MM LARK

THEORY, CONSTRUCTION & FLYING MANUAL

CONTENTS

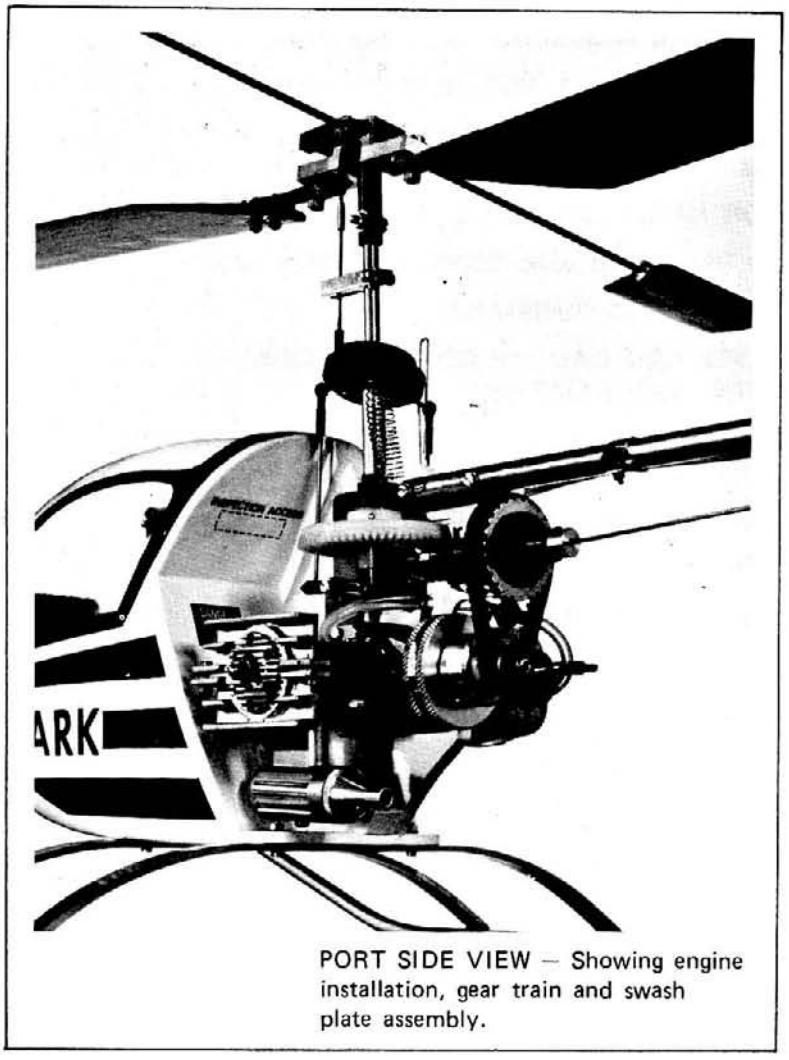
ORDERS FOR SPARE PARTS OR ANY CORRESPONDENCE CONCERNING YOUR 'LARK' HELICOPTER SHOULD BE ACCOMPANIED BY THE KIT SERIAL NUMBER –

LA 062224

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 2 to 3 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 to limit the tools required to make the Lark to those normally in the hands of most modellers viz:- screwdriver, pliers, hand drill and bits, small saw, small file, soldering iron (only on linkage and you can use epoxy as an alternative) etc. etc. Adhesives are not included but we recommend P.V.A. for all wood to wood joints (unless otherwise advised)for A.B.S. to wood , a good impact adhesive such as Evostik Impact or Dunlop Thix o fix and two part quick drying Epoxy for other bonds as instructed and 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.



PORT SIDE VIEW — Showing engine installation, gear train and swash plate assembly.

The 'Lark' illustrated here and on page 40 is one of several prototypes used in the development of this model helicopter.
Some differences in detail design and materials exist between this and the production version.

The greatest difficulty with model helicopters is in learning to fly them with the minimum of repairs. If there is no-one 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.
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 helicopters 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 is 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 ball joint 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 5 ply as shown in FIG. 1.

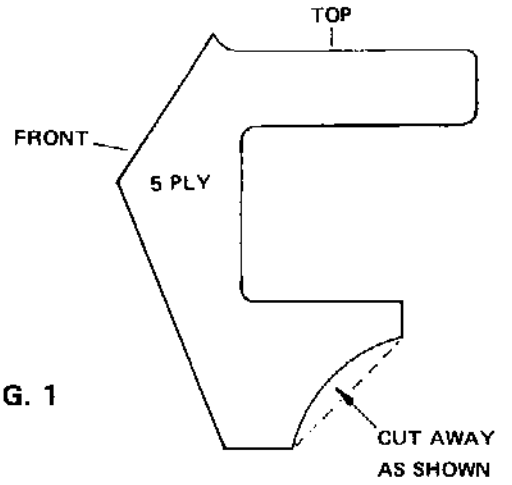


FIG. 1

An aluminium alloy plate, which carries the engine, gears, tank etc., bolts to the left (port) side of the 5 ply former like this. FIG. 2.

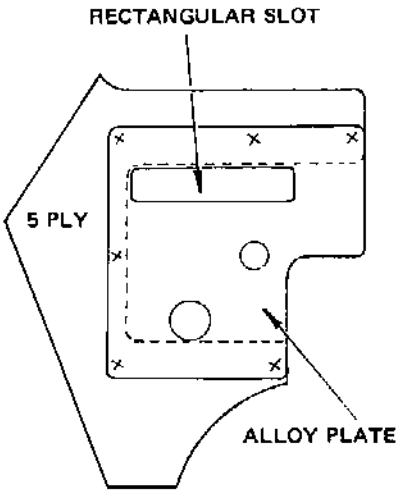


FIG. 2

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.

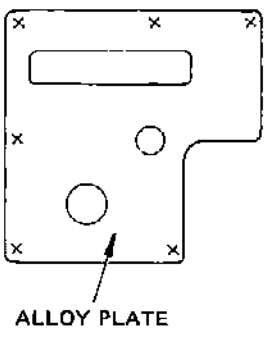


FIG. 3

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 5 ply. 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.

Locate two bearers $\frac{1}{4}$" square and $\frac{1}{2}$" x 3/8" and epoxy them to the left (port) side of the 5 ply former. Refer to the drawing so that their position is exact. FIG. 4.

Sand the structure to tidy corners etc.

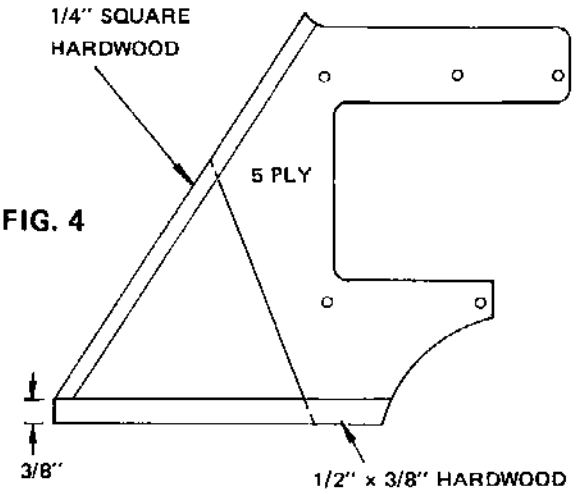


FIG. 4

Locate the larger $\frac{1}{4}$" sheet balsa former FIG. 5.

FIG. 5

Locate the 1/8" sheet ply oblong former approx. 4" x 5". This is the cabin floor and undercarriage mounting plate. The 4" sides are the front and rear. FIG. 6.

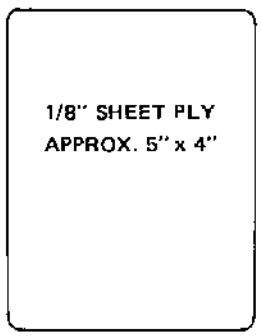


FIG. 6

The structure so far completed is epoxied to the cabin floor; but first a position must be drawn on the floor. This position is found by using the $\frac{1}{4}$" sheet balsa former introduced earlier.

Lay the ply on the workbench with the long sides to left and right of you.

Lay the balsa former over the ply with the rectangular notch towards you and to the right. There will be 1/8" overlap either side when it is positioned correctly. Move the balsa former to the short edge of the ply nearest to you and use the notch as a guide to make two pencil marks at the notch edges. FIG. 7.

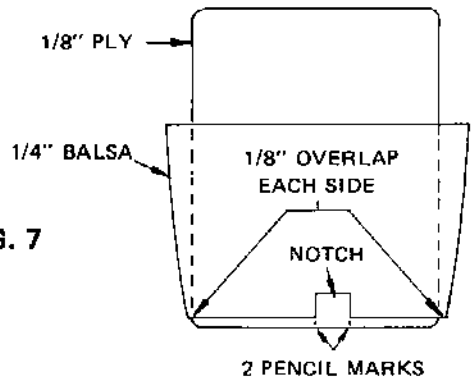


FIG. 7

Move the balsa former away from you and make two more pencil marks on the other short edge of the ply. FIG. 8.

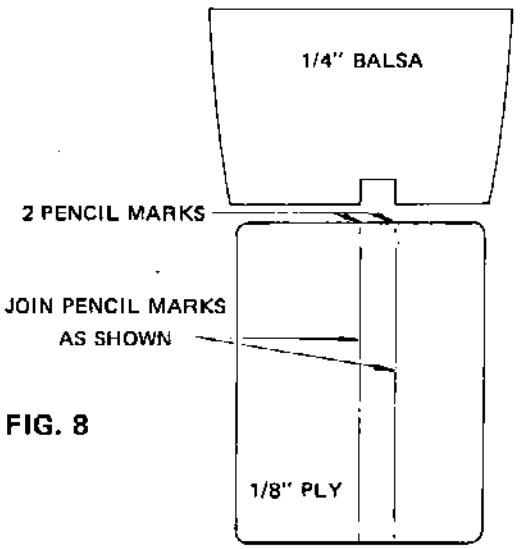


FIG. 8

Join the pencil marks with two lines. FIG. 8.

Epoxy the large bearer of the structure between the two pencil lines.

It will be seen that the 5 ply former is positioned towards the right (starboard) side of the model. This will bring the rotor shaft to the centre of the model.

While the epoxy is setting make sure the 5 ply is at 90^{0} to 1/8" ply undercarriage plate.

The notched edge of the $\frac{1}{4}$" sheet balsa former should now be bevelled so that it fits across the larger bearer ($\frac{1}{2}$" x 3/8").

Also bevel the top of the notch. This former fits against the 5 ply former. FIG. 9.

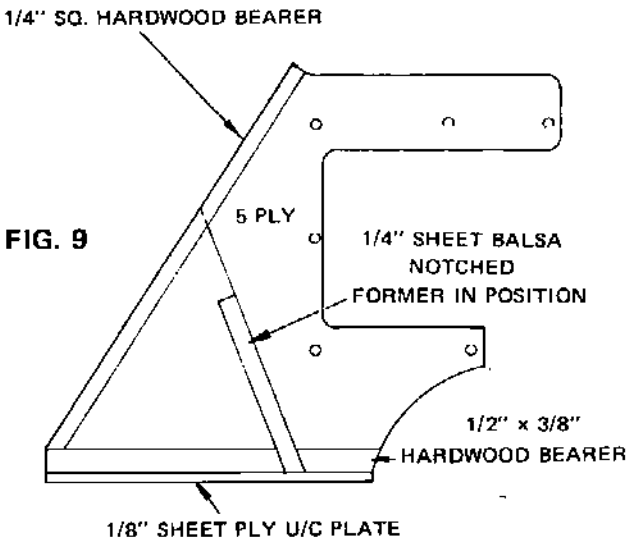


FIG. 9

Glue the balsa $\frac{1}{4}$" former in position.

Locate the smaller $\frac{1}{4}$" sheet balsa former also notched.

Bevel the notch only and juggle the former into place above the other $\frac{1}{4}$" sheet balsa former. Trim for a perfect fit.

When satisfied with the fit, glue the former into place. FIG. 10

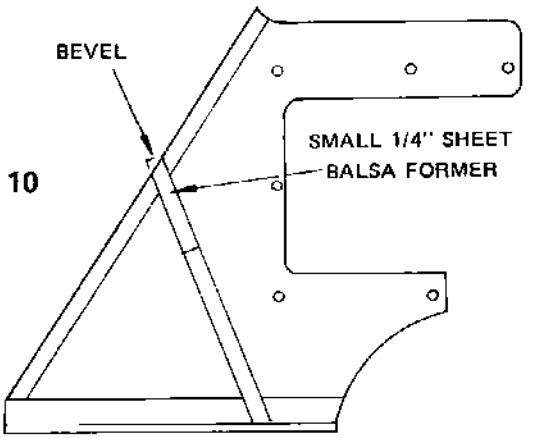


FIG. 10

Bevel the edge of the small $\frac{1}{4}$" sheet balsa former so that it follows the line of the $\frac{1}{4}$" sq. hardwood bearer.

Lightly sand the structure to tidy it up.

Cut the lower ABS plastic fuselage moulding to size using scissors. You will find two faint lines down the sides. Cut along these lines exactly and straight across the bottom at the line ends. Sand the edges smooth.

Check the ABS fuselage for fit with the structure. Pencil mark the 1/8" ply undercarriage bearer position on the inside of the ABS fuselage. When satisfied glue the two together with Evostick impact adhesive (not epoxy). Take great care. Sand the edges smooth when the glue is dry.

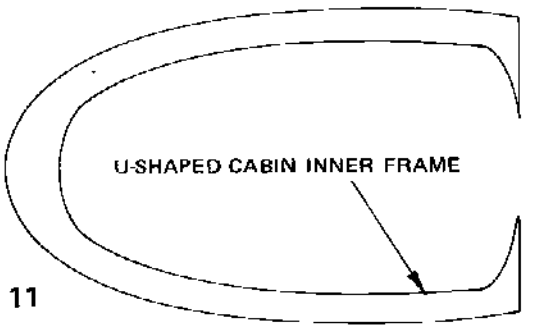


FIG. 11

Locate the U shaped cabin inner frame FIG. 11., which is made from 1/8" ply.

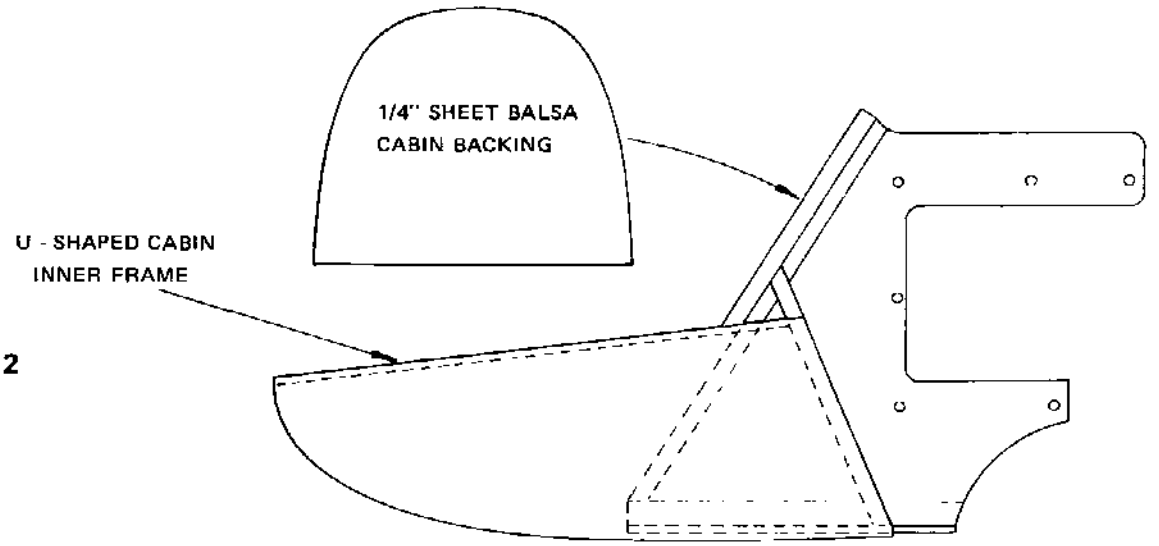


FIG. 12

This fits round the inside edge of the fuselage, flush with the edge. The two ends will need bevelling to get a comfortable fit.

Glue the frame into place using Evostick impact but slide it into place while the glue is wet. Sand the edges smooth when the glue has dried.

There are two small gaps either side of the fuselage, at the rear, near the undercarriage mounting plate. Fill both gaps with scrap balsa using Evostick impact as adhesive. Sand smooth.

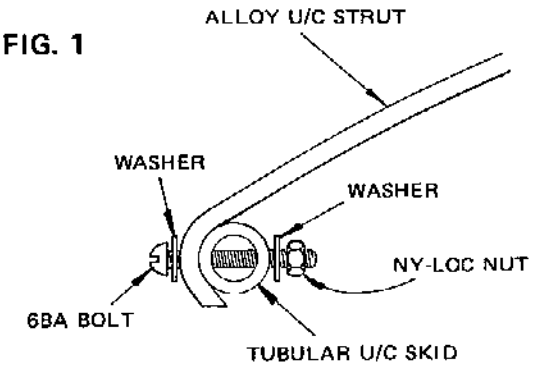
Locate the semi-eliptical piece of $\frac{1}{4}$"sheet balsa. This is the cabin backing part and fits at the rear of the cabin. FIG. 12.

Bevel the straight edge, sand and epoxy into place. The bevelled edge sits on top of the cabin inner frame at either side.

There are two small triangular holes, one either side of the fuselage. Fill these with scrap balsa and cut some pieces of scrap ABS plastic to finish the job. Trim and sand so that the ABS merges with the fuselage and cabin backing piece.

The skids and struts are easily identified and simply bolt together using $\frac{3}{4}$" 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 rear strut should butt against the plastic fuselage and rest against the 1/8" ply undercarriage plate. The bolt holes for the rear strut will then come behind the cabin rear. FIG. 2.

With a pencil mark four spots using the fixing holes in the struts as a guide.

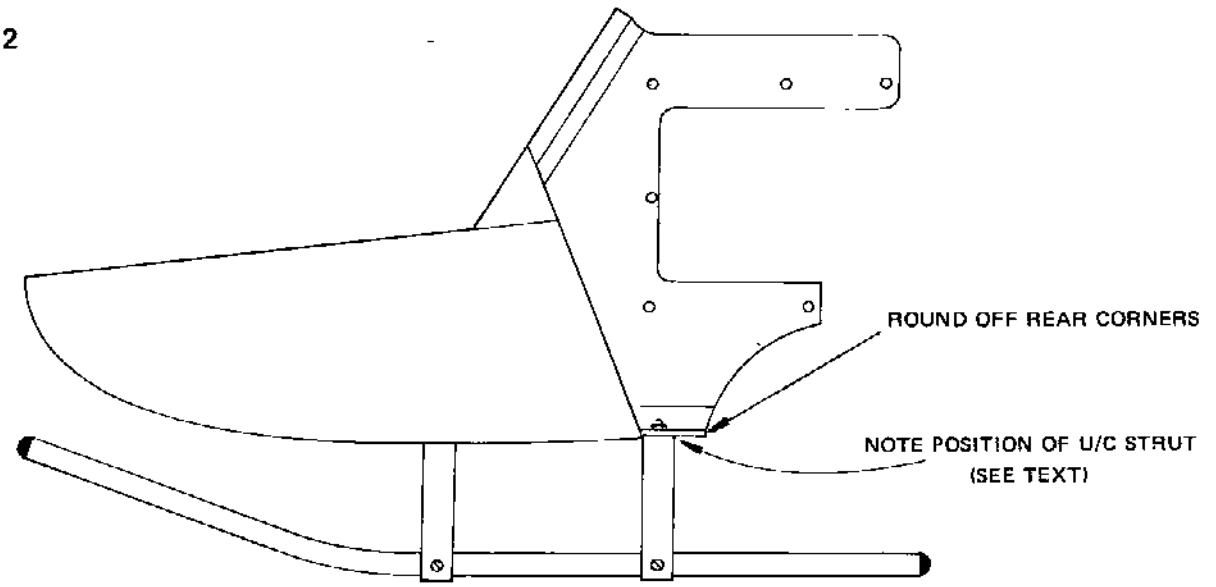
Drill the fuselage at these spots using a 1/16" drill as a guide and a 7/64" drill to finish.

Round off the corners of the 1/8" ply undercarriage plate as indicated in FIG. 2.

Don't bolt the undercarriage in place yet.

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.

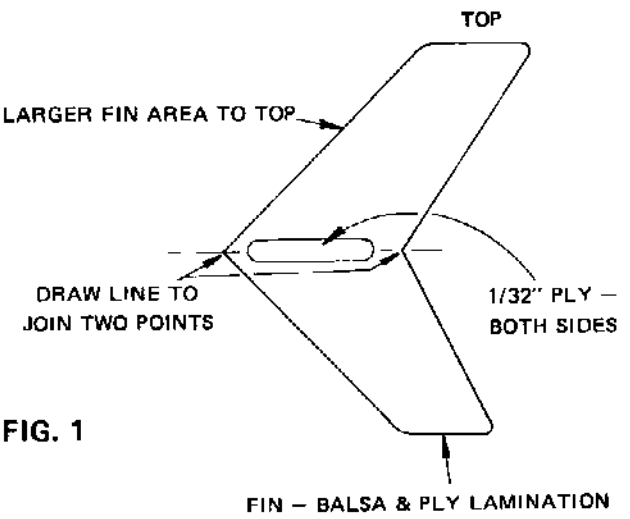


FIG. 1

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:-

Remove the four drive and rotor shaft mounts, with phosphor bronze bearings, from their sprues and trim off any flashing with a sharp balsa knife. (The blade will have a tendency to slip so mind your fingers). Make sure any flashing is removed from the bearing holes.

Take each bearing separately and, using the $\frac{1}{4}$" 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 $1\frac{1}{4}$" 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).

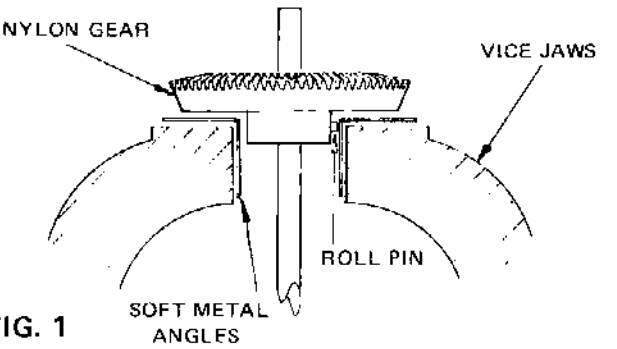


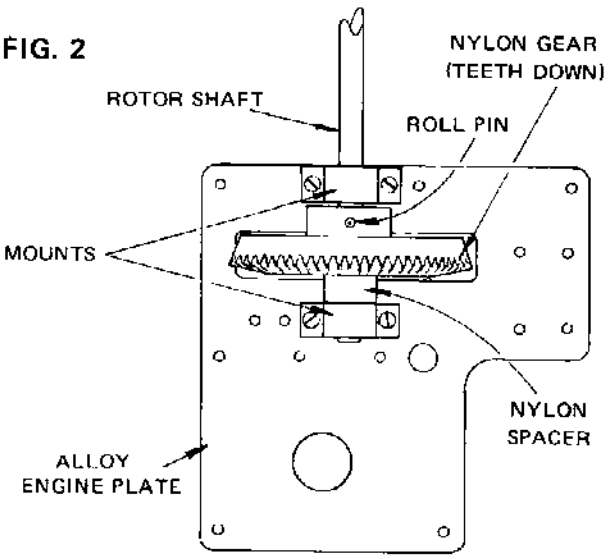
FIG. 1

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 $\frac{1}{2}$" 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

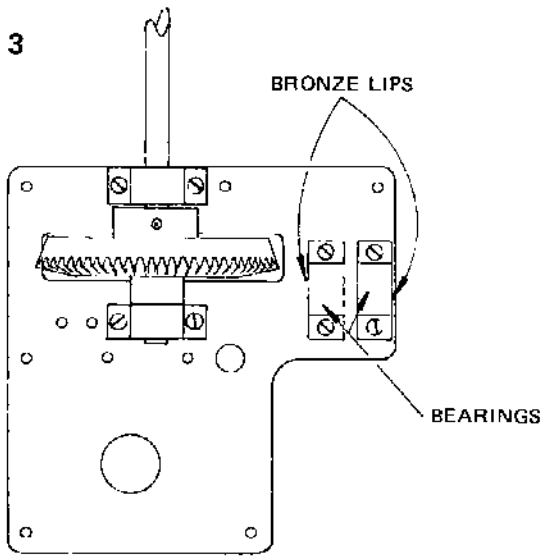
tightening nuts add a little Torqseal (this takes 3 hours to set so if necessary you can again slacken nuts during this period) do not over tighten or this will cause distortion of nylon mounts — recheck for free rotation of shaft.

FIG. 2



Now mount the bearings for the counter shaft using screws and washers under heads as with main shaft, with bronze lips facing outwards (FIG. 3). 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 by chance possess 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. If you have no reamer then again careful use of the round needle file in the plate fixing holes will be required until the desired line up is obtained.

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 bearings 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, do not over tighten so avoiding distortion of nylon mount lugs.

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.

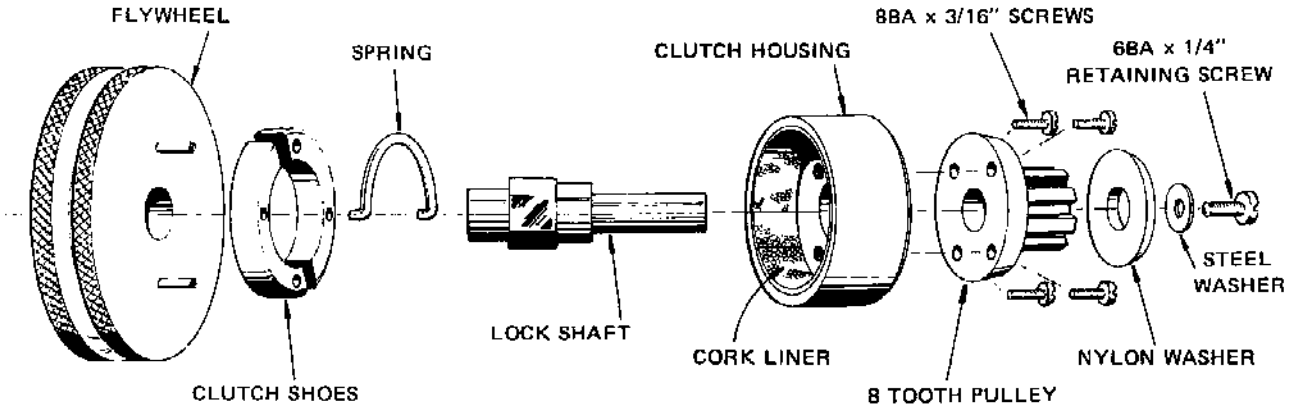


FIG. 4 CLUTCH ASSEMBLY

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

Stick cork liner around inner circumference of clutch housing with epoxy, use only a thin coating of adhesive and trim off surplus cork.

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 $\frac{1}{4}$" 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, pins facing outwards and follow with lock shaft which should be tightened 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. Push clutch shoes on to flywheel pins as shown in drawing, before adding spring slightly compress inwards with pliers so that ends of clutch shoes touch when spring is in place. 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 clutch shoes.

Press nylon washer on to end of shaft and add 6 BA x $\frac{1}{4}$" retaining screw with steel washer under head, to end of shaft and tighten.

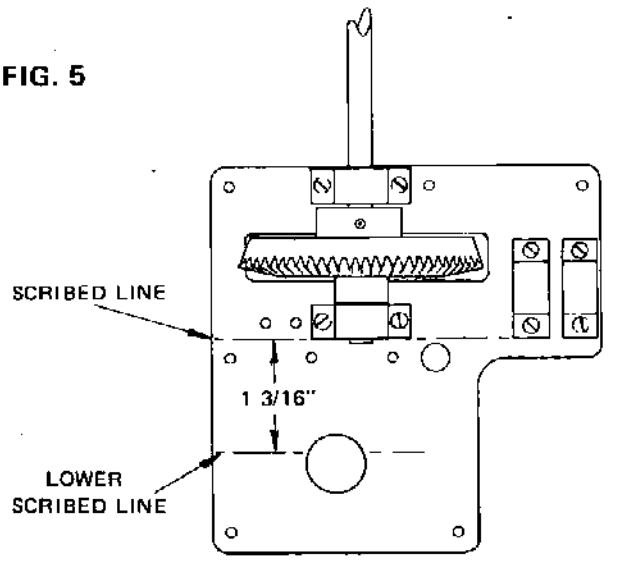
Since no two makes of engine are alike the mounting holes have to be drilled by the builder.
The following method is recommended.

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.

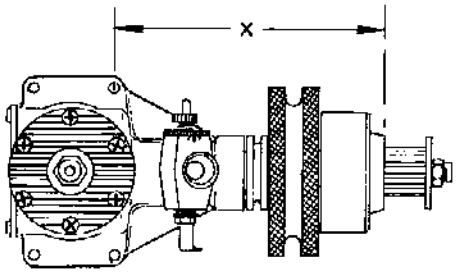
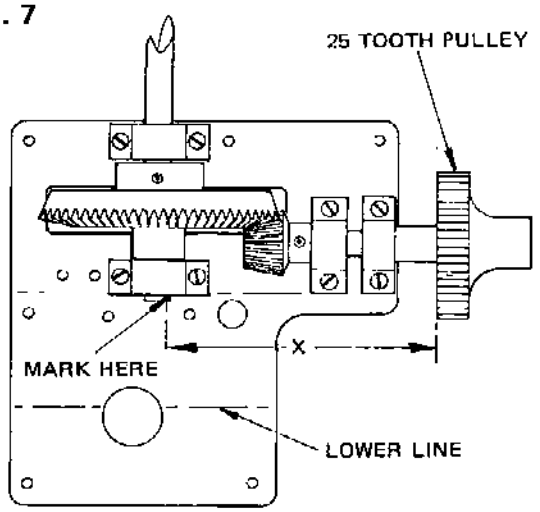


FIG. 6

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.

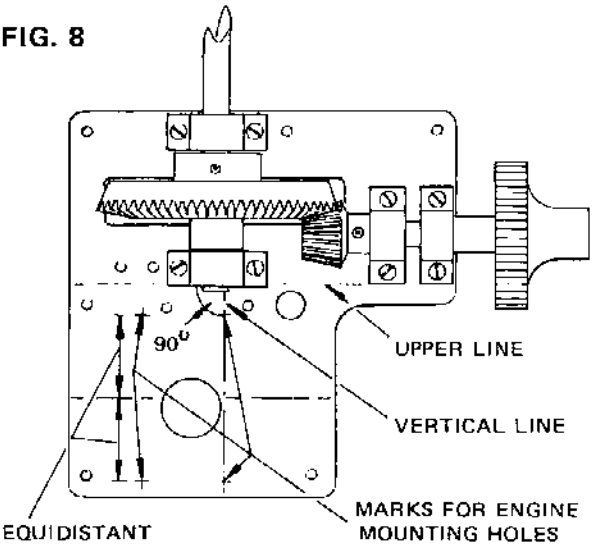
FIG. 7



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



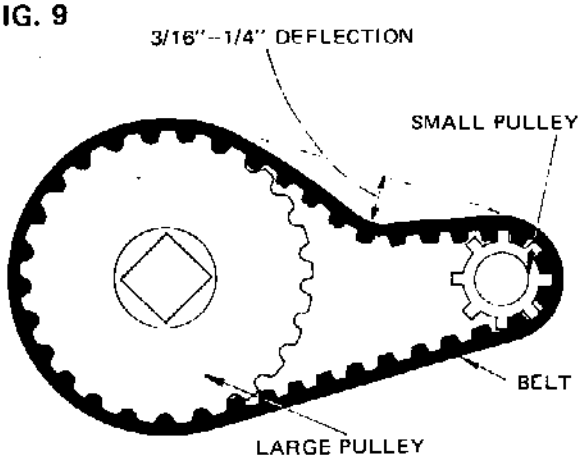
Measure the distances between the engine mounting holes and make four marks on the mounting plate to coincide with these using the scribed lines as a reference. You should have two marks equidistant from the lower scribed line on either side of it. FIG. 8.

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 $\frac{1}{4}$" 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



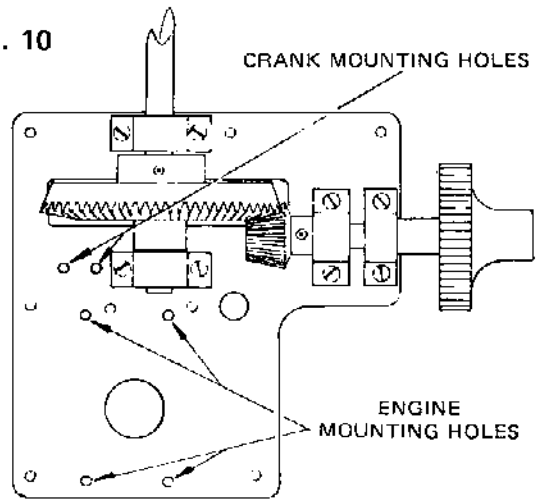
The belt should have a slackness of 3/16" to $\frac{1}{4}$". FIG. 9.

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).

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).

The two mini bellcranks are now mounted on the plate. Each crank has a stand off pillar, the short pillar on left (engine side), long pillar on right side, and each is secured by a 6 BA bolt and nut (long and short bolts supplied). The mounting holes are located to the side of the lower rotor shaft bearing. FIG. 10.

FIG. 10



One crank goes on either side of the mounting plate.

The crank that fits in the hole nearest the rotor shaft bearing is fitted on its pillar on the right (starboard) side of the plate. The crank boss faces outwards.

The other crank fits on its pillar in the other hole and on the left (port) side with its boss also facing away from the mounting plate. Remove any flashing from the plastic, check the cranks for freeness. Use Torqseal to secure the nuts.

Only use Torqseal where advised during the construction. Don't be tempted to use it for other nuts etc. on the model.

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.

With a 7/64" drill make holes in the ply just deep enough to clear the ends of the bolts. Use a $\frac{1}{4}$" 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.

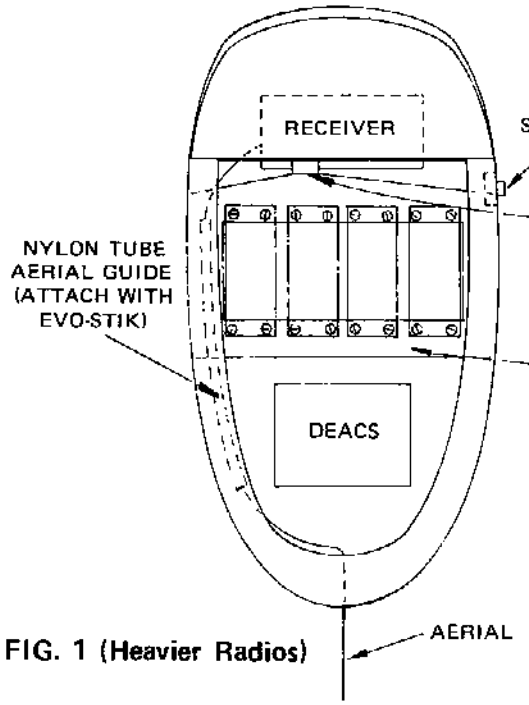


FIG. 1 (Heavier Radios)

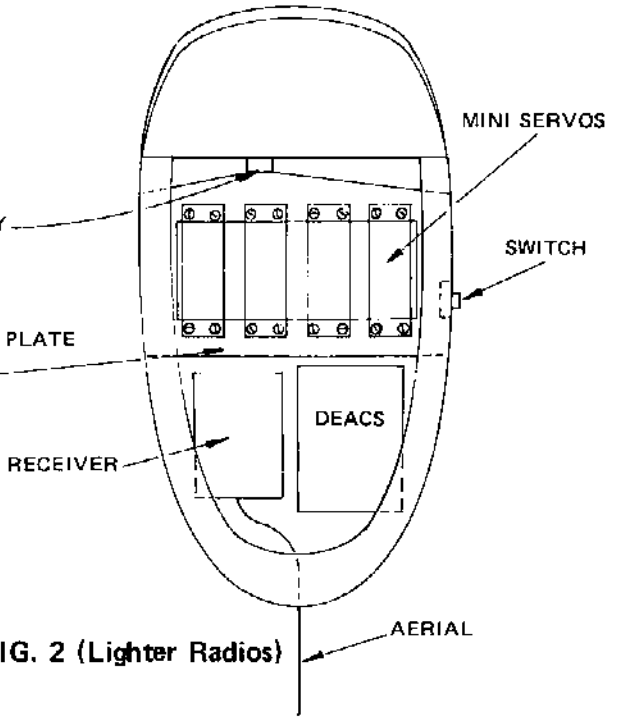


FIG. 2 (Lighter Radios)

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.

Two suggested layouts are shown Fig. 1 and Fig. 2. The fugelage is seen from the top.

The servos are fitted to a 3/16" or $\frac{1}{4}$" ply plate, which is made to fit across the fuselage. A side view is shown in Fig.3.

Reinforce the A.B.S. fuselage on the inside, where the servo plate is glued, with thin ply to spread the load. Fig.4.

Glue the thin ply to the A.B.S. (with Evostik Impact or similar) first, or you won't get the plate in, then the servo plate should be epoxied to the ply.

If the receiver is fitted behind the servos, Fig.1, it will have to be installed before the servos are finally screwed in place.

A thin ply reinforcement should also be used at the switch and aerial outlet positions.

The purpose and position of each servo is shown in Fig.5.

With the foregoing considerations in mind install the radio.

Linkage accessories for this purpose are

FIG. 3

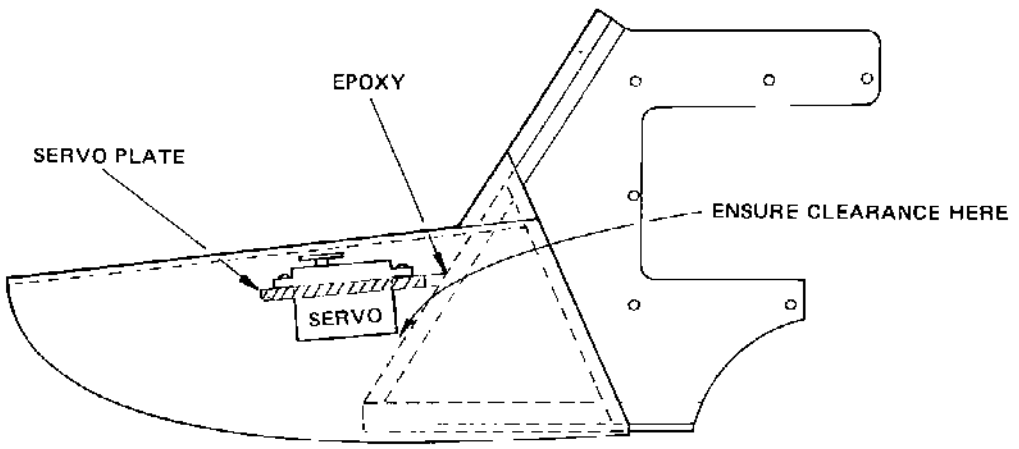


FIG. 4

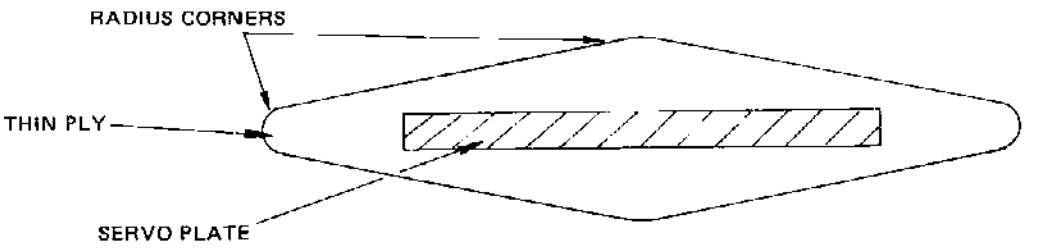
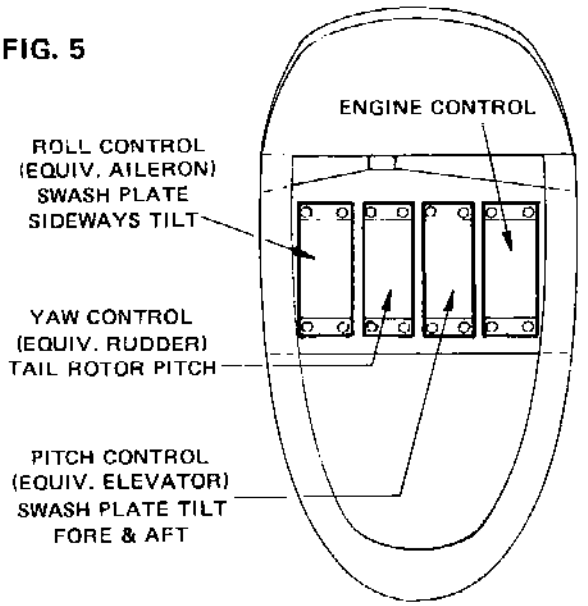


FIG. 5



included viz:- Wire push rods with nylon adjustable links 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 balsa fuselage rear.

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

Depending on the engine you have used the crank may catch one of the engine mounting pillars. If this happens file the pillar or trim a fraction off the crank.

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. 6

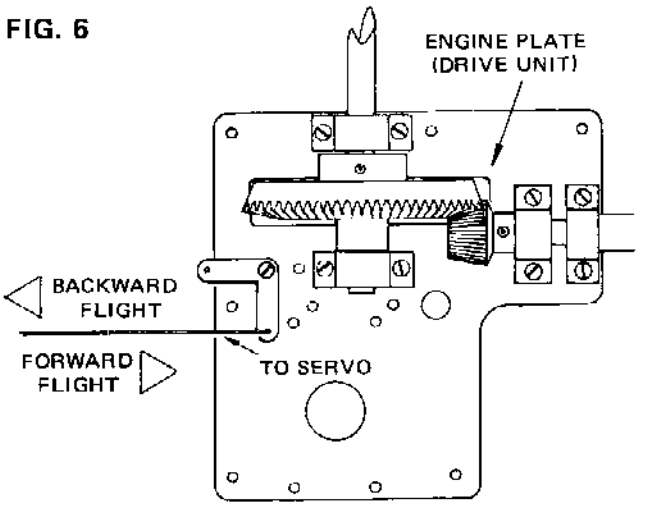
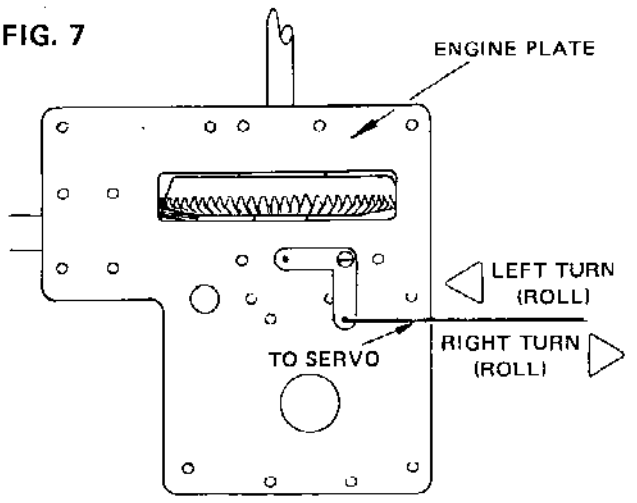


FIG. 7



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

You have already built the fin. Drill two holes with a 3/32" drill $1\frac{1}{2}$ inches apart through the plywood reinforcements of the fin. Fig.1. These holes should match up with the predrilled holes in the boom.

Temporarily bolt the fin in place with 8BA bolts and nuts on the starboard (right) side of the boom. The larger side of the fin is upwards.

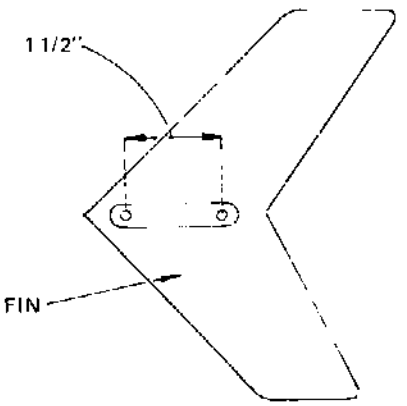


FIG. 1

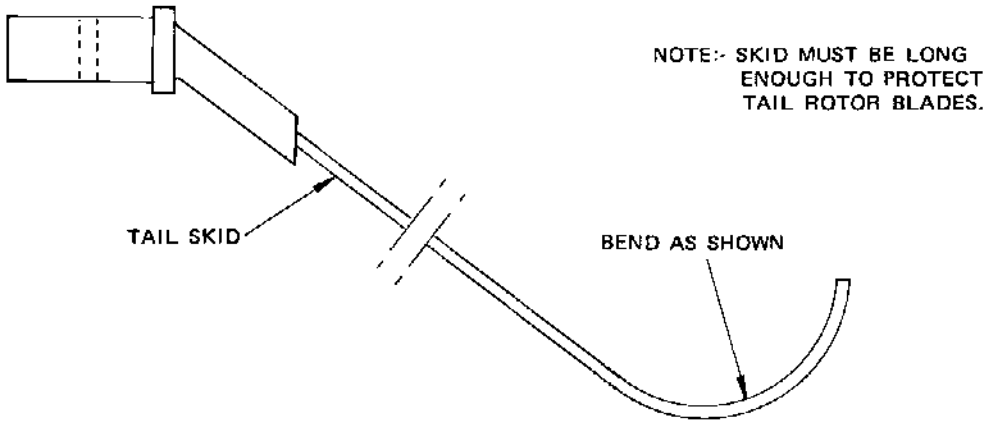


FIG. 1

Bend the tail skid to shape, as shown in the drawing, and push in to end of boom. Fig.1. This is retained by rear gear cage fixing bolt.

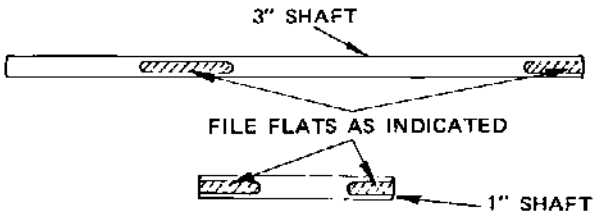


FIG. 2

The tail rotor assembly contains two shafts 3" long and 1" long. Before assembling the tail rotor the shafts must have flats filed at the positions shown in the diagram Fig.2. You will need a sharp file for this because the shafts are hardened to avoid bending problems after a crash.

Install the small shaft in the gear cage as in Fig.3. Screw a brass mitre gear on the inside and the aluminium alloy 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.

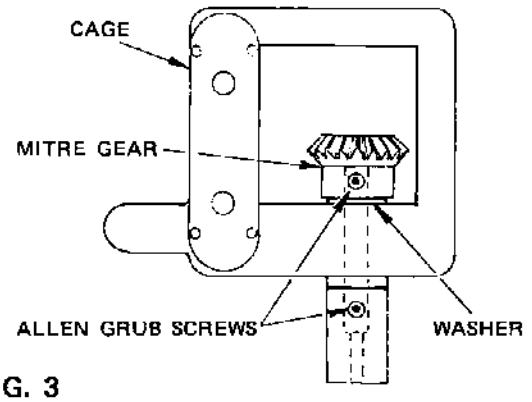


FIG. 3

Install the large shaft in the gear cage as in Fig.4. Screw 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.

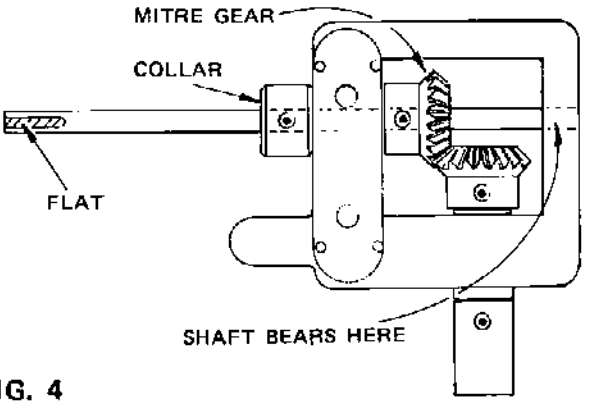


FIG. 4

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. With the initial batches of Kits it will be necessary to take a small knife and bend up the last $1\frac{1}{2}$ turns of spring to make end loops.

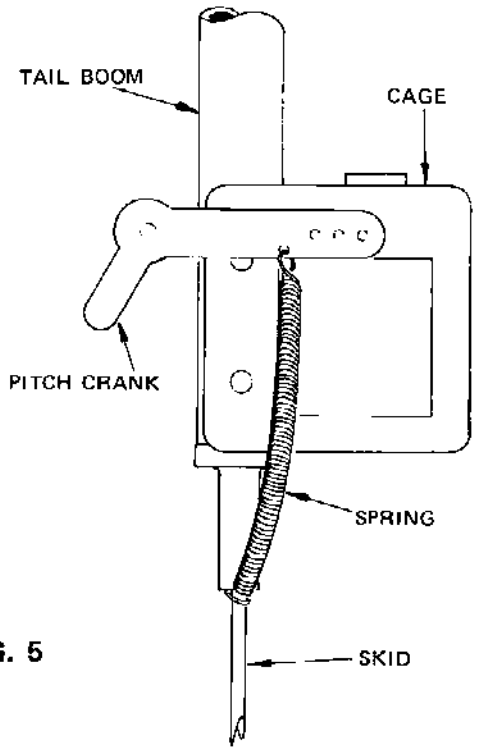


FIG. 5

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

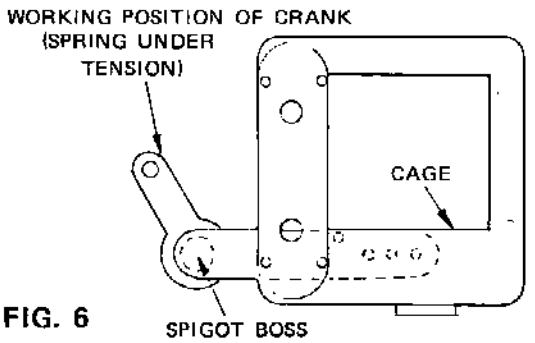


FIG. 6

Fit the tail rotor blade holders to the tail rotor head as shown in Fig.7, using the brass blade connecting shaft and 8BA bolts and washers. Use Torqseal to secure the bolts - a little only so it doesn't jam up the mechanism.

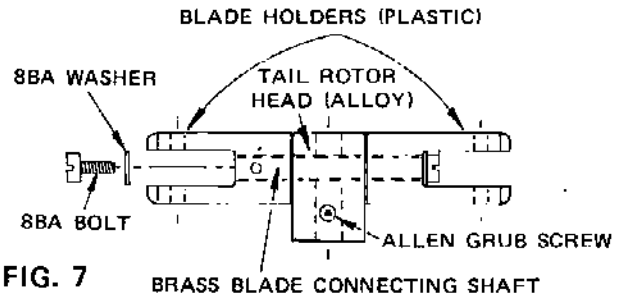


FIG. 7

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.

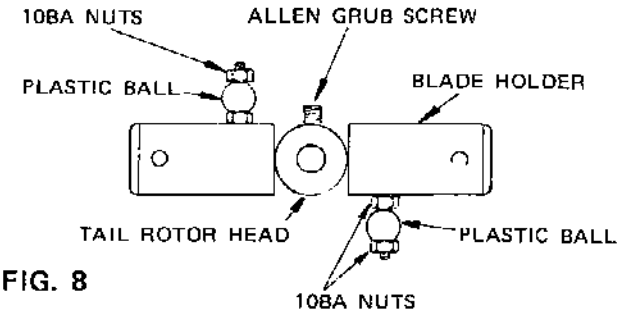


FIG. 8

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

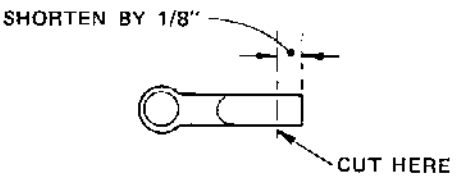


FIG. 9

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

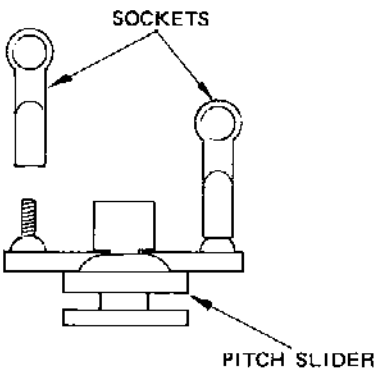


FIG. 10

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.

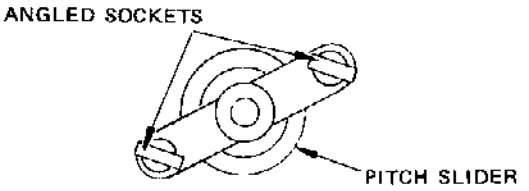


FIG. 11

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.

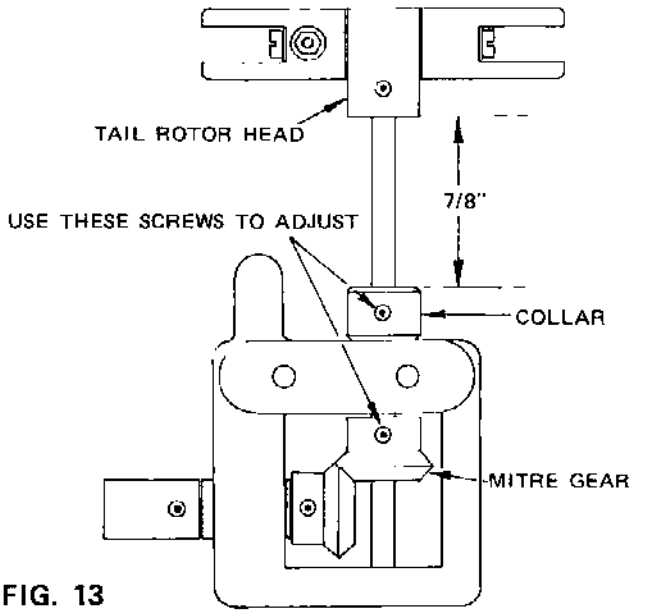
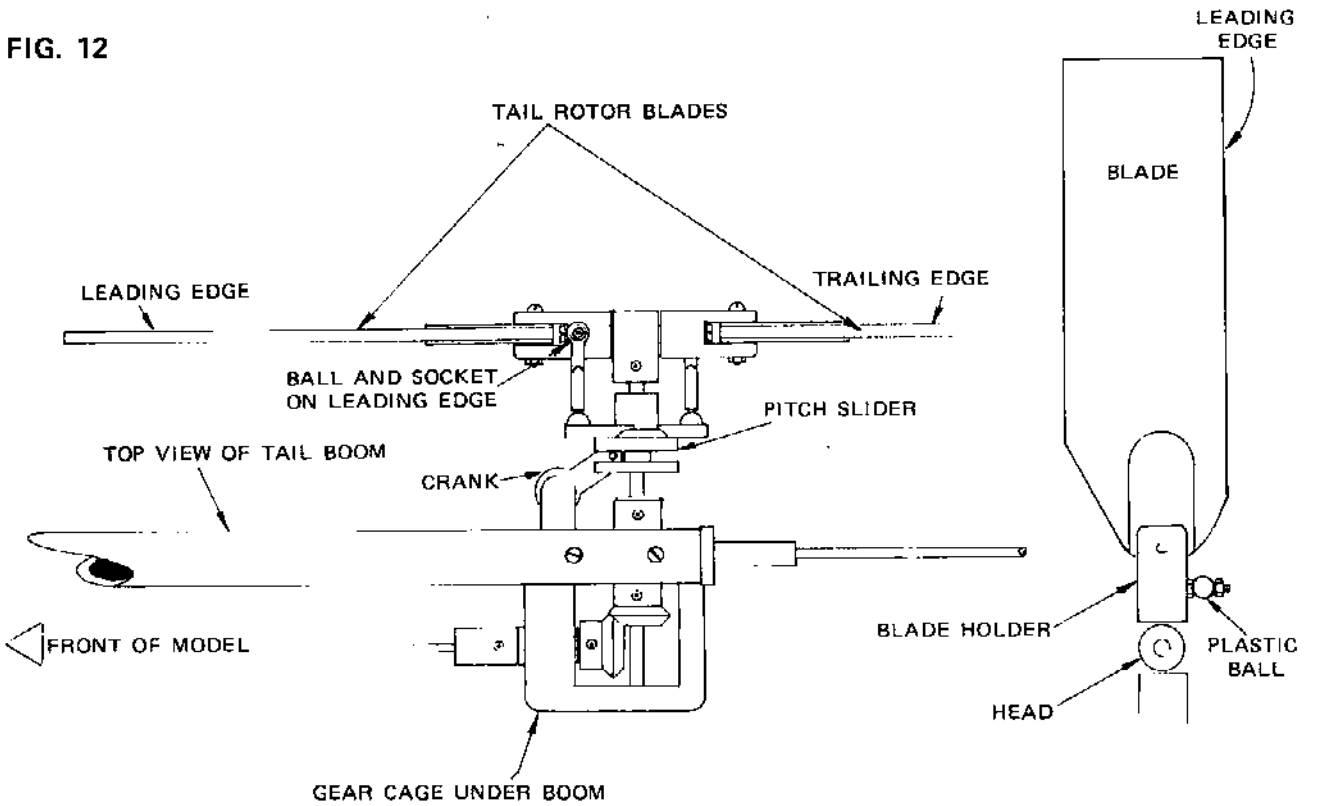


FIG. 13

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.

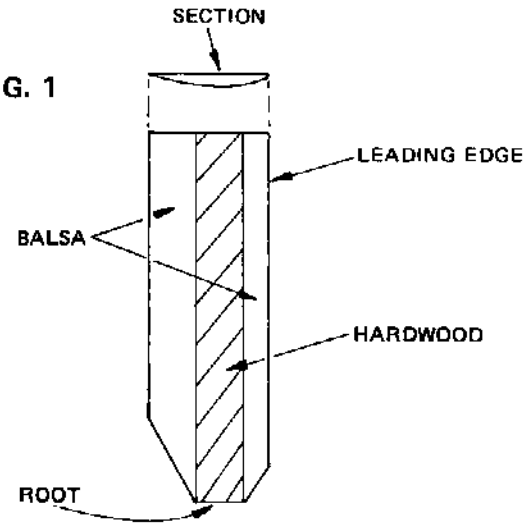
FIG. 12



The blades are constructed from three pieces of wood as shown in Fig. 1.

Stick the pieces together with P.V.A. white glue, pin them down to your building board, over a piece of scrap paper to prevent them sticking to the board. The leading edge of both blades should be to your right. Make two identical blades.

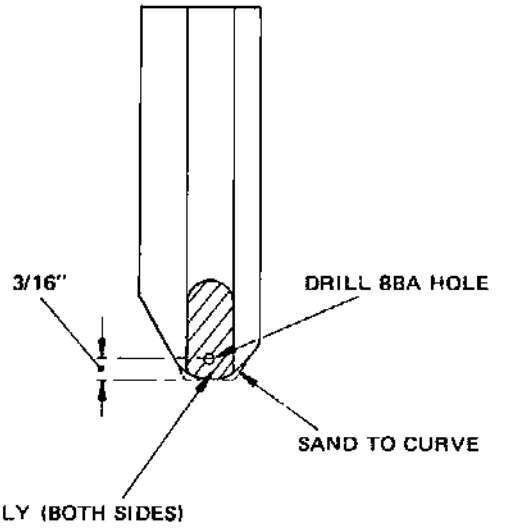
FIG. 1



When the glue is dry remove the blades from the board, turn them over so that the leading edge is to your left, and the root (Fig.1) is towards you. Sand them flat.

Sand the other side of the blades to an aerofoil section. (Fig.1)

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 Kwikcote the fit should be quite free.

Note: Tail Rotor Assembly should measure 8¾" diameter when completed.

FIG. 1

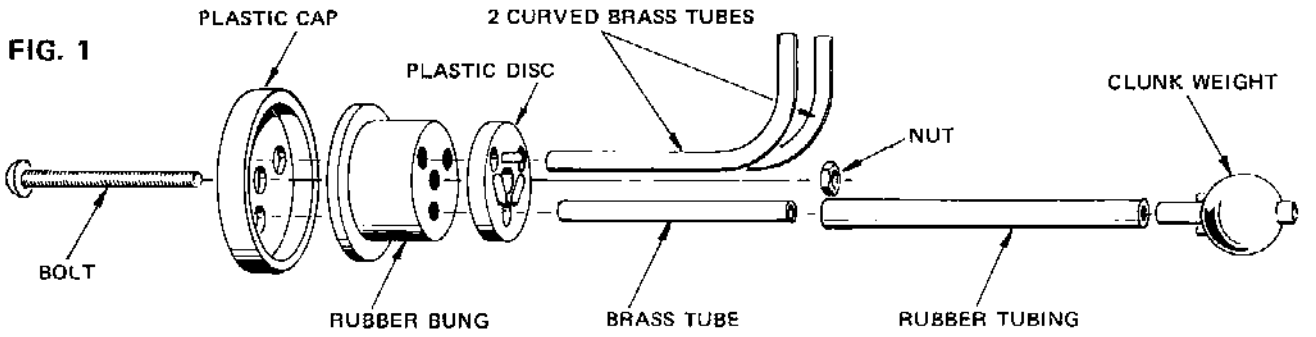
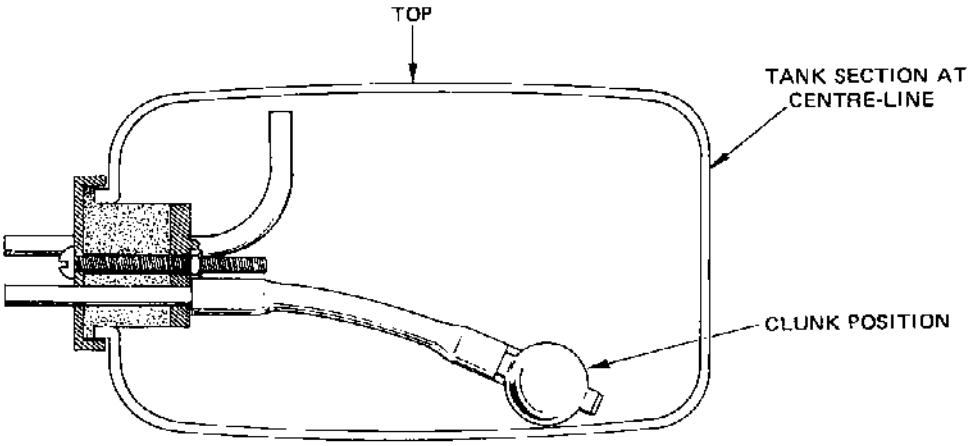


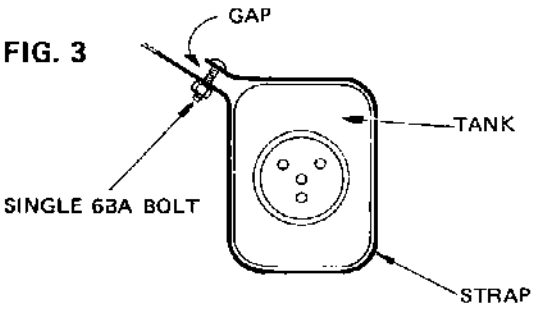
FIG. 2



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 9"x1¼" aluminium supplied.

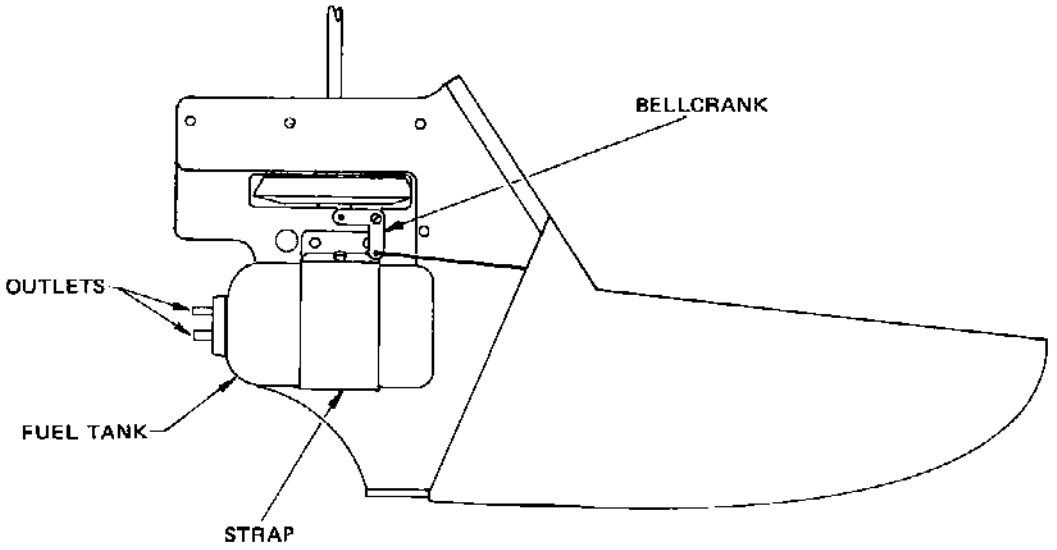
Fold the strap round the tank carefully as shown in Fig.3.

Drill two holes to take a single 6BA bolt, as shown, in the centre of the strap. Leave a gap of about ¼" 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 just clears the bellcrank on the right (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.

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.

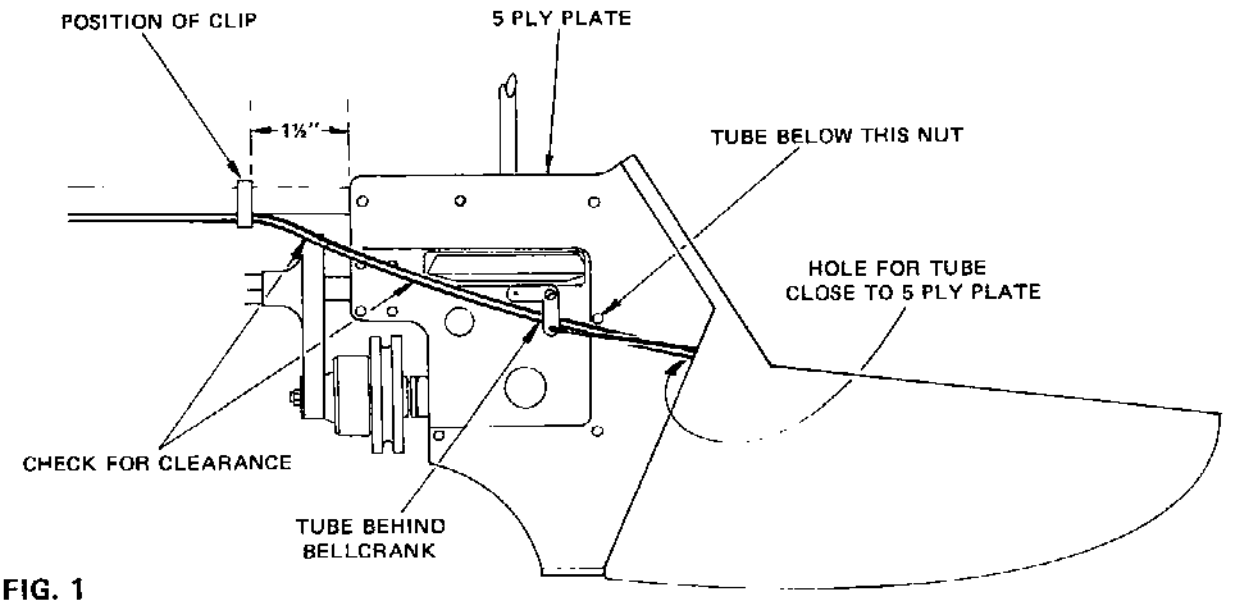


FIG. 1

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 close to the 25 tooth pulley, close to the nylon bevel gear, under the bellcrank pillar, against the 5 ply plate and through the fuselage rear.

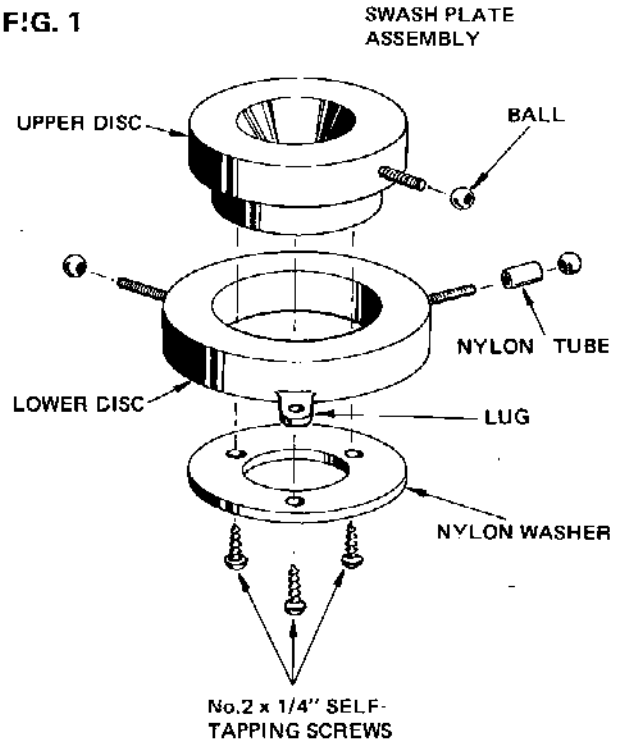
Make a hole in the fuselage rear to take the tube, which should be a tight fit in the hole. The hole should also be against the ply plate and in approximately the same line as the roll control rod. Lay the tube to one side until final assembly.

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

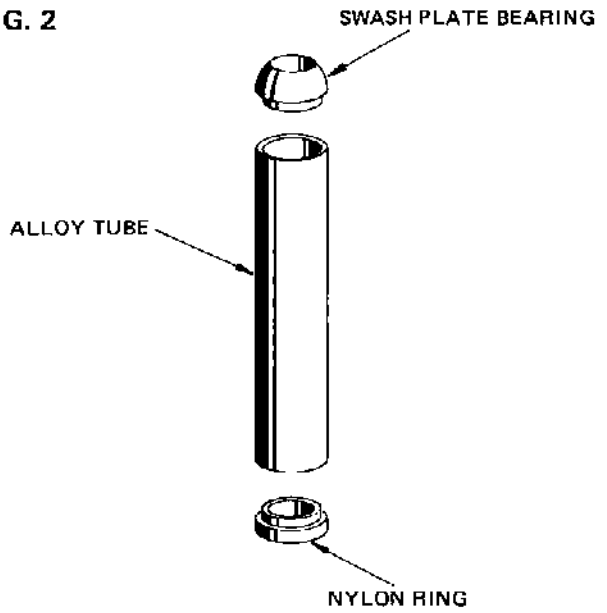


Assemble the swash plate, using three self-tapping screws. Fig.1.
The lug on the side of the lower disc is on the bottom edge.

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.

The swash plate is connected with ball and socket joints.

FIG. 2



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.

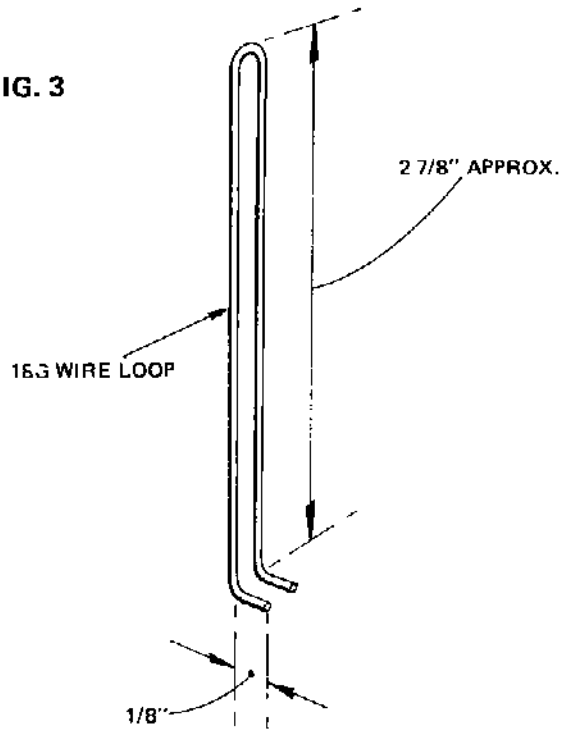
Slide the assembly over the rotor shaft until the nylon ring meets the upper rotor shaft bearing block.

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.

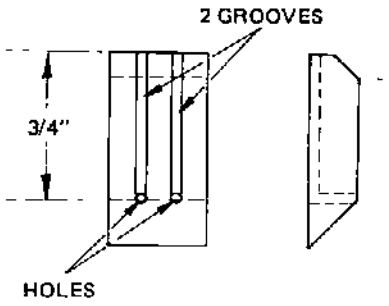
Bend the ends of the 18G wire loop at an angle of 90° and about 1/8" long. Fig. 3.

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.

Bend the end coils of swash plate retaining spring upwards at both ends and hook the

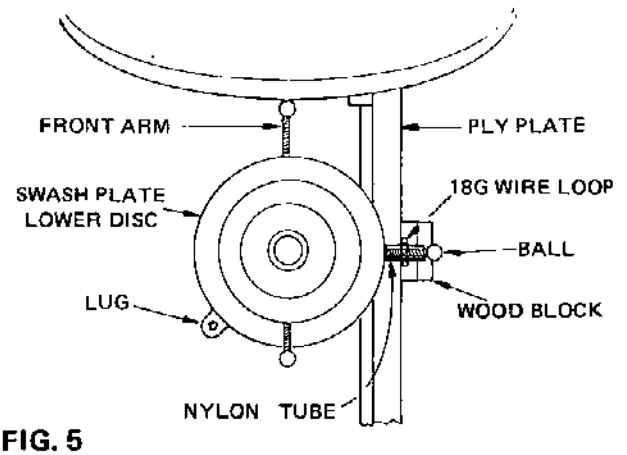


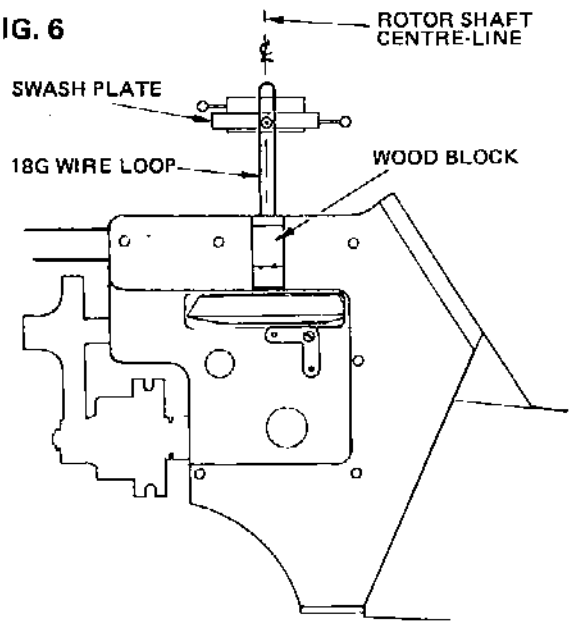
FIG. 5

swash plate retaining spring through the lug in the swash plate lower disc. The other end of the spring is held by the forward boom fixing bolt, under the washer. Remove the bolt first.

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.
If the rotor shaft tube is fitted with a plastic sleeve this should be left in position between upper and lower holes. Fig.1.

The Rotor head pivot shaft is a 1" length of 10G steel rod.

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.1.

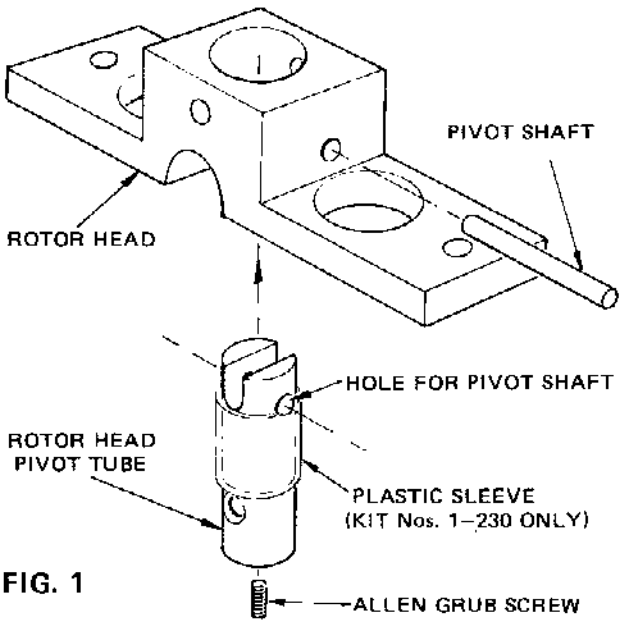


FIG. 1

With the aid of the Allen key a $\frac{1}{4}$" 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. 1.
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, the more cautious modellers may even care to add a small dab of solder each end as well for safety sake.

The pitch crank is an L shaped plastic moulding. Fig. 2.

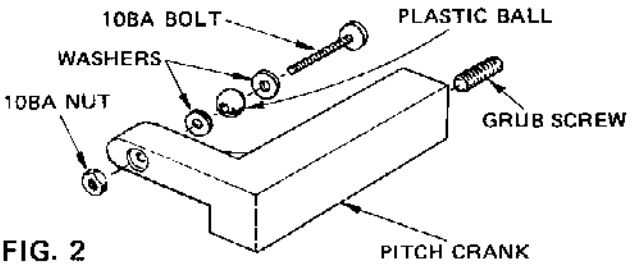


FIG. 2

Attach a ball, from a ball and socket connector, with a 10 BA nut and bolt as shown in Fig. 2. Secure the nut with Torqseal and cut off any surplus length of screw.

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. 3. with a washer either side of head.
The arm on the pitch crank is at the top. Fig. 2.

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

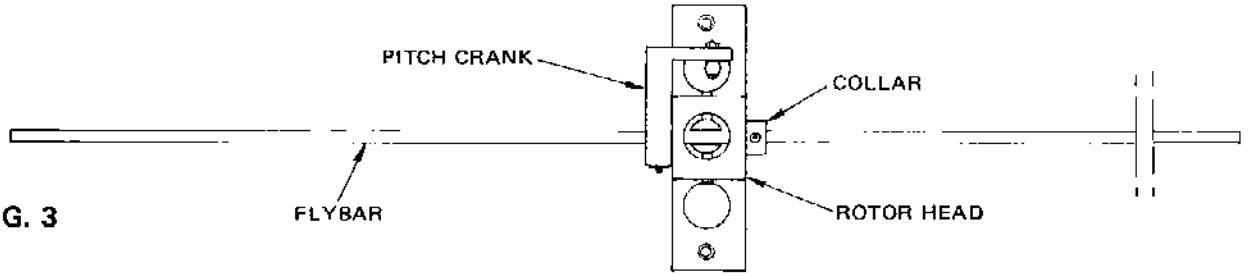


FIG. 3

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

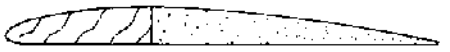


FIG. 1

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.

taking each blade in turn through the same stage.

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!

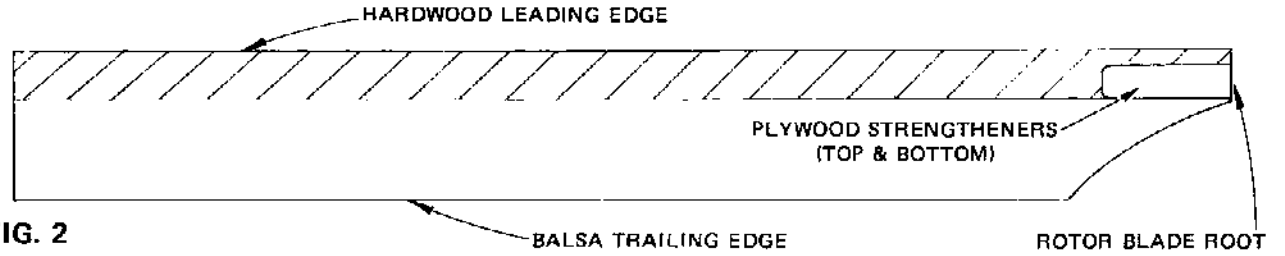


FIG. 2

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.

Carve and sand the upper 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. This can be achieved by carving and sanding in stages,

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.

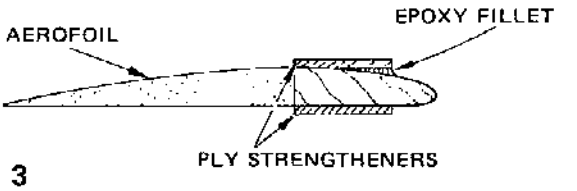


FIG. 3

Drill two holes in the blade roots, as shown in Fig.4, using 1/16" and 7/64" drills. Use the steel blade holders for positioning the holes, with a pencil through the holes.

Don't bolt the blade holders in position yet.

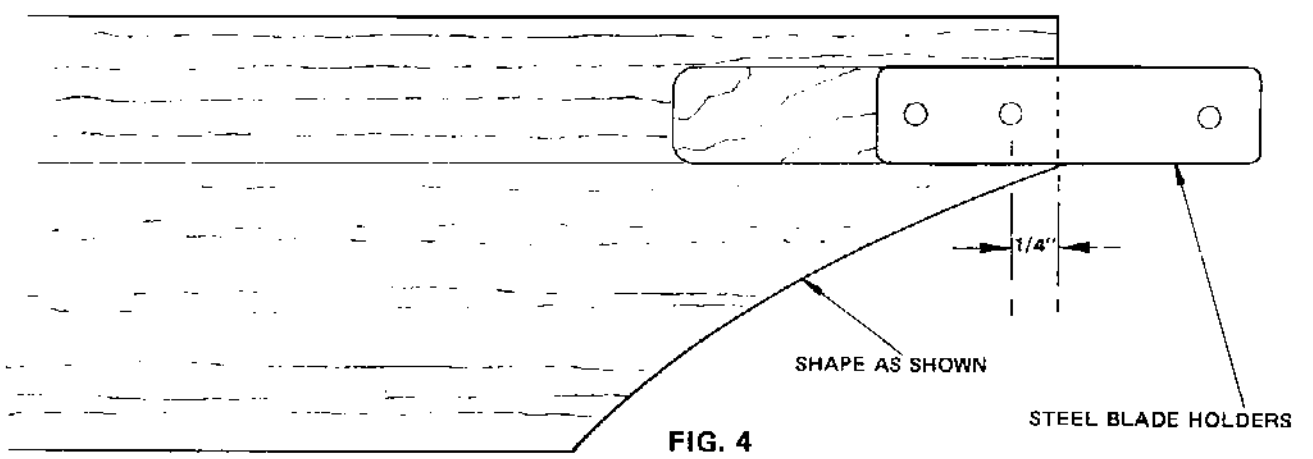


FIG. 4

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.

Paint, finish and decorate the following items:

1) Fuselage.
2) Tail boom.
3) Undercarriage.
4) Fin.
5) Main rotor blades.
6) Tail rotor blades.

The transfer/trim sheet includes many items of decoration including colour flash and lettering for fuselage sides, various signs and lettering for use at points as desired. Stripes for adding to main rotor and tail rotor blade tips etc.

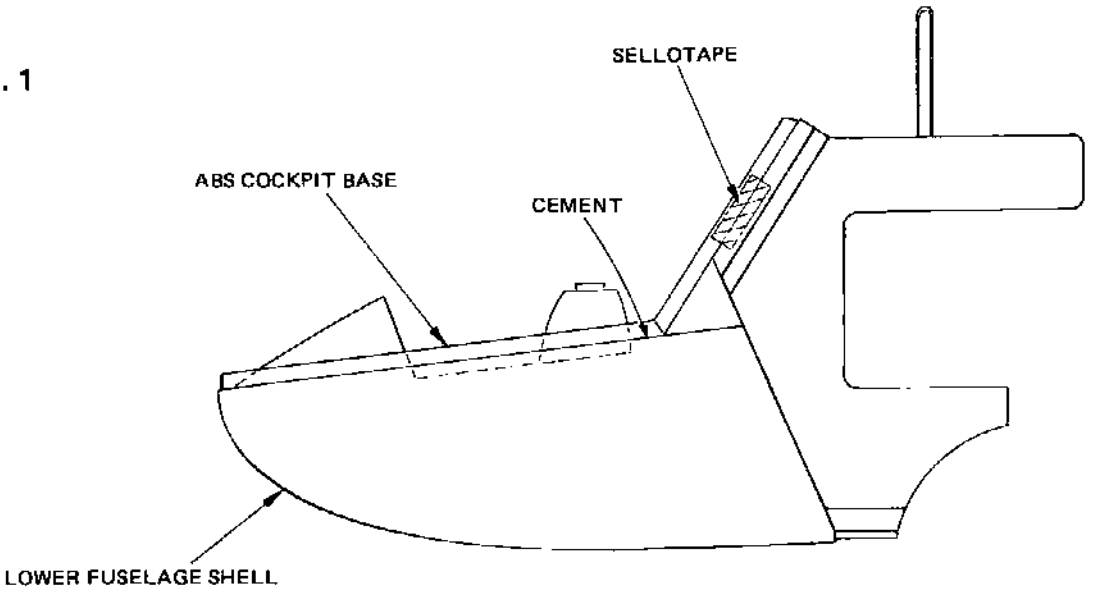
The cockpit unit is built and finished last. This unit is held in place with Velcro tape (supplied) and the finished fuselage, with tape glued in place, acts as a jig.

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.

Kwikcote can be used instead of painting on the rotor blades.

FIG. 1



The ABS plastic part of the cockpit has already been trimmed to shape for checking servo clearance.

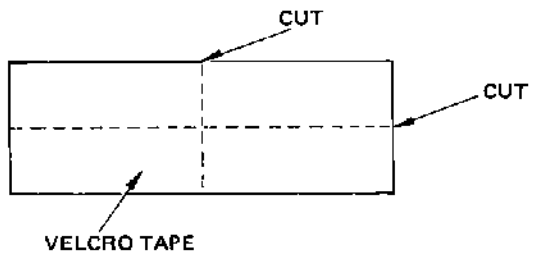
When the paint on the fuselage is perfectly dry, use Sellotape to fix the ABS cockpit interior to the fuselage. Fig. 1.

Use balsa cement or M.E.K. to glue the joint on either side. Fig.1.

Glue the pilot's head in place with Evostik or Epoxy.

Remove the cockpit interior and paint and finish to taste. Don't paint the underside.

FIG. 2



Cut the Velcro tape into four equal parts, lengthwise and crosswise. Fig. 2. Velcro adheres using a hooks and eyes system, so separate the tape and glue the four eyes pieces to the underside of the cockpit interior, using Evostik Impact. Fig.3.

Glue the four Velcro hooks pieces to the fuselage, making sure they coincide with the eyes pieces; but don't press the Velcro together yet. Again use Evostik or similar impact adhesive.

When the Evostik is thoroughly dry, fit the cockpit to the fuselage. This holds the cockpit firmly while the canopy is being glued in place.

Make a small hole near the pilot so that the finished cockpit can breathe.

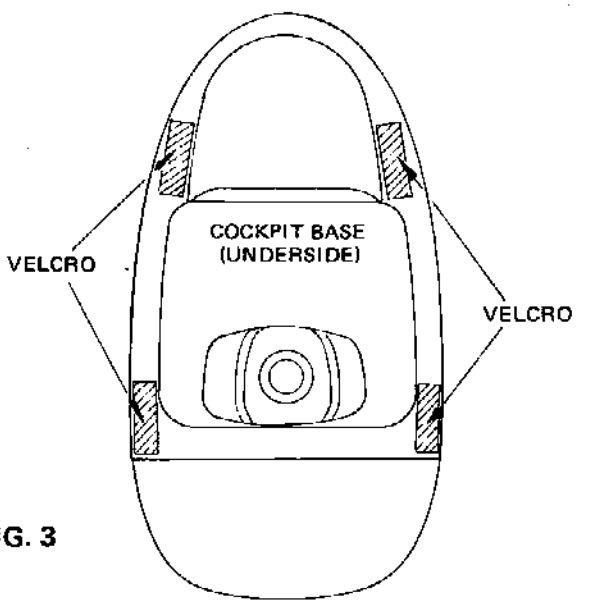


FIG. 3

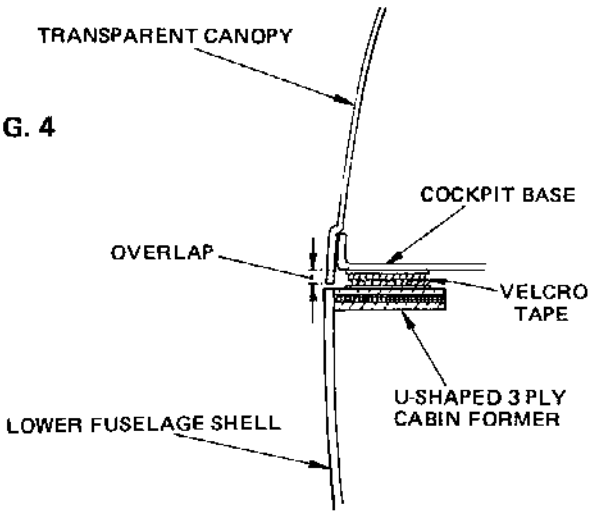
Trim the canopy to shape. Allow the bottom edge of the canopy to overlap the A.B.S. slightly in order to help hide the Velcro. Fig.4.

Glue the canopy in place using clear impact adhesive (Bostik No.1). Marking the canopy and cockpit before gluing will act as a guide. Make sure no glue gets on the fuselage.

Tidy up the canopy edges after removing from the fuselage when the glue is dry.

Mask off and paint.

FIG. 4



ATTACHMENT OF CANOPY TO LOWER SHELL

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 Kwikcote 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 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.

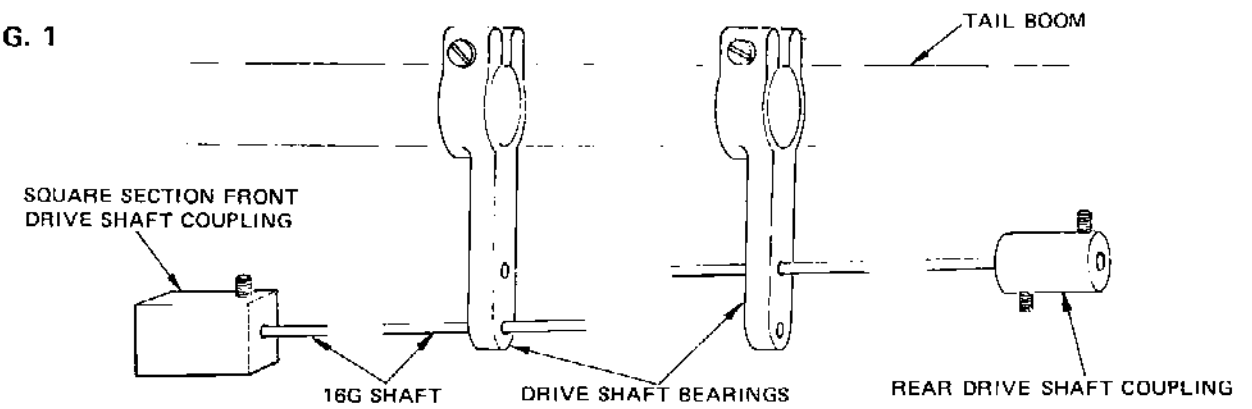
File a flat on the cut end of the drive shaft.

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 quick link in place using most of the thread.

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

Make sure the quick 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 so that it fits properly in the 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 quick link to do this.

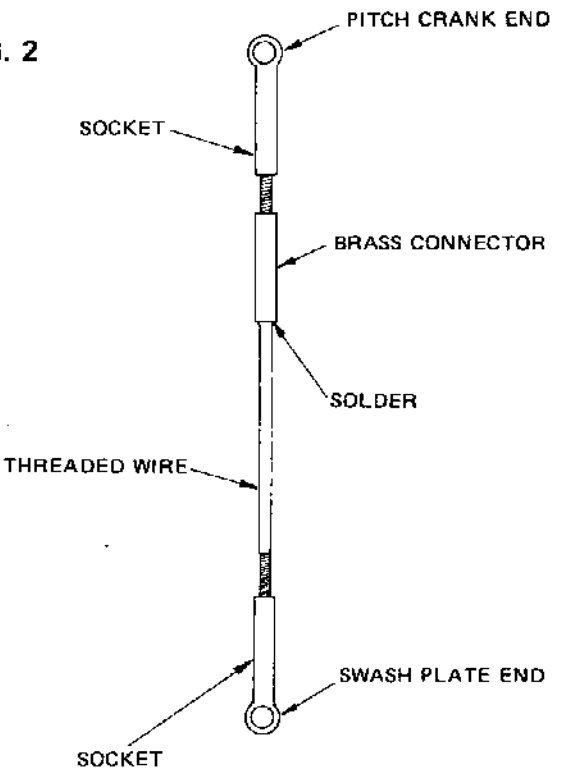
Attach the heat sink to the engine. The heat sink is bored out to suit the larger engines. If an engine with a small diameter head is used then use the shim material supplied in the kit, as packing between cylinder head and heat sink, for a close fit.

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.

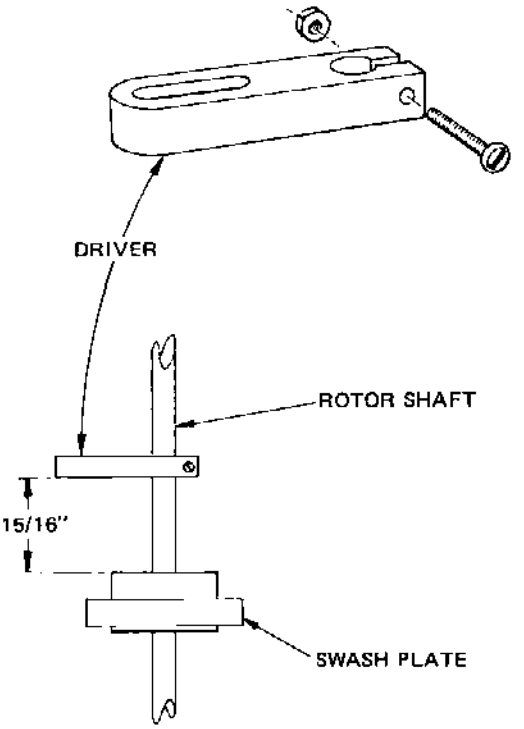
Fit the 6BA nut and bolt and washers, but don't tighten yet.

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.

FIG. 3



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.

The plates go on top of the blades.

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.

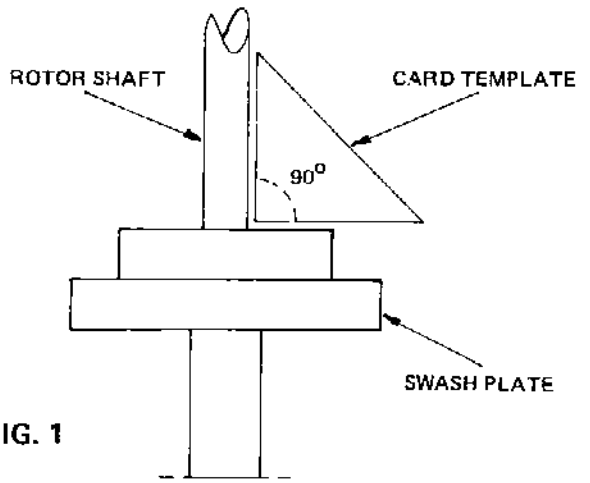


FIG. 1

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.

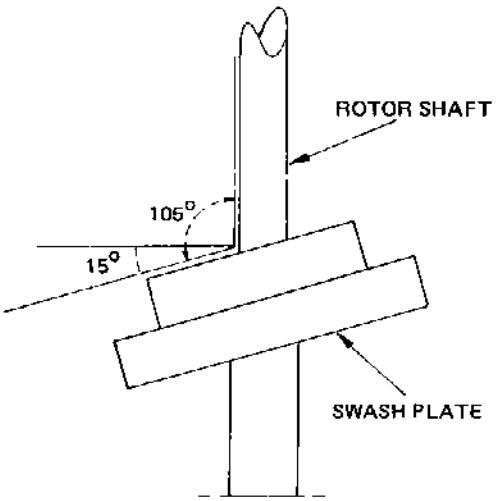
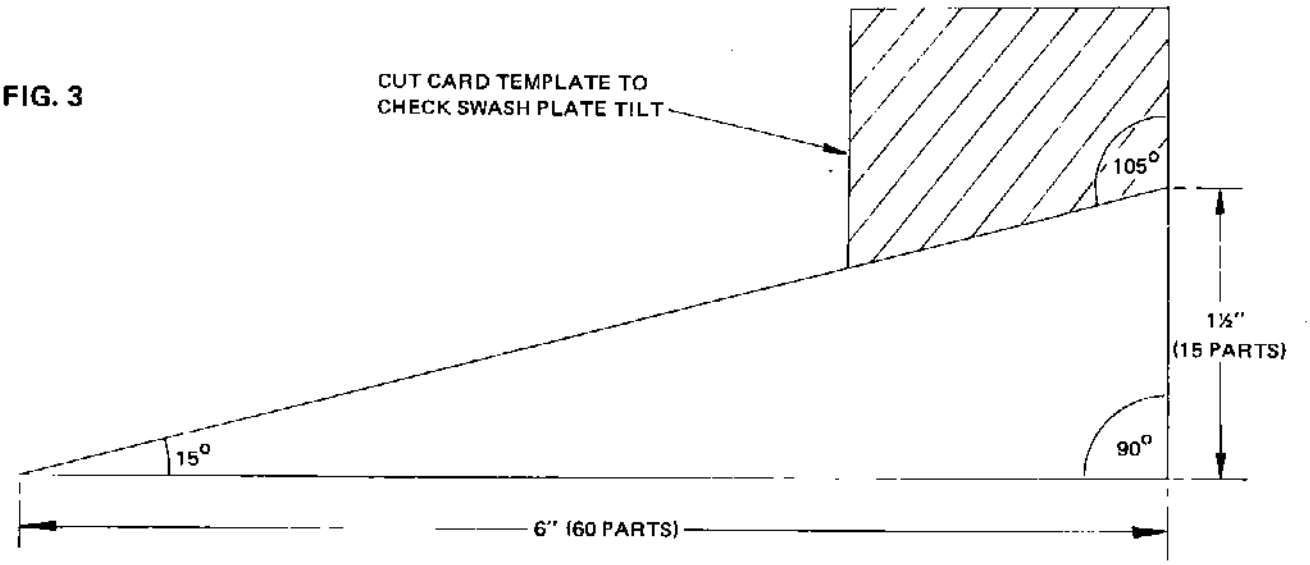


FIG. 2

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.

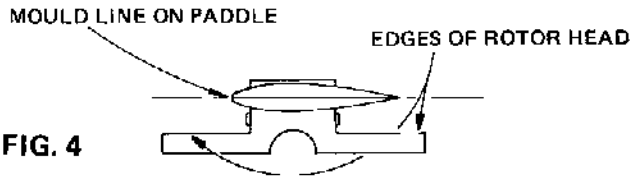


FIG. 4

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 Hexagon 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.

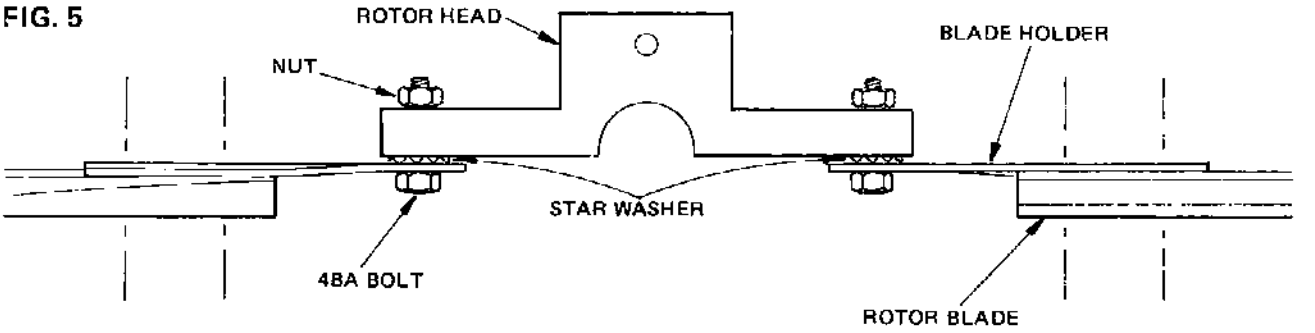
Turn the rotor assembly upside down and balance it on the flybar.

Use paint or Kwikcote 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



With a large 90° set square, or one corner of your favourite magazine, square up one of the rotor blades to the flybar and tighten the nuts holding the blade.

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.

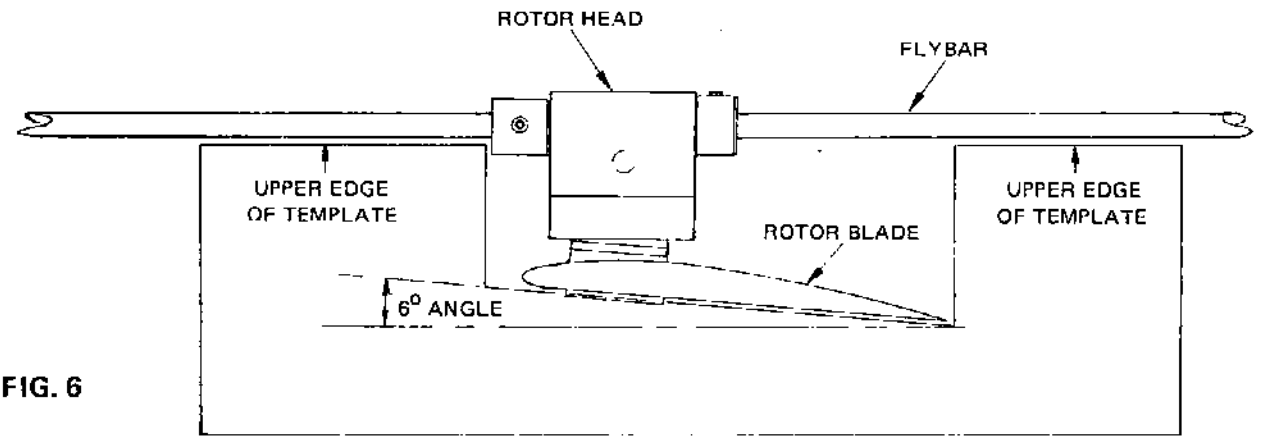


FIG. 6

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

Ideally the flying site should be a large area of short grass free from bystanders, especially dogs, small boys andphotographers. 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 clevis 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.

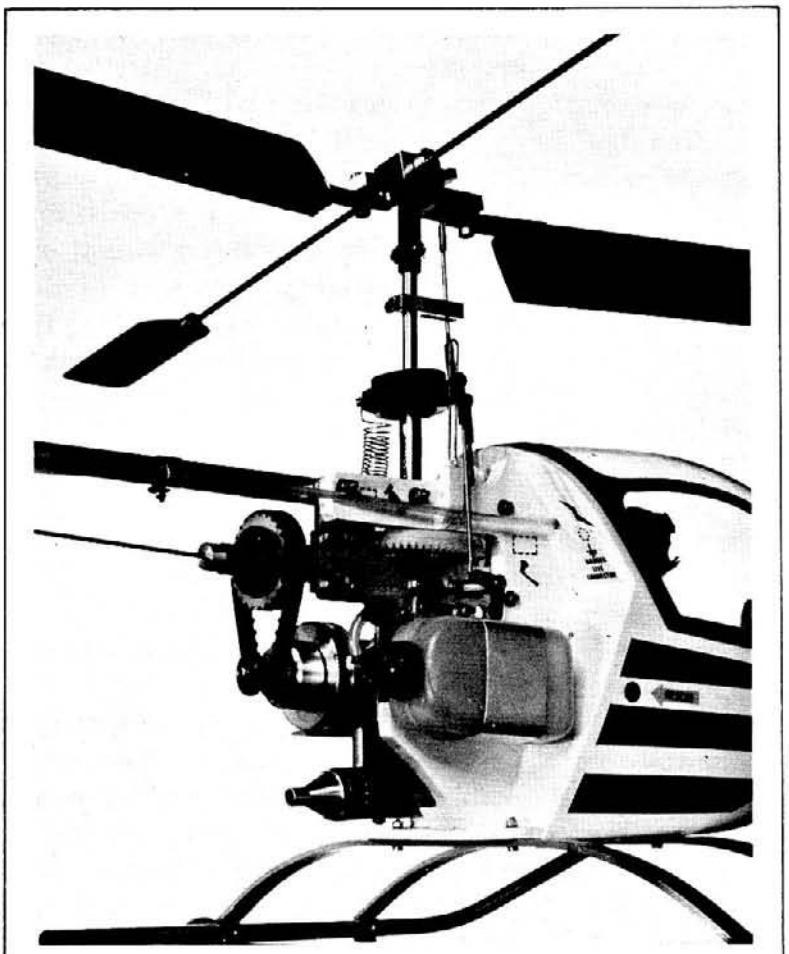
If you read these instructions about 100 times before you attempt to fly, there is a reasonable chance of getting down in one piece.

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 and it wasn't until recently that Dieter Shluter in Germany proved their practicality. The "Lark" 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.



STARBOARD SIDE VIEW – Showing attachment of fuel tank and its plumbing, swash plate assembly and linkages.

L.M.1	One Manual + Cabin Structure Drawing		
H.W.1	Engine Bearer	- 9 mm. (3/8") Ply.	Pack One
H.W.2	Cabin Rear Upper	- Balsa.	
H.W.3	Cabin Rear Lower	- Balsa.	
H.W.4	Cockpit Backing	- Balsa.	
H.W.5	Cabin Inner U Frame	- Ply.	
H.W.6	Cabin Floor/Landing Gear Mounting Plate	- Ply.	
H.W.7	Body Reinforcing Struts	- 2 off Hardwood $\frac{1}{4}$" sq. & 5/8" x 5/16".	
H.C.1	Cabin Body	- A.B.S. Forming	Separate
H.C.2	Cabin Canopy	- Butyrate Forming	Separate
H.C.3	Canopy Base with integral panel and pilots shoulders	- A.B.S. Forming	Separate
H.C.4	Pilots Head	- Moulded	Pack Two
H.C.5	Velcro Tape 3"	- For fixing canopy to body	
H.F.T.1	Fuel Tank	- 4 oz. with fittings	Pack Three
H.F.T.2	Tank Strap	- Dural Strip 9" x $1\frac{1}{4}$" Fxg.3 off 6BA x $\frac{1}{2}$" bolts, nuts and washers - included in	Separate Pack Two
H.U.1	Undercarriage Cross Struts	- Two in formed dural Fxgs.4 off 6BA $\frac{1}{2}$"bolts, washers, nyloc nuts- included in	Separate Pack Two
H.U.2	Undercarriage Skids	- Two in formed dural with four nylon end caps,4-6BAx $\frac{3}{4}$" bolts,washers & nyloc nuts	Pack Four
H.C.6	Transfer Sheets	- Cabin Flashes,name,markings, blade stripes,Union Jacks etc.	Seperate
H.H.1	Main Rotor Head	- Dural (or steel)	Pack Five
H.H.2	Head Pivot Pin	- Silver Steel +2 Starlock washers	
H.H.3	Paddle Bar	- 3 mm. steel wire $14\frac{1}{2}$" Hardware - 1 x P.11 Collet, Socket Set Screw 4BA x 1/8"	Separate
H.H.4	Paddles	- Two nylon with inserts, fxg. 4 x 4BA x 3/16" Socket Sets	Pack Five
H.H.5	Pitch Crank	- Nylon with insert, hardware 1 x 4BA x $\frac{1}{4}$" Socket set screw, 1 x 10 BA x 3/8" bolt, nut & 2 washers	

H.H.6	Blade Connecting Plates	- Two in formed steel, hardware 4 x 6BA x 5/8" bolts, washers and nyloc nuts. Two 4BA x ½" Hex head bolts, 2 washers, 2 nuts, 2 star washers	Pack Five
H.H.7	Rotor Blade Set	- Balsa/Hardwood - Two L.E. in spindled hardwood, 2 ¼" balsa T.E. Plus 4 ply reinforcements	Pack Six
H.H.8	Shaft Head Tube	- Dural (or steel) with 4 BA x ½" bolt, nut & washer plus 4 BA x ¼" socket set screw (fits internal)	
H.H.9	Swash Plate Driver	- Nylon with 6BA x ½" bolt, lock washer and nut	
H.H.10	Compensating Spring	- 22 gauge wire + fxg. tag	
H.H.11	Swash Plate	- Nylon 3 parts with 3 No. 2 x ¼" self tapping screws	
H.H.12	Wire Guide & Block	- 18 gauge wire/hardwood (for roll control limiting)	Pack Seven
H.H.13	Rotor Shaft	- ¼" Silver Steel - predrilled	
H.H.14	Swash Plate Spacer Assy.	- Dural and nylon (three parts)	
H.H.15	Mini Cranks/Stand off Bushes	- 2 Nylon cranks, short stand off & long stand off nylon. Hardware 1 x 6BA x 1" bolt, 1 x 6BA x 1¼" bolt, 2 washers & 2 nuts	
H.H.16	Linkage Accessory Pack	- 6 x N.11 type rods, 4 ball sockets N.68, 1 adaptor P.6, 4 pcs. N.26 retainers, 3 x N.10 quick links and 2 x N.12 keepers	Pack Eight
H.D.1	Engine Mounting Plate	- Dural Pressing. Fxg. 4 x 6BA x 5/8" bolts, nuts, large washers	
H.D.2	Drive Shaft Mounts	- 4 off Nylon with Oilite bearings Fxg. 8 x 6BA x ½" bolts, nuts, washers	Pack Nine
H.D.3	Large Bevel Gear	- Nylon with 3/32" dia. roll pin for fixing to shaft	
H.D.4	Small Bevel Gear	- Steel with 1 x 4BA x 3/16" socket set screw	
H.D.5	Engine Mounting Pillars	- 4 x Aluminium with 4 x 6 BA x 1" bolts, nuts, washers	

H.D.6	Engine Heat Sink	- Cast aly. anodised with 2 x 6 BA x 1½" bolts, nuts, spring washers plus strip shim steel	Pack Nine
H.D.7	Inter Drive Shaft	- Steel ¼" x 2½"	
H.D.8	25 Tooth Drive Pulley	- Nylon with metal bush (with integral tail shaft drive cup) Fxg. 1 x 4BA x ¼" socket set screw	
H.D.9	Tail Shaft Front Coupling	- Dural with 1 x 4BA x 3/16" socket set screw	
H.D.14	Main Gearwheel Spacer	- Nylon	
B.70	Drive Belt	- 7" dia. 35 tooth	
H.D.10	Flywheel	- Aluminium with shoe pivot pins	Pack Ten
H.D.11	Clutch Housing	- Dural	
H.D.11A	Clutch Liner	- Cork	
Py.8	8 Tooth Pulley with retaining washer	- Nylon G.F., 4 off 8BA x 3/16" bolts, 1 x 6BA x ¼" bolt with 6BA washer large	
H.D.12	Clutch Shoes	- 1 pair in Steel	
H.D.12A	Clutch Spring	- Spring Steel	
H.D.13	Hexagon Lock Shaft	- Steel ¼" U.N.F. (Veco, O.S. 20/25 etc.)	
H.D.13A	Hexagon Lock Shaft	- Steel 6 mm. (Enya 19 BB etc.)	
H.T.1	Boom End Plug with integral skid	- Nylon/14 gauge wire	Separate
H.T.2	Tail Gear Cage	- Nylon G.F. with phosphor bronze insert bearing 2 off 6BA x 1" bolts, 2 nyloc nuts, 4 washers	Pack Eleven
H.T.3	Rotor Pitch Crank	- Nylon with 1 off No.2 x ½" self tapping screw plus large washer	
H.T.4	Rotor Crank Return Spring	- Spring Steel	
H.T.5	Rotor Pitch Slider	- Nylon + 1 pr. Ball joint ends + 4 x 10 BA nuts	
H.T.6	Tail Rotor Blades	- Parts for pair precut in hard-wood & balsa 2 off 8 BA x ½" bolts, nuts, 4 washers	
H.T.7	Bevel Gears	- Two in Brass with 2 off 4 BA x 3/16" socket set screws plus 2 thust washer 4 BA	

H.T.8	Tail Rotor Head	- Dural with 2 off 4BA x $\frac{1}{4}$" socket set screws	Pack Eleven
H.T.9	Tail Rotor Shaft	- 10 gauge Steel - 3" plus 1 collet (P.11) with 1 x 4BA x 1/8" socket set screw	Pack Eleven
H.T.10	Blade Connecting Shaft	- Brass with 2 x 8BA x 3/16" screws	Pack Eleven
H.T.11	Rotor Blade Holders	- Two in nylon	Pack Eleven
H.T.12	Drive Shaft Rear Coupling	- Dural with 2 x 4BA x $\frac{1}{4}$" socket set screws	Pack Eleven
H.T.13	Gear Shaft	- 10 gauge Steel x $\frac{3}{4}$"	Pack Eleven
H.T.14	Tail Drive Shaft	- Wire 16 gauge x 22"	Separate
H.T.15	Rotor Pitch Linkage	- Nylon Tube 28",22g wire 25" 1 P.6 adaptor, 1 x 1/16" A/F wrench, 1 N.39 quick link, 3 plastic tube straps, tube Torqseal	Pack Twelve
H.T.16	Tail Drive Bearings	- Two in Nylon with 2 6BA x $\frac{1}{2}$" bolts, nuts and washers	Pack Twelve
H.T.17	Tail Fin	- Precut Ply/Balsa 3 parts plus ply plates and 2 off 6BA x 1"bolts, nuts and washers - included in	Pack One
H.T.18	Tail Boom	- Aluminium predrilled - hardware 2 x 6BA x $1\frac{1}{4}$" bolts, 2 nuts, 2 large & 2 small washers	Boom Separate Hardware Pack Twelve

NOT Supplied Adhesives

- Evostik Impact or Dunlop Thix-o-fix, for A.B.S. to wood
- P.V.A. White Glue, for wood to wood
- Quick Set Epoxy, as directed
- Bostik No. 1 Clear, for canopy fixing - USE SPARINGLY

Paint for finishing trim (Enamel or Polyurethane NOT Cellulose) Kwikcote for covering blades if required.

The makers in their continued efforts to further improve the product reserve the right to vary the contents of this Kit as necessary without prior notice. Any major ~~damages~~ changes will be covered by an Eratta notice included with the manual.

LARK ERRATA

Page 15 — The bosses on the two small 90° cranks should both face inwards, not outwards as stated.

Page 16 — Column 2. After "Fig. 5" read:- At this stage trim A.B.S. Cockpit interior, score across moulded line, nick side walls with knife and bend as shown Fig. 1, Section 16. Check that this part will not interfere with servo installation.

Page 19 — Fig. 1. Tail skid should be bent approximately 45° at position as indicated by arrow and words "TAIL SKID".

Page 22 — Tail rotor diameter recommendation of $8\frac{3}{4}$" is minimum. Designer suggests 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.

Page 27 — First column, last paragraph. Swash Plate Spring now has end loops ready made.

Page 28 — Section 13. Column 1, last paragraph. Please note that saucer shaped lock washer is fitted dished face outwards. Fit one to very end of shaft before inserting through head and tap second one into place after assembly.

Page 43 — HT.2 Tail Gear Cage now has 3 phosphor bronze bearings.

Page 44 — HT.10 Blade Connecting Shaft now made in steel.

NOTE — Light machine oil should be regularly applied to the three phosphor bronze bearings in tail gear cage also to brass pinions and above engine four main Oilite bearings. When using Bostik No. 1 to bond canopy to interior this should be applied sparingly as it is a solvent to the plastic material.

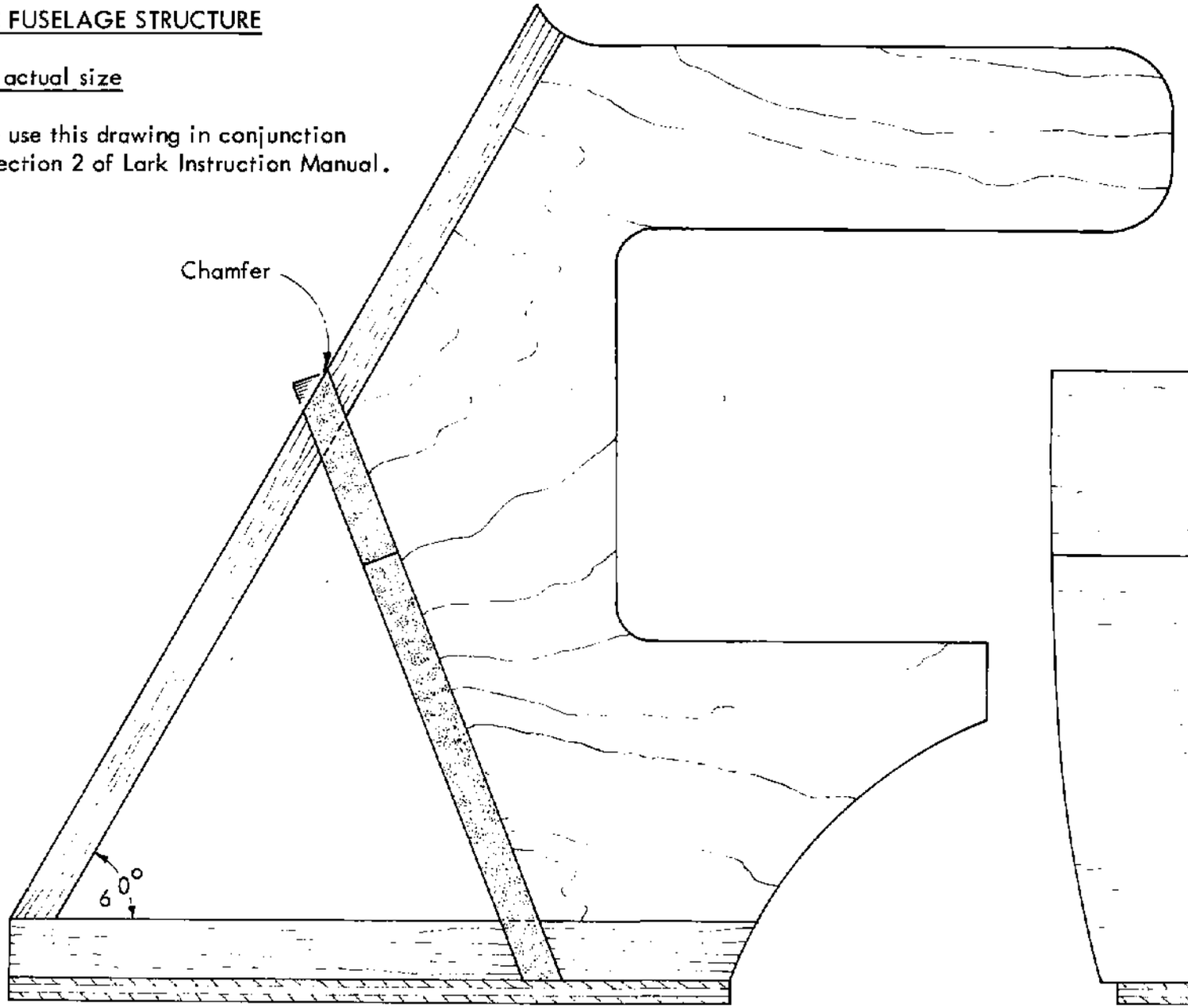
Page 29 — H.H.6. Blade Connecting Plates Fig.4. Now with three fixing holes and extra hardware.

MM LARK

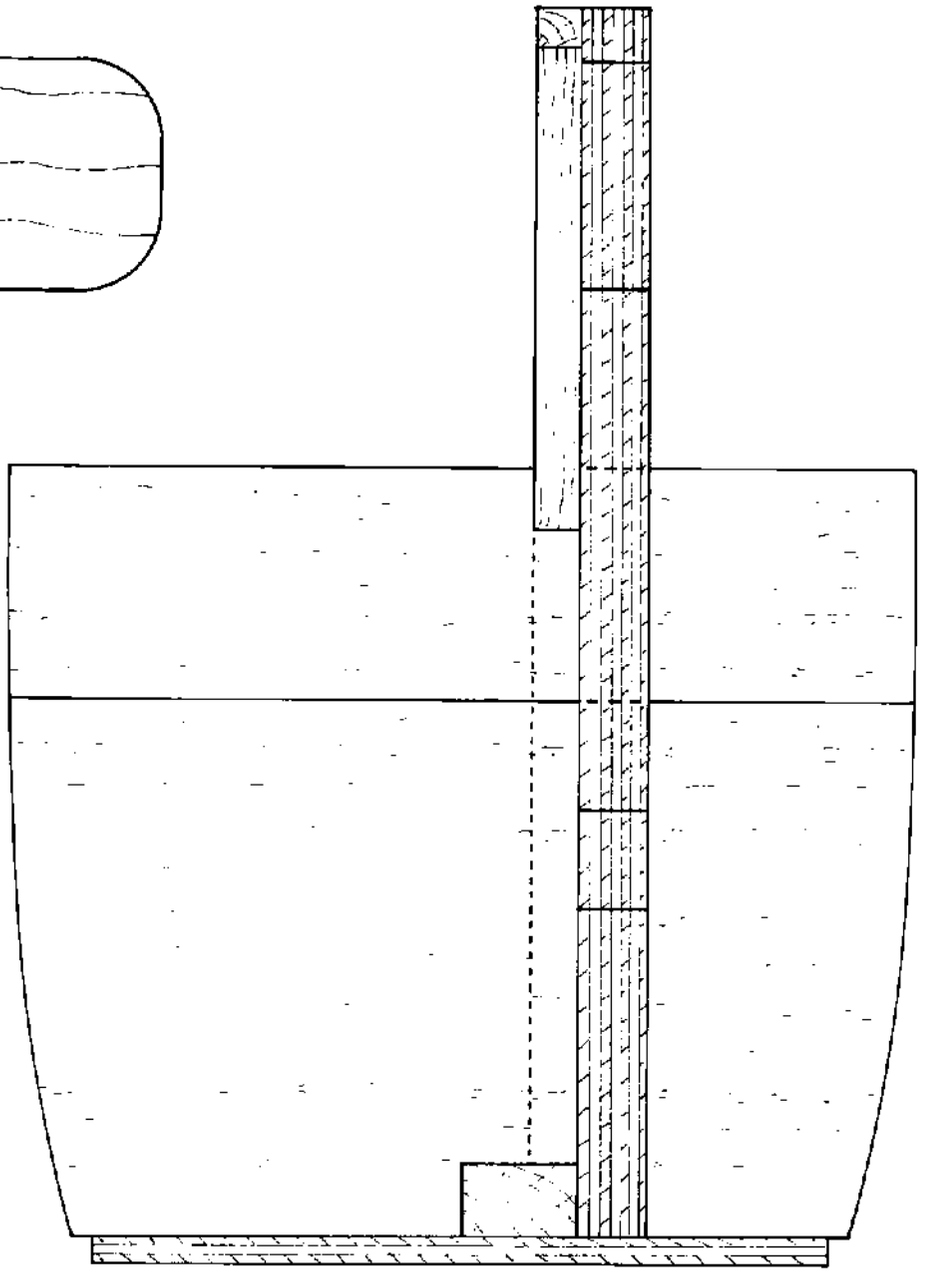
BASIC FUSELAGE STRUCTURE

drawn actual size

Please use this drawing in conjunction with section 2 of Lark Instruction Manual.



View from Port (Left) Side



View from Rear