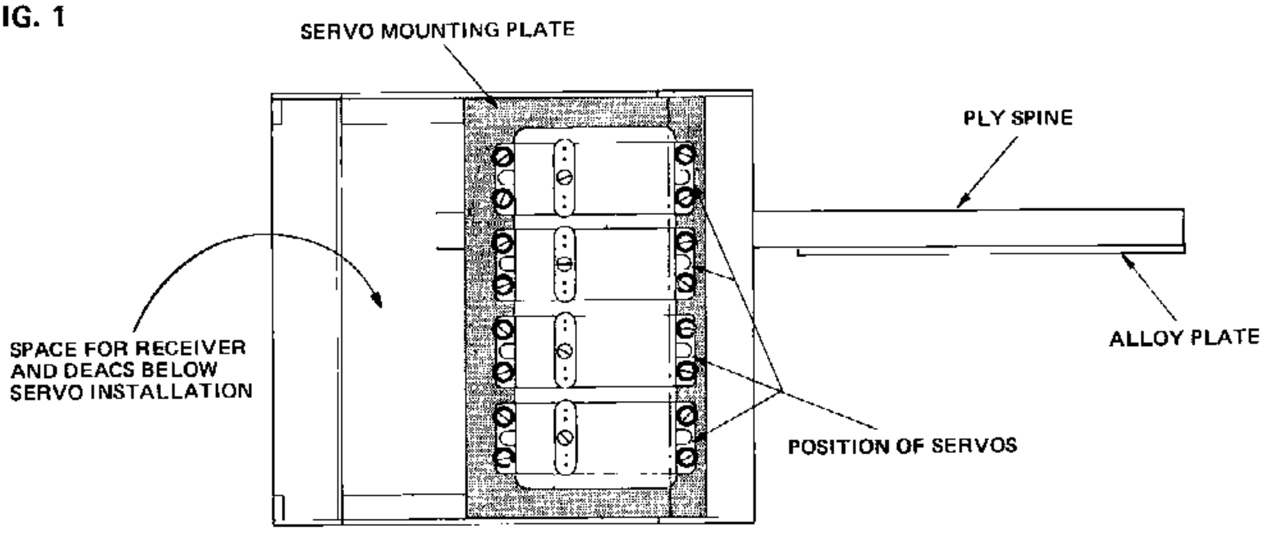
FIG. 10

With a 7/64" drill make holes in the ply just deep enough to clear the ends of the bolts. Use a ¼" drill to clear the nuts. Check the drive unit for fit and temporarily bolt into place.

Only four bolts are required. The two holes at the top rear of the drive unit also serve to mount the tail boom and extra long bolts are provided for this. Don't mount the boom yet.

Make sure no oil gets on the woodwork from the engine.

FIG. 1



Temporarily bolt the undercarriage in place.

The radio, naturally, fits in the fuselage. All modern radios should suit the model. A four channel digital system is essential. Either mini or standard servos will fit across the fuselage side by side.

A suggested layout is shown Fig. 1. The fuselage is seen from the top.

The servos are fitted to a $\frac{1}{4}$" (6 mm.) ply plate, which is made to fit across the fuselage and cut out to suit servos. A side view is shown in Fig. 2.

The purpose and position of each servo is shown in Fig. 3.

With the foregoing considerations in mind install the radio.

FIG. 2

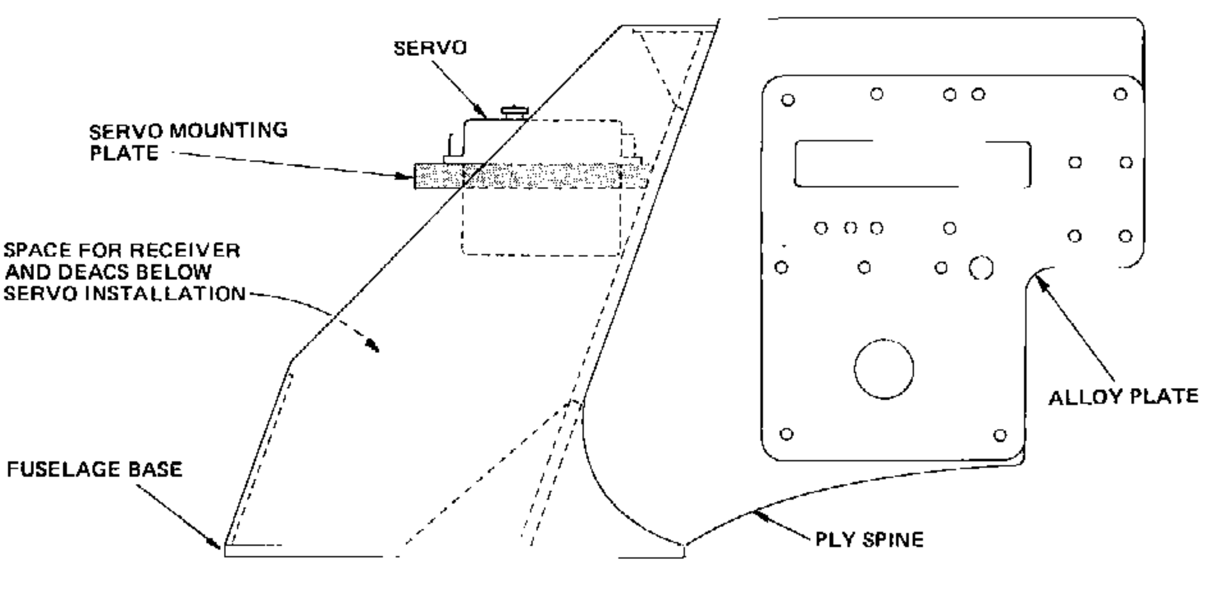
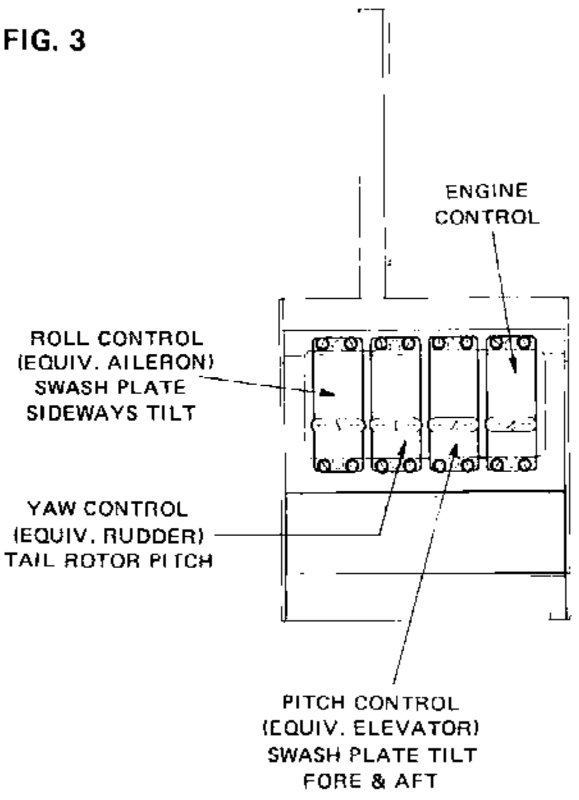


FIG. 3



Linkage accessories for this purpose are included viz:- Wire push rods with nylon ball and sockets for servo end. Cut threaded rods to required length, screw on nylon link and bend $\frac{1}{4}$" right angle at crank and throttle arm end, and secure with small press-on nylon retainers supplied (or solder if preferred).

Connect the engine to its servo. A hole must be made in the ply fuselage rear as shown and T & L pivots fitted to fuselage bulkhead. Install mini cranks and link up with wire rods. See Figs. 4 and 5.

Depending on the engine you have used the throttle linkage rod may foul one of the lower engine mounting pillars. If this is the case, crank the push rod to avoid contact.

Connect the pitch control in a similar manner to the bell crank on the port (left) side of the drive unit. Fig. 6.

Connect the roll control to the bell crank on the starboard (right) side of the drive unit. Fig. 7.

The tail rotor (yaw) control is fitted later.

Use the transmitter mode that you are accustomed to. DON'T change to a new mode or you will be totally lost when you learn to fly the model. DON'T listen to other people's opinions on this unless they are experienced model helicopter pilots.

The two controls to the swash plate (we will build it shortly) are the equivalent, more or less, of elevator and aileron control. The tail rotor is the equivalent of rudder control.

FIG. 4

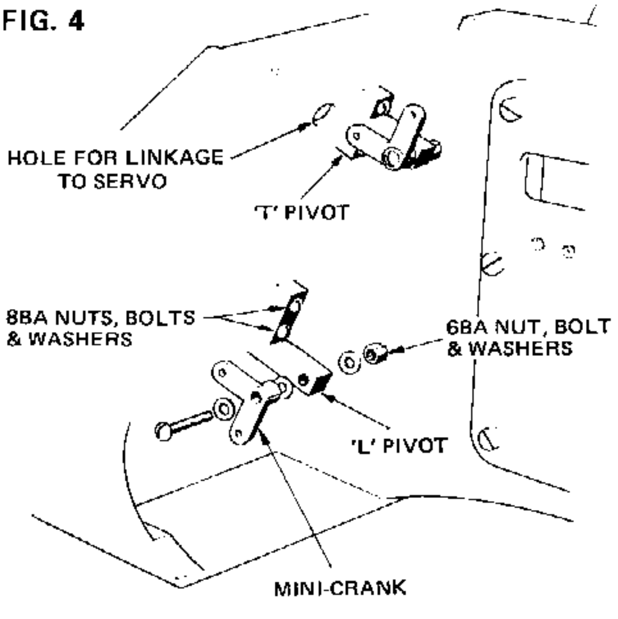


FIG. 5

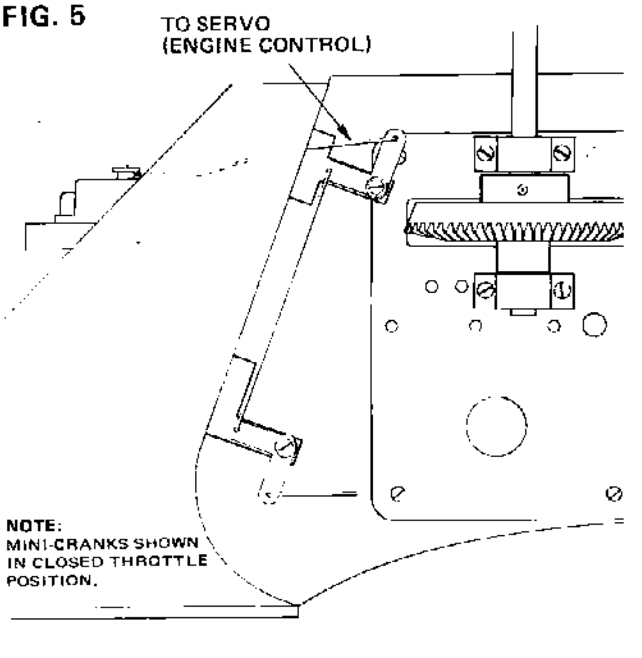


FIG. 6

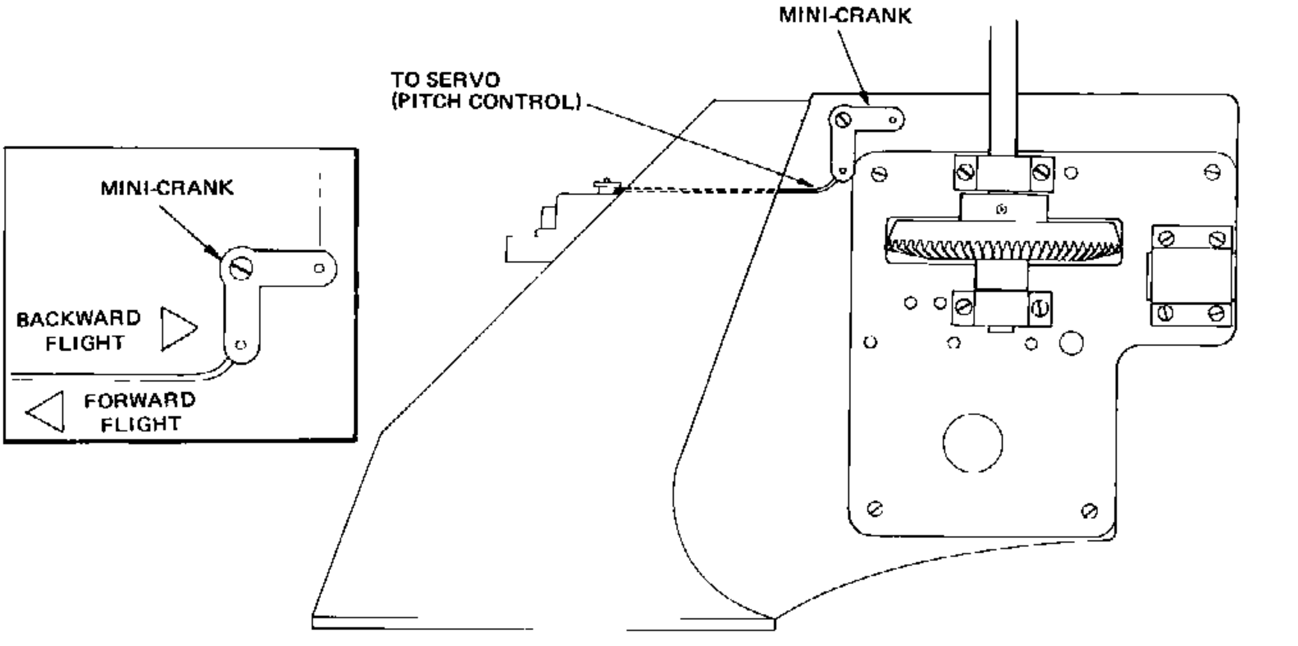
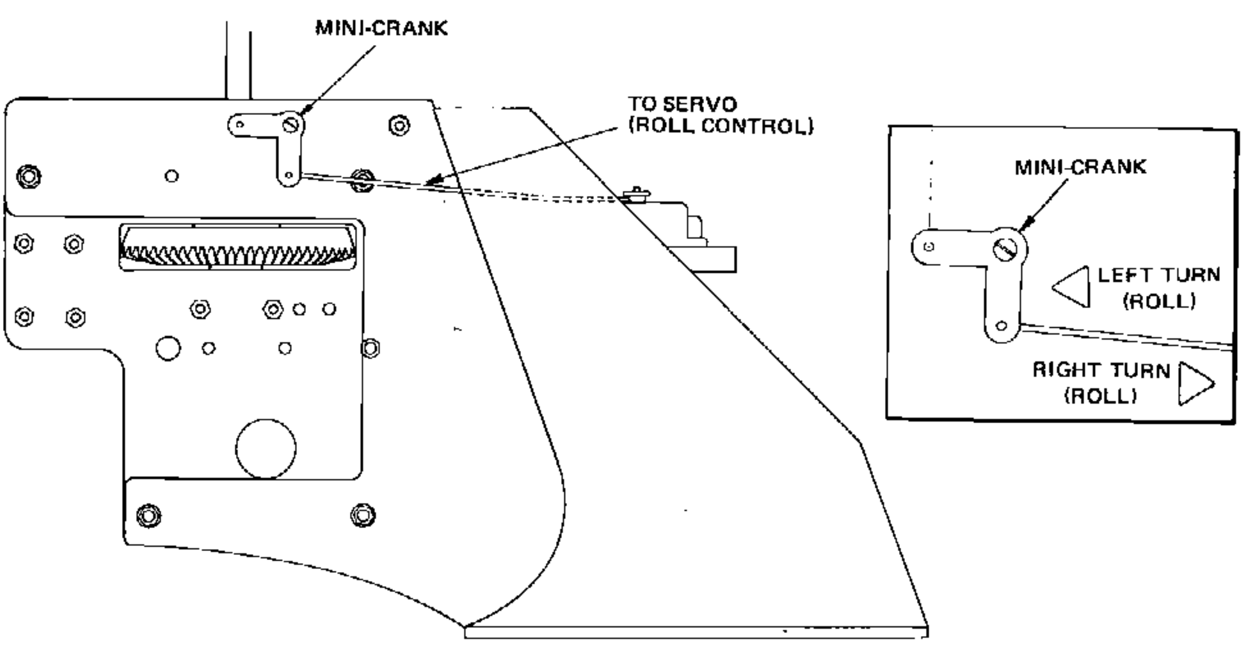
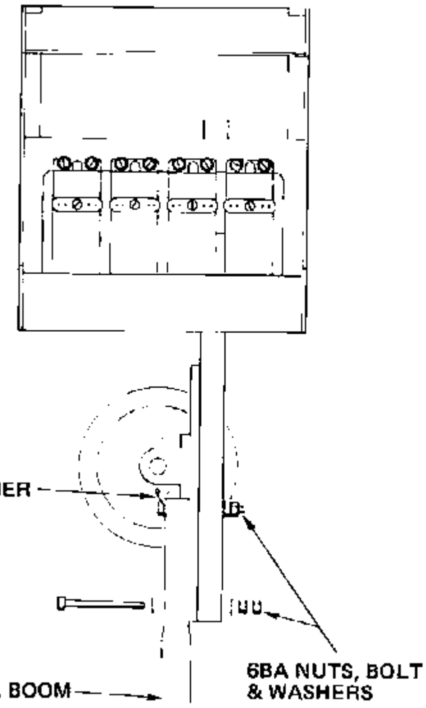


FIG. 7



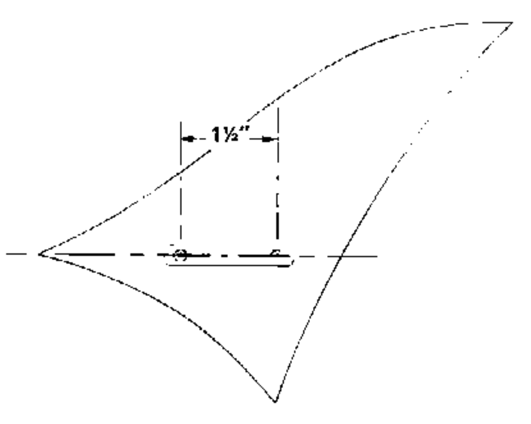
Note:
The pitch control mini-crank should be mounted on the long stand-off spacer in order that the linkage clears the engine mounting plate. The short stand-off spacer is used to mount the roll control mini-crank on the starboard (right hand) side.

FIG. 1



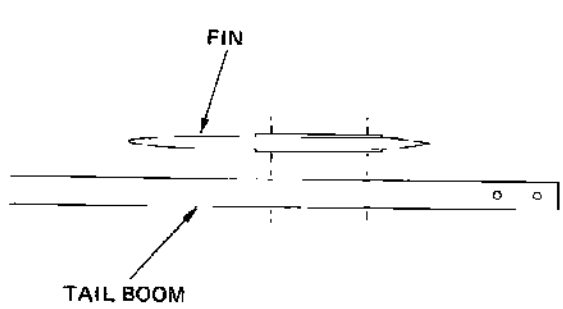
As previously mentioned, the tail boom is bolted to the drive unit and plywood mounting plate. Temporarily fit the boom in position with socket type hardened 6 BA bolts and nuts supplied. Fig. 1.

FIG. 2



You have already built the fin. Drill two holes with a 3/32" drill 1½ inches apart through the plywood reinforcements of the fin. Fig. 2. These holes should match up with the predrilled holes in the boom.

FIG. 3



Temporarily bolt the fin in place with 6 BA bolts and nuts on the starboard (right) side of the boom. The larger side of the fin is upwards.

The tail skid is pre-bent from 12g wire as shown in Fig. 1 and fits to skid bush with lock screw, bush then fits into end of boom and is held by rear gear cage fixing bolt.

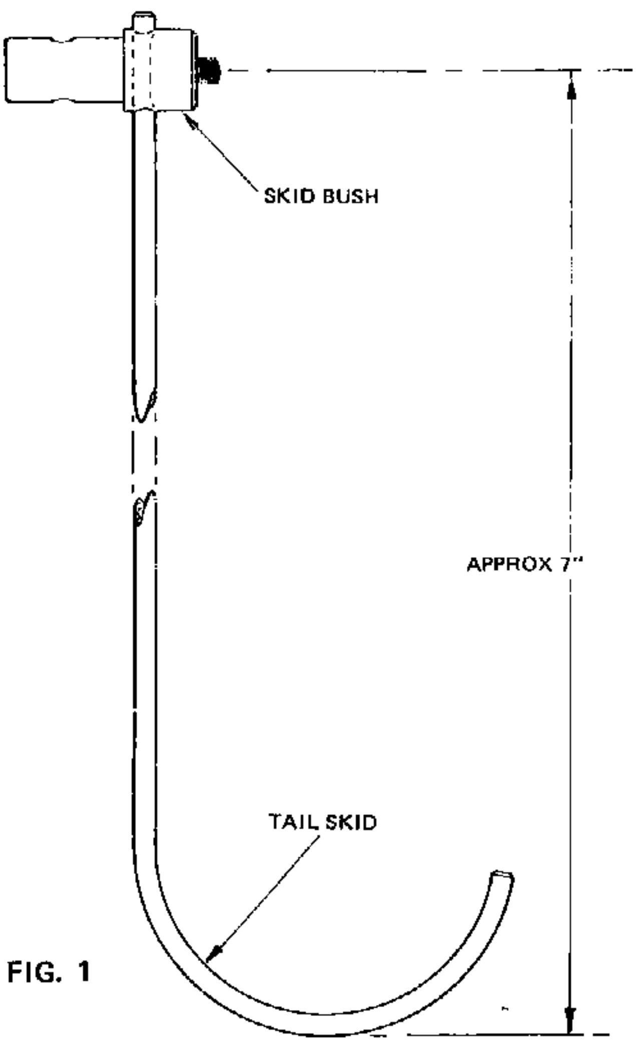


FIG. 1

The tail rotor assembly contains two shafts 3" long and 1 1/8" long. FIG. 2.

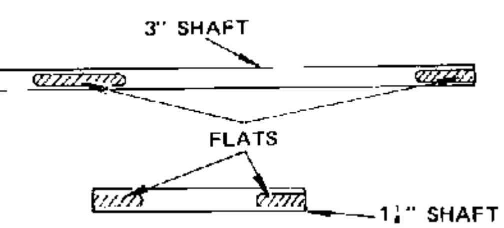


FIG. 2

Install the small shaft in the gear cage as in Fig. 3. Screw a brass mitre gear on the inside and the universal drive shaft rear coupling on the outside with grub screws. Insert a washer in the position shown. Make sure the grub screws are tightened on the flats and the shaft rotates freely.

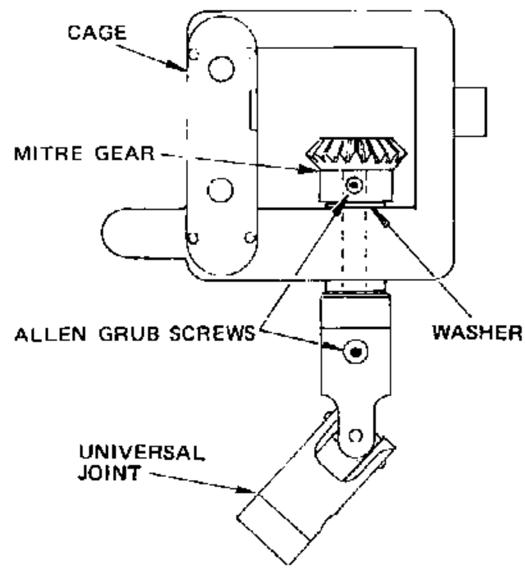


FIG. 3

Install the large shaft in the gear cage as in Fig. 4. Fit the other brass mitre gear on the inside, and the aluminium alloy collar on the outside. Make sure the end of the large shaft has the flat on it as shown in Fig.4. The mitre gear screws on to the inner flat. There is a second bearing hole for the long shaft - ensure that it fits into this. Make sure the drive is perfectly free but with no end play.

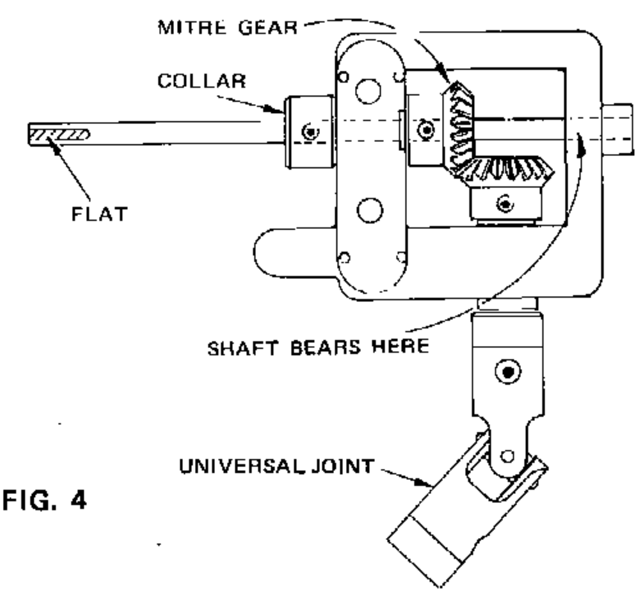


FIG. 4

The tail rotor pitch crank is the next item to fit. This goes on a spigot, which is part of the gear cage moulding. Secure the crank with a washer and self-tapping screw.

Fit the tail rotor spring after final assembly of tail unit to boom by hooking one end over tail skid wire and the other into hole in back edge of pitch crank FIG. 5.

The reason for the spring is to take up any play in the tail rotor control linkages. Make sure the crank is perfectly free.

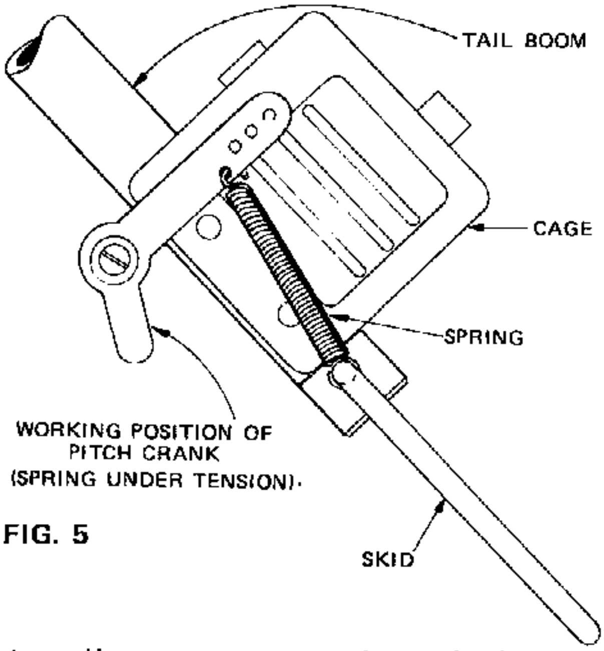
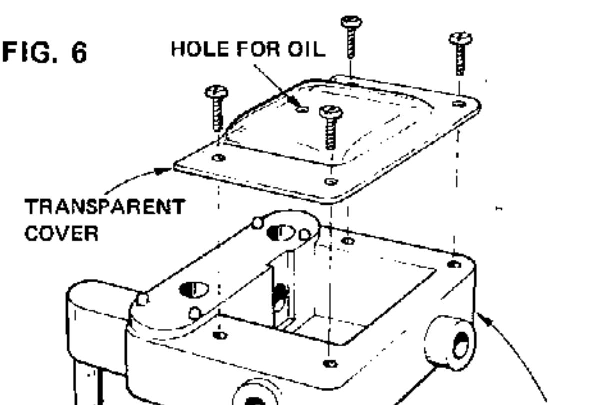


FIG. 5

A small transparent cover is supplied to retain oil in gear cage, drill cover and gear cage moulding and fix in place with small self-tapping screws supplied, Fig. 6. Also drill small hole for replenishing with machine oil.

FIG. 6



Fit the tail rotor blade holders to the tail rotor head as shown in Fig.7, using the brass blade

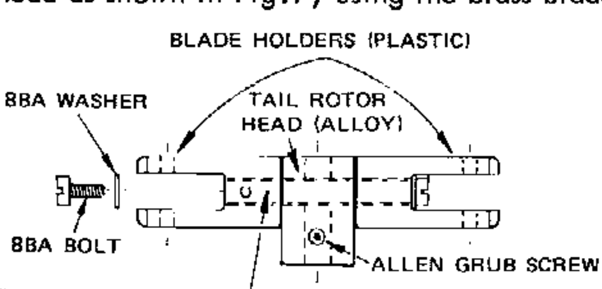


FIG. 7

connecting shaft and 8BA bolts and washers. Use Torqseal to secure the bolts - a little only so it doesn't jam up the mechanism.

Each blade holder has a 10BA piece of studding moulded into it. This is to take the ball of a ball and socket joint.

Screw a 10BA nut on to the studding to act as a spacer.

Cut the ball from the sprue and slide it over the studding.

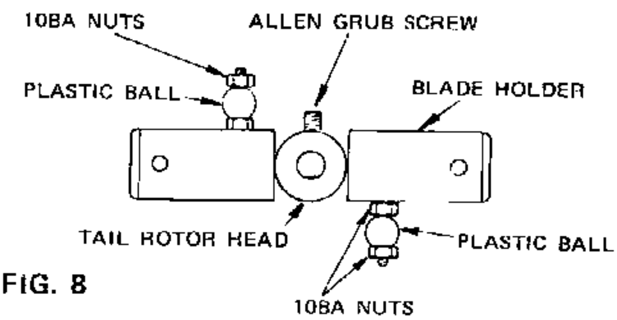


FIG. 8

Secure the ball with another 10BA nut, using Torqseal to hold the nut in place. Fig.8. Repeat for the second blade holder.

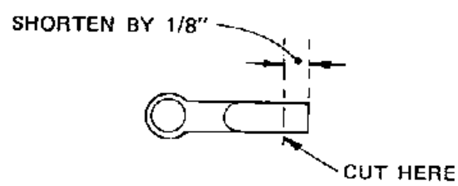


FIG. 9

Cut 1/8" exactly from the ends of the sockets of the ball and socket joints (2 off). Fig.9.

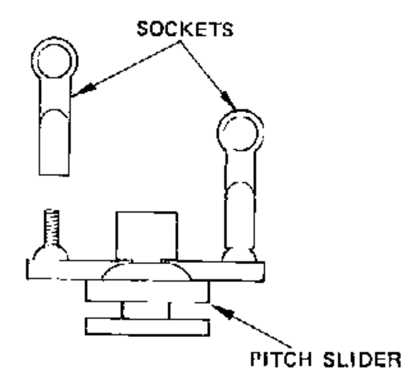


FIG. 10

Screw the shortened sockets on to the 8BA studs, which are moulded into the tail rotor pitch slider. Fig.10. Angle the sockets as shown in Fig.11.

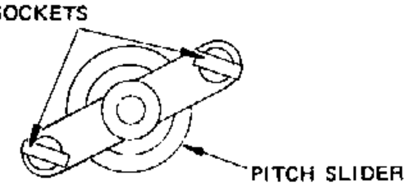


FIG. 11

Slide the pitch slider on to the tail rotor shaft with the sockets facing away from the tail rotor bracket. Engage the steel pin of the bellcrank in the slot of the pitch slider. Push the tail rotor head as far as it will go on to the end of the tail rotor shaft and tighten the grub screw on to the flat.

The plastic balls fitted to the tail rotor blade holders are on the same side of the holders as the leading edge of the tail rotor blades. The tail rotor rotates in a clockwise direction when viewed from the left side of the model. (The tail rotor is on the right side and its bracket will be fitted underneath the boom.) Fig.12.

Connect the ball and socket joints.

With a set of dividers and a ruler, adjust the distance between the tail rotor head and collar until it is 7/8". The grub screws in the mitre gear and collar must be slackened for this. N.B. Don't move the rotor head position on the shaft. Fig.13.

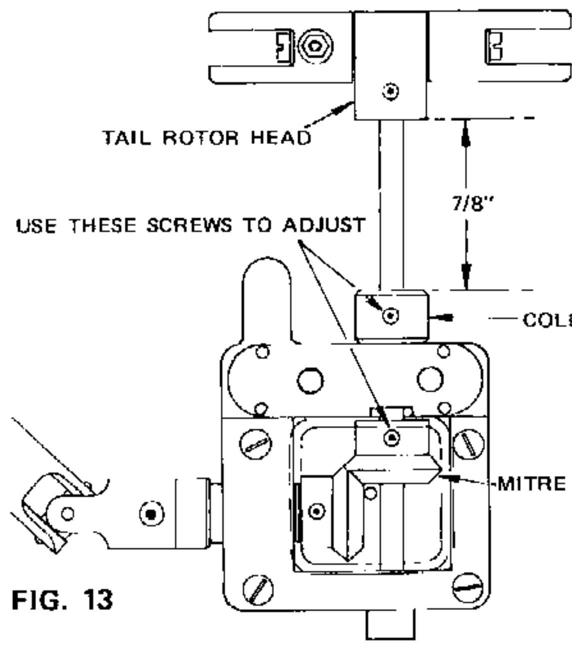
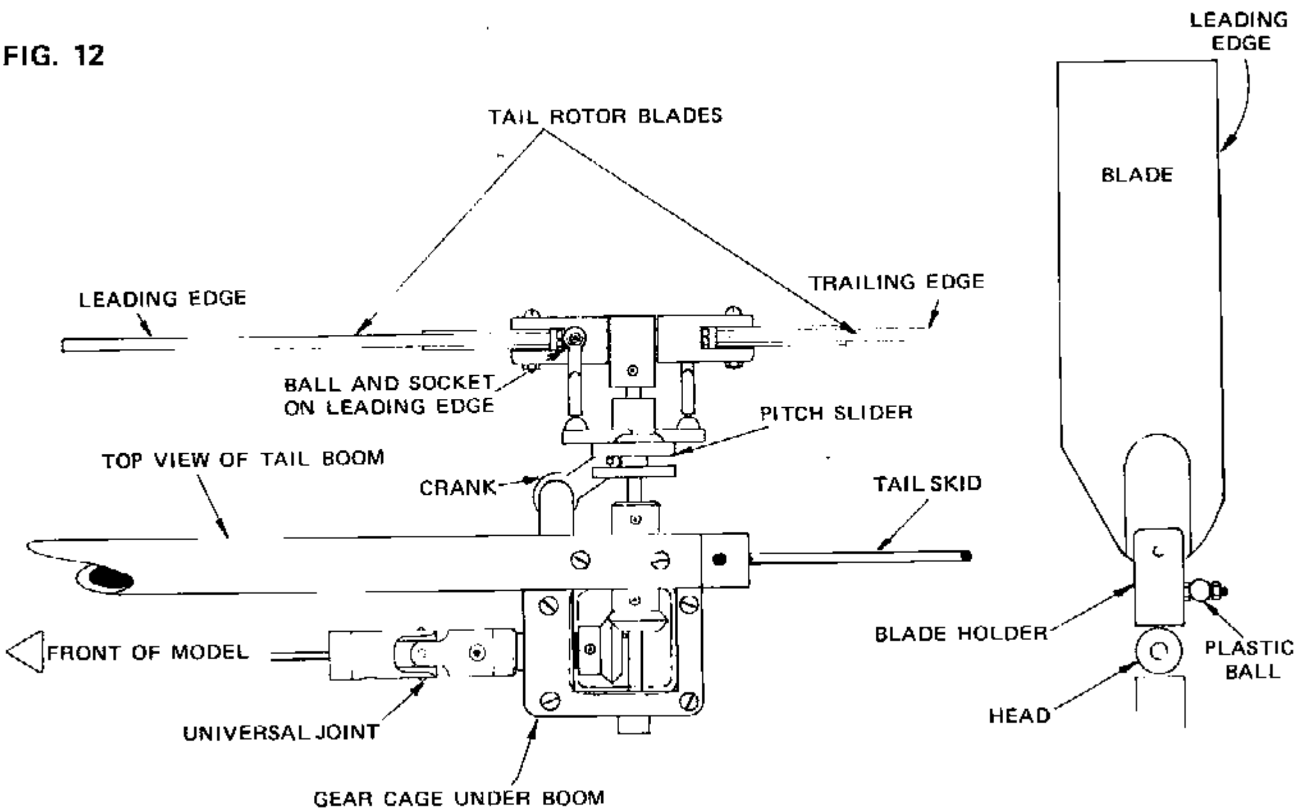


FIG. 13

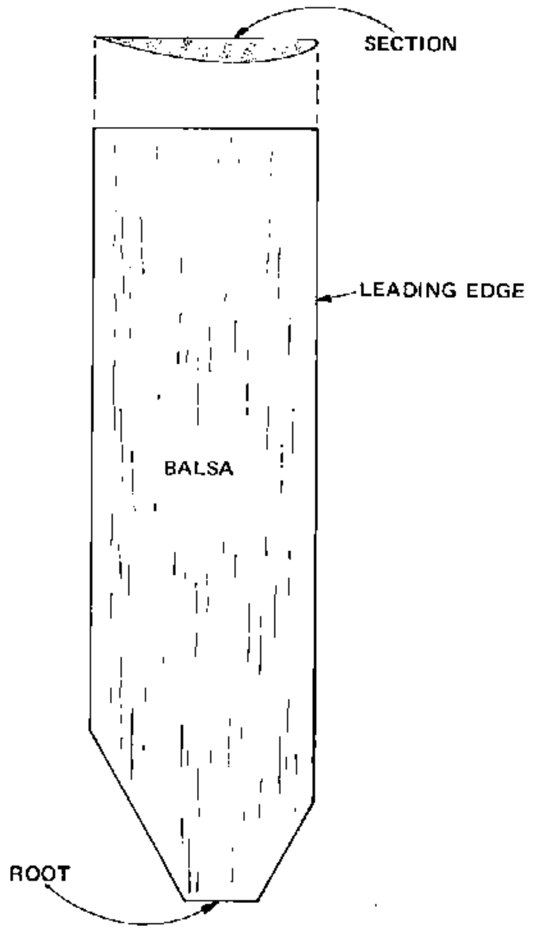
Fit the tail rotor assembly to the underside of the boom, at the same time locking the skid in position with the rear assembly fixing bolt.

FIG. 12



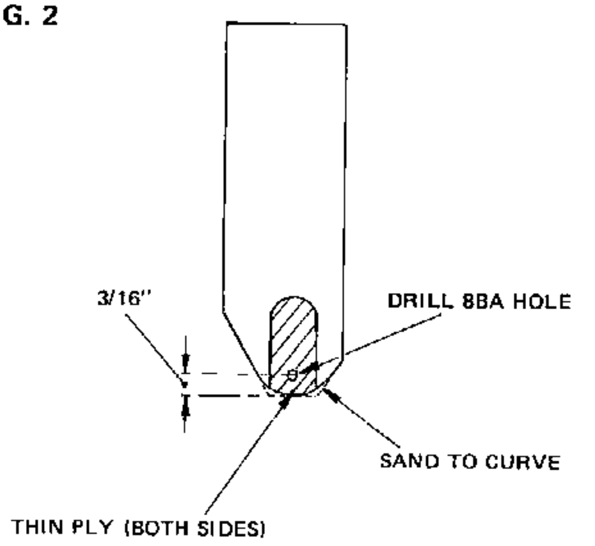
The blades are supplied cut to outline in balsa wood and should be sanded to airfoil section as Fig. 1.

FIG. 1



The leading edge of both blades should be to your right. Sand two identical blades.

FIG. 2



Glue the thin ply reinforcing pieces to the roots of the blades, one at either side. Fig.2.

When the glue is dry sand the roots to a curve.

Drill a hole in each root, to clear an 8BA bolt, 3/16" from the end. Fig.2.

Check the blades for fit in the blade holders of the tail rotor assembly. (To allow for painting or covering with Micro-Cover the fit should be quite free).

Note: Tail Rotor Assembly should measure 8¾" diameter minimum when completed but this can be increased to 9 1/8" should it be found that more directional control is required by adding 1/8" x 3/16" hardwood strip to each tip.

FIG. 1

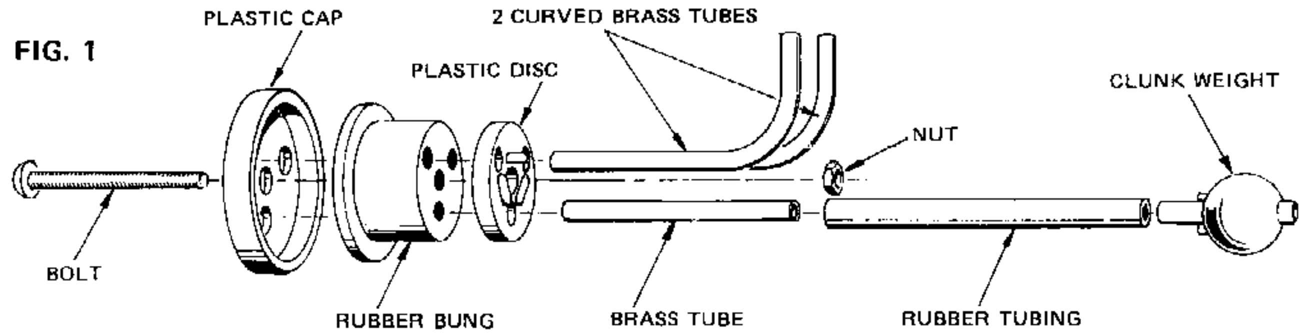
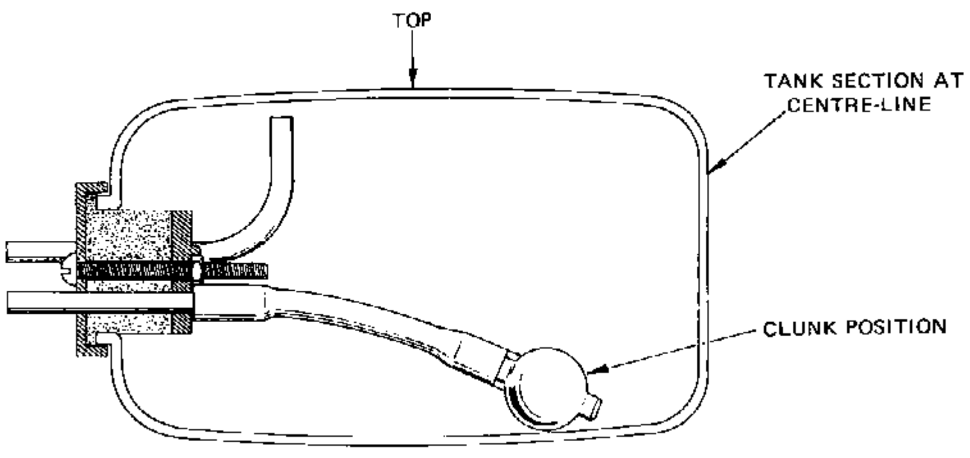


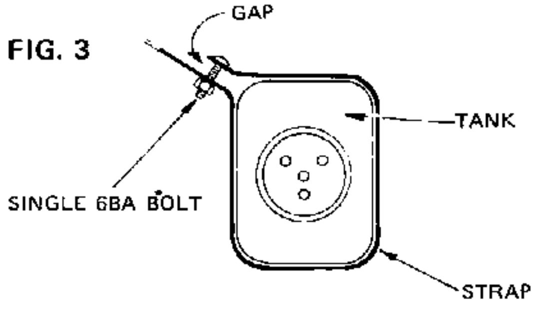
FIG. 2



Assemble the tank as shown in the diagrams Figs. 1 and 2.

The clunk weight should rest on the bottom of the tank in the position shown in Fig.2.

FIG. 3



The tank is attached to the engine plate with a strap made from the $1\frac{1}{4}$" wide aluminium supplied.

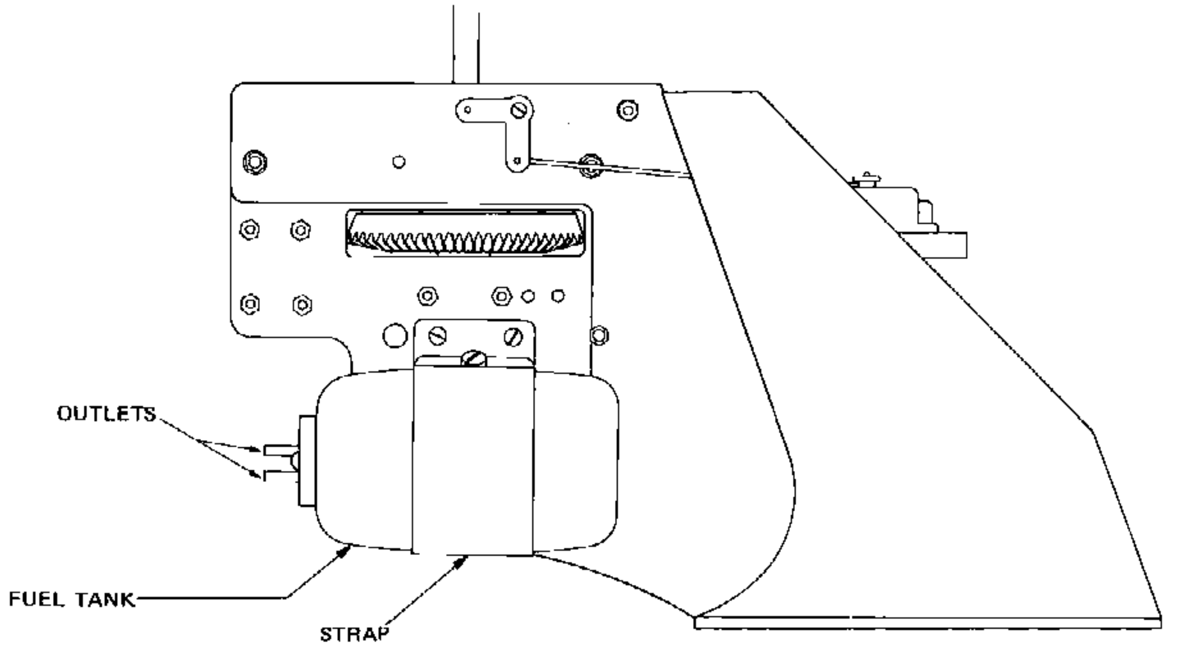
Fold the strap round the tank carefully as shown in Fig.3.

Drill two holes to take a single 6BA bolt, as shown, in the centre of the strap. Leave a gap of about $\frac{1}{4}$" so that the strap bites into the tank when the bolt is tightened. The two remaining holes in the engine plate are used for fixing the tank strap.

The free end of the strap should be trimmed to length and bent so that when bolted in position it locates the fuel tank to the starboard side of the model. Fig.4.

Drill two 6BA holes in the end of the strap to coincide with the holes in the engine plate.

FIG.4



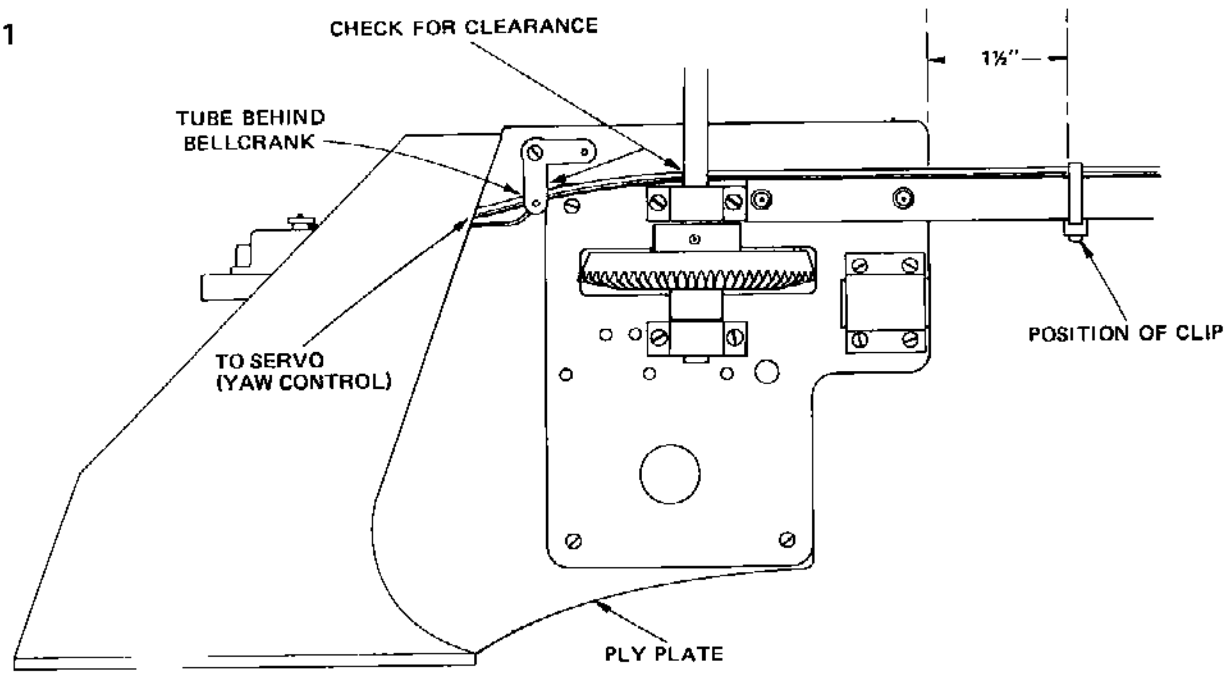
Temporarily bolt the tank in position on the engine plate, using 6BA bolts. The tank outlets face the tail of the model. Fig. 4. Connect the tank to the engine using silicone fuel tubing. The hole in the engine plate near the tank strap acts as a guide for the fuel line.

N.B. IT IS ESSENTIAL TO FIT A FUEL FILTER IN THE FUEL LINE TO THE ENGINE. (Supplied in kit)

Fit the filter on the tank side of the engine mounting plate. Make sure the fuel pipe to the engine goes to the tank outlet attached to the clunk weight.

One of the breather pipes should be plugged using a scrap of silicone tubing and a small dowel. This prevents spillage during flight. Remove when fuelling. Pressurizing the tank is not advised.

FIG. 1



The tail rotor pitch is controlled by a piece of 22G piano wire inside a nylon tube. The route of the nylon tube must be checked out at this stage in the construction, but the tube must not be fitted yet.

As can be seen in Fig. 1 the tube is clipped to the tail boom with a nylon strap (do not fit yet) then passes behind main drive shaft and through fuselage rear ply plate.

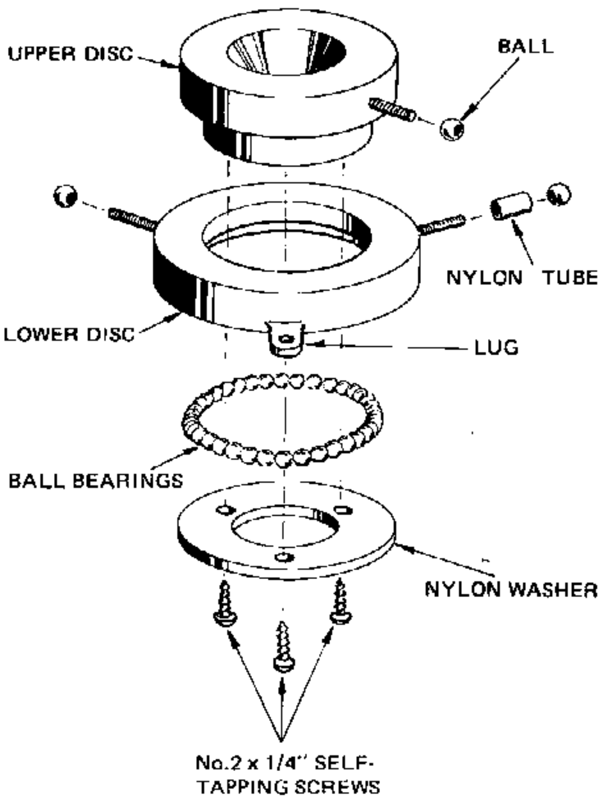
Make a hole in the fuselage rear to take the tube, which should be a tight fit in the hole. The hole should also be against the ply plate and in approximately the same line as the roll control rod. Lay the tube to one side until final assembly.

A description of the swash plate and its function was given in the theory at the beginning of the instructions.
Basically there are three plastic parts:-

1) The upper disc (identified by the single 8BA threaded rod moulded into the side)
2) The lower disc (identified by the two 8BA threaded rods moulded into the side and at 90° to each other.)
3) A large nylon washer.

Remove any flashing from the nylon with the aid of a sharp knife.

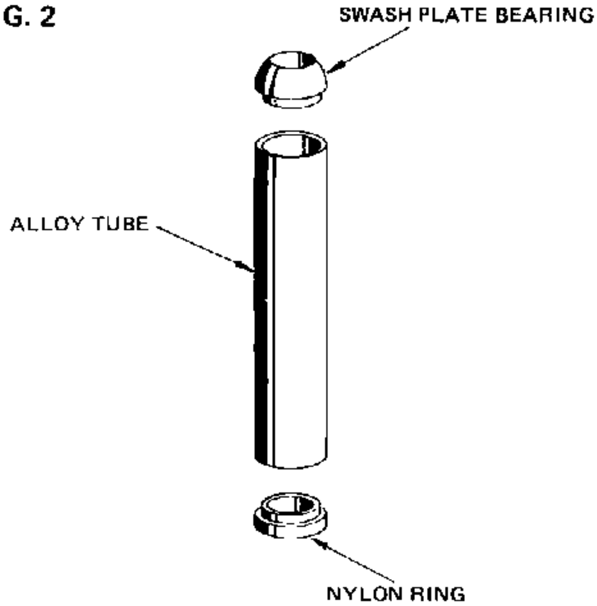
FIG. 1



Assemble the swash plate, using three self-tapping screws. Fig. 1. To facilitate fitting of ball bearings assemble parts up-side down on a flat surface.

N.B. The upper disc must rotate perfectly freely inside the lower disc.
If the fit is sloppy it doesn't matter. The swash plate retaining spring removes all slop from the system.

FIG. 2



The swash plate is connected with ball and socket joints.

Cut a small piece off the end of the tail rotor control nylon tube 13/32" long, and slip it over the 8BA studding on the lower disc. Fig. 1.

Screw three plastic balls on to the 8BA studding while they are still on the sprue.
If the balls snap off prematurely they can be coaxed into place using the plain part of the jaws of a long nosed pair of pliers.

The swash plate is positioned on the rotor shaft by an aluminium tube which is fitted with the swash plate bearing at one end, and a nylon ring at the other end. Fig. 2.

Fit the bearing and ring to the aluminium tube.

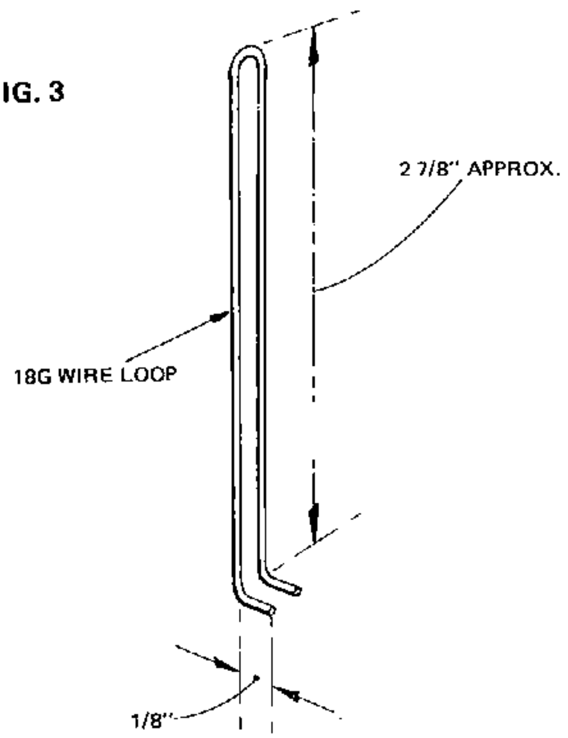
Slide the assembly over the rotor shaft until the nylon ring meets the upper rotor shaft bearing block.

Lower the swash plate, larger disc first, over the rotor shaft until it sits on its bearing.

A steady is required to stop the lower disc of the swash plate rotating. This is in the form of an 18G wire loop epoxied to the plywood engine plate and held with a wooden block.

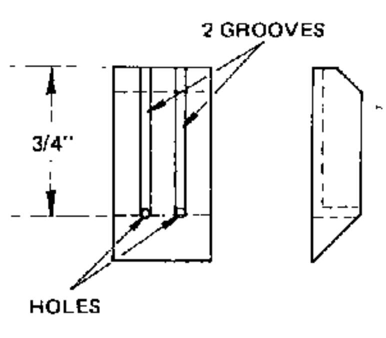
Bend the ends of the 18G wire loop at an angle of 90° and about 1/8" long. Fig. 3.

FIG. 3



Cut two grooves and drill two holes in the small wooden block supplied. Fig. 4. Trim to shape. The distance between the grooves should be the same as the distance between the 18G wire legs.

FIG. 4



Use plenty of epoxy glue to fix the wire steady in place. Fig. 5. Complete with wood block.

N.B. The front arm should be parallel with the ply plate and facing forward when the nylon tube is resting against the rear leg of the wire loop.

The wire loop should be vertical. Check by eye, using the rotor shaft as a guide. Fig. 6.

Hook the swash plate retaining spring through the lug in the swash plate lower

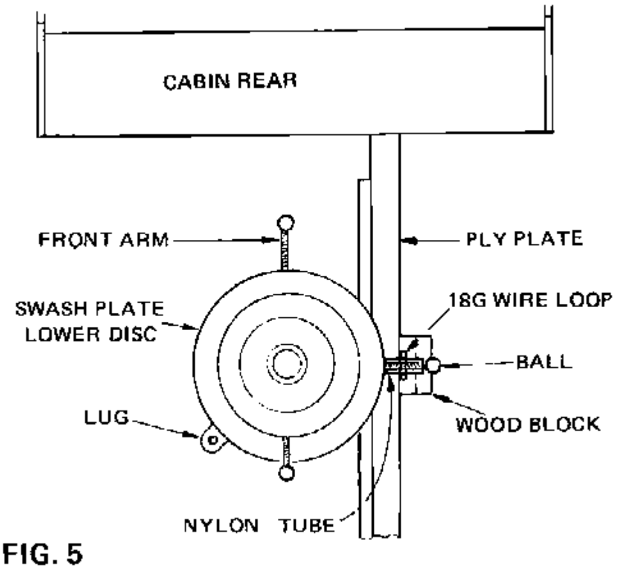


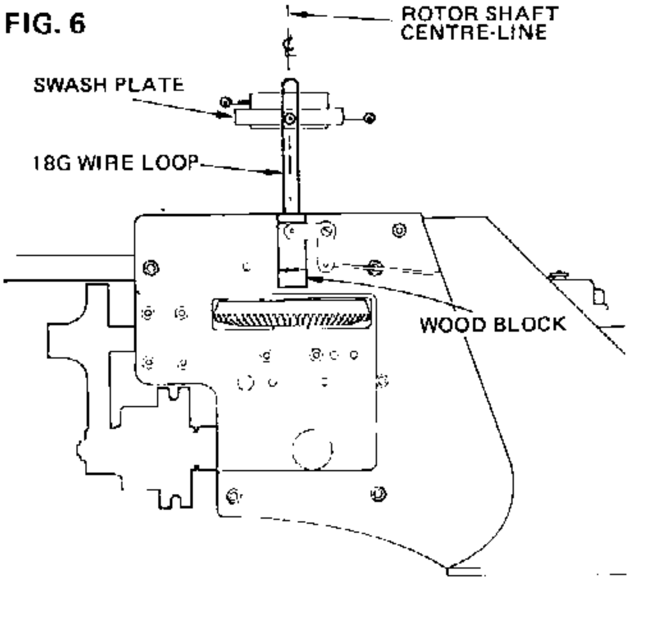
FIG. 5

disc. The other end of the spring is held by the eyelet with small hole which is fitted under forward boom fixing bolt.

Connect the swash plate lower disc arms to the bellcranks, using the bearing sockets and threaded rods. Screw on socket and cut rods to required length, bend a right angle at end, insert in crank hole and push on small nylon retainer (or add a dab of solder if preferred).

The swash plate should be as square as possible to the rotor shaft. This can easily be done by eye, against a plain background to avoid optical illusions. This will be rechecked later in the construction.

FIG. 6



The rotor head pivots on and is attached to the shaft by the rotor shaft tube, which is suitably drilled and machined.

The Rotor head pivot shaft is a 1⅛" length of steel rod, with a groove turned at each end.

Assemble side plates with radius edges outwards to main plate fitting block with phosphor bronze bushes at the same time check assembly for free movement and adjust by tweaking plates outward if necessary.

Remove screws and fit one rubber stop in each of four holes in block then reassemble using Torqseal on screws and oiling pivot points and internal phosphor bronze bearing. Fig. 1.

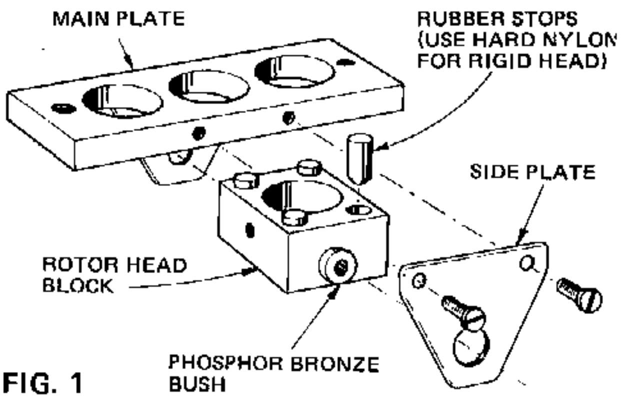


FIG. 1

Hard nylon stops can be substituted to convert to rigid non-teeter head.

The rigid head is recommended for beginners.

Slide the pivot shaft through the rotor head at one end, through the small hole in the rotor head pivot tube, and out the other side of the head. Fig. 2.

With the aid of the Allen key a ¼" grub screw is fitted up the centre of the pivot tube to hold the pivot shaft in position. Make sure the pivot tube is central, and tighten the grub screw. Fig. 2.
Use Torqseal on this screw.

It is most important that the pivot shaft should not come adrift and a Star-lock washer is supplied to press on either end dished faces outwards. Fit one to groove at one end of shaft before inserting through head and tap second one into place after assembly.

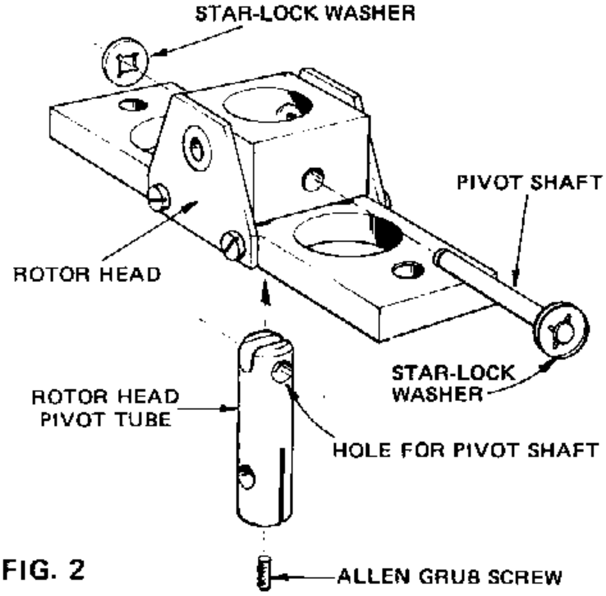


FIG. 2

The pitch crank is an L shaped plastic moulding. Fig. 3.

Attach a ball, from a ball and socket connector, with a 10 BA nut and bolt as shown in Fig. 3. Secure the nut with Torqseal and cut off any surplus length of screw.

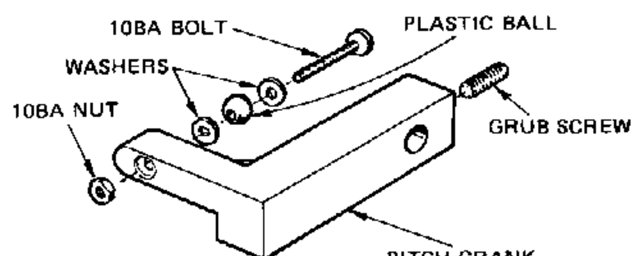


FIG. 3

The flybar (10G wire 14" long) is passed through the rotor head at right angles to the pivot shaft. An aluminium collar and the pitch crank hold the flybar in position. Slide these in place. Fig. 4.

The arm on the pitch crank is at the top. Fig. 4.

Find the centre of the flybar and ensure that it is in the centre of the rotor head by measurement.

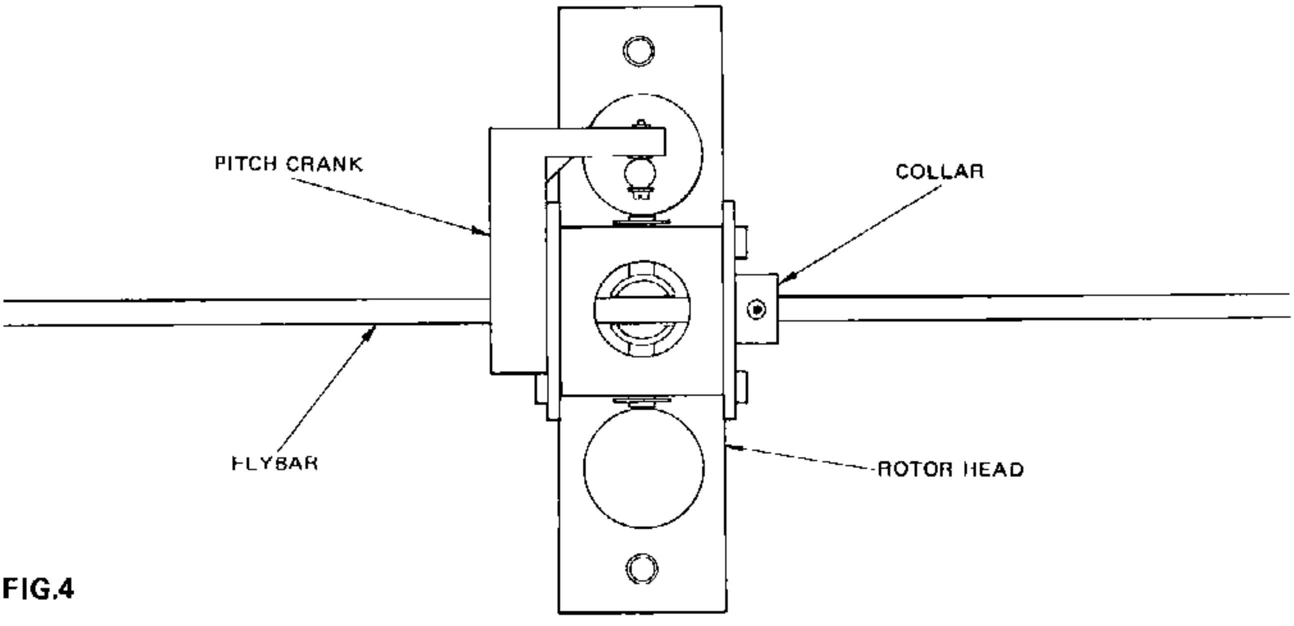


FIG.4

Tighten the aluminium collar temporarily.

Find the position on the flybar that coincides with the grub screw in the pitch crank, and file a flat on the flybar at this point. Temporarily tighten the grub screw.

Fit the paddles (small aerofoils). Temporarily tighten the grub screws. The Rotor travels clockwise viewed from the top looking forward. The paddles should be set to do likewise.

Final adjustments will be made later.

The blades are constructed from a hardwood leading edge and a balsa trailing edge fixed together with P.V.A. white glue.

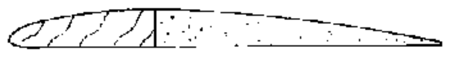


FIG. 1

Pin the trailing edge down to your building board and glue (with P.V.A.) the leading edge to it, curved side up. Use some old paper under the blade to prevent it sticking to the board.

Weigh the blades and sand the heavier one if necessary. Blade weight can also be adjusted at the painting or covering stage if preferred.

The rotor turns in a clockwise direction when viewed from the top, which means that the root of each blade is as shown in Fig.2. N.B. Make two identical blades, not a left and a right!

Glue the plywood strengthening pieces to each root top and bottom and cut the balsa part of each root as shown in Figs. 2. & 4.

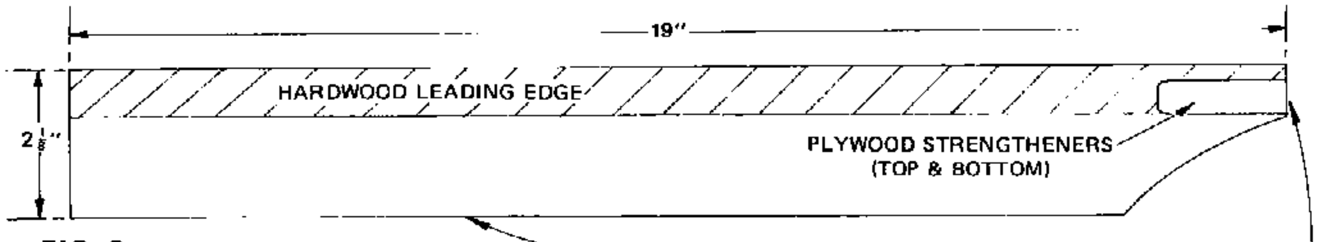


FIG. 2

Build the second blade in the same manner.

When the glue is dry remove both blades from the board and sand their undersides flat.

Ensure the blades are identical in size, 19" long and 2 1/8" wide. The dimensions are not critical so long as they are both the same.

Round off the leading edges.

Sand the balsa trailing edges until an aerofoil shape is achieved. Fig. 1. Again the shape is not critical, but the blades should match as closely as possible.

Drill three holes in the blade roots, as shown in Fig. 4, using 1/16" and 7/64" drills.

Use the steel blade holders for positioning and mark centres for drilling.

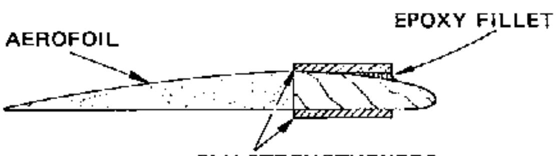


FIG. 3

Don't bolt the blade holders in position yet.

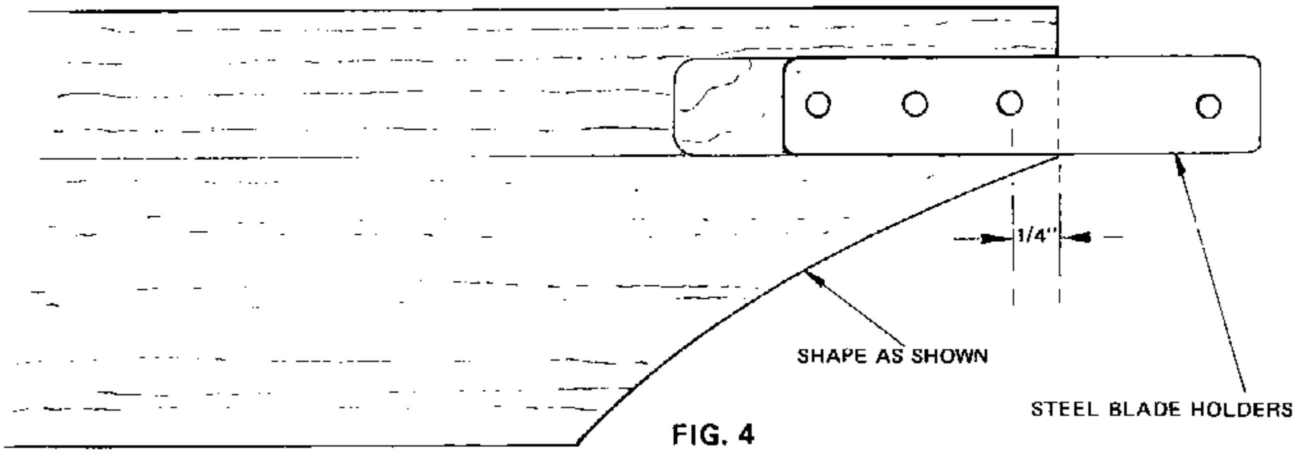


FIG. 4

Remove the tail boom.

Remove the tail rotor, fin and skid from the boom.

Remove the fuel tank.

Remove the radio.

Unsnap the ball link to the swash plate roll control arm so that it can be withdrawn from the wire steady.

Remove the engine plate and associated components by unscrewing the remaining 6BA bolts, four in all. Take care the connections to the servos are free to clear their holes in the fuselage.

Remove the undercarriage.

Finish, paint and decorate the following:
Fuselage Cabin and Base, Fin, Main Rotor Blades, Tail Rotor Blades.
Polish and decorate the Tail Boom and Undercarriage.

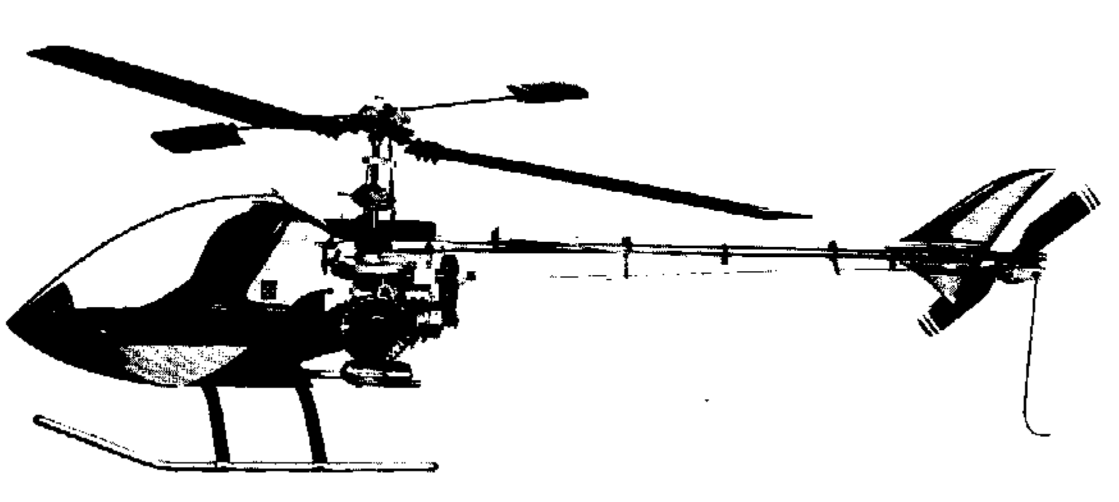
The transfer/trim sheet includes many items of decoration including colour flash and lettering for fuselage cabin and fin, plus signs and lettering for use at points as desired. Stripes for adding to main rotor and tail rotor blade tips etc. Use clear varnish to protect them from fuel.

The cabin unit is built and finished last. This unit is held in place with Velcro tape (supplied).

100% polyeurethane paint is advised for finishing, especially round the engine bay. The first coat over wood acts as a filler, and after sanding makes a good base for subsequent coats. White is suggested as a basic colour for maximum visibility.

Take care when applying the large transfers, and use clear polyeurethane to protect them.

MicroCover or similar covering materials may be used as an alternative to a painted finish on the rotor blades.



Decals are provided for a paint scheme similar to the one illustrated above. Colour areas are divided into sections to make application easier.

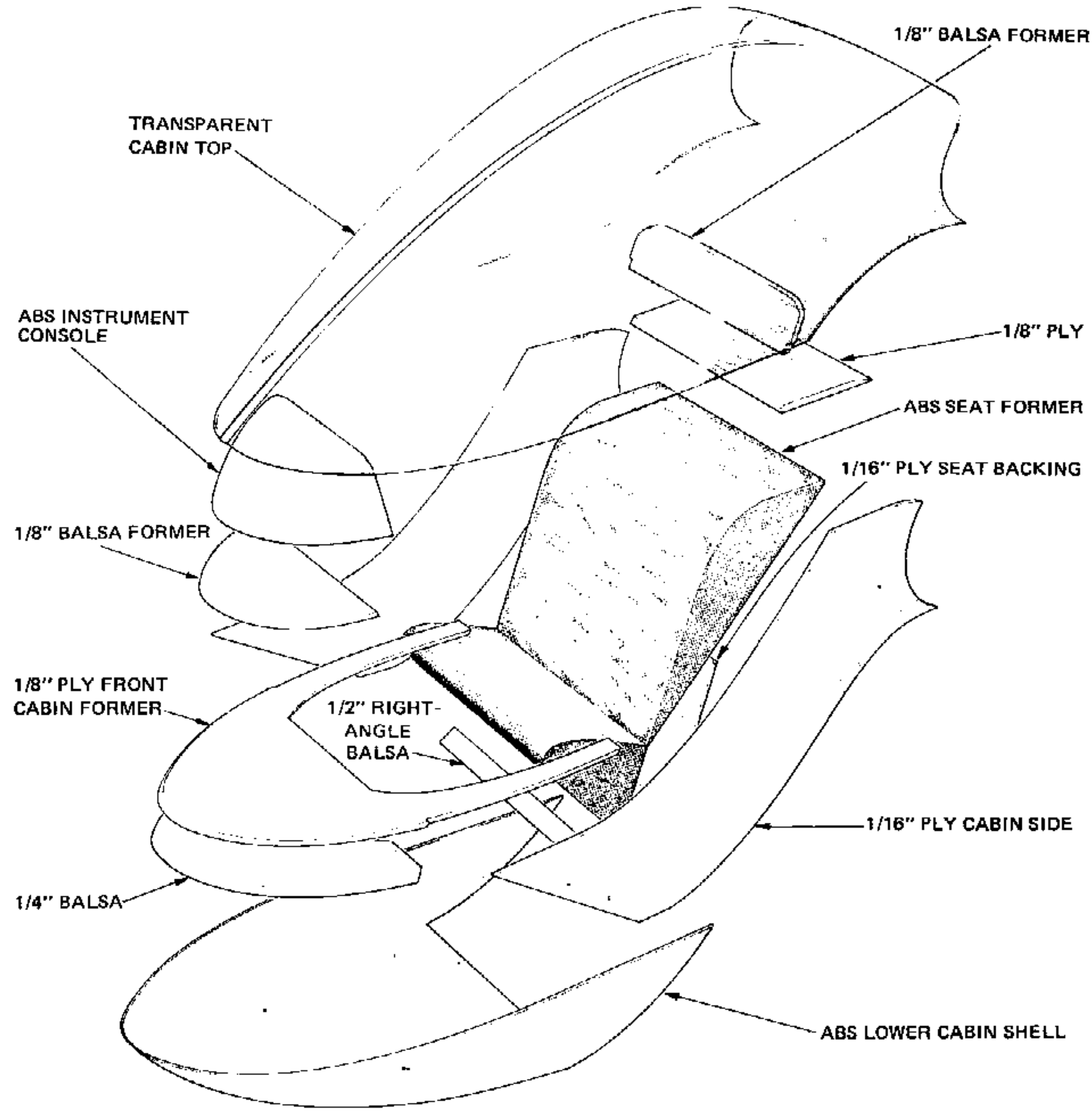


FIG. 1

An exploded view of the cabin assembly showing the general location of the components is illustrated in Fig. 1.

Cut the A.B.S. seat former to shape Fig. 1. Guide lines are moulded into the seat.

Sand and glue in place the 1/16" ply seat backing piece with impact glue. Chamfer the lower edge where it will butt with the A.B.S. Lower Cabin shell. Fig. 2.

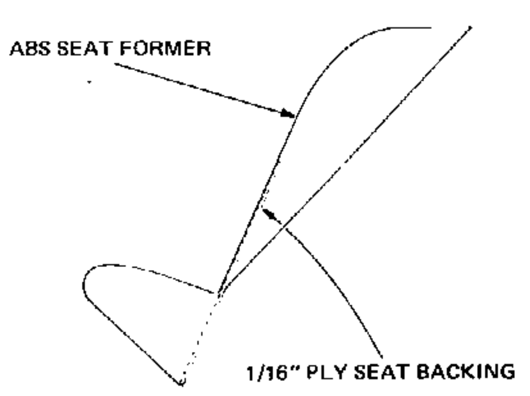
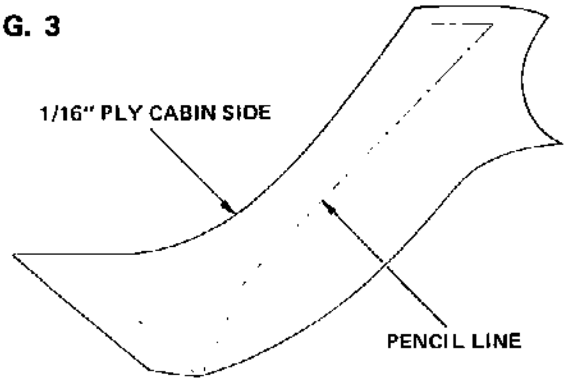


FIG. 2

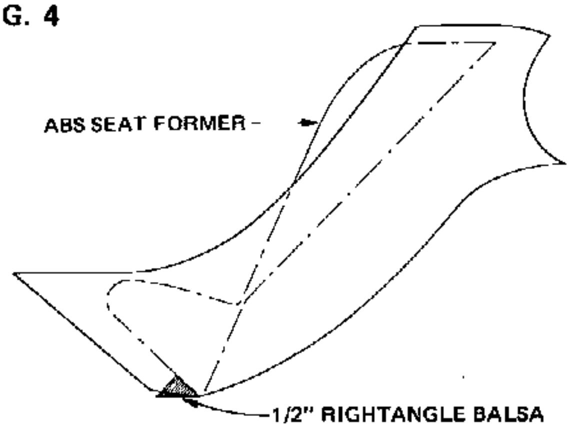
Using the plan, make pencil marks on the 1/16" ply cabin sides indicating the seat position, Fig.3.

FIG. 3



Glue the cabin sides to the seat using Evostik impact adhesive.

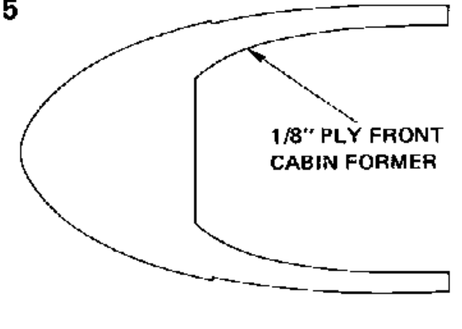
FIG. 4



Glue in place the ½" rt. angle balsa cross piece at the base of the seat (sand to fit). Use Epoxy to the ply and impact adhesive to the A.B.S. Fig. 4.

When the glue is dry sand away flush with the cabin sides.

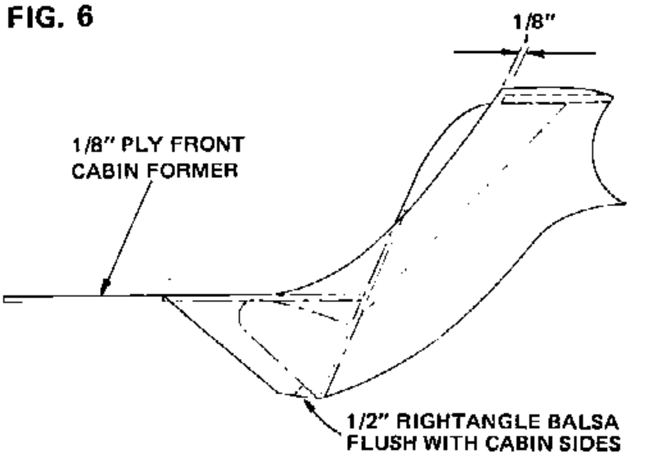
FIG. 5



Check the 1/8" ply front cabin former Fig. 5 for fit and glue it in position, checking with the plan and using epoxy glue.

N.B. Make sure the seat does not twist during this stage.

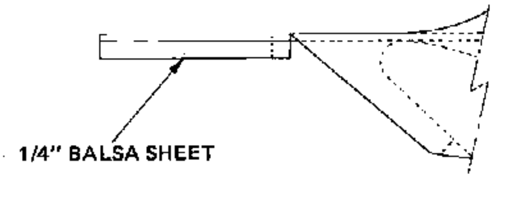
FIG. 6



Similarly glue in place the 1/8" ply piece at the top of the seat. Chamfer the front edge to follow the line of the cabin sides. The front edge of the 1/8" ply should be 1/8" behind the front edge of the cabin sides. Fig. 6.

Glue ¼" balsa piece below the 1/8" ply front cabin former. This serves as a gluing area for the A.B.S. cabin bottom. Fig.7.

FIG. 7

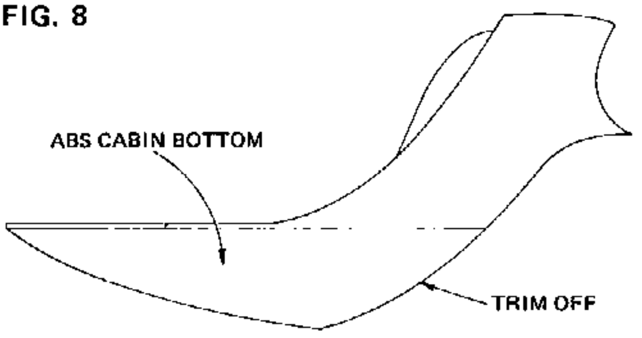


The cabin top is glued to the 1/8" ply and butts against the A.B.S. bottom.

Sand and trim the structure and A.B.S. bottom until they fit comfortably. Use impact adhesive to glue the A.B.S. in place. Fig.8.

When the glue is dry trim off the A.B.S. to follow the line of the plywood sides and bottom.

FIG. 8



Glue the 1/8" balsa cabin top shaping piece in place, check with the plan. Fig.9.

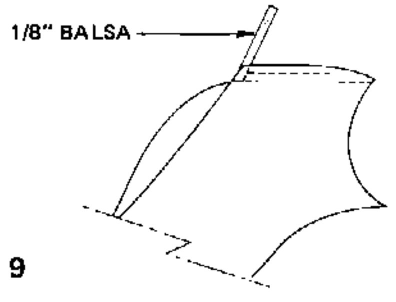


FIG. 9

Check the cockpit canopy for fit. Carve and sand the structure until the fit is satisfactory.

The cockpit interior can now be painted and fitted out to taste. A pilot weighing 1½ ozs. approximately can be fitted, make sure there is no chance of the pilot coming loose. The 1/16" ply seat backing piece should help here. If this is not desired then a piece of lead weighing 1 oz. should be inserted in the instrument console. A former of 1/8" sheet balsa is glued to the base of the console before it is fitted in place. Fig.10.

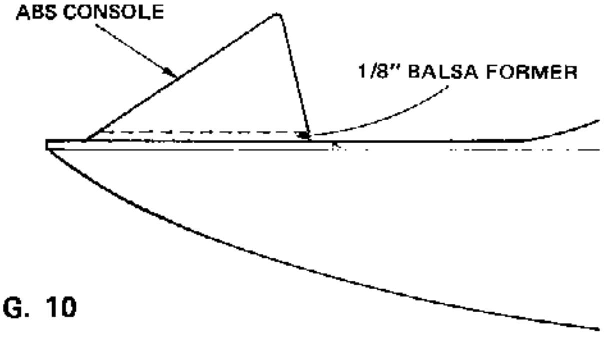
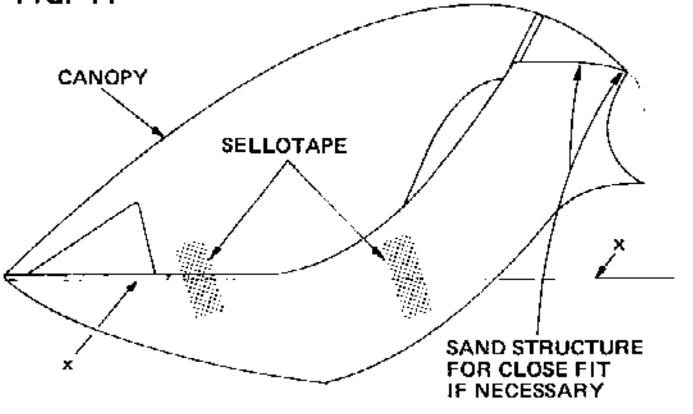


FIG. 10

Trim the bottom edges off the canopy and secure it temporarily in place with sellotape. Fig.11. (The canopy is eventually glued to the 1/16" ply side pieces and cut to the contours of these pieces).

FIG. 11



With a sharp knife score along the line X where the canopy meets the A.B.S. base. The canopy butts against the A.B.S. so that there is no overlap. Score through the sellotape last.

Remove the canopy and break away the excess along the score line. Remove the sellotape.

Using Evostik first spread an even, thin layer over the ply side pieces. Next, apply Evostik sparingly to the edges of the structure. Place the canopy in position before the Evostik has dried, i.e. immediately. The canopy can be manoeuvred if required so that it butts perfectly with the A.B.S. base. Secure again with sellotape as in Fig.11.

Leave the structure overnight to set. Remove the sellotape. Trim the edges of the canopy to follow the contours of the ply side pieces.

Use Epoxy glue to tidy any cracks and fill any holes. Sand the edges and the butt joint between the canopy and A.B.S. base.

Glue the Velcro tape in place, as shown on the plan, before painting. Use Bostick clear adhesive, or other impact adhesive, and allow it to set for several days.

Make a small hole in the rear of the seat to allow for expansion and contraction of the air in the cabin under different temperatures.

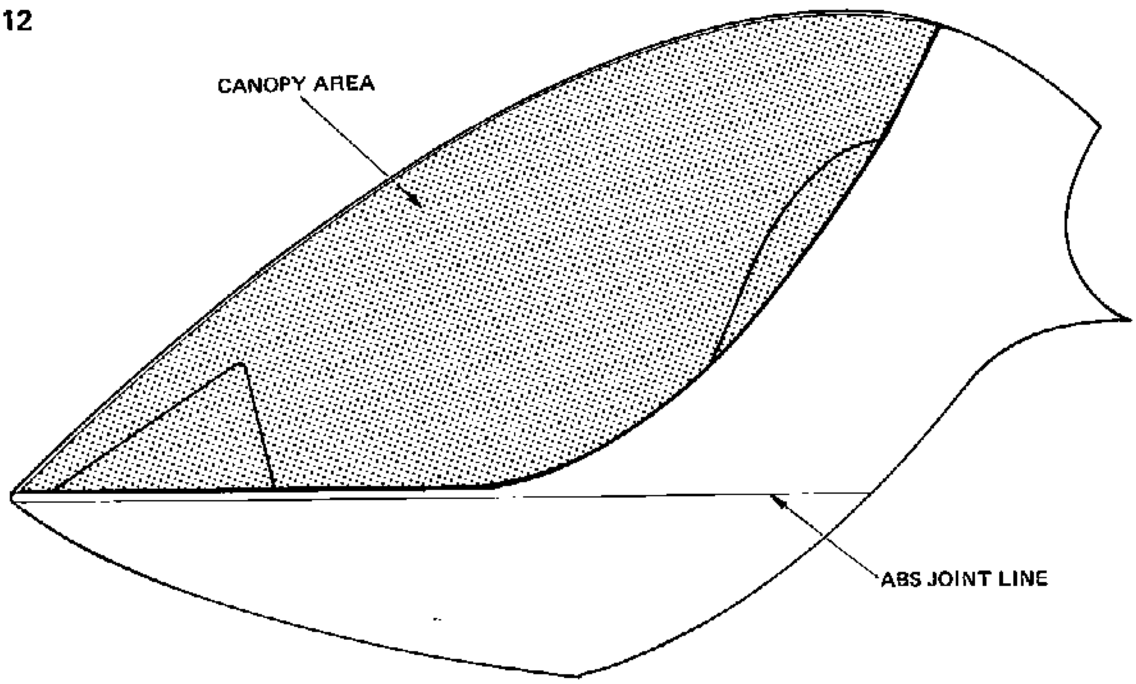
The completed cabin may now be painted. A two-tone colour scheme looks attractive and can be so arranged to help hide the butt joint where the upper and lower A.B.S. shells come together.

Mask off the canopy area before painting as shown in Fig. 12.

Apply the transfers supplied and varnish them for protection against fuel.

IMPORTANT - Do not use cellulose based paint as this may damage the A.B.S. plastic parts.

FIG. 12



N.B. Use Torqseal only where recommended

Bolt the undercarriage to the fuselage.

Reinstall the engine unit, making sure the engine crankcase backplate bolts are tight.

Reinstall the radio and connect up the swash plate and engine servos.

Bolt the tail boom in position, not forgetting the swash plate retaining spring.

Bolt the fin in place on the starboard (right) side of the boom. Secure the nuts with Torqseal.

Reinstall the fuel tank and connect it to the engine.

Bolt the tail rotor assembly and skid in place.

Install the tail rotor blades, using 8BA nuts, bolts and washers. When viewed from the port (left) side of the model the leading edge of the uppermost blade should be facing to the rear of the model. Rotate the blades to check and refer back to Section 8. The nuts should be finger tight and secured using Torqseal. The blades should be just unable to fall, due to gravity, when rotated to a horizontal position.

The tail rotor is balanced by loosening the grub screw, which holds the brass mitre gear on the rotor shaft, and spinning the rotor on its bearings. The pin in the bellcrank should not be in position when this is done. Use paint or MicroCover to balance the blades.

Relocate the bellcrank pin in the slot in the slider and retighten the brass mitre gear on its flat.

The tail rotor is connected to the main gear train using a shaft of 16G wire. The components used are shown in Fig.1.

File a flat on one end of the 16G shaft.

Fit the square section drive shaft front coupling to the flat end of the drive shaft.

Remove the universal joint drive shaft rear coupling from the tail rotor assembly.

Locate the front coupling in the square hole in the 25 tooth pulley.

Mark and cut the drive shaft to length (the front coupling should not quite reach the bottom of the square hole in the 25 tooth pulley). The rear end of the drive shaft should just touch the small rotor gear shaft.

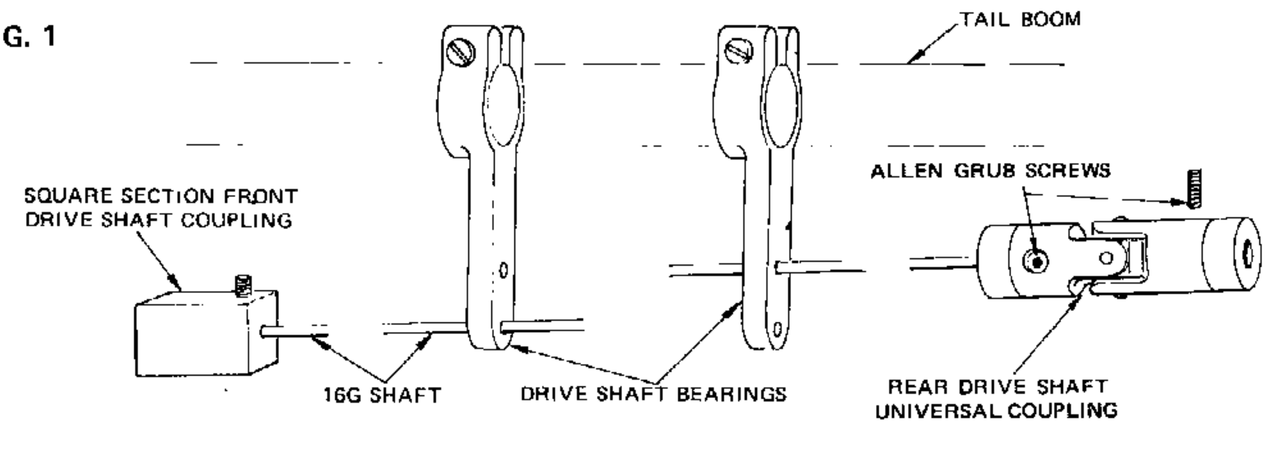
File a flat on the cut end of the drive shaft.

Slide the two drive shaft bearings on to the drive shaft. Use the lower hole for the front bearing and the upper hole for the rear bearing. Fig.1.

Slide the rear drive shaft coupling on to the drive shaft, using the small hole.

Locate the square section front coupling in the square hole in the 25 tooth pulley.

FIG. 1



Snap the drive shaft bearings over the tail boom. Slide the rear coupling over the tail rotor shaft and tighten the grub screw on to its flat.

Push the drive shaft as far back as it will go and tighten the other grub screw in the rear coupling on to its flat.

Fit the drive shaft bearings with 6BA bolts washers and nuts. Don't tighten yet.

Position the bearings on the boom so that the drive shaft is as near as possible in a straight line.

Tighten the 6BA bolts.

The tail rotor pitch crank is connected to its servo by means of a 22G wire running in a nylon tube. (Refer back to Section 11).

Route the nylon tube as described in Section 11.

Use the three plastic clips to secure the tube to the tail boom. The front clip should be approximately ¾" behind the 25 tooth pulley. The rear clip should be just in front of the fin. The centre clip can be anywhere in the middle of the boom. The nylon tube should end 1" behind the rear clip.

Solder one end of the 22G wire to the small brass cable link adaptor. Bend the end of the wire into a tight loop to give a better grip. (If you are not too good at soldering it is worth asking a friend to help.)

Screw the ball joint in place using most of the thread.

Slide the 22G wire into the nylon tube and connect the ball joint to the outer hole on the tail rotor pitch crank.

Make sure the ball link doesn't catch the grub screw in the tail rotor drive coupling. This problem can be cured by filing a deeper flat on the small drive shaft in the tail rotor cage.

Connect the other end of the 22G wire to the tail rotor servo. Bind and solder a piece of 16g wire to servo end and use N.12 quick keeper to connect linkage to servo arm.

When the tail rotor servo is in neutral, the tail rotor pitch slider should be in the middle of its travel. Adjust the ball link to do this.

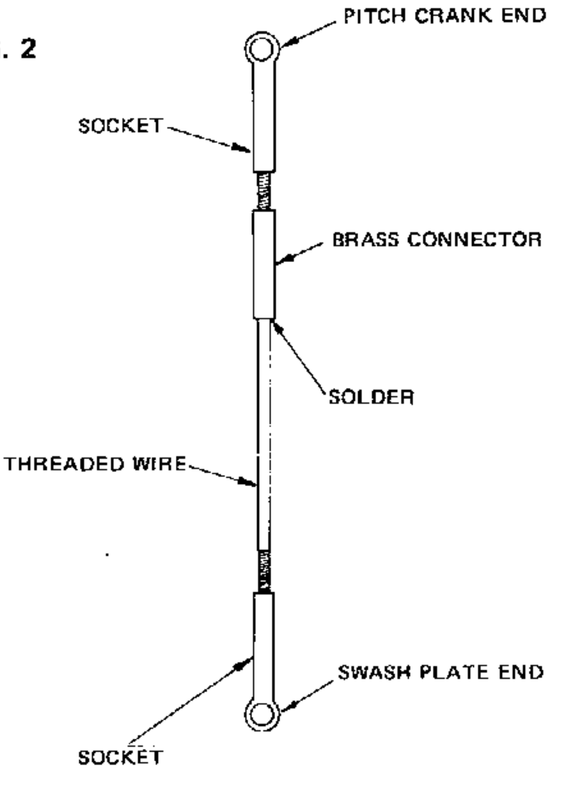
Attach the heat sink to the engine. One or two corrugations can be cut off if necessary on smaller diameter head engines. A wire clamping strap is supplied and a close fit for good heat dissipation is required.

Make sure the throttle opens and closes fully at extremes of control. A final check can be made during ground run up trials.

Temporarily fit the rotor head.

The flybar pitch crank must now be connected to the upper disc of the swash plate. This coupling is shown in Fig.2.

FIG. 2



Screw the socket pieces most of the way on to the threads.

Cut the threaded wire to length, so that when it is pushed right inside the brass connector and the ball and socket joints are snapped together, the pitch crank is parallel with the top of the swash plate.

Remove the connecting assembly.

Remove the socket pieces.

Solder the brass connector to the threaded wire.

Remove the rotor head.

Slide the swash plate driver on to the rotor shaft so that it is 15/16" above the swash plate as in Fig.3.

Fit the 6BA nut and bolt and washers, but don't tighten yet.

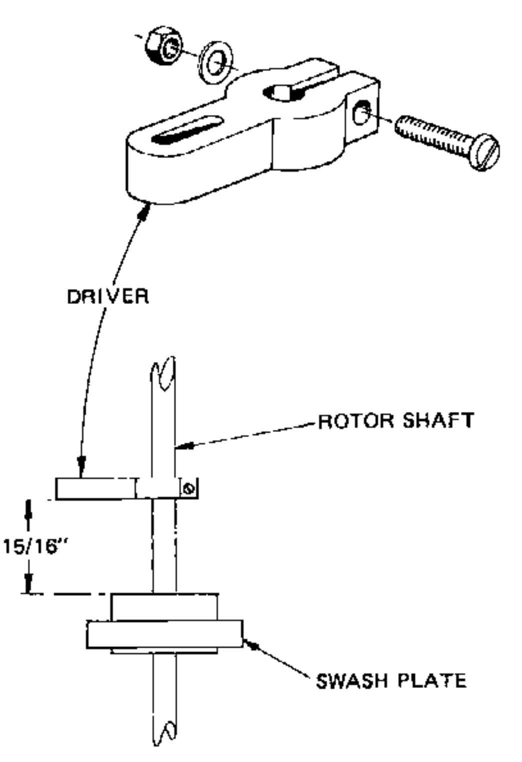
Screw a socket end back on to the brass connector of the linkage just completed.

Pass the threaded wire end through the swash plate driver and screw the other socket end in position.

Snap this end on to the ball of the swash plate upper disc.

Bolt the rotor blade connecting plates in position, using 6 BA x 5/8" bolts and nyloc nuts and washers. Refer back to Section 14.

FIG. 3



The plates go on top of the blades.

Fill the tail gear cage with machine oil and keep regularly topped up to ensure at all times lubrication to bearings and gears.

Lubricate main rotor head bearings and layshaft bearings, then always oil these regularly.

It is worth checking back to Section 6 to remind yourself of the radio functions. To recapitulate briefly:-

The elevator (pitch) function tilts the swash plate forward.
The aileron (roll) function tilts the swash plate right to bank to the right.
The rudder (yaw) function when moved to the right should increase the pitch of the tail rotor blades to turn the nose of the model to the right.
The engine control function to suit yourself.

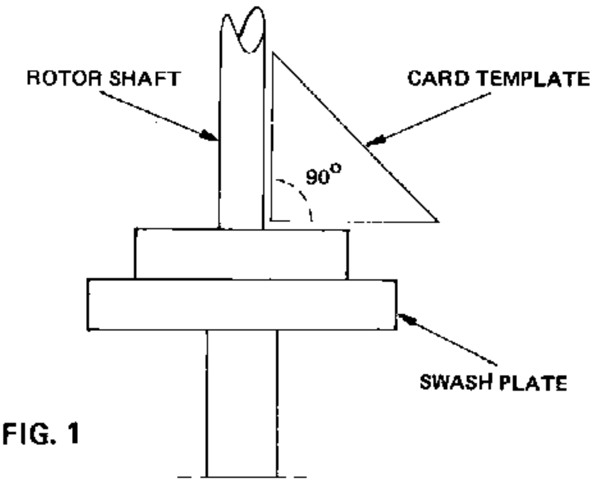


FIG. 1

Centralise the transmitter trims except for pitch trim, which should be pulled fully back.

Switch on the transmitter.

Switch on the receiver.

When the servos have settled, switch off the receiver.

Switch off the transmitter.

Adjust linkages until the swash plate is at 90° to the rotor shaft in pitch and roll directions. This is best done by making a small cardboard template. Fig. 1.

The swash plate should tilt about 15° from the horizontal to give good control response. Fig. 2.

You may have become acquainted with the one in sixty rule; but if not, it is simply this: a slope of one part in sixty parts is equal to one degree for small angles. Fig.3 gives an example.

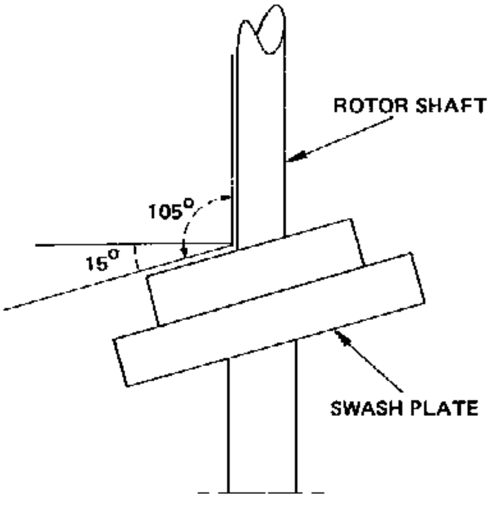
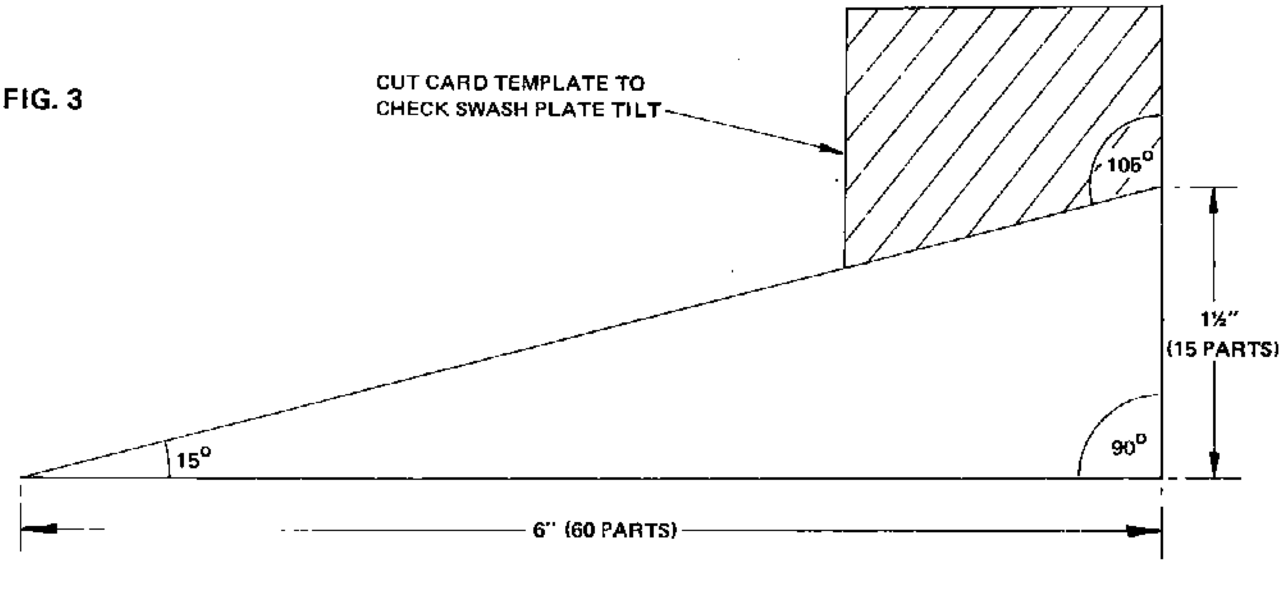


FIG. 2

FIG. 3



Using the 90° template and the 105° template readjust the linkages and servo throws until the swash plate is square to the rotor shaft and has the correct amount of movement.

The pitch trim should still be pulled back as before for the above operations.

Temporarily fit the rotor head and flybar assembly and connect it to the swash plate.

Adjust the ball and socket connectors on the connecting linkage until the rotor head pitch crank is parallel to the top of the rotor head.

Disconnect the pitch crank ball and socket joint and test the flybar and paddles for balance. This was done previously, but there is no harm in rechecking. The pitch crank and collar should be moved until the balance is correct. Ensure the pitch crank is well tightened on its flat.

Reconnect the ball and socket joint.

If during flying the flybar gets bent, it can be checked for balance by simply disconnecting the pitch crank to see which way the flybar falls. A bent flybar is one of the causes of quite violent oscillations in flight.

The paddles were only temporarily screwed in place. They should now be set in their permanent position as follows:

Turn the rotor shaft until the flybar is across the fuselage.

By eye, sight along the flybar and rotate the nearest paddle until its moulding line is in line with the edges of the rotor head. Fig.4.

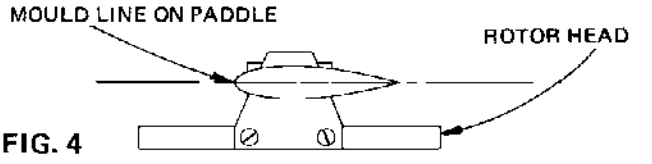


FIG. 4

Tighten the paddle grub screws very tightly.

Without rotating the rotor shaft repeat for the other paddle.

Spend some time over this and use a plain background when sighting to avoid any optical illusions.

Remove the rotor head.

Attach the rotor blades by their holders under the rotor head. A 4 BA socket head bolt is first passed through the hole in the rotor blade holder and a star washer is then slipped over the thread of the bolt. The 4 BA bolt is then screwed into the rotor head from the underside and a 4 BA nut is used to lock the bolt in place. Only gently tighten the nuts at this stage. Fig. 5.

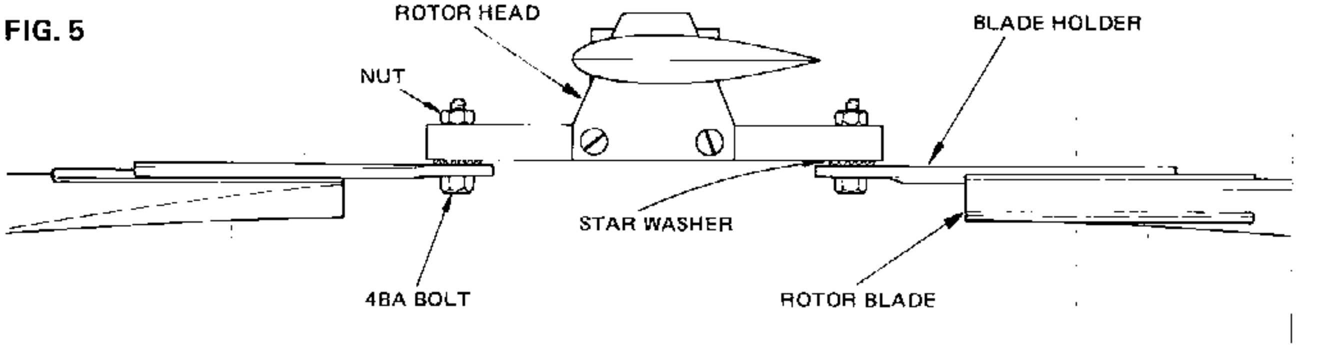
Turn the rotor assembly upside down and balance it on the flybar.

Use paint or Micro-Cover until the balance is exactly right. Remember that paint gets lighter as it dries.

Refit the rotor head assembly using a 4 BA bolt and two nuts, one for clamping and one for locking.

Do not connect the ball joint yet.

FIG. 5



To prevent main head gyroscopic vibrations the main blades are set at 3° to 6° forward sweep angles relative to flybar. For example, with 5° forward sweep angles with flybar will be 85°, 95°, 85° and 95° see Fig. 7. This is known as lead lag and is in fact full size practice.

Adjust the other blade until the flybar balances perfectly horizontally. Tighten the nuts holding the blade.

Connect the ball joint on the pitchcrank.

Tighten the bolt which clamps the swash plate driver. The arm on the upper disc of the swash plate should first be moved into line with the pitch arm on the lower swash plate disc. If the rotor blades are in line with the tail boom, then the swash plate driver is correctly positioned.

The coning angle or diahedral of the blades must now be determined.

Bend each blade upwards at the blade holders.

Stretch a piece of cotton from tip to tip. If it just touches the top of the rotor head then the coning angle is correct.

Measure the distance from each blade tip to the tail boom vertically.

These should be exactly the same. If not then reduce the angle of one blade and increase the other until their distances above the tail boom are the same. Recheck the coning angle with the piece of cotton.

When satisfied, make a gauge from an odd piece of wood and keep it in your model box.

Make a further gauge for checking the pitch of the blades as follows. Fig.6.

The angle is found using the one in sixty rule. The flybar is used as a guide in determining the angle of the blade. The angle of the blade holders may not be exactly right. Use a small adjustable spanner to make any final corrections.

Recheck the coning angle.

The whole alignment procedures can be performed quite quickly once the knack has been achieved.

Centralise the pitch (elevator) trim on the transmitter.

Check the centre of gravity of the model by supporting it in your hands under the flybar, with the main blades fore and aft. Sight the rotor shaft against the nearest vertical object such as a door or window frame. If your house is a bit crooked use a plumb line attached to the ceiling.
Ideally the centre of gravity should be on or near the shaft. If it is badly out, use ballast to correct.

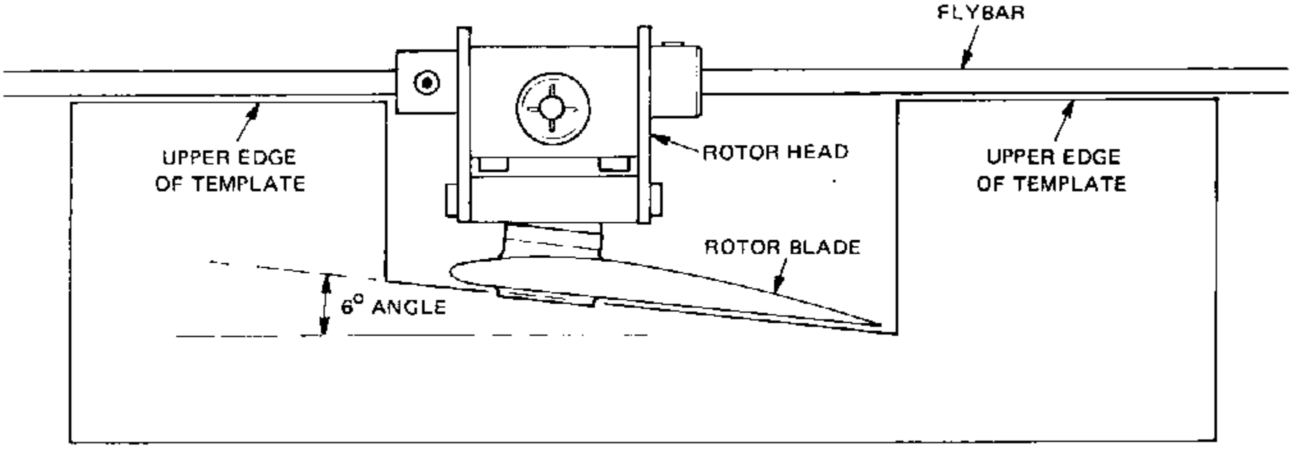
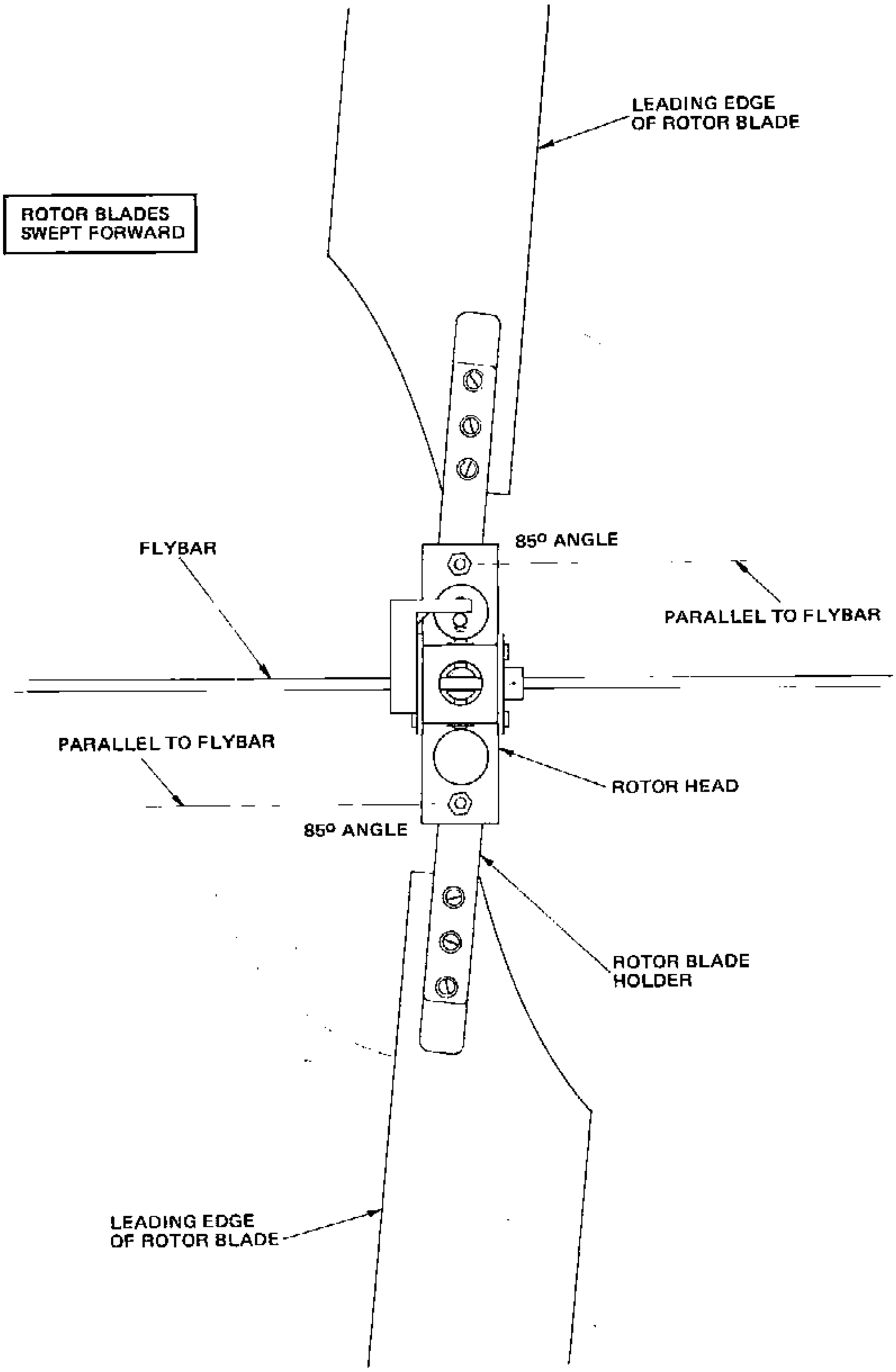


FIG. 6

HOLD GAUGE UNDER BLADE AND SIGHT THE UPPER EDGE AGAINST THE FLYBAR.

FIG. 7


LEADING EDGE
OF ROTOR BLADE
ROTOR BLADES
SWEPT FORWARD
FLYBAR
85° ANGLE
PARALLEL TO FLYBAR
PARALLEL TO FLYBAR
ROTOR HEAD
85° ANGLE
ROTOR BLADE
HOLDER
LEADING EDGE
OF ROTOR BLADE

Ideally the flying site should be a large area of short grass free from bystanders, especially dogs, small boys and photographers. Avoid long grass, weeds, hedges, trees etc. Helicopters can't be flown in a small space when you are learning.
The first thing to learn is a good starting procedure. The essential requirement is a starting cord. A leather thong or nylon curtain cord is fine. If you choose the nylon melt the ends to stop it fraying.
The toothed belt can be slipped off the pulleys for starting, this makes everything safe; but mind you don't over rev the engine when it starts.
The model must be held down while the starting cord is being used. This is done by a friend, a suitable cradle on your model box, or simply by hooking the skid round a screwdriver pushed into the ground. It is suggested behind the rear strut on the starboard (right) side. The starting cord is operated from the port side.
Fuel up, prime through carburettor, attach starter battery and start. You will find that using a starting cord is rather awkward at first, but you'll soon get the idea.
An electric starter can be used with a Vee belt and the pulley on the starter.
Make sure you don't try starting the engine in the wrong direction.
Always start in a low throttle setting.
When the engine is running throttle back until the clutch drops out and replace the belt on its pulleys.
The engine can be started with the belt in place, but watch the throttle setting.
With the engine ticking over and the clutch out, carry the model by the rotor head to the take-off point. Run the engine on the rich side. A lean engine is a dead engine. Put the model on the ground, check the tail rotor and swash plate servos and gradually open the throttle until the model becomes light. The tail will probably swing. If the swing is large the link will need adjusting. If all is well then do some practice tail rotor controls until the direction becomes second nature. Always look at the nose of the model when doing this, it is the nose which tells you which way you are going when in flight. Your tail rotor is the equivalent of a rudder. If the tail skid keeps catching the ground, push the pitch control forward slightly.
If there is a good model helicopter pilot available enlist his help just as you would when learning to fly fixed wing aircraft. If there is no experienced help available then pluck up courage for your first flight.
The ideal wind condition is a gentle breeze, this smooths out tail rotor controls. Point her into the wind. Gently open the throttle, carefully correcting any tendency for the model to swing. Push gently forward on the stick. If things start to get out of hand throttle back and try again. All being well you will achieve a lift-off.
The reason for pushing forward on the stick into a gentle breeze is to take off in forward flight, also called translational flight, which is any flight other than hovering. In this condition the tail rotor control is far less sensitive - you get a better chance. Once airborne it is essential to avoid doing two things:-

1) throttling back quickly in panic
2) pulling the stick back.

The first is self-evident - it will drop out of the sky. The second is a natural reaction flying fixed wing if you want to climb away. With a helicopter the effect is to fly backwards. In practice, this doesn't happen. The model will flip round through 180° and probably continue to rotate. If this happens to you - and it probably will - remember these four things:-

1) don't panic
2) don't throttle back
3) push the stick gently forward
4) use the tail rotor to stop rotation.

Your height and speed can be adjusted by the amount you push forward on the stick. Keep pushing gently forward and try an aileron turn. You should find this easy, with the model responding much like a fixed wing. Don't get carried away or the tank will run dry, which is fatal for the model. Turn the model into the wind and prepare to land. This is the difficult bit. Gradually reduce the throttle control and try to keep near the hover or creeping slowly forward. Hovering has been compared with a balancing act and involves juggling with all four controls at once. At the risk of being a bore, keep leaning forward on the stick, keep flying into wind by tail rotor and swash plate adjustments, and finally adjust the rate of descent with the throttle.

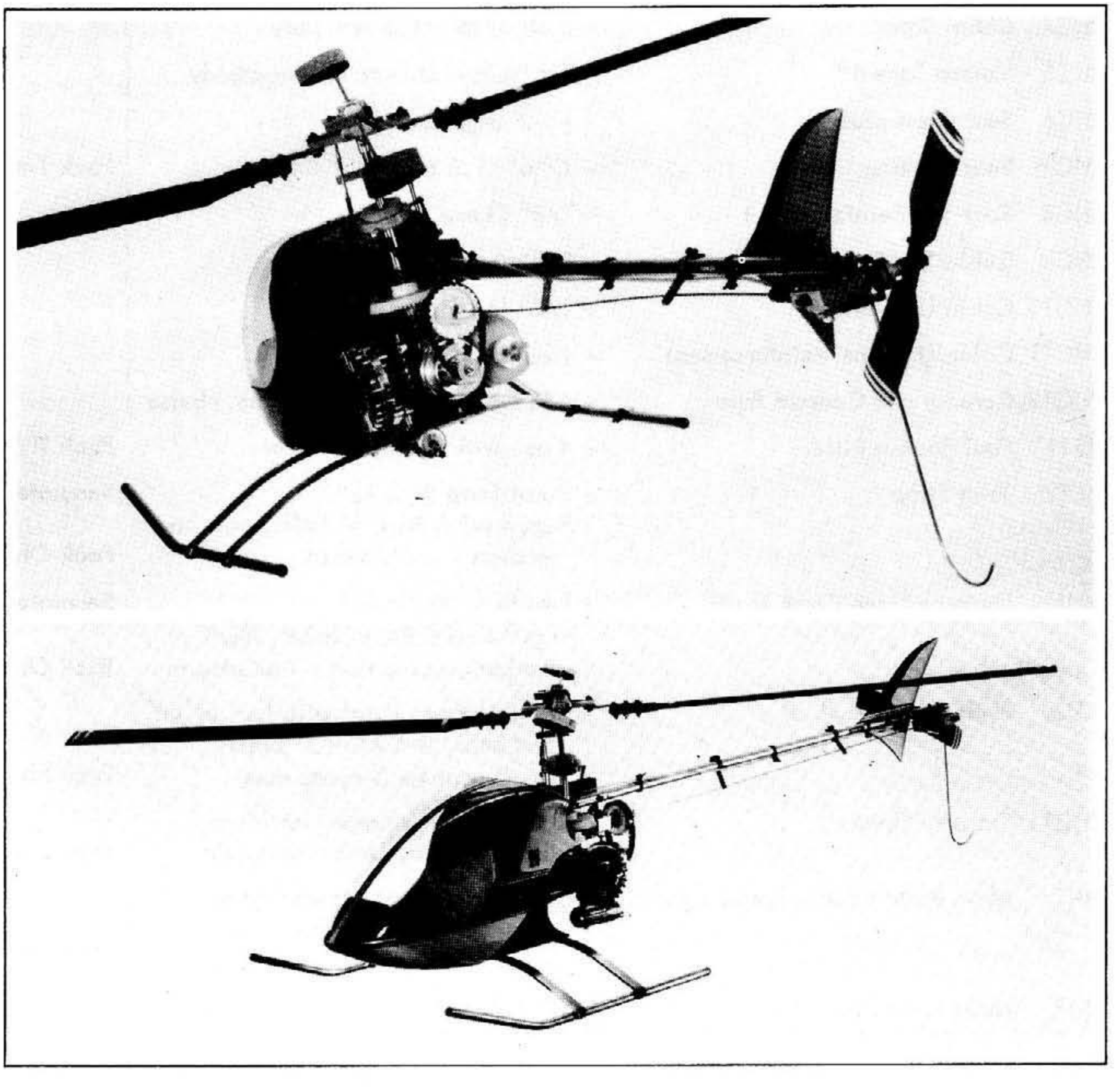
If you read these instructions about 100 times before you attempt to fly, there is a reasonable chance of getting down in one piece.

You will have realized by now why a large area is needed for flying, and why a total absence of distractions is essential. The concentration required to start with is enormous, but less is needed as you progress.

CONCLUSION

The subject of helicopter aerodynamics is obviously a complex one and there are few books readily available written in layman's terms. One exception is a book called "The Helicopter and How it Flies" by John Fay and published by Pitmans. Model helicopters are still in their infancy, although the original Lark has contributed much to their popularity in the U.K. The "Lark-2" should open the door wider so that a larger number of modellers can have a try at fathoming the complexities of rotary flight.

Peter Valentine.



2LM1 One Manual + Cabin Structure/Fuselage base drawing + printed instrument panel

2HW1	Engine Bearer	- 9 mm. (3/8") Ply	Pack One
2HW2	Fuselage Back	- Ply 3 mm.	Pack One
2HW3	Fuselage Base	- Ply 3 mm.	Pack One
2HW4	Fuselage Sides	- 2-Ply 1.5 mm.	Pack One
2HW6	Fuselage Top & Front Supports	- 1 each in 1/16" (1½ mm.) Ply	Pack One
2HW7	Fuselage Reinforcing Struts	- 2 off Hardwood ¼" sq.	Pack One
2HW8	Servo Mounting Plate	- 6.5 mm. Ply 2½" x 4 3/8"	Pack One
2HC1	Cabin Body Base	- A.B.S. Forming	Separate
2HC2	Cabin Canopy	- Butyrate Forming	Separate
2HC3	Seat Forming	- A.B.S. Forming	Separate
2HC4	Cabin Sides	- 2 off 1/16" (1.5 mm.) ply	Pack Two
2HC5	Velcro Tape 6"	- For fixing cabin to fuselage body	Pack Two
2HC6	Seat Cross piece	- ½" rt.angle balsa	Pack Two
2HC7	Seat Backing	- 1/16" (1.5 mm.) ply	Pack Two
2HC8	Seat Top Reinforcement	- 1/8" (3 mm.) ply	Pack Two
2HC9	Cabin Top Support	- Preshaped 1/8" balsa	Pack Two
2HC10	Cabin U Former	- 1/8" (3 mm.) ply	Pack Two
2HC11	Cabin U Former reinforcement	- 1 out of ¼" balsa	Pack Two
2HC12	Console and Console Base	- ABS Forming and 1/8" (3 mm.) balsa	Pack Two
HFT1	Fuel Tank + Filter	- 4 oz. with fittings + Filter	Pack Three
HFT2	Tank Strap	- Dural Strip 9" x 1¼" Fxg. 3 off 6 BA x ½" bolts, nuts and washers - included in	Separate Pack One
HU1	Undercarriage Cross Struts	- Two in formed dural Fxgs. 4 off 6 BA ½" bolts, small washers, nyloc nuts - included in	Separate Pack One
HU2	Undercarriage Skids	- Two in formed dural with four nylon end caps, 4-6 BA x ¾" bolts, small washers & nyloc nuts	Pack Four
2HC11	Transfer Sheets	- Cabin Flashes, name, markings, blade stripes, Union Jacks etc.	Separate
HH1	Main Rotor Head - teeter type	- Dural parts - main lower plate, 2 triangle side plates and pivot block. 4 off 6 BA x ¼" screws	Pack Five
HH2	Head Pivot Pin	- Silver Steel + 2 Starlock washers	Pack Five

HH3	Paddle Bar	- 3 mm. steel wire 14½" Hardware - 1 x P.11 Collet, Socket Set Screw 4 BA x 1/8"	Separate Pack Five
HH4	Paddles	- Two nylon with inserts, fxg. 4 x 4 BA x 3/16" Socket Sets	Pack Five
HH5	Pitch Crank	- Nylon with insert, hardware 1 x 4 BA x ¼" Socket set screws, 1 x 10 BA x 3/8" bolt, nut and 2 washers	Pack Five
HH6	Blade Connecting Plates	- Two in formed steel, hardware 6 x 6 BA x 5/8" bolts, small washers and nuts. Two 4 BA x ½" Socket head bolts, 2 large washers, 2 nuts, 2 star washers. 1 off 3/32" A/F Hex Wrench	Pack Five
HH7	Rotor Blade Set	- Balsa/Hardwood - 2 L.E. in spindled hardwood, 2 ¼" balsa T.E. Plus 4 ply reinforcements	Pack Six
HH8	Shaft Head Tube	- Steel with 4 BA x ½" bolt, nut and washer plus 4 BA x ¼" socket set screw (fits internal)	Pack Seven
HH9	Swash Plate Driver	- Nylon with 6 BA x ¾" bolt, 2 small washers and nut	Pack Seven
HH10	Compensating Spring	- 22 gauge wire + fxg. tag	Pack Seven
HH11	Swash Plate	- Nylon 3 parts with 3 No. 2 x ¼" self-tapping screws + ball bearing pack	Pack Seven
HH12	Wire Guide & Block	- 18 gauge wire/hardwood (for roll control limiting)	Pack Seven
HH13	Rotor Shaft	- ¼" Silver Steel - predrilled	Pack Seven
HH14	Swash Plate Spacer Assy.	- Dural and nylon (three parts)	Pack Seven
2HH15	Mini Cranks/Stand off Bushes	- 4 Nylon cranks, 1 short stand off & 1 long stand off nylon. Hardware - 1 x 6 BA x 1¼" bolt, 1 x 6 BA x 1" bolt, 2 nuts & 4 washers small	Pack Seven
2HH17	'T' & 'L' shaped mini-crank pivot brackets	- 1 each type - nylon + fixing hardware, 2 x 6 BA x ¾" bolts, 2 nylon lock nuts & 6 washers. For fixing brackets 4 x 8 BA x ½" bolts, nuts and washers	Pack Seven

2HH16	Linkage Accessory Pack	- 6 x N.11B Threaded Rods, 8 x N.68 Ball Sockets + 10 BA hardware. 1 x P.6 Adaptors, 8 pcs. N.26 Retainers, 1 x N.12 Quick keeper plus 6" piece 16g wire	Pack Eight
HD1	Engine Mounting Plate	- Dural Pressing. Fxg. 4 x 6 BA x 5/8" bolts, nuts, large washers	Pack Nine
2HD2	Drive Shaft Mounts Main & Inter	- 2 off Nylon with Oilite bearings 1 off Dural with Oilite bearings Fxg. 8 x 6 BA x ½" bolts, nuts, small washers. 4 off ¼" I.D. shim washers use as spacers between layshaft bearing and HD8 Pulley if required	Pack Nine
HD3	Large Bevel Gear	- Nylon with 3/32" dia. roll pin for fixing to shaft	Pack Nine
HD4	Small Bevel Gear	- Steel with 1 x 4 BA x 3/16" socket set screw	Pack Nine
HD5	Engine mounting Pillars	- 4 x Aluminium with 4 x 6 BA x 1" bolts, nuts, washers	Pack Nine
HD6	Engine Heat Sink	- Aluminium - Concertina formed with aly strap and for clamping with 1 x 6 BA x ¾" bolt + nut & washer	Pack Nine
HD7	Inter Drive Shaft	- Steel ¼" x 2½"	Pack Nine
HD8	25 Tooth Drive Pulley	- Nylon with metal bush (with integral tail shaft drive cup) Fxg. 1 x 4 BA x ¼" socket set screw	Pack Nine
HD9	Tail Shaft Front Coupling	- Dural with 1 x 4 BA x 3/16" socket set screw	Pack Nine
HD14	Main Gearwheel Spacer	- Nylon	Pack Nine
B70	Drive Belt	- 7" dia. 35 tooth	Pack Nine
2HD10	Flywheel	- Aluminium	Pack Ten
2HD11	Clutch Housing	- Dural	Pack Ten
2HD11A	Clutch Liner	- Ferodo	Pack Ten
PY8	8 Tooth Pulley with retaining washer	- Nylon G.F., 4 off 8 BA x 3/16" bolts, 1 x 6 BA x ¼" bolt with 6 BA washer large	Pack Ten
2HD12	Clutch Shoe/Centering Washer	- Machined steel, with 2 6 BA x ½" fixing screws & washers + specially machined centering washer	Pack Ten

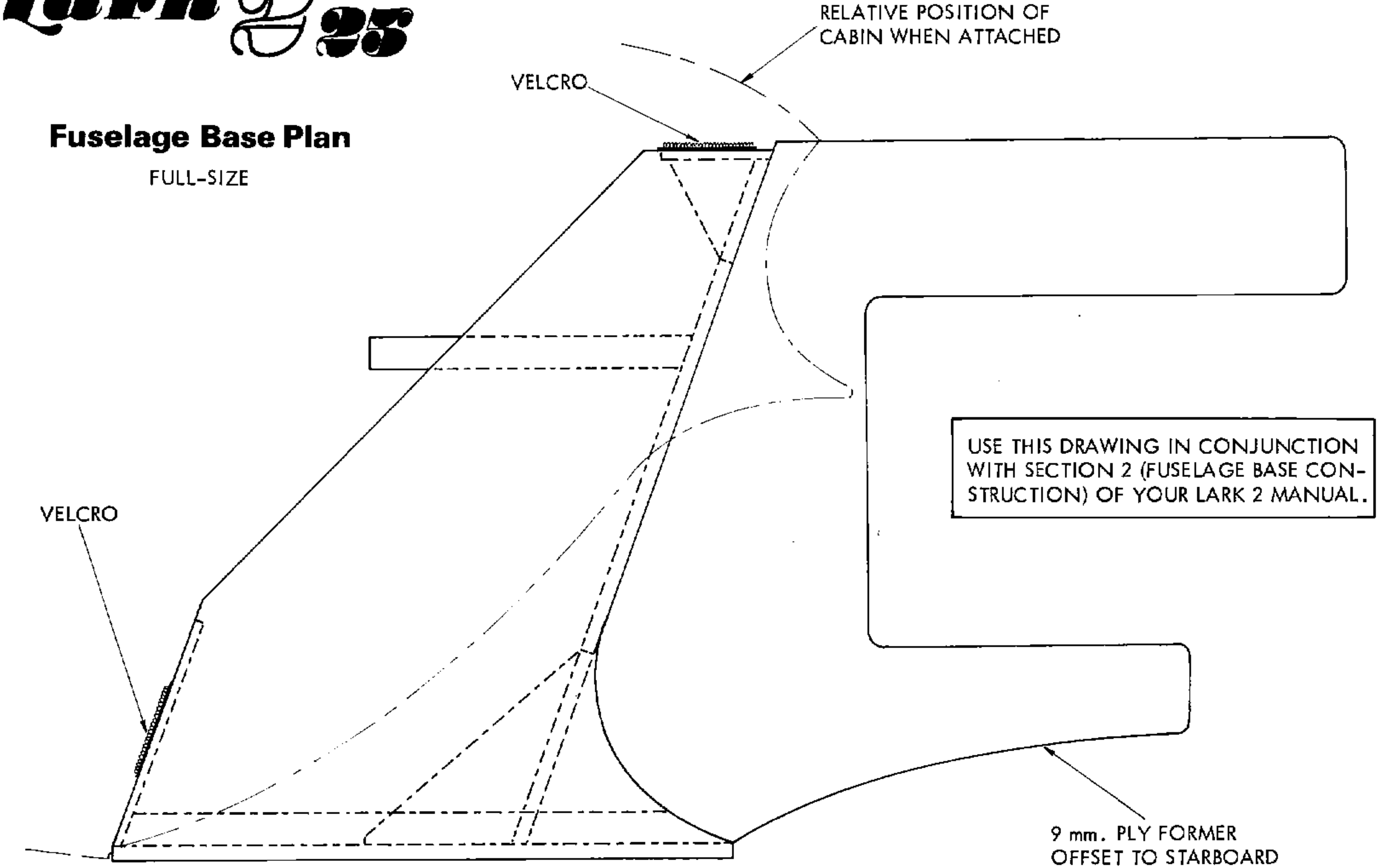
HD13	Hexagon Lock Shaft	- Steel $\frac{1}{4}$" U.N.F. (Veco, O.S. 20/25 etc., HB25)	Pack Ten
HD13A	Hexagon Lock Shaft	- Steel 6 mm. (Enya 19 BB etc.)	Pack Ten
2HT1	Boom End Plug with wire skid	- Dural with lock screw Pre-bent 12g wire skid	Pack Eleven Separate
HT2A	Tail Gear Cage with integral oil bath and transparent cover	- Nylon with phosphor bronze insert bearings. 2 x 6 BA x 1" bolts, 2 nyloc nuts, 4 washers. 4 x $\frac{1}{4}$" S.T. Screws for fixing oil cover	Pack Eleven
HT3	Rotor Pitch Crank	- Nylon with 1 off No. 2 x $\frac{1}{2}$" self tapping screw plus large washer	Pack Eleven
HT4	Rotor Crank Return Spring	- Spring Steel	Pack Eleven
HT5	Rotor Pitch Slider	- One in Nylon	Pack Eleven
HT6	Tail Rotor Blades	- 1 pair, precut in balsa + 2 ply reinforcements, 2 off 8 BA x $\frac{1}{2}$" bolts, nuts, 4 washers	Pack Eleven
HT7	Bevel Gears	- Two in Brass (or steel) with 2 off 4 BA x 3/16" socket set screws plus 2 thrust washer 4 BA	Pack Eleven
HT8	Tail Rotor Head	- Dural with 2 off 4 BA x $\frac{1}{4}$" socket set screws	Pack Eleven
HT9	Tail Rotor Shaft	- 10 gauge Steel - 3" plus 1 collet (P.11) with 1 x 4 BA x 1/8" socket set screw	Pack Eleven
HT10	Blade Connecting Shaft	- Steel with 2 x 8 BA x 3/16" screws	Pack Eleven
HT11	Rotor Blade Holders	- Two in nylon	Pack Eleven
2HT12	Drive Shaft Rear Coupling	- Universal Joint + 2 x 4 BA x $\frac{1}{4}$" socket set screws	Pack Eleven
HT13	Gear Shaft	- 10 gauge Steel	Pack Eleven
HT14	Tail Drive Shaft	- Wire 16 gauge x 22"	Separate
HT15	Rotor Pitch Linkage	- Nylon Tube 28", 22g wire, 1 P.6 adaptor, 1 x 1/16" A/F wrench, 3 N.68 Ball Socket + hardware, 3 plastic tube straps, tube Torqseal	Pack Twelve
HT16	Tail Drive Bearings	- Two in Nylon with 2 6 BA x $\frac{1}{2}$" bolts, nuts and washers	Pack Twelve
2HT17	Tail Fin Parts	- 1 Precut Ply, 2 precut balsa parts plus two ply reinforcing plates & 2 off 6 BA x 1" bolts, nuts and washers	Included in Pack One

HD13	Hexagon Lock Shaft	- Steel ¼" U.N.F. (Veco, O.S. 20/25 etc., HB25)	Pack Ten
HD13A	Hexagon Lock Shaft	- Steel 6 mm. (Enya 19 BB etc.)	Pack Ten
2HT1	Boom End Plug with wire skid	- Dural with lock screw Pre-bent 12g wire skid	Pack Eleven Separate
HT2A	Tail Gear Cage with integral oil bath and transparent cover	- Nylon with phosphor bronze insert bearings. 2 x 6 BA x 1" bolts, 2 nyloc nuts, 4 washers. 4 x ¼" S.T. Screws for fixing oil cover	Pack Eleven
HT3	Rotor Pitch Crank	- Nylon with 1 off No. 2 x ½" self tapping screw plus large washer	Pack Eleven
HT4	Rotor Crank Return Spring	- Spring Steel	Pack Eleven
HT5	Rotor Pitch Slider	- One in Nylon	Pack Eleven
HT6	Tail Rotor Blades	- 1 pair, precut in balsa + 2 ply reinforcements, 2 off 8 BA x ½" bolts, nuts, 4 washers	Pack Eleven
HT7	Bevel Gears	- Two in Brass (or steel) with 2 off 4 BA x 3/16" socket set screws plus 2 thrust washer 4 BA	Pack Eleven
HT8	Tail Rotor Head	- Dural with 2 off 4 BA x ¼" socket set screws	Pack Eleven
HT9	Tail Rotor Shaft	- 10 gauge Steel - 3" plus 1 collet (P.11) with 1 x 4 BA x 1/8" socket set screw	Pack Eleven
HT10	Blade Connecting Shaft	- Steel with 2 x 8 BA x 3/16" screws	Pack Eleven
HT11	Rotor Blade Holders	- Two in nylon	Pack Eleven
2HT12	Drive Shaft Rear Coupling	- Universal Joint + 2 x 4 BA x ¼" socket set screws	Pack Eleven
HT13	Gear Shaft	- 10 gauge Steel	Pack Eleven
HT14	Tail Drive Shaft	- Wire 16 gauge x 22"	Separate
HT15	Rotor Pitch Linkage	- Nylon Tube 28", 22g wire, 1 P.6 adaptor, 1 x 1/16" A/F wrench, 3 N.68 Ball Socket + hardware, 3 plastic tube straps, tube Torqseal	Pack Twelve
HT16	Tail Drive Bearings	- Two in Nylon with 2 6 BA x ½" bolts, nuts and washers	Pack Twelve
2HT17	Tail Fin Parts	- 1 Precut Ply, 2 precut balsa parts plus two ply reinforcing plates & 2 off 6 BA x 1" bolts, nuts and washers	Included in Pack One

Lark D25

Fuselage Base Plan

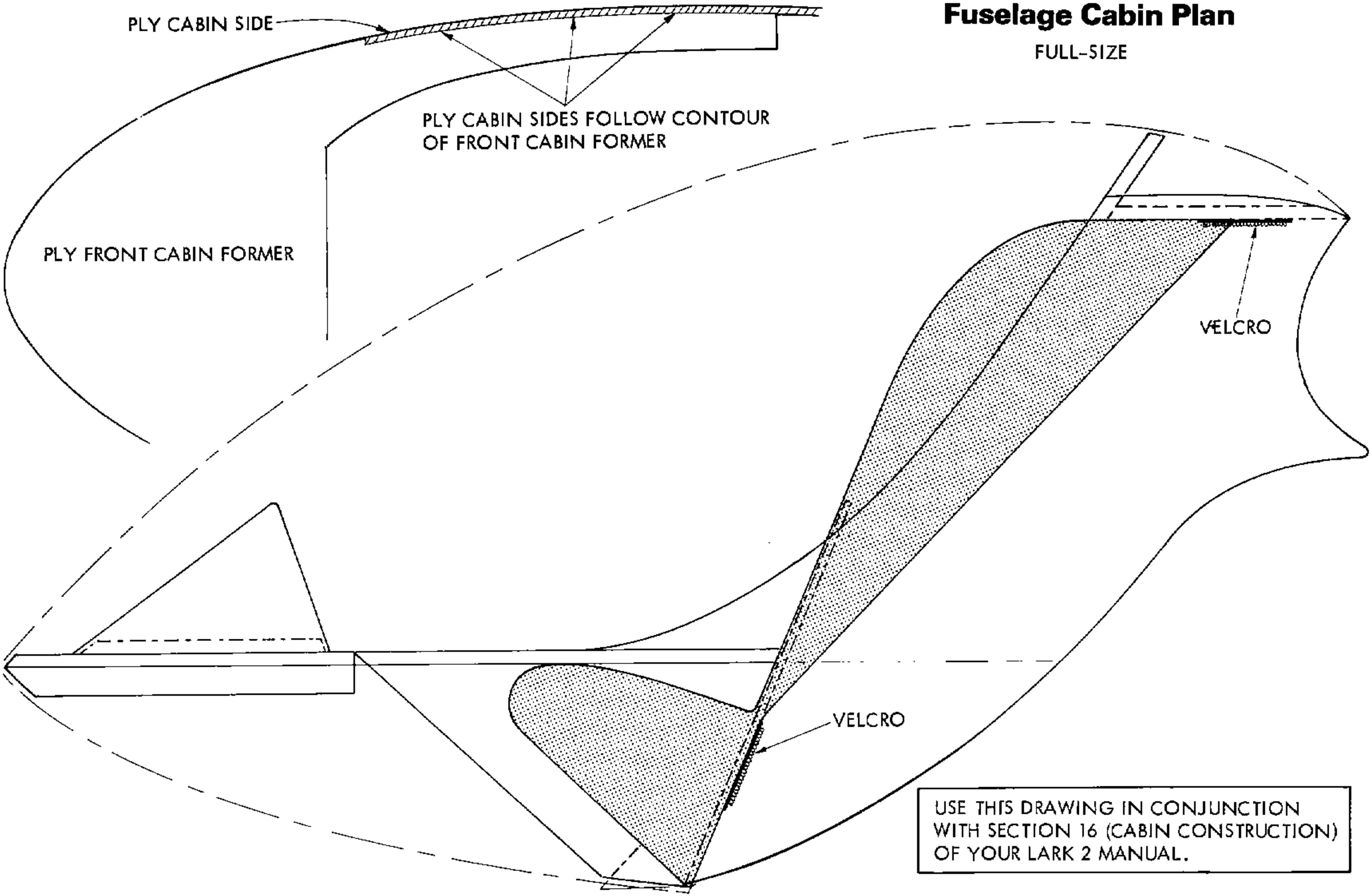
FULL-SIZE



USE THIS DRAWING IN CONJUNCTION WITH SECTION 2 (FUSELAGE BASE CONSTRUCTION) OF YOUR LARK 2 MANUAL.

Fuselage Cabin Plan

FULL-SIZE



USE THIS DRAWING IN CONJUNCTION WITH SECTION 16 (CABIN CONSTRUCTION) OF YOUR LARK 2 MANUAL.