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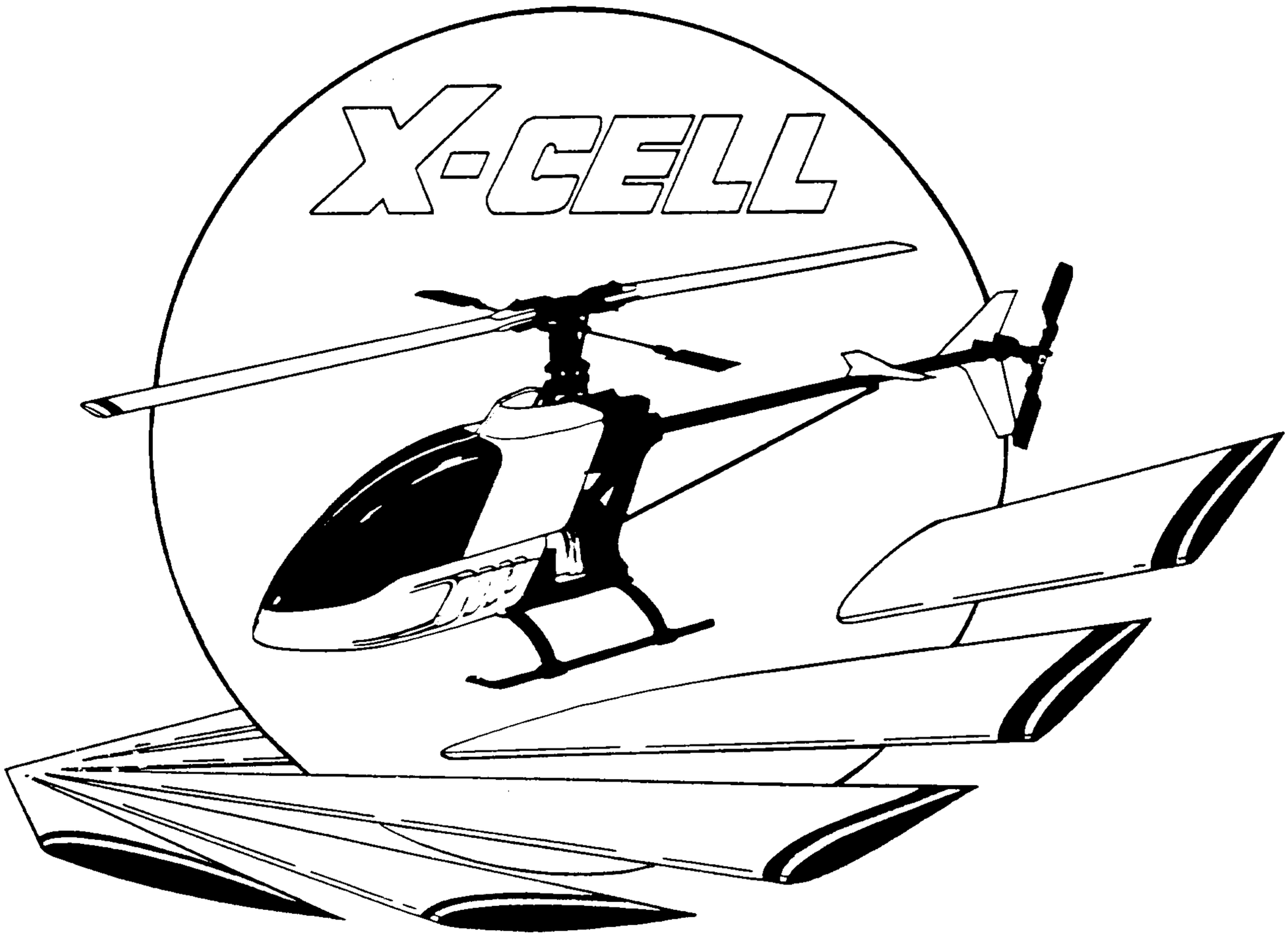


X-CELL THIRTY AND FORTY SERIES HELICOPTER

INSTRUCTION MANUAL

Part Number: 0701

*Box cover information does not apply in full to the Series .30 & .40 kits. Please use this manual as your guideline to parts.

miniature aircraft USA

R/C HELICOPTER SAFETY

A radio-controlled model helicopter is a technically complex device that must be built and operated with care. It is also a fascinating and challenging part of the R/C Sport, the mastery of which is very rewarding.

A model helicopter must be built exactly in accordance with the building instructions. The kit manufacturer has spent much time and effort refining his product to make it reliable in operation and easy to build. The essentially bolt-together construction can proceed quite rapidly, giving the builder a strong sense of accomplishment that encourages too-rapid progress from one construction phase to the next, so that the completed model can be more quickly seen and enjoyed.

It is essential to recognize and guard against this tendency. Follow building instructions exactly. Use only original parts - even single screws - and consider no alterations. Vibration and stress levels are high and all fasteners and attachments must be secure for safety in operation.

Note that this is the first use of the word SAFETY in these comments. Previously the kit manufacturer's efforts to ensure RELIABLE operation were mentioned. That is ALL that he can do. Safe operation is the responsibility of the builder/flyer and starts with careful construction and continues with selection and installation of reliable radio equipment, engine, and fuel system, and the proper use of starters and other support equipment.

The need for safety is nowhere greater than at the flying field. A number of guidelines for safe flight have been developed by experienced flyers and are set down here. It is urged that they be read, understood and followed.

GUIDELINES FOR SAFE R/C HELICOPTER FLIGHT

1. Fly only at approved flying fields and obey field regulations.
2. Follow frequency control procedures. Interference can be dangerous to all.
3. Know your radio. Check all transmitter functions before each flight.
4. Be aware that rotating blades are very dangerous and can cause serious injury. Always hold the rotor head while starting the engine and do not release until at the take off point.
5. Never fly near or above spectators or other modelers.
6. If a beginner, get help trimming the model, and flight training later.
7. Don't "track" the main blades while holding the tail boom. This is a temptation to builders who cannot hover yet and is very dangerous.
8. Follow all recommended maintenance procedures for model, radio, and engine.

WARNING

This helicopter is not a toy, but a complex flying machine that must be assembled with care by a responsible individual.

Failure to exert care in assembly, or radio or accessory installation, may result in a model incapable of safe flight or ground operation. Rotating components are an ever-present danger and source of injury to operators and spectators.

Since the manufacturer and his agents have no control over the proper assembly and operation of his products, no responsibility or liability can be assumed for their use.

X-CELL LIMITED WARRANTY

The warranty covers defects in material or workmanship or missing components to the original purchaser for 30 days from the date of purchase. Miniature Aircraft, USA will replace or repair, at our discretion, the defective or missing component. Defective components must be returned to us prior to replacement.

Any part, which has been improperly installed, abused, crash damaged, or altered by unauthorized agencies is not covered. Under no circumstances will the buyer be entitled to consequential or incidental damages. The components used in this kit are made from special materials designed for specific applications and design strengths. We recommend that all replacement parts be original parts manufactured by Miniature Aircraft, USA only, to ensure proper and safe operation of your model. Any parts used which were manufactured by any firm other than Miniature Aircraft, USA VOIDS all warranties of this product by Miniature Aircraft, USA.

PROCEDURES

Mail all warranty information within 15 days of original purchase date. If service is required, send the component in question (if not missing) together with a photocopy of your bill of sale and an accurate description of the problem and part. Ship components fully insured and prepaid. Miniature Aircraft, USA is not responsible for any shipping damages. We will, at our discretion, notify you of any costs involved, or ship it COD. You are required to pay all postage, shipping and insurance charges.

INTRODUCTION

Congratulations! You have just purchased the highest quality Helicopter kit available and one which will build up in a short time into the finest flying helicopter on the market today!

There -- the conventional introduction has been taken care of!

If you just skimmed through it, that's fine. It was there just to get you up to speed anyway. Be warned, however, that is one of very few paragraphs that you dare skim through in this Construction Manual!!

We won't list all of the features of the helicopter here either. You probably read our brochure before buying the kit and it lists over forty impressive features. If you gave your copy to a friend, there is another in the kit. After you refresh your memory, give this one to another friend.

Briefly, this is a light weight, beautifully performing chopper that is ruggedly built of quality materials embodying state-of-the-art design and engineering. This Construction Manual will attempt to do justice to it. Read on .....

SYSTEM REQUIREMENTS

In addition to the kit, you will require:

1. A Helicopter Radio with 5 Servos

Typically, such a radio provides 5 or more channels to control Fore and Aft Pitch (Elevator); Roll (Aileron); Yaw (Rudder); Throttle; and Collective Pitch (changes pitch of both main blades together to vary lift). Throttle and Collective Pitch servos are controlled together by the normal throttle stick movement. This arrangement not only provides adequate servo power for all functions, but also allows important channel mixing functions to be provided by the transmitter.

Conventional four-channel radios can be used with a fifth servo added for Collective Pitch. This servo is normally operated in parallel with the Throttle servo through a "Y" connector. Such a system is adequate but performance is limited by the lack of "mixing" functions which, in the typical helicopter radio, provide tail rotor compensation for varying throttle/collective inputs, as well as "throttle hold" for autorotation practice, "hi-idle" for aerobatics, and a multiple servo reversing feature which allows sustained inverted flight.

In any event, it is recommended that any system used incorporate powerful, precise centering, ball bearing servos in order to realize optimum performance from this very responsive helicopter.

2. An Engine and Matching Muffler

Since the X-Cell is offered in .30(5cc), .40(6.5cc), .50 (8.5cc), and .60 (10cc) versions, a wide choice of engines is available. Its light weight allows good performance with virtually any modern two-stroke engine in good condition; this characteristic, coupled with outstandingly "tight" and balanced control response, provides unequalled performance with the higher power engines.

A matching muffler is required in a configuration that directs the exhaust down and away from the engine when mounted in the helicopter position. Miniature Aircraft, USA provides a wide selection of mufflers and tuned pipes ideal for helicopter use, as well as offering several engines especially selected to provide top performance.

3. A Rate Gyro

Probably the one advance in model helicopter technology - with the possible exception of Collective Pitch - that contributes most to easy and enjoyable flight is the insertion of an "angular rate sensitive" gyroscope in the yaw (rudder) servo lead from the receiver. This device senses even minute swings of the helicopter nose (yaw) left or right and makes immediate corrective inputs to the tail rotor servo to counteract these movements. This action is not to be confused with that of an "autopilot" in that it does not keep the helicopter pointed in one direction. The amount of its corrections depends on how sharply the nose begins to swing - a small correction for a small amount,

or a larger correction for a larger amount. In other words, the gyro response varies with the angular rate of change, which is why this particular type of gyro is called a "rate" gyro as distinguished from a "position" gyro.

The important effect is to make the helicopter much easier to control, and it is highly recommended that a gyro be used in the X-CELL. Miniature Aircraft, USA has offered rate gyros to modelers since their inception and currently stocks units ideal for all helicopter use.

It is essential to have your Radio and Engine on hand before beginning kit construction because they will be needed fairly early in the building sequence. The Muffler and Gyro are not such immediate needs except that the gyro control switch box is easier to install early.

CONSTRUCTION

The X-CELL has been designed for easy and straight-forward assembly but, like any precision device, considerable care should be taken and work should progress in a methodical and orderly fashion.

Please read these instructions thoroughly, prepare your workplace, and get all required tools together before you begin.

THE KIT PACKAGE

The kit includes a detailed drawing showing all parts - with numbers - in proper relation to each other in easy to understand subassemblies. The drawing also includes a detailed pictorial fastener list, radio and servo installation, and set-up data such as exact push rod lengths where possible, and a metric scale for your convenience. Metric hardware is used because its design and quality are superior for use in precise mechanisms.

After the plans, canopy halves, and large decal trim are removed from the kit, a cardboard tray can now be removed to disclose the rest of the parts which are either in bags containing just the parts needed for a particular assembly step, or packaged or wrapped separately.

By taking out just the major parts and the bag of small parts called for in any assembly step, confusion between similar parts and fasteners can be minimized.

Also in the box will be a small bag of spare parts such as nuts and bolts. A package containing Allen wrenches and certain other special tools needed for construction is also included.

TOOLS REQUIRED

In addition to the tools listed below, it is quite important to have a good place to work. An actual workbench is not needed because no metalworking (filing, etc) is required and just the wood radio tray and plastic canopy require material removal and sanding operation. Your work table should, however, be protected from marring by the various metal parts used.

Screwdrivers - both slotted and cross-recess (Phillips Head) #00, #1
Long-Nosed Pliers
Tweezers
Hand Drill with appropriate bits
Dremel Power Tool or equivalent
Small Fine File
5.0mm Open End Wrench
5.5mm Open End Wrench (can be 7/32")
7mm Open End Wrench (can be 9/32")
Allen Wrenches (supplied in kit)
Appropriate Socket Wrench for your engine shaft nut
Glowplug Wrench (Part #4649)
Scissors

Poly-Zap Pt-22 Cyano Glue (#4945)
Cyanoacrylate Glue (both thin and gap-filling)
Loctite (MA/USA) thread lock liquid (supplied in kit)
(**NOTE:** Use only the material supplied or its **EXACT** equivalent)
Wood finishing materials (sandpaper, paint, etc)
Masking tape
11mm sq x 1' Long Wood Block for Head Setup (supplied in kit)
Heat Gun (Monokote type)
Grease, Teflon Filled (Order #4709 - 2 oz tube, or #4707 - 1 oz syringe)
Tri-Flow Teflon Oil (Part #4801)

In addition, the following will make assembly easier and prove useful later, in your model toolbox:

Ball Link Application Tool (part #0529)
4.0 mm Nut Driver (#4665)
5.0mm Nut Driver (#4669)
5.5mm Nut Driver (Socket on a Handle) (#4670)
7mm Nut Driver (#4671)
1.5mm Allen Wrench on a Handle (#4651)
2.0mm Allen Wrench on a Handle (#4653)
2.5mm Allen Wrench on a Handle (#4655)
3mm Allen Wrench on a Handle (#4657)
Ball Link Pliers (Part #0545)
Pitch Gauge (Part #0526)
Flybar Lock (Part #0505)
Tail Rotor Blade Balancer (Part #3750)
Long Curved Forceps (#4569)

These tools can be obtained from your local hobby shop, or ordered directly from Miniature Aircraft, USA.

ASSEMBLY INSTRUCTIONS

The instructions to follow will build up subassemblies and incorporate them in the helicopter in a logical sequence. The subassemblies will be clearly recognizable on the main drawing as will the parts and fasteners used. Take a few minutes to carefully study the entire drawings (view #'s and figure #'s) before beginning assembly. Note that the drawing includes a series of "exploded" views which show the various subassemblies with the individual parts shown unassembled but in relative positions which make obvious the manner in which the parts fit together to create the subassembly.

Each assembly step will begin with an exact list of parts required including locations in the kit box where appropriate. ***Series .40 parts will be identified with an * where different from Series .30 parts.*** There is essentially no difference in assembly operations. It will be helpful to have a small dish, or box available in which to place the small parts, bolts and nuts for each step for easy access. Any special tools required will be called out in the text.

SPECIAL CAUTION

Parts #0693, #0695, #0697, and #0699 special control ball spacers must be glued into their respective parts using POLY-ZAP CYANO ONLY (order #4945). This is EXTREMELY IMPORTANT to ensure proper adhesion strength of these parts.

Parts #0041, #0042, #0044, #0046 hardened **8.8 grade** slotted crossed recessed bolts are a special grade of hardness used for the application of the control steel balls #0361. When replacements are necessary, **use only exact hardness bolts.** Order **specific part** numbers from Miniature Aircraft USA.

Parts #0603, #0605, and #0131 must rotate freely on their respective adjoining parts. **Relief of these parts may be necessary.** Use a light oil when assembling.

ASSEMBLY SEQUENCE

I. ROTOR HEAD ASSEMBLY

STEP 1. Assemble Head Block and Yoke
2. Install Bell Mixers on Main Blade Mounts
3. Assemble and Install Main Blade Mounts
4. Assemble flybar, weights, paddles and arms
5. Fabricate Main Rotor Blades and Install
6. Balance Head Assembly

II. MAIN FRAME STRUCTURE

STEP 1. Assemble Landing Gear
2. Assemble Elevator (Pitch) Swing Arm Unit
3. Assemble Aileron (Roll) Bellcranks to Main Frames
4. Assemble Main Frames, Supports and Tray and Mount Assembled Landing Gear
5. Assemble Main Shaft, Gear, Swashplate, and Washout Unit
6. Assemble and Install Front Tail Drive
7. Assemble Engine and Clutch Unit
8. Complete Main Frame Structure

III. RADIO TRAY ASSEMBLY

STEP 1. Assemble Wood Parts
2. Fit Servos and Disassemble
3. Paint Tray

IV. TAIL ASSEMBLY

STEP 1. Assemble Tail Rotor Transmission and Collective
2. Assemble Tail Boom, Drive Shaft, and Fins
3. Install Tail Rotor Transmission

V. RADIO TRAY AND TANK INSTALLATION

STEP 1. Mount Radio Tray and Fuel Tank to Main Frame Structure
2. Reinstall Servos, Add Radio, Gyro, and Switches

VI. ROTOR HEAD AND TAIL ASSEMBLY INSTALLATION

STEP 1. Mount Rotor Head
2. Mount Tail Boom and Engage Drive
3. Mount Tail Rotor Control Rod and Guides

VII. CANOPY PREPARATION

STEP 1. Assemble Canopy and Paint

VIII. FINAL ASSEMBLY AND SET UP

STEP 1. Set Servo Neutrals at Transmitter
2. Mount Servo Control Arms (or Wheels)
3. Install Control Rods
4. Final Assembly and Balance
5. Control Set Up

I. ROTOR HEAD ASSEMBLY

Step 1. Assemble Head Block and Yoke

Parts Required:

1	#0289 Main Rotor Head Block	Bag #1
1	#0291 Flybar Yoke	Bag #1
1	#0293 Pivot Block, Flybar Yoke	Bag #1
2	#0603 Delrin Flybar Pivot Bushings	Bag #1
1	#0295 Transverse Shaft, Flybar Yoke	Bag #1
2	#0605 Delrin Flybar Yoke Bushings	Bag #1
2	#0297 Guide Pins, Washouts (M25x24)	Bag #1
2	#0033 M3x5 Phillips Cr Rec Screws	Bag #1
2	#0053 M3x5 Socket Set Screws	Bag #1
1	#0051 M3x3 Socket Set Screws	Bag #1
2	#0361 M2 Steel Balls	Bag #1
2	#0044 M2x12 8.8 Gr Hard Slotted Machine Screws	Bag #1
2	#0695 #2 Control Ball Spacers (4mm)	Bag #1
* 2	#0301 Ball Bearings M3x10 (Pivot Block)	Optional #0725 Bearing Kit
* 2	#0299 Ball Bearings M4x10 (Flybar Yoke)	Optional #0725 Bearing Kit

NOTE: When fitting Delrin bushings onto the flybar pivot block and the flybar yoke, it may be necessary to trial fit them for initial free movement. Each bushing is machined with a very small rib on the inside surface to allow for proper break-in and provide minimal slop. If excessive drag is noticed and you wish to pre-fit them, then the procedure is simple.

For the flybar pivot bushings, merely slide them back and forth along the flybar for a brief moment until they move more freely. The pivot block bushings can be pre-fitted by gently sliding them over the shank of a long 3.0mm bolt such as a #0075 or #0077. This effort, along with a light oil will ensure smooth initial operation. Do not overdo it and create a sloppy bushing fit.

A. Examine **View #1** showing the Head Block and Flybar Yoke assembly. Lay out the #0289 Head Block, the #0291 Flybar Yoke, the #0293 Pivot Block, the #0295 Transverse Shaft, and two #0603 Delrin Pivot Bushings (or two #0301 Ball Bearings). Slide a Delrin Bushing on each end of the Pivot Block and seat each fully (if necessary, tap into place). If using bearings apply force **only** to the inner race.

Identify the two small holes recessed at the ends of the middle bore in the #0289 Head Block, and squarely thread an M3x5 Phillips Cross Rec Screw into one hole until it seats. Slide the Pivot Block unit into the middle bore from the other end until it seats against the screw head. Now thread the other M3x5 Phillips Screw into the remaining hole until it seats and traps the Pivot Block. The Block should now be free to rotate but exhibit no end play. If necessary, back off the M3x5 screws approximately 1/8 of a turn to enable free rotation. Rotate the Pivot Block until its cross hole is squarely visible through the side slots in the Head Block, and press the Flybar Yoke (#0291) onto the Pivot Block Shaft until its holes line up with the Pivot Block bore. (The use of a heat gun may aid in relieving plastic stresses.)

B. Orient the #0295 Transverse Shaft so that its two small cross holes are oriented parallel to the long dimension of the Head (up and down), and press it through the Yoke/Pivot Block bore from one end until it is centered.

With the Head Block held inverted, one hole in the Transverse Shaft should be visible through the tapped hole in the Pivot Block which, in turn, is visible through the Head Block bore (use a strong light from the side). If not, slide the Shaft partly out, re-orient and try again. When aligned, anchor the Shaft to the Pivot Block by threading an M3x3 Set Screw (with Loctite) into the small tapped hole until it engages the Transverse Shaft hole.

Screw two M3x5 Socket Set Screws into the end cross holes in the Yoke #0291 and, making sure that the Yoke ends are not bowed in or out, tighten against the Transverse Shaft. Use slow cyanoacrylate glue on the threads and do not over-tighten.

Slightly roughen up with 80 grit sandpaper one end of each guide pin #0297. Apply **SLOW** cyano glue.

C. Drive the two #0297 Guide Pins into the bottom holes in the Head Block until they seat solidly (they will project about 16mm when seated). (Cyano Glue)

Press the two #0605 Delrin Bushings (or two #0299 Ball Bearings) into the bearing cavities in the ends of the Yoke #0291. Apply **poly-zap cyano** to two #0695 control ball spacers and press completely into place on each side of part #0291 Yoke. Using two #0044 M2x12 slotted screws, slide one #0361 steel ball on each. Apply **SLOW** cyano glue on the screw threads and thread each screw/ball assembly into the previously glued control ball spacers #0695 on each side of the Yoke #0291, being certain they are square and in-line. Do not over-tighten. **See Views #1 and #11.**

NOTE: This is the first of many control link balls that will be threaded into plastic parts during construction and three important requirements **MUST** be met. First, the screw thread must be started squarely in the hole ("backing up" the thread a small amount before turning in the normal direction will help prepare the plastic hole to accept the screw thread). Second, a small amount of **SLOW** cyanoacrylate glue must be applied to the thread; normally this can be done to the remaining threads after the part has been threaded halfway on. Be careful not to get glue on the ball or your fingers! Third, the screw/ball assembly must not be threaded in so tightly that the threads created in the plastic are stripped. Many of the screw/ball assemblies use special control ball spacers intended to seat against the plastic part surface. Thread the assembly down until the 2mm steel balls **just contact the parts surface.**

Step 2. Install Bell Mixers

Parts Required:

2	#0333 Bell Mixer	Bag #1
2	#0093 Special Bell Mixer Bolts (M3x19)	Bag #1
4	#0131 Plastic Bearing Bushings	Bag #1
2	#0044 M2x12 8.8 Gr. Hard Slotted Machine Screws	Bag #1
2	#0695 #2 Control Ball Spacer (4mm)	Bag #1
2	#0017 Hex Nut (3mm)	Bag #1
2	#0693 #1 Control Ball Spacer (7mm)	Bag #1
2	#0046 M2x16 8.8 Gr. Hard Slotted Machine Screws	Bag #1
4	#0361 M2 Steel Balls	Bag #1
* 4	#0159 M3x7 Ball Bearings	Optional #0725 Bearing Kit

A. Apply poly-zap cyano glue to two #0695 control ball spacers and press one completely into each #0333 bell mixer. Using two #0044 (M2x12) screws slide one #0361 steel ball on each screw. Partially thread each screw/ball assembly into each pre-glued #0695 spacers in the #0333 bell mixers. Repeat the above process using two each #0046 (M2x16) screws, #0361 steel balls, and #0693 (7mm) control ball spacers into the remaining holes in each bell mixer #0333. Use slow cyano on each screw assembly. Apply cyano **only after starting** the threads so that none will flow inside into the bearing cavities. Be sure to thread squarely without over-tightening. **See Views #1 & 11.**

B. Using a #0093 Bell Mixer Bolt to assist in alignment, press a #0131 Plastic Bushing (or #0159 Ball Bearing) into each side of each #0333 Bell Mixer. Be sure the bearings are square and properly seated.

C. Slide each Bell Mixer Assembly on a #0093 Bell Mixer Bolt and thread into the farthest hole out in the control arms on the Main Blade Mounts #0317. The hole closer in on the control arm is designed to be used with the Delta III Conversion Kit (optional). Using Loctite, thread #0017 M3 Nut on the exposed threads of #0093 Bolt on the inside of the blade mount arm. Tighten nut securely against inside of control arm. Be sure that the stepped side of Bell Mixers are facing in toward the blade mount control arms. Hold #0017 Nut with proper size wrench and adjust #0093 Bolt until #0333 Bell Mixer has no lateral play and no bearing drag. Do NOT allow the nut to rotate. The M3 Nut should remain secured against inside surface of control arm #0317. **See View #1.**

Step 3. Assemble and Install Main Blade Mounts

Parts Required:

1	#0609 Main Blade Axle	Bag #1
2	#0317 Main Blade Mounts	Step #2 Assembly
4	#0319 Ball Bearings, Main Blade Axle (M8x10.5)	Bag #1
2	#0323 Dampner O-Rings	Bag #1
2	#0085 M5x16 Socket Head Cap Screws	Bag #1
2	#0611 Special Washer (Large)	Bag #1
2	#0612 Special Washer (Small)	Bag #1

NOTE: Before beginning this section be sure to DEGREASE the threads in the blade Axle #0609 and Bolts #0085 with alcohol or thinner.

A. Select both #0317 Main Blade Mounts from **Step #2** and four #0319 Ball Bearings. Press a Ball Bearing (either way) into a Blade Mount cavity on the single ear end. Seat it fully. Press the second Ball Bearing into the Mount from the fork end. Seat it squarely and fully by sliding the #0609 Main Blade Axle through this bearing, through the Mount, and through the bearing already in the Mount. Install two #0319 Ball Bearings in the other Blade Mount in an identical way. Remove the Axle. (Should any difficulty appear in seating the Bearing #0319 into the mount, a 7/16" or equivalent socket may be used as a pressing tool.) Pressure should only be applied to the outer ring of the ball bearing.

B. Referring to **View #1**, carefully slide a #0323 Dampner O-Ring about 30mm onto the #0609 Main Blade Axle, being careful not to damage it on the sharp end of the Axle. Insert the long end of the Axle into the top hole of the Head Block until the O-Ring seats in its annular cavity. Slide the other O-Ring on the opposite end of the Shaft until it seats in its cavity.

C. Slide a Blade Mount on one end of the Axle. Refer to **View #1** for proper orientation.

D. Place a #0611 Special Washer (Large) followed by a #0612 Special Washer (Small) on a M5x16 (#0085) Socket Head Screw. **See View #1.** Using one of the Allen Wrenches provided in the kit, thread the bolt into the Blade Axle through the forked end of the assembled Blade Mount. Tighten most of the way and slide the blade against this stack to square it up. Now remove the screw and apply Loctite sparingly to the threaded hole with a toothpick and reinsert the screw firmly.

E. Repeat step "D" to install the other Main Blade Mount. Using the two Allen Wrenches in the kit, tighten the whole Axle Assembly firmly. **IMPORTANT:** Overtightening may result in **DAMAGE** occurring to the main blade axle. **NOTE:** The use of Loctite on these main head bolts is essential!

Step 4. Add Flybar, Paddles, Weights, and Control Arms

Parts Required:

1	#0607 Flybar .30/.40	Bag #10 (in tail boom)
2	#0311 Flybar Control Paddles	Bag #1
2	#0309 Flybar Weights	Bag #1
2	#0307 Control Arms - Flybar	Bag #1
2	#0305 Control Arm Spacers - Flybar	Bag #1
4	#0051 M3x3 Socket Set Screws	Bag #1
2	#0053 M3x5 Socket Set Screws	Bag #1
4	#0135 Plastic Ball Links (Short)	Bag #1
2	#0313 Special Control Rods (Short) (M2x12)	Bag #1

A. Thread the M3x3 Socket Set Screws partly into the two tapped holes in each of the two #0309 Flybar Weights. Similarly, thread an M3x5 Socket Set Screw in the threaded hole in each #0307 Flybar Control Arm.

B. Insert the flybar #0607 into the bearings provided in the main head assembly. Follow with one #0305 spacer and one #0307 control arm on each side. Slide each up to the delta offset plates and center the flybar. Apply Loctite and very lightly tighten the M3x5 socket set screw in each control arm until it just touches the flybar. Shift the flybar until there is no side to side play between the control arms and the flybar is balanced. Now sight from one side at both control arms. Align each level with the other. It is helpful to use a small pair of straight edges on each control arm to insure that they are each level to the other. Securely tighten each socket set screw in each control arm.

C. Slide one #0309 flybar weight onto one end of the flybar. Mark with tape or pen a point 25.0mm (about 1") from the end of the flybar. apply a small amount of slow cyano or epoxy on the flybar threads and install one #0311 control paddle to the 25.0mm depth. Visually align it level with its corresponding control arm. A pitch gauge set at zero is most helpful for this step (you may consider the Miniature Aircraft USA precision pitch gauge #0526 for the and future set-up steps) when used with a simple straight edge held on the control arm. Repeat these steps on the opposite end of the flybar. A template is shown in **Figure #1** that can also assist you in paddle alignment.

When both control paddles and their respective control arms are all level to each other, determine the approximate position of each flybar weight and fine tune their positions for balance. If you are a beginner or sport flier, you will find the weights work best at or near each paddle. If you prefer the quick response required for hot aerobatics, then position the weights inward towards the control arms. Basically the model is still fully aerobatic in either set-up, but the response time will change.

D. Assemble two short #0135 Ball Links on each #0313 Control Rod. Start a Ball Link on each end of the fully threaded Rods and thread on simultaneously until the Links come together. Back off one half turn. Match for exact length and snap a control arm between the LONG shank ball on a Bell Mixer and the ball on the Flybar Yoke on each side. Put the Rotor Head aside.

Step 5. Fabricate Main Rotor Blades

Parts Required:

4	#0034 Phillips Countersunk Head Tapping Screws	Bag #1
2	#3710 Lead Strips	Bottom of Box
2	#3712 Balsa Strips	Bottom of Box
2	#0601 Blade Mount Reinforcements (2 pr)	Bag #1
2	#3654 Main Rotor Blades (X-30)	Box
1	#3725 RotorSport Covering Pkg.	Box
1	#3711 Trim (balancing) Strip	Decal Sheet
2	#3723 Brass Blade Bushing	Bag #1

A. Sand each Rotor Blade with 220 or 320 grit sandpaper until very smooth. (Use of a sanding block and proper attention to thin trailing edges will ensure retention of the correct airfoil. Be certain the trailing edge remains straight during this operation).

B. Lay all four blade reinforcement halves on a table with insides facing up. Match male and female reinforcement halves together. Using **slow cyano only**, choose the male reinforcement half and apply even amounts of slow cyano to inner surface of reinforcement and line up with rotor blade root. Push reinforcement on to blade root until it is completely snapped down. It may be necessary to use a rubber hammer for this step. Take care not to damage rotor blade. Immediately apply cyano to matching female reinforcement half and assemble on blade in the same manner as the first half. Press the brass bushing #3723 completely into blade mount pivot hole. Insert 2 #0034 Phillips screws into remaining two holes in blade mount reinforcements. Tighten securely. Next apply pressure to

the reinforcement halves by either clamping together or using a heavy object as a weight on top of the blade reinforcement. Tighten securely. Set aside and allow to dry and repeat process on second blade. **See Figure #2A and View #1.**

C. Cut the lead strips #3710 into six pieces equal in length to the slots provided in the main rotor blades and equal length to each other. **NOTE:** Using a sanding block, sand each lead strip on a flat surface by rolling under sanding block. If an exact gram weight is desired, the use of a gram scale will be necessary. For an approximate weight, the following guide may be used:

Net blade weight written on root of blade	+ _____	Grams
Full length of Lead Strip w/ Balsa Caps (3 pcs)	+ 11	Grams
Blade Covering	+ 10	Grams
Approximate Blade Weight	= _____	Grams

If less weight is desired, shorten the lead strips and mount them towards the outside of the milled slots. It is very important that while adding the lead to the rotor blades that the overall weight of the rotor blades remain relatively equal to each other. This can be achieved by a gram scale; if one is not available, then we have an alternative method which works very well.

Mount the unfinished rotor blades into the previously assembled main rotor head using Allen Bolts #0082 and Locknuts #0021. Tighten snugly. Pivot the rotor blades until both blades are centered and in line with the main rotor blade mounts #0317 and parallel to each other. Suspend the rotor head and blades in a balancing device as described in Step 6. **See Figure #3.** If the rotor blades do not appear to balance very well, remove the blades and replace on opposite ends of the main rotor head. Recheck balance and choose the better of the two blade positions.

Insert pre-cut lead strips into the milled slots in each rotor blade and observe balance. If balance needs correcting, cut down the lead strip in the heavier blade or add weight to the lighter blade. Adjust until balance is achieved.

D. Starting at the outer end of the slot, apply a coat of slow cyano around the lead in the slot. In a few moments follow with a layer of baking soda and saturate with cyano. **See Figure #2B.** If you've chosen epoxy for this step, simply apply epoxy to the slot and install the lead. Smooth excess epoxy with your finger. Keep in mind that a balsa strip will be used as a cap for the slot so allow a small gap. Recheck the balance one more time, and remove blades from Rotor Head. Mark which side of head each individual Rotor Blade was attached.

E. At this point you should have lead strips installed and cyano or epoxy cured. As an initial step in balancing we will now establish the "Center of Balance" point. Using a "Bic" type pen, dowel, or tube of any type, position the blade lengthwise in front of you on a flat-level surface. Using the pen as a fulcrum at 45° to the leading edge, determine the balance point, mark the blade accordingly, and repeat at 90° to the previous line. **See Figure #2C.** (Hint: Gently rotate the pen right or left until the balance is established and mark well for future reference even after sanding. Both blades should balance within 1-2mm of each other. Since they were factory matched in this manner and all materials added were accurately measured, you should have no difficulty. However, if there is an imbalance, the blades may be matched by two possible methods. First, determine which blade you wish to shift and in what direction. For example, if tip weight is to be added, first try saturating the tip area (3"-4") with thin cyano glue. If more weight is needed, then simply route out a small area at the tip of the milled slot and glue in a small amount of the excess lead strip as needed. Keep in mind that any weight added to the blade being corrected must also be added to the other blade at the **Center of Balance point**, thus retaining the original balance of the two blades.

An optional brass powder may also be used as a balancing aid and as an option to increase the weight of the rotor blade. Order #3709.

F. Cut balsa strips for each slot and trim to fit (i.e., round corners). Press balsa firmly into slots and secure with cyano on all sides. Block sand the raised portion until flush with blade surface. Coat with a film of cyano and wipe away excess. **See Figure #2D.**

G. At your option, seal the wood at the hub and tip areas with either instant cyano or fuel proof paint. In either

case, mask the mounting faces of the Blade Hub since they are molded for a precise fit in the Blade Mounts. Lightly re-sand blades with 220 or 320 grit sand paper once again. (Carefully remove all dust using a clean towel, wiping several times. A clean blade is a must for proper adhesion of the blade covering material.)

H. With the blades now ready for cover, select a clean flat surface and, after removing the backing material from a piece of blade covering, lay it adhesive side up.

Carefully examine the accompanying **Figure #2E** before proceeding. Now, carefully measure 10mm in from the NEAR edge and mark each end with a ball point pen. Holding the blade with Hub in your left hand and the blade tip in your right, set the trailing edge down on the marks with the left end of the covering in a position to just clear the base of the Hub when it is wrapped into position. Rock gently to adhere the covering to the trailing edge. At this point, the 10mm section of blade covering will be visible between yourself and the blade trailing edge. Fold the blade down towards yourself and apply pressure onto the 10mm section of the marked covering. This will establish the bottom of the blade. Lift the blade up with covering clinging to the trailing edge and firmly smooth the short (10mm) side onto the underside of the blade with a continuous slide of the finger. Continue rubbing the entire trailing edge as you rotate the blade upright. Do not allow the covering to touch the top blade surface until the trailing edge is firmly bonded with a clean sharp fold. Now rotate the blade further and progressively smooth the covering end to end as you go. Continue around the leading edge and back to overlap the starting edge of the covering on the bottom of the blade. Trim excess covering neatly from the tip of the blade and smooth the entire surface again. Repeat this process with the other blade. **See Figure #2E.**

NOTE: A useful technique to allow good control of this sticky material and prevent it from prematurely adhering to the blade in any area is to weight the covering by sticking a piece of wire to what will be the final edge of the covering to be adhered, before starting. This will cause the covering to maintain a continuous roll away from the blade surface until deliberately pressed down. **See Figure #2E.**

Step 6. Balance Head Assembly

Parts Required:

2 #0082 M4x35 Socket Head Cap Screws	Bag #1
2 #0021 M4 Locknuts	Bag #1

Equipment Required:

NOTE: The performance potential of modern R/C Helicopters is so great that the use of specialized equipment for proper assembly and setup is fully justified by the results achieved. This is particularly true of balance procedures for all rotating parts. Nothing so clearly distinguishes one helicopter from the rest as perfect blade tracking and freedom from vibration.

This manual describes only the procedure useable without special equipment which includes balancing the Flybar on its own bearings in the Pivot Block, and then suspending the Head (with main Blades) from the Flybar across two straight edges, such as two rectangular blocks of wood. This procedure has been proven very effective and produces a vibration free head.

The ultimate in head balance can be achieved by the use of a good static balancer such as the High Point Balancer (sold by MA/USA) or its equivalent. Its value lies in its ability to include Main Blade balance. If such a unit is available, use it following the instructions with it.

A. Support the Rotor Head Assembly from Step 4 above vertically in some manner (a vise with soft jaws, etc) that allows the Flybar to pivot freely around a horizontal position. Adjust the Flybar Weight inward slightly on the paddle end that rotates downward. Continue small adjustments until the Flybar will remain level. Tighten all **FOUR** weight set screws **TIGHT**, using Loctite.

B. Mount the Main Rotor Blades to the Head using M4x35 Socket Head Screws and M4 Locknuts. Position the blades straight out from the Head and tighten the screws just enough to hold blade in position.

C. Obtain two wood blocks at least 75mm (3") high with parallel surfaces (two short sections of a good quality "two by four" serve very well) and two single side razor blades. Then suspend the Head and Blade assembly between them, supported on the Flybar. Refer to **Figure #3**. One Main Blade will invariably tilt downward. **NOTE:** As described before, rotation of main blades on rotor head may result in a better balance. Cut a partial strip of the red tape provided (the degree of unbalance will give an indication of the width necessary) and apply near the end of the LIGHT (opposite) Blade. Just stick a corner of the tape to the blade until the exact amount is determined. When exact balance is achieved (when the blade tips are equidistant from the bench top), apply the tape to the blade starting underneath, as with the regular covering.

Identify the Blade Mount carrying the red taped blade with a small drill spot or a touch of paint, remove both blades and set both the head and the blades aside until Step V-1.

II. MAIN FRAME STRUCTURE

Step 1. Assemble Landing Gear

Parts Required:

2	#0151 Flexible Struts	Box
2	#0657 Skids	Bag #10 (Wrapped)

Special Tool Required: Heat Gun (Monokote type) or a source of heat such as boiling water

A. Examine **View #2** on the drawing to determine assembly orientation of the Struts and Skids. Note that Struts sweep forward.

B. Wearing a glove or using a cloth for protection from heat, pick up one Flexible Strut and, with a Skid conveniently at hand, heat one end of the Strut until the Skid can be pushed into the hole from the front without undue pressure. **Do not overheat!** Push the Skid through until its end projects rearward through the Strut exactly 180mm.

C. Pick up the second Strut, heat it the same way and press it on the Skid until the Skid projects rearward from it exactly 37mm. Again check drawing for orientation. The distance between the bolt holes from the front to the rear strut should be 111mm.

D. Grasp the forward Strut again, heat its opposite end and, in a similar fashion, press the second Skid through this hole. Continue until it is about to engage the second Strut. Now heat the rear strut and, before the front one cools, slide the skid through both into its final position. Set this subassembly aside.

Step 2. Assemble Elevator (Fore and Aft Pitch) Swing Arm Unit

Parts Required:

2	#0155 Elevator Swing Arm Halves	Bag #2
1	#0099 Special Bolt (M3x30)	Bag #2
4	#0131 Plastic Bearing Bushings	Bag #2
1	#0157 Elevator Bellcrank	Bag #2
2	#0161 Pivot Pins - Elevator (M3x12)	Bag #2
1	#0019 M3 Locknut	Bag #2
2	#0047 M2x16 Sltd HD Machine Screws	Bag #2
2	#0015 M2 Hexnut	Bag #2
3	#0361 M2 Steel Balls	Bag #2
1	#0699 Control Ball Spacers #4 (1mm)	Bag #2
2	#0693 Control Ball Spacers #1 (7mm)	Bag #2

1	#0042 Sltd CH HD Machine Screw (M2x10) 8.8 GR	Bag #2
2	#0046 Sltd CH HD Machine Screws (M2x16) 8.8 GR	Bag #2
* 2	#0159 M3x7 Ball Bearings	Optional #0725 Bearing Kit

A. Study **View #2** on the drawing to understand how this Swing Arm subassembly is built up.

B. Pick up one Swing Arm Half, #0155, and holding it so that the outside surface of the fork end is against a solid surface, press a Pivot Pin, #0161, into the fork end hole from the inside until its end is flush with the outside surface (bottoms against the supporting surface). Tapping the Pin into place with a mallet or wood block may be necessary. Repeat the process with the other Swing Arm Half.

C. Press a Plastic Bearing Bushing #0131 into the hole at the opposite end of each Swing Arm Half. Do this from the outside. Set both pieces aside.

D. Select the Elevator Bellcrank, #0157, from Bag #2, one #0042 slotted screw, one #0361 Steel Ball, and one #0699 Control Ball Spacer. Slide the Steel Ball on the M2x8 screws while following the procedure previously described, glue the Control Ball Spacer, #0699, (**using poly-zap only)** and screw the Ball Assembly into the arm of the Bellcrank using slow cyano on the screw threads. **Refer to Views #2 and #11 on the drawings.**

E. Following the above procedure, select two #0046 Slotted Screws, two #0361 Steel Balls, and two #0693 Control Ball Spacers. Glue and screw these two screw assemblies in place, again referring to the drawings for positions.

F. Select either the Bellcrank Ball Bearings #0159 (optional #0725) or plastic Bearing Bushings #0131 and press them into the remaining holes in the Bellcrank.

G. Referring to **View #2** again, assemble the Swing Arm to the Bellcrank by squarely pushing the Pivot Pins into the Bellcrank Bearings or Bushings, aligning and pressing the Arm Halves together. Push the Special Bolt #0099 through the Pivot Stud Bushings as a further alignment aid, loosely thread its M3 locknut on it, and secure the halves together with the two (M2x16) bolts (#0047) and nuts, using Loctite. Set the subassembly aside.

Step 3. Assemble Aileron (Roll) Bellcranks to Main Frames

Parts Required:

1	#0653 Main Frame, Right	Box
1	#0655 Main Frame, Left	Box
2	#0167 Aileron Bellcranks (Roll)	Bag #2
2	#0169 Aileron Bellcrank Studs (Roll)	Bag #2
4	#0131 Plastic Bearing Bushings	Bag #2
2	#0171 Aileron Stud Retainer Collars	Bag #2
2	#0051 M3x3 Socket Set Screws	Bag #2
2	#0019 M3 Locknuts	Bag #2
4	#0361 M2 Steel Balls	Bag #2
2	#0697 Control Ball Spacer #3 (2mm)	Bag #2
2	#0041 Sltd CH HD Machine Screws (M2x8) 8.8 GR	Bag #2
2	#0042 Sltd CH HD Machine Screws (M2x10) 8.8 GR	Bag #2
2	#0699 Control Ball Spacer #4 (1.0mm)	Bag #2
4	#0159 Ball Bearings (M3x7)	Optional #0725 Bearing Kit

Special Tool Required: Hand Drill (for use as collet to hold parts)
NOTE: If using an electric drill, do NOT plug in!

A. Study **View #2** on the drawing to determine proper holes for Roll Bellcrank mounting in Frames. Mark if

necessary.

B. Select a Bellcrank Stud #0169 from the bag and the Left Main Frame #0655 from the box. Open the chuck on your hand drill until it will accept the unthreaded end of the Bellcrank Stud, inset the Stud up to its shoulder and tighten the chuck moderately. **NOTE:** This method of holding the Studs for mounting in place protects the Stud bearing surface better than others. Later, Ball Bearings or Bushings will slide easily in place. Holding the drill chuck in your hand, insert the Stud in the proper hole in the Frame from the outside, and screw an M3 Locknut tightly onto the Stud from the inside of the Frame.

C. In a similar manner, mount the other Bellcrank Stud to the Right Main Frame #0653. Check Stud surfaces that had been held in the drill chuck for smoothness and freedom from burrs.

D. Remove a roll bellcrank #0167 from Bag #2 [two #0041 slotted screws, two #0361 M2 steel balls and two #0699 control ball spacers (1mm); two #0042 slotted screws, two #0361 M2 steel balls, and two #0697 control ball spacers (2mm)]. Holding the bellcrank #0167 with its flat side towards you, glue the 1mm control ball spacer #0699 into the lower hole **using poly-zap only.** Glue the #0697 control ball spacer (2mm) into the upper hole. Pick up the other Bellcrank and, holding it oriented exactly as you did the first one, glue a #0699 spacer into the upper hole this time and glue the #0697 spacer into the lower hole. **Use poly-zap cyano only.** Screw one #0041 screw (M2x8) and one #0361 steel ball into each #0699 control ball spacer (1mm) on each bellcrank #0167. Screw one #0042 crew (M2x10) and one #0361 steel ball into the remaining larger control ball spacers #0697 on each bellcrank. This provides right and left bellcranks as will become apparent upon installation. (Don't forget the slow cyano glue.)

E. Take the four Bushings #0131 from the parts bag (four optional Bearings #0159) and press them squarely into each end of the remaining holes in the two Bellcranks. See **View #2.**

F. Partially thread the M3x3 Socket Set Screws into the two Retaining Collars #0171.

G. Hold the LEFT Main Frame upright with its Stud facing you, and select the Bellcrank which will slide on the stud with one arm vertically down containing a SHORT ball, and the other arm pointing aft (to your right) containing a long ball. Place a SMALL amount of Loctite on the set screw threads projecting from one Retainer Collar and, after ensuring that NO Loctite can possibly get to a ball bearing or bushing, retain the Bellcrank by sliding the collar on the stud and tightening the set screw. Check to be sure that the Bellcrank operates smoothly; if not, slightly back off retaining collar.

H. Mount the other Bellcrank and Collar to the Right Main Frame in an identical way. Holding the frames together in normal orientation will show that each has a Bellcrank that can be held with an arm pointing rearward with a long ball on it.

I. Recheck steel ball locations on the Bellcrank. The shorter balls should be at the lower end of each Bellcrank.

Step 4. Assemble Main Frames, Supports, Tray to Landing Gear

Parts Required:

8	#0061 Socket Head Cap Screws (M3x8)	Bag #3
	Landing Gear Assembly	From Step 1
	Pitch Swing Arm Assembly	From Step 2
	Main Frame Assemblies	From Step 3
1	#0651 Front Frame Support Plate	Bag #3
2	#0649 Main Frame Strut Plates	Bag #3
1	#0182 Main Shaft Bearing Block, Lower	Bag #3
1	#0185 Front Tail Boom Support Halves	Bag #3
1	#0676 Front Tail Boom Strut Support	Bag #3
8	#0077 M3x30 Socket Hd Cap Screws	Bag #3

4	#0071 M3x18 Socket Hd Cap Screws	Bag #3
2	#0063 M3x10 Socket Hd Cap Screws	Bag #3
20	#0019 M3 Locknuts	Bag #3
4	#0003 M3 Flat Washers (Large)	Bag #3
2	#0241 Housing Guide Sleeves	Bag #3
2	#0235 Ball Bearings (M5x15)	Bag #3
2	#0233 Start Shaft Bearing Housing	Bag #3

A. View #2 on the drawing shows the relative parts placement and fasteners used in building up this basic frame structure. All parts should be fastened loosely until late in the sequence so that a final "squaring" and alignment can be properly done.

B. Mount the front support plate #0651 to both main frames using (8) M3x8 #0061 socket head cap screws and (8) M3 locknuts #0019. Do not tighten nuts.

C. Remove the Pivot Stud and locknut temporarily assembled to the Elevator Swing Arm and insert the Arm assembly into position between the Frames making sure that the Bellcrank arm projects through the aperture in the right side frame with the ball end UP. Reassemble the Pivot Stud through the correct frame holes to properly constrain the Swing Arm Assembly **(See View #2)**, and replace the locknut. Do not tighten.

D. Using two M3x30 Socket Head Cap Screws and M3 Locknuts, mount the Lower Main Shaft Bearing Block #0182 in position with the bearing facing up. Do not tighten nuts.

E. Using four M3x30 Socket Head Cap Screws and M3 Locknuts, loosely mount the two Front Tail Boom Support Halves #0185 in position.

F. Using two M3x10 Socket Head Cap Screws, mount the Front Tail Boom Strut Support #0676 between the Frames at the holes to the rear of the slotted holes provided for Fan Housing rear mounting. **See View #2.** The screws thread directly into the ends of the Support. Do not tighten.

G. Refer to **View #5.** Place one Plastic Start Shaft Bearing Housing Half #0233 flat face down on a hard surface and press both Housing Guide Sleeves #0241 into the holes provided until flush on the bottom. Place both Ball Bearings #0235 on a clean surface with the Ball Races exposed. Moderately pack both bearings with grease (order #4707). Snap both bearings with open races towards each other into the bearing cavities provided in part #0233. Press the remaining housing half #0233 onto the protruding sleeves #0241 until both housing halves meet together. Mount assembled start shaft bearing block in position between side frames, using two M3x30 socket bolts (#0077) and M3 locknuts (#0019) with M3 flat washers (#0003) under the screw heads and the nuts. **See View #2.** Do not tighten.

H. Place the Frame assembly, as completed to this point, on a flat surface and, ensuring that both frame bottom flanges rest solidly on the surface, generally "square up" the entire unit and snugly tighten all screws and nuts except those retaining the Tail Boom Support, the Swing Arm, and the Front Tail Boom Strut Support. Check to see that the Swing Arm assembly pivots freely within the rectangular frame holes.

I. Place the Landing Gear Assembly on a flat surface, locate the two Main Frame Strut Plates #0649 on the Flexible Struts over their mounting holes and, using four M3x18 Socket Head Cap Screws, mount the completed Frame assembly to the Landing Gear. The most convenient procedure is to insert two screws through the holes in the front Gear Strut. Secure with M3 Locknuts. Repeat the procedure at the rear Gear Strut. At this point it may be necessary to reheat the rear Strut with the heat gun and slightly reposition it to line up with Frame and Strut Plate holes. Anchor its M3x18 Screws with M3 locknuts and tighten all around.

J. At this point refer to the drawing exploded views again to ensure proper placement and orientation of all parts.

Step 5. Assemble Main Shaft, Gear, Swashplate, and Washout

Parts Required:

1	#0613 Main Rotor Shaft **OR** #0614 Long Main Shaft	Bag #4
2	#0205 Main Shaft Retainer Collars	Bag #4
1	#0182 Main Shaft Bearing Block, Upper	Bag #4
1	#0207 Main Gear	Bag #4
1	#0710 Autorotation Hub with Bearings	Bag #4
1	#0211 Upper Hub Spacer (Plastic)	Bag #4
1	#0618/0617 Upper & Lower Swashplate Ring with Bearing	Bag #4
6	#0041 M2x8 slotted Screws	Bag #4
1	#0615 Swashplate Pivot Ball	Bag #4
1	#0616 Swashplate Pivot Ball Retaining Ring	Bag #4
1	#0219 Center Hub, Washout	Bag #4
2	#0221 Washout Control Arms	Bag #4
2	#0223 Special Links, Washout	Bag #4
2	#0097 Special Bolts, Washout Arms (M3x22)	Bag #4
2	#0225 Pivot Pins, Washout Arms	Bag #4
4	#0131 Plastic Bearing Bushings	Bag #4
4	#0227 Ctrl Rods, Lower Swashplate (M2x42)	Bag #4
8	#0133 Plastic Ball Links Long	Bag #4
2	#0077 M3x30 Socket Hd Cap Screws	Bag #4
6	#0069 M3x16 Socket Hd Cap Screws	Bag #4
4	#0051 M3x3 Socket Set Screws	Bag #4
9	#0019 M3 Locknuts	Bag #4
1	#0067 M3x14 Socket Hd Cap Screw	Bag #4
2	#0619 10mm Special Washer	Bag #4
11	#0361 M2 Steel Balls	Bag #4
3	#0044 Sltd CH HD Machine Screws (M2x12) 8.8 GR	Bag #4
7	#0042 Sltd CH HD Machine Screws (M2x10) 8.8 GR	Bag #4
2	#0695 Control Ball Spacer #2 (4mm)	Bag #4
4	#0159 Ball Bearing (M3x7)	Optional #0725 Bearing Kit

A. Referring to **View #3** on the drawing, select the Main Gear #0207 and the Autorotation Hub #0710 from Bag #4, six M3x16 Socket Head Cap Screws, and six M3 Locknuts from the parts bag. Noting that the Gear is two-sided and can be assembled either way, press the Gear onto the shorter boss of the Hub, being careful to align the mounting bolt holes. Insert the six M3x16 Screws from the Gear side and secure from the Hub side with the six M3 Locknuts. Tighten securely. Lightly oil (**DO NOT GREASE**) the autorotation bearings.

B. Mount the Upper Main Shaft Bearing Block #0182 in place, bearing side down, using two M3x30 Socket Head Cap Screws and M3 Locknuts. Do not tighten.

C. Lay out both Shaft Retainer Collars #0205 and partially thread two M3x3 Socket Set Screws in each.

D. Determine the Main Shaft assembly sequence from **View #3** and lay out the following parts:

Main Shaft #0613 **OR** Long Main Shaft #0614
Two Retainer Collars #0205
10mm Special Washer #0619
Upper Plastic Hub Spacer #0211
Main Gear and Hub Assembly
10mm Special Washer #0619
1 #0067 Socket HD Cap Screw (M3x14)
1 #0019 Hex Locknut M3

NOTE: One of two main shafts may exist in your kit. They are easily identified by their overall length:

#0613 -- Standard, 183mm
#0614 -- Long, 193mm.

If #0614 has been provided with your kit, you have a few options available. You can elect to utilize its entire length (effectively raising the rotor system 10.0mm for additional collective or cyclic travel). Or you may use 5.0mm less by placing a special plastic 5.0mm spacer #0210 under the autorotation hub above the #0619 washer and bolt. Similarly, two #0210 spacers may be used, effectively bringing the useable shaft length down to that of the #0613 Standard Main Shaft. Of course, this is not the intent of shaft #0614 Long. In most types of pitch set-ups, the added length is an asset, not a detriment. You are encouraged to use #0614 in its full length. Further in the instructions suitable pushrod adjustment lengths will be given corresponding to whichever shaft length is utilized.

#0210 spacers are available from your dealer or Miniature Aircraft USA directly. If two #0210 spacers are ever used, it will be necessary to make a 22.0mm diameter hole for clearance in the fan shroud. Again, it is suggested you use #0614 in its full length rather than utilize two spacers.

Insert the Main Shaft into the upper Bearing Block; then, in sequence, slide it through a Retainer Collar, the center hole of the Elevator Bellcrank, another Retainer Collar, the lower Bearing Block, the Upper Plastic Hub Spacer, one #0619 washer, the Main Gear (large hub **DOWN**), another #0619 special washer (10mm), and then insert into the hole provided one #0067 M3x14 Socket Head Bolt and one #0019 M3 Locknut. Tighten securely. Tighten the M3x3 Set Screws in the lower collar #0205 just above the lower bearing block to retain the stack.

E. Rotate the Main Shaft (it will be freer one way) to ensure that the main bearings are aligned and tighten the screws and nuts on both Bearing Blocks. Replace the Swing Arm Pivot Stud and tighten its Locknut. **NOTE:** The Elevator Bellcrank may seem slightly snug on the Main Shaft. This is intentional and will free up properly on the first flight.

F. Test the Main Gear for vertical movement on the Shaft. There should be just noticeable movement of the gear between the lower collar and the bearing block. If not, loosen the collar above the lower Bearing Block and move it up just slightly and retighten. Slide the upper collar up against the bottom of the upper bearing and tighten it. The Main Shaft should now show no vertical movement, and the Gear just a very small amount (approximately 0.5mm).

G. Remove one set screw at a time from each retainer, apply a small amount of Loctite and reassemble. Examine the swashplate and **View #3** on the drawing for control ball positioning.

H. Using four #0042 M2x10 Slotted Screws and four #0361 M2 Steel Balls, thread one screw and ball into each hole position on the inner ring of the swashplate. Mount one #0044 (M2x12) slotted screw with two #0361 steel balls stacked onto the screw into any hole in the swashplate outer ring. Screw three #0042 M2x10 slotted screws with steel balls in the remaining outer ring holes. **Slow cyano each screw.** Insert the swashplate pivot ball #0615 in the top cavity in the swashplate upper ring, followed by the swashplate ball retaining ring #0616 (smooth side facing out). Retain in place using six #0041 M2x8 slotted screws. Adjust all 6 screws retaining the pivot ball until the swashplate pivots smoothly on the main shaft with no visible play in the pivot ball.

I. Take the two washout control arms #0221 from Bag #4, two #0044 M2x12 slotted screws, two #0361 steel balls, and two #0695 control ball spacers #2 (4mm). Using **Poly-zap** cyano, glue each #0695 spacer into each control arm #0221. Thread one #0044 screw and one #0361 steel ball into each pre-glued spacer in each control arm. Use slow cyano on the screw threads and tighten until the steel ball meets the spacer. **See View #3.**

J. Press Ball Bearings #0159 (optional kit #0725) or Bushings #0131 into both sides of the center holes in both Control Arms.

K. Using two Special Washout Arm Studs, and carefully following **View #3** on the drawing, screw the Arms to the Washout Center Hub #0219. (Suggestion: squarely start the thread of each Stud into its hole in the Hub part way first without the Arm.) The control Balls should face inward. Tighten entire assembly until there is no lateral play and no bearing drag.

L. Remove the two Special Washout Links #0223 from Bag #4 and, using two Pivot Pins #0225, assemble the

Links to the Control Arms. Their orientation is shown in **View #3** on the drawing. Note that they mount on the short ends of the Arms, projecting inward. The pins press in place centered in the links. Using a Heat Gun, blow heat on the pivot pin area until the arm and the link pivot freely. Do NOT damage with too much heat. Apply a very small amount of slow cyano glue on each end of the pins. Be careful not to get any glue between the control arms #0221 and the links #0223. **THEY MUST PIVOT! See View #3.**

M. Complete four Control Rods #0227 by threading a Plastic Ball Link #0133 on each end. The length of the finished Rods is determined by laying them over the precise full scale view on the control Rod length chart on the drawing. The rods must be identical in length. As a check dimension, the length of metal rod between inner plastic link faces is 20.5mm with the #0613 Standard Main Shaft; 27mm with the #0614 Long Main Shaft **and** one spacer; or 29.5mm with the #0614 Long Main Shaft. Refer to **Figure #10.**

N. Referring to **View #11** on the drawing for control rod placement, snap the ball link on one end of a rod to the OUTSIDE ball on each of the double balls mounted to the Elevator Bellcrank. Similarly, snap a ball link on the longer of the balls on each Roll Bellcrank.

O. Slide the Swashplate on the Main Shaft. Holding the four control rods up, snap the four top ball links to the outer Swashplate. Be sure the double ball on the Swashplate faces to the **LEFT.** The link from the left Roll Bellcrank should be snapped on the **INNER** ball.

P. Slide the Washout assembly on the Main Shaft and snap the Washout Links to two balls on the inner Swashplate. Refer to **View #3** for orientation.

Step 6. Assemble and Install Front Tail Drive

Parts Required:

1	#0239 Front Drive Pinion Shaft	Bag #5
2	#0233 Front Drive Housing Halves	Bag #5
2	#0235 Ball Bearings, Front Drive (M5x15)	Bag #5
1	#0237 Retainer Collar	Bag #5
1	#0231 Front Drive Pinion Gear	Bag #5
2	#0241 Housing Guide Sleeves	Bag #5
2	#0077 M3x30 Socket Hd Cap Screws	Bag #5
4	#0003 M3 Flat Washers	Bag #5
2	#0019 M3 Locknuts	Bag #5
2	#0051 M3x3 Socket Set Screws	Bag #5

Special Material Required: Grease, Teflon Filled

A. Place one Front Drive Housing Half #0233 flat face down on a hard surface and press both Housing Guide Sleeves #0241 into the holes provided. Refer to **View #4** on the drawing. Insert both Sleeves until flush on the bottom.

B. Place both Ball Bearings #0235 on a clean surface with the ball races exposed. Moderately pack both bearings with grease (order part #4707).

C. Select the Front Drive Pinion Shaft #0239. Using alcohol or similar cleaner and a q-tip or small piece of cloth, clean the shaft (where the bearings will be placed) and the inside of the bearing inner races. Using a toothpick, apply a **small** amount of Loctite on the shaft in the approximate final position of the first installed bearing. Install this bearing. Repeat the process for the second bearing.

D. Slide the rear bearing back until the Shaft and bearings can be inserted onto the Housing Half (with sleeves) with the bearings fully seated on either side of the center section of the Housing Half. The remaining Housing Half can then be aligned over the Guide Sleeves and pressed in place to fully retain the bearings. **Do not force!** If bearings are properly seated, the assembly will close completely with the Guide Sleeves flush on both sides.

E. Place a small amount of Loctite on one M3x3 Socket Set Screw and thread it part way into the Retainer Collar #0237. Slide it on the long end of the Shaft until it contacts the bearing and tighten moderately. Be **CERTAIN** no Loctite can get to the bearing. Also be sure the other bearing is solidly seated against the flange on the Shaft. Check for a free rotation, loosen collar if binding is noticed.

F. Slide the Drive Pinion Gear #0231 loosely on the long end of the Shaft (the set screw will be added later).

G. After referring to **View #4** on the drawing, install the subassembly in the Frame assembly, using 2 M3x30 Socket Head Cap screws, four Flat Washers, and two M3 Locknuts. Push the unit up as far as the screw slots will allow. Do not tighten.

H. Determine that the Front Tail Rotor Drive Pinion is properly in place and engaging the teeth on the upper face of the Main Gear. Apply a small amount of Loctite to two M3x3 Socket Set Screws and thread into the Pinion Gear. By sliding the pinion in or out on its shaft and by sliding the Front Drive Housing up or down, find a position giving smooth gear engagement. This procedure is very important to ensure a correct gear and drive shaft alignment and durability. DO NOT take alignment for granted even if gear mesh seems smooth. The output shaft #0239 needs to be parallel with the main gear. Also, sight line-up of block to determine that the output in #0239 for tail rotor drive shaft is straight and in the center of the front tail tube plastic blocks #0185. A small piece of 2mm wire (approximately 2" long) can be inserted in the output shaft for additional line-up help. (**NOTE:** Tail rotor drive shaft should insert into #0239 output shaft easily when assembling tail tube assembly to main frames.) Front pinion gear should have slight amount of rotational play in the main gear and operate freely. Tighten the two Housing bolts and the Pinion set screw. Make sure the set screw engages the FLAT on the shaft when this is done. Do not over tighten the housing bolts. Over tightening will cause pressure on the bearings.

I. Set the Frame Assembly aside temporarily.

Step 7. Assemble Engine and Clutch

Parts Required:

1	#0643 Cooling Fan Shroud - 2 pcs	Box
1	#0707 Fan Hub with Fan (assembled)	Bag #6
1	#0007 Special Engine Washer (M6.6x12.3)	Bag #6
1	#0641 Fan Drive Collet 1/4"	Bag #6
2	#0645 Engine Motor Mounts	Bag #6
1	#0621 Start Cone	Bag #6
1	#0709 Clutch Bell (assembled)	Bag #6
2	#0627 Special Washer (5mm)	Bag #6
1	#0361 M2 Steel Ball	Bag #6
1	#0625 Rubber O-Ring (5mm)	Bag #6
10	#0063 Socket Head Cap Screw (M3x8)	Bag #6
8	#0003 Flat Washer M3 Large	Bag #6
2	#0052 Socket Set Screw (M3x6)	Bag #6
3	#0032 Ph Pan Head Tapping Screws (M2.9x9.5)	Bag #6
2	#0027 Ph Pan Head Tapping Screws (M2.2x9.5)	Bag #6
1	#0042 Slotted Ch HD Machine Screw (M2x10) 8.8 GR	Bag #6
1	#0697 Control Ball Spacer #3 (2mm)	Bag #6
1	#0730 Clutch with Shaft Installed	Bag #6
2	#0731 Delrin Clutch Isolator	Bag #6
2	#0732 Special Clutch Bolts (M3x14) 12.9 GR Hard	Bag #6
2	#0733 Steel Clutch Bolt Supports	Bag #6
1	#0734 Delrin Clutch Disc	Bag #6
1	#0735 Delrin Hub Isolator	Bag #6
* 2	#0646 Special Motor Mounts .40 size	Bag #6

* 1 #0708 Fan Hub with Fan Assembled .40 size Bag #6

Additional Requirements:

1 2-Cycle Glow Engine of your choice
1 Matching Muffler - Helicopter Type
1 Recommended Glow Plug

Special Tools Required: 1 Dial Indicator or equivalent (for testing fan runout)

A. Although not essential, it is suggested that the engine to be used receive a suitable break-in run prior to installation. Set the throttle barrel stop to allow full carburetor shut off at the low end and retain (or record) the idle and high speed mixture needle settings. These settings are more easily done on a test bench.

B. The precise centering of the fan and clutch assembly is achieved by the use of a special collet #0641 (for O.S., Enya, and Super Tiger engines) for X-CELL .30 Series kits. The X-CELL .40 series (which is designed especially for O.S. 40 SF and FSR engines) uses the collet contained as standard behind the thrust driver of O.S. engines. Collet #0641 has a bore of .250" diameter. This will fit the following: O.S. .32 (all types); Enya .30 and .35; Super Tiger G .34. If you have chosen any other .30 size engine and your crankshaft is not .250" diameter, contact your dealer or Miniature Aircraft USA for assistance. In the case of the O.S. .40 series, no additional collet will be required (simply remove the original thrust driver and utilize the stock brass collet in its original position). this is essential for a true running engine/shaft assembly and a vibration-free helicopter! (Radios and servos live short, unhappy lives in high vibration applications!) (**NOTE:** It may be necessary to cut approximately 2.0mm to 4.0mm from the top of the engine crankshaft for clearance of main clutch unit. When cutting, cover all open engine surfaces.)

C. Remove the prop nut and washer from your engine. (In the case of only the .40 series, remove the original O.S. .40 thrust driver, revealing the original brass collet.) On .30 series installations, wrap one layer of Teflon pipe sealant tape around the crankshaft of your .30 engine of choice. Place the #0707 cooling fan on the .30 crankshaft. Wrap one layer of Teflon pipe tape around the tapered side of #0641 collet and slide it in place (small end down) in the fan hub. .40 series installations call for cooling fan #0708 to be installed directly onto the original O.S. .40 brass collet (in a manner similar to the way the original O.S. thrust washer fit the collet). Center the fan to engage the collet, slide #0007 engine washer on the shaft and replace the engine prop nut (the use of Loctite is recommended). Make sure the collet fully engages the fan and tighten securely, using Loctite.

D. Using whatever device is available, determine that the Fan runs square and true when the engine shaft is rotated. If it does not, remove Fan and Collet and rotate them to a new position and reinstall. This is an important step. If a dial indicator is used, acceptable alignment is shown by a less than .06mm (.002") excursion of the needle during a full rotation of the engine shaft. If difficulties persist in aligning the fan unit, refacing the knurled engine prop driver with a lathe will help the alignment process. Many of the knurled engine prop drivers do not run true.

E. After alignment, the prop nut must again be tightened very securely to prevent slippage during engine start or backfiring. A good method of tightening is to have a helper grasp the fan with a heavy cloth wrapped around it while the nut is tightened with an appropriate socket wrench. (**NOTE:** A slight shift in dial indicating reading may occur as the fan nut is increasingly tightened. It is very important that the engine nut be quite tight; however, caution must be used when dealing with 1/4" crankshaft sizes to avoid breakage.)

F. Select the #0735 delrin hub isolator. Press it fully in place inside the fan hub counter bore surrounding the engine nut and washer. It should sit flush with the upper surface of the fan hub. Select (2) #0732 special 12.9 hard clutch bolts and (2) #0733 steel clutch bolt supports. Note that the flanged side faces the fan hub. Apply Loctite to each bolt and install them along with their supports into the M3 holes within the fan hub. Tighten securely. Select the #0734 delrin clutch disc and install it onto the upper fan hub surface. Be sure that it fits flush with each flange of parts #0733. Select (2) #0731 delrin clutch isolators and press them fully in place over the bolts and supports until they contact the #0734 disc.

G. Select the #0730 clutch assembly. Press it fully in place over the #0731 delrin isolators and into the #0735 hub isolator. When installed properly, approximately .75mm of each delrin #0731 will protrude above the upper surface of the clutch (note, however, that the bolt heads will not extend above the clutch upper surface).

H. If you are building a standard kit or are still using the original bronze bushings inside the clutch bell, install (1) #0627 special 5.0mm washer onto the clutch shaft and slide it fully down to the clutch. If optional #0636 ball bearings have been utilized in place of the bronze bushing on the clutch bell, slide (1) additional #0627 washer in place, for a total of two. In either case, follow with (1) #0625 rubber O-Ring. If bushings are in use, apply a **very small** amount of grease to the O-Ring. Remove the assembled clutch bell #0709 from Bag #6. If bushings are used, apply a top quality lubricant (such as molybium) grease inside the clutch gear. If ball bearings are utilized, do not apply grease. Slide the clutch bell onto the start shaft and wipe away any excess grease, if any was used.

I. Select (2) #0645 motor mounts (or (2) #0646 mounts in the .40 size kit), (4) #0063 socket head bolts, and (4) #0003 M# washers from Bag #6. Fit the engine to each motor mount using socket bolts and washers. Do not tighten.

J. Slide the pre-assembled engine unit in between the side frames from the underside, until the clutch gear contacts the lower bearing of the #0233 bearing block. Secure to the side frames using (4) M3x10 socket head bolts #0063 and (4) M3 washers #0003. **NOTE:** The engine unit must be aligned very carefully to assure proper clutch engagement. Adjust the motor unit until the main rotor gear and clutch bell will spin freely with no binds. (Clutch bell does not try to engage the centrifugal clutch.) When properly set up, there should be very minimal gear play and about .5 to 1.0mm of up/down play in the clutch bell. The engine should be exactly vertical at all views and centered evenly between the frames. **NOTE:** As a final check, it is useful to remove the upper bearing block to be sure no side load exists in the clutch start shaft. The block should then be reinstalled along with the #0621 start cone. The cone should sit directly on the top bearing and be secured with Loctite and (2) M3x6 socket set screws.

K. Remove the two piece fan shroud #0643 from the box and hold them in their proper position around the fan inside the main frame members. The shroud halves can be screwed together around the fan using two #0027 Phillips screws (M2.2x9.5) from the parts bag. Take the remaining three Phillips screws #0032 (M2.9x9.5) and mount the shroud in place using the frame slots provided. Refer to **View #5**. Check for fan clearance and tighten all three screws.

SERVICE NOTES:

1. As designed, it is possible to remove the engine without removing the clutch from the model. Merely remove the (4) motor mounts to frame bolts and the engine will disengage from the clutch. Until some break-in has occurred, there may be a little resistance to this separation initially, so some effort may be required to remove the unit.

2. Long term use may cause a little wear on both Delrin clutch isolators #0731. This will not cause any problem unless you find them to be broken or totally worn through. If so, they will require replacements.

3. By its nature, this system is self-aligning in that it can absorb any run-out during operation. It is important to note that its efficiency and useful life will be greatly enhanced by a careful and properly aligned installation.

Step 8. Complete Main Frame Structure

Parts Required:

1	#0247 Radius Arm Support	Bag #6
1	#0249 (M2x42) Control Rod	Bag #6
2	#0133 Plastic Ball Links (Long)	Bag #6
2	#0063 M3x10 Socket Hd Cap Screws	Bag #6
2	#0019 M3 Locknuts	Bag #6

1	#0361 M2 Steel Balls	Bag #6
1	#0042 Sltd Ch Hd Machine Screws (M2x10) 8.8 GR.	Bag #6
1	#0697 Control Ball Spacer #3 (2mm)	Bag #6

IMPORTANT NOTE: If you have determined that your kit contains mainshaft #0613 or you are choosing (2) #0210 plastic spacers as an option with #0614, follow these steps: take the radius arm support #0247 from Bag #6 and bolt it in position on the top left main frame as shown in **View #2.** Use two M3x10 socket head bolts and M3 locknuts.

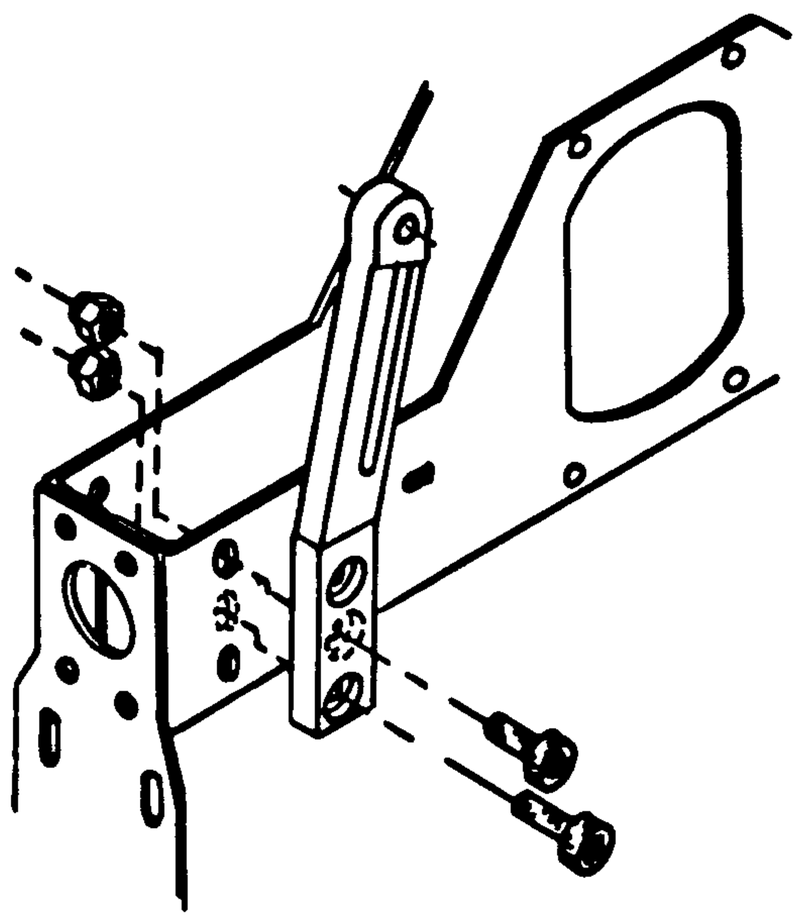
If you are using main shaft #0614 with no #0210 spacers or just one, follow these preliminary steps:

Drill a new hole 15.5mm from the bottom of support #0247 (directly between the existing holes) with a #32 drill (.116" or 3.0mm) completely through. Make a countersunk hole at half depth using a #3 drill (.213" or 5.5mm) and light pressure. **See View #2A Alternate.**

Drill a new hole in the left main frame directly between the two existing support mounting holes (16.0mm from the top or bottom edge) with a #32 drill (.116" or 3.0mm).

Install anti-rotation support #0247 using the upper two holes in the frame and lower two holes in the support. This will raise the support by about 9.0mm (thereby accommodating any additional main shaft length).

VIEW (2A) ALTERNATE



A. Select a 2mm Control Ball Spacer, #0697, and, using **poly-zap cyano only**, glue in place in the radius arm #0247. Slide a steel ball #0361 onto the #0042 (M2x10) slotted screw. Using slow cyano, thread the screw/ball assembly into the previously glue spacer #0697. Tighten completely.

B. Thread the Plastic Ball Links on the (M2x38) Control Rod #0249 to the length that matches the Radius Arm Rod length in the Control Arm chart. The reference dimension for the length of the Rod between the Ball Links is 22mm. Snap this Rod on the Radius Arm Support ball end and onto the outer (only remaining) ball of the double ball on the Swashplate. Refer to **View #11.**

C. Set the Main Frame Structure aside until final assembly.

III. RADIO TRAY ASSEMBLY

Step 1. Assemble Wood Parts

Parts Required:

1	#0665 Wood Parts Package	Bag #7
2	#0032 Ph Pan Head Topping Screws (M2.9x9.5)	Bag #7
2	#0063 Socket Head Cap Screw (M3x10)	Bag #7
1	#0667 Gyro Plate	Bag #7
3	#0003 M3 Washer	Bag #7
1	#0071 Socket Head Cap Screw (M3x18)	Bag #7
3	#0019 M3 Locknuts	Bag #7

A. Examine exploded **View #6** showing the placement of wood parts in the Radio Tray. Also refer to the **View #8** showing servo placement and note the Throttle Servo position.

B. Select the center tray support that holds the Throttle Servo and make a trial fit of your servo in the cut-out. Enlarge if necessary (just enough for safe clearance). Drill the proper holes to mount your servo, using your radio hardware. Set the servo aside.

C. Measure the center line of the underside of the top tray and mark each end. **NOTE:** When finished, the top tray will have the aileron servo cut-out offset towards the left side of the model (the left as viewed from behind as in an automobile). Center the vertical center support (it holds the throttle servo) with the cut-out for the throttle servo towards the front on the underside of the top tray **flush** and square with the rear edge. Cyano in place.

D. Place the front vertical support (it has two large diameter holes) under the front edge of the top tray and against the front edge of the previously glued vertical center support. Cyano in place.

E. Position this assembly on the top of the lower tray (the largest wood part). **NOTE:** When properly positioned, the vertical center support will be 25.0mm from the left cut-in area and 11.0mm from the right cut-in area. Forward positioning is correct when 7.0mm of the vertical center support extends past the rear edge of the lower tray. Cyano all contact areas.

F. Position the switch plate against the right end of the vertical support with the narrower top edge underneath the top tray and the large (gyro switch) hole to the rear of the front vertical support. Center it so that each switch will have sufficient space for installation. Cyano in place.

G. Install the hardwood blocks. Two are used to raise the rudder servo. Cyano them liberally. The third is placed horizontally in the lower left corner of the vertical center support directly over the 3.0mm hole in the corner flush with the rear of the center bullhead approximately 1/16" above the lower wood tray. Cyano in place. Drill through the block with a 3.1mm drill (1/8" or #30 drill) using the existing hole as a guide.

H. Lightly sand the entire radio tray, including removing any splinters around the holes, and make a trial assembly of the tray to the main frame, using three #0003 M3 washers, two #0063 (M3x10) socket head bolts, three #0019 M3 Locknuts, and one #0071 M3x18 socket head bolt through the wood parts. **See View #6.**

Step 2. Fit Servos and Disassemble

Parts Required:

2	#0353 Roll Servo Pivots (Female)	Bag #7
2	#0351 Roll Servo Pivot Supports (Male)	Bag #7

2 #0357 Plastic Pivot Grommets Bag #7
8 #0027 M2.2 x9.5 Self Tapping Screws Bag #7

Additional Requirements: 1 Helicopter Radio, Complete with 5 servos and mounting hardware.

A. Examine **View #8** on the drawing to determine servo placement for each control function. Note especially that the Aileron (Roll) servo is mounted on pivots to allow it to rock fore and aft under control of the Collective Pitch servo ahead of it. **View #7** shows the pivot structure.

B. Select the servo to be used for Roll control and insert all four rubber grommets provided with your radio system. Select a #0351 Roll Servo Pivot from the parts bag and, holding it in place under one end (**See View #7**), use a small drill to mark it for proper hole drilling to accept two of the servo mounting screws from your radio hardware. (**NOTE:** Recognize that screwing this servo to the Pivot is just like screwing the servo down to a wood or plastic servo tray in that a small enough drill must be selected to allow your particular screws to thread into the plastic.) Drill the holes and screw the Pivot to the servo. In identical fashion, mount the remaining #0351 Pivot to the other end of the Servo.

C. Invert the Radio Tray assembly and, referring to the drawing, mark the center of each end of the Roll servo cutout.

D. Press two #0357 Plastic Pivot Bushings into the holes in the two #0353 Roll Servo Pivots. Again referring to **View #7**, hold the servo in approximate position centered in its clearance hole in the tray and press the bushings of the Pivot Supports into the servo Pivot ends (lightly grease). Normally, the servo assembly can now be held against the bottom of the tray with adequate clearance and sufficient wood material under the Pivot supports to allow the assembly to be screwed in place. If not, modify the hole in the tray as necessary.

E. Remove the Pivot Supports from the servo assembly and, based on the trial positioning in D above and using a 7/64" drill bit, drill two mounting holes in each pivot Support from the bottom. Replace pivot supports.

F. Reposition the servo assembly as in D above, making sure that the Supports are centered on the cutout centerline and the servo is centered in the cutout. **The servo output should line up directly in line with the vertical center wood support.** GLUE the Pivot supports to the bottom of the tray, using cyano. (Hold the Support Plastic Grommets snugly against the Servo Pivots.) Using a smaller drill, drill the four pivot mounting holes and screw the assembly in place. Check the servo for good retention end-wise and freedom to pivot.

G. Check mounting cutout clearance for each of the remaining tray-mounted servos, and mount them in the normal way, using your radio hardware and rubber grommets per the manufacturer's instructions. Orient them as shown in the drawing.

H. Check servo clearance in the cutout of the #0653 right main side frame and increase if necessary. Drill for servo mounting as required. Mount the servo using the four sheet metal screws provided.

I. Disassemble all servos and mounting parts. (The Elevator servo may be left in place if desired.)

Step 3. Paint Tray

A. Paint tray with any fuel proof paint material. Set the wood assembly aside to dry.

IV. TAIL ASSEMBLY

Step 1. Assemble Tail Rotor Transmission and Collective

Parts Required:
1 #0421 Tail Rotor Gear Hosing (2 pcs) Bag #8
1 #0423 Input Shaft, Tail Rotor Bag #8

4	#0425 Ball Bearings (M5x13)	Bag #8
2	#0427 Bevel Gears	Bag #8
1	#0429 Output Shaft, Tail Rotor	Bag #8
1	#0431 E-Clip, Output Shaft	Bag #8
1	#0433 Gear Spacer, Output Shaft	Bag #8
1	#0435 Brass Control Slider	Bag #8
1	#0437 Plastic Control Slider Ring	Bag #8
2	#0439 Ball Bearings, Control Ring (M6x10)	Bag #8
1	#0441 Plastic Pitch Plate, Tail Rotor	Bag #8
1	#0443 Snap-On Retainer, Pitch Plate	Bag #8
2	#0133 Ball Links Long	Bag #8
1	#0445 Bellcrank, Tail Rotor	Bag #8
1	#0095 Special Bolt, T/R Bellcrank (M3x19)	Bag #8
2	#0131 Plastic Bearing Bushing	Bag #8
1	#0447N Delta Hub, Tail Rotor	Bag #8
4	#0447-1 Spring Lock Clips	Bag #8
1	#0447-3 Dampener Silicone	Bag #8
1	#0447-2 Delta Hub Pivot Pin	Bag #8
2	#0453 Tail Rotor Blade Mounts	Bag #8
4	#0455 Ball Bearings, Blade Mounts (M3x10)	Bag #8
2	#0460 Special T/R Pivot Bolts (2)	Bag #8
4	#0025 Phillips Self-Tapping Screws (2.2x6.5)	Bag #8
3	#0041 M2x8 Machine Screws	Bag #8
2	#0073 M3x20 Socket Head Screws	Bag #8
2	#0019 M3 Locknuts	Bag #8
1	#0053 M3x5 Socket Set Screw	Bag #8
4	#0051 M3x3 Socket Set Screws	Bag #8
2	#0691 White T/R Blades	Bag #8
2	#0042 Slotted Cheese HD Screw (M2x10) 8.8 GR	Bag #8
3	#0361 M2 Steel Balls	Bag #8
5	#0001 M2 Washer	Bag #8
2	#0687 T/R Blade Mount Bearing Spacer	Bag #8
2	#0689 M3 Special Washer	Bag #8
2	#0009 3MM Small Washer	Bag #8
2	#0159 Ball Bearings (M3x7)	Optional #0725 Bearing Kit

A. **View #9** on the drawing shows the parts that make up the bevel gear transmission and tail rotor pitch control unit. The assembly sequence to follow is intended to allow convenient balancing of the tail rotor.

B. Parts placement to make up the Tail Rotor collective pitch control is also shown in **View #9**. Begin by assembling one #0361 steel ball and one #0001 M2 washer onto one #0041 slotted screw. Thread this assembly into the side hole of the Plastic Control Ring #0437. Use slow cyano and thread the screw/ball assembly squarely in place.

C. Place the two #0439 Ball Bearings (M6x10) on a clean paper with the balls visible. Lightly grease each.

D. Slide one bearing on the #0435 Brass Control Slider, ball side last. Lightly slide the Control Ring over the Slider, followed by the other bearing, ball side FIRST, and finally the #0441 Pitch Plate small end first. Press together until the bearings squarely and completely enter the recesses in the Control Ring. Do not force.

E. Examine the #0443 Pitch Plate Retainer, noting its four inside spring fingers and cupped shape. It will be pressed on the end of the Brass Slider to retain this subassembly, but this must be done with great care to ensure that the Control Ring is neither too tight nor too loose. The control ring bearings are precise and delicate but necessary for a tight slop free tail rotor control. This will be achieved by using the following procedure.

F. Cut a hole just large enough to go over the end of the Brass Slider in a small piece of very thin plastic such as the flap from a plastic sandwich bag (Saran Wrap, etc) and place it over the Slider against the Pitch Plate face. Rest the Slider vertically against a wood or cardboard surface, Pitch Plate up, and press the Retainer in place, cupped face **UP**. A piece of scrap wood with an appropriate drilled hole in it will be very helpful for this operation. Continue pressing the Retainer in place until it seats against the thin plastic shim. Carefully tear and pull the plastic out. This should provide a subassembly in which the Control Ring is free to rotate smoothly but with negligible endplay. Apply cyano to retainer clip.

G. Screw #0133 Ball Links to the Pitch Plate using M2x8 Machine Screws. Just seat the screws, so that the links can rotate with firm pressure.

H. **IMPORTANT:** Clean any oil from pivot pin #0447-2, set screw #0053, and output shaft #0429 before assembling. Select the #0447N delta hub, the #0447-2 grooved 2.0mm pivot pin and the #0447-3 dampener silicone tube from the parts bag. Examine **View #9** and **Figure #4** to see the correct orientation of the pivot pin to the tail blade assembly. This is most important. It will only fit two ways and one is wrong for proper function. Press the silicone tube about 10.0mm up over the end of the output shaft with the cross drilled hole. Slide the delta hub (with proper pin orientation) up onto the silicone. Now press both together up onto the shaft until the cross hole in the shaft appears to align with the 2.0mm through hole of the delta hub. Use a 1.5 allen wrench or small drill to pierce through the silicone dampener. Temporarily install the #0053 M3x5 socket set screw into the end of the output shaft. Test its hole depth by making sure it can contact a drill or 1.5 tool pushed all the way through the hub/silicone/shaft assembly. This will make sure no burrs are inside the threaded hole to prevent good contact during final assembly. Having made this test, remove the M3x5 set screw. Press the grooved delta pin #0447-2 into the assembly until equal parts are shown on each end of the hub. Drip Loctite (liberally) into the threaded hole and install the M3x5 set screw again. Select (2) #0001 M2 flat washers and (2) #0447-1 lock clips (extras are provided if you break one). Use a small piece of brass tubing or a 5.5mm nut driver to snap a lock clip on top of a M2 washer on each end of the grooved pivot pin. Be sure not to use pliers and that the clip reaches the groove fully. While this system can properly function without any clips at all, it will add additional security. Slide the control ring assembly on the output shaft from the grooved end, with ball links towards the hub. Snap each ball link in place. You will now see that an imaginary diagonal line (say, for instance, as 10:00 to 4:00) will pass through each control ball and the pivot pin.

I. Take the two #0453 tail rotor blade mounts from the parts bag and thread one #0042, one #0361, and one #0001 into the outboard holes, using slow cyano as before. **See View #9.**

J. Press #0455 Ball Bearings (M3x10) into the Mounts, on the control arm end, seating them squarely and fully.

K. Stack one #0689 special washer, one #0009 spacer washer, one #0455 ball bearing and one #0687 bearing spacer on each #0460 M3x16 **Hardened** socket head bolt. **See View #9.** Insert each #0460 bolt assembly into each blade mount #0453 from the forked end through the previously pressed in bearing #0455. Apply Loctite with a toothpick in the threads in the Tail Rotor Hub #0447. Tighten bolts #0460 securely. The Tail Rotor blade mounts should rotate smoothly and freely.

L. Mount Rotor Blades #0691 using M3x20 Socket Head Cap Screws and M3 Locknuts. Blades should be oriented for clockwise rotation with ball links leading the blade mounts. **See View #9.** Tighten just enough so that the blades will hold position.

M. To balance the entire rotating Tail Rotor assembly, ensure that the blades extend straight out from the hub and grasp just the Control Ring in two fingers, holding the rotor shaft level. The tail rotor should remain in any position if balance is correct (and the control ring bearings are properly free). If not, and one blade rotates downward, add weight in the form of a narrow strip of colored tape to the end of the **OTHER** blade bit until balance is achieved. Remove the blades and set aside. Make note from which side each tail blade was removed. **PROPER BLADE BALANCE IS ESSENTIAL.** A blade balancing device is available from Miniature Aircraft, USA, order #3750.

N. Lay the four Ball Bearings #0425 (M5x13) on a clean sheet of paper, ball side up, and apply a small amount

of grease #4707 to the ball race of each. In sequence, on the narrow grooved side of the output shaft, slide a #0425 ball bearing (sealed side first), the #0433 gear spacer, and the #0427 bevel gear (teeth toward the E-Clip groove). Snap the #0431 E-Clip in the narrow slot at the end of the Output Shaft. Select one bearing and, ball side first, slide it on the short end of the Output Shaft up against the E-Clip. Apply a small amount of Loctite to each of two M3x3 Socket Set Screws and thread them part way into the boss of the bevel gear.

O. Refer to the drawing and select the bottom #0421 Gear Housing Half (cavity up - ear to the right). Place the Output Shaft in the cavity with the bearings at the extreme ends, with the E-Clip to the left. While pressing the Shaft toward the E-Clip to seat its bearing, hold the Gear and Spacer against the other bearing and tighten the gear set screws securely. Be sure one set screw is on the flat. There should be no endplay in the assembly.

P. Select the Input Shaft #0423. Clean the Shaft and inner bearing races with alcohol (or similar cleaner). Apply a small amount of Loctite to the position on the Shaft of the first bearing and install the bearing. Repeat the process and install the second bearing. **This procedure is most important.** Thread two M3x3 Socket Set Screws in the remaining bevel gear, again using Loctite, and slide it on the Input Shaft with teeth side out. Separate the two bearings far enough on the shaft to allow insertion in the housing with the two bevel gears in mesh. The bearings should seat against the molded in spacer. Press this stack together and tighten both set screws in the gear. **NOTE:** Be sure one set screw seats on the flat (load with grease #4707). The other Gear Housing Half can now be put in place and should rest fully against the first half. Secure together using 4 #0025 Phillips screws into the four holes at the rear of the housing from the top side. The shafts should now rotate freely with no play. If desired, additional grease may be added to the bearing cavities before this step.

Q. Press either #0131 Bushings or #0159 Ball Bearings (#0725 Optional Bearing Kit) into the holes in the Tail Rotor Bellcrank #0445, using the Special Bellcrank Bolt #0095 to keep the bearings or bushings aligned during the process. The bearings should have ball sides facing in. Engage the control Ring Ball in the cup end of the Bellcrank and squarely thread the Stud into the boom on the Gear Housing from the bottom. Use cyano with care. Tighten the stud until there is no play or bearing drag.

R. Recheck the complete assembly for smoothness of action and put aside.

Step 2. Assemble Tail Boom Drive Shaft Tube and Fins

Parts Required:

1	#0669 Tail Boom	Bag #10
3	#0673 T/R Drive Shaft Plastic Guides	Bag #9
3	#0477 T/R Control Rod Guides	Bag #9
2	#0032 Phillips Pan Head Tapping Screw (M2.9x9.5)	Bag #9
1	#0685 Vertical Fin	Bag #9
1	#0683 Rear Fin and Transmission Mount	Bag #9
1	#0479 Stabilizer Mount	Bag #9
1	#0481 Stabilizer Fin	Bag #9
1	#0483 Rear Tail Boom Support Fitting	Bag #9
1	#0071 M3x18 Socket Head Cap Screws	Bag #9
2	#0025 Phillips Self Tapping Screws (2.2x6.5)	Bag #9
3	#0043 M2x10 Machine Screws	Bag #9
3	#0015 M2 Hex Nuts	Bag #9
1	#0019 M3 Locknuts	Bag #9

A. Using the tail boom support #0677 from bag #10 apply a small amount of **SLOW** Cyano to each guide and press each T/R drive shaft plastic guides #0673 into the tail boom as follows: First, press the center guide 12" from one end, then press each remaining guide 6" from each end of the tail boom, using a suitable size wooden dowel or stick. This will equally space each guide in the tail boom.

B. **View #9** will show relative placement of the Fin and Stabilizer and their supports on the tail boom.
C. Using two #0032 M2.9x9.5 self tapping screws, assemble #0685 Vertical Fin to the Rear Fin and Transmission

Mount #0683. Slide this assembly onto the notched end of the Tail Boom #0669 until the mount #0683 is flush with the end and orient until the notch is opposite the fin (horizontal when the fin is vertical). **See View #9.**

D. Slide the Stabilizer Mount #0479 into approximate position on the Boom and press the Rear Tail Boom Strut Support Fitting #0483 over the lower ears of the Mount and anchor with an M3x18 Socket Head Screw and M3 Locknut. Tighten only lightly. Mount the Stabilizer to the top of the Mount with two Phillips Self Tapping screws #0025 from the parts bag.

E. Loosely mount the three Tail Rotor Control Rod Guides #0477 by wrapping them around the boom and securing each with an M2x10 Machine Screw and M2 Hex Nut. Mount one between the Fin and Stabilizer and two ahead of the Stabilizer. (The screws are long enough to allow the Control Rod to be snapped in from the sides when needed.)

Step 3. Install Tail Rotor Transmission

Parts Required:

1	#0675 T/R Drive Shaft	Bag #10
3	#0032 Phillips Pan Head Tapping Screws (M2.9x9.5)	Bag #9
2	#0057 Socket Set Screws (M4x4)	Bag #9
1	#0019 Hex Locknut (3mm)	Bag #9
1	#0063 Socket Head Cap Screw (M3x10)	Bag #9

A. On the Input Shaft of the Tail Rotor Assembly note the two threaded cross holes in the large diameter. Select two M4x4 Socket Set Screws, apply Loctite, and thread them partially in place.

B. Identify the flat on one end of the Drive Shaft #0675 and, orienting it so that it faces one of the set screws, insert the Drive Shaft in the end hole of the Input Shaft as far as it will go. Tighten the set screw LIGHTLY against the flat (make certain of this orientation) and then tighten the opposite set screw. **THEN** tighten the first set screw. **RECHECK** the tightness of **BOTH** set screws.

C. Lightly grease the Drive Shaft and slide it into the Tail Boom from the Fin end until the Tail Rotor Drive Housing enters the Boom. Press the Housing halves together and orient so that the ridge on the housing enters the notch. Push it on until transmission butts up against the tail boom. Now slide the Vertical Fin assembly back against the face of the Drive Housing and rotate it until the Housing can be screwed to the rear Vertical Fin Clamp, using three #0032 M2.9 x9.5 self tapping screws. Thread the screws on squarely and use a small amount of cyano. Do not over tighten. Now tighten clamp #0683 securely using one #0063 M3x10 socket head bolt and one #0019 M3 locknut. The Vertical Fin should be at right angle to the Tail Rotor and its Shaft. Set the assembly aside.

V. RADIO TRAY AND TANK INSTALLATION

Step 1. Mount Tray and Fuel Tank to Main Frame Structure

Parts Required:

1	#0647 Fuel Tank with Cap (8 oz)	
or 1	#0648 Fuel Tank with Cap (10 oz)	
1	#0397 Length Fuel Tubing	Tank
1	#0401 Fuel Clunk	Tank
1	#0403 Fuel Pickup	Tank
1	#0405 Fuel Vent	Tank
2	#0011 M5 Washers	Tank
2	#0013 M5 Nuts	Tank
2	#0681 1" sq Tank Support Tape	Bag #7
2	#0682 8" Tie Wraps	Bag #7

A. Remove contents of the Fuel Tank. This should include all tank parts listed above. Set the tank upright and

draw a line exactly 62mm from its bottom (the bottom being the opposite end of the Fuel Cap).

B. Drill appropriate holes and mount the #0403 Fuel Pickup and the #0405 Fuel Vent fittings. The positions shown on the drawing are recommended. Carefully clean the Tank of all debris and install the #0401 Fuel Clunk using an 83mm cut section of the Tubing provided. Check that the fuel clunk will not touch the end of the fuel tank when vertical hung.

C. Referring to **View #6**, center the tank under the radio tray with its bottom on the right side of the helicopter and the marked line centered with the vertical center wood piece. This will center the fuel tank for canopy clearance. Mark the upper side of the fuel tank for application of the two sided mounting tape #0681. Thoroughly clean the fuel tank with alcohol. Apply the mounting tape on the marked positions. Remove the protective film from the mounting tape and secure the fuel tank in the pre-centered position using two #0682 8" plastic tie wraps.

D. Before installing the Fuel Cap, rotate both plastic ends of each side of the rubber plug until none of the holes in the rubber are visible to ensure a proper seal. A light amount of **blue RTU** may be used. Install rubber cap plug in the fuel tank and tighten the center screw securely. **See View #6.**

E. Mount #0667 Gyro Plate found in Bag #7 just behind the fan shroud using 2 #0032 M2.9x9.5 Phillips self tapping screws. **See View #5.** Paint or seal wood plate before installation.

F. Recheck Radio Tray position (level and back solidly against the Frame structure) and tighten all screws.

Step 2. Reinstall Servos, Add Radio, Gyro, and Switches

Requirements: 1 Radio System (from **Step II-2**)
1 Rate Gyro System (recommended)

A. Reinstall all servos, using hardware used in II above. Check the pivot structure on the Roll (Aileron) servo for proper movement.

B. Consult the Radio System and Gyro System Manuals and mount the system elements. Suggested Receiver, Battery, Gyro, and Switch positions are shown on the drawing. These were selected to provide proper helicopter balance with typical systems, but other arrangements are possible. Note that the holes are provided for servo lead routing, etc. Neatly bundle all surplus lead lengths and anchor with tie wraps or other means. Be sure to follow Radio (AND Gyro!) System recommendations for protection against vibration. Run the antenna well clear of engine and servos. (Miniature Aircraft USA offers a "whip" antenna particularly well adapted to helicopter use.) Do not anchor the frame-mounted Elevator (Pitch) servo leads at this time. (The Servo Extension Lead from your Radio System probably had to be used here.)

C. Test the system and recharge batteries but do not be concerned with servo arms, or servo travel and control direction at this point.

VI. ROTOR HEAD AND TAIL ASSEMBLY INSTALLATION

Step 1. Mount Rotor Head

Parts Required:

1	#0091 Special Head Retainer Bolt (M3x15)	Bag #1
1	#0019 M3 Locknut	Bag #1
2	#0335 (M2x75) Hiller Control Rods	Bag #1
2	#0337 (M2x30) Flybar Control Rods	Bag #1
8	#0133 Nylon Ball Links - Long	Bag #1

A. Examine the Drawing **Views #1 and #3** showing the complete helicopter head. With the Swashplate and

Washout Unit already in place on the helicopter Main Shaft from Step I - 6, slide the Rotor Head on the Shaft and down until the two pins engage the Washout slots. By holding the Main Gear and rotating and sliding the Head, bring the cross hole in the Head into alignment with the hole near the top of the shaft. (It may be necessary to clean plastic molding "flash" from this hole.) Insert the #0091 Head Retainer Bolt (this is a special hard pre-cut bolt with short threads) from the side having the round recess, and screw it through until it just emerges into the hex recess on the other side. Insert the M3 Locknut in this recess and, while holding it in position, screw the bolt through and tighten snugly. (The screw cannot be pushed through the assembly because the holes in the plastic head are deliberately tight for optimum retention.)

B. Prepare the two Control Rods #0335 and #0337 by threading #0133 Ball Links squarely on each end until the Rods are at the exact lengths shown for them (Hiller and Flybar) in the Control Rod Chart, **Figure #10.** Reference dimensions between inside Ball Link ends are: 58mm and 8.5mm for the #0613 Standard Shaft and the #0614 Long Shaft using 2 #0210 spacers; and 56mm and 6.5mm for the #0614 Long Shaft using one #0210 spacer. As with all Control Rods, be sure of adequate thread engagement at each ball link.

C. Snap the longer pair of Control Rods between the remaining balls on the Bell Mixers and the remaining balls on the Swashplate. Snap the shorter pair between the Flybar Control Arms and the Washout unit.

D. This completes the Head installation. For convenience in handling, do not remount the Main Rotor Blades until later.

Step 2. Mount Tail Boom and Engage Drive

Parts Required:

1	#0677 Tail Boom Support Strut (X-30)	Bag #10
2	#0057 M4x4 Socket Set Screws	Bag #9
2	#0025 Phillips Self Tapping Screws (M2.2 x 6.5)	Bag #9

A. Study **Views #2 and #9** showing Tail Boom and Main Frame details. Take the Tail Assembly from Step IV-3 and slide it partly into position between the halves of the Front Tail Boom Support. Holding the helicopter so that the end of the Front Tail Drive Shaft is visible ahead of the Support, slide the Boom further while engaging the Drive Shaft in the hole in the Tail Drive. Slide the Boom further until its front edge is flush with the front of the Support. The Drive Shaft should project well into the Tail Drive but should not bottom. Sighting from the rear of the helicopter, rotate the Boom until the Vertical Fin is parallel to the Main Shaft, and tighten the four Support screws snugly.

B. Identify the two frame holes through which the Front Tail Drive can be seen and visibly locate the drive shaft flat. Select an M4x4 Set Screw, apply Loctite and by holding it on an Allen wrench, screw it into one of the threaded cross holes in the Shaft. Be positive that the Flat on the Drive Shaft is felt under the set screw. Tighten ONLY until contact is made, then add the second M4x4 screw in the opposite hole and TIGHTEN. Then tighten the first screws. **(This SEQUENCE is important.)** To visually align the drive shaft, we recommend that a 4mm hole be drilled in the bottom side of the tail tube approximately 45mm back from the rear of the side frames. Use small drills to start the hole, avoiding contact with the drive shaft while drilling. To properly align drive shaft, spin the main gear and, using a flashlight, observe through the drilled hole the drive shaft alignment. If correcting is needed, mark one 4mm set screw for individual identification. Slightly loosen marked set screw and tighten the opposing set screw, recheck alignment. Alternate set screw sequence if needed. Repeat process until aligned. Tighten both set screws securely and check alignment once more.

C. Loosen the screws holding the #0676 Front Strut Support in the Frames and slide the #0677 Tail Boom strut in position over projecting boss. **Use slow epoxy glue or J.B. Weld only. (No cyano glues.)**

D. Loosen the screw holding the #0483 Rear Strut Fitting to the Stabilizer Mount and slide the assembly back until the Fitting can be inserted into the Strut. Again use epoxy but move the Stabilizer quickly back into good horizontal alignment before the epoxy sets up. Tighten the Stabilizer screw again. Drill a hole, one on each end

of the Tail Boom support midway through the aluminum tube into the plastic fitting, using a #49 or 1.8mm drill bit. Install 1 #0025 screw in each hole. **See Views #2 and #9.**

Step 3. Mount Tail Rotor Control Rod and Guides

Parts Required:

1	#0375 Front Tail Rotor Control Rod (M2x700)	Bag #10
1	#0679 Rear Tail Rotor Control Rod	Bag #10
1	#0385 Control Rod Coupler	Bag #9
2	#0137 Plastic Clevises	Bag #9
1	#0387 Front Rod Guide, T/R Control (2 pcs)	Bag #9
1	#0015 M2 Hex Nut	Bag #9
1	#0045 Slotted Machine Screw (M2x14)	Bag #9

A. Examine the #0385 Control Rod Coupler, noting that it will accept the Control Rods beyond their thread. The intent is to better support the Rods against bending. Use the Coupler to join the Rear and the proper Front Control Rods together. (Protect the Rods with tape or cloth when clamping them to allow the Coupler to be screwed on.) Be sure both Rods enter the Coupler approximately 7mm in depth.

B. Stack the two part #0387 Front Rod Guides on the M2x14 Screw and screw it partly into position at the small hole on the left side frame per **View #11 and Figure #5.** Using Loctite, secure with an M2 Nut #0015 from the inside of the main side frame.

C. Screw a Nylon Clevis on each end of the completed Control Rod and (long end to the rear) snap it into each of the four Rod Guides along the Tail Boom and into the Front Rod Guide. **Refer to Views #10 and #11.** Bend the tail end of the tail rotor control rod approximately 168° in order to align with the tail rotor bellcrank. **Refer to Figure #9.** Snap the rear clevis in the middle hole of the Tail Rotor Bellcrank (use a 3mm piece of fuel tubing as a keeper). Adjust the positions of the three Rod Guides along the Boom to allow a free-sliding Control Rod and tighten their screws as well as the one in the Front Rod Support. (Use Loctite.) Do not attach to the Rudder (Yaw) Servo yet. Set the helicopter aside.

VII. CANOPY PREPARATION

Step 1. Assemble Canopy and Paint

Parts Required:

1	#0659 Canopy (2 pcs)	Box
1	#0499 Canopy Latch	Bag #11
1	#0661 Trim Decal Sheet	Box

A. Examine the two Canopy halves. Note that they have been die cut to minimize cutting and trimming operations before bonding together. It is still necessary to cut out the back, top and bottom portions along the molded-in guide lines. **Refer to Figure #6.** Use scissors and/or a motor tool or a hot knife (a small soldering iron fitted with a collet to hold an "Exacto" blade).

B. Clean the bonding surfaces of the Canopy parts carefully and clamp together in proper alignment using spring clips obtainable in a stationery store. **See Figure #8.** Recheck parts alignment.

C. Holding the assembly in an inverted position, flow gap-filling cyano (the ideal material has proved to be Poly-Gap) along the groove at the joint. Using a limited flow of cyano and progressively turning the assembly, a bead of material can be run along the entire seam without overflowing onto the canopy surfaces. (A cyano accelerator can be used to "freeze" the progress of the bead at any time; check the particular brand of accelerator for use with plastics.) Allow to cure. Cut small reinforcing strips and bond one at the end of the glue bead on the bottom of the canopy and the other just inside the upper end of the seam leaving room for the Canopy Latch. Refer to the

for the Canopy Latch. Refer to the drawing for placement.

D. Trim the canopy edge to 3mm (1/8") all around and sand all plastic edges smooth. (Protect the canopy surfaces with masking tape.)

E. Using cyano, mount the #0499 Canopy Latch in place. **Refer to Figure #6** for position. Add a second fillet of cyano for additional strength.

F. Carefully wash the canopy with detergent. Mask the window area and the fuel tank viewing area. The window area is marked by a "raised welt" around the window and the full view area is shown by a fine scribed line. Use the material and pattern provided to mask this area inside and out prior to painting. The pattern provided will result in a masked area slightly larger than shown on the decal stripe sheet. This allows the decal to conceal the paint edge. Take care in removing the mask to avoid damage to the paint surface.

G. The decorative Trim Decal Sheet can be used to finish the Canopy as desired.

VIII. FINAL SET UP AND BALANCE

COMMENTS: As noted in the Introduction, this helicopter will only reach its high performance potential when used with a five-servo Helicopter Radio. Such radio systems are available from virtually all radio manufacturers and, while differing greatly in many respects, have the following features in common:

1. Five servo operation including Throttle and Collective Pitch functions on the same stick.
2. Servo reversing capabilities on most channels.
3. Adjustable servo "dual rate" selection for Elevator (fore and aft Pitch), Aileron (Roll), and Rudder (Yaw).
4. Separate amplitude adjustments (some very complex & switchable in flight) for Throttle and Collective Pitch.
5. An adjustable mixing function which couples Rudder (Yaw) with Throttle/Collective to compensate for torque-induced adverse yaw (the nose tried to turn left when power is increased and vice-versa).
6. A good Instruction Manual - perhaps the most important common feature of all.

It is vital that this Manual be read and understood before undertaking final helicopter set-up; not only to understand the way your radio provides the above functions but also to understand the various additional mixing functions your transmitter provides, and to learn the location of the various switches and adjustable pots (some hidden under back plates, etc.) which must be used in helicopter set-up.

The instructions that follow recognize the similarities and differences between radio systems and deliberately provide a basic "one-half stick collective/level swashplate/neutral tail rotor" control condition from which nearly all further adjustments can be made at the transmitter.

Step 1. Set Servo Neutrals at Transmitter

Refer to the Radio Manual for position of all switches and knobs for neutral set-up. This should include Aileron (Roll), Elevator, Rudder and any external pitch trims. Set invert, idle up, and throttle hold systems in the INHIBIT (OFF) mode. Set Throttle trim at the low end and set the Throttle at half stick. Set all dual rate switches in the "HI" position.

Step 2. Mount Servo Control Arms/Wheels

Parts Required:

1	#0015 M2 Hex Nut	Bag #11
1	#0043 M2x10 Machine Screw	Bag #11
1	#0001 M2 Washer	Bag #11
1	#0361 Steel Ball (M2) Hollow	Bag #11

The hardware and Control arm package in the Radio System

(For all servo correct directional travel see **Figure #10**)

A. Elevator Servo: Referring to Drawing **View #11 and Figure #10,** mount a Servo Arm vertically upwards and parallel to the main shaft, projecting up. It should have holes out 10mm to 12mm. (**NOTE:** Most servo arms mount on splined (serrated) output shafts and may not have a neutral position exactly as needed. Pick the closest one.) Check for proper directional travel and reverse at transmitter if necessary. Forward stick pushes servo arm forward. **Refer to Figure #10.**

B. Rudder Servo: First check servo for proper directional travel. Right tail stick command pulls the pushrod forward. Reverse if necessary. Turn on tailrotor/throttle mixing function (sometimes called ATS). Switch the ATS switch in transmitter to "R" (right hand rotation). Adjust compensator dials to one-half or (#5). Check proper compensation direction by increasing the throttle stick. This should result in pulling forward like a right hand command. If incorrect, switch ATS switch to "L" and recheck. After check completion, return throttle stick to the one-half stick position. Pick a servo arm that has holes at least out to 11mm and mount it at 90° facing inward. The preceding rudder steps will enable equal tailrotor control in both directions at lift-off (one-half throttle stick). **Refer to Views #8 and #11 and Figure #10.**

C. Throttle Servo: Without disturbing the Throttle stick halfway setting, mount a 14mm arm straight downwards from the servo. At this time, consult your Engine Instruction, loosen and reposition the carburetor control arm so that it projects straight up (vertically) when the arm is in its mid-travel position (halfway between full throttle barrel opening and fully closed kill position previously set in section I-7. Check for proper servo travel direction. Push rearward to increase throttle. Switch if necessary.

D. Collective Pitch Servo: With the transmitter stick still at the one-half position, select a large servo wheel (not an arm) and rotate on the servo spline until a hole may be selected which is approximately 2mm rearward from 90° (neutral) to the right of the servo and 8 to 14mm out. Mount a #0361 steel ball using a #0015 M2 Hex nut, #0043 M2x10 machine screw and a #0001 2mm washer provided in Bag #11. (Use Loctite.) **See Figure #11 and View #7.** The closer to 8mm towards the center of the servo the ball is mounted, the softer collective response will be. The farther out, the quicker collective will be. Some radio systems without electronic endpoint adjustments will need to be mounted towards the 14mm point in order to obtain enough collective travel. Proper directional travel pushes rearward to increase collective pitch. **Refer to Figure #11.**

E. Do not disturb the Aileron (Roll) Servo controls until the Control Rod installation is made.

Step 3. Install Control Rods

Parts Required:

1	#0359 Roll Servo Link Retaining Bar	Bag #11
1	#0001 M2 Washer	Bag #11
1	#0043 M2x10 Slotted CH HD Screw	Bag #11
3	#0361 M2 Hollow Steel Balls	Bag #11
2	#0045 M2x14 Machine Screws	Bag #11
5	#0015 M2 Hex Nuts	Bag #11
1	#0367 Elevator (Pitch) Control Rod (M2x60)	Bag #11
1	#0369 Collective Control Rod (M2x35)	Bag #11
2	#0371 Aileron (Roll) Control Rods (Bent) (M2x90)	Bag #11
1	#0373 Throttle Control Rod (M2x130)	Bag #11
6	#0389 Elevator Servo Lead Retainers	Bag #11
3	#0137 Plastic Clevises	Bag #11
7	#0133 Plastic Ball Links - Long	Bag #11
2	#0513 Wood Blocks Swashplate Adjustment	Bag #11

A. Aileron Servo: **Study Views #7, #8, and #11,** showing the special control arm assembly on this pivoting servo. Note that the three control rods running to it have their ball links trapped by the arm assembly and, therefore, must

be fabricated first.

Identify the #0369 Collective Control Rod and the two #0371 Aileron (Roll) Control rods and install #0133 Plastic Ball Links on both ends of each. Proper lengths are shown on the Control Rod Chart as before. (**Figure #7.**) Snap #0361 Steel Balls (drilled version) in the Links on the bent ends of the two Aileron Rods. Orient so the holes are visible.

As shown in the drawing, insert one #0043, one #0361 steel ball, and one #0001 M2 washer in the center hole of the #0359 Roll Servo Link Retaining Bar from the bottom and secure it with an M2 Hex nut. Use Loctite.

Select a double ended Servo Arm from the Radio System hardware, long enough to match the 24mm hole separation on the Retaining Bar. If necessary, obtain an undrilled arm or wheel and drill and shape it to suit. Mount it exactly parallel with the servo lengthwise.

Insert an M2x14 Screw in each end hole of the Retaining Bar, slide an Aileron Rod Ball on each and secure with an M2 Hex nut. Snap the Collective Rod Ball Link on the center ball and mount the assembly of three Rods to the Servo Arm. Secure with two M2 Hex nuts from underneath the Arm. Tighten securely using a small wrench or long-nosed pliers. Use Loctite. Check the configuration against the drawing. (Collective Rod forward.)

B. Collective Servo: Maintaining the throttle transmitter stick in the one-half position, snap the Collective Control Rod, #0369, on the ball on the servo wheel. The Aileron (Roll) Servo should be exactly upright in its pivots. If not, re-adjust collective rod length. Next adjust both Aileron Rods, #0371, until the roll bellcranks, #0167, are parallel with the top of the side frames, #0653 and #0655, keeping both Aileron Rods the same length.

C. Swashplate: Insert the two 11mm wood blocks, #0513, (**NOTE:** Only one side is 11mm) between the top of the Frame and the bottom of the Swashplate. Slide the Swashplate down squarely against it. Refer to **Figure #8.** Now test the Aileron (Roll) (two) and Elevator Control Rods, #0227 (two), for proper length by lightly holding their free ball links against the steel balls on the Swashplate - Aileron and Elevator Bellcranks. Adjust lengths as necessary and snap all four in place. (**NOTE:** The lower elevator ball links snap onto the outer balls on the double steel balls. The left Aileron upper ball link snaps onto the inner ball on the double threaded steel ball.) The proper condition should allow the Swashplate to remain level at the 11mm position with all three servos (collective, aileron, and elevator) still centered. Finally check for proper Aileron Servo travel direction. Right Aileron command should tilt the Swashplate to the right. Refer to **Figure #10.** Change if necessary. **NOTE:** When using Long Shaft #0614 with one or none of the #0210 spacers, the 11mm wood block can **NOT** be used. Alignment will be done by sight.

D. Elevator (Fore and Aft Pitch) Servo: Install a #0137 Plastic Clevis and a #0133 Ball Link on #0367 Elevator Control Rod using the dimension shown on the Control Rod Chart (**Figure #7**). Snap the clevis into the 8mm radius hole on the servo arm. Use a piece of fuel line as a safety retainer. Finally adjust the Control Rod, #0367, until the ball link aligns with the Elevator Bellcrank steel ball while still retaining the wood blocks under the Swashplate. After completion, remove wood blocks. Install #0389 Servo Lead Retainers on socket screw heads where appropriate to route the servo lead forward. Refer to **View #3.**

E. Throttle Servo: If the radio system has a throttle function called "Hovering Throttle" preset at neutral or "O" position. Using two Plastic Clevises and #0373 Throttle Control Rod, make up a Control Rod, snap one end on the Throttle servo arm and set the proper length to hold the engine throttle arm in the vertical up position. Operate the throttle servo and check for full carburetor closing and opening. Adjust radio endpoints (if equipped) or change servo arm length as necessary to achieve full travel. Use 2 fuel line safeties on clevises.

F. Rudder Servo: With throttle stick at one-half, snap the front control rod clevis into the servo arm 8 to 10mm from center. Check and adjust clevis until the outer hole in the tailrotor bellcrank #0445 is approximately 1-2mm rearward from the back edge of the tailrotor transmission housing #0421. This should result in approximately 20mm distance between the tail rotor blades when folded together. **See Figure #12.** Check both left and right tail rotor commands at low and high throttle positions for no binds. Adjust transmitter endpoints (if equipped) or change servo arm length if necessary. Safety both clevises with fuel line keepers.

Step 4. Final Swashplate and Flybar Alignment

Swashplate: A final check for a level swashplate may be achieved with the use of a main rotor pitch gauge (order #0526). Snap the flybar lock #0505 into the head position. Position the pitch gauge on one rotor blade

and set the pitch reading in the blade. Rotate the main rotor head in all four 90° positions. If the swashplate is truly level, the pitch reading will remain the same in all four quadrants. If incorrect, adjust the rods just below the swashplate until a level swashplate is achieved.

Flybar Paddles: Now that the swashplate has been leveled the flybar paddles may be leveled also. Set your pitch gauge on 0°, position on paddle and adjust paddles until they are level (parallel) with the main rotor head. Each paddle and #0307 control arms must remain parallel to each other. **(VERY IMPORTANT)**

Step 5. Final Assembly and Balance

Parts and Equipment Required:
1 Helicopter Muffler or Tuned Pipe with Mounting Hardware
1 Yaw Rate Gyro

A. Install the Muffler or Tuned Pipe per its instructions. Connect a section of fuel line from the Tank clunk fitting to the carburetor, incorporating a fuel filter (not supplied) is recommended. Add a muffler to tank line again, with filter, if tank pressurization is desired.

B. Carefully read the gyro instructions provided. Mount the gyro selected on double layers of 2-sided vinyl servo tape on the gyro plate just behind the cooling fan shroud. It may be necessary to remove the gyro cover to enable insertion in the side frames. Replace the gyro cover after installation. Use two #0389 wire lead retainers to route the wires. **See View #5.** Set gyro sensitivity to approximately 40-50%. Turn gyro and radio switches on and check for proper gyro/rudder directional operation. Helicopter nose pulled to the left should result in a **right** tail rotor command. Reverse gyro if incorrect. When using a gyro, a battery pack with 1000mah minimum is recommended. When switching gyro on and off, observe that rudder servo retains its same centering position. If needed, adjust gyro centering per gyro instructions.

C. Balance: Check the completed helicopter by suspending it from the flybar (with the flybar crosswise) just above a level surface. With an empty fuel tank, it should remain level or tilt forward no more than 6 or 7mm (1/4") as measured over the length of a skid. Adjust battery pack position (or similar system element) to achieve this.

Step 6. Final Set Up

Comments: Your helicopter is now complete. There remains only the establishment of the proper control set-up at the transmitter. The Pitch, Roll, Yaw and Collective Pitch values recommended here have been arrived at after much test flying and work very well with both X-CELL SERIES .30 and .40 models.

A. Fore and Aft Pitch and Roll: The Elevator and Aileron servo arm lengths specified give full design travel. Dual Rates should be initially set at one half full travel. The Flybar weights give good aerobatics when fully out. Halfway settings provide fast response.

B. Yaw: The Rudder servo arm length given provides a very responsive tail. Experiment with Dual Rate adjustment until the set up with the particular gyro installed provides good but not extreme yaw response.

C. Collective Pitch: For best results to enable accurate pitch settings, a Flybar locking device should be used (order part #0505). Initially set the hover pitch setting in the main rotor blades (one-half throttle stick position) by adjusting the Hiller Rods, #0335, until +4 1/2 is achieved. Lengthen to increase pitch, shorten to reduce pitch. Do both blades. To achieve the remaining pitch curve setting, adjust the pitch trimmers on the transmitter or alter the collective servo arm length if necessary. The chart below gives adjustment degree values useable with our .30, .40, .50, and .60 models:

Low Stick --- minus 1° - soft landings, initial flights
minus 4° - aerobatics, autorotations
Half Stick -- plus 4°; .40 Series plus 5°

High Stick -- plus 8° - average engine
plus 9° - high performance engine and tuned pipe combination

Autorotation - plus up to 12° available depending on transmitter

Excellent INVERTED performance is obtained with the reverse of the above values (except autorotation!)

Low Stick --- plus 1° or 2°
Half Stick -- minus 4°; .40 Series minus 5°
High Stick -- minus 8 to 9°

Step 7. Additional Transmitter Adjustments (Optional) READ RADIO OWNERS MANUAL CAREFULLY.

A. Throttle Hold: With the throttle hold switch **on**, set the carburetor for a low reliable idle which will disengage the centrifugal clutch. Set throttle hold pitch curve for approximately -4° low to +12° high.

B. Idle Up: Some transmitters are equipped with multi-idle up switches. If only one is available, a higher idle-up setting will be necessary for some aerobatic maneuvers.

Multiple Switches:

1) Set approximately 50% throttle setting equal to hovering position. Low pitch range approximately -2°. (Loops, hovering, stall turns, rolling stall turns, general flying)
2) Set approximately 70-80% throttle setting. (Rolls, split S)
Low pitch range. -3° to -4°.

Whichever idle-up settings you choose, set for constant blade speed during maneuvers. Fine tuning by flight testing will be necessary.

C. Invert Flight Set-Up: Activate the invert function on transmitter. With the roll servo exactly vertical, adjust the Hiller Pushrods #0335 until there is 0 collective pitch in both rotor blades. Set the transmitter throttle stick at one-half (Hover) and re-position the collective servo control arm at about (20) rearward from center (towards positive pitch side). Now flip the invert switch; the control arm position should move the same distance (20) from center towards the front (negative pitch side). Re-position until this is achieved. With the invert switch in the normal position for upright flying, choose a hole on the servo arm out 10-12mm from center and re-adjust the collective control rod #0369 until +4° (positive) is achieved at one-half throttle stick. Flip the invert switch to invert and check to see if the pitch readings are -4° negative. If not, re-adjust the collective arm length or collective servo control rod until equal-opposite (+ and -) pitch readings are achieved at hover. If only lower or higher equal-opposite pitch readings are obtained, the external transmitter pitch trimmer or hovering pitch trimmer can be adjusted and will increase or decrease both negative and positive pitch simultaneously. Now adjust high and low pitch settings as outlined in Step 4-D. Some radios have separate invert pitch curves available. Re-check all pitch settings before flying.

Step 8. Final Assembly Inspection

A. Check entire machine for any loose nuts, bolts, or screws.

B. Re-check plans for proper assembly.

C. Inspect radio installation. Check to see that there is no mistake in the operational direction of each servo with no binds. Refer to **Figure #10.**

D. Check all rod connections for proper installation.

E. Check all moving components on helicopter for bind free operation.

F. After completion of the final inspection, we recommend that you familiarize yourself with all stick movements, switches and functions of the radio system as it relates to your helicopter. Refer to **Figure #10.**

Practice until you feel comfortably ready for your first flight. Be careful to always ensure that the batteries in your radio system are fully charged before each flying session. We recommend the use of a good battery voltage meter to monitor the voltage level during use.

Step 9. Necessary Flight Items

A. Obtain items necessary for flight use
1) Glow fuel (Nitro; about 10 - 15%)
2) Fuel pump (electric or manual)
3) Electric Starter (12v)
4) Special Starter extension (Part #4681 from Miniature Aircraft, USA)
5) 12v battery (preferably a gel-cell; 5.5 amp minimum)
6) 12v charger
7) 1.5v glow plug batter with charger
8) Extra glow plugs
9) Ample tools for field use
10) Frequency flag displaying your transmitters' frequency colors or numbers (Supplied with your radio system)
11) Power Panel (optional)

B. At the flying field:
1) Obey any flying field rules
2) Check the frequency board or any fliers for frequencies in use before turning on your transmitter
3) Perform a pre-first flight radio range check as per radio specifications
4) Pre-check all radio functions
5) Check for possible help from other helicopter pilots
6) Be sure not to leave radio unit on between usage

C. Starting and Stopping of the Engine

TO START: Always start the engine by using the transmitter trigger only (high throttle trim, low throttle stick). Connect the glow plug battery connection selected to the engine glow plug. Connect the start to the 12v battery and check that it operates in a counter-clockwise rotation. Hold the rotor head firmly with one hand. Engage the starter extension on the starter with the starting cone on top of the engine start shaft and rotate. When the engine starts remove the starter and glow plug battery.

TO STOP: Set the transmitter throttle stick and trimmer to its lowest setting. If it does not stop, but is running slowly enough to halt the rotor blades, then do so and remove the fuel line to stall the engine. In this case, re-adjust linkage until engine may be stopped by use of transmitter trimmer. (After daily use of your model engine, we recommend the use of an after run oil for engine protection.)

Step 10. First Flight Adjustments

A. Engine Carburetor Settings: With engine running, set the idle adjustments to enable the engine to maintain a rich reliable idle (trying to four cycle) at low throttle, mid to high trim. Set the high speed needle to accelerate, but slightly rich. The motor should transition smoothly from high rpm's to low rpm's during the flight of the helicopter.

B. Throttle Adjustments: Fine tuning of the throttle may be done with the hovering throttle dial on your transmitter to ensure that from just before lift-off to hovering the helicopter will maintain a constant blade speed of approximately 1550-1600 rpm's. For best results, this constant blade speed should also be maintained during descent to hovering. The hovering trim dial will not affect the endpoints of the servo movements. This same effect can also be achieved with use of "idle up".

If your transmitter is not equipped with these functions, this effect will need to be achieved mechanically by different position relationships on the carburetor or servo arms. (**NOTE:** Rotor rpm's may be greatly affected by engine settings.)

C. Collective: Try to maintain original hovering recommended pitch settings. Flight trim for fine tuning once engine settings have been achieved. Fine tune low pitch settings for aerobatic maneuvers desired. Fine tune high pitch settings to match performance level of engine used.

D. Main Rotor Blade Tracking: The tracking of the main rotor blades may be checked just prior to lift-off. be sure to maintain a safe distance from your machine. The adjustments can be made by changing the length of the Hiller Rods, #0335, on each side of the head. A piece of colored tape must be applied to one blade during balancing in order to determine which blade is high or low. Tracking procedure:

- Blade speed is low, lower the higher blade
- Blade speed is high, raise the higher blade
- If blades are out an inch or better, re-check original bench pitch settings

E. Radius Arm Adjustment: The radius arm control arm can be adjusted to mix small amounts of elevator or aileron together. The arm rod length given on the rod chart has been arrived at due to many flight tests. Any further adjustments will have to be arrived at by flight testing.

F. Tail Rotor Trimming: Adjust tail rotor trimming as needed by moving transmitter until a stabilized tail is achieved. Re-center trimmer and adjust tail rotor control rod clevises until tail stabilizes with trimmer in neutral.

G. Tail Rotor Compensation: If the tail rotor swings during acceleration, the transmitter compensation dials need to be adjusted. When the nose swings to the right, LESS UP compensation is needed; nose to the left, MORE UP compensation is needed. Adjust compensation until tail remains stable during acceleration. DOWN compensation can be set during rapid descents.

H. Swashplate Trimming: When the helicopter drifts to the left or the right, adjust aileron transmitter trimmer until stabilized. Re-center trimmer and adjust lower swashplate aileron rods until stabilized again. Repeat same process for fore and aft (elevator) control.

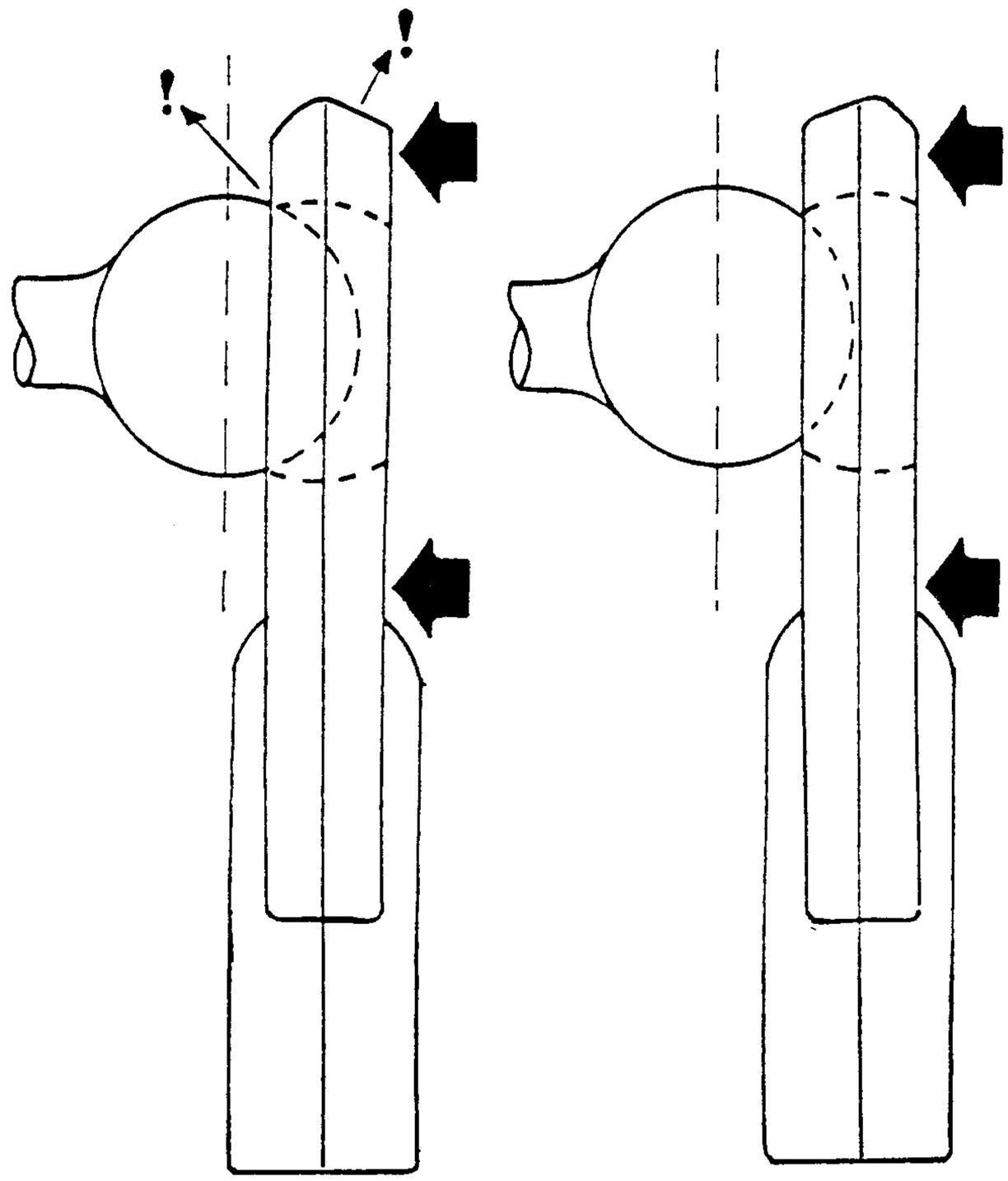
We wish you good luck and many happy hours of flying!
If you have any further questions, feel free to call us.

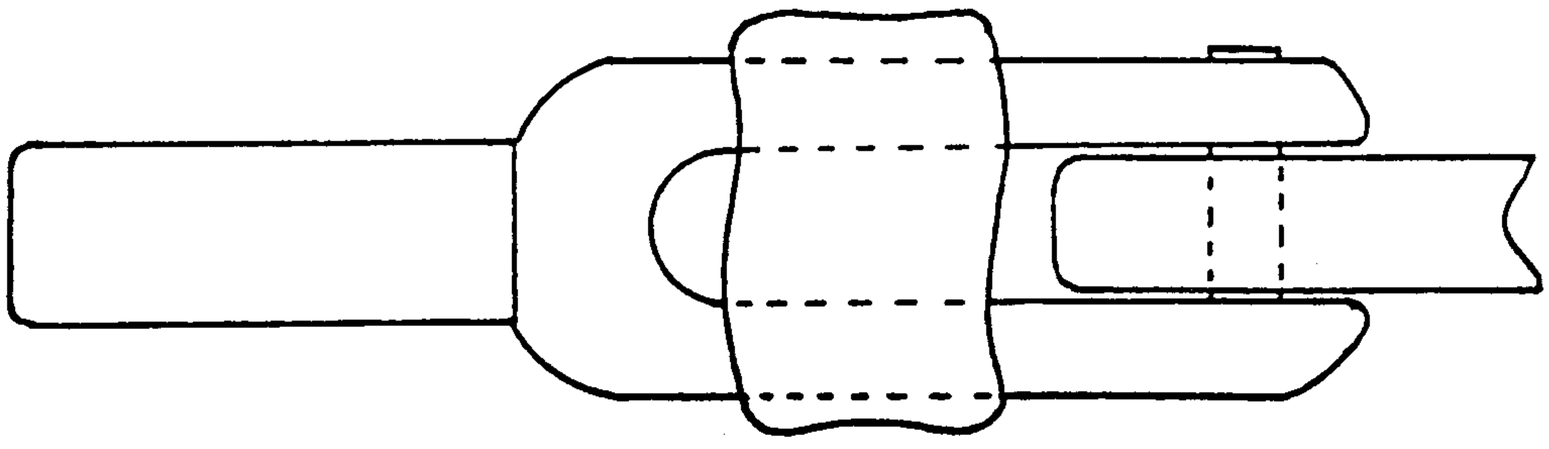
MINIATURE AIRCRAFT, USA
2324 N. Orange Blossom Trail
Orlando, FL 32804
(407) 422-1531

IMPORTANT Tips for correct use of parts 0133, 0135, and 0137.

! Taper on top of link and depth at rest on ball indicates proper side for installation.

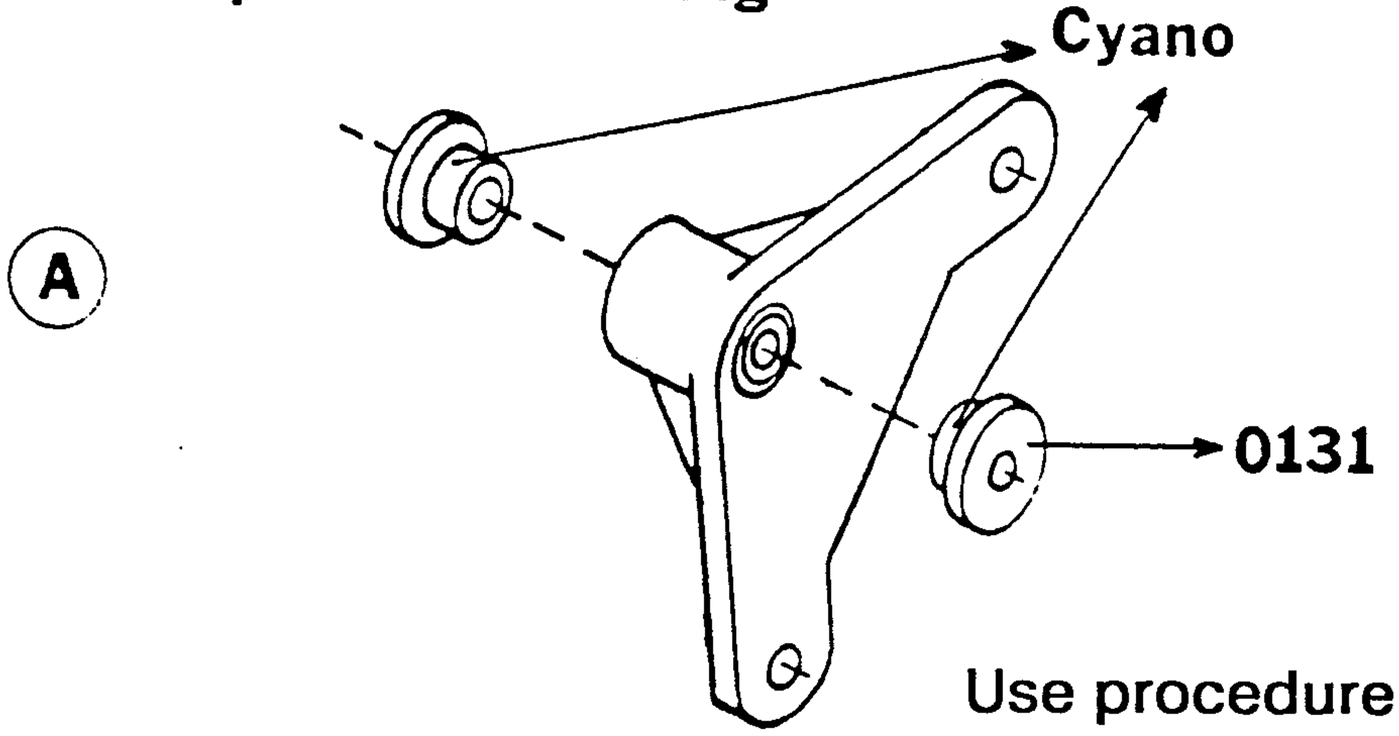
CORRECT **WRONG**





"Safety" all clevis links with 4.0mm. long fuel tubing.

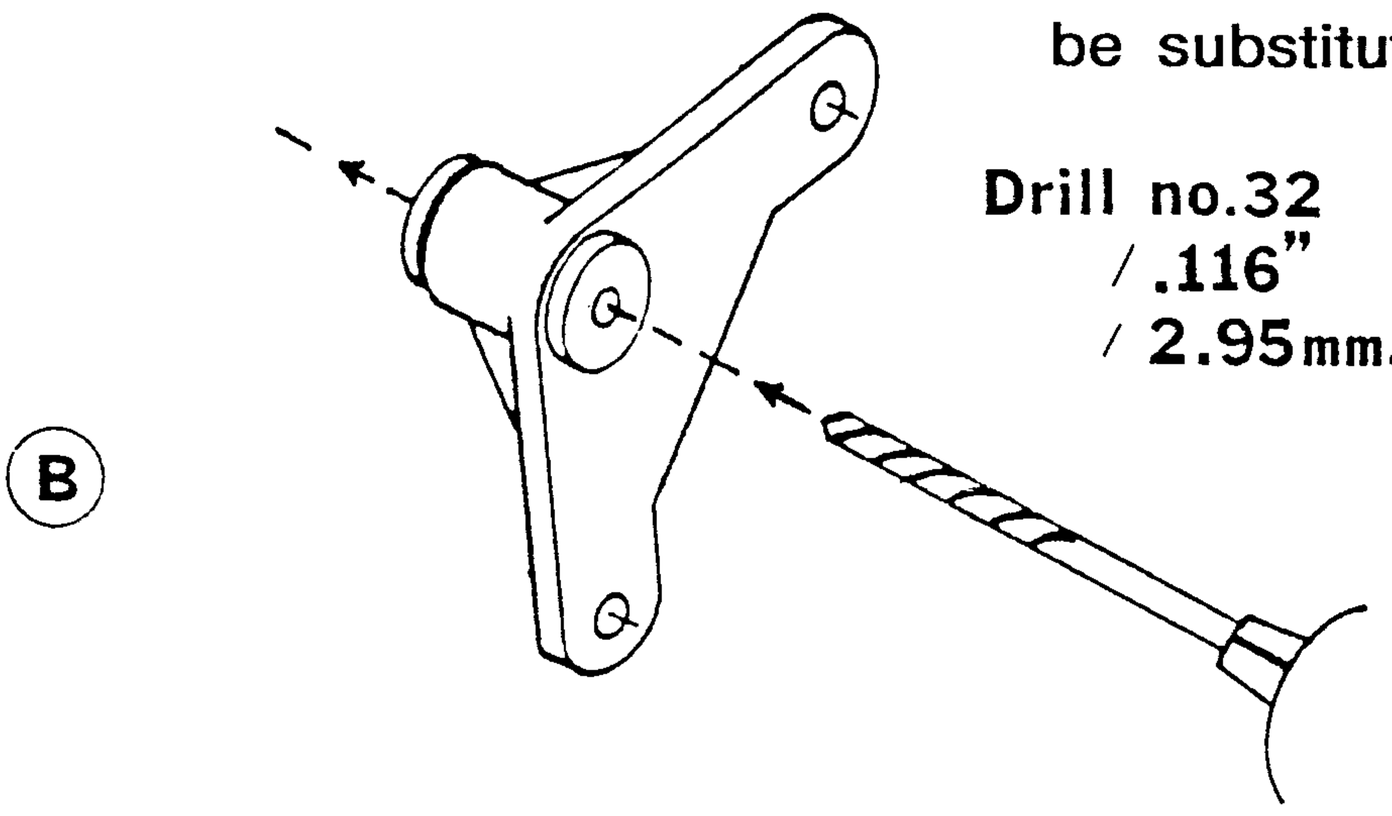
Procedure to fit bushings properly... IMPORTANT part should pivot freely. This gives precise fit, far superior to molding.



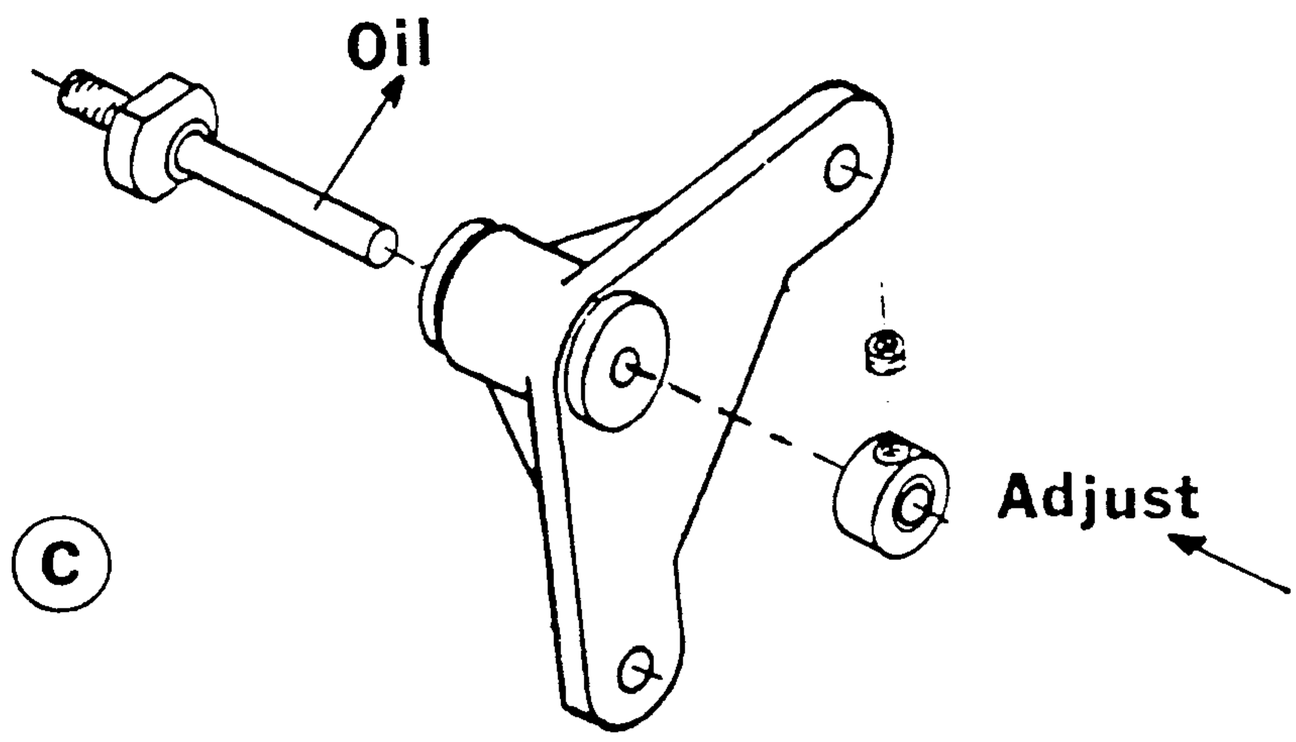
Use procedure on parts:

0221, 0445, 0157, 0167, 0155

(Ball bearing 0159 may be substituted.)



Drill no.32
/ .116"
/ 2.95mm.



NO.	I.D.	O.D.
0001	2.0	5.0
0003/0689	3.0	9.0
0009	3.0	7.0
0627	5.0	10.0
0007	6.6	12.3
0611	5.0	X15.0
0612	5.3	x9.5
0329	8.0	x13.0x.25
0619	10.0	x 16.0

NO.	SIZE
0161	3.0x11.7
0225	2x13.7
0451	2x17.7
0297	2.5x24

NO.	SIZE
0025	2.2X6.5
0027	2.2X9.5
0029	2.2X13
0052	M3X6
0051	M3X3
0053	M3X5
0054	M4X6
0057	M4X4
0033	M3X5
0031	2.9X6.5
0032	2.9X9.5
0034	2.9X13.0
0093	M3X15
0095	M3X19
0097	M3X22
0099	M3X30
0082	M4X35
0085	M5X16

HEAD BOLT *

NO.	SIZE
0015	M2
0017	M3
0019	M3
0021	M4
0041	M2X8
0042	special hard — M2X10
0043	M2X10
0044	special hard - M2X12
0045	M2X14
0046	special hard - M2X16
0047	M2X16
0061	M3X8
0063	M3X10
0065	M3X12
0067	M3X14
0069	M3X16
0091	11.0 - special hard - M3X16
0071	M3X18
0073	M3X20
0075	M3X25
0077	M3X30
0460	special hard - M3X16

M1:1