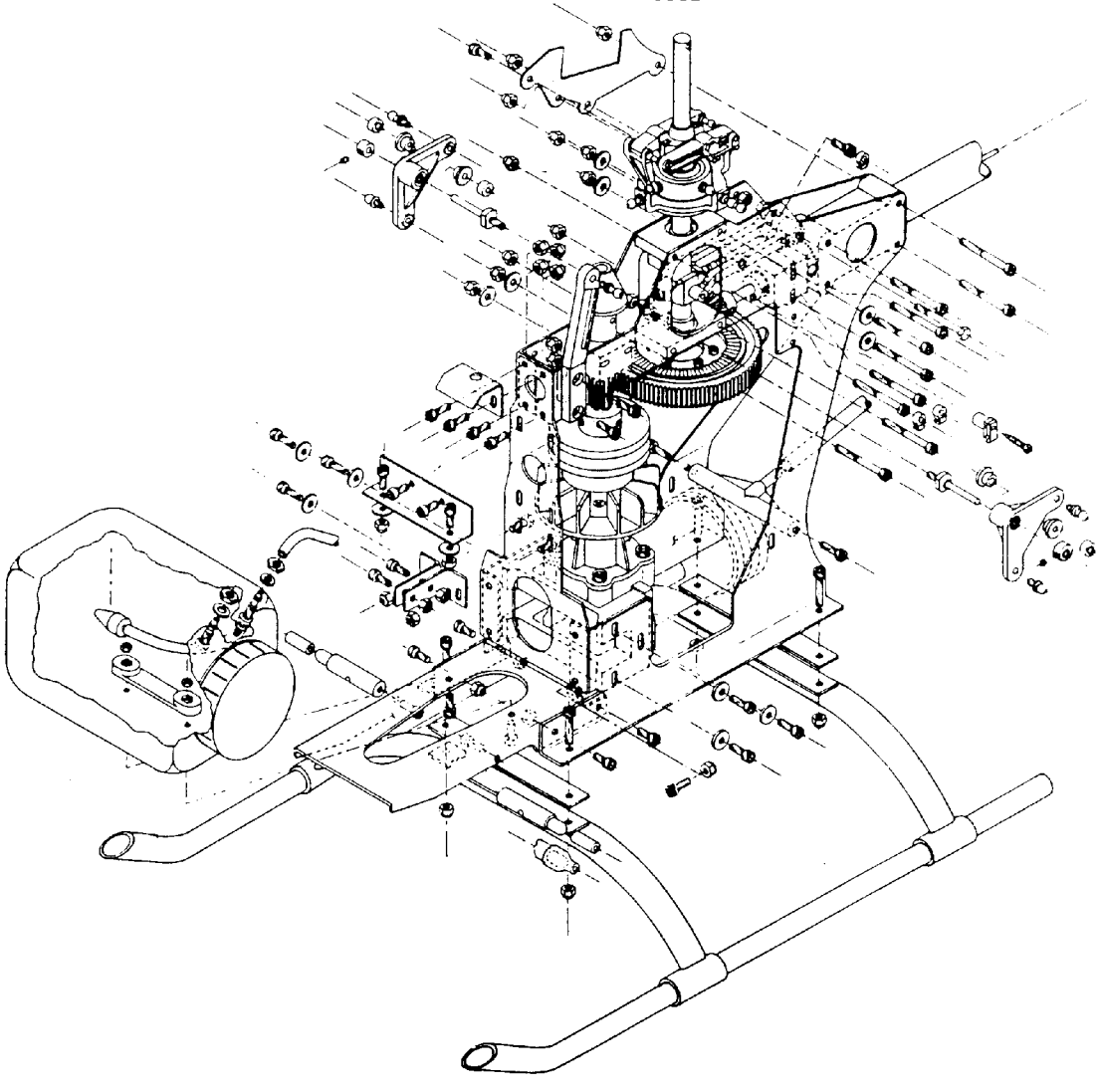
X-CELL

SIXTY SERIES HELICOPTERS

With #0546 Uni-Ball Clutch System

INSTRUCTION MANUAL

PART NUMBER: 0503



miniature aircraft USA

X-CELL .60 SERIES HELICOPTER

With #0546 Uni-Ball Clutch System

INTRODUCTION

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

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

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

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

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

SYSTEM REQUIREMENTS

In addition to the kit, you will require:

1. A Helicopter Radio with 5 Servos

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

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

2. An Engine and Matching Muffler

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

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

3. A Rate Gyro

Probably the one advance in model helicopter technology that contributes most to easy and enjoyable flight is the insertion of an "angular rate sensitive" gyroscope in the yaw (rudder) servo lead from the receiver. This device senses even minute swings of the helicopter nose (yaw) left or right and makes immediate corrective inputs to the tail rotor servo to counteract these movements. This action is not to be confused with that of an "autopilot" in that it does not keep the helicopter pointed in one direction. The amount of its corrections depends on how sharply the nose begins to swing - a small correction for a small amount, or a larger correction for a larger amount. In other words, the gyro response varies with the angular rate of change, which is why this particular type of gyro is called a "rate" gyro as distinguished from a "position" gyro.

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

It is essential to have your Radio and Engine on hand before beginning kit construction because they will

be needed fairly early in the building sequence. The Muffler and Gyro are not such immediate needs except that the gyro control switch box is easier to install early.

CONSTRUCTION

The Standard .60 helicopter kit 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)
Glowplug Wrench (Part #4648)
Scissors
Slow Zap (#4917)
Thin Cyanoacrylate Glue (#4881)
Loctite (MA/USA) thread lock liquid (supplied in kit)
(**NOTE:** Use only the material supplied or its EXACT equivalent)
Masking tape, Paint for finishing Canopy, 80 and 220 Grit Sandpaper
Heat Gun (Monokote type)
Grease, Teflon Filled (Order #4709 - 2 oz tube, or #4707 - 1 oz syringe)
Tri-Flow Teflon Oil (Part #4801)
J.B. Weld Epoxy (#4853)

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

Ball Link Application Tool (part #0529)
5.0mm Nut Driver (#4669)
5.5mm Nut Driver (Socket on a Handle) (#4670)
7mm Nut Driver (#4671)
Fan Drive Collet O.S. SX (#0262)
Fan Drive Collet 7mm Enya 60 (#0265)
Fly-Bar Alignment Kit (#0510)
Universal Swashplate Lock (#0512)
1.5mm Allen Wrench on a Handle (#4651)
2.0mm Allen Wrench on a Handle (#4653)
2.5mm Allen Wrench on a Handle (#4655)
3mm Allen Wrench on a Handle (#4657)
Ball Link Pliers (Part #0545)
Pitch Gauge (Part #0526)
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 into the Head Block
2. Final Assembly of the Fly-Bar Yoke, Guide Pins and Head Button
3. Building and Installing the Bell Mixers
4. Assemble and Install the Main Blade Mounts
5. Add the Fly-Bar, Control Arms and Head Bolt
6. Assembly of Flybar Paddles

II. BUILDING THE TOP MAIN FRAME SECTIONS

STEP
1. Assemble Aileron (Roll) Bellcranks to Main Frames and Mount Tail Push Rod Guides
2. Assemble Elevator (fore and aft) Swing Arm Unit
3. Install Main Shaft Bearing Blocks

4. Assemble Front Tail Drive Transmission
5. Install Front Tailboom Support Halves
6. Assemble and Install Start Shaft Bearing Block

III. **ASSEMBLY OF THE MAIN SHAFT COMPONENTS**

STEP 1. Alignment and Tightening of Bearing Block Assemblies
2. Installing the Mainshaft, Autorotation Unit with Maingear
3. Assembling Swashplate
4. Assembling Lower Swashplate Control Rods and Anti-Rotation Arm
5. Assembling Wash-Out Unit

IV. **ASSEMBLE OF FRONT FRAME SECTIONS**

STEP 1. Assembly of Front Vertical and Tank Support

V. **INSTALLING ENGINE AND FAN SHROUD ASSEMBLIES**

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

VI. **INSTALLATION OF LANDING GEAR ASSEMBLY**

STEP 1. Assemble Landing Gear and Install

VII. **RADIO TRAY ASSEMBLE AND SERVO INSTALLATION**

STEP 1. Installation of Radio Tray Frame Supports
2. Mount Servo's into Plastic Tray Components and Assemble Plastic Tray
3. Mount Plastic Tray to Main Frames and add Front Brace
4. Mount Elevator Servo

VIII. **INSTALLING FUEL TANK SYSTEM**

STEP 1. Assemble Fuel Tank

IX. **ASSEMBLE THE TAIL ROTOR TRANSMISSION**

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

X. **BUILDING THE TAILBOOM**

STEP 1. Installing Wire Drive
2. Installing the Tail Rotor Pushrod Guides and Fin Mounts

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

STEP 1. Install the Switch for the Receiver, Gyro, Radio Receiver, Battery and the Antenna
2. Install Rudder Pushrod

3. Install Elevator Pushrod
4. Install Aileron and Collective Pushrods
5. Install Throttle Pushrod
6. Rotor Head and Fly-Bar Hiller Control Rods

XII. **CANOPY PREPARATION** P - 44

STEP 1. Assemble Canopy and Paint

XIII. **BUILDING THE ROTOR BLADES** P - 45

STEP 1. Assembling Blade Mounts
2. Adding Lead Strips
3. Initial Balancing
4. Cover Blades
5. Final Balance of Blades and Rotorhead
6. Adjustment of Static Tracking

XIV. **FINAL MECHANICAL AND ELECTRICAL SET-UP** P - 49

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

XV. **FINAL ASSEMBLY AND BALANCE** P - 51

XVI. **FINAL ASSEMBLY INSPECTION** P - 51

XVII. **NECESSARY FLIGHT ITEMS** P - 51

XVIII. **STARTING AND STOPPING ENGINE** P - 52

XIX. **FIRST FLIGHT ADJUSTMENTS** P - 52

I. ROTOR HEAD ASSEMBLY

NOTE: At the builders discretion the bearings and shaft in this section may be glued together using Locktite (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 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 locktite 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, Guide Pins, and Head Button.

Parts Required:

4	#0063	M3x10 Socket Head Bolt	Bag 1C
2	#0115	M3x10.5 Threaded Ball	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

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.

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 standard .60 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 Bolt	Bag 1E
2	#0085	M5x16 Socket Head Bolt	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 Spacer	Bag 1E
2	#0327	Bearing Retainer Washer	Bag 1E
2	#0329	Thin Shim Washer	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, 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 four #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 (thin ones) 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 #0085 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 Head Bolt.

Parts Required:

1	#0303	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 Spacer	1F
2	#0307	Flybar Control Arm	1F

Refer to Drawings #1.

A. Insert the flybar #0303 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 (Small and Large)	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 acrobatic.
- 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. Assembly Aileron (Roll) Bellcranks to Main Frames and Mount Tail Push Rod Guides

Parts Required:

1	#0163	Main Frame, Right		Box
1	#0165	Main Frame, Left		Box
2	#0167	Aileron Bellcranks (roll)	Bag#	2A
2	#0169	Aileron Bellcrank Studs (roll)		2A
4	#0159	Ball Bearings M3x7		2A
2	#0171	Aileron Stud Retainer Collars		2A
2	#0105	(M3x4.5) Threaded Balls		2A
2	#0107	(M3x6) Threaded Balls		2A
2	#0051	(M3x3) Socket Set Screws		2A
2	#0019	M3 Locknuts		2A
1	#0387-A	T/R Control Rod Front Guide		2A
1	#0387-B	T/R Control Rod Front Guide		2A
1	#0029	M2.2x13 Phillips Self Tapping Screws		2A

Refer to Drawings #2.

A. Build a left and a right top main frame #0165 & #0163 by installing on the outer side a bellcrank pivot stud #0169 in each frame and a M3 locknut #0019 on the inside of each frame. Tighten securely.

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

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

D. Partially threaded the M3x3 set screws #0051 into the two retaining collars #0171.

E. Hold the left main frame with its stud facing you, and select the bellcrank which will slide on the stud with one arm vertically down containing a short ball, and the other arm pivoting forward containing a long ball #0107. Place a small amount of Loctite on the set screw threads, partially 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 forward with a long ball on it.

G. Install the tailrotor pushrod guides #0387 into the left mainframe using one M2.2x13 Phillips self tapping screws #0029.

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

Parts Required:

2	#0131	Plastic Bearing Bushing	Bag#	2B
1	#0099	Special Bolt M3x30		2B
2	#0155	Elevator Swing Arm Halves		2B
1	#0157	Elevator Bell Crank		2B
1	#0105	M3x4.5 Threaded Ball		2B
2	#0113	M3x10.5 Double Threaded Balls		2B
2	#0159	Ball Bearings M3x7		2B
2	#0161	Pivot Pins Elevator		2B
1	#0019	3mm Locknut		2B
2	#0047	Slotted Cheese Head Machine Screws M2x16		2B
2	#0015	Hex Nuts 2mm		2B
1	#0365	Aluminum Elevator Servo Mount		2B

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 #0163. As per the drawing insert the special bolt #0099 from the right side through the elevator servo mount #0365 and into 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 #0165 and one M3 locknut #0019. Do not fully tighten at this time.

Step 3. Installing Mainshaft Bearing Blocks

Parts Required:

2	#0182	Main Shaft Lower Bearing Block	2C
4	#0077	M3x30 Socket Head Blocks	2C
4	#0019	M3 Locknuts	2C

Refer to Drawings #2.

A. Install the upper bearing block #0182 (bearing side facing down) in between the two main frames in its respective position using two #0077 M3x30 socket head bolts and two #0019 M3 locknuts. Do not fully tighten.

B. Install the lower bearing block #0182 (bearing side facing up) using two #0077 M3x30 socket head bolts and two #0019 M3 Locknuts. Do not fully tighten.

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

Parts Required:

3	#0051	M3x3 Socket Set Screws	2D
2	#0233	Front Drive Housing Halves	2D
2	#0235	Front Drive Ball Bearings	2D
1	#0237	Front Drive Retainer Collar	2D
2	#0241	Front Drive Housing Guide Sleeves	2D
1	#0231	16 Tooth front Drive Pinion	2D
1	#0239	Front Drive Pinion Shaft	2D
2	#0077	M3x30 Socket Head Cap Screws	2D
4	#0003	Flat Washer M3 (large)	2D
2	#0019	Hex Locknut M3	2D

Refer to Drawings #2.

A. Clean the I.D. of the two bearings #0235 and the front input shaft #0239 with thinner to remove any oil.

B. **NOTE:** At the builders discretion the bearings and shaft in this section may be glued together using locktite (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 #0239 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 #0231 and position the pinion on the shaft and tighten down one set screw in the flat spot nearest the end just enough to keep the gear on the shaft but at the same time allowing it to slide on the shaft. Final adjustment and tightening will come later.

F. 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 in through the left main frame first. **Do not fully tighten.**

Step 5. **Install Front Tailboom Support Halves.**

Parts Required:

2	#0185	Front Tail Boom Support Halves	2E
4	#0077	M3x30 Socket Head Cap Screws	2E
4	#0019	Hex Locknuts M3	2E

Refer to Drawings #2.

NOTE: Upper two #0077 bolts must insert through the elevator plate #0365.

A. Install the tailboom support halves #0185 using four M3x30 bolts #0077, and four M3 locknuts #0019 in through the left main frame first. **Do not fully tighten.**

Step 6. **Assemble and Install Start Shaft Bearing Block.**

Parts Required:

1	#0199	Star Shaft Ball Bearing M6x19	2F
1	#0198	Start Shaft Bearing Block w/Bearing (assembled)	2F
1	#0559-1	Bearing Block Adapter	2F
2	#0077	M3x30 Socket Head Cap Screws	2F

4	#0003	Flat Washers 3mm (large)
2	#0019	Hex Locknuts M3

Refer to Drawings #2.

A. Assemble clutch shaft bearing block #0198 and bearing block adapter #0559-1. Clean the stepped area in the block and on the bottom of the adapter with alcohol or thinner. Apply a thin coat of Loctite on the adapter base. **Wipe away any excess to avoid bearing contamination.** Position the block on a flat surface (Bearing down) and place the adapter #0559("cup" side up) in place on top of the block #0198. Insert a wooden dowel or appropriately sized socket inside the cup area and tap the adapter into the block until fully inserted.

B. Apply a very thin coat of Loctite on the outside of M6x19 bearing #0199 and set it onto the adapter cup #0559-1. Use a large socket or block of wood (with a hole as to avoid contact with the bearing inner race). Tap the bearing fully in place.

C. Install the clutch shaft bearing block using two M3x30 bolts #0077, four M3 large washers #0003 and two M3 locknuts #0019 in through the left main frame first. **NOTE:** The #0559-1 bearing adapter block will be on the top side.

III. ASSEMBLE OF THE MAINSHAFT COMPONENTS

Step 1. Alignment and Tightening of Bearing Block Assemblies.

Parts Required:

1	#0203	Main Shaft	3A

Refer to Drawings #3.

A. Temporarily slide the main shaft #0203 into both main shaft bearing blocks. Lay the bottom edges of the main side frames on a flat surface and tighten the upper and lower main shaft bearing block bolts #0077.

B. Tighten the M3 locknut on the special bolt #0099. Do not over tighten. The elevator swing arm should pivot freely.

C. Snugly tighten the start shaft upper bearing block.

D. Lightly tighten the tail boom support halves.

E. Remove the main shaft #0203.

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

Parts Required:

1	#0203	Main Shaft	3A
1	#0209	Autorotation Hub with Bearing Assembled	3A
1	#0207	Main Gear 9:0 to 1	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.

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

Parts Required:

10	#0133	Plastic Balls Links Long	Bag 3D
1	#0247	Radius Arm Support	3A
2	#0063	M3x10 Socket Head Bolts	3D
2	#0019	M3 Locknut	3D
1	#0107	M3x6 Threaded Ball	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. Using two #0063 M3x10 socket head bolts and two #0019 M3 locknuts bolt into position, one #0247 radius arm support onto the top left main frame.

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

E. 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 5. **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 thread a ball into the hole in the long end of each Arm from the flat side. Use Slow Cyano. Make sure the balls are threaded squarely in place and lightly seated against their flanges.

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

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. ASSEMBLE OF FRONT FRAME SECTIONS

Step 1. Assembly of Front Vertical Frame and Tank Support.

Parts Required:

1	#0175	Front Frame Support Plate	Bag 4A
1	#0189	Tank Support Tray	4A
1	#0179	Canopy Latch Plate	4B
2	#0245	Lower Canopy Support Studs	4B
2	#0065	M3x12 Socket Head Cap Screws	4C
18	#0063	M3x10 Socket Head Cap Screws	4C
12	#0019	3mm Hex Locknuts	4C
8	#0003	Flat Washers 3mm (large)	4C
1	#0191	Motor Mount	4D

Refer to Drawings #4.

A. Install the motor mount into the lower section of the main frame assembly using six M3x10 socket head bolts #0063 and six M3 washers #0003. This is only a temporary installation of the motor mount for frame alignment. Four of the #0063 bolts will be replaced with #0065 bolts in **Section VI.**

B. Place the frame assembly on a flat surface and, ensuring that both frame bottom flanges rest solidly on the surface, generally "square up" the entire unit and snugly tighten the motor mount bolts.

C. Mount the front support plate #0175 to the front side of both main frames using six #0063 M3x10 socket head bolts, two #0065 M3x12 socket bolts, and eight #0019 M3 locknuts. Use the #0065 M3x12 bolts to mount the canopy latch plate #0179 against the upper front face , two holes of the front support plate #0175. Tighten all bolts and nuts securely.

D. Mount the two lower canopy support studs to the forward holes in the sides of the tank support tray using two M3x10 socket head bolts. Use Loctite. Tighten securely. Cut two 12mm lengths of fuel tubing(supplied with tank) and press them fully on the ends of the studs. These will provide resilient canopy mounting.

E. Mount the tank support tray #0189 in position under the front support plate #0175, using four #0063 M3x10 socket head bolts and four #0019 M3 locknuts. Tighten securely.

V. INSTALLING ENGINE AND FAN SHROUD ASSEMBLIES

Step 1. **Mounting Flywheel.**

Parts Required:

1	#0546-17	Cooling Fan (Assembled)	Bag 5A
1	#0546-21	Fan Assembling Tool	5A
4	#0546-16	Urethane Dampeners	5B
1	#0546-5	Upper Fan Drive Collet (O.S. SX)	5B
1	#0331	M13x.5 Flat Steel Washer	5B

1	#0007 M6.6x12.3 Flat Steel Washer	5B
1	#0546-6 Lower Fan Drive Collet	5B
1	#0546-8 Upper Fan Drive Collet (O.S. SFN)	5B

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

Collet Pack	**Engine Application**
0546-4 - Included in kit -	O.S. .61SX-H, RX-H
0546-7 - Included in kit -	O.S. .61SFN-H, RFN-H
0546-9 - (Opt.)	ENYA 60XF, XLF
0546-11 - (Opt.)	Y.S 61FSH, FRH
0546-14 - (Opt.)	Webra 61H (X-Cell/Schluter type with 9.5mm O.D. solid crankshaft) and 50 H.
0546-15 - (Opt.)	Webra 61, Pico, Rossi and O.P.S. with special "Heim" type 8.0mm O.D. solid crankshaft.
0546-22 - (Opt.)	Super Tigre .61-H (with 1/4" crankshaft threads)

Webra Note: Most Webra Heli engines fall into one of three crankshaft categories:

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

Refer to Drawings #5.

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

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

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

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

Engines not requiring shortening:

O.S. 61 SX/RX
O.S. 61 SFN-H/RFN-H
Y.S. 61 FSH/RSH
Webra 50 heli
Super Tigre .61 H (1/4" crank type)

Engines requiring shortening:

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

The best procedure for cutting the crank threads without damage is to install the crank nut below the cut area, make the cut with a Dremel tool and carbide disc. Chamber the edge with a file, and "chase" the threads by un-threading the nut. Be sure to thoroughly shield the engine against metal particles.

NOTE: Some engines such as O.S. 61SX and Y.S. 61 will require a "thin-wall" type socket to tighten the crank nut.

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

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

1. O.S. 61 SX-H/RX-H (Collet Pack #0546-4).
- Install the large I.D. (9.5mm) base collet #0546-6(with the tapered side upward away from the engine) into position against the factory 1.0mm thick front bearing spacer washer.
- Slide fan hub assembly #0546-17 onto the base collet.
- Insert the upper collet #0546-5 (8.0mm I.D.) with the tapered side facing down in the fan hub. **NOTE:** This collet has a 9.52mm I.D. step for crankshaft clearance.
- Follow with the #0331(M13.0x8.0x.5) flat washer. Apply a little Loctite to the factory nut and install and tighten firmly.

2. O.S. 61 SFN-H/RFN-H (Collet Pack #0546-7).
- Install the large I.D. (9.5mm) base collet #0546-7(with the tapered side upward away from the front bearing) into position against the factory bearing spacer washer.
- Slide fan hub assembly #0546-17 onto the base collet.
- Insert the upper collet #0546-8 (6.23mm I.D.) with the tapered side and internal step facing downward into the hub.
- Follow with flat washer #0007 (M11.75x6.5x1.7). Apply a little Loctite to the factory nut and install and tighten firmly.

3. Enya 60 XF/XLF (Collet Pack #0546-9).
- Install one #0325 flat washer (M16.0x10.0x1.0) onto the crankshaft up against the front engine bearing.
- Install the large I.D. (9.5mm) base collet #0546-6(with the tapered side upward away from the front bearing) into position against the #0325 washer.
- Slide fan hub assembly #0546-17 onto the base collet.
- Insert the upper collet #0546-10 (7.0mm I.D.) with the tapered side facing down in the hub.
- Follow with the #0005(M11.75x6.5x1.7) flat washer. Apply a little Loctite to the factory nut and install and tighten firmly.

4. Y.S. 61 FSH/FRH(Collet Pack #0546-11).

- Install space adapter #0546-13 onto the crankshaft with the "Double Stepped" side facing and contacting the front engine bearing.
- Install the large I.D. (9.5mm) base collet #0546-6(with the tapered side upward away from the engine) into position against the #0546-13 spacer/adapter.
- Slide fan hub assembly #0546-17 onto the base collet.
- Insert upper collet #0546-12 (with the tapered side downward into the hub).
- Follow with #0331 flat washer(M13.0x8.0x.5). Apply a little Loctite to the factory nut and install and tighten firmly.

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

- Install #0325 flat washer (M16.0x10.0x1.0) onto the crankshaft up against the front engine bearing.
- Install spacer/adapter #0546-13 onto the crankshaft with the "Double Stepped" side facing and contacting the previously installed #0325 flat washer.
- Both collets in this application are the same #0546-6. Install one(tapered side away from the engine) up against the spacer/adapter #0546-13.
- Slide fan hub assembly #0546-17 onto the base collet.
- Insert the remaining #0546-6 collet (tapered side downward) into the fan hub.
- Follow with #0005 flat washer (M11.75x6.5x1.7). Apply a little Loctite to the factory nut and install and tighten firmly.

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

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

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

- Install #0331 (M13.0x8.0x.5) washer onto the crankshaft up against the front engine bearing.
- Install #0546-20 spacer on top of the 0331 washer. Follow with (1) #0546-5 collet with the tapered side away from the engine.
- Slide fan hub assembly #0546-17 onto the first collet.
- Insert the remaining #0546-6 collet (tapered side downward) into the fan hub.
- Follow with (2) #0007 flat washers (M11.75x6.5x1.7). Apply a little Loctite to the factory nut and install and tighten firmly.

8. Super Tigre .61-H (with 1/4" crankshaft)
Pack #0546-22.

- Install one #0325 flat washer (M16.0x10.0x1.0) onto the crankshaft. Disregard if your engine was previously equipped with a similar washer next to the bearing.
- Install the large I.D. (9.5mm) base collet #0546-6(with the tapered side upward away from the engine) into position against the factory 1.0mm thick front bearing spacer washer.
- Slide fan hub assembly #0546-17 onto the base collet.
- Insert the upper collet #0546-5 (8.0mm I.D.) with the tapered side facing down in the fan hub. **NOTE:** This collet has a 9.52mm I.D. step for crankshaft clearance.
- Follow with the #0331(M13.0x8.0x.5) flat washer. Apply a little Loctite to the factory nut and install and tighten firmly.

Following your appropriate collet pack and prior to inserting the urethane dampener, use the fan tool provided to hold the fan hub securely for crank nut tightening. The tool has studs that will fit into opposite corners of the fan hub cut-outs.

G. Select the (4) urethane dampeners #0546-16. Grip a dampener firmly with a pair of pliers (with about 1/3 exposed below) and insert one fully into each cavity provided as shown. Using a slight rocking motion to start it into the hole provided. Once started, use a tool (or tabletop) to press the urethane fully into

the hole. They should not protrude past the top surface of the hub when properly installed. if they do, trim the excess flush with the hub using a single-sided razor blade.

TIP: If the urethane is to difficult to press into position, firmly squeeze it with flat pliers and then try the installation again. This will change its O.D. temporarily to ease insertion.

Step 2. **Installation of Clutch Assembly and Align Engine.**

Parts Required:

1	#0285 Aluminum Start Cone	Bag 5C
1	#0273 Clutch Spacer Washer	5C
1	#0275 Clutch Bell w/Bearings, Pinion, Liner(Assembled)	5C
1	#0546-1 Clutch Assembly	5C
2	#0053 M3x5 Socket Head Set Screws	5C
1	#0558 (Previously installed in frames from Section 2, step 6)	

Refer to Drawing #5.

IMPORTANT: For this system to function properly it is essential that:

A. The clutch /bell assembly "hang" from the start shaft bearing block with a minimum of .10mm (.004) to a maximum of .2mm (.010") vertical end play prior to engine installation. This is accomplished by adjusting the height of the start cone or uni-lock adapter on the start shaft against the upper bearing. If additional height is desired for fuselage or similar application, a spacer must be added between the start adapter and the upper bearing.

B. Remove the previously installed double bearing block #0558 in the main frames.

C. Stack the spacer washer #0273, the clutch bell #0275, and the double bearing block #0558 (circular side facing upward), onto the pre-assembled centrifugal clutch #0546-1. Slide the assembly up into position with in the main frames and install the aluminum start cone #0285 using two #0053 M3x5 socket set screws. Adjust the assembly until the proper end play is achieved. Secure the two #0053 set screws with Loctite. Once this is done, install the bearing block bolts #0077, washers #0003, and locknuts #0019 and make a preliminary gear mesh setting.

When aligning the pinion 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.

NOTE: It is helpful to position the block as low as the bolt/holes will allow, as in long term use, if any shifting occurs (from engine wear or loosening bolts) that there will still be some slight adjustment available to you without moving the motor mount.

Step 3. **Installing the Engine and Fan Shroud Braces.**

Parts Required:

4	#0080 M4x14 Socket Head Bolts	Bag 5D
4	#0065 M3x12 Socket Head Bolts	5D
1	#0549-6 Fan Shroud Brace (Right)	5D

1	#0549-7	Fan Shroud Brace (Left)	5D
1	#0546-19	Alignment Tool	5D

Refer to Drawing #5.

A. Remove the previously installed motor mount #0191 from within the main frames. Only two of the #0063 bolts and all of the washer #0003 will be used.

B. The motor mount can be flipped over if necessary to vary its height in the mainframes. If you are using an O.S. engine the two holes next to each other will be on the top side of the motor mount.

C. Mount the motor mount #0191 to the engine using four M4x14 socket head bolts #0080 with Loctite. Tighten the bolts enough to hold the engine against the motor mount, yet still allowing you to slightly move the engine from side to side.

D. 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.**

E. 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.

F. Once the tool is in position temporarily secure the motor mount with one socket bolt M3x10 - #0063 and flat washer M3 #0003 in the further most rear hole of the motor mount on each side. Select both pieces of the fan shroud brace #0549-6 (right) and #0549-7 (left). The left hand version mounts via the uppermost and lowermost motor mount bolts through the 4.75mm and 3.0mm holes in the braces. When installed, the left hand version sweeps forward and inward at the top. The 4.75mm hole at the bottom allows fore and aft adjustment, while the slot at the top allows up/down fan shroud adjustment. The right hand version is the opposite. Use two M3x12 socket head bolts #0065 with the M3 large flat washers #0003 at the lower end of the brace (into the motor mount). It is best to use the rearmost motor mount bolt on each side to hold the motor and alignment while adjusting the fan shroud braces for proper fan clearance. Use Loctite on all motor mount bolts.

G. Push upward on the engine assembly while firmly holding the start shaft with downward pressure so that all components are snug against the alignment tool. Once in place, check to see that the start shaft still loaded downward ensuring that the clutch bell end-play is still evident.
Visually inspect the installation. (**Tip:** It is most helpful in alignment of this and other aspects of helicopter assembly to obtain very small bubble level to aid in alignment. If you cannot locate such items contact Miniature Aircraft USA for a source). The engine/clutch should be level and evenly contacting the alignment tool as viewed from all angles. Alternately tighten all motor mount/engine bolts and remove the alignment tool. Re-check for proper gear mesh and clutch bell end play.

H. Install the carburetor at this time.

Step 4. **Installing The Fan Shroud Assembly.**

Parts Required:

1	#0548-5	Fan Shroud (left and right)	Bag 5A
5	#0029	M2.2x13 Phillips Screws	5E
4	#0061	M3x8 Socket Head Cap Screws	5E
2	#0009	Flat Washers M3 small	5E

Refer to Drawing #5.

NOTE: Generally, the rear fan shroud mounting boss will tolerate any re-positioning of the fan shroud to accommodate the various gear ratios. If, for some reason, you would like to move the rear of the shroud also, there is extra plastic molded behind the bolt holes on each side to allow for the drilling of new holes. However, this is usually not necessary.

A. Install both halves of the fan shroud #0548-5 into position and then screw the halves together using five, M2.2x13 Phillips screws #0029 from the right side.

B. Place two M3 small washer #0009 on two M3x10 socket head bolt #0061 and thread them into the front fan shroud mounting holes through each upper hole in the fan shroud braces. Use a small amount of slow cyano on each bolt. Do not tighten completely.

C. Screw an M3x8 bolts #0061 into the fan shroud lower mounts on each side. Use slow cyano.

D. Align the final shroud so that it is square to the fan and then tighten all previously installed hardware. Check for no binding when engine is rotated. It may be necessary to loosen the four bolts #0065 holding the front fan shroud braces and re-adjust for proper fan clearance.

NOTE: It is possible to R & R the engine/motor mount assembly without disturbing the clutch/bell assembly or the gear mesh if your careful. You will find service, in this regard, to be far simpler than with the conventional system.

"Fan Removal for R & R"

Removal of the fan hub from the engine is quite simple. Support the fan/hub assembly from beneath as near to the engine as possible. Un-thread the crank nut until it is even with or slightly above the ends of the crankshaft. Tap the nut/crank with a wooden dowel and hammer or the plastic handle of a tool. The upper collet should release easily, unless you have used excessive amounts of Loctite. If this is the case apply a little solvent such as acetone or thinner to the upper collet to help loosen the Loctite.

VI. INSTALLATION OF LANDING GEAR ASSEMBLY

Step 1. **Assemble Landing Gear and Install.**

Parts Required:

2	#0153	Skids	Bag 6A
2	#0151	Struts	6A
4	#0019	M3 Locknuts	6B
4	#0071	M3x18 Socket Head Bolts	6B
2	#0177	Main Frame Strut Plates	6B

Refer to Drawing #6.

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

A. Examine view on the drawing to determine orientation of the struts #0151 and skids #0153. Note that the struts sweep forward.

B. Wearing a glove or using a cloth for protection from heat, pick up one flexible strut and, with a skid conveniently at hand, heat one end of the strut until the skid can be pushed into the hole from the front without undue pressure. **Do not overheat!** Push the skid through until its end projects rearward through the strut exactly 227mm.