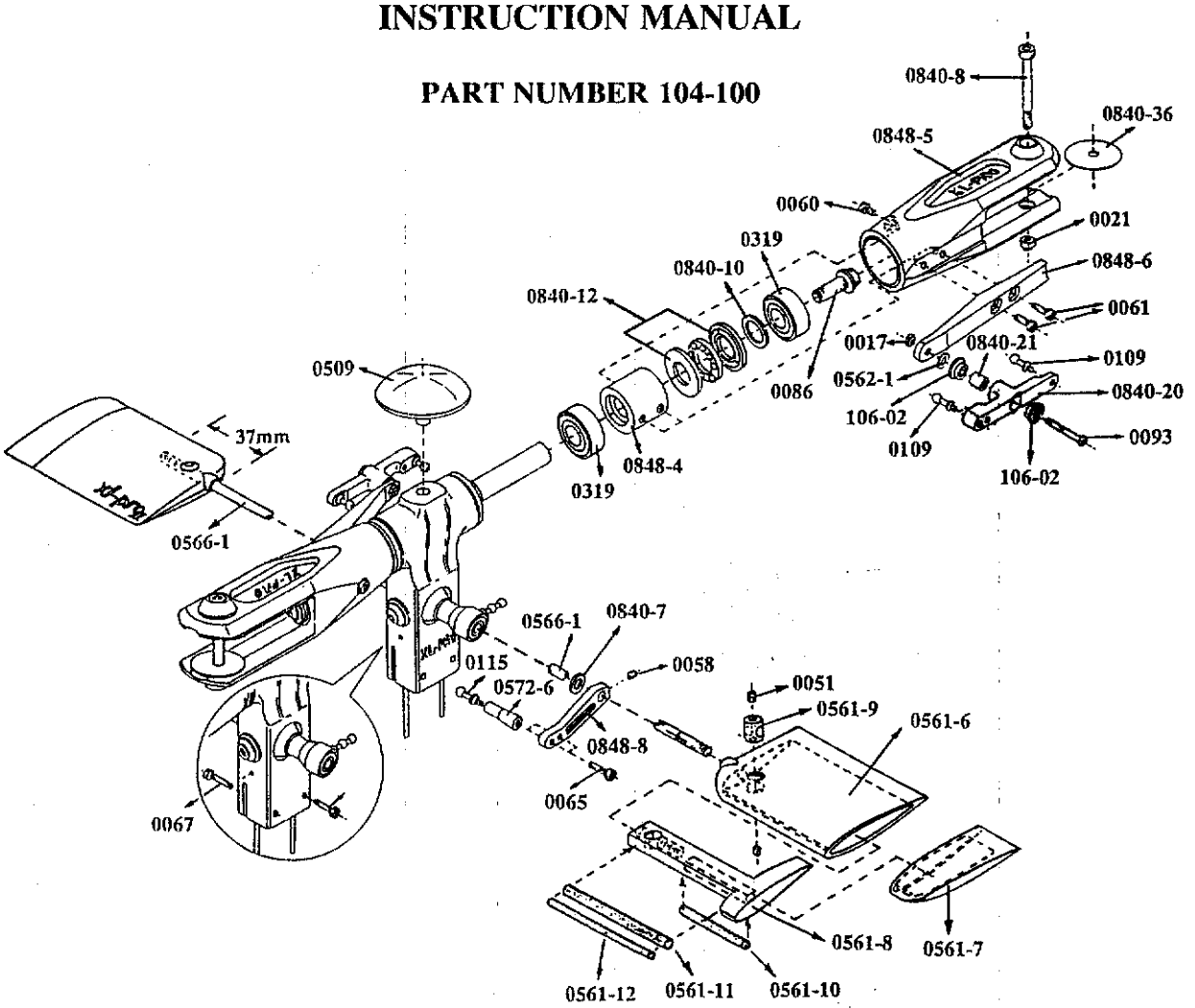
X-CELL .60 GRAPHITE *SE* HELICOPTER KIT

(SPECIAL EDITION)

INSTRUCTION MANUAL

PART NUMBER 104-100



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.

X-CELL

WARRANTY REGISTRATION

Please print or type, filling in the information listed below and mail immediately

104352

Model No:_____ Serial No:_____ Price Paid:_____

Owners Name:_____ Age:_____

Address:_____

City:_____ State:_____ Zip:_____

Purchased From:_____

Dealer's Address:_____

_____

Comments:_____

_____

MINIATURE AIRCRAFT USA
3743 SILVER STAR ROAD
ORLANDO, FLORIDA 32808
U.S.A

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 special 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 part 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.**

MINIATURE AIRCRAFT, USA
3743 Silver Star Road
Orlando, FL 32808

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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.

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 Graphite is offered in a .60 (10cc) version, a wide choice of engines are 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 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 Graphite .60 SE 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 work place, and get all required tools together before you begin.

THE KIT PACKAGE

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

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 blades and fiberglass 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
5.5mm 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
Vinyl Two-Sided Servo Tape 1/8" (#3869)
Glowplug Wrench (Part #4648)
Scissors
Slow Zap (#4917)
Thin Cyanoacrylate Glue (#4881)
Loctite (MA/USA) thread lock liquid (supplied in kit)
(**NOTE:** Use only the material supplied or its EXACT equivalent)
Masking tape, Paint for finishing Canopy, 80 and 220 Grit Sandpaper
Heat Gun (Monokote type)
Grease, Teflon Filled (Order #4709 - 2 oz tube, or #4707 - 1 oz syringe)
Tri-Flow Teflon Oil (Part #4801)
J.B. Weld Epoxy (#4853)

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

Ball Link Application Tool (part #0529)
5.0mm Nut Driver (#4669)
5.5mm Nut Driver (Socket on a Handle) (#4670)
7mm Nut Driver (#4671)
Fan Drive Collet O.S. SX (#0262)
Fan Drive Collet 7mm Enya 60 (#0265)
Fly-Bar Alignment Kit (#0510)
Universal Swashplate Lock (#0512)
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)
Tail Rotor Blade Balancer (Part #3750)

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 before beginning assembly. Note that the drawings include 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. 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.

NOTE: Beginning the assembly sequence with the Rotor Head rather the basic Main Frame Structure may seem unusual but allows the use of the engine start/clutch shaft as a very effective alignment tool to facilitate Rotor Head assembly before the shaft itself is assembled.

ASSEMBLY SEQUENCE

I. ROTOR HEAD ASSEMBLY

STEP
1. Install The Fly-Bar Support Tube Assembly
2. Building and Installing the Bell Mixers
3. Assemble Main Blade Mounts and Axle
4. Add the Fly-Bar, and Control Arms
5. Assembly of Flybar Paddles

II. BUILDING TOP MAIN FRAME SECTIONS

STEP
1. Assemble Aileron (Roll) Bellcranks to Main Frames
2. Assemble Elevator Servo Graphite Mount
3. Assemble Elevator Bellcrank and Mount to Main Frames
4. Install Main Shaft Bearing Blocks and Swashplate Antirotation Bracket
5. Assemble Lower Main Shaft Bearing Block and Front Tail Drive Transmission

6. Install Front Tailboom Support Halves and Rear Rudder Servo Mount
7. Assemble and Install Start Shaft Bearing Block, and Install Front Frame Corner Blocks
8. Assemble Elevator Push-Pull Bellcrank

III. ASSEMBLY OF MAIN SHAFT COMPONENTS

STEP 1. Alignment and Tightening of Bearing Block Assemblies
2. Installing the Mainshaft, Autorotation Unit with Maingear
3. Assemble the Slipper Autorotation Unit and Adjustment of the Main Shaft Unit
4. Assembling Swashplate
5. Assembling Wash-Out Unit

IV. BUILDING LOWER MAIN FRAME SECTION

STEP 1. Assemble Lower Main Frame Section and Attach Graphite Front Frame Plate
2. Assembly of the Top Main Frame Section to the Lower Main Frame Section
3. Mount Gyro Plate
4. Mount Upper Canopy Stand-Offs

V. INSTALLING ENGINE AND FAN SHROUD ASSEMBLIES

STEP 1. Mounting Flywheel
2. Installation of Clutch Assembly and Align Engine
3. Installing the Engine and Fan Shroud Braces
4. Installing the Fan Shroud Assembly

VI. RADIO TRAY ASSEMBLE AND SERVO INSTALLATION

STEP 1. Installation of Radio Tray Frame Supports
2. Mount Servo's into Plastic Tray Components and Assemble Plastic Tray
3. Mount Servo Tray to Mechanics
4. Mount Elevator Servo and the Gyro Motor Assembly
5. Assemble Collective Push-Pull Arm

VII. INSTALLATION OF LANDING GEAR ASSEMBLY

STEP 1. Assemble Landing Gear and Install

VIII. INSTALLING FUEL TANK SYSTEM

STEP 1. Assemble Fuel Tank System
2. Mounting the Fuel Tank

IX. ASSEMBLE THE TAIL ROTOR TRANSMISSION

STEP 1. Assemble Tailrotor Hub and Blade Holders
2. Assemble Pitch Slider and Bellcrank
3. Assemble Gear Box and Tail Rotor Hub

X. BUILDING THE TAILBOOM

STEP 1. Installing Tube Drive
2. Installing the Tail Rotor Pushrod Guides, Fin Mounts and Rudder Servo

XI. **INSTALLATION OF REMAINING RADIO EQUIPMENT, ASSEMBLING AND INSTALLING PUSHRODS**

STEP 1. Install the Switch for the Receiver, Gyro, Radio Receiver, Battery and the Antenna
2. Install Rudder Servo and Pushrod
3. Install Elevator Pushrod
4. Install Aileron and Collective Pushrods
5. Install Collective Push-Pull Pushrods
6. Install Lower Swashplate Control Rods
7. Install Throttle Pushrod
8. Install Rotor Head, Fly-Bar and Hiller Control Rods

XII. **CANOPY PREPARATION**

STEP 1. Mounting the Clear Lexan Window
2. Mounting Canopy
3. Installation of Thumb Screw Plastic Caps

XIII. **BUILDING THE ROTOR BLADES**

STEP 1. Assembling Blade Reinforcements
2. Adding Lead Strips
3. Initial Balancing
4. Cover Blades
5. Final Balance of Blades and Rotorhead

XIV. **FINAL MECHANICAL AND ELECTRICAL SET-UP**

STEP 1. Setting Up the Collective Servo
2. Final Swashplate and Fly-Bar Alignment
3. Adjusting Pitch Curves
4. Adjusting Swashplate Throw
5. Adjusting Rudder
6. Gyro
7. Elevator and Aileron Dual Rates and ATV's

XV. **FINAL ASSEMBLY AND BALANCE**

XVI. **FINAL ASSEMBLY INSPECTION**

XVII. **NECESSARY FLIGHT ITEMS**

XVIII. **STARTING AND STOPPING OF THE ENGINE**

XIX. **FIRST FLIGHT ADJUSTMENTS**

I. ROTOR HEAD ASSEMBLY

NOTE: At the builders discretion the bearings and shaft in this section may be glued together using loctite (red, green, or blue). If you choose to do this the disassemble process will become very difficult and will require the application of heat to break down the glue.

Step 1. Install the Fly-Bar Support Tube Assembly

Parts Required:		Bag#
1	#0844-1 C.N.C. Head Block	1A
1	#0840-25 Flybar Support Tube	1A
2	#0840-26 Pivot Bearing Adapters	1A
2	#0840-33 M4x12 Button Head Allen Bolts	1A
2	#0113 M3x10.5 Double Threaded Balls	1A
2	#0597-1 Brass Spacers	1A
2	#0299 M4x10 Ball Bearings	1A
2	#0067 M3x14 Socket Head Bolts	1A

Refer to Drawings # 1.

A. Carefully press into each end of the flybar support tube #0840-25 one of the M4x10 ball bearings #0299 seating each completely.

B. Press into each ball bearing #0283 (pre-assembled in the head block) one of the pivot bearing adopters #0840-26. Insert and center the flybar support tube #0840-25 into the large hole in the center side of the head block. Apply Loctite to each M4x12 button head Allen bolts #0840-33, insert each into both pivot bearing adopters #0840-26 and then in the threaded hole in the center of the flybar support tube. (NOTE: The flat side on each end of the support tube must be oriented as per the drawing.)

C. Slide one brass spacer #0597-1 onto each M3x10.5 double threaded ball. Apply Loctite to the remaining exposed threads and screw each into the threaded holes on each end of the flybar support tube #0840-25. Tighten securely.

D. Temporarily thread two M3x14 socket head bolts #0067 into the lower side of the head block. Start each into the opposite un-threaded sides, first. Do not fully tighten at this time. Final tightening will be done later in section 11, step 8.

Step 2. Building and Installing the Bell Mixers

Parts Required:		Bag#
4	#106-02 M3x7 Flanged Bearings	1B
2	#0562-1 Shim Washers	1B
2	#0840-21 Brass Sleeves	1B
2	#0848-6 Machined Pitch Arms	1B
2	#0840-20 Machined Bell Mixers	1B
4	#0109 M3x8 Threaded Steel Balls	1B
2	#0093 M3x18 Phillips Screws	1B
2	#0017 M3 Hexnuts	1B

Refer to Drawings # 1.

A. Clean the entire bell mixer #0840-20 in thinner to remove any oil. Clean the O.D. of the M3x7 flanged bearing #106-02. At the builders discretion use red or green Loctite to install the bearings into each mixer. Press one bearing into one side of the bell mixer, then insert the brass sleeve #0840-21 into the bell mixers bearing cavity, and press the second bearing in the opposite side of the bell mixer. This will captivate the sleeve in between both bearings. Repeat this process with the other bell mixer. **NOTE:** If more pressure is required than thumb pressure to install the bearing, find a small socket that fits the flanged portion of the bearing and gently press the bearing into place.

B. Install two M3x8 threaded steel balls #0109 into each bell mixer with Loctite. View drawing to ensure that they go in from the correct side. For most general purposes the outer threaded holes in the bell mixer will be used.

C. Insert through the bearings in each bell mixer from the flat side one M3x18 Phillips screw #0093. Slide one shim washer #0562-1 onto the exposed threads. Using Loctite, thread these bell mixer assemblies into each pitch arm #0848-6. Tighten securely ensuring that there is no bearing drag or knotchiness. Thread one M3 Hex nut #0017 onto the exposed threads on the inside pitch arm. Use Loctite and tighten securely.

Step 3. Assemble Main Blade Mounts and Head Axle

Parts Required:		Bag#
2	#0848-5 Machined Blade Mounts	1C
2	#0021 M4 Locknuts	1C
2	#0840-8 Main Blade Pivot Bolts M4 (12.9gr)	1C
4	#0319 Main Blade Mount Ball Bearing M8	1C
2	#0840-12 Thrust Bearings (3 piece)	1C
2	#0840-36 Fiber Blade Spacers	1C
2	#0329 M8x13.25 Thin Spacers	1C
1	#0848-1 Stainless Steel Axle	1C
2	#0848-2 M8 Retainer Rings ("C" rings)	1C
2	#0848-3 M8 Thick Spacers	1C
2	#0086 M5x12 Flanged Socket Head Bolts	1C
2	#0848-4 Aluminum Retainer Sleeves	1C
2	#0840-10 Small Thrust Bearing Spacers	1C
4	#0844-2 Rubber O-ring Dampeners	1C
4	#0061 M3x8 Socket Head Bolts	1C
2	#0060 M3x5 Socket Head Bolts	1C
1	#0848-9 Tool (Aluminum Tube)	1C
1	#0509 Large Head Button	1C

SPECIAL TOOL REQUIRED - "External Type" retaining pliers for small external type "C" rings.

A. Select one head axle #0848-1 and one M8 retaining ring #0848-2. Using the proper tool, open the ring only enough to allow it to slide over the axle and into position within one of the grooves provided. **"IMPORTANT"** Be sure it is fully seated within the grove all the way around. Rotate it if necessary to confirm it's position.

B. Examine the drawing to see the correct orientation of the bearing and spacers. First, slide one ball bearing #0319 onto the axle up against the retaining ring #0848-2. Follow with one aluminum retaining sleeve #0848-4. **NOTE:** The side of the retaining sleeve with the counterbore relief is to face the previously installed ball bearing #0319.

C. **SPECIAL NOTE:** Each thrust bearing assembly will contain one outer ring that has a smaller I.D. hole than the other outside ring. Identify this feature before proceeding. Select one thrust bearing #0840-12. Test each outer race on the axle to determine which has the larger I.D.. Install the larger I.D. bearing race with the grooved side away from the retaining sleeve #0848-4. Apply grease to the groove. Next, slide the ball/cage into position, using more grease. Slide the remaining small I.D. bearing race into position with the groove facing the ball/cage.

D. Select one small thrust bearing spacer #0840-10 and slide it up to the thrust bearing outer race, followed by one ball bearing #0319. Sparingly apply Blue Loctite to the threads of one M5x12 flanged socket head bolt #0086 and install it into the axle, tightening only finger tight at this time.

E. Going to the opposite side of the axle, slide one thin spacer #0329 up against the previously installed "C" ring on the opposite side of the assembled bearings. Follow with one M8 thick spacer #0848-3. Be sure the sharp edge faces the #0329 washer and not the dampening O-ring within the head block #0844-1.

F. Press into each side of the main rotor head block two each of the rubber O-ring dampeners #0844-2. Slide the partially assembled axle unit into the O-rings within the head block and through the other side. Push it fully against the O-rings. From the opposite side, slide one M8 thick spacer #0848-3 onto the axle (again making sure the smooth side faces the O-ring). Follow this with one thin spacer #0329. Slide each up against the O-rings. Secure in place, with one M8 retaining ring #0848-2 ("C" ring), again using the proper "C" ring pliers. Expand it as little as possible and slide it onto the axle fully into position within the groove provided. Select the special tool #0848-9 and slide it over the axle up against the "C" ring. Tighten down using one M5x12 axle bolt #0086 until the "C" is pushed into position within the groove in the axle. Usually a "snap" sound will confirm proper fit. Remove the #0086 bolt and special tool. Double check by rotating the "C" ring if necessary. It is most important that the "C" clip is correctly installed within the groove.

G. Following the same order in step "B" through "D", install all necessary bearings and components on the remaining side of the axle.

H. Using the appropriate M3 allen wrenches, moderately-simultaneously tighten each M5x12 flanged socket head bolt #0086.

I. Slide one machined blade mount #0848-5 into position on the bearing and align the holes with those of the aluminum retainer sleeve #0848-4 on the axle. On the side of the blade mount with only one hole install one M3x5 socket head bolt only finger tightened at this time. As per the drawing, position the previously assembled pitch arm into the grooved milled side of the blade mount #0848-5 using two M3x8 socket head bolts #0061 (NOTE: The pitch arm is a firm press fit.) Start to thread one or both #0061 bolts a few turns with a small amount of Loctite. Using a plastic tool handle or a wooden block, tap the pitch arm into place. Moderately tighten both #0061 bolts. Remove the previously installed M3x5 socket bolt #0060, Loctite, and moderately tighten. Repeat this process on the opposite blade mount. A small amount of end play will exist in each blade gap, confirm by pulling hard on each grip.

J. Temporarily install the two main blade bolts #0086, two M4 locknuts #0021, and two fiber blade spacers #0840-36.

K. Apply a small portion of Slow Zap to the bottom stud of the head button #0059. Do not allow any zap to run down into the head block. Press the head button into the top side of the head block #0844-1 and seat fully.

Step 4. Add The Flybar and Control Arms

Parts Required:		Bag#
1	#0566-1 Flybar	10A
2	#0848-8 Machined Fly-Bar Control Arms	1D
2	#0572-7 Aluminum Stand-Offs	1D
2	#0840-7 M4 Flat Washers	1D
2	#0115 Threaded Steel Balls	1D
2	#0058 M4x5 Socket Set Screws	1D
2	#0065 M3x12 Socket Head Bolts	1D

Refer to Drawings # 1.

A. **NOTE:** The flybar control arms have been designed for maximum clearance offering a choice of two ratio's. This choice should be based on your particular flying style. The outer hole is considered the "Normal" position. The inner hole will result in a slightly quicker response time with less stability.

B. As per the drawing, assemble each flybar control arm #0848-8 using Loctite as follows: Attach each stand-off #0572-6 (The larger end) to the inside of the machined flybar arms #0848-8 using one M3x12 socket head bolt #0065 on each. Thread one threaded steel ball #0115 into the smaller end of each aluminum stand-off #0572-6. Tighten securely.

C. Insert the flybar #0566-1 into the bearings in the flybar support tube #0840-25. Follow with one M4 flat washer #0840-7 and one assembled flybar control arm on each end of the flybar. Apply Loctite to two M4x5 socket set screws #0058 and start each into the flybar arms #0848-8 until they just touch the flybar. Center the flybar in the rotor head. As per the drawing, align the flybar control arms with each other and tighten the set screws securely. **NOTE:** A pair of straight edges are useful to align the arms as shown.

Step 5. Assembly of Flybar Paddles

Parts Required:		Bag#
4	#0051 M3x3 Set Screws	1E
2	#0561-6 Flybar Paddles Main Section	1E
2	#0561-7 Flybar Paddle End Caps	1E
2	#0561-8 Flybar Paddle Plastic Inserts	1E
2	#0561-9 Flybar Paddle Aluminum Safety Locks	1E
2	#0561-10 Flybar Paddle Lead Weight Thick, 44mm (5.8 grams)	1E
2	#0561-11 Flybar Paddle Lead Weight Thick, 65mm (8.6 grams)	1E
2	#0561-12 Flybar Paddle Lead Weight Thin, 65mm (5.7 grams)	1E

Refer to Drawings # 1.

A. <u>NOTE:</u> Before assembling the paddles it will be necessary to choose the over-all paddle weight desired by the number of lead strips used to achieve a desired flying characteristics.

The following characteristic may be expected with the installation of the lead strips:

- With no lead (total weight approximately 24.0 grams) - Crisp control with fast cyclic authority.
- With single strip of large lead mounted in insert (total weight approximately 32.0 grams) - Crisp control will remain with increased stability.
- With two strips of large lead , one mounted in the insert and the other mounted on the leading edge of the insert. (total weight approximately 40.0 grams) - Excellent hovering control with increased forward flight stability. Enhancing smooth and precise FAI type aerobatics.
- With three lead strips (total weight approximately 45.0 grams) - Extreme hovering stability. Slow and precise aerobatic maneuvers.

: Assemble both paddles simultaneously.

B. Remove all the sections of lead #0561-10, 0561-11, 0561-12 from section 1F. Roll the lead under a sanding block using 80 grit sandpaper until they are flat and thoroughly roughened. Select the shortest piece of lead #0561-10 (44mm) and press it completely into the slot in the plastic insert #0561-8, thin cyano in place.
Using 80 grit sand paper roughen the entire surfaces of the plastic inner insert 0561-8. Slow cyano glue the desired amount of lead #0561-11 and #0561-12 onto the leading edge of the plastic insert. If both pieces of the lead are used glue the thick section of lead #0561-11 on first. Carefully line up the lead pieces with the plastic insert and allow to dry. Slightly shape sand the leading edge of lead and any excess glue until the assembled plastic paddle insert will slide inside the paddle main section, #0561-6.

C. With 80 grit roughen up the internal surfaces (as best you can) of the paddle main section #0561-6 and the paddle end cap #0561-7. Slide the assembled insert #0561-8 into the main paddle section until the hole in the insert and the paddle for the aluminum safety lock aligns. If this does not align, sand the lead until alignment is achieved. Re-install the plastic insert. Align the un-threaded hole in the aluminum safety lock #0561-9 in-line with the Fly-Bar insertion hole in the plastic paddle. Press and center the safety lock into the paddle.
Wick thin zap around the protruding end of the plastic inner sleeve #0561-8. Wipe away any excess glue.

NOTE: If a gram scale is available weigh both paddles including the end caps #0561-7, to determine if they are matching in weight. To correct, drill small holes in the end of the plastic insert or add weight to the inside of the end caps. (Glue the end caps in place, only if a gram scale was used. If a gram scale is not available, proceed with the next step).

D. From each end of the flybar measured in 37mm and place a mark (masking tape works well). Thread each paddle up to the marks. Each paddle must be equal distance out on the flybar. Study drawings for correct paddle orientation.

NOTE: If a gram scale is not available, the flybar system will need to be checked for balance. Temporarily snap the end caps in place. Un-snap any ball links connected to the flybar system and check the flybar for a level balance. If incorrect alter paddles as described in section ("D-NOTE"). After all corrections above have been made the end caps may be glued in place. Final balance of completed paddle may be achieved by using a small piece of black tape on the paddles leading edge.

E. Temporarily thread two #0051 M3x3 set screws into each aluminum safety lock. The set screws will be securely tightened after the flybar alignment process has been completed in **Section XIV Step 2.**

II. BUILDING TOP MAIN FRAME SECTIONS

Step 1. Assembly Aileron Bellcranks to Main Frame

Parts Required:		Bag#
2	#0586-24 Graphite Top Main Frame Sides	2A
2	#0169 Aileron Bellcrank Pivot Studs	2B
2	#0009 Flat Steel Washers 3mm (small)	2B
2	#0019 Hex Locknuts 3mm	2B
2	#0167 Aileron Bellcranks	2B
4	#0159 Ball Bearings M3x7	2B
2	#0105 M3x4.5 Threaded Balls	2B
2	#0107 M3x6 Threaded Balls	2B
2	#0051 M3x3 Socket Set Screws	2B
2	#106-25 Aileron Bellcrank Retainer Collars(gold)	2B

Refer to Drawings # 2.

A. Build a left and a right top main frame #0586-24 by installing on the outer side a bellcrank pivot stud #0169 in each frame with a flat steel washer 3mm small #0009 and a m3 locknut #0019 on the inside of each frame. Tighten securely.

B. Using slow cyano thread a #0107 M3x6 threaded ball and a #0105 M3x4.5 threaded ball into the flat side of the bellcranks #0167. Do the same thing on the other bellcrank only reversing the position of the balls so that the bellcranks are opposite each other.

C. Press all four bearings #0159 into the two bellcranks ensuring that they are square and fully seated.

D. Partially thread the M3x3 set screws #0051 into the two retaining collars #106-25.

E. Hold the left main frame 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 pivoting forward containing a long ball #0107. Place a small amount of Loctite on the set screw threads, partially threaded into the collar, and retain the bellcrank by sliding the collar on the stud and tighten the set screw. Check to be sure that the bellcrank operates smoothly; if not, slightly back off retaining collar.

F. Mount the other bellcrank and collar to the right main frame in a similar way. Holding the frames together in normal orientation will show that each has a bellcrank that can be held with an arm pointing forward with a long ball on it.

Step 2. Assemble Elevator Servo Graphite Mount

Parts Required:		Bag#
3	#106-22 Rubber Grommet Isolators	2C
3	#106-24 Dampening Sleeves	2C
6	#0003 Flat Washers M3 (Large)	2C

3	#0019 3mm Locknuts	2C
1	#0586-5 Graphite Elevator Plate	2C
3	#0840-31 M3X16 Button Head Allen Bolts	2C

Refer to Drawings # 2.

A. Install the three rubber grommets #106-22 into the graphite elevator plate. Squeeze grommets together and push in as far as possible. Use a small straight screw driver and work around the grommets, pushing one side all the way through. Center the three dampening sleeves #106-24 in the grommets.

B. Refer to the drawing for proper orientation. Bolt the elevator plate to the outside of the right graphite upper frame plate #0586-24 using the following hardware: three #0840-31 M3x16 button head screws, six #0003 M3 washers (large), and three #0019 M3 locknuts. Tighten snugly.

Step 3. Assemble Elevator Bellcrank Assembly and Mount to Main Frames.

Parts Required:		Bag#
1	#0826-1 C.N.C. Elevator Swing-Arm with Bearings	
2	#0051 M3x3 Socket Set Screws	2D
2	#0161 Pivot Pins M3x12	2D
1	#0826-3 Brass Spacer Tube	2D
1	#0079 M3x35 Socket Head Bolt	2D
1	#0009 M3 Small Washer	2D
1	#106-28 Bellcrank Stand-Off	2D
1	#0825-1 C.N.C. Main Bellcrank	2D
1	#0825-2 C.N.C. Bellcrank Control Arm	2D
2	#0059 M2.5x8 Tapered Socket Head Bolts	2D
3	#0105 M3x4.5 Threaded Steel Balls	2D
2	#106-02 M3x7 Flanged Ball Bearing	2D

Refer to Drawings # 2.

NOTE: Before assembling the elevator swing arm assembly, study the drawings for correct orientation of all necessary parts.

A. Select two M3x7 flanged ball bearings #106-02, press them completely into the bearing cavities on either side of the C.N.C. main bellcrank #0825-1. In the two threaded holes on each end of the C.N.C. main bellcrank install two M3x4.5 threaded steel balls #0105, use Loctite. Using two M2.5x8 tapered socket head bolts #0059 with Loctite, assemble the C.N.C. bellcrank control arm #0825-2 to the top side of the C.N.C. main bellcrank #0825-1. Tighten securely. Using Loctite, install the remaining M3x4.5 threaded steel ball #0105 into the upper threaded hole on the bellcrank control arm #0825-2.

B. As per the drawing, orientate the assembled main bellcrank from step "A" between the forked end of the C.N.C. elevator swing-arm #0826-1. Press the two pivot pins #0161 through the swing-arm and into the pre-assembled bearings #106-02 in the main bell crank #0825. If a pin resist sliding into place with hand pressure, use pliers positioned inside the main bellcrank #0825 and outside the pivot pin #0161. Gently press the pin into position. The inside of the pin should be flush with the inside of the ball bearing. Secure in place using two M3x3 socket set screws #0051 with Loctite.

C. On the opposite end of the elevator swing arm #0826. Insert one brass spacer tube #0826-3 into the pre-pressed ball bearings.

D. Select the left hand graphite upper frame plate #0586-24. As per the drawing insert one M3x35 socket head bolt #0079 and one M3 small washer #0009. On the inside of the frame install the assembled elevator swing arm unit with the bellcrank control arm #0825-2 facing away from the inside of the left hand frame #0586-24. Follow this assembly with the right hand graphite upper frame plate #0586-24 (From step 2) making sure that the bellcrank arm #0825-2 projects through the aperture in the right side frame with the ball end up. Using Loctite secure in place on the outside of the right frame with one bellcrank stand-off #106-28.

Step 4. Installing Main Shaft Upper Bearing Block and Swashplate Antirotation Bracket.

Parts Required:		Bag#
1 #0227	Control Rod M2x38	2E
2 #0133	Plastic Ball Links - Long	2E
5 #0016	M3 Star Lockwashers (inner)	2E
5 #0061	M3x8 Socket Head Bolts	2E
1 #0823-1	C.N.C. Thrust Bearing Block	2E
1 #0823-2	C.N.C. Anti-Rotation Guide	2E
1 #0555-1	Special Ball 3mm Hole	2E

Refer to Drawings # 2.

A. Thread a plastic ball link #0133 on each end of a control rod #0227 until the length of the metal rod between the inner plastic link face is 31mm with each ball turned 90 degrees to each other. Press into one ball link one special ball (3mm hole) #0555-1. Snap the opposite ball link onto the outside rear ball #0105 mounted on the C.N.C. main bellcrank #0825-1. The rod should project upwards.

B. Install the C.N.C. antirotation guide #0823-2 to the rear side of the C.N.C. thrust bearing block #0823-1 using one M3x8 socket head bolt #0061 and one M3 washer star lockwasher #0016. Tighten securely using Loctite.

C. Install the upper assembled bearing block unit between the two top frame plates using four M3x8 socket head bolts and four M3 star lockwashers #0016. Do not fully tighten.

Step 5. Assemble Lower Main Shaft Bearing Block and Front Tail Drive Transmission.

Parts Required:		Bag#
2 #0019	M3 Locknuts	2F
6 #0009	M3 Washers (small)	2F
1 #0832-1	Bearing Block with #0183 Bearing	2F
1 #0832-2	Vertical Bearing Block with #0425 Bearing	2F
2 #0077	M3x30 Sock Head Bolts	2F
4 #0002	M3 Lockwashers	2F
3 #0051	M3x3 Socket Set Screws	2F
2 #0233	Front Drive Housing Halves	2F
2 #0235	Front Drive Ball Bearings	2F
1 #0237	Front Drive Retainer Collar	2F
1 #0231	16 Tooth front Drive Pinion	2F

1	#0832-3 Front Transmission Output Shaft	2F
2	#0003 Flat Washers M3 (Large)	2F
4	#0063 M3x10 Socket Head Bolts	2F
2	#0240 Threaded Inserts	2F
1	#0507 Front Transmission Alignment Tool	2F

Refer to Drawings # 2.

A. Clean the I.D. of the two bearings #0235 and the front input shaft #0832-3 with thinner to remove any oil.

B. **NOTE:** At the builders discretion the bearings and shaft in this section may be glued together using loctite (red, green or blue). If you choose to do this the disassemble process will become very difficult and will require the application of heat to break down the glue.

Slide one of the bearings #0235 onto the shaft #0832-3 about half way then apply a small amount of Loctite to your finger and rub it around the shaft up next to the shoulder. Slide the bearing up next to the shoulder. Rub a small amount of Loctite where the other bearing is to be located then slide this bearing into position.

C. Lay one of the front drive housing halves #0233 on the table and press the knurled end of each threaded insert #0240 fully into the drive housing half. Next press the output shaft assembly into the bearing cavities in this half. Put the remaining drive housing half #0233 in place and press the two halves together.

D. Apply blue Loctite to one of the M3x3 set screws #0051 and start it in the retainer collar #0237. Slide the collar all the way up against the bearing and tighten the set screw. Ensure that the input shaft is slid completely up against the bearing. Check for binding.

E. Start the remaining two M3x3 set screws #0051 into the front drive pinion #0231 and position the pinion on the shaft and tighten down one set screw in the flat spot nearest the end just enough to keep the gear on the shaft but at the same time allowing it to slide on the shaft. Final adjustment and tightening will come later.

F. Examine the drawing to see the position of the bearing blocks #0832-1 and #0832-2 in the upper frames. Install both blocks using two M3x30 socket head bolts, four M3 washers #0009, and two M3 locknuts #0019. Do not fully tighten at this time. NOTE: The main bearing block #0832-1 mounts with the bearing facing upwards.

G. Slide the bevel gear/front transmission assembly in between the upper main frames, inserting the front side of the front transmission output shaft #0832-3 into the vertical bearing block #0832-2.

H. Bolt the left top mainframe side plate assembly to the front transmission for the tailrotor using two M3x10 socket head bolts #0063, two M3 lock washers #0002 and two M3 flat washers #0003. Check the drawings for proper orientation.

I. Bolt the top right side plate assembly to the front transmission block using the following sequence: Two M3x10 socket head bolts #0063, two M3 lockwashers #0002, two M3 flat washers (small) #0009, and one front transmission alignment tool #0507, facing forward. **NOTE:** The #0507 alignment tool will be a snug fit on the #0063 bolts, this is designed that way to ensure the accuracy of the alignment tool. Do not fully tighten.

Step 6. **Install Front Tailboom Support Halves and Rear Rudder Servo Mount.**

Parts Required:		Bag#
2	#0185 Front Tail Boom Support Halves	2G
4	#0079 M3x35 Socket Head Cap Screws	2G
8	#0009 Flat Steel Washers M3 (small)	2G
4	#0019 Hex Locknuts M3	2G
1	#0818-1 Graphite Servo Mount	2G
1	#0818-3 Rudder Servo Block	2G
1	#0818-2 Rudder Servo Boom Mount	2G
4	#0560-8 M2.5 Flat Washer	2G
4	#0037 M2.5x25 Phillips Machine Screws	2G

Refer to Drawings # 2.

A. Using the rudder servo as a guide, mount the rudder servo block #0818-3 and the rudder servo boom mount #0818-2 to the graphite servo mount #0818-1 using, four M2.5x25 Phillips machine screws #0037 and four M2.5 flat washer #0560-8. Remove the servo at this time.

B. Install the assembled graphite servo mount #0818-1 and the tailboom support halves #0185 using four M3x35 socket head bolts #0079, eight M3 small washers #0009, and four M3 locknuts #0019. The graphite servo mount #0818-1 mounts on the right side of the upper main frames. Do not fully tighten.

Step 7. **Assemble and Install Start Shaft Bearing Block, and Install Front Frame Corner Blocks.**

Parts Required:		Bag#
4	#0063 M3x10 Socket Head Bolts	2H
4	#0009 M3 Flat Washers (Small)	2H
1	#0558 Start Shaft Bearing Block w/Bearing (assembled)	2H
2	#0077 M3x30 Socket Head Cap Screws	2H
4	#0003 Flat Washers 3mm (large)	2H
2	#0019 Hex Locknuts M3	2H
2	#106-72 Frame Corner Blocks	2H

A. Install the clutch shaft bearing block #0558 using two M3x30 bolts #0077, four M3 large washers #0003 and two M3 locknuts #0019. The bearing block adapter #0559-1 will be positioned on the top side.

B. Using Loctite, Install the two front frame corner blocks #106-72 to the inside of each main frame #0586-24, using two M3x10 socket head bolts #0063 and two M3 flat washers (Small) #0009. Tighten snugly at this time.

Step 8. **Assemble Elevator Push-Pull Bellcrank.**

Parts Required:		Bag#
1	#0019 M3 Locknut	2I
1	#0009 M3 Small Washer	2I
2	#0101 M2x5 Threaded Steel Ball	2I

1	#0107 M3x6 Threaded ball	2I
2	#0553-2 Special Flanged Bearings	2I
1	#0819-1 Machined Push/Pull Arm	2I

Refer to Drawings # 2.

NOTE: Three positions for the outer control balls are available (A,B,C) which will result in various ATV settings.

A. Install the two special flanged bearings #0553-2 into each side of the center bearing cavity in the machined push/pull arm #0819-1. It may be necessary to tap them in using a small block of hard wood and a hammer. Tap lightly.

B. Study the drawings to determine which side the steel balls are inserted on the machined push/pull arm #0819-1. Bolt two threaded steel balls #0105 and one threaded steel ball #0107 in their respective positions. Use Loctite.

C. Slide the machined push/pull arm onto the bellcrank stand-off #106-28. It may be necessary to tap in place. Secure using one M3 locknut #0019, and one M3 small washer #0009.

III. ASSEMBLE OF THE MAIN SHAFT COMPONENTS

Step 1. Alignment and tightening of the bearing block assemblies.

Parts Required:		Bag#
1	#0614 Main Shaft	3A

Refer to Drawings # 3.

A. Temporarily slide the main shaft #0614 into both main shaft bearing blocks. Lay the bottom edges of the upper graphite main side frames on a flat surface and tighten the lower main shaft bearing block front bolt only #0077. Apply Loctite to each of the four upper bearing block bolts #0061 and tighten securely.

B. Tighten the elevator swing arm bolt #0079 going into the bellcrank stand-off #106-28.

C. Lightly tighten the tail boom support halves.

D. Remove the main shaft.

Step 2. **Installing the Mainshaft, Autorotation Unit with Maingear.**

Parts Required:		Bag#
1	#0614 Main Shaft (Previously used in step 1)	3A
1	#0209 Autorotation Hub with Bearing Assembled	3A
1	#0557 Main Gear 9:0 to 1 (Machined)	3A
2	#0205 Main Shaft Retainer Collars	3B
4	#0051 Socket Set Screws M3x3	3B
1	#0540-1 Custom Thrust Bearing	3B
1	#0540-2 Custom Spacer	3B
6	#0840-31 M3x16 Button Head Socket Head Bolts	3B

6 #0019 Hex Locknuts 3mm 3B

Refer to Drawings # 3.

NOTE: Before installing the mainshaft clean well to remove any residue.

A. Examine the mainshaft thrust bearing #0540-1. If one of the outer halves of the bearing has a (O) stamped on it, this half of the bearing must be installed on the bottom. Some bearings are unmarked and may be installed either way.

B. Fill the ball retainer in the thrust bearing full of grease, teflon based #4709 and apply grease to both halves of the thrust bearing.

C. Place the thrust bearing spacer #0540-2 on top of the thrust bearing. NOTE: If you smear a little grease on the spacer it will sit still.

D. Place the thrust bearing unit between the frames and up into the bottom of the upper bearing block #0823-1 and hold in place with one finger.

E. Slide the mainshaft #0614 down through the top bearing block and through the thrust bearing. (NOTE: The bored end of the main shaft is the top side.)

F. Next place one of the retainer collars #0205 under the thrust bearing and slide the mainshaft through this.

G. Next hold the elevator bellcrank #0825 up and slide the mainshaft through this.

H. Place another mainshaft retainer collar #0205 under the elevator bellcrank and slide the mainshaft through this and the lower bearing block #0832-1.

I. Start two M3x3 socket set screws #0051 into each #0205 retainer collars.

J. Noting that the maingear #0557 is two-sided and can be mounted either way, press the gear onto the shorter boss of the autorotation hub, being careful to align the mounting bolt holes. Insert the six M3x16 button head socket head bolts #0840-31 from the gear side and secure from the hub side with the six M3 locknuts #0019. Tighten securely. Lightly oil (DO NOT GREASE) the autorotation bearings. (NOTE: Tri-Flow Teflon Oil is recommended, order #4801).

Step 3. **Assemble the Slipper Autorotation Unit and Adjustment of Main Shaft Unit.**

Part Required:		Bag#
1 #0211	Plastic Autorotation Hub Spacer (Upper)	3C
1 #0551-3	Large I.D. (.393") Externally Threaded Collar	3C
2 #0551-5	M4x4 Pointed Socket Set Screws	3C
1 #0552-1	Rubber O-Ring	3C
1 #0552-2	Adjusting Ring	3C
1 #0552-4	Friction Disc	3C
1 #0552-5	Socket Head Bolt (M2.5x12)	3C

Refer to Drawing # 3.

Special tool required: Rough sandpaper and an X-acto knife.

Optional Requirements: J.B. Weld Epoxy #4853

A. Using 80-grit sandpaper, rough up the angled edge or corner of the bottom of the autorotation hub where the friction disc #0552-4 will be bonded. Also use an X-acto knife to scratch the inside of the friction disc. **NOTE:** Do not apply to much pressure to the friction disc as it is thin and will bend easily. Also clean both parts with a paper towel and some thinner.

B. Apply blue Loctite to the two M4x4 pointed socket set screws #0551-5 and start them in the externally threaded collar #0551-3.

C. Place the plastic auto hub spacer # 0211 on top of the main gear and auto hub and then slide the unit up onto the mainshaft.

D. Slip the threaded collar on the mainshaft next and run the pointed set screws #0551-5 into the hole going through the mainshaft. Tighten securely using Loctite.
NOTE: The set screws when tightened should be inside the threads of the threaded collar #0551-3.

E. Apply blue Loctite to two M3x3 set screws #0051 in the lower mainshaft retainer collar.

F. Place your middle finger on either hand on the bottom of the mainshaft. Place your thumb on the same hand on top of the bottom mainshaft retainer collar and squeeze together. This will pull the mainshaft all the way up and take the vertical play out of the maingear. Tighten up one of the set screws in the collar and then do two things; Spin the main gear while holding the mainshaft to ensure that it spins freely. Next check for vertical play in the main gear by holding it on both sides with both hands and try to move the gear up and down. The ideal situation is where there is virtually no vertical play but at the same time the gear spins freely. Once you are satisfied tighten both set screws in the retainer collar securely.

G. Clean the inside of the adjusting ring #0552-2 and cyano the rubber O-ring #0552-1 in place. Start the socket head bolt #0552-5 in the adjusting ring.

H. Mix J.B.Weld #4853 and use a small straight screwdriver and apply a thin even coat to the roughed up portion of the auto hub. Apply a thin even coat to the friction disc. Place the friction disc in place on the bottom of the auto hub and seat as squarely as possible. Put some grease on your finger and rub it all over the O-ring, then thread the adjusting ring up on the threaded collar and up against the friction disc. Once the O-ring makes contact, tighten it one-half turn more then tighten the socket head bolt. Spin the maingear while holding the mainshaft about two turns. This will seat the friction disc squarely to the auto hub.

I. Apply some blue Loctite to two M3x3 set screws in the upper mainshaft retainer collar #0205. Pull this collar all the way up making sure that the mainshaft thrust bearing is fully seated in the bottom of the bearing block #0823-1. Pull down on the top of the mainshaft with your thumb while pulling up on the upper retainer collar with your middle finger. Tighten both set screws securely.

J. Before proceeding to the following steps, the J.B. Weld must be allowed to completely dry. Once dry back-off the #0552-1 and #0552-2 autorotation parts completely out of contact with the bottom of the autorotation hub.

K. Remove the M3x3 set screws from the front tailrotor pinion gear #0231 and apply Loctite. Re-install screws but do not tighten.

L. Push the transmission down into the main gear so that it is seated. Slide the pinion gear back on the shaft till it rubs the step on the maingear then slide the pinion forward about a half of a millimeter then lightly tighten the set screw against the flat. View the gear mesh from underneath the top mainframe. Rotate the maingear 360 degrees and make sure that the pinion gear does not get up against the back edge of the maingear. There should be some clearance all the way around. Once satisfied tighten both set screws securely.

M. Next adjust the gear mesh between the front transmission and the maingear. You do not want any play between the gears but no binding or tight spots. If either exists, loosen the mesh slightly. To ensure that the front transmission is level with the main gear. Line up the front transmission alignment tool #0507 parallel with the lower edge of the support main frame side. Re-check gear mesh before final tightening. Once satisfied, tighten all four M3x10 socket head bolts #0063 holding the front transmission housing. Recheck the gear mesh again. If the mesh is ok, tighten the rear bolt going through the lower bearing blocks #0832-1 and #0832-2. Recheck mesh once more.

Step 4. **Assembling Swashplate.**

Parts Required: Bag#

1 #0217	Aluminum Swashplate (10mm)	3D
4 #0051	M3x3 Set Screws	3D
5 #0107	M3x6 Threaded Steel Balls	3D
5 #0109	M3x8 Threaded Steel Balls	3D
1 #0159	M3x7 Ball Bearing	3D
3 #0687	Bearing Spacers	3D
1 #0073	Socket Head Bolt M3x20	3D
1 #0597-1	M3x3.2 Brass Spacer	3D

Refer to Drawing # 3.

SPECIAL NOTE: If a 3-D set-up with extreme cyclic travel is desired it is suggested to use the two extra M3x6 threaded balls #0107 on the inner ring position that connects to the special links #0232.

A. Apply a small amount of Loctite to the four M3x3 set screws #0051 and install them into the outer ring of the swashplate. These set screws are for adjusting the play out of the radial bearing. Lightly tighten up two set screws opposite each other and then check to make sure that the bearing doesn't get notchy. Once these two set screws are set the other two can be set in the same manner.

B. Examine the swashplate #0217 for control ball positioning. Using a small amount of Loctite on each, thread four M3x8 threaded balls #0109 on the inner ring of the swashplate at 90 degrees apart. Thread two M3x6 threaded balls #0107 in to two opposite holes in the outer ring of the swashplate.

C. NOTE: The drawing shows two variations of the lower swashplate elevator ball controls. The shorter ball controls will result in lower ATV's. The longer ball controls will allow increased ATV's in you radio. As per your choice of ratios's Assemble either one #0107 or #0109 threaded steel ball into one of the remaining lower swashplate holes. Use

Loctite .

D. Slide the swashplate down the main shaft #0614 from the top side. Align the remaining threaded holes in the lower swashplate ring with the slotted C.N.C. antirotation guide #0823-2 on the back of the upper main shaft bearing block.

E. Again as per your choice of ratio's stack the following parts on the M3x20 socket head bolt #0073, one M3x3.2 brass spacer #0597-1, one M3x7 ball bearing #0159, three bearing spacers #0687, and through the upper control ball #0555-1/ball link #0133/control rod #0227 assembly previously installed. See drawings. Apply a small amount of Loctite to the exposed threads on the M3x18 socket head bolt #0071 and install it in the remaining hole in the lower ring of the swashplate. The M3x7 ball bearing #0159 should be between the slot in the C.N.C. antirotation guide #0823-2.

Step 5. **Assembling Wash-Out Unit.**

Parts Required:		Bag#
1 #0571-1	Machined Wash-Out Center Hub	3E
2 #0093	Special Bolts M3x15	3E
2 #0109	M3x8 Threaded Steel Balls	3E
2 #0223	Wash-Out Special Links	3E
2 #0221	Wash-Out Arms	3E
4 #0159	M3x7 Ball Bearings	3E
2 #106-07	Pivot Pins	3E
5 #106-08	Circlips	3E
2 #0562-1	Spacer Washer 3.2x5.0x.13	3E
2 #0009	M3 Washers	3E

Refer to Drawing # 3.

NOTE: One extra #106-08 circlip is included.

A. Take the two washout control arms #0221 and the two M3x8 Balls #0109 (longer shank) and thread a ball into the hole in the long end of each Arm from the flat side. Use Slow Cyano. Make sure the balls are threaded squarely in place and lightly seated against their flanges.

B. Press Ball Bearings #0159 into both sides of the center holes in both Control Arms #0221.

C. Using two M3x15 special bolts #0093, two M3 washers #0009 and two spacer washers #0562-1, screw the arm onto the wash-out hub #0571-1, use Loctite. The control ball should face inward. Tighten entire assembly until there is no lateral play and no bearing drag.

D. Using two pivot pins #106-07 assemble the wash-out special link #0223 to each control arm #0221. Their orientation is shown on the drawing. Note that they mount on the short end of the arms, projecting inward. The pins press in place centered in the links. Secure each end of the pins using circlips #106-08. The special links #0223 should have no end play and pivot freely. If they do not pivot freely, carefully apply heat with a heat gun until they operate smoothly.

E. Slide assembled wash-out unit down onto the mainshaft, snap the two #0223 wash-out links onto any two opposite #0109 steel balls on the inner ring of the swashplate.

IV. BUILDING LOWER MAIN FRAME SECTION

Step 1. Assemble Lower Mainframe Section and Attach Graphite Front Frame Plate.

Parts Required:			Bag#
1	#0191	Motor Mount	4A
2	#0586-20	Graphite Lower Main Frame Sides	4A
1	#0586-21	Aluminum Lower Frame Channel (right)	4A
1	#0586-22	Aluminum Lower Frame Channel (Left)	4A
1	#0586-23	Graphite Vertical Front Plate	4A
2	#106-72	Frame Plate Corner Blocks	4B
18	#0063	M3x10 Socket Head Cap Screws	4B
4	#0019	3mm Hex Locknuts	4B
12	#0009	Flat Washers 3mm (small)	4B
6	#0003	Flat Washers 3mm (large)	4B

Refer to Drawings # 4.

A. Building a right and a left main frame #0586-20 by bolting the aluminum lower frame channel #0586-21 (right) and #0586-22 (left) to the outside of frame using four M3x10 socket head bolts #0063, four 3mm locknuts #0019, and four 3mm small washers #0009, mounting in the rearward two holes on each side plate. The washers go on the inside of the frames. Do not fully tighten at this time.

B. Bolt the frames together using the motor mount #0191, six M3x10 socket head bolts #0063, and six M3 large washer #0003. This is only a temporary installation on the motor mount for frame alignment. Four of the #0063 bolts will be replaced with #0065 bolts in **Section V.** Do not fully tighten at this time.

C. After examining drawings, bolt two vertical frame corner blocks #106-72 to the front insides of the lower graphite main side frames 0586-20. With four M3x10 socket head bolts #0063 and four M3 washers (small) #0009. Use blue Loctite. Do not fully tighten.

D. Bolt the graphite vertical front plate #0586-23 to the vertical frame corner blocks #106-72 on the front of the graphite lower main frame sides #0586-20. Using four M3x10 socket head bolts #0063 and four M3 flat washers small #0009. Use blue Loctite. Do not fully tighten.

Step 2. Assembly of the Top Main frame Section to the Lower Main Frame Section.

Parts Required:			Bag#
2	#106-76	Threaded Spacers	4C
4	#106-78	Un-threaded Spacers	4C
4	#0077	M3x30 Socket Head Bolts	4C
6	#0009	Flat Washers 3mm small	4C
2	#0063	M3x10 Socket Head Bolts	4C

Refer to Drawings # 4.

A. Slide the top main frame assembly down into position. Place two M3 small washers #0009 on two M3x10 socket bolts #0063 and then start the bolts in the lower two holes on the top of the graphite vertical front plate #0586-23 and into the lower holes in the

upper corner blocks #106-72 mounted in the upper main frame assembly. (use Loctite)

B. Place four M3 small washers #0009 on four M3x30 bolts #0077. Hold an un-threaded spacer #106-78 between the lower mainframe and the upper mainframe on either side and pass a M3x30 bolt through the lower frame and spacer. Slide a threaded spacer #106-76 between the top mainframe and in line with the un-threaded spacer then thread the M3x30 bolt into the spacer. Do not fully tighten any bolts at this time.

C. With the mechanics sitting on a flat surface snug up the six bolts holding the motor mount between the frames. Tighten the four bolts that hold the lower aluminum frame channels #0586-21, 0586-22 with the machine sitting on the table.

D. Tighten all fourteen bolts going into the frame plate corner blocks #106-72. Use Loctite.

E. Tighten the four M3x30 #0077 bolts holding the lower main frame section to the top main frame section together at the rear of the machine. These bolts are going through the un-threaded spacers #106-78 and into the threaded spacers #106-76. Use Loctite.

Step 3. Mount Gyro Plate.

Parts Required:			Bag#
1	#0586-25	Graphite Gyro Plate	4D
1	#0595-1	Left Rear Gyro Mounting Plate	4D
1	#0595-2	Right Rear Gyro Mounting Plate	4D
2	#0009	Flat Washers 3mm small	4D
2	#0063	M3x10 Socket Head Bolts	4D
2	#0019	Hex Locknuts M3	4D

Refer to Drawings # 4 and #6.

Note-Optional Gyro Location:

As per drawing #6, the gyro may be mounted under the servo tray if desired. If this is your choice, the gyro mounting plates are not installed until the lower tray supports and plastic tray are assembled in Step #6.

A. Mount one left and right gyro mounting plate #0595-1 and 0595-2 on the insides of the lower main side frames #0586-20 using two M3x10 socket head bolts #0063, two flat washers M3 small #0009 and two hex locknuts 3mm #0019. Align plates in an horizontal position and tighten securely.

B. Attach the graphite gyro plate #0586-25 to the top sides of the mounting plates using silicone or Goop adhesive.

Step 4. Mount Upper Canopy Stand-Off.

Parts Required:			Bag#
1	#106-62	Upper Canopy Stand-Off	4E
1	#0179	Canopy Latch Plate	4E
2	#0065	M3x12 Socket Head Bolts	4E
1	#0063	M3x10 Socket Head Bolt	4E
3	#0003	Flat Washer M3 (large)	4E

Refer to Drawings # 4.

A. Mount one upper canopy stand-off #106-62 to the canopy latch plate #0179 as per drawing, using one M3x10 socket head bolt #0063 and one flat washer large #0003. Tighten securely using blue Loctite.

B. Using two M3x12 socket head bolts #0065 and two M3 flat washers large #0003, bolt the upper canopy latch assembly to the front top side of the graphite vertical front plate. Tighten securely using Loctite.

V. INSTALLING ENGINE AND FAN SHROUD ASSEMBLIES

Step 1. **Mounting Flywheel.**

Parts Required:		Bag#
1	#0579-4 C.N.C. Aluminum Cooling Fan	5A
1	#0546-21 Fan Assembling Tool	5A
2	#0546-16 Urethane Dampeners (molded)	5B
1	#0546-5 Upper Fan Drive Collet (O.S. SX)	5B
1	#0331 M13x.5 Flat Steel Washer	5B
1	#0007 M6.6x12.3 Flat Steel Washer	5B
1	#0546-6 Lower Fan Drive Collet	5B
1	#0546-8 Upper Fan Drive Collet (O.S. SFN)	5B
2	#0078 M4x12 Socket Head Bolts	5B

NOTE: - This kit includes only (O.S. 61) collet pack. You must purchase separately the appropriate "**Collet Pack**" containing all hardware for any other specific engine.

Collet Pack	**Engine Application**
0546-4 - Included in kit -	O.S. .61SX-H, RX-H
0546-7 - Included in kit -	O.S. .61SFN-H, RFN-H
0546-9 - (Opt.)	ENYA 60XF, XLF
0546-14 - (Opt.)	Webra 61H (X-Cell/Schluter type with 9.5mm O.D. solid crankshaft) and 50 H.
0546-15 - (Opt.)	Webra 61, Pico, Rossi and O.P.S. with special "Heim" type 8.0mm O.D. solid crankshaft.
0546-22 - (Opt.)	Super Tigre .61-H (with 1/4" crankshaft threads)
0546-24 - (Opt.)	New Style Y.S. .61 ST & Y.S. .91 AC-M (Short Stroke)

Webra Note: Most Webra Heli engines fall into one of three crankshaft categories:
- Those with 9.5mm O.D. crankshaft previously having a factory fan/hub assembly.
- Those with 8.0mm O.D. crankshaft designed for use in Graupner/Heim or Robbe Magic/Futura Heli's. Use **Collet Pack** #0546-15.
- Those with 1/4" O.D. Stepped crankshaft similar to O.S. 61 SFN-H. This configuration will use **Collet Pack** #0546-7 with minor modification.

Refer to Drawings #5.

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 are more easily done on a test bench.

B. The precise centering of the fan assembly is achieved by the use of special collets provided in the Custom kits. This will fit the majority of engines commonly selected for helicopter use. Measure the shaft diameter of your engine and if it differs, contact your dealer or Miniature Aircraft USA direct to obtain the correct collet pack. This is essential for a true running engine/shaft assembly and a vibration-free helicopter! (Radio and servos live short, unhappy lives in high vibration applications!)

C. For all engines factory equipped with thrust drive washers, collet and/or keys, remove them. Webra engines previously equipped with cooling fans should have them removed along with the drive keys. O.S. 61 SX and SFN-H series engines utilize a 1.0mm thick spacer washer between the thrust washer and front bearing which must be left in place for our use. Some Super Tigre .61-H engine may have a similar washer beneath the thrust drive washer. Be sure you have only (1) washer in place between the front bearing and base collet.

D. A few types of engines will require slight shortening of the crankshaft threads. Use the following guidelines:

IMPORTANT: When tightening crankshaft nuts, collet and fan hub do not use the fan blades as a device to hold the unit. This will damage the fan and the bond between the fan and the hub. Use only the proper factory recommended fan hub tool or remove the carburetor and insert as large a wooden dowel as will fit into the crankshaft. Do not use any device designed to lock the piston from the glow plug hole as these will damage the piston, crank or connecting rod.

Engines not requiring shortening:
O.S. 61 SX/RX, O.S. 61 SFN-H/RFN-H, Y.S. 61 FSH/RSH, Webra 50 heli,
Super Tigre .61 H (1/4" crank type)

Engines requiring shortening:
Enya 60 XF----------Cut 4.0mm - Approx.
Webra 61 H (9.5mm crank X-Cell/Schluter Type)---------- Cut 2.0mm - Approx.
Webra 61 H (Pico, O.P.S., Rossi, (8mm crank Heim type)------ Cut 4.0mm - Approx.

The best procedure for cutting the crank threads without damage is to install the crank nut below the cut area, make the cut with a Dremel tool and carbide disc. Chamber the edge with a file, and "chase" the threads by un-threading the nut. Be sure to thoroughly shield the engine against metal particles.
NOTE: Some engines such as O.S. 61SX and Y.S. 61 will require a "thin-wall" type socket to tighten the crank nut.

E. To ensure concentricity, only use the proper **Collets** for your engine. Similarly, do not make any substitution for any special spacers or hardware.
Important: - In any installation, be certain that the crankshaft does not extend above the top surface of the fan hub. Select the correct instruction steps for your particular engine.

F. Use the following guides for installing the fan and the collet packs.

1. O.S. 61 SX-H/RX-H (Collet Pack #0546-4).
- Install the large I.D. (9.5mm) base collet #0546-6(with the tapered side upward away from the engine) into position against the factory 1.0mm thick front bearing spacer washer.
- Slide fan hub assembly #0579-4 onto the base collet.
- Insert the upper collet #0546-5 (8.0mm I.D.) with the tapered side facing down in the fan hub. **NOTE:** This collet has a 9.52mm I.D. step for crankshaft clearance.
- Follow with the #0331(M13.0x8.0x.5) flat washer. Apply a little Loctite to the factory nut and install and

tighten firmly.

2. O.S. 61 SFN-H/RFN-H (Collet Pack #0546-7).

- Install the large I.D. (9.5mm) base collet #0546-7(with the tapered side upward away from the front bearing) into position against the factory bearing spacer washer.
- Slide fan hub assembly #0579-4 onto the base collet.
- Insert the upper collet #0546-8 (6.23mm I.D.) with the tapered side and internal step facing downward into the hub.
- Follow with flat washer #0007 (M11.75x6.5x1.7). Apply a little Loctite to the factory nut and install and tighten firmly.

3. Enya 60 XF/XLF (Collet Pack #0546-9).

- Install one #0325 flat washer (M16.0x10.0x1.0) onto the crankshaft up against the front engine bearing.
- Install the large I.D. (9.5mm) base collet #0546-6(with the tapered side upward away from the front bearing) into position against the #0325 washer.
- Slide fan hub assembly #0579-4 onto the base collet.
- Insert the upper collet #0546-10 (7.0mm I.D.) with the tapered side facing down in the hub.
- Follow with the #0005(M11.75x6.5x1.7) flat washer. Apply a little Loctite to the factory nut and install and tighten firmly.

4. Y.S. 61 Heli (Collet Pack #0546-24).

- Install space adapter #0546-13 onto the crankshaft with the "Double Stepped" side facing and contacting the front engine bearing.
- Install the large I.D. (9.5mm) base collet #0546-6(with the tapered side upward away from the engine) into position against the #0546-13 spacer/adapter.
- Slide fan hub assembly #0579-4 onto the base collet.
- Insert upper collet #0546-12 (with the tapered side downward into the hub).
- Follow with #0331 flat washer(M13.0x8.0x.5). Apply a little Loctite to the factory nut and install and tighten firmly.

5. Webra 61 Heli (X-Cell/Schluter type with 9.5mm solid crankshaft) - (Collet Pack #0546-14).

- Install #0325 flat washer (M16.0x10.0x1.0) onto the crankshaft up against the front engine bearing.
- Install spacer/adapter #0546-13 onto the crankshaft with the "Double Stepped" side facing and contacting the previously installed #0325 flat washer.
- Both collets in this application are the same #0546-6. Install one(tapered side away from the engine) up against the spacer/adapter #0546-13.
- Slide fan hub assembly #0579-4 onto the base collet.
- Insert the remaining #0546-6 collet (tapered side downward) into the fan hub.
- Follow with #0005 flat washer (M11.75x6.5x1.7). Apply a little Loctite to the factory nut and install and tighten firmly.

6. Webra 50 Heli (X-Cell/Schluter type with 9.5mm solid crankshaft) - (Collet Pack #0546-14).

- Follow same steps as in webra .61 above except that the #0325 (M16x10x1.0) flat washer next to the front bearing is eliminated.

7. Webra 61 H, Pico, O.P.S. and Rossi, special O.S. .61 HG (Heim type with 8.0mm solid crankshaft) - (Collet Pack #0546-15).

- Install #0331 (M13.0x8.0x.5) washer onto the crankshaft up against the front engine bearing.
- Install #0546-20 spacer on top of the 0331 washer. Follow with (1) #0546-5 collet with the tapered side away from the engine.
- Slide fan hub assembly #0579-4 onto the first collet.
- Insert the remaining #0546-6 collet (tapered side downward) into the fan hub.
- Follow with (2) #0007 flat washers (M11.75x6.5x1.7). Apply a little Loctite to the factory nut and install and tighten firmly.