KAVAN

# Bell JetRanger

## WITH KAVAN SYSTEM

SECOND EDITION

## *Assembly and flying instructions*


Dear Friend,

It is indeed an extreme pleasure to welcome you to the Kavan Bell Jet Ranger R/C Helicopter team. With the purchase of this helicopter kit you joint the thousands of modelers around the entire world, who are already building or flying what we feel is the most advanced R/C Helicopter available, anywhere.

With the introduction of the Jet Ranger we have established a special Helicopter Service Department. The sole purpose of this department is to assist and keep our team members posted on the progress and further development of the Jet Ranger. Our Engineering Department has many new and exciting developments underway, which we feel you would be interested in. In order to do this though we do need your assistance. Would you please take only a few moments and fill in the enclosed Post Card and mail it, so we may add your name and address to our current mailing list? It is our intent to keep our members posted via newsletters and bulletins, but again, we need your name and address to do so.

The Service Department and I welcome any and all of your comments or suggestions at any time. Do not hesitate to contact us whenever there is any sort of a problem, for we all profit by the flow and exchange of information / ideas....

The Engineering Department is already in the advanced stages of testing a few auto-rotation devices as well as several new rotor-head combinations to make the Jet Ranger fully aerobatic....! That's right, we want the model fully capable of performing loops and rolls, just as the conventional fixed-wing aircraft. We are planning to make conversion-kits, which adapt to all of our Jet Rangers.

Again, welcome and thank you for choosing the Kavan "Bell Jet Ranger", and I hope you find our efforts in the dynamic new field of R/C Helicopters to your complete enjoyment.

Many happy"Lift-Offs" and Landings,

Franz Kavan


# R/C HELICOPTER DESIGN AND CONTROL

Before the introduction of the Kavan "Bell-Jet Ranger", basically, there was only one method of R/C Helicopter Control, namely the Hiller Servo-rotor System. This is broken into two categories; the simple Hiller System and the Hiller System with collective-pitch.

I. Simple Hiller System
The pitch angle (incidence) of the main rotor blades is fixed on a common plate. Lift-thrust is varied in proportion to the actual speed of the main rotor blades, there, of course, will be some delay as the engine accelerates and decelerates.

II. Hiller System with collective-pitch
In this type of system the delay or response time is eliminated as the rotor-speed is almost constant, and lift-thrust is varied by controlling the pitch-angle (incidence).

In both cases the Hiller Servo-rotor is actually used to control the movements of the helicopter. The control-actions of the cyclic-servos are fed to the servo-rotor and then in turn fed to the rotor blades themselves. Although the servo-rotor design and operation are simple and effective, there is, however, a certain amount of inherent delay associated with this method of control.

With the advent of the Kavan Bell-Jet Ranger, utilizing the Bell - Kavan- System of control and collective-pitch, the delay or response time has virtually been eliminated. This then is the beginning of a new era in R/C Helicopter Design/Engineering. The Jet Ranger model is then a true-to-scale model, whose performance matches that of its full size counterpart, not only in appearance, but, more important in precision.

The main rotor blades are directly controlled through mixing-levers, and the so-called servo-rotor provides stabilization only. This then is the most sophisticated R/C Helicopter ever produced on a mass production basis, and due to its advanced design affords the ultimate in precision control for maneuvering, instantaneously.....without delay.

## CONSTRUCTING THE KAVAN JET RANGER HELICOPTER

Knowing that for many the Kavan Jet Ranger R/C Helicopter is going to be the modeler's first experience into the new and exciting realm of rotary-winged-aircraft, we have made every effort to compile and assemble what we hope you will find "a very complete and comprehensive Instruction Manual".

We have listed the entire program in easy-to-follow, step-by-step, sequences. It is recommended that the builder follow these sequences of tasks, adjustments, etc., so as to successfully complete and fly the Jet Ranger in minimal time, while avoiding unnecessary back tracking due to overlooked or forgotten items.

Although our primary goal is having each and every builder completely satisfied and successful, the builder's co-operation is needed also! Follow the instruction sequence as listed and check off each task or phase as it is finished. This sequence will insure that the proper assemblies are completed and ready when needed and the adjustments, etc are complied with, in their perspective order.

The Kavan Jet Ranger Helicopter is a precision machine as well as it is a complex aircraft, and though it should go without saying, we repeat: "Study each and every task or phase thoroughly...before beginning!" For your convenience easy reference can be found in the many photographs, detailed drawings and the full size plans.

In addition to the complete line of Kavan R/C Model accessories and the Jet Ranger Kit, we have added a line of R/C Helicopter accessories. Should you plan on installing any of these accessories now or later on, please make allowances for them during the initial construction.

### EQUIPMENT, not furnished:

For motive power your Jet Ranger requires the installation of a well run in, 10 cc (Fi), throttle-equipped, RC engine. As most engines vary in the design of the exhaust-port we have only provided the special Kavan muffler. The engine-adaptor plate is purchased separately. Your local Kavan dealer can supply this item as well as the recommended Kavan 1¼ ounce fuel tank and accessories.

Most any brand of four channel proportional radio equipment can be used for the guidance system of the Jet Ranger. It is necessary that five (5) servos be used for the proper operation and control. Two (2) of the servos, throttle and collective-pitch must be connected electronically to the throttle-channel of the radio receiver. Most radio manufacturers can supply a "wye-cord" for this type of operation, should you not wish to make your own connector.

A question that often arises when talking to prospective R/C helicopter pilots is: "What is the best type of mode of transmitter stick arrangements to use for flying a helicopter?" Our answer remains the same...: "All types and modes are being successfully used". If you are an accomplished fixed-wing R/C pilot, keep the same arrangement you are accustomed to.

For sake of clarity only, the Instruction Manual is based on the 2 stick Mode II transmitter arrangement. Mode II employs the throttle and yaw (rudder) control on the left-hand stick with longitudinal (elevator), and lateral (aileron) control on the right-hand stick. Choose the arrangement that suits you best, after all you are going to pilot the model.

We have based our radio installations of the use of rotary-output type of servos. Should the builder choose to use the linear-type of servos, he will have to make some modifications himself.

Most helicopters are designed to be started with an electric starter. If you do not yet own an electric starter, consider purchasing a Kavan starter. Although most starters will work on the Jet Ranger, the best results are found by using those which have a speed range of 2200 to 2800 RPM under loaded conditions. The use of any starter which turns much faster will only cause undue wear on the clutch-lining.

## GENERAL CONSTRUCTION NOTES:

Many of the plywood parts within the cabin structure will be exposed to the engine fuel and oil. Others will be visible through the clear cabin windows. It is recommended that these parts be sealed and lightly sanded before they are cemented into position Clear Hobby-Poxy or K & B Superpoxy are some of the best sealers we have found for this.

When cementing, wood-to-wood, use a good grade of white-glue, i.e.: Elmers or Tite bond, etc., of course, any good epoxy-cement may also be used. Use the supplied Stabilit-Express for cementing the plywood assemblies to the fiberglass body-shell, and the other assemblies as directed within the manual. We have also supplied a tube of Stabilit-Dur, this is to be used for cementing the clear windows in place. We have tested many brands of cements for these two applications, and have found the Stabilit products best suited to these needs. Do not use the Express for metal-to-metal or plastic-to-metal joints.....

The supplied tube of "LOP" (Loctite) should be used on all screws and bolts which are not secured with elastic stop-nuts! There is vibration within all helicopters that can easily undo these nuts and bolts causing costly failures.

In general there are no special tools required for constructing the Kavan Jet Ranger, other than those tools normally used by the average R/C modeler. We have supplied the metric wrenches as required. A very handy item though may be a metric scale and metric-to-decimal conversion chart. The conversion itself is quite simple, one need only remember that each millimeter is equal to: .03937 of an inch. (For most practical purposes .039" will be accurate enough for bolt holes, etc., use the larger fraction: .03937 of an inch for the larger dimension conversions).

A word of caution - fiberglass particles can have a ruinous effect on bearings. Protect these vital parts whenever sanding, filing or routing the fiberglass body parts.

## FUSELAGE CONSTRUCTION

1. Construction begins by cutting out all of the formers shown on the two printed plywood sheets. As Former No. 9 and 9A receive special treatment, only rough-cut these away from the full sheet and set them aside. We recommend that you drill or cut out the larger of the round holes (those not for bolts), the smaller holes should be drilled to size according to their use. We will cover these sizes as construction moves along. This would be a good time also to seal those formers which will be used within the body-shell.

) In order to retain the scale-like appearance of your Jet Ranger and to make the task more simple, the recessed portions of the body-shell not only indicate the window outlines, but also serve as a cementing ledge for installing the clear windows later on. Refer to Fig. 1, note that a narrow portion of the recess is retained for this purpose. This ledge should be approximately 1/16 inch wide. Cut out all the openings for these windows, EXCEPT... the two (2) top window openings, these will be done a bit later.

There are any number of methods for removing the excess of the window-openings which may be employed, i.e.: from drilling small adjacent holes to using a small key hole saw. The most efficient method found is using a hand-motor tool (Dremel etc.), fitted with a 1/8 inch diameter router-bit. Obtain and cement (Epoxy), a small 1/4" OD x 1/8" ID ball-bearing onto the router-bit itself. The ball-bearing's outer-race then acts as an automatic guide, maintaining the proper margin for the router-bit, as it is kept in contact with the inside edge of the recess. Finish the edges with a small file and sandpaper to remove any uncut threads or burrs.

(Most hobby shops stock an assortment of the router-bits and the small ball-bearings are obtained through bearing-supply houses. A small electric hand drill can be used in lieu of the high-speed motor tool.)

Cut the formers No. 9 and 9A at this time. The formers are printed on the plywood, nested together. These must be separated carefully! Although the inside corners of No. 9A are shown with rather sharp angles, these corners should have a radius, so the separation-cut can be made in on pass. Use a thin saw blade, avoid removing excess material between the two formers. Cut directly on the line. The dashed-lines indicate the location only, of the yaw and collective servos. These cut-outs must be adjusted to accomodate the servos you plan on using. Drill the pilot-holes for mounting the servos also. Drill the thirteen (13), small holes shown with a No. 47 (.0785") drill. Cut out the remaining openings. Refer to Fig. 2. These formers may now be sealed.

Assemble the cabin floor unit. This assembly includes formers No. 1A, 1L, 1R, 8 and 8A. (Note the front edge of No. 8 is beveled approximately 25-degrees, indicated by the dashed line). Former No. 8A is cemented to the underside of No. 8 as indicated by the pair of dashed-lines. Complete this assembly as shown in Fig. 3. It is important that formers No. 1L and 1 R are perpendicular to the former No. 8. Set aside to cure.

The access opening on the top side of the body-shell is now prepared. Set former No. 9 over the rough-cut opening and carefully center it between the recesses provided for the fiberglass cabin-top. The rear edges of this former must contact the vertical portion of the body-shell. Refer to Fig. 4. When centered, carefully scribe a line onto the body-shell with a sharp, soft pencil,using No. 9 as a template. Remove the excess body material then from within this scribed-line. Using the Stabilit Express, cement former No. 9A to the inside of the body-shell using the prepared opening edges as a guide. Use either C-clamps or spring type clothespins to hold this former until cured. Refer to Fig. 5. Remove any excess cement within the access opening itself.

Assemble the plywood transmission box. This assembly includes formers No. 4, 4A, 4B, 5, 5A, 5B, 6, 6A, 7 and 7A plus two 1 mm plywood strips: 4C and 5C. Drill the holes in: 4A, 4B, 5A and 5B with a No.22 (.157") drill for the four (4) vibration-mounts No. 24. Refer to Fig. 6. Note: No. 7A <u>is not</u> cemented onto the assembly! This former is secured with two (2) screws for easy removal to allow the placement and removal of the engine/transmission assembly later.

The lower edges of the assembly can be beveled as indicated by the dashed-lines after cement has cured. The assembly should be perfectly square upon completion. As the box forms the engine-compartment, it would be wise to apply an additional coat of fuel-proof sealer to the inside of the box.

7 The fiberglass cabin-top is now trimmed and fitted to the recess provided for it on the top of the body-shell. When satisfied with the fit, securely tape (masking tape) the cabin-top in place. Drill the required four (4) holes, one at each corner, as shown on the plans using a No. 32 (.116") drill, first as a pilot-hole. Remove the cabin-top and enlarge the body holes with a No. 22 (.157") drill for the 3 mm blind-nuts. Install the blind-nuts inside with a bit of epoxy-cement. The cabin-top will be secured with four (4) 5 x 16" pan-head screws and flat-washers. Refer to Fig. 7.

8. ) The cabin floor assembly is now installed into the body-shell. Use Stabilit Express on all the edges that contact the body-shell. A small weight should be placed on the assembly to hold it until cured. A few spring type clothespins or C-clamps will be helpful at the lower front-window openings also. Refer to Fig. 8.

The balance of the body-former: No. 2A, 2L, 2R, 3L and 3R may then be installed. Refer to Fig. 9. Do not disturb the body until the cement has cured!

<u>NOTE:</u> DO NOT force fit any of the body-formers, this could distort the body contours. Trim the formers as required and use the supplied Stabilit Express for cementing wood to fiberglass.

9. A few of the mechanical components must now be assembled and then attached to former 9.

First the aluminum bearing-plate No. 3209, (which includes bearing No. 3210), is secured onto the aluminum bearing-bracket No. 3208 with four (4) 2.6 x 9 mm screws and nuts. Refer to Fig. 10. This assembly and two (2) angle brackets No. 3503 are bolted to former 9 with 2 x 8 mm screws and nuts. Install the bolts so the nuts will be on the wood side, tighten the screws so the nuts move into the plywood a bit, then seal with a bit of epoxy cement. Refer to Fig. 11 and 12.

The windows on the top of the body-shell may now be scribed, using the fitted cabin-top as a guide, retain a small portion of the recess for a cementing ledge. Refer to Fig. 13.

Cut and trim the scribed opening for the main rotor shaft shown on the cabin-top.

10.( ) With the cabin-top bolted in place, set the fuselage upside down on the work bench. Insert the prepared former No. 9 so it again nests inside of former No. 9A, from which it was originally separated. Before inserting, place a small amount of epoxy cement at each of the corners and tack-cement No. 9 to the fiberglass cabin-top only!!! Avoid cementing No. 9 to No. 9A!!! Refer to Fig. 14. After the tack-cement has cured, remove the cabin-top and complete the cementing with Stabilit Express. Small sections of the furnished nylon cloth (No. 3420) should be used for additional reinforcing. Refer to Fig. 15. Set this unit aside to cure properly.

11. Former No. 11, which supports the tail rotor drive shaft and control rod plus the horizontal stabilizers can now be completed and installed. Refer to Fig. 15. Drill the holes as shown and epoxy the two (2) large T-nuts into the notches provided. While the epoxy cures for the T-nuts, drill out the two (2) slight indents molded into the fiberglass tail-boom (one on each side) with a No. 31 (.120") drill.

Attach former No. 11 onto a 16" long, pine or spruce stringer with pins or a small nail. (Printed side towards the stringer). Refer to Fig. 16. From the cabin-access opening, insert the former so as to align the T-nuts with the holes drilled into the tail-boom. Install a 3 x 12 mm screw through each hole to hold the former in place while the stringer is pulled off the nail. Cement the former in place. Place small amounts of cement onto the end of a scrap stringer to place the cement on the former and the fiberglass, apply at both sides of the former (front and back).

12.( ) The nylon-bearing No. 3205 is now cemented onto former No. 9 below the aluminum bearing-bracket. Insert the nylon-bearing and align it for cementing (Express) by inserting the main rotor drive shaft No. 3201. Refer to Fig. 17. Note that the nylon-bearing flange has a raised-rib denoting its centerline. This rib must be aligned with the printed line adjacent to its mounting hole to obtain the proper angle for the main rotor shaft. DO NOT REMOVE THE SHAFT UNTIL THE CEMENT HAS FULLY CURED...!!!

13.( ) Remove the main rotor shaft from the cabin-top assembly (when cement has cured!) and install the gear-bushing No. 3202 onto the lower end of the shaft. This is the end at which the shaft has been turned to a smaller diameter! Carefully align the mating holes and insert the split-spring pin No. 3203. Refer to Fig. 18. Install the nylon spurgear No. 3204 onto the gear-bushing with three (3) No. 3111 3 x 8 mm socket head-screws. Refer to Fig. 19.

14.( ) Attach the four (4) rubber vibration-mounts No. 3024 to the brackets within the readied plywood transmission box. The shorter of the studs fit into the brackets. Use 4 mm nuts and flat-washers to secure. Insert this assembly into the body-shell. Refer to Fig. 20. DO NOT CEMENT!!! Install the transmission base plate No. 3101 onto the vibration-mounts. The wing-nuts No. 3024 can be used temporarily to hold the base plate. Refer to Fig. 21. (Note the location of the air-inlet opening of the base plate!) The prepared main rotor shaft is installed loosely into the cabin-top from the bottom side, up. Fasten the cabin-top to the body-shell. Lower the main rotor shaft so as to engage the smaller end into the ball-bearing of the transmission base plate. The entire transmission box assembly is positioned within the body-shell so the shaft drops easily into the bearing and rotates freely. The large nylon gear No.3204 must be parallel to the top surface of the transmission base plate! Refer to Fig. 22. When this alignment is achieved, secure the transmission box to the body-shell with a few dabs of 5-Minute Epoxy just to prevent it from shifting. When the epoxy has cured, complete the cementing with Stabilit Express. Force the cement between the wood parts and the body. Small sections of the supplied nylon cloth may be used within the box to reinforce the bond between the plywood and the body-shell. This will also seal-off any spaces or gaps. Allow ample time for curing.

The landing-gear can be assembled at this time. Refer to Fig. 22 and the plans for details. Slide the landing gear clamps over the skids to locate the bolt holes. Drill the arches with a No. 31 (.20") drill for the clamps and use a No. 22 (.157") drill for the rubber vibration-mounts. The holes should also be drilled in the body-shell for attaching the landing gear. The large openings in the cabin floor (former No. 8) can be used to reference the required spacings. The four (4) No. 3024 wing-nuts secure the shock mounts to the wood arches, and four (4) 4 mm plain-nuts with washers are used in the body. We have provided the wing-nuts to assist in removing the landing gear for transporting the model. For the final assembly the aluminum-skids should be wrapped with a layer or two of electrical tape etc. to improve the friction between the clamps and the skids. Use the 3 x 15 mm pan-head screws and flat-washers for the clamps.

For training purposes we recommend the wide training gear.

) Transmission Assembly

Bolt the bevel-gear assembly No. 3105 onto the top of the transmission base-plate with four (4) 3 x 7 mm socket head-screws and lock-washers. Refer to Fig. 23.

Before bolting the two engine/clutch frames No. 3102 onto the base plate note that the engine mounting sides of these frames have a projecting-flange. These flanges can be faced inward or outwards depending on the width of the engine crankcase. Trim the flanges if required. Determine which way fits your engine best,then bolt these frames in place along with the lower bearing-plate No. 3103 and the rear stabilizing-plate No. 3104 with 4 x 7 mm socket head-screws and lock-washers. Tighten the screws evenly and securely. Refer to Fig. 24.

Insert the small tail rotor drive shaft No. 3118 with its bevel-gear No. 3117 into the bevel-gear assembly. Refer to Fig. 26.

17. ) Insert the intermediate drive shaft with clutch-bell No. 3113 through the lower bearing-plate and the upper-bearing installed in the bevel-gear assembly. Now slide the spur-gear No. 3114 and the bevel-gear No. 3115 onto the projecting end of this shaft, engaging the two bevel-gears. Refer to Fig. 25 and 26. These gears are then secured to the shaft with the split-spring pins No. 3116. Carefully drive these pins in place so as not to mar or damage the teeth of the gears!

The drive-pulley with its clutch assembly installed is now placed onto the lower end of the intermediate shaft into the clutch-bell and secured to the shaft with a 3 x 6 mm socket head-screw and flat-washer. Hold the clutch-bell to tighten the screw. Refer to Fig. 27.

18. ) Preparing the engine

Before the engine can be aligned and bolted to the engine/clutch frames, it must be fitted with the split tapered-bushing, the drive pulley No. 3130 and the cooling fan No. 3131. In that order. Refer to Fig. 28 and 29.

Select the proper bushing (from the three supplied), which fits your engine's crankshaft. The supplied bushings should accomodate most of the popular 10 CC R/C engines. For the Taipan-Engine No. 3054, a special split taper-bushing and drive pulley is required.

Some engines, the older Supertigers for example, employ a taper-cone on the crankshaft to secure the engine's drive-washer, for this type of engine, simply remove the drive-washer and install the drive pulley directly onto the crankshaft (check the taper for other engines), omitting the supplied taper-bushing.)

We have found it advisable on some engines to remove the original drive-washer and replace it with a flat-washer (of appropriate diameter) or turn down the drive-washer in order to have the drive-pulley closer on the frames, affording clearance between the top of the special Kavan muffler and the removable hatch, former No. 7A.

For some engines it may be necessary to enlarge the mounting hole of the cooling-fan. Use a lock-washer or LOP on the engine prop-nut to secure the fan and drive-pulley!

Avoid using mufflers which afford a lot of back-pressure, thereby lowering the engine's output, for this reason we have supplied the special Kavan muffler.

19. Mounting the enginge

Slip the timing-belt No. 3138 over the engine drive-pulley and the clutch-pulley while placing the engine onto the engine-frames of the transmission. Position and clamp the engine to the frames so the timing-belt is centered on its respective pulleys. Refer to Fig. 30. Scribe the engine's mounting holes onto the engine-frames. Remove the engine and while protecting the bearings of the transmission, drill the frames with a No. 21 (.159") drill. The engine is then secured with four (4) 4 x 18 mm socket head cap-screws and elastic stop-nuts. Place the supplied ground-wire solder-lug No. 3142 under one of the mounting-bolt heads.

As the timing-belts have a manufacturing tolerance the tension of the belt must be tested, and if found too loose the engine must be shimmed accordingly. If the engine must be shimmed, be sure to shim both sides of the engine equally so as not to distort the crankcase! Use flat shim-stock or washers etc. To test the tension depress the belt mid-way between the pulleys with a moderate finger pressure (approximately 1 lb.), the belt should deflect approximately 1/16 inch from a straight line across the top of the pulleys. Refer to Fig. 30.

If you are going to operate your Jet Ranger in the hotter climates (over 85 degrees F.) we recommend the installation of the "heat-sink" on the engine-head. See order No. 3910.

20.( ) Complete the transmission assembly by adding the angle-bracket No. 3122 with two (2) 2 x 8 mm pan head-screws and nuts along with the throttle bell-crank No. 3123. Use the bell-crank bushing No. 3124 with a 2 x 12 mm pan head-screw, one (1) flat-washer on each side and a 2 mm nut. Connect the throttle-arm of the engine to the bell-crank with a 2 x 70 mm threaded-rod and two (2) No. 3140 clevices. Lock one clevis with a 2 mm nut. Install the spring wire contact for the engine glow plug No. 3141. Refer to Fig. 30.

21.( ) Cooling-fan shroud

Install the completed engine/transmission assembly onto the vibration-mounts of the installed plywood transmission box. Again, temporarily secure the transmission using the 4 mm wing-nuts. Invert the fuselage and scribe a 118 mm (4.645") diameter circle onto the body-shell. Use the center hole of the engine's crank-shaft as the pivot point for the compass. Refer to Fig. 31.

Remove the engine/transmission assembly and cut away the excess material from within the scribed circle. To maintain the effectiveness of the cooling-fan form a circle of the furnished 1 mm thick plywood and cement this plywood shroud into the prepared opening. To reinforce the bond use sections of the nylon cloth with Stabilit Express within the transmission box. When cured, trim the plywood shroud to clear the timing-belt and clutch-pulley, sand the plywood flush with the bottom of the fuselage. Refer to Fig. 32. This plywood shroud should be sealed with fuel-proof paint.

The muffler may be now installed on the engine. Locate its position onto the body-shell and cut its exit-hole. Allow for its movement when making this exit-hole (a 3/4 inch diameter hole is ample). Refer to Fig. 32

22. Tail Rotor Transmission

Referring to the full size plans, make the required cut-out for the out-put shaft of the tail rotor transmission on the tail-boom. Refer to Fig. 33.

Drill the three (3) holes in former No. 12 with a No. 22 (.157") drill and install the 3 mm blind-nuts. Apply a bit of epoxy-cement to the blind-nuts to secure them avoid getting cement into the threads. Be sure the tail rotor transmission fits into this former and that the bolt-holes align with the blind-nuts.

23.( ) READ THE FOLLOWING STEPS CAREFULLY BEFORE PROCEEDING WITH THE TASK!!!

To achieve the proper alignment of the tail rotor transmission with respect to the bevel-gear assembly on the engine/transmission it is necessary to use the tail rotor drive shaft No. 3422 as a guide to its installation.

BEFORE ANY FINAL CEMENTING WE RECOMMEND THAT THE FOLLOWING ASSEMBLIES BE TESTED AND TRIED FOR FIT PLUS ALIGNMENT, WITHOUT CEMENT...

The tail-rotor transmission is bolted onto former No. 12 with three (3) 3 x 12 mm pan-head screws and lock-washers. The tail rotor drive shaft is cemented (Epoxy) into the input shaft of the tail rotor transmission. This assembly is inserted into the tail-boom along with the former No. 12A. The other end of the long drive shaft is slid into its position in the out-put shaft of the bevel-gear assembly at the engine/transmission.(This shaft may be shortened if found too long). Fig. 34.

The out-put shaft of the tail rotor transmission No. 3404 must be aligned perpendicular to the vertical and horizontal centerlines of the model when the cementing is completed. Refer to Fig. No.34

The former No. 10 and the white plastic guide tube No. 3424 should also be cemented in place within the body-shell to support and align the drive shaft. IT IS IMPORTANT THAT THE DRIVE SHAFT FOLLOWS AS STRAIGHT-A-LINE POSSIBLE. This may be sighted from the front cabin windows.

Reinforce the bond of Former No. 10 with sections of nylon cloth. When cementing Formers No. 12 and 12A in position avoid getting cement onto the tail rotor transmission for this unit must be removable for service.

24. Horizontal-stabilizers

Refer to the full size plans for details. From the supplied 1.5 x 70 mm balsa sheet cut the planking skins as shown. Note that a right hand and left hand assembly are required. Cement and pin the 7 x 12 mm leading-edge spar onto the bottom skin. (The shorter edge is the leading-edge of the skins). Block up the trailing-edge of the bottom skin 3/4-inch. Drill the hole in former No. 13A with a No. 32 (.116") drill and cement this former in position. Cement the fiber tube No. 3031 to this former and the back of the leading-edge spar. Avoid getting cement into the tube. Cement former No. 13B into position. Refer to Fig. 35. The top planking skin is then beveled at the trailing-edge and cemented in place. A small weight placed on this skin holds it until the assembly cures, later these units are trimmed and sanded to the airfoil shape as shown.

Mount the horizontal-stabilizers onto the tail-boom using 3 x 12 mm pan head-screws and plain-washers. Using a long narrow screw driver for the screws inserted into the fiber-tubes, turn the screws into the T-nuts installed on former No. 11. The flat-washers are placed between the stabilizers and the tail-boom. The inboard edges of the stabilizers may be sanded, if required, to align these units to the tail-boom. The proper incidence-angle is shown on the construction plans.

25.( ) Vertical stabilizer

Refer to the full size plans for details. Cut the two (2) required sections from the supplied balsa sheet: 6 x 100 mm. Notch and install the wire tail-skid in place as shown. Reinforce the center joint and tail skid with sections of nylon cloth. This unit is secured to tail-boom with two sheet metal screws, it may also be cemented if desired. Refer to Fig. 36. (For replacement/removal etc. we recommend omitting the cement).

The fuselage end-cap should be built at this time. Rough-saw the furnished balsa-block as shown. Bend the aluminum strip and cement the strip and former No. 14 to the balsa block. When cured attach the rough-end-cap to the tail boom with self-taping-screws. Sand the end-cap to final shape using the end of the fiberglass tail-boom as a guide. The end-cap may be hollowed out to reduce its weight. Refer to Fig. 37 and 38.

At this point the basic construction is completed. The remaining tasks to be finished on the body-shell are: cutting the holes for the exhaust stacks, radio switch, charging and glow-plug jacks.

You may begin the preparations for final painting. The fiberglass parts should be wet-sanded (No.400) to remove the release-agent, then primed with an auto-body primer, the small imperfections, pin holes, etc., will then be more visible. Fill these with lacquer putty or your favorite filler. Wet-sand again (No.400 or No.600) and apply the finish coats of paint.

The wood parts should be sanded and sealed before applying the primer base. Wet-sand before painting. We have shown several paint schemes on the kit-carton and have provided the appropriate decals.

When the painting and trim is completed attach the landing gear, the horizontal and vertical stabilizers, and cement the exhaust stacks in place. DO NOT cement the windows in place. This should be done in the final phase, just before flying. Refer to Fig. 39 for details on making the windows removable. We recommend making the two front-side windows removable for service.

26.( ) Installing main rotor shaft

The previously assembled shaft is now inserted into the cabin-top assembly. Insert the shaft into the nylon-bushing cemented to former No. 9. Before sliding the shaft into the ball-bearing on the angled aluminum-bracket slide the two (2) aluminum retaining collars No. 3206 onto the shaft. Install the 4 x 5 mm socket head set-screws into the collars which will secure the shaft in place. Bolt the cabin-top assembly onto the body-shell inserting the lower end of the shaft into its bearing on the transmission base-plate. Tighten the set-screws in the collars to secure the shaft.

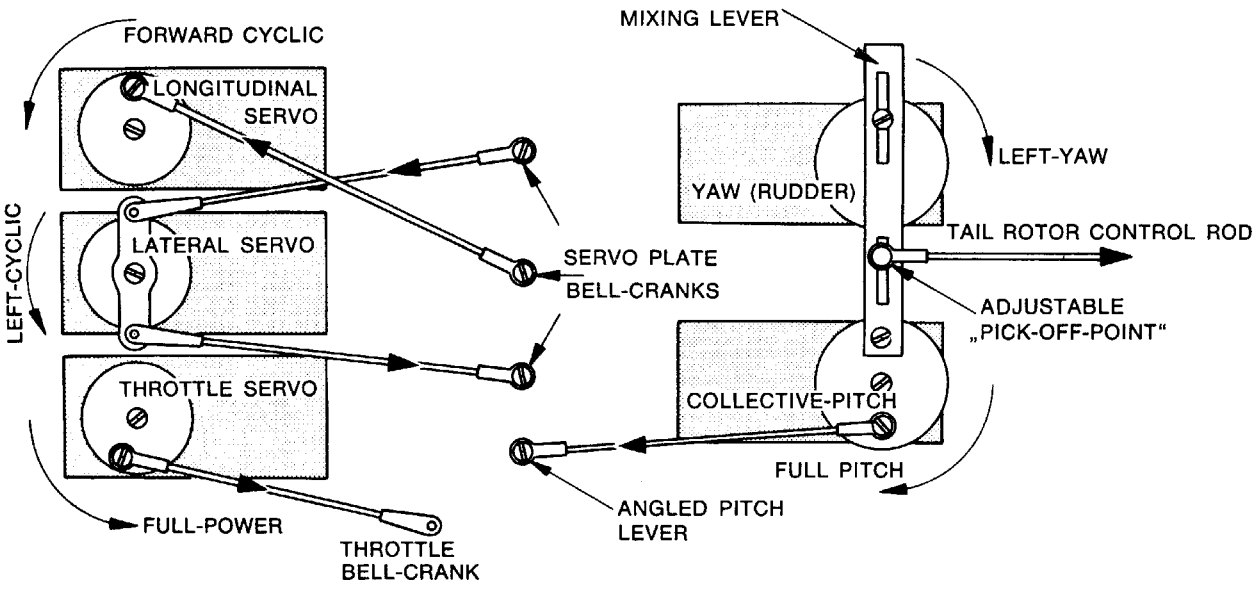
Don't forget the LOP (Loctite)! The top collar abuts the upper bearing, while the lower collar rests on the nylon-bearing, preventing movement in either direction.

27.( ) Control and cabin-top

Prepare the aluminum servo-base plate No. 3501. Referring to the full size plans, note the locations of the three (3) required servos. As it was in step No. 3, these locations are indicated by the dashed-lines, these openings must be made to accommodate your servos. Drill the servo mounting holes as required. The plate is also cut to the size and shape as indicated. Drill the eight (8) holes shown for the hinges with a No. 47 (.0785") drill. Using 2 x 8 mm pan head-screws and nuts secure the four (4) nylon hinges No. 3502 onto the servo mounting-side of the plate. Refer to Fig. 40.

28.( ) Servo mounting

The five (5) required servos should now be mounted. Three (3) servos: throttle, lateral and longitudinal control are mounted onto the aluminum servo-plate while the other two (2) servos collective and yaw control are mounted into their respective openings in former No. 9. The following sketch shows the location and rotation required for the various control functions of each servo. This view is shown looking down onto the control top, while the top is laying inverted on the work surface! Should the rotation of your servos not correspond to the sketch you may choose to change their rotation electrically or alter the connections. STUDY THE SKETCH THOROUGHLY BEFORE PROCEEDING WITH THE SERVO MOUNTING AND/OR ALTERING THE CONTROL ROD CONNECTIONS.




**SERVO ROTATION AND CONTROL LINKAGE**

29.( ) Mount the servo-plate (with servos attached) onto the cabin-top by inserting a bearing shaft No. 3504 through the two (2) nylon hinges at the servo end of the plate and the two (2) angled-brackets secured to former No. 9 (step No.9). Coat each end of this shaft with Epoxy-cement to prevent the shaft from shifting.

30.( ) Mount a brass-ball (part of a ball joint) onto each end of the three servo bell-cranks No. 3505 with a 2 x 10 mm pan head-screw, place a flat-washer between the brass-balls and the servo bell-crank. Install these bell-cranks, the angled pitch-level No. 3506 and the straight pitch-arm No. 3507 onto the servo-plate using the remaining bearing shaft No. 3504, installed through the nylon-hinges on the servo-plate. Secure the set-screws of the pitch-lever and pitch-arm. Refer to Fig. 41.

31.( ) Mount two (2) of the plastic ball-joints onto former No. 9 in their respective locations with 2 x 15 mm pan head-screws and plain-washers inserted from below the angled bearing-plate. Engage the ball-joints onto the sliding brass-balls fitted on the pitch-levers. Refer to Fig. 42. By moving the upper arm of the angled pitch-lever, the entire servo-plate should move freely, up and down, as it must control the collective-pitch of the main rotor blades.

32.( ) Install the supplied "Servo-out-put-arm/wheels" on the servos. The larger wheel (27 mm in diameter) are installed on the collective-pitch and yaw servos. The smaller wheels are installed on the throttle and longitudinal servos while the straight-arm is used on the lateral servo. Should the square mounting holes be too large for the drive-boss of your servos, use shim-stock around the boss to insure a snug fit.

33.( ) <u>Control Linkage</u>

Initially, all the servos must be in the NEUTRAL position. The collective-pitch and yaw servos are connected first. Mount a brass-ball onto the short center slot of the mixing-lever No. 3508 using a 2 x 10 mm screw and nut. Index the nut into the recess on the bottom of the mixing-lever, this holds the nut captive allowing adjustments later of this "pick-off-point" for tail rotor control.

The end of the mixing-lever with the single hole is mounted onto the out-put wheel of the collective-servo using a 6 x 8 mm flanged-bushing No. 3509 and a 2 x 12 mm screw. Use a flat-washer under the screw head. Thread the screw into the servo-wheel and lock it with a 2 mm nut. The other end of the mixing-lever with the long-slot is mounted in like manner, using another flanged-bushing onto the out-put wheel of the yaw servo. Refer to the servo sketch at task No. 28. The bushings must not bind or restrict the motion of the mixing-lever. To insure the proper amount of control motion, use the outer most holes of the servo-sheels.

34.( ) Install a plastic ball-joint onto one end of four (4) double threaded 2 x 82 mm rods No. 3510. Onto the other end of two (2) of these rods install a clevis No. 3140 (kwik-link). Install a complete ball-joint connector onto the remaining rod-ends. The center distance between these connectors should be approx. 95 mm (3.740"). Install these rods between the bell-cranks and the servos. Adjust the final lengths of the cyclic-control rods so

the horizontal-arms of the servo bell-cranks are parallel to the aluminum servo-plate. When installing the control-rod from the collective servo to the vertical arm of the angled-pitch lever, select a hole in the servo wheel that will provide 8 mm (.315") of TOTAL-TRAVEL for the three servo bell-cranks when measured between the top of former No. 9 and the brass-balls mounted at the ends of the servo bell-cranks. With the collective servo in the neutral position, the aluminum servo-plate must be parallel to former No. 9. When measuring the total-travel, the transmitter trim-lever should be in the full trim position, and the throttle control lever must be moved from full power and pitch to low power and pitch positions. The entire servo-plate must move up and down freely without binding. The throttle-servo connection will be made later on.

35.( ) Swash Plate

Onto the outer ring of the swash-plate install four (4) brass-balls in this manner: insert a 2 x 10 mm pan head-screw into the ball. Lock the brass-ball on with a 2 mm nut. Place a flat-washer on the projecting end of the screw and insert the screw into the hole of the swash-plate and secure with another 2 mm nut. Two (2) brass-balls are also installed on the inner ring of the swash-plate in like manner, except for these, omit the flat-washers and use 2 x 8 mm screws. Refer to Fig. 43.

Install a plastic ball-joint onto each end of three (3) 2 x 82 mm double threaded-rods. The center distance between the ball-joints should be 95 mm (3.740"). Insert these rods through their respective holes in the angled aluminum bearing-bracket and former No. 9. Engage one end of each rod onto the brass-balls fitted onto the end of the bell-cranks of the servo-plate. Install a plastic ball-joint onto the end of the single threaded-rod 2 x 82 mm. Engage this ball-joint onto one of the brass-balls fitted on the outer-ring of the swash-plate. Now slide the swash-plate onto the main rotor shaft. The attached rod (drag link) is inserted into the narrow slot at the top, rear, of the aluminum angled bearing-bracket and into the small hole of former No. 9 between the collective and yaw servos. Also engage the remaining three (3) brass-balls on the swash-plate into the plastic ball-joint ends of the control-rods attached to the servo bell-cranks. Refer to Fig. 66.

36.( ) At this time bench-test and adjust the control functions of the swash-plate. Read the following carefully! Connect the servos to the radio system so they are operable. Position the transmitter control-sticks and trim-levers as follows:

TRIM-LEVERS: Longitudinal-cyclic (forward and reverse) in full reverse. Lateral-cyclic (left and right) in neutral. Throttle/collective full or high trim.

CONTROL-STICKS: Longitudinal/lateral-cyclic in the neutral position. Throttle/collective in the full power and full pitch position. Yaw (rudder) in the neutral position.

Turn on the radio system. At the above settings the swash-plate MUST BE PERPENDICULAR to the main rotor shaft! If not, adjust the lengths of the control rods to achieve this perpendicular position.

Now operate the throttle/collective control-stick, the swash-plate must slide down the main rotor shaft 8 mm (.314") or just over 5/16". This will coincide with the required pitch change from the Zero-Degrees to the Six-Degrees positive for the main rotor blades. If the movement of the swash-plate is less, select another hole on the servo-wheel of the collective-pitch servo to achieve this amount of movement.

Next, test the control action of the swash-plate. Place the cabin-top in its normal operating position and position yourself directly behind the cabin-top so you can see the movements of the swash-plate. Move the longitudinal/lateral control-stick forward, towards the top of the transmitter, the swash-plate must tilt forward, or away from you. Move the control-stick down or to the reverse position, the swash-plate must tilt towards you. In like manner, moving the control-stick laterally to the left, the swash-plate must tilt towards the left. Moving the control-stick to the right, the swash-plate must tilt towards the right. If the swash-plate does not follow the control-stick movements, interchange the connections at the servo out-put wheels as required. The total amount of angular deflection required at the ball-joints of the swash-plate can be measured from full-forward to full-reverse as well as from full-left to full-right,this should be 6 mm (.236"). These adjustments can also be made at the servo-wheels if required.

While making these tests be certain that the drag-link is not retracted from its hole in former No. 9, when the swash-plate is deflected towards the front and the collective is in the full position Also be sure the drag-link rod does not contact the mixing-lever when the swash-plate is deflected rearward at the collective is in the lowest position.

37.( ) Assemble the guide No. 3219 by cementing (Epoxy) the four (4) 1.5 mm rods No. 3220 into the holes provided. Install the 3 mm set-screws and temporarily secure the guide into position on the main rotor shaft. Do not secure the screws at this time, this will be done later when adjusting the main rotor blades. Refer to Fig. 44.

38.( ) Tail rotor assembly

Mount a brass-ball onto the tail rotor bell-crank No. 3405 with a 2 x 12 mm pan head-screw. Place a flat-washer between the ball and the bell-crank. Mount the bell-crank onto the tail rotor transmission using a 2 x 12 mm screw, flat washer and bushing No. 3124. Use a 2 mm nut to lock the screw after it has been turned into its threaded hole.

Mount a brass-ball onto the control-bushing No. 3408, use a 2 x 6 mm screw and apply a bit of epoxy-cement to the threads to secure it. (This hole is slightly off-center). Slide the bushing onto the long-bushing No. 3407. Place the special-washer No. 3409 on the projectin end of the long-bushing and then place the nylon control-plate No. 3410, shouldered-end first, against the washer. Using a bit of epoxy-cement, cement the control-plate to the long-bushing making a small fillet, so when cured, the control-bushing is free to rotate on the long-bushing with very little end play. Refer to Fig. 45.

Cut approximately 2 mm (.080") (at the end of the projecting ridges) off the rod end of two (2) plastic ball-joints, and using 2 x 8 mm screws secure these ball-joints to the nylon control-plate projecting away from the control-bushing. This assembly can now be slid onto the out-put shaft of the tail rotor transmission. Refer to Fig. 45.

39.( ) Mount a brass-ball onto each of the tail rotor blade-retainers No. 3423 with 2 x 10 mm screws, place a flat-washer between the brass-balls and blade-retainers. Use a bit of epoxy-cement on the screw-threads. Refer to Fig. 47.

40.( ) The assembled blade-retainers and mounting-hub can now be installed on the tail rotor drive shaft No. 3404 by inserting the steel pin No. 3413 through the hole in the hub and the drive-shaft. The pin is secured in place with a 3 x 3 mm set-screw, turned into the end of the drive-shaft. Engage the balls on the retainers into the plastic ball-joints on the control-plate. Refer to Fig. 48.

41.( ) Make the control-rod for the tail rotor blades using the short threaded-rod 2 x 40 mm,on one end install a regular plastic ball-joint and on the other end install a plastic ball-joint, of which approximately 2 mm (.080") has been removed. The center-distance of these ball-joints should be 55 mm (2.165"). The cut down ball-joint engages the ball on the control-bushing, while the regular ball-joint engages the ball on the tail rotor bell-crank.

42.( ) Install the completed tail rotor transmission and control assembly into position on former No. 12. Mount the cabin-top on the body-shell and assemble the tail rotor control-rod No. 3420. The collective-pitch and yaw servos must be in the neutral position and the tail rotor bell-crank must be in its neutral position. Refer to Fig. No. 49. The bell-crank is shown in its neutral position.

Solder a threaded-coupler No. 3419 to one end of the tail rotor control rod No. 3420 and thread a clevis (kwik-link) onto the coupler. Insert this control rod onto its guide-tube No. 3421. From the aft-end of the tail-boom insert the control rod and guide-tube through the hole in former No. 11 and 10. Engage the clevis into the end-hole of the tail rotor bell-crank. When properly located, epoxy the guide-tube to former No. 10.

Thread a plastic ball-joint onto the remaining threaded-coupler and engage this ball-joint onto the "pick-off-point" ball on the mixing-lever of the collective and yaw servos. Using the coupler as guide mark the control-rod for length, allowing for that portion which is needed for soldering. Remove the cabin-top. Remove the plastic ball-joint and solder the threaded-coupler to the control-rod. Assemble and test the function of the control rod as follows:

Set the collective-pitch servo to its full-trim neutral-stick position. The yaw control servo should be at its neutral-trim and neutral-stick position. The tail rotor bell-crank must be in the neutral position at this time. Move the yaw control-stick to its extreme left-position, the control assembly on the tail rotor drive-shaft should slide towards the left or away from the tail-boom 4 mm (.157"), (or approximately 5/32-inch).

Moving the control-stick to the extreme right-position the control assembly should slide to the right or towards the tail-boom. The total-travel of the control assembly should be then 8 mm (.314" or just over 5/16-inch). Should more movement be required, move the clevis connection at the tail rotor bell-crank closer to its pivot point. The actual pitch for the tail rotor blades will be adjusted later. Install the fuselage end-cap and ascertain that the movement of the bell-crank is not restricted by the end-cap.

43.( ) Main Rotor Head

For your convenience and to insure the proper alignment, the major portions of the rotor head assembly have been factory-done. The remaining tasks are quite simple, but read carefully, follow the assembly steps as directed, and use extreme care, for the centrifugal forces involved produce very high stresses. Use only those components supplied, DO NOT substitute parts or bolts, etc.

Insert the main rotor hub No. 3301, into the center hole of the blade retainer seesaw No. 3302 and insert the bearing-pin No. 3303 through the side-holes of the seesaw and into the hole of the hub. Center the bearing-pin in the hub and temporarily secure the bearing-pin with a 3 x 8 mm set-screw turned into the threaded hole on one side of the hub. Place the two (2) needle-bearings No. 3304 onto the projecting ends of the bearing-pin and into the holes of the seesaw. Center the seesaw with the hub and carefully epoxy the needle-bearings to the seesaw. The epoxy should form a small fillet around the outer cage of the bearings. DO NOT ALLOW the epoxy to contact the needles of the bearings. The inner end of the bearings should contact the main rotor hub. Degrease all parts before cementing. Refer to Fig. 50.

44.( ) The stabilizer-seesaw No. 3316 is installed in a similar manner, but instead of needle bearings the bronze-bushings No. 3315 are used. These bushings are to be SOLDERED to the main rotor hub, not cemented!!! The stabilizer-seesaw bearing-pin No. 3314 is temporarily secured with a 3 x 3 mm socket head set-screw installed into the threaded hole on the top of the stabilizer-seesaw. Refer to Fig. 51.

45.( ) Solder a brass-ball onto the narrow ends of the two (2) pitch-arms No. 3310. Rough up the other ends of the pitch-arms and epoxy them into the angled holes at the inboard ends of the blade retainers. Refer to Fig. 52.

46.( ) Install the two (2) stabilizer-rods No. 3317 into the ends of the stabilizer-seesaw. Secure the rods using 4 x 5 mm socket head set-screws. Be certain that these set-screws engage the narrow groove near the ends of the stabilizer-rods. The aerodynamic damping blades No. 3318 are then threaded onto the stabilizer-rods. Note that only a portion of the holes through the blades are threaded. This will be the outboard end of the blades. Screw these blades on as far as they will go while still maintaining the proper direction for the airfoil of the blades with regard to rotation. When viewed from above the rotation of the main rotor head is counter-clock wise. The centerline of the airfoil must be perpendicular to the main rotor hub before locking the blades in position with 4 mm elastic stop-nuts. Balance the en-

tire stabilizer assembly by turning one of the blades further onto or off the stabilizer-rod. The stabilizer, when in balance, should be level or perpendicular to the main rotor hub (shaft). Refer to Fig. 53 and 54.

47.( ) Remove 2 mm (.080") from the rod ends of four (4) plastic ball-joints. Install these ball-joints onto two (2) threaded rods 2 x 17 mm. Thread the ball-joints until the ends of ball-joints contact each other. These assemblies are then installed so one end engages the inner most brass-ball of the mixing-levers of the stabilizer-seesaw while the other end engages the brass-ball soldered to the blade retainer pitch arms No. 3310.

The main rotor assembly may be set aside until needed for balancing the main rotor blades and final assembly.

48.( ) Main Rotor Blades

Cement the shaped and notched leading and trailing-edges together with white-glue. Use masking tape to hold these parts together. Lay the blades on a flat work surface. Use a few small weights to keep the blades straight while curing. Check the alignment of the leading and trailing edges to insure symmetry. Refer to Fig. 55.

Before cutting the hardwood reinforcements from the preshaped blank, scribe a centerline on the top surface of the blank, 14 mm (.551") from its leading-edge (the thicker edge). This will be the working centerline. Note that pairs, rights and lefts are required before cutting. DO NOT drill nor notch these reinforcements at this time.

When the blades are cured, trim and sand the balsa portions to the symmetrical airfoil shape as detailed on the plans. Scribe a center-line on both sides of the blades 17 mm (.669") aft of the leading-edge.

Using white-glue, cement the reinforcements onto the blades, carefully aligning the scribed centerlines of the reinforcements to the centerlines scribed on the blades. Use C-clamps to secure until cured. IF PROPERLY SCRIBED AND ALIGNED THE SURFACES OF THE REINFORCEMENTS SHOULD BE PARALLEL TO EACH OTHER!!!

Carefully locate and drill the 7 mm (.275") holes for the mounting bushings No. 3323. If you do not have a 7 mm drill use a small size drill and ream the hole to fit the bushing. This is to be a snug-fit, not a force-fit!! Trim and notch the root ends of the blades and epoxy the steel blade tongues No. 3322 in place. DO NOT force-fit the blade tongues. Trim the blades to length as shown: 735 mm (or 28 15/16"). This is the over-all length. Refer to Fig. 55.

49.( ) Balancing the Main Rotor Blades

In simple terms, the blades must be of equal weight, and the center-of-gravity (or balancing point) must be in the same location for each blade.

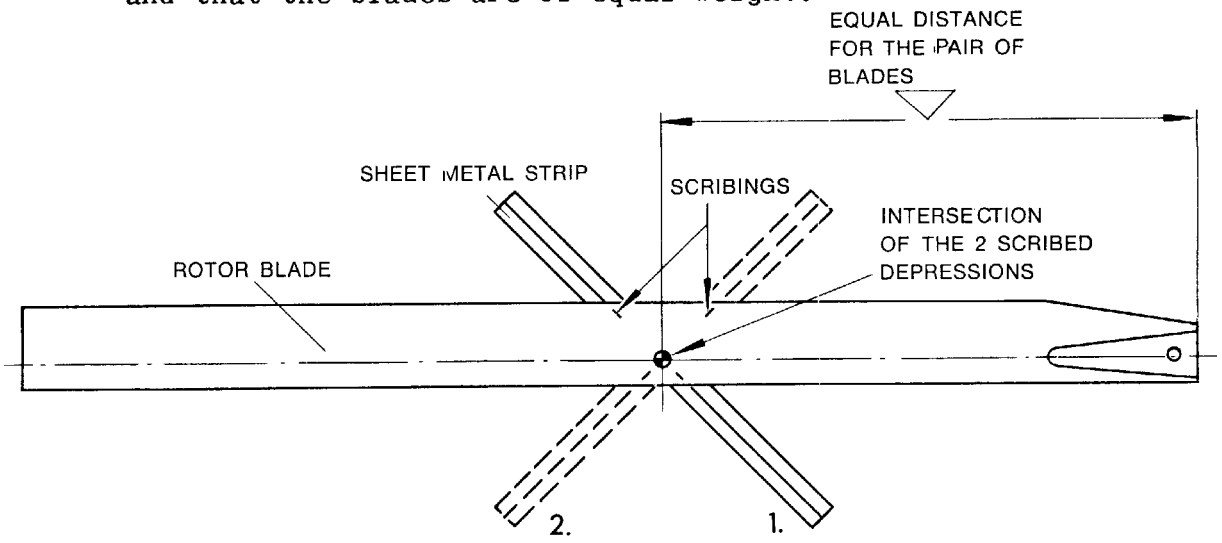
Carefully weigh each blade and determine which of the blades is lighter. If the difference is very slight (a few grams only) an additional amount of sanding on the heavy blade can make the weights equal. If the difference is more than a few grams, we have provided some lead-shot, from which you may select one or more, so when added to the weight of the lighter blade, the total equals the weight of the heavier blade. Before drilling the light blade and cementing the

lead-shot into place, the center-of-gravity of each blade must be located.

Place the supplied sheet metal strip in a vise sharp edge up. Now place the heavier of the main rotor blades top surface up onto the sharp edge of the metal strip. The blade should be at a 45 degree angle to the metal strip. Adjust the blade until it balances level. When it does, apply a bit of pressure on the blade so the sharp edge scribes a slight depression into the wood. Next, rotate the blade 90 degrees (horizontally) and repeat the balancing and scribing process. When the blade is removed and inverted, the intersection of the two (2) scribed depressions indicate the exact static center-of-gravity of this blade. See sketch below.

Repeat the process on the remaining lighter blade comparing the now scribed center-of-gravity lines will indicate where to position the lead-shot into the lighter blade, so when completed the center-of-gravity for each blade is at the same location along the length of the blades. The lead-shot may be attached, for trial, with masking tape to the light blade. While the blade is rebalanced on the sharp edge, adjust the location of the lead-shot until the desired center-of-gravity location is achieved. Drill a hole into the blade leading-edge along the scribed center-line and epoxy the lead-shot in place.

NOTE: The location of the actual center-of-gravity when measured from the blade end is not important. The only important thing is that this location is the same for both blades, and that the blades are of equal weight.



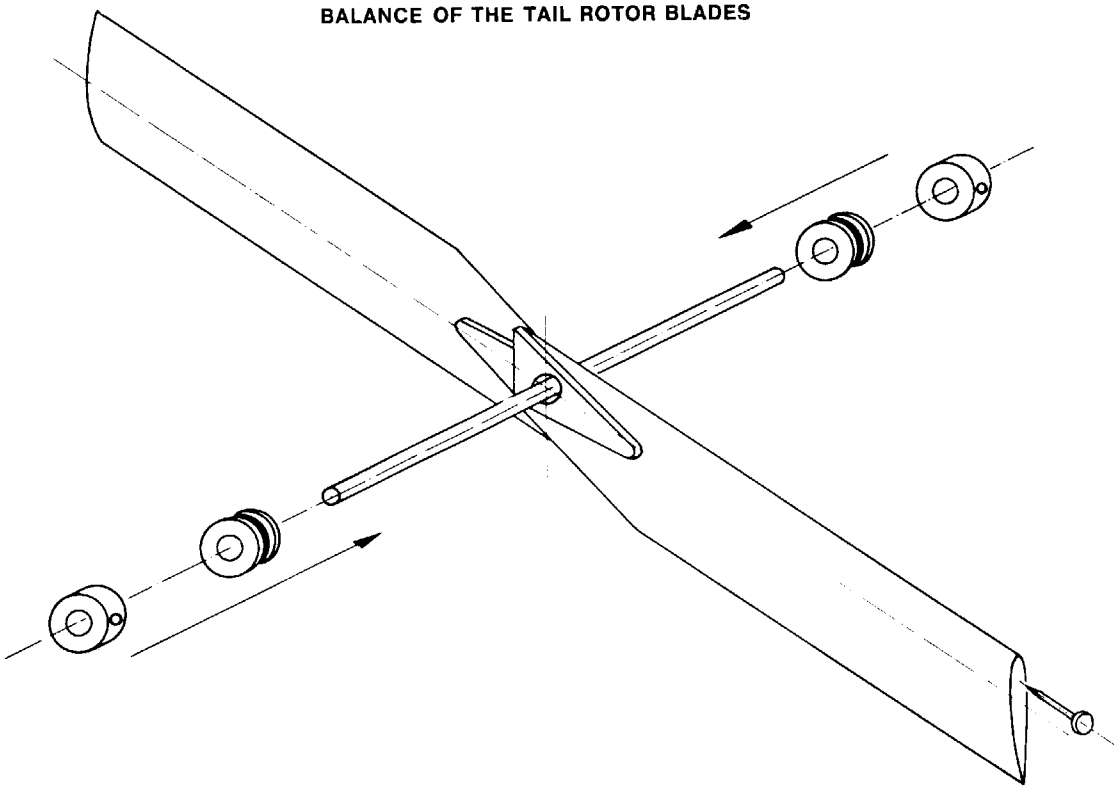

LOCATING THE CENTER OF GRAVITY

50.( ) Tail Rotor Blades

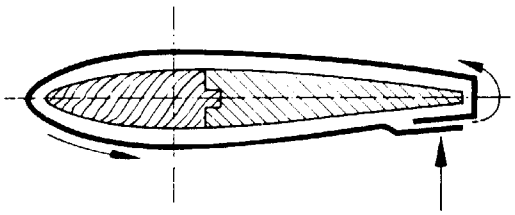
Shown on the full size plans, cut pairs of reinforcements from the shaped hardwood stock. Using white-glue cement these reinforcements to the airfoiled tail rotor blade stock. Fig. 56. Trim the blades to length 115 mm (or 4 1/2") and drill a No. 31 (.120") hole for the mounting-bolt. The blades are then balanced by inserting 3 mm diameter shafts into the holes of the blades. Slide a small rubber grommet and wheel collar over each end of the shaft. By squeezing against the collars and securing their set-screws, the blades are held in a parallel position. Set the shaft across a pair of parallel plates (i.e.: the jaws of a vise etc.), the blades should balance in a level position. Sand the heavier

blade to balance. See sketch below. The blades can then be sealed and painted. Recheck the balance again after painting. Add weight to the lighter blade by inserting a small nail or pin into the end of the lighter blade. Coat the nail with epoxy cement first. A narrow strip of tape or monocote may also be used to weight the lighter blade.

BALANCE OF THE TAIL ROTOR BLADES

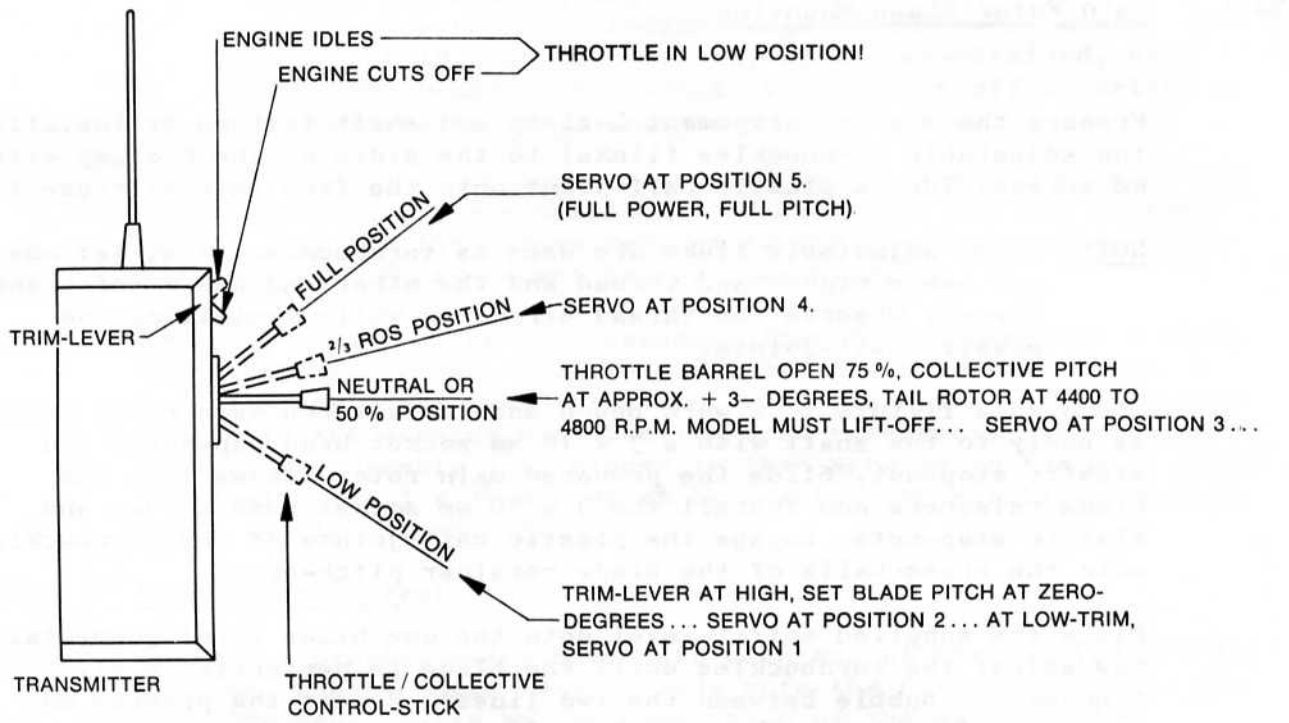


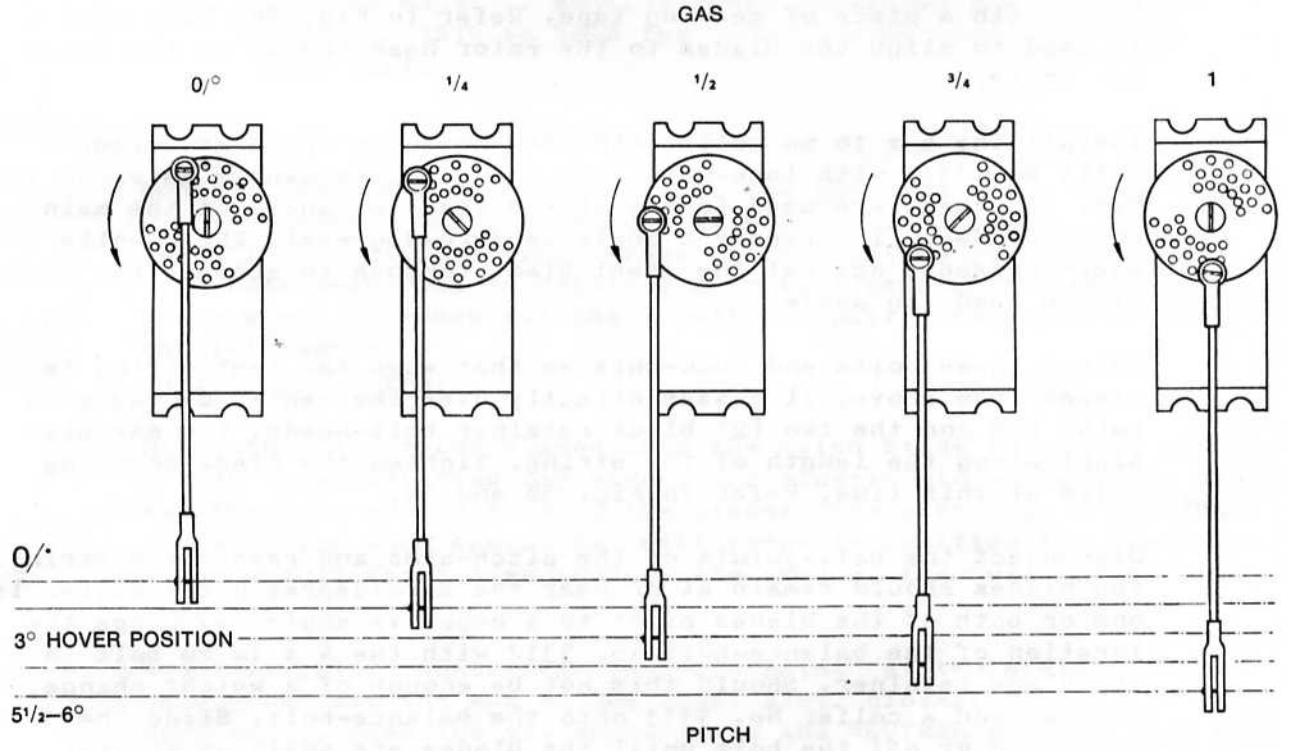
COVERING THE MAIN ROTOR BLADES



51.( ) Covering the Main Rotor Blades

The blades are covered with the supplied self-adhesive covering sheet from the tips to the outboard ends of the hardwood-reinforcements. To properly cover the blades, approximately 3/8" of an inch of the sheet is first attached to the bottom of the blades at the trailing-edge and wrapped around the trailing edge, over the top of the blade around the leading-edge and terminates by over-lapping the sheet at the bottom near the trailing-edge. This positions the seam properly with the air-flow. See above drawing of blade covering. The remaining portion of blades can be given a light coat of sealer or paint. As an aid to blade tracking later on, paint or monocote the ends of the blades in contrasting, different colors: i.e. one red and one blue, etc.


ENGINE IDLES
ENGINE CUTS OFF
THROTTLE IN LOW POSITION!
SERVO AT POSITION 5.
(FULL POWER, FULL PITCH)
FULL POSITION
SERVO AT POSITION 4.
TRIM-LEVER
2/3 ROS POSITION
THROTTLE BARREL OPEN 75 %, COLLECTIVE PITCH
AT APPROX. + 3– DEGREES, TAIL ROTOR AT 4400 TO
4800 R.P.M. MODEL MUST LIFT-OFF... SERVO AT POSITION 3...
NEUTRAL OR
50 % POSITION
LOW POSITION
TRIM-LEVER AT HIGH, SET BLADE PITCH AT ZERO-
DEGREES... SERVO AT POSITION 2... AT LOW-TRIM,
SERVO AT POSITION 1
TRANSMITTER
THROTTLE / COLLECTIVE
CONTROL-STICK


GAS
0/°
1/4
1/2
3/4
1
0/°
3° HOVER POSITION
5 1/2–6°
PITCH

52.( ) Main Rotor Blade Mounting

Prepare the special alignment C-clamp and shaft fixture by installing the adjustable turnbuckles (links) to the sides of the C-clamp with 2 mm screws. Turn a plastic ball-joint onto the free ends of these links.

NOTE: These adjustable links are used as turnbuckles, that is: one end has a right-hand thread and the other end has a left-hand thread. Observe the thread direction while installing the plastic ball-joints.

Clamp this fixture to a work bench and install the main rotor head assembly to the shaft with a 3 x 18 mm socket head cap-screw and elastic stop-nut. Slide the prepared main rotor blades into the blade retainers and install the 3 x 30 mm socket head-screws and elastic stop-nuts. Engage the plastic ball-joints of the turnbuckles onto the brass-balls of the blade retainer pitch-arms.

Place the supplied spirit-level onto the one blade reinforcements. Now adjust the turnbuckles until the blade is perfectly level. (Center the bubble between the two lines). Repeat the process on the remaining blade. Refer to Fig. 57.

The blades are now at Zero-degrees, pitch angle or incidence.

At the tip of each blade, make a small slot or saw cut 17 mm (.669"), aft of the leading-edge. Stretch the supplied nylon string across the length of the blades, fit the string into the slots at the ends of the blades and secure the string under each blade with a piece of masking tape. Refer to Fig. 58. This string is used to align the blades to the rotor head (known as the lead-lag angle).

Install the 4 x 16 mm bolts with lock-nuts and the 4 mm balance-bolts No. 3312 with lock-nuts into the blade retainers as shown in Fig. 59. These are used to adjust the lead-lag angle of the main rotor blades. (The required angle is Zero-degrees). These bolts exert pressure against the steel blade tongues to achieve the Zero-degree lead-lag angle.

Adjust these bolts and lock-nuts so that when the taut string is viewed from above, it passes directly over the center of the main rotor hub and the two (2) blade retainer bolt-heads. You may also sight along the length of the string. Tighten the blade mounting bolts at this time. Refer to Fig. 58 and 59.

Disconnect the ball-joints of the pitch-arms and remove the string. The blades should remain at or near the Zero-degree pitch angle. If one or both of the blades pivot to a negative angle, exchange the location of the balance-bolt No. 3312 with the 4 x 16 mm bolt in the blade retainer. Should this not be enough of a weight change, you may add a collar No. 3313 onto the balance-bolt. Slide the collar on or off the bolt until the blades are again at or near the Zero-degree pitch angle. Refer to Fig. 61.

NOTE: It is not uncommon to have one of the balance-bolts projecting towards the leading-edge of one blade and the other bolt projecting towards the trailing-edge of the other blade. What is important is that both blades, while unrestrained, REST AT OR NEAR ZERO-DEGREE PITCH ANGLE. You may cut off a portion of the balance-bolts to achieve this condition.

53.( ) Should the main rotor seesaw tend to lean toward one side or the other, you may place a small nail or brad into the end of the higher blade so the seesaw returns to its level position. Coat the nail with Epoxy-cement before inserting.

54.( ) Remove the main rotor head assembly from the fixture and install the rubber damper No. 3326 into the main rotor blade seesaw. A bit of soapy water aids insertion. Be certain all the set screws and bolts are secured with Loctite upon reassembly. The entire main rotor assembly with blades is then secured to the main rotor shaft with the 3 x 18 mm socket head-screw and elastic stop-nut. Refer to Fig. 62 and 63.

55.( ) Main Rotor Control

Install a plastic ball-joint onto each end of the two (2) 2 x 145 mm rods, engage these control-rods onto the blade pitch-arms and onto the brass-balls on the inner ring of the swash-plate.

NOTE: Adjust the lengths of these rods so that when the throttle trim-lever is in the full or high position and the throttle/collective control-stick is in the lowest or idle position, the main rotor blades must be set to a Zero-Degree Pitch setting. Use the spirit-level placed on the blade-reinforcements to confirm this Zero-degree pitch-angle, also be certain the model is setting level. Position and secure the guide No. 3219 to hold the control-rods parallel to the main rotor shaft.

56.( ) Throttle/Collective Control

Connect the throttle bell-crank to the throttle servo using a short threaded-rod, a plastic ball-joint and a clevis. The throttle-barrel positions versus the collective-pitch settings have been described in details. A typical connection onto a servo wheel is shown for the non-linear action required of the throttle servo.

57.( ) Tail Rotor Control

Mount the tail rotor blades into the nylon blade retainers with 3 x 18 mm socket head cap-screws and elastic stop-nuts. Only tighten the nuts enough to hold the blades from pivoting. Centrifugal force, later when operating, will properly position the blades. Also, should the blades contact the ground, they will pivot without breaking.

The ball-joint connection "pick-off point" at the mixing-lever should be near the end of the short-slot, closest to the yaw (rudder) servo. When the yaw servo is in the NEUTRAL position and the collective is at its extreme low position, the pitch of the tail rotor blades should be set at ZERO-degrees. This adjustment is made on the short control-rod between the tail rotor bell-crank and the control-bushing, NOT at the tail rotor bell-crank which should also be in a NEUTRAL position. See step 42.

58.( ) Completion

Make the permanent radio and fuel-system installations. Connect wires to the glow-plug clip, ground-lug and external connector No. 3143. Trim and cement the windows in place. Make the front side windows removable as detailed in Fig. 39. We also recommend that until the model is test flown and the final adjustments established, you leave the large window on the right side of the model out.

When everything is installed test the model for balance. Loop a wire or stout cord around the main rotor hub, under the stabilizer-seesaw. Position the stabilizer-rods parallel to the centerline of the model. When the model is supported by the wire or cord, the top of the tail-boom should be level. This can be checked with the small spirit-level.

Thoroughly inspect the entire model to be certain that everything is secure and in its proper location. Page through the Instruction Manual. All the steps to this point should be checked off, if not, ascertain that all the tasks have been complied with.

Lubicate all the moving parts and bearings using the pen-lubricator supplied in the kit with 3 in 1 oil or equal. A reminder: Good lubrication is less time consuming and costly than replacements!

PLEASE READ CAREFULLY!!!

There is a very important factor which R/C helicopter pilots must keep in mind at all times: The energy or centrifugal forces of the main rotor blades is almost unbelievable and certainly worthy of much respect and caution. The tip-speed of the blades in operation will be in excess of 170 miles per hour! This striking force is approximately 200 to 250 pounds easily capable of inflicting serious injuries! Please take precautionary measures during practice or demonstration flights, and strictly avoid operating near or over spectators and well wishers. Help keep this a safe and enjoyable hobby/sport.....

Before proceeding with the test flying, the builder should fully understand some of the operational features of the Kavan Jet Ranger.

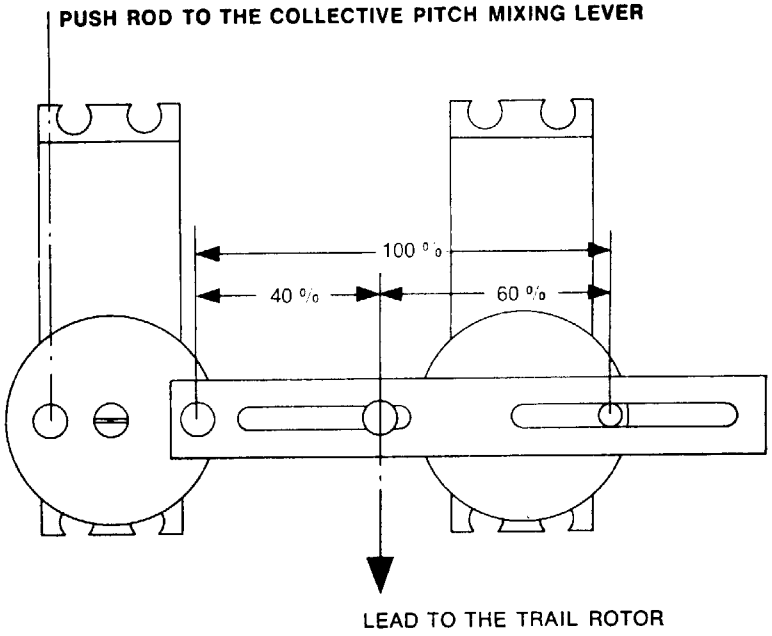
Mixing-Lever and Pick-Off-Point

In normal operation the collective-pitch (blade angle) of main rotor blades is for the most part constantly being adjusted, thereby changing the lift-thrust being produced by the blades. As this thrust changes, the torque against the helicopter also changes. As the main rotor blades turn in a counter-clock wise direction torque effects on the helicopter tend to make the helicopter turn in the clockwise direction. The tail rotor is used to counteract this torque. When the thrust of the tail rotor blades equals the torque effect on the helicopter imposed by the main rotor the helicopter remain stable or pointed in one direction.

In simple terms, as the collective-pitch changes so does the torque against the helicopter's fuselage. To hold the fuselage stable, the tail rotor's thrust must be adjusted proportionally to counteract this torque.

When properly adjusted, the mixing-lever does this adjusting for the most part, automatically. As the mixing-lever is connected to the collective-pitch servo for any change in collective: There is corrective control action transmitted to the tail rotor, thereby cancelling out the changing torque on the fuselage. Due to the variables in engines and rotor-torque etc., the amount of collective control required at the tail rotor can be adjusted by changing or moving the "pick-off-point" connection on the mixing-lever. We have established only a general starting point in locating the pick-off-point. The builder will have to adjust this point through experience and experimentation once the actual test flying begins.

As the mixing-lever is also connected to the yaw servo, full control for rotating the helicopter is always available through the yaw servo's control. See sketch below.




## SUPPLEMENTARY ACCESSORIES

Electrical Fuel Control Article No. 3906

This warning device is highly recommended for any RC helicopter. It will warn you in time when the fuel level drops to the minimum. This unit prevents crashes due to lack of fuel and consequently may spare you much agony and financial loss.

For additional safety, this unit is equipped with dual bulbs and colored lenses. Should one light fail for some reason, then there is still one in reserve to do the job. The warning lights are fed with electricity from a 4.8 Volt battery over a sensor built into the fuel tank. This fuel level warning device may also be used in other models, boats and aircraft.

Position Blinking Lights Article No. 3904

This unit will give your KAVAN Bell Jet Ranger true to scale appearance. A must for scale enthusiasts! The battery, which feeds the electrical fuel control, above, also supplies this unit with sufficient electricity. The package consists of two bulbs, the fittings, and the corresponding lenses.

Cockpit Article No. 3913

This beautiful article is printed in 3 colors (fuel-proof) and equipped with a scale plastic screen.

Pilot Article No. 3911

Handpainted, sitting position Especially fitted for the Jet Ranger.

Heat Sink Article No. 3910

| | | | |
|---|---|---|---|
| No. 1 | Supt. G 60 - Fi<br>Supt. ST 51 - 60<br>Enya 60/III<br>Veco 61 - USA<br>O.P.S. 60<br>Webra 61 Speed | No. 2 | Webra 61<br>Veco 61 (Germany<br>O.S. Max 60 |
| | | No. 3 | Merco 49 - 61<br>Taipan 61 |
| | | No. 4 | H.P. 61 |

Silencer Adapter Article No. 110

Your Jet Ranger kit contains a specially developed and designed silencer. Please see your favorite hobby dealer and ask for the KAVAN adapter to fit the engine you plan to use in the model. Note the following adapter Nos. for the engines in question:

| | | | |
|---|---|---|---|
| No. 0 | Supt. St 61-60 | No. 6 | Taipan 61 |
| " 1 | Supt. G 60 Fi | " 12/15 | Enya 60 |
| " 2 | O.S. Max 60 | " 4/11 | Merco 61 |
| " 3 | Webra 61 | " 16 | H.P. 61 F. |
| " 3 | Veco 61 Germany | " 21 | Supt. G 60 Fi New |
| " 14 | Veco 61 - USA | " 22 | Webra 61 Speed |

KAVAN Fuel Tank 400 ccm Article No. 31

KAVAN Fuel Filter Article No. 19

This item insures troublefree performance for your engine.

KAVAN Gyroscope Article No. 3901

The Kavan Bell Jet Ranger is so contructed that it has the maximum flying abilities. With exact trim you are even able to execute free-flights. However, until the pilot has reached much proficiency that he can control the RC helicopter perfectly, it is of great help for him to fly with the electric KAVAN gyroscope-stabilizer.

The gyroscope dampens the movement around the vertical axis by 80 %, i.e. it prevents a quick or strong turn of the fuselage out of the position that it has taken by starting into the wind, and just this movement is the greatest difficulty for the beginner as it is a reaction not known with fixed wing models.

The gyroscope is connected to the tail rotor servo and when the helicopter moves around its vertical axis the control from the gyroscope comes directly to this servo. Thus the helicopter remains in its position which makes the KAVAN gyroscope nearly indispensable for the first training with any RC helicopter.

Floats Article No. 3914

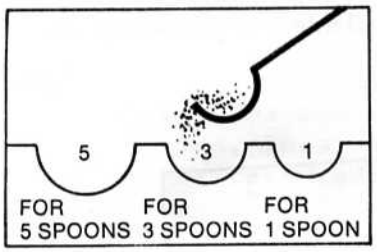
This item will open completely new dimensions for the RC helicopter pilot, permitting him to fly near or over the water. The floats can be simply and easily attached to the landing gear of the craft.

## HANDY HINTS

In the course of the further development of the KAVAN Bell Jet Ranger the following handy hints according to experiences are given as well as technical improvements for the benefit of the flying characteristics, currently enlarged.

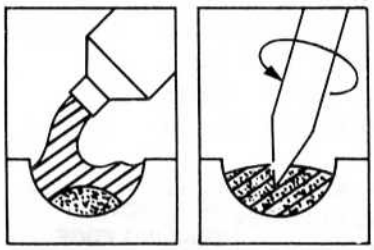
First some hints for the Stabilit Express:

### 1) Stabilit Express (Instructions)




1. Parts to be glued must be completely clean and free of oils etc. (use alcohol, aceton etc. to degrease). Sand and leave surface slightly rough if possible.

2. Depending on how much epoxy you need, take either one, three or five spoons full of the hardener in powder form (part B) and place it into the holes marked 1, 3 or 5.



3. Fill the remainder of the hole with resin (part A)

4. Mix thoroughly, using the tapered end of the spatula.

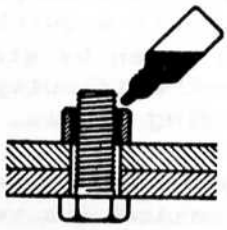
5. Apply this mixture to both parts which you want glued and hold parts in place with pins, clamps or tape, until cement has set (approx. 20 min.).

6. Cured particles of Stabilit Express may easily be removed from the holes of of the mixer by pushing against it from the bottom with your thumb.

2) Curing Data: Micture has a working time of 8 minutes. Completely cured for maximum strength after 1 hour (500 lbs/ccm).

Mix only the amount you need to work with at one time. Arrange the parts which have to be epoxied in such a manner that you can work rapidly. Avoid waste - the package enclosed is ample for the kit.

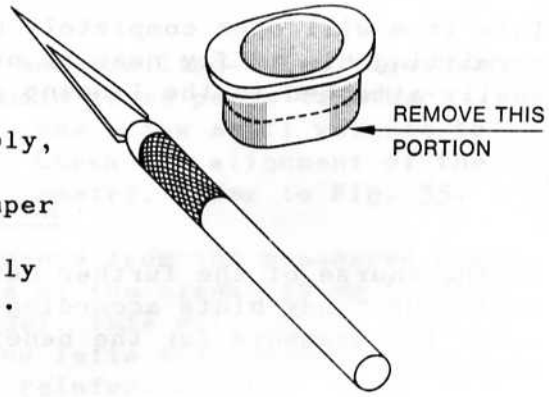
## 3) LOP (Instructions)



All bolts which should be secured with Lop must be degreased and cleaned thoroughly with solvent. Apply a small amount of Lop to the threads where the nut is and tighten same. In this manner the nut is secured against vibrations, yet it can be removed easily any time.

Although we follow rigid inspection procedures for all factory-assemblied components to insure that Lop (Loctite) is used on all screws, bolts and nuts. Please inspect these fasteners. Should traces of Loctite not be visible and evident, undo these fasteners, apply Loctite, and reassamble as a precautionary safety-measure....

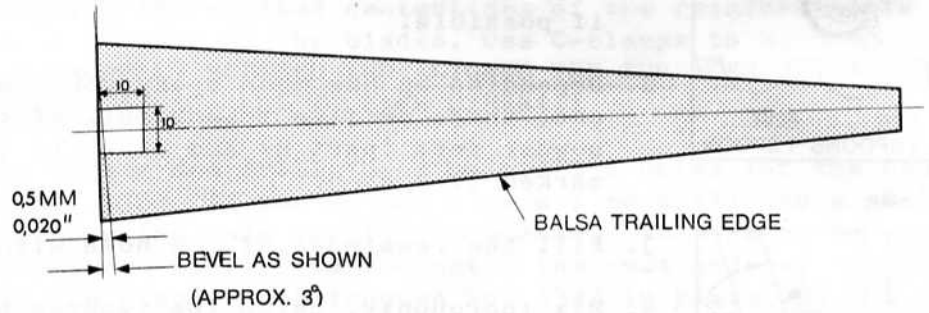
## 4) Main Rotor Assembly

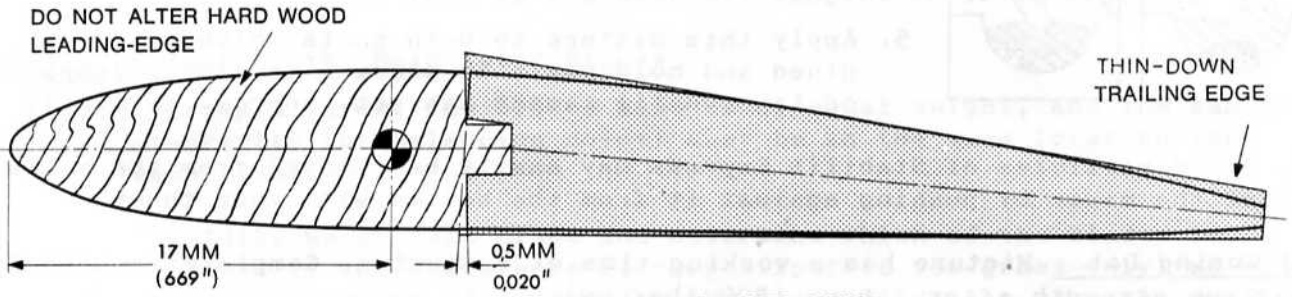



The rubber damper of the main-seesaw assembly, may be cut down as shown here. Remove 1/4" (6.3 mm), from the lower portion of the damper thus allowing the main rotor blades to flap further and with less restraint. Cut carefully and maintain a straight, flat bottom surface.

## 5) Revision of the Main Rotor Blades

For those modelers operating the Jet Ranger in areas of high-altitudes or areas which experience high-desity-altitudes, 3000 ft. and above, we have asked Dr. Wortmann to recalculate the airfoil of the main rotor blades. The new composite, computer-design, shows that only a slight modification is required to the original blade-airfoil. We have included a drawing of this modification.




**REVISED AIRFOIL**

6) It's a good idea to have an extra set of blades around, it's also just easy to build two sets as it is to build one, it's certainly faster th building them separately..... (Should you ever break one blade, DO NOT arbitrarily, use a single replacement blade from a reserve set! Both blades MUST be of equal weight and center of gravity location).

7) A few small cup-screws (hooks) turned into the cabin-floor No.8, and rubber bands work well to secure the fuel tank. Place the tank on a fo rubber pad to prevent foaming.....

8) It is highly recommended that at least once a month the servos are dis assembled and the potentiometer cleaned thoroughly.

9) We recommend that you guide the tail rotor shaft No. 3422 into a brass tube or nylon tube of about 24" and mount same at the tail end of the fuselage.

10) Engine over-heating may also be a problem in these high-altitude areas this may be overcome by using an engine-fuel of low nitro-content (10 or less), and the installation of the accessory: heat-sink on the engi

Please sand off the cylinder head so that the anodized particles are re moved so that the heat-sink may have better contact with the head.

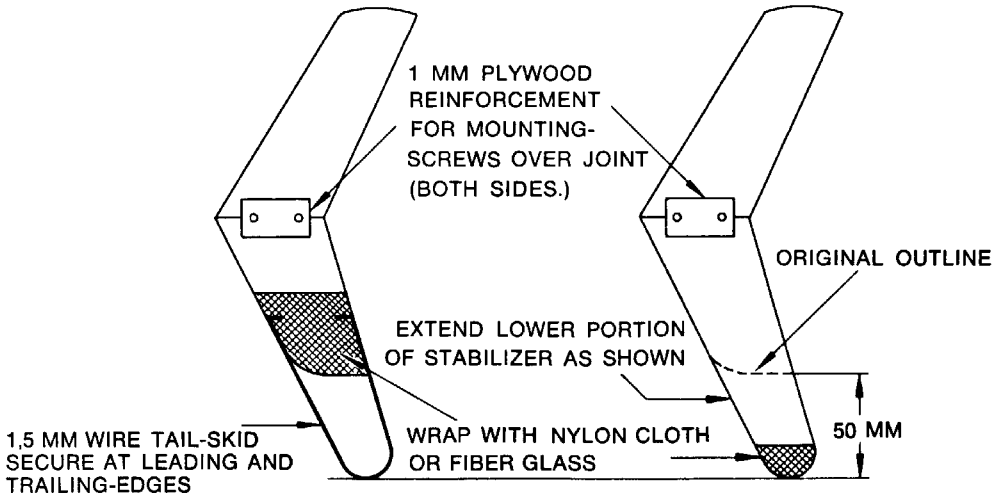
11) Landing Gear

It is recommended to glue the clamps No. 3023 together with the alu tu in order to secure them against twisting.

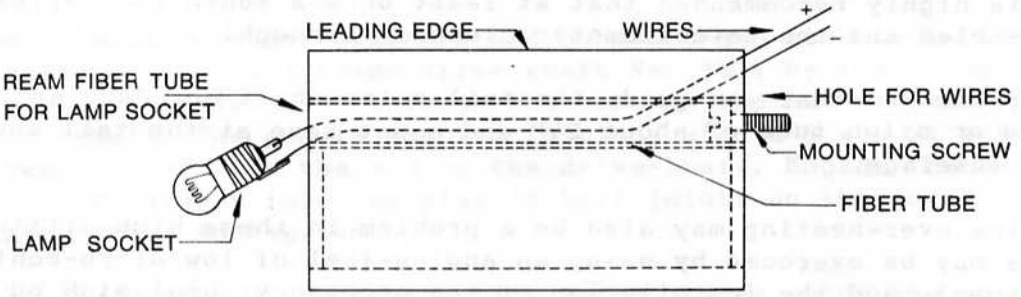
12) Oiler

Fill the oiler with a good sewing machine oil.

13) To protect and avoid damaging the tail rotor blades, etc., the Novice R/C Helicopters is advised to construct an additional/special vertical stabilizer (rudder) for use during the learning-process, patterned aft those shown in the sketch below. The scale, vertical-stabilizer and ta skid, detailed on the plans may be insufficient to withstand the abuse normally encountered while learning. Although any method of reinforcem may be employed, avoid adding excessive weight. The proper center-of-gravity for the model must be maintained. Any weight added at the tail end of the model will require the addition of ballast at the front end

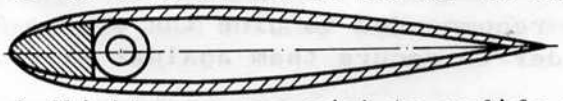


14) To make the installation of the blinking navigation-lights a simple operation, we offer the following suggestions: drill a small hole at the invoard-edge of the stabilizers so to intersect the fiber-tube at a point clear of the mounting screw-head for the power-wiring. See accompanying sketch. Drill mating-holes in the tail boom. Insert the mounting-screws into the fiber-tube before threading the power-wires into the tube. Allow enough slack in the wires to allow clearance between the lamp-socket and the screw-driver. Carefully ream the fiber-tube to accommodate the lamp-socket for a friction fit. After the stabilizer is mounted, simply insert the lamp and socket into the fiber-tube as far as the lamp allows. The lamps may be painted with colored-dope, red for the left, green for the right-stabilizer. The lamp used in the tail-boom plug is left clear. Do not cement the sockets in plac



LEFT HAND STABILIZER SHOWN.

15) Before you go to the flying field, check your ball links whether they have become defective because of over stressing. The plastic eye of this ball link can get loose or be broken. It is better to change it before than to run any risk!

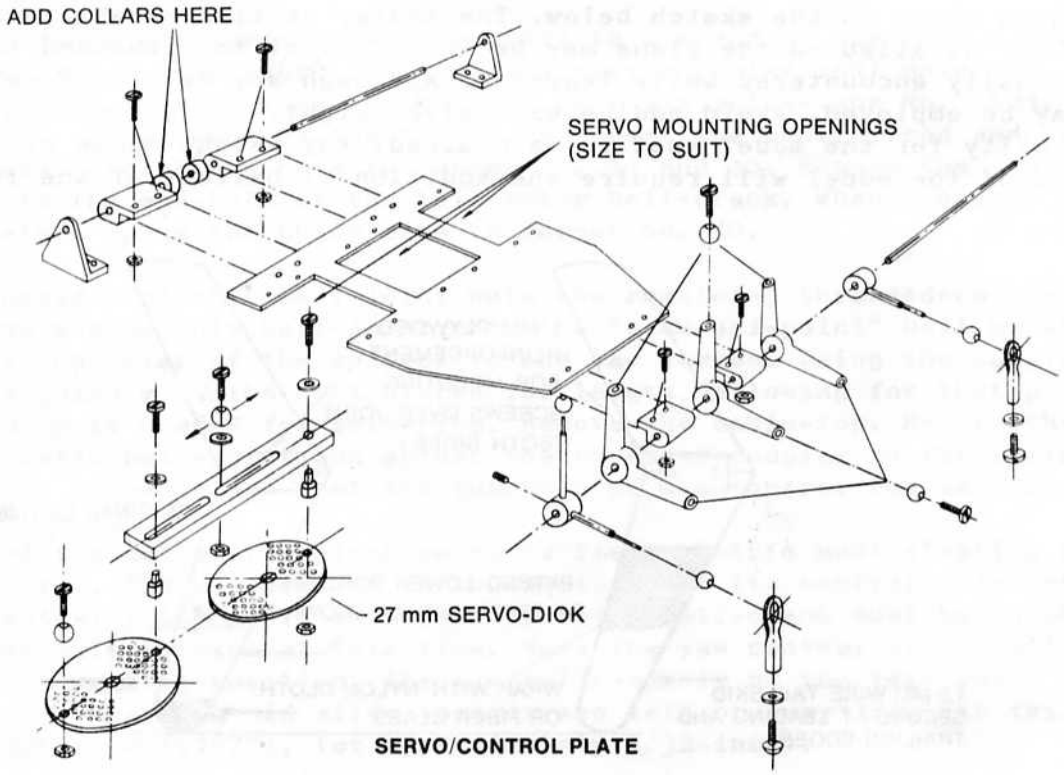


16) Horizontal Stabilizer

In the course of many hours of flight you may wish to modify the horizontal stabilizer (see drawing). This modification gives better flying characteristics than the scale horizontal stabilizer.

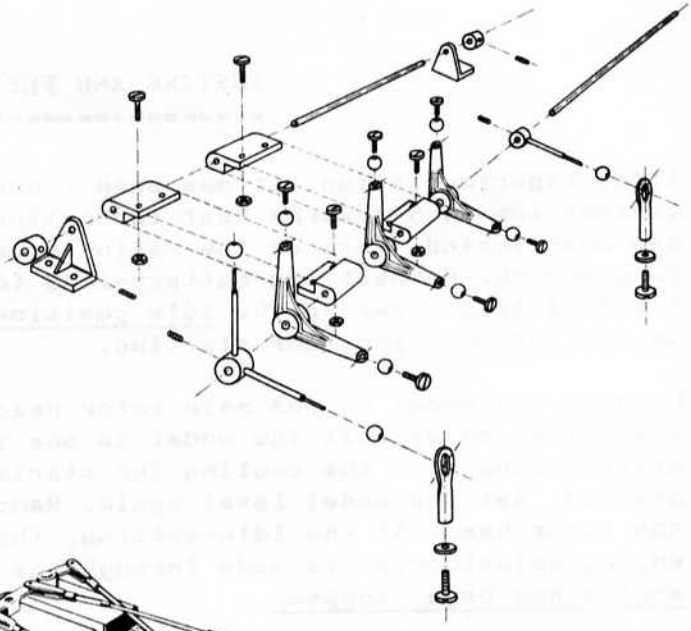
17) Servo Control Plate

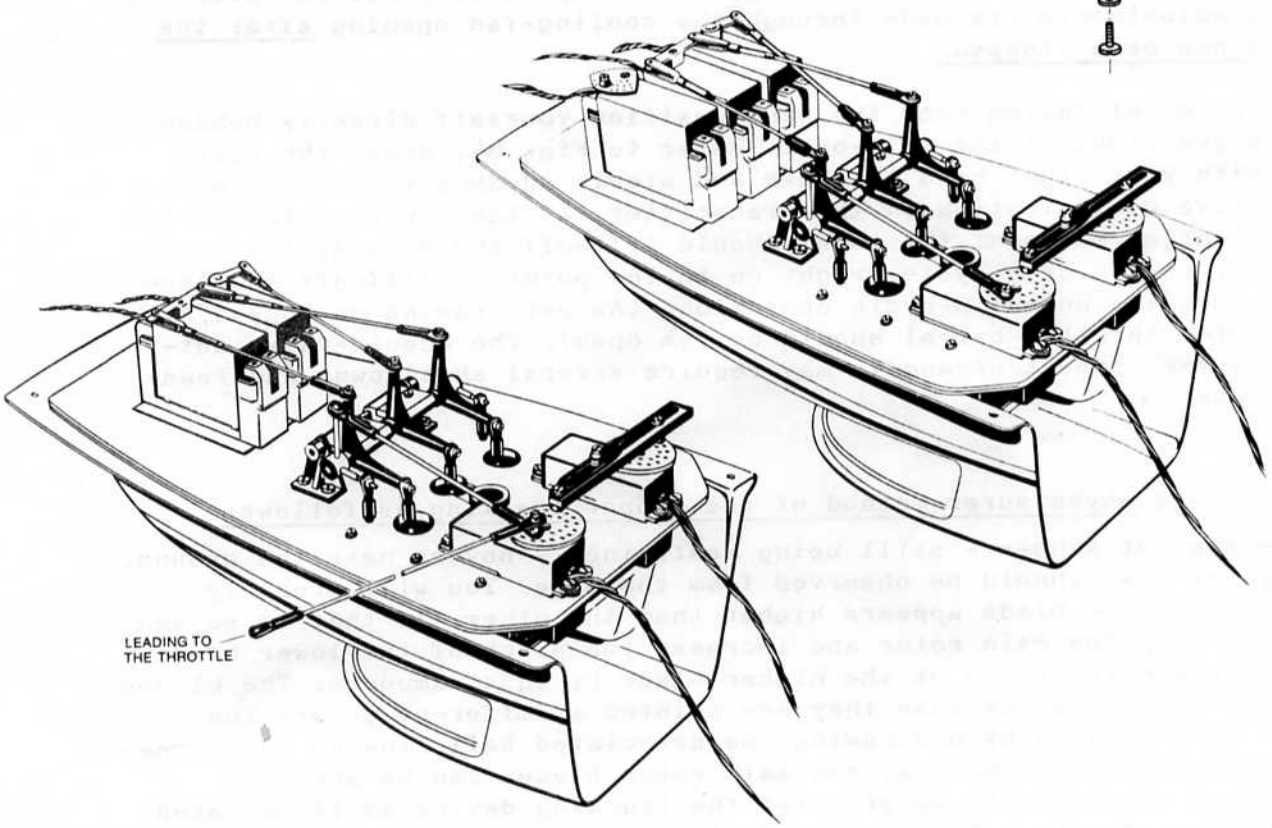
For the use of 3 servos we made a drawing for better understanding.



SERVO/CONTROL PLATE

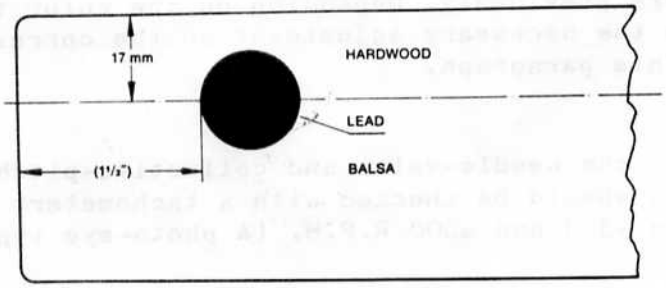
18) Through experience we have found that the Jet Ranger can be flown, using only four servos. These four servos can be mounted direktly onto former No. 9. As shown on the drawing here, the aluminium servo is omitted completely. The nylon hinges are bolted together in pairs. Locate the angle brackets to retain the original position of the large bell cranks.






19) Main Rotor Blades

You will find in your kit 2 large lead balls. These large lead balls are supposed to be flattened in order to get a disc of a thickness of 7 mm (9/32), which has not nessecarily to be done with a hammer, but can also be pushed flat with a screw vise. Then you build one disc each in the end of the main rotor blades (see drawing). In this way you cause a stretching of the main rotor blades, an equal motion, and you will be content.



## TESTING AND FLYING

After experimentation, it has been found that glow-fuel of low nitro content (2% to 5%) works best for helicopter-flying. After your model has been fueled, turn on the radio system and perform the normal ground range-check. Connect the battery-lead to the glow-plug-jack. Set the throttle trim-lever to the idle position and the throttle control-stick to the low position, for starting.

Holding the model by the main rotor head assembly (not the blades or stabilizer-rods),tilt the model to one side and engage the electric starter-cone onto the cooling fan starter-hub. After the engine is started, set the model level again. Remove the battery-lead and release the rotor head. At the idle-setting, the rotors should not revolve. All engine adjustments are made through the cooling-fan opening after the engine has been stopped.

With the model facing into the wind position yourself directly behind and to the right of the tail-boom. Refer to Fig. 64, grasp the tail-boom with your right hand as shown and slowly advance the throttle/collective control-stick on the transmitter. At the 50% position of the control-stick movement the model should lift-off the ground. The engine should run rich or 4 cycle, right up to the point of lift-off and then break into its normal 2-cycle operation. (As per drawing on Page 17A, the engine throttle-barrel should be 75% open). The needle-valve setting is very important and it may require several shut-downs and readjustments.

Another and maybe surer method of the proper tracking as follows:

While the Jet Ranger - still being restrained - hovers near the ground, the rotor disc should be observed from the side. You will probably notice that one blade appears higher than the other. If that is so you have to stop the main rotor and increase the pitch of the lower blade and decrease the pitch of the higher blade by equal amounts. The blades are differentiated because they are painted a different color. The pitch is increased by unscrewing the associated ball link on the threaded rod. Proper tracking of the main rotor blades can be achieved easily if one actually constructed the tracking device as illustrated in the main drawing. The strips of plywood which are built into the tips of the main rotor blades, can easily be marked with different colors of chalk and will then serve as a guide to measure the tracking of the blades. Allow the rotor to turn at such an RPM which is just under the lift-off point. Proceed according to fig. No. 68. Affix masking tape to the blade tracking device. Now, slowly and carefully advance the blade tracking device to the close proximity of the turning rotor blades until the tips of the colored blades barely touch the masking tape, leaving particles of one of the two colors which you applied to the rotors previously. Depending on the color that is rubbed off, you may now do the necessary adjustment on the corresponding blade as illustrated in this paragraph.

As a further test of the needle-valve and collective-pitch settings, the tail rotor speed should be checked with a tachometer, at lift-off it should be between 4300 and 4800 R.P.M. (A photo-eye type tachometer works best).

Should the tail rotor speed be higher or lower than those listed, then the pitch of main rotor blades must be adjusted accordingly. These adjustments are made on the two (2) control-rods connecting the swash-plate to the mixing-levers of the stabilizer-seesaw. Reducing the length of these rods decreases pitch and increases speed while lengthing the rods increases pitch and lowers the speed of the rotors.

While your Jet Ranger is being restrained, and it hovers near the ground the rotor-disk should be observed from the side. Both blade tips should track on a common horizontal-plane. As the blade tips are of different colors this can be easily checked. If one blade appears to be tracking higher than the other return the engine to the idle-position. After the blades stop rotating,partially decrease the pitch of the higher running blade and also increase the pitch of the lower running blade a bit. Restrain the model and check the tracking and tail rotor speed again.

The longitudinal and lateral-trim of the model should also be adjusted while the model is restrained. The trim-levers of the transmitter should be adjusted to cancel-out any tendencies of the model's movements to the left or right (lateral or aileron-trim) or fore and aft (longitudinal or elevator-trim). The model should hover reasonably stable with little effort to restrain it. During the adjustments, you should become familiar with the throttle-collective control (ascending and descending).

When you get-the-feel of this control function the first unrestrained tests can begin.

With the model on a flat smooth surface facing into the wind, slowly advance the throttle. As the model becomes buoyant just before lift-off you will probably notice that the model has a tendency to rotate (yaw) either to the left or right. In most cases this yaw condition can be canceled out with the yaw-control trim-lever of the transmitter. When making this adjustment observe the rotation of the entire fuselage or the front-end of the model, ie.: should the front-end of the model tend to rotate left or counter-clock wise, move the trim-lever to the right. If it rotates to the right or clock wise move the trim-lever to the left.

It will be very helpful to watch the front-end of the model rather than the tail-boom for making yaw corrections. Should you watch the tail-boom the corrections need be just opposite those listed above.

If the amount of yaw-trim available is insufficient to counteract the yaw-tendencies then the short control-rod between the tail-rotor bell-crank and the control bushing can be made longer or shorter as required. Do not make these adjustments on the long control-rod from the tail rotor mixing-lever and the tail rotor bell-crank.

## FLYING

Note: When operating your Jet Ranger avoid doing so in the turbulent air conditions which are normally found near buildings, trees and shrubs etc. These turbulence can have ruinous effects. Helicopters can handle moderately steady winds much better than they can handle turbulent or gusty conditions.

Move your model to an open, turf field. (For training purposes). Advance the throttle slowly until the model becomes slightly buoyant, operate the longitudinal control-stick and notice how the helicopter begins to tilt forward and rearwards, also check the lateral control actions. Avoid applying too much control or the model may be tipped too far, thereby causing damage. You should spend some time becoming accustomed to control functions before lifting the model into flight.

At first, only apply enough throttle/collective, so the model lifts-off only a few inches above the ground, then reduce the throttle/collective slowly allowing the model to settle again. If properly adjusted the model should rise straight up without any tendencies to move about or rotate (yaw). Make any necessary adjustments before proceeding.

For those modelers not familiar with flying a helicopter we would like to pass-on some advice before proceeding. It's a known fact that to hover a helicopter is one of the more difficult maneuvers to learn and perform. Also trying to operate a helicopter just several-inches above the ground (in ground effect) takes a great deal of practice and skill. As helicopters have more stability in forward flight this can be an asset for the novice, so we base the training sequences upon this fact. We do not recommend the tethered method for training purposes.

With the model facing into the wind and a very slight amount of forward cyclic-trim applied, increase the throttle/collective to lift-off. The model should be lifted-off some 1 or 2 feet and flown slowly forward a short distance (some 6 to 10 feet), then slowly reduce the throttle/collective allowing the model to settle. Position yourself some 5 to 1o feet behind and to one side of the model and follow it along as you make these short flights across your flying-site. Continue these short flights to the limit of the flying-site. After stopping the rotors, return to the original down-wind position and resume the short flights again. As you become more confident and proficient rather than extending the distance of each hop begin to lengthen the time-intervals between lift-offs and landings as an approach to learning to hover the model. This is one of the most successful training exercises found to date.

Always face the model into the wind for lift-offs and avoid operating with the model's skids just a few inches above the ground in the turbulent ground-effect. Practice the slow forward flights, slowing the flights until you can keep the model over a fixed spot (hovered). Practice hovering at various altitudes, learning how to return the model to the ground from the slow forward flights and the hover-positions.

Don't become impatient!! Learning to fly a helicopter takes time and deep concentration. Take a break periodically. Avoid an audience if you can. Practice as often as you can. Become proficient in hovering your model.

It has been proven that the R/C helicopter pilot can save his model from some critical flight-positions if he is well versed in hovering his model. Do not allow others to induce you into premature flights around the field. You will have ample opportunity to demonstrate your new-learned skills in due time.

Learn to fly your Jet Ranger in a constant heading square pattern. Lift-off some 3 to 5 feet and into the wind, fly forward approximately 10 feet, pause, and hover for a moment, then fly the model laterally to the left 10 feet keeping the model facing into the wind. Pause and hover for a moment, they fly the model 10 feet rearwards, again keeping it facing

the wind. Pause, and hover a moment, then fly the model laterally 10 feet to the right. Stop and hover over the original lift-off point. This is an extremely good co-ordination maneuver/exercise. On each leg of the maneuver attempt to maintain a constant altitude and rate of speed.

There are many close-in exercises which can be practiced before beginning the higher altitude and speed flights around the flying-site such as: Slow circular or square pattern-flights around yourself, small figure eights out in front of yourself and rectangles,only to name a few. Any and all exercises build confidence and improve co-ordination.

When you feel you can control your model with reasonable confidence, the next step is learning to fly around the field. The Jet Ranger behaves much like a conventional R/C airplane in forward flight. Lift-off into the wind and hover at an altitude of 4 to 6 feet. Check the trim and control functions. By giving a small amount of forward-cyclic (down-elevator) the model will begin to pick up forward speed and gain some altitude. Do not panic if the model climbs to 20 or 30 feet of altitude, just do not allow the model to keep accelerating. Reduce the throttle/collective and forward-cyclic to maintain a moderate speed. When the model is 75 to 100 feet away, start a left turn by introducing a bit of left-cyclic along with a small amount of left yaw-control. As the turn begins the nose of the helicopter will tend to drop much like an airplane. To prevent the model from losing altitude begin to apply reverse-cyclic (up-elevator) to maintain the established altitude. (The left-hand turn is recommended first only because due to the counter-clockwise rotation of the main rotor less control-action is required than for making a right-hand turn.) After circling the field once or twice, you can begin the landing descent. Reduce the throttle/collective and apply a bit of reverse-cyclic slowing the model and losing altitude at the same time. For the first landings from these forward flights rather than slowing the model to almost a hover condition at a high-altitude make the descent at an angle of approximately 30-degrees until the model is some 6 to 8 feet above the ground. Add more throttle/collective to stop the descent and hover a moment over the intended landing spot before landing.

An important aspect in making flights around the field is that the helicopter while flying down-wind should not be flown slower than the speed at which the wind is moving. The moving wind, acting against the helicopters' tail-boom and vertical stabilizer can cause the model to weather-vane, when least expected!!! Pay strict attention to the altitude of the helicopter while flying at a 90 degree-angle to your line of sight. Helicopters in general offer a poor visual silhouette at a distance and it takes only a moment to become disorientated.

As you become more familiar with your Jet Ranger you may notice that under some conditions when advancing the throttle/collective control the model tends to yaw (rotate) indicating that an improper amount of corrective thrust is being generated at the tail rotor. This can be adjusted by moving the "pick-off-point" of the tail rotor control-rod to compensate or balance the sudden torque of the main rotor.

As your confidence builds and skill improve begin working on: fast-starts, pin-wheels (yaw-turns), stall turns, high-speed Yo-Yo's, spot landings, and all the maneuvers possible within the flight-envelope of helicopters, and you also then join the ranks as an accomplished R/C helicopter pilot.

In closing, we wish you many enjoyable hours of flying and much success and one last reminder: "It is the successful flyer, who thoroughly"pre-flights" his model before each and every flight.

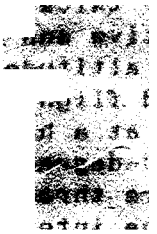
## PRE-FLIGHT CHECK LIST

(Before starting engine)

Main Rotor Assembly:

1. ( ) Damping blades secure and perpendicular to main rotor shaft
2. ( ) Stabilizer-rods secured, not nicked or bent
3. ( ) Bearing-pins and bearings secure
4. ( ) Seesawa and mixing levers move freely
5. ( ) Plastik ball-joints properly engaged and sound, no sings of wear
6. ( ) Main rotor blade secured, aligned and no cracks at reinforcements
7. ( ) Pitch-arms/links straight and secure
8. ( ) Main rotor hub-bolt secure, no vertical motion of main rotor shaft
9. ( ) All bolts and ball-joints secure at swash-plate. Guide hub secured to shaft. Swash-plate lubricated.
10. ( ) Main rotor assembly rotates freely
11. Cabin-top mounting screws secure

Tail Rotor Assembly:



1. ( ) No excessive-movement of blade retainers
2. ( ) Blades and retainers secure and sound
3. ( ) Hub pinned and secure
4. ( ) Ball-joints engaged and sound
5. Control-plate secure and bushings lubricated
6. ) No end-play on drive shaft or back-lash
7. ( Control-rods secure, move freely
8. ( ) Tail rotor rotates freely when main rotor is hand-turned

Internal:

1. ) Inspect servo/control assembly for loose components. All ball-ball-joints connected.
2. ( ) Mixing lever secure
3. ( ) Servos secure and no wires interfering with control functions. Batteries charged.
4. ( ) Test all control functions at normal ground-check distance
5. ( ) Radio, battery and servo plugs secured
6. ( ) Transmission bolts secure
7. ( ) Glow-plug wiring sound, no broken solder-joints
8. ( ) Fuel tank and system operative. No kinks in lines.
9. ( ) Receiver and battery-pack secured
10. ( ) Ball-joint of angled pitch-lever lubricated

General:

1. ( ) Low fuel-warning system operative. Tank filled.
2. ( ) Landing gear bolts secure
3. ( ) Timing belt properly tensioned
4. ( ) Cooling fan secure and free of nicks, rotates without touching cooling-shroud
5. ( ) Removable windows in place
6. ( ) Test continuity of glow-plug
7. ( ) Stabilizers secure and at proper angle
8. ( ) Proper center-of gravity with tank filled
9. ( ) Transmitter trimlevers in proper positions. Throttle lever in low position.

Starting:

1. ( ) Radio system turned on
2. ( ) Low fuel-warning system turned on
3. ( ) Engine primed (through muffler exhaust stack)
4. ( ) Glow-plug connected to starting battery
5. ( ) Insure that electric starter rotates in proper direction. (Clockwise when viewed from starting-cone end)
6. ( ) Controls set for engine idle position
7. ( ) Grasp main rotor assembly, tilt model, engage starter. Start engine.
8. ( Have assistant remove starting equipment a safe distance. Allow engine to idle for a few moments before disconnecting battery from glow-plug.

   Carefully release main rotor assembly, stand clear of model and advance throttle to one-third open position, allowing engine to warm. Recheck control functions.

   Check rotor blade tracking before any attempt to lift-off model, also trim levers as required. Be sure spectators remain at a safe distance. Avoid flying near obstructions and near or over spectators.

Allow engine to idle for a few moments before disconnecting battery from glow-plug.

Carefully release main rotor assembly, stand clear of model and advance throttle to one-third open position, allowing engine to warm. Recheck control functions.

Check rotor blade tracking before any attempt to lift-off model, also trim levers as required. Be sure spectators remain at a safe distance. Avoid flying near obstructions and near or over spectators.

## SPARE PARTS LIST

| REF. NO. | DESCRIPTION - ACCESSORIES | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3901 | Gyroscope | Piece | |
| 3902 | Mitsumi - Micromotor | Piece | |
| 3903 | Gyroscope - potentiometer | Piece | |
| 3903a | Gyroscope - tension springs | Piece | 2 |
| 3903b | Gyroscope - trim-pot | Piece | |
| 3904 | Position blinking light | Piece | |
| 3905 | Extra set of bulbs | Piece | 4 |
| 3905a | Extra set of lenses and brackets | Piece | 4 |
| 3906 | Electronic fuel control | Piece | |
| 3907 | Extra set of bulbs | Piece | 2 |
| 3907a | Extra set of lenses and brackets | Piece | 2 |
| 3910 | Heat sink<br>No. 1 Supt. G 60 Fi<br>Supt. ST 51-60<br>Enya 60/III, Veco 61-USA<br>O.P.S. 60 - Webra 61 speed<br><br>No. 2 Webra 61, black-head, Veco 61 (Germany) O.S. Max 60<br>No. 3 Merco 49 - 61, Taipan 61<br>No. 4 H.P. 61 | Piece | |
| 3911 | Pilot for helicopter, hand-painted | Piece | |
| 3911a | Pilot for helicopter, unpainted | Piece | |
| 3912 | Cockpit - Instrument console | Piece | |
| 3913 | Plastic tail cone | Piece | |
| **3914** | **Floats** | **Set** | |

| REF. NO. | DESCRIPTION - MISCELLANEOUS | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3015 | Helicopter fuselage, complete | Piece | |
| 3015a | Cabin top only | Piece | |
| 3016 | Pen lubricator | Piece | |
| 3017 | Spirit level | Piece | |
| 3018 | Training skids, 60 cm, complete | Set | |
| 3019 | (Landing Gear), strut 60 cm wide | Piece | 2 |
| 3020 | Skids, standard version 40 cm | Set | |
| 3021 | Strut for skids 40 cm wide | Piece | 2 |
| 3022 | Aluminium skid, bent to shape | Piece | 2 |
| 3023 | Clamp with nut and screws | Set | |
| 3024 | Rubber shock mount | Piece | 4 |
| 3028 | Tail rotor blades | Set | |
| 3029 | Steel bow for tail skid | Piece | 2 |
| 3030 | Exhaust pipe | Piece | 2 |
| 3031 | Fibre tube | Piece | 4 |
| 3032 | Welding nut | Piece | 10 |
| 3037 | Silencer with all extras (no adapter) | Piece | |
| 3038 | Levelling fixture | Piece | |

| REF. NO. | DESCRIPTION - ACCESSORIES | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3038a | Brass rings bolt for 3038 | Piece | 8 |
| 3039 | Sheets of plywood | Piece | 2 |
| 3040 | Main rotor blades | Set | |
| 3041 | Allen wrench (SW 1,5 -2 - 2,5 - 3 mm) | Set | |
| 3042 | Extended socket wrench SW 7 mm | Piece | |
| 3043 | Open-end wrench SW 7 mm | Piece | |
| 3044 | Stabilit Express, large | Piece | |
| 3044a | Stabilit Express, small | Piece | |
| 3046 | Lop ("Lock-tite") | Piece | |
| 3047 | Windows, blue | Set | |
| 3048 | Windows, white | Set | |
| 3051 | Steel plate with cutting edge | Piece | |
| 3052 | Lead pellete 7 mm dia., 14 mm dia. | Set | |
| 3053 | Decals | Set | |
| 3054 | Split cone for small timing belt gear for Taipan | Piece | |
| 3055 | Nylon cord 2 m nylon thread 2 m | Set | |
| 3057 | Assembly and flying instructions | Piece | |
| 3058 | Main plan | Piece | |
| 3070 | Washers, assorted | Set | |
| 3071 | Nuts, assorted | Set | |
| 3072 | Pan head screws, assorted | Set | |
| 3073 | Socket head screws, assorted | Set | |
| 3074 | Socket head screws, assorted | Set | |
| 3075 | Pins, assorted | Set | |
| 3076 | Push rod, assorted | Set | |
| 3077 | Bearing bolts, steel pins, assorted | Set | |

| REF.NO. | DESCRIPTION - TRANSMISSION | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3101 | Transmission base plate | Set | |
| 3102 | Engine and clutch frame | Piece | 2 |
| 3105 | Bevel gear transmission | Piece | |
| 3105a | Bevel gear transmission w/ball bearings | Piece | |
| 3106 | Mounted/ball bearing, 8 mm dia. No. 608 | Piece | |
| 3107 | Ball bearing, 6 mm dia. No. 628 | Piece | |
| 3108 | Ball bearing, 6 mm sealed,No. 627 z | Piece | |
| 3109 | Ball bearing, 4 mm dia. No. 624 C3 | Piece | |
| 3113 | Clutch bell housing with shaft | Piece | |
| 3114 | Metal spur gear | Piece | |
| 3115 | Bevel gear (6 mm I.D.) with pin | Piece | |
| 3117 | Bevel gear (4 mm I.D.) | Piece | |
| 3118 | Drive shaft | Piece | |
| 3118a | Drive shaft, with bevel gear mounted | Piece | |
| 3119 | Bushing | Piece | 2 |
| 3120 | Lock washer 13 | Piece | |
| 3122 | Angle bearing | Piece | |
| 3123 | Bell crank, 7.8 mm dia. | Piece | |
| 3129 | Split cone, 7,8,9 mm dia. | Piece | |
| 3130 | Timing belt gear, small | Piece | |
| 3131 | Cooling fan | Piece | |
| 3132 | Clutch lining | Piece | |

| REF. NO. | DESCRIPTION - TRANSMISSION | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3133 | Timing belt gear, large, w/ball bearings | Piece | |
| 3134 | Special screw | Piece | 10 |
| 3135 | Clutch shoe | Piece | 3 |
| 3136 | Tension springs | Piece | 4 |
| 3137 | Special screw | Piece | 10 |
| 3138 | Timing belt | Piece | |
| 3140 | Clevis | Piece | |
| 3143 | Glow plug connector with clamps | Set | |
| 3148 | Clutch compl. mounted as provided in the kit | Piece | |

| REF. NO. | DESCRIPTION - MAIN ROTOR SHAFT | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3201 | Main rotor shaft | Piece | |
| 3202 | Gear bushing | Piece | |
| 3204 | Plastic spur gear | Piece | |
| 3205 | Nylon bearing | Piece | 3 |
| 3206 | Set collar | Piece | 2 |
| 3208 | Bearing bracket | Piece | |
| 3209 | Bearing plate | Piece | |
| 3210 | Ball bearing No. 6000 | Piece | |
| 3213a | Swash plate, compl. mounted as provided | Piece | |
| 3213 | in the kid / Swash plate, outer ring | Piece | |
| 3214 | Ball bearing No. 16004 | Piece | |
| 3215 | Swash plate, inner ring | Piece | |
| 3216 | Swash plate, ball joint | Piece | |
| 3219 | Guide with 4 steel pins | Piece | |
| 3220 | Pin 1.5 mm dia. | Piece | 10 |

| REF. NO. | DESCRIPTION - MAIN ROTOR HEAD | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3301 | Hub | Piece | |
| 3302 | Seesaw | Piece | |
| 3302a | Seesaw w/blade mounts, as provided in the kit | Piece | |
| 3304 | Needle bearing | Piece | 2 |
| 3306 | Axle | Piece | 2 |
| 3308 | Blade mount | Piece | |
| 3308a | Blade mount with ball bearing No. 626 Z | Piece | |
| 3309 | Safety washer 4 mm | Piece | 10 |
| 3310 | Pitch arm | Piece | 2 |
| 3312 | Special screw M 4 x 44 with socket head | each | 2 |
| 3313 | Set collar with socket head screw/screw M 4 x 16 M 3 x 3 | Piece | 4 |
| 3315 | Sintered socket 3 x 6 | Piece | 6 |
| 3316 | Seesaw with 4 brass rivets 2 mm dia. x 14 | Piece | |
| 3316a | Seesaw w/mixing lever completely mounted | Piece | |
| 3317 | Stabilizer rod | Piece | 2 |
| 3318 | Aerodynamic damping blades | Piece | 2 |

| REF. NO. | DESCRIPTION - MAIN ROTOR HEAD | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3319 | Mixing lever compl. w/4 brass rivets 2 mm dia. x 14 | Piece | 2 |
| 3321 | Blade tongue w/brass bushing, 7 x 13.8 mm | Piece | 2 |
| 3324 | Ball joint, plastic | Piece | 10 |
| 3324a | Ball joint, plastic w/brass ball | Piece | 10 |
| 3326 | Rubber damper | Piece | |
| 3328 | New System | Piece | |

| REF. NO. | DESCRIPTION - TAIL ROTOR | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3401 | Housing | Piece | |
| 3401a | Housing, compl. mounted as provided in the kit | Piece | |
| 3402 | Ball bearing, 4 mm dia., sealed No. 624 z | Piece | |
| 3403 | Bushing | Piece | 2 |
| 3404 | Tail rotor shaft | Piece | |
| 3404a | Tail rotor shaft with bevel gear and ball bearing, mounted | Piece | |
| 3405 | Bell crank | Piece | 2 |
| 3407 | Long brass bushing | Piece | |
| 3408 | Control bushing | Piece | |
| 3410 | Nylon control plate | Piece | 2 |
| 3412 | Hub with steel pin 2 mm dia. x 10 | Piece | |
| 3414 | Ball bearing 3 mm dia. No. 623 | Piece | |
| 3415 | Bushing | Piece | 5 |
| 3419 | Push rod (bowden rod) | Piece | 2 |
| 3420 | Steel wire 1,5 mm dia. w/plastic tube 1,2 mm dia. | Piece | |
| 3422 | Flexible tail rotor drive shaft | Piece | |
| 3423 | Blade mounts tail | Piece | |
| 3423a | Blade mounts tail complete mounted as provided in the kit | Piece | |

| REF. NO. | DESCRIPTION - SERVO MOUNTING PLATE | UNIT | PC/PR P.CARD |
|---|---|---|---|
| 3501 | Servo base plate 120 x 90 | Piece | |
| 3502 | Nylon hinge | Piece | 4 |
| 3503 | Angle bearings | Piece | 2 |
| 3504 | Bearing shaft 2 mm dia. x 80 | Piece | 2 |
| 3505 | Bell crank | Piece | 3 |
| 3506 | Pitch angle lever | Piece | |
| 3507 | Pitch lever | Piece | |
| 3508 | Mixing lever with 2 bushings | Piece | |