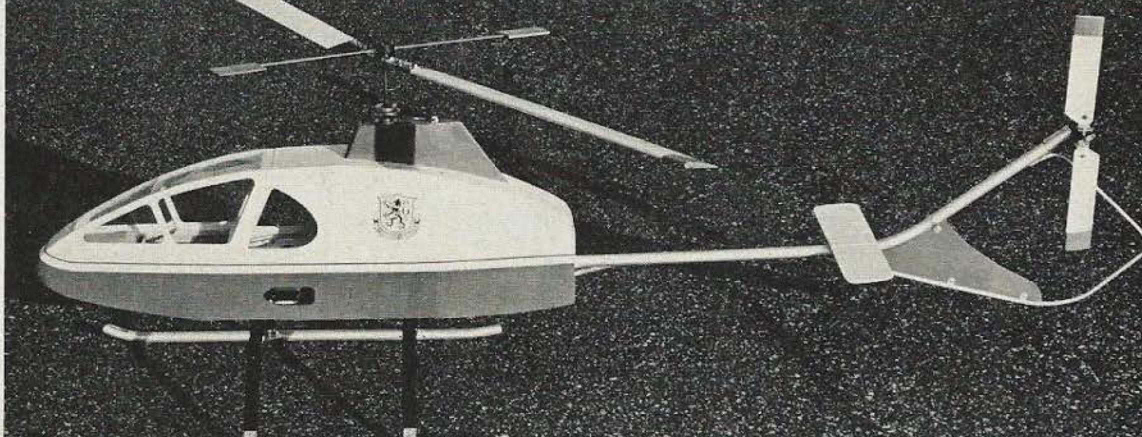
NATE RAMBO'S

RUNWAY SWEEPER

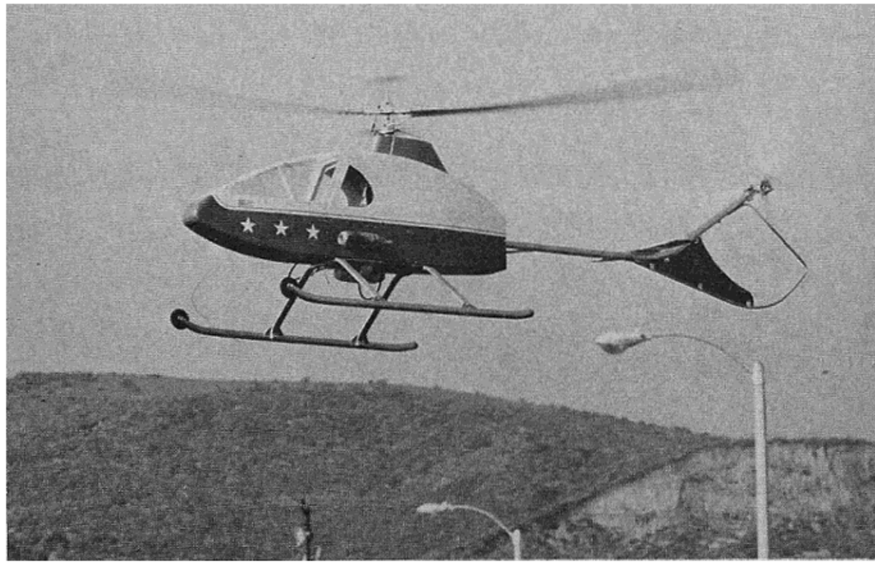
A recognized West Coast flyer provides not only a helicopter construction article but also a broad base of information concerning helicopter modeling. The author's philosophy and approach to designing and building model helicopters will be of value to all those interested in pursuing this aspect of our hobby.



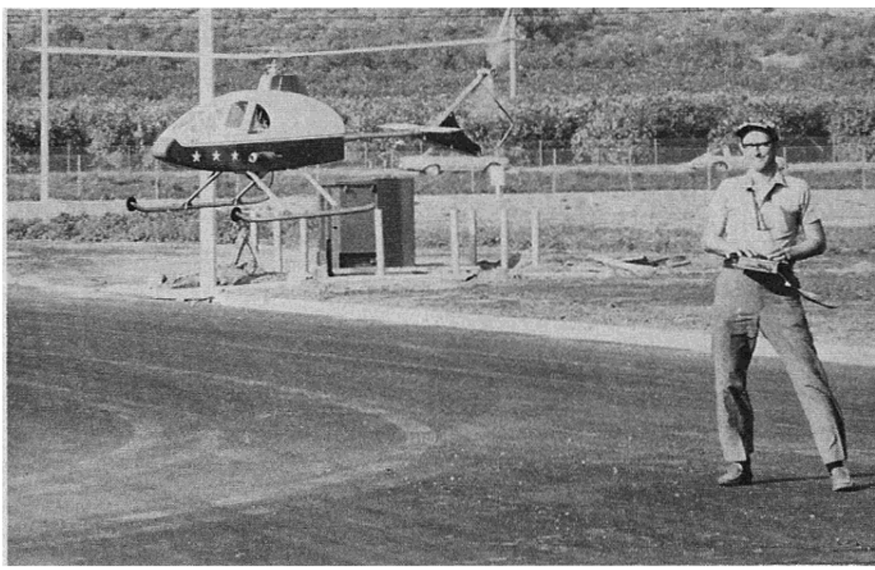
I have always felt that the RC helicopter modeler should approach his hobby just like any other RC modeler approaches his. By this I mean a person should be able to create or build a helicopter airframe in a similar manner to that used by the fixed wing flyer. Certainly, some new tools and materials and techniques should join the old razor blade and glue. But the joy of creating a beautiful model should remain unchanged. The modeler should be able to create and build his own airframe because that's what modeling is all about. The average helicopter modeler should not have to be a machinist; he should merely procure and use a set of helicopter machinery just as any other modeler procures and uses an engine, radio system, or retract landing gear mechanism.

With the above philosophy in mind, I have designed and built a series of original helicopters. The design presented here is the Runway Sweeper (RS for short). I hope that what is provided in the form of drawings and text is viewed as more than just a construction article. It is my intent to stimulate modelers' thinking and perhaps to inspire new helicopter modelers to this approach. In doing so, they will develop new designs and utilize new materials while applying some good old fashioned modeling expertise to this new branch of our hobby.

Before I go into the details of R S, let's talk about helicopter machinery (i.e., the clutch, transmission, rotor head, rear gear box and other esoteric paraphernalia peculiar to a rotary wing monster). There are three basic ways to acquire this very specialized hardware. The first and hardest way is to build it, possibly using John Burkham or Gene Rock's drawings. That method is pretty time-consuming and becomes a "thing unto itself." To me, the method is unacceptable. Another way is to go hog wild and buy a complete helicopter kit. In this case, all you have to do is follow the manufacturer's instructions, fly the complete machine for a period of time, and allow the ancient rules of aeromodeling to leave you with the machinery sans airframe. Here the cost seems pretty steep. But for those who have neither the incentive to build the machinery nor the pile of cash to buy a complete kit, there is one other method. Find a person who has bought one of the many complete helicopter kits on the market and after a crash or two is willing to dispose of what is left, namely the mechanics. The latter method happens to be the one I used to procure not one but two sets of mechanical components at very



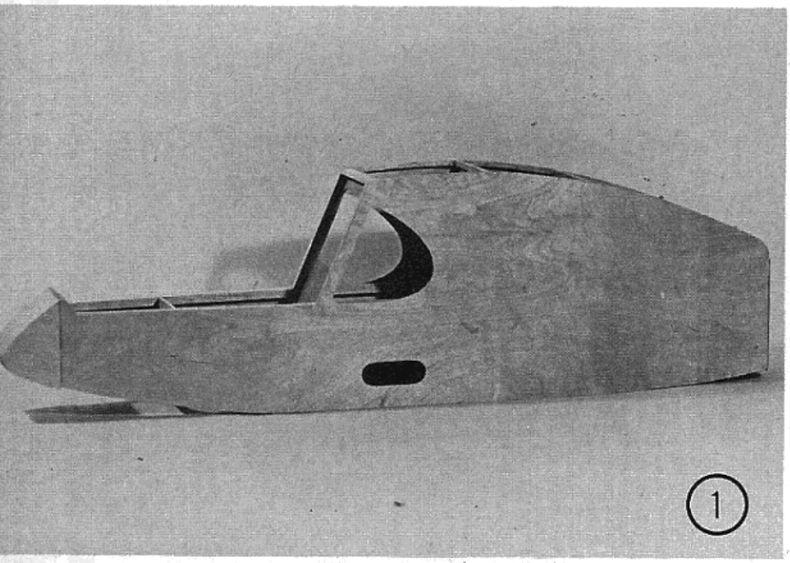
Author's helicopter hovering gracefully. Note lamp posts along road used as flying site.

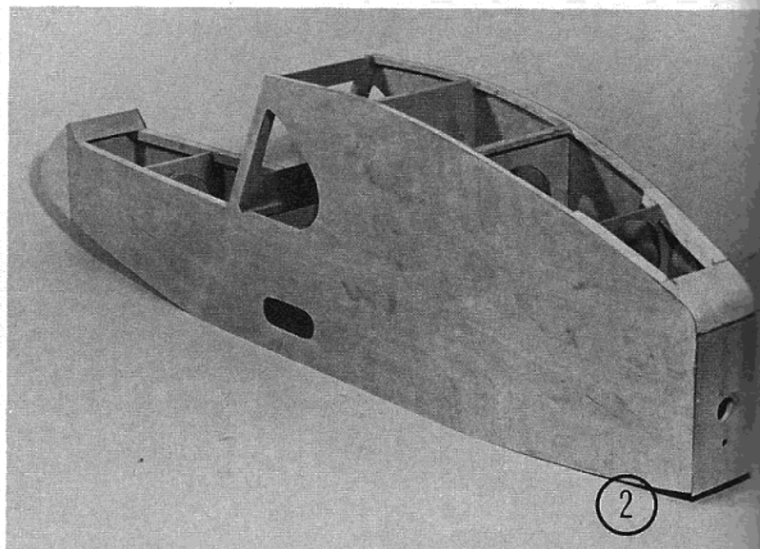


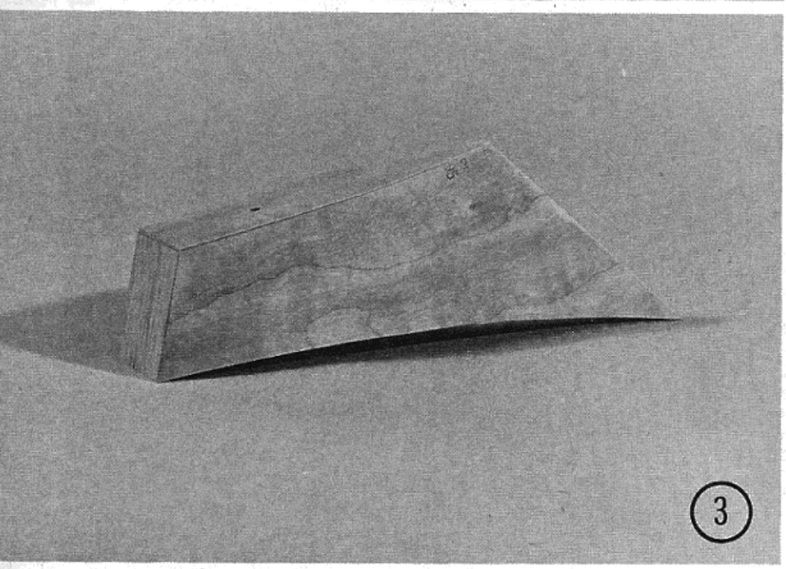
Nate flying his chopper from a confined space on a road - - - easy if wind conditions require.

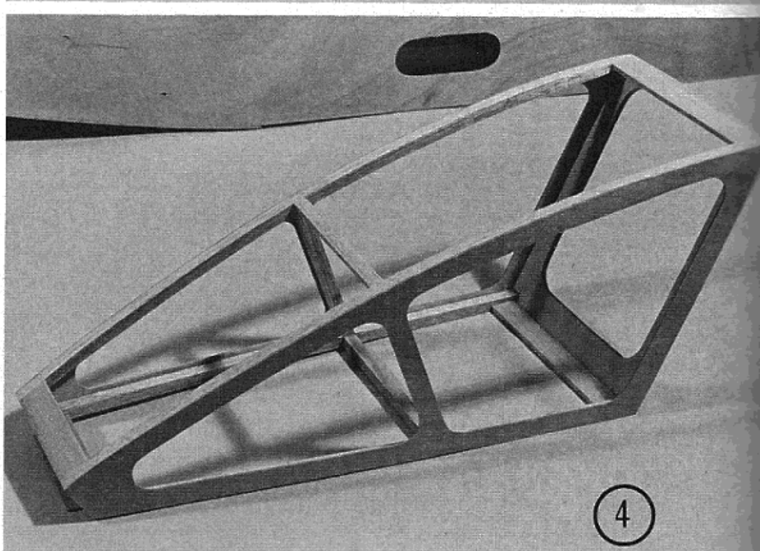
John Minassian makes a low pass with his RS. Ship was built one week and flown the next!

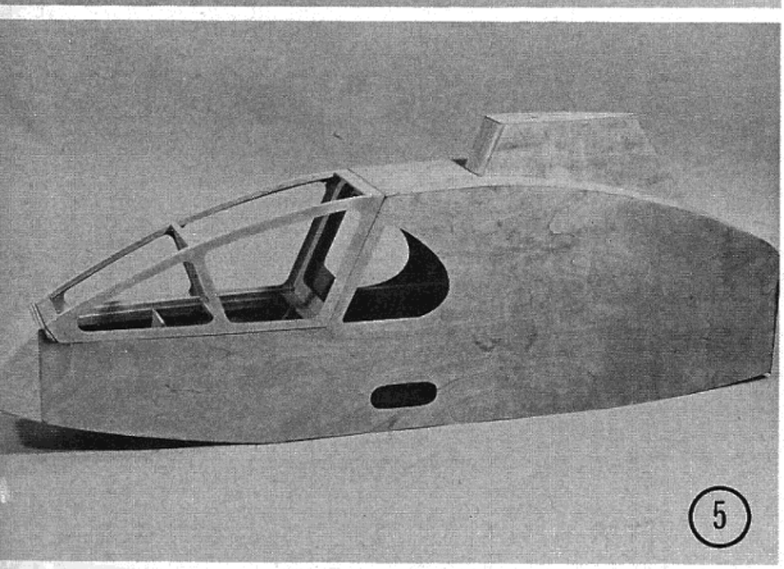
(1) Basic fuselage box, less top and bottom skin. (2) Another view of basic fuselage showing former and stringer locations. (3) Mast tower ready for installation on fuselage. (4) The canopy frame using optional 1/32" ply sides, eliminating twisting. (5) The completed fuselage, ready for attachment of tail boom. (6) Brass drive shaft housing fitted through slot in aluminum tail boom, before bending boom.

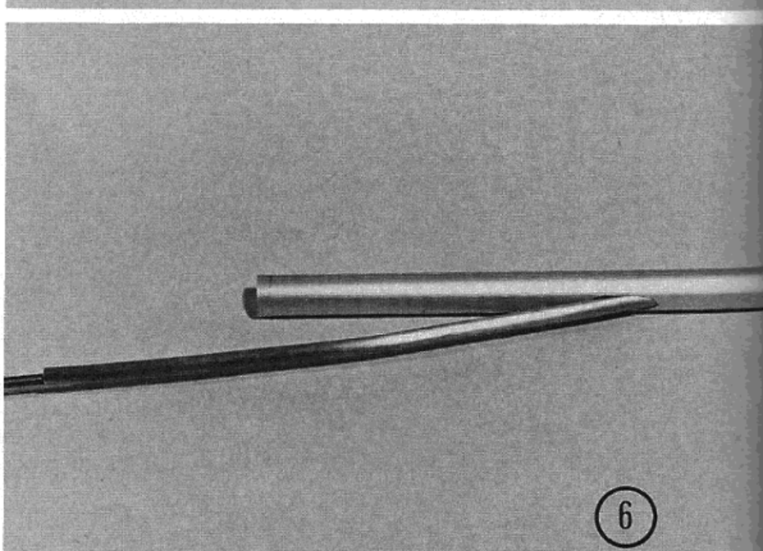




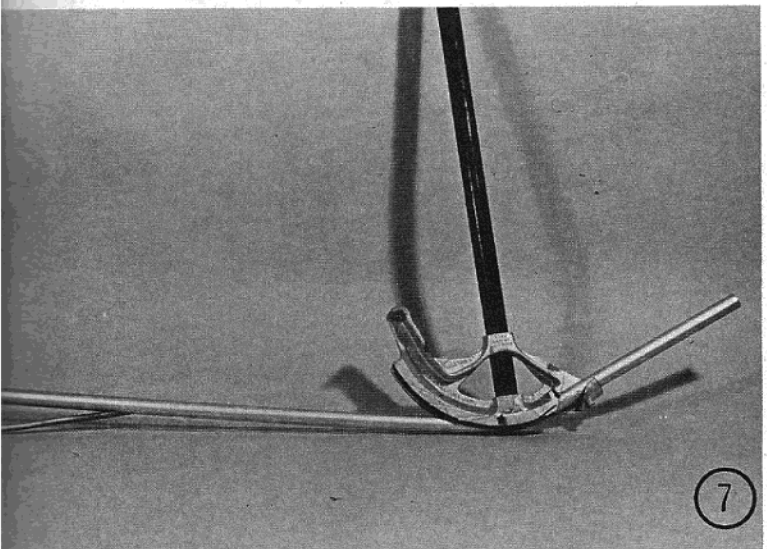


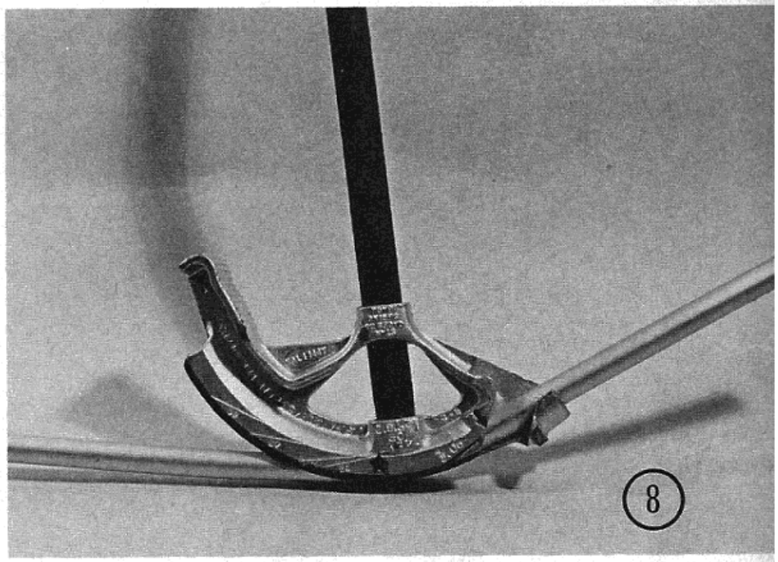


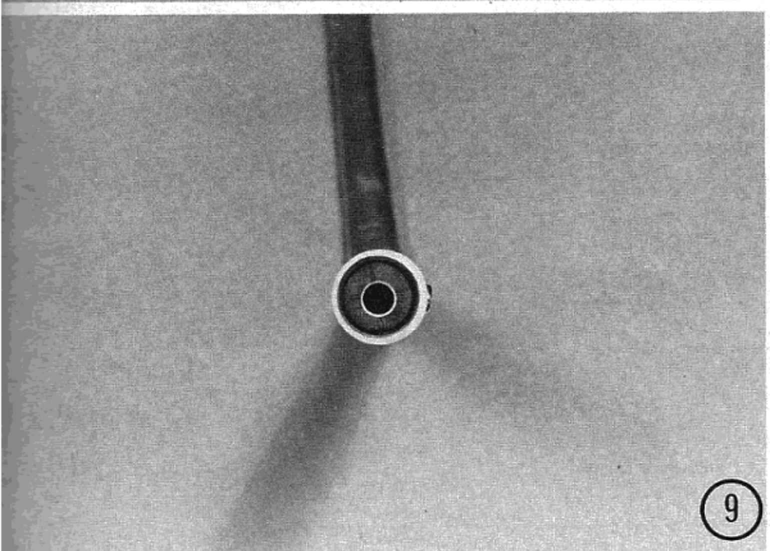


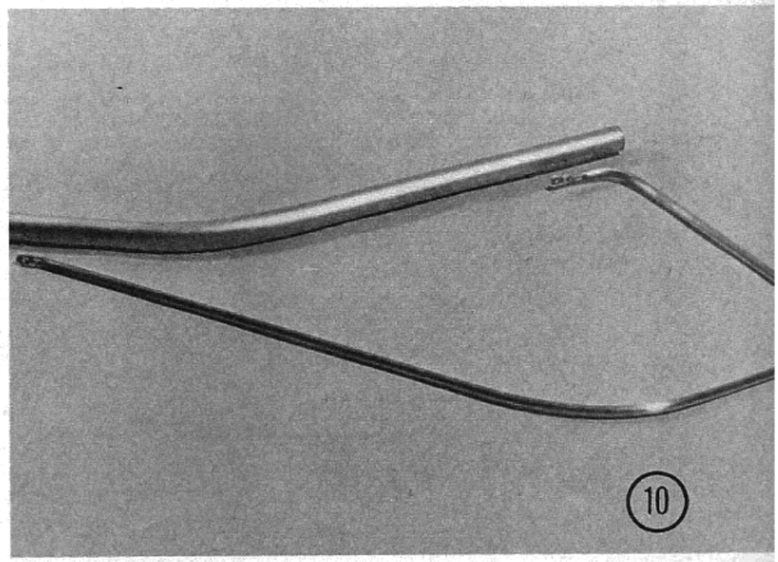


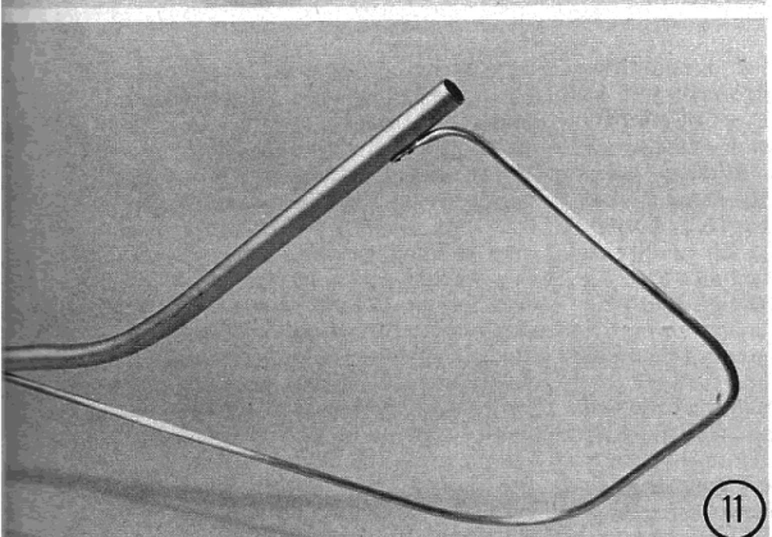
(7) With drive tube in place, both boom and drive tube are bent to conform to plans. (8) 3/4" conduit benders are available at most hardware stores - - - some even rent them. (9) On the RCM prototype, we added a wooden plug to center brass drive tube. (10) 1/4" aluminum fin and skid frame, ready to install. (11) Fin-skid frame in place. End of tail boom has been shortened to accept a tube adapter to fit our Schuco-Hegi gearbox. (12) Tail boom and drive shaft assembled into fuselage. Bottom rear skin can now be added.

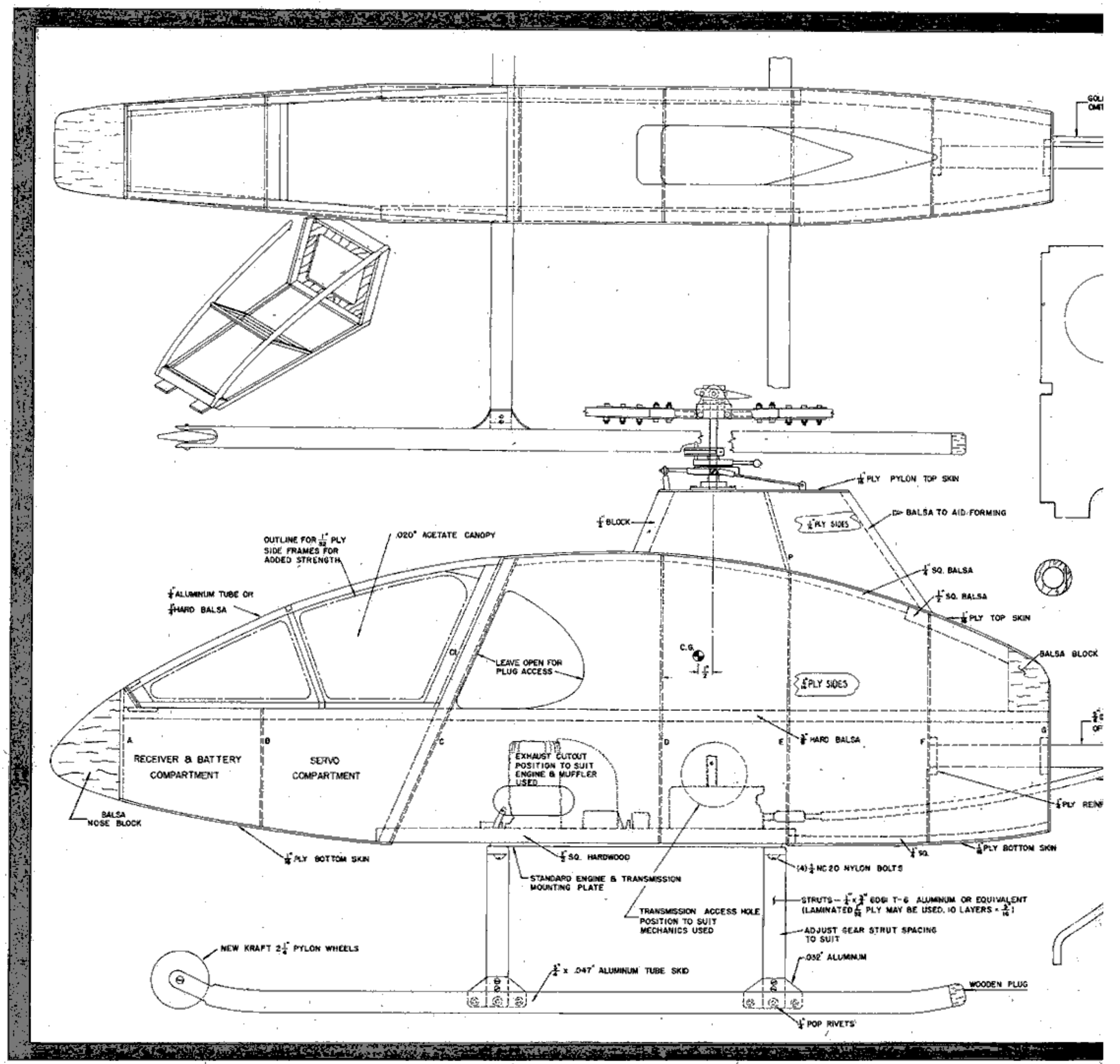












low cost. One of these sets was used in R S. It is possible that the reader might use my technique to obtain a set of mechanics to build R S or some other helicopter design.

Let's now say a little about design ideas and how the R S design was formulated. My first concern was that which is weighed by all other modelers about to embark on a new project. The question was with regard to scale versus non-scale. A lot of factors come into view here. In this case, the machine was to be an advanced trainer. My thought was to make it as quickly and cheaply as possible. Furthermore, the machine had to be easily repaired (old "crash" Nate, they call me). Therefore, I decided on a non-scale design.

The next main design question was size. Any model helicopter must be designed for a specific set of mechanics. R S designed around those which came from an old Schluter Huey Cobra kit (basically the same as sold today in the Shuco-Hegi Huey Cobra). Those mechanics use a .60 to .80 size engine and establish the following:

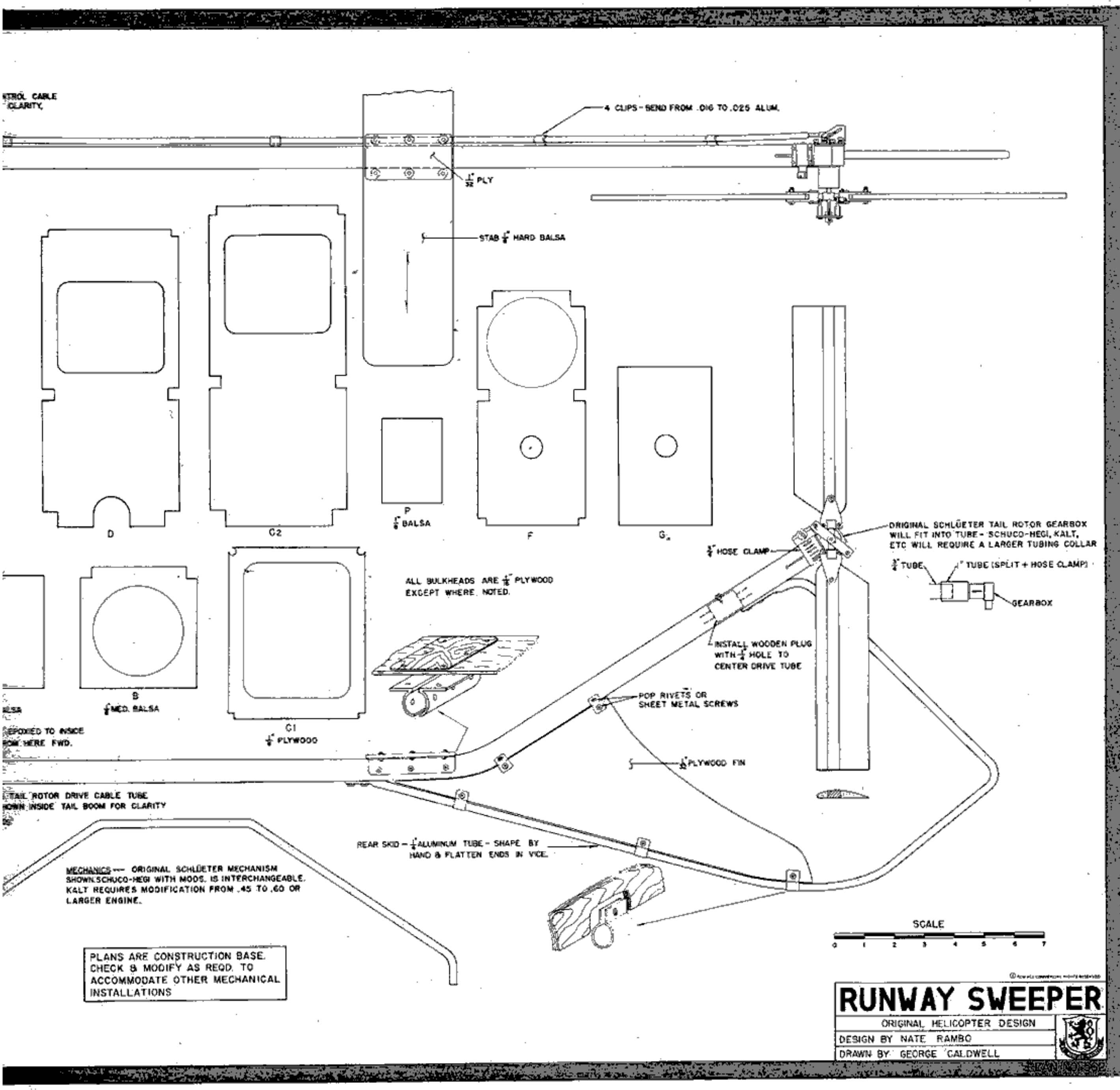
Main Rotor Diameter – 58 to 63 inches.

Tail Rotor Diameter – 14 to 16 inches.

These factors dictated the basic size of the R S design particularly with regard to tail length. Nose length was primarily a matter of being able to keep the Center of Gravity far enough forward. If a set of different mechanics were utilized, the size of R S would merely have been changed accordingly. For instance, a four-fifths size R S works out beautifully for the Kalt mechanism.

The design of the undercarriage shown on the plans is a compromise. Its size is somewhere between a very large training gear necessary for the new student and a small one suitable only for the experts. It is a skid type gear rather than wheel type because I thought wheels would roll when not desired. The two small wheels placed high on the forward end of the skids are for two purposes. The first is to permit high speed rolling take-offs. The second is to permit lifting the model by the tail boom and wheeling it around instead of carrying it.

The easy building and repairability



angle led me to design the R S with an aluminum tail boom. It is easy to make and particularly easy to replace after damage occurs because of engine failure, colliding with a street lamp, losing a tail rotor, shearing a drive pin, pilot error, etc., etc. (Naturally, I categorically deny ever personally making a pilot error!) After tail boom replacement, the ship can often look like new instead of showing repair scars like wood fuselages show.

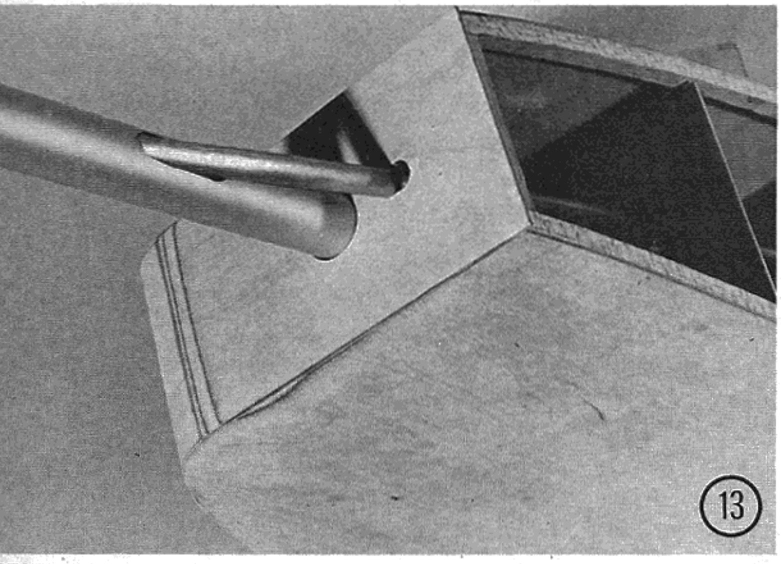
The R S tail boom was designed low with an upward sweep at the back in order to get plenty of rotor clearance without having to put mechanical flapping restrictors on the rotor head. The upward sweep puts the tail rotor high to prevent rolling moment from the rotor side force and provides good ground clearance without a high landing gear. This helps prevent roll-overs.

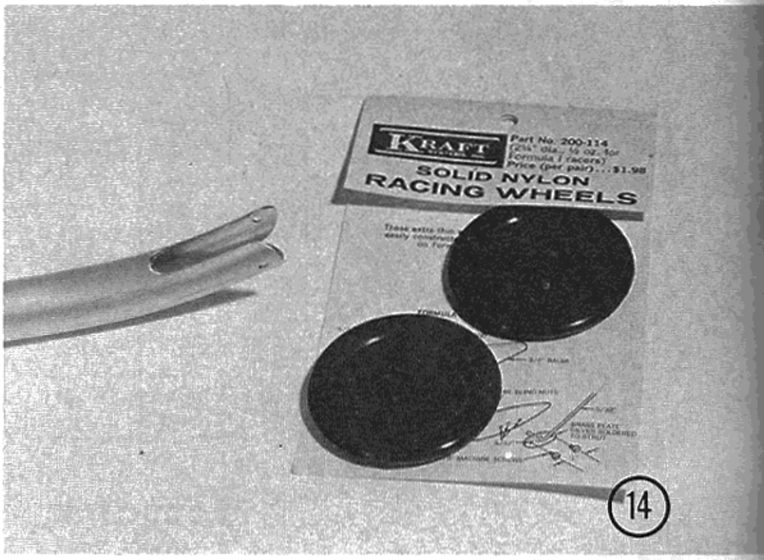
The easy building philosophy led me to design the main pod on the R S like a box. All modelers know that there is nothing easier to design or build than a box-type fuselage. So I elected to use this simplest of methods. Actually, the entire helicopter is very simple as is attested by the fact that my good friend John Minassian built and flew his R S within a period of a week.

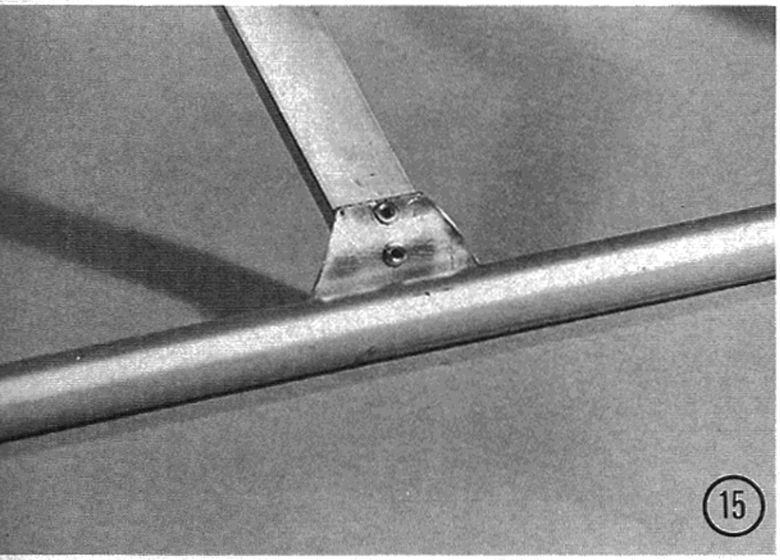
While establishing the basic R S design ideas, I kept constant attention to using easy-to-procure materials. Going back to the aluminum tail boom, a piece of 3/4-inch diameter by .047 wall thickness Reynold's soft aluminum tube was selected. This is readily available at any hardware store and is soft enough to permit bending with an electrician's pipe bender. The 1/4" diameter brass tail rotor drive tube must be in place prior to bending this boom. Thinner wall tubing (.035) is acceptable but must be cut and spliced rather than bent. When slotted at the back end, the 3/4" boom will conveniently hold the Schluter tail rotor gear box. For the Schuco-Hegi or Kalt mechanism, see details on plans. An automobile hose clamp tightens the gear box in place. If the original drive shaft is in poor shape, a piece of large (truck) speedometer flexible drive cable is acceptable if the 1/4" brass tube is bent with a large radius.

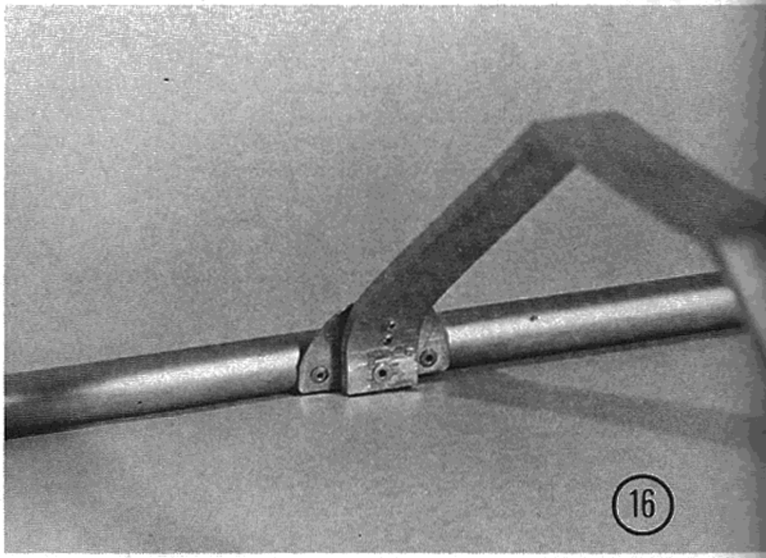
It is of note that a three foot

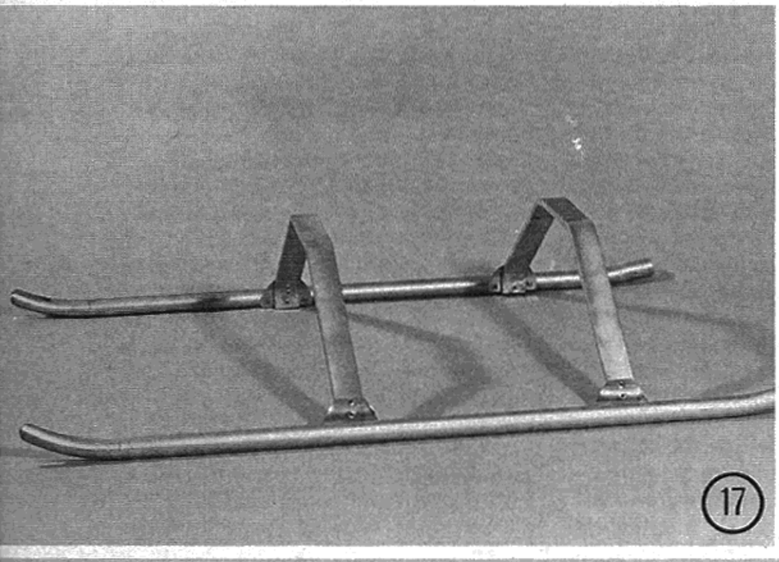
(13) Another view of tail boom and drive shaft assembled into fuselage. (14) New Kraft racing wheels used in slots in front of skids. (15) Aluminum struts and patch plates pop riveted to skids. (16) Another view of skid-strut attach points. (17) The completed landing gear. (18) Alternate gear construction using laminated 1/32" plywood arch struts with wrap-around clamps on to skids.

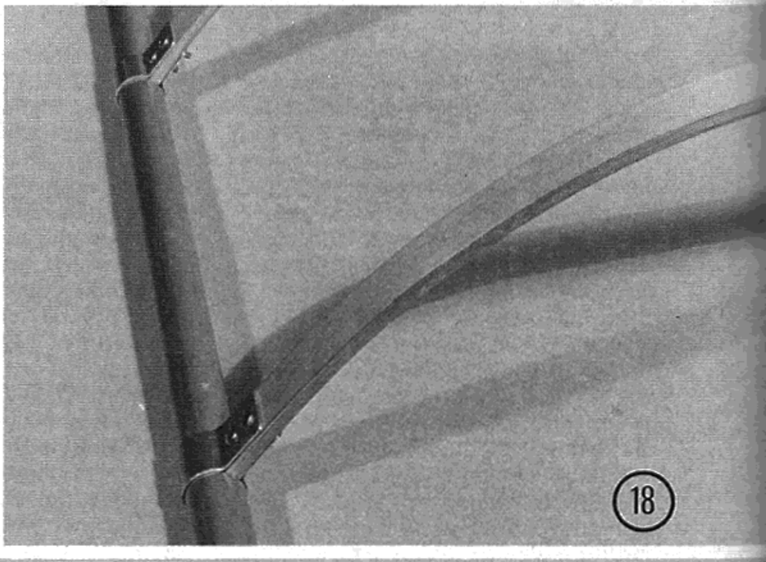




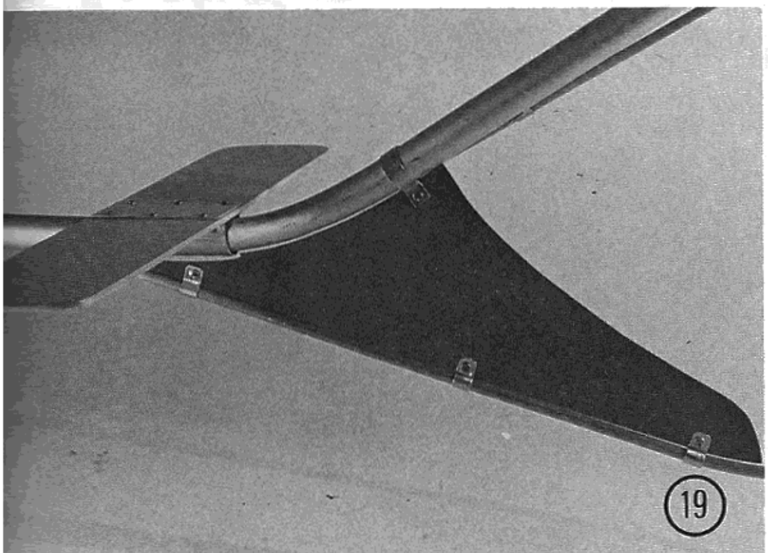


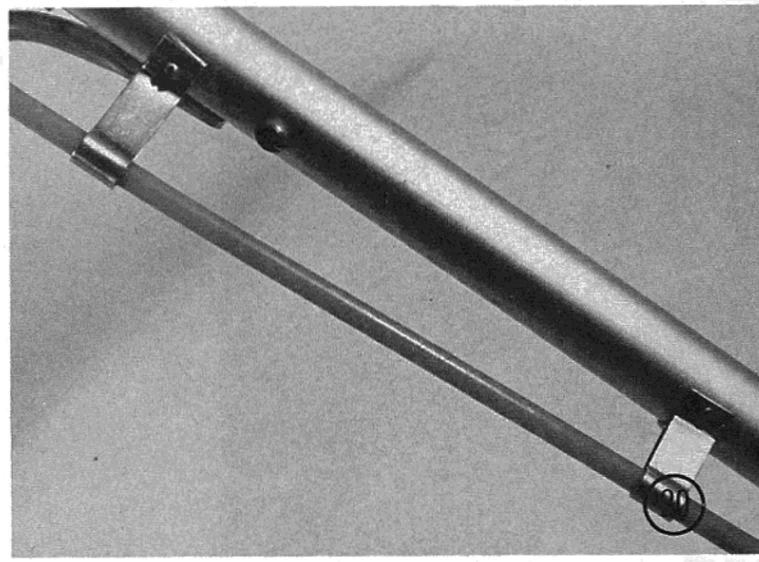


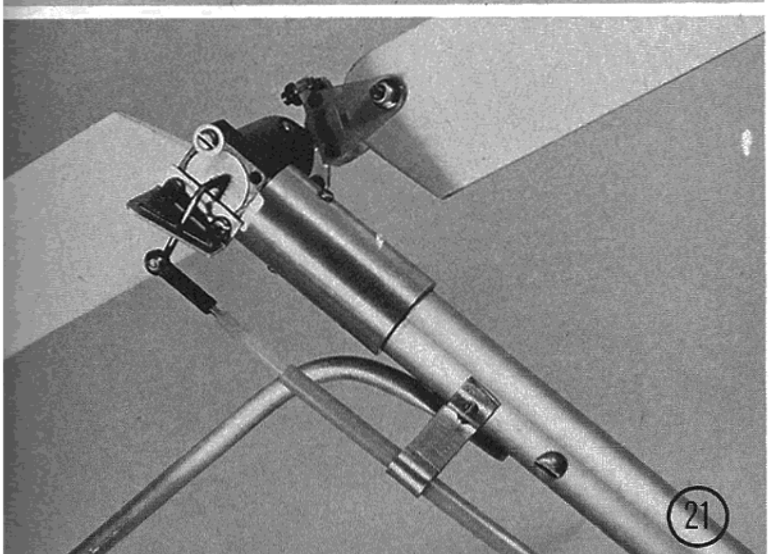


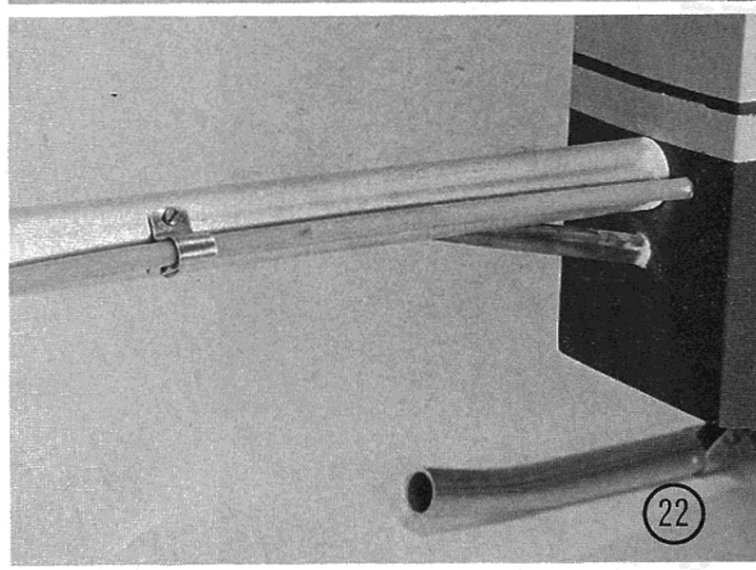


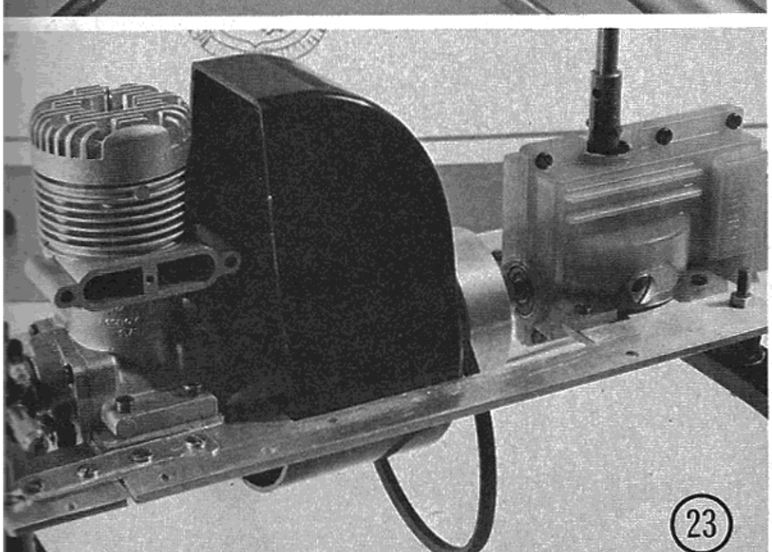
(19) Thin aluminum straps used to attach ply stab and fin. (20) Aluminum posts fabricated to support tail rotor control tube. We used sheet metal screws instead of pop rivets for convenience. (21) Tail rotor installed. We machined the aluminum adapter sleeve for a force fit on boom. A piece of standard tube could have been split lengthwise and used with hose clamp. (22) Boom, drive shaft, and tail rotor control rod as they exit fuselage. (23) Mechanical drive train – Hegi with S.T. .71 - - - ready to be mounted in RS. Short adapter plate behind engine was necessary to adapt gear strut spacing to Hegi mechanics. (24) Tank can be mounted inside, but it is easily visible here. Transmission can be seen through access hole to allow checking of fluid level.

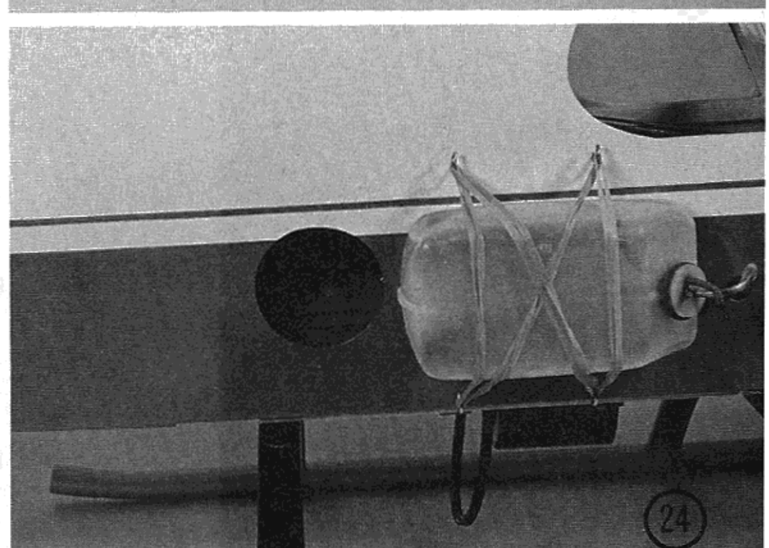




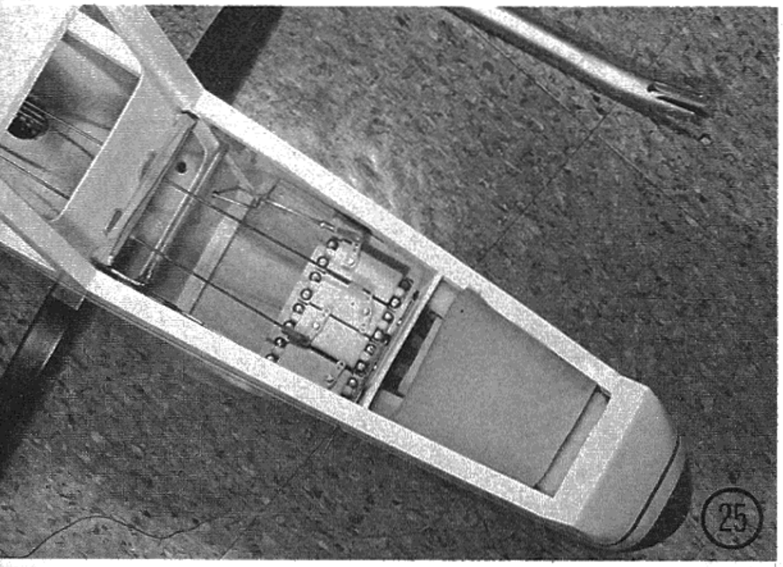


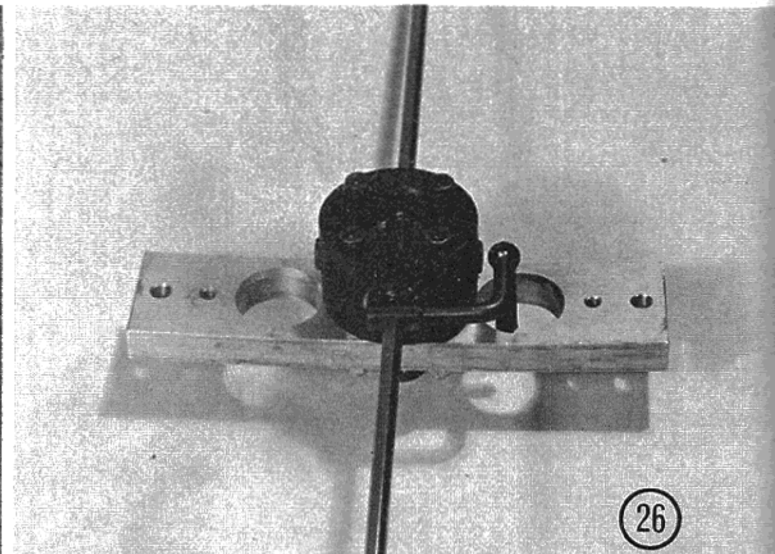


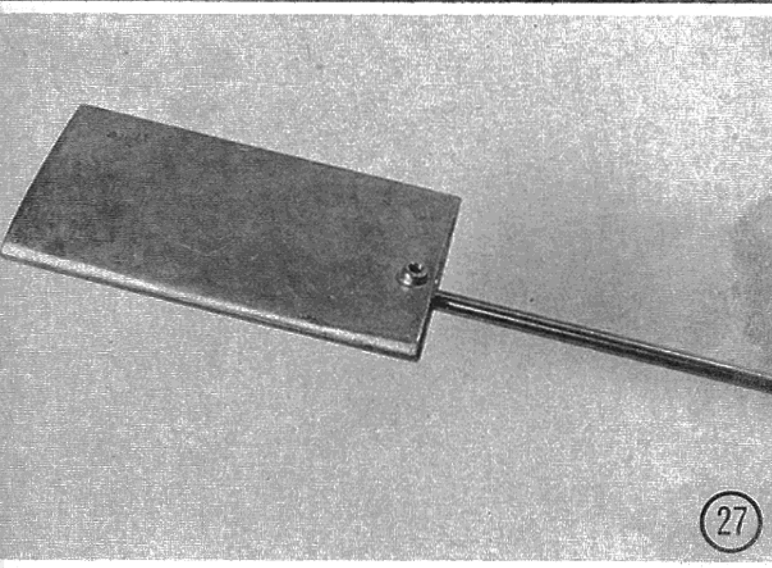


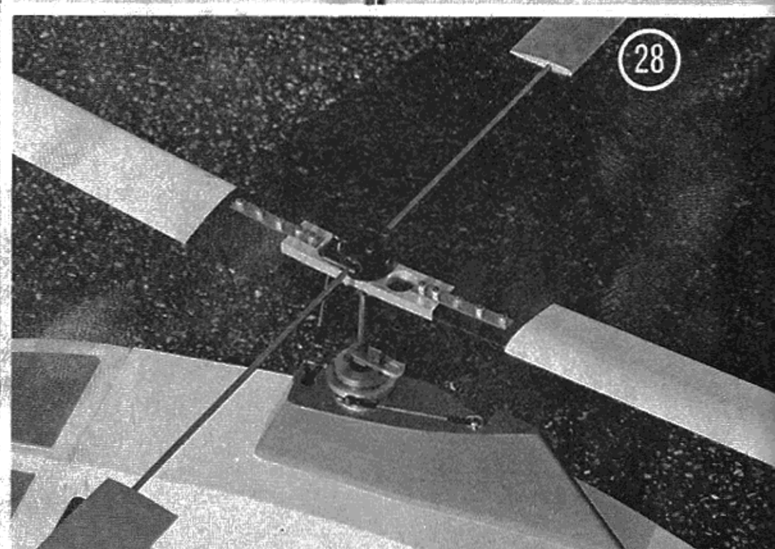


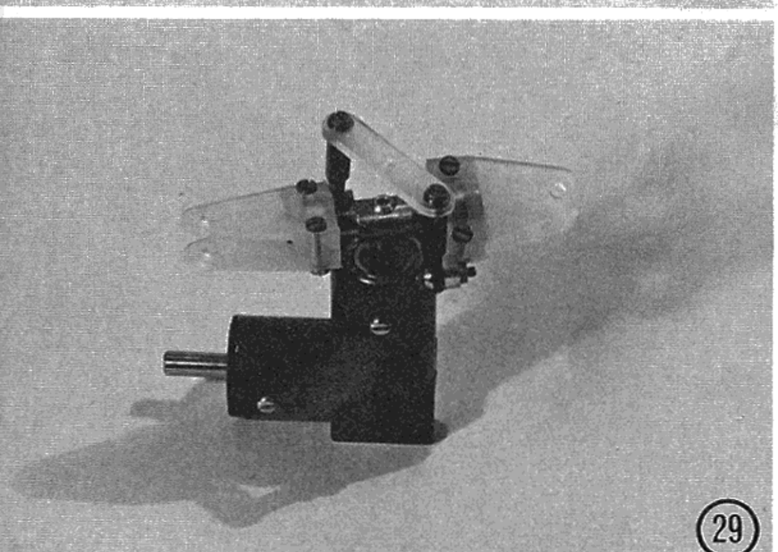
(25) Radio installation. Four World Engines S5A servos fit neatly side-by-side. The two center servos drive bellcranks to cyclic controls. Receiver and battery foam packed in front compartments. (26) View of Schuco-Hegi rotor head assembly. (27) Close-up of Schuco-Hegi paddle bar and flybar installation. (28) Completed head for Runway Sweeper. (29) Schuco-Hegi tail rotor gear box assembly. (30) Completed tail rotor mechanism. Schuco-Hegi components available from Model Helicopters, Tustin, California.

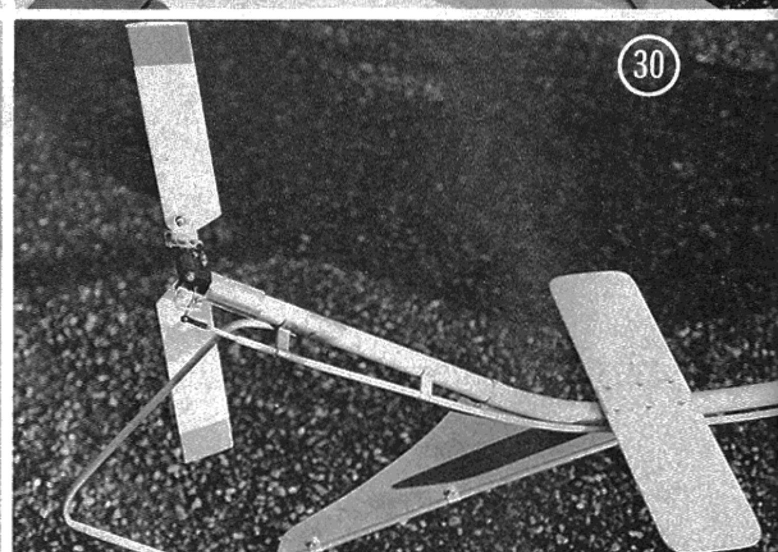












section of 1/4" diameter thin wall brass tubing is required for the tail rotor drive tube. My local hobby shop had three foot sections in stock (distributed by A & L Distributors). A suitable substitute can be made from 3 one foot sections. They should be spliced together using pieces of the next size bigger tubing for reinforcement sleeves at the solder joints.

I selected some 1/4" by .035 aluminum tubing (6061-T6) at the local aluminum shop for a fin frame. It is not difficult to bend, flatten, drill, and pop rivet a piece of this in place as shown. On the subject of pop rivets, a study of the plans will reveal their use at many points. I suggest that any modeler desiring to scratch-build helicopter airframes to buy a pop rivet tool and a generous supply of assorted rivets. They are always handy around the house, too.

The skids and landing gear are made of 6061-T6 aluminum. The only reason for this is that the metal is commonly available and is relatively tough. Unfortunately, the latter characteristic makes the material difficult to form. Therefore, if 5052H34 or some better aluminum is available, I suggest it be used.

The thin wheels shown on the plans probably won't be available unless you have a junk box that dates circa 1947. The thickness of most wheels available today will dictate placement on the outside of the skids instead of placement as shown.

The fuselage box and most of the formers are 1/16" plywood. I bought two 12 by 48 inch pieces at the local hobby shop at a cost of four dollars each. This is pretty cheap considering the cost of balsa these days. There is no splicing. The plywood cuts with a saw and sands beautifully. The round holes were all cut with a cheap hole saw. All joints were made with Devcon epoxy glue, this being one of the few epoxy glues which are compatible with sanding resin. Two external and internal coats of K & B Superpoxy or Francis polyester sanding resin prepares the plywood for finish. Here I used Superpoxy, two coats of primer and one coat of each color. You just can't say enough good things about K & B Superpoxy, particularly if it's put on plywood which provides a rough, mar-resistant base.

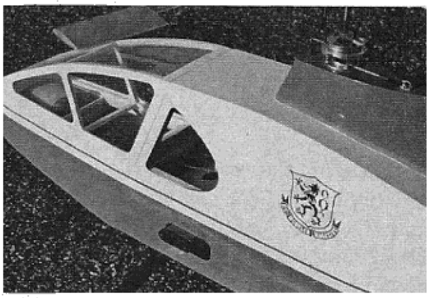
Be sure to keep the weight down as much as possible when building R S or any other helicopter. Through the complete designing and building cycle, one must think about how to save weight. An empty weight of 11¼ to 12¼ pounds is about right for R S.

Building and attaching the main rotor blades is the next item. Forget about buying expensive rotor blade kits. I use a ramin wood leading edge and pre-shaped balsa wood trailing edge. Ramin wood is a beautiful clear grain wood available at most cabinet shops. For five dollars you should be able to get enough for eight or ten sets of blades. Included in the price will be the cost of cutting the ramin to your rectangular cross-section specifications which should be the same as those originally used with the mechanism. The ramin can then be easily contoured to airfoil shape with a block plane provided a few holding strips are first nailed near the edge of your workbench to hold the wood while planing. I use 5-Minute Devcon Epoxy to glue the leading and trailing edges together. Final shaping and sanding can then be accomplished. A good grade of shelf paper makes an excellent cover. No other finishing is required.

Some of us have found that if the main rotor blade chord is reduced slightly from that originally called out, the machine may fly better. The main reason for this is that the rotor must turn faster to develop the same lift. This permits the engine to turn higher rpm's where greater horsepower (i.e. faster rotor acceleration) can be obtained by going to full throttle. The best thing to do is try different size blades to find the best size.

With regard to blade attachment, I firmly recommend using a single bolt attachment on R S or any other "chopper." Instead of bolting the blade straps to the teeter-totter plate with two #4 bolts, use one #10 hex head bolt and lock nut. This permits the blade to pivot rather than breaking in a crash or roll-over. Believe me, this attachment method saves rotor blades and a lot of frustration.

Before installing my mechanism in the R S, I replaced the cloth/rubber starting V-belt with a glass reinforced plastic belt. These wear forever and



RCM'S prototype RS uses Du-Bro muffler.

I've never broken one. They are obtainable at the local vacuum cleaner repair shop. I suggest a Japanese Bando No. 412 or similar belt. Never use a starter with a plastic pulley. It will wear and result in belt grabbing.

The main power package installation in R S is quite simple; it must be quite simple in any helicopter. (Future repeated removal may become necessary.) Eight 4-40 screws hold it in place. Most of the fuselage bottom is open to facilitate installation and maintenance. Be sure that the main power package can be rapidly connected and disconnected from the throttle servo, fuel tank, and both drive shafts. Note that one access hole is positioned so that the transmission-to-main rotor shaft bolt is accessible for disassembly. Also, external access to add oil to the transmission is possible through the same hole. There is nothing more exasperating than having to pull a whole power package just to check or add transmission oil!

Be sure to get some Zip Grip or similar adhesive. Put this on all nuts, bolts, and set screws in the mechanism. This is a marvelous material which has prevented many crashes by keeping all the parts tight.

Flatten the servo paddle shaft where the control arm screw seats. This is the most critical control attachment on the machine. Also, replace all foreign ball clevis plastic parts with Rocket City "Missing Link" plastics.

Author's RS with home-built collective pitch head.

The American-made plastic fitting is superior in design and more secure in flight.

Both John Minassian's and my R S used external fuel tanks installed near the Center of Gravity. I am not proud of the appearance and have since moved the tank inside. Regardless of where the tank is installed, I suggest some method of visually sighting fuel level. Most flyers also add a timer on their transmitter to warn them of low fuel level.

The original R S control installation had a large number of control rods in the cabin. These were primarily to control a home-made collective pitch rotor head. That home-made device was full of problems which ultimately caused me to remove it and all the extra control rods. My only comment here is for those who insist on having collective pitch to reassess their position with complexity, crash damage, and adjustment in mind.

Model helicopters should balance just ahead of the main rotor mast. Each helicopter is slightly different depending on horizontal stabilizer size and other factors. About 3/8" forward of the mast was correct for R S. This results in zero fore-and-aft swash plate trim while hovering because it offsets the rotor downwash effect on the stabilizer.

I suggest using K & B 500 fuel in R S. The fuel provides good power, burns cleanly, and its residue is easy to remove. If, when starting and test spinning R S, there is any hint of improper engine performance, don't fly. I found that if I, for instance, ignore the signs of a bad glow plug, I am asking for a crash. The glow plug is an insipient problem in the power system which loves to produce cold running engines and power failures during descent when the throttle is back.

The R S should weigh about 12½ to 13 pounds with its fuel tank full. If the machine acts underpowered and won't lift off in dead calm air at this weight, look for friction in the tail rotor drive or mis-adjusted main rotor blade pitch. Also check for clutch slip by putting belt grip liquid in the clutch.

John Minassian's RS makes a low speed pass around the camera.

This article is not the proper place to diverge deeply into flying techniques. But for the beginner who does not know the fundamentals of helicopter flying, I can suggest only two basic things when training with R S. First, use an even wider landing gear than shown on the plans. Also, don't translate until hovering is completely mastered. As far as hover training is concerned, I find tethers of little value. I never was able to learn to hover on tethers because they unduly interferred with or upset the machine. The best day to practice is when there is a 5-10 mph wind. This helps stabilize the machine and hovering is much easier than in calm air.

If the R S tail rotor pitch is adjusted for hovering trim, the machine will try to yaw right in forward flight. This is due to "unloading" of the main rotor which requires less torque to sustain rpm's. Bending the lower fin to give left yaw in forward flight will greatly help to circumvent this characteristic. Some designers build this feature into their helicopters, others just apply yaw correction. Adequate tail rotor pitch control will also help fight this problem if manual control compensation is preferred.

If the modeler has used one of the rigid Cardon-type rotor heads, such as come in the Schuco-Hegi kit, the R S will tend to roll right in forward flight. This is due to the advancing blade having more lift than the retreating blade. The only way to avoid this is to modify the head to provide teeter-totter flapping. If the modeler is a beginner, the rotor head should not be modified until he can hover with the rigid-type head.

But enough! Whether you are a mere mortal or one who has mastered these "infuriated palm trees," go forth! Build an R S or create your own design.

But above all, put real modeling into this specialty area of our hobby!

From RCModeler June 1974