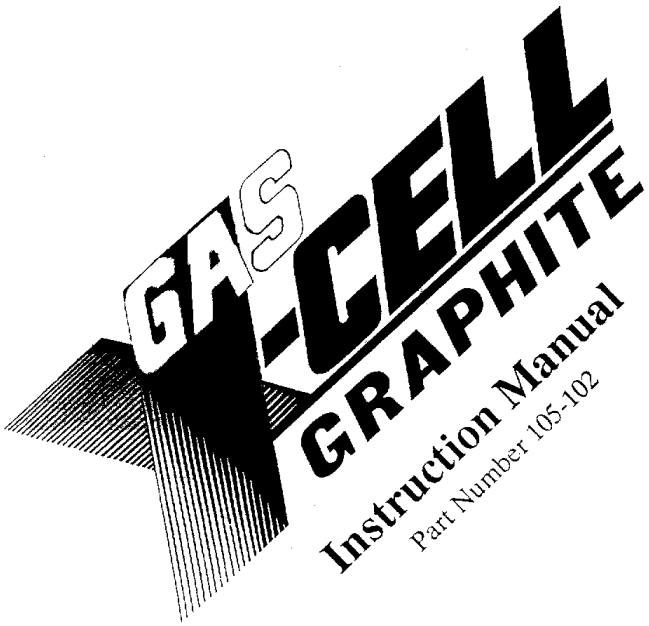


Instruction Manual

Part Number 105-102

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

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

Owners Name:_____ Age:_____

Address:_____

City:_____ State:_____ Zip:_____

Purchased From:_____

Dealer's Address:_____

_____

Comments:_____

_____

NOTE: In the X-Cell Gas Graphite Manual page 51, Section XVIII, Paragraph B, reference is made to engine carburetor settings. This paragraph refers the builder to review the Zenoah Quartz G-23 Instruction Manual for initial needle settings. It is our recommendation that all settings be done according to the Zenoah Manual except for the high speed setting. We recommend a high speed setting of 1 to 1-1/2 turns counter clockwise.

NOTE: If the muffler supplied with you Zenoah Quartz G-23 has a exhaust extension tube greater then 1 inch in length, we highly recommend the excess to be removed.

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.

A word of warning, new laws are in effect concerning transportation on commercial airlines any item containing or utilizing gasoline as a fuel system. Check with your local airlines concerning these matters.

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

Phone (407) 292-4267
FAX (407) 292-4296

XL-GAS GRAPHITE SERIES HELICOPTER

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. 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 helicopters 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 Gyro is not important at this time, except that the gyro control switch box is easier to install early.

CONSTRUCTION

The XL-Gas Graphite 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, and a metric scale for your convenience. 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)
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)
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)
Flybar Lock (Part #0505)
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 Pivot Block and the Head Button into the Head Block
2. Final Assembly of the Fly-Bar Yoke and Guide Pins
3. Building and Installing the Bell Mixers
4. Assemble and Install the Main Blade Mounts
5. Add the Fly-Bar, Control Arms and Paddles
6. 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 (Fore and Aft) Swing Arm Unit
4. Assemble Front Tail Drive Transmission
5. Install Antirotation Arm, Lower Mainshaft Bearing Block, Tailboom Support Halves, Front Frame Plate and the Clutch Shaft Bearing Block
6. Mount Lower Frames, Gyro Mounting Plates and the Upper Mainshaft Bearing Block.

III. ASSEMBLY OF MAIN SHAFT COMPONENTS

STEP
1. Installing the Mainshaft, Autorotation Unit with Maingear
2. Assembling Swashplate
3. Assembling Lower Swashplate Control Rods and Anti-Rotation Arm Pushrod
4. Assembling Wash-Out Unit

IV. ASSEMBLING ENGINE COMPONENTS

STEP
1. Mounting the Pull Starter
2. Mounting the Flywheel, Fan Shroud and Rear Motor Mount

V. BUILDING AND INSTALLING THE CLUTCH SYSTEM

STEP
1. Assembling the Clutch to the Clutch Bell
2. Install the Clutch Bell Assembly
3. Installing the Engine, Lower Frame Rails and Gyro Plate

VI. BUILDING AND INSTALLING THE LANDING GEAR

VII. RADIO TRAY ASSEMBLE AND SERVO INSTALLATION

STEP
1. Installation of Radio Tray Supports
2. Assemble Plastic Tray and Install Servo's
3. Mount Servo Tray to Mechanics
4. Installing the Elevator Servo and the Gyro Motor Assembly

VIII. GAS TANK INSTALLATION

STEP
1. Build the Gas Tank
2. Mounting the Gas Tank

IX. ASSEMBLE THE TAILROTOR TRANSMISSION

STEP
1. Assemble Tailrotor Hub and Blade Holders
2. Assemble Pitch Slider and Bell Crank
3. Assemble the Gear Box
4. Install Assembled Tail Rotor Hub

X. **BUILDING THE TAIL BOOM**

STEP 1. Install Tube Drive
2. Installing Tailrotor Pushrod Guides, Fin Mounts and Push Rod
3. Install Twin Boom Supports

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. Setting up the Tailrotor Servo
3. Install the Elevator Servo Pushrod
4. Install the Aileron and Collective Pushrods
5. Install the Throttle Pushrod
6. Install the Rotor Head, Flybar and Hiller Control Rod

XII. **CANOPY PREPARATION**

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

XIII. **BUILDING THE ROTOR BLADES**

STEP 1. Assembling the Blade Mounts
2. Adding the Lead Strips
3. Initial Balance
4. Cover Blades
5. Final Balance of Blades and Rotor Head

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

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

XV. **FINAL ASSEMBLY AND BALANCE**

XVI. **FINAL ASSEMBLY AND INSPECTION**

XVII. **NECESSARY FLIGHT ITEMS**

XVIII. **FIRST FLIGHT ADJUSTMENTS**

XIX. **STARTING AND STOPPING THE ENGINE**

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 Pivot Block and the Head Button into the Head Block

Parts Required:

2	#0033 M3x5 Phillips Machine Screws	Bag 1B
1	#0289 Head Block	Bag 1A
1	#0294 Long Pivot Block	Bag 1B
2	#0301 Pivot Ball Bearings	Bag 1B
2	#0563-1 Brass Inserts	Bag 1B
2	#0563-2 M3x8 Socket Set Screws	Bag 1B

Refer to Drawings # 1.

A. Clean the I.D. of the pivot ball bearings #0301 and the long pivot block #0294 using a paper towel and some thinner. At builders discretion apply a very small amount of loctite to the shaft on both sides of the pivot block. Slide the bearings all the way on the block, one on each side. (If necessary, tap into place, applying force only to the inner race.)

B. Identify the two small holes recessed at the end of the middle bore in the #0289 head block and squarely thread an M3x5 Phillips head screw #0033 into one hole until it seats. Do not over-tighten. Slide the pivot block unit into the middle bore from the other end until it seats against the screw head previously installed. Thread the other M3x5 phillips screw into the remaining hole until it seats and traps the pivot block assembly. Neither screw should be so tight as to bind the bearings. Instead, they should be adjusted equally so that neither end play nor binding exist.

C. **Installing Static Tracking Screws**

Purpose:

To allow adjustable static tracking of the rotor head due to slight variations in blade height at the tips by eliminating any looseness about the mainshaft due to wear or stretching of the base of the head block.

Special Tools Required:

1 Small Hammer

Examine the head block #0289 closely. On each side (at the base) just above where each #0297 pin is installed, you will notice a hole molded in the plastic.

Select an M3 bolt from the spare parts and screw it 3/4 of a turn into the knurled end of one of the brass inserts (#0563-1). Hold this straight with respect to the hole and use light tapping pressure on the bolt head (with a small hammer) to start the insert into the hole. When you are satisfied that the insert has started into the hole straight, remove the M3 bolt and use the hammer to set it flush with the head. Due to it's slotted construction and knurled edge, the brass insert will "set" itself firmly into the plastic. No Cyano is required. Repeat

the process on the other side.

Again, using an M3 socket-head bolt from your spares, it is now necessary to test the threads. Screw the bolt into the insert slowly. It will have some resistance and possibly squeak a little. This is fine since this process will spread the insert deeper into the sides of the hole. Remove the bolt and repeat on the other insert.

Start each set screw #0563-2 and screw in until it is flush with the surface of the rotor head. Final adjustment will come after the main rotor blades have been mounted.

Step 2. Final Assembly of the Flybar Yoke and Guide Pins

Parts Required:

4	#0063	M3x10 Socket Head Bolts	Bag 1C
2	#0115	M3x10.5 Threaded Balls	Bag 1C
2	#0292	Flybar Yoke Halves	Bag 1C
2	#0296	Pivot Block Spacers	Bag 1C
2	#0297	M2.5x24 Guide Pins	Bag 1C
2	#0298	Delrin Bearing Cups	Bag 1C
2	#0299	Flybar Bearings (M4x10)	Bag 1C
2	#0339	Delta III Plates	Bag 1C
1	#0509	Large Head Button	Bag 1C

Refer to Drawings # 1.

A. Rotate the pivot block until the cross hole is squarely visible through the side slots in the head block (it may be held in this position using the clutch shaft of the clutch assembly #0267). Slide one #0296 plastic spacer onto each end of the exposed shafts from the pivot block #0294. Holding the pivot block cross hole level within the head block and press one #0292 flybar yoke half (rounded side outward) fully onto each end of the pivot block. Align each flybar yoke half with the "tool" leveling the pivot block. This step is important but not critical since the through hole in the pivot block is only a "clearance hole" for the flybar to pass through.

B. Examine each #0298 Delrin bearing cup. Note that one side is made to accept an #0299 (M4x10) bearing with a snap fit. Insert one #0299 bearing into each bearing cup, making sure that it is fully seated. Select both #0339 delta offset plates. The O.D. of each #0298 bearing cup is designed to snap into the delta offset plate. Install one into each plate.

For your convenience, temporarily apply a small piece of tape on each side of the rotor head block and designate one side as the left side and one as the right side. Examine each delta offset plate carefully. You will see that each is symmetrical with the exception of a protruding end with an M3 threaded hole. Holding the rotor head block with the left side facing you, position one delta offset plate up against one end of each flybar yoke half (aligning each un-threaded hole in the plate with each flybar yoke half hole) with the M3 threaded hole offset to your right. Install two M3x10 socket head bolts with a small amount of slow cyano through each delta offset plate and into each flybar yoke half. Be sure that the bearing faces outward. Rotate the head block 180° and repeat the process. This pivot block/delta plate assembly should now pivot freely and the through hole in the pivot block should be in alignment with each M4x10 bearing.

Apply a small amount of Loctite to each #0115 threaded ball and install them from the outside into each delta offset plate. Note that each will slightly scuff against the head of the nearest M3x10 socket head bolt during installation. This will not cause any problem. Be sure each #0115 ball is fully tightened.

C. Drive the two #0297 guide pins into the bottom holes in the head block until they seat solidly. (They will project about 16.0mm when seated.) **NOTE:** The lower 8mm of the pins #0297 may be roughened with 80 grit sandpaper and press in place with epoxy or slow cyano.

D. Using either a X-acto knife or 220 grit sandpaper, rough up the top of the head block around the center hole and the bottom portion of the head button #0509 where the two parts will make contact. Apply a small portion of Slow Zap to the head button only! Do not allow any Zap to run down into the head block. Press the head button into the block #0289 and seat fully. Use Kicker to dry the Zap on the outside of the block to keep the glue from running down the block while drying if needed.

Step 3. Building and Installing the Bell Mixers

Parts Required:

2	#0017	M3 Nuts	Bag 1D
2	#0093	Special Bell Mixer Screws (M3x18)	Bag 1D
4	#0115	M3x10.5mm Threaded Balls	Bag 1D
4	#0159	Ball Bearings for Bell Mixer (M3x7)	Bag 1D
2	#0317	Main Blade Mounts	Bag 1A
2	#0333	Bell Mixers	Bag 1D

Refer to Drawings # 1.

NOTE: This is the first step involving the threading of control link balls into plastic parts and three important requirements must be met. First, the ball thread must be started squarely in the hole. This is assured by first pushing the ball onto the allen wrench (a quality feature of this kit is the series of custom control balls used that have hex sockets in the end), and carefully starting the threaded end into the hole as squarely as possible. This can be determined by alternately viewing the ball and wrench from two aspects 90 degrees apart ("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 cyano acrylate 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 -- use a toothpick. Third, the ball must not be threaded in so tightly that the threads created in the plastic are stripped. Each ball has a flange intended to seat against the plastic part, so thread the ball down until this flange just contacts the surface.

A. Thread two long shank threaded balls #0115 into each #0333 bell mixer. Use slow cyano and be sure to thread in squarely without over-tightening.

B. Using a #0093 bell mixer screw to assist in alignment, press a #0159 ball bearing into each side of each #0333 bell mixer. Be sure the bearings are square and properly seated.

C. Examine the #0317 blade mounts. Two holes are provided on each pitch arm for the installation of the bell mixers. For the purpose of this particular model, you will only be using the hole **nearest** the main body of the blade mount. Upon further examination, you will find a small raised area surrounding each hole. Since the outer hole is **not** to be used, it is advised that you remove the small raised area from that

hole. A sharp knife will do this easily. This will provide suitable bearing clearance when the bell mixer is finally installed in the other hole.
With the stepped side facing away from the head of #0093, slide each bell mixer assembly on a #0093 bell mixer screw and thread into the hole nearest the main body of each #0317 blade mount. Using Loctite, thread a #0017 M3 nut on the exposed threads of #0093 screw on the inside of the blade mount arm. Tighten the nut securely against the inside of the control arm. Do not be alarmed if the nut takes on a slanted appearance after light tightening -- its function is solely as **extra** security and is not at all critical (should you wish, the nut may be completely eliminated by putting a small amount of slow cyano or epoxy over the exposed threads - it is your option). Apply slow cyano to the nut against the plastic, as a fillet. Be sure each bell mixer is adjusted to allow for no drag or free play.

Step 4. Assemble and Install the Main Blade Mounts

Parts Required:

2	#0021	M4 Locknuts	Bag 1E
2	#0082	M4X45 Socket Head Bolts	Bag 1E
2	#0085	M5x16 Socket Head Bolts	Bag 1E
1	#0315	Main Blade Axle	Bag 1E
1	#0316	10mm Fuel Tubing	Bag 1E
4	#0319	Ball Bearings	Bag 1E
2	#0321	Thrust Bearings	Bag 1E
2	#0323	Dampener Rubber O-Rings	Bag 1E
2	#0325	Thrust Bearing Spacers	Bag 1E
2	#0327	Bearing Retainer Washers	Bag 1E
2	#0329	Thin Shim Washers	Bag 1E

Refer to Drawings # 1.

NOTE: Prior to beginning this section, be sure to degrease the threads in the #0315 blade axle and bolts #0085 with alcohol or thinner.

A. Using a pair of needle nose pliers or by use of Miniature Aircraft USA special Head Axle Dampener Installation Tool #0522, spread the 10mm piece of fuel tubing #0316 over the #0315 blade axle. Center the fuel tubing on the blade axle and glue in place with slow cyano. **NOTE:** The fuel tubing will be providing the lifting point for the model instead of the #0323 O-rings doing this job. This will allow the O-rings to provide dampening for the model which is what they are designed to do.

B. Select both #0317 main blade mounts from Step #3. Also select two #0319 ball bearings, one #0321 thrust bearing, one #0325 thrust bearing spacer, one #0327 retainer washer, and one #0085 M5x16 socket head bolt from the parts bag. Press a ball bearing into a blade mount cavity on the control arm end. Seat it fully. Press the second ball bearing into the mount from the fork end. Seat it squarely and fully by using a socket or pipe of suitable diameter (the same O.D. as the bearing) to avoid any pressure on the inner race. Check alignment by sliding the #0315 main blade axle through this bearing, through the mount, and through the previously installed bearing. Remove the axle. Repeat this entire process with the second blade mount.

C. Carefully slide a #0323 dampener O-ring about 30mm onto the #0315 main blade axle, taking care not to damage it on the sharp edge 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.

D. Select the two #0329 shim washers and slide one on each end of the blade axle. Slide a blade mount on one end of the axle. Refer to drawing #_1_ for proper orientation.

E. Lay the #0321 thrust bearing on a clean surface and separate the two races and the ball ring. Note that one race has a larger inside hole diameter than the other. This point is most important. Determine the larger-holed race by slipping each race onto the end of the axle and choose the looser one. Lay the larger race down, ball groove-up, and place the ball ring on it. Apply a small amount of grease and place the other race on the ball ring (groove down). Set aside until you reach Step G.

F. Slide the #0325 thrust bearing spacer into the fork end of a blade mount up against the ball bearing.

G. Place a #0327 bearing retainer washer on the M5x16 socket head bolt and insert the screw down into the thrust bearing from the top. Apply a small amount of Loctite on the threads inside the main axle. Invert the bolt and thrust bearing assembly and, using one of the Allen wrenches in the kit, thread it into the blade axle through the fork end of the assembled blade mount. Tighten most of the way, and slide the blade mount against this stack to square it up. (The thrust bearing should engage the shouldered part of the axle with the small I.D. race nearest the head of the M5x16 bolt).

H. Repeat steps E, F, and G to install the other main blade mount. Using the two Allen wrenches in the kit, tighten the whole axle assembly firmly. (**IMPORTANT:** DO NOT OVER-TIGHTEN or axle damage may result.) Be sure each blade mount control arm is oriented to the head block as shown in view #1. This is to say that with the right hand rotation of this model, each blade will be commanded by the control arm at its leading edge.

I. Temporarily install the two M4x45 socket head bolts #0082 and two M4 locknuts #0021 into the blade holders.

Step 5. Add the Flybar, Control Arms and Paddles.

Parts Required:

1	#0566-1 Flybar(Inside Tailboom)	Bag 10A
1	#0019 M3 Locknut	1F
2	#0053 M3x5 Set Screws	1F
1	#0091 M3x16(12.9) Head Bolt	1F
2	#0305 Control Arm Spacers	1F
2	#0307 Flybar Control Arms	1F

Refer to Drawings # 1.

A. Insert the flybar #0566-1 into the bearings provided in the #0339 delta offset plates. Follow with one #0305 spacer and one #0307 control arm on each side. Slide each up to the delta offset plates and then 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 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. **NOTE:** Available through Miniature Aircraft USA is a special Fly-Bar Alignment Kit. Order #0510.

B. Temporarily install the main head bolt #0091 and one M3 locknut #0019 into the remaining hole on both sides of the main rotor head block #0289, just below the Delta offset plates #0339. The locknut, inserts into the hex shaped hole. Only slightly tighten the head bolt #0091, at this time.

Step 6. Assembly of Flybar Paddles

2	#0561-3	Pro-Paddles Main Section	1A
10	#0561-1	Brass Weight Set Screws	1G
4	#0561-2	Pro-Paddle End Caps	1G

Refer to Drawings #1.

A. **NOTE:** Before assembling the paddles it will be necessary to choose the over-all paddle weight desired by the number of brass screws used to achieve a desired flying characteristics.

The following characteristic may be expected with the installation of the set screws:

- With no set screws (total weight approximately 14.5 grams) - Crisp response similar to #0311 paddles but without any fore and aft sensitivity in fast flight.
- With one to four set screws (total weight approximately 16.2 - 20.5 grams) - graduating increase in stability yet still fully aerobatic.
- With five set screws (total weight approximately 22.0 grams) - excellent smooth hovering and FAI type aerobatics. NOTE: should you wish, it is possible to use a lead strip capped by one set screw to bring the total weight up to about 40.0 grams. Such choices are made considering flying style and total blade weight.

B. Thread into the front hole on the inner end of each fly-bar paddle #0561-3 the desired number of brass weight set screws #0561-1. Completely install each set screw before installing the next one.

C. The end caps #0561-2 are simple to install. Set each into position (but not fully flush). Apply a little cyano to the joint and press each end of the paddle onto a flat surface to set the caps flush. Wipe the excess glue away with a paper towel (quickly). Use a light spritz of kicker to quick cure.

D. Ideally, each paddle should be threaded onto the flybar covering a minimum of 25.0mm. However, should you desire a shorter disc, they may be further threaded to encompass up to a total of 40.0mm of flybar. Be sure to secure threads with slow cyano or epoxy. Align paddles level to each other and in line with the fly-bar control arms #0307. Check drawings for proper orientation. The use of Miniature Aircraft's Fly-Bar Alignment Kit #0510 is very helpful for this step. Final balance of the fly-bar assembly may be achieved by either adjusting the position of one of the brass set screw weights or by trimming the brass weight with wire cutters.

II. BUILDING TOP MAIN FRAME SECTIONS

Step 1. Assemble Aileron Bellcranks to Main Frames

Parts Required:

2	#105-13	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 #105-13 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 bellcrank #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 rearward containing a long ball #0107. Place a small amount of Loctite on the set screw threads, partially screw into 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 rearward with a long ball on it.

Step 2. Assemble Elevator Servo Graphite Mount

Parts Required:

3	#0586-6	Elevator Plate Spacers	2C
3	#0586-8	M3x20 Hex Bolts	2C
3	#106-22	Rubber Grommet Isolators	2C
3	#106-24	Dampening Sleeves	2C

3	#0009	Flat Steel Washers M3 (small)	2C
6	#0003	Flat Washers M3 (Large)	2C
3	#0019	3mm Locknuts	2C
1	#0586-5	Graphite Elevator Plate	2C
3	#0586-7	M3x15 Hex 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 inside of the right graphite upper frame plate #105-13 using the following hardware: three #0586-7 M3x15 hex bolts, three #0009 M3 washers (small), six #0003 M3 washers (large), three #0586-6 elevator plate spacers and three #0019 M3 locknuts. Tighten securely.

Step 3. Assemble Elevator (Fore and Aft Pitch) Swing Arm Unit.

Parts Required:

2	#0131	Plastic Bearing Bushings	Bag#	2D
1	#0099	Special Bolt M3x30	-	2D
2	#0155	Elevator Swing Arm Halves		2D
1	#0157	Elevator-Bell Crank		2D
1	#0105	M3x4.5 Threaded Steel Ball		2D
2	#0113	M3x10.5 Double Threaded Balls		2D
2	#0159	Ball Bearings M3x7		2D
2	#0161	Pivot Pins Elevator		2D
1	#0019	3mm Locknut		2D
2	#0047	Slotted Cheese Head Machine Screws M2x16		2D
2	#0015	Hex Nuts 2mm		2D

Refer to Drawings #2.

A. 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.

B. Press a plastic bearing bushing #0131 into the hole at the opposite end of each Swing Arm Half. Do this from the outside. Slide the special bolt #0099 into each #0131 to check that it pivots freely. Slightly open the holes if needed.

C. Select the Elevator Bellcrank #0157 from the parts bag, and the Threaded Ball #0105 (single ball end) from the parts bag. Using the proper size Allen Wrench from the tool bag and following the procedure previously described, glue and screw the ball into the arm of the Bellcrank.

D. Following the above procedure, screw in place and glue the two Double End Balls #0113, again referring to the drawing for position.

E. Select the Ball Bearings #0159 and press them into the remaining holes in the Bellcrank #0157.

F. Assemble the swing arm halves #0155 to the elevator bellcrank #0157 by squarely pushing the pivot pins #0161 into the ball bearing #0159, aligning and pressing the arm halves together. Secure the halves together with two M2x16 slotted bolts #0047 and M2 hex nut #0015, using Loctite.

G. Select the right hand main frame plate #105-13. As per the drawing insert the special bolt #0099 from the left side through the frame plate. Slide the assembled elevator bellcrank assembly onto the special bolt on the inside of the right upper frame side, making sure that the bellcrank arm projects through the aperture in the right side frame with the ball end up. Follow this assembly with the left hand side frame assembly #105-13 and one M3 locknut #0019. Do not fully tighten at this time.

Step 4. **Assemble Front Tail Drive Transmission.**

Parts Required:

3	#0051	M3x3 Socket Set Screws	2E
2	#0233	Front Drive Housing Halves	2E
2	#0235	Front Drive Ball Bearings	2E
1	#0237	Front Drive Retainer Collar	2E
2	#0241	Front Drive Housing Guide Sleeves	2E
1	#0232	15 Tooth front Drive Pinion	2E
1	#0800-6	Front Transmission Output Shaft	2E
2	#0077	M3x30 Socket Head Cap Screws	2E
4	#0003	Flat Washers M3 (large)	2E
2	#0019	Hex Locknuts M3	2E

Refer to Drawings # 2.

A. Clean the I.D. of the two bearings #0235 and the front input shaft #0800-6 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 #0800-6 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 push the output shaft assembly into this half. Put the other half in place and press the two halves together. Start the front transmission sleeves #0241 into the two holes in the drive housing then turn the unit over on the table with the sleeves against the table and push down on the drive housing until the housing is flush against the table.

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 #0232 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. Bolt the front tail drive transmission into the upper main side frames using two M3x30 bolts #0077, four M3 large washers #0003 and two M3 locknuts #0019. Do not fully Tighten.

Step 5. **Install Antirotation Arm, Lower Mainshaft Bearing Block, Tailboom Support Halves, Front Frame Plate and the Clutch Shaft Bearing Block**

Parts Required:

1	Clutch Shaft Bearing Block with Clutch Bell	2F
4	#0003 3mm Large Washers	2G
11	#0063 M3x10 Socket Head Bolts	2G
1	#106-62 Upper Canopy Stand-Off	2G
2	#106-72 Frame Plate Corner Blocks	2G
1	#0107 M3x6 Threaded Steel Ball	2G
1	#0247 Radius Arm Support	2G
18	#0009 M3 Small Washers	2G
2	#0185 Front Tailboom Support Halves	2G
8	#0077 Socket Head Bolts M3x30	2G
10	#0019 M3 Locknuts	2G
1	#0182 Mainshaft Bearing Block w/Bearing	2G
1	#105-10 Front Frame Plate	2A

Refer to Drawings # 2.

A. Using two #0063 M3x10 socket head bolts, two 3mm small washers #0009 and two #0019 M3 locknuts bolt into position, one #0247 radius arm support onto the top left main frame. The holes are slotted. Center the radius arm in the slots.

B. Using slow cyano, glue the #0107 M3x6 threaded ball in place in the top hole in the #0247 support.

C. Install the lower bearing block #0182 (bearing side facing up) using two #0077 socket head bolts M3x30, four #0009 flat washers M3 small and two #0019 hex locknuts M3. **Do not fully tighten.**

D. Install the clutch/bell, clutch shaft bearing block assembly using two M3x30 bolts #0077, four M3 large washers #0003 and two M3 locknuts #0019. **Do not fully tighten.**

E. Install the tailboom support halves #0185 using four M3x30 bolts #0077, eight M3 small washers #0009 and four M3 locknuts #0019. **Do not fully tighten.**

F. Install the #106-72 frame plate corner blocks with four M3x10 bolts #0063 and four M3 small washers #0009. **Do not fully tighten.**

G. Mount the #106-62 upper canopy stand-off to the #105-10 front frame plate with one M3x10 bolt.

H. Mount the front frame plate #105-10 to the upper main frame corner blocks #106-72 using four M3x10 bolts #0063. **Do not fully tighten.**

Step 6. **Mount Lower Frames, Gyro Mounting Plates, Upper Mainshaft Bearing Block**

Parts Required:

2	#105-12 Graphite Lower Main Frame Plates	2A
4	#105-14 Socket Head Bolts M3x45	2H
17	#0009 3mm Small Washers	2H
9	#0063 Socket Head Bolts M3x10	2H
4	#105-16 Unthreaded Dog-Bone Spacer	2H
2	#106-76 "Threaded" Spacers	2H
2	#106-72 Frame Plate Corner Blocks	2H
1	#0182 Main Shaft Bearing Block w/Bearing	2H
2	#0077 Socket Head Bolts M3x30	2H
3	#0019 3mm Locknuts	2H
1	#0595-2 Gyro Mounting Plate	2H
1	#0203 Main Shaft (Standard)	2A

Refer to Drawings # 2.

A. Install the corner blocks #106-72 to the inside bottom of the front frame plate #105-10 using four M3x10 bolts #0063 and four 3mm small washers #0009. **Do not fully tighten.**

B. Attach the lower mainframe plates #105-12 to the lower corner blocks #106-72 using four M3x10 bolts #0063 and four 3mm small washers #0009. **Do not fully tighten.**

C. Attach the lower frames to the upper frames at the rear using four M3x45 bolts #105-14, four 3mm small washers #0009, four un-threaded "Gold" spacers #105-16 and two threaded spacers #106-76 "Black" that go between the upper frames. **Do not fully tighten.**

D. Install the upper mainshaft bearing block #0182 with the bearing side facing down using two M3x30 bolts #0077, four 3mm small washers #0009 and two 3mm locknuts #0019. **Do not fully tighten.**

E. Remove the mainshaft #0203 from bag 2A and clean the mainshaft with some type of solvent to remove the oily coating.

F. Temporally slide the main shaft through the mainshaft bearing blocks #0182 as to align them so that we can begin to tighten all the bolts in the frame structure.

G. At this point all bolts going through the upper frames and all bolts holding the front plate and the lower frames to the top frames should be just slightly loose enough as to allow a little movement.

H. Sit the mechanics on a hard flat surface and press down on the top mainframes to ensure that everything is square.

I. Tighten all the bolts in the following sequence; Mainshaft bearing blocks, clutch shaft bearing block, the four M3x45 bolts #105-14 holding the lower frames to the upper frames at the rear

of the mechanics. Next tighten all of the M3x10 bolts #0063, holding the front frame plate #105-10 to the mechanics.

J. Attach the right gyro mounting plate #0595-2 to the inside of the lower main frame #105-12 using one #0063 M3x10 socket head bolt, one #0009 M3 washer and one #0019 M3 locknut. Level the gyro mounting plate and tighten.

K. Remove the mainshaft and the clutch shaft bearing block and set aside for the time being.

L. The rest of the bolts will be tightened at a later time.

III. ASSEMBLE MAINSHAFT COMPONENTS

Step 1. **Installing the Mainshaft, Autorotation Unit with Maingear.**

Parts Required:

1	#0203	Main Shaft (From Bag 2A)	
1	#0209	Autorotation Hub with Bearing Assembled	3A
1	#0207	Main Gear 90 Tooth	3A
2	#0205	Main Shaft Retainer Collars	3B
6	#0051	Socket Set Screws M3x3	3B
6	#0069	Socket Head Bolts	3B
6	#0019	Hex Locknuts 3mm	3B
1	#0211	Plastic Autorotation Hub Spacer	3B
1	#0213	Steel Autorotation Lower Spacer	3B
1	#0215	Retainer Collar	3B

Refer to Drawings # 3.

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

A. Slide the mainshaft #0203 down through the top bearing block #0182.

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

C. Next hold the elevator bellcrank #0157 up and slide the mainshaft through this.

D. Place another mainshaft retainer collar #0205 under the elevator bellcrank and slide the mainshaft through this and the lower bearing block #0182.

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

F. Noting that the maingear 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 socket head bolts #0069 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).

G. Place the plastic auto hub spacer #0211 on top of the main gear and auto hub and then slide the autorotation unit up onto the bottom side of the mainshaft. Follow this assembly with one #0213 lower steel autorotation spacer and one #0215 retainer collar. Secure the retainer collar to the main shaft using two #0051 M3x3 set screws. Tighten securely using loctite.

H. 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.

I. Apply some blue Loctite to two M3x3 set screws in the upper mainshaft retainer collar #0205. Pull down on the top of the mainshaft with your thumb while pulling up on the upper collar with your middle finger. Tighten both set screws securely.

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

K. 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.

L. Next adjust the gear mesh between the front transmission and the maingear. You want no play between the gears but no binding or tight spots. If either exists, loosen the mesh slightly. Ensure that the universal joint end of the shaft is pointed straight down the tailboom. To check this find a shaft or drill bit that will fit into the universal joint and check to see if it is centered between the tailboom support halves. Once both of the alignments are done tighten the two M3x30 bolts and re-check alignment. Sometimes it will change slightly when you tighten the bolts.

Step 2. **Assembling Swashplate.**

Parts Required:

1	#0217	Aluminum Swashplate (10mm)	Bag 3C
4	#0051	M3x3 Set Screws	3C
3	#0107	M3x6 Threaded Steel Balls	3C
4	#0109	M3x8 Threaded Steel Balls	3C
1	#0111	M3x10.5 Thd. Double Ball	3C

Refer to Drawing #3.

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. Using Loctite mount three M3x6 threaded ball #0107 in three of the four holes in the outer ring of the swashplate. In the remaining forth hole thread one #0111 M3x10.5 Double Ball.

C. Slide the swashplate down the main shaft #0203 from the top side.

Step 3. **Assembling Lower Swashplate Control Rods and Anti-Rotation Arm Pushrod.**

Parts Required:

10	#0133	Plastic Balls Links Long	Bag 3D
1	#0249	M2x42 Control Rod	3D
4	#0227	M2x42 Control Rods	3D

Refer to Drawing #3 and #11.

A. 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 control rods with ball links attached over the precise full scale view on the control rod length chart. See drawings. The rods must be identical in length. As a check dimension, the length of metal rod between inner plastic link faces is 22.0mm.

B. Referring to the drawing for control rod placement, snap the ball link on one end of a control 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. 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.

C. Thread the plastic ball links on the M2x42 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 23mm. Snap this rod on the radius arm support ball end and onto the outer (only remaining) ball of the double ball on the swashplate.

Step 4. **Assembling Wash-Out Unit.**

Parts Required:

1	#0219	Wash-Out Center Hub	Bag 3E
2	#0097	Special Bolts M3x22	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

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 tread 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.

C. Using two special washout arm bolts #0097, and carefully follow the drawing , screw the arms on the washout center hub #0219. (Suggestion: squarely start the thread of each bolt into its hole in the hub part way first without the arm.) 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. ASSEMBLING THE ENGINE COMPONENTS

Step 1. **Mounting the Pull Starter.**

Parts Required:

1	#105-5 Gas Engine	Box
1	#105-26 Adapter Plate	4B
1	#105-32 Pull Starter	4B
4	#105-38 M4x10 Socket Head Bolts	4C
8	#105-34 4mm Flat Washers	4C
4	#105-36 4mm Lock Washers	4C

Refer to Drawings # 4.

NOTE: We highly suggest removal and balancing of the engine flywheel before assembling the pull starter components. The flywheel may be balanced using a High-Point balancer. Take care not to loose any components, mounted under the flywheel.

A. Remove the gas engine #105-5 from the box.

B. Open bag four and take out the bag containing the pull starter #105-32 and the hardware bag.

C. Mount the pull starter #105-32 using the four M4x10 bolts #105-38, four 4mm flat washers #105-34 and four 4mm lock washers #105-36. **NOTE:** Study the drawing to ensure proper orientation of the pull starter. Four extra #105-34 4mm flat washers have been included to be

used under the 105-38 bolts for bolt and flywheel clearance.

Step 2. **Mounting the Flywheel, the Fan Shroud and the Rear Motor Mount.**

Parts Required:

1	#105-58 Rear Motor Mount	4E
1	#105-56 Fan Shroud Rubber Moulding	4E
4	#0031 M2.9x6.5 Phillips Screws	4E
1	#105-52 Fan Shroud	4A
1	#105-46 Fan Shroud Adapter Plate	4D
4	#105-44 M5x8 Flat Head Screws	4D
1	#105-48 Fan Hub w/Fan	4D
1	#105-42 M6x16 Flat Washer	4D
1	#105-40 M6x15 Socket Head Bolt	4D
4	#0546-16 Urethane Dampeners	4D
1	#0078 M4x14 Socket Head Bolt	4E
1	#105-54 M4x10 Flat Washer	4E
1	Strip of Plastic	4A

Refer to Drawings # 4.

A. Mount the fan shroud adapter plate #105-46 to the motor using the four M5x8 screws #105-44. Study the drawings to ensure proper orientation.

B. Wipe the inside of the fan hub #105-48 and the tapered end of the crankshaft to ensure that they are clean. A small amount of Tri-Flo oil may be applied to the crankshaft and collets after cleaning to aid in the alignment process.

C. Mount the fan hub #105-48 to the crankshaft using the M6x15 bolt #105-40 and the M6x16 flat washer #105-42. Apply blue Loctite to the threads of the bolt. Tighten securely. **NOTE:** An Allen wrench for the M6x15 bolt is provided in the engines tool bag.

D. Press the four urethane dampeners #0546-16 into the slots in the top of the flywheel. A pair of pliers and soapy water will make the job easier. Tap in completely using a small rubber hammer.

NOTE: Once fully seated if any of the Delrin isolators are sticking up above the top of the flywheel, trim off with a razor blade.

E. Study the drawing, starting at one end and working your way around install the rubber moulding #105-56 around the big hole in the fan shroud #105-52. Use Poly Zap or Flex Zap to secure in place.

F. Cut four 10mm x 10mm squares out of the left over fan shroud material. Use Poly or Flex Zap to glue these over the four holes that will be used for mounting the fan shroud. Use a small hand drill to redrill the holes in the fan shroud.

G. Mount the fan shroud #105-52 to the fan shroud adapter plate #105-46 using four M2.9 x 6.5 Phillips screws #0031.

H. Study the drawing and loosely mount the rear motor mount #105-58 to the top of the cylinder head using a M4x14 bolt #0078 and a M4x10 flat washer #105-54. **NOTE:** The hole in the motor mount is offset and must go towards the top.

V. BUILDING AND INSTALLING THE CLUTCH SYSTEM

Step 1. Assembling the Clutch to the Clutch Bell.

Parts Required:

	Clutch Shaft Bearing Block, Clutch Bell w/Pinion and Lower Bearing are (Pre-Assembled) from Section II. Step 5.	
1	#105-76 Clutch with Shaft & Delrin Ball	5B
1	#0273 Clutch Bell Spacer	5C
2	#0051 M3x3 Set Screws	5C
1	#0215 Wheel Collar	5C

Refer to Drawings # 5.

A. At the builders discretion the clutch shaft may be Loctite to the clutch shaft bearing block bearing. If you choose to do this, all parts to be Loctite, must be cleaned of any oils. This will stop all wear between the shafts and the inner race of the bearing. However this will make disassembly more difficult. **NOTE:** If you decide to do this do not Loctite the bottom clutch bell bearing to the clutch shaft because it only turns when the engine is idling.

B. Next slide the M6x8.5 clutch bell spacer washer #0273 down the clutch shaft. Slide the clutch shaft up through the clutch bell and fully seat the clutch. If you are Loctiting the shaft at this time use your finger to rub a small amount of Red Loctite around the shaft. Next work the clutch shaft in and out about 10mm to get Loctite between the shaft and the bearing. Now fully seat the clutch again and immediately slide the wheel collar #0215 down into position, apply some blue Loctite to the M3x3 set screw #0051 and tighten the wheel collar leaving between a half to one millimeter free play in the clutch bell. Once this distance is set and the wheel collar is tight, lay the assembly aside to dry for about twenty minutes. **NOTE:** Make sure that the wheel collar is against the top bearing while the Loctite is setting up.

Step 2. Installing the Clutch Bell Assembly.

Parts Required:

Two M3x30 bolts #0077, four M4 flat washers #0003 and two M3 locknuts #0019 previously used while tightening up the frames with the bearing block installed.

Refer to Drawings # 5.

A. Slide the clutch bell assembly into position from underneath the upper main frames. Secure the bearing block with two M3x30 bolts, four 3mm large washers #0003 and two 3mm locknuts #0019. **Do not fully tighten.**

B. When aligning the pinion gear to the main gear #0207, two things must line up. First the two gears should have a little play between them throughout the entire rotation of the maingear and the pinion gear must be at 90 degrees to the main gear. The later can best be achieved by using

a small bubble level that is easily obtainable at most hardware stores. Place the level on the outer ring of the maingear and level the mechanics, then place the bubble on the clutch bell. Once these two requirements are met, securely tighten the two M3x30 bolts.

Step 3. Installing the Engine, Lower Frame Rails and the Gyro Plate.

Parts Required:

2	#105-93 Coil Spacers	5D
2	#0077 M3x30 Socket Head Bolts	5D
1	Engine Coil Assembly (no number assigned)	5A
1	#105-88 Lower Frame Rail (Right)	5A
1	#105-86 Lower Frame Rail (Left)	5A
1	#0546-19 Alignment Tool	5A
2	#0087 M4x20 Socket Head Bolts	5D
2	#105-90 M4x14 Flat Washers	5D
9	#0063 M3x10 Socket Head Bolts	5D
4	#0009 3mm Small Washers	5D
7	#0019 3mm Locknuts	5D
1	#105-84 Gyro Mounting Plate	5A
5	#0003 3mm Large Washers	5D
2	#105-91 Special Engine Spacers	5D
1	#105-89 3mm Star Washer	5D
1	#0595-1 Left Rear Gyro Mounting Plate	5D

Refer to Drawings # 5.

A. Slide the engine up into the frames and engage the Delrin ball and the drive pins on the bottom of the clutch into the Delrin isolators in the top of the flywheel. **Do not fully seat.**

B. Take the alignment tool #0546-19 and slide it between the top of the flywheel and the bottom of the clutch. Notice that it has a notch in the cutout area near the handle portion. This is for clearance for one of the drive pins.

C. Once the tool is in position place your thumbs one on each side of the clutch bell. Put your remaining fingers underneath the fan shroud # 105-52 and pull up on the engine until the clutch is fully seated. Leave the alignment tool for now.

D. Place a M4x4 flat washer on one of the M4x20 bolts #0087. Run the bolt through the left hand lower frame rail #105-86, through the lower frame #105-12, into one special engine space #105-91 and thread the bolt into the motor. **Do not fully tighten.**

E. Run three of the M3x10 bolts #0063 through the lower frame rail holes. Two in the rear holes and one in the front holes. Use 3mm small washers #0009 on the rear bolts on the inside of the frames. Start three 3mm locknuts and run up but do not fully tighten. The front bolt is merely for alignment and will be removed later.

F. Repeat steps D. and E. for the right hand side of the mechanics.

G. The three lower frame rail bolts M3x10 #0063 need to be tightened while holding the frame rails flush with the lower edge of the lower main frames.

H. Holding the engine up against the clutch as previously done, have someone tighten the M4x14 bolts. Recheck to see that the bolts are secure.

I. Mount the rear motor mount to the lower main frame, use three M3x10 bolts #0063 and three 3mm large washers #0003, using Loctite. On the left hand side only use the upper hole in the motor mount. The lower hole will be used to mount the coil assembly. Tighten these three bolts and the M4x14 bolt #0078 holding the rear motor mount #105-58 to the motor. Mount the coil assembly and the left gyro mounting plate #0595-1 using the following: Two #0077 M3x30 socket head bolts, two #0003 M3 large washers, one coil assembly, two #105-93 coil spacers, one #105-89 3mm star washer, one #0595-1 gyro mounting plate and one #0019 M3 locknut. Use Loctite on the lower #0077 bolt in the motor mount. NOTE: The star washer #105-89 mounts in between the lower main frame #105-12 and the gyro mounting plate #0595-1. Connect the coil wires as needed.

J. The engine installation is now complete, the alignment tool #0546-19 can now be removed and the two M3x10 bolts #0063 in the front lower frame rails.

K. The rear gyro mounting brackets #0595 should be roughly level and in line with each other. The bolts holding them should be fairly snug. Next position the rear gyro mounting plate #105-84 between the frames and stick it squarely and securely to the mounting brackets. Using Goop #0502. **NOTE: <u>The plate should not be touching the lower main frames.</u>**

L. Loosen both bracket bolts slightly and use a 12 inch ruler to level the plate so that it is sitting perfectly square to the mainshaft.

VI. <u>BUILDING AND INSTALLING THE LANDING GEAR</u>

Parts Required:

2	#3923	Struts	6A
2	#3927	Skids	6A
4	#0075	M3x25 Socket Head Bolts	6B
4	#0003	3mm Large Washers	6B
4	#0019	3mm Locknuts	6B
2	#3927-1	Skid Caps (Front)	6B
2	#3927-2	Skid Caps (Rear)	6B
4	#3923-1	Landing Gear Spacers	6B

Refer to Drawings # 6.

A. The Tuf-Strut I landing gear struts are not pre-drilled for mounting to the mechanics because they are a universal gear set for various applications. Drill two 3mm or a 1/8" hole at 102mm spacing in each strut.

B. Mount the struts to the lower frame channels using four M3x25 bolts #0075, four landing gear spacers #3923-1, four M3 washers #0003 and four M3 locknuts #0019. **NOTE: <u>The struts should be curving forward towards the front of the model.</u>**

C. Use a heat gun to heat the struts where the skids slide through. Get them hot, it makes it alot easier. **NOTE:** Do one side at a time. The skids should stick out the back side of the rear strut, 70mm.

D. Cyano the end caps into the skids using slow cyano. It may be necessary to heat the end caps to ease installation.

VII. RADIO TRAY ASSEMBLY AND SERVO INSTALLATION

Step 1. Installation of Radio Tray Supports.

Parts Required:

1	#0347 Upper Tray Frame Support	7B
4	#0063 M3x10 Socket Head Bolts	7B
4	#0065 M3x12 Socket Head Bolts	7B
1	#105-94 Lower Radio Tray Support (Left)	7A
1	#105-96 Lower Radio Tray Support (Right)	7A
6	#0009 3mm Small Washers	7B
6	#0019 3mm Locknuts	7B
2	#105-98 Lower Canopy Stand Offs	7B

Refer to Drawings # 7.

A. Mount the upper tray frame support #0347 to the vertical front plate #105-10 using two M3x10 socket head cap screws #0063, two M3 washers #0009 and two locknuts M3 #0019. Only assemble loosely at this time.

B. Mount the lower radio tray supports #105-94 and #105-96 to the lower frame rails #105-88 and #105-86, using four M3x12 bolts #0065, four 3mm small washers #0009 and four 3mm locknuts. **Do not fully tighten.**

C. Mount the lower canopy stand-offs #105-98 to the lower radio tray supports with two M3x10 bolts #0063.

Step 2. Assemble Plastic Tray and Install Servo's

Parts Required:

6	#0029 M2.2x13 Phillips Tapping Screws	7C
15	#0027 M2.2x9.5 Phillips Tapping Screws	7C
8	#0001 Flat Washers 2mm (small)	7C
2	#0575-3 Servo Spacer Blocks w/Three Holes	7C
2	#0575-1 Servo Screw Doubler Blocks w/Two Holes	7C
4	#0035 M2.2x16 Phillips Tapping Screws	7C
1	#0575-4 Upper Servo Tray	7A
1	#0575-5 Lower Servo Tray	7A
1	#0575-6 Main Vertical Support and Throttle Mount	7A
2	#0351 Roll Servo Pivots (male)	7C
2	#0353 Roll Servo Pivots (female)	7C
1	#0575-7 Secondary Vertical Brace "H"	7A

1	#0575-8 Switch Plate	7A
1	#105-92 Throttle Servo Spacer (Long)	7C
2	#0357 Plastic Pivot Bushings	7C
1	#105-93 Throttle Servo Spacer (Short)	7C

Refer to Drawings # 7.

A. Examine the exploded view showing the placement of plastic parts and servos in the radio tray.

B. **Servo Installation:** The order of assembly of the various parts is not critical; however, experience has shown that it is more convenient to initially fit the servo prior to overall assembly. The reason for this is due to adjustable nature of servo openings. Obviously this tray must accept all popular servo sizes, so the following will outline each servo installation.

Mount Servo's as Follows:

1. **Roll (Aileron) Servo:** Note 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. Select the servo to be used for Roll control and install all four rubber grommets. Select a #0351 Roll Servo Pivot from the parts bag and, holding it in place under one end, 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. Press two #0357 plastic pivot bushings into the holes in the two #0353 Roll Servo Pivots. 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). **NOTE:** The servo should pivot freely. Slightly enlarge pivot bushing holes if needed.

Rotate each #0353 servo pivot into their respective position on the underside of the upper tray #0575-4. Hold the entire servo assembly and the upper tray together. Allow no side play in the servo and center the output spline with the true center of the tray(the rear hole of the screw to the vertical support #0575-6 is true center). Lightly cyano glue the pivot supports #0353. Re-check the servo alignment, good retention end-wise and freedom to pivot. Glue securely. From the top side of the upper tray drill two small holes through the slots provided into the servo pivots #0353. Secure using four #0027 (M2.2x9.5) self-tapping screws and four M2 washers #0001.

2. **Rudder Servo:** Select two plastic spacer blocks #0575-3. Using the original servo hardware, mount the blocks to the servo allowing at least 1.0mm of servo case clearance. Set the assembly into position in the tray. The output position of the servo is to the rear of the tray. Align the center hole on each block #0575-4 install a #0027 M2.2x9.5 Phillips Screw into each center hole. Center the servo within the opening and tighten all four servo screws previously installed. Apply a thin coat of cyano around each block #0575-3.

3. **Collective Servo:** Mount the collective servo with the splined output shaft towards the rear. Secure servo using the four servo screws provided in the radio system and two doubler blocks #0575-1.

4. **Throttle Servo:** Select two Delrin spacer blocks #105-92 and 105-93 (White), using the original servo hardware, mount the blocks to the servo allowing at least 1.0mm of servo case clearance. The taller block #105-92 goes towards the rear of the model. Set the assembly into position in the tray. The output position of the servo is toward the front of the tray. Mount the servo to the tray using four M2.2x13

Phillips screws #0029 and four 2mm washers #0001.

C. **Overall Assembly:** Refer to **View** for overall positioning of all plastic parts. It is best if a thin line of cyano is put on the mating surfaces prior to installation of the screws. Using two #0027 (M2.2x9.5) Phillips self-tapping screws, fasten the vertical tray #0575-6 to the underside of the upper tray #0575-4. Secure the secondary vertical brace #0575-7 ("H" shaped) to the front side of the vertical tray #0575-6 using one #0027 M2.2x9.5) screw. Mount the vertical brace with the screw eyelets pointing forward(towards the helicopter's nose). Position the main lower plate #0575-5 and secure using two #0029 (M2.2x13) Phillips tapping screws through the front two holes in the upper servo plate #0575-4. Use two #0027 (M2.2x9.5) in the center two holes on the bottom side.

Step 3. Mounting Servo Tray to Mechanics

Parts Required:

Special Tool:		One 3mm or 1/8" Inch Drill Bit	
14	#0003	3mm Large Washers	7D
6	#0065	M3x12 Socket Head Bolts	7D
6	#0019	3mm Locknuts	7D

Refer to Drawings # 7.

A. Mount the radio tray to the upper tray mount #0347 using two M3x12 bolts #0065, two 3mm washers #0003 and two 3mm locknuts #0019. Before tightening the bolts that hold the tray to the bracket or the bolts that hold the bracket to the front frame plate, make sure the tray is held up against the bracket tight and that the tray is level and not leaning left or right.

B. Using a 3mm or 1/8" drill bit and using the holes in the lower servo tray supports #105-94 and #105-96 as a guide drill through the servo tray and install the Mx12 bolts with the 3mm washers #0003 and 3mm locknuts. Once these four bolts are in, tighten these along with the four bolts that hold the tray braces to the lower frames.

Step 4. Installing the Elevator Servo and the Gyro Motor Assembly

Parts Required:

4	#0560-2	M2.5x16 Phillips Screws	7E
4	#0560-8	2.5mm Flat Washers	7E
4	#0560-4	2.5mm Lock Washers	7E
4	#0560-3	2.5mm Hex Nuts	7E
2	#4695	4 Inch Nylon Ties	7E
3	#0389	Wire Lead Retainers	7E

Refer to Drawings # 7.

A. The elevator servo goes into the graphite dampened plate with the output shaft towards the mainshaft. Secure the servo with four M2.5x16 Phillips bolts #0560-2, four 2.5mm flat washers #0560-8, four 2.5mm lock washers #0560-4 and four 2.5mm hex nuts #0560-3.

B. Use the wire lead retainers #0389 to hold the servo wire to the frames.

C. Mount the gyro motor to the gyro plate #105-84, using two strips of servo tape, one on each side of the gyro motor.

D. Use the two four inch nylon ties #4695 to secure the wire lead coming from the gyro motor to the lower mainframes.

VIII. GAS TANK INSTALLATION

Step 1. **Build the Gas Tank.**

Parts Required:

Special Tool: 3/16" Drill Bit

1	#0648	10 oz. Gas Tank w/Cap	8A
1	#105-100	Gas Line (19 inches)	In Tank
2	#0405	Vent Fitting	In Tank
1	#0401	Gas Clunk	In Tank
1	#0403	Gas Fitting	In Tank
3	#0011	Washers M5x10	In Tank
3	#0013	5mm Hex Nuts	In Tank
2	#0682	8 inch Tie Wraps	8A

Refer to Drawings # 8.

A. Study the drawings and drill the holes for the gas tank fittings #0405 and #0403. Carefully clean all debris from the tank.

B. Mount both the gas vent fitting #0405 and the carburetor return fitting #0405 using two M5x10 washers and two 5mm hex nuts #0013.

C. Cut a piece of gas line 70mm long. Put the gas clunk #0401 on one end the gas fitting #0403 on the other. Install the assembly into the tank using one M5x10 washer #0011 and one 5mm hex nut #0013. Before completely tightening rotate the tank and check how the clunk works. It must fall down and touch each side as that side is facing downward. Rotating the clunk line will change this, either helping or hurting the clunking effect. Tighten the fittings, securely. **NOTE:** The fuel Clunk must not touch the end of the tank when held on end, so as not to cause an obstruction in the fuel draw.

D. Before installing the gas cap, rotate both plastic ends of each side of the rubber plug until none of the holes in the rubber are visible to ensure proper seal. Install rubber cap plug in the gas tank and tighten the center screw securely. **NOTE:** The rubber plug is a special material for gasoline. **Do not use the plug for methanol fuels.**

Step 2. **Mounting the Gas Tank.**

A. Using two strips of servo tape on top of the fuel tank and position the tank under the servo tray and stick in place. Use the two 8 inch tie wraps #0682 to secure the tank. **NOTE:** Use of a gas filter is recommended.

B. Install approximately 7 inches of gas line from the carburetor primer bulb (on the rear side of the carburetor) to the carburetor return fitting. Use 5 inches of gas line for the carburetor intake and the remaining gas line may be used as an over-flow line.

IX. ASSEMBLE THE TAILROTOR TRANSMISSION

Step 1. **Assemble Tailrotor Hub and Blade Holders.**

Parts Required:

2	#0463	Tail Rotor Blades	9A
4	#0019	Hex Locknuts 3mm	9A
2	#0073	M3x20 Socket Head Bolts	9A
2	#0103	M2x5 Threaded Steel Balls (Long Thread)	9A
2	#0299	M4x10 Ball Bearings	9A
2	#0453	Tail Rotor Blade Mounts	9A
2	#0457	T/R Thrust Bearings	9A
4	#0446-3	Special Shims .001	9A
4	#0446-4	Special Shims .003	9A
1	#0446-1	One-Piece Machined 4mm Stud Steel Tail Rotor Hub	9A

Refer to Drawing #9.

NOTE: Remember to clean all steel components before applying Loctite.

A. Take the two tailrotor blade mounts #0453 and thread the M2x5 threaded balls #0103 into the outboard holes, using slow cyano.

B. Press the M4x10 ball bearing #0299 into the blade mounts, on the root end, seating them squarely and fully.

C. Lay out the two thrust bearing assembles #0457. Use two spare 4mm bolts for greasing and assembling the thrust bearings. Each bearing has one race that has a smaller I.D. Place the small I.D. halves on the two bolts with the ball grove facing up. Apply grease all the way around the groove. Next place the ball retainers with the cup sides up onto the balls. Apply grease to the top sides of the bearing race that has a larger I.D.. Place the other halves of the bearings on the bolts completing the assemblies, wipe off any excess grease.

D. Slide the blade holders onto the one piece machined steel T/R hub #0446-1 followed by the thrust bearings. **NOTE:** The large I.D. half of the thrust bearings has to go on the steel hub first, leaving the small I.D. half next to the shims #0446-3 or #0446-4 and the locknut #0019.

E. Thread the #0019 M3 locknuts up onto the steel hub and lightly tighten. Check for end play in the blade holders. **NOTE:** If there is end play in the blade holders it will have **NO** adverse effect on the operation of the tailrotor due to centrifugal force loading the thrust bearing as it was designed to do. However two different sizes of shims are provided if you would like to remove some of the end play. **NOTE:** A small amount of end play must exist so as not to put the bearing in a bind. If shims are used, place an equal amount on each side because it is important to keep the distance equal between the center of the hub and each blade pivot hole.

F. Insert into each blade holder #0453 one tail rotor blade #0463 followed by one M3x20 socket head bolt #0073. The tail rotor pivot bolts #0073 should be facing inward. Secure using one #0019 3mm locknut. Tighten only enough that the tail blade can rotate with slight pressure. **NOTE:** If the tail blade and mount are held horizontally the tail blade will not fall.

NOTE: Re-check drawing for correct tail blade directional orientation for a clockwise rotation.

Repeat entire procedure for the other tail blade.

G. To balance the entire tail rotor assembly the #0429 tail rotor output shaft found in section 9C may be used as a balance bar. Lightly grease the output shaft and slide the #0449 rubber dampener found in section 9D half way over the shaft. Clean the exposed shaft of grease. Slide the assembled tail rotor hub onto the rubber dampener.
NOTE: To accurately balance the tail rotor, the tailrotor blades must extend straight out from the hub and parallel to each other.
Set this entire unit in between two "glass" glasses on a flat surface. If there is an imbalance the heavy blade will hang lower. Add weight in the form of a narrow strip of colored tape or preferable use a small 3mm washer on the blade pivot bolt of the lighter blade, to balance. (If the washer is used trim the washer with a pair of cutters to achieve the proper weight needed.) The tail should remain in any position if balance is correct. Proper blade balance is essential. Remove the output shaft #0429 and rubber dampener #0449.

Step 2. **Assemble Pitch Slider.**

Parts Required:

2	#0041	M2x8 Slotted Cheese Head Machine Screws	9B
1	#0101	M2x5 Thread Steel Ball(Short Thread)	9B
2	#0133	Long Ball Links -- Long	9B
1	#0435	Brass Tail Rotor Control Slider	9B
1	#0437	Plastic Control Slider Ring	9B
2	#0439	M6x10 Ball Bearings	9B
1	#0441	Plastic Pitch Plate - Tail Rotor	9B
1	#0443	Snap on Retainer Pitch Plate	9B

Refer to Drawing #9.

A. Begin by threading the M2x5 short threaded ball #0101 into the side hole of the control ring #0437. Use cyano and thread the ball squarely in place.

B. Place the two #0439 ball bearings (M6x10) on a clean paper with the balls visible. Lightly grease each.

C. Slide one bearing on the #0435 brass control slider. Lightly slide the control ring over the slider, followed by the other bearing, 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.

D. 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 to tight nor to loose. The control ring bearings are precise and delicate but necessary for a tight play free tail rotor control.

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 vertical 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 end play. Apply slow cyano to retainer clip where it touches the pitch control plate.

E. Screw #0133 ball links to the pitch plate using M2x8 machine screws #0041. Just seat the screws, so that the links can rotate with firm pressure.

Step 3. **Assemble the Gearbox and Bell Crank.**

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 application of heat to break down the glue.

Parts Required:

1	#0800-7 T/R Input Shaft	Bag 9C
4	#0025 Phillips Pan Head Self Tapping Screws M2.2x6.5	9C
4	#0051 M3x3 Socket Set Screws	9C
1	#0421-A T/R Gear Box Housing	9C
1	#0421-B T/R Gear Box Housing	9C
4	#0425 M5x13 Tail Gear Box Ball Bearings	9C
1	#0429 T/R Output Shaft	9C
1	#0431 E-Clip - Output Shaft	9C
1	#0433 Plastic Gear Spacer - Output Shaft	9C
2	#0427 Bevel Gears	9C
1	#0095 Special Bolt Tail Rotor Bellcrank	9C
2	#0159 M3x7 Ball Bearings	9C
1	#0445 T/R Bellcrank	9C
4	#0426 .005" (.12mm) shims	9C

Refer to Drawing #9.

SPECIAL NOTE FOR INSTALLING #0427 OR #0547 TAIL ROTOR GEARS IN ALL X-CELL OR XL-PRO HELICOPTERS.

Four #0426 .005" (.12mm) shims are provided for adjusting the gear mesh. In most cases none will be required, however in some cases 1 or 2 per gear may be necessary to achieve optimal gear mesh.

The set-up procedure is as follows:

1.) Trial fit all components (without shims) and assemble gear box with a couple of the #0025 screws. To be accurate, it is necessary to insert the transmission into the tailboom each time you wish to check gear mesh. This is because the boom will slightly compress the transmission case.

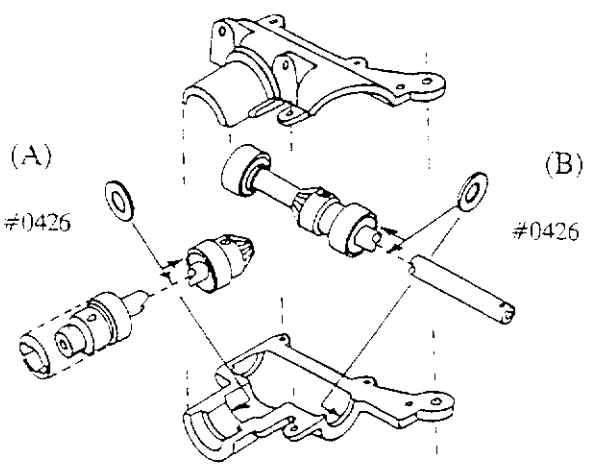
Each shaft assembly should be individually test fitted with each transmission case in place to check for end-play and excessive bearing loads. The former is caused by the gear being set too far from the bearing

or spacer and the later is from too much spacing causing the assembly to "snap" into place in the transmission.

2.) If it is determined that shims are required, trial fit one-at-a-time (never exceeding two in any one location) to optimize gear backlash. The above procedures must be adhered to each time a shim is tested (to avoid end play or bearing pre-load).

By examining the drawing you will see that only two positions are acceptable for shimming. Position (A) is behind the bearing nearest the gear on the input shaft and next to the stepped area of the transmission. Position (B) is outside the bearing on the output shaft but inside the flange of the transmission case.

The most desired gear mesh will be that of minimum backlash, even the point of having slight interference during rotation. This condition will " Break-in" during the first few flights. As with any similar system, we always recommend a through check over after the first 20 - 30 flights to ensure good mesh and change to new grease (to remove any break-in debris).



A. At this time clean the input shaft #0800-7 and the output shaft #0429, the inner race on the four ball bearings #0425 and the two bevel gears.

B. At builders discretion apply a small amount of blue Loctite to input shaft #0800-7 next to the delrin coupler. Slide one of the bearings #0425 all the way up against the delrin. Lay the lower half of the T/R gear box #0421-A on the table and hold the input shaft over the T/R gear box half and apply a small amount of Loctite where the second bearing goes and slide the bearing into position. Apply blue Loctite to the two M3x3 set screws #0051 and start each in to the bevel gear #0427. Place the gear on the shaft and run one of the set screws down and make sure that it is on the flat. Push this assembly down into the lower T/R gearbox half and adjust the gear so that no end play exist but without binding the two bearings. Tighten the two set screws thoroughly and set aside this assembly to cure for a few minutes.

C. Snap the E-clip #0431 into the groove on the T/R output shaft #0429. Apply a small amount of Loctite to the small portion of the shaft beside the E-clip. Slide one of the two remaining bearings #0425 onto the shaft and up against the E-clip.

D. Apply blue Loctite to the two remaining M3x3 set screws and start them onto the bevel gear #0427. Slide this gear onto the shaft teeth first and run one of the set screws down into the flat spot on the shaft. Slide the plastic spacer #0433 on next followed by the remaining ball bearing #0425. Apply Loctite where the bearing will sit. Lay the other T/R gear box half #0421-B on the table and place the output shaft into its perspective position. Once again adjust the gear and tighten so that there is no end play and no binding in the bearings. **Caution:** This is a small gear, do not over tighten.

E. After curing apply a liberal amount of grease to both gears. With the two shafts in there respective positions bring the two T/R gearbox halves together and install the four M2.2x6.5 phillips screws #0025. **NOTE:** Be sure to install the screws from the correct side. Check for binding, if any - sand plastic spacer between output gear and bearing and reposition gear.

F. Slide the T/R pitch slider onto the shaft. (Pre-Assembled in step 2)

G. Press two #0159 ball bearings into the holes in the tail rotor bellcrank #0445, using the special bellcrank bolt #0095 to keep the bearings aligned and in place.

H. Engage the control ring ball in the clip end of the bellcrank assembly #0445 and squarely thread the special bolt #0095 into the gear housing #0421 from the bottom. Tighten the bolt until there is no play or bearing drag.

Step 4. **Install Assembled Tail Rotor Hub.**

Parts Required:

3	#0447-1 Locking Clips (Circlips)	Bag 9D
1	#0447-2 Groove Pivot Pin	9D
1	#0449 Rubber Dampener	9D
2	#0001 Flat Washers 2mm (small)	9D
1	#0053 M3x5 Socket Set Screw	9D

(one #0447-1 has been supplied as a spare)

Refer to Drawing #9.

A. Press the silicone dampening #0449 sleeve onto the output shaft about 10mm in length. Use a 1.5 Allen wrench or a small drill to pierce through the silicone dampener and through the cross hole in the output shaft. Insert the M3x5 socket set screw into the end of the output shaft #0429 and temporarily tighten the M3x5 set screw #0053 against the Allen wrench or drill bit to ensure that no burrs exist in the shaft. Loosen the set screw and remove the allen wrench or drill bit. Check with the drawing to ensure the proper orientation of the delta tail hub before pushing it over the silicone sleeve. Hold the hub with the pin hole lined up with the hole in the output shaft then push the hub into position, a small amount of grease maybe necessary to get the hub to slide over. You may want to slide a smaller object than the pivot pin through the hub and shaft initially to get the hub centered easily.

B. Center the pivot pin #0447-2 in the T/R hub than apply blue Loctite to the M3x5 set screw #0053, in the end of the output shaft and tighten. **NOTE:** Do not over tighten, breakage of the pin could result.

C. Place a M2 washer #0001 on the pivot pin then snap the clip #0447-1 into the groove. Repeat this process for the other end of the pin.

D. Snap the two ball links #0133 onto the balls #0103 on each tail rotor blade mount.

X. BUILDING THE TAIL BOOM

Step 1. **Installing Tube Drive.**

Parts Required:

1	#0556-1	Aluminum Tailboom(31.5" long)	Bag10A
1	#0809-1	Tube Drive Shaft	10A
4	#0057	M4x4 Set Screws	10B
2	#0800-2	Delrin Shaft/Bearing Adapters	10B
2	#0800-3	Torque Tube Ball Bearings	10B
2	#0800-4	Delrin Bearing Supports	10B
4	#0800-5	X-Cell O-Rings	10B
2	#0800-11	Male Universals	10B

Refer to Drawing # 10.

A. Snap (one) inner bearing adapter #0800-2 inside the ball bearing #0800-3. Support the bearing below the inner race and press the delrin adapter in place until it snaps. Place the assembly over an upright outer delrin bearing support #0800-4 (cupped end) with the adapter flange upward. Press until it also snaps in place. Repeat with the other parts. Slide (one) O-ring #0800-5 into the first outside groove of either end of the completed bearing assembly. Pass a second O-ring in the same manner into the second groove. Repeat this process on the remaining bearing assembly. Using a wooden dowel or similar device which will slide inside the tailboom. Press each boom bearing assemblies into the tail boom 10.5" from each end. (**NOTE:** A small amount of dish washing soap and water inside the boom and on the rubber O-Rings will make the assembly slide easier.)

B. Note the design of the steel insert in the graphite shaft #0809-1. The alignment of the male universal #0800-11 is dictated primarily by its fit over the exposed portion of the steel insert. When slid in place, it will automatically stop at the end of the graphite tube. As a secondary point of alignment, the large I.D. bore of the male universal will snugly fit over the O.D. of the graphite shaft. This provides additional support for the ends of the graphite tube which are the most vulnerable to damage. There may be a little fitting necessary to install the male universal. Ideally, the fit should be a light press fit(never force it in any way). If the male part will not fit in this manner, simply lightly sand the last 15.0mm of the graphite tube with a little sandpaper such as 400-600 grit, using a rotating motion between fingers. When the male universal is properly positioned, you will see the center point of each milled flat directly in the center of the set screw holes. Apply Loctite and securely tighten the M4x4 set screws #0057.
NOTE: It is not recommended to apply adhesive to any part of the male universal installation since future service will be impossible.
After one male universal is in place, insert the graphite tube into the tail boom through each

bearing assembly, sliding in far enough to allow installation of the remaining universal joint. Install the other universal #0800-11 in the same way.

Step 2. **Installing Tail Rotor Push Rod Guides, Fin Mounts and Push Rod.**

Parts Required:

1	#0375	T/R Push Rod (700mm)	10A
1	#0556-3	T/R Pushrod Extension	10A
1	#0481	Horizontal Fin	10A
1	#0486	Vertical Fin	10A
5	#0477	T/R Control Rod Guides	10C
1	#0385	T/R Control Rod Coupler	10C
1	#0479	Horizontal Fin Mount	10C
5	#0015	Hex Nuts 2mm	10C
5	#0043	M2x10 Slotted Machine Screws	10C
2	#0025	M2.2x6.5 Phillips Screws	10C
2	#0079	M3x35 Socket Head Bolts	10C
2	#0075	M3X25 Socket Head Bolts	10C
4	#0019	3mm Locknuts	10C
2	#0487	Vertical Fin Clamps	10C
1	#0003	3mm Large Washer	10C
3	#0061	M3x8 Socket Head Bolts	10C
1		Previously Assembled Tail Rotor Gearbox	
1	#0035	M2.2x16 Phillips Screw	10C
1	#0387	Tail Rotor Control Rod Guide	10C
2	#0137	Plastic Clevis	10C

Refer to Drawing # 10.

NOTE: The notched end of the tail boom is the rear (Tail Transmission) side.

A. Slide the #0479 horizontal fin clamp onto the tailboom 9-3/8" from the rear. Loosely mount the four tailrotor control rod guides #0477 by wrapping them around the boom and securing each with an M2x10 machine screw #0043 and a M2 hex nut #0015. Mount one between the horizontal fin clamp #0479 and the "rear" end of the tailboom and mount the other three in front of the horizontal fin clamp.(The screws are long enough to allow the control rod to be snapped in from the sides when needed). Measuring from the notched end of the tailboom, the first control rod guide should be 100mm from the end. The next guide should be 130 millimeters from the first one. The next 3 guides should be 145 millimeters apart.

B. Insert an M3x35 socket head screw #0079 through the top front hole in the vertical fin #0486 and through a vertical fin clamp #0487 and loosely thread on an M3 locknut. Insert an M3x25 screw #0075 through the bottom front hole in the fin and the lower hole in the clamp and add a locknut. Assemble the rear clamp to the remaining holes in the fin in identical fashion, with the exception that one #0003 3mm washer will be inserted in between the slot in the fin clamp #0487. **NOTE:** The #0079 bolt (3x35mm) must go through the M3 washer. **NOTE:** This washer applies to the rear clamp ONLY.

C. Slide the assembled tailrotor gear box into the boom as far as it will go, slide the clamp up against the tailbox and align the three holes. Screw the tailbox to the clamp using the three

M3x8 bolt #0061. Ensure that the tailbox is fully seated in the boom then tighten the vertical fin clamp bolts.

D. Install the two M2.2x6.5 Phillips screws #0025 in the two holes in the top of the horizontal fin #0481 and into the fin mount #0479. A small amount of Goop or silicone glue under the horizontal fin #0481 will help extend the life of the fin.

E. Examine the central rod coupler #0385, noting that it will accept the control rods beyond their threaded portion. The intent is to better support the rods against bending. Use the coupler to join the tail rotor control rod #0375, and the tail rotor control rod extension #0556-3. (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. Start a clevis #0137 on each end of the push rod. Exact adjustment will be made later.

F. Slide the tailboom into the mechanics holding the tailbox with your right hand and holding the mainshaft with your left. Spin the main shaft back and forth until the tail drive engages, then push the boom in as far as it will go. Mark the boom next to the tailboom support halves #0185 with a piece of tape or put a small scratch on it with an X-acto knife. Slide the boom back about 1.0mm. Standing behind the model, sight the tailbox to the mainshaft. Make sure that the T/R shaft is perpendicular to main shaft. Tighten the four M3x30 bolts #0077 in the tailboom support halves, then recheck alignment. **Option:** Due to the size of some workshops and the aggravation of spinning a model around on the table wondering what you are going to knock over next with the tailboom, you may want to wait until you've finished setting up the main mechanics before installing the tailboom.

G. Bend the tail end of the tail rotor control rod approximately 168 degrees in order to align with the tail rotor bellcrank #0445.

H. Install the tailrotor pushrod and hook up the rear clevis #0137 to the center hole in the bellcrank on the tail box using a small piece of fuel line stretched over the clevis as a safety.

I. Install the front tailrotor pushrod guide #0387 on the upper mainframe using one M2.2x16 Phillips screw #0035.

J. Align all the pushrod guides so that there is no binding throughout the travel of the pushrod.

Step 3. **Installing Twin Boom Supports.**

Parts Required:

2	#0585-6	Graphite Boom Supports	10A
8	#0009	3mm Small Washers	10D
1	#0073	M3x20 Socket Head Bolt	10D
2	#0065	M3x12 Socket Head Bolts	10D
3	#0019	3mm Locknuts	10D
4	#0585-7	Threaded Inserts	10D
4	#0585-8	Female Mounts	10D

Refer to Drawing # 10.

A. Assemble each graphite boom support #0585-6 using four #0585-7 threaded male inserts and four #0585-8 female mounts as follows: Using 80 grit sand paper (or similar) roughen the smooth raised areas next to the threads on each #0585-7 threaded male insert. Clean both the #0585-7 and #0585-8 parts with alcohol or thinner.

Gluing the ends in place is a simple matter and can be done in a number of ways.

METHOD (A) - Apply J.B. Weld epoxy liberally to the threaded male insert #0585-7 (avoiding the threads) and the inside of each tube end. Push each insert in place until only the threads are exposed. Allow to dry overnight. The following day, apply RED Loctite, slow CA, or epoxy to the threads and screw each female mount #0585-8 in place. Note that each mount has a 2-1/4 degree angle milled into it to allow for the width variation from frames to tail clamp as shown in the drawing. Promptly proceed with steps "A" and "B". Obviously, the choice of adhesives will dictate the speed of which you must proceed in this step. Allow assembly to cure fully before operation.

METHOD (B) - If you are in a rush, this is the quickest method. Screw each threaded male insert #0585-7 into a female mount #0585-8. Apply Slo C.A. to the insert and the I.D. of the female mount. Spray a little C.A. Kicker onto the graphite tube (on one end only) and insert it fully into the mount assembly. The other end must be assembled, aligned and installed without Kicker so sufficient time is available. (After installation Kicker can be used if desired). Again, be sure to study the drawing so that parts are not improperly aligned and not useable.

B. Mount each graphite boom support #0585-6 to the inside of the lower frames using two M3x12 bolts #0065, six 3mm small washers #0009 and two 3mm locknuts #0019.

C. Place a 3mm small washer #0009 on the M3x18 bolt #0073. Run the bolt through the left boom support then place a washer on the bolt. Next slide the horizontal fin clamp #0479 on the boom to line it up with the bolt. Use a M2.5 driver or Allen wrench to thread the bolt through the fin mount. Place another washer on the bolt, slide the right boom support onto the and secure with a 3mm locknut. **NOTE:** Before fully tightening make sure that the horizontal fin is square to the main shaft.

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.**

A. Provisions have been made in plastic tray switch plate #0575-8 for the receiver switch and the gain box for the gyro. If you elect to use these positions. Mount the two devices at this time.

B. Plug all your servo leads into the receiver. Do not allow any wires to rub the corners of the graphite frames or any moving part. Route all wires as neatly as possible using small tie wraps to hold in place.

C. Mount the gyro amplifier on the bottom side of the plastic servo tray. Use double sided servo tape to secure in place.

D. Wrap the receiver and battery in foam and mount on the front of the plastic servo tray. Secure with either velcro or tie wraps loosely pulled.

E. If a whip antenna will be used, tests have proven that the best place to mount the antenna base is on the radio plastic tray #0575 sticking straight forward.

F. If you are electing to use a full length antenna, route it out of the canopy then down to the landing gear strut next to the skid and then back up to the tailboom. Again ensure that the wire doesn't rub any corners and is free from moving parts.

SPECIAL NOTE: If using a computer radio, clear all ATV's to 100%. Clear normal throttle and normal pitch curves so that they are linear and throwing to there limits. Clear sub trims, trim memory, stunt trims, or anything that would change servo centering. Check direction of the servos.

In the following steps, be sure to use Loctite on all steel threaded balls #0103, nuts and screws. All measurements given for pushrods are from the inside of the ball links at the connection point with the push-rods. Unless otherwise specified.

Step 2. **Setting up the Tail Rotor Servo.**

A. Activate the electronic tail rotor compensation for "Right" (clockwise) rotor rotation. Check direction of the tail rotor servo by giving a right tail rotor command. The servo arm should move towards the front of the servo tray. With the gyro running move the nose of the helicopter to the left, the servo arm should move towards the front of the tray again.

B. Position the collective stick at half stick. The servo arm should be square to the servo tray.

C. Snap the clevis into one of the holes on the servo arm at least 11mm out on the servo arm.

Step 3. **Install the Elevator Servo Pushrod.**

Parts Required:

1	#0367	Control Rod	11A
1	#0133	Long Plastic Ball Link	11A
1	#0137	Plastic Clevis	11A

Refer to Drawing # 11.

A. Start the clevis #0137 on one end of the M2x60 control rod and the long ball link #0133 on the other end. Adjust to a length of 41mm between the links.

B. Install this pushrod on the #0105 ball of the elevator bellcrank #0157 in the swing arm.

C. With the radio on position a wheel on the elevator servo and drill a hole 12.5mm out on the wheel and straight up from the servo arm retainer screw.

D. Study the drawing of the servo wheel. It must be trimmed so that the clevis has clearance to move to both extremes without hitting the servo wheel.

E. As with the rudder control rod install a piece of fuel line on the clevis as a safety.

Step 4. **Install the Aileron and Collective Pushrods.**

Parts Required:

2	#0371	Threaded Pushrods M2x90	11B
6	#0133	Long Plastic Ball Links	11B
1	#0359	Roll Servo Link Retainer Bar	11B
3	#0361	M2 Steel Balls	11B
6	#0015	2mm Hex Nuts	11B
1	#0101	Threaded Steel Ball M2x5	11B
2	#0045	M2x14 Threaded Machine Screws	11B
1	#0042	M2x10 Threaded Machine Screw	11B
1	#0001	2mm Flat Washer	11B
1	#0369	M2x35 Threaded Pushrod	11B

Refer to Drawings #11.

A. Study the drawing showing the special control arm assembly on the aileron 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.

B. Select the M2x35 control rod #0369, start two plastic ball links #0133 one on each end and adjust so that there is 22mm of rod between the links.

C. Select the two thread pushrods M2x90 (curved) #0371 and thread one #0133 ball link(long) onto each end of both control rods. Thread the links on the curved ends of the rods until the base of the ball link #0133 is 11mm from the center of the bend in the rod #0371. Thread the remaining ball link on until a distance of 69mm is achieved between the base of the links.

D. Snap one M2 steel ball #0361 (drilled version) in the ball links on the bent ends of the two aileron rods #0371.

E. Insert one M2x5 threaded ball #0101 in the center hole of the roll servo link retainer bar #0359 from the bottom and secure it with one hex nut M2 #0015. Use Loctite.

F. Select a double ended servo arm from the radio system hardware, long enough to match the 24mm hole separation on the retainer bar. If necessary, obtain an un-drilled arm or wheel and drill and shape it to suit. Center the servo electronically and mount it exactly parallel with the servo lengthwise.

G. Insert an M2x14 screw in each end hole of the retainer bar, slide an aileron roll bar on each and secure with an M2 hex nut. Snap the collective rod ball link on the center ball and mount the assembly of the three rod 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). Snap the ball links onto the #0105 threaded balls on the roll bell cranks #0167.

H. With the radio on center the collective stick. Position wheel on the collective servo. Drill a hole 11mm out and square to the servo. Install the M2 steel ball #0361 on top of the servo arm using a M2x10 threaded machine screw #0042, a 2mm flat washer #0001 and a 2mm hex nut #0051. Use Loctite. Snap the remaining ball link on the collective rod onto this 2mm ball.

I. With the collective stick in the center, the roll servo should be exactly vertical and both aileron bellcranks are square to the frames.

Step 5. **Install the Throttle Pushrod.**

Parts Required:

1	#0679	M2x170 Control Rod	11C
2	#0133	Long Plastic Ball Links	11C
1	#0015	2mm Hex Nut	11C
1	#0042	M2x10 Slotted Machine Screw	11C
1	#0001	2mm Flat Washer	11C
1	#0361	2mm Steel Ball	11C

Refer to Drawings #11.

A. With the throttle stick in the center position, and a servo wheel on the throttle servo. Drill a hole 14mm out and straight down. Mount the 2mm steel ball #0361 to the outside of the wheel using one M2x10 machine screw #0042, a 2mm washer #0001 and a 2mm hex nut #0015. Use Loctite.

B. Start a plastic ball link #0133 on each end of the M2x170 control rod and adjust to a length of 148mm between the ball links. Snap the control rod onto the carburetor arm and the servo arm. Adjust the throttle ATV's for no binding at low or high throttle.

C. Adjust the hover throttle so that the carburetor is 13mm from full open at a hover. This will give a good starting point and about 1450 rpm (Head Speed) in a hover.

Step 6. **Install Rotor head, Flybar and Hiller Control Rods.**

Parts Required:

8	#0133	Ball Links (long)	11D
4	#0135	Ball Links (short)	11D
2	#0313	Threaded Rods M2x10	11D
2	#0335	Threaded Rods M2x75	11D
2	#0337	Threaded Rods M2x27	11D

Refer to Drawing #11.

A. Remove the special head bolt #0091 from the head, slide the head down onto the mainshaft and align the hole on the top side of the main shaft with the hole in the head block. This can be accomplished by holding the rotor head in one hand and spinning the maingear clockwise with the other. Install the special bolt and tighten.

B. At this point check to see how free the washout block slides up and down the guide pins #0297 in the bottom of the head block. If it is stiff, disengage the wash out block and rotate it 180 degrees and try again. Determine which way is best and use pliers to tweak the pins a small amount as needed to one side or the other until the washout block slides up and down the pins with a minimum of drag.

C. Start a long ball link on each of the two flybar control rods #0337 and adjust to 9mm. Snap both control rods to the flybar control arms and washout arms.

D. Start a long #0133 on each end of the Hiller control rods #0335 and adjust to a length of 59mm. These rods go from the bell mixers on the blade holders to the swashplate. Snap both into position.

E. Start a short ball link #0135 on each end of rod #0313 and adjust to a length of 1mm between the ball links. These rods go from the bell mixer to the delta plate on the rotor head.

XII. CANOPY PREPARATION

Step 1. **Mounting Clear Lexan Window.**

Part Required:

1	#106-96	Lexan Window	Box
1	#0504-1	Epoxy Glass Canopy	Box
12	#0024	M2.2x4 Phillips Pan Head Self-Tapping	Bag 12A

Refer to Drawing #12.

NOTE: Because of current trends to apply wild paint job to canopy and fins, the window area was left in the canopy to allow people to express their creative side. However, a clear Lexan window is supplied for those who wish to be able to see in.

A. If you wish to use the Lexan window you must cut the opening in the canopy. Cut just inside the scribe line with a cutting wheel and clean up with a sanding drum, small file or sand paper.

B. Examine the Lexan window and note that there are two scribe lines around it's perimeter. The outer most line is your guide for cutting. Cut about 2mm - outside this line using sharp scissors or a dremel tool and cutting disc (USE EYE PROTECTION).

C. If you wish to screw the window in place, twelve self tapping screws #0025 (M2x6.5) are provided. The location of each screw will be as follows: one mounted on either side of the nose about one inch from the center, one mounted on either side of the top about one inch from the center one centered at the nose, one positioned at each of the three rounded corners, the remaining four screws (one for each side) should be mounted in between the nose and the back two lower mounted screws and between the top two screws an each side. Dividing these areas in half. After determining location of each of the 2.2x4 Phillips self tapping screws #0024, drill a hole at each location using a #56 or .046 bit. Holes should be 3mm from edge of canopy opening. Extra screws are provided if needed.

NOTE: Alternately, Miniature Aircraft USA canopy glue #0502 or epoxy can be substituted for screws. Use coarse sand paper (80 grit) to roughen the surfaces to be glued.

Position window in canopy and starting at the nose, drill the front two holes using the same bit. Start screw and tighten snug. Next, drill the top two holes. Work your way along each side installing screws as you go.

NOTE: Once the canopy is painted and window is permanently installed, apply a drop of Polyzap to the screws on the inside of the canopy.

NOTE: Lexan window may be dyed or tinted using Rit dye with warm water and a little white vinegar.

Step 2. **Mounting Canopy.**

Parts Required:

2	#0003	3mm Large Washers	Bag 12A
2	#0063	M3x10 Cap Head Bolts	Bag 12A
3	#106-97	Rubber Grommets	Bag 12A

Refer to Drawing #12.

A. Drill a 1/8" guide or starter hole in the marked location for the canopy mounts and grommets. Use a grinding stone or a tapered reamer to enlarge the holes to 7.5 - 8mm. It may be necessary to use a small screwdriver to help work the grommets into the canopy. Apply medium cyano to each grommet **inside** the canopy.

B. To install the canopy on the model, slide the canopy into position apply thumb pressure to the grommet on top of the canopy on the standoff, push grommet down until it seats. Hold the canopy on both sides and pull it over the lower standoffs and push grommets all the way on. Place a 3mm large washer on both M3x10 cap head bolts and screw into standoffs.

Step 3. **Installation of Thumb Screw Plastic Caps.**

Parts Required:

2	#106-95	Thumb Screw Plastic Caps	Bag 12A

Refer to Drawing # 12.

NOTE: **Installation of Thumb Screw Plastic Cap for Canopy Retainer Screws:** Suggestion - Use #105-98 stand-off and a block of wood. Thread the M3x10 bolt fully into the #105-98 stand-off and place the plastic cap upside down on a flat surface. Use a block of wood and hammer (or bench vise) to press the bolt head into the plastic cap. **NOTE:** It is a hard press, no glue is needed.

XIII. BUILDING THE ROTOR BLADES

Step 1. **Assembling Blade Mounts.**

Parts Required:

2	3674-1	Pro-Wood Rotor Blades	Wrapped in Box
4	0019	M3 Locknuts	13A
4	0093	M3x15 Phillips Bolts or Socket Head Bolts	13A
2 pair	3674-5	Pro .60 Blade Reinforcements(Top and Bottom)	13A
4	3674-6	Carbon Fiber Inserts	13A
2	3723	Brass Blade Pivots	13A

Refer to Drawing # 13.

A. First identify the top and bottom plastic blade reinforcements #3674-5 marked with a "T" and "B". Thoroughly rough up the surface to be glued using either 36 - 40 grit sand paper or a sharp object.

B. Match the holes in the carbon fiber plates #3674-6 with the blade reinforcements #3674-5. Thoroughly rough up the mating surfaces on each.

C. Press into the larger of the three holes in each blade root-one #3723 brass blade pivot. Center the brass pivot in the holes.

D. Press each top and bottom plastic reinforcement onto the brass pivots on each blade. Line up the two bolt holes in each reinforcement with the two small holes in each blade. Press one #0093 Phillips head bolt threw any of the two holes in each blade. With a pencil or pin trace around the outer perimeters of each plastic reinforcement #3674-5 (Both top and bottom). Remove the bolts #0093 and plastic reinforcements #3674-5.

WARNING: Blade reinforcements must be glued using SLOW CYANO ONLY. **No other glue will work satisfactorily.** Read Section "E" entirely before proceeding.

E. Match each blade reinforcement #3674-5 with it corresponding carbon fiber insert #3674-6. (Refer to section "B"). Insert into the two small holes on each carbon fiber insert two #0093 Phillips head bolts. (**NOTE:** The surface which was not sanded will be on the bolt head side). On the top side of the rotor blade liberally apply slow cyano glue to the inside of the traced area for the blade mount. Press the top plastic reinforcement onto the glued area while lining-up the two bolt holes. Wipe away any excess glue. Immediately apply slow cyano to the insert area for the graphite plate. Press the matching graphite plate into position. Again wiping away any excess glue. Completely thread both of the Phillips head screws into the blade. On the bottom side of the blade repeat the above process using the bottom plastic blade reinforcement with matching carbon fiber insert. Secure by using two #0019 M3 locknuts and by clamping the blade pivot area with vise grips, table vise or a suitable clamping device. Allow to thoroughly dry. Repeat step "E" on matching blade.

Step 2. **Adding Lead Strips.**

Parts Required:

2	3674-8	3/16" x 362mm Round Lead	13B
3	3712	Balsa Blade Caps	13B

Refer to Drawing # 13.

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. Cut the lead strips #3674-8 into six lengths, the same length as the long slots along the leading edge of the blades. Cut two shorter pieces of lead for the two shorter slots. Be sure that all like lead strips remain equal in length.

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.

C. Place all the lead strips in their respective slots and weigh the blades on a gram scale or our new blade balancing system #0514. The total weight should be the same. If not, trim the lead in one of the slots until equal weight is achieved.

NOTE: If a gram scale is not available the following guide may be used:

Net blade weight (weight is written or root of blade)	+____ grams
Approximate weight of lead and wood strips installed	+_44__ grams
Approx. Blade covering installed	+_12__ grams
Approximate weight of blade mounts installed	+_15__ grams
Total Flying Weight	=____ grams

D. If less weight is desired, trim one of the lead pieces in each blade until desired weight is achieved.

E. If more weight is desired, you may also add bronze powder #3709 to the blades.

F. Starting at the outer end of the slot, apply a coat of thin cyano around the lead in the slots. Allow to sit for about 30 seconds, then apply cyano accelerator. Repeat this process until near the top. A small gap must be left as to allow room for the balsa strip #3712.

Step 3. **Initial Balance.**

Refer to Drawing # 13.

A. 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 level surface. Using the pen as a fulcrum at 45 degrees to the leading edge, determine the balancing point, mark the blade accordingly, and repeat at 90 degrees to the previous line. (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 1-2 millimeters of each other. Since they were factory matched and all material added 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 which direction. For example, if tip weight is to be added, simply rout out a small area at the tip of the blade 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. The optional bronze #3709 powder may also be used as a balancing aide. See #14.

B. Cut balsa strips #3712 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 the blade surface. Coat with a film of cyano and wipe away excess.

C. At your option, seal the wood at the hub and tip areas with either instant cyano or fuel-proof paint. Lightly re-sand blades with 220 or 320 grit sandpaper once again. Carefully remove all dust using a clean towel or a tack rag, wiping several times. At clean blade is a must for proper adhesion of the blade covering material.

Step 4. **Cover Blades.**

Parts Required:

2 3674-7 Blade Covering White (In box)

Refer to Drawing # 13.

A. With the blades now ready for cover, select a clean flat surface and after removing the backing material from a piece of blade covering #3674-7, lay it adhesive side up. Now carefully measure 10mm in from the near edge and mark each end with a ballpoint pen. Holding the blade with the hub in your left hand and the blade tip in your right hand, set the trailing edge down on the mark from 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 toward yourself and apply pressure on the 10mm section of the marked covering. This will establish the bottom of the blades. 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 blade and smooth the entire surface again. Repeat this process with the other blade. **Note:** A useful technique to allow good control of this sticky material and to prevent it from prematurely adhering to the blades in any area, weight the covering by sticking a piece of wire on 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. Repeat entire process with the remaining blade.

Step 5. **Final Balance of Blades and Rotor Head.**

Refer to Drawing # 13.

Equipment Required: **NOTE:** The performance potential of modern R/C helicopters is so great that the use of specialized equipment for proper assembly and set-up is fully justified by the results achieved. This is particularly true of balancing 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 usable without special equipment which includes balancing the fly bar on its own bearing 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 using a good static balancer such as the balancer #0514 sold by Miniature Aircraft USA or its equivalent. Its value lies in its ability to include main blade balance. If you have such a unit, use it following the instructions with it.

A. Support the rotor head assembly from Step 4 above vertically in the same manner. (A vice with soft jaws, etc.) that allows the fly bar to pivot freely around a horizontal position. Adjust the fly bar weight inward slightly on the paddle end that rotates downward. Continue small adjustments until the fly bar will remain level. Tighten all four weight set screws tight using Loctite.

B. Remove the rotor head from the main shaft. Mount the main rotor blades to the head using M4X35 socket head bolt #0082 and M4 lock nuts #0021, temporarily installed in section I. Position the blades straight out from the head and tighten the screws just enough to hold the blades in position.

C. Obtain two wood blocks at least 75mm (3 inches) high with parallel surfaces (2 short sections of good quality 2x4 serve very well) and two single side razor blades. Then, suspend the head and blade assembly between them supported on the fly bar. One main blade will invariably tilt downward.

Note: As described, before rotation of main blade 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 equal distance from the bench top) apply the tape to the blade starting underneath, as with the regular covering.

D. Re-install the entire balanced rotor head assembly onto the main rotor shaft.

XIV. FINAL MECHANICAL AND ELECTRONIC SET-UP

Step 1. **Setting up the Collective Servo.**

Refer to Drawings # 11.

A. Move the collective stick slowly all the way to the top and check that the collective arm is going as far as possible without putting the elevator bellcrank #0157 in a bind where it sticks through the mainframe and adjust ATV as necessary.

B. Move the collective stick slowly all the way to the bottom and adjust the ATV so that the collective arm goes all the way to the bottom without binding.

C. With the pushrod lengths given you should be able to use 100 to 110% ATV travel on the pitch servo.

D. With the collective stick at the top check that the swashplate is moving all the way to the top without binding. Adjust the four lower swashplate rods #0227 if necessary.

E. Once again check all collective and aileron, servo's, bellcranks, and pushrods at one half throttle stick for vertical and horizontal positioning.

Step 2. **Final Swashplate and Fly-Bar Alignment.**

Refer to Drawing # 11.

NOTE: Miniature Aircraft offers both swashplate and fly-bar alignment tool kits. Order #0510 and #0512.

A. **Swashplate:** A final check for a level swashplate may be achieved with the use of a main rotor pitch gauge (#0526) and a fly-bar lock (#0505). All transmitter stick and servo arms should be in a neutral position. Snap the fly-bar lock into the rotor head. Position the pitch gauge on one main rotor blade and set the pitch reading in the blade. Rotate the main rotor head in all four 90 degree positions. If the swashplate is truly level,the pitch reading will remain the same in all four positions. If incorrect, adjust the rods just below the swashplate until a level swashplate is achieved.

B. **Fly-Bar Paddles:** Now that the swashplate has been leveled, the fly-bar paddles may also be leveled, set your pitch gauge on 0 degrees. position on the paddle and adjust the paddles until they are level(Parallel) with the main rotor head. A straight rod such as a fly-bar may be used on the rotor head top as an aid in aligning the paddles. It is very important that the fly-bar control #0307 and the fly-bar paddles are all parallel to each other. For an excellent aid order #0510. (Fly-Bar alignment tool kit).

Step 3. **Adjusting Pitch Curves**.

Refer to Drawing # 11.

A. If you have selected an FAI type set up, you will probably want to run, depending on blade selection, 5 to 6 degrees of pitch in a hover (one half collective stick position) with about 10 degrees of pitch at full stick position and about 3 degrees of negative at low stick position. For the idle-up(s) you will want around 4.5 to 5 degrees of pitch at hover, 8.5 to 9.5 degrees at full top and 2.5 to 4 degrees of negative at low. For throttle hold, you will need about 5 degrees at hover, 11 or 12 degrees of positive at full and 4 to 5 degrees of negative at the low.

If you are setting up for hot-dogging, normal stick for hovering should be roughly the same as an FAI set-up. The same is true for the first idle up if your radio is equipped with two idle ups. You would use the first idle up for doing normal aerobatics, then the second idle up would be set up with 0 degrees of pitch at half stick, 4 degrees of negative at quarter stick, 4 degrees of positive pitch at three quarter stick and between 8.5 to 9.5 degrees of positive pitch at full and between 8.5 to 9.5 degrees of negative pitch at low. Throttle hold should be similar to the FAI set up, with the exception of maybe having a little more negative pitch at low for quick descents.

Step 4. **Adjusting Swashplate Throw.**

Refer to Drawing # 11.

A. Set the pitch gauge for 0 degrees of pitch. Move the collective stick until pitch gauge lines up with flybar. Set the pitch gauge for -6 degrees and with the main blades running parallel to the tail boom, give full right cyclic and adjust ATV so that the rotor blade has -6 degrees of cyclic pitch change. Repeat this process for the other side using +6 degrees on the pitch gauge. Repeat process for the elevator set up. This is the recommended maximum amount of swashplate travel that should be used.

Step 5. **Adjusting Tailrotor**

Refer to Drawing # 11.

First check servo for proper directional travel. Right tail stick command pulls the pushrod forward. Reverse if necessary. Turn on the ATS mixing function (for right hand rotation) on your transmitter. The 0 point should be at 1/2 throttle stick position. Adjust the low and high point to approximately 25% each. This will provide a good starting point for your first flight. Check for proper compensation direction by increasing the throttle stick. This should result in pulling forward like a right hand command. Re-Check that at 1/2 throttle stick the rudder servo arm has remained in neutral.
With the throttle and rudder stick in their center position adjust the tail rotor control rod until the outer hole in the tail rotor bellcrank #0445 is approximately 1-2mm rearward from the back edge of the tail rotor transmission housing #0421. This should result in approximately 20mm distance between the tail rotor blades when folded together. Check both left and right tail rotor commands at low and high throttle

positions for no binds. Adjust transmitter ATV's if necessary.

Step 6. **Gyro.**

A. Carefully read the gyro instructions provided. Set gyro sensitivity to approximately 40-50%. Turn gyro and radio switches on and check for proper gyro/rudder direction 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.

Step 7. **Elevator and Aileron Dual Rates and ATV's.**

Depending on the characteristics of which you desire dual rates should be set for your flying style. A starting point of about 70% on aileron and elevator work well. ATV's should be set for no binding.

XV. FINAL ASSEMBLY AND BALANCE

A. A fuel filter is recommended.

B. 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.

XVI. FINAL ASSEMBLY INSPECTION

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

B. Re-check plans for proper installation.

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

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. 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.

XVII. NECESSARY FLIGHT ITEMS

A. Obtain item necessary for flight:

1. Unleaded Gasoline (High Test)
2. Oil: Two Cycle Racing Oil - Preferably Synthetic
3. Ample tools for field use
4. Frequency flag displaying your transmitters frequency colors or numbers (Supplied with your radio system)
5. **Always mix the GASOLINE AND OIL in a well ventilates area. (The engine owners manual will explain the gas/oil mixture)**

B. At the flying field:

1. Obey all flying field rules
2. Check the frequency board or any fliers for frequencies in use, before turning on your transmitter.
3. Perform a pre-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 transmitter on between flights.
7. **WE STRONGLY URGE THE USE OF A FIRE EXTINGUISHER AT THE FLYING SITE. GASOLINE IS FAR MORE VOLATILE THAN METHANOL BASE FUELS. THEREFORE THE LIKELY HOOD OF FIRE IS MUCH GREATER.**
8. Carry gasoline in gasoline approved containers.
9. When transporting gasoline make sure that the container is sealed tightly.
10. Avoid prolonged breathing of gasoline vapors as they can be hazardous to your health.
11. If you smoke, do not smoke on the way to and from the flying field.
12. Do not smoke while fueling, de-fueling or flying a gas powered model.
13. If there are children in the house, do not leave the plug wire attached to the spark plug. If the carburetor has any fuel in it the possibility for personal injury is possible.

XVIII. FIRST FLIGHT ADJUSTMENTS

A. Before flying double check direction of each control; tailrotor compensation direction and gyro direction. The first few flights should be limited to hovering only.

B. **Engine Carburetor Settings:** Refer to the Zenoah Quartz G-23 instruction manual for adjusting carburetor. This manual also provides a trouble shooting chart for defining engine problems.

C. **Throttle and Pitch Curve:** After the needle valves are adjusted the model can be trimmed for hover. The throttle curve should be adjusted so that the model is almost to the hover head speed just above quarter stick. This helps the model lift off smoothly and also allows you to do slow vertical descents without the engine dropping out. The throttle curve above half stick should also be adjusted so that slow vertical ascents can be made without the engine speeding up or slowing down. Simultaneously adjust the hover pitch and hover throttle for the head speed you want to hover at, also ensure that the model is hovering at half stick. Next adjust the high and low side of the normal pitch curve until the model has the collective response you want in a hover.

NOTE: 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. **Tail Rotor Trimming:** Adjust the tail rotor control rod clevises until the tail stabilizes with trimmer in neutral.

E. **Tail Rotor Compensation:** With the model in a trimmed stationary hover adjust the top tailrotor compensation so that the nose of the model stays straight during a slow vertical ascent. Starting at a height of fifteen to twenty feet, descend and watch for the nose of model to change direction or drift to one side or the other. Adjust lower tail comps. to correct this. NOTE: The speed that you ascend and descend should be as slow as a FAI pilot might ascend and descend his heli while performing a top hat maneuver.

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

Gyro:

G. If you are using a dual rate gyro adjust the high rate for hovering as high as it will go without oscillation of the tail. Once you get the model flying in forward flight adjust the gyro on the low rate as high as it will go

without the tailrotor oscillating.

H. **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

I. **Top Pitch:** Adjust the top end pitch on your idle up functions so that the model will fly at full throttle without losing head speed. A model with to much top end pitch tends to be "pitchy" and unstable.

J. **Adjustment of Static Tracking.**

A. Screw in (2) M3x8 socket set screws #0563-2 at the base of the main rotor head block until they just contact the mainshaft. Stand your transmitter antenna (or something else to use as a measure) under the tip of the one blade and rotate the head carefully to make a comparison of the tip height of each blade. Adjust each set screw until moderate pressure exists on the main shaft and each blade tip is at the same height.

First Flight Tip

After hovering the model, land and let blades stop by themselves. Recheck tip height and readjust, if necessary. **IMPORTANT:** Always be sure that the blade pivot bolts are quite snug--offering significant resistance to the lead/lag of the blades. Also, after this procedure, it may be necessary to readjust the tracking slightly.

XIX. STARTING AND STOPPING THE ENGINE

To Start:

A. Always start the engine with the throttle trim up. The throttle or collective stick should be all the way down or closed. Check idle-ups and throttle hold for proper position of switches(off).

B. The air cleaner provided with this engine has a built in choke feature. If the engine is cold or hasn't been run in the last hour or so it may be necessary to turn the choke on.

C. The correct procedure for using the pull starter is as follows: Hold the rotor head with your left hand, place your left foot on the left landing gear skid, between the two landing gear struts and pull the pull starter handle with your right hand. Short quick pulls should be sufficient to start the engine.

D. If the choke is on, pull the starter until the engine fires or attempts to start. Turn the choke off, and pull the starter cord until engine starts.

To Stop:

A. If the throttle servo is set up to completely close the carburetor with the throttle trim down, this will shut the engine off. Forceps can also be used to cut off the gas supply to the carburetor.

B. Forceps should be left on the gas line to prevent leaking and fumes from escaping thus minimizing the chances of a fire.

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

The staff at Miniature Aircraft USA would like to express their appreciation to Tim Schoonard, Wayne Mann and Paul Bittengle for their time and dedication in the creation and final production of the X-Cell Gas Graphite Instruction Manual.

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SPECIAL NOTICE
XL-SERIES HELICOPTERS VERSES DUAL-TAIL USAGE

Subject: A). #0541 and 0541-1 High Performance Dual FAI Tail Rotor System.

B). #1006 XL-PRO and #1007 Optima XL-PRO.

C.) #0547 High Speed Tail Gear .30, .40, .50 and .60 size.

1). If the customer purchases a 0541 & 0541-1 Dual Tail Rotor System for installation on a XL-PRO .60 Graphite FAI Helicopter Kit #1006 or Optima XL-PRO .60 Graphite FAI Kit #1007, the customer is required to purchase (2) #0427 Tail-Rotor Beveled gears for proper operation and installation.

2). If the customer purchased #0547 High Speed Tail Rotor gear kit for X-Cell .30, .40, .50 and .60's and decides to install a #0541 or #0541-1 Dual-Tail Rotor System, the customer is required to re-install the #0427 Tail-Rotor gears supplied with the kit or purchase (2) #0427 replacement parts.

Common Solution to Tracking Problems on X-Cell 50, 60 Series Helicopters

- **Probable Cause** -
  Thrust bearing limited by Loctite contamination.
  Solution - Apply loctite inside axle hole rather than on bolt. Use very small amount and allow at least 1 hour cure prior to use.

- **Probable Cause** -
  Thrust bearing is notchy from a contamination of dirt and or crash. Since thrust bearings cannot be properly checked without operational loads it is best to not reuse them after a crash or extended operation. (Avg. use 1 year)
  Solution - Replace units as per manual.

- **Probable Cause** -
  Thrust bearing installed backwards.
  Solution - Always be sure that the load bearing side be nearest the bearing bolt. In other words, the larger I.D. side goes nearest the head block. Carefully reassemble in correct orientation.

- **Probable Cause** -
  Thrust bearing bound-up on head axle. This inhibits correct thrust bearing operation as blade loads vary.
  Solution - Do not overtighten axle bolts. This will cause the ends or the axle to "Swell" or "Roll" slightly limiting the thrust bearing. This is noticeable when the thrust bearing will not easily slide off the axle. Prior to replacement, the axle should be replaced.

- **Probable Cause** -

  Main axle bent causing intermittent tracking problem as the axle tries to rotate slightly within the head block.

  Solution - Replace axle.

- **Probable Cause** -

  Bell mixers are not uniformly installed. This can be either a mixer reversed on the pivot bolts or rotated so that dissimilar length control balls connect to the hiller rods on each side of the head.

  Solution - Carefully study the instruction manual and the appearance of the mixers on the rotorhead. Each mixer has a "stepped" area surrounding one bearing. This "step" should always face the pitch arm portion of the blade holder also, the short control ball #0109 must always connect to the long hiller rods and not the short flybar yoke rods.

- **Probable Cause** -

  Blade pivot bolts are too loose. Due to slight variations in blade cordwise C.G. and the oscillation state in which the blades function during pitch changes, it is suggested that the pivot bolt be used as a "shock absorber" to hinder exaggerated blade oscillation.

  Solution - Tighten blade pivot bolts until the blades are very snug within the mounts - commonly, this would mean that by holding the blade and the flybar, and pivoting the blade the flybar would deflect at least 2" prior to blade movement. 9 out of 10 modelers set this up far too loosely.

- **Probable Cause** -

  Improperly assembled blade reinforcement causing considerable difference in one hiller rod and the other to achieve tracking.

  Solution - Replace blades and study the assembly procedures carefully prior to assembly.

- **Probable Cause** -

  Blade spanwise C.G. not matched.

  Solution - It is most important that the spanwise C.G. be exactly matched prior to covering and that the blades have the same total weight.

X-CELL GAS FUEL/OIL RECOMMENDATIONS

1. Ratio - 40:1 in Amoco Premium or similar white gas.

   IMPORTANT: - The oil must be the following type to maximize performance and cooling:

   - Petroleum based only.
   - "Ashless" type.
   - 2 cycle air cooled type, not the type used for water cooled engines such as Marine applications.
   - Do not run carburetor excessively rich or plug fouling and/or radio interference may result due to plug carbon build up.

X-CELL GAS TECH TIPS

Subject: X-Cell Gas Spark Plug Tuning.

If, like most, you think spark plugs are a "No-Brainer", your only partially right. Spark plug adjustment and installation is important to peak engine performance in your X-Cell Gas model, so keep the following points in mind:

1) Never assume the new plug is properly gaped - check it yourself - many tools and methods are available to set plug gaps, but the most accurate are the wire type. Always be sure the side electrode is parallel, flat and centered over the center electrode. The gap should be equal and uniform across the two surfaces. It may seem trivial, but it is important and will pay-off in improved operation.

2) If your plug has a removable top cap be sure it is not loose.

3) Plugs with removable seal washers should be tightened with a torque wrench to factory specifications, but most modelers will probably ignore this.. As an alternative, you should insert the plug, turn it to where it is firmly finger-tight and make a 1/4 revolution turn using an appropriately sized socket wrench (to avoid damage to the porcelain).

4) Frequently check the plug for build-up of carbon deposits (varies depending on the oil used, cylinder temperature, and fuel mixture) which can cause poor ignition and radio interference. Plugs are best cleaned with a commercial plug cleaner used by auto parts/repair shops or solvents and a small wire wheel/brush. Always re-check the gap.

5) Always use the correct length plug. If the plug were too short, spark will occur in the shrouded area of the plug hole instead of down in the combustion chamber. The plug could mis-fire, the empty threads collect ignition debris and cause pre-ignition. Too much plug reach will cause pre-ignition because the exposed threads will burn and collect carbon deposits (also possibly damaging the cylinder head threads during plug removal. Of coarse, at the worst, the piston may hit the plug and be destroyed or at least, close the gap.

1. SAFETY PRECAUTIONS

- **This manual describes the engine. For its mounting and control, see the instruction manual for the model airplane, helicopter and boat.**
- **Each engine is designed for use on each model airplane, helicopter and boat. If it is used for any other purpose, we cannot be responsible for its reliability or safety.**
- **Use genuine parts for replacement.**
- **Check the propeller, rotor and screw propeller every time. If it is damaged, replace it with a new one.**
- **If the propeller (or the rotor or the screw propeller) hit something while the engine is in operation, immediately stop the engine and check it.**
- **Start the engine on a flat surface without pebble stones.**
- **Never modify the flywheel.**
- **Check the flywheel. If it is damaged, replace it with a new one.**
- **When mixing the fuel, or operating the engine, carry it out in a well-ventilated place.**

2. MOUNTING G230PU

Make sure that the G230PU is mounted on the aircraft grade plywood with more than 6mm of thickness or a mount of equivalent strength and is firmly fixed with 4 bolts.

[NOTE]

1. Be sure to set flat washers or metal plate on the reverse side of the mount to prevent bolts from sinking into the mount. Before be sure to check for loose bolts.
2. Since the engine is equipped with a float-less carburetor with a diaphragm pump, the direction of cylinder and position of fuel tank can be freely selected .
3. If the rubber joint is placed between the engine and the body for anti-vibration, check if the rubber is too week and select the proper hardness of the rubber, in order to avoid the unexpected vibration under operating engine RPM zone.
   Note carefully that if the engine is vibrated at idling, then the idling RPM is likely to get unstable due to overflow at carburetor by the vibration.
4. Coat the bolts for muffler with anti-looser (e.g., Locktite or equivalent).when assembling.

3. PROPELLER, ROTOR & SCREW PROPELLER

1. Propeller for airplane

The recommended prop sizes are as shown in the table bellow.

Diameter × Pitch (in.)
18 × 6, 16 × 8 - 10

This engine with a standard muffler produces the maximum output when the engine is running at about 10,000rpm. Be sure to use a propeller which makes the engine speed approximately 7,000-9,500rpm while the airplane is flying.

[NOTE]

When mounting the spinner, set a pin on the hub with more than 3mm of diameter, thus preventing slipping.

2. Rotor for helicopter

Adjust the rotor-pitch to obtain 9,000-10,000 rpm of the engine at full throttle operation.

3. Screw Propeller for boat

The exhaust system (e.g., muffler) is not equipped with as standard. When you select the exhaust system for the engine, check how many the engine speed (rpm) is required when the maximum output is generated by using the muffler you select.

And then decide the appropriate the screw propeller that would meet such engine speed (rpm) that the muffler required.

In general, standard size of the screw propeller (Surface prop type) are as follows:

Diameter (mm)	Pitch ratio (mm)
65 - 75	1.9 - 1.4

4. FUEL

Mix. gasoline and 2-stroke oil at a mixing ratio of 25:1-40:1

[NOTE]

1. Be sure to use a gasoline-resistant fuel piping (Do not use any silicon rubber tube).
2. Never use any alcohol fuel or alcohol added fuel, or the rubber part' in the carburetor will be damaged.

5. OPERATION

Hand flip start

Since the G230PU is equipped with the ultra compact C.D.I. type flywheel magneto ignition system, it should be started according to the following procedure;

* The magneto system of G230PU is designed in such a way that when the exhaust port is closed by the piston, that is, when the compression stroke starts (Refer to Fig. 1-A), sparks are never produced on spark plug no matter how fast the propeller may be flipped. Be sure to quickly flip the propeller when the edge of magnet on the rotor is approaching the coil (Fig. 1-B). It means that the propeller should be quickly flipped about 90 degrees in crank angle before the compression is about to start.

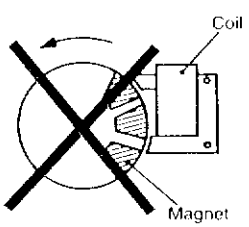


Fig.1-A

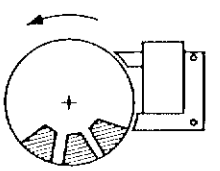


Fig.1-B

How to Start the Engine

1. For Airplane
   a. Fill the fuel tank with the fuel .
   b. Choke the engine and turn the propeller a few times until the fuel appears at the carburetor.
   c. Set the throttle valve at the idle position or at the position

slightly open from the idle position. Quickly flip the propeller in the counterclockwise direction according to the procedure described above. Flip the propeller a few times. Then the engine starts.

2. For Helicopter & Boat
   a. Fill the fuel tank with the fuel.
   b. Push the priming bulb upper the carburetor until fuel appears in the priming bulb.(for Helicopter)
   c. Choke the engine and open the throttle valve approximately 1/3~1/2 of the full open position.
   d. Quickly pull the starter cord when the initial explosion is heard.
   e. When the initial explosion is heard, open the choke, set the throttle valve at the idle position or at the position slightly open from the idle position and quickly pull the starter cord a few more times. Then the engine starts.

[NOTE]

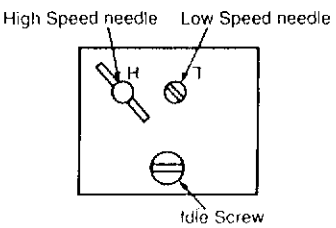
- Be sure to open the choke when the initial explosion is heard.
- When the choke is opened, be sure to close the throttle valve to a position near the idle position before starting the next flipping (If the engine is started while the throttle is wide open, a great thrusting force is produced, which is very dangerous).
- Be sure to wear a thick glove when flipping the propeller. Use all fingers, except thumb, for the flipping operation.

How to Stop the Engine

For stopping the engine, the black lead wire from the coil should be grounded to the engine body, or the throttle valve should be closed completely.

6. CARBURETOR ADJUSTMENT

The carburetor is provided with 3 adjust screws which are set to the best (approximately) positions by our company, but they may need a little adjustment depending on the temperature, atmospheric pressure (altitude), etc. of the area where the engine is used. Start the engine without making any adjustments. Make readjustments only when the engine shows any mal-functioning.



1. Standard opening of each needle as follows;
   Low speed needle : 1⅛ ± ¼
   High speed needle: 1⅜ ± ¼

Idle Screw: Turning this screw clockwise increases the idling R.P.M. Turning it counterclockwise decreases the idling R.P.M

Low speed needle: This is the fuel adjust screw (not the air screw). Turning this needle clockwise makes the mixture gas leaner and turning it counterclockwise makes it richer.

High speed needle: Turning this needle clockwise makes the mixture gas leaner and turning it counterclockwise richer. Set this needle at a position which is 1/4 open from the maximum R.P.M. position while the airplane is on ground.

[NOTE]

1. Do not tighten the High and Low Speed needles too firmly.
2. When the unit has just started and the engine is not warm enough, there may be insufficient acceleration and the engine may be stopped. Be sure to perform idling before operation.

7. ENGINE BREAK-IN

No specific break-in is required. The engine is gradually broken-in as it is used and the output is also increased gradually.

8. SERVICING

The engine can be disassembled or reassembled without any specific difficulties, but be careful of the following matters;

a. For disassembling, the special tools shown in the parts list are required in addition to the general tools. Be sure to use a new gasket when the crankcase and cylinder have been disassembled.

b. Removing rotor

1. Screw in the stopper (P/N 3350-96220) in place of the spark plug. Then turn the rotor counterclockwise until the piston touches the stopper. Take care it can cause damage to the piston or connecting rod if the stopper is not screwed in to the bottom.
2. Loosen and remove the rotor securing nut.
3. Remove the rotor by using the puller (P/N 1490-96101). Do not hit on the crankshaft by a hammer, that can increase the runout of the shaft.

c. Assembling crankcase

1. Apply grease on the oil seal lips and oil on the bearing.
2. Assemble the crankshaft with a new gasket.
3. When both front and rear crankcases are tightened, the portion of gasket protruding on the cylinder mounted surface should be cut off with a knife until the gasket becomes flush with the cylinder mounted surface.

d. Assembling piston

Before assembling the piston, apply the oil on the small end bearing and piston, and set the piston ensuring that the arrow mark on the top of piston is directed toward the direction of exhaust port.

e. Assembling cylinder

1. Coat the oil on the inner surface of cylinder.
2. The piston is provided with a knock pin which stops the piston ring from turning. Set the splitted section of piston ring at the knock pin and assemble the cylinder ensuring not to break the piston ring.

f. Adjusting air gap of coil.

The air gap of coil should be adjusted to 0.3 mm (0.01").

g. Adjusting ignition time.

This engine with the point-less C.D.I. type requires no adjustments of ignition time.

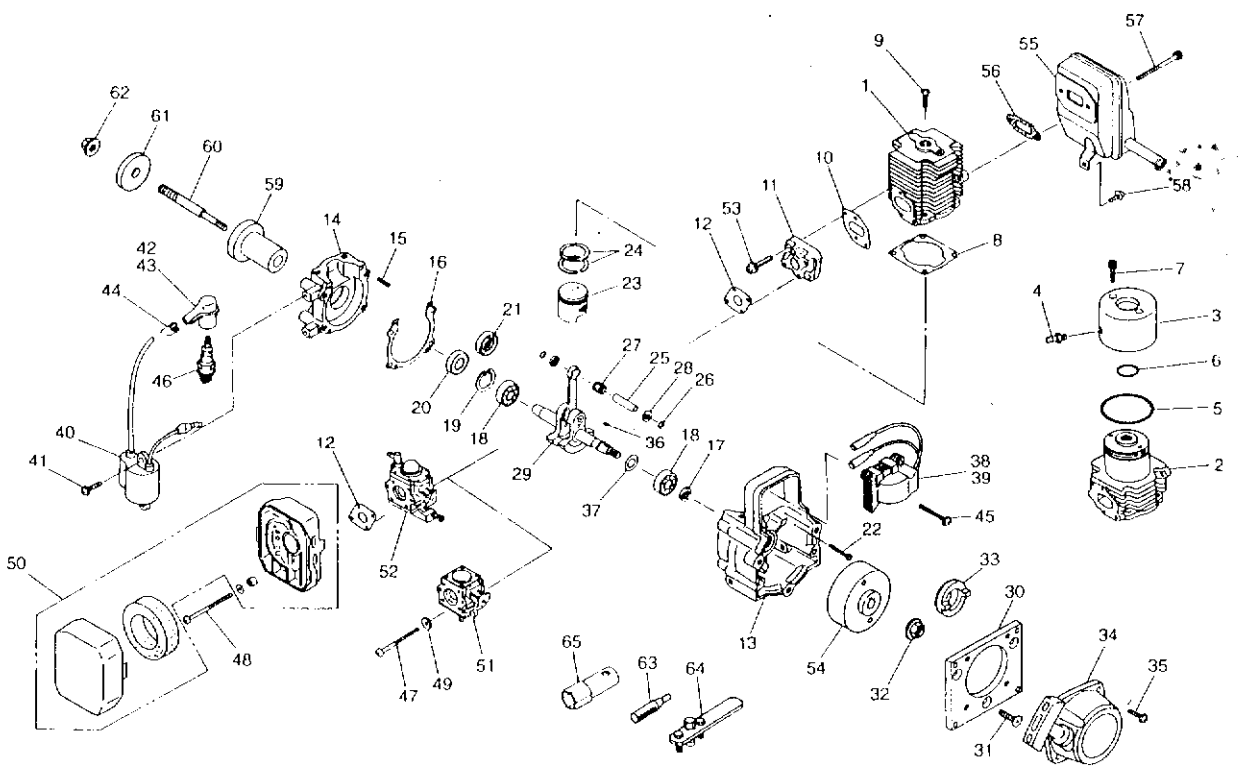
9. SPECIFICATIONS

MODEL	ZENOAH G230PU	ZENOAH G230PUH	ZENOAH G230PUM
PURPOSE	Airplane	Helicopter	Boat
TYPE	Air cooled		Water cooled
DISPLACEMENT	22.5cc		
BORE × STROKE	32mm × 28mm		
COMPRESSION RATIO	7.4 : 1		
MAXIMUM OUTPUT	2.1PS/10500rpm [∗ 1.9PS/10500rpm]		2.2PS/11000rpm
OPERATING ENGINE SPEED	2000~10000rpm	3000~11000rpm	3500~15000rpm
IGNITION SYSTEM	CDI type Flywheel magneto		
CARBURETOR	WALBRO WA197A	WALBRO WA167A	WALBRO WA197A
AIR CLEANER	—	Dry type	—
STARTING	Hand flip	Recoil starter	
FUEL	2-cycle oil pre-mixed gasoline (Mix ratio 25~40:1)		
SPARK PLUG	NGK BMR7A or CHAMPION RCJ6		
DRY WEIGHT	1.42Kg [∗1.58Kg]	1.49Kg [∗1.65Kg]	1.45Kg

[NOTE] [∗ with standard muffler]

Specifications are subject to change without notice.

10. PARTS LIST



[NOTE] The parts indicated " ∗ " in the part number column are supplied as an assembly. No individual part available.

Index No.	Parts No.	Description	Q'ty per unit PU	PUH	PUM
1	1148-12111	CYLINDER	1	1	0
2	1160-12110	CYLINDER	0	0	1
3	1160-12210	JACKET	0	0	1
4	07851-00515	JOINT	0	0	2
5	07000-03038	O RING 3×38	0	0	1
6	1160-12320	O RING 1.5×19.5	0	0	1
7	1160-12330	BOLT M3×8	0	0	2
8	1140-13120	GASKET CYL	1	1	1
9	3310-12281	BOLT M5×20	4	4	4
10	1140-13150	GASKET INSU	1	1	1
11	1148-13161	INSULATOR	1	1	1
12	1148-13131	GASKET CARB	1	2	1
	1155-21101	CRANKCASE COMP	1	1	1
13	∗	CRANKCASE (R)	1	1	1
14	∗	CRANKCASE (F)	1	1	1
15	2629-21130	PIN	3	3	3
16	1140-21140	GASKET CASE	1	1	1
17	2169-21210	SEAL 12×22×7	1	1	1
18	1155-21240	BEARING	2	2	2
19	04065-02812	RING SNAP	1	1	1
20	06034-06001	BEARING	1	1	0
21	1650-21220	SEAL OIL	0	0	1

Index No.	Parts No.	Description	Q'ty per unit PU	PUH	PUM
22	01252-30530	BOLT M5×30	4	4	4
23	5600-41111	PISTON	1	1	1
24	1850-41210	RING PISTON	2	2	2
25	1101-41310	PIN PISTON	1	1	1
26	1260-41320	RING SNAP	2	2	2
27	1140-41330	BEARING	1	1	1
28	1101-41340	WASHER THRUST	2	2	2
29	1155-42000	CRANKSHAFT C	1	1	1
30	1155-74110	PLATE MOUNT	1	1	1
31	0262-10516	SCREW CM5×16	3	3	3
32	1650-43230	NUT	1	0	0
33	1160-75210	PULLEY	0	1	1
34	1861-75100	RECOIL ASSY	0	1	1
35	0263-30414	SCREW M4×14	0	4	4
36	1000-43240	KEY	1	1	1
37	1140-43250	SHIM	0~2	0~2	0~2
38	2629-71210	COIL SO (GRAY)	1	0	0
39	1160-71210	COIL SO (RED)	0	1	1
40	2629-71311	COIL IG	1	1	1
41	0263-30414	SCREW M4×14	2	2	2
42	2629-72210	CAP PLUG (BLACK)	1	0	0
43	2850-72110	CAP PLUG (RED)	0	1	1

Index No.	Parts No.	Description	Q'ty per unit PU	PUH	PUM
44	1400-72121	SPRING	1	1	1
45	0260-30422	SCREW M4×22	2	2	2
46	1148-73120	SPARKPLUG BMR7A	1	1	1
47	0263-30550	SCREW M5×50	2	0	2
48	0263-30555	SCREW M5×55	0	2	0
49	1142-83110	SPACER 5×10×1.6	2	0	2
50	1751-82002	AIRCREANER	0	1	0
51	1145-81002	CARBURETOR 197A	1	0	1
52	1148-81002	CARBURETOR 167A	0	1	0
53	0263-90520	SCREW M5X20	2	2	2
54	1155-71110	ROTOR	1	1	1
55	1148-08010	MUFFLER	1	1	0
56	1140-13140	GASKET MUFF	1	1	0
57	01252-30550	BOLT M5×50	2	2	0
58	0263-30408	SCREW M4×8	1	1	0
59	1152-43260	HUB	1	0	0
60	1152-43281	STUD	1	0	0
61	1152-43290	WASHER HUB	1	0	0
62	3350-53410	NUT	1	0	0
63	3350-96220	STOPPER (OPT)	1	1	1
64	1490-96101	PULLER ASSY (OPT)	1	1	1
65	1110-91320	SOCKET	1	1	1